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SEDIMENTATION IN MICROTIDAL COASTAL LAGOONS, SOUTHERN RHODE ISLAND

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INTRODUCTION

The Charlestown barrier spit-lagoon complex is centrally located on the southern Rhode Island coast (Fig. 1). The barrier spit is 6 km long E-W, varies in width from 200 to 400 meters, and serves to separate the back-barrier lagoon from Block Island Sound to the south. This coastline is classified as a mixed energy, wave-dominated coast after Hayes (1980) (Fig. 2). Local relative sea-level rise is proceeding at a rate of 30 cm per 100 years (Hicks, 1974).

The barrier spit includes a narrow beach, a low dune ridge, vegetated back-barrier flats, and a stabilized inlet (Fig. 3). Subenvironments within the back-barrier lagoon (Fig. 4) include washover lobes to the west of the inlet, flood-tidal delta deposits north of the inlet, a low-energy lagoonal basin, and erosional terraces along the near margins of the lagoon.

STOP 1. Charlestown Breachway and Flood-Tidal Delta

Two stone jetties have been used to stabilize the Charlestown Breachway. Construction was begun in 1952 and completed in 1954 (Lee, 1980). The breachway is oriented N-S, is 33 meters wide, and 1.6 meters deep. Spring tide range (16 August 1979) within the breach is 80 cm, the maximum surface flow velocity was 170 cm sec^{-1}. Flow through the breach is flood dominant. The inlet throat widens at the termination of the jetties and a small flood-tidal delta is present in the main channel.

The main channel bifurcates around Wards Island with the greatest volume of water proceeding north over the west lobe of the flood-tidal delta (Fig. 5).

Four vibracores were taken along a transect through this area (Fig. 4). Three cores were taken from the east lobe and one in the lagoon to the north. A cross-section constructed from core logs (Fig. 6) shows glaciofluvial deposits overlain by fresh-water wetland peat succeeded by a marine lagoon sequence. The lagoon sequence begins with erosional terrace/beach deposits followed by low-energy lagoon organic silt. Distribution of these deposits is controlled by the underlying Pleistocene topography and they are not always present in all cores. Flood-tidal sands are deposited over the finer grained basin sediments.

A sedimentation rate of 6.9 ± 1.4 cm yr^{-1} has been established for the flood-tidal area through the use of Pb-210 dating (Fig. 7). See Figure 4 for sampling location.

From 1951-1980 the flood-tidal delta grew by 141683 m^3 (Fig. 8). Sixty-one percent (87091 m^3) of this accretion occurred between 1951 and 1963, twenty-eight percent (39500 m^3) occurred between 1963 and 1972, while only eleven percent

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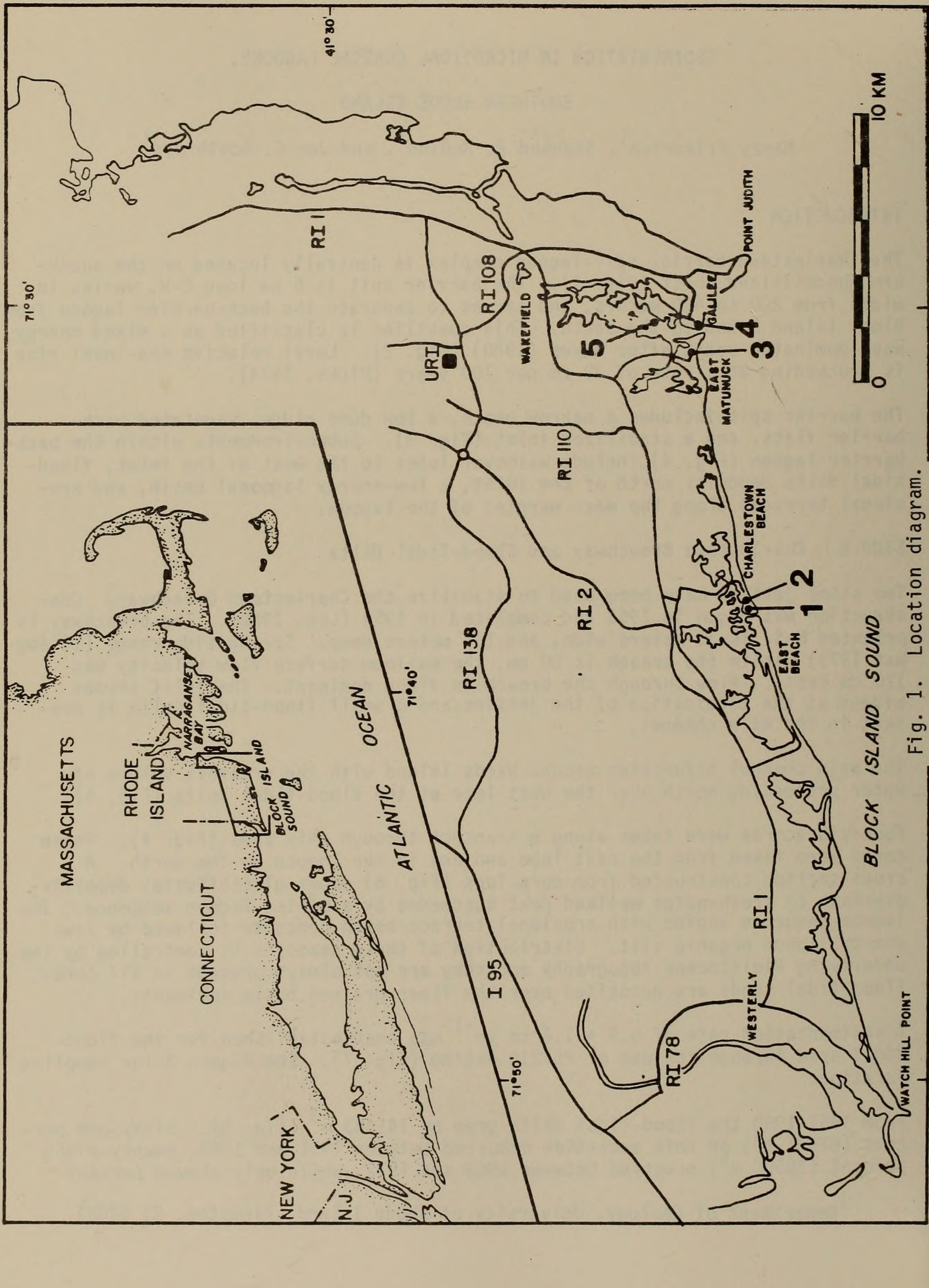

Fig. 1. Location diagram.

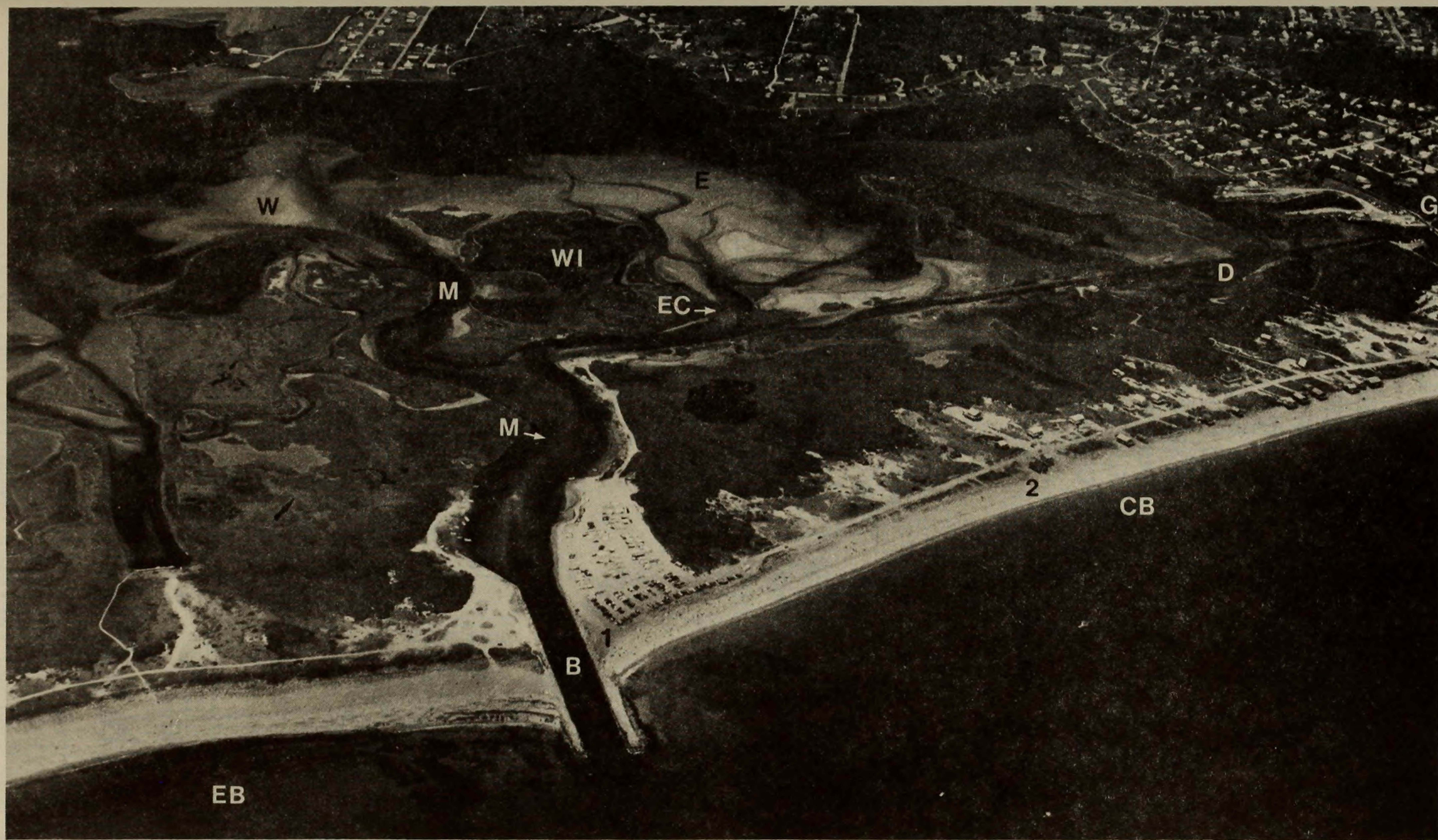

Fig. 2. The Ninigret Pond flood-tidal delta and adjacent barrier spits. B - Charlestown Breachway, CB - Charlestown Beach, D - dredge channel, E - East Lobe of flood-tidal delta, EB - East Beach, EC - East Main Channel, G - Green Hill Bridge, M - Main Channel, W - West Lobe of flood-tidal delta, WI- Wards Island, 1 - Stop 1, 2 - Stop 2, site of the CHA-EZ profile. The low-energy basins of the lagoon are in the top of the photo. This photo is a low oblique looking north, taken on 28 June 1981.

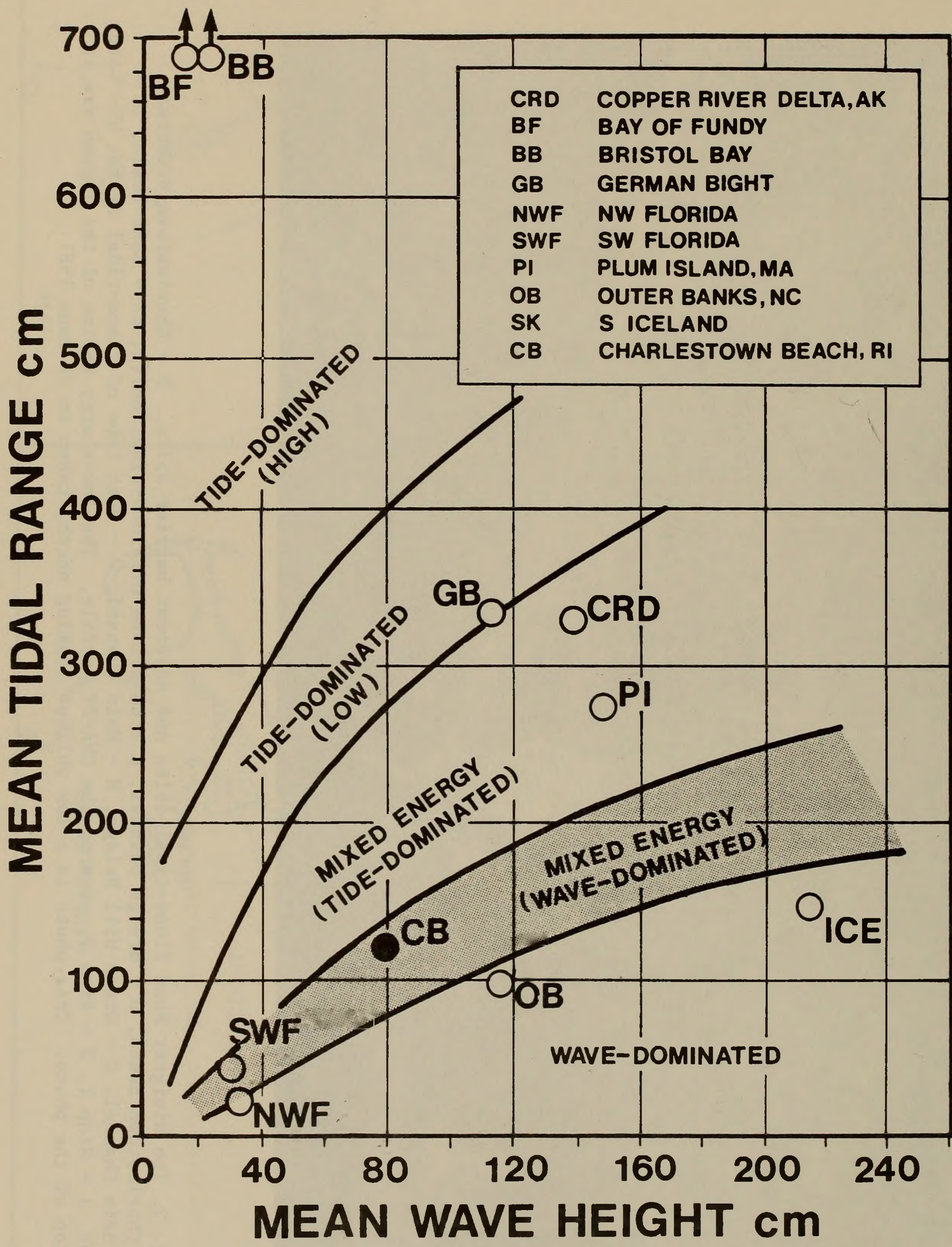

Fig. 3. A plot of wave height versus tidal range. The Rhode Island coastline is indicated by the filled circle and is labelled CB. From Hayes (1979), Charlestown wave data from Swanson (written communication, 1980).

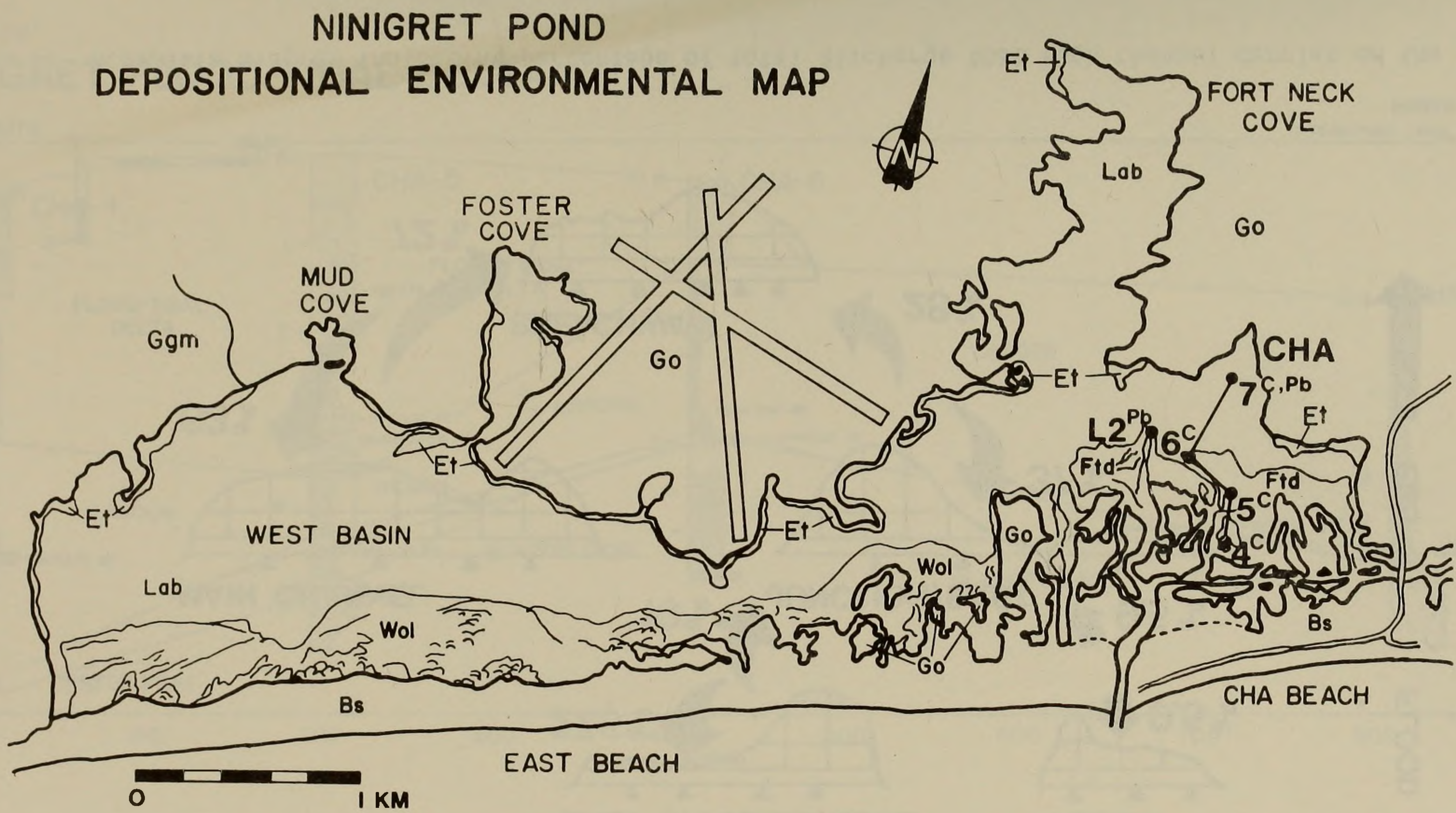

Fig. 4. Simplified depositional environmental map with vibracore and radiometric dating locations. Large letters (CHA) designate core transect, numbers along the transect identify core locations. Small letters (C, Pb) indicate C-14 or Pb-210 dating sites. The geologic units are Bs - barrier spit, Ftd - flood-tidal delta, Wol - washover lobe, Lab - lagoon basin, Et - erosional terrace, Go - glacial outwash, and Ggm - glacial ground moraine.

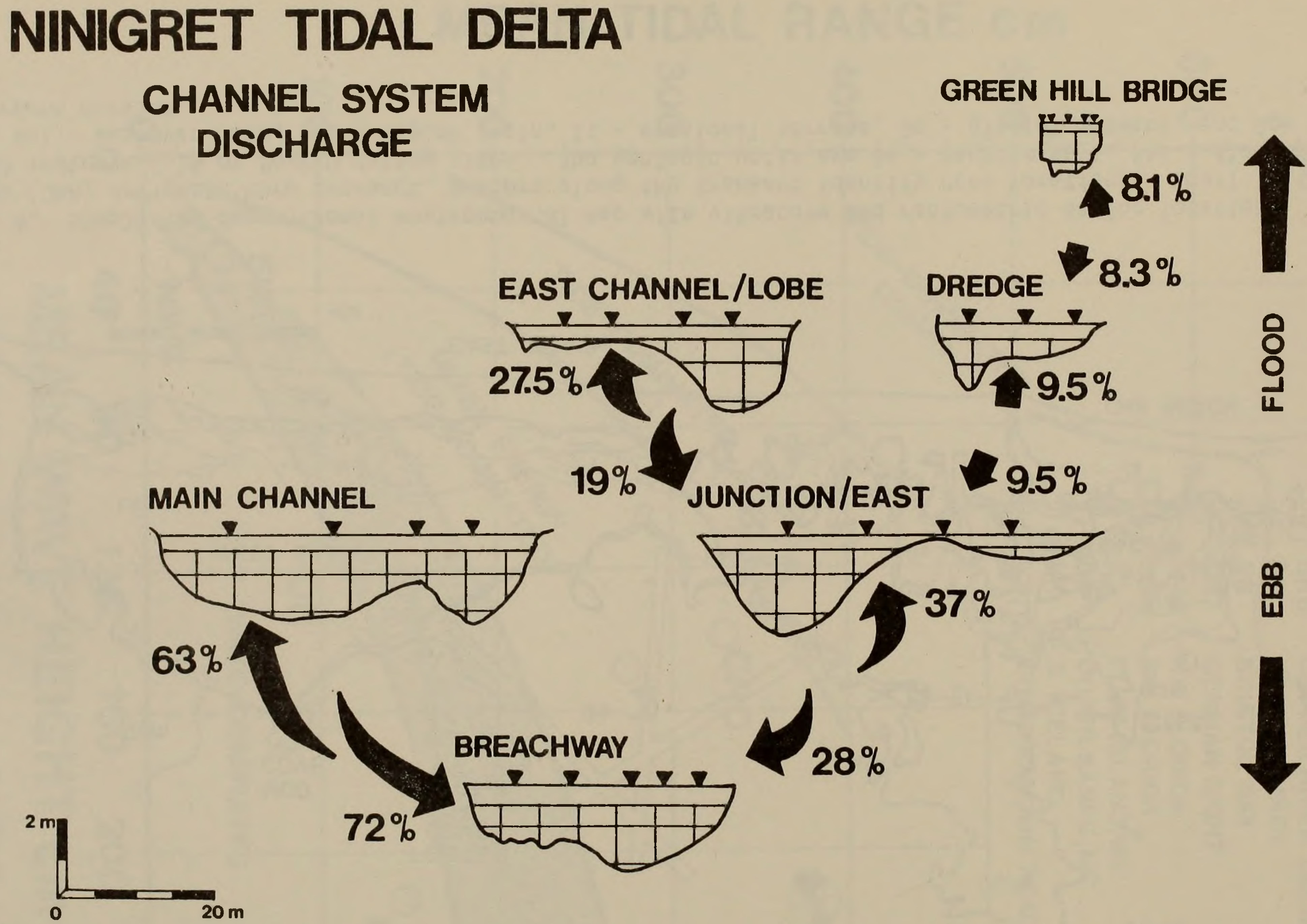

Fig. 5. Schematic diagram indicating percentage of total discharge that each channel carries on the flood and ebb.

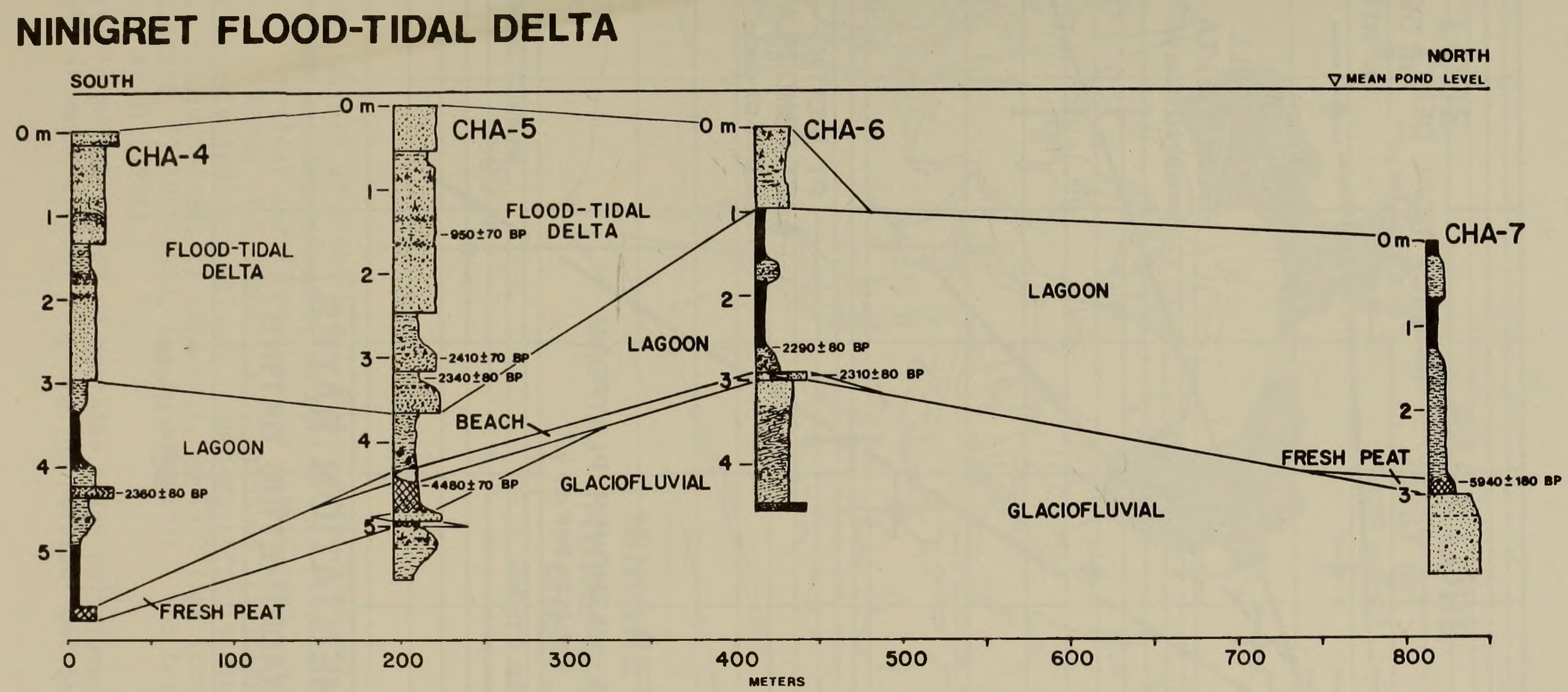

Fig. 6. Flood-tidal delta transect, Ninigret Pond. See Figure 3 for locations. Grain size is shown by width of log, narrow for silt to wide for gravel; internal stratification, shells, and roots also shown. Ages were obtained from C-14 dating of shells, peat and wood.

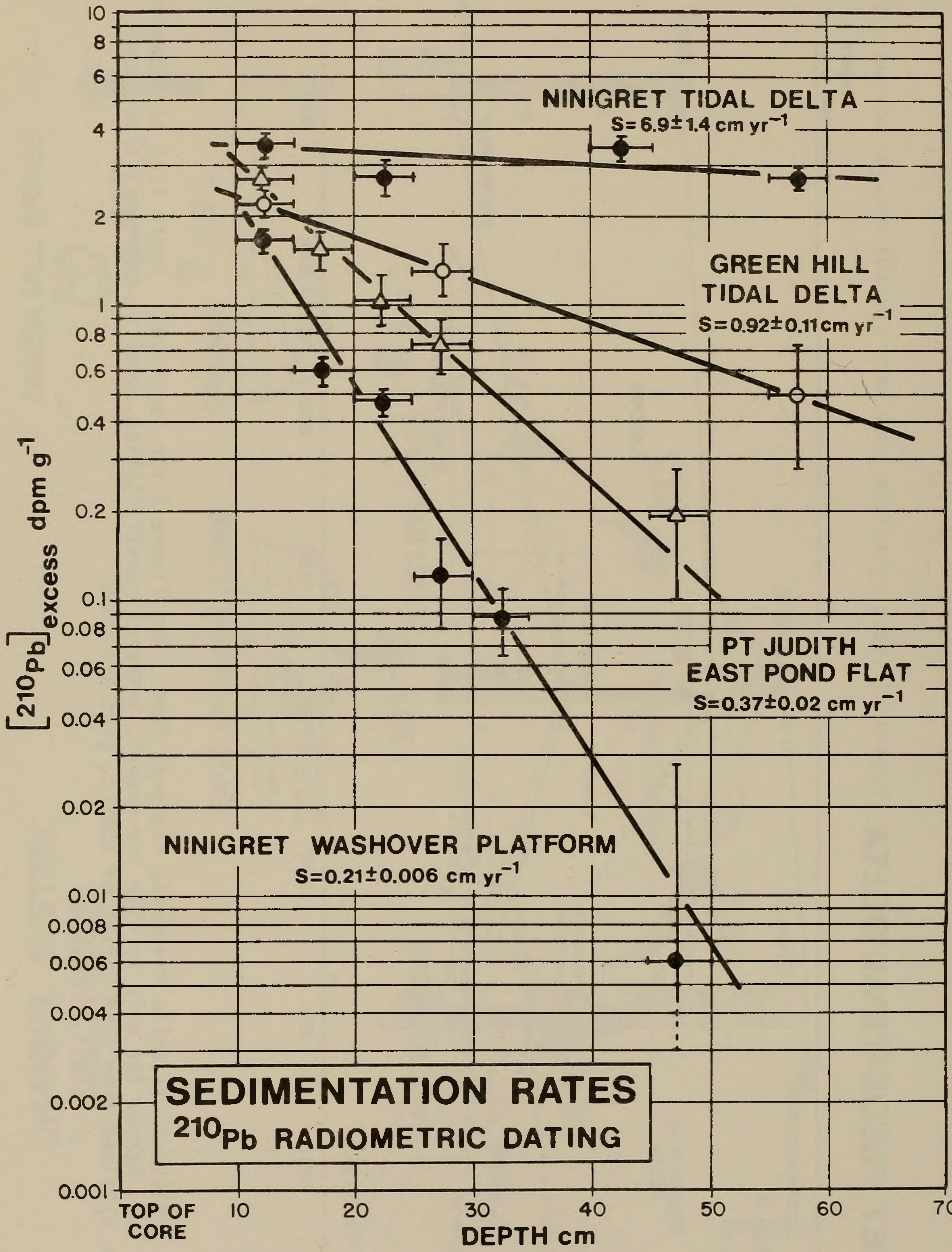

Fig. 7. Sediment accumulation rates obtained by Pb-210 dating of organic material in cores. Sampling location for Ninigret Pond is shown in Figure 3 ($L2^p$).

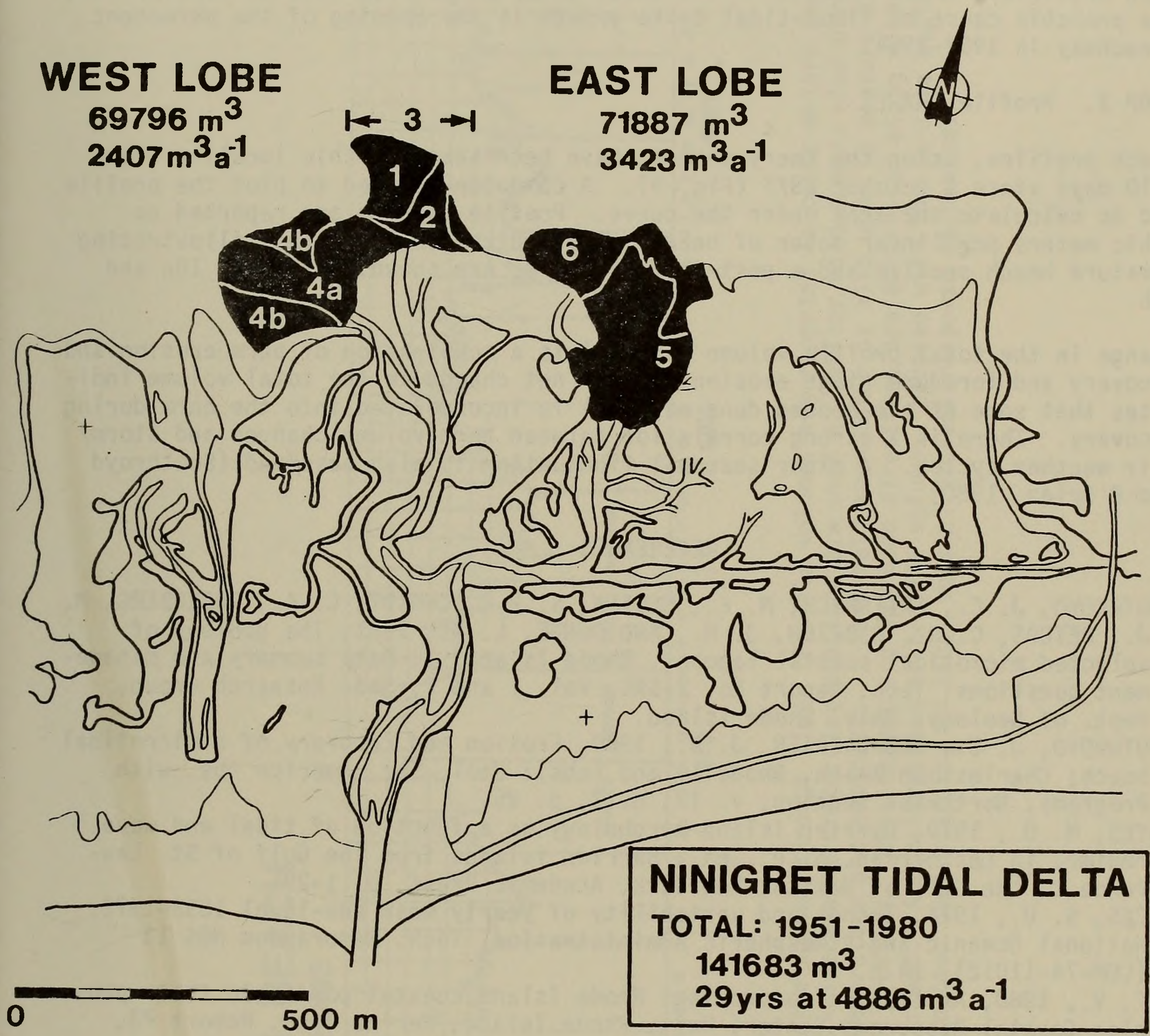

Fig. 8. Growth of flood-tidal delta lobes, Ninigret Pond. Areal change through time was determined by measuring intertidal and subtidal flats on sequential vertical aerial photographs (1951, 1963, 1972, 1975, 1980). A sediment thickness of 1.0 and 1.3 m, based on stratigraphy in vibracores, was used to compute sediment volumes. Numbers refer to times of accretion as follows: 1) 1975-1980, 2) 1972-1975, 3) 1972-1980 (composite), 4a) 1951-1963, 4b) 1963-1972, 5) 1951-1963, and 6) 1963-1972. See text for volumes. From Boothroyd et al (1981).

(15093 m^3) occurred between 1972 and 1980. Examination of aerial photographs show negligible areal changes in the flood-tidal delta from 1938 to 1951 so that the probable cause of flood-tidal delta growth is the opening of the permanent breachway in 1952-1954.

STOP 2. Profile CHA-EZ

Beach profiles, using the Emery method, have been taken at this locality every 1-10 days since 1 October 1977 (Fig. 9). A computer is used to plot the profile and to calculate the area under the curve. Profile volumes are reported as cubic meters per linear meter of beach. Two contrasting profiles, illustrating a mature beach profile and a post-storm profile, are shown in Figures 10a and 10b.

Change in the total profile volume (Fig. 9) is a combination of berm erosion and recovery and foredune ridge erosion. Small net change in the total volume indicates that some of the eroded dune material is incorporated into the berm during recovery. There is a strong correlation between berm volume changes and storm/fair weather cycles. A minor seasonal fluctuation is also observed (Boothroyd and O'Brien, 1980).

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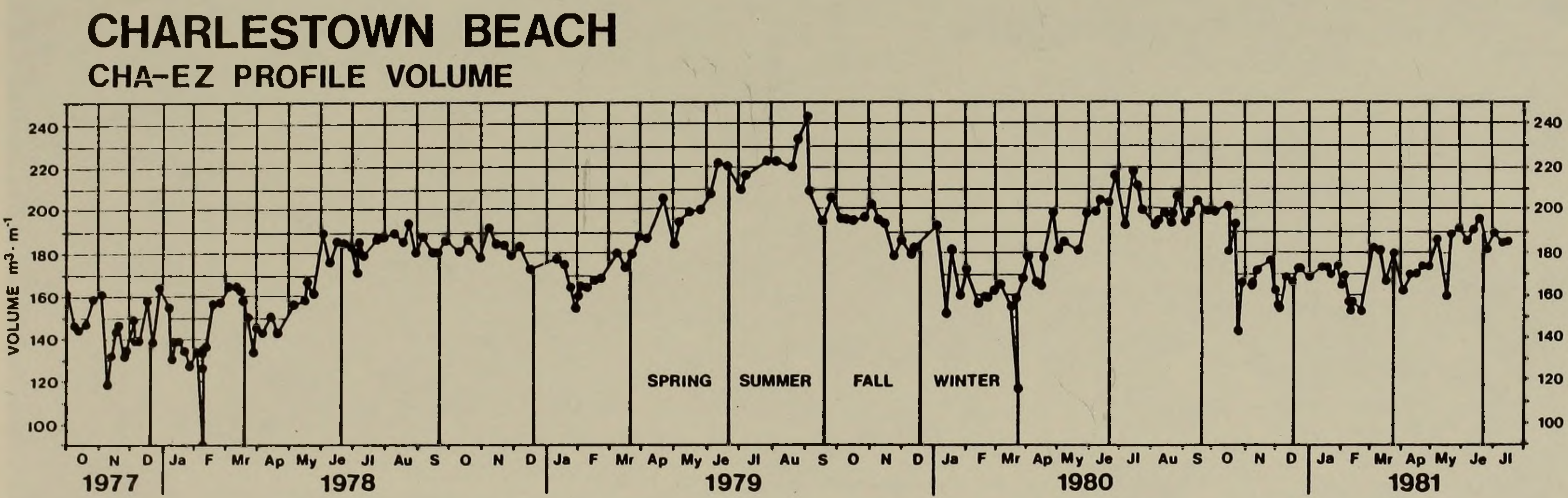

Fig. 9. Plot of CHA-EZ profile volume through time. Profile volumes are reported as cubic meters per linear meter of beach. Two on-site weather recording stations are used to monitor wind speed, wind direction, barometric pressure, temperature and humidity. A hand held anemometer is also used to measure wind velocities on the beach during profiles. Wave height and approach directions are determined along with longshore drift direction and speed. A consideration of profile volumes, coupled with the on-site weather and wave data, will lead to a better understanding of local coastal process-response mechanisms.

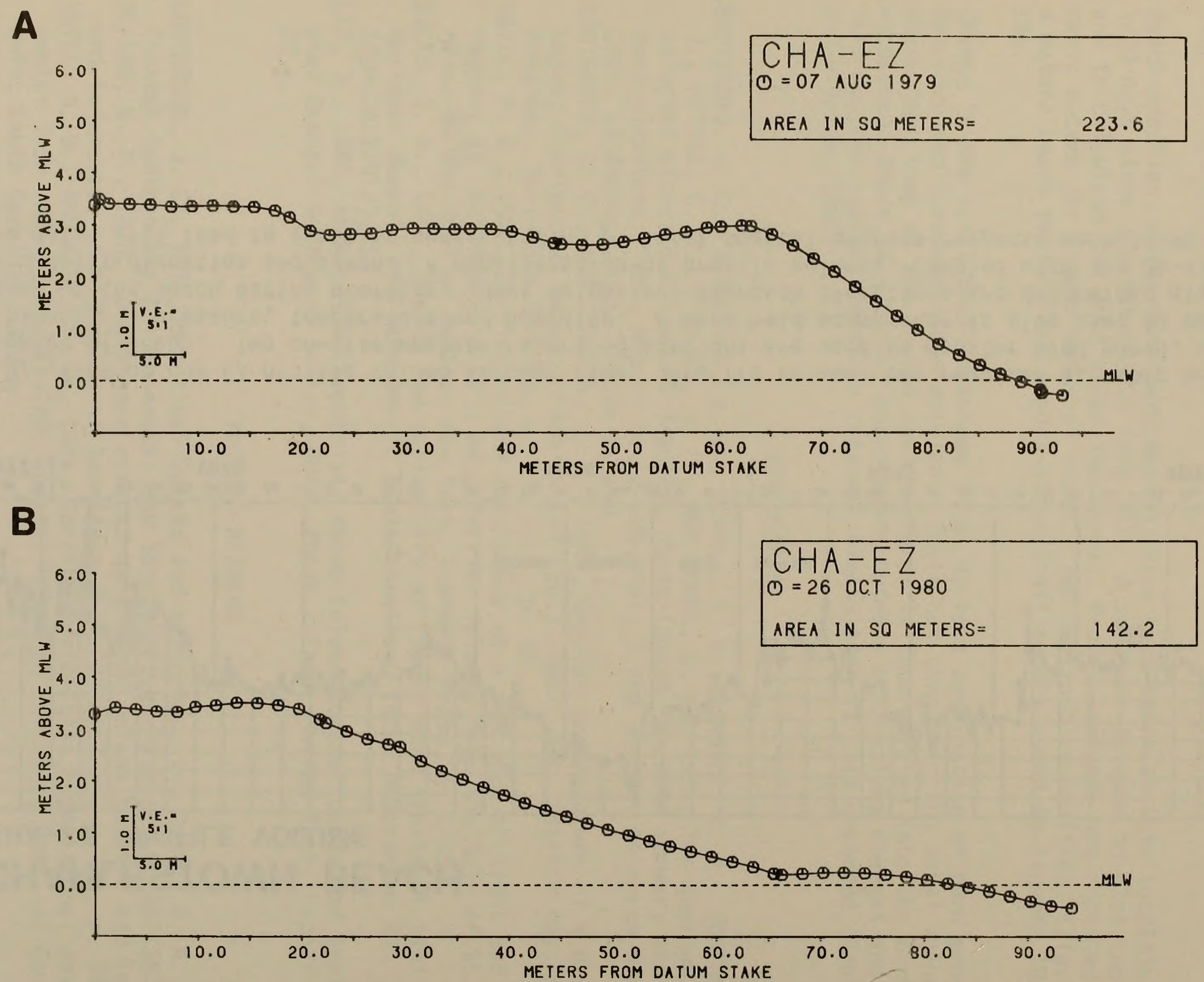

Fig. 10. Computer plotted profiles for the CHA-EZ location. A) Mature profile - exhibits a large berm, steeply sloping beach face, gently landward dipping berm top, and a poorly-to-well-developed seaward dipping face landward of the berm top. B) Post-storm profile - a flat beach with a pronounced intertidal to subtidal bulge of sand. The swash bar is quickly returned to rebuild the berm and recovery is rapid.

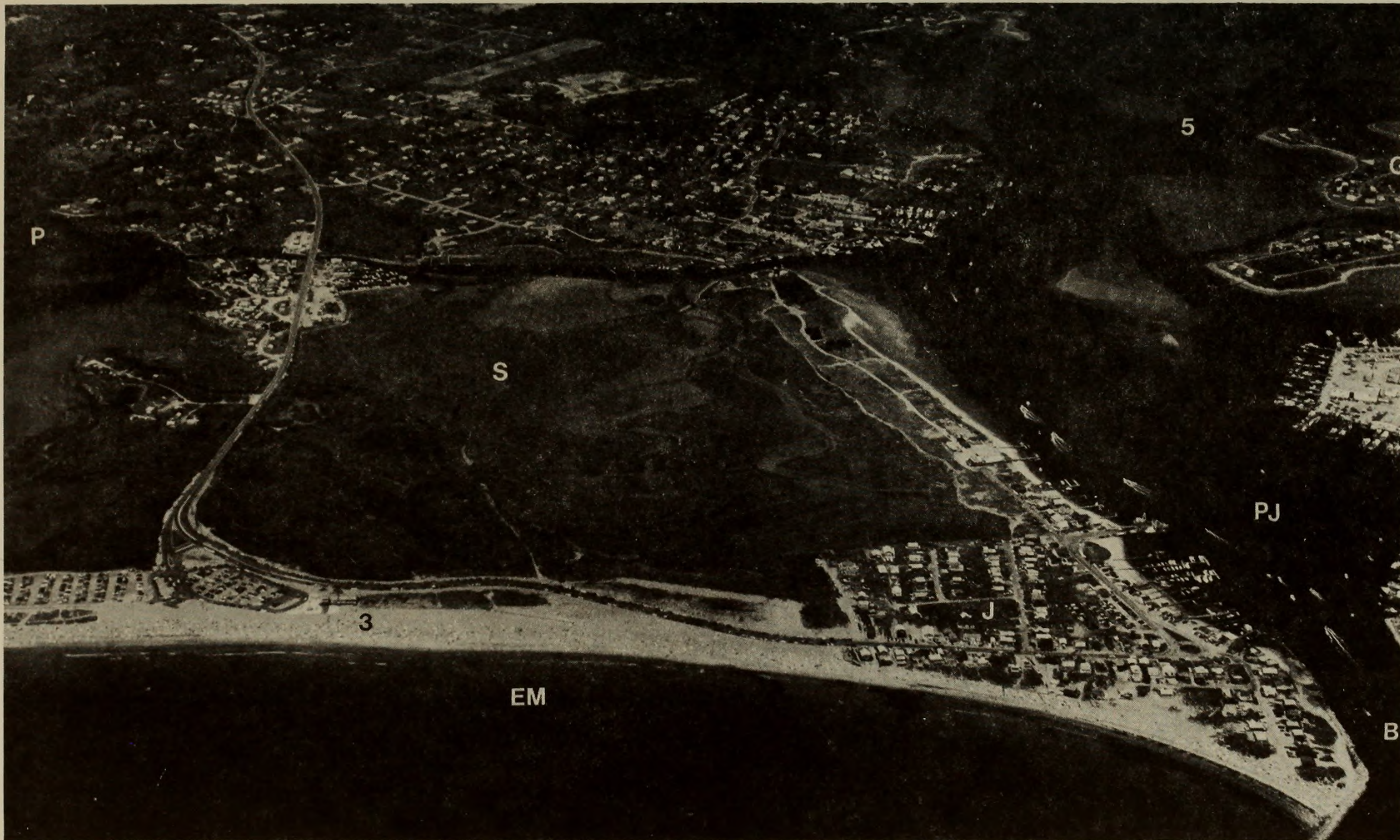

Fig. 11. Lower Point Judith Pond and Succotash Marsh. B - Point Judith Breachway, EM - East Matunuck State Beach, G - Great Island, J - Jerusalem, P - Potter Pond, PJ - Point Judith Pond, S - Succotash Marsh, 3 - Stop 3, 5 - Stop 5, an intertidal flat. The docks of Galilee can be seen in the right of the photo (Stop 4). This photo is a low oblique looking north, taken on 28 June 1981.

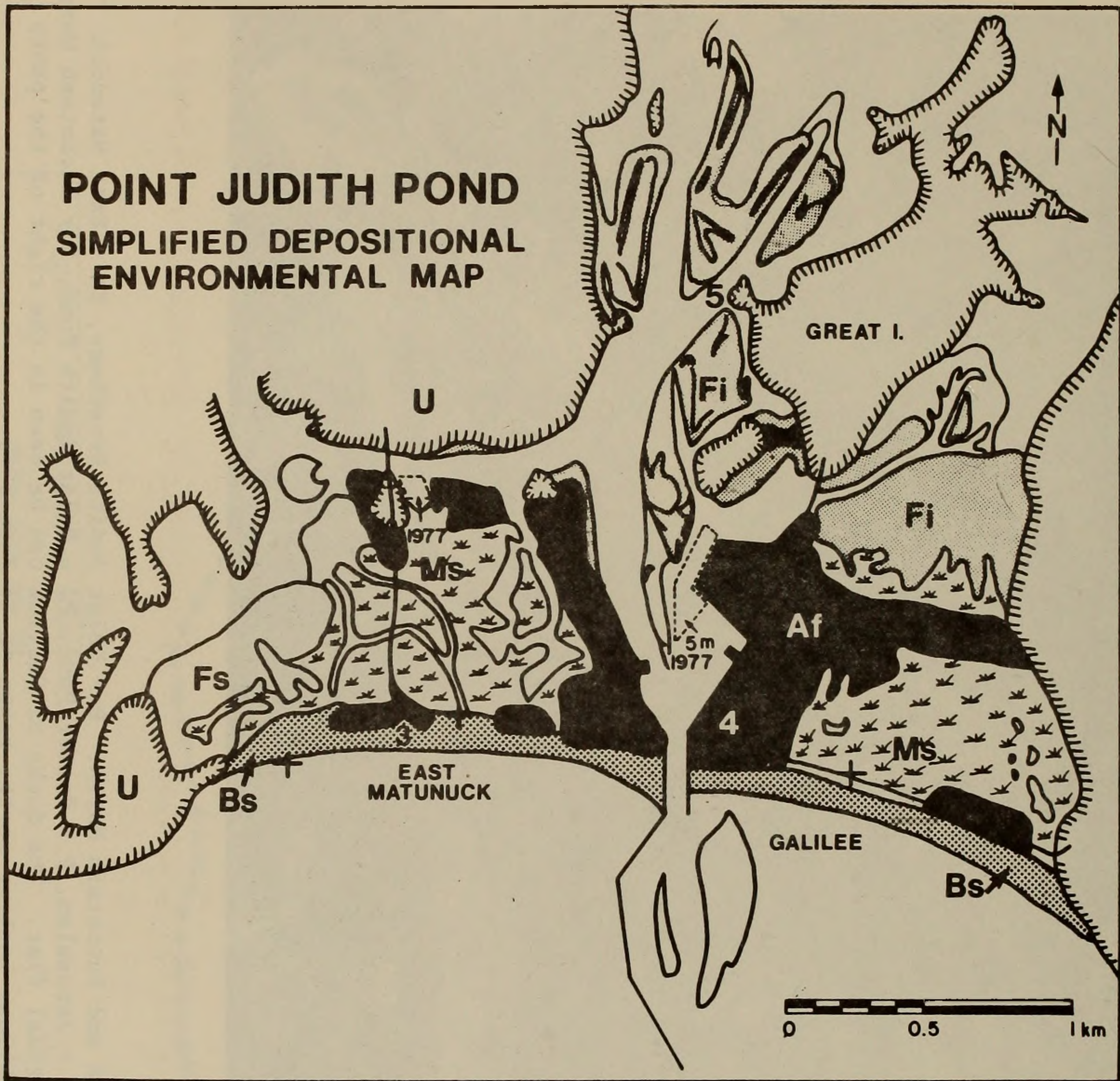

Fig. 12. Lower Point Judith Pond and Succotash Marsh, simplified depositional-environmental map. Numbers refer to stop locations. Geologic units: Af - artificial fill, Bs - barrier spit, Ms - marsh, U - glacial upland, Fi - intertidal flats, Fs - subtidal flats.

Itinerary

The field trip will leave from the Keaney parking lot beside the athletic fields, University of Rhode Island. It involves walking in water, wet sand and mud. A small boat will be used to gain access to two stops. Wear hip waders, sneakers, or tennis shoes. Do not wear field or hiking boots.

Distance (In Miles)		Route and Stops
Pt. to Pt.	Total	
0	0	Leave Keaney parking lot, turn right (west) on RI 138.
0.6	0.6	Intersection of RI 110 at lights. Turn left (south) on RI 110. This route is also called Ministerial Road.
3.8	4.4	Tuckertown Four Corners, intersection of Wordens Pond Road on the right (west), and Tuckertown Road on the left (east), located on ice-contact deposits just north of the Charlestown end moraine. Proceed south through the intersection and up onto the moraine.
0.7	5.1	Backside (ice-contact slope) of Charlestown moraine.
1.3	6.4	Intersection with Old Post Road, and beginning of proximal outwash plain. Proceed south to US 1.
0.2	6.6	US 1, go west past exits to Moonstone and Green Hill beaches. Charlestown moraine on the right.
1.2	7.8	Charlestown Beach exit; Exit from left lane onto US 1, north.
0.3	8.1	Exit right at Charlestown Beach breachway sign. Proceed 100 yds. to stop sign (intersection with US 1A); continue straight through stop sign. Pass over proximal outwash plain (former potato farm).
0.5	8.6	Turn left at stop sign onto Schoolhouse Rd; follow Beach/Breachway signs.
0.1	8.7	Turn right onto Charlestown Beach Rd. Proceed south on the outwash plain; across a small till upland, and down to the lagoon.
1.3	10.0	Green Hill Pond bridge; Charlestown Pond with dredged channel to the right; Green Hill Pond

		to the left (small island with house is a till upland). Beyond the pond is Green Hill, a drumlin.
		Bear left off bridge onto back barrier. Proceed 200 yds.
0.2	10.2	Bear right to travel west along the back barrier. Example of a developed barrier spit, most houses built since 1970.
0.5	10.7	Location of CHA-EZ profile.
0.1	10.8	Two houses formerly on left lost in 1977-78; area of active overwash.
0.1	10.9	Charlestown Breachway (State Camping Area), gravel parking lot.
		STOP 1. This will be a long stop to view the breachway jetties constructed in 1952, and then walk north (lagoonward on flood-tidal delta deposits. 200 m north is a straight, manmade channel dredged in 1962 to Green Hill Pond. Embark in boats for a short cruise to the tidal-delta flats. Note the channel point bars, channel-margin flats, flood ramp, and high marsh.
		Leave breachway parking lot, heading east along back barrier.
0.2	11.1	Location of CHA-EZ beach profile.
		STOP 2. The beach profile has been run at 1-10 day intervals since Oct, 1977. Severe erosion occurred during 1977-78; no dune recession has been recorded since Feb. 1978 (as of early Aug. 1981). The houses are on piling with floor joints set at the 1938 hurricane storm-surge still water level.
0.7	11.8	Return east along back barrier to the Green Hill Pond bridge. Proceed north.
1.3	13.1	Intersection Charlestown Beach Rd. and Schoolhouse Rd. Turn left at Stop sign onto Schoolhouse Rd.
		Proceed 200 yds.; turn right, heading north.
0.5	13.6	Stop sign; intersection with US 1A. Continue straight.
0.1	13.7	Bear right onto US 1 (north). Drive east and north along the front slope of the Charlestown moraine, past exits for Moonstone and Matunuck beaches.

		Proceed up onto the moraine with a view of Potter Pond on the right.
5.1	18.8	Exit right off US 1 north at the Jerusalem, Snug Harbor, East Matunuck State Beach sign. Proceed south on Succotash Rd.
0.6	19.4	Bear right at fork.
0.7	21.1	Potter Pond bridge: Succotash Marsh on left; Potter Pond right; houses built on glacial upland and areas of dredge spoil.
0.6	21.7	Bear right into East Matunuck State Beach parking lot.
		<u>STOP 3.</u> The State Beach pavilion sits astride the location of the 1897 tidal inlet. We will walk west to the gravel washover fans on the spit fronting Potter Pond; then east onto Succotash Marsh, a marsh-covered flood tidal delta. The areas covered with shrubs are glacial "islands" poking through the tidal-delta deposits.
		Return north along Succotash Rd; over Potter Pond bridge to US 1.
1.9	23.6	Turn right onto US 1 (north).
3.0	26.6	Saugatucket River passes under the road to Pt. Judith Pond (on the right).
0.8	27.4	Exit right off US 1 at sign for Point Judith, Scarborough, and Galilee. Proceed up off-ramp; turn right onto Woodruff Ave; follow signs for Point Judith. Bear right at lights onto RI 108 (south).
		Drive south on RI 108 several miles, through to intersection with traffic lights. You are traversing along Pt. Judith end moraine.
4.2	31.6	Fisherman's Memorial State Park on right; the site of coastal defense gun batteries guarding the east entrance to Narragansett Bay during WW II.
0.1	31.7	Exit right off 108, onto the "Escape Route", heading west (road work begun in 1954 and finished in 1956).
0.7	32.4	Sand Hill Cove Marsh on left East Pond, part of Point Judith Pond on right.
0.5	32.9	Turn left (south) at T-intersection onto Great Island Rd. Entering Village of Galilee.

0.4	33.3	Turn right into parking lot next to breachway jetty.
		STOP 4. Pt. Judith breachway. An inlet formed naturally at this site in 1901 and was stabilized with jetties beginning in 1909. Tidal-current discharge is 6-8 times that of Ninigret Pond and periodic maintenance dredging is needed to remove the flood ramp and ebb spits, and maintain project depth over the developing bedforms.
		Turn right (east) out of parking lot.
0.1	33.4	Turn left at sign for Providence, and Great Island.
0.4	33.8	Turn right at Stop sign onto Great Island Rd (north). Proceed north to Great Island.
0.3	34.1	Great Island Bridge.
0.1	34.2	Bear left at blinking light onto Conch Rd.
0.2	34.4	Turn left onto Island Rd. (also sign for Mollusk Drive).
0.1	34.5	Bear right down private drive to small, sandy parking lot. STOP: private property; leave vehicle and walk to house on point; request permission to cross property.
		STOP 5. There is a good view at low tide from this island of glacial material. Visible are the mid-pond intertidal flat and bar systems. We will visit the largest flat, by boat, embarking from the boat launching area near the parking lot. Note the variety of fauna on the tidal flat.
		END OF TRIP