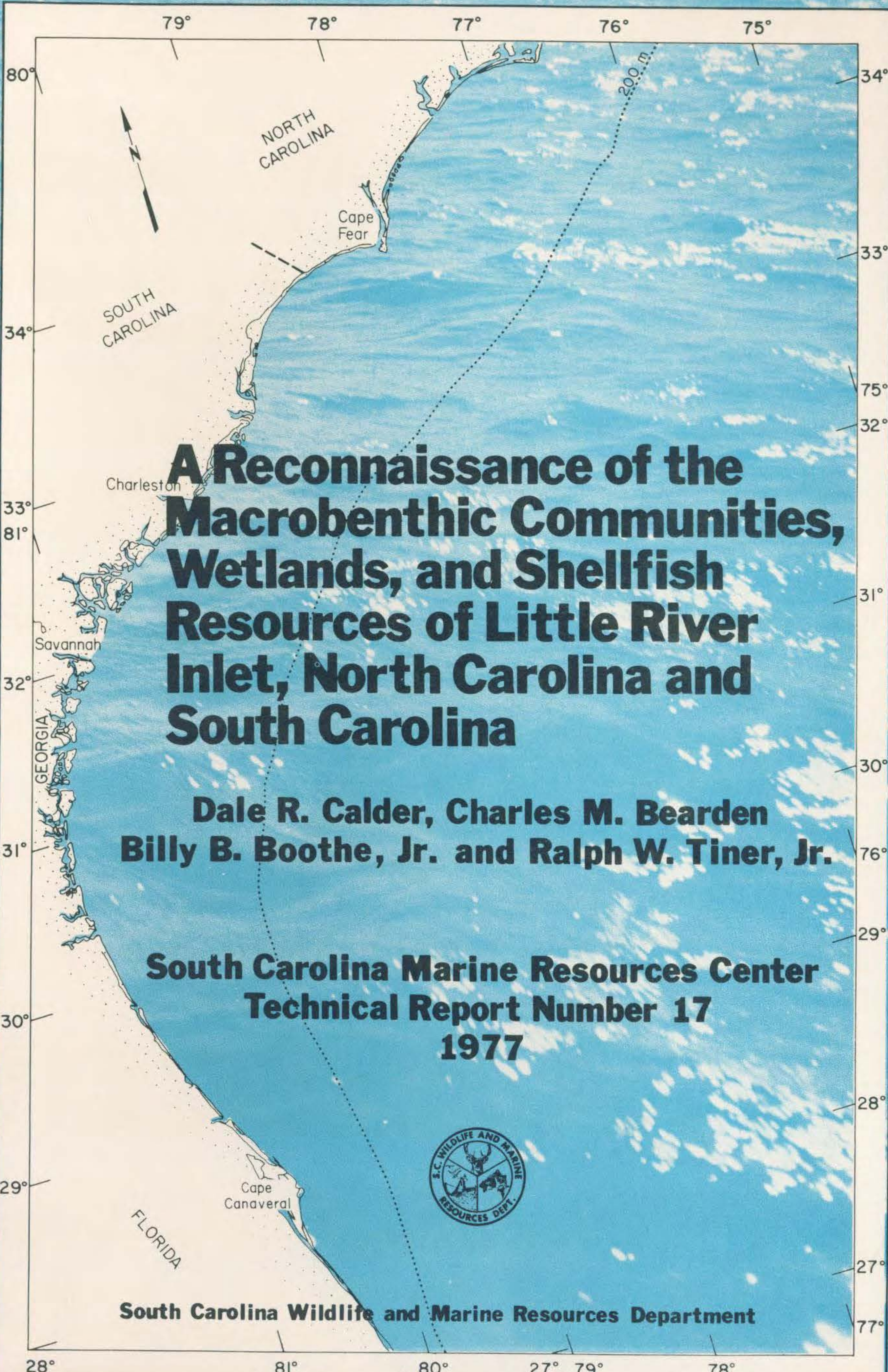

A Reconnaissance of the Macrobenthic Communities, Wetlands, and Shellfish Resources of Little River Inlet, North Carolina and South Carolina

Dale R. Calder, Charles M. Bearden
Billy B. Boothe, Jr. and Ralph W. Tiner, Jr.

South Carolina Marine Resources Center
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South Carolina Wildlife and Marine Resources Department

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by

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INTRODUCTION

The recreational and commercial fisheries of Little River Inlet are significant to the economy of the Grand Strand area. Both Little River in South Carolina and Calabash in North Carolina are important harbors for recreational craft, party fishing boats, and commercial fishing vessels. The Little River Inlet system is a major nursery area for penaeid shrimp, blue crabs, and numerous species of fishes. Common salt-water game fish inhabiting the area include spot, spotted sea trout, black drum, flounder, red drum, croaker, mackerel, and bluefish. Although most of the estuary is currently polluted and shellfish harvesting is prohibited abundant resources of the American oyster (*Crassostrea virginica*) and the hard clam (*Mercenaria mercenaria*) are present.

Little River originates in Little River swamp, South Carolina, and flows generally eastward, entering the Atlantic Ocean at Little River Inlet between Bird Island and Waties Island. The inlet provides an ocean entrance to the Atlantic Intracoastal Waterway and to several tidal creeks. The Little River system is characterized by medium energy ocean beaches, sand and mud flats, intertidal shellfish beds, and expanses of salt and brackish water marshes intersected by numerous creeks. The estuary receives an average freshwater inflow of 1200 CFS, and salinities vary considerably. Well-developed ebb and flood tidal deltas occur near the mouth of the inlet. Channel alignment shifts so frequently in the area that maintenance of channel markers in proper positions by the U. S. Coast Guard has been extremely difficult. The sand bars are hazardous to navigate at times, especially during low tides and rough seas.

In 1975, the U. S. Congress authorized a navigational improvement study for Little River Inlet. The Charleston District of U. S. Army, Corps of Engineers was assigned responsibility for the engineering and design of this project, which would provide a deeper, more stable channel to the ocean through the inlet bars. Construction plans include the creation of a 300 foot wide and 12 foot deep entrance channel extending 3200 feet through the outer bar to the Atlantic Ocean, a 90 foot wide and 10 foot deep inner channel from the inlet entrance to the AIWW, and a jetty system on the north and south sides of the inlet, extending approximately 3835 and 3570 feet into the ocean, with sand transition dikes connecting the jetties to shore. Approximately 1,141,000 cubic yards of sandy material from some 40 acres of bottom would be dredged during construction of the project. Dredged material would be utilized either for nourishment of adjacent beaches or, if feasible, stockpiled and subsequently positioned along the sand dike alignment.

In April 1976, the Charleston District of the U. S. Army, Corps of Engineers entered into a contract with the Division of Marine Resources of the South Carolina Wildlife and Marine Resources Department for an environmental reconnaissance of the Little River Inlet estuary. The major objectives of this study were to collect and analyze hydrographic, benthic, and sediment samples, and to survey, classify, and chart the marsh vegetation and shellfish resources in the vicinity of the project area. This study was of a short term nature and is not intended as either a comprehensive environmental assessment of the Little River Inlet system or a detailed impact study of the Little River Navigation Project.

MATERIALS AND METHODS

Benthic Ecology

Qualitative and quantitative samples were collected at 26 stations in the Little River Inlet area during 1976 to determine macrobenthic community structure in the area (Fig. 1, Table 1). Sampling of the intertidal macrofauna of Waties Island Beach and Bird Island Beach adjacent to the inlet was undertaken on 19 April 1976. Stations were chosen at high tide, mid-tide, and low tide levels along a transect on each of the two beaches. Two replicate samples, each consisting of a surface area of 0.10 m^2 and a volume of 10.5 liters, were taken at each station using a quadrat and shovel. Samples were washed through a 1.0 mm sieve. Organisms retained on the sieves were removed to bottles and preserved in 10% seawater formaldehyde, stained with rose bengal, and returned to the laboratory for sorting, identification, and enumeration.

Subtidal quantitative samples were collected in Little River Inlet during 20-21 April 1976 using a 0.13 m^2 modified Petersen Grab. Two replicate samples were taken at each of the three stations in the entrance channel, nine stations in the inner channel, and eight stations in adjacent waterways. Samples were sieved and processed as described for the intertidal material.

Qualitative samples of the epifauna were taken with a modified oyster dredge at the three stations in the entrance channel on 21 April, at stations in the adjacent waterways on 20 April, and at stations in the inner channel on 22 April. A single three-minute tow was made at each station except LRI-1, where two three-minute tows were taken.

Species diversity was measured using Shannon's formula (Pielou, 1966):

$$H' = -\Sigma pi \log_2 pi$$

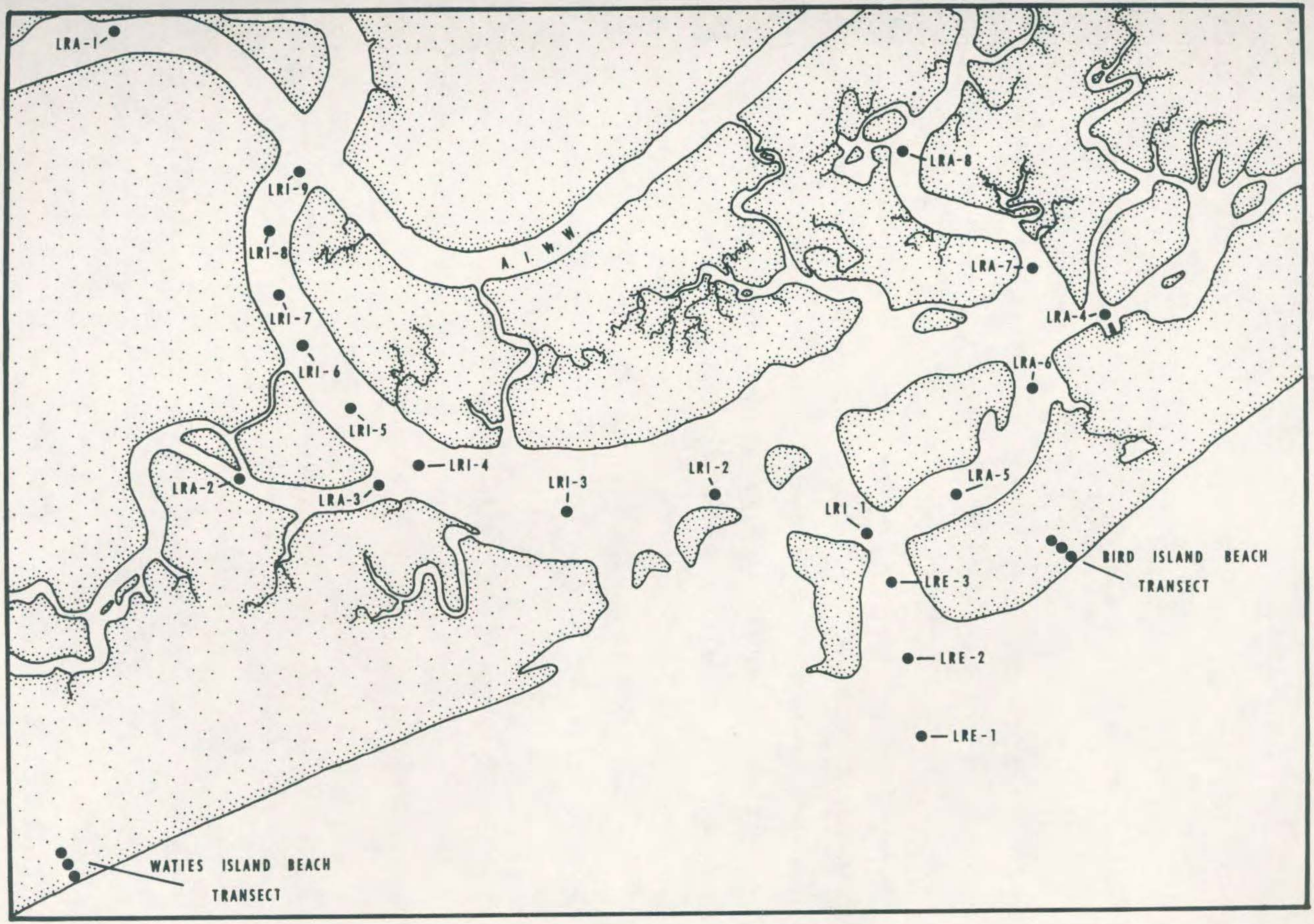


FIGURE 1. Benthic sampling stations in the Little River Inlet area.

Table 1. Locations where benthic sampling was conducted in the Little River Inlet area.

Station	Location	Depth (m)	Date
WI-1	Waties Island - High Tide	Intertidal	19-IV-76
WI-2	Waties Island - Mid-Tide	Intertidal	19-IV-76
WI-3	Waties Island - Low Tide	Intertidal	19-IV-76
BI-1	Bird Island - High Tide	Intertidal	19-IV-76
BI-2	Bird Island - Mid-Tide	Intertidal	19-IV-76
BI-3	Bird Island - Low Tide	Intertidal	19-IV-76
LRI-1	Inner Channel	4.5	20, 22-IV-76
LRI-2	Inner Channel	3.0	20, 22-IV-76
LRI-3	Inner Channel	4.5	20, 22-IV-76
LRI-4	Inner Channel	4.0	20, 22-IV-76
LRI-5	Inner Channel	5.0	20, 22-IV-76
LRI-6	Inner Channel	6.5	20, 22-IV-76
LRI-7	Inner Channel	5.5	20, 22-IV-76
LRI-8	Inner Channel	3.5	20, 22-IV-76
LRI-9	Inner Channel	4.0	20, 22-IV-76
LRE-1	Entrance Channel	6.0	21-IV-76
LRE-2	Entrance Channel	3.5	21-IV-76
LRE-3	Entrance Channel	3.0	21-IV-76
LRA-1	Adjacent Waterways	5.0	20, 21-IV-76
LRA-2	Adjacent Waterways	2.5	20, 21-IV-76
LRA-3	Adjacent Waterways	1.5	20, 21-IV-76
LRA-4	Adjacent Waterways	1.5	21, 22-IV-76
LRA-5	Adjacent Waterways	4.0	20, 21-IV-76
LRA-6	Adjacent Waterways	4.5	20, 21-IV-76
LRA-7	Adjacent Waterways	3.5	20, 21-IV-76
LRA-8	Adjacent Waterways	2.0	20, 21-IV-76

where H' is the diversity in bits of information per individual, and p_i equals $\frac{ni}{N}$ or the proportion of the sample belonging to the i^{th} species.

Species richness was calculated from the formula:

$$SR = \frac{S-1}{\ln N}$$

where S is the number of species and lnN is the natural logarithm of the total number of individuals of all species in the sample. Evenness was measured by:

$$J' = \frac{H'}{\log_2 S}$$

where H' is the species diversity and S is the number of species.

Sediment samples were taken at station LRE-2 in the entrance channel, and at stations LRI-1, LRI-3, LRI-5, LRI-7, and LRI-9 in the inner channel. These samples were frozen with dry ice and shipped to the Corps of Engineers, South Atlantic Division Laboratory, Marietta, Georgia for processing. Analyses were made to determine particle size, volatile solids, total organic carbon, COD, Kjeldahl nitrogen, oil and grease, lead, zinc, mercury, total phosphorus as PO_4, iron, and cadmium.

Hydrographic samples were taken during ebb-tide on 20 April 1976 at stations LRI-1, LRI-3, LRI-7 and LRI-9. Rough seas prevented sampling at station LRE-1 as planned. On 21 April 1976, hydrographic samples were again collected during ebb tide at each of the above stations, including station LRE-1. At each station, samples were taken 1.0 m below the surface and 0.3 m above the bottom using Van Dorn bottles. Parameters measured included temperature, salinity, dissolved oxygen, NO_3, NO_2, PO_4, SiO_2, turbidity, suspended solids, and settleable solids. In addition, salinity samples were taken 1.0 m above the bottom at hourly intervals from low tide (0900) to high tide (1500) at station LRA-3 on 22 April, 1976 to determine whether the inlet estuary is tidally poikilohaline or homoiohaline.

Marsh Vegetation

An inventory of the tidal wetlands within the Little River Inlet study area was conducted during May and June 1976 to delineate and describe the major types of marsh plant associations. The area was photogrammetrically examined using scaled black and white, color, and color infrared aerial photography from the files of the Division of Marine Resources and the Charleston District, Corps of Engineers.

Low altitude color infrared imagery, obtained in March 1974 at a scale of 1:6000 (1" = 500') served as the standard for vegetative interpretation. Low altitude color photography (1:7200 scale), taken under contract for the Corps of Engineers in March 1975 by Piedmont Aerial Surveys, was also used to verify and supplement the 1974 photography. Higher altitude color infrared photography taken in April 1976 was used to update the orientation of the inlet and accompanying sand bars and to identify other significant physical changes within the study area.

Aerial photography for the Division of Marine Resources was taken employing a modified Fairchild K-17 mapping camera improved through the addition of a higher resolution six inch focal length Planagon lens. The camera was mounted in a wood-framed fiberglass pod attached under the fuselage of a Cessna 172 air-craft. Kodak Aerochrome Infrared (2443) color film was used exclusively.

Four major classifications of vegetative cover were delineated on the photography using standard color tone and texture identification techniques. These categories were upland, low marsh, high marsh, and upper high marsh. Upland areas were not classified according to specific communities since most of the impact of the project would be borne within the intertidal wetland areas. Interpretation of the marshes was aided by the correlation of specific tonal signatures on the imagery to subtle changes of elevation indicated on the map.

Ground truth surveys of the study area were conducted in June 1976 to verify photo-interpretive results and to obtain necessary descriptive information about plant composition in the associated marshlands. Nineteen sampling locations, in addition to three marsh transects (200', 200', 75') were established within the project area (Fig. 11). General field observations at the sampling locations, including dominant vegetation and associated plants, revealed plant composition of these wetlands. Marsh transects provided data on plant zonation within the salt marshes. Manual of the Vascular Flora of the Carolinas (Radford, Ahles, and Bell, 1968) served as the principal reference text for plant identification and nomenclature.

Information obtained from photo-interpretation and ground surveys was used to produce a vegetative map of the study area (Fig. 11). This map designates tidal marshlands, adjacent uplands, major disposal areas (diked and undiked), intertidal flats (mud or sand), and beaches.

Shellfish Resources

Intertidal oyster reefs within 0.5 miles of the centerline of the channel were surveyed during April and May 1976. This survey was conducted using a shallow draft, 14-foot outboard boat, and ground inspection. Location and size (length and width) of intertidal oyster reefs were recorded in the field on black and white aerial photographs and later transposed to an overlay map. Coverage of each reef by living oysters as light, medium, or heavy, was also recorded. Aerial infrared photographs were utilized to provide supplemental information on the size and location of intertidal oyster reefs situated in shallow flats and inaccessible areas. A survey of the hard clam resources of the area was also conducted using a shallow draft outboard boat equipped with patent tongs designed to sample one square yard of bottom per grab. Sampling was conducted along pre-established transect lines in Little River and adjacent tributary creeks. Sampling stations were located 100 feet apart, with a distance of 200 feet between transects. Acreages of bottoms containing clams were estimated from samples taken using the patent tongs.

RESULTS AND DISCUSSION

Hydrography and Sediments

The Little River Inlet system conforms with Pritchard's (1955) definition of an estuary as "a semi-enclosed coastal body of water having a free connection with the open sea and within which the seawater is measurably diluted with fresh water runoff." Low salinity water enters the inlet area via the Atlantic Intracoastal Waterway, and despite mixing processes some salinity stratification was observed, particularly at station LRI-9 (Table 2). It should be noted that this study was conducted during a drought of several weeks and salinities may have been somewhat higher than normal.

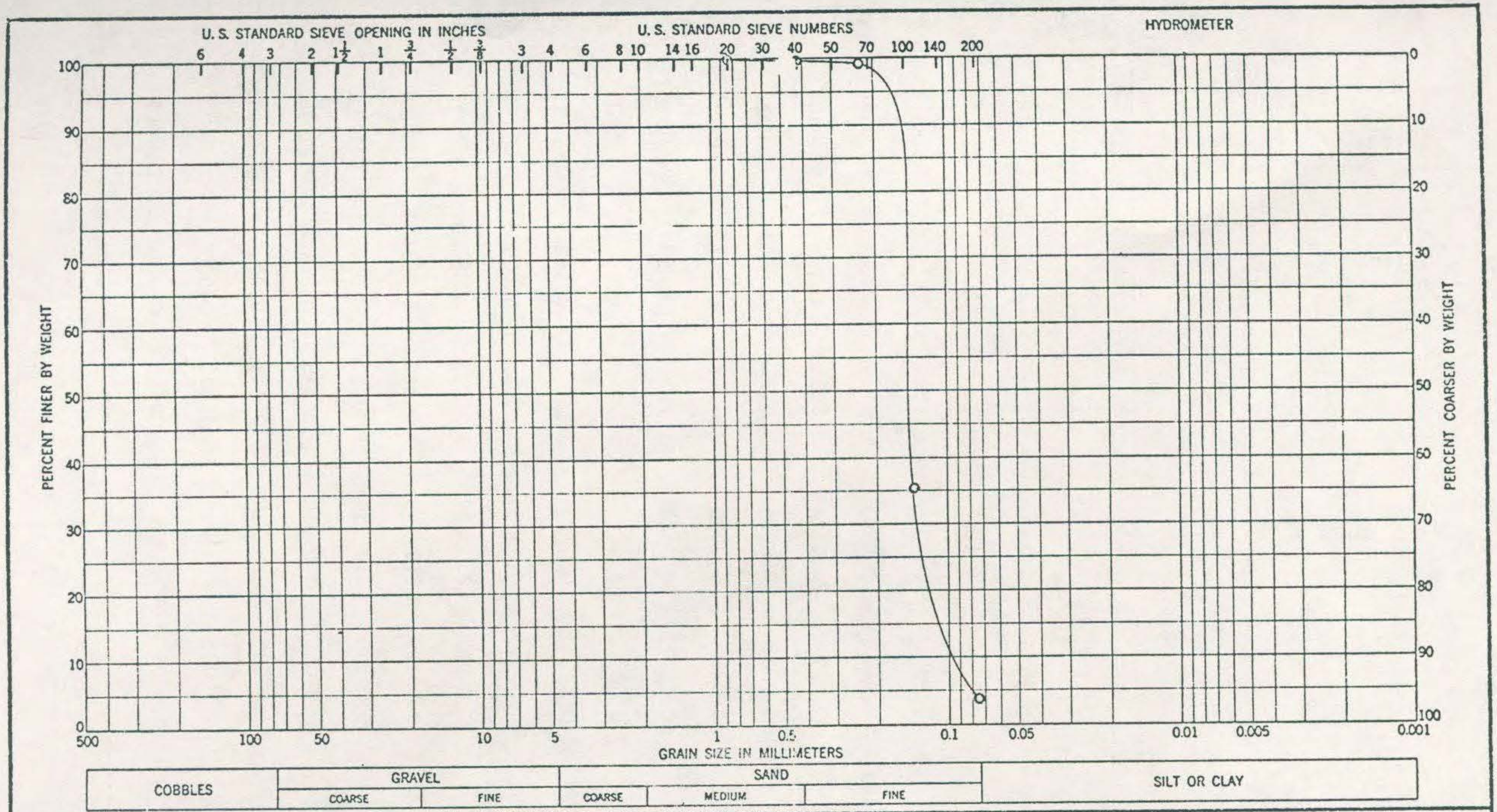
Pronounced oscillations in salinity were evident over a tidal cycle in Little River Inlet during the study, and the system is regarded as a "fluctuating" (poikilohaline) estuary. During high tide, relatively clear, greenish coastal water was present throughout the lower portion of the inlet. In contrast, the entire estuary was occupied by turbid, brownish-colored water of substantially lower salinity at low tide. Bottom salinity samples taken hourly from low to high tide at station LRA-3 on 22 April 1976 varied from a minimum of 23.95 o/oo to a maximum of 32.97 o/oo. Such highly variable conditions of salinity have a pronounced effect on the species composition of benthic communities in estuaries (Dahl, 1956; Boesch, 1976; Calder, 1976). The hydrography of Little River Inlet thus differs substantially from that observed previously in nearby Murrells

Table 2. Hydrographic data collected during benthic studies in the Little River Inlet.

Station	Date	Depth	Temp. (C)	Salinity (o/oo)	D.O. (mg/l)	Turbidity (FTU)	Solids (mg/l)		Nutrients (μg/l)			
							Suspended	Settleable	NO_3	NO_2	PO_4	SiO_2
LRE-1	21-IV-76	Surface	21.8	33.25	7.6	2.7	-	-	11.6	3.8	18.0	168.6
		Bottom	18.5	33.96	6.5	13.0	-	-	2.7	1.5	6.5	119.4
LRI-1	20-IV-76	Surface	22.5	33.14	7.8	2.9	-	-	2.0	0.8	6.5	91.3
		Bottom	22.0	33.70	7.8	3.8	-	-	2.8	1.0	25.5	42.2
	21-IV-76	Surface	22.8	32.75	7.8	3.2	-	-	-	-	10.5	70.2
		Bottom	22.6	33.25	7.8	3.7	-	-	1.6	0.8	9.0	77.3
LRI-3	20-IV-76	Surface	21.2	33.71	7.9	3.1	54.0	61.2	10.1	0.7	19.5	35.1
		Bottom	20.9	33.74	7.7	3.2	-	-	6.2	0.8	12.0	42.2
	21-IV-76	Surface	22.7	32.97	7.6	3.1	-	-	-	-	10.5	84.3
		Bottom	22.4	33.13	7.7	2.7	-	-	22.1	1.0	7.0	119.4
LRI-7	20-IV-76	Surface	22.2	29.59	7.2	4.3	50.8	50.8	23.1	1.4	-	238.8
		Bottom	21.7	31.42	7.3	5.0	-	-	6.1	1.3	10.5	175.6
	21-IV-76	Surface	22.7	32.00	7.6	3.8	-	-	2.1	1.7	16.5	140.5
		Bottom	22.3	33.02	7.4	3.4	-	-	7.4	1.0	9.0	70.2
LRI-9	20-IV-76	Surface	24.4	25.56	6.9	5.4	64.4	20.4	31.8	2.5	41.0	456.6
		Bottom	23.5	28.21	7.2	5.1	99.8	12.8	15.4	2.4	18.0	330.2
	21-IV-76	Surface	23.2	31.00	7.4	4.4	73.6	2.4	-	-	10.5	112.4
		Bottom	22.8	32.81	7.3	5.3	-	-	-	-	7.5	70.2

Table 3. Chemical analysis of sediment samples from Little River Inlet. Values are expressed as percent by weight (dry basis).

	LRE-2	LRI-1	LRI-3	LRI-5	LRI-7	LRI-9
Volatile Solids (Max. 6.0)	1.06	0.43	0.68	1.11	1.10	2.04
T.V.S. Formula EC	1.60	1.36	1.42	2.45	1.96	1.89
Total Organic Carbon	<0.10	<0.10	<0.10	0.40	0.20	0.21
C.O.D., (Max. 5.0)	0.29	0.40	0.10	1.15	0.65	0.58
Nitrogen, Kjeldahl (Max. 0.10)	0.042	0.050	0.046	0.066	0.048	0.045
Oil and Grease (Max. 0.15)	0.025	0.022	0.020	0.028	0.049	0.030
Lead (Max. 0.005)	0.0005	<0.0005	<0.0005	0.0011	0.0013	0.0006
Zinc (Max. 0.005)	0.0011	0.0005	0.0006	0.0013	0.0007	0.0010
Mercury (Max. 0.0001)	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Total P as PO_4	0.07	0.04	0.04	0.06	0.07	0.05
Iron	0.355	0.075	0.165	0.460	0.220	0.260
Cadmium	<0.00005	<0.00005	<0.00005	0.00008	0.00006	0.00006
Arsenic	0.00012	0.00009	0.00005	0.00013	0.00005	0.00012
Chromium	0.00100	0.00040	0.00060	0.00140	0.00090	0.00090
Nickel	0.00050	<0.00050	<0.00050	0.00080	<0.00050	0.00060
Copper	0.00056	0.00034	0.00038	0.00124	0.00042	0.00048
Beryllium	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Selenium	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Vanadium	0.0008	<0.0005	<0.0005	0.0017	0.0010	0.0009

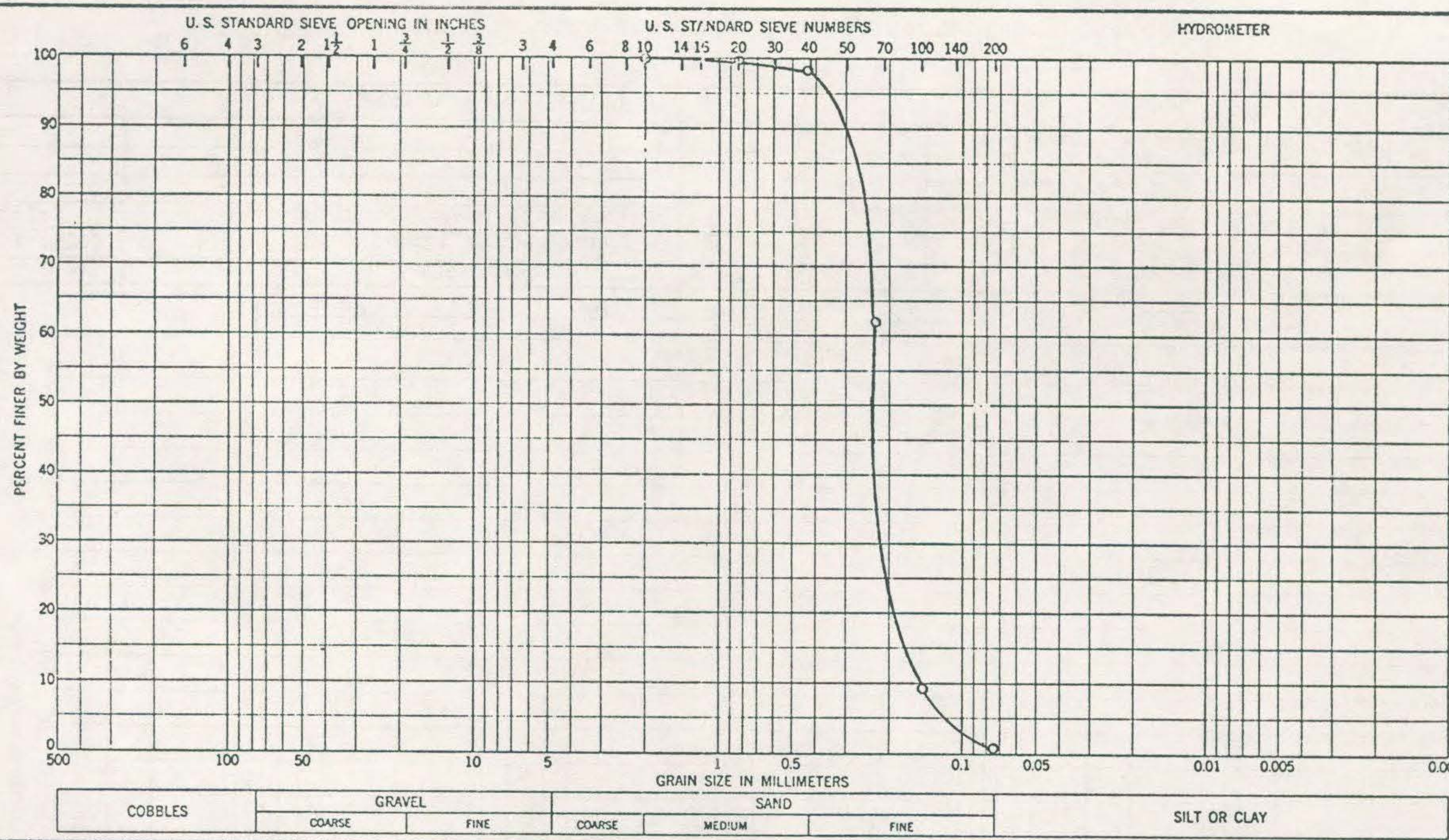


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
76002	--	Gray poorly graded sand(SP)	–	–	–	–

Project: Little River, South Carolina
Lab. No. 3S-607 */
Area: --
Boring No.: --- Sample No. 76002
Date: 4 June 1976

GRADATION CURVES

FIGURE 2. Particle size analysis for sediments from station LRE-2.

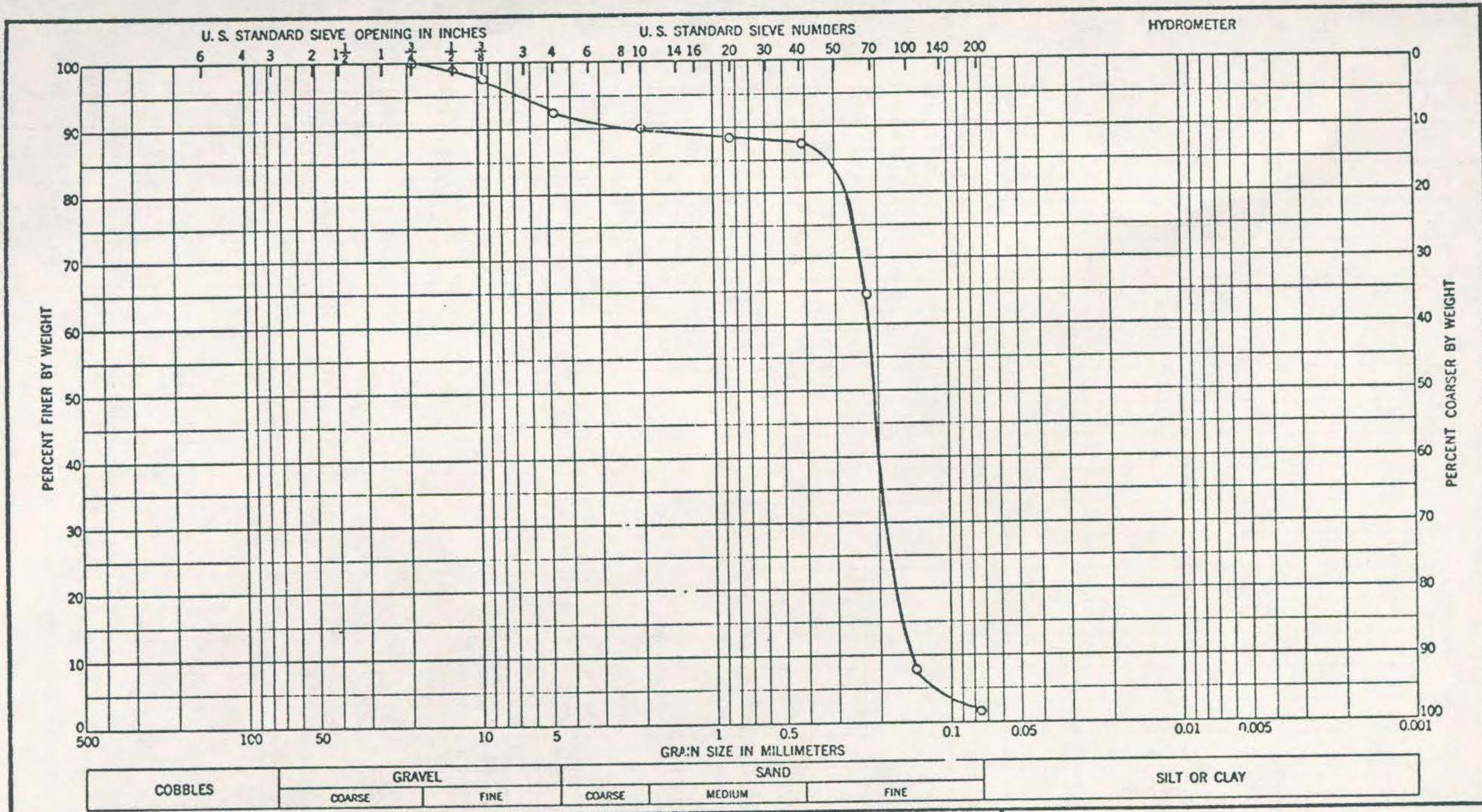


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
02-76004, LRI-1	--	Light gray poorly graded sand (SP)	-	-	-	-

Project Little River, South Carolina
Lab. No. 3S-608 *
Area --
Boring No. --Sample No. 02-76004,LRI-1
Date 4 June 1976

GRADATION CURVES

FIGURE 3. Particle size analysis for sediments from station LRI-1.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
02-76006, LRI-3	-	Gray poorly graded sand w/trace gravel size shell(SP)	-	-	-	-

Project Little River, S. C.

Lab. No. 3S-609 *

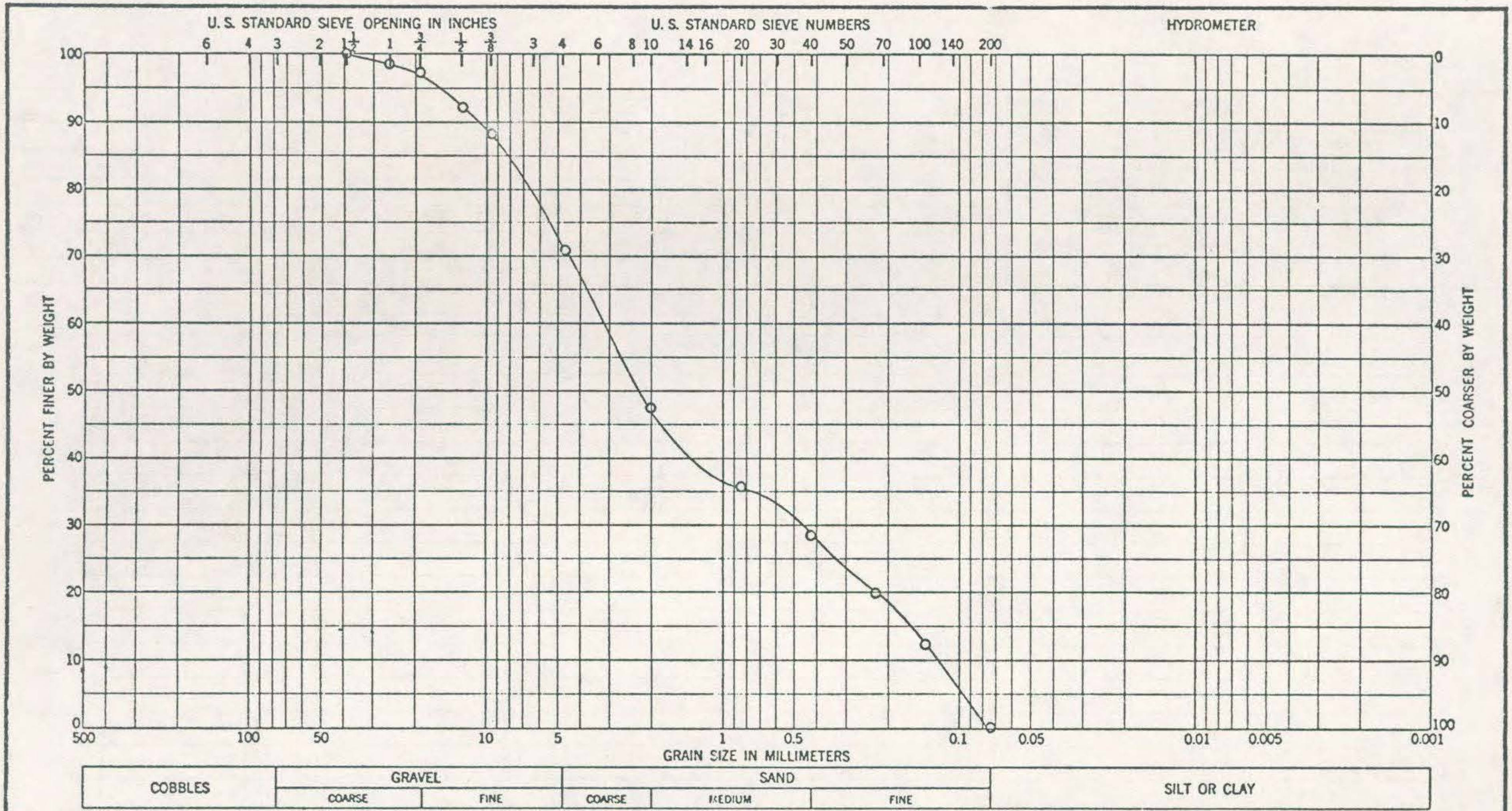
Area --

Boring No. -- Sample No. 02-76006, LRI-3

Date 4 June 1976

GRADATION CURVES

FIGURE 4. Particle size analysis for sediments from station LRI-3.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
02-76008, LRI-5	--	Gray poorly graded sand size shell fragments w/some gravel sizes	-	-	-	-

Project Little River, South Carolina
Lab. No. 3S-610 *

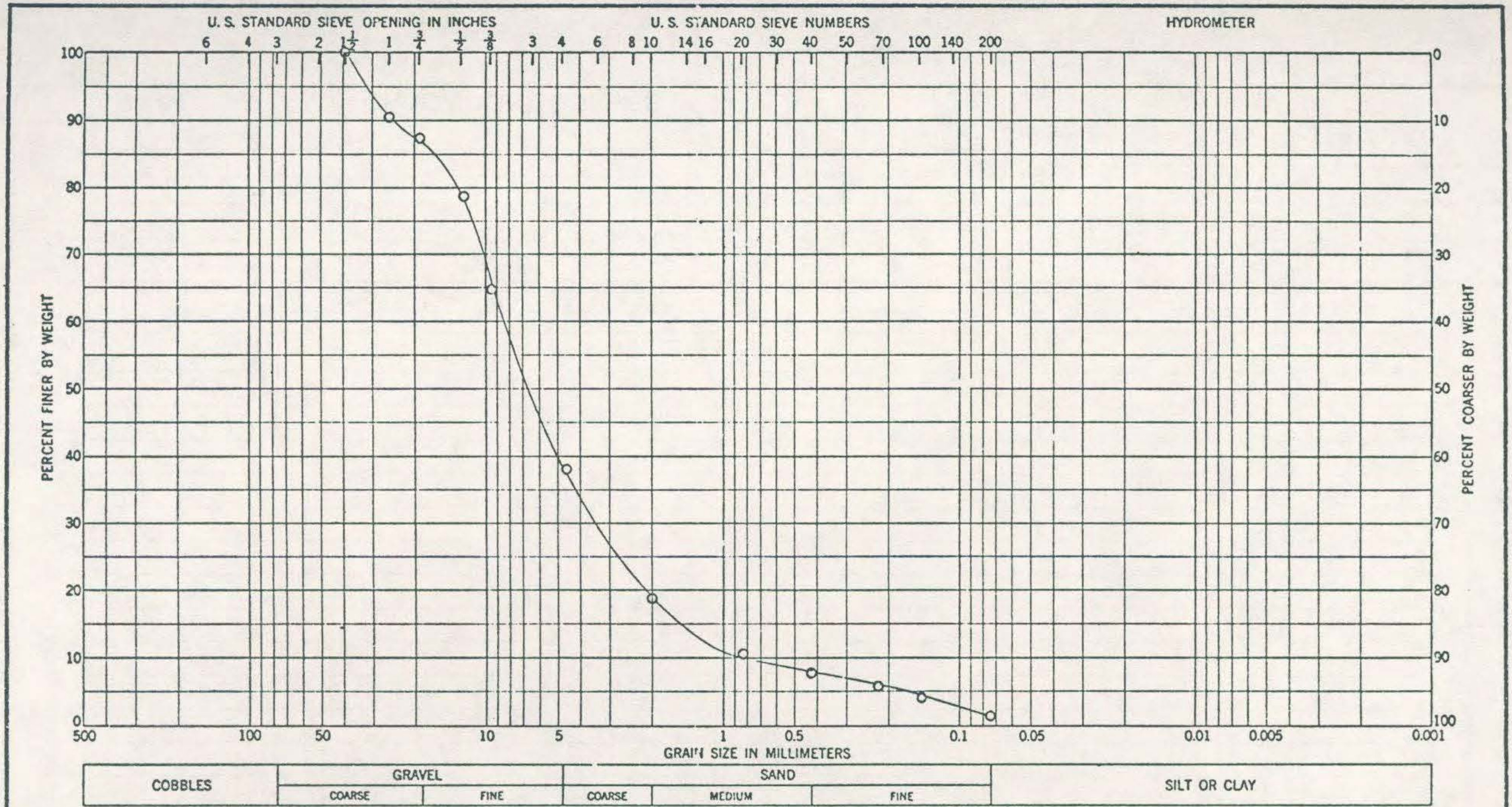
Area --

Boring No. -- Sample No. 02-76008, LRI-5

Date 4 June 1976

GRADATION CURVES

FIGURE 5. Particle size analysis for sediments from station LRI-5.

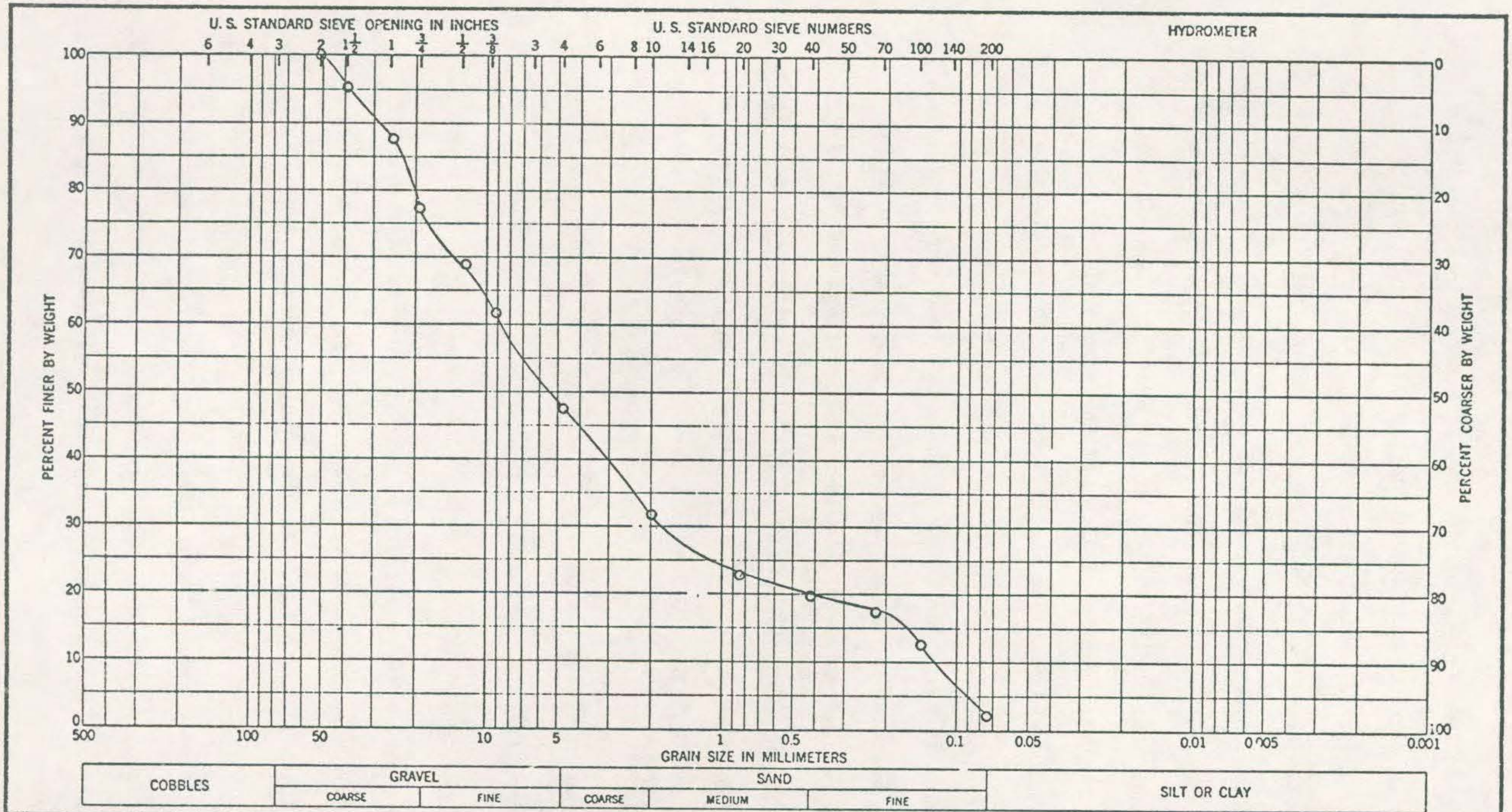


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
02-76010, LRI-7	--	Gray poorly graded gravel size shell fragments w/trace sand	-	-	-	-

GRADATION CURVES

Project	Little River, S.C.
	Lab. No. 3S-611 * ✓
Area	--
Boring No.	-- Sample No. 02-76010, LRI-7
Date	4 June 1976

FIGURE 6. Particle size analysis for sediments from station LRI-7.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
02-76012, LRI-9	--	Gray well graded gravel size shell fragments w/trace sand	-	-	-	-

GRADATION CURVES

Project	Little River, S. C.
	Lab. No. 3S-612 *
Area	--
Boring No.	--Sample No. 02-76012,LRI-9
Date	4 June 1976

FIGURE 7. Particle size analysis for sediments from station LRI-9.

Inlet (Calder, Bearden, and Boothe,1976). The latter receives negligible fresh water inflow and more nearly corresponds to Odum and Copeland's (1972, 1974) definition of a neutral embayment.

Hydrographic parameters measured during the study in addition to salinity are given in Table 2. No evidence of oxygen depletion was noted during the study in Little River Inlet, although coliform counts are sufficiently high that shellfish beds in the area have been closed by the South Carolina Department of Health and Environmental Control. The lowest oxygen value observed was 6.5 mg/l in a bottom water sample from station LRE-1.

Sediment samples from station LRE-2 in the entrance channel and stations LRI-1 and LRI-3 in the inner channel were mostly gray or light gray poorly graded sand (Figs. 2-4). Sediments at stations LRI-5, LRI-7, and LRI-9 further up the inner channel were primarily composed of gravel-size shell fragments, with a trace of sand (Figs. 5-7). Chemical analyses of these sediment samples (Table 3) did not reveal any substance exceeding maximum requirements for the determination of the acceptability of dredge spoil disposal to the nation's waters (U. S. Army, Corps of Engineers, personal communication).

Benthic Community Structure

Both species richness and diversity of benthic invertebrates were low on intertidal sand beaches of Waties Island and Bird Island adjacent to Little River Inlet (Tables 4,5). Beaches such as these present a rigorous habitat for marine invertebrates, with pounding waves, longshore currents, shifting sands, tidal rise and fall, heavy predation, and extremes of temperature and salinity. While relatively few species are normally able to live in such areas, some of those represented frequently

Table 4. Species of macroinvertebrates collected on Waties Island Beach, and their estimated densities in numbers m^{-2}. Estimates were based on two 0.10 m^2 samples at each of three stations, one at high tide, one at mid-tide, and one at low tide.

A = amphipod, B = bivalve, I = isopod, G = gastropod

Species	High Tide	Mid-Tide	Low Tide
Parahaustorius longimerus (A)		395	465
Amphiporeia virginiana (A)	10	5	215
Neohaustorius schmitzi (A)	5	205	10
Donax variabilis (B)		135	50
Chiridotea caeca/stenops (I)		5	5
Chiridotea sp. (I)	5	5	
Polinices duplicatus (G)			5
No. Individuals	20	750	750
No. Species	3	6	6
Species Richness	0.67	0.76	0.76
Species Diversity (H')	1.50	1.59	1.38
Evenness (J')	0.94	0.61	0.53

Table 5. Species of macroinvertebrates collected on Bird Island Beach, and their estimated densities in numbers m^{-2}. Estimates were based on two 0.10 m^2 samples at each of three stations, one at high tide, one at mid-tide, and one at low tide.

B = bivalve, A = amphipod, P = polychaete, I = isopod, D = decapod

Species	High Tide	Mid-Tide	Low Tide
Donax variabilis (B)		355	205
Parahaustorius longimerus (A)		140	155
Neohaustorius schmitzi (A)		70	135
Spionidae (undet.) (P)		60	40
Amphiporeia virginiana (A)			35
Chiridotea sp. A (I)		20	
Nemertina (undet.)		10	5
Mysid (undet.)			15
Chiridotea sp. B (I)			10
Emerita talpoida (D)			10
Spiophanes bombyx (P)	5		
Nudibranch (undet.)			5
No. Individuals	5	655	615
No. Species	1	6	10
Species Richness	0.00	0.77	1.40
Species Diversity (H')	0.00	1.86	2.44
Evenness (J')	0.00	0.72	0.73

occur in large numbers. Previous studies have shown that key macroinvertebrate species in such habitats along the southeastern United States are haustoriid amphipods, coquina clams, polychaetes, isopods, mole crabs, and ghost crabs (Pearse, Humm, and Wharton, 1942; Dexter, 1969; Shealy, Boothe, and Bearden, 1975; Calder, Bearden, and Boothe, 1976). Haustoriid amphipods and the coquina clam, Donax variabilis, accounted for 98.4% of the macrofauna observed on Waties Island Beach, and 85.8% on Bird Island Beach. In each case, substantially fewer individuals and species were found at high tide than at mid or low tide.

As indicated in a previous report (Calder, Bearden, and Boothe, 1976), beach areas generally appear to be a better choice for disposal of dredged material, particularly when the spoil is predominantly sandy, than wetlands or waterways within an inlet. Animals of high and medium energy beaches are adapted to an unstable substrate, are typically mobile, and have high fecundity. Resiliency of such populations following temporary disturbance should therefore be higher than for organisms either in subtidal areas inside the inlet or in the marsh. Again, the impact on intertidal beach communities could be minimized by placing dredge spoil high in the intertidal zone.

Infaunal species dominated benthic communities at the three stations in the entrance channel (Tables 6, 7); relatively little hard substrate was available for the attachment of epifaunal organisms. At the outermost two stations (LRE-1 and LRE-2), the substrate was relatively soft and polychaetes were well represented. Species numbers and diversity were both rather high at these stations. A completely different community of infaunal invertebrates was encountered at LRE-3, which had substantially fewer species and a much lower species diversity. Strong tidal currents

Table 6. Species of macroinvertebrates collected in the entrance channel, and their estimated densities in numbers m^{-2}. Estimates were based on two 0.13 m^2 samples at each of three stations.

P = polychaete, A = amphipod, B = bivalve, E = echinoderm, G = gastropod, I = isopod, D = decapod

Species	LRE-1	LRE-2	LRE-3
Spiophanes bombyx (P)		354	
Parahaustorius longimerus (A)			177
Neohaustorius schmitzi (A)			158
Magelona sp. (P)	131	8	4
Tellina sp. (B)	46	73	
Clymenella torquata (P)	54	19	
Hemipholis elongata (E)		58	
Glycera dibranchiata (P)	15	35	
Paraprionospio pinnata (P)	31	19	
Nemertina (undet.)	19	15	
Heteromastus filiformis (P)		35	
Polychaeta (undet.)	12	23	
Sigambra sp. (P)	8	23	
Turbonilla interrupta (G)	27		
Aglaophamus verrilli (P)	12	12	
Pectinaria gouldii (P)	19	4	
Haminoea solitaria (G)	12	8	
Nereis succinea (P)	4	15	
Batea catharinensis (A)	4	15	
Corophium sp. (A)	4	15	
Eteone sp. (P)		15	
Diopatra cuprea (P)		12	
Sabellaria vulgaris (P)		12	

Table 6. (continued)

Species	LRE-1	LRE-2	LRE-3
Anadara ovalis (B)		12	
Notomastus sp. (P)		8	
Nephtys bucera (P)	4	4	
Nereidae (undet.) (P)	8		
Eteone heteropoda (P)		8	
Spionidae A (P)		8	
Busycon carica (G)		8	
Brachidontes exustus (B)		8	
Mulinia lateralis (B)		8	
Edotea montosa (I)		8	
Microprotopus shoemakeri (A)	8		
Pinnixa retinens (D)	8		
Leptosynapta inhaerens (E)	8		
Abarenicola sp. (P)	4		
Haploscoloplos fragilis (P)		4	
Owenia fusiformis (P)	4		
Sthenelais boa (P)		4	
Spionidae B (P)	4		
Polinices duplicatus (G)		4	
Mitrella lunata (G)	4		
Terebra dislocata (G)		4	
Nucula proxima (B)	4		
Anadara sp. (B)		4	
Donax variabilis (B)			4
Pelecypoda A (undet.)			4
Pelecypoda B (undet.)	4		

Table 6. (continued)

Species	LRE-1	LRE-2	LRE-3
Chiridotea caeca/stenops (I)			4
Ovalipes ocellatus (D)			4
Neopanope sayi (D)			4
Pinnixa sayana (D)		4	
Pinnixa sp. (D)	4		
Brachyuran (young adult)		4	
Chaetognatha (undet.)	4		
Ascidiacea (undet.)		4	
No. Individuals	466	874	359
No. Species	28	37	8
Species Richness	4.39	5.32	1.19
Species Diversity (H')	3.86	3.73	1.46
Evenness (J')	0.80	0.71	0.49

Table 7. Benthic invertebrates from dredge collections at three stations in the Entrance Channel.

Species	LRE-1	LRE-2	LRE-3
Phylum Cnidaria			
Rhopilema verrilli (polyp)			+
Phylum Annelida			
Sabellaria vulgaris		+	
Phylum Mollusca			
Brachidontes exustus			+
Busycon canaliculata		+	
Busycon carica	+	+	
Phylum Arthropoda			
Balanus amphitrite		+	
Balanus sp. (cyprids)			+
Portunus gibbesi	+	+	
Portunus spinimanus	+		
Phylum Hemichordata			
Balanoglossus aurantiacus	+		
No. Species	4	5	3

flow through this area at the relatively restricted opening of the inlet, and the bottom was scoured of finer sediments. The amphipods Parahaustorius longimerus and Neohaustorius schmitzi, species characteristic of dynamic, sandy substrates, were by far the most abundant organisms at this location.

The bottom at stations from LRI-1 to LRI-4 was mostly fine sand, with relatively little shell. The infauna (Table 8) resembled that of station LRE-3, with large numbers of sand-dwelling haustoriid amphipods. Neohaustorius schmitzi, Parahaustorius longimerus, and Lepidactylus dytiscus accounted for 93.5% of the fauna at these four locations. Epibenthos was sparce at all four stations (Table 9) and no invertebrates were collected at all in two three-minute tows at LRI-1.

With a change in predominant substrate type from sand to shell beyond LRI-4, a pronounced change occurred in the benthic community structure. Haustoriid amphipods, which had dominated in samples from LRI-1 through LRI-4, were completely lacking at stations from LRI-5 through LRI-9 (Table 8). They were replaced at these stations largely by polychaetes, primarily the species Spiophanes bombyx, Heteromastus filiformis, and Nereis succinea. Species numbers and diversity were also markedly higher at the upper five stations of the inner channel. The number of epifaunal species also rose abruptly at station LRI-5, although most of the species represented were decidedly euryhaline and normally occur in the middle and upper reaches of more homoiohaline estuaries. Many of the species encountered are typical fouling organisms on oyster shells in estuarine areas. Barnacles (Balanus improvisus), mussels (Brachidontes exustus), hydroids (Obelia dichotoma), and bryozoans (Membranipora tenuis) were particularly abundant at these stations. Oyster shells were common at most locations from LRI-5 to LRI-9.

Table 8. Species of macroinvertebrates collected in the inner channel, and their estimated densities in numbers m^{-2}. Estimates were based on two 0.13 m^2 samples at each of nine stations.

A = amphipod, P = polychaete, B = bivalve, D = decapod, E = echinoderm, I = isopod, F = flatworm, B = barnacle

Species	LRI-1	LRI-2	LRI-3	LRI-4	LRI-5	LRI-6	LRI-7	LRI-8	LRI-9
Neohaustorius schmitzi (A)		262	782	358					
Spiophanes bombyx (P)			12		42	139	127	92	273
Heteromastus filiformis (P)					12	123	50	19	246
Nereis succinea (P)					8	54	42	27	169
Parahaustorius longimerus (A)	62		131	39					
Lepidactylus dytiscus (A)	154	35		12					
Polychaeta A (undet.)					12	62		12	35
Brachidontes exustus (B)			27		4		4	69	
Neopanope sayi (D)						8	12	4	58
Spionidae B (P)							4	4	73
Podarke obscura (P)								12	62
Glycera dibranchiata (P)						15	8	12	35
Streblospio benedicti (P)							31	15	15
Mercenaria mercenaria (B)					4		12	19	19
Nemertina (undet.)					12	15		4	19
Notomastus sp. (P)					4	23		8	4
Pagurus longicarpus (D)		35							
Actiniaria (undet.)					4	23			4
Clymenella torquata (P)						8			23
Melita nitida (A)									31
Schistomeringos rudolphi (P)							8	4	15
Pelecypoda (undet.)							12		12
Hemipholis elongata (E)							4	4	15
Eteone lactea (P)					4		15		

Table 8. (continued)

Species	LRI-1	LRI-2	LRI-3	LRI-4	LRI-5	LRI-6	LRI-7	LRI-8	LRI-9
Nuculana sp. (B)						15	4		
Pectinaria gouldii (P)						8			8
Scaleworm (undet.)						8			8
Polychaeta B (undet.)								4	12
Tellina sp. (B)			8	4	4				
Autolytus sp. (P)									15
Phyllodoce sp. (P)								15	
Solen viridis (B)									15
Magelona sp. (P)			4	8					
Anadara ovalis (B)						8			4
Mysid (undet.)				12					
Nephtys bucera (P)					8				
Aricidea sp. (P)					8				
Sabellaria vulgaris (P)								8	
Nucula proxima (B)							8		
Cyathura burbancki (I)						8			
Chiridotea sp. (I)			8						
Edotea montosa (I)							8		
Stylochus ellipticus (F)			4						
Nemertina (undet.)							4		
Glycera americana (P)					4				
Diopatra cuprea (P)									4
Eteone heteropoda (P)								4	
Phyllodoce arenae (P)							4		
Sigambra sp. (P)							4		
Sabella microphthalma (P)									4
Spionidae A (P)					4				

Table 8. (continued)

Species	LRI-1	LRI-2	LRI-3	LRI-4	LRI-5	LRI-6	LRI-7	LRI-8	LRI-9
Mulinia lateralis (B)					4				
Abra lioica (B)					4				
Balanus improvisus (Ba)					4				
Unciola serrata (A)					4				
Paracaprella tenuis (A)					4				
Amphipod (undet.)							4		
Clibanarius vittatus (D)									4
Pagurus sp. (D)					4				
No. Individuals	216	332	976	433	158	517	365	336	1182
No. Species	2	3	8	6	21	15	20	19	27
Species Richness	0.19	0.34	1.02	0.82	3.95	2.24	3.22	3.09	3.67
Species Diversity (H')	0.86	0.95	1.04	1.00	3.89	3.11	3.31	3.45	3.58
Evenness (J')	0.86	0.60	0.35	0.39	0.89	0.79	0.77	0.81	0.75

Table 9. Benthic invertebrates from oyster dredge collections at nine stations in the Inner Channel.

Species	LRI-1	LRI-2	LRI-3	LRI-4	LRI-5	LRI-6	LRI-7	LRI-8	LRI-9
Phylum Porifera									
Microciona prolifera		+							
Cliona celata				+	+			+	
Porifera (undet.)		+							
Phylum Cnidaria									
Rhopilema verrilli (polyp)			+	+					
Bougainvillia rugosa				+	+		+		+
Garveia franciscana								+	
Garveia humilis								+	
Amphinema dinema					+				+
Campanulina sp.						+	+		
Obelia dichotoma				+	+	+	+	+	+
Astrangia danae					+				
Actiniaria (undet.)								+	+
Phylum Platyhelminthes									
Stylochus ellipticus					+	+	+	+	+
Phylum Rhynchocoela									
Nemertina (undet.)					+				
Phylum Entoprocta									
Barentsia gracilis									+
Phylum Bryozoa									
Alcyonidium hauffi					+				
Anguinella palmata				+	+				
Bowerbankia gracilis					+	+	+	+	

Table 9. (continued)

Species	LRI-1	LRI-2	LRI-3	LRI-4	LRI-5	LRI-6	LRI-7	LRI-8	LRI-9
Membranipora arborescens					+				
Membranipora tenuis					+	+		+	+
Conopeum tenuissimum					+		+	+	+
Electra monostachys				+	+		+	+	+
Phylum Annelida									
Notomastus sp.								+	
Nereis succinea				+	+		+	+	+
Sabellaria vulgaris					+			+	+
Hydroides dianthus					+			+	+
Syllidae (undet.)								+	
Polychaeta (undet.)								+	
Phylum Mollusca									
Crepidula plana									+
Urosalpinx cinerea						+			
Nudibranch (undet.)		+			+				+
Anadara ovalis								+	
Brachidontes exustus			+		+	+	+	+	+
Lithophaga bisulcata					+				
Modiolus modiolus squamosus					+				
Martesia cuneiformis					+		+		
Crassostrea virginica					+			+	+
Mercenaria mercenaria					+			+	
Pelecypoda (undet.)								+	
Phylum Arthropoda									
Balanus amphitrite		+							

Table 9. (continued)

Species	LRI-1	LRI-2	LRI-3	LRI-4	LRI-5	LRI-6	LRI-7	LRI-8	LRI-9
Balanus improvisus			+	+	+	+	+	+	+
Cleantis planicauda			+						
Melita nitida									+
Erichthonius brasiliensis					+				
Paracaprella tenuis					+			+	
Clibanarius vittatus			+						
Pagurus longicarpus		+							
Callinectes sapidus							+		+
Hexapanopeus angustifrons		+			+				
Eurypanopeus depressus							+		
Phylum Echinodermata									
Asterias forbesi (juv.)								+	
Phylum Chordata									
Molgula manhattensis				+	+			+	+
No. Species	0	6	5	9	29	8	13	25	20

Benthic invertebrates of the inlet are strongly influenced by the local hydrography as well as by bottom type. The number of species is reduced under the estuarine conditions of the inlet, and the stress of variable salinity is particularly evident on the epifauna. There were no assemblages in Little River Inlet comparable to those observed previously in Murrells Inlet (Calder, Bearden and Boothe, 1976), where rich communities of sponges, whip corals, bryozoans and bivalves provided shelter and substrate for a large number of motile species. Conspicuously missing in the inner channel were such common species of polyhaline areas as Leptogorgia virgulata (whip coral), Schizoporella errata, Bugula neritina, and Parasmittina nitida (bryozoans), and Eudendrium carneum (hydroid). Short-term variations in salinity are known to have a greater impact on the epifauna than on the infauna (Sanders, Mangelsdorf, and Hampson, 1965). They demonstrated that salinity in a poikilohaline estuary is much more stable in the sediments than in the overlying water column, and that the epifauna is therefore subjected to greater physiological stress than the infauna.

In addition to the nine stations in the inner channel, eight others were occupied in adjacent waterways of Little River Inlet. Polychaetes were the dominant infaunal animals at all of these stations (Table 10). A large number of live oysters, along with typical brackish water oyster associates, were collected at station LRA-1 in the intracoastal waterway. The epifauna was substantially better represented at stations LRA-7 and LRA-8 in Bonaparte Creek than any other area sampled in the inlet (Table 11). A number of Euryhaline Marine I species (those tolerating salinities from above 30 o/oo to a minimum of 18 o/oo) were present, suggesting that this creek has polyhaline salinities and probably less pronounced oscillations in salinity compared with other areas studied in the inlet.

Table 10. Species of macroinvertebrates collected in adjacent waterways, and their estimated densities in numbers m^{-2}. Estimates were based on two 0.13 m^2 samples at each of eight stations.

P = polychaete, B = bivalve, A = amphipod, G = gastropod, D = decapod, E = echinoderm, T = tunicate, C = cumacean

Species	LRA-1	LRA-2	LRA-3	LRA-4	LRA-5	LRA-6	LRA-7	LRA-8
Spiophanes bombyx (P)		42	58	123	139	81	54	424
Nereis succinea (P)	23	23					246	316
Podarke obscura (P)		39					331	8
Notomastus sp. (P)	23	35			15		85	62
Polychaeta A (undet.)	54	23	8	15	12		77	46
Tellina sp. (B)	23	19		4	108	35		
Clymenella torquata (P)		23		27			100	15
Corophium lacustre (A)	62			12			69	
Nemertina (undet.)	15		8	8	4	8	8	46
Melita nitida (A)	85							
Mercenaria mercenaria (B)	23	19		4			15	15
Autolytus sp. (P)		4						69
Nephtys bucera (P)			42		19	12		
Acanthohaustorius sp. (A)			19		23	31		
Streblospio benedicti (P)		15		12				39
Turbonilla sp. (G)		4		46				
Paraprionospio pinnata (P)				39	8			
Glycera dibranchiata (P)	23			19				
Crassostrea virginica (B)	31	4						
Glycera americana (P)				8				23
Actiniaria (undet.)							8	15
Tharyx setigera (P)							15	8
Neopanope sayi (D)		4						15
Spionidae B (P)							15	

Table 10. (continued)

Species	LRA-1	LRA-2	LRA-3	LRA-4	LRA-5	LRA-6	LRA-7	LRA-8
Pelecypoda (undet.)		15						
Microprotopus raneyi (A)							15	
Asterias forbesi (E)								15
Hemipholis elongata (E)								15
Pectinaria gouldii (P)				4			8	
Abra lioica (B)				4				8
Glycera sp. (P)		4					4	
Haploscoloplos fragilis (P)	8							
Polydora ligni (P)					4	4		
Pista sp. (P)							8	
Diodora cayenensis (G)							8	
Brachidontes exustus (B)		8						
Spisula sp. (B)							8	
Mulinia lateralis (B)							8	
Chione cancellata (B)								8
Batea catharinensis (A)							8	
Alpheus normanni (D)							8	
Pagurus sp. (D)								8
Portunus sp. (D)								8
Molgula manhattensis (T)							8	
Heteromastus filiformis (P)				4				
Onuphis sp. (P)		4						
Diopatra cuprea (P)					4			
Polychaeta B (undet.)				4				
Gastropoda (undet.)				4				
Nucula proxima (B)				4				
Nuculana sp. (B)			4					

Table 10. (continued)

Species	LRA-1	LRA-2	LRA-3	LRA-4	LRA-5	LRA-6	LRA-7	LRA-8
Cyclaspis varians (C)				4				
Oxyurostylus smithi (C)					4			
Ampelisca vadorum (A)				4				
Corophium sp. (A)		4						
Trichophoxus epistomus (A)						4		
Protohaustorius deichmannae (A)					4			
Listriella clymenellae (A)				4				
Monoculodes sp. (A)		4						
Pinnixa chaetopterana (D)					4			
No. Individuals	370	293	139	353	348	175	1106	1163
No. Species	11	19	6	21	13	7	22	20
Species Richness	1.69	3.17	1.01	3.41	2.05	1.16	3.00	2.69
Species Diversity (H')	3.18	3.79	2.06	3.35	2.47	2.14	3.21	2.94
Evenness (J')	0.92	0.89	0.80	0.76	0.67	0.76	0.72	0.68

Table 11. Benthic invertebrates from oyster dredge collections at eight stations in adjacent waterways.

Species	LRA-1	LRA-2	LRA-3	LRA-4	LRA-5	LRA-6	LRA-7	LRA-8
Phylum Porifera								
Cliona celata							+	+
Cliona truitti							+	+
Phylum Cnidaria								
Ectopleura dumortieri				+				+
Turritopsis nutricula							+	+
Hydractiniidae (undet.)							+	
Bougainvillia rugosa		+						
Garveia franciscana		+						
Garveia humilis								+
Amphinema dinema								+
Pandeidae (undet.)		+					+	
Eudendrium sp.							+	+
Clytia cylindrica							+	+
Clytia kincaidi								+
Obelia dichotoma	+	+		+			+	+
Campanulina sp.			+	+				
Campanopsis (?) sp.							+	+
Schizotricha tenella							+	+
Renilla reniformis						+		
Haliplanella luciae							+	
Astrangia danae							+	
Phylum Platyhelminthes								
Stylochus ellipticus	+	+		+			+	+

Table 11. (continued)

Species	LRA-1	LRA-2	LRA-3	LRA-4	LRA-5	LRA-6	LRA-7	LRA-8
Phylum Rhynchocoela								
Nemertina (undet.)							+	
Phylum Entoprocta								
Pedicellina cernua							+	+
Phylum Bryozoa								
Anguinella palmata							+	+
Bowerbankia gracilis							+	+
Aeverrillia setigera							+	
Membranipora tenuis	+	+	+	+			+	+
Conopeum tenuissimum	+	+						
Electra monostachys		+		+				
Bugula neritina				+				
Schizoporella errata							+	
Parasmittina nitida							+	
Phylum Annelida								
Clymenella torquata				+				
Nereis succinea	+	+		+			+	+
Sabellaria vulgaris		+		+			+	+
Hydroides dianthus							+	+
Polydora sp.	+							
Phylum Mollusca								
Diodora cayenensis								+
Urosalpinx cinerea							+	+
Eupleura caudata							+	+

Table 11. (continued)

Species	LRA-1	LRA-2	LRA-3	LRA-4	LRA-5	LRA-6	LRA-7	LRA-8
Busycon carica							+	+
Brachidontes exustus	+	+	+	+				+
Anomia simplex								+
Crassostrea virginica	+	+					+	+
Chione cancellata							+	+
Martesia cuneiformis							+	+
Phylum Arthropoda								
Balanus amphitrite				+				
Balanus improvisus	+	+	+	+			+	+
Erichthonius brasiliensis	+		+					
Paracaprella tenuis							+	+
Alpheus normanni							+	+
Callinectes sapidus			+					+
Panopeus herbstii	+							+
Phylum Echinodermata								
Asterias forbesi							+	+
Ophiothrix angulata							+	
Mellita quinquesperforata					+			
Phylum Chordata								
Molgula manhattensis							+	
No. Species	11	13	6	13	1	1	36	35

Live oysters were common at these two stations, but shells in the creek were heavily infested with boring sponges, and several predatory gastropods were collected. The fewest species in samples from stations in adjacent waterways were obtained at stations LRA-3, LRA-5, and LRA-6; the bottom at each of these stations was predominantly sandy with little shell or other firm substrates.

Tidal Marshes

Tidal marshes of Little River Inlet were classified as salt marshes; their floral composition reflects the marine influence of the region. A list of plants observed during field surveys, along with their location within the marshes or contiguous uplands, is given in Table 12.

In general, the salt marshes of Little River Inlet may be separated into low marsh and high marsh zones based on tidal elevation and vegetative composition. The regularly flooded low marsh extends from a point slightly above the mean low water mark approximately to the mean high water level. The high marsh occurs above this zone in an area which is flooded only by spring and storm tides. Differences in tidal elevation and such related physical conditions as soil salinity and submergence and exposure are accompanied by an obvious change in plant community composition between these two marsh zones.

A monospecific community of smooth cordgrass, *Spartina alterniflora*, typifies the low marsh. Lacking major competitors, this plant dominates intertidal marsh and frequently attains heights of six feet or more along creek margins. Smooth cordgrass is generally regarded as the most valuable and productive salt marsh plant along the Atlantic and Gulf coasts from an ecological standpoint.

In contrast with the low marsh, plant composition of the high marsh is more varied. Several halophytes occur in abundance, including glasswort

Table 12. List of observed marsh and marsh-bordering plants in the Little River Inlet study area.

Common Name	Scientific Name	Abbreviation	Location
Smooth cordgrass	*Spartina alterniflora*		low marsh, high marsh
	short form	SSA	
	medium form	MSA	
Marsh-hay cordgrass	*Spartina patens*	Sp	high marsh, shrub border
Sea lavender	*Limonium* sp.	L	high marsh, shrub border
Glasswort	*Salicornia virginica*	Sv	high marsh
Salt-marsh aster	*Aster* sp.	A	high marsh
Sea ox-eye	*Borrichia frutescens*	Bf	high marsh, shrub border
Salt-grass	*Distichlis spicata*	Ds	high marsh, shrub border
Salt-marsh fimbristylis	*Fimbristylis spadicea*	Fs	high marsh, shrub border
Seaside goldenrod	*Solidago sempervirens*	Ss	high marsh, shrub border
Coastal dropseed	*Sporobolus virginicus*	SV	high marsh
Black needlerush	*Juncus roemerianus*	Jr	high marsh, shrub border
American three-square	*Scirpus americanus*	Sa	high marsh
Salt-marsh bulrush	*Scirpus robustus*	Sr	high marsh
Narrow-leaved cattail	*Typha angustifolia*	Ta	high marsh
Sea-blite	*Suaeda linearis*	Sl	high marsh (shell mounds)
Swithgrass	*Panicum virgatum*	Pv	shrub border
Poison ivy	*Rhus radicans*	Rr	shrub border
High tide bush	*Iva frutescens*	If	shrub border
Sea myrtle	*Baccharis hamilifolia*	Bh	shrub border, adjacent upland
Wax myrtle	*Myrica cerifera*	Mc	shrub border, adjacent upland
Coastal cedar	*Juniperus virginiana*	Jv	adjacent upland
Slash pine	*Pinus elliottii*	Pe	adjacent upland
Loblolly pine	*Pinus taeda*	Pt	adjacent upland
Yaupon	*Ilex vomitoria*	Iv	adjacent upland
Live oak	*Quercus virginiana*	Qv	adjacent upland
Greenbriar	*Smilax* sp.	S	adjacent upland
Pokeweed	*Phytolacca americana*	Pa	adjacent upland
Broomsedge	*Andropogon* sp.	A	adjacent upland, shrub border
Finger grass	*Chloris* sp.	C	adjacent sand flat
Beach elder	*Iva imbricata*	Ii	adjacent sand flat
Sea oats	*Uniola paniculata*	Up	adjacent dune ridge
Camphorweed	*Heterotheca subaxillaris*	Hs	adjacent sand flat, spoil area
Dock	*Rumex* cf. *hastatulus*	Rh	adjacent sand flat, spoil area

(Salicornia virginica), sea lavender (Limonium spp.), salt marsh aster (Aster sp.), salt grass (Distichlis spicata), salt marsh bulrush (Scirpus robustus), and a stunted form of smooth cordgrass. As the high marsh approaches the upland, several other marsh plants enter the community, including salt marsh fimbristylis (Fimbristylis spadicea), seaside goldenrod (Solidago sempervirens), black neddlerush (Juncus roemerianus), high tide bush (Iva frutescens), sea myrtle (Baccharis halimifolia), switchgrass (Panicum virgatum), wax myrtle (Myrica cerifera), and broomsedge (Andropogon sp.). This upper high marsh community is dominated by marsh-hay cordgrass (Spartina patens) and saltgrass (Distichlis spicata), while sea ox-eye (Borrichia frutescens), high tide bush (Iva frutescens) and salt marsh bulrush (Scirpus robustus) are also quite abundant. Cattail (Typha angustifolia) and three-square (Scirpus americanus) are locally abundant in the marshes near the Atlantic Intracoastal Waterway, apparently associated with freshwater inflow of Little River.

The plant composition of nineteen areas within the study region is given in Table 13. Dominants, as well as associated plants and approximate elevation, are included.

Marsh Transect Survey

Three histograms (Figs. 8-10) were constructed for the established marsh transects to display specific zonal trends in the plant communities of the Little River Inlet marshes. The height of the bar represents the relative abundance of species on a scale from 1 to 4.

Transect 1 on Bird Island exhibited a change in floral composition coincident with increasing elevation from one dominated by smooth cordgrass at the lowest elevation to one with several common species in higher elevations (Fig. 8). The lower level of the high marsh is

Table 13. Results of field observations of 19 marsh locations in Little River Inlet study area.

Station No.	General Location	Dominant Vegetation	Associated Vegetation	Approximate Elevation (Ft. Above MLW)	Comments
1	Bird Island	Spartina alterniflora		4.2	Monospecific stand
1a	Bird Island	Spartina patens	SSA, L, Bf, Sv, Ds, Fs, Ss, Hs, Rh	7.2	Probable old spoil mound
2	Bonaparte Creek	Spartina alterniflora		4.6	Monospecific stand
3	Goat Island	Spartina alterniflora	Higher elevations - Sv Bf, L, Sp, Fs	4.3	Seaward edge of island - Sp. v., Sp, If, Pv, Up, Bh, Bf, L, Ds, Jr
4	Goat Island	Spartina alterniflora (MSA & SSA)	Marsh edge - SSA, Ds, Sp, Bf, If, Pv, Bh, Jr	3.5	Edge of island - Pt, Mc, S and other maritime forest species
5	Goat Island	Spartina patens	If, Bf, L, Bh, Mc, Pv, Jr	5.5	Lower elevations - MSA, Sv, Ds, Bf, L, A
5a	Goat Island	Spartina alterniflora	Higher elevations - Ds, MSA, Bf, L, Sp, If	3.7	
6	Waties Island	Salicornia virginica	SSA, Ds, L, Bf	5.3	Higher elevations (spoil mound) - Sp, If, Bf, Ds, SSA, A, Pv, Fs, Ss, Sp. v.
7	Waties Island	Spartina patens (higher levels)	Bf, If, Ds, Sv, A, L	5.5	Spartina patens replaced by Spartina alterniflora at lower elevations
		Mixed community (lower levels)	Bf, Ds, Sv, SSA, A, L		
8	Waties Island	Spartina patens	Fs, Ds, Bf, L, Mc, Sr, Iv	5.8	
9	Mink Island	Spartina alterniflora		5.2	Monospecific stand
10	Mink Island	Mixed community - Mc, Jv, Iv, Bh, If	Typical high marsh species	7.4	Former open marsh disposal area
11	Milliken Cove	Spartina alterniflora	Sr, If, Bf, Sp and other high marsh species	4.5	
12	Colkins Neck AIWW	Spartina alterniflora	Ta, Bf, If, Bh and other high marsh species	5.0	
13	Little River Neck Little River	Spartina alterniflora	Sa, Sr, Ta, Jr, Sv, L, Sp, If, Bf, Bh, Sl	4.5	Edge of mainland - Mc, Bh, Pt, Jv, Qv, Iv; Scirpus americanus abundant along marsh-upland border
14	The Battery Island	Spartina alterniflora		3.4	Monospecific stand
15	Dunn Sound Creek	Spartina alterniflora		4.4	Monospecific stand
16	Dunn Sound Creek	Spartina alterniflora		4.2	Monospecific stand
17	Dunn Sound Creek	Spartina alterniflora		3.2	Monospecific stand

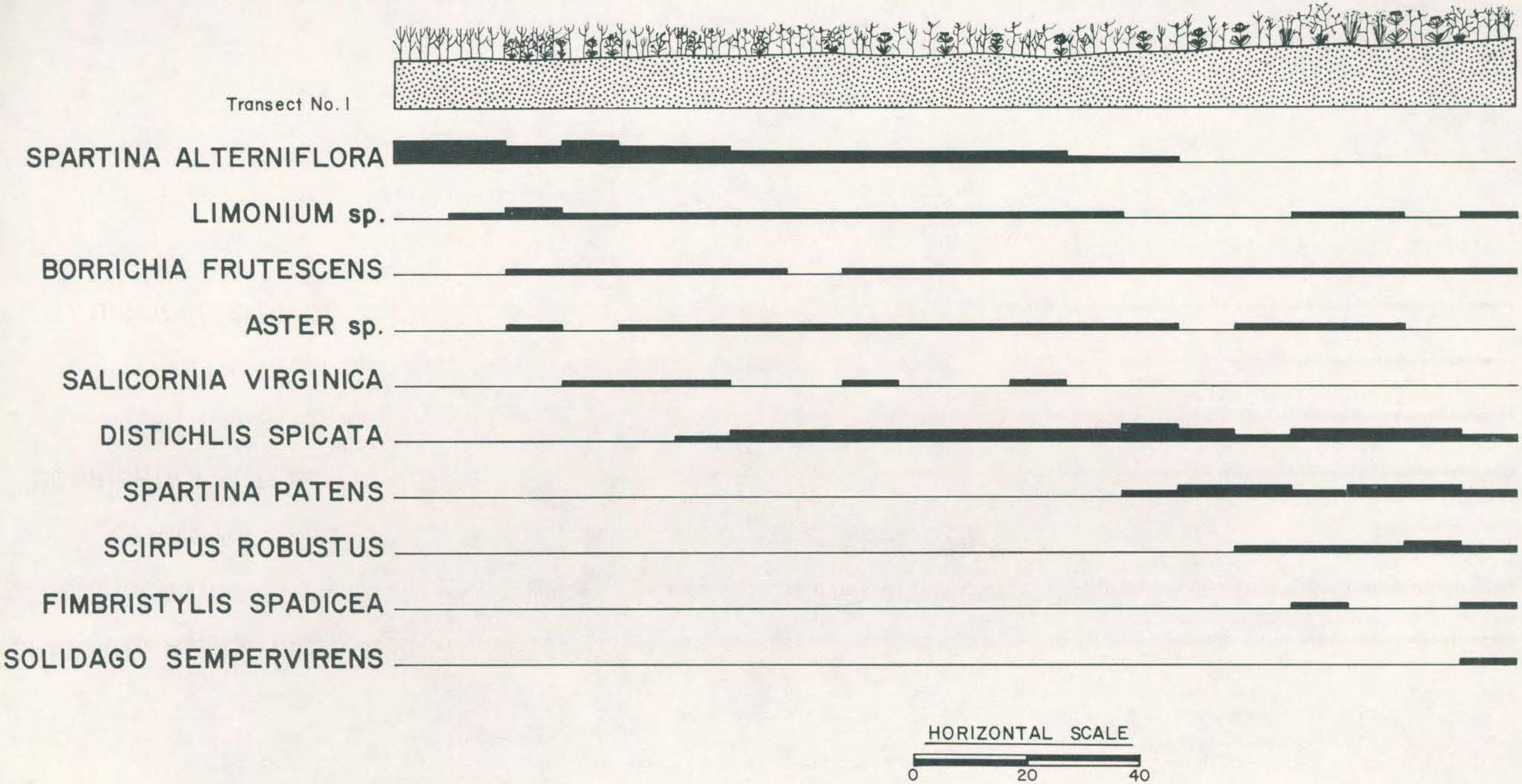


FIGURE 8. Bird Island floral transect.

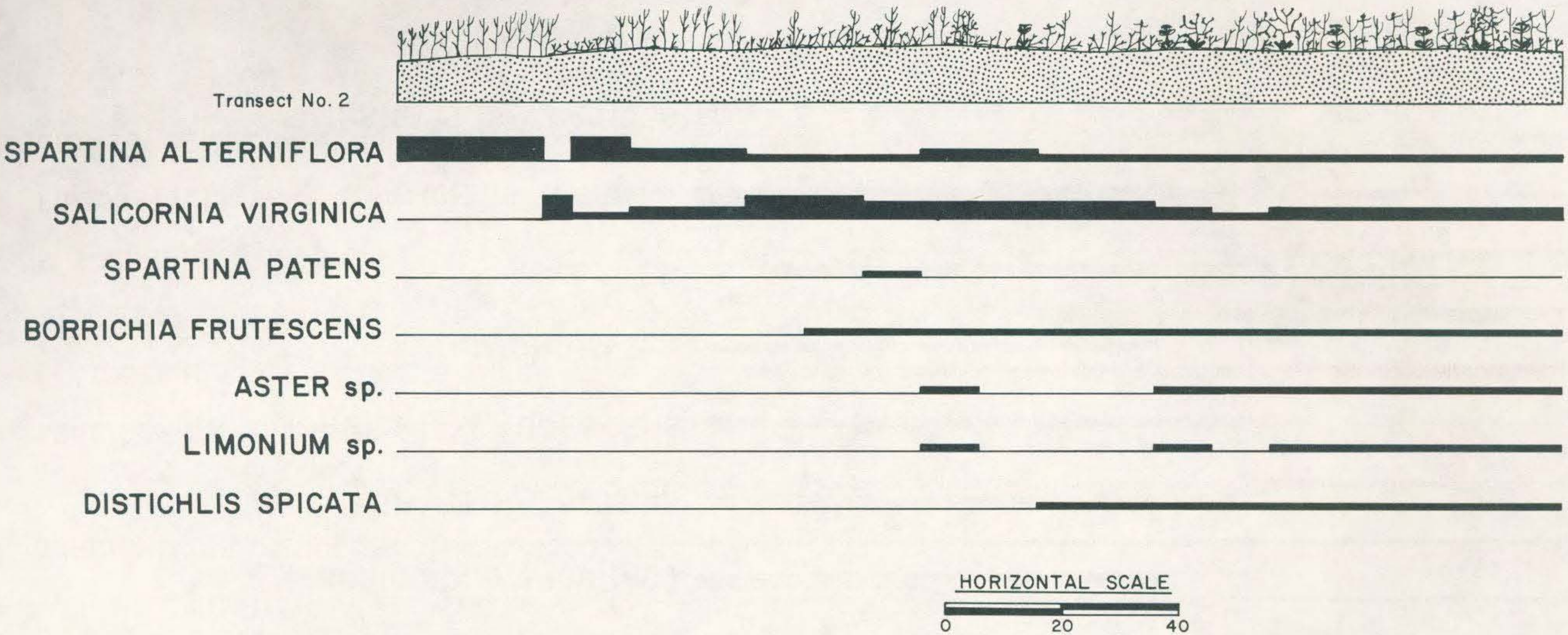


FIGURE 9. Waties Island floral transect.

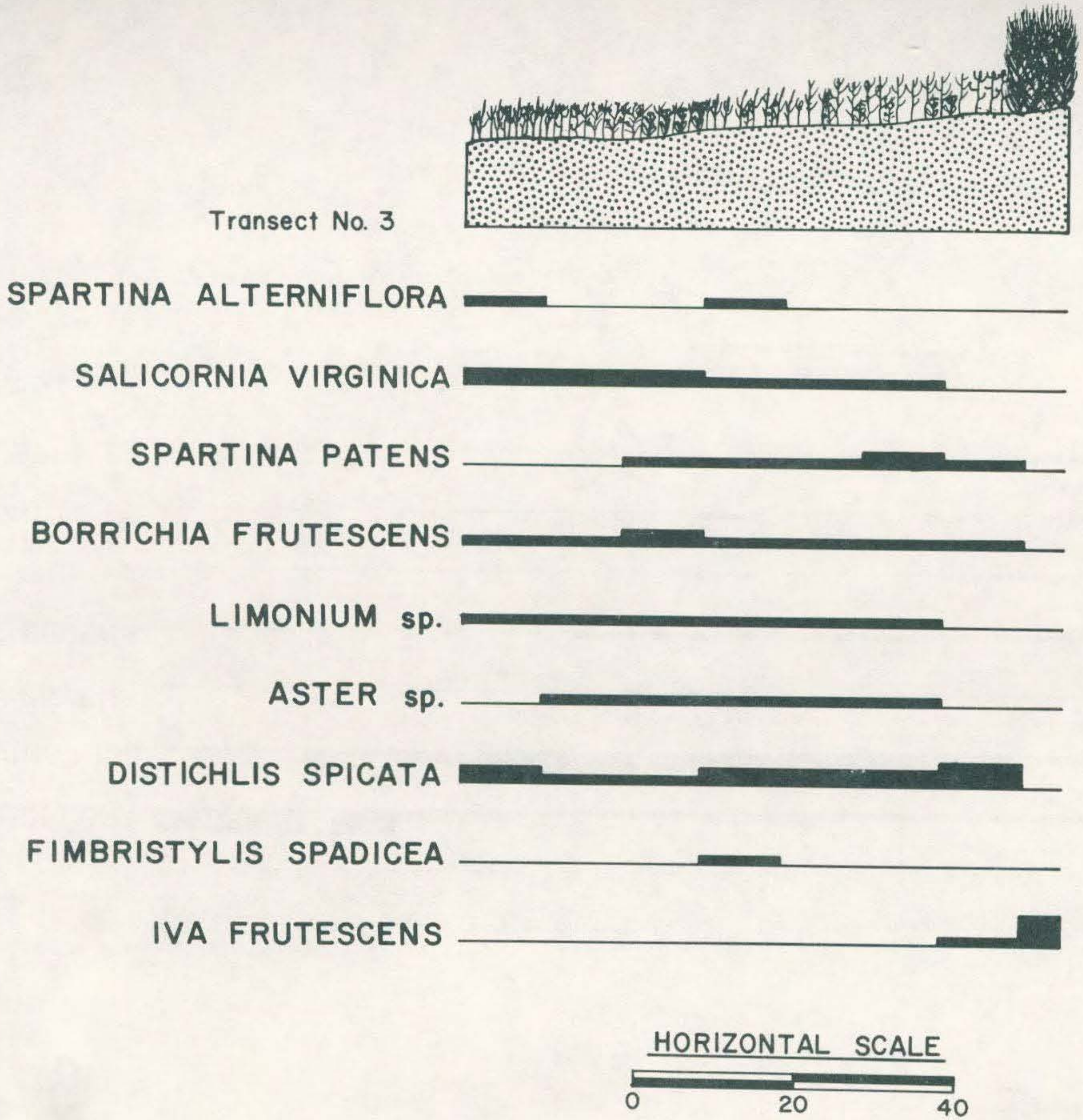


FIGURE 10. Waties Island upper high marsh floral transect.

occupied primarily by smooth cordgrass, salt grass, sea ox-eye, aster, sea lavender, and glasswort. At the upper level nearer the upland, smooth cordgrass and glasswort are replaced by marsh-hay cordgrass, saltmarsh bulrush, fimbristylis, and goldenrod. Although not observed within this transect, high tide bush and wax myrtle are present in the immediate vicinity, while sea myrtle occurs in the general area as a bordering species.

Transect 2 on Waties Island (Fig. 9) was similar to the lower portion of Transect 1. In this area, glasswort was more abundant than in the Bird Island transect. It occurred mainly with smooth cordgrass yet sea ox-eye, salt grass, marsh-hay cordgrass, aster, and sea lavender were also observed in this association.

The high marsh-upland border, including the marsh shrub zone, was surveyed in Transect 3 on Waties Island (Fig. 10). This transect began at the margin of a rather extensive _Salicornia_ meadow (Station 6), where glasswort, saltgrass, stunted smooth cordgrass, sea ox-eye, and sea lavender were present. Toward high ground along this transect, marsh-hay cordgrass and fimbristylis appeared. Saltgrass flourished from this general area to the beginning of the shrub zone, where high tide bush predominated.

Habitat Types

Using current photogrammetric techniques, nine habitat types were identified and delineated within the 2,765 acres of the Little River Inlet study area (Fig. 11). Approximate acreages for these habitats are presented in Table 14.

Tidal marshes encompassed approximately forty percent (1050 acres) of the study area. The majority of these wetlands (84% or 900 acres) was classified as low marsh, while the remaining wetland was designated

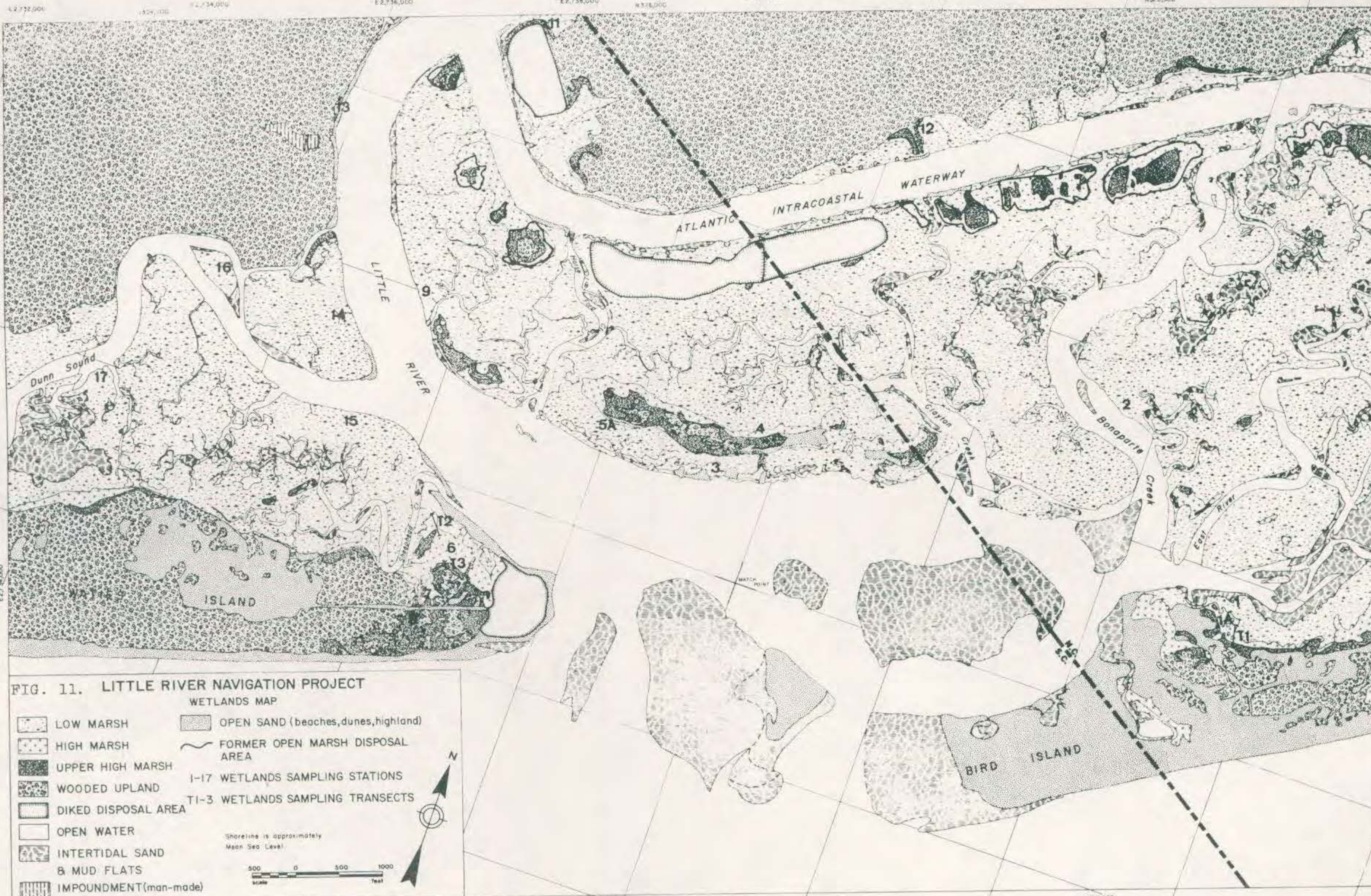


FIG. 11. LITTLE RIVER NAVIGATION PROJECT
WETLANDS MAP

Table 14. Habitat types within the Little River Inlet study area.

Habitat Type	Number of Acres
Open Water	471
Intertidal Sand and Mud Flats	282
Low Marsh	883
High Marsh	110
Upper High Marsh	57
Diked Disposal Areas	57
Open Sand (beaches, dunes, highland)	213
Wooded Upland	690
Impoundments	2

as either high marsh or upper high marsh. Fifty-seven acres of former salt marsh have been diked by the Corps of Engineers for maintenance of the Atlantic Intracoastal Waterway, while other marsh areas, formerly low marsh, have been altered to high marsh, upper high marsh, or wooded upland habitats by past open marsh disposal techniques.

Over 900 acres of upland habitat, including open sand areas and wooded highland, were present within the study region. Open water and intertidal flats occupied 753 acres. Only one impoundment, nearly two acres in size, occurred here.

Oyster Reefs

Intertidal oyster reefs within 0.5 miles of the centerline of the proposed channel are shown in Fig.12. These include shoreline (bank) reefs and isolated reefs (beds) located in shoal and flat areas.

The total acreage of intertidal oyster reefs within the project area amounted to about 2.480 acres. Approximately 1.840 acres of the total were shoreline reefs, including 0.904 acres having heavy coverage, 0.742 acres of medium coverage, and 0.193 acres of light coverage by living oysters. Individual reefs (beds) totalled only 0.638 acres, including 0.586 acres of heavy coverage, 0.025 acres of medium coverage, and 0.267 acres of light coverage.

No significant reefs of subtidal oysters were found in the Little River study area.

Clam Resources

Approximately 37 acres of bottoms containing hard clams were located in the Little River study area (Fig.13). These were located both in intertidal and subtidal areas within Little River and its tributary creeks. Bottoms containing hard clams totalled 12 acres in Dunn Sound Creek,

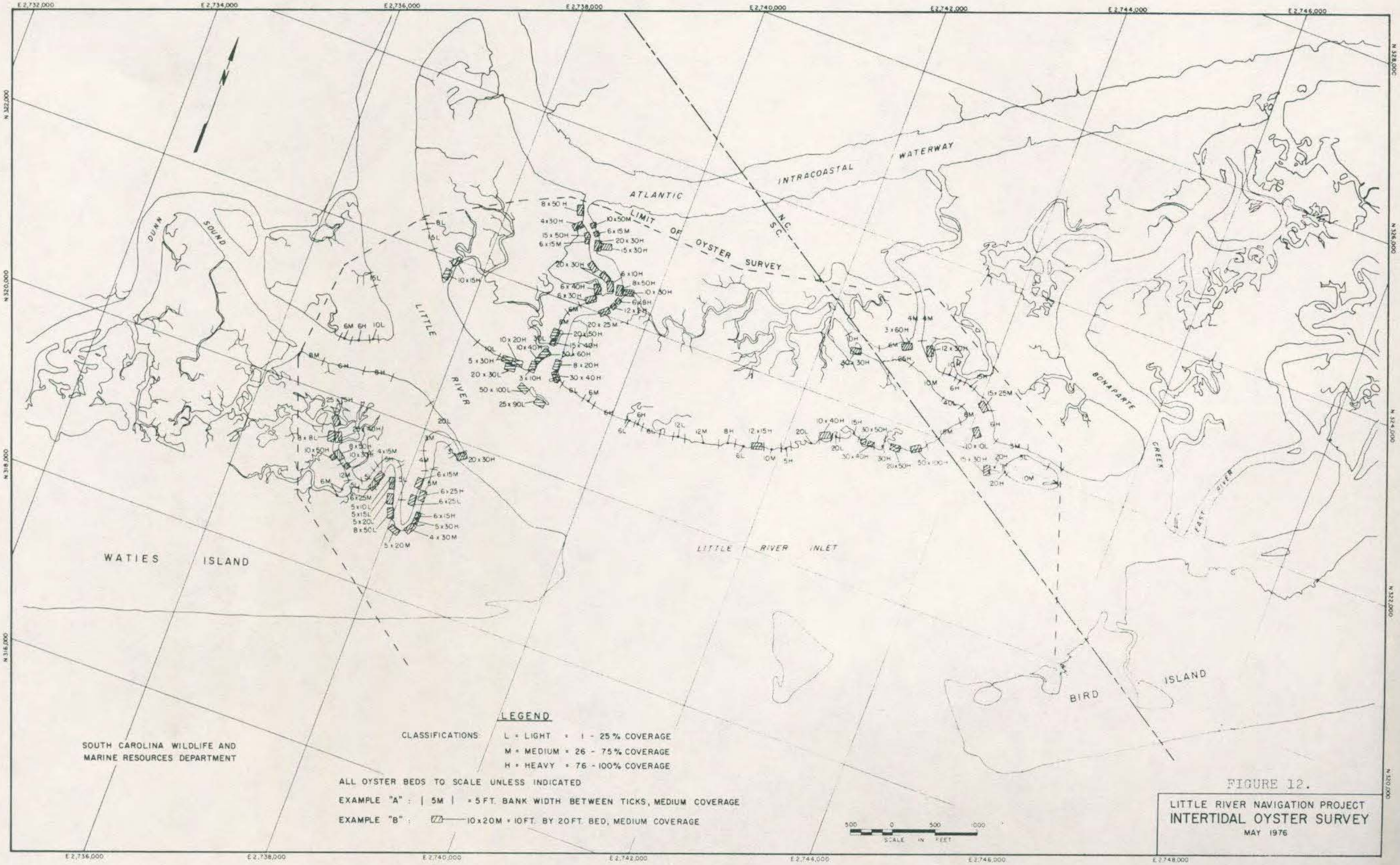


FIGURE 12.

LITTLE RIVER NAVIGATION PROJECT
INTERTIDAL OYSTER SURVEY
MAY 1976

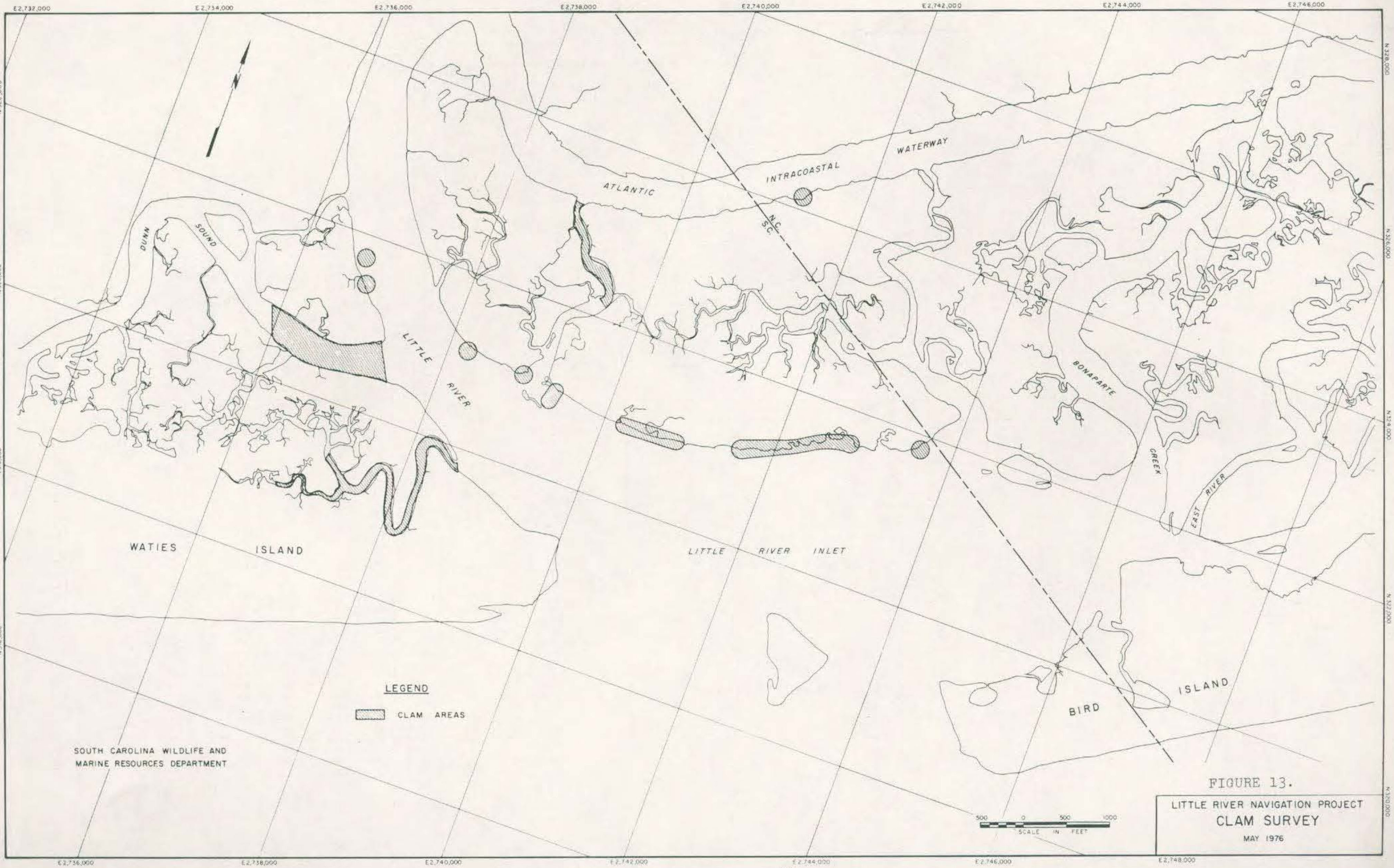


FIGURE 13.

LITTLE RIVER NAVIGATION PROJECT
CLAM SURVEY
MAY 1976

7.4 acres in Horse Ford Creek, 9 acres in Sheepshead Creek, and 8.21 acres in Little River.

SUMMARY AND RECOMMENDATIONS

Little River Inlet is a small estuary behind two barrier islands (Waties Island and Bird Island) on the border of North Carolina and South Carolina. The bottom is sandy in most of the lower portion of the estuary, and predominantly shelly in the creeks and in the main channel toward the Atlantic Intracoastal Waterway. Extensive ebb and flood tidal deltas occur near the mouth, making navigation in and out of the inlet treacherous. The proposed Little River Navigation Project of the U. S. Army, Corps of Engineers would provide a stable channel and jetty system into the inlet.

Environmental investigations were conducted at Little River during spring and summer 1976 to inventory the benthic communities, wetlands, and shellfish resources prior to initiation of the proposed project. This represents the first report of the benthic communities and wetlands of this estuary.

The Little River estuary serves as an important nursery area for important species such as penaeid shrimp, blue crabs, and fishes. In addition, it is a productive shellfish growing area, although it is presently closed to shellfish harvesting because of water pollution. Little River is an important harbor for recreational craft and party fishing vessels. Because of its significance to recreational and commercial fisheries, the Little River system is important to the economy of the Greater Myrtle Beach area.

Little River Inlet is presently subjected to wide oscillations in salinity, and the number of benthic invertebrate species in the area is low compared with such areas as Murrells Inlet, Price Inlet, and Capers Inlet because of the reduced salinities and poikilohaline conditions.

The intertidal areas of Waties Island and Bird Island were populated by only a few species, all of which are typical of sandy beaches. Haustoriid amphipods and the bivalve Donax variabilis were abundant at both locations. These organisms typically have high resiliency following disturbance. On ecological grounds, the upper intertidal zone of these beaches would be preferable as sites for sandy dredge spoil disposal to regions inside the inlet, and especially wetlands areas.

The invertebrates collected at three stations in the entrance channel consisted largely of infaunal polychaetes and amphipods. This is a dynamic area and no lasting adverse effects on benthic communities are foreseen from the minimal dredging and construction proposed under the Little River Navigation Project. Construction of jetties at the mouth would provide substrate for epifaunal assemblages and benthic algae, both of which are very limited in the entrance channel area at present. These jetties would also provide habitat for numerous fish species, thereby improving sport fishing in the area.

The lower half of the inner channel is currently dominated by sand-dwelling haustoriid amphipods. If the area remains sandy after completion of the navigation project, these animals should rapidly recolonize dredged areas and community structure should remain essentially the same. If conditions are altered so that the substrate becomes shelly or muddy, it is likely that benthic assemblages would become dominated by polychaetes. The upper half of the inner channel and all of the stations sampled in adjacent waterways were dominated by polychaetes. With the exception of LRA-3, LRA-5, and LRA-7, the bottom at these stations was shelly. No dredging appears necessary at any of these locations and little if any impact on the benthos is anticipated unless the hydrography of the area is altered.

The Little River study area covered approximately 2,765 acres including open water, flats, marshlands, disposal areas, impoundments, beaches, and upland areas. Tidal marshes, making up about forty percent or 1,050 acres of this total, were classified as low marsh, dominated by Spartina alterniflora (900 acres), and high marsh, populated by a variety of species (150 acres).

Since no marshland disposal sites are proposed for the Little River Navigation Project, adverse effects upon wetlands should be minimal. It does appear that the proposed sand dikes on Waties and Bird Islands would cross some marginal marshland and intertidal areas. If possible, these dikes should be aligned to avoid the wetland areas mentioned.

Intertidal oyster reefs in the study area were small and widely scattered, totalling about 2.5 acres. No dredging or disposal operations are planned within the immediate vicinity of these reefs, and little physical damage to intertidal oyster communities is foreseen, provided that no extensive sand transport from channel dredging occurs.

An estimated 37 acres of intertidal and subtidal bottoms containing hard clams were located in the Little River study area. Hard clams potentially represent the most valuable molluscan resource in the Little River estuary. In spite of the present closure of the area to shellfish harvesting, hard clams could be removed by commercial operators and replanted in clean waters elsewhere for depuration prior to marketing. Bottoms with concentrations of hard clams were located primarily near the inner shorelines of Little River and in tributary creeks, and none were found within the proposed inlet channel area. Immediate physical effects of the proposed dredging on these resources should be minimal, although the long range effects of the project on the clam resources are not known.

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