

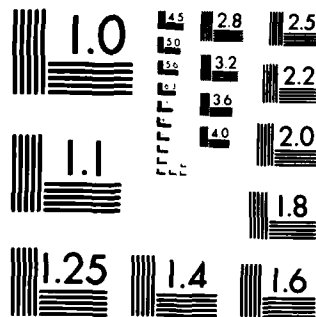
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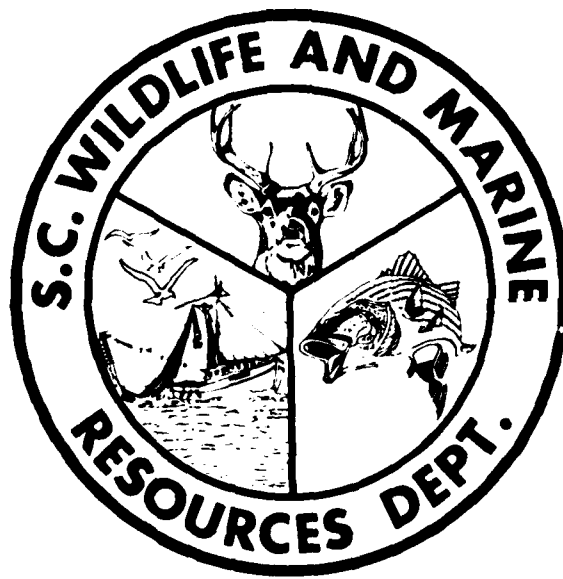


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ENVIRONMENTAL STUDIES OF LITTLE RIVER INLET,
HORRY COUNTY, SOUTH CAROLINA
AND
BRUNSWICK COUNTY, NORTH CAROLINA



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ENVIRONMENTAL STUDIES OF LITTLE RIVER INLET,
HORRY COUNTY, SOUTH CAROLINA
AND
BRUNSWICK COUNTY, NORTH CAROLINA

Final Report Submitted To

Charleston District,
U.S. Army, Corps of Engineers
Contract No. DACW60-76-C-0017

by

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INTRODUCTION

The Little River Inlet System, situated at the North Carolina - South Carolina border, is significant to the economy of the Grand Strand area in terms of recreational and commercial fisheries. This estuary is an important nursery area for penaeid shrimp, blue crabs, and numerous fin-fish species. Common saltwater game fish inhabiting the area include spot, sea trout, drum, flounder, channel bass, mackerel and bluefish. Although most of the Little River area is currently polluted and shellfishing is prohibited, abundant resources of the American oyster (Crassostrea virginica), and the hard clam: (Mercenaria mercenaria), are present. Little River is an important harbor for recreational craft, party fishing boats, and commercial fishing vessels.

Little River originates in Little River Swamp and flows generally eastward, entering the Atlantic Ocean at Little River Inlet between Waties Island and Bird Island. The inlet provides an ocean entrance to the Atlantic Intracoastal Waterway and to several tidal streams in the Little River-Calabash estuarine area. The Little River estuarine system is characterized by high energy ocean beaches, sand and mud flats, intertidal shellfish beds, and expanses of salt and brackish water marshes intersected by numerous tidal streams. The estuary receives significant freshwater inflow (average 1200 CFS) and salinities vary considerably. The channel at the entrance of the inlet has shifted constantly over the years and depths across the ocean and inner bars are inadequate for navigational purposes. Channel alignment shifts so frequently that maintenance of channel markers in proper positions by the U. S. Coast Guard has been extremely difficult. During low tides and rough seas, the chan-

nel bars are quite hazardous to vessels, and become impossible to navigate at times.

In 1965, the U. S. Congress authorized a navigational improvement study for Little River Inlet. The Charleston District, U. S. Army Corps of Engineers, was assigned responsibility for the engineering and design of this project.

The proposed navigation project is designed to provide a deeper, more stable channel to the ocean through the inlet bars. The project consists of an entrance channel 300 feet wide and 12 feet deep extending from that depth in the Atlantic Ocean through the outer bar - a distance of 3200 feet; an inner channel 90 feet wide and 10 feet deep from the entrance channel to the AIWW; 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 will be removed by dredging during construction. Approximately 40 acres of sandy bottom will be dredged during construction of the Project. Dredged material will be either utilized for nourishment of adjacent beaches or stockpiled and subsequently positioned along the sand dike alignment, if feasible.

In April of 1976, the Charleston District, Corps of Engineers entered into a contract with the Division of Marine Resources of the South Carolina Wildlife and Marine Resources Department for environmental studies of Little River. 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 intertidal oyster reefs in the vicinity of the project area. This study was of a short term nature and does not constitute a comprehensive environmental impact study of the Little River Navigation Project.

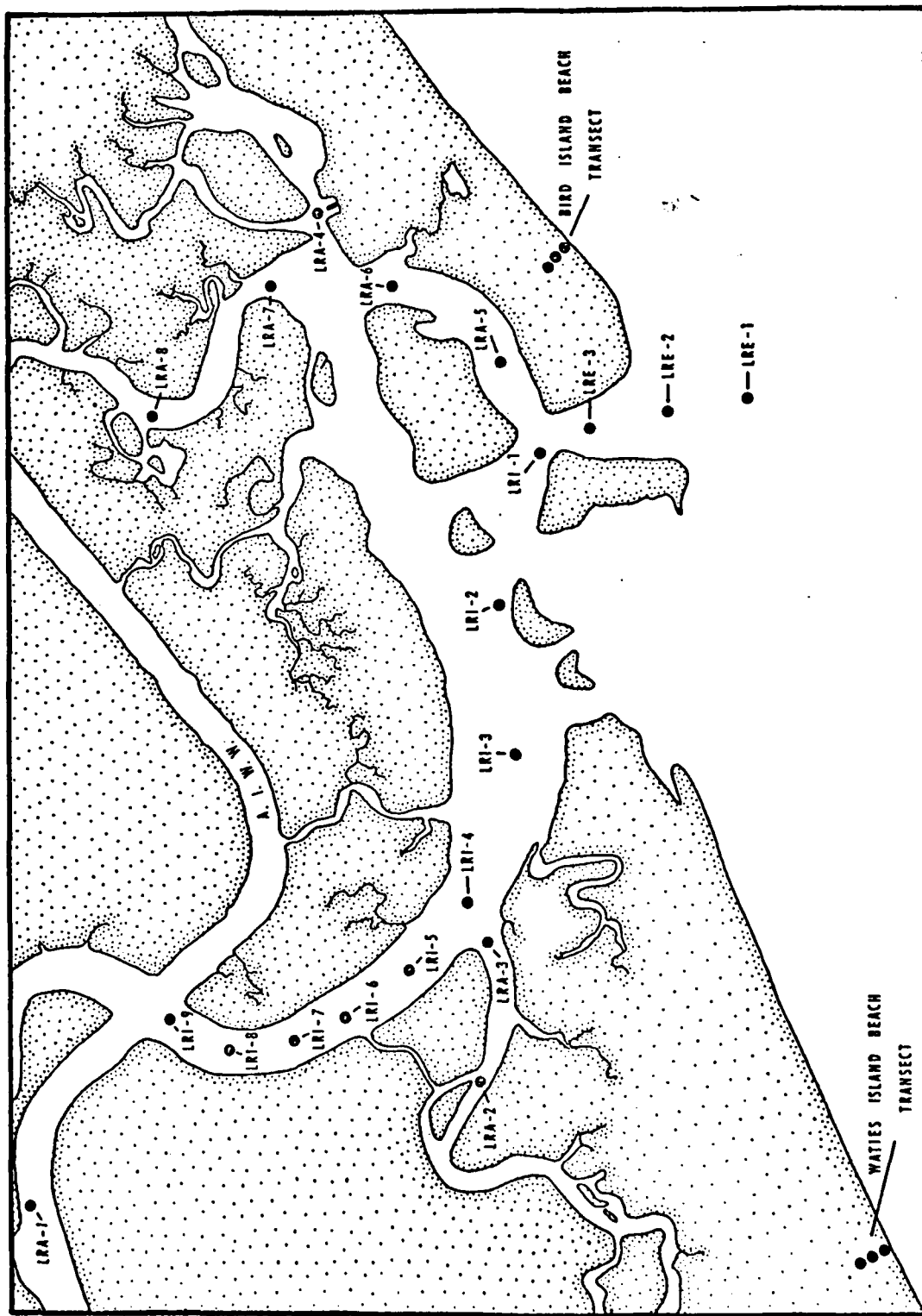


Fig. 1. Benthic sampling stations in the Little River Inlet area.

MATERIALS AND METHODS

Benthic Ecology

Qualitative and quantitative sampling of the benthos was conducted at 26 stations in the Little River Inlet area during 1976 to determine community structure and species diversity of 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 m² and a volume of 10.5 liters, were taken at each station. Samples were washed through sieves of 2.0 and 1.0 mm. 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 m² 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.

Species diversity was measured using the Shannon-Weaver Index (Pielou, 1966):

$$H' = -\sum p_i \log_2 p_i$$



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

Sediment samples were taken at station LRE-2 in the entrance channel, and LRI-1, LRI-3, LRI-5, LRI-7, and LRI-9 in the inner channel. These were frozen with dry ice and shipped to the U. S. Army Corps of Engineers, South Atlantic Division Laboratory, Marietta, Georgia for processing. Analyses were made on the samples 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, 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, to determine whether the inlet estuary is tidally poikilohaline or homoiohaline, salinity samples were taken 1.0 m above the bottom at hourly intervals from low tide (0900) to high tide (1500) at station LRI-3 on 22 April, 1976.

Marsh Vegetation

An inventory of the tidal wetlands within the Little River Inlet study area was conducted during May and June of 1976 to delineate and describe the major types of marsh plant associations. The area was photogrammetrically examined using Marine Resources Division and Charleston District scaled black

and white, color and color infrared aerial photography.

Low altitude color infrared imagery flown 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), flown 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 bodies and identify other significant physical changes within the study area.

Marine Resources Division aerial photography was taken employing a modified Fairchild K-17 mapping camera improved through the addition of a higher resolution 6 inch focal length Planagon lens. The camera was mounted in a wood-framed fiberglass pod attached under the fuselage of a Cessna 172 aircraft. 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, namely upland, low marsh, high marsh, and upper high marsh. Upland areas were not classified according to specific communities since most of the impact of 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 to verify photo-interpretive results and to obtain necessary descriptive information about plant composition of the associated marshlands. Nineteen sampling locations, in addition to three marsh transects (200', 200', 75') were established within the project area (See appended map). 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 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. This map, prepared at a scale of 1:6000, 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 of 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 estuary is regarded as poikilohaline. 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 Inlet. The latter receives negligible fresh water inflow and more nearly corresponds to Odum and Copeland's (1972, 1974) definition of a neutral embayment (Calder, Bearden, and Boothe, 1976).

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 did not reveal any substance in excess of the maximum requirements for the determination of the acceptability of dredge spoil disposal to the nation's waters (Table 3).

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 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 appear to be a better choice for disposal of dredged material, particularly when the spoil is predominantly sandy, than wetlands or waterways within the 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 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 sparse 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. The biota of the inlet is strongly influenced by the local hydrography. The number of species is reduced under the estuarine conditions of the inlet, and the stress of highly variable salinity is particularly evident on the epifauna. There were no assemblages in Little River Inlet comparable to the "live bottom" areas observed previously in Murrells Inlet (Calder, Bearden and Boothe, 1976), where rich communities of sponges, whip corals, and bryozoans provided shelter, substrate, and food 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 and Sertularia stookeyi (hydroids). 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 col-

lected 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 anywhere else 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. 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; bottom type at each of these stations was predominantly sandy with little shell or other firm substrate.

Field Observations of Tidal Marshes

Tidal marshes of Little River Inlet were classified as salt marshes since their plant 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 two major zones, low marsh and high marsh, based on tidal elevation and vegetative composition. The regularly flooded low marsh extends from a point slightly above the mean low water mark to the appropriate mean high water level. The high marsh occurs above this zone in an area which is flooded only by higher than average tides, i.e., spring and storm tides. This difference in tidal elevation and related physical conditions (i.e., submergence and exposure, soil salinity, etc.) is 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 the inter-

tidal 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, with several halophytes occurring in abundance: glasswort (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: salt marsh fimbristylis (Fimbristylis spadicea), seaside goldenrod (Solidago sempervirens), black needle-rush (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.

Table 13 outlines the plant composition of nineteen areas within the study region. Dominant vegetation, as well as associated plants and approximate elevation, are indicated.

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 (T1) on Bird Island exhibited a change in community 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 occupied primarily by six plants: 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 other marsh plants: marsh-hay cordgrass, saltmarsh bulrush, fimbriatylis, 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 (Waties Island) was similar to the lower portion of T1 (Fig. 9). In this area, glasswort was more abundant than in the Bird Island transect. It occurred mainly with smooth cordgrass, yet other species were also observed in this association at lower densities: sea ox-eye, salt grass, marsh-hay cordgrass, aster, and sea lavender.

A transect of the high marsh-upland border, including the marsh shrub zone, was surveyed on Waties Island (Transect 3) and is shown in 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 fimbriatylis appeared. Saltgrass flourished from this general area to the beginning of the shrub zone, where high tide bush predominated.

Environmental Baseline Statistics

Using current photogrammetric techniques, nine habitat types were identified and delineated within the 2,765 acres of the Little River Inlet study area (see appended environmental baseline map). 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 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 on the appended overlay charts. 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 (see appended map). 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, 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 North Carolina-South Carolina border. 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. The region near the mouth has extensive sandy shoals, making navigation in and out of the inlet treacherous.

Environmental investigations were conducted at Little River during the spring and summer of 1976 to inventory the benthic communities, wetlands, and shellfish resources in the vicinity of the proposed navigation project. This represents the first comprehensive study of the benthic communities and wetlands of this estuary. This study was undertaken to provide an environmental assessment of the area prior to initiation of the Little River Navigation Project, which will provide for a stable channel and jetty system into the inlet.

The Little River estuary serves as an important nursery area for important species such as penaeid shrimp, blue crabs, and finfishes, and is a productive shellfish growing area, although it is presently closed to shellfishing 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 com-

pared with such areas as Murrells Inlet, Price Creek, and North 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 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 Inlet Navigation Project. Construction of jetties at the mouth will provide substrate for epifaunal assemblages and benthic algae, both of which are very limited in the entrance channel area at present. These jetties will 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 the area 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, was classified as (1) low marsh, dominated by Spartina alterniflora (900 acres) and (2) high marsh, vegetated 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 Waiter and Bird Islands may 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. Provided that no extensive sand transport from the inlet channel dredging occurs, no physical damage to intertidal oyster communities is foreseen.

An estimated 37 acres of intertidal and subtidal bottoms containing hard clams were located in the Little River study area. Hard clams represent the most potentially valuable molluscan resources in the Little River estuary. In spite of the present closure of the area to shellfishing, hard clams could be removed by commercial operators and replanted in clean waters elsewhere for depuration prior to marketing. Hard clam bottoms 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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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	-	19-IV-76
WI-2	Waties Island - Mid-Tide	-	19-IV-76
WI-3	Waties Island - Low Tide	-	19-IV-76
BI-1	Bird Island - High Tide	-	19-IV-76
BI-2	Bird Island - Mid-Tide	-	19-IV-76
BI-3	Bird Island - Low Tide	-	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

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

Station	Date	Depth	Temp. (C)	Salinity (‰)	D.O. (mg/l)	Turbidity (FTU)	Solids (mg/l)		Nutrients (µg/l)			
							Suspended	Settleable	N03	N02	P04	Si02
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).

	LRI-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

Table 4. Species of macroinvertebrates collected on Woties 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, G = gastropod, I = isopod

Species	High Tide	Mid-Tide	Low-Tide
<u>Parahaustorius longimerus</u> (A)		395	465
<u>Amphiporeia virginiana</u> (A)	10	5	215
<u>Neohaustorius schmitzi</u> (A)	5	205	10
<u>Donax variabilis</u> (B)		135	50
<u>Chiridotea caeca</u> (I)		5	5
<u>Chiridotea</u> sp. (I)	5	5	
<u>Polinices duplicatus</u> (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

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
<u>Donax variabilis</u> (B)		355	205
<u>Parahaustorius longimerus</u> (A)		140	155
<u>Neohaustorius schmitzi</u> (A)		70	135
<u>Nerinides unidentata</u> (P)		60	40
<u>Amphiporeia virginiana</u> (A)			35
<u>Chiridotea</u> sp. A (I)		20	
Nemertine (undet.)		10	5
Mysid (undet.)			15
<u>Chiridotea</u> sp. B (I)			10
<u>Emerita talpoida</u> (D)			10
<u>Spiophanes bombyx</u> (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

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.

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

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

Table 6. (continued)

Species	LRE-1	LRE-2	LRE-3
<u>Sabellaria vulgaris</u> (P)		12	
<u>Anadara ovalis</u> (B)		12	
<u>Notomastus hemipodus</u> (P)		8	
<u>Nephtys bucera</u> (P)	4	4	
<u>Lycastopsis</u> sp. (P)	8		
<u>Eteone heteropoda</u> (P)		8	
<u>Spio</u> sp. (P)		8	
<u>Busycon carica</u> (G)		8	
<u>Brachidontes exustus</u> (B)		8	
<u>Mulinia lateralis</u> (B)		8	
<u>Edotea montosa</u> (I)		8	
<u>Microtopus shoemakeri</u> (A)	8		
<u>Pinnixa retinens</u> (D)	8		
<u>Leptosynapta inhaerens</u> (E)	8		
<u>Arenicola marina</u> (P)	4		
<u>Haploscoloplos fragilis</u> (P)		4	
<u>Owenia fusiformis</u> (P)	4		
<u>Sthenelais boa</u> (P)		4	
<u>Spio setosa</u> (P)	4		
<u>Polinices duplicatus</u> (G)		4	
<u>Mitrella lunata</u> (G)	4		
<u>Terebra dislocata</u> (G)		4	
<u>Nucula proxima</u> (B)	4		
<u>Anadara</u> sp. (B)		4	
<u>Donax variabilis</u> (B)			4
Pelecypoda A (undet.)			4
Pelecypoda B (undet.)	4		

Table 6. (continued)

Species	LRE-1	LRE-2	LRE-3
<u>Chiridotea caeca</u> (I)			4
<u>Ovalipes ocellatus</u> (D)			4
<u>Neopanope sayi</u> (D)			4
<u>Pinnixa sayana</u> (D)		4	
<u>Pinnixa</u> sp. (D)	4		
Brachyuran (young adult)		4	
Chaetognatha (undet.)	4		
Ascidian (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

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

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

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

[illegible]

1

[illegible]

Table 8. (continued)

Species	LRI-1	LRI-2	LRI-3	LRI-4	LRI-5	LRI-6	LRI-7	LRI-8	LRI-9
<u>Sigambra bassi</u> (P)							4		
<u>Sabella microphthalma</u> (P)									4
<u>Spio</u> sp. (P)					4				
<u>Mulinia lateralis</u> (B)					4				
<u>Abra lioica</u> (B)					4				
<u>Balanus improvisus</u> (Ba)					4				
<u>Unciola serrata</u> (A)					4				
<u>Paracaprella tenuis</u> (A)					4				
Amphipod (undet.)							4		
<u>Clibanarius vittatus</u> (D)									4
<u>Pagurus</u> sp. (D)					4				
No. Individuals	216	332	975	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

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									
<u>Microciona prolifera</u>		+							
<u>Cliona celata</u>				+	+			+	
Sponge (undet.)		+							
Phylum Cnidaria									
<u>Rhopilema verrilli</u> (polyp)			+	+					
<u>Bougainvillia rugosa</u>				+	+		+		+
<u>Garveia franciscana</u>								+	
<u>Garveia humilis</u>								+	
<u>Amphinema dinema</u>					+				+
<u>Campanulina</u> sp.						+	+		
<u>Obelia dichotoma</u>				+	+	+	+	+	+
<u>Astrangia danae</u>					+				
Anemone (undet.)								+	+
Phylum Platyhelminthes									
<u>Stylochus ellipticus</u>					+	+	+	+	+
Phylum Rhynchocoela									
Nemertine (undet.)					+				
Phylum Entoprocta									
<u>Barentsia gracilis</u>									+
Phylum Bryozoa									
<u>Acyonidium hauffi</u>					+				

Table 9. (continued)

Species	LRI-1	LRI-2	LRI-3	LRI-4	LRI-5	LRI-6	LRI-7	LRI-8	LRI-9
<u>Anguinella palmata</u>				+	+				
<u>Bowerbankia gracilis</u>					+	+	+	+	
<u>Membranipora arborescens</u>					+				
<u>Membranipora tenuis</u>					+	+		+	+
<u>Conopeum tenuissimum</u>					+		+	+	+
<u>Electra monostachys</u>				+	+		+	+	+

Phylum Annelida

<u>Notomastus hemipodus</u>					+
<u>Nereis succinea</u>	+	+		+	+
<u>Sabellaria vulgaris</u>			+		+
<u>Hydroides dianthus</u>			+		+
Syllidae (undet.)					+
Ampharete sp.					+

Phylum Mollusca

Crepidula plana								+
Urosalpinx cinerea							+	
Nudibranch (undet.)	+			+				+
Anadara ovalis								+
Brachidontes exustus		+		+	+	+	+	+
Lithophaga bisulcata				+				
Modiolus modiolus squamosus				+				
Martesia cuneiformis				+		+		
Crassostrea virginica				+			+	+
Mercenaria mercenaria				+			+	
Bivalve (undet.)							+	

Table 9. (continued)

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

Table 10. Species of macroinvertebrates collected in adjacent waterways, and their estimated densities in numbers m⁻². Estimates were based on two 0.13 m² samples at each of eight stations.

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

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

Table 10. (continued)

Species	LRA-1	LRA-2	LRA-3	LRA-4	LRA-5	LRA-6	LRA-7	LRA-8
<u>Neopanope savi</u> (D)		4						15
<u>Spio setosa</u> (P)							15	
Pelecypoda (undet.)		15						
<u>Microprotopus ranevi</u> (A)							15	
<u>Asterias forbesi</u> (E)								15
<u>Hemiphelis elongata</u> (E)								15
<u>Pectinaria gouldii</u> (P)				4			8	
<u>Abra lioica</u> (B)				4				8
<u>Glycera</u> sp. (P)		4					4	
<u>Haploscoloplos fragilis</u> (P)	8							
<u>Polydora ligni</u> (P)					4	4		
<u>Pista</u> sp. (P)							8	
<u>Diodora cayenensis</u> (C)							8	
<u>Brachidontes exustus</u> (B)		8						
<u>Spisula</u> sp. (B)							8	
<u>Mulinia lateralis</u> (B)							8	
<u>Chione cancellata</u> (B)								8
<u>Batea catharinensis</u> (A)							8	
<u>Alpheus normanni</u> (D)							8	
<u>Pagurus</u> sp. (D)								8
<u>Portunus</u> sp. (D)								8
<u>Molgula nanhattensis</u> (T)							8	
<u>Heteromastus filiformis</u> (P)				4				
<u>Onuphis</u> sp. (P)		4						
<u>Diopatra cuprea</u> (P)					4			
<u>Ampharete</u> sp. (P)				4				

Table 10. (continued)

Species	LRA-1	LRA-2	LRA-3	LRA-4	LRA-5	LRA-6	LRA-7	LRA-8
Gastropod (undet.)				4				
<u>Nucula proxima</u> (B)				4				
<u>Nuculana</u> sp. (B)			4					
<u>Cyclaspis varians</u> (C)				4				
<u>Oxyurostylus smithi</u> (C)					4			
<u>Ampelisca vadorum</u> (A)				4				
<u>Corophium</u> sp. (A)		4						
<u>Trichophoxus epistomus</u> (A)						4		
<u>Protohaustorius deichmannae</u> (A)					4			
<u>Lystriella clymenellae</u> (A)				4				
<u>Monoculeides</u> sp. (A)		4						
<u>Pinnixa chaetopterana</u> (B)					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

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								
<u>Cliona celata</u>							+	+
<u>Cliona truitti</u>							+	+
Phylum Cnidaria								
<u>Ectopleura dumortieri</u>				+				+
<u>Turritopsis nutricula</u>							+	+
Hydractiniidae (undet.)							+	
<u>Bougainvillia rugosa</u>		+						
<u>Garveia franciscana</u>		+						
<u>Garveia humilis</u>								+
<u>Amphinema dinema</u>								+
Pandeidae (undet.)		+					+	
<u>Eudendrium</u> sp.							+	+
<u>Clytia cylindrica</u>							+	+
<u>Clytia kincaidi</u>								+
<u>Obelia dichotoma</u>	+	+		+			+	+
<u>Campanulina</u> sp.			+	+				
<u>Campanopsis</u> (?) sp.							+	+
<u>Schizotricha tenella</u>							+	+
<u>Renilla reniformis</u>						+		
<u>Haliplanella luciae</u>							+	
<u>Astrangia danae</u>							+	
Phylum Platyhelminthes								
<u>Stylochus ellipticus</u>	+	+		+			+	+

Table 11. (continued)

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

Table 11. (continued)

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

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	<u>Spartina alterniflora</u> short form medium form	SSA MSA	low marsh, high marsh
Marsh-hay cordgrass	<u>Spartina patens</u>	Ss	high marsh, shrub border
Sea lavender	<u>Limonium</u> sp.	L	high marsh, shrub border
Glasswort	<u>Salicornia virginica</u>	Sv	high marsh
Salt-marsh aster	<u>Aster</u> sp.	A	high marsh
Sea ox-eye	<u>Borrchia frutescens</u>	Bf	high marsh, shrub border
Salt-grass	<u>Distichlis spicata</u>	Ds	high marsh, shrub border
Salt-marsh fimbriatylis	<u>Fimbristylis spadicea</u>	Fs	high marsh, shrub border
Seaside goldenrod	<u>Solidago sempervirens</u>	Ss	high marsh, shrub border
Coastal dropseed	<u>Sporobolus virginicus</u>	SV	high marsh
Black needlerush	<u>Juncus roemerianus</u>	Jr	high marsh, shrub border
American three-square	<u>Scirpus americanus</u>	Sa	high marsh
Salt-marsh bulrush	<u>Scirpus robustus</u>	Sr	high marsh
Narrow-leaved cattail	<u>Typha angustifolia</u>	Ta	high marsh
Sea-blite	<u>Suaeda linearis</u>	Sl	high marsh (shell mounds)
Swathgrass	<u>Panicum virgatum</u>	Pv	shrub border
Poison ivy	<u>Rhus radicans</u>	Rr	shrub border
High tide bush	<u>Iva frutescens</u>	If	shrub border
Sea myrtle	<u>Baccharis hamifolia</u>	Bh	shrub border, adjacent upland
Wax myrtle	<u>Myrica cerifera</u>	Mc	shrub border, adjacent upland
Coastal cedar	<u>Juniperus virginiana</u>	Jv	adjacent upland

Common Name	Scientific Name	Abbreviation	Location
Slash pine	<u>Pinus elliotii</u>	Pe	adjacent upland
Loblolly pine	<u>Pinus taeda</u>	Pt	adjacent upland
Yaupon	<u>Ilex vomitoria</u>	Iv	adjacent upland
Live oak	<u>Quercus virginiana</u>	Qv	adjacent upland
Greenbriar	<u>Smilax</u> sp.	S	adjacent upland
Pokeweed	<u>Phytolacca americana</u>	Pa	adjacent upland
Broomsedge	<u>Andropogon</u> sp.	A	adjacent upland, shrub border
Finger grass	<u>Chloris</u> sp.	C	adjacent sand flat
Beach elder	<u>Iva imbricata</u>	Ii	adjacent sandflat
Sea oats	<u>Uniola paniculata</u>	Up	adjacent dune ridge
Camphorweed	<u>Heterotheca subaxillaris</u>	Hs	adjacent sandflat, spoil area
Dock	<u>Rumex</u> cf. <u>hastatulus</u>	Rh	adjacent sandflat, spoil area

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	<i>Spartina alterniflora</i>		4.2	Monospecific stand
1a	Bird Island	<i>Spartina patens</i>	SSA, L, Bf, Sv, Ds, Fs, Ss, Hs, Rh	7.2	Probable old spoil mound
2	Bonaparte Creek	<i>Spartina alterniflora</i>		4.6	Monospecific stand
3	Goat Island	<i>Spartina alterniflora</i>	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	<i>Spartina alterniflora</i> (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	<i>Spartina patens</i>	If, Bf, L, Bh, Mc, Pv, Jr	5.5	Lower elevations - MSA, Sv, Ds, Bf, L, A
5a	Goat Island	<i>Spartina alterniflora</i>	Higher elevations - Ds, MSA, Bf, L, Sp, If	3.7	
6	Waties Island	<i>Salicornia virginica</i>	SSA, Ds, L, Bf	5.3	Higher elevations (spoil mound) - Sp, If, Bf, Ds, SSA, A, Pv, Fs, Ss, Sp. v.
7	Waties Island	<i>Spartina patens</i> (higher levels) Mixed community (lower levels)	Bf, If, Ds, Sv, A, L, Bf, Ds, Sv, SSA, A, L	5.5	<i>Spartina patens</i> replaced by <i>Spartina alterniflora</i> at lower elevations
8	Waties Island	<i>Spartina patens</i>	Fs, Ds, Bf, L, Mc, Sr, Iv	5.8	
9	Mink Island	<i>Spartina alterniflora</i>		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

STATION NO.	GENERAL LOCATION	DOMINANT VEGETATION	ASSOCIATED VEGETATION	APPROPRIATE ELEVATION (Ft. above MLW)	COMMENTS
11	Milliken Cove	<i>Spartina alterniflora</i>	Sr, If, Bf, Sp and other high marsh species	4.5	
12	Colkins Neck ATW	<i>Spartina alterniflora</i>	Ta, Bf, If, Bh and other high marsh species	5.0	
13	Little River Neck Little River	<i>Spartina alterniflora</i>	Sa, Sr, Ta, Jr, Sv, L, Sp, If, Bf, Bh, Sl	4.5	Edge of mainland - Mc, Bh, Pt, Jv, Qv, Iv; <i>Scirpus americanus</i> abundant along marsh-upland border
14	The Battery Island	<i>Spartina alterniflora</i>		3.4	Monospecific stand
15	Dunn Sound Creek	<i>Spartina alterniflora</i>		4.4	Monospecific stand
16	Dunn Sound Creek	<i>Spartina alterniflora</i>		4.2	Monospecific stand
17	Dunn Sound Creek	<i>Spartina alterniflora</i>		3.2	Monospecific stand

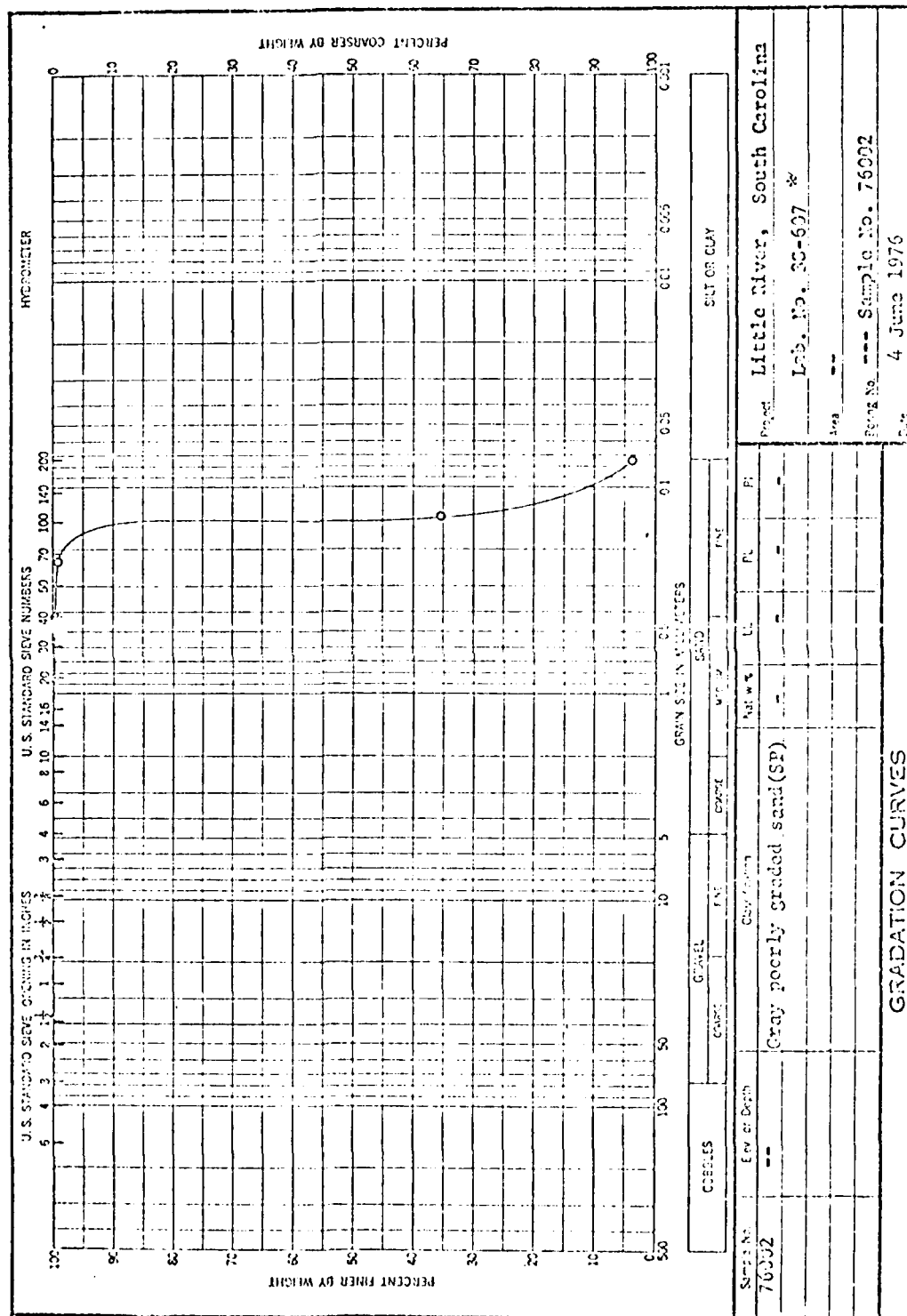
TABLE 14. Habitat types within the Little River Inlet study area.

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

WORK ORDER NO. 5924
Req. No. SACEG-76-45

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

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



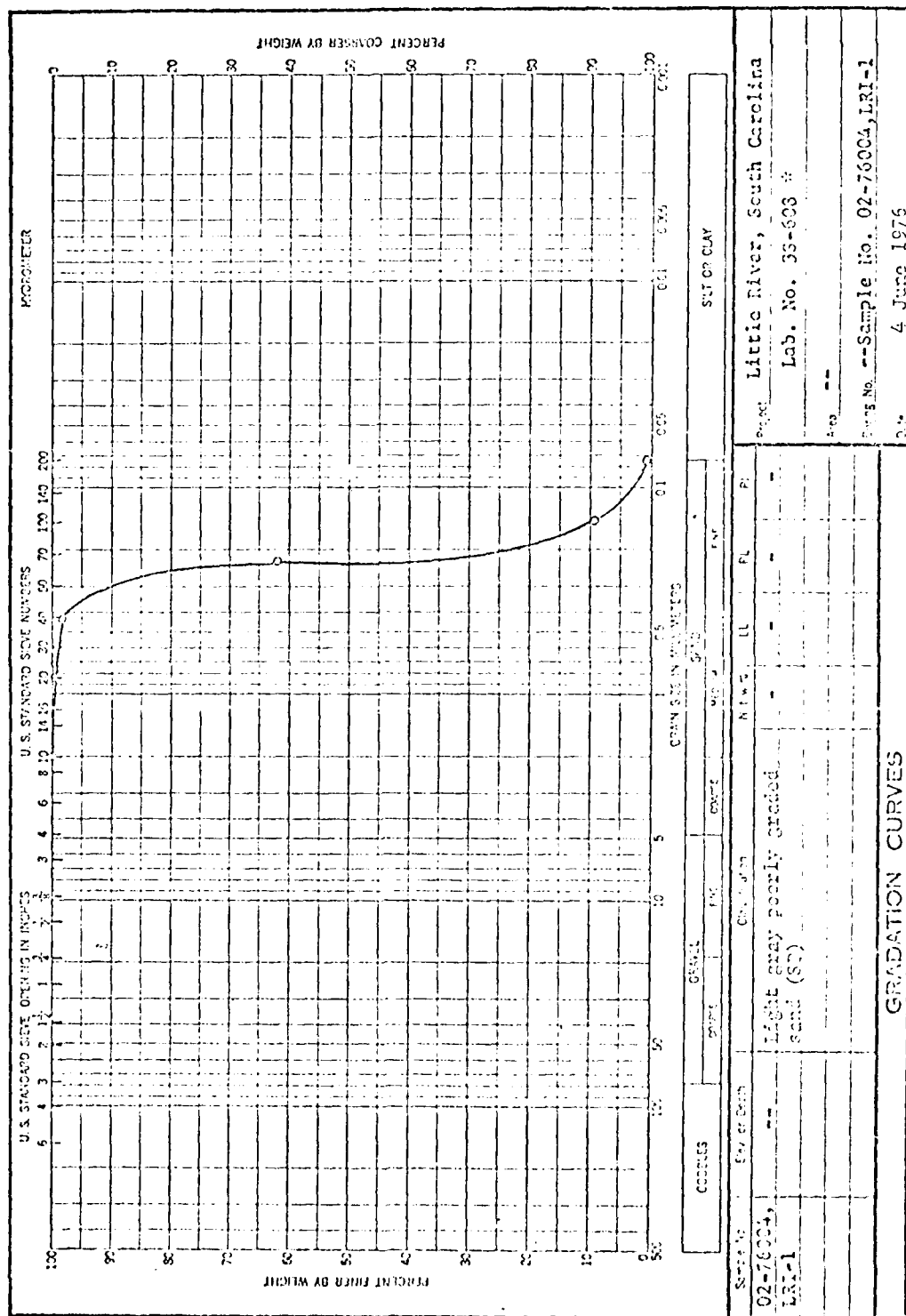
* Chemical Analysis on S&D Form 158-R.

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TEST ORDER NO. 2007
Req. No. SACEC-76-45

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



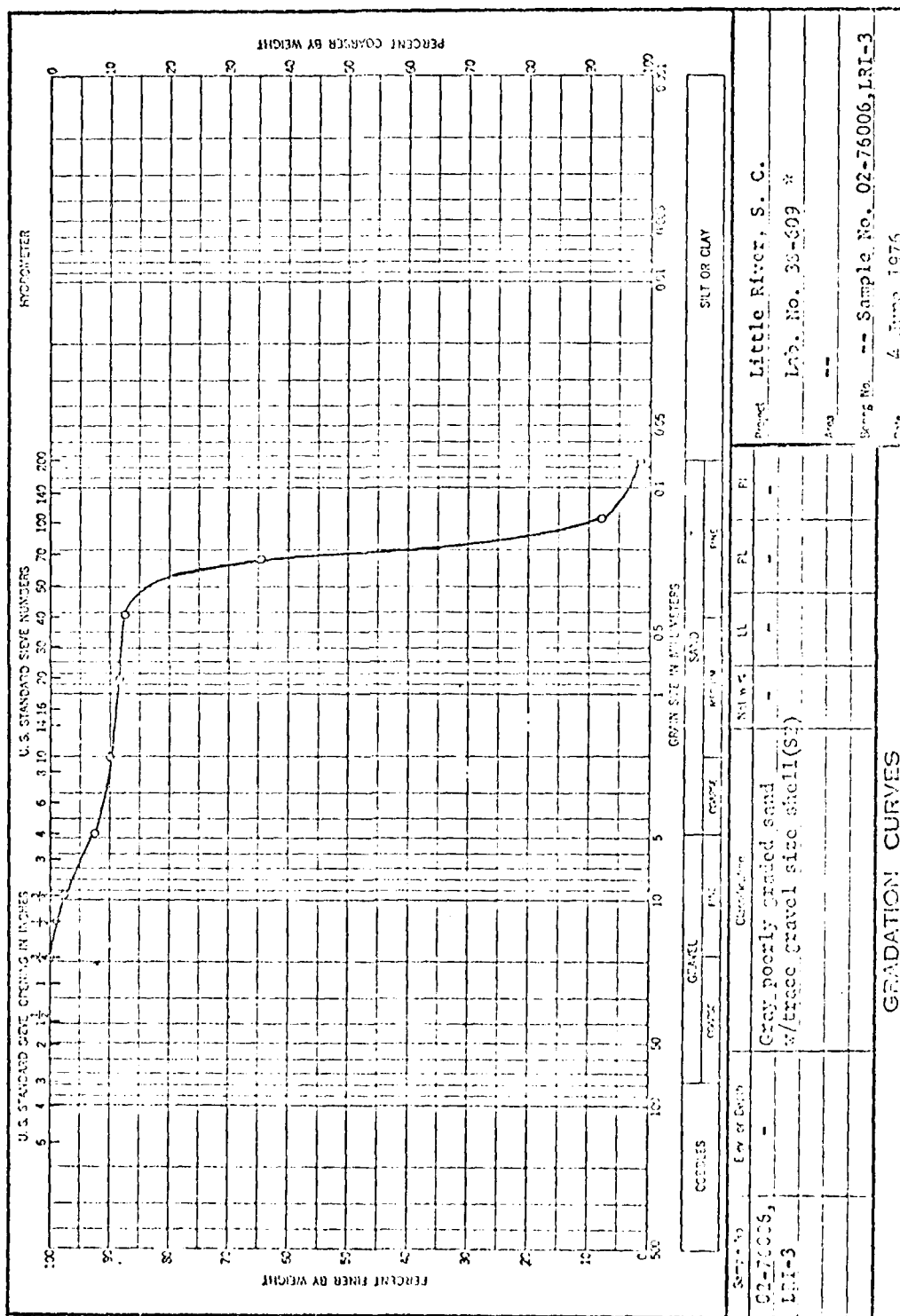
* Chemical Analysis on SAD Form 150-R.

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REQ. NO. SAC-76-45

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



* Chemical Analysis on SAD Form 150-R.

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1 MAY 63

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CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30051

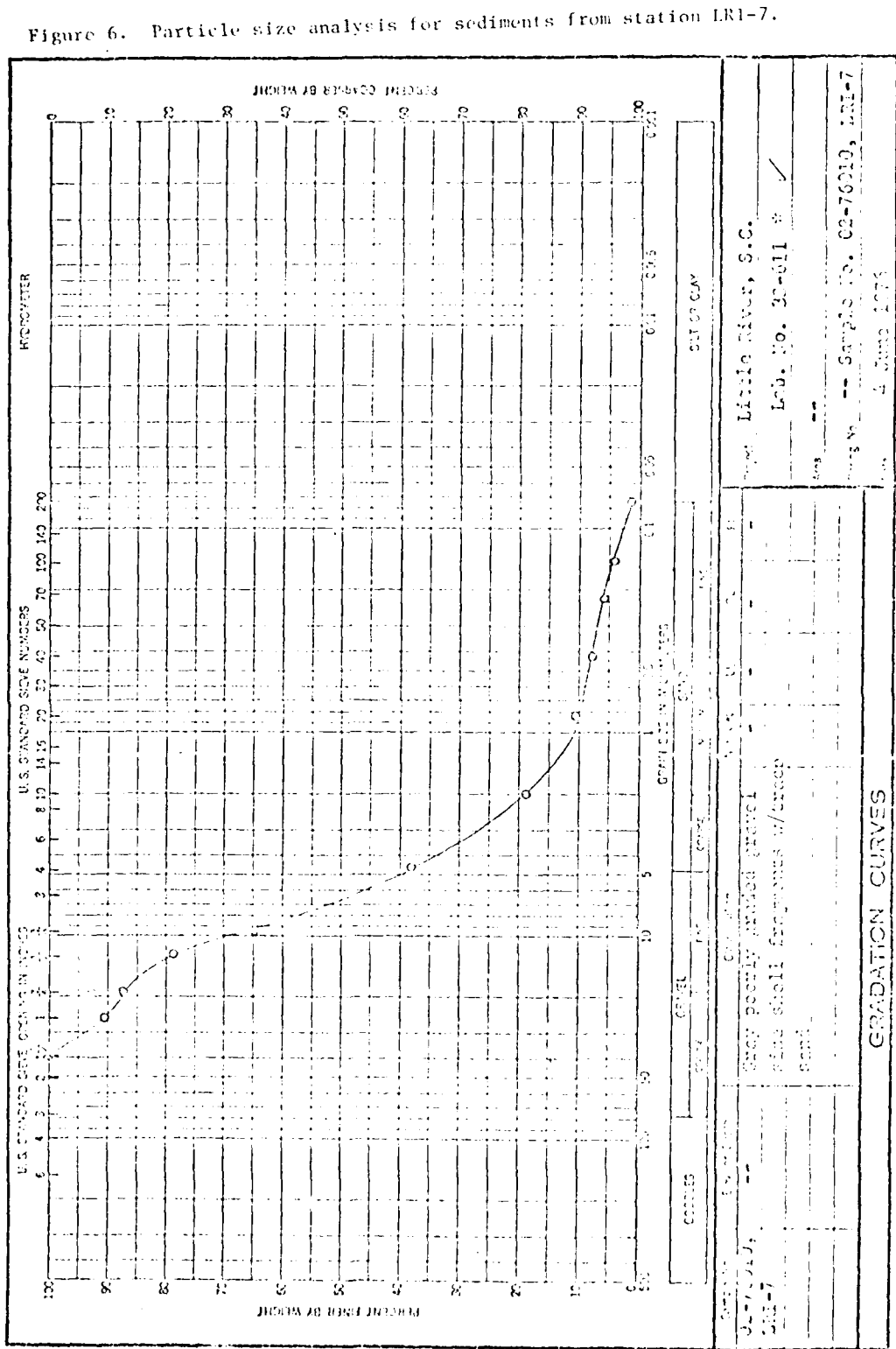
Sieve Size (inches)	Percent Finer (%)
12	100
4.75	85
2.5	65
1.18	45
0.85	35
0.425	15
0.25	5

* Chemical Analysis on SAD Form 158-R.

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DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
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WORK ORDER NO. 3024
REQ. NO. SACEC-76-45



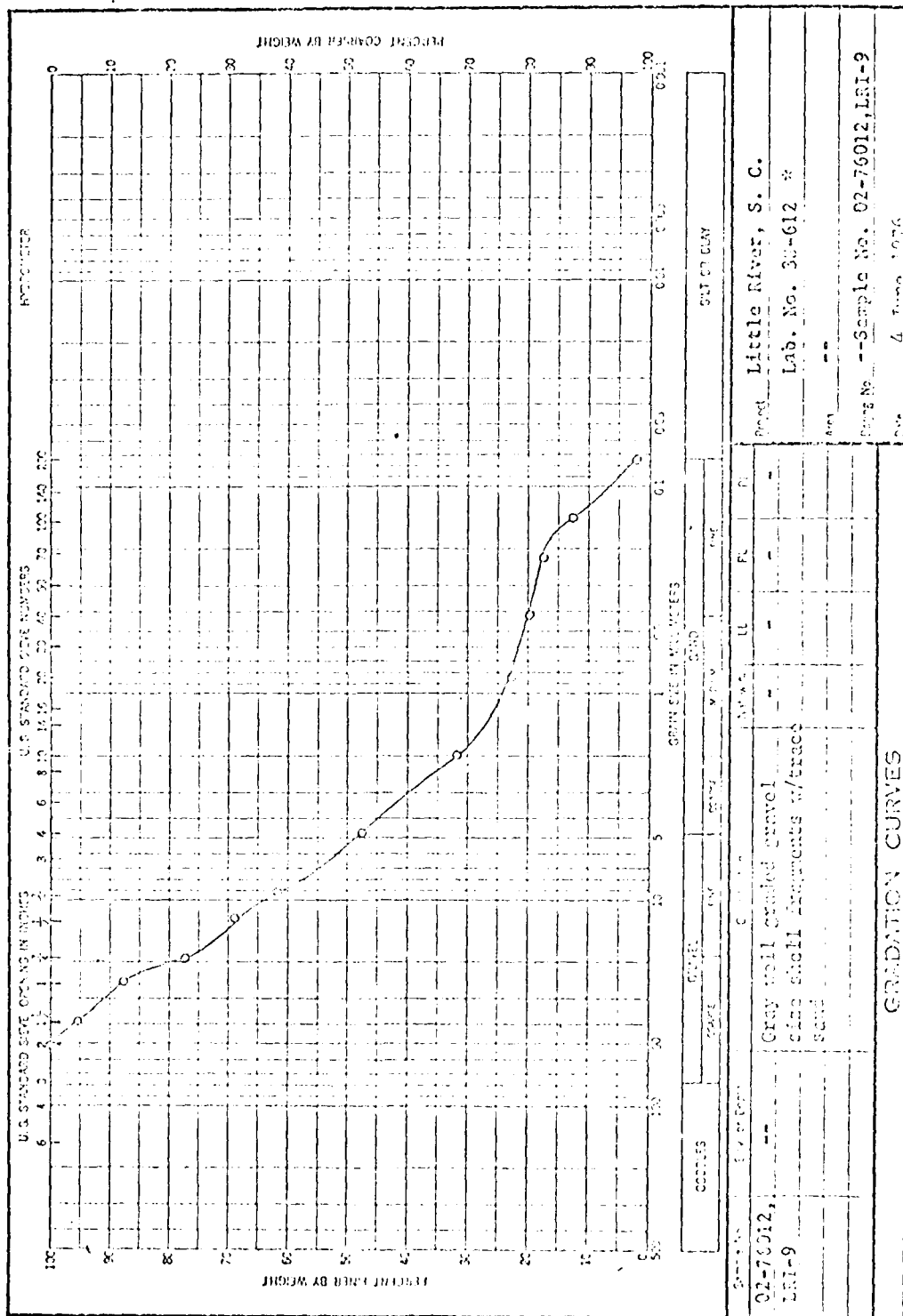
* Chemical Analysis on S&D Form 153-R.

ENC 10/11/76, 2037

FORM UNDER NO. 7047
REQ. NO. SAGEC-76-45

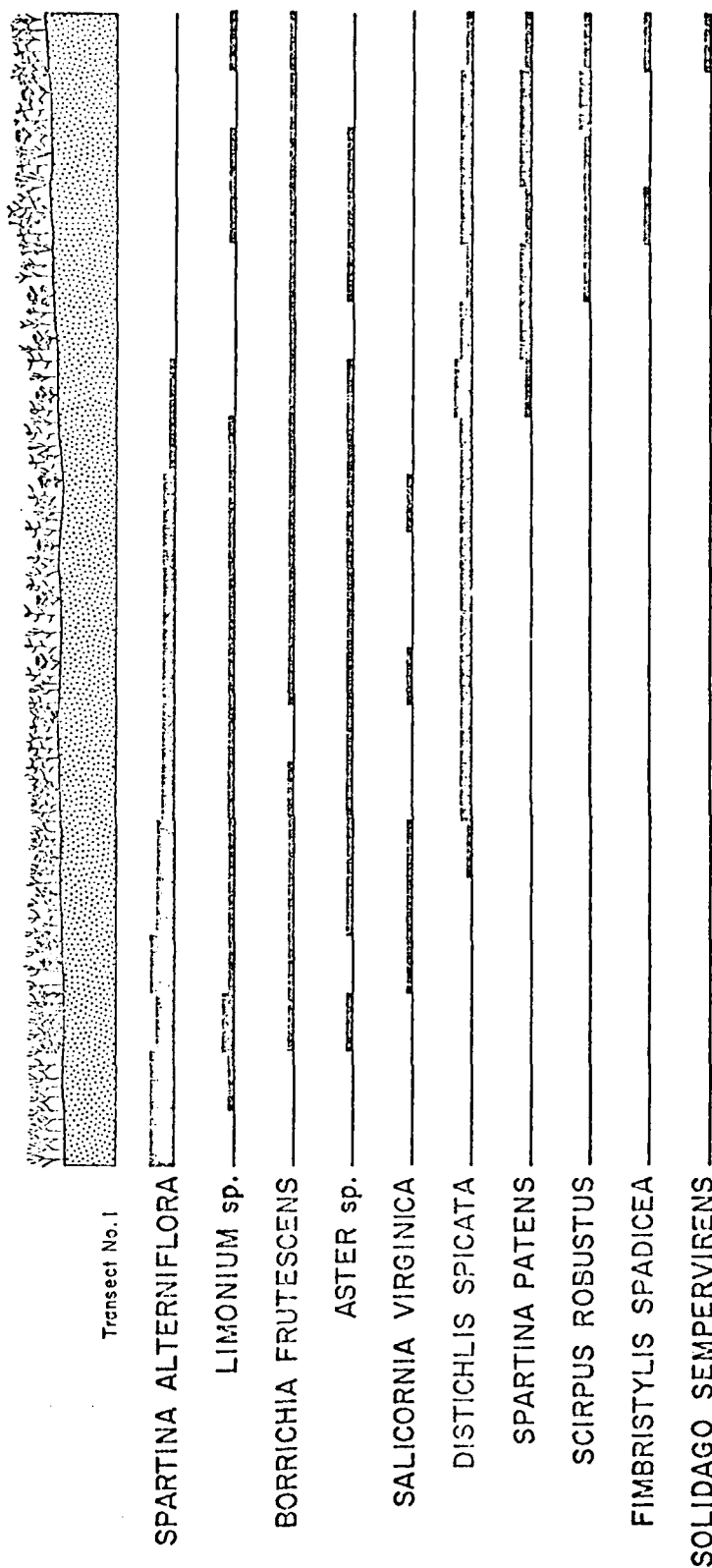
DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH OCEAN DRIVE, MARIETTA, GA. 30061

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



* Chemical Analysis on S&D Form 158-R.

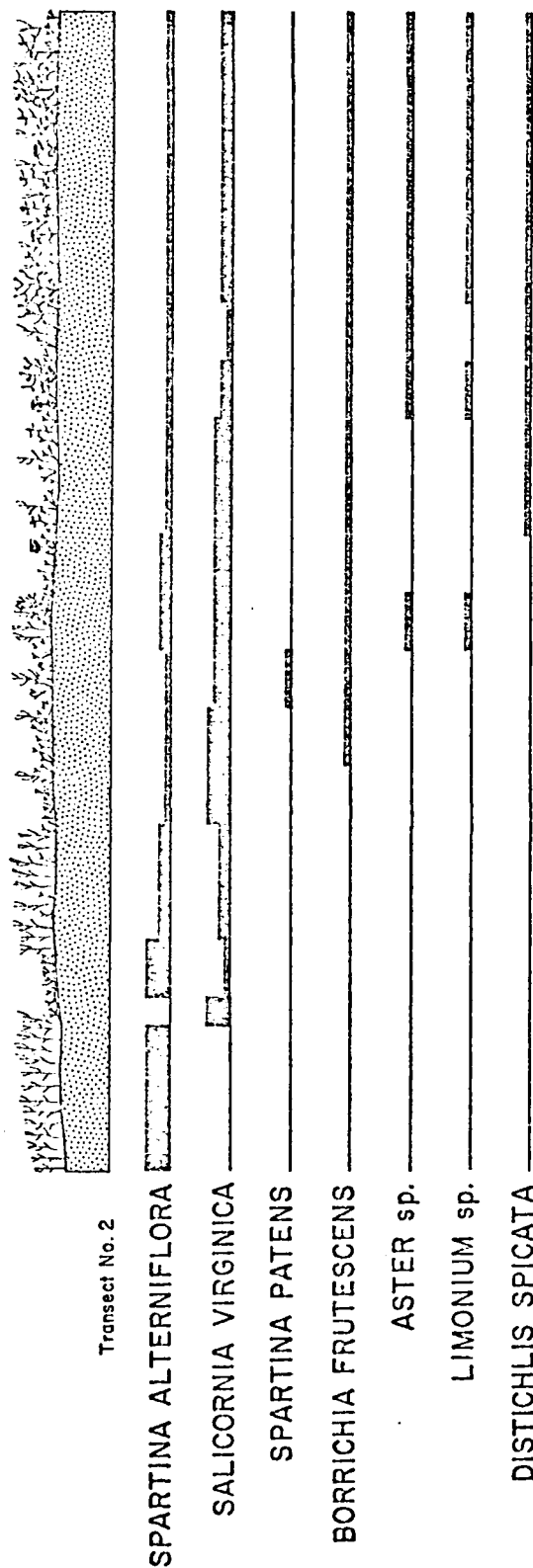
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HORIZONTAL SCALE

0 20 40

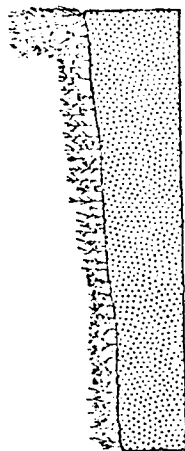
Figure 6. Bird Island Transect. Change in community structure coincident with increasing elevations. Lower elevations are dominated by smooth cordgrass, whereas higher elevations exhibit a more heterogeneous structure.



HORIZONTAL SCALE

0 20 40

Figure 9. Walters Island Transect. Glasswort was most abundant in this transect, however, *Spartina alterniflora* dominated the lowest levels and mixed with *Salicornia* further landward.



Transect No. 3

SPARTINA ALTERNIFLORA

SALICORNIA VIRGINICA

SPARTINA PATENS

BORRICHIA FRUTESCENS

LIMONIUM sp.

ASTER sp.

DISTICHLIS SPICATA

FIMBRISTYLIS SPADICEA

IVA FRUTESCENS

HORIZONTAL SCALE

0 20 40

Figure 10. Waiters Island Upper High Marsh Transect. Change in elevation results in a corresponding change in plant composition. *Salicornia* is more prevalent at the lower elevations, while *Distichlis*, *Spartina patens*, and *Iva* are most abundant nearer the upland.

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