DREDGED MATERIAL RESEARCH PROGRAM

TECHNICAL REPORT D-78-15

HABITAT DEVELOPMENT FIELD INVESTIGATIONS, BOLIVAR PENINSULA MARSH AND UPLAND HABITAT DEVELOPMENT SITE, GALVESTON BAY, TEXAS

APPENDIX C: BASELINE INVENTORY OF AQUATIC BIOTA

by

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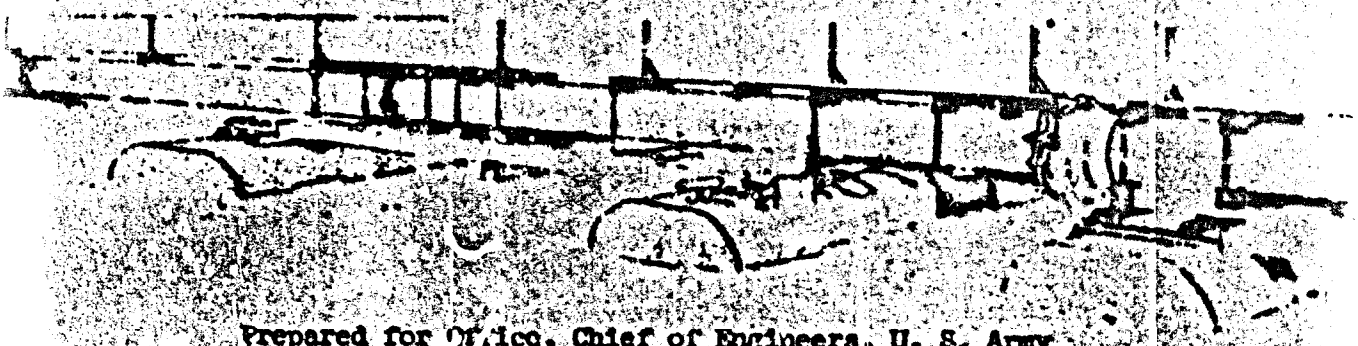

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MARSH AND UPLAND HABITAT DEVELOPMENT SITE
GALVESTON BAY, TEXAS

Appendix A: Baseline Inventory of Water Quality, Sediment Quality, and Hydrodynamics

Appendix B: Baseline Inventory of Terrestrial Flora, Fauna, and Sediment Chemistry

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Plankton, nekton, macrobenthos, and sediments were obtained from a bare, sandy dredged material disposal area in Galveston Bay, Texas. Samples were collected from March through October 1975 to identify, enumerate, and estimate biomass of aquatic biota prior to construction of a wave protection dike and propagation of vegetation within the dike.

This report presents the results of that study. The temporal and spatial distribution of aquatic biota and the field site are discussed. Also provided

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20. ABSTRACT (Continued).
Galveston Bay.

The study indicated that the abundance and diversity of aquatic biota followed expected seasonal patterns and indicated generally low levels. Spatial distribution of aquatic biota indicated greater abundance within the western half of the site.

The report recommends that sampling during future studies be conducted for a complete calendar year to substantiate suggested seasonal trends. The future sampling program should also collect during day and night to indicate diel patterns of abundance. Future studies should include the study of a relatively undisturbed area nearby to indicate biological development of the site after dike construction and plant propagation.

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SUMMARY

Plankton, nekton, macrobenthos, and sediments were inventoried from an intertidal dredged material sand flat in lower Galveston Bay, Texas. Monthly collections were conducted from March through June 1975 and then collection frequency was decreased to bimonthly through October 1975 for a total of six sample periods. The objective of the study was to identify, enumerate, and estimate the biomass of the aquatic biota using the site prior to the beginning of habitat development engineering and plant propagation activities.

The inventory revealed a generally low diversity and abundance of biota with seasonal trends in abundance that were similar to those reported in other studies of the Galveston Bay area. The sparsity of organisms in the study area appeared to be due to the absence of adequate epibenthic habitat and the susceptibility of the area to natural physical extremes, such as wind and wave action.

Phytoplankton represented the only primary producers at the field site since no submergent or emergent macrophyton were observed. Phytoplankton samples were dominated by diatoms with Leptocylindricus minimus and Asterionella japonica comprising over 57 percent of all phytoplankton collected. Phytoplankton concentrations were slightly higher in the eastern half of the study area.

Zooplankton samples were dominated by barnacles and copepods. These two groups represented 95 percent of the zooplankton collected. Their distribution was variable. 55 percent collected within the area to be protected, 38 percent east of the site, but only 7 percent collected in the area a short distance west of the proposed levee area.

Nekton, collected with a beam trawl, bar seine, and shrimp trawl were represented by 28 species in various life stages. Micropogon undulatus and Brevoortia patronus were the most abundant fishes collected. Invertebrates collected by the above gear were dominated by Penaeus setiferus and P. aztecus comprising 87 percent of the catch. The distribution and abundance of both vertebrate and invertebrate nekton

appeared random throughout the study with no definite patterns detected other than expected seasonal trends in abundance.

Benthic samples were dominated by polychaetes. There were 18 polychaete species representing 43 percent of all benthic organisms collected. Density of benthos was low with only 11.9 organisms collected per litre of sediment samples. Benthic distribution was variable between transects perpendicular to and transects parallel with the shoreline. Benthic abundance was greater on the western half of the field site and at mid-depth stations and was least abundant near shore.

A general survey of oyster bed locations in Galveston Bay was also conducted and revealed that the oyster bed nearest to the field site was over 6 km away.

Measurement of the sediment organic content revealed low values (0.14 grams per litre) relative to other bay areas. The low organic content was caused by a lack of detrital material and submerged vegetation and because strong currents appeared to remove fine-grained material from much of the area. Fine-grained sediment observed in the western half of the field site was associated with a higher concentration of organic matter and greater abundance of benthos, zooplankton, meroplankton, and nekton.

PREFACE

The study reported herein was developed as part of the U. S. Army Corps of Engineers Habitat Development Project, one segment of the Dredged Material Research Program (DMRP). The DMRP was sponsored by the Office, Chief of Engineers, U. S. Army, and assigned to the Environmental Laboratory (EL) of the U. S. Army Engineer Waterways Experiment Station (WES), in Vicksburg, Mississippi.

The study was conducted under Interagency Agreement No. WESRF 75-101 by the National Marine Fisheries Service (NMFS), Southeast Fisheries Center, Galveston Laboratory, Galveston, Texas, as part of DMRP Task 4A, "Marsh Development." Field investigations were conducted along a dredged material sand flat in lower Galveston Bay, Texas, during the period from March through October 1975. Sampling was conducted during the above period to characterize the aquatic community of area prior to modification of the site by construction of a wave protection inclosure and propagation of intertidal vegetation within the inclosure.

This study was accomplished under the general supervision of Dr. J. W. Angelovic. Messrs. K. N. Baxter and J. M. Lyon provided particular assistance in coordinating the study.

This DMRP contract was managed by Mr. H. B. Allen with technical assistance from Mr. J. D. Lunz, EL. Supervision was provided by Dr. C. J. Kirby, Chief of the Environmental Resources Division, and Dr. J. H. Harrison, Chief, EL. Mr. K. K. Smith was manager of the Habitat Development Project.

COL G. H. Hilt, CE, and COL J. L. Cannon, CE, were Directors of WES during the conduct of this study and the preparation of this report. Mr. F. R. Brown was Technical Director.

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CONVERSION FACTORS, METRIC (SI) TO U. S. CUSTOMARY UNITS OF MEASUREMENT

Metric (SI) units used in this report can be converted to U. S. customary units of measurement as follows:

Multiply	By	To Obtain
Celsius degrees or kelvins	9/5	Fahrenheit degrees*
Cubic metres	35.31466	Cubic feet
Grams	0.002204622	Pounds (mass)
Kilometres	0.613711	Miles (U. S. statute)
Litres	0.2642	Gallons (U. S. liquid)
Metres	3.280839	Feet
Microns	0.00003937	Inches
Millilitres	0.0002642	Gallons
Millimetres	0.3937007	Inches
Square kilometres	0.3861021	Square miles (U. S. statute)
Square metres	10.76391	Square feet
Radians	0.0174533	Degree (angle)

*To obtain Fahrenheit (F) temperature readings from Celsius (C) readings, use the following formula: $F = 9/5\ (C) + 32$. To obtain Fahrenheit readings from Kelvin (K) readings, use: $F = 9/5\ (K - 273.15) + 32$.

HABITAT DEVELOPMENT FIELD INVESTIGATIONS, BOLIVAR PENINSULA MARSH AND UPLAND HABITAT DEVELOPMENT SITE, GALVESTON BAY, TEXAS

APPENDIX C: BASELINE INVENTORY OF AQUATIC BIOTA

Introduction

1. An inventory and assessment of aquatic biota was conducted by the National Marine Fisheries Service (NMFS) to provide an indication of the abundance and distribution of estuarine organisms occurring within the intertidal area adjacent to a dredged material disposal site in Galveston Bay, Texas. The objective of the inventory was to provide baseline data prior to construction of a wave protection inclosure and propagation of vegetation within the inclosure. A pilot study was conducted in March 1975 to provide insight into a proposed sample design. Following the pilot study, sampling was conducted in April, May, June, August, and October 1975 (Table A1).* To supplement data gained during the field sampling program, a literature search was conducted and results of this search are presented in Appendix B'.

2. The study site is located on the bay side of Bolivar Peninsula about 7 km east of the western end of the peninsula (Figure 1). The area is a long sand flat approximately midway between Baffle Point and the Gulf Intracoastal Waterway (GIWW) channel cut at Sievers Cove (Figure 1). The study site is situated on an open bay margin of sand flat with low, man-made dunes projecting into the bay at points where dredged material was released during earlier dredging disposal operations. Erosion from rain and prevailing winds has caused more of the barrier island dredged sand to drift from the dunes into the bay. On a number occasions, strong surges of water were observed at times of sampling. one point the water suddenly receded an estimated 10 m from the shoreline with more than a 0.15-m decrease in elevation. Within several minutes the water surged back as if it were affected by a passing ship. No ships were seen during these times, and other than the GIWW on the southern side of the island, the closest channel is the Houston Ship

*Tables A1 through A9 are located in Appendix A' of this report.

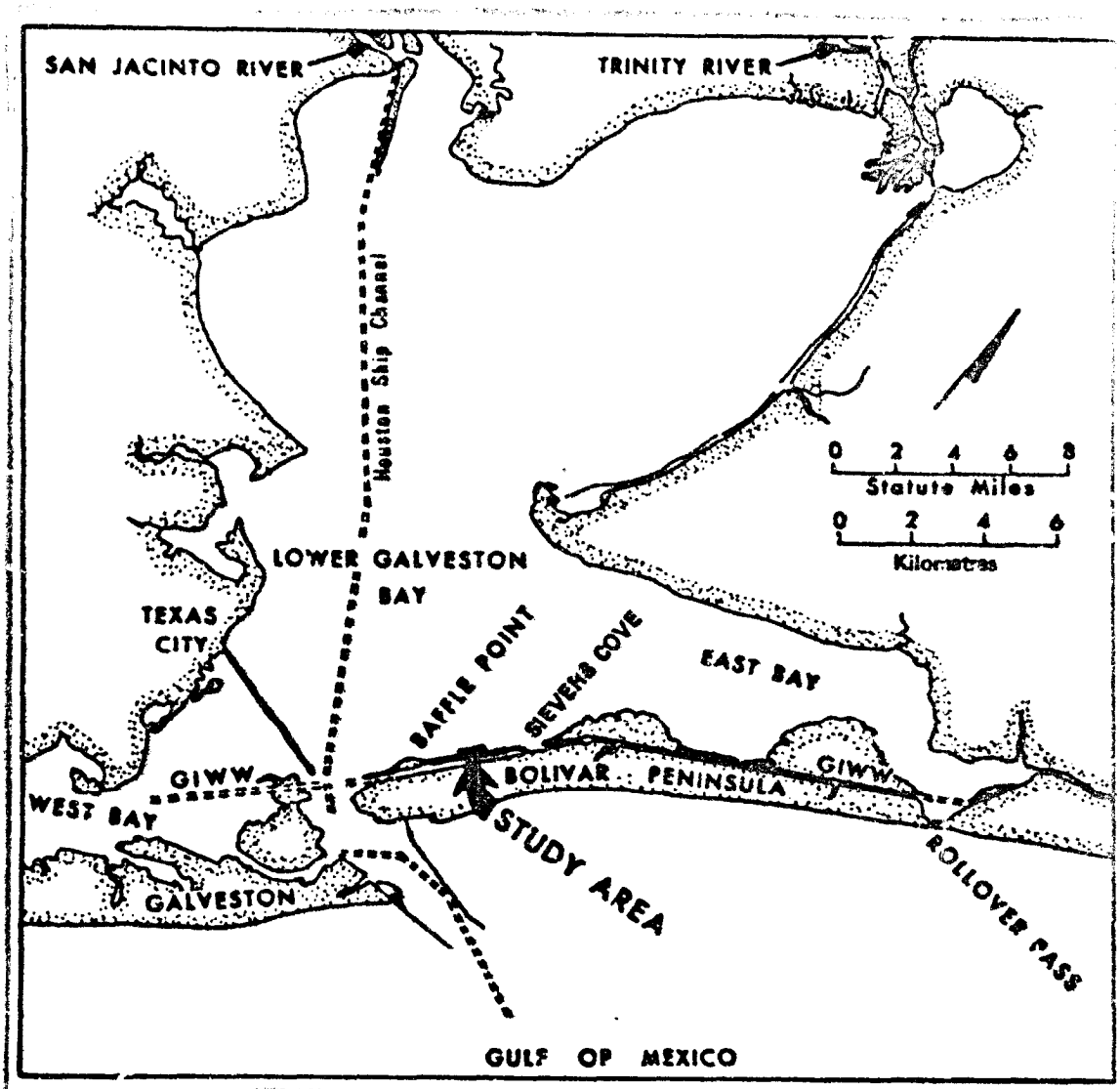

Figure 1. The study site on Bolivar Peninsula in Galveston Bay, Texas

Channel some 8 km away. This surging of water was strong enough to cause stirring and removal of fine sediments. Configuration of the projecting sand plumes indicated an east-to-west movement of prevailing currents. The exposed nature of the area and prevailing currents tend to restrict the sediments to larger particles.

3. Physical parameters of the study site are similar to those of a lagoon system (Emery et al. 1957) with sandy bottom and accompanying currents, long stretches of open straight shoreline, little depth and gradient, and practically no epibenthic life. It is not a typical estuarine situation, but rather a euryhaline transitional zone at a junction of East Bay, Lower Galveston Bay, and open gulf waters. Salinities taken on sampling dates of high standing tide ranged from 10 to 25 parts per thousand (ppt) (Table A2). Pullen and Trent (1969) recorded salinities at the site in 0.6 m of water during 1963-64 and reported a range of 16.1 to 32.4 ppt. Available data reflect a salinity regime from an upper bay environment to a gulf water environment and suggest that species not able to move in and out of the area are restricted to euryhaline forms. Lower salinity waters resulting from dilution by Trinity and San Jacinto River discharges and immediate area runoff also contribute to the wide-ranging salinity regime. Shallowness of the area causes considerable influence from the freshwater sources as well as from northerly winds. These winds can drop temperatures rapidly and expose vast portions of the sand flat leaving no escape route for aquatic organisms except toward mid-bay.

Materials and Methods

Sampling locations

4. A total of 12 sampling stations were established within the immediate vicinity of the originally proposed wave protection inclosure. (The levee inclosure was relocated later in the study and three additional stations were established.) The 12 stations were distributed along four transects perpendicular to shore, each with three stations, which formed three transects parallel to shore, each with four stations (Figure 2).

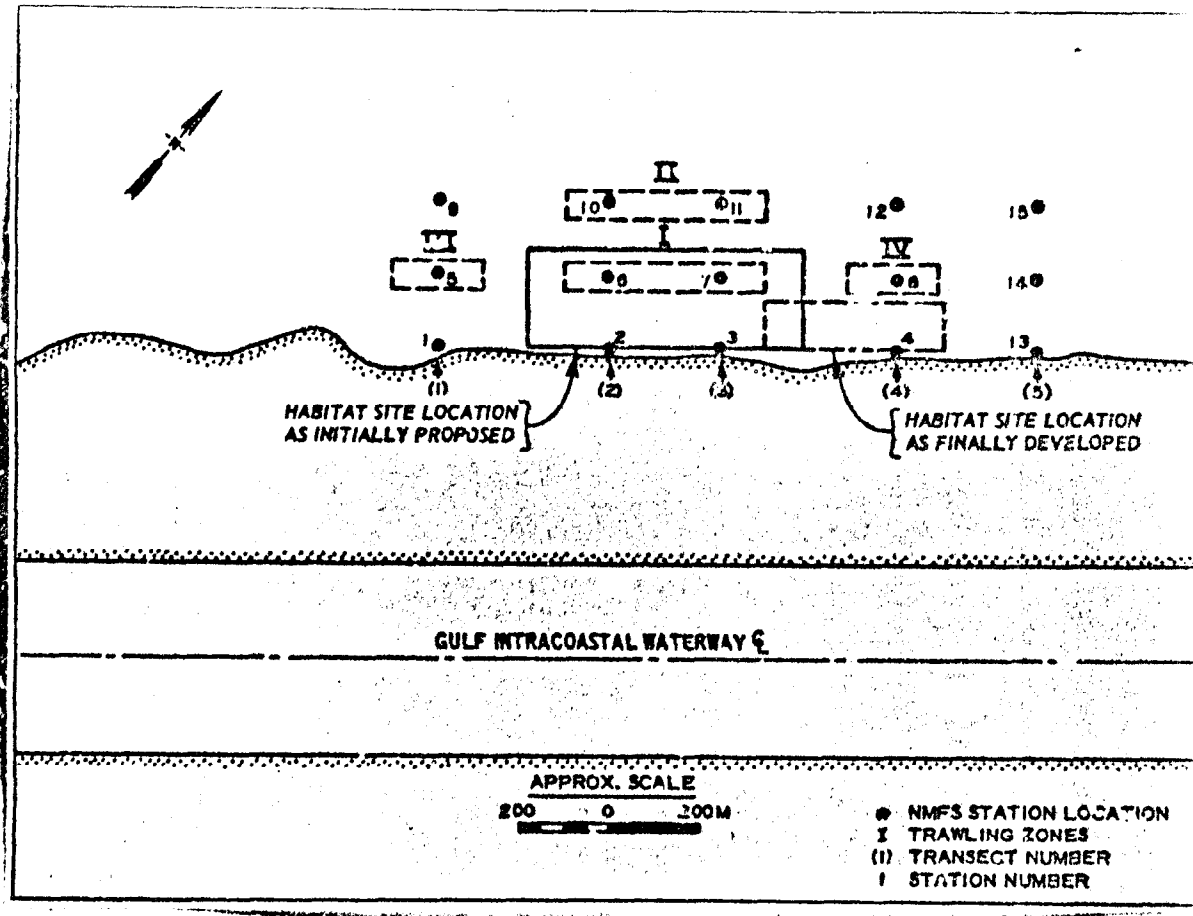

Figure 2. Location of sampling stations, transects and zones

All of the 12 stations were sampled for benthos and sediment characteristics but only the four near-shore stations were sampled for meroplankton and postlarval nekton as indicated in Table A1. In conjunction with the 12 sample stations, four trawling zones were established for the collection of phytoplankton, zooplankton, and nekton. Zone I was located inside the proposed wave protection inclosure, Zone II directly offshore, Zone III to the west, and Zone IV to the east of the study area (Figure 2).

5. The locations of the stations and zones described above were selected in relation to the originally proposed location of the levee inclosure. However, in July 1975 the NMFS was informed that a new location for the inclosure had been selected approximately 300 m east of the original site. NMFS, therefore, established three more sample stations along one transect (the fifth) perpendicular to the shore (Figure 2). This additional transect was approximately 300 m from transect 4.

Sampling Schedule

6. A pilot study was conducted in March 1975 to determine potential necessary changes in sample station locations and sampling techniques and to define macrohabitats. Following the pilot study, samples were collected monthly from April through June and in August and October 1975 (Table A1). Exceptions to the above schedule are pointed out below.

Phytoplankton

7. Phytoplankton samples were obtained during the first four collection periods (including the pilot samples in March). After the collections in June 1975, sampling of phytoplankton was terminated.

8. One-litre whole water samples were collected and preserved in five percent formalin buffered with tris (hydroxy-methyl) aminomethane and taken to the laboratory for processing. Counts were made with a Palmer-Maloney counting cell and a phase contrast microscope. Phytoplankton data represent counts of seven or fourteen preparations calculated to give the number per millilitre. Seven preparations represent a total volume of 0.1 ml. Counts that are less than 100/ml are based on the observations of one specimen of that species in the total number of preparations counted. Many of the organisms observed occurred in

various colonial forms. For these, the individual cells and not the colony were counted.

Zooplankton

9. Duplicate zooplankton samples were taken in each of the four zones during the first four sample periods; zooplankton sampling was restricted to Zones I and II in August and October 1975.

10. Samples obtained during the March pilot study were collected with a 153μ plankton net. However, the mesh clogged and was replaced with a ½-m, 243μ mesh net for subsequent samples. Each net used was equipped with a flowmeter. The net was towed for one minute, the meter reading recorded, and the samples extracted and preserved in five percent buffered formalin. Processing the samples in the laboratory consisted of recording a 24-hr settle volume, taking aliquots, allowing them to settle for 24 hrs, and reading the volume. Numbers of organisms counted were adjusted to cubic metres of water strained. Counting was done with a dissecting microscope and a Sedgewick-Rafter counting cell.

Nekton

11. Nekton samples were collected from the four zones during five of the six sample periods (no samples were obtained in May) with a 3-m wide flat shrimp trawl made of 25-mm stretch mesh. Two shrimp trawl samples were taken at each of the four zones. Nets were towed for five minutes and covered a distance of approximately 200 m. Distance was determined by towing between station stakes. The second tow was made in the opposite direction from the first. Trawled samples were iced and taken fresh to the laboratory where they were kept refrigerated or frozen until processing could be done. At the laboratory species were identified and enumerated, and the range of length (Tables A3 and A4) and weight per species were determined.

12. Samples of juvenile nekton were taken at shoreline stations 1 through 4 in March, April, June, August, and October. Station 13 was added in October. A 15-m, 13-mm stretch mesh bar seine (a net with neither pocket nor bag and hung on bars, not points) was towed along shore a distance of 15 m, brought ashore, and the sample removed and

treated as above. The organisms were later identified and counted and range of lengths recorded. Meroplankton and postlarval fishes also were sampled at all shore stations. They were collected with a 1.8-m beam trawl (Renfro 1963) that consisted of a 1.3-m-wide body of 0.47-mm mesh and a number one mesh plankton net with detachable cod end bucket. The net was towed slowly in a semicircle guided by a 45-m length of line staked at the shoreline. The line caused a 180° arc to be completed 90 m along the shore from the starting point. Samples were then removed and preserved in five percent formalin until identified by species and counted at the laboratory.

Benthos

13. Benthic samples were taken in March, April, June, August, and October at all stations except stations 13, 14, and 15, which were sampled after they were added in October. Samples were taken with an Ekman dredge mounted on a galvanized pipe to aid penetration of the substrate. Duplicate grabs were made at each station. Each sample was separated into halves with one half used for benthos identification and enumeration and the other for determination of organic content. This system provided two taxonomic samples and two samples for organic content from each station. The samples were kept fresh in ice chests and refrigerated until processed.

14. Laboratory processing of benthic samples began by determining sediment volume. The March pilot study indicated accurate readings of the graduated cylinders containing sediment samples could be obtained after a 10-min settling period. A settling period of one-half hour did not appear to change the reading significantly. Next, samples were sieved through a 0.5-mm screen, and the retained material was preserved in 70 percent ethanol and examined under a dissecting microscope. Rose Bengal stain was applied to the sample after the first scanning. The sample was then reexamined to determine if any organisms or fragments remained. Finally, benthic organisms were classified to the lowest practical taxonomic level, usually species.

Sediment analysis

15. Samples for characterization of sediment organic content were

collected in duplicate in conjunction with the benthic samples as discussed above. Each of the duplicate samples was dried at 60°C for a minimum of 24 hrs, then ashed at 500°C for an additional 24 hrs. Procedures followed were those recommended by the National Research Council, National Academy of Sciences Biological Methods Panel Committee on Oceanography (1969). Temperatures were selected as the maximum ones that could be used without causing a breakdown of lipids when drying and carbonates when ashing.

Results and Discussions

Phytoplankton

16. Table 1 contains the mean number of diatoms per milliliter by month with all zones combined. Detailed data are available in Table A3. The eight most abundant genera and species that made up 94 percent of the total are listed separately (Table 1) while all others are combined. It is quite evident that a spring bloom occurred in April with Leptocylindrus minimus representing the most abundant organism. Organisms listed in these tables are ones expected and are of normal densities.

17. There were no submergent or emergent macrophyton in the sample area. Phytoplankton, therefore, were the only primary producers found. Species abundance, when compared with other studies of Galveston Bay (Copeland and Bechtel 1971), gives no indication of water-quality problems in the study area.

Zooplankton

18. Seasonal difference in the zooplankton data followed the expected pattern of spring abundance, especially in barnacle cypris larvae collected in March and April. These two major groups, barnacles and copepods, made up 95.1 percent of all zooplankton organisms counted; polychaetes accounted for 4.6 percent; and all other groups combined accounted for 0.3 percent (Table 2). Zone 1 samples contained 52 percent of all barnacle larvae, 42 percent of the copepods, 71 percent of the polychaete larvae, and 49 percent of all other organisms counted.

Higher catches of zooplankton in Zone I, as compared with catches in other zones, may have been due to eddying currents in this zone. The August and October data from Zones I and II did not differ from previous data except for an increase in numbers of copepods in the fall samples (Table A6). This seasonal increase conforms to other recorded data of both phytoplankton and zooplankton and therefore is not considered unusual. Copeland and Fruh (1970) found copepods to be the most abundant organism in East Bay samples with barnacles the second most abundant group. Although this study's sampling methods differed from theirs, similar results were obtained; copepods were the most abundant zooplankton collected in this study except during the spring (April) when barnacle larvae collected in Zone I were most abundant.

Nekton

19. Various life stages of nektonic organisms were collected in three types of sampling gear: 1.8-m beam trawl; 15-m bar seine; and a 3-m shrimp trawl. This beam trawl was selective for meroplanktonic postlarval forms. A species usually occurred first in beam trawl shore samples as postlarvae (Table 3) then in the bar seine as young juveniles (Table 4), and last in shrimp trawl samples as late juveniles and young adults (Table 5). For example, in March postlarval brown shrimp Penaeus aztecus, were taken at shore stations with the beam trawl (Table 3). Subadults were taken offshore with the shrimp trawl by June (Table 5). The same pattern was demonstrated for white shrimp, P. setiferus, starting later in the season (June). Larger white shrimp from previous spawnings were taken in April.

20. Postlarval fishes taken in the beam trawl were most abundant in March when 88 percent of all 1,505 specimens collected were Gulf menhaden, Brevoortia patronus (Table 3). This species accounted for 78 percent of all postlarval fishes caught with the beam trawl during the study. Of the 28 species collected with this gear, most were marine estuarine, not estuarine only. Distribution of species and of numbers appeared random throughout the study with no obvious patterns. With an average tow covering 180 m^2 of bottom, (Baxter 1963) there was one postlarval fish collected per 2.1 m^2 of shore station area sampled

21. The bar seine captured the early juvenile stage of fishes. Highest catches with this gear occurred in March. There were 2,604 Atlantic croakers, Micropogon undulatus, in the March samples. This species was abundant at all four stations. All species are listed in descending order of abundance in Table 4. Each tow covered approximately 700 m^2; therefore, one fish was collected for every 2.8 m^2 of shore station seined.

22. To determine if relative differences in abundance and distribution of fishes and crustaceans occurred along the shoreline, data from the beam trawl (Table A3) and bar seine (Table A4) were combined. Numbers of fishes were evenly distributed between stations 1 (28 percent), 2 (29 percent), and 3 (30 percent). However, only 13 percent of the fishes were collected from station 4 at the eastern end. Brown and white shrimp were caught at all stations and were the most abundant invertebrates collected. No pattern was observed in the data other than the seasonal abundances of animals in the spring.

23. Shrimp trawl data were gathered from the four zones shown in Figure 2. As in the shoreline fish data, the only obvious difference is a seasonal one. Only 664 fish were captured in approximately 24,000 m^2 of bottom covered. This yields one fish per 36 m^2 of bottom. By weight, 1 g of fish was caught per 6.2 m^2 of bottom. Areal and temporal abundance and biomass data for trawl-caught nekton are presented in Table A7. Trawl-caught fish are listed in descending order of abundance and by month in Table 5, June was the month of greatest abundance when 40 percent of the trawled specimens were caught. Only 4 species of invertebrates were caught in the trawl (Table 5).

Benthos

24. Benthic data collected during the study are presented by sample period in Table 6. Detailed benthic data are presented by station, collection date, and sample replicate in Table A8. All benthic forms found fit into a grouping of eight taxa arranged by station and transect in Table 7. Table 8 compares benthos from transect 5, collected in October, with October collections from the four other transects.

25. Benthic abundance was found to be greater in the western portion of the site (transects 1 and 2). This was probably due to deposition of finer sediment observed in that area. Benthic abundance also varied between transects parallel to shore with fewer benthic animals collected along the shore than at middepth and offshore transects.

26. Of all benthic organisms identified, Polychaeta was the most abundant taxon comprising 40 percent of the benthic organisms collected. Sixteen species of polychaetes were taken representing 13 genera. Two species of polychaetes dominated the annelid population throughout the study. Eteone heteropoda comprised 34 percent of the number collected. Parendalia fauveli, the second most common species, accounted for 22 percent of all polychaetes taken. Although Capitella capitata is often a common species in estuarine studies, it made up only four percent of the Polychaeta collected. This species is usually found in finer textured bottoms or mud substrates.

27. Data of the most abundant polychaete, E. heteropoda, were examined for distribution within the area. Shoreline stations produced 55 percent of the total caught. No one station yielded more than 32 percent or less than 18 percent of those taken at shore stations. E. heteropoda occurred at all stations during this study. When transects perpendicular to shore were compared, transect 3 produced the greatest number of this species.

28. Upon examination of the distribution of all polychaetes collected, abundance was found to be greater in the western half of the field site. This distribution was similar to that observed for most benthic organisms collected; polychaetes were also more abundant at shore stations. Gilmore and Trent (1974) also found polychaetes most abundant at shore stations in a West Bay study. Station 1 in August and in October contained the most organisms by actual numbers, per square metre of bottom, and per litre of sediment. Both collections were also highest in organic content of the sediment for those two months. Transect 1 yielded 33 percent of all polychaetes; transect 2 contained 36 percent; transect 3 24 percent; and transect 4 [illegible] 17 per cent [illegible]

October, 17 percent of the polychaetes collected at the site were from the new transect 5.

29. In addition to polychaetes, other abundant benthic organisms included one species each of isopod, amphipod, and pelecypod. The isopod, Xenanthura brevitelson, was the most abundant species of all arthropod crustaceans obtained. Of the 542 arthropod crustaceans collected, this species represented 67 percent (364 specimens) and was collected on all sample dates and at all stations except station 8. Seventy percent of all X. brevitelson specimens were collected from the western transects (1 and 2). Transect 4 yielded only 8 percent of the total number collected.

30. Dominant amphipods were Haustoriidae, a family of burrowing amphipods well adapted to dynamic sand environments. Two and possibly more species of haustoriids occurred in the collections but identification below family could not be accomplished. Most amphipods occurred in April when 43 percent of the total number were taken. Distribution among transects was uniform, varying from 20 to 27 percent. Haustoriids were taken at every station in the area and occurred in every month.

31. The dominant pelecypod of the area (89 percent of the total number) was Periploma inequale, the unequal spoon clam, common to sandy bottom lagoons and inlet areas. Only four other pelecypod species were collected, including Mercenaria campechiensis and the long razor clam, Ensis minor. E. minor specimens, which were each 25 mm long, were the only pelecypods taken that measured more than 3 mm. Larger shells of this species were observed along the shore edge during the study but none were found alive or intact. It should be noted that no adult molluscs were collected and it is not known whether or not they complete their life cycle at this site. As with many other forms, pelecypods were in greatest abundance in the month of April. It is also interesting to note that although Mulinia lateralis and Macoma tenta are two species of pelecypods that are often dominant in benthic communities (Thorson, 1957), only eleven M. lateralis and three M. tenta were taken during this study.

32. The only other molluscs collected, other than pelecypods, were

larger than 2 mm was a moon snail, Polinices duplicatus. This specimen measured 25 mm, and was the only predatory species of mollusc taken. The other two species, Caecum pulchellum and Teinostoma biscaynense, are small and usually not abundant. Scarcity of the highly predatory P. duplicatus in the collections is probably due to the lack of prey in the area.

33. In addition to the benthic organisms described above, three forms of meiobenthos were also observed in the substrate: forams, ostracods, and nematodes. All three forms were abundant in March, and were most abundant in April, followed by a sharp decrease or total absence in numbers through the summer. A few nematodes and foraminifera were observed in the October samples. This is the expected pattern of seasonal abundance and agrees with studies such as that by Day et al. (1973). Because the sieve size of 0.5 mm is not really quantitative for these forms, no finer definition of meiofauna abundance was attempted.

Sediment analysis

34. Grams of organic matter per square metre of sediment surface are reported in Table 9 for every station sampled each month and by transects parallel and perpendicular to shore. Data for each replicate are presented in Table A9. Organic content of the area is considered to be low when compared with a general bay area. Sandy substrates in estuaries generally contain less organic matter than do finer grained substrates. The area does not have submerged vegetation, so there was, with only one exception, no detritus in samples. As discussed earlier, strong currents probably remove material of small particle size.

35. Grams of organic content per litre of sediment (g/ls) were also determined. All g/ls data gathered during the study from stations 1 through 15 are recorded in Table 10. The average g/ls for those stations was 0.1467. If station 1 data taken in August are not included, the average g/ls is 0.1323. This one extremely abundant sample yielded 68 percent of all organic matter for August and 13 percent of all organics combusted during this study. Station 1 in August also contained 44 percent of all polychaetes at that location during the study (Table A8a). It was the only time vegetative litter was observed at the sediment surface

36. The amount of sedimentary organic content conforms to the seasonal pattern shown in abundance of organisms. A peak occurred in April and numbers decreased thereafter. Overall, organic content was highest in April (Tables 9 and 10) and lowest in October.

37. A chi-square test was performed to compare station differences using the hypothesis that there were no differences in organic matter between stations. All seasonal data were pooled for each station. At the 5 percent level with 14 degrees of freedom, no significant difference was detected. When transect data were examined, however, a trend was apparent that organic matter was greater at western transects 1 and 2.

Conclusions

38. Gilmore and Trent (1974) found slightly over 1200 polychaetes per square metre of open bay in West Bay samples. Samples from the proposed habitat site yielded an average of 358 polychaetes per square metre. With all macrobenthos combined, Gilmore and Trent collected an average of 1300 organisms per square metre. An average of only 864 macrobenthic organisms were collected per square metre at the habitat development site. In another study done in March, 1972*, 16 km east of this study site and along a similar shoreline, an average of 1105 macrobenthic animals were collected per square metre. In March 1975, this study yielded an average of 326 animals per square metre of bottom. In both of the other studies, polychaetes were more dense, the sites were further removed from influence of gulf waters, they were nearer Spartina marsh areas, and had not been subjected to recent deposition of dredged material. This could account for more uniform and productive environments in the other two studies.

39. Greatest organic content was found in April sampling (18.6 g/ per station). At that time phytoplankton, zooplankton, and meiobenth

*Unpublished data, National Marine Fisheries Service, Southeast Fisheries Center, Galveston Laboratory, Galveston, Texas.

[illegible] were at their peak. Table 11, a summary of data for [illegible] and the overall 8-month study period combined, contains numerical abundance and biomass of the different parameters collected. It can be seen that postlarval and early juvenile fishes were not abundant any month except March. Zooplankters were lowest in August, but June was the month of lowest abundance of phytoplankton, benthic animals and organic content.

40. Ctenophores and coelenterates are not included in tabulated data but were observed throughout the study. When the pilot study was conducted in March, only a small number of Beroe ovata were observed in the water column. In April, B. ovata was still present and occasionally Stomolophus meleagris were found stranded along the shoreline. Numbers of S. meleagris increased on the shore by June and some were seen in August. By May, Anemiopsis maccradyi was dense enough to cause clogging of the plankton net. M. maccradyi remained abundant through August. One of their predators, Chrysaora quinquecirrha, also became abundant in August.

41. Limited numbers of higher tropic level scavenger and predator species attest to the paucity of epibenthic life. The only epibenthic scavenger collected was the hermit crab, Clibanarius vittatus.

42. The closest oyster reef detected was over 6 km from the habitat development site. In Spartina and in oyster biotopes of East Bay, finer sediments, high animal abundance, and species of higher trophic level occur. Either type of assemblage could result if deposition of fine-textured sediment occurs and physical structures are placed in the study area to retain these finer sediments.

Recommendations

43. A project such as this should include the study of a relatively undisturbed area nearby and the study results should be used as an indication of the biological development of the study site.

44. [illegible]ling should extend through one calendar year to encompass a complete life cycle of some organisms and determine [illegible] seasonal utilization of the area by others. Diel sampling [illegible]

show nocturnal differences, especially in epibenthic forms.

45. A structure placed in an area for the purpose of increasing productivity should allow for some circulation of water. Circulation aids in preventing unstable situations such as phytoplankton blooms, allows freedom of movement by organisms that would use the area, and transports finer sediments for deposition. Strong scouring currents should, however, be restricted by structure design.

46. Structural configuration should simulate natural conditions. In this case, nearby Elmgrove Point and Marsh Point areas (U. S. C&GS Chart 1282) have desirable parameters. At both locations, bayous meander in a northwesterly direction from Bolivar Peninsula to the bay through marsh grass. The direction of the bayous and sand plume configuration indicates prevailing currents to the west. By applying desired design factors vegetative production might occur naturally in an altered area.

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Table 1

Diatom Species in Descending Order

of Abundance and Percent of Total

March - June 1975*

Species	Date - Number/ml				Mean	Percent
	March	April	May	June		
Leptocylindrus minimus	1,102	6,700	15	210	2,007	35.5
Asterionella japonica	2,749	1,728	65	540	1,270	22.4
Navicula (1 to 5 spp.)	252	308	240	1,395	549	9.7
Skeletonema costatum	1,289	518	15	232	514	9.1
Thalassiosira (1 to 3 spp.)	154	1,198	210	202	450	8.0
Nitzschia (1 to 3 spp.)	111	392	555	285	336	5.9
Chaetoceros socialis		288		112	100	1.7
Coscinodiscus (sp.)	88	98	22	105	78	1.3
All Others	746	255	252	202	364	6.4
Total	6,491	11,485	1,374	3,283	5,658	100.0

*No phytoplankton were collected in August or October 1975.

Table 2

Major Groups of Zooplankton by Zones

March - October 1975

Groups	Zone - Number/m^3 I	II	III	IV	Mean	Std. Dev.	Percent
Barnacles	976.7	202.2	123.0	268.8	393	393.8	49.5
Copepods	611.7	254.6	183.9	397.4	362	188.7	45.6
Polychaetes	104.1	14.5	6.9	20.6	36	45.4	4.6
All Others	4.5	3.0	.5	1.2	2	1.6	0.3

Note: Zooplankton were not collected [illegible]nes III and IV in August and October.

Table 3

Number of Postlarval Fishes and Crustaceans Taken at Shore Stations With the Beam-Trawl in Descending Order of Abundance

March - October 1975

Taxa	Date					Total
	March 18	April 15	June 17	August 19	October 14	
Fish						
Gulf Menhaden (*Brevoortia patronus*)	1331	117				1448
Bay Anchovy (*Anchoa mitchilli*)	5		57	3	58	123
Atlantic Croaker (*Micropogon undulatus*)	70				2	72
Darter Goby (*Gobionellus boleosoma*)	32	2	9		3	46
Pinfish (*Lagodon rhomboides*)	20	12				32
Sheepshead (*Archosargus probatocephalus*)		25				25
Striped Mullet (*Mugil cephalus*)	18		1			19
Spot (*Leiostomus xanthurus*)	18					18
Southern Kingfish (*Menticirrhus americanus*)				10	4	14
Black Drum (*Pogonias cromis*)	4	6				10
Naked Goby (*Gobiosoma bosci*)			1	4	3	8
Ladyfish (*Elops saurus*)	2	4				6
Red Drum (*Sciaenops ocellata*)					6	6

(continued)

Table 3 (continued)

Taxa	Date					Total
	March 18	April 15	June 17	August 19	October 14	
Spotted Seatrout (Cynoscion nebulosus)				5		5
Inshore Lizzardfish (Synodus foetens)		1	2			3
Bay Whiff (Citharichthys spilopterus)	3					3
Speckled Worm Eel (Myrophis punctatus)	2					2
Longnose Killifish (Fundulus similis)			2			2
Tidewater Silverside (Menidia beryllina)			1		1	2
Atlantic Threadfin (Polydactylus octonemus)			2			2
Star Drum (Stellifer lanceolatus)					1	1
Atlantic Bumper (Chloroscombrus chrysurus)				1		1
Florida Pompano (Trachinotus carolinus)				1		1
Silver Perch (Bairdiella chrysura)			1			1
Southern Stargazer (Astroscopus y-graecum)		1				1
Chain Pipefish (Syngnathus louisianae)					1	1
Clown Goby (Microgobius gulosus)					1	1

(continued)

Table 3 (concluded)

Taxa	Date					Total
	March 18	April 15	June 17	August 19	October 14	
White Mullet (Mugil curema)			1			1
Totals	1505	168	77	24	80	1854
Crustaceans						
Brown Shrimp (Penaeus aztecus)	2122	138	40	73	2	2375
White Shrimp (Penaeus setiferus)	7		14	257	24	302
Seabob (Xiphopeneus kroyeri)				16	1	17
Blue Crab (Callinectes sapidus)				10		10
Hermit Crab (Clibanarius vittatus)				4		4
Totals	2129	138	54	360	27	2708

Table 4

Number of Juvenile Fishes and Crustaceans Taken at Shore Stations with the Bar Seine in Descending Order of Abundance

March - October 1975

Taxa	Date					Total
	March 18	April 15	June 17	August 19	October 14	
Fish						
Atlantic Croaker (Micropogon undulatus)	2604	28	338		1	2971
White mullet (Mugil curema)			690	56		746
Spot (Leiostomus xanthurus)	253	3	198			454
Atlantic Threadfin (Polydactylus octonemus)		2	265			267
Bay Anchovy (Anchoa mitchilli)	137	2	37	57		233
Gulf Kingfish (Menticirrhus littoralis)			15	83	20	118
Sea Catfish (Arius felis)			77	39	1	117
Longnose Killifish (Fundulus similis)	34	13	15	45	2	109
Spanish Sardine (Sardinella anchovia)	77					77
Bay Whiff (Citharichthys spilopterus)	60	3				63
Sand Seatrout (Cynoscion arenarius)			4	2	44	50
Striped Mullet (Mugil cephalus)	4	1	21	7		33
Rough Silverside (Membras martinica)			5	24		29

(continued)

Table 4 (continued)

Taxa	Date					Total
	March 18	April 15	June 17	August 19	October 14	
Florida Pompano (Trachinotus carolinus)			8	8		16
Crevalle Jack (Caranx hippos)			11	1		12
Gulf Killifish (Lucania parva)					9	9
Black Drum (Pogonias cromis)			5	2		7
Atlantic Bumper (Chloroscombrus chrysurus)					6	6
Atlantic Spadefish (Chaetodipterus faber)			5			5
Southern Flounder (Paralichthys lethostigma)	3	1				4
Southern Stargazer (Astroscopus y-graecum)		4				4
Leatherjacket (Oligoplites saurus)				2		2
Pinfish (Lagodon rhomboides)	2					2
Harvestfish (Peprilus alepidotus)				2		2
Sailfin Molly (Poecilia latipinna)					2	2
Silver Perch (Bairdiella chrysura)				1		1
Blackcheek Tonguefish (Symphurus plagiusa)			1			1
Least Puffer (Sphoeroides parvus)			1			1

(continued)

Table 4 (concluded)

Taxa	Date					Total
	March 18	April 15	June 17	August 19	October 14	
Scaled Sardine (Harengula pensacolae)				1		
Tidewater Silverside (Menidia beryllina)	1					
Red Drum (Sciaenops ocellata)			1			
Totals	3175	57	1697	330	85	53
Crustaceans						
White Shrimp (Penaeus setiferus)	16		1	344	4773	5134
Brown Shrimp (Penaeus aztecus)	371		371	3	196	941
Grass Shrimp (Palaemonetes sp.)	16	40	4		126	186
Seabob (Xiphopeneus kroyeri)				124	126	250
Blue Crab (Callinectes sapidus)	118	26	38	56		238
Hermit Crab (Clibanarius vittatus)				206		206
Totals	521	66	414	733	5221	6955

Table 5

Number of Trawl-Caught Fishes and Invertebrates by Months in Descending Order of Abundance, March - October 1975

Taxa	Date					Total No.	Total [illegible]
	March 18	April 15	June 17	August 19	October 14		
VERTEBRATES:							
Atlantic Croaker (Micropogon undulatus)	227	5	153	42		427	[illegible]
Spot (Leiostomus xanthurus)	1	9	62	4	4	80	292.2
Sea Catfish (Arius felis)			10	63	7	80	810.0
Gulf Butterfish (Peprilus burti)	5		13			18	18.6
Bay Anchovy (Anchoa mitchilli)		8	2			10	30.6
Crevalle Jack (Caranx hippos)				7		7	31.4
Atlantic Thread Herring (Opisthonema oglinum)			6			6	20.2
Atlantic Threadfin (Polydactylus octonemus)			6			6	22.4
Pinfish (Lagodon rhomboides)			4			4	57.0
Harvestfish (Peprilus alepidotus)				4		4	7.2
Southern Stargazer (Astroscopus y-graecum)	2	1				3	3.4
Gulf Menhaden (Brevoortia patronus)			2		1	3	30.6
Sand Seatrout (Cynoscion arenarius)			3			3	32.4

(continued)

Table 5 (Concluded)

Name	Date: March 15	April 15	June 7	August 19	October 14	Total No.	Total Wt.
Black Drum (Pogonias cromis)				3		3	[illegible]
Least Puffer (Sphoeroides parvus)	1		2			3	[illegible]
Inshore Lizzardfish (Cynodus foetens)			1			1	[illegible]
Red Drum (Sciaenops ocellatu)				1		1	[illegible]
Striped Mullet (Mugil cephalus)			1			1	[illegible]
Atlantic Cutlassfish (Trichiurus lepturus)			1			1	15.4
Bighead Searobin (Prionotus tribulus)	1					1	1.0
Florida Pompano (Trachinotus carolinus)			1			1	3.6
Southern Kingfish (Menticirrhus americanus)				1		1	47.4
Totals	237	23	267	125	12	664	3886.3
INVERTEBRATES:							
Brown Shrimp (Penaeus aztecus)	3		264		1	268	621.3
White Shrimp (Penaeus setiferus)	116	3			55	174	513.7
Blue Crab (Callinectes sapidus)	9		4	2		15	2601.0
Squid (Loligo sp.)				2	5	7	[illegible]
Totals	128	3	268	4	61	[illegible]	[illegible]

Table 6

Number of Benthic Invertebrates Arranged by Collection Dates and Species, March-October 1975

Taxa	Date					Total Number
	March	April	June	August	October	
RHYNCOCOELA						
Tubulanus pellucidus	2	2	2	[illegible]	[illegible]	13
POLYCHAETA						
Eteone heteropoda	27	55	3	12	17	164
Scoloplos fragilis			5	7	[illegible]	36
S. fragilis			1			1
Prionospio fauveli	7	5	3	37	58	130
Paraonidae fragilis			9	22	[illegible]	52
Heteromastus filiformis			5	21	[illegible]	32
Nereis succinea	2	2		2		6
N. occidentalis			1			1
Owenia fusiformis		1				1
Pseudeurythoe ambigua	1	2		1	4	8
Glycindes solitaria		1		2		3
Nephtys sp.					1	1
Nephtys magellanica		1				1
Capitella capitata			1		19	20
Mediomastus californiensis			2			2
Diopatra cuprea				1		1
ORBINIIDAE			6			6
TEREBELLIDAE			1			1
UNKNOWN (Young)			3			3
MOLLUSCA						
GASTROPODA						
Teinostoma biscaynense	2	1				3
Polinices duplicatus	2			1	[illegible]	4
Caecum pulchellum				1		1
PELECYPODA						
Periploma inequale	40	80	8	1	25	154
Mulinia lateralis	2	1			[illegible]	11
Ensis minor		2				2
Macoma tenta			1	2		3
Acteocina campechiensis		1				1
Unidentified					[illegible]	[illegible]

(continued)

Table 6 (concluded)

Taxa	Date					Total Number
	March	April	June	August	October	
CUMACEA		1		1		2
ISOPODA						
Xenanthura brevitelson	68	136	19	68	73	364
HAUSTORIIDAE	49	73	19	5	25	171
BRACHYURA						
Pinnixa cristata		1			4	5

*Unidentified fragments not included.

Table 7

Macrobenthic Organisms per Litre of Sediment According to Taxa, Stations, and Transects,

March-October 1975

	Organism-Number/litre of Sediment								All Benthos
	Polychaetes	Nemerteans	Amphipods	Isopods	Pelecypods	Gastropods	Brachyurans	Cumaceans	per Litre
Shore Stations									
1	14.0	-	1.4	4.7	0.1	-	-	-	20.2
2	6.0	0.1	0.8	1.7	0.1	-	-	-	8.7
3	5.0	-	2.3	2.0	0.5	-	-	0.1	9.9
4	4.3	-	1.2	2.1	0.1	-	-	-	7.7
Middepth Stations									
5	4.5	0.1	2.4	7.9	1.5	0.1	-	-	16.5
6	4.5	0.1	3.0	13.9	3.8	0.1	0.1	-	25.5
7	3.4	0.2	3.0	6.8	1.8	-	-	0.1	15.3
8	1.6	0.1	1.9	-	1.4	-	-	-	5.0
Offshore Stations									
9	4.0	0.1	1.8	1.5	3.9	0.3	-	-	11.6
10	6.2	0.3	2.1	2.6	4.1	0.3	-	-	15.6
11	7.1	0.5	1.3	3.2	1.8	0.2	-	-	14.1
12	5.6	0.3	0.8	1.6	1.6	-	0.4	-	10.7
Transects perpendicular to shore									
1	7.2	0.1	1.9	4.8	1.9	0.1			16.9
2	5.6	0.2	1.8	5.8	2.5	0.1			16.0
3	5.1	0.2	2.2	4.0	1.3	0.1			12.9
4	3.7	0.1	1.3	1.2	1.2	-			7.5
Transects parallel to shore									
Shore	7.2	0.1	1.4	2.6	0.2	-			11.6
Middepth	3.5	0.1	2.6	7.8	2.1	0.1			16.2
Offshore	5.7	0.2	1.5	2.1	2.8	0.2			12.5
All data X	5.5	0.1	1.7	3.7	1.7	0.1			12.8

Table 8

Benthic Organisms per Litre of Sediment by Transect, October 1975

Taxa	Transect 1	2	3	4	5	All Transects*
Polychaetes	10.6	7.8	7.5	5.1	6.4	7.5
Isopod	4.3	2.5	3.6	1.4	0.8	2.5
Amphipod	1.0	1.2	0.6	0.6	0.6	0.8
Pelecypod	0.5	1.2	0.6	0.8	0.9	0.8
Gastropod	0.2	-	-	-	-	< 0.1
Nemertea	-	0.2	0.4	0.2	-	0.2
Brachyura	-	-	-	0.4	0.1	0.1
All Benthos*	16.6	12.9	12.7	8.5	8.8	11.9

*Total numbers of organisms divided by total litres of sediment.

Table 9

Grams of Organic Matter per Square Metre Sediment Surface, by Stations, Transects, and Months,*

March-October 1975

	March	April	June	August	October	All Months Combined
			Transects 1-5			
Station						
1	12.8224	28.2239	11.7416	97.0807	13.1108	32.5959
2	10.0151	9.3649	13.3778	6.5231	6.2820	9.1126
3	3.7416	18.5963	7.0656	4.0086	7.6081	8.2040
4	8.7616	5.3390	1.5285	6.9709	5.3003	5.5601
5	7.5541	29.3304	5.1152	8.6760	2.6008	10.6153
6	25.9892	5.6138	2.0409	4.3789	1.9720	7.9990
7	2.2807	4.9924	3.0743	4.8439	5.1238	4.0631
8	20.4792	34.1485	3.8579	4.1679	2.1787	12.9664
9	5.8256	2.9322	2.2130	3.2292	2.0366	3.2474
10	4.7147	51.1922	2.8793	5.3649	2.9451	13.4194
11	2.9386	27.8364	5.3261	2.8159	1.9548	8.1744
12	3.3369	6.1442	5.9419	8.3918	4.8008	5.7232
13	-	-	-	-	2.7642	2.8642
14	-	-	-	-	3.7115	3.7115
15	-	-	-	-	9.5500	9.5500
Transects perpendicular to shore						
1	8.6673	20.1621	6.3566	36.3286	5.9160	15.4861
2	13.5730	22.0569	6.0993	5.4223	3.7330	10.1769
3	2.9869	17.1417	5.1553	3.8894	4.8955	6.8138
4	10.8592	15.2105	3.7761	6.5102	4.0933	8.0898
5	-	-	-	-	5.3419	5.3419
Transects parallel to shore						
Shoreline	8.8351	15.3810	8.4283	28.6458	7.0131	13.6607
Middepth	14.0258	18.5212	3.5220	5.5166	3.1174	8.5706
Offshore	4.2039	22.0262	4.0900	4.9504	4.2575	7.9056
All Data	9.0216	18.6428	5.3467	13.0376	4.7959	10.1689

*Determined by ash-free dry-weight procedure.

Table 10

Grams of Organic Matter per Litre of Sediment

Arranged by Station, Transect, and Month,*

March-October 1975

	March	April	June	August	October	All Months Combined
			Transects 1-5			
Station						
1	0.2041	0.4708	0.3084	1.3664	0.1581	0.5015
2	0.1069	0.1529	0.2235	0.0681	0.0522	0.1207
3	0.0920	0.3255	0.0949	0.0521	0.0637	0.1256
4	0.1244	0.1145	0.0352	0.0683	0.0660	0.0817
5	0.1334	0.4883	0.0834	0.0716	0.0331	0.1620
6	0.4679	0.0816	0.0456	0.0414	0.0269	0.1327
7	0.0477	0.4752	0.0816	0.0762	0.0558	0.1473
8	0.3980	0.6848	0.0864	0.0308	0.0269	0.2454
9	0.1294	0.0717	0.0528	0.0281	0.0200	0.0604
10	0.0904	0.9339	0.0615	0.0625	0.0266	0.2350
11	0.0637	0.4667	0.0932	0.0475	0.0302	0.1403
12	0.0677	0.1005	0.1221	0.0889	0.0520	0.0862
13	-	-	-	-	0.0347	0.0347
14	-	-	-	-	0.0374	0.0374
15	-	-	-	-	0.0899	0.0899
Transects perpendicular to shore						
1	0.1556	0.3436	0.1482	0.4887	0.0704	0.2413
2	0.2217	0.3895	0.1102	0.0573	0.0352	0.1528
3	0.0678	0.4225	0.0899	0.0586	0.0499	0.1377
4	0.1967	0.2999	0.0812	0.0627	0.0483	0.1378
5	-	-	-	-	0.0540	0.0540
Transects parallel to shore						
Shore-line	0.1319	0.2659	0.1655	0.3887	0.0749	0.2054
Mid-depth	0.2618	0.4325	0.0743	0.0550	0.0360	0.1719
Off-shore	0.0878	0.3932	0.0924	0.0568	0.0437	0.1328
All Data	0.1605	0.3639	0.1074	0.1668	0.0516	0.1467

*Determined by ash-free dry-weight procedure.

Table 11

Seasonal Distribution of Environmental Parameters

March-October 1975

	March	April	June	August	October	All Months Combined
Organics g/m^2	9	19	5	13	5	10
Benthos Organisms/m^2	804	1363	326	775	1055	864
Phytoplankton (Diatoms/ml)	6530	11482	3285	-	-	-
Zooplankton per m^3 (Zones I and II)	2563	3762	297	58	416	1419
Postlarval Fishes per 1,000 m^2	2090	233	107	36	86	644
Early Juvenile Fishes per 1,000 m^2	1142	23	607	119	24	366
Juvenile Fishes per 1,000 m^2	19	2	28	13	1	13

- = No data.

APPENDIX A'

Sampling Collection Data From The Bolivar Peninsula Site

Table A1

Types of Collections Taken by

Dates, Zones, and Stations

1975	Zone				Station											
	Intertidal	Open Water	West Intertidal	East Intertidal	Shoreline					Outer-Intertidal					Cr	
	I	II	III	IV	1	2	3	4	13	5	6	7	8	14	9	10
March 18	P	P	P	P												
	Z	Z	Z	Z	M	M	M	M	M							
	N	N	N	N	B	B	B	B		B	B	B	B		B	B
April 15	P	P	P	P						B	B	B	B			D
	Z	Z	Z	Z	M	M	M	M								
	N	N	N	N	B	B	B	B								
May 13	P	P	P	P												
	Z	Z	Z	Z												
June 18	P	P	P	P												
	Z	Z	Z	Z	M	M	M	M		B	B	B	B		B	B
	N	N	N	N	B	B	B	B								
August 19	Z	Z														
	N	N	N	N												
					M	M	M	M		B	B	B	B		B	B
					B	B	B	B								
October 14	Z	Z			B	B	B	B	B							
	N	N	N	N						B	B	B	B	B	B	B
					M	M	M	M	M							

Key: P - Phytoplankton
Z - Zooplankton
N - Nekton
M - Meroplankton postlarval fish
B - Benthos

Table A2

Environmental Data Collected on Each Sample Date

Date and Location 1975	Temperature (°C)		Salinities (Parts per Thousand) Transects and Zones					Remarks
	Air	Water	(I)	2 (II)	3 (III)	4 (IV)	5	
March 18								
Shore	18-20	17-20	19	19	19	19		Wind 10 Knots per hou
Offshore	18-20	18-18	20	20	20	20		Tide app. 0.3 m
April 15								
Shore	20-23	17-18	15	15	15	14		Wind 8 Knots per hou
Offshore		14-16	12	12	12	12		Tide app. 0.1 m
May 13								
Shore	29-29	29-29	10	10	10	10		Wind 10 Knots per hou
Offshore		29-29	10	10	10	10		
June 17								
Shore		28-31	12	12	12	12		Wind 16 Knots per hou
Offshore	28-31	28-29	12	12	14	12		Tide 0.5 m
August 19								
Shore	28-34	28-32	19	20	19	19		Wind calm, S.
Offshore	28-35	28-30	20		20	17		Tide 0.1 m
October 14								
Shore	28	26-28	24	24	24	22	20	Wind 10 Knots per hou
Offshore	28	26	24	25	25	24		15 Knots per hour, NW

Table A3

Abundance and Range of Lengths (mm) of Postlarval Fishes and Crustaceans Taken at Shore Stations with the Beam-Trawl, March - October 1975

Species	Date of Collection																			
	March 18				April 15				June 17				August 19				October 14			
	Stations																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	13
Gulf Menhaden	296	40	930	65	48	12	6	51													
Brevoortia patronus	19/	18/	19/	18/	18/	16/	18/	18/													
	22	22	29	21	23	21	20	20													
Bay Anchovy	1	1	3						7	10	34	6				3	2	15	23	3	15
Anchoa mitchilli	/	/	28/						22/	19/	6/	20/				42/	14/	15/	14/	21/	11/
	48	43	45						44	27	43	26				45	22	19	21	22	22
Atlantic Croaker	17	10	20	23															1	1	
Micropogon undulatus	23/	23/	19/	23/															/	/	
	43	36	33	37															6	8	
Darter Goby	6	11	14	1		2				1	4	4						1	1		1
Gobionellus	9.8/	9.2/	9.8/	/		10/				/	8.2/	8.7/						/	/		/
boleosoma	10	10	11	11		14				8.6	8.9	9.9						13	9.2		8.9
Pinfish	4	3	13		2	3	2	5													
Lagodon rhomboides	13/	13/	12/		13/	12/	12/	12/													
	14	14	14		14	13	12	13													
Sheepshead					6	11	2	6													
Archosargus					8.0/	8.6/	8.4/	8.1/													
probatocephalus					9.3	9.5	8.6	8.4													
Striped Mullet	1	2	15									1									
Mugil cephalus	/	19/	17/									/									
	12	22	24									93									
Spot	6	2	9	1																	
Leiostomus	11/	11/	10/	/																	
xanthurus	13	12	14	13																	

(continued)

Table A3 (continued)

Species	Date of Collection																			
	March 18				April 15				June 17				August 19				October 14			
	Stations																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	3	4	13
Southern Kingfish *Menticirrhus americanus*													3 20/ 33	4 14/ 43	1 / 22	2 4.2/ 4.3		3 25/ 28	1 / 20	
Black Drum *Pogonias cromis*	1 / 5.9	1 / 5.7	2 5.5/ 5.8		2 5.1/ 5.5	1 / 5.3		3 5.1/ 5.8												
Naked Goby *Gobiosoma bosci*											1 / 8.3				3 7.3/ 7.6	1 / 6.6	1 / 7.4	1 / 7.0	1 / 8.0	
Ladyfish *Elops saurus*		1 / 38	1 / 33		3 31/ 43	1 / 35														
Red Drum *Sciaenops ocellata*																		3 5.8/ 8.3		3 7.3/ 7.6
Spotted Seatrout *Cynoscion nebulosus*													1 / 4.8	1 / 5.3	3 4.1/ 5.5					
Inshore Lizardfish *Synodus foetens*					1 / 41				1 / 39	1 / 37										
Bay Whiff *Citharichthys spilopterus*	1 / 32		2 9.9/ 10																	
Speckled Worm Eel *Myrophis punctatus*			2 46/ 52																	
Longnose Killifish *Fundulus similis*										1 / 34	1 / 30									

(continued)

Table A3 (continued)

Species	Date of Collection																			
	March 13				April 15				June 17				August 19				October 14			
	Stations																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Tidewater Silverside											1							1		
Menidia beryllina											/							/		
											27							29		
Atlantic Threadfin									2											
Pol dactylus									49/											
octonemus									53											
Star Drum																	1			
Stellifer																	/			
lanceolatus																	5.0			
Atlantic bumper																	1			
Chloroscombrus																	/			
chrysurus																	9.3			
Florida Pompano																1				
Trachinotus																/				
carolinus																13				
Silver Perch									1											
Baridiella chrysura									/											
									4.2											
Southern Stargazer					1															
Astroscopus y-graecum					/															
					38															
Chain Pipefish																		1		
Syngnathus louisianae																		/		
																		104		
Clown Goby																				1
Microgobius gulosus																				/
																				8.1
White Mullet									1											
Mugil curema									/											
									32											

(continued)

Table A3 (concluded)

Species	Date of Collection																			
	March 18				April 15				June 17				August 19				October 14			
	Stations																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		2	3	4
Brown Shrimp	482	240	1265	135	75	34	17	12	11	10	8	11	23	26	18	6				
Penaeus aztecus	11/	11/	11/	11/	10/	10/	11/	11/	44/	25/	44/	/	8/	9/	19/	8/				
	14	13.5	17	14	17	13	13	13	75	71	30	55	9	90	95	20				
White Shrimp	1		5	1					4		1	9	21	82	93	61	11		1	7
Penaeus setiferus	/		40/	/									5/	5/	5/	5/	22/			
	45		50	55									7	45	65	33	45			
Seabob													12	2	1	1	1			
Xiphopeneus													10/	9/	/	/	/			
kroyeri													34	15	12	12	33			
Blue Crab													4		3	3				
Callinectes sapidus													11/		12/	9.1/				
													24		24	23				
Hermit Crab														2		2				
Clibanarius vittatus																				
Total	483	240	1270	136	75	34	17	12	15	10	9	20	60	112	115	73	12	0	1	7

Table A4

Abundance and Range of Lengths (mm) of Juvenile Fishes and Crustaceans

Taken at Shore Stations with the Bar Seine

March - October 1975

Species	Date of Collection: March 18 — Stations 1	2	3	4	April 15 — 1	2	3	4	June 17 — 1	2	3	4	August 19 — 1	2	3	4	October 14 — all stations
Atlantic Croaker	996	697	360	551	10	18			72	192	68	6					1
Micropogon	20/	18/	25/	25/	35/	40/			41/	40/	47/	53/					
undulatus	75	66	70	65	50	50			82	88	75	75					
White Mullet									85	494	104	7	37	13		8	
Mugil curema									35/	26/	26/	33/	42/	44/		41/	
									54	59	39	47	76	69		71	
Spot	14	205	16	18		3			55	39	69	35					
Leiostomus	37/	27/	13/	35/		/			44/	40/	45/	38/					
xanthurus	62	69	54	64		40			75	69	70	72					
Atlantic Threadfin					2				41	76	134	14					
Polydactylus					40/				46/	45/	44/	45/					
octonemus					50				55	54	55	59					
Bay Anchovy	38	9	73	17	2				6	12	18	1	11	7	25	4	
Anchoa mitchilli	41/	45/	41/	38/	45/				37/	38/	26/	/	29/	32/	31/	20/	
	52	49	57	51	50				46	53	47	44	44	41	39	38	
Gulf Kingfish									3	6	6		27	36	38	2	20
Menticirrhus littoralis									37/	32/	25/		24/	26/	35/	29/	
									48	42	108		56	54	56	37	
Sea Catfish									17	40	8	12	9	2	28		1
Arius felis									40/	43/	77/	78/	41/	38/	41/		
									102	232	94	100	55	46	48		
Longnose Killifish	3	1	29	1	6	2	5		4	3	8		1	16	2	26	2
Fundulus similis	40/	/	29/	/	40/	40/	40/		36/	34/	27/		/	38/	36/	30/	
	61	61	68	65	60	45	55		47	43	55		40	42	39	43	

(continued)

Table A4 (continued)

Species	Date of Collection / Stations																	Total
	March 18				April 15				June 17				August 19				October 14	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	all stations	
Spanish Sardine	76			1														77
Sardinella anchovia	19/			/														19/
	23			22														23
Bay Whiff	14	26	5	15	1	2												63
Citharichthys	25/	23/	21/	27/	/	/												21
cpilopterus	39	55	28	48	35	45												55
Sand Seatrout									1	1	1	1	2					50
Cynoscion									/	/	/	/	27/				44	27/
arenarius									48	38	61	50	31					71
Striped Mullet			4				1		9	4		8	1	6				33
Mugil cephalus			19/				/		103/	70/		71/	/	75/				19/
			24				30		141	136		122	80	99				141
Rough Silverside									1	3		1		8		16		29
Membras martinica									/	24/		/		30/		30/		24/
									73	73		63		44		44		73
Florida Pompano									4	2	2		1	1	1	5		16
Trachinotus carolinus									26/	40/	35/		/	/	/	35/		26/
									37	41	37		44	42	33	50		50
Crevalle Jack									4		7			1				12
Caranx hippos									27/		29/			/				27/
									34		32			37				37
Rainwater Killifish																		
Locania parva																	9	9
Black Drum									1	2	1	1		2				7
Pogonias cromis									/	29/	/	/		64/				28/
									28	36	32	34		62				62
Atlantic Bumper																		
Chloroscombrus chrysurus																	0	0

(continued)

Table A4 (continued)

Species	Date of Collection: March 18 — Stations 1	2	3	4	April 15 — 1	2	3	4	June 17 — 1	2	3	4	August 19 — 1	2	3	4	October 14 — all stations	Total
Atlantic Spadefish									2	2		1						5
Chaetodipterus									25/	14/		/						14/
faber									26	21		22						26
Southern Flounder	1						1											4
Paralichthys	35/						/											35/
lethostigma	39						70											70
Southern Stargazer					3	1												4
Astroscopus y-graecum					30/	/												30/
					35	30												35
Leather jacket													1	1				2
Oligoplites saurus													/	/				46/
													56	46				56
Pinfish	2																	2
Lagodon rhomboides	13/																	13/
	14																	14
Harvest fish																		
Peprilus alepidotus															2			2
															18/			18/
															22			22
Sailfin Molly																		
Poecilia latipinna																	2	2
Silver Perch																		
Bairdiella chrysura													1					1
													/					/
													55					55
Black Cheek Tonguefish									1									1
Symphurus plagiusa									/									/
									47									47
Least Puffer									1									1
Sphoeroides parvus									/									/
									28									28

(Continued)

Table A4 (concluded)

Species	Date of Collection																	Total
	March 18				April 15				June 17				August 19				October 14	
	Stations																	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	all stations	
Scaled Sardine													1					1
Harengula pensacolae													/					/
													35					35
Tidewater Silverside				1														1
Menidia beryllina				/														/
				60														60
Red Drum									1									1
Sciaenops ocellata									/									/
									183									183
Total	1146	938	487	604	24	26	7	0	306	878	426	87	92	73	106	59	85	5344
White Shrimp			13	3							1		310	24	10		4773	3134
Penaeus setiferus			44/	45/							/		28/	34/	40/			28/
			83	55							124		80	72	67			124
Brown Shrimp									106	132	90	23	1		2		196	570
Penaeus aztecus									38/	31/	40/	41/	/		67/			31/
									84	90	92	78	59		78			92
Seabob													124				126	250
Xiphopeneus kroyeri													25/					25/
													87					87
Blue Crab	32	21	24	41	9	12	5		10	17	10	1	24	21	7	4		238
Callinectes sapidus	17/	16/	10/	16/	25/	25/	25/		14/	15/	19/	/	16/	16/	18/	18/		10/
	69	75	70	88	90	70	70		137	47	162	19	102	120	38	25		162
Hermit Crab													73	73	33	27		206
Clibanarius vittatus													/	/	/	/		/
													?	?	?	?		?
Grass Shrimp	1	9	6		12	220	5	1	2	1	1						126	186
Palaemonetes sp.	/	28/	22/		30/	35/	35/	30/	29/	/	/							22/
	28	36	34		40	40	40	35	30	32	29							40
Total	33	30	43	44	21	32	20	3	118	170	102	24	532	118	52	31	5221	6584

Table A5

Counts of Phytoplankton, March-June, 1975

(Numbers per Millilitre)*

Organism	Zones I	II	III	IV
a. March 18, 1975				
Diatoms				
Asterionella japonica**	3205	1350	3680	2760
Leptocylindrus minimus	680	1055	2145	530
Skeletonema costatum	660	870	1135	2490
Navicula spp.	445	185	190	190
Rhizosolenia fragilissima	345	110	60	230
Chaetoceros similis	165			130
Amphora ostrearia	140			
Surirella smithii	140		60	
Thalassiosira rotula	140	60	320	120
Thalassionema nitzchioides	120	60		
Coscinodiscus sp.	60	130	60	100
Biddulphia mobiliensis	60			
Rhizosolena robusta	60			
Nitzchia closterium	60	60	130	
Podosira stelliger	60			
Ditylum brightwelli	60	120	100	135
Licmophora jurgensii	60			
Pleurosigma aestaurii	60			
Cyclotella sp.		100		290
Hantzschia virgata		60		
Rhizosolenia hebeta		60		
Nitzschia sp.			100	60
Gyrosigma sp.			60	
Amphora sp.		110		
Thalassiosira nordenskioldii				130
Subtotal	6520	4330	8040	7165
Dinoflagellates				
Peridinium trochoideum	60			
Exuviella cassubica	60	110		
Dinoflagellate cyst	60			
Prorocentrum micans		60		
Lunate cyst		180		180
Subtotal	180	350	0	180
Green Algae				
Biflagellated zoospore	60			
Carteria sp.	60			
Stichococcus sp.	60			
Unidentified coccoid			430	
Subtotal	180	0	430	0

Table A5 (continued)

Organism	Zones I	II	III	IV
b. April 15, 1975				
Diatoms				
*Leptocylindrus minimus***	5240	7850	6920	6790
Asterionella japonica	2690	1060	1450	1710
Thalassiosira rotula	580	60	1410	1160
Thalassiosira pseudonana	410	620	340	210
Nitzschia closterium	400	260	140	140
Skeletonema costatum	330	250	930	660
Navicula spp.	230	310	480	210
Chaetoceros socialis	230		440	480
Melosira suleata	160	60		60
Coscinodiscus sp.	60	60	60	210
Nitzschia sp.	60	210		360
Pleurosigma sp.	60			
Melosira sp.		60		
Rhizosolenia sp.		60		
Amphora sp.			120	
Hemiaulus hauckii			60	
Ditylum brightwellii			60	60
Thalassionema nitzschioides			60	60
Fragilaria sp.				140
Cyclotella sp.				120
Subtotal	10350	10860	12470	12370
Dinoflagellates				
Exuviella (cassubica?)		60		
Peridinium trochoideum		60		
Exuviella (baltica?)			140	
Cyst				60
Subtotal	0	120	140	60
Green Algae				
Carteria sp.	60	60	60	
Dunaliella sp.	60	60		60
Subtotal	120	120	60	60
Blue-Green Algae				
Oscillatoria sp.	60			
Chroococcus sp.		60		
Spirulina (filament)		60		
Subtotal	60	120	0	0

(continued)

Table A5 (continued)

Organism		Zone I	Zone II	Zone III	Zone IV
	c. May 13, 1975				
Diatoms					
*Nitzschia lanceolata***		510	240	270	210
Chaetoceros gracile		120	30	330	
Navicula spp.		150	180	510	120
Thalassiosira pseudonana		120	120	420	180
Nitzschia closterium[2]		120	150	510	210
Leptocylindrus minimus		120		110	30
Gyrosigma hippocampus		30	30	30	110
Skeletonema costatum		30	30		
Hantzschia sp.			120	120	30
Coscinodiscus sp.			30	30	30
Bacteriastrum sp.			30	30	
	Subtotal	1200	960	2360	920
Dinoflagellates					
Gymnodinium sp.		30			
Prorocentrum micans		30	110		
	Subtotal	60	110	0	0
Euglenoids					
Eutreptia sp.			30		30
	Subtotal	0	30	0	30
Green Algae					
Platymonas sp.		30	30	110	30
	Subtotal	30	30	110	30
Blue-Green Algae					
Gleocapsa sp.		240	210	540	360
Oscillatoria sp.		540		1470	420
	Subtotal	780	210	2010	780

(continued)

Table 5 (concluded)

Organisms	Zones I	II	III	IV
d. June 17, 1975				
Diatoms				
Navicula spp.	1440	1710	1290	1140
Asterionella japonica[2]	540	360	90	1170
Leptocylindrus minimus	360	180	150	150
Chaetoceros socialis	300		120	30
Nitzschia closterium	210	240	180	210
Skeletonema costatum[2]	210	300	120	300
Coscinodiscus sp.	210	210	90	120
Thalassiosira rotula	210	330		270
Nitzschia lanceolata	120	120	90	90
Licmorpha flabellata	60			
Thalassionema nitzschioides	60		120	30
Rhizosolenia sp.	60		30	
Cyclotella sp.		240	120	90
Subtotal	3780	3690	2400	3600
Dinoflagellates				
Prorocentrum micans	90			
Dinoflagellate cyst	30	60	30	
Exuviella sp.			60	
Subtotal	120	60	90	0
Green Algae				
Dunaliella sp.		90	90	60
Subtotal	0	90	90	60
Euglenoids				
Eutreptia pertyi		60	30	30
Subtotal	0	60	30	30
Blue-Green Algae				
Oscillatoria sp.	2970	930	780	660
Chroococcus sp.	510	210	90	390
Gloeocapsa	270	180		60
Subtotal	3750	1320	870	1110
TOTAL	27,130	22,460	29,100	26,395

*Counts were made with a Palmer-Maloney counting cell and a phase-contrast microscope. The number shown represents the counts of seven or fourteen preparations calculated to give the number per millilitre. Seven preparations represent a total volume of 0.1 millilitre.

**Many of the organisms observed occurred in various colonial forms. For such individuals the individual cells and not the colony are counted.

+Counts that are less than 100 per millilitre are based on the observation of one specimen of that species in the total number of preparations counted.

Table A6

Replicate Zooplankton Samples by Zone, Date, and Taxa

(Organisms per m^3 Water)

Taxa	Date										
	March 18		April 15		May 13		June 17		August 19		October
	Replicate		Replicate		Replicate		Replicate		Replicate		Rep
	A	B	A	B	A	B	A	B	A	B	A
	a. ZONE I										
Copepod	557.5	2194.4	1348.2	1876.6	4.0	7.5	45.6	655.0	22.9	25.5	159.0
Barnacle	823.0	4870.5	2340.4	3458.0	5.3	4.5	12.5	108.7	34.6	43.4	3.3
Polychaete	212.4	909.9	17.9	22.7	0.7		0.9	3.1	2.1	1.2	8.5
Mysidacean	79.6										
Crustacean Egg	26.5										
Nematode		160.6									
Crab Zoea			15.7	29.1				3.1	2.1		
Palaemonid							2.9	1.6			
Callianassid							0.9	1.6			
Isopoda								1.6	6.3	1.2	
Urochordate											10.5

(continued)

Table A6 (continued)

Taxa	Date: March 18 Replicate A	March 18 Replicate B	April 15 Replicate A	April 15 Replicate B	May 13 Replicate A	May 13 Replicate B	June 17 Replicate A	June 17 Replicate B	August 19 Replicate A	August 19 Replicate B	Oct Re
				b. ZONE II							
Copepod	174.4	33.0	1112.6	780.6	101.1	66.4	132.3	166.3	43.9	22.6	23
Barnacle	69.8	66.0	1092.4	1052.5	23.4	24.5	21.9	26.3	9.0	6.3	
Polychaete	58.1	16.5		8.0	3.2	2.0	1.2	1.2		0.7	05
Nematode				1.1							
Crab Zoea			8.6	9.1	1.6	0.6		1.2	9.0	1.7	3
Palaemonid					0.4	0.9					
Callianassaid							2.3				
Isopoda						0.3		1.2	0.3		
Anchovy Larva				1.1							
Brown Shrimp						0.6					
Urochordate											175
Crustacean Zoea					0.4						
Anchovy					0.8						

(continued)

Table A6 (continued)

Taxa	Date: March 28 Replicate A	March 28 Replicate B	April 15 Replicate A	April 15 Replicate B	May 13 Replicate A	May 13 Replicate B	June 17 Replicate A	June 17 Replicate B	August 19 Replicate A	August 19 Replicate B
e. ZONE III										
Copepod	141.7	35.9	152.1	78.2	119.1	79.5	268.6	596.1	Note: Zooplank not collected or October in	
Barnacle	57.6	77.8	430.3	348.1	41.8	4.7	5.3	18.8		
Polychaete	35.4	12.0	4.0	2.5	0.7					
Crab Zoea					4.2	1.2		4.9		
Palaemonetes								1.8		
Brown Shrimp							1.3	1.4		
Medusae	4.4									
Crab Megalops		3.0								
Anchovy					0.7					
White Shrimp							1.3			

(continued)

Table A6 (concluded)

Taxa	Date: March 18 Replicate A	March 18 Replicate B	April 1[illegible] Replicate A	April 1[illegible] Replicate B	May 13 Replicate A	May 13 Replicate B	June 17 Replicate A	June 17 Replicate B	August 19 Replicate A	August 19 Replicate B	Oc[illegible] Re[illegible] A
				d. ZONE IV							
Copepod	206.0	48.5	227.8	2016.4	126.9	160.8	143.1	249.4			
Barnacle	123.6	299.0	923.0	720.1	11.8	12.8	17.0	42.7			
Polychaete	67.4	89.7	1.81	3.13	1.2	1.8					
Crab Zoea			11.79	43.83	2.4	1.2					
Palaemonetes					1.5	0.9	1.9				
Callianassidae							1.9				
Isopoda					0.3		1.9				
Gastropod			0.9								
Anchovy Egg				6.26							
Brown Shrimp						0.6					
Fish Larva					0.3	0.3					

Note: Zooplankton not collected in A[illegible] or October in ZONE

Table A7

Trawl-Caught Fishes and Invertebrates by Month, Zone, and Tow

Taxa	Zone I, Tow Number 1	Zone I, Tow Number 2	Zone II, Tow Number 1	Zone II, Tow Number 2	Zone III, Tow Number 1	Zone III, Tow Number 2	Zone IV, Tow Number 1	Zone IV, Tow Number 2
				a. March 1975				
VERTEBRATES:								
Atlantic Croaker (Micropogon undulatus)	86.3* 29**	98.1 36	78.4 23	97.7 27	117.1 36	106.0 21	66.1 24	[illegible]
Spot (Leiostomus xanthurus)	6.1 1							
Sea Catfish (Arius felis)								
Gulf Butterfish (Peprilus burti)		8.1 3			1.0 1	2.1 1		
Southern Stargazer (Astroscopus y-graecum)	1.1 1				1.1 1			
Least Puffer (Sphoeroides parvus)				10.8 1				
Bighead Searobin (Prionotus tribulus)			1.0 1					

* Total weight in grams.

** Number of organisms collected.

(continued)

Table A7 (continued)

Taxa	Zone I Tow 1	Zone I Tow 2	Zone II Tow 1	Zone II Tow 2	Zone III Tow 1	Zone III Tow 2	Zone IV Tow 1	Zone IV Tow 2
			b. March 1975 (continued)					
INBERTEBRATES:								
Brown Shrimp (Penaeus aztecus)	1.0 / 1						1.4 / 1	1.[illegible] / 1
White Shrimp (Penaeus setiferus)	14.3 / 4	27.2 / 10	77.9 / 21	50.3 / 17	33.3 / 12	35.2 / 10	70.3 / 21	59.[illegible] / 21
Blue Crab (Callinectes sapidus)				410.8 / 3	187.2 / 2	436.4 / 2	389.0 / 2	148.[illegible] / 1
			c. April 1975					
VERTEBRATES:								
Atlantic Croaker (Micropogan undulatus)	2.0 / 1		1.2 / 1				2.8 / 1	8.[illegible] / 2
Spot (Leiostomus xanthurus)			5.2 / 1	12.3 / 2	7.1 / 1	40.1 / 5		
Bay Anchovy (Anchoa mitchilli)	2.8 / 1		4.9 / 1	9.1 / 2		9.3 / 2	3.1 / 1	0.[illegible] / 1
Southern Stargazer (Astroscopus y-graecum)						1.2 / 1		
INVERTEBRATES:								
White Shrimp (Penaeus setiferus)							15.4 / 1	25.[illegible] / 2

(continued)

Table A7 (continued)

Taxa	Zone I Tow Number 1	Zone I Tow Number 2	Zone II Tow Number 1	Zone II Tow Number 2	Zone III Tow Number 1	Zone III Tow Number 2	Zone IV Tow Number 1	Zone IV
			d. June 1975					
VERTEBRATES:								
Atlantic Croaker (Micropogon undulatus)	40.6 14	43.5 16	120.3 37	92.7 26	25.6 8	40.3 11	90.0 26	40 1
Spot (Leiostomus xanthurus)	69.6 7	87.6 10	200.6 23	33.8 4	7.5 1	7.3 1	97.4 9	69 7
Sea Catfish (Arius felis)	12.9 1	32.8 2	54.1 4	15.6 1			15.0 1	1
Butterfish (Peprilus burti)	2.4 4	2.4 3	0.8 2		0.5 1	1.0 2	0.3 1	
Bay Anchovy (Anchoa mitchilli)			0.8 2					
Atlantic Thread Herring (Opisthonema oglinum)		6.5 3	13.7 3					
Atlantic Threadfin (Polydactylus octonemus)							6.6 2	1
Pinfish (Lagodon rhomboides)	19.4 1		19.8 2		17.8 1			

(continued)

Table A7 (continued)

Taxa	Zone I Tow 1	Zone I Tow 2	Zone II Tow 1	Zone II Tow 2	Zone III Tow 1	Zone III Tow 2	Zone IV Tow 1	Zone IV Tow 2
			June 1975 (continued)					
VERTEBRATES (continued)								
Gulf Menhaden (Brevoortia patronus)							9.5 1	19.5 1
Sand Seatrout (Cynoscion arenarius)			31.0 2	1.2 1				
Least Puffer (Sphoeroides parvus)			1.3 1	2.7 1				
Inshore Lizardfish (Synodus foetens)							26.4 1	
Striped Mullet (Mugil cephalus)			146.2 1					
Atlantic Cutlassfish (Trichiurus lepturus)				18.4 1				
Florida Pompano (Trachinotus carolinus)					33.6 1			
INVERTEBRATES								
Brown Shrimp (Penaeus aztecus)	134.3 42	145.6 49	102.1 39	91.6 38	76.3 29	89.8 29	53.4 16	62.4 22
Blue Crab (Callinectes sapidus)	139.4 1	270.2 1		145.6 1		26.0 1		

(continued)

Table A7 (continued)

Taxa	Zone I Tow Number 1	Zone I Tow Number 2	Zone II Tow Number 1	Zone II Tow Number 2	Zone III Tow Number 1	Zone III Tow Number 2	Zone IV Tow Number 1	Zone IV Tow Number 2
				e. August 1975				
VERTEBRATES:								
Atlantic Croaker (Micropogon undulatus)		45.1 5	85.0 9	111.2 10	84.0 7	89.4 8	8.8 1	16.5 2
Spot (Leiostomus xanthurus)		35.7 2		20.0 1		18.2 1		
Sea Catfish (Arius felis)		25.2 11	205.8 31	95.2 13	1.8 1	71.0 7		
Crevalle Jack (Caranx hippos)	2.4 1	4.3 1		3.7 1	10.3 1	7.4 1	1.0 1	2.3 1
Harvestfish (Peprilus alepidotus)			2.3 1		2.1 1			2.8 2
Black Drum (Pogonias cromis)			64.8 2	43.2 1				
Red Drum (Sciaenops ocellata)		170.8 1						
Southern Kingfish (Menticirrhus americanus)			47.4 1					
INVERTEBRATES:								
Blue Crab (Callinectes sapidus)				150.3 1	285.3 1			
Squid (Loligo sp.)				20.1 1			13.6 1	

Table A7 (concluded)

Taxa	Zone I Tow Number 1	Zone I Tow Number 2	Zone II Tow Number 1	Zone II Tow Number 2	Zone III Tow Number 1	Zone III Tow Number 2	Zone IV Tow Number 1	Zone IV Tow Number 2
				f. October 1975				
VERTEBRATES:								
Spot (Leiostomus xanthurus)							38.0 / 2	36.0 / 2
Sea Catfish (Arius felis)				6.0 / 1	11.0 / 2	30.0 / 2	24.0 / 2	
Gulf Menhaden (Brevoortia patronus)								21.6 / 1
INVERTEBRATES:								
Brown Shrimp (Penaeus aztecus)				1.5 / 1				
White Shrimp (Penaeus setiferus)	53.0 / 26		0.3 / 2	1.0 / 1		8.0 / 6	39.6 / 20	
Squid (Loligo sp.)			0.4 / 2	6.0 / 2				8.8 / 1

Table A8
Numbers of Benthos Collected Per Square Metre by Sampling Date and Station
a. Polychaetes

Station	Sample Half	Sample Date				
		March 18	April 15	June 18	August 19	October 14
1	A	86	689	172	2067	947
	D	430	517	258	1636	1636
2	A	603	603	172	603	947
	D	344	430	86	430	430
3	A	517	775	258	86	172
	D	258	689	258	344	258
4	A	517	258	86	344	344
	D	430	172	172	344	344
5	A	86	86	258	430	775
	D	86	86	172	344	1119
6	A	344	258	0	258	344
	D	258	258	172	344	603
7	A	0	344	258	86	258
	D	258	172	86	172	344
8	A	0	86	0	0	258
	D	0	86	0	430	344
9	A	344	172	258	258	689
	D	0	86	172	603	172
10	A	172	172	172	517	775
	D	172	172	253	258	947
11	A	86	430	86	344	1206
	D	0	86	0	517	1033
12	A	86	258	86	517	603
	D	258	258	172	430	1033
13	A					1722
	D					603
14	A					258
	D					517
15	A					1722
	D					603
Average by Date		222	298	150	473	649

(continued)

Table A8 (continued)

b. Nemerteans

Station	Sample Half	Sample Date: March 18	April 15	June 18	August 19	October 14
1	A	0	0	0	0	0
	D	0	0	0	0	0
2	A	0	0	0	0	86
	D	0	0	0	0	0
3	A	0	0	0	0	0
	D	0	0	0	0	0
4	A	0	0	0	0	0
	D	0	0	0	0	0
5	A	0	0	0	0	0
	D	0	0	0	86	0
6	A	0	0	0	0	0
	D	0	86	0	0	0
7	A	0	0	0	0	0
	D	0	86	0	0	0
8	A	86	0	0	0	0
	D	0	0	0	0	0
9	A	86	0	0	0	0
	D	0	0	0	0	0
10	A	0	0	0	0	0
	D	0	0	172	0	0
11	A	0	0	0	86	86
	D	0	0	0	0	86
12	A	0	0	0	0	0
	D	0	0	0	86	86
13	A					0
	D					0
14	A					0
	D					0
15	A					0
	D					0
Average by Date		7	7	7	10	14

(continued)

Table A8 (continued)

c. Amphipods

Station	Sample Half	Sample Date: March 18	April 15	June 18	August 19	October 14
1	A	86	172	172	0	0
	D	258	86	86	0	0
2	A	86	0	86	86	172
	D	86	86	0	0	0
3	A	258	0	689	0	0
	D	86	0	344	0	86
4	A	0	172	0	0	86
	D	86	86	86	172	172
5	A	0	1033	0	0	0
	D	86	430	86	0	172
6	A	430	517	0	0	172
	D	344	344	0	0	86
7	A	258	603	0	86	0
	D	0	775	0	0	0
8	A	1033	172	0	0	0
	D	172	0	0	0	86
9	A	172	0	0	86	258
	D	172	344	86	0	86
10	A	258	258	0	0	172
	D	86	430	0	0	0
11	A	172	172	0	0	86
	D	0	172	0	0	86
12	A	86	172	0	0	0
	D	0	258	0	0	0
13	A					0
	D					0
14	A					258
	D					0
15	A					86
	D					86
Average by date		176	262	68	18	72

(continued)

Table A8 (continued)

d. Isopods

Station	Sample Half	Sample date: March 18	April 15	June 18	August 19	October 14
1	A	430	0	0	603	172
	D	430	258	258	2[illegible]3	430
2	A	0	0	0	344	517
	D	86	0	0	258	86
3	A	0	0	0	430	0
	D	258	86	0	517	0
4	A	0	0	0	344	172
	D	86	0	86	172	603
5	A	172	947	430	258	517
	D	258	1636	172	689	947
6	A	1120	2325	172	258	86
	D	1808	1808	0	1119	172
7	A	0	1119	0	86	689
	D	86	947	172	0	775
8	A	0	517	0	0	0
	D	0	86	0	0	0
9	A	86	517	0	0	86
	D	86	603	0	86	0
10	A	86	0	172	258	258
	D	0	1033	172	0	172
11	A	517	0	0	0	86
	D	344	430	0	258	0
12	A	86	947	0	0	0
	D	0	430	0	0	0
13	A					344
	D					0
14	A					0
	D					0
15	A					172
	D					0
Average by date		235	570	68	247	240

(continued)

Table A8 (continued)

e. Pelecypods

Station	Sample Half	Sample Date				
		March 18	April 15	June 18	August 19	October 14
1	A	0	0	86	0	0
	D	0	0	0	0	0
2	A	0	0	86	0	0
	D	0	0	0	0	0
3	A	86	86	0	86	0
	D	86	0	0	0	0
4	A	0	0	0	0	0
	D	0	0	0	86	0
5	A	0	172	0	0	86
	D	258	517	0	0	86
6	A	603	775	0	0	86
	D	603	344	0	0	0
7	A	0	430	0	0	86
	D	86	344	0	0	86
8	A	0	517	0	0	430
	D	0	86	0	0	0
9	A	517	517	0	86	0
	D	517	603	258	86	86
10	A	344	0	0	0	517
	D	517	1033	0	0	0
11	A	0	0	86	0	0
	D	0	430	258	0	86
12	A	172	947	0	0	0
	D	0	430	0	0	0
13	A					0
	D					0
14	A					86
	D					344
15	A					0
	D					172
Average by Date		158	301	32	14	64

(continued)

Table A8 (continued)

f. Gastropods

Station	Sample Half	Sample Date March 18	April 15	June 18	August 19	October 14
1	A	0	0	0	0	0
	D	0	0	0	0	0
2	A	0	0	0	0	0
	D	0	0	0	0	0
3	A	0	0	0	0	
	D	0	0	0	0	0
4	A	0	0	0	0	0
	D	0	0	0	0	0
5	A	0	0	0	0	0
	D	0	0	0	86	0
6	A	0	0	0	0	0
	D	86	0	0	0	0
7	A	0	0	0	0	0
	D	0	0	0	0	0
8	A	0	0	0	0	0
	D	0	0	0	0	0
9	A	0	0	0	86	0
	D	0	0	0	0	86
10	A	172	86	0	0	0
	D	0	0	0	0	0
11	A	86	0	0	0	0
	D	0	0	0	0	0
12	A	0	0	0	0	0
	D	0	0	0	0	0
13	A					0
	D					0
14	A					0
	D					0
15	A					0
	D					0
Average by Date		14	3	0	7	3

(continued)

Table A8 (concluded)

g. Cumaceans and Crabs*

Station	Sample Half	Sample Date: March 18	April 15	June 18	August 19	October 14
1	A	0	0	0	0	0
	D	0	0	0	0	0
2	A	0	0	0	0	0
	D	0	0	0	0	0
3	A	0	0	0	0	0
	D	0	86**	0	0	0
4	A	0	0	0	0	0
	D	0	0	0	0	0
5	A	0	0	0	0	0
	D	0	0	0	0	0
6	A	0	86**	0	0	0
	D	0	0	0	0	0
7	A	0	0	0	0	0
	D	0	0	0	86**	0
8	A	0	0	0	0	0
	D	0	0	0	0	0
9	A	0	0	0	0	0
	D	0	0	0	0	0
10	A	0	0	0	0	0
	D	0	0	0	0	0
11	A	0	0	0	0	0
	D	0	0	0	0	0
12	A	0	0	0	0	0
	D	0	0	0	258†	0
13	A					0
	D					0
14	A					0
	D					0
15	A					0
	D					86†
Average by date		0	7	0	14	0

* Actual total number collected are 2 cumaceans and 4 crabs.

** Cumaceans.

† Crabs.

Grams of Organic Content per Litre of Sediment by Station, Sample, and Month

Station	Sample No's	March	April	June	August	October
1	B	0.0215	0.2204	0.3633	0.1813	0.0717
	C	0.3160	0.6594	0.0516	2.6723	0.2344
2	B	0.0941	0.1574	0.1373	0.0313	0.0616
	C	0.2313	0.1508	0.3174	0.1143	0.0447
3	B	0.1202	0.1956	0.0341	0.0548	0.0580
	C	0.0704	0.4442	0.1411	0.0491	0.0703
4	B	0.1367	0.1326	0.0399	0.0544	0.0575
	C	0.0333	0.0522	0.0322	0.0837	0.0737
5	B	0.1359	0.1261	0.0709	0.0876	0.0230
	C	0.1302	0.9072	0.1041	0.0400	0.0342
6	B	0.0798	0.0706	0.0323	0.0412	0.0301
	C	0.8282	0.0893	0.0547	0.0386	0.0235
7	B	0.0580	0.0962	0.0771	0.0655	0.0606
	C	0.0360	0.5863	0.0737	0.0850	0.0465
8	B	0.00175	0.0749	0.0805	0.0314	0.0203
	C	0.08252	1.1048	0.0932	0.0304	0.0385
9	B	0.1459	0.0927	0.0384	0.0283	0.0246
	C	0.1209	0.0532	0.0680	0.0279	0.0177
10	B	101189	1.0457	0.0565	0.0972	0.0209
	C	0.0683	1.0694	0.0664	0.0348	0.0322
11	B	0.0551	0.4729	0.0840	0.0548	0.0350
	C	0.0725	0.6463	0.1029	0.0371	0.0271
12	B	0.0573	0.0714	0.1400	0.0370	0.0625
	C	0.0780	0.1446	0.0951	0.1189	0.0439
13	B					0.0335
	C					0.0357
14	B					0.0401
	C					0.0334
15	B					0.0444
	C					0.1130

APPENDIX B: Bibliography of the Aquatic Biota of Galveston Bay, Texas

This bibliography was developed as a part of an inventory and assessment of the aquatic biota of the Corps Bolivar Peninsula [illegible] development site on Galveston Bay, Texas. Some listed references do not deal with organisms in Galveston Bay but are pertinent because studies were conducted on organisms found in the Galveston estuarine system.

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Habitat development field investigations, Bolivar Peninsula marsh and upland habitat development site, Galveston Bay, Texas; Appendix C: Baseline inventory of aquatic biota / by James M. Lyon and Kenneth N. Baxter, National Marine Fisheries Service, Southeast Fisheries Center, Galveston Laboratory, Galveston, Tex. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.

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Appendix B: Bibliography of the Aquatic Biota of Galveston Bay, Texas.

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(Continued on next card)

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TA7.W34 no.D-78-15 Appendix C