Populations and Communities

Status, Trends, and Probable Causes for Changes in Living Resources in the Galveston Bay System

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The diverse uses of the Galveston Estuary inevitably pose potential threats to the survival of many estuarine species. The purpose of this study was to assess the relative health of the Galveston Estuary by evaluating the status and trends of several selected endemic species in order to identify potential problems, as indicated by significant declines in abundance, and to investigate the probable causes of these declines.

A limited number of species was selected by members of GBNEP's Scientific and Technical Advisory Committee for initial examination. The list was assembled to include those groups fundamental to maintaining the Galveston Estuary ecosystem, and economically important taxa: commercially and ecologically important finfish and shellfish, locally breeding birds, alligators, plankton, and open bay and marsh benthos. There were two phases to the project: the identification and examination of existing data sets containing information about target species, and the statistical analysis of those data sets with sufficient information to demonstrate temporal change.

Fisheries Species

Trends in finfish and shellfish populations were determined using Texas Parks and Wildlife Department Coastal Fisheries (CF) data collected using a variety of types of gear from 1975 through 1990. Trends for the species caught most commonly by bag seine (sampled along the shoreline) and trawl (sampled in the mid-bay) are shown in Figures 1 and 2. Fourteen species were analyzed initially to detect chronic

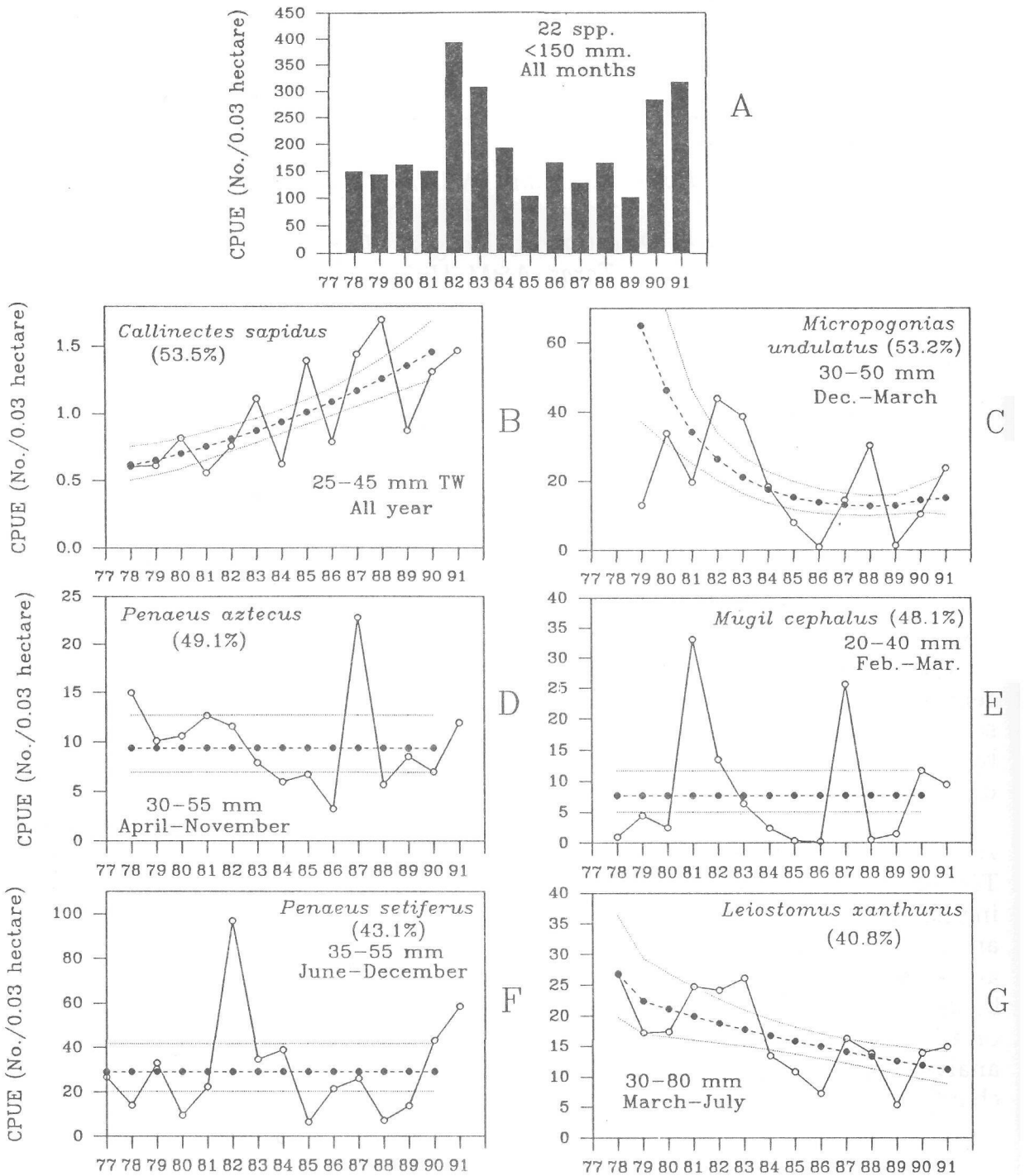
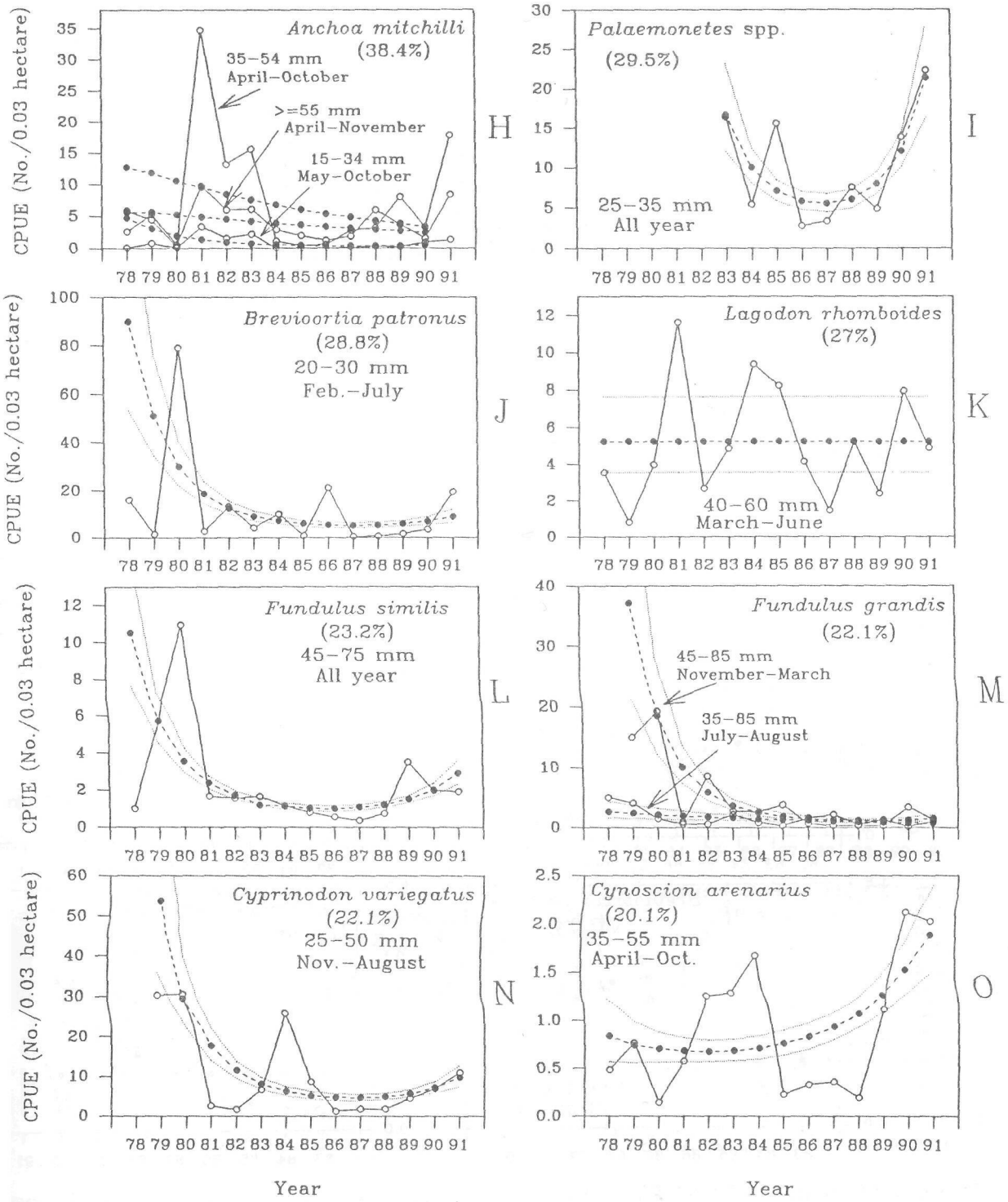


Figure 1. Mean annual CPUE and fitted values with confidence intervals for most common species caught by bag seine, Galveston Bay shoreline. Percentage of samples containing that species are in parentheses. A) Bar graph for all species present in 10% of samples, <150 mm TL, B) Blue crab, C) Atlantic croaker, D) Brown shrimp, E) Striped mullet, F) White shrimp, G) Spot, H) Bay anchovy, I) Grass shrimp, J) Gulf menhaden, K) Pinfish, L) Longnose killifish, M) Gulf killifish, N) Sheepshead minnow, and O) Sand seatrout.


Anchoa mitchilli
(38.4%)
35–54 mm
April–October
>=55 mm
April–November
15–34 mm
May–October
H
Palaemonetes spp.
(29.5%)
25–35 mm
All year
I
Brevioortia patronus
(28.8%)
20–30 mm
Feb.–July
J
Lagodon rhomboides
(27%)
40–60 mm
March–June
K
Fundulus similis
(23.2%)
45–75 mm
All year
L
Fundulus grandis
(22.1%)
45–85 mm
November–March
35–85 mm
July–August
M
Cyprinodon variegatus
(22.1%)
25–50 mm
Nov.–August
N
Cynoscion arenarius
(20.1%)
35–55 mm
April–Oct.
O
CPUE (No./0.03 hectare)
78 79 80 81 82 83 84 85 86 87 88 89 90 91
Year

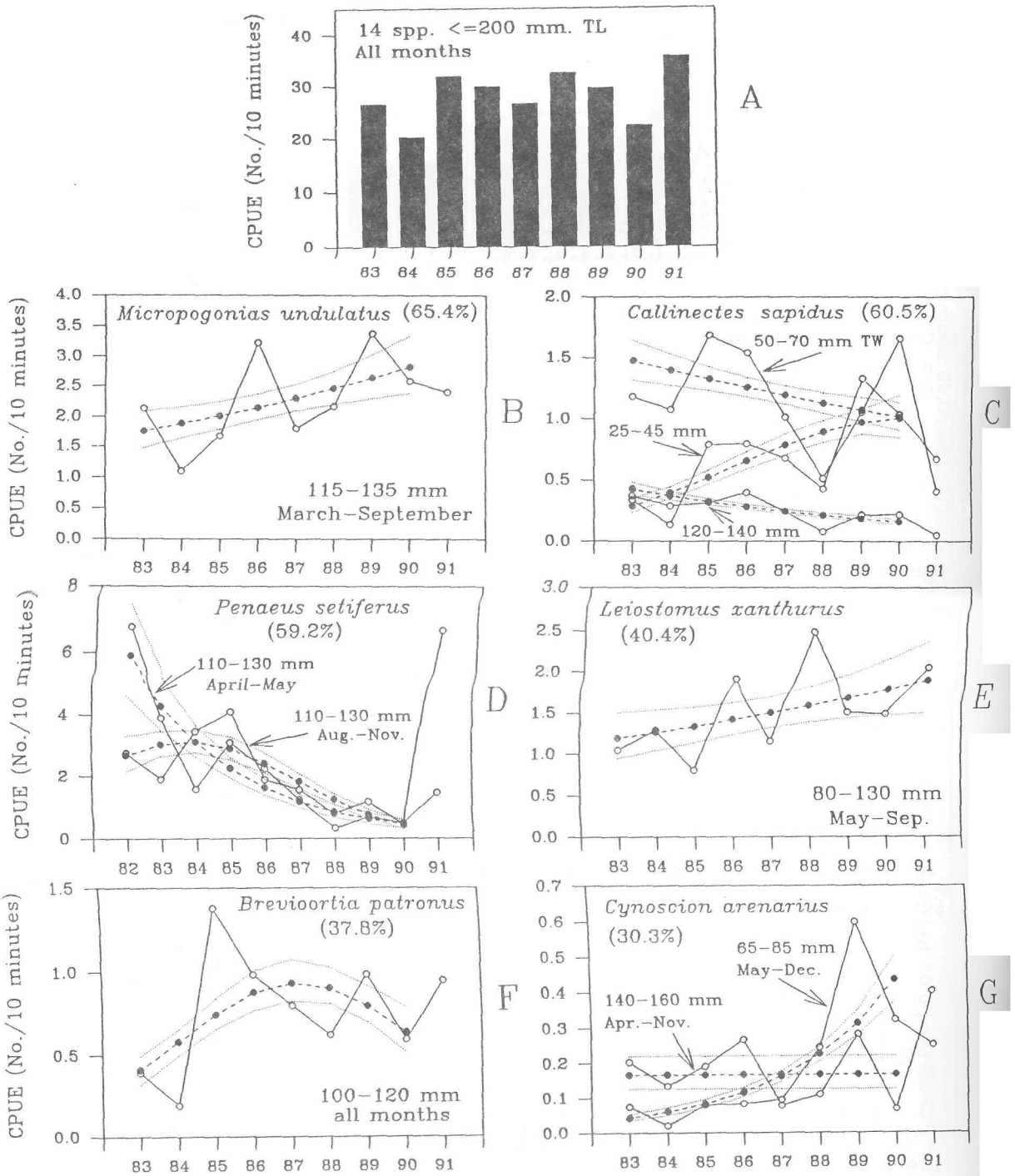
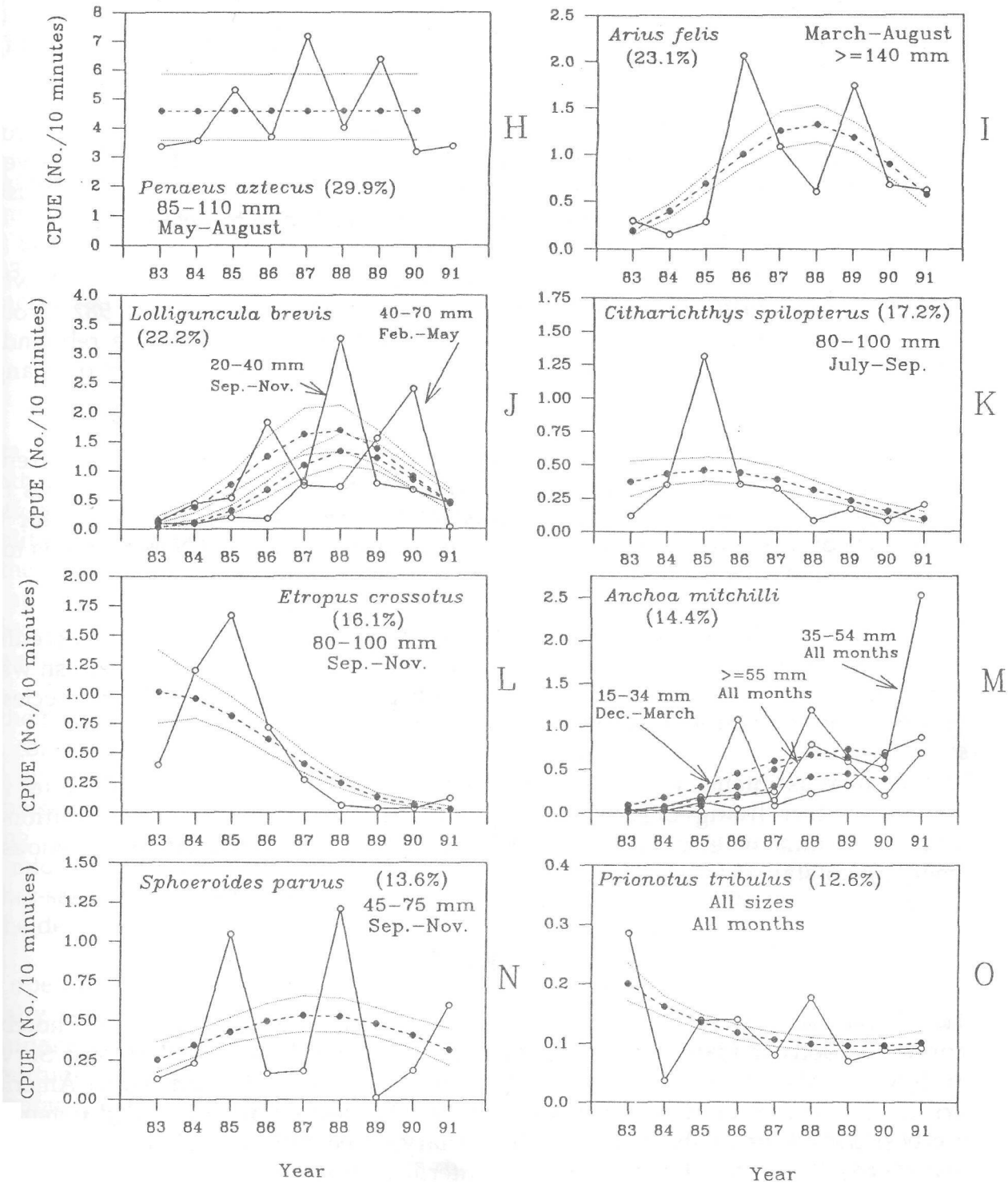


Figure 2 Mean annual CPUE and fitted values with confidence intervals for 14 most common species caught by trawl, mid-Galveston Bay. Percentage of samples containing that species are in parentheses. A) Bar graph for all species present in over 10% of samples, B) Atlantic croaker, C) Blue crab, D) White shrimp, E) Spot, F) Gulf menhaden, G) Sand seatrout, H) Brown shrimp, I) Hardhead catfish, J) Brief squid, K) Bay whiff, L) Fringed flounder, M) Bay anchovy, N) Least puffer, and O) Bighead searobin.


H
Penaeus aztecus (29.9%)
85–110 mm
May–August
I
Arius felis
(23.1%)
March–August
>=140 mm
J
Lolliguncula brevis
(22.2%)
20–40 mm
Sep.–Nov.
40–70 mm
Feb.–May
K
Citharichthys spilopterus (17.2%)
80–100 mm
July–Sep.
L
Etropus crossotus
(16.1%)
80–100 mm
Sep.–Nov.
M
Anchoa mitchilli
(14.4%)
15–34 mm
Dec.–March
>=55 mm
All months
35–54 mm
All months
N
Sphoeroides parvus (13.6%)
45–75 mm
Sep.–Nov.
O
Prionotus tribulus (12.6%)
All sizes
All months
CPUE (No./10 minutes)
Year

declines in catch per unit effort (CPUE), defined as severe downward trends not influenced by data for a single year, and apparent in more than one life stage. Chronic declines were found only for blue crab and white shrimp.

Blue crab juveniles (25-45 mm Total Width) increased but there was a strong decreasing trend in spawning-age crab. The decrease in large crabs in recent years may be a response to the dramatic increase in crab harvest since 1981. If there is no change in current population parameters, crab may continue to decline.

Young-of-the-year white shrimp (35-55 mm Total Length) showed no trend, while all larger white shrimp showed a marked decline in abundance from 1982 through 1990. However, newly available monitoring results for 1991 showed a rebound to 1983 levels, possibly the result of high freshwater inflows in recent years or changes in fishery regulations enacted in 1991.

Most species investigated showed different life stages to be a mixture of trends, including no trend at all (e.g., brown shrimp, southern flounder). For species that have high fecundity and live in an unstable environment, it is natural for the abundance of different age classes to be highly variable and for different trends to be exhibited simultaneously.

A cyclical abundance pattern characterizes many species, especially juveniles, suggesting large-scale climatic cycles may be influential. High inflows of fresh water and nutrients in recent years resulted in high populations of some fish species in 1991 (especially planktivorous forms).

Factors such as intensive shrimp trawling and the loss of wetlands and oyster reef certainly affect living organisms, directly and by altering the distribution of nutrients within the estuary, though their effects are not as immediately obvious or amenable to statistical demonstration.

Birds

Trend analyses on birds were mainly accomplished using data from the Shorebird Survey of Bolivar Flats, Christmas Bird Count, Texas Colonial Waterbird Survey, Mid-Winter Waterfowl Transects, Mid-Winter Cruise Counts, and North American Breeding Bird Survey. Colonial waterbirds are the best documented and potentially the best indicators of the health of the estuary. Declining trends in those colonial waterbirds that feed at the marsh-bay interface (tricolored herons, snowy egrets, black skimmers, roseate spoonbills, and great egrets) suggest recent reductions in tidal marsh habitat and/or marsh prey species may have affected bird populations.

The probable causes for a general decline in northern pintails and green-winged teal probably lie beyond the Galveston Estuary, such as the loss of wetland habitat on

their breeding grounds on the Great Plains. Non-migratory mottled ducks are affected by conditions within Texas, most probably by the loss of habitat.

Alligators

Night-counts of alligators from 1971 through 1984 showed a non-linear increase in numbers. The lowest counts occurred in the late 1970s. Satisfactory models could not be developed to explain the variation in numbers of nests from 1979 through 1983; however, no trends were evident using night-counts of alligators during this same period.

Benthos

Data in existing literature were examined in order to characterize the Galveston Bay benthos. Depressed benthic assemblages were found around brine separator platforms, and it is probable that similarly depressed fauna may be found at other localities throughout the bay and along the bay margin. Assemblages in the center of the bay appear to be normal for the prevailing salinity regime. There appears to be an abundance gradient in the Galveston Estuary in which the number of individuals increases from the Trinity Bay-Upper Galveston Bay region to the Lower Galveston Bay-West Bay region.

In the brackish waters of the delta marshes of Trinity Bay, marine worms dominated the community of submerged soil-dwelling animals. Brackish-water clams were also abundant in subtidal habitats adjacent to delta marshes. Small crustaceans (e.g., amphipods), abundant elsewhere, were nearly absent from the delta. Animals living in submerged soils attained their highest densities and greatest variability in the mid-salinity marshes of Moses Lake and Smith Point. Benthic densities in the higher-salinity marshes of West Bay and Christmas Bay were intermediate to those in the deltas and in the Moses Lake and Smith Point region.

On open-bay submerged soils, marine worms, mollusks, and crustaceans were usually the dominant animals. Typically, one or two species were numerically dominant and these dominant species were generally one or two orders of magnitude more abundant than other species. Freshwater flood conditions can temporarily alter the normal seasonal pattern of spring peak abundance and low fall abundance. Bottom-dwelling animals can be good indicators of salinity, but there are not enough data among the studies reviewed to document long-term changes in salinity patterns.

Plankton

Existing literature was also used to characterize plankton. Available studies reported that diatoms and a green alga (*Chlorella* sp.) were dominant during the cold months, whereas several different species were dominant during other times of the year. Generally, high cell numbers were more common in waters of lower salinity (0 to 15 ppt) than in waters of higher salinity (16 to 33 ppt), though the abundance of dominant species did not correlate precisely with temperature or salinity.

Limited data make it difficult to draw conclusions about long term trends in phytoplankton biomass. There was some evidence for an increase in maximum chlorophyll levels (higher density of green algae): the maximum chlorophyll concentration measured in the late 1950s was ca. 45 mg m^{-3}, but ca 70 mg m^{-3} during the 1970s.

Even less information is available on the spatial and temporal distribution of zooplankton than for phytoplankton. The dominant species of zooplankton were copepods, larval marine worms, and larval barnacles. No clear seasonal pattern in the abundance of any of the dominant species was found.

Conclusions

Using the concept that biodiversity and ecological processes can be used to measure ecosystem health leads to the conclusion that the overall health of the Galveston Bay System appears to be fair to good. This conclusion was based on the observation that there was not a wholesale decline in species population abundances and that a large number of species were present in all trophic levels, indicating that energy and material transport within and between trophic levels was occurring more or less naturally. There were some significant increases in populations, namely in American alligators, red drum, spotted seatrout, Atlantic croaker, black-bellied plovers, willets, sanderlings, western sandpipers and olivaceous cormorants. Although not a subject of this study, the brown pelican population also has increased. These provide evidence that the ecosystem is still operating and that rehabilitation programs can have an effect.

However, apparent long term declines indicated in striped bass, green turtle, and diamondback terrapin populations are cause for concern, as are recent declines in white shrimp, blue crab, mottled ducks, northern pintail, blue winged teal, and all colonial water birds except olivaceous cormorants. This, coupled with the knowledge that there have been major losses of wetlands and possibly oyster reef, that pressure for development along estuarine shoreline continues, and that the total harvest of animals that depend on the estuary has increased by 2000 percent during the last 100 years (including offshore harvest of shrimp and menhaden),

provides reason to question whether the health of the Galveston Estuary can be maintained.

Recommendations

All the conclusions in this study regarding trends were made with the knowledge that data sets generally suffered from one or more of the following: sampling periods were short relative to population dynamics, spatial or temporal representation was poor, effort was not known, and sample sizes were small. Other data are available but have not all been synthesized and recorded in usable form. Nevertheless, the record was adequate to support the conclusions drawn and to provide information for improving future monitoring programs.

An integrated sampling program is needed to track short-lived organisms (phyto- or zooplankton) as measures of ambient estuarine quality and longer-lived organisms (larger shellfish and fishes) as measures of trends in estuarine quality. Some species of birds should also be included in an integrated monitoring program as indicators of the quality of mudflat (American oystercatcher), beach (Wilson's plover, least terns), or marsh (clapper rail, marsh wren) habitats, or of the health of the estuary in general (seaside sparrow). The sampling regime should be designed to address not only the question of population abundances but also why they are changing and whether humans have any control over the changes. The description of nutrient flux and estuarine energetics and the role of climate should be specifically addressed.

Though the system is still too poorly understood to permit quantitative recommendations for ensuring the health of the estuary, it is clear that: 1) sufficient freshwater inflow must be maintained in order to maintain productivity; and 2) bulkheading and development on tidal marsh should be discouraged.

Characterization of Benthic Assemblages of Galveston Bay: 1990-1992

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The few existing studies that document benthic community structure in open-bay habitats of Galveston Bay, Texas, are limited in spatial and temporal scope such that available information is inadequate to provide a baseline for impact assessments. In order to address concerns for environmental impacts of alternative dredged material disposal practices in the bay, the U.S. Army Corps of Engineers (USACE) is presently conducting a four-year study (1990-1993) to characterize benthic communities in lower and upper portions of the estuary. Uncontaminated sediments from maintenance dredging of the Houston Ship Channel are currently placed in disposal areas approximately 1,500 ft wide and parallel to the ship channel at a distance of 1,000 ft from the channel centerline. This investigation is comparing sediments and benthic assemblages in channel-edge, maintenance dredged material disposal areas, and undisturbed open-bay bottom habitats. A companion study, also described in these proceedings, separately addresses the consequences of in-bay disposal of new work dredged material.

Sampling has been conducted at stations arranged along four transects perpendicular to the channel: two transects located in the lower bay and two transects in the upper bay (Figure 1). Channel-edge stations are located at a distance of 500 ft from the channel centerline; disposal area stations at 1,000, 1,500, and 2,500 ft; and open-bay stations at 5,000, 10,000, and 15,000 (additional 20,000 ft open-bay stations lie on the upper bay transects). Transects were sampled in July 1990, March and July 1991, and March and June 1992.

Sediment profile imagery (SPI) and quantitative box-coring were performed in triplicate at each station on each sampling date. SPI involves the use of a specialized camera system to obtain images of a vertical cross-section of the sediment-water interface. Image analysis yields information on physical (e.g., surface relief, sediment grain size, compaction), chemical (e.g., depth of the apparent redox potential discontinuity (RPD)), and biological (e.g., presence/absence of tubes, burrows and other indicators of bioturbation) characteristics of the sediment. Sediment subsamples were removed from one box-core at each station for determination of organic content and granulometric analysis (mean grain size, percent sand, silt, and clay).

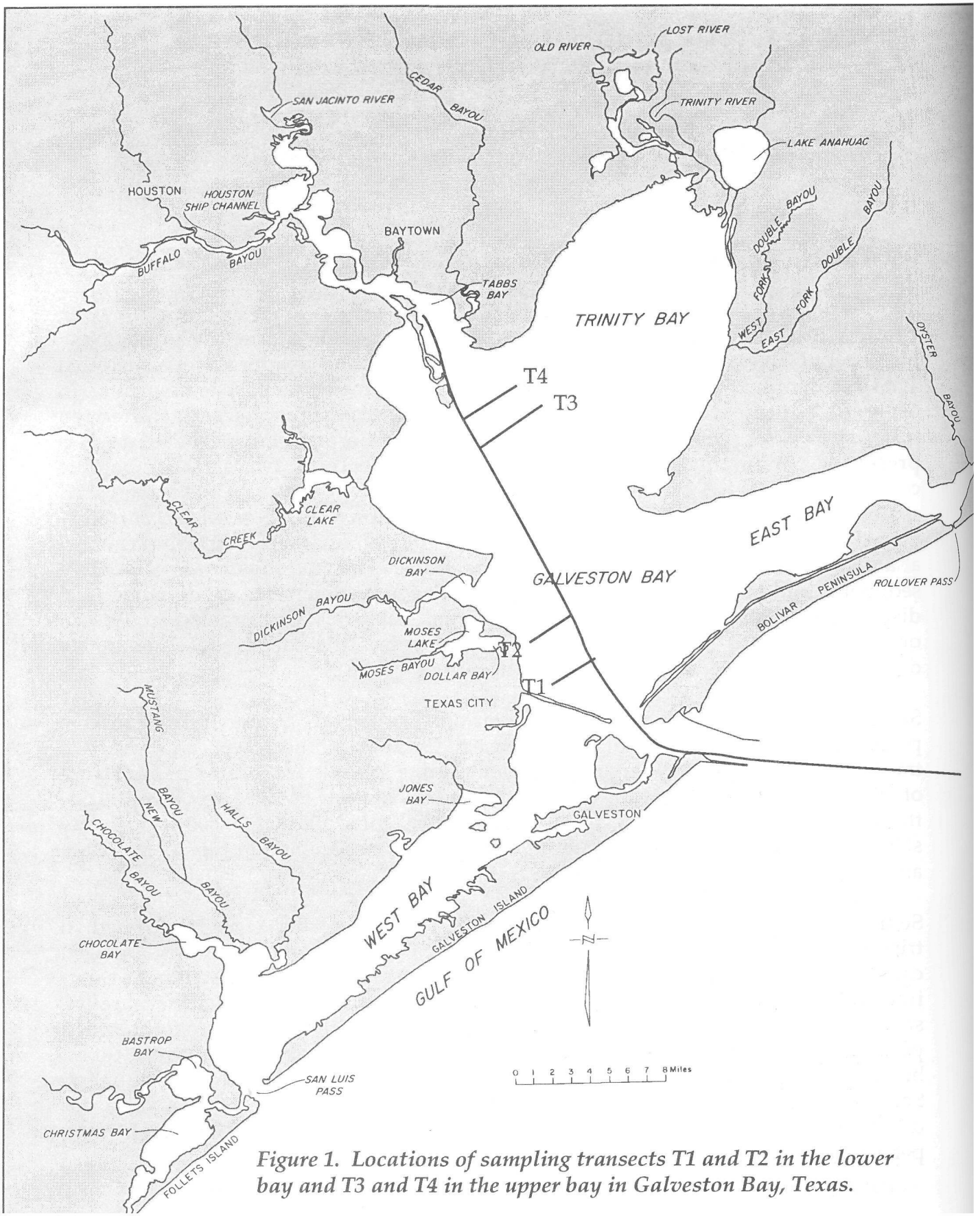

Figure 1. Locations of sampling transects T1 and T2 in the lower bay and T3 and T4 in the upper bay in Galveston Bay, Texas.

Benthic infauna were sampled to a depth of 10 cm with a Gray-O'Hara box-core (0.06 m^2). Organisms retained on a 0.5 mm seive were identifed to the lowest possible taxonomic level and enumerated. Wet-weight biomass was measured for major taxonomic levels. Abundance, biomass, and species richness data were analyzed by repeated measures analysis of variance to determine the significance of changes in community and individual species distributions among habitats over time. Cluster analysis was employed to identify assemblages of similarly distributed species.

Mean surface relief values, a measure of physical disturbance as evidenced by bedforms or feeding pits, ranged from 0.59 to 1.67 cm. Surface relief was generally greater in the upper bay than the lower bay in both channel-edge and disposal area habitats. In contrast, surface relief was consistently greater in the lower bay than in the upper bay at open-bay habitat stations. Mean penetration depth, a measure of sediment compaction and cohesiveness, ranged from 2.19 to 19.69 cm. Penetration was deeper in the upper bay as compared to the lower bay, and at open-bay stations as compared to disposal areas. Mean RPD depth was highly variable within habitat types, particularly at channel-edge and disposal area stations. Mean RPD depths ranged from 0.57 to 2.10 cm, and were deepest in upper bay channel-edge stations.

Sediment granulometric analysis indicated that coarsest sediments (fine sand with shell hash) were found in the channel-edge habitat of the uppermost transect. Very fine sands dominated all lower bay habitats and the remaining channel and disposal area habitats of the upper bay. Open-bay habitats in the upper bay were characterized primarily by silts and clays. This pattern was consistent across all sampling dates, although there was some evidence of a loss of fine sediments between the June 1990, and March 1991, sampling dates. This change may reflect winnowing of fine grained sediments during very high flows of flood waters during that time period.

Species richness, the total number of species per sample, was highest along lower bay Transect 1 and steadily declined toward upper bay Transect 4 (Figure 2). Species richness among the lower bay habitats was highest in Transect 1 channel-edge and open-bay habitats. There were no significant differences between the remaining lower bay habitats. In the upper bay, highest species richness was found in the channel-edge and disposal area habitats of Transect 3. The remaining upper bay habitats had significantly fewer species. The observed pattern of species richness appears to be closely related to the prevailing salinity gradient.

The distribution of total wet-weight biomass followed the same pattern as species richness with the exceptions that biomass did not decline as sharply from lower to upper bay and Transect 3 disposal area values were higher than that of the adjacent channel-edge habitat (Figure 3). Mean abundances of animals per sample did not differ significantly between the lower and upper bay (Figure 4). Distributions of both abundance and species richness were very similar.

Cluster analysis identified three species assemblages clearly associated with the salinity gradient. The assemblages consist of species most common in the upper bay

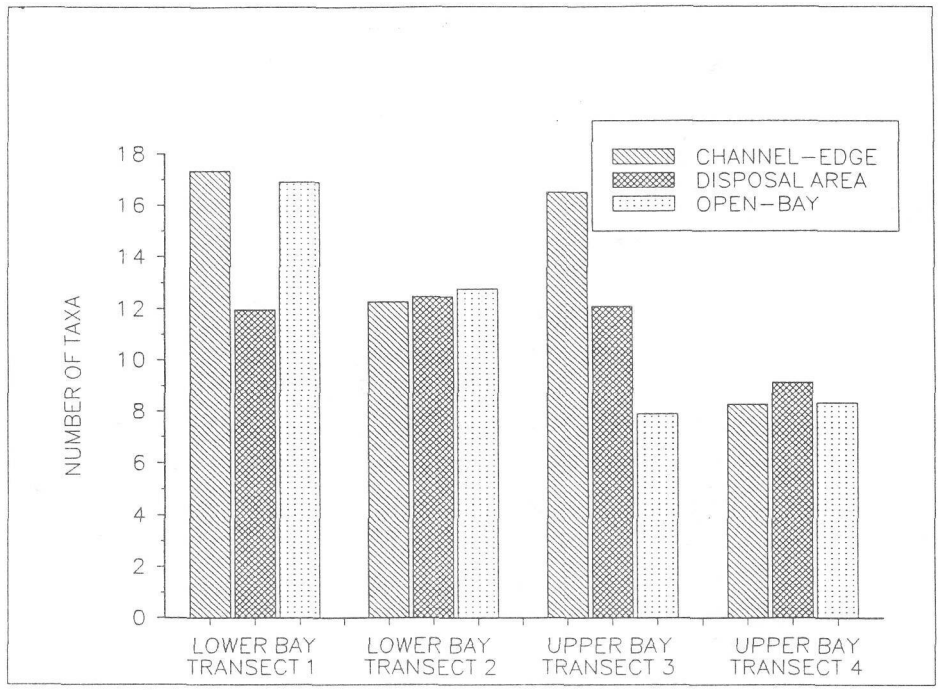

Figure 2. Mean species richness values of infauna among benthic habitats in Galveston Bay, Texas.

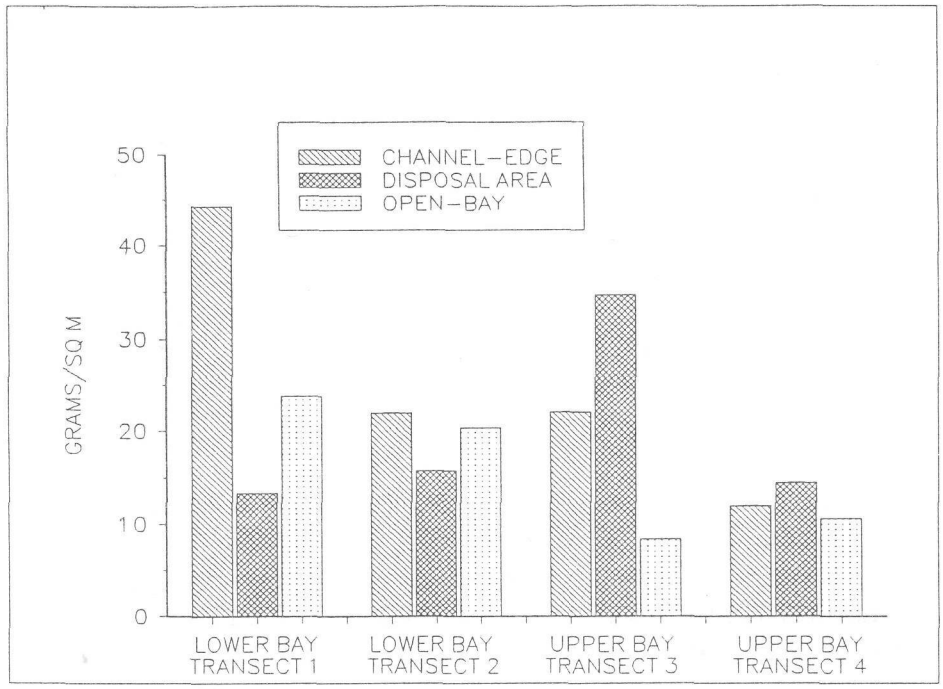

Figure 3. Mean total biomass of infauna among benthic habitats in Galveston Bay, Texas.

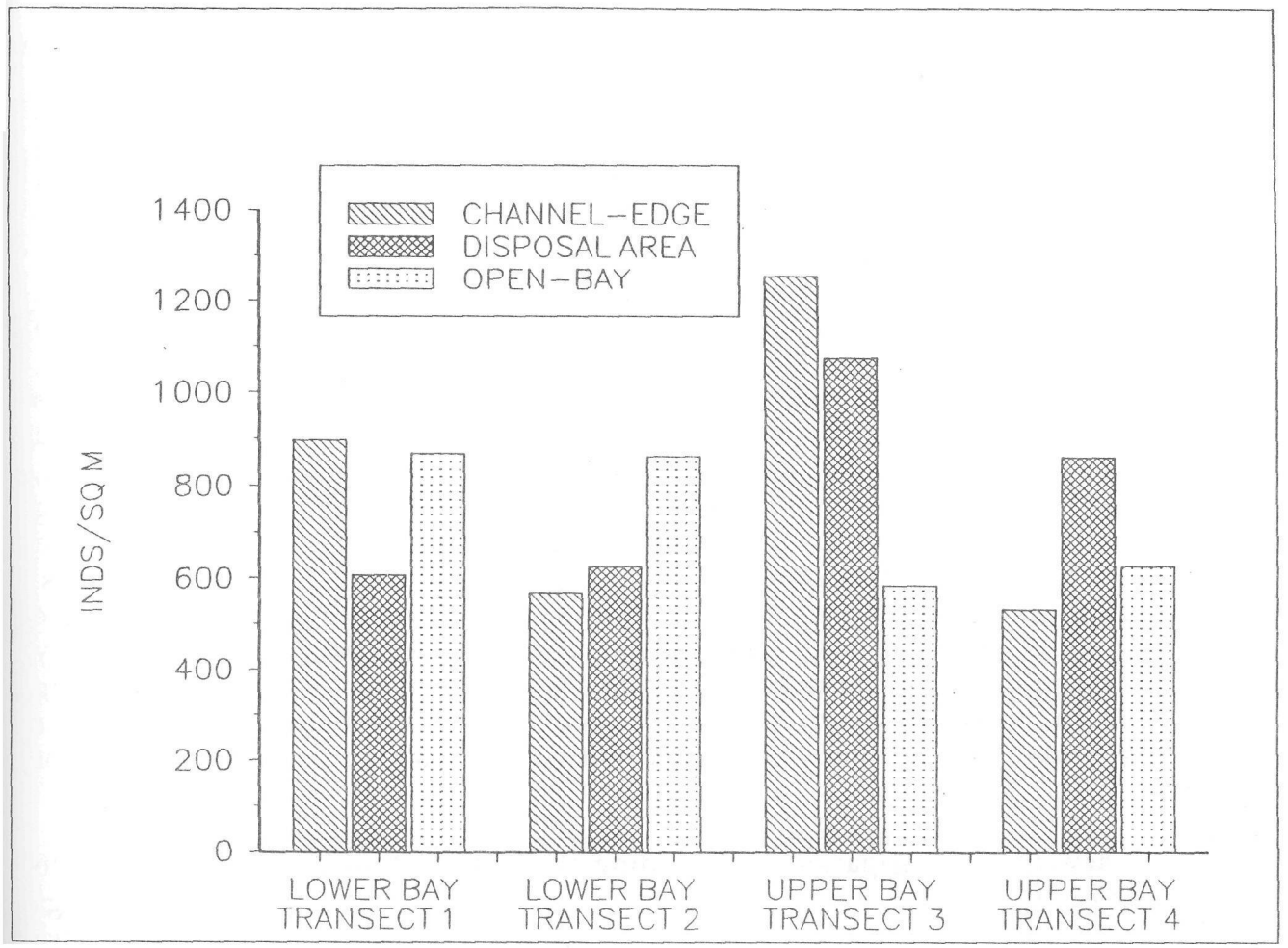

Figure 4. Mean abundances of infauna among benthic habitats in Galveston Bay, Texas.

(*Texadina barretti, Macoma mitchelli, Parandalia* sp. and *Callianassa* sp.), species most common in the lower bay (*Nereis micromma, Magelona* sp., *Cossura soyeri* and *Paraprionospio pinnata*), and numerically dominant ubiquitous species (*Mediomastus ambiseta, Glycinde solitaria* and *Rhynchocoela*).

Community level parameters such as total species, biomass, and densities did not display distinct differences between habitat types. Several distribution patterns were evident at the species level, however. For example, the capitellid polychaete, *Mediomastus ambiseta*, the most abundant and widespread infaunal species, was found in highest densities in upper bay open-bay habitats. Lowest density occurred in the disposal area habitats. Rhynchocoels and the polychaete, *Glycinde solitaria*, both widespread and abundant species, had identical distribution patterns, being most numerous in open-bay habitats on Transects 1, 2, and 4. *Mulinia lateralis*, a bivalve mollusc, was most common in the lower bay and in channel habitats. Haustoriid amphipods and the isopod, *Xenanthura brevitelson*, were predominantly associated with disposal area habitats, perhaps due to their affinity for sandy sediments. The occurrences of several polychaete species, including *Magelona* sp., *Cossura soyeri, Nereis micromma, N. succinea*, and *Paramphinome* sp., were found to be strongly associated with specific stations rather than habitat types.

In summary, this investigation is providing the most detailed characterization to date of open-bay benthic conditions and infaunal assemblages. Preliminary findings indicate that dramatic differences do not occur between channel-edge, maintenance dredged material disposal area, and undisturbed open-bay habitats in terms of benthic community structure. Observed patterns are primarily attributable to faunal changes along the prevailing salinity gradient and secondarily to differences in substrate type. Although subtle differences in distribution of certain taxa can be discerned, the infaunal benthos of Galveston Bay can generally be described as opportunistic species adapted to a dynamic salinity regime and variable physical conditions typical of shallow Gulf of Mexico estuaries.

Benthic Recovery on Experimental Dredged Material Disposal Mounds in Galveston Bay, Texas

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An investigation of benthic recovery on experimental plots of new work dredged material is currently underway by the U.S. Army Corps of Engineers Galveston District (COE). The objective of this study is to determine the rate of recovery of benthic communities, in terms of both structure and function, following placement of stiff Pleistocene clay on open-bay bottoms in Galveston Bay.

Baseline studies were conducted in June 1990, consisting of characterizations of physical and biological conditions in lower and upper Galveston Bay (LaSalle et al., 1991a and LaSalle et al., 1991b). An updated characterization of benthic conditions and assemblages on transects in the vicinity of the experimental plots can be found in these proceedings. Two 23-acre experimental plots were constructed between December 1991, and March 1992. One experimental (B and F) and two reference (A and D, E and F) plots are located in both lower and upper bay areas (Figure 1). All plots lie along a line parallel to and 6,500 ft east of the Houston Ship Channel.

Post-dredged materials were sampled in March, June, and August 1992, and will continue though 1993. Sampling at each plot included sediment profiling imagery (SPI), sediment granulometry and organic content, and benthic infaunal box-cores (0.06 m^2). Because the experimental mounds were constructed six weeks apart, post-disposal sampling represents a different time sequence for each plot (Table 1).

Table 1. Sampling schedule at the experimental dredged material disposal plots in lower and upper Galveston Bay. Samples have been collected through August , 1992, and data analyzed through June, 1992.

	Elapsed Post Disposal Time	
Sampling Date	Lower Bay	Upper Bay
une 1990	Baseline	Baseline
March 1992	6 weeks	2 weeks
une 1992	21 weeks	15 weeks
August 1992	31 weeks	23 weeks
March 1993	58 weeks	54 weeks
une 1993	73 weeks	67 weeks
August 1993	83 weeks	75 weeks

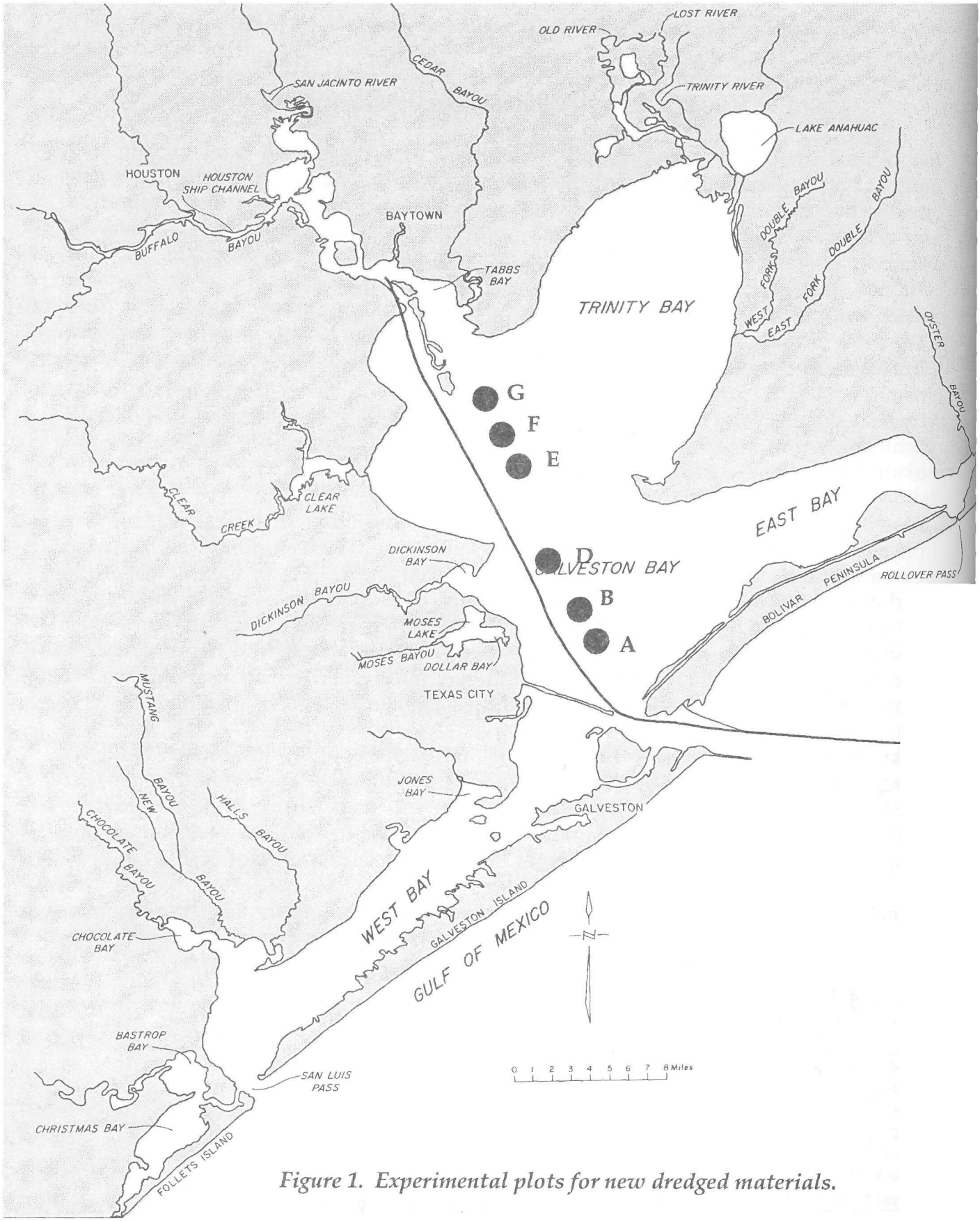

Figure 1. Experimental plots for new dredged materials.

Ten SPI stations were occupied in each reference plot, and 24 stations in each experimental plot. Sediment and infaunal samples were obtained at 10 stations in each experimental and reference plot during each sampling event. Precision bathymetry of the experimental plots conducted by the COE indicated that the constructed dredged material mounds provided an initial 2-4 ft lift of the bay bottom. Both mounds were similar in having extensive coverages of hard clay material. Bottom sediments at the upper bay site are much less dense than at the lower bay site, resulting in displacement of bottom sediments by dredged material. Consequently, although an equivalent volume of dredged material was placed at each site (200,000 cubic yards), the upper bay mound covers somewhat less bottom area. SPI surveys of both mounds in March 1992, confirmed this dredged material distribution pattern and provided information on the substrate features of each mound. From this information, box-core stations were allocated among "hard" clay, sand, and shell hash, and "soft" silt portions of each mound.

In June 1990, SPI camera penetration, a measure of sediment density or compaction, was significantly lower in lower bay (means ranging from 4.15 to 8.15 cm) than in upper bay plots (means ranging from 9.36 to 13.79 cm). A higher percentage of fine sands in the lower bay as compared to a predominance of silts in the upper bay accounted for this difference. The mean depth of the redox potential discontinuity (RPD) was relatively shallow in all plots, ranging from 0.46 to 0.84 cm among lower bay plots, and from 0.66 to 0.79 cm among upper bay plots (based on eight replicates per plot). Measures of mean surface relief (indicative of the presence/absence of bedforms or biological activity) were low, ranging from 0.65 to 0.75 cm and 0.50 to 0.81 cm among lower and upper bay plots, respectively.

Polychaetes were the dominant taxon in the baseline plot samples in the lower bay, whereas arthropods were dominant in the upper bay. Baseline densities and total biomass values were variable between plots in both areas of the bay. Plots D and G had particularly low biomass values.

In the first post-disposal survey (March 1992), camera penetration at both mounds was low compared to the reference plots, reflecting the presence of hard clay and sand substrates. Images of the sediment/water interface clearly revealed the presence of numerous, large clay balls at a number of stations on both mounds. Mean RPD depth was higher at the mound stations than in the reference plots. This difference largely reflected the presence of interstices within the dredged material matrix and not oxygen penetration into the sediments. Mean surface relief was greater at the lower and upper bay mounds (1.67 and 1.39 cm, respectively) than in the reference plots, due to the rugosity of the dredged material compared to the natural flatness of the reference plots. The dredged material "signature" of sediments at both mounds was readily distinguishable from reference plot images.

In March 1992, benthic infaunal assemblages on both experimental plots were depressed in terms of both density (Figures 2 and 3) and biomass (Figures 4 and 5). These parameters were also reduced from baseline values in the reference plots,

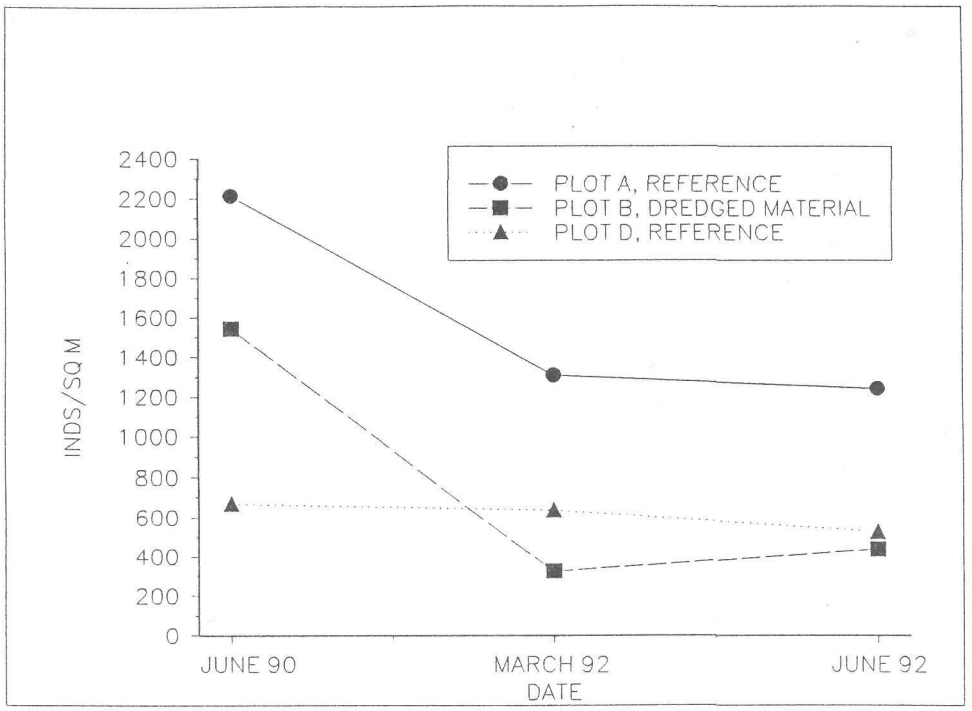

Figure 2. Changes in mean density of benthic infauna in experimental and reference plots in lower Galveston Bay, Texas.

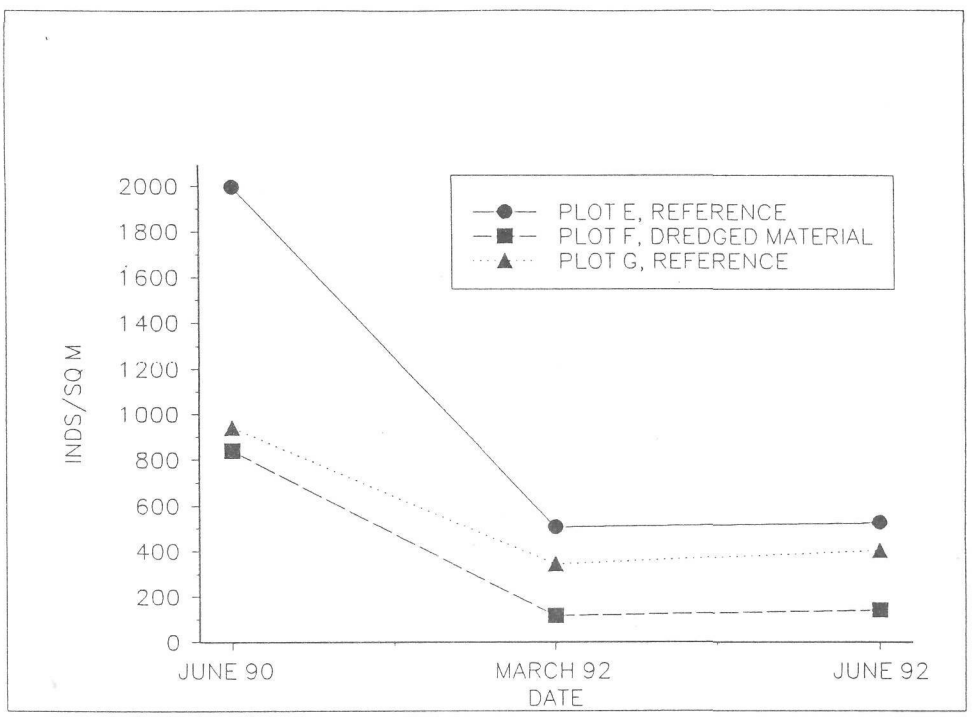

Figure 3. Changes in mean density of benthic infauna in experimental and reference plots in upper Galveston Bay, Texas.

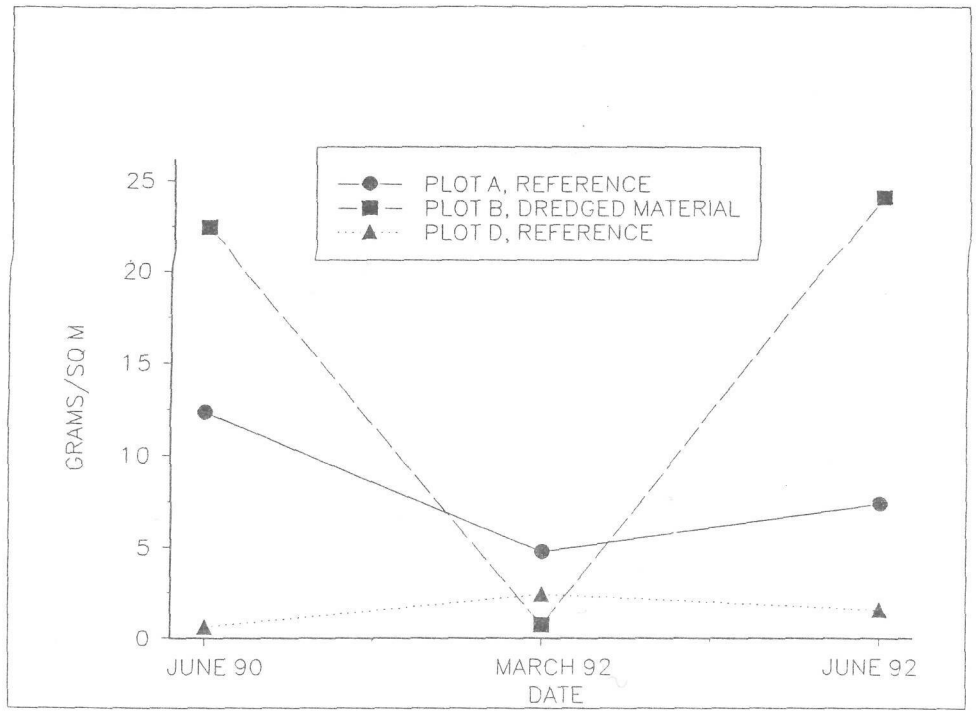

Figure 4. Changes in mean total biomass of benthic infauna in experimental and reference plots in lower Galveston Bay, Texas.

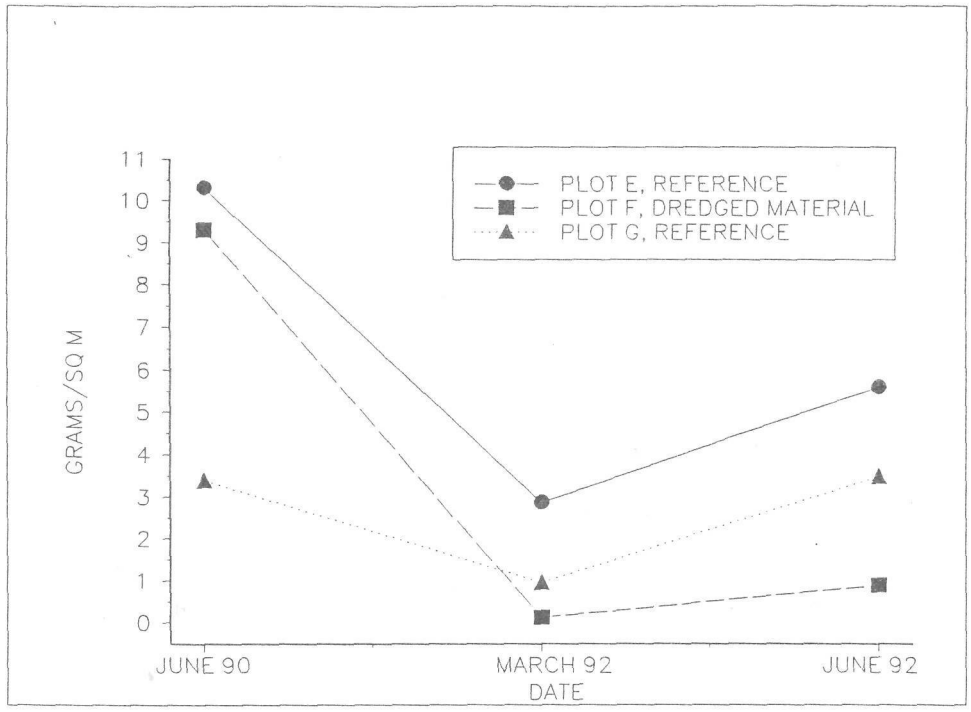

Figure 5. Changes in mean total biomass of benthic infauna in experimental and reference plots in upper Galveston Bay, Texas.

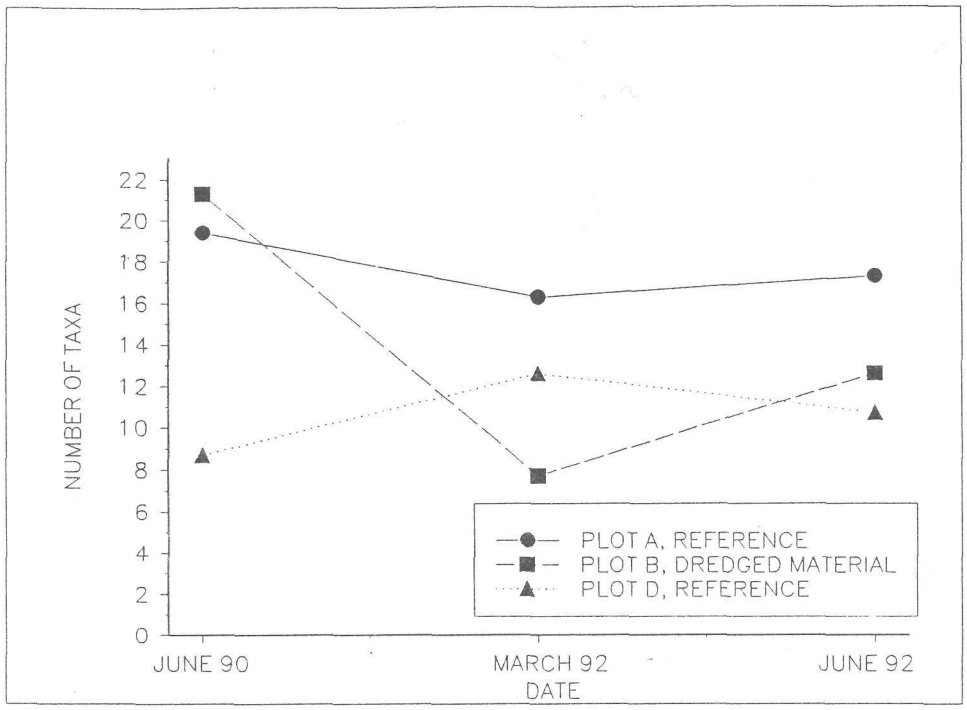

Figure 6. Changes in mean number of benthic infaunal taxa per replicate in experimental and reference plots in lower Galveston Bay, Texas.

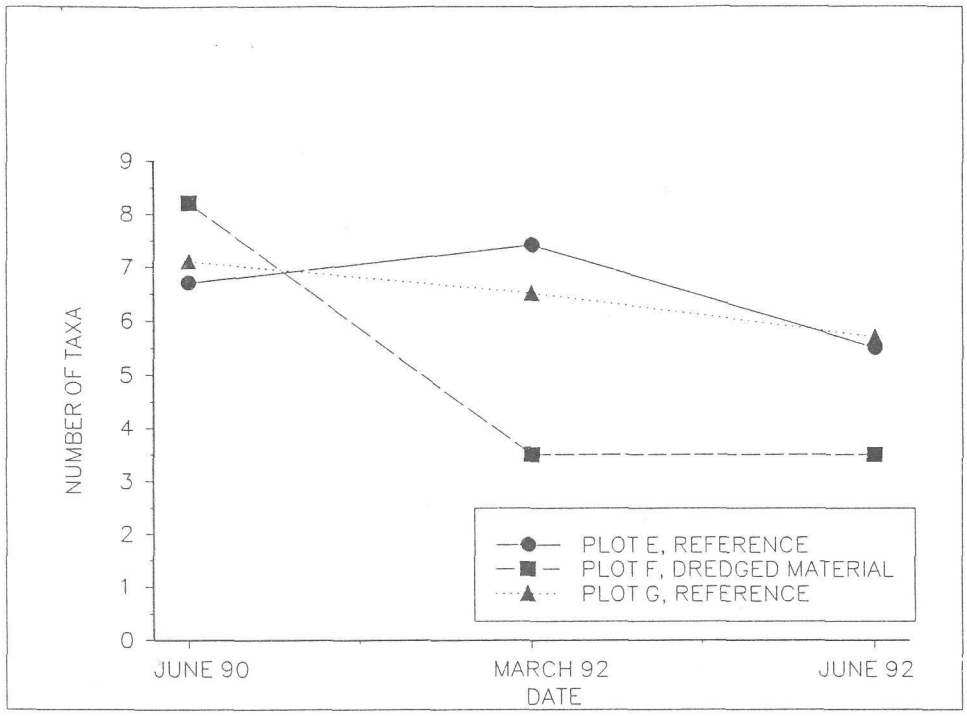

Figure 7. Changes in mean number of benthic infaunal taxa per replicate in experimental and reference plots in upper Galveston Bay, Texas.

except at D, which was depressed in the baseline as well. Observed numbers of total taxa in experimental plots (33 at B, 20 at F), were only slightly lower than in lower bay reference areas (42 at A, 36 at D), and intermediate to those in the upper bay (24 at E, 15 at G), indicating that recruitment began soon after placement of dredged material. A more accurate measure of recovery is mean number of taxa per replicate (Figures 6 and 7), which was reduced at both mounds in March samples.

SPI sampling in June, 1992, revealed some evidence of weathering of both mounds. The dredged material signature had changed considerably, notably by disappearance of most large clay balls from the surface and the presence of a measurable RPD. Camera penetration remained shallower than in the reference areas.

Densities of benthic infauna remained essentially unchanged between March and June 1992 in all plots (Figures 2 and 3). Total biomass in the lower bay experimental plot did rebound to baseline levels, due to a large increase in mollusk biomass, whereas reference plots did not change significantly (Figures 4 and 5). In contrast, reference plots in the upper bay showed increased biomass values as compared to the experimental plot. A different pattern is seen in the mean taxa per replicate data, in which upper bay values did not change appreciably between March and June, but the lower bay mound did show a substantial rebound (Figures 6 and 7), particularly among polychaete species.

In summary, results of the benthic recovery study are inconclusive at this time. Only short-term post-disposal (21 and 15 weeks at the lower and upper bay mounds, respectively) data analyses have been completed. Some evidence of recovery can be seen in the data. Weathering of hard clay sediments comprising the mounds appears to be progressing. Recruitment of benthic taxa to bay bottoms disturbed by disposal occurred rapidly, although in a patchy manner. Benthic assemblage densities remain relatively low at both mounds, but signs of recovery in terms of biomass and taxa per replicate are evident at the lower bay mound. Initial findings indicate that recovery at each mound will follow different trajectories in terms of these benthic community parameters.

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