

PRELIMINARY RESULTS OF THE 1984-85 NATIONAL BENTHIC SURVEILLANCE PROJECT:  
SOUTHEAST ATLANTIC AND GULF OF MEXICO COASTS

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ABSTRACT

The sampling and analytical programs of the National Benthic Surveillance Project are described for the 18 sites in the southeast region of the United States. Preliminary data are presented and tentative conclusions and observations are drawn.

INTRODUCTION

The National Benthic Surveillance Project is a multi-year environmental survey of the coastal waters of the United States. Its primary objective is to quantify the current status and future trends in the health of fish and the concentrations of important chemical parameters indicative of pollution. Along the southeast Atlantic and Gulf of Mexico coasts, the project is conducted at 18 sites (Figure 1).

Bottom dwelling fish (Atlantic croaker, *Micropogonias undulatus* and spot, *Leiostomus xanthurus*) and surficial bottom sediments are collected at each site for histopathological (Oxford Laboratory), organic contaminant (Charleston Laboratory), and elemental (Beaufort Laboratory) analyses. Liver, kidney and gill tissue are subjected to gross and microscopic examination for lesions. Liver tissue is analyzed for a suite of chlorinated organic compounds, including the DDT family and PCB congeners, and the 15 elements Ag, As, Cd, Cr, Cu, Fe, Hg, Ni, Mn, Pb, Sb, Se, Sn, Tl and Zn. Sediments are analyzed for the same analytes as liver tissue with the addition of a suite of aromatic compounds, the elements Al and Si, total organic carbon, particle size and coprostanol. Collections were made during August-October in 1984 and 1985 and are planned for the same period in 1986. The sampling period was selected to optimize the collection of maximum size, zero-year-class individuals that are sexually immature and have a high probability of having resided in the general vicinity of the sampling site during the juvenile stage.

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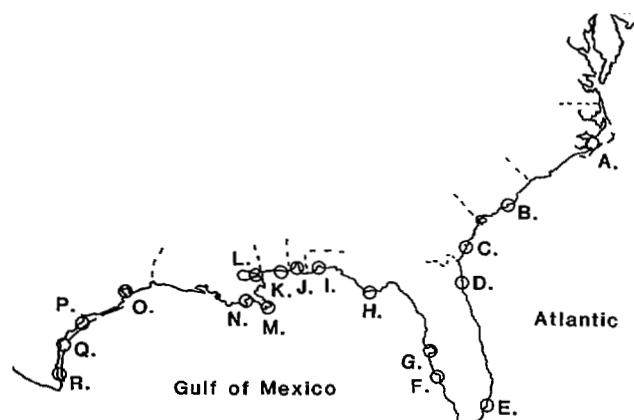


Figure 1. Benthic Surveillance sites along the southeastern Atlantic and Gulf of Mexico coasts

- A. Pamlico Sound (PAM)
- B. Charleston Harbor (CHS)
- C. Sapelo Sound (SAP)
- D. St. Johns River (SJR)
- E. Biscayne Bay (BIS)-new for 1986
- F. Charlotte Harbor (LOT)
- G. Tampa Bay (TAM)
- H. Apalachicola Bay (APA)
- I. Pensacola Bay (PEN)-not sampled 1984
- J. Mobile Bay (MOB)
- K. Round Island - Mississippi Sound (ROU)
- L. Heron Bay - Mississippi Sound (HER)
- M. Mississippi River Delta (MRD)
- N. Barataria Bay (BAR)
- O. Galveston Bay (GAL)
- P. San Antonio Bay (SAB)
- Q. Corpus Christi Bay (CCB)
- R. Lower Laguna Madre (LLM)

Only a partial set of samples from the first year's collection (cycle 1) were analyzed at the time of this writing. Data are available for histopathology; organic contaminants in liver and bile; and trace and minor elements, total organic carbon and particle size in sediments. The purpose of this paper is to summarize and provide examples of available data and to provide initial characterization and intercomparison of the sites.

## DISCUSSION AND SUMMARY

### Pathology

During the first year, 260 croaker and 321 spot were examined for the following categories of pathological disorders: inflammatory, degenerative, necrotic, hyperplastic/regenerative, and preneoplastic/neoplastic lesions; fluid hemodynamic imbalances; and structural development anomalies. Sometimes the preservation of tissues was inadequate, which made it difficult to determine whether a particular lesion resulted from an extrinsic factor or from autolysis or poor fixation. In interpreting the histological appearance of these tissues, effort was made to avoid false positive identification of lesions. Thus, if bias does exist, the data will tend to be conservative and underestimate incidence of lesions.

For example, the incidences of the four types of inflammatory lesions observed, vasculitic, cholangitic, hepatitic and pancreatitic, are shown in Figures 2-5 for croaker and spot. In general, the incidences of other lesion types were much lower and had a high rate of zero observations. Necrotic lesions in liver, inflammatory lesions in kidney, and proliferative non-neoplastic lesions in kidney showed appreciable incidences, even so the frequency of low and zero observations was still high. Lesions showing incidence profiles that resemble those of organic contaminants in tissue and, based on partial data, those in sediments are 1) necrotizing granulomas of kidney, 2) MMC (melanin-macrophage center) proliferation in kidney, and 3) cholangiocellular necrosis in the liver. These lesions are similar to those which appear to have significance in flatfish collected from the northeast Atlantic coast of the United States. Because of the small number of tissue samples examined from any one area, further analysis should await completion of at least the second year's data.

### Organic contaminants

The aromatic hydrocarbons and chlorinated compounds determined in tissue and sediment samples are as follows:

#### Aromatic Hydrocarbons

Naphthalene	1-Methylphenanthrene
2-Methylnaphthalene	Fluoranthene
1-Methylnaphthalene	Pyrene
Biphenyl	Benz(a)anthracene
2,6-Dimethylnaphthalene	Chrysene
Acenaphthene	Benzo(e)pyrene
Fluorene	Benzo(a)pyrene
Phenanthrene	Perylene
Anthracene	Dibenz(a,h)anthracene

### Chlorinated Compounds

Hexachlorobenzene (HCB)	<u>o,p'</u> - DDD
gamma-BHC (Lindane)	<u>p,p'</u> - DDD
alpha-BHC	<u>o,p'</u> - DDT
Heptachlor	<u>p,p'</u> - DDT
Heptachlor epoxide	Dichlorobiphenyls
Aldrin	Trichlorobiphenyls
Dieldrin	Tetrachlorobiphenyls
Mirex	Pentachlorobiphenyls
alpha-Chlordane	Hexachlorobiphenyls
trans-Nonachlor	Octachlorobiphenyls
<u>o,p'</u> - DDE	Nonachlorobiphenyls
<u>p,p'</u> - DDE	

Of these compounds, the data for chlorinated pesticide residues in liver tissue are complete and will be summarized. We present the data for alpha-chlordane, dieldrin and the sum of DDT compounds (Figure 6-7) for illustration because they are present at almost every site and because restrictions on the use of the first two compounds are comparatively recent.

For the southeast region as a whole, pesticide residue concentrations for most of the individual compounds tended to vary in a similar pattern within sites as the total levels varied widely among sites. This pattern is evident in the data for alpha-chlordane, dieldrin and sum of the DDT's. All liver samples were found to contain alpha-chlordane, trans - nonachlor and dieldrin; most contained lindane and p,p'-DDE and p,p'-DDD of the DDT family. No sites were found to be completely free of persistent pesticide residues. Parent DDT compounds (o,p' - and p,p' - DDT) were found in samples from several sites indicating, perhaps, the utility of liver measurements to detect long term accumulation of this banned pesticide which presumably has been transported environmentally into U.S. waters from distant sources. This contrasts with the finding of no parent DDT compounds in our analyses of stomach contents, an indicator of current exposure.

### Trace and Minor Elements

Of the seventeen elements measured in sediments, data for Cd, Cu, Cr, Pb, Ag and Hg are presented for the purposes of preliminary assessment of chemical composition of the sediments, inter-comparison of sites based on chemical composition, and assessment of evidence for pollutant metal inputs to the sediments.

Based on an analysis of Al, Si and Cr concentrations and sediment particle size data, the collected sediments appear to be predominately detrital in origin rather than biogenic or authigenic. Their elemental compositions are expected to be principally controlled by texture and, therefore, comparison of sites based on elemental compositions of sediments should proceed with sediments of similar textural character. In view

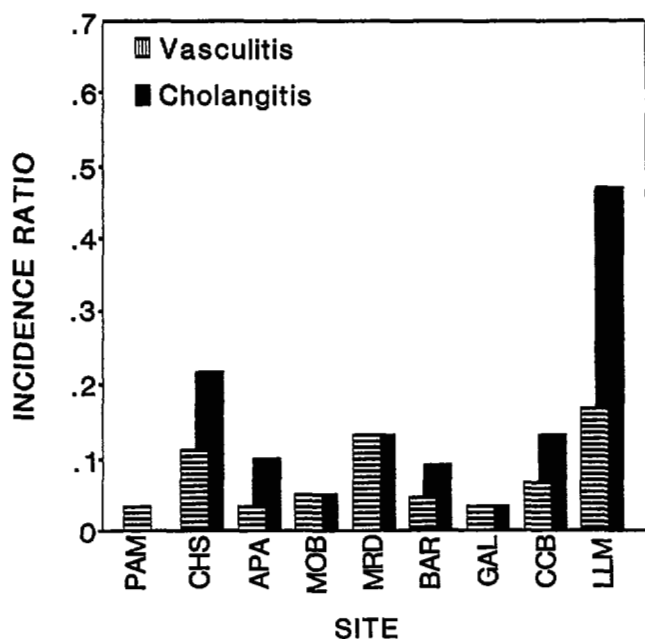


Figure 2. Inflammatory liver lesions in Atlantic croaker. Vasculitic and cholangitic types.

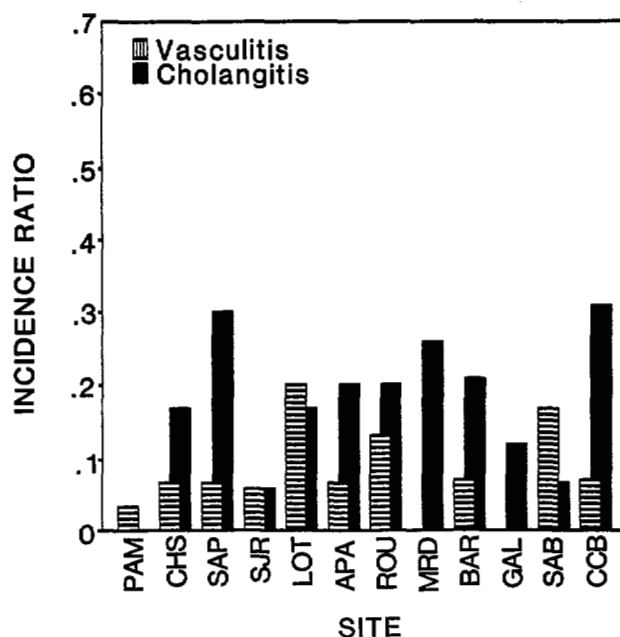


Figure 4. Inflammatory liver lesions in spot. Vasculitic and cholangitic types.

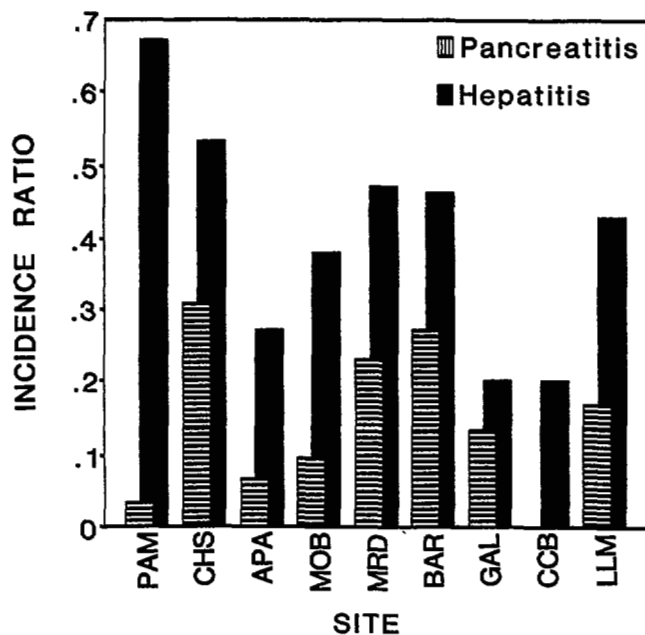


Figure 3. Inflammatory liver lesions in Atlantic croaker. Pancreatitis and hepatitis types.

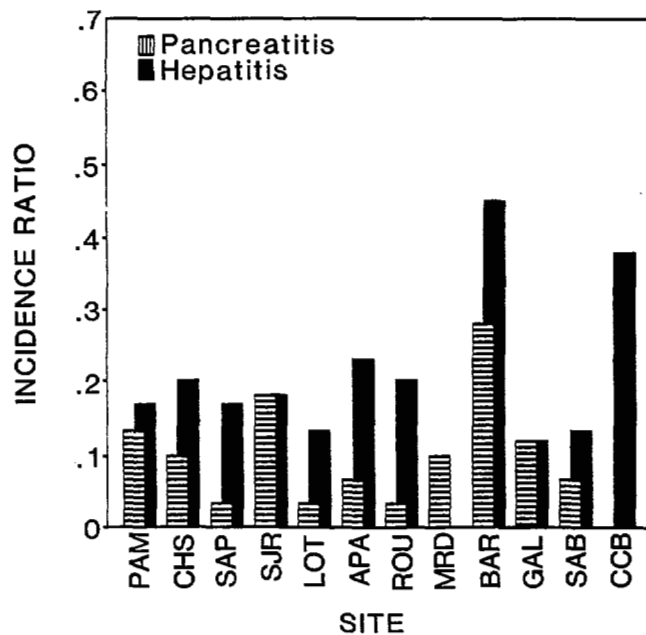


Figure 5. Inflammatory liver lesions in spot. Pancreatitis and hepatitis types.

of this, the concentrations of minor elements are best compared on a dry weight basis normalized to the fine-grained fraction (silt-clay) of the sediment (Figures 8-9).

Another approach to the intercomparison of sites on the basis of sediment characteristics is with minor element to aluminum ratios. Aluminum concentrations normalized to the fine-grained fraction indicate that the fine sediments at the sites are very similar to crustal material. Aluminum concentration also has a positive relationship with the fine-grained fraction in the sediment. Thus, the ratio of minor elements to aluminum in the fine-grained sediment fraction should be useful to determine, to a first approximation, the relative enrichment or depletion of the minor elements in the sediment (Table 1).

Since we do not have reference sediments at each site that represent sediment composition prior to the advent of significant activities by man, the

Table 1. Minor Element to Aluminum Ratios in Rock and Sediment Materials.

Material	Cu/Al $\times 10^{-4}$	Cr/Al $\times 10^{-3}$	Cd/Al $\times 10^{-6}$	Pb/Al $\times 10^{-4}$	Hg/Al $\times 10^{-7}$	Ag/Al $\times 10^{-7}$
World Average Continental Crust (1)	6.71	1.22	2.44	1.52	9.76	8.54
World Average Shale (1)	7.12	1.25	3.75	2.50	5.00	12.5
Near-shore, detrital sands (2)	4.32	1.91	-	8.02	-	-
Near-shore, detrital clays (3)	3.86	2.11	-	5.00	-	-
Near-shore, detrital sands and muddy sands (4)	9.78	1.79	-	13.6	-	-
Continental Shelf, detrital sands and silts (5)	8.14	5.55	-	2.91	-	-
1984 Benthic Surveillance sediments (6)	2.14	1.22	2.66	4.33	11.7	21.6

(1) Krauskopf, 1967; (2) Hirst, 1962 cited in (7), mean of 12 sediments; (3) Hirst, 1962 cited in (7), mean of 6 sediments; (4) Moore, 1963 cited in (7), mean of 125 sediments; (5) White, 1970 cited in (7), mean of 45 sediments; (6) This work, median of 45 sediment samples; (7) Calvert, 1976.

comparative basis for assessing pollutant contributions to the sediments must be the average composition of crustal rocks and ancient sediments of the same textural type (shale). Average metal concentrations and metal to aluminum ratios for crustal rocks and shale are included in Figures 8-9 and Table 1, respectively (Krauskopf, 1967). Based on these comparisons, several tentative conclusions can be drawn about the metal content of sediments at the 15 sites.

Observed copper concentrations are comparatively uniform and, although lower than comparator rocks, are characteristic of background levels in recent coastal sediments. Mercury values are also generally uniform among the sites and intermediate between crustal material and shale concentrations. Cadmium concentrations are more variable than other metals and indicate enrichment in the sediments at several of the sites. Chromium concentrations generally reflect average values for crustal material and shale. Silver and lead data indicate enrichment by varying amounts at almost all the sites. The metal to aluminum ratios support these conclusions.

#### CONCLUDING REMARKS

In-depth analysis of the first year's histopathology, organic compound and elemental data can proceed shortly as the analyses are completed. The obvious first step is the correlation of the incidences of lesions with chemical indicators of pollutant inputs.

In addition to biological and chemical data, other factors may be important when considering biological effects. Levels of contamination may not have a one-to-one relationship to the incidence of lesions observed. Several of the elements and compounds being measured may have biological effects at thresholds well below the levels measured in the more polluted sites. This could be reflected in a rather even distribution of some types of lesions among sites with widely variable chemical characteristics. Another factor is adaptation and selection that may, in some cases, result in fish which reside in contaminated areas having a lower frequency of some types of lesions than occurs in fish which inhabit less contaminated areas or which spend only part of their time in more contaminated areas.

In interpreting the pathological observations, a few general points may be useful. Inflammatory lesions are not necessarily restricted to degraded environments. They are often related to the presence of parasitic organisms. These may in turn be more prevalent in unadulterated environments which contain the diversity of species necessary to carry out their complex life cycles. On the other hand, inflammation may be caused by infectious microorganisms which may be enhanced by the congregation of abnormal numbers of fish such as might occur at a sewage outfall. Infection may also be enhanced by the effect of some contaminants on the immune

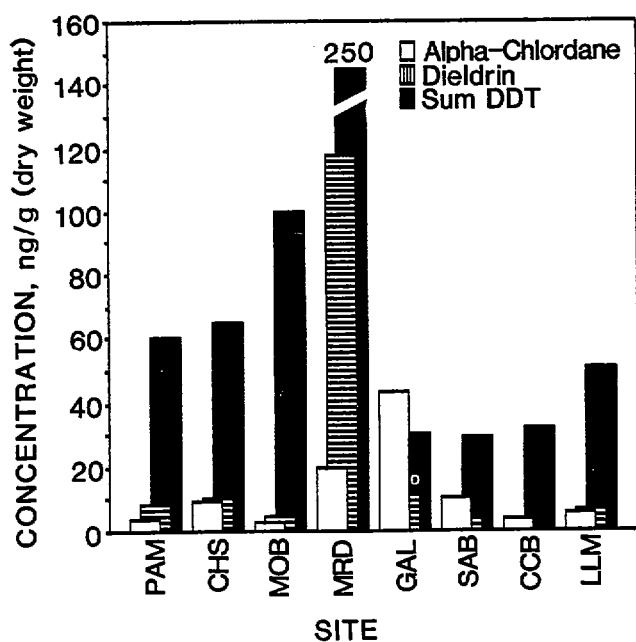


Figure 6. Alpha-chlordane, dieldrin and sum of DDT compounds in liver tissue of Atlantic croaker. Concentrations at each site represent average values for 1 to 3 composite samples of 10 livers each.

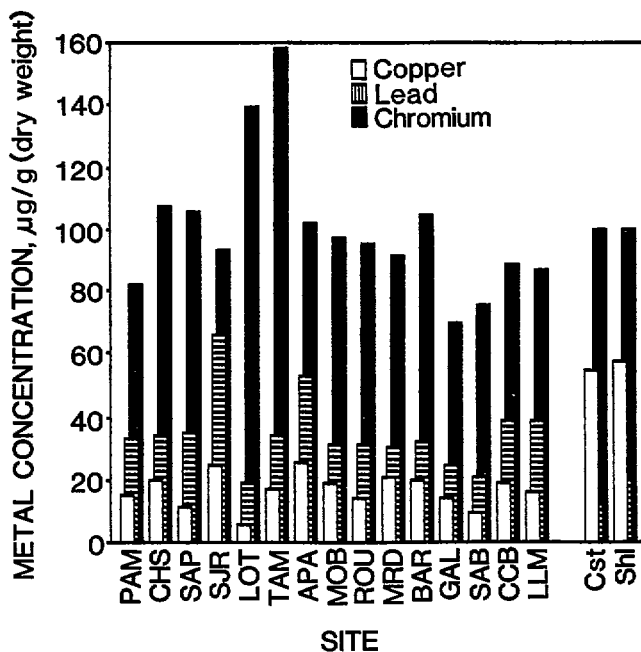


Figure 8. Copper, lead and chromium in surficial sediments. Concentrations at each site represent median values for three stations.

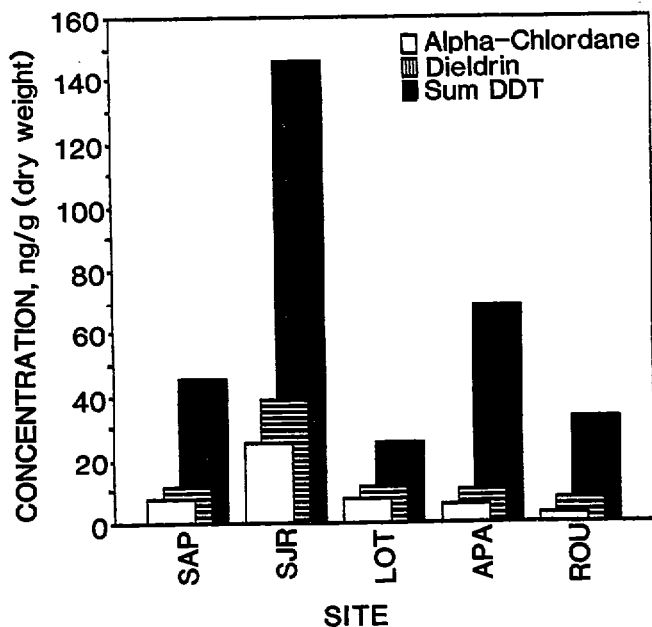


Figure 7. Alpha-chlordane, dieldrin and sum of DDT compounds in liver tissue of spot. Concentrations at each site represent average values for 1 to 3 composite samples of 10 livers each.

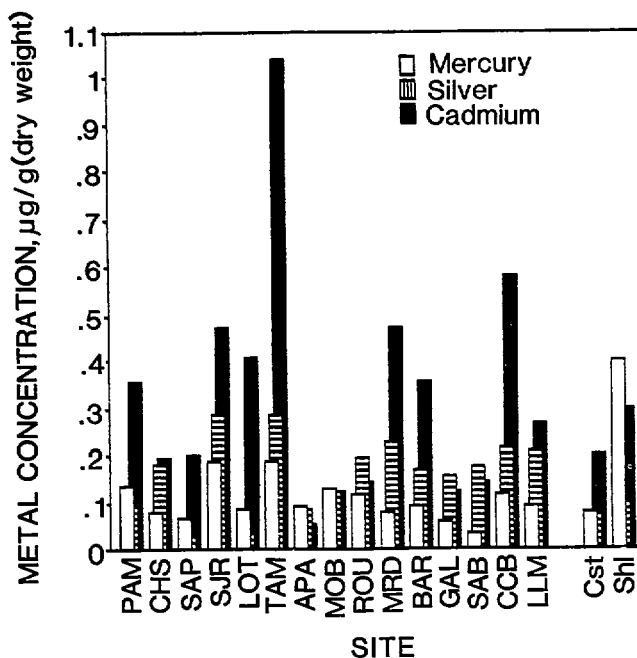


Figure 9. Mercury, silver and cadmium in surficial sediments. Concentrations at each site represent median values for three stations.

systems of fish. Degenerative lesions should cause one to be suspicious of the presence of a toxin. Necrotic and regenerative lesions might be related to several causes, including all of the above. These brief remarks should emphasize the need for caution in interpreting pathological data.

The concentrations of pesticide residues in croaker and spot livers vary considerably among sites. The data for alpha-chlordane, dieldrin and sum of DDT compounds show greater than a factor of 10 difference between extreme values. These total liver tissue concentrations, even in the most highly contaminated locations in the southeast, are well below recommended whole-body residue levels for the protection of aquatic life (NAS/NAE, 1972). Preliminary data for chlorinated compounds in sediments are showing the same relative concentration patterns among the sites as was observed in liver tissue.

The elemental concentration data for sediments indicates that, although variable degrees of metal enrichment are indicated for lead, silver, cadmium and possibly for mercury, none of the sediments are heavily polluted compared to values reported in Table 1 and elsewhere in the literature (e.g. Forstner and Wittmann, 1981). That this should be the case follows from several considerations. In general, the pollutant loads entering waters of the southeast region historically have been less than some other regions of the U.S. Many of the sites were chosen as controls for more populated and, therefore, potentially more impacted sites. At all sites, sediment stations were selected to represent average conditions in the water body and areas known or suspected to have highly polluted sediments were avoided.

#### ACKNOWLEDGMENTS

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