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Ambient Toxicity Testing in Chesapeake Bay

Year 6 Report

Chesapeake Bay Program

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September 1998

Ambient Toxicity Testing in Chesapeake Bay

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FOREWORD

This study was designed to evaluate ambient toxicity in the Chesapeake Bay watershed by using a battery of water column and sediment toxicity tests in concert with both fish and benthic community assessments. A team of scientists from two Chesapeake Bay research laboratories and Maryland Department of Natural Resources worked jointly to complete this goal. Water column toxicity studies and overall project management were directed by Lenwood W. Hall, Jr. of the University of Maryland's Agricultural Experiment Station. Sediment toxicity tests and water/sediment chemical analysis were managed by Raymond Alden of Old Dominion University Applied Marine Research Laboratory. Margaret McGinty of Maryland Department of Natural Resources was responsible for the fish community assessments. This report summarizes data from the sixth year of a six-year ambient toxicity testing program. The following government agencies were responsible for supporting and/or managing this research: U.S. Environmental Protection Agency, Maryland Department of Environment and Maryland Department of Natural Resources.

ABSTRACT

Data presented in this report were collected during the sixth year of a research program designed to assess ambient toxicity of living resource habitats in Chesapeake Bay. The goals of this study were to identify toxic ambient areas in the Chesapeake Bay watershed by using a battery of standardized, directly modified, or recently developed water column and sediment toxicity tests concurrently with fish and benthic community assessments (index of biotic integrity approaches). The toxicity of ambient estuarine water and sediment was evaluated during the fall of 1996 at eight stations in following areas: Patuxent River (four stations) and Chester River (four stations). The toxicity of ambient estuarine water was assessed at all stations by using the following estuarine tests: 8-d larval sheepshead minnow, *Cyprinodon variegatus,* survival and growth test; 8-d *Eurytemora affinis* (copepod) life cycle test and two separate 48-h coot clam, *Mulinia lateralis* embryo/larval tests. Toxicity of ambient estuarine sediment was determined by using the following tests: 10-d sheepshead minnow embryo-larval test; 20-d survival, growth and reburial test with the amphipods *Leptocheirus plumulosus* and *Lepidactylus dytiscus* and 20-d polychaete worm, *Streblospio benedicti* survival and growth test. Both inorganic and organic contaminants were assessed in ambient sediment and inorganic contaminants were measured in ambient water concurrently with toxicity testing to assess "possible" causes of toxicity. Both fish and benthic communities were also assessed at the eight stations. An index of biotic integrity was determined for each trophic group.

Both univariate and multivariate (using all endpoints) statistical techniques were used to analyze the water column and sediment toxicity data. Results from univariate analysis of water column tests with *Cyprinodon* showed that growth was reduced at three of the downstream stations on the Chester River. Normal shell development was also reduced for *Mulinia* at all four Chester River stations during both 48 h tests. *Eurytemora* and *Cyprinodon* survival were not significantly reduced at any of the four Chester River sites. Metal concentrations were generally low at all Chester River sites, although one copper concentration (4.7 ug/L) exceeded the marine chronic criteria. Results from multivariate analysis of water column data showed a high level of toxicity at one of the Chester River sites and a low to moderate degree of toxicity at two of the Chester River sites.

Water column toxicity was generally less at the four Patuxent River sites. *Mulinia* normal shell development was reduced at the all four sites during the second test; no significant effects were reported during the first test. *Eurytemora* survival, *Cyprinodon* survival and *Cyprinodon* growth were not significantly reduced at any of the Patuxent River sites when compared with the controls. Concentrations of metals were low at all locations. Results from multivariate analysis with water column data showed a high degree of toxicity at one Patuxent River station and a low to moderate degree of toxicity at another Patuxent River station.

Sediment toxicity was reported for three to five endpoints for all Chester River sites. The following endpoints were significantly different than the reference for the most toxic site: Sheepshead minnow egg hatching and larval survival, *L. plumulosus* survival and weight and *L. dytiscus* survival. The two upstream Chester River stations were the most toxic areas as four to five endpoints were different than the reference. For the two downstream stations, *L. plumulosus* survival and weight and *L. dytiscus* survival were significantly lower than the reference. Dieldrin and DDT (exceeding ER-L values at all sites and the ER-M at the upstream site) were detected at all four stations and may have contributed to some of the biological effects. DDT concentrations followed a gradient decreasing downstream (63 to 4.3 ug/kg). Five different metals exceeded the ER-L values in the Chester River

sites but in all cases the SEM/AVS ratio was very low suggesting that metal toxicity was unlikely. Results from multivariate analysis with sediment toxicity data showed a high level of toxicity at the two upstream Chester River stations and a low to moderate level of toxicity at the two downstream stations.

Sediment toxicity data for the Patuxent River sites showed that *L. plumulosus* survival and weight gain were significantly reduced at all four sites when compared with the controls. In addition, *L. dytiscus* survival was also reduced at the downstream station. Dieldrin and DDT (exceeding ER-L values) were detected at all sites, and may have contributed to some of the observed mortalities and reduction in growth for the amphipod tests species. A concentration gradient of total DDT was observed increasing from 3.1 ug/kg downstream to 39 ug/kg upstream. Metals were detected at concentrations above the ER-L only in sediments from the two upstream stations. Based on SEM/AVS calculations, it is unlikely that any of the metals measured in this system would be bioavailable to cause toxicity. Results from multivariate analysis with sediment data showed a low to moderate degree of toxicity for one Patuxent River station.

Results from the fish IBI analysis from seining showed that IBI scores at all four Chester River stations were below the reference condition. In contrast, three of the four sites in the Patuxent River scored above the reference condition for the fish IBI. Trawl index scores for fish were poor for two of the downstream Chester sites and rated fair for the two upstream stations. For the Patuxent River, the two middle stations rated poor for the trawl index score and the upstream and downstream station rated fair. The benthic index of biotic integrity (B-IBI) showed that all four station in the Chester River meet the restoration goal or rated as not-degraded. In contrast, the upstream Patuxent River station was rated as degraded and the downstream station was rated as severely degraded. Both middle stations in the Patuxent River were rated as non-degraded (meets the restoration goals).

In summary, water column toxicity data, sediment toxicity data and the fish IBI data suggest that various Chester River stations have a moderate to high range of relative toxicity and or impairment of biological communities. With the exception of the benthic IBI data, this represents fairly consistent agreement among the results from the various types of data used for assessing toxicity/biological impairment in this Chesapeake Bay eastern shore river. A final analysis of the toxicity and community metric data for the Patuxent River showed that the water column toxicity data (multivariate analysis) and the benthic B-IBI data suggest toxicity/biological impairment at one station. The sediment toxicity data (multivariate analysis) and the fish trawl index score also suggested some, but lower, toxicity/biological impairment at another station.

ACKNOWLEDGMENTS

We acknowledge the U. S. Environmental Protection Agency's Chesapeake Bay Program Office for supporting this study. We would like to acknowledge individuals from the University of Maryland and Old Dominion University for technical assistance and the U. S. EPA's Chesapeake Bay Program Office and Maryland Department of the Environment for their comments on the study design.

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SECTION 1

INTRODUCTION

The link between contaminants (including adverse water quality such as reduced dissolved oxygen) and biological effects is an area of concern in critical Chesapeake Bay habitat areas. Information derived from the loading of toxic chemicals and/or chemical monitoring studies are not adequate for assessing the biological effects resulting from numerous sources such as multiple point source effluents, nonpoint source runoff from agriculture, silviculture and urban sites, atmospheric deposition, groundwater contamination, and release of toxic chemicals from sediments. The most realistic approach for evaluating the adverse effects of toxic conditions on living resources is by direct measurement of biological responses in the ambient environment. For the purposes of this report, the ambient environment is defined as aquatic areas located outside of mixing zones of point source discharges.

Studies designed to address the link between contaminants and adverse effects on living aquatic resources in the ambient environment have been supported by various state and federal agencies in the Chesapeake Bay watershed. These ambient toxicity tests are designed to detect toxic conditions on a much broader scale than traditional effluent toxicity tests. These tests are a first tier type approach used as a screening tool to identify areas where ambient toxicity exists and future assessment efforts are warranted. Biological responses such as survival, growth, and reproduction of resident species are used to identify conditions in the ambient environment resulting from point and non-point sources.

Assessments of ambient toxicity are consistent with the the Chesapeake Bay Basinwide Toxics Reduction Strategy which has a commitment to develop and implement a plan for Baywide assessment and monitoring of the effects of toxic substances, within natural habitats, on selected commercially, recreationally and ecologically important species of living resources (CEC, 1989). This commitment is also consistent with the recommendations of the Chesapeake Bay Living Resource Monitoring Plan (CEC, 1988).

The idea for an Ambient Toxicity Testing Program was discussed at an Ambient Toxicity Assessment Workshop held in Annapolis, Maryland in July of 1989 (Chesapeake Bay Program, 1990). The goals of this workshop were to provide a forum on how to use biological indicators to monitor the effects of toxic contaminants on living resources in Chesapeake Bay. Recommendations from this workshop were used to develop an ongoing ambient toxicity monitoring program (1990 to present).

Studies from previous ambient toxicity assessments in the Chesapeake Bay (1990-1995) have been completed and reports have been published (Hall et al., 1991; Hall et al., 1992; Hall et al., 1994; Hall et al., 1996; Hall et al. 1997a). General conclusions to date have shown that 47% of the time water column tests conducted in 33 stations (14 rivers and harbors) have suggested some degree of toxicity. The most toxic sites were located in urbanized areas such as the Elizabeth River, Baltimore Harbor, Middle River and Willoughby Bay. Water quality criteria for copper, lead, mercury, nickel and zinc were exceeded at one or more of these sites. Some degree of sediment toxicity was reported from 60% of the ambient tests at 33 stations conducted during the six year period (1990 - 1995). The Elizabeth River and Baltimore Harbor stations were reported as the most toxic areas based on sediment results. Sediment toxicity guidelines (Long and Morgan, 1990; Long et al., 1995) were exceeded for one or more of the following metals at these two locations: arsenic, cadmium, chromium, copper, lead, nickel and zinc. At the Elizabeth River station, nine of sixteen semi-volatile organics and two of seven pesticides measured exceeded the ER-M values. Various semi-volatile organics exceeded the ER-M values at a number of Baltimore Harbor sites; pyrene and dibenzo (a, h) anthracene were particularly high at one of the stations (Northwest Harbor).

The goals of this study were to conduct a suite of water column and sediment toxicity tests in concert with fish and benthic community assessments (IBI type approach) at four stations in the Chester River and four stations in the Patuxent River. The fish and benthic community assessments were new components for the ambient toxicity testing program that provided field data for the status of biological communities at the study sites. In order to provide limited exposure data for correlation with the toxicity data and biological assessments, inorganic contaminants were evaluated in water and both organic and inorganic contaminants were evaluated in sediment during these experiments.

SECTION 2

OBJECTIVES

This ambient toxicity study was a continuation of an assessment effort previously conducted from 1990-1995 in the Chesapeake Bay watershed. The major goal of this program was to assess and determine the toxicity of ambient water and sediment in selected areas of the Chesapeake Bay watershed by using a battery of standardized, directly modified, or recently developed water column and sediment toxicity tests. Biological communities (fish and benthos) were also evaluated at the study sites.

The specific objectives of the sixth year of this study were to:

- assess the toxicity of ambient estuarine water and sediment during the fall of 1996 at the four stations in the Chester River and four stations in the Patuxent River;
- determine the toxicity of ambient estuarine water described in the first objective by using the following estuarine tests: 8-d larval sheepshead minnow, *Cyprinodon variegatus* survival and growth test; 8-d *Eurytemora affinis* (copepod) life cycle test and 48-h coot clam, *Mulinia lateralis* embryo-larval tests;
- evaluate the toxicity of ambient sediment described in the first objective by using the following estuarine tests: 10-d sheepshead minnow embryo-larval test; 20-d amphipod, *Lepidactylus dytiscus* and *Leptocheirus plumulosus* survival, growth and reburial test and 20-d polychaete worm, *Streblospio benedicti* survival and growth test;
- measure inorganic contaminants in ambient water and organic and inorganic contaminants in sediment concurrently with toxicity tests to determine "possible" causes of toxicity;
- determine the relative sensitivity of test species for each type of test and compare between test methods to identify regions where ambient toxicity exists;
- summarize water column and sediment toxicity data from 1990 to 1996 using a composite index approach for each site; and
- assess the status of fish and benthic communities at the eight stations using an Index of biotic integrity approach

SECTION 3

METHODS

3.1 Study Areas

The rationale of selecting study sites in the Chester and Patuxent River are presented below (Figure 3-1). The Chester River was selected for the following reasons; (1) pesticide use is high in this basin compared to other coastal plain basins as it is dominated by agricultural activity (67%) and concentrations of both atrazine and metolachor have been detected in this river (Hall et al., 1997b); (2) Maryland DNR has assessed fish communities in this river and determined that localized communities appear to be potentially impacted (Margaret McGinty, personal communication); (3) despite the ecological importance of this river, ambient toxicity tests have not been previously conducted by the ambient toxicity testing program; therefore, new data would be generated to assist the Toxic Subcommittee's Regional Focus Workgroup in classifying areas of potential toxicity and (4) benthic community assessments were already scheduled for this river in 1996 therefore coordination with this activity would be cost effective. Coordinates for the four Chester River locations were as follows: CH6 (39 11 48 x 76 03 42), CH5 (39 10 36 x 76 02 54), CH4 (39 09 30 x 76 03 06) and CH2 (39 05 02 x 76 12 18) (Figure 3-1).

The Patuxent River was selected for the following reasons; (1) based on freshwater fish IBI values in this basin, fish assemblages appear to be somewhat impaired when compared to other coastal plain basins; (2) this river has not been tested in previous ambient toxicity testing efforts therefore, new data would be available for the Regional Focus Workgroup to use for classifying the toxicity status of this basin in the Bay watershed and (3) benthic community assessments were already scheduled for this river in 1996 therefore coordination with this activity would be cost effective. Coordinates for the four Patuxent River sites were as follows: Chalk Point - PCP (38 32 48 x 76 40 34); Buzzard Island - PBZ (38 29 13 x 76 39 48); Jack Bay - PJB (38 25 44 x 76 35 17) and Broomes Island - PBR (38 24 16 x 76 32 52).

3.2 Water Column Toxicity Tests

The objectives of the water column toxicity tests were to determine the toxicity of ambient water at the eight stations described above. The following tests were conducted at these stations during the fall of 1995: 8-d larval sheepshead minnow survival and growth test; 8-d *E. affinis* life cycle test and two 48-h coot clam embryo/larval tests. A suite of metals was also measured in ambient water used for these tests.

3.2.1 Test species

Larval sheepshead minnows and the copepod *E. affinis* have been used in the previous five years of ambient toxicity testing. These test species were selected because they meet most of the following criteria: (1) resident Chesapeake Bay species, (2) sensitive to contaminants in short time period (less than 10 d) and (3) standard test organism that does not require additional research. Larval sheepshead minnows are highly abundant, resident Chesapeake Bay organisms used extensively in standard tests. Sheepshead minnows have demonstrated moderate sensitivity in subchronic tests and are commonly used in EPA's and MDE's Whole Effluent Toxicity Testing Program. *E. affinis* is an extremely abundant, resident Chesapeake Bay zooplankton species that is sensitive to contaminants. We previously developed a Standard Operating Procedure for this species that was used for these tests (Ziegenfuss and Hall, 1994).

The coot clam, *M. lateralis*, was a new species added to the suite of test organisms during the third year of ambient toxicity testing. This clam is a small (< 2 cm length) euryhaline bivalve. It is a numerically dominant species in the mesohaline areas of the Chesapeake Bay as well as numerous tributaries (Shaughnessy et al., 1990). Embryo/larval development occurs in the water column in approximately 6-8 days. It is, therefore, suitable for water column testing because the sensitive life stage occurs in the water column. The coot clam adds another dimension to the suite of test organisms because it represents a type of species (bivalves) not represented during the first two years of testing. This clam is not a standard test organism, however, the U.S. EPA has written a draft test method for estimating toxicity of effluents using *Mulinia* (Morrison and Petrocelli, 1990a; 1990b). We also developed a Standard Operating Procedure for testing *Mulinia* (Hall and Ziegenfuss, 1993).

3.2.2 Test Procedures

Test procedures and culture methods previously described in the year 1 report for the 8-d larval sheepshead minnow survival and growth test and 8-d *E. affinis* life cycle test were used for this study (Hall et al., 1991). The test procedures for the coot clam described in the year 3 report were also used for these experiments (Hall et al. 1994). The sources for the species were as follows: sheepshead minnows, Aquatic Biosystems, Denver, Colorado; *E. affinis*, in-house cultures (orginally from University of Maryland - Chesapeake Biological Laboratory) and coot clams (U. S. EPA Laboratory in Narragansett, Rhode Island).

3.2.3 Statistical Analysis

Univariate statistical tests described in Fisher et al. (1988) were used for each test species when appropriate. The goal of this study was not to generate typical LC50 data with various dilutions of ambient water. For each test species response, control and test conditions (100 percent ambient water) were compared using a one-way Analysis of Variance (ANOVA). A statistical difference between the response of a species exposed to a control condition and an ambient condition was used to determine toxicity. Dunnett's (parametric) or Dunn's (non-parametric) mean testing procedures were used in cases where comparisons of a species response on a spatial scale was necessary.

3.2.4 Sample Collection, Handling and Storage

Sample collection, handling and storage procedures used in the previous studies were implemented (Hall et al., 1991). Ambient water was collected from all study areas and taken to our toxicity testing facility at the Wye Research and Education Center, Queenstown, Maryland for testing.

Grab samples were used because they are easier to collect, require minimum equipment (no composite samplers), instantaneous toxicity is evaluated, and toxicity spikes are not masked by dilution. Grab samples collected from each station represented a composite of the water column (top, mid-depth and bottom). A metering pump with teflon line was used to collect samples in 13.25 L glass containers.

The time lapsed from the collection of a grab sample and the initiation of the test or renewal did not exceed 72 hours. Water column samples were collected on days 0, 3 and 6 during the 8 day tests. All samples were chilled after collection and maintained at 4°C until used. Water from each ambient site and control was renewed in test containers every 24 hours. The temperature of the ambient water used for testing was 25°C. Salinity adjustments (increase) were performed on samples collected from less saline sites to obtain a standard test salinity of approximately 15 ppt.

3.2.5 Quality Assurance

A copy of our general Standard Operating Procedures (SOP) Manual (including the sheepshead minnow SOP) was submitted and approved by the sponsor prior to the study (Fisher et al., 1988). Standard Quality Assurance (QA) procedures used in our laboratory for The State of Maryland's Whole Effluent Toxicity Testing Program were followed (Fisher et al., 1988). These QA procedures were also used during the previous five years of ambient toxicity testing study. Specific SOPs for *E. affinis* (Ziegenfuss and Hall, 1994) and *M. lateralis* (Hall and Ziegenfuss, 1993) were followed. The control water used for these experiments was obtained from a pristine area of the Choptank River. The water was autoclaved and filtered with a 1 um filter. Hawaiian (HW) Marine sea salts were used to salinity adjust samples to 15 ppt. The pH was also adjusted to 7.5 to 8.0 after salinity adjustment.

Acute reference toxicant tests with cadmium chloride were conducted with the same stocks of species used for ambient toxicity tests. Cadmium chloride was selected as the reference toxicant because there is an established data base with this chemical for all of the proposed tests. Reference toxicity tests were used to establish the validity of ambient toxicity data generated from toxicity tests by ensuring that the test species showed the expected toxic response to cadmium chloride (Fisher et al., 1988). The reference toxicant tests were conducted on each test species and source (of species) once during this study using procedures described in Hall et al. (1991).

3.2.6 Contaminant Analysis and Water Quality Evaluations

The contaminant analyses used for these studies provided limited information on selected contaminants that may be present in the study areas. It was not our intention to suggest that the proposed analysis for inorganic contaminants would provide an absolute "cause and effect relationship" between contaminants and biological effects if effects were reported. Information on suspected contaminants in the study areas may, however, provide valuable insights if high potentially toxic concentrations of inorganic contaminants were reported in conjunction with biological effects.

Aqueous samples for analysis of inorganic contaminants listed in Table 3.1 were collected during the ambient toxicity tests. These contaminants and methods for their measurement have been used in our previous ambient toxicity testing study (Hall et al., 1991). Analytical procedures and references for analysis of these samples are presented in Table 3.1. Total inorganic contaminant analysis (dissolved metals) were conducted on filtered samples using 0.40 um polycarbonate membranes. The Applied Marine Research Laboratory of Old Dominion University conducted the inorganic analysis.

Standard water quality conditions of temperature, salinity, dissolved oxygen, pH and conductivity was evaluated at each site after sample collection. These conditions were evaluated every 24 hours at all test conditions during the tests.

3.3 Sediment Toxicity Tests

All tests and analyses were conducted according to the SOPs and QA plans previously submitted to the sponsor. The methods described in this report are general summaries of those protocols.

3.3.1 Test Species

Sediment samples (100 percent ambient sediment samples) from eight stations were tested using four organisms: eggs of the sheepshead minnow *Cyprinodon variegatus*, the amphipods *Lepidactylus dytiscus* and *Leptocheirus plumulosus*, and the polychaete worm *Streblospio benedicti*.

3.3.2 Test Procedures

All tests were conducted for 10 days at 25°C and monitored daily. Daily monitoring in the sheepshead test included the assessment of egg and larval mortality, hatching success and water quality parameters (Hall et al., 1994) until the end of the test. On day 10 of the *S. benedicti*, *L. plumulosus*, and *L. dytiscus* tests, mortalities were recorded, and the animals were returned to the original test containers. The organisms were then monitored daily for an additional 10 days. Numbers of live animals were recorded on day 20. Any living organisms were preserved for length and weight measurements.

The sediment samples were collected from four stations in the Chester River and four stations in the Patuxent River. (see Section 3.1). Control sediments for each species consisted of native sediments from the area in which the test organisms were collected or naturally occur. Control and reference sediments (see below) were tested with each set of test samples. Reference sediments were employed to assist in determining any possible naturally occurring geochemical and physical conditions inherent to the sediment being tested which may influence mortality.

Because of the large range in particle size between test sites observed in past studies, two reference sediments were used with each organism per test. These reference sediments bracketed the sediment particle sizes found at the selected test sites (for discussion of grain size adjustments see Hall et al., 1992). For example, one reference sediment most closely matched the test site with highest sand content and one reference most closely matched the test site with highest silt/clay proportion. Reference and control sediments were designated as follows: (1) Lynnhaven sand, (2) Lynnhaven mud, and (3) Poropatank sediment. Lynnhaven mud was used as the control sediment for *S. benedicti* and *C. variegatus* eggs, Lynnhaven sand was used as the control for *L. dytiscus*, and Poropotank sediment was used as the control for *L. plumulosus*. Lynnhaven sand (98.81 percent sand) and Poropotank sediment (1.45 percent sand) bracket the particle size of nearly all test samples and were therefore considered suitable as reference sediments as well. The test sediment samples were also analyzed for sand, silt, and clay content, and the particle size/composition of the test sediments were quite variable even between replicates at the same site (Section 4.2.1).

The culture and maintenance procedures used for the polychaete *S. benedicti* and the amphipod *Lepidactylus dytiscus* are described in Hall et al. (1991). *Leptocheirus plumulosus* and the sheepshead minnow egg tests are described in Hall et al. (1994).

3.3.3 Statistical Analysis of Sediment Data

The goal of this study was not to generate LC50 data from dilution series tests. The main objective was to evaluate for each test species, the response (mortality, growth, etc.) when tested in 100 percent ambient sediment, as compared to a control. Statistical differences between the responses of species exposed to control and ambient sediments were used to determine the toxicity. Evaluations relative to particle size effects were made based on the response seen in the reference sediments. Sheepshead egg data were evaluated using ANOVA contrasts and compared to the controls. Evaluation of total mortality was assessed by combining egg mortality, larval mortality, and unhatched eggs remaining at the termination of the test. Unhatched eggs were included as mortality based upon previous observations and the assumption that probability of hatching and thus survival decreases essentially to zero by test termination.

For all other tests, the statistical approaches that were employed in the first five years of the study (Hall et al., 1992) were again utilized in the sixth year. Basically, the analyses consisted of analysis of variance (ANOVA) models with *a priori* tests of each treatment contrasted to the controls. Arcsine transformations were used for the percent mortality data. Mortality was corrected for particle size effects using the regression equations presented in year 2 of the study. Length and weight were expressed as percentage of change from the initial length and weight measurements.

3.3.4 Sample Collection, Handling and Storage

The general sediment sample collection, handling, and storage procedures described in Hall et al. 1991 were used in this study. Sediment samples were collected at each site by Applied Marine Research Laboratory (AMRL) and Wye Research and Education Center (WREC) personnel and returned to the laboratory for testing. The sediments were collected September 26 and 27, 1996 by petite ponar grab. True field replicates were maintained separately for transport to the laboratory. Sediment was collected at each site by first randomly identifying five grab sample locations along a 100 meter square grid. At each site a discrete field subsample was collected for bioassays and stored on ice. A separate subset from the same ponar grab series was placed into a handling container. Subsamples from all five sites within a station were serially placed into the same handling container. When all five sites within the station had been sampled, the entire batch was homogenized and distributed into the sample containers designated for chemical analyses. All samples were transported on ice, out of direct sunlight. Bioassay samples were held in refrigerators at 4°C until initiation of the toxicity tests. Samples for chemical analysis were frozen and stored until tested. All samples were analyzed within EPA recommended holding times.

3.3.5 Quality Assurance

All quality assurance procedures submitted previously to the sponsoring agency were implemented following the testing protocols and associated SOP's. Laboratory quality assurance procedures for sediment and pore water and inorganic and organic chemical analyses followed standard EPA quality assurance guidelines.

Static acute non-renewal water-only 96-h reference toxicant tests were performed for each species during each sampling period. Cadmium chloride was used as a reference toxicant for each animal because the existing laboratory data base is available for this chemical. Reference toxicant information was used to establish the validity and sensitivity of the populations of animals used in the sediment test. Seasonal changes in sensitivity have been observed previously in *L. dytiscus* (Deaver and Adolphson, 1990), therefore consideration of this QA reference data is paramount to proper interpretation.

3.3.6 Contaminant and Sediment Quality Evaluations

Contaminants were evaluated concurrently with toxicity tests. It was not our intention to suggest that the presence of inorganic and organic contaminants provide an absolute "cause and effect" relationship between contaminants and any observed biological effects. Information on suspected contaminants does however, provide valuable insights if high concentrations of potentially toxic contaminants were reported in conjunction with biological effects.

Sediment samples for organic contaminants analysis were collected in conjunction with bioassay sediment samples. The contaminants assayed are listed in Appendix A. Polynuclear aromatic hydrocarbons were extracted and analyzed in accordance with SW-846 Methods 3550, 3640 and 8270 (U. S. EPA, 1994). Pesticides and Aroclors were extracted and analyzed in accordance with SW-846 Methods 3350, 3640 and 8081 (U. S. EPA, 1994).

All sediment samples were analyzed for acid volatile sulfides (AVS) and Total Organic Carbon (TOC). Samples were frozen until analysis, at which time they were thawed, then homogenized by gently stirring. Sediment samples were analyzed for AVS using the method of DiToro et al. (1990) and the U. S. Environmental Protection Agency method "Determination of Acid Volatile Sulfides in Sediment" (U. S. EPA, 1991). Details of the analytical procedures for both AVS and TOC are described in Hall et al., 1991. Pore water samples were removed from all sediment samples by squeezing with a nitrogen press. All pore water samples were filtered then frozen until analyses of ammonia, nitrite and sulfides were conducted. These analyses were conducted on all samples. Details of the methods are described in Hall et al. (1991).

All sediment samples were analyzed for the following bulk metals: aluminum, cadmium, chromium, copper, lead, nickel, tin and zinc, using an ICP (inductively coupled plasma atomic emission spectroscopy) following USEPA/SW-846, Method 6010 (see Hall et al., 1991). In addition, a Simultaneously Extractable Metals (SEM) analysis was conducted on all samples to use with the AVS data to determine the potential toxicity of the sediment due to metals. The sample for the SEM analysis was obtained from a step in the AVS procedure. The AVS method was detailed in Hall et al. (1991). The SEM sample was the sediment suspension remaining in the generation flask after the cold acid extraction had been completed. The sediment suspension was filtered through a 0.2 micron membrane filter into a 250 ml volumetric flask. The sample was then diluted to volume with deionized water. The concentrations of the SEM were determined by EPA-600/4-79-020 Methods for Chemical Analysis of Water and Wastes (U.S. EPA, 1979). Cadmium, lead, copper, nickel, and zinc were determined by ICP following U.S.EPA method number 200.7. Mercury was determined by cold vapor generation following USEPA method number 245.1. The concentrations were then converted to micromoles per gram dry sediment and were added together to give total SEM.

3.4 Analysis of Six Year Data Base

A series of summary statistical analyses were conducted in order to provide environmental managers with summary information concerning the relative toxicity of water and sediments from the collection areas. These analyses also provide quantitative indicators of the degree of confidence which may be given to differences between responses observed for "clean" ("reference") conditions and those seen for test media (water or sediments) of unknown quality. These analyses are based upon the summary composite indices first developed for the toxicity axis of the "sediment quality triad" (Long and Chapman, 1985; Chapman, 1986; Chapman et al. 1987 and Chapman 1990). This approach has been modified to provide confidence limits on composite indices designated as "ratio-to-reference mean" (RTRM) indices (Alden, 1992). Details of the calculation of the RTRM indices for the Ambient Toxicity Program are presented in the Year 3 report (Hall et al., 1994).

In order to make the RTRM indices more meaningful to managers, a method was developed to scale the values, so that they range between a "best case" (uncontaminated) condition, represented by a score of 0 and a "worst case" (highly contaminated and toxic) condition, represented by a score of 100. A value of 0 would represent the median response of a reference test of uncontaminated water or sediment, while a value of 100 would represent a condition producing the maximum detrimental responses in all of the endpoints (e.g. no growth, reproduction, or survival of all test populations). Not only does this sort of scaling provide a "frame of reference" to address the question of "how bad is this site?", but it allows scores of RTRM indices from different years (which may have had different numbers of endpoints) to be evaluated on the same scale. This well-defined scaling system is much more readily interpreted than the sediment quality triad RTR values or the RTRM indices, which have a reference value of 1, but have an open-ended scale for toxic conditions, the maximum value of which depends upon the number of endpoints, the magnitude of the test responses, and the reference response values used in the calculations.

The scaled RTRM index, hereafter designated as "toxicity index" or TOX-INDEX, was calculated as follows. The RTRM values and confidence limits were calculated as in previous years (Hall et al., 1994). The reference median for any given site was subtracted from all reference and test values (medians, lower and upper confidence limits). This step scales the reference median to 0. The values are then divided by a "worst case" constant for each test data set. This "worst case" constant is calculated by taking the test data set and setting the values to the maximum detrimental responses for each endpoint (e.g. no survival, growth, reproduction, hatching of eggs, etc.), calculating the RTRM values for these "worst case" conditions by dividing by the appropriate reference means (i.e.,for the sediment data set, each sample was matched to the reference data set that most closely matched the sediment characteristics) and calculating the "worst case" constant as the mean of RTRM values for all endpoints. The division by the "worst case" constant makes all values (medians and confidence limits) a fraction of the "worst case" condition. The TOX-INDEX values are converted to a percentage scale by multiplying by 100. The TOX-INDEX medians and confidence limits for test and reference conditions of each site are plotted on maps of the Bay to indicate the relative toxicity of various geographic locations. For graphical purposes, the lower confidence limits of the reference data are not shown, unless the test confidence limits overlap those of the reference conditions (i.e. a portion of the confidence limits for both the test and reference conditions are less than zero).

In order to provide more information to the TOX-INDEX maps, pie charts are included to indicate the relative percentage of endpoints that were shown to be different between the test and reference data sets in the RTRM simulations. Therefore, a highly toxic site would not only be shown to have high TOX-INDEX values which display a low degree of uncertainty (i.e., to have narrow confidence bands that are well separated from reference conditions), but it would also be shown to have a high percentage of endpoints that were adversely affected by the toxic conditions.

This type of presentation should provide managers with a tool to evaluate the relative ecological risk of the sites in comparison to each other and aid in targeting mitigation efforts on a spatial scale. A site with TOX-INDEX confidence limits that overlap those of a reference site, and which displays few statistically significant endpoints, would be expected to pose little ecological risk with respect to ambient toxicity. On the other hand, a site displaying a large TOX-INDEX value, with confidence limits that are well separated for the reference condition and with many significantly impacted endpoints would be expected to pose a much greater ecological risk. The ecological significance of toxicity at sites with intermediate TOX-INDEX scores would have to be interpreted through the best professional judgement of scientists and managers, although the relative magnitude of the values does provide information on the relative degree of toxicity with respect to other sites. Although absolute ecological risk assessments would require much more intensive biological evaluations of long-term population and community level effects, TOX-INDEX provides a screening system that indicates the relative ranking by which regions can be prioritized for management actions related to toxicity. Thus, the maps provide quantitative indications of the magnitude, certainty and consistency of toxic effects.

The site location symbols in the TOX-INDEX maps indicate the degree to which water or sediment benchmarks (water quality criteria or ER-M values, respectively) were exceeded. Thus, the maps also display the qualitative degree of chemical contamination.

3.5 Fish Index of Biotic Integrity

3.5.1 Data Collection

Each site was sampled monthly for fish assemblages during the summer index period (July, August, and September, 1996). This period reflects the time of greatest fish species diversity and abundance in the Chesapeake Bay due to the function of the estuary as spawning and nursery habitat for anadromous, marine, and estuarine resident species. The summer period also represents the time when adverse environmental effects are most evident.

Sites were sampled inshore using a 30.5m X 1.2m beach seine with 6.4mm mesh. The seine was pulled with the tide employing the quarter sweep method where one end of the seine is held on shore while the other end is extended fully perpendicular to shore and then pulled in an arc to the beach. Two seine hauls were conducted at each site with a 30 minute interval between to allow for repopulation of the seine area. Fish from the first seine haul were held and released after completion of the second seine haul. Fish collected on the second pass were also released after processing.

In the channel adjacent to the seine area, fish were sampled using a 3.1m otter or box trawl with 12.8mm stretch mesh and 50.8cm by 25.4cm doors. A single trawl was towed with the tide at two knots for five minutes.

All fish captured in the seines and trawls were identified to species, counted, and minimum and maximum lengths recorded for each species. Age was recorded for game species and species of commercial importance. Scales were collected for these species when age determinations could not be made in the field. When field identification was not possible, specimens were retained for later laboratory evaluation.

Water temperature, pH, dissolved oxygen, conductivity, and salinity were measured with a Hydrolab Surveyor III at each site. Measurements were taken in the channel near each trawl site at bottom, mid-water and surface depths. Water clarity was measured with a Secchi disc at each site. Detailed sampling methods are described in Carmichael et al., 1992a.

Fish catch data and water quality data were recorded in the field on standardized data sheets. All data sheets were verified in the field prior to leaving a site. These sheets were again proofed in the laboratory for errors and omissions. Data were keypunched into ASCII files, then compared to the original field data sheets to locate any data entry errors. Corrected data files were then converted to PC-SAS data sets. Data were proofed again using a computerized quality control program designed for the project. Finalized data sets were created for analysis and computation of IBI metrics.

3.5.2 Index of Biotic Integrity Calculations

Data for each site were summed for the entire summer season. Data were prepared using a program which assigns spawning location, feeding strategy, and area of residence (freshwater, estuarine or marine species) for each species (Table 3.2). These assignments were made based on the adult life stages of each species. This information was derived from the scientific literature (best professional judgement was used when literature information was not available).

IBI metrics were calculated by site. Nine metrics were used to calculate the IBI score. The metrics were divided into three categories: *Richness Measures* - total number of species, number of species captured in the bottom trawl, number of species comprising 90% of the catch; *Abundance Measures* - number of anadromous fish, number of estuarine fish, total number of fish with menhaden removed; *Trophic Measures* - proportion of planktivores, proportion of carnivores, proportion of benthivores. Abundance and proportion metrics were then normally transformed. Normally transformed metrics were ranked into thirds and assigned a value of 5, 3, or 1. All metrics in the upper third were given a 5, middle third a 3, and lower third a 1. Planktivores were ranked in reverse because increasing trends in abundance are qualitatively associated with increases in pollutant loadings (Vaas and Jordan, 1990).. The individual ranks were then summed to give a total for each site. This total represents the IBI score. Where salinity effects were observed (through correlation analysis), the residuals were ranked following the same procedure. A more detailed description is presented in Carmichael et al., 1992b.

3.5.3 Establishing Reference Conditions

Reference IBI conditions were established based on examining numerous years of data existing for the Wicomico River. The 95% confidence intervals about the mean IBI score for the Wicomico River were calculated. The lower limit of the 95% confidence interval (IBI score of 31) was identified as the cut off point for reference systems (any value below this is not meeting the reference standard).

3.5.4 Trawl Index

A trawl index was calculated for each station. The index was derived by calculating the mean rank of the monthly bottom trawl richness measures for each station. The mean ranks were then assigned a narrative rating of good (mean rank greater than 3.4), fair (mean rank between 1.7 and 3.4), and poor (mean rank less than 1.7).

3.5.5 Water Quality

The seasonal mean values for select water quality parameters were examined for each site. For the purposes of this report, dissolved oxygen (DO) was examined in terms of the Chesapeake Bay Program (CBP) dissolved oxygen restoration goal (Jordan et al., 1992). Specifically, dissolved oxygen concentrations greater than or equal to 5.0 mg/L above the pycnocline, and 3.0 mg/L below the pycnocline were adequate concentrations for sustaining aquatic life. Any concentration reported in violation of these restrictions was considered to be stressful to most aquatic life processes. Secchi depth was also examined and compared to Submerged Aquatic Vegetation (SAV) habitat requirements.

3.6 Benthic Index of Biotic Integrity

3.6.1 Data Collection

Benthic infauna samples were collected during the summer of 1996 using a Young bottom grab sampler. Three grabs were taken at each Long Term Benthic (LTB) monitoring site. A single grab was taken at the auxiliary sites. Samples were sieved in the field, through a 0.5-mm sieve. Samples were stained in rose bengal and preserved in 10% buffered formalin for laboratory identification. The samples were processed in the laboratory, and all organisms were identified to the lowest possible taxonomic level. Most organisms were identified to the species level with the exception of polychaete worms and other organisms whose identifications were too labor intensive to determine the species level.

3.6.2 Benthic Index of Biotic Integrity Calculations

Individual metrics were calculated for each site, with the metrics varying depending on habitat parameters. Metrics used in the low mesohaline areas include the Shannon-Weiner diversity index, the total abundance, biomass, abundance of pollution indicative taxa (expressed as a percentage), biomass of pollution-sensitive taxa (expressed as a percentage), and biomass greater than 5 cm below the sediment-water interface (expressed as a percentage). A detailed description of metric and metric development is presented in Weisburg et al. (1997). Metrics scores were evaluated against established scoring criteria to determine the rank of the metric. The mean of these rank scores was then determined. This mean rank score represented the B-IBI score for the site. B-IBI scores are expressed numerically and in terms of Chesapeake Bay Program Restoration Goals (Ranasinghe et al., 1997).

SECTION 4

RESULTS

4.1 Water Column Tests

The following results from water column tests are presented below: toxicity data, contaminants data, water quality data and toxicity data from reference toxicant tests.

4.1.1 Toxicity Data

Survival, growth, reproduction and percent normal shell development from the three estuarine tests conducted from 10/1/96 to 10/09/96 are presented in Tables 4.1 to 4.4. Based on univariate analysis, sheepshead minnow survival was not reduced at any of the stations; however, reduced growth was reported three Chester River sites (CH2, CH4 and CH5) (Tables 4.1 and 4.2). The percent normal shell development of the Coot clam was reduced at all four Chester River sites during both 48 h tests (Table 4.3). Reduced shell development was not reported during the first test at the Patuxent River sites but significant effects were found at all four sites during the second test. Survival of *Eurytemora* was not significantly different than the controls for any of the eight stations. However, survival ranging from 11 to 36 % was reported for two Chester River sites (CH4 and CH5) and two Patuxent River sites (PCP and PBR). The high variability among the replicates for the various test conditions resulted in little power to detect differences. Mean percent gravid females and mean percent immatures were not significantly reduced at any of the ambient conditions when compared with the controls (Table 4.4).

4.1.2 Contaminants Data

Inorganic contaminants data from the eight stations are presented in Table 4.5. All metal concentrations were generally low. The only metal concentration to exceed the marine chronic water quality criteria was a copper concentration of 4.68 ug/L at CH4.

4.1.3 Water Quality Data

Water quality parameters reported from grab samples collected three times at all stations are presented in Table 4.6. These ambient water quality conditions appeared adequate for survival of test species. Water quality conditions reported in test containers during testing are reported in Appendix B. All parameters appeared adequate for survival of test species.

4.1.4 Reference Toxicant Data

Forty-eight hour LC or EC50 values for the three test species exposed to cadmium chloride during reference toxicant tests are presented in Table 4.7. These toxicity values were compared with the values from the previous five years for all species except the coot clam, where only three years of data were available. The LC50 for Eurytemora (0.126 mg/L) is within the range reported during the first five years. The EC50 for the Coot clam (0.04 mg/L) is also within the range reported during years 3-5. The Sheepshead minnow LC50 (2.3 mg/L) is approximately 0.8 mg/L higher than the highest value reported in the first five years of testing. However, this value is still within an acceptable range (within a factor of 3). The reference toxicant data in Table 4.7 demonstrates that the test species from the various sources are healthy and the ambient toxicity data were valid.

4.2 Sediment Tests

The following results from sediment toxicity tests are presented below: toxicity data, sediment chemistry data and data from reference toxicant tests.

4.2.1 Toxicity Data

Survival data from sediment toxicity tests conducted with the four test species at the eight station are presented in Tables 4.8 through 4.11. For species that were affected by the percent sand, silt and clay in the sediment, predicted mortalities were adjusted using the results of particle size analysis performed on all replicates for each test site. Results of the particle size analysis in Table 4.12 showed large variation in particle size/ composition of the test sediments both within and between sites. For the 20 day tests, mean control survival for all species was greater than 90% at day 10 and greater than 77% at day 20. The overall mean survival for the *C. variegatus* egg test was 94% in control sediment (Lynnhaven mud) (Table 4.8). Statistical differences were reported for *C. variegatus* survival endpoints in sediment collected from CH-5 and CH-6 (upstream Chester River stations). Percent survival and percent dead fish were also significantly different from controls in Poropotank mud (*C. variegatus* reference mud).

Particle size adjusted *L. dytiscus* survival was significantly different from controls in CH-2, CH-4 and CH-5 (Chester River sediments), PBR (Patuxent River - Broomes Island) and Poropotank River reference sediment (Table 4.9). There were no significant differences in adjusted *L. dytiscus* survival at day 20 for any sites. *Leptocheirus plumulosus* survival was not significantly different from the control sediment in any of the test or reference sites at day 10 but significant differences were reported for all sites and the reference on day 20 (Table 4.10). Particle size adjusted *S. benedicti* survival at all sites was not significantly different from controls at either day 10 or 20 (Table 4.11).

Results from analysis of growth data for *L. dytiscus*, *L. plumulosus* and *S. benedicti* are presented in Tables 4.13 to 4.15. Growth for *L. dytiscus* (both weight and length) in any of the ambient sediments was not significantly different than the controls (Table 4.13). Length of *L. plumulosus* was not significantly different at any of the ambient sites when compared with the controls (Table 4.14). However, weight was significantly different at all sites. *Streblospio benedicti* weight and length were significantly different from controls in Lynnhaven sand (reference sediment); length was also significantly different in sediment from CH-5 (Table 4.15).

4.2.2 Contaminants Data

Toxicity of chemicals in sediments is determined by the extent to which chemicals bind to the sediments. There are many factors that influence the binding capabilities of a particular sediment. The toxicity of non-ionic organic chemicals is related to the organic content of the sediments, and it appears that the bioavailability of sediment-associated metals is related to the concentration of Acid Volatile Sulfides (AVS) present (DiToro, 1990). Sediment samples from the eight stations and the controls were analyzed for Total Organic Carbon (TOC) and Acid Volatile Sulfides (AVS). The results are shown in Tables 4.16 and 4.17. At present, there is no readily accessible data base for comparison of TOC normalized data, therefore the TOC analysis from this study was included to allow for future comparisons. Percentage TOC (dry weight) ranged from 0.08 for Lynnhaven sand to 5.60 for Poropotank mud. The AVS approach to sediment contaminants evaluation has been published by DiToro (1990). To appropriately interpret the AVS data, simultaneously extractable metals (SEM) must also be analyzed. The data for SEM are presented in Table 4.18. In evaluating the AVS values, a ratio of the sum of the SEM to the total AVS is calculated. If the ratio is greater than one (1), toxicity is predicted. It should be noted however, that if the total concentration of metals is very low, toxic effects may not be observed. If the SEM:AVS ratio produces a value less than one, it is assumed that there is sufficient AVS present in the sediment to bind with the metals, rendering them non-bioavailable and non-toxic. Evaluation of the SEM to AVS ratio is included in Table 4.17. All Chester and Patuxent River stations had ratios much less than one (range of 0.074 to 0.209), therefore toxicity due to metals would be unlikely. Inorganic contaminants data from the eight stations are presented in Table 4.19 with toxicity benchmark concentrations. Sediment-sorbed contaminants have been extensively studied by Long and Morgan (1990) and Long et. al. (1995). These studies have established tables of concentrations at which biological effects would be expected if these contaminants were present in the sediment. The lower ten percentile of data for which biological effects were observed was established as the "Effects Range-Low" (ER-L). The median concentrations for which biological effects were observed were identified as the "Effects Range-Median" (ER-M). Long et. al. (1995) indicate that the ER-L and ER-M values can be used for comparisons between sites. The concentrations of toxicants in the sediments of the sites are compared with the ER-L or ER-M values, which are used simply as "benchmarks" for the relative degree of contamination. Those contaminants with concentrations exceeding the ER-L fall into a category that Long et. al. (1995) consider to be the "possible" effects range for toxic effects. Contaminant concentrations above the ER-M fall in the category of "probable" toxic effects. Of course, many biogeochemical factors influence biological availability of contaminants in sediments, so comparisons of "bulk" chemical concentrations against these benchmark values represent rough attempts at ranking the relative potential of various sediments for toxicity. These comparisons are believed to be overly conservative in many cases, so theoretically-based approaches such as the SEM/AVS method described above should be given more weight in the interpretation of the data.

All test sites had concentrations above the detection limits for the eleven metals analyzed (Table 4.19). All metal concentrations at two Patuxent River stations (PBR and PJB) were below the ER-L values. The ER-L values for six metals (As, Cd, Cr, Pb, Ni and Zn) were exceeded at the Patuxent River - PCP station. The ER-Ls for five metals were exceeded at the Patuxent River-PBZ station (As, Cr, Pb, Ni and Zn). The ER-L values for arsenic and nickel were exceeded at all Chester River stations. For the Chester River (CH-5) station, five metals exceeded the ER-L values (As, Pb, Hg, Ni, and Zn). This was the only ambient site where mercury exceeded the ER-L value. The ER-L values for two to four metals were exceeded at the other Chester River sites. ER-L values were not exceeded at the Lynnhaven site and only two metals exceeded the ER-L at the Poropotank site.

The results of pesticides and semi-volatile organic compound analyses in sediment samples are presented in Appendix A. Dieldrin, an extremely persistent insecticide used on corn and for termite control, was found in all sediments. The range for the eight ambient sites was 0.67 to 3.6 ug/kg. Concentrations in the Chester River were somewhat higher than the Patuxent River. Presently, there are no ER-L values for sediment that can be used for comparison. DDT was detected above the ER-L value of 1.58 ug/kg (Long et al., 1995) in sediment from all sites except the Poropotank mud. Concentrations of DDT were higher at Chester River sites when compared to the Patuxent River. The DDT ER-M of 46.1 ug/kg was exceeded at the CH-6 site (63 ug/kg). DDD was reported at all Chester River sites except CH-6. DDD was below the detection limit for two Patuxent River sites

(PJB and PBR) and below 1.0 ug/kg for the other two Patuxent River sites. DDE was reported above the detection limit for all sites. The highest concentration from the eight ambient sites was reported from Chester River CH-6. The ER-L value of 2.2 ug/kg reported by Long et al. (1995) was exceeded at CH-6 (5.1 ug/kg), CH-4 (2.3 ug/kg) and PCP (3.0 ug/kg). Polynuclear Aromatic Hydrocarbons (PAHs) were not detected at any of the sites.

Sediment pore water was analyzed for sulfide, ammonia, and nitrite at all stations and the controls (Table 4.20). Ammonia concentrations were converted to percent unionized ammonia (toxic form). Unionized ammonia was generally higher for Patuxent River sites (PBR = 1.7 mg/L; PJB = 1.2 mg/L) than for the Chester River sites (< 0.50 mg/L). Nitrate concentrations ranged from 0.0011 to 0.0053 mg/L for the eight sites with no apparent differences between the two rivers. Sulfide concentrations ranged from 0.0003 to 0.0528 mg/L for the ambient sites with both the low and high value reported in the Chester River.

4.2.3 Reference Toxicant Data

The relative sensitivities of each set of test organisms were evaluated with cadmium chloride ($CdCl_2$) reference toxicant tests. The results of each reference toxicant test conducted with each batch of amphipods, worms and Sheepshead minnows are shown in Table 4.21. All test LC50's were within the range of the previous reference toxicant tests conducted.

4.3 Fish Index of Biotic Integrity

4.3.1 Fish Community

A summary of the fish data for all sites combined showed that 46,486 individuals representing 35 species were captured (Appendix C). White perch, Atlantic silversides and striped bass were the most dominant species, as collectively these three species represented 93% of the total catch.

A summary of the individual metric values for each site are presented in Table 4.22. The Chester River stations had fewer individuals per site than the Patuxent River, with the lowest abundance at station CH6. Abundance measures were greater for the Patuxent than the Chester River. The number of species was similar among the Chester River stations. However, species richness measures (number of species that comprise 90% of the catch) were somewhat variable with the highest richness at station CH6. Number of species varied in the Patuxent River ranging from 13 to 20. Richness measures such as the number of species comprising 90% of the catch were fairly low in the Patuxent. This is attributed to the large number of white perch, Atlantic silversides and striped bass that dominated the catch (see Appendix C).The number of species in the bottom trawl were similar between the rivers, but the Patuxent showed the best metric score (station PB2) for this measure. The trophic measures, showed variation among stations. The extreme was station PCP which showed a strong dominance of carnivores (94% of catch).

Patuxent River stations ,except PJB, had IBI scores determined from seining that were equal to or exceeded the reference condition of 31 (Table 4.23). In contrast, all the Chester River IBI scores were below the reference condition. The trawl index scores were less consistent as there were two stations that rated fair and two stations that rated poor in each river (Table 4.24).

4.3.2 Water Quality

Dissolved oxygen at all stations met the requirements recommended by the U. S. Envrionmental Protection Agency's Chesapeake Bay Program Office (Table 4.25). The mean dissolved oxygen value was greater than 5.0 mg/L above the pycnocline at all stations and the bottom values were greater than 3.0 mg/L. Secchi depth measurements were below the criteria for SAV recovery (0.97 m) at all sites except the Patuxent River PBR site (Table 4.26).

4.4 Benthic Index of Biotic Integrity

Abundance of benthic species by station is presented in Appendix D. The number of benthic species collected at the four Patuxent River stations ranged from 7 to 20 species. The most dominant species were the polychaete, *Streblospio benedicti*, the clam, *Macoma balthica* and the oligochaete *Tubificoides spp*. The number of benthic species collected at the four Chester River stations ranged from 11 to 24 species. The most dominant species in this river were the oligochaete, *Tubificoides spp*., the polychaete, *Polydora cornuta* and the snail, *Littoridinops tenuipes*.

The B-IBI scores for the Patuxent River ranged from 2.0 (severely degraded at PBR) to 3.8 (meets restoration goals at PBZ) (Table 4.27). Benthic communities in the Chester River appeared to be in better condition as the IBI scores for all sites fell within the range for meeting the restoration goals. Scores in the Chester River ranged from 3.4 to 4.6.

SECTION 5

DISCUSSION

5.1 Patuxent River

The water column/sediment toxicity data, water column/sediment contaminants data and the community metric data for fish and benthos (IBI calculations) presented in this report allows a cumulative "weight of evidence approach" for assessing the condition of each respective river (Table 5.1). The water column toxicity data from all Patuxent river sites generally showed minimal toxicity (from univariate analysis) as the only significant effects were reported from the second coot clam test at all sites. However, the multivariate analysis using all endpoints showed toxicity at the Broomes Island station and a lower level of toxicity at Buzzard Island (see Section 6.1). The link between inorganic contaminants and biological effects is weak since concentrations of metals in the water column from all four Patuxent River sites were very low.

Sediment toxicity data for the Patuxent River sites showed that *L. plumulosus* survival and weight gain were significantly reduced at all four sites when compared with the controls. In addition, *L. dytiscus* survival was also reduced at the Brooms Island site (PBR). Results from multivariate sediment analysis showed that the Buzzard Island station had the highest level of toxicity in the Patuxent River using all endpoints (see Section 6.2). Dieldrin and DDT (exceeding ER-L values) were detected at all sites, and may have contributed to some of the observed mortalities and reduction in growth for the amphipod tests species. A concentration gradient of total DDT was observed to increase from 3.1 ug/kg downriver to 39 ug/kg at the upriver station. Metals were detected at concentrations above the ER-L only in sediments from Chalk Point (PCP) and Buzzard Island (PBZ), which were the two upstream stations. Based on SEM/AVS calculations it is unlikely that any of the metals measured in this system would be bioavailable to cause toxicity.

The status of biological communities at the four sample sites in the Patuxent River provides additional information for determining the condition of this aquatic system. Patuxent River fish IBI scores suggested that the fish community is generally healthy with the possible exception of Station PJB (Jack Bay). The trawl index score which is a measure of diversity in deeper water shows somewhat depressed scores at PJB and PBZ when compared with the reference condition. However, the trawl index scores at the other two sites were reported to be fair.

Based on the B-IBI values, the benthos seem to be responding somewhat differently to the ambient conditions of the Patuxent River, than the fish. The benthic community is degraded or severely degraded at the upper and lower stations, and within the reference condition at the middle two stations. The difference in responses between the two biological communities could be attributed to temporal scales, or stressor types. Fish are mobile, and can move from an area that is temporarily stressed (i.e. episodic hypoxia events) and quickly repopulate the area when the stressed is relieved. Because benthos are not mobile, they may suffer community disturbance after repeated episodic events. It is also quite possible that the different biological communities are responding to different stressors. The fish are influenced by large scale water quality effects. The benthos are subject to smaller scale disturbances, of water and sediment quality. Fish and benthos also respond differently to soluble versus non-soluble contaminants. Fish are more likely to be stressed by contaminants that are water soluble and can be accumulated from the water. In contrast, benthos are more likely to be impacted by sediment bound (non water soluble) contaminants. Another factor that should also be considered with these somewhat different results is the predatory actions of the fish community on the benthos. The areas where the fish community appeared unstressed are areas where the benthic community is depressed. Conversely, stations where the fish community scores are somewhat depressed, the benthic community appears to be healthy. Lack of agreement between the fish and benthic IBI data, does not detract from the use of these data in determining some degree of biological impairment for at least two sites in the Patuxent River. Similar results have been reported by other investigators. For example, Yoder and Rankin (1994) have reported a larger percentage of disagreement than agreement between fish and benthic IBI data for large freshwater river systems in the State of Ohio.

A final analysis of the toxicity and community metric data shows that the water column toxicity data (multivariate analysis) and the benthic B-IBI data suggest toxicity/biological impairment at the Broomes Island station (Table 5.1). The sediment toxicity data (multivariate analysis) and the fish trawl index score also suggest some, but lower, toxicity/biological impairment at the Buzzard Island station.

5.2 Chester River

A discussion of the Chester River "weight of evidence" for assessing water column/sediment toxicity data, water column/sediment contaminants data, and community metric data for fish and benthos is presented below (see Table 5.1). Results from water column toxicity tests showed that normal shell development of the coot clam and was significantly reduced at all four Chester River sites. Growth of sheepshead minnows was also reduced at all sites except CH-6. Results from multivariate analysis also suggest low to high relative levels of toxicity at three Chester River stations (all except CH-6). Collectively, these data suggest that the water in this river caused some toxicity to the test species. A copper concentration of 4.68 ug/L ,which exceeded the marine chronic water quality criteria, was also reported at CH-4.

Sediment toxicity was reported for three to five endpoints for all Chester River sites. Highest toxicity from univariate analysis was reported for CH-5 as the following endpoints were significantly different than the reference: Sheepshead minnow egg hatching and larval survival, *L. plumulosus* survival and weight and *L. dytiscus* survival. The next highest total toxicity was reported at CH-6 as all the endpoints described above for CH-5 were significantly different than the reference except *L. dytiscus* survival. For both CH-2 and CH-4, *L. plumulosus* survival and weight and *L. dytiscus* survival were significantly lower than the reference. Sediment toxicity results from univariate analysis agree with the above data, as a relatively high level of toxicity was reported at CH-5 and CH-6 and low to moderate toxicity was reported at CH-2 and CH-4. Dieldrin and DDT (exceeding ER-L values at all sites and the ER-M at CH-6) were detected at all four stations and may have contributed to some of the biological effects. DDT concentrations followed a gradient decreasing downstream (63 to 4.3 ug/kg). Five different metals exceeded the ER-L values in the Chester River sites but in all cases the SEM/AVS ratio was very low indicating that metal toxicity was unlikely.

The Chester River fish IBI did not meet reference standards at any of the stations tested. Unlike the Patuxent River, no gradient effect is obvious with the IBI scores. The station in the vicinity of Chestertown (CH-6) appears to be the most severely impacted, with some apparent recovery at station CH-5. The degraded condition of station CH-6 could possibly accentuate the community at station CH-5. The upper station may remain consistently poor, forcing the fish to seek habitat up and down stream away from this area. In a recent study on the Chester River, stations located above and below Chestertown (CH-6) showed recovery in the fish community along with elevated metals concentrations and the presence of Simazine in sediments (Margaret McGinty, personal communication).

The trawl index scores provide somewhat different results than the IBI scores based on seining. These index scores seem to show a gradient effect similar to the Patuxent River, where the scores generally declined at the down stream stations. It is difficult to attribute this to a large scale water quality effect. For example, dissolved oxygen data do not indicate any significant perturbations, yet the Secchi depths do not meet the established goals for restoration. These data could imply that the impacts are more recent thus the shifts in the biological communities are recent. It could also imply that the large scale stressors and stressor patterns differ in the Chester River (a large agricultural dominated system) from those in the Patuxent (a large urban/forest dominated system).

The benthic community assessments for the Chester River showed that all of the stations met the expected conditions. The lowest scores were reported at the middle river stations. These data are in contrast to previously reported benthic assessments in the Chester River where all station tested failed to meet the restoration goals (Ranasinghe et al., 1994). As previously reported for the Patuxent River, the benthic and fish IBI data are not in full agreement. It is possible that local physical habitat disturbances (i.e., loss of SAV and structural habitat, shoreline erosion, etc.) are influencing the structure of the fish community at the study stations but are not impacting the benthos. The conflicting results between the benthos and fish could also suggest that these biological communities are responding to different types of stressors due to either mobile (fish) or sedentary life styles (benthos) or solubility of contaminants. Fish are more likely impacted by water soluble contaminants while benthos are more likely impacted by sediment bound contaminants with low water solubility. As discussed in Section 5.1 for the Patuxent River, the lack of agreement between the benthic and fish IBI data does not detract from the value of these data for determining the status of specific biological communities. In this case, the fish communities appear to be somewhat impaired in the Chester River.

In summary, water column toxicity data, sediment toxicity data and the fish IBI data suggest that various Chester River stations have a moderate to high range of relative toxicity and or impairment of biological communities (Table 5.1). With the exception of the benthic IBI data, this represents fairly consistent agreement among the results from the various types of data used for assessing toxicity/biological impairment in this Chesapeake Bay eastern shore river.

SECTION 6

ANALYSIS OF SIX YEAR DATA BASE

6.1 Water Column Toxicity

The results of Toxicity Index calculations for water column toxicity for the 1990, 1991, 1992-93, 1994, 1995, and 1996 experiments are summarized in Figures 6.1, 6.2, 6.3, 6.4, 6.5, and 6.6, respectively. The species tested and the number of endpoints used varied slightly from year to year. Therefore, comparisons of index values within the figures for same year are more comparable than those of different years. The Toxicity Index calculations were generated for each station and year from concurrent reference (control value) and test conditions and therefore they provide interpretation on the relative magnitude of the toxic response of the various sites. This analysis also provided a degree of confidence that could be given to differences between reference and test values. A summary of comparison of Toxicity Index values for reference (control) and test sites is presented in Table 6.1.

The Toxicity Index analysis for the 1990 data in Figure 6.1 showed that the Elizabeth River was clearly the most toxic site tested as the median for the index of the test condition was clearly greater than the reference (control). The confidence limits for the reference and test condition did not overlap at this location. Nearly half of the endpoints displayed significant differences between the reference and test conditions. The results from the Elizabeth River are not surprising since significant mortality was observed in two of the three tests that were conducted. The second most toxic station identified with the Toxicity Index analysis was the Patapsco River, for which significant mortality was reported in one out of three tests. However, the confidence interval was fairly wide (indicating variability) for this station and there was no difference in the median values for the reference and test site. The results from the Indian Head, Freestone Point, Possum Point, Morgantown, Dahlgren and Wye River stations indicated no significant difference, with index values between the reference and test conditions for the 1990 tests. Both Morgantown and Dahlgren stations did show limited biological effects with one of the tests (significant mortality with the sheepshead minnow test). However, these results from the test condition were not significantly different than the reference when all endpoints from all tests were combined for the final index calculations.

The Toxicity Index calculations for the 1991 experiments are presented in Figure 6.2. Four water column tests with two endpoints for each test were used to determine the final values for two testing periods (summer and fall). The Wye River site showed the most significant effects, as significant mortality was reported for two different test species during different testing periods. Although the median values from the reference and test sites were different, there was overlap of confidence limits with these two conditions. A comparison of reference and test index values for the Patapsco River, Morgantown and Dahlgren sites showed no significant differences. However, reduced growth of the sheepshead minnow was reported at both the Morgantown and Dahlgren sites during the summer experiments.

The results from the 1992-93 experiments presented in Figure 6.3 include experiments conducted during the fall (1992) and spring (1993) at each of the 6 sites (2 sites per river). The most toxic sites were reported at both Middle River stations (Wilson Point and Frog Mortar Creek). Results from the coot clam toxicity tests (2 tests per experiment conducted in the fall and spring) showed consistent toxicity at both sites. Although median values were similar for both Middle River sites, the variability at Wilson Point was much greater than at Frog Mortar. Water quality criteria were exceeded at both sites. The results from Toxicity Index analysis at the other 4 sites showed no difference between the reference and the test condition. The only other biological effect reported at any of these 4 sites was significant mortality of E. affinis at the Quarter Creek site during the spring experiments.

The results of the 1994 experiments are presented in Figure 6.4a and 6.4b. The Toxicity Index values from the Severn, Magothy and Sassafras Rivers were quite similar to those of the corresponding references (Fig. 6.4a). However, the confidence limits for all sites in these rivers except South Ferry (Magothy) did not overlap the limits for the reference condition. Thus, the sites displayed statistical differences that appeared to be negligible in an ecological sense. On the other hand, Sparrows Point in Baltimore Harbor displayed significant toxicity (Fig. 6.4b). The Curtis Bay exhibited no toxic effects, while the other Baltimore Harbor sites displayed statistically significant but negligible toxicity.

The results of the 1995 studies are presented in Figure 6.5. The Toxicity Index values for the Lynnhaven River were not significantly different from the reference. In the James River basin, the James River "Above", the James River "Below" and the Willoughby Bay sites displayed Toxicity Index values which were significantly greater than the respective references, but the values for former two sites were only slightly greater than the reference condition in overall magnitude. The York River sites also displayed negligible to low water column toxicity: the Pamunkey "Above" and York River "Below" sites had Toxicity Index values that were not significantly different from the references; the York River "Above" had only a very slight elevation of toxicity above controls; and the Pamunkey "Below" displayed a low to moderate level of toxicity, similar to the magnitude observed for the Willoughby Bay site.

Figure 6.6 presents the results of the 1996 studies, which focused on the Chester and the Patuxent Rivers. The water from all of the sites except Jack Bay in the Patuxent River exhibited significant differences in Toxicity Index values compared to the reference conditions. However, the Broomes Island site in the Patuxent and the CH5 (Skillet Point) site in the Chester River had somewhat higher values. The water from the Chalk Point site in the Patuxent and the CH6 (Scott's Point) site in the Chester River had the lowest levels of toxicity. The values from the remaining sites were intermediate and indicative of moderately low toxicity.

A summary of the six year water column data base using the Toxicity Index analysis (Figure 6.7) indicated the following ranking of toxicity for the various sites:

- the sites (and dates tested) displaying the greatest water column toxicity were as follows:
  - Sparrows Point, Baltimore Harbor (1994)
  - Broomes Island in the Patuxent River (1996)
  - Willoughby Bay (1995)
  - Middle River (1994)
  - Pamunkey River, below West Point in the York River basin (1995)
  - Elizabeth River (1990)
  - Site CH5, Skillet Point in the Chester River (1996)

- the sites that displayed a low to moderate degree of water column toxicity were:
  - Site CH2, Tams Point, in the Chester River (1996)
  - Site CH4, Melton Point, in the Chester River (1996)
  - Buzzard Island in the Patuxent River (1996)
  - James River, above and below Newport News (1995)
  - Manor House site, Wye River (1991)
  - Patapsco River (1990)
  - Gibson Island site in Magothy River (1994)

- the sites (listed geographically, from north to south)
  that displayed water column toxicity that was low in magnitude, but significantly different from reference (control) responses were:
  - Sassafras River (1994)
  - Bear Creek, Middle Branch, Northwest Harbor and Outer Harbor sites in Baltimore Harbor (1994)
  - Site CH6, Scotts Point, in the Chester River (1996)
  - Chalk Point in the Patuxent River (1996)
  - Severn River (1994)
  - York River, above Cheatham Annex (1995)

- the sites that displayed no significant water column toxicity were:
  - Curtis Bay, Baltimore Harbor (1994)
  - South Ferry, Magothy River (1994)
  - Wye River (1990, 1992-3)
  - Jack Bay in the Patuxent River (1996)
  - Bivalve and Sandy Hill Beach sites in the Nanticoke River (1992-3)
  - Dalgren (1990, 1991), Freestone Point (1990), Indian Head (1990), Morgantown (1990, 1991), and Possum Point (1990) sites in the Potomac River
  - Pamunkey River, above West Point (1995)
  - York River, below Cheatham Annex, (1995)
  - Lynnhaven River (1995)

Stations listed as having greatest or low to moderate toxicity are candidates for future assessments. The spatial and temporal scale for water column toxicity testing, number of contaminants measured (based on loading and associated use data) and frequency of contaminant monitoring should be increased at these stations (or adjacent areas) to develop a better understanding of causality.

6.2 Sediment Toxicity

The results of the Toxicity Index calculations for sediment toxicity for the 1990, 1991, 1992-93, 1994, 1995, and 1996 studies are summarized in Figures 6.8, 6.9, 6.10, 6.11, 6.12, and 6.13, respectively. It should be noted that the species and the number of endpoints tested varied slightly from year to year, so comparisons of index values within the figures (within the same year) are more comparable than those between figures. Nonetheless, the comparisons of concurrent reference and test experiments provide insight into the relative magnitude of the toxic responses of the various sites. Table 6.2 summarizes the comparisons presented in Figures 6.8 - 6.13.

During the 1990 study, the Elizabeth River was clearly the most toxic of the sites, since all species displayed nearly complete mortality during the first 10 days of the experiment (i.e., the median for the index for the test data was greatly separated from the median for the reference data, with little variation; Figure 6.8). The Elizabeth River provides an example of the worst case Toxicity Index values. The confidence limits of the test data index values were well separated from those of the corresponding reference sites for a number of other sites: Patapsco River; Wye River; and the Freestone Point, Possum Point and Dahlgren sites on the Potomac River (although the latter two sites displayed a considerable degree of variation in index values). The Indian Head and Morgantown sites on the Potomac River displayed only slight separation between the median index values for the test and reference conditions. Thus, the magnitude of potential toxicity appears to be less for the Indian Head and Morgantown sites than for the others. It should be noted, however, that all sites selected for the first year of the study were those considered "suspect" due to the results of previous studies, so it is not surprising that most displayed significant deviations from the reference conditions.

The 1991 study involved an assessment of the effects of short-term temporal variability (a summer versus a fall collection) on the apparent toxicity of sediments from four sites. The separation between test and reference treatments was greatest for the Patapsco River site, with less separation being displayed for Dahlgren, Morgantown, and the Wye (Figure 6.9). The results of the Patapsco River index comparison were remarkably similar to those observed for the 1990 study. The Dahlgren site index values, which were quite variable in the 1990 study, were still separated from the reference values in the 1991 study. The small degree of separation observed between the Morgantown index limits and reference limits in 1990 was also observed for 1991. The Wye River index limits were only slightly separated from the reference limits due to the fact that only one of the two sets of experiments displayed significant differences between test and control treatments. This slight variability in responses could be due to temporal variation in toxicity, but is more likely due to small scale spatial heterogeneity (i.e., sediments were taken from the same general station, but there may have been patchiness in sediment quality in the grabs composited for the two sets of tests). Overall, the degree of variability observed in the Toxicity Index limits for the combination of the two sampling events was quite small for all four sites. The patterns were remarkably consistent with those observed at these same sites during the previous year.

The 1992-93 study also involved two sampling periods during the Fall and Spring. The test and reference Toxicity Index limits overlapped for all of the sites selected for testing (Figure 6.10). Thus, the sites in the Middle River (Frog Mortar and Wilson Point), the Wye River (Quarter Creek and Manor House), and the Nanticoke River (Sandy Hill Beach and Bivalve) appeared to contain sediment displaying little or no overall toxicity compared to reference conditions. It should be noted, however, that the Frog Mortar sediments were quite heterogenous in character and they displayed somewhat elevated metals in the composite samples (see Hall *et al.*, 1993). Therefore, there may be patches of contaminated sediments at this site, which may have produced responses in a few of the field replicates. The purpose of taking true field replicates at two different times during the 1992-93 study was to produce confidence limits to indicate the probability of observing the same sort of response if the site were sampled again, so the observed variability provides insight into the variation in sediment quality expected for this site.

The results of the 1992-3 studies on the two Wye River sites (Quarter Creek and Manor House) displayed little difference from the reference conditions, which is in contrast to the apparent toxicity observed in 1990 and one of the sampling period of the 1991 study. The Wye River Manor House site was sampled during the first four years of testing.

The 1994 studies focused upon the Sassafras River, the Annapolis region, and the Baltimore Harbor/Patapsco River (Fig. 6.11a and 6.11b). The Sassafras River sites displayed no sediment toxicity (Fig. 6.11a). The Magothy River sites exhibited slight to moderate toxicity, particularly for the South Ferry site, which was highly variable (Fig. 6.11a). The Annapolis site on the Severn River also displayed significant but moderately low toxicity. On the other hand, the Toxicity Index limits from the Severn River site at the Route 50 bridge overlapped those of the reference site. The Baltimore Harbor sites showed various degrees of toxicity from slight (Outer Harbor) to quite high (Bear Creek and Northwest Harbor), with most displaying moderate toxicity (Sparrow Point, Middle Branch and Curtis Bay; Fig. 6.11b). All Baltimore Harbor sites contained sediments that exceeded ER-M values for 3 or more contaminants.

The 1995 studies focused on sites in the James River and York River basins and a site in the Lynnhaven River (Fig. 6.12). The Toxicity Index was elevated for the Willoughby Bay site, which is located near the mouth of the James River and in the vicinity of heavy military, residential, and marina activities. The James River site below Newport News displayed Toxicity Index values that were also significantly elevated relative to the reference, but the degree of toxicity was lower than for the Willoughby site. None of the other sites displayed overall significance in the Toxicity Index comparisons to references, although the Lynnhaven site was the only one to display no significant endpoints in the univariate comparison of confidence limits.

The 1996 studies focused on the Chester and the Patuxent Rivers (Figure 6.13). All sites in the Chester River displayed some degree of toxicity. The CH2 (Tams Point) and CH4 (Melton Point) sites in the Chester River had sediments that produced a low to moderate level of toxicity, while sediments from the CH5 (Skillet Point) and CH6 (Scotts Point) sites were associated with a higher degree of toxicity. The magnitude of toxicity displayed by sediments from the latter two sites was of the same overall magnitude as that observed during earlier studies for the South Ferry site in the Magothy River and two of the sites (Possum Point and Dahlgren) in the Potomac River (see below). In contrast, sediments from the Patuxent River were, for the most part, not significantly toxic. While the median toxicity index values (5-10 on the toxicity index scale) for the Patuxent River sites were somewhat higher than for the reference condition, variation in results made these differences not statistically significant except for the Buzzard Island site. The Buzzard Island site displayed a moderately low level of toxicity that was statistically greater than the reference condition.

A summary of the six year sediment data base using the Toxicity Index analysis (Figure 6.14) indicated the following ranking of toxicity for the various sites:

- the sites (and dates tested) displaying the greatest sediment toxicity were as follows:
    - Elizabeth River (1990)
    - Northwest Harbor, Bear Creek, Sparrows Point, Curtis Bay, and Middle Branch sites in Baltimore Harbor (1994)
    - Willoughby Bay site in James River basin (1995)
    - Sites CH5, Skillet Point, and CH6, Scotts Point, in the Chester River (1996)

- South Ferry site in the Magothy River (1994)
- Possum Point and Dahlgren sites in the Potomac River (1990)

• the sites that displayed a low to moderate degree of sediment toxicity were:

- Patapsco River sites (1990, 1991)
- Freestone Point (1990) and Dahlgren (1991) sites in the Potomac River
- Site CH2, Tams Point, in the Chester River (1996)
- Annapolis site in the Severn River (1994)
- Manor House site, Wye River (1991)
- Site CH4, Melton Point, in the Chester River (1996)
- James River site, below Newport News (1995)
- Buzzard Island site in the Patuxent River (1996)
- Outer Harbor site, Baltimore Harbor (1994)

• the sites (listed geographically, from north to south) that displayed sediment toxicity that was low in magnitude, but significantly different from reference responses were:

- Gibson Island site in the Magothy River (1994)
- Manor House site, Wye River (1990)
- Morgantown (1990, 1991) and Indian Head (1990) sites in the Potomac River

• the sites (listed geographically, from north to south) that displayed no significant sediment toxicity were:

- Frog Mortar and Wilson Point sites in the Middle River (1992-3)
- Betterton and Turner Creek sites in the Sassafras River (1994)
- Quarter Creek and Manor House sites in Wye River (1992-3)
- Broomes Island, Jack Bay, and Chalk Point sites in the Patuxent River (1996)
- Bivalve and Sandy Hill Beach sites in Nanticoke River (1992-3)
- Pamunkey and York River sites (4 sites) (1995)
- James River site, above Newport News (1995)
- Lynnhaven River site (1995)

Future assessments are recommended for stations that fall into the categories of greatest toxicity or low to moderate toxicity. In order to develop a better understanding of the "cause and effect" relationship, the spatial and temporal scale of testing and the organic and inorganic contaminant measurements (based on loading and usage data for the area) should be expanded.

SECTION 7

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SECTION 8

LIST OF TABLES AND FIGURES

Table 3.1 Analytical methods used for inorganic analysis in water samples. The following abbreviations are used: AE-ICP (Atomic Absorption - Inductively Coupled Plasma), AA-H (Atomic Absorption - Hydride), AA-F (Atomic Absorption - Furnace), AA-DA (Atomic Absorption - Direct Aspiration) and AA-CV (Atomic Absorption - Cold Vapor).

Contaminant	Method	Method #	Reference
Arsenic	AA-H	206.3	U.S. EPA, 1979
Cadmium	AA-F	213.2	U.S. EPA, 1979
Chromium, Total	AA-F	218.2	U.S. EPA, 1979
Copper	AA-F	220.2	U.S. EPA, 1979
Lead	AA-F	239.2	U.S. EPA, 1979
Mercury	AA-CV	245.1	U.S. EPA, 1979
Nickel	AA-F	249.2	U.S. EPA, 1979
Selenium	AA-H	270.3	U.S. EPA, 1979
Zinc	AA-DA	200.7	U.S. EPA, 1979

Table 3.2 Trophic classification, spawning location, and residency of fish captured at the eight sampling locations.

SPECIES NAME	TROPHIC LEVEL	FAMILY	SPAWN LOCATION	RESIDENCY
Alewife *Alosa pseudoharengus*	Planktivore	Clupeidae	Freshwater Anadromous	Non-resident
American shad *Alosa sapidissima*	Planktivore	Clupeidae	Freshwater Anadromous	Non-resident
Atlantic menhaden *Brevoortia tyrannus*	Planktivore	Clupeidae	Marine	Non-resident
Atlantic needlefish *Strongylura marina*	Carnivore	Belonidae	Marine	Non-resident
Atlanitic silverside *Menidia menidia*	Planktivore	Atherinidae	Estuarine	Resident
Banded killifish *Fundulus diaphanous*	Planktivore	Cyprinodonitdae	Freshwater	Resident
Bay anchovy *Anchoa mitchelli*	Planktivore	Engraulidae	Estuarine	Resident
Blueback herring *Alosa aestivalis*	Planktivore	Clupeidae	Freshwater Anadromous	Non-resident
Bluefish *Pomatomus saltatrix*	Carnivore	Pomatomidae	Marine	Non-resident
Bluegill *Lepomis macrochirus*	Planktivore	Centrarchidae	Freshwater	Resident
Bluespotted sunfish *Ennaeacanthus gloriosus*	Planktivore	Centrarchidae	Freshwater	Resident
Channel catfish *Ictalurus punctatus*	Benthic	Ictaluridae	Freshwater	Resident
Cownose ray *Rhinoptera bonasus*	Benthic	Rhinopteridae	Marine	Non-resident
Gizzard shad *Dorosoma cepedianum*	Planktivore	Clupeidae	Freshwater	Resident
Golden shiner *Notemigonus crysoleucas*	Planktivore	Cyprinidae	Freshwater	Resident
Hickory shad *Alosa mediocris*	Planktivore	Clupeidae	Freshwater Anadromous	Non-resident
Hogchoker *Trinectes maculatus*	Benthic	Solidae	Estuarine	Resident

SPECIES NAME	TROPHIC LEVEL	FAMILY	SPAWN LOCATION	RESIDENCY
Inland silverside *Menidia beryllina*	Planktivore	Atherinidae	Estuarine	Resident
Eastern mosquitofish *Gambusia holbrooki*	Planktivore	Poeciliidae	Freshwater	Resident
Mummichog *Fundulus heteroclitus*	Planktivore	Cyprinodontidae	Estuarine	Resident
Naked goby *Gobiosoma bosc*	Benthic	Gobiidae	Estuarine	Resident
Northern pipefish *Syngnathus fuscus*	Planktivore	Syngnathidae	Estuarine	Resident
Pumpkinseed *Lepomis gibbosus*	Planktivore	Centrarchidae	Freshwater	Resident
Rough silverside *Membras martinica*	Planktivore	Atherinidae	Estuarine	Resident
Sheepshead minnow *Cyprinodon variegatus*	Planktivore	Cyprinodontidae	Freshwater	Resident
Silvery minnow *Hybognathus nuchalis*	Planktivore	Cyprinidae	Freshwater	Resident
Spot *Leiostomus xanthurus*	Benthic	Sciaenidae	Marine	Non-resident
Spottail shiner *Notropis hudsonius*	Planktivore	Cyprinidae	Freshwater	Resident
Striped bass *Morone saxatilis*	Carnivore	Moronidae	Freshwater Anadromous	Non-resident
Striped killifish *Fundulus majalis*	Planktivore	Cyprinodontidae	Estuarine	Resident
Tesselated darter *Etheostoma olmstedi*	Benthic	Percidae	Freshwater	Resident
Weakfish *Cynoscion regalis*	Carnivore	Scianidae	Marine	Non-resident
White perch *Morone americana*	Carnivore	Moronidae	Freshwater Anadromous	Non-resident
Winter flounder *Psuedopleuronectes americanus*	Benthic	Pleuronectidae	Marine	Non-resident
Yellow perch *Perca flavescens*	Carnivore	Percidae	Freshwater Anadromous	Resident

Table 4.1. Survival of *E. affinis* and sheepshead minnow larvae after 8d tests conducted at 8 stations from 10/01/96 to 10/09/96.

		Cumulative Percent Survival Per Day							
Species	Station	1	2	3	4	5	6	7	8
E. affinis	CONTROL								79
	CH2								54
	CH4								36
	CH5								11
	CH6								75
	PCP								35
	PBZ								50
	PJB								89
	PBR								28
Sheepshead	CONTROL	100	100	100	100	100	98	98	98
minnow	CH2	100	100	100	100	100	100	100	100
	CH4	100	100	100	100	100	98	98	98
	CH5	100	100	100	100	100	98	98	98
	CH6	100	100	100	100	100	100	100	98
	PCP	100	100	100	100	100	100	100	100
	PBZ	100	100	100	100	100	100	100	100
	PJB	100	100	100	100	100	100	100	100
	PBR	100	100	100	100	100	100	100	100

Table 4.2 Growth data from sheepshead minnow larvae from the 10/01/96 to 10/09/96 experiments.

Sheepshead larvae dry weight (initial weight at day 0=0.16 mg)

Station	n at d8	(mg at d=8)	±S.E.
CONTROL	39	1.36	0.06
CH2	42	0.83*	0.07
CH4	39	0.91*	0.05
CH5	41	0.90*	0.06
CH6	42	1.07	0.09
PCP	40	1.45	0.15
PBZ	40	1.26	0.13
PJB	40	1.37	0.03
PBR	41	1.61	0.08

* Growth was significantly less in ambient condtions compared to controls (P<0.05).

Table 4.3. Percent normal shell development from two 48h coot clam embryo/larval tests conducted from 10/04/96 to 10/06/96 (test 1) and 10/07/96 to 10/09/96 (test 2).

	Test 1		Test 2	
Station	Percent Normal	±S.E.	Percent Normal	±S.E.
CONTROL	96.2	0.50	97.6	0.46
CH2	92.4*	0.43	89.1*	2.33
CH4	91.0*	1.31	82.4*	4.25
CH5	84.3*	2.05	73.2*	2.19
CH6	63.3*	1.26	58.7*	3.62
PCP	96.2	0.56	87.6*	1.26
PBZ	97.0	0.07	87.5*	3.26
PJB	94.0	1.11	80.6*	2.76
PBR	96.3	0.36	90.5*	2.37

* Percent normal shell development in ambient conditions was significantly less than the controls ($P<0.05$).

Table 4.4. Reproduction and maturation data for *Eurytemora* after 8d tests at 8 stations from 10/01/96 to 10/09/96.

Station	Mean Percent Survival	±S.E.	Mean Percent Gravid Female	±S.E.	Mean Percent Immature	±S.E.
CONTROL	78.7	10.7	0.0	0.0	88.5	0.5
CH2	53.7	27.6	40.0	4.0	15.5	6.5
CH4	36.3	19.5	39.0	1.0	16.5	3.5
CH5	10.7	7.5	0.0	0.0	83.5	16.5
CH6	75.0	0.0	0.0	0.0	44.3	6.6
PCP	35.0	5.1	36.3	15.3	20.0	20.0
PBZ	50.0	25.4	10.0	10.0	5.0	5.0
PJB	88.7	5.7	40.0	10.0	14.0	6.0
PBR	27.7	27.7	10.0	0.0	40.0	0.0

Table 4.5. Inorganic contaminants data from the 8 stations sampled during the fall of 1996 (10/01/96 - 10/09/96). Marine U.S. EPA chronic water quality criteria (WQC) are listed beside each metal. All values exceeding the criteria are underlined.

Metals & WQC (ug/L)	Stations							
	CH2	CH4	CH5	CH6	PCP	PBZ	PJB	PBR
As (-)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Cd (9.3)	0.40	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Cr (50)	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.13	2.10
Cu (2.9)	2.1	<u>4.68</u>*	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Pb (5.6)	1.03	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
Hg (0.025)	<0.250	<0.250	<0.250	<0.250	<0.250	<0.25	<0.25	<0.25
Ni (8.3)	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
Se (54)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Zn (86)	26.0	20.0	20.0	39.0	16.0	20.0	20.0	20.0

* Maryland estuarine acute copper criteria of 6.1 ug/L was not exceeded.

Table 4.6. Water quality parameters reported in the field during water sample collection in the fall of 1996.

Date	Station	Temp. (C)	Salinity (ppt)	Cond. (umhos/cm)	DO (mg/L)	pH
10/01/96	PCP	19	7	10000	7.6	7.79
	PBZ	19	9	13000	7.8	7.71
	PJB	19	11	15500	8.0	7.82
	PBR	20	12	17000	7.8	7.99
	CH2	20	8	12000	8.5	8.18
	CH4	20	7	10000	7.0	7.37
	CH5	20	4	3500	7.8	7.05
	CH6	20	3	3000	8.2	7.25
10/04/96	PCP	20	7	10000	7.4	7.52
	PBZ	19	9	13000	7.3	7.60
	PJB	20	11	15000	7.1	7.72
	PBR	18	11	15500	7.8	7.73
	CH2	17	8	10500	8.5	7.87
	CH4	17	6	8000	8.2	7.06
	CH5	17	3	4000	8.5	7.28
	CH6	16	2	2000	8.1	7.23
10/07/96	PCP	15	6	8500	8.4	7.68
	PBZ	15	10	13000	8.6	7.72
	PJB	17	11	15000	8.4	7.88
	PBR	17	12	16000	8.6	7.90
	CH2	17	8	11000	9.5	8.18
	CH4	17	7	9500	9.0	7.75
	CH5	17	5	7000	9.5	7.44
	CH6	16	4	5000	9.7	7.72

Table 4.7. Toxicity data (48h LC50s or EC50s in mg/L) from reference toxicant tests conducted with cadmium chloride for the three test species. Previous values from years 1 thru 5 are reported.

			Previous 48h LC50 values				
Date	Species	48h LC50	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
-----	Grass Shrimp	-----	0.502	0.230	1.340	0.72	-----
12/04/96	Sheepshead minnow	2.30	0.51	1.54	1.18	0.71	1.03
10/29/96	*E. affinis*	.126	.021	0.095	.120	.143	.192
10/14/96	Coot clam	.040[a]	-----	-----	.005[a]	.008[a]	.069[a]

[a] Value is an EC50 (percent normal shell development is the endpoint).

Table 4.8 Survival data from *C. variegatus* at the eight stations. Tests were conducted from 10/11/96 to 10/21/96. "(R)" = Reference, "(C)"= Control.

Species	Station	% Survival	%Hatched	%dead fish	%dead eggs
C. variegatus					
	Broomes Island	94.00	96.00	2.00	4.00
	Buzzard Island	92.00	96.00	4.22	4.00
	Chalk Point	96.00	98.00	2.00	2.00
	Jack Bay	94.00	94.00	0.00	6.00
	CH4	96.00	96.00	0.00	4.00
	CH6	72.00*	80.00*	10.44*	20.00*
	CH5	64.00*	72.00*	12.66*	26.00*
	CH2	90.00	90.00	0.00	10.00
	Poropotank (R)	74.00*	94.00	21.33*	6.00
	Lynnhaven Mud (C)	94.00	94.00	0.00	6.00
	Lynnhaven Sand (R)	100.00	100.00	0.00	0.00

Note: * indicates significantly different from control (α=0.05).
% Survival =1-[(Dead fish + dead eggs at test termination)/(# eggs exposed)]*100.
% Dead fish = (Dead fish)/(# hatched)*100
% Dead eggs = (Dead eggs)/(# exposed)*100
% Hatched = (# hatched)/(# eggs exposed)*100

Table 4.9 Survival data from *L. dytiscus* at the eight stations. Tests were conducted from 10/8/96 to 10/28/96. "(R)" = Reference, "(C)"= Control. "SE" = Standard Error.

Species	% Survival							
	Day 10				Day 20			
L. dytiscus	Unadjusted	SE	Adjusted	SE	Unadjusted	SE	Adjusted	SE
Station								
Broomes Island	56.00*	8.43	67.25*	8.85	2.00*	1.22	31.14	6.86
Buzzard Island	51.00*	7.97	77.51	11.23	0.00*	0.00	64.20	15.81
Chalk point	59.00*	14.53	77.18	15.27	2.00*	1.22	50.47	20.96
Jack Bay	61.00*	5.34	76.71	6.95	2.00*	1.22	46.14	14.49
CH4	35.00*	5.00	51.47*	7.51	0.00*	0.00	27.24	6.42
CH6	50.00*	10.12	72.88	12.86	2.00*	2.00	60.70	17.12
CH5	47.00*	4.06	73.68*	6.37	0.00*	0.00	52.78	8.01
CH2	39.00*	3.32	60.36*	5.10	0.00*	0.00	36.14	5.19
Poropotank (R)	32.00*	3.00	50.11*	4.70	0.00*	0.00	27.28	3.68
Lynnhaven Sand (C)	95.00	3.87	95.72	3.57	83.00	7.68	85.29	6.98

NOTE 1: *Significantly less than controls ($p<0.05$).

NOTE 2: Adjusted *L. dytiscus* survival is percent survival adjusted for predicted particle size effects.

Table 4.10 Survival data from *L. plumulosus* at the eight stations. Tests were conducted from 10/8/96 to 10/28/96. "(R)" = Reference, "(C)"= Control. "SE" = Standard Error.

Species	% Survival			
L. plumulosus	Day 10		Day 20	
	Unadjusted	**SE**	**Unadjusted**	**SE**
Station				
Broomes Island	78.00	2.00	29.00*	11.34
Buzzard Island	81.00	5.33	20.00*	5.70
Chalk point	77.00	5.15	22.00*	8.89
Jack Bay	83.00	4.64	29.00*	11.77
CH4	82.00	4.06	17.00*	5.15
CH6	70.00	5.70	22.00*	11.14
CH5	75.00	7.42	9.00*	5.34
CH2	87.00	3.39	32.00*	12.51
Poropotank (C)	91.00	2.45	78.00	4.06
Lynnhaven Sand (R)	68.00	8.46	5.00*	1.58

NOTE: *Significantly less than controls ($p<0.05$).

Table 4.11 Survival data from *S. benedicti* at the eight stations. Tests were conducted from 10/8/96 to 10/28/96. "(R)" = Reference, "(C)"= Control. "SE" = Standard Error.

Species	% Survival							
	Day 10				Day 20			
S. benedicti	**Unadjusted**	**SE**	**Adjusted**	**SE**	**Unadjusted**	**SE**	**Adjusted**	**SE**
Station								
Broomes Island	84.00	6.60	86.97	7.22	70.00	12.94	79.46	8.50
Buzzard Island	61.00	14.09	61.00	14.09	60.00	14.58	60.00	14.58
Chalk point	77.00	5.61	77.00	5.61	77.00	5.61	77.00	5.61
Jack Bay	65.00	12.65	67.00	13.75	63.00	12.61	65.00	13.78
CH4	64.00	13.27	64.00	13.27	56.00	10.77	56.00	10.77
CH6	54.00	12.39	54.00	12.39	54.00	12.39	54.00	12.39
CH5	68.00	8.60	68.00	8.60	61.00	11.45	61.00	11.45
CH2	55.00	14.40	55.00	14.40	55.00	14.40	55.00	14.40
Poropotank (R)	78.00	19.53	78.00	19.53	75.00	18.77	75.00	18.77
Lynnhaven Mud (C)	91.00	9.00	91.00	9.00	80.00	13.87	80.00	13.87
Lynnhaven Sand (R)	56.00	11.66	71.93	14.04	53.00	10.32	71.55	13.95

NOTE 1: *Significantly less than controls ($p<0.05$).

NOTE 2: Adjusted *S. benedicti* survival is percent survival adjusted for predicted particle size effects.

Table 4.12 Particle size analysis of sediments from eight stations, references and controls used in toxicity tests. Samples collected 9/27/96- 9/28/96.

Station	Replicate	%Sand	%Silt	%Clay
CH6	1	4.8588	60.4426	34.6985
CH6	2	1.4214	65.0266	33.5520
CH6	3	1.9569	60.8182	37.2249
CH6	4	6.5812	56.3507	37.0681
CH6	5	1.0494	59.7769	39.1737
CH5	1	1.9527	57.5917	40.4556
CH5	2	1.8972	56.6151	41.4878
CH5	3	0.9289	59.7472	39.3239
CH5	4	0.9309	59.5422	39.5268
CH5	5	0.6320	59.7537	39.6143
CH4	1	11.6117	55.3148	33.0735
CH4	2	10.8396	53.9508	35.2096
CH4	3	15.1181	51.0730	33.8089
CH4	4	20.2243	49.6180	30.1577
CH4	5	9.3163	56.7009	33.9828
CH2	1	3.3620	65.5957	31.0423
CH2	2	3.9253	69.0467	27.0280
CH2	3	3.1973	64.2249	32.5778
CH2	4	3.9007	63.8474	32.2519
CH2	5	3.4458	62.4197	34.1346
Chalk Point	1	2.1050	59.7226	38.1724
Chalk Point	2	0.8855	58.6474	40.4672
Chalk Point	3	1.3752	59.0570	39.5678
Chalk Point	4	2.1309	59.1726	38.6965
Chalk Point	5	2.4705	61.2740	36.2554
Buzzard Island	1	0.6466	61.8543	37.4992
Buzzard Island	2	0.9146	63.0279	36.0576
Buzzard Island	3	0.4985	62.2733	37.2282
Buzzard Island	4	1.4933	59.6263	38.8804
Buzzard Island	5	2.5251	60.6535	36.8214
Jack Bay	1	35.3537	46.7255	17.9208
Jack Bay	2	22.1238	54.5614	23.3148
Jack Bay	3	36.5227	46.6844	16.7929
Jack Bay	4	52.8549	37.1563	9.9888
Jack Bay	5	89.4585	7.3244	3.2171
Broomes Island	1	36.9015	49.9813	13.1171
Broomes Island	2	32.7501	54.4393	12.8107
Broomes Island	3	65.8362	26.4176	7.7463
Broomes Island	4	70.5216	21.6572	7.8212
Broomes Island	5	70.7473	21.8274	7.4253
Lynnhaven Mud		2.5278	84.4850	12.9872
Lynnhaven Sand		98.8095	0.5905	0.6000
Poropotank Mud		1.4455	62.5686	35.9860

Table 4.13 Growth data (dry weight and length) for *L. dytiscus* after 20-day exposure to sediments. Initial weight and length represent the mean and SE of 5 replicates of 20 animals each species at the start of the test. Data for each replicate is the mean of the surviving animals. Tests were conducted 10/8/96 through 10/28/96. "(R)" = Reference, "(C)"= Control.

Site	Number of True Replicates	Weight(mg)	S.E.	Length(mm)	S.E.
L. dytiscus					
Initial	5	0.1785	0.0243	3.9494	0.1602
Broomes Island	5	0.1950	0.0919	5.8640	0.7688
Buzzard Island	0	-	-	-	-
Chalk point	2	0.1900	0.0849	4.7738	0.4833
Jack Bay	2	0.3550	0.3465	5.8980	0.9984
CH4	0	-	-	-	-
CH6	1	0.1750	-	4.0638	-
CH5	0	-	-	-	-
CH2	0	-	-	-	-
Poropotank (R)	0	-	-	-	-
Lynnhaven Sand (C)	5	0.0854	0.0252	4.3050	0.0267

*Significantly less than controls ($p < 0.05$).

Table 4.14 Growth data (dry weight and length) for *L. plumulosus* after 20-day exposure to sediments. Initial weight and length represent the mean and SD of 5 replicates of 20 animals each at the start of the test. Data for each replicate is the mean of the surviving animals. Tests were conducted 10/8/96 through 10/28/96. "(R)" = Reference, "(C)"= Control.

Site	Number of True Replicates	Weight(mg)	S.E.	Length(mm)	S.E.
L. plumulosus					
Initial	5	0.0613	0.0028	3.9931	
Broomes Island	5	0.0776*	0.0106	4.4958	0.3508
Buzzard Island	5	0.0726*	0.0186	4.3505	0.1884
Chalk point	5	0.0675*	0.0078	4.3679	0.1519
Jack Bay	5	0.0897*	0.0026	4.3970	0.0988
CH4	5	0.0404*	0.0115	4.4391	0.1811
CH6	5	0.0213*	0.0184	4.2341	0.3655
CH5	5	0.1142*	0.0336	4.8192	0.2449
CH2	5	0.0643*	0.0251	4.1584	0.1949
Poropotank (C)	5	0.2834	0.0224	4.1787	0.0794
Lynnhaven Sand (R)	5	0.0913*	0.0468	4.8954	0.5272

*Significantly less than controls ($p < 0.05$).

Table 4.15 Growth data (dry weight and length) for *S. benedicti* after 20-day exposure to sediments. Initial weight and length represent the mean and SE of 5 replicates of 20 animals each species at the start of the test. Data for each replicate is the mean of the surviving animals. Tests were conducted 10/8/96 through 10/28/96. "(R)" = Reference, "(C)"= Control.

Site	Number of True Replicates	Weight(mg)	S.E.	Length(mm)	S.E.
S. benedicti					
Initial	5	0.0562	0.0029	5.3215	0.1279
Broomes Island	5	0.0848	0.0083	7.2303	0.1874
Buzzard Island	5	0.0944	0.0187	6.8598	0.4042
Chalk point	5	0.0780	0.0043	7.2277	0.2850
Jack Bay	5	0.0824	0.0253	7.0806	0.6537
CH4	5	0.0576	0.0140	6.1651	0.4414
CH6	5	0.0575	0.0134	6.5797	0.3152
CH5	5	0.0544	0.0106	5.9877*	0.2862
CH2	5	0.0758	0.0060	6.3575	0.3434
Poropotank (R)	5	0.1028	0.0074	7.5033	0.3588
Lynnhaven Mud (C)	5	0.0878	0.0101	7.2081	0.5100
Lynnhaven Sand (R)	5	0.0349*	0.0040	5.2097*	0.1748

*Significantly less than controls ($p < 0.05$).

Table 4.16 Chemical data (TOC) for sediment samples from the eight stations and the controls. All data are on a dry weight basis.

Station	Total Organic Carbon (%)
Lynnhaven Mud	1.48
Lynnhaven Sand	0.08
Poropotank Mud	5.60
CH6	3.17
CH5	2.94
CH4	2.36
CH2	2.22
Chalk Point	2.75
Buzzard Island	2.56
Jack Bay	0.95
Broomes Island	0.85

Table 4.17 Average SEM and AVS values and the SEM:AVS ratio for sediment samples tested in 1996.

Sample Id	Mean AVS µmole/gram	Mean SEM µmole/gram	Ratio
Lynnhaven Mud	14.74	0.681	0.046
Lynnhaven Sand	1.34	0.022	0.016
Poropotank Mud	7.96	1.857	0.233
CH6	21.23	1.730	0.081
CH5	25.24	1.861	0.074
CH4	8.25	1.399	0.170
CH2	8.42	1.761	0.209
Chalk Point	18.79	1.868	0.099
Buzzard Island	14.33	1.632	0.114
Jack Bay	6.64	0.746	0.112
Bromes Island	5.21	0.623	0.120

Table 4.18 SEM analysis for sediments collected 9/27 and 9/28/96. Concentrations for each metal are expressed in umol per gram of sediment dry weight.

	Cadmium Mean	Copper Mean	Lead Mean	Nickel Mean	Zinc Mean	Mercury Mean	Sum Mean
Site							
Broomes Island	0.000	0.027	0.020	0.031	0.544	0.0000	0.623
Buzzard Island	0.006	0.098	0.095	0.155	1.278	0.0000	1.632
Chalk Point	0.008	0.164	0.086	0.205	1.405	0.0000	1.868
Jack Bay	0.000	0.032	0.025	0.025	0.665	0.0000	0.746
CH4	0.000	0.091	0.101	0.141	1.065	0.0000	1.399
CH6	0.000	0.063	0.105	0.149	1.413	0.0000	1.730
CH5	0.000	0.082	0.130	0.155	1.494	0.0000	1.861
CH2	0.000	0.125	0.115	0.188	1.333	0.0000	1.761
Lynnhaven Sand	0.000	0.000	0.000	0.000	0.022	0.0000	0.022
Lynnhaven Mud	0.000	0.000	0.024	0.039	0.617	0.0000	0.681
Poropotank Mud	0.000	0.132	0.084	0.085	1.556	0.0000	1.857
Detection Limits	0.0003	0.0050	0.0006	0.0004	0.0005	0.00005	

Table 4.19 Inorganic contaminants for sediment samples from the eight stations and the controls. (Note: single underlined values represent concentrations exceeding "Effects Range-Low", and double underlined values represent concentrations exceeding "Effects Range-Median" levels listed below as defined in Long et al 1995). NA = not available; -- = not listed; < = values were less than those listed.

SITE	Contaminant (µg/g)										
	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Sn	Zn
Broomes Island	8580	0.75	0.247	15.5	6.3	15.8	0.029	7.5	0.223	0.171	41.2
Jack Bay	12500	5.09	0.385	23.5	7.8	16.2	0.043	10.7	0.267	<0.138	54.6
Buzzard Island	43800	13.46	0.760	81.7	25.7	52.1	0.127	40.0	0.500	<0.318	226
Chalk Point	45000	14.06	1.246	81.5	30.1	53.7	0.110	44.7	1.001	<0.305	225
CH2	32700	12.00	0.327	47.8	24.1	56.1	0.114	39.9	0.845	<0.256	227
CH4	32600	12.56	0.247	59.1	18.0	40.0	0.087	30.8	0.610	<0.251	118
CH5	47300	11.72	0.321	72.1	21.4	59.3	0.158	37.6	0.686	<0.307	243
CH6	36100	10.12	0.345	53.5	17.8	49.9	0.095	30.9	0.587	<0.305	141
Lynnhaven Sand	659.0	0.57	0.020	<1.5	<1.5	3.6	0.014	<1.5	<0.006	0.618	3.8
Lynnhaven Mud	17300	6.98	0.284	31.9	15.5	25.9	0.098	17.3	0.318	0.187	85.6
Poropotank	44700	14.71	0.248	62.6	23.1	43.0	0.113	28.4	1.114	<0.368	147.0
Detection Limit	0.301	0.015	0.030	0.003	0.003	0.003	0.030	0.006	0.015	0.301	0.003
Effects range:											
LOW	--	8.2	1.2	81	34	46.7	0.15	20.9	--	NA	150
MEDIAN	--	70	9.6	370	270	218	0.71	51.6	--	NA	410

Table 4.20 Chemical data for pore water samples from the eight stations and the references and controls.

Site:	Ammonia (mg/L)	Nitrite (mg/L)	Sulfide (mg/L)	Unionized Ammonia (mg/L)
Broome's Island	37.80	0.0011	0.0073	1.7103
Buzzard Island	16.63	0.0050	0.0120	0.6987
Chalk Point	12.61	0.0053	0.0026	0.5389
Jack Bay	26.99	0.0039	0.0085	1.2495
CH4	3.59	0.0019	0.0528	0.1617
CH6	8.60	0.0030	0.0003	0.3723
CH5	8.93	0.0022	0.0306	0.3916
CH2	8.10	0.0014	0.0003	0.4764
Lynnhaven Sand	0.06	0.0019	0.0131	0.0035
Lynnhaven Mud	44.49	0.0000	-	1.7177
Poropotank	12.95	0.0143	0.0481	0.5243

Table 4.21 Reference toxicant data results from 96-hr, water only, reference toxicant tests for the sixth year of the ambient toxicity project. Cadmium chloride ($CdCl_2$) was used for all organisms.

Organism	Chemical	LC50 & CIs (mg/L Cd)		Historical Mean
L. plumulosus	$CdCl_2$	0.479	(0.378 - 0.606)	0.956
L. dytiscus	$CdCl_2$	1.267	(1.005 - 1.598)	3.353
S. benedicti	$CdCl_2$	4.669	(3.968 - 5.493)	4.090
C. variegatus	$CdCl_2$	1.074	(0.761 - 1.517)	0.798

Table 4.22 Individual metric values for each station.

	Chester River Stations				Patuxent River Stations			
Metric	CH2	CH4	CH5	CH6	PCP	PBZ	PJB	PBR
Total abundance with menhaden removed	4561	2773	1802	986	9033	9778	8205	9267
Abundance estuarine individuals	1809	1852	1147	268	568	5487	4904	3193
Abundance anadromous individuals	2722	854	610	654	8453	3958	3237	5952
Proportion of carnivores	0.52	0.31	0.30	0.53	0.94	0.40	0.39	0.64
Proportion of planktivores	0.48	0.69	0.68	0.46	0.06	0.60	0.60	0.35
Proportion of benthivores	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.01
Total number of species	15	14	15	15	14	20	16	13
Number of species captured in the bottom trawl	2	4	3	4	3	5	3	4
Number of species comprising 90% of catch	4	2	3	5	2	2	3	3

Table 4.23. Fish IBI values for Patuxent and Chester River stations. Reference score was 31.

River	Station	IBI Score
Patuxent	PCP	33
	PBZ	31
	PJB	27
	PBR	33
Chester	CH2	27
	CH4	25
	CH5	29
	CH6	23

Table 4.24. Trawl Index score and rating for each station sampled in the Patuxent and Chester Rivers.

River	Station	Trawl Index Score	Rating
Patuxent	PCP	3.00	fair
	PBZ	1.00	poor
	PJB	0.33	poor
	PBR	1.70	fair
Chester	CH2	1.00	poor
	CH4	1.33	poor
	CH5	2.00	fair
	CH6	1.70	fair

Table 4.25 Dissolved oxygen concentrations above and below the pycnocline for the study sites.

River	Station	Above Pycnocline DO (mg/L)	Below Pycnocline DO (mg/L)
Chester	CH2	7.4	5.1
	CH4	7.2	6.4
	CH5	6.9	6.1
	CH6	7.6	7.6
Patuxent	PCP	6.8	5.2
	PBZ	5.4	4.2
	PJB	6.8	3.7
	PBR	5.5	3.5

Table 4.26. Secchi depth by station. The habitat requirement for one meter restoration of SAV in the Chesapeake Bay for mesohaline habitat is 0.97 meters.

River	Station	Secchi Depth (m)
Patuxent	PCP	0.54
	PBZ	0.57
	PJB	0.81
	PBR	1.03
Chester	CH2	0.79
	CH4	0.63
	CH5	0.67
	CH6	0.52

Table 4.27. Benthic Index of Biotic Integrity values and classifications for the stations sampled in the Patuxent and the Chester Rivers.

River	Station	B-IBI Value	Benthic Community Condition
Patuxent	PCP	2.60	Degraded
	PBZ	3.80	Meets Restoration Goal
	PJB	3.00	Meets Restoration Goal
	PBR	2.00	Severely Degraded
Chester	CH2	4.60	Meets Restoration Goal
	CH4	3.40	Meets Restoration Goal
	CH5	3.40	Meets Restoration Goal
	CH6	3.80	Meets Restoration Goal

Table 5.1. Comparison of toxicity results from water column and sediment toxicity tests (multivariate analysis), along with the fish and benthic IBI data for ambient stations tested in 1996. A yes (Y) means some significant level of toxicity or impaired biological response was reported. A no (N) means it was not.

	Result			
Station	Water	Sediment	Fish[a]	Benthos
PCP	N	N	N	Y
PBZ	Y	Y	Y	N
PJB	N	N	Y	N
PBR	Y	N	N	Y
CH2	Y	Y	Y	N
CH4	Y	Y	Y	N
CH5	Y	Y	Y	N
CH6	N	Y	Y	N

[a] If either the fish seining or trawling data suggested impairment "yes" was included.

Table 6.1 Summary of comparisons of water column RTRM indices for references and test sites presented in Figure 6.1-6.5. Comparisons for which confidence limits overlap are indicated by "O", those for which the confidence limits do not overlap are indicated by "X", while "–" indicates no data taken for the period.

STATION	1990	1991	1992-3	1994
BALTIMORE HARBOR BEAR CREEK (1)	-	-	-	X
CURTIS BAY (2)	-	-	-	O
MIDDLE BRANCH (3)	-	-	-	X
NORTHWEST HARBOR (4)	-	-	-	X
OUTER HARBOR (5)	-	-	-	X
PATAPSCO RIVER (6a, b)	O	O	-	-
SPARROWS POINT (7)	-	-	-	X
ELIZABETH RIVER (8)	X	-	-	-
MAGOTHY GIBSON ISLAND (9)	-	-	-	X
SOUTH FERRY (10)	-	-	-	O
MIDDLE RIVER FROG MORTAR (11)	-	-	X	-
WILSON POINT (12)	-	-	X	-
NANTICOKE RIVER BIVALVE (13)	-	-	O	-
SANDY HILL BEACH (14)	-	-	O	-
POTOMAC RIVER DAHLGREN (15a, b)	O	O	-	-
FREESTONE POINT (16)	O	-	-	-
INDIAN HEAD (17)	O	-	-	-
MORGANTOWN (18a, b)	O	O	-	-
POSSUM POINT (19)	O	-	-	-
SASSAFRAS BETTERTON (20)	-	-	-	X
TURNER'S CREEK (21)	-	-	-	X
SEVERN ANNAPOLIS (22)	-	-	-	X
JUNCTION ROUTE 50 (23)	-	-	-	X
WYE RIVER MANOR HOUSE (24a, b, c)	O	O	O	-
QUARTER CREEK (25)	-	-	O	-

Table 6.1 (cont.)

STATION	1995	1996
PAMUNKEY RIVER		
PAMUNKEY RIVER ABOVE WEST POINT (26)	O	-
PAMUNKEY RIVER BELOW WEST POINT (27)	X	-
YORK RIVER		
YORK RIVER ABOVE CHEATHAM ANNEX (28)	X	-
YORK RIVER BELOW CHEATHAM ANNEX (29)	O	-
JAMES RIVER		
JAMES RIVER ABOVE NEWPORT NEW SHIPBUILDING (30)	X	-
JAMES RIVER BELOW NEWPORT NEW SHIPBUILDING (31)	X	-
WILLOUGHBY BAY (32)	X	-
LYNNHAVEN RIVER (33)	O	-
CHESTER RIVER CH2 (34)	-	X
CHESTER RIVER CH4 (35)	-	X
CHESTER RIVER CH5 (36)	-	X
CHESTER RIVER CH6 (37)	-	X
PATUXENT RIVER BROOMES ISLAND (38)	-	X
PATUXENT RIVER JACK BAY (39)	-	O
PATUXENT RIVER BUZZARD ISLAND (40)	-	X
PATUXENT RIVER CHALK POINT (41)	-	X

Table 6.2 Summary of comparisons of sediment RTRM indices for reference and test sites presented in Figures 6.7- 6.11. Comparisons for which confidence limits overlap are indicated by "O", those for which the confidence limits do not overlap are indicated by "X", while "–" indicates no data taken for the period.

STATION	1990	1991	1992-3	1994
BALTIMORE HARBOR BEAR CREEK (1)	-	-	-	X
CURTIS BAY (2)	-	-	-	X
MIDDLE BRANCH (3)	-	-	-	X
NORTHWEST HARBOR (4)	-	-	-	X
OUTER HARBOR (5)	-	-	-	X
PATAPSCO RIVER (6a, b)	X	X	-	-
SPARROWS POINT (7)	-	-	-	X
ELIZABETH RIVER (8)	X	-	-	-
MAGOTHY GIBSON ISLAND (9)	-	-	-	X
SOUTH FERRY (10)	-	-	-	X
MIDDLE RIVER FROG MORTAR (11)	-	-	O	-
WILSON POINT (12)	-	-	O	-
NANTICOKE RIVER BIVALVE (13)	-	-	O	-
SANDY HILL BEACH (14)	-	-	O	-
POTOMAC RIVER DAHLGREN (15a, b)	X	X	-	-
FREESTONE POINT (16)	X	-	-	-
INDIAN HEAD (17)	X	-	-	-
MORGANTOWN (18a, b)	X	X	-	-
POSSUM POINT (19)	X	-	-	-
SASSAFRAS BETTERTON (20)	-	-	-	O
TURNER'S CREEK (21)	-	-	-	O
SEVERN ANNAPOLIS (22)	-	-	-	X
JUNCTION ROUTE 50 (23)	-	-	-	O
WYE RIVER MANOR HOUSE (24a, b, c)	X	X	O	-
QUARTER CREEK (25)	-	-	O	-

Table 6.2 (cont.)

STATION	1995	1996
PAMUNKEY RIVER		
PAMUNKEY RIVER ABOVE WEST POINT (26)	O	-
PAMUNKEY RIVER BELOW WEST POINT (27)	O	-
YORK RIVER		
YORK RIVER ABOVE CHEATHAM ANNEX (28)	O	-
YORK RIVER BELOW CHEATHAM ANNEX (29)	O	-
JAMES RIVER		
JAMES RIVER ABOVE NEWPORT NEW SHIPBUILDING (30)	O	-
JAMES RIVER BELOW NEWPORT NEW SHIPBUILDING (31)	X	-
WILLOUGHBY BAY (32)	X	-
LYNNHAVEN RIVER (33)	O	-
CHESTER RIVER CH2 (34)	-	X
CHESTER RIVER CH4 (35)	-	X
CHESTER RIVER CH5 (36)	-	X
CHESTER RIVER CH6 (37)	-	X
PATUXENT RIVER BROOMES ISLAND (38)	-	O
PATUXENT RIVER JACK BAY (39)	-	O
PATUXENT RIVER BUZZARD ISLAND (40)	-	X
PATUXENT RIVER CHALK POINT (41)	-	O

Figure 3.1 Eight stations sampled during the 1996 Ambient Toxicity Program.

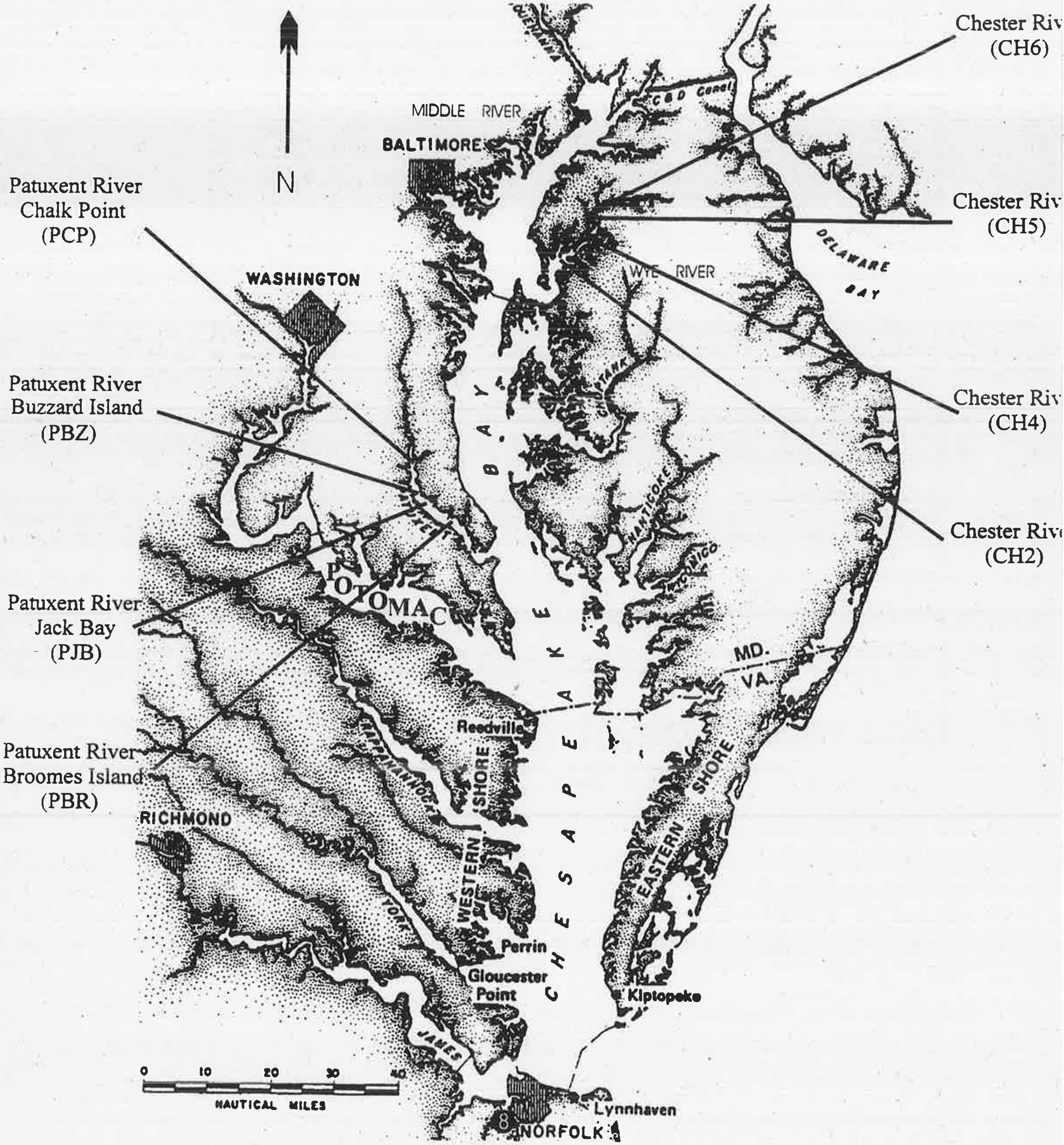


Figure 6.1 Toxicity Index results for the 1990 water column data. (See Section 3.4 for a detailed description of presentation.)

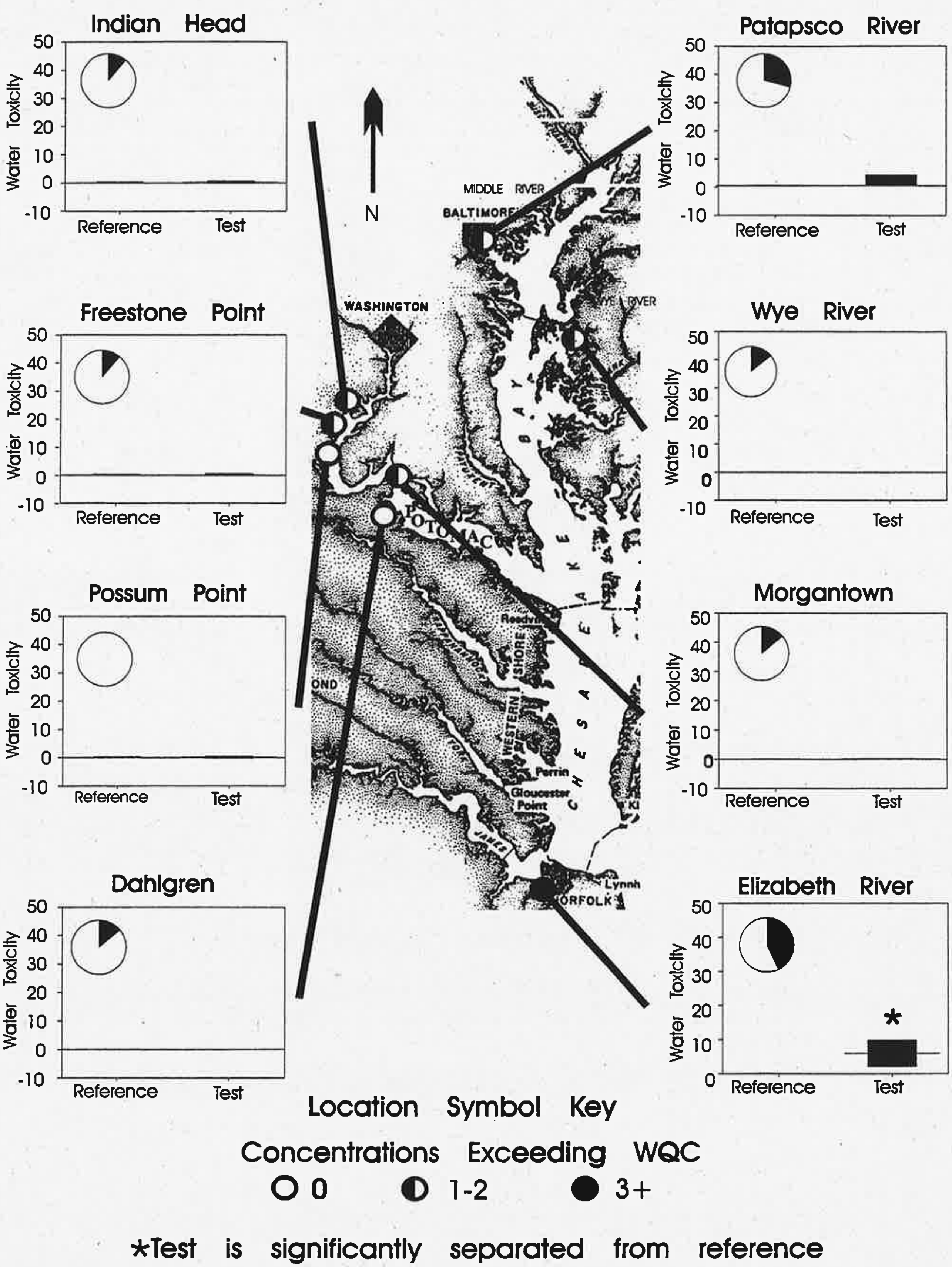


Figure 6.2 **Toxicity Index results for the 1991 water column data. (See Section 3.4 for a detailed description of presentation.)**

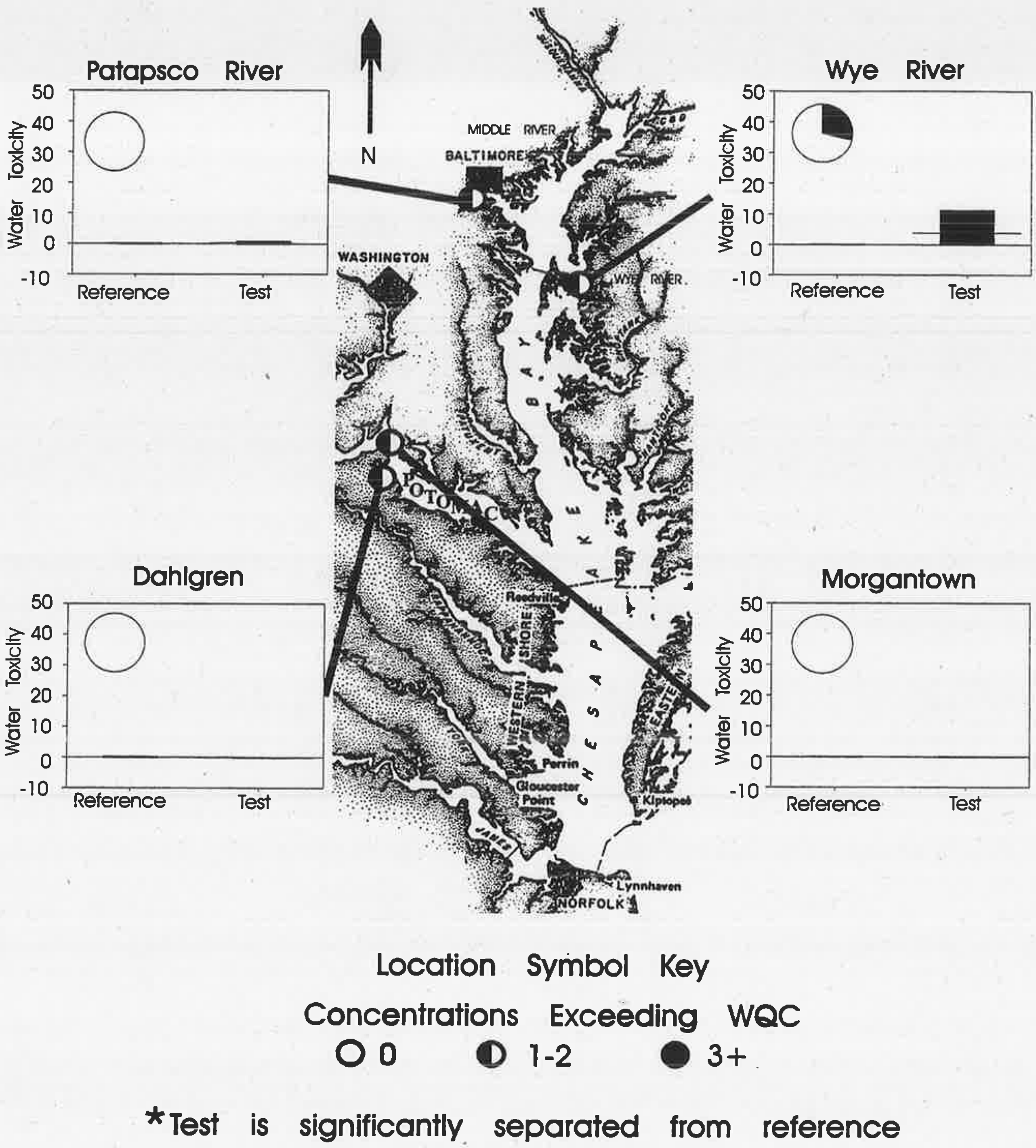


Figure 6.3 Toxicity Index results for the 1992-1993 water column data. (See Section 3.4 for a detailed description of presentation.)

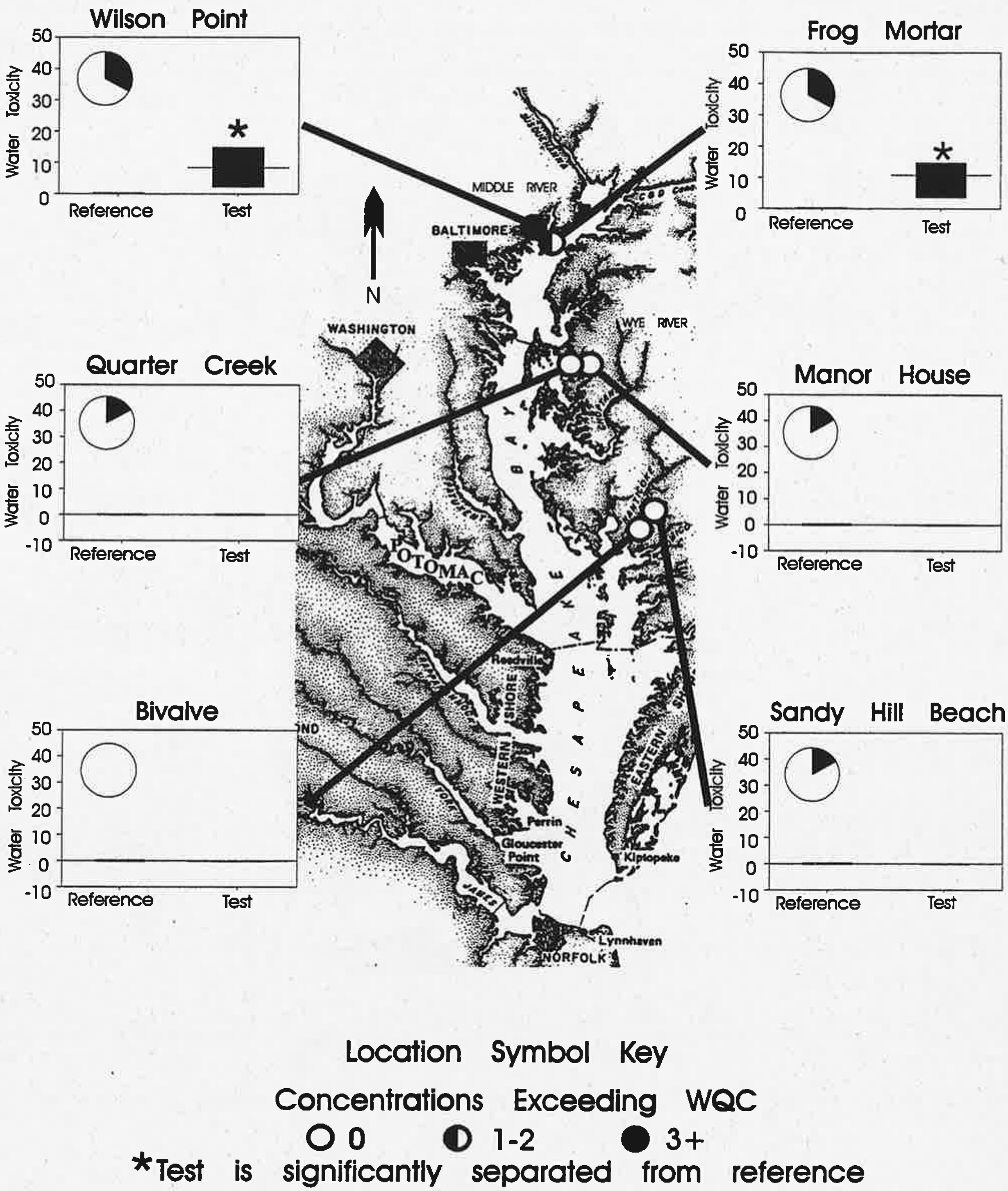


Figure 6.4a Toxicity Index results for the 1994 water column data for the Severn, Magothy and Sassafras Rivers. (See Section 3.4 for a detailed description of presentation.)

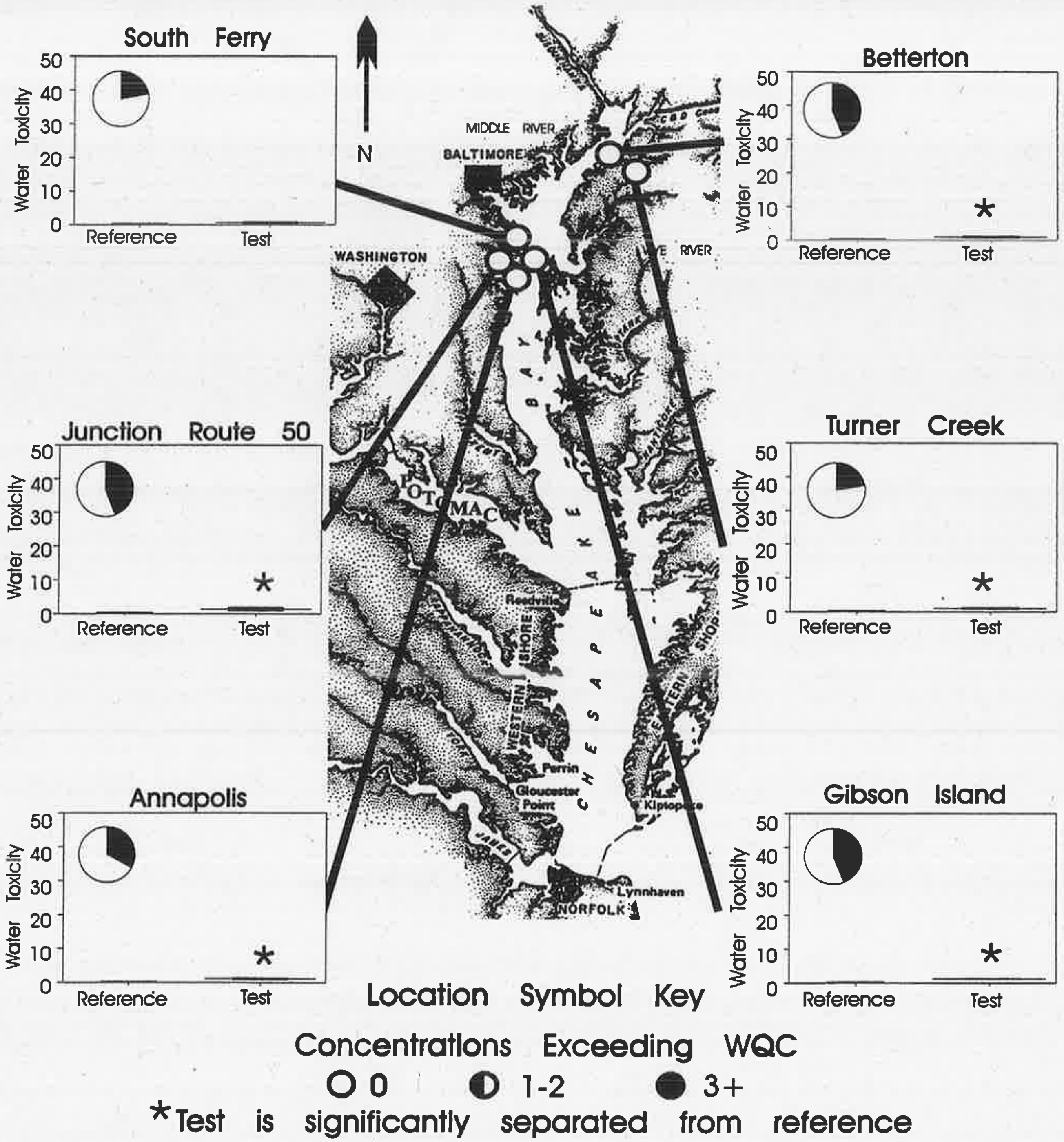


Figure 6.4b Toxicity Index results for the 1994 water column data for Baltimore Harbor sites. (See Section 3.4 for a detailed description of presentation.)

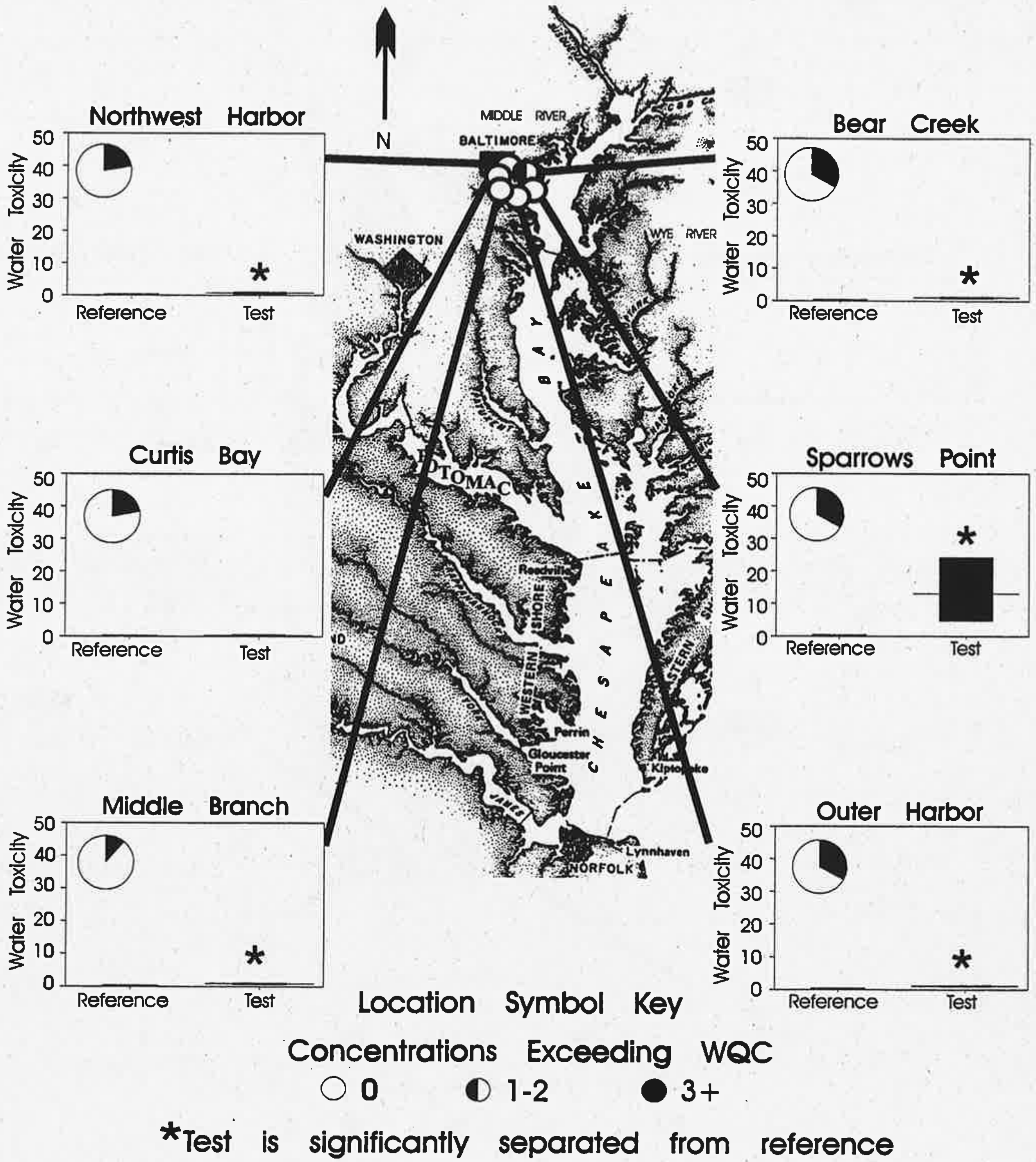


Figure 6.5 Toxicity Index results for the 1995 water column data. (See Section 3.4 for a detailed description of presentation.)

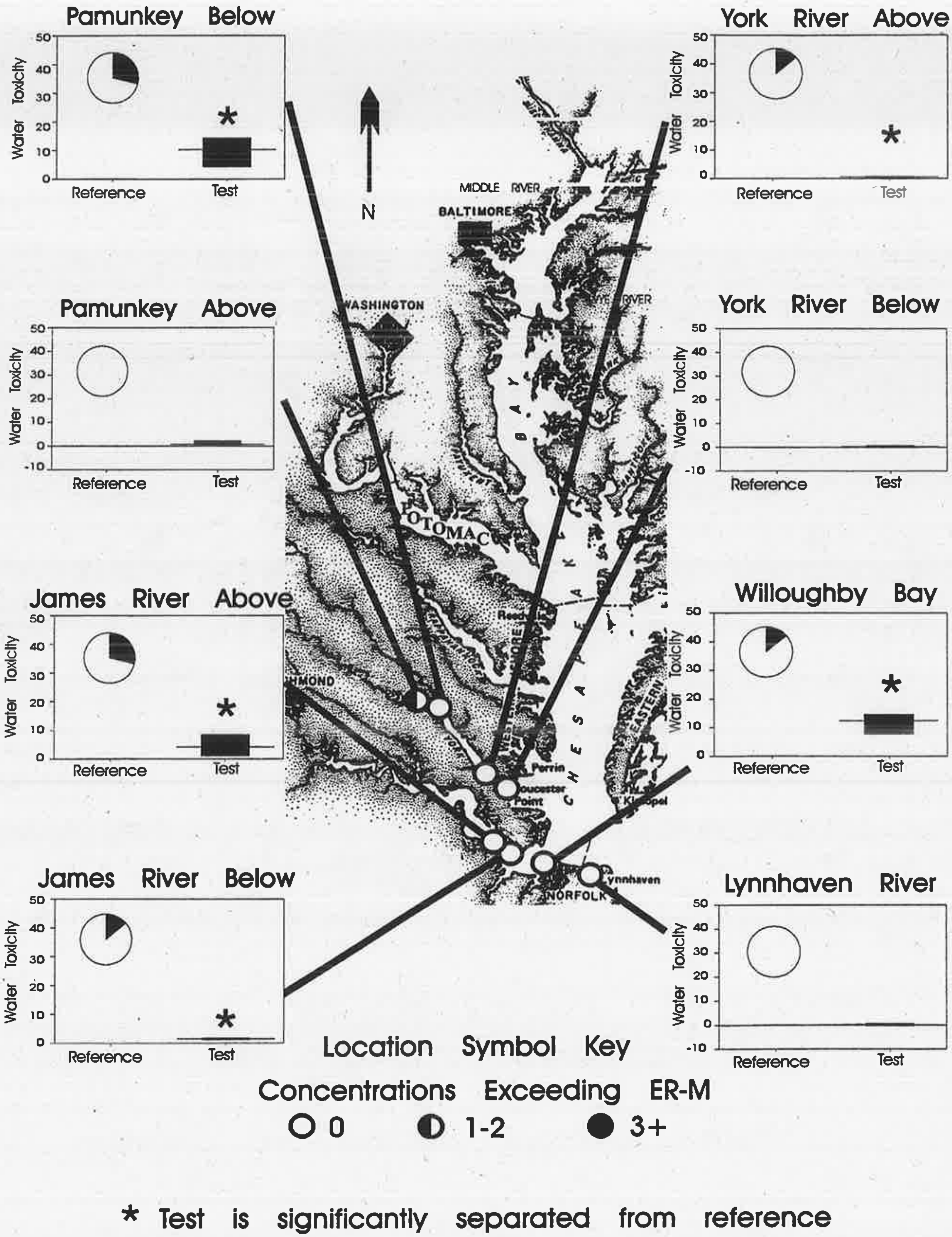
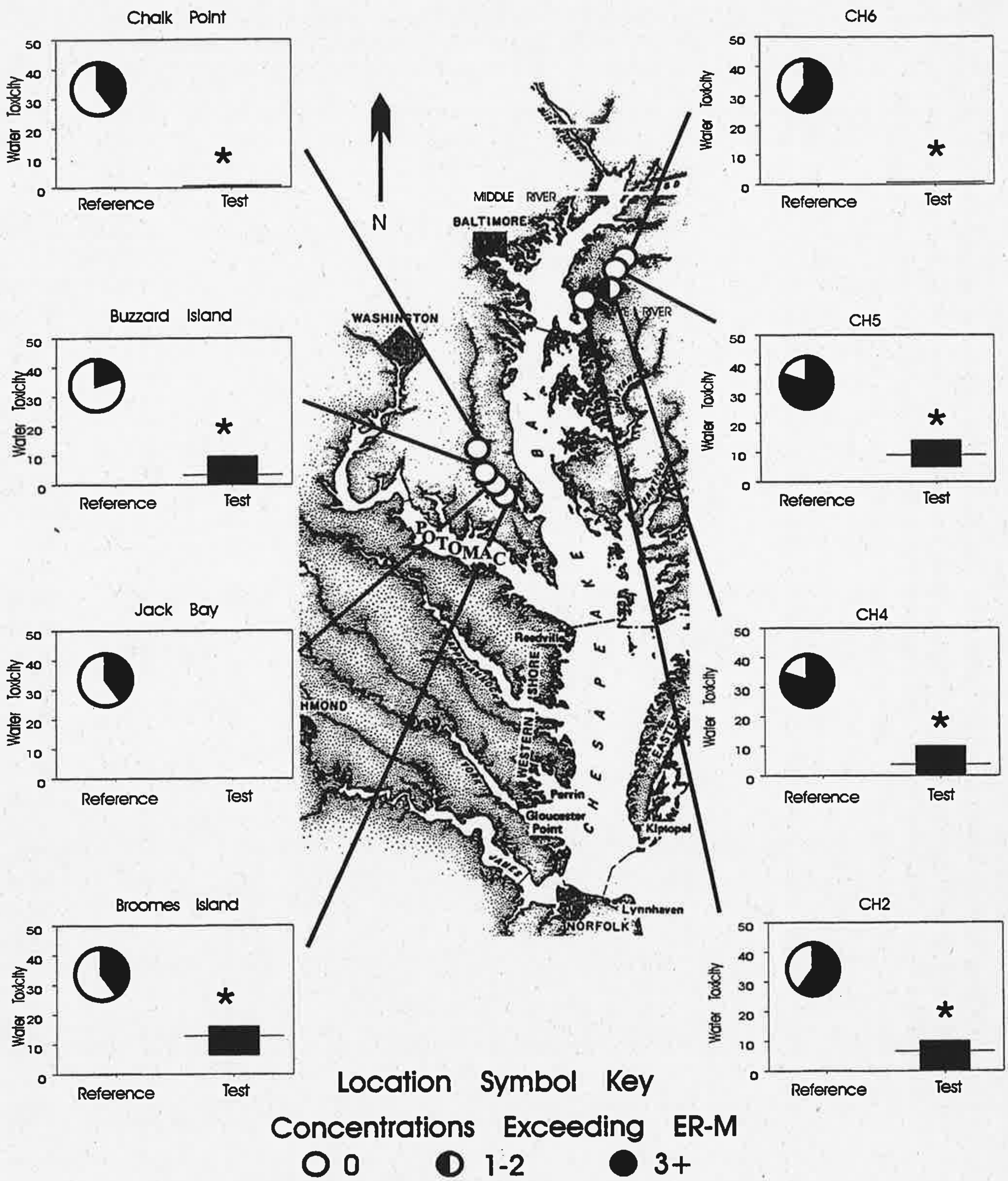


Figure 6.6 Toxicity Index results for the 1996 water column data. (See Section 3.4 for a detailed description of presentation.)



* Test is significantly separated from reference

Figure 6.7 Summary of water column Toxicity Index results for 1990-1996. The sites are ranked according to median Toxicity Index values. Also shown are the 95% confidence limits for the Toxicity Index values (open bars) and the percentage of endpoints displaying significant differences from the references (controls). The dashed horizontal line is the maximum upper confidence limit observed for any reference during the study and is included as a general benchmark. The identities of the site numbers are provided in Table 6.1.

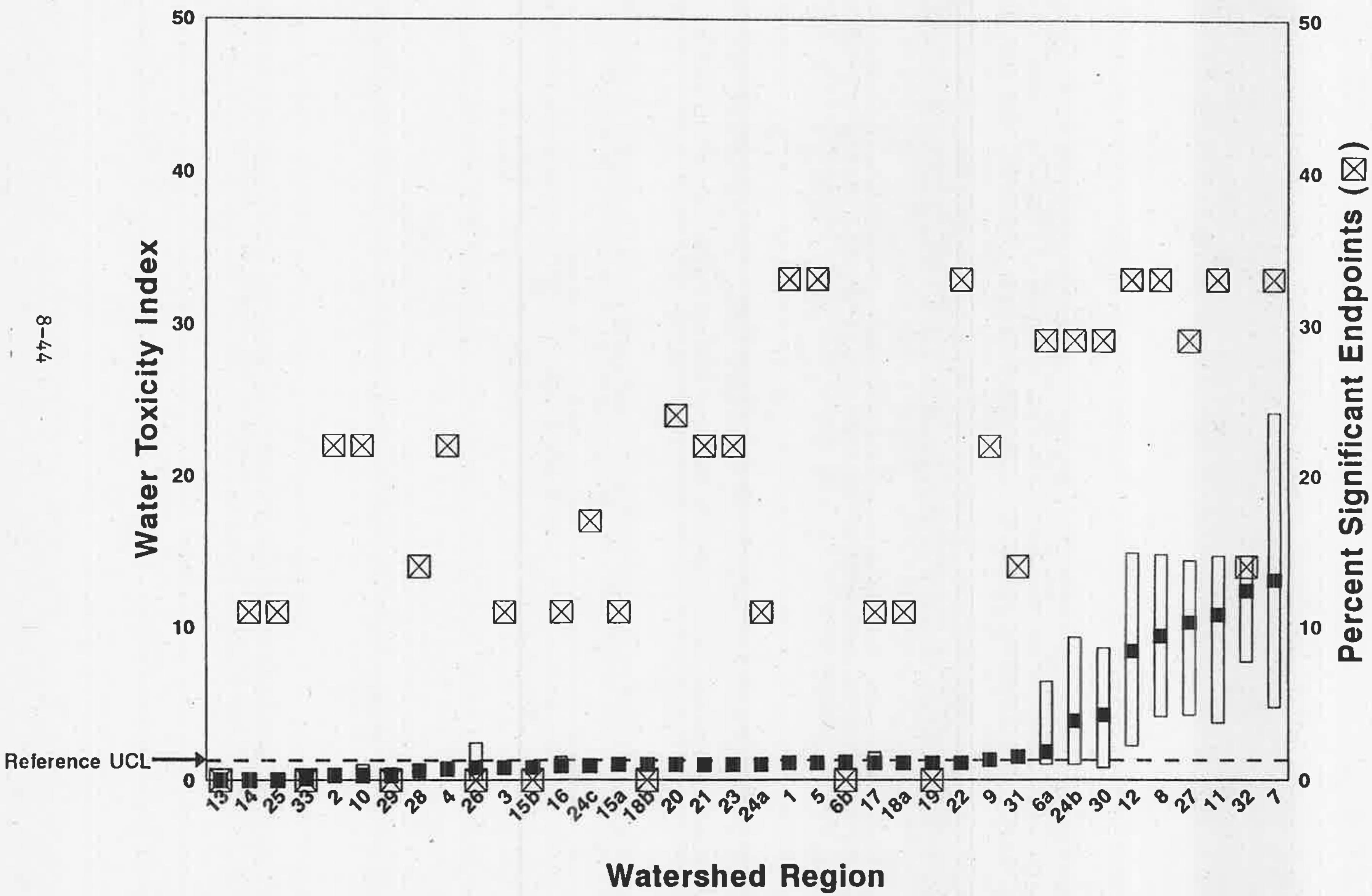


Figure 6.8 Toxicity Index results for the 1990 sediment data. (See Section 3.4 for a detailed description of presentation.)

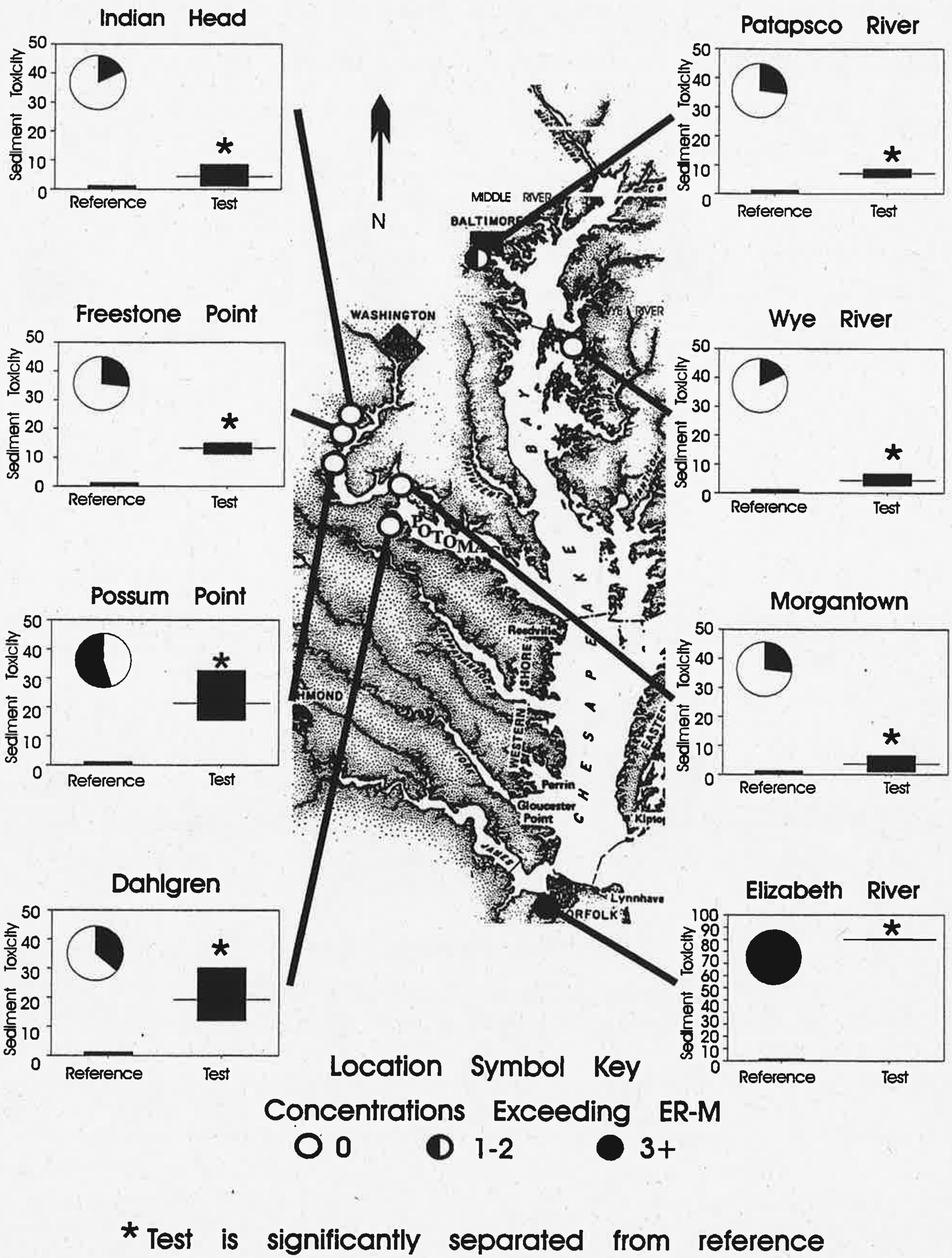


Figure 6.9 Toxicity Index results for the 1991 sediment data. (See Section 3.4 for a detailed description of presentation.)

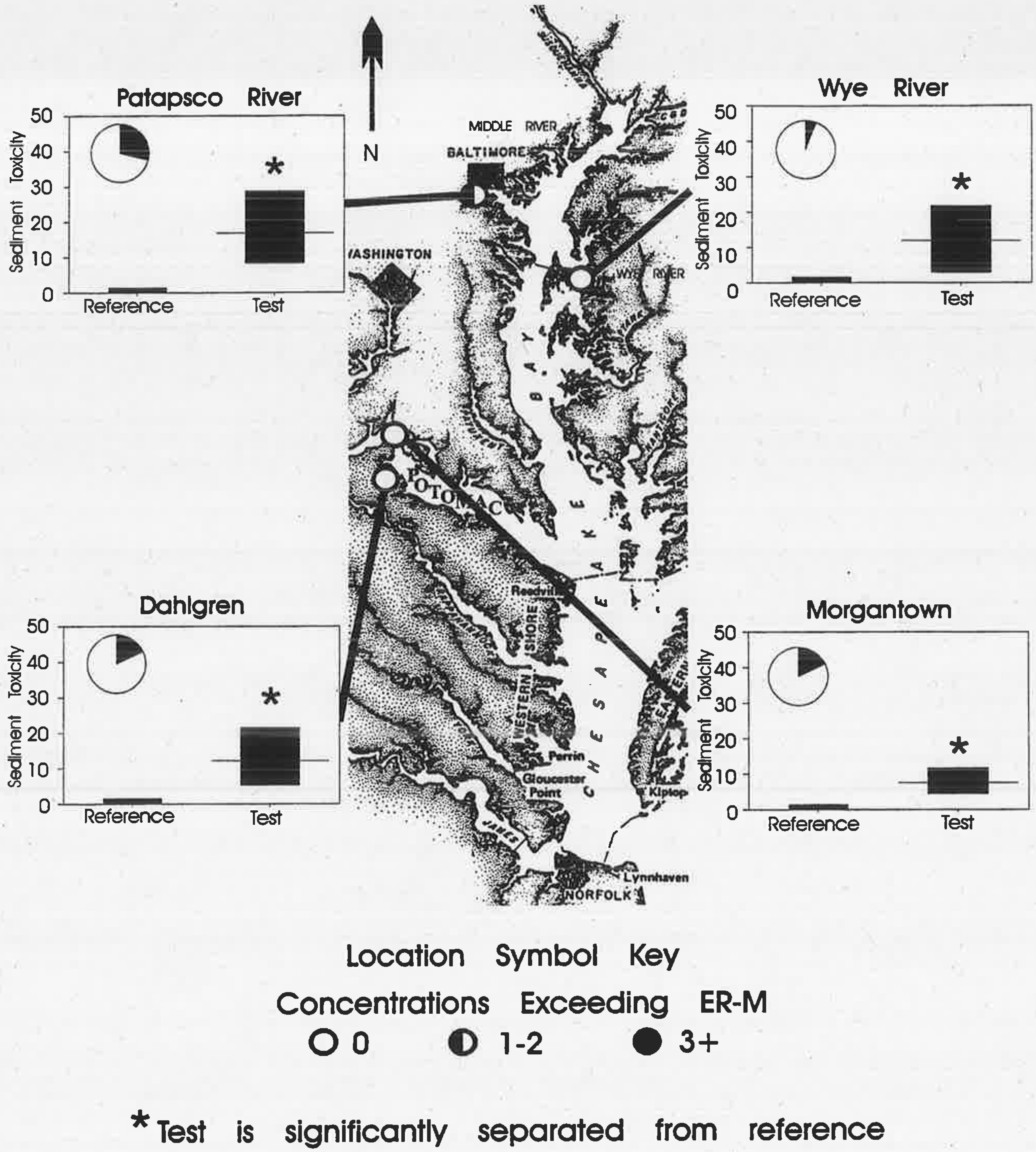


Figure 6.10 Toxicity Index results for 1992-1993 sediment data. (See Section 3.4 for a detailed description of presentation.)

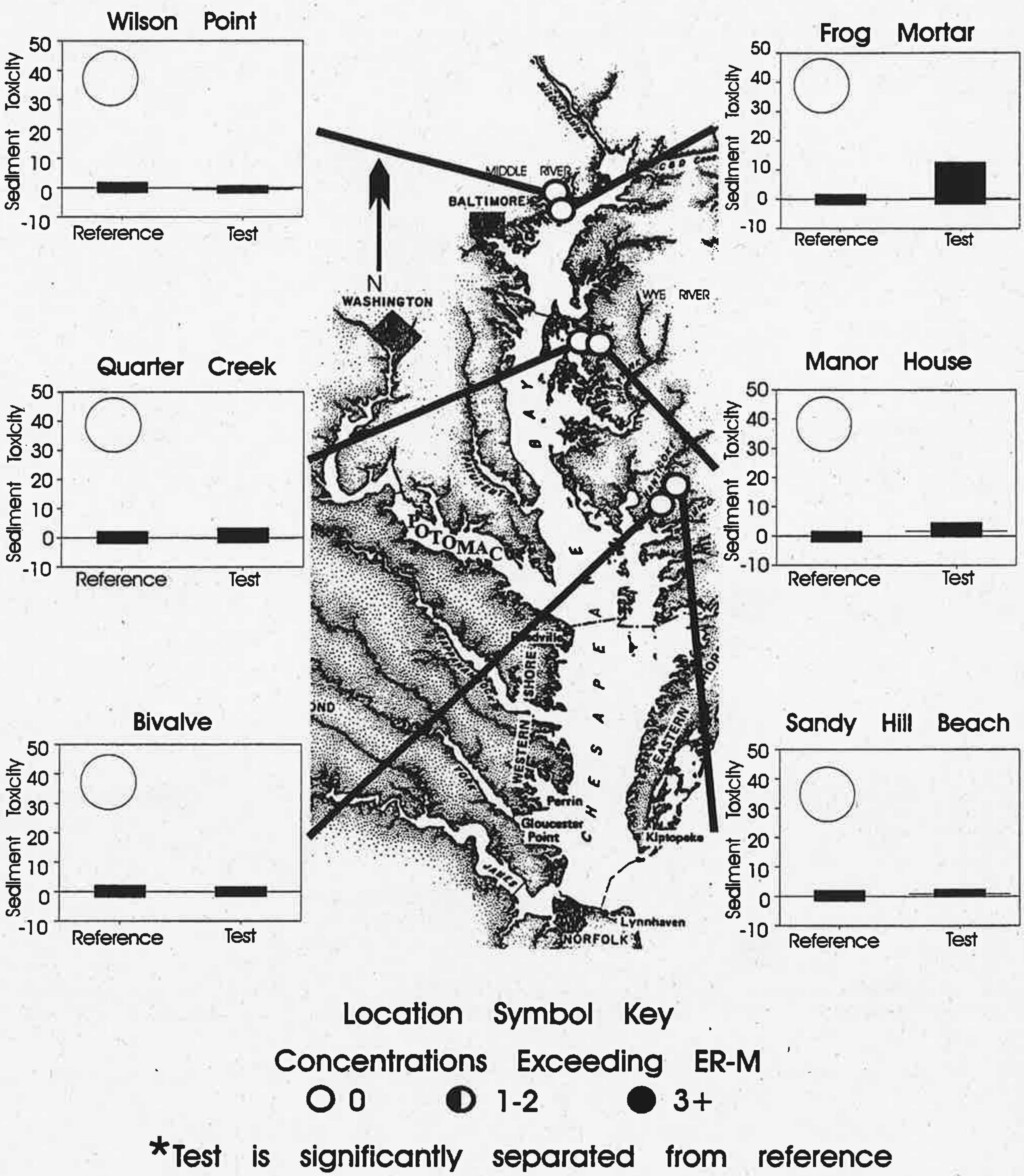


Figure 6.11a Toxicity Index results for the 1994 sediment data from the Severn, Magothy and Sassafras Rivers. (See Section 3.4 for a detailed description of presentation.)

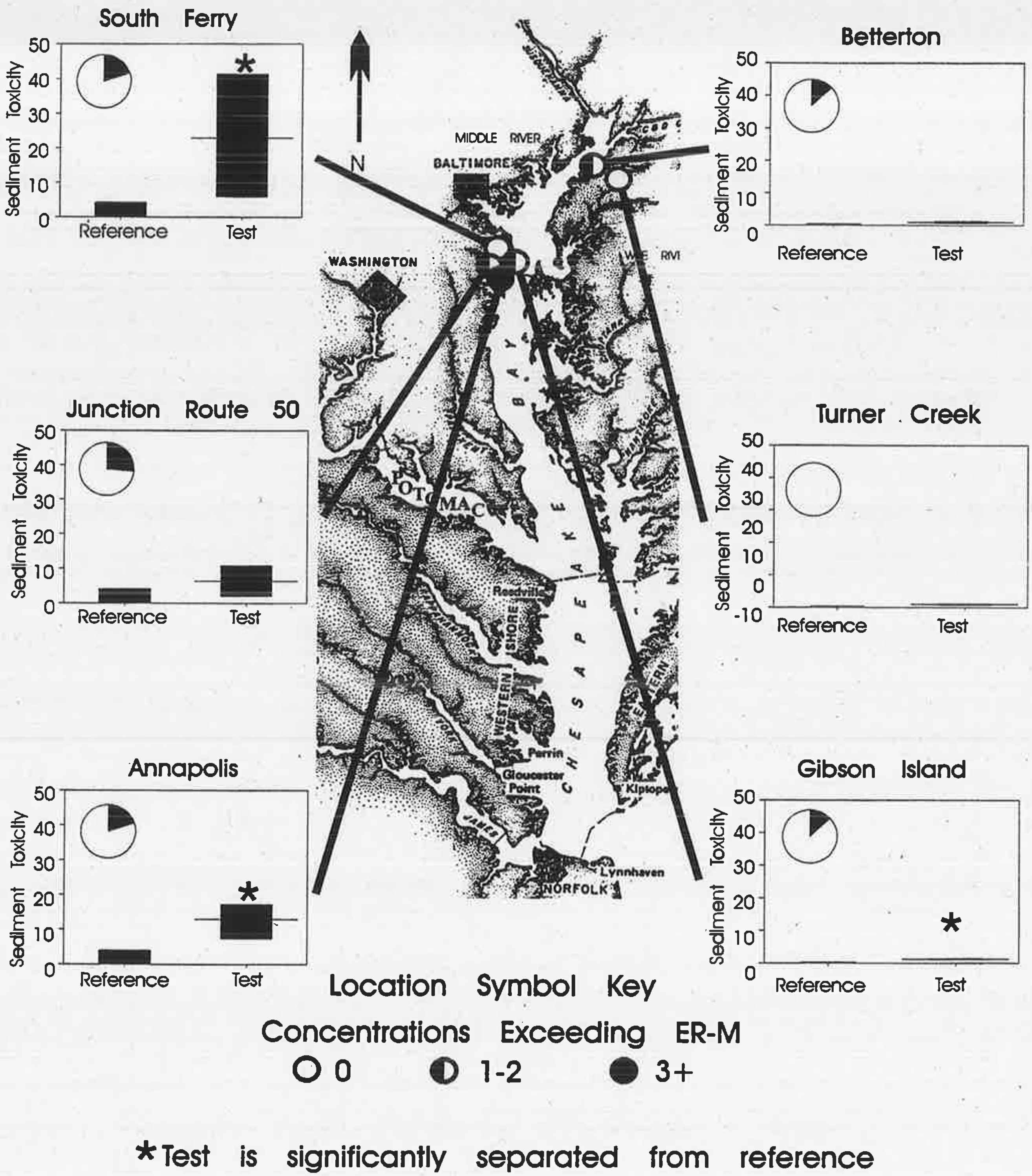


Figure 6.11b Toxicity Index results for the 1994 sediment data from Baltimore Harbor sites. (See Section 3.4 for a detailed description of presentation.)

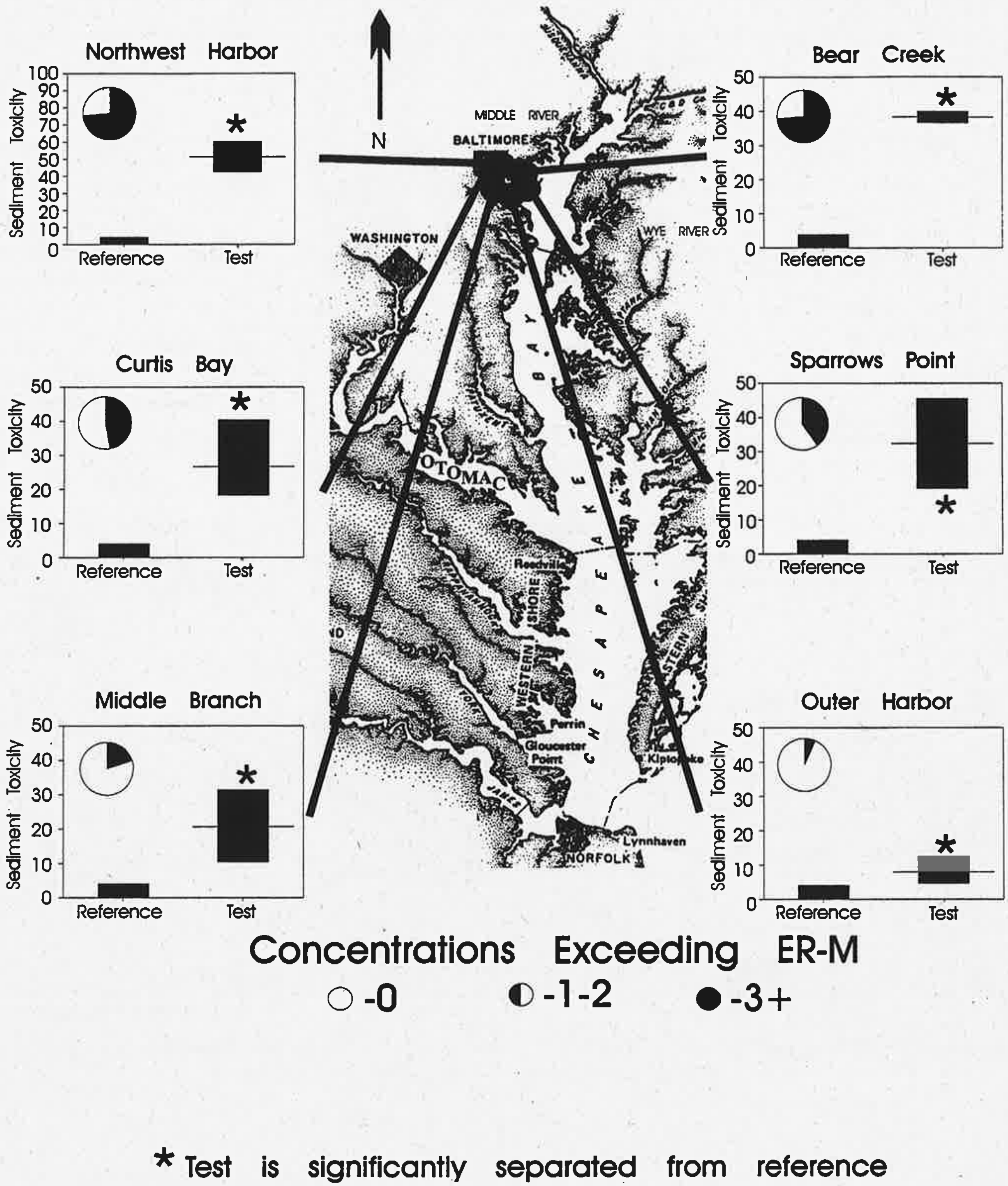


Figure 6.12 Toxicity Index results for the 1995 sediment data. (See Section 3.4 for detailed description of presentation.)

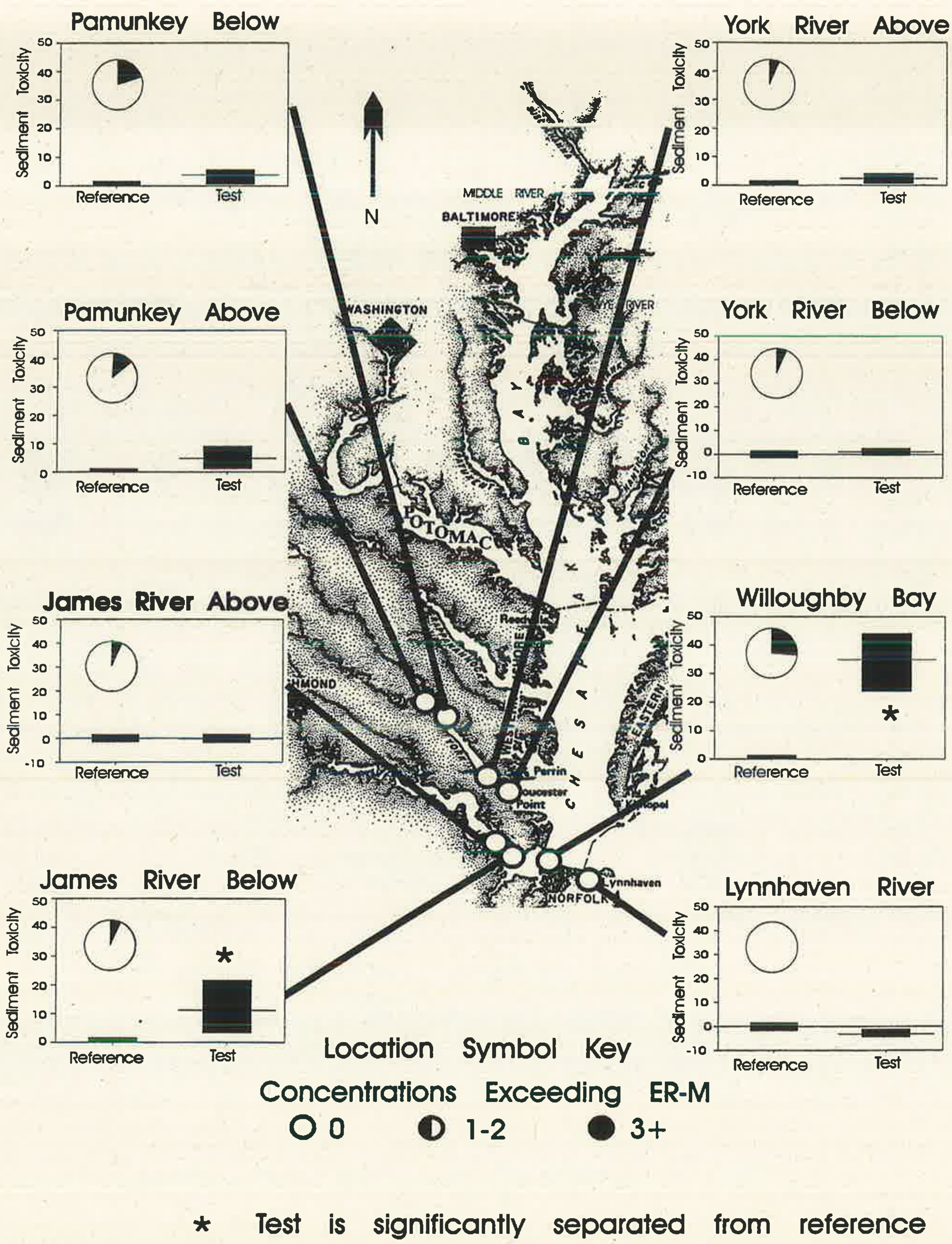


Figure 6.13 **Toxicity Index results for the 1996 sediment data. (See Section 3.4 for a detailed description of presentation.)**

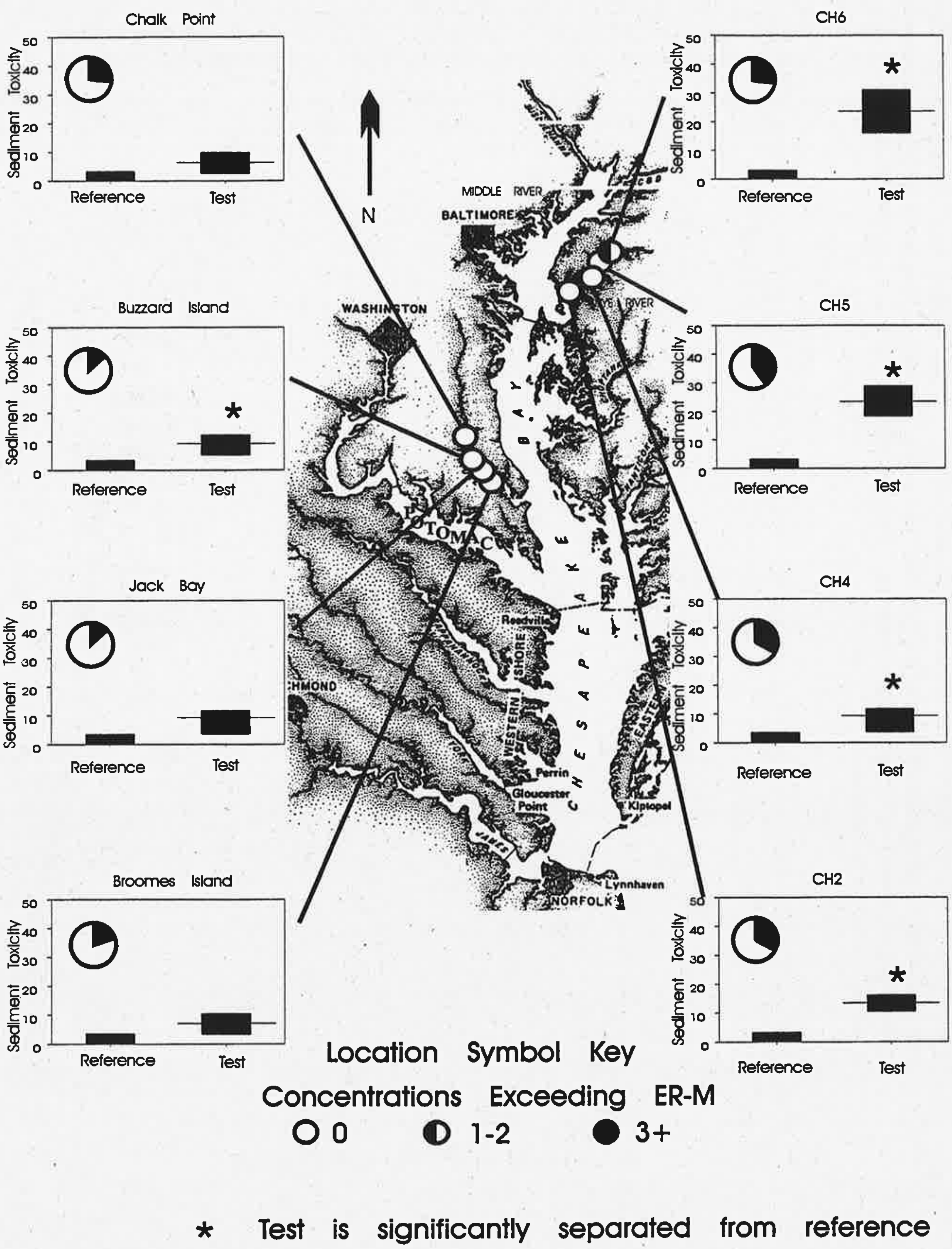
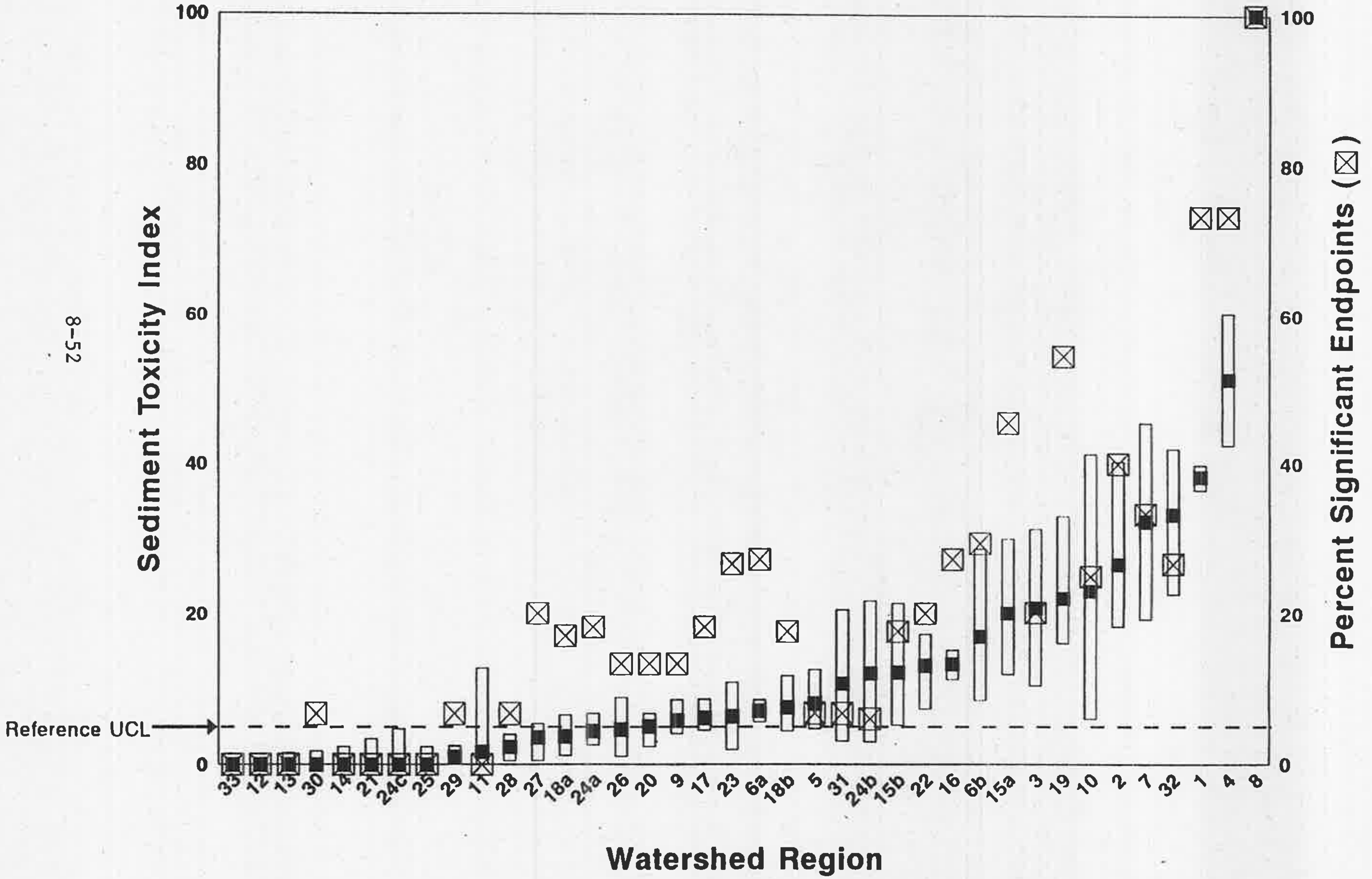


Figure 6.14 Summary of sediment Toxicity Index results for 1990-1996. The sites are ranked according to median Toxicity Index values. Also shown are the 95% confidence limits for the Toxicity Index values (open bars) and the percentage of endpoints displaying significant differences from the references. The dashed horizontal line is the maximum upper confidence limit observed for any reference during the study and is included as a general benchmark. The identities of the site numbers are provided in Table 6.2.



APPENDIX A

Pesticides and semi-volatile compounds
data from sediment toxicity tests

AMRL ECAL ORGANICS DATA SHEET
MATRIX SPIKE RECOVERY SEMI-VOLATILE COMPOUNDS

Contractor:	MDNR	Spike Log #:	MS1024
Contract ID:	Amtox '96	Spike Dup Log #:	MS1024d
Date Collected:	9/19-10/3/96	Sample Ref. #:	50183
Date Received:	10/10/96		
Date Extracted:	10/24/96		
Date Analyzed:	12/3/96		
Instrument:	Finnigan MAT Incos 50		
Analyst:	RJM II		
Method:	USEPA 8270 modified		
Data File Path:	f:\organics\analysis\bna\sed\qc\spike		
Data File:	amtox.xls		
Historical Data File:			

Reference Number	Compound	Spike Amt.	Sample ug/l	MS Conc. ug/l	Final Vol.	MSD Conc. ug/l	Final Vol.	MS % Recovery	MSD % Recovery	% RPD	QC LIMITS * % RPD	% Rec.
4	2-CHLOROPHENOL	1ML	200	77.7	38.9	73.6	36.8	38.9	36.8	5	40	27-123
5	PHENOL	1ML	200	174.1	87	166.1	83.1	87.0	83.1	5	42	12-89
6	1,4-DICHLOROBENZENE	1ML	100	52.1	52.1	44.4	44.4	52.1	44.4	16	28	36-97
7	N-NITROSO-DI-N-PROPYLA	1ML	100	70.2	70.2	69.7	69.7	70.2	69.7	1	38	41-116
10	1,2,4-TRICHLOROBENZENE	1ML	100	76.7	76.7	69.8	69.8	76.7	69.8	9	28	39-98
11	4-CHLORO-3-METHYLPHEN	1ML	200	180.7	90.3	183.9	92	90.3	92.0	2	42	23-97
15	ACENAPHTHENE	1ML	100	92.9	92.9	91.3	91.3	92.9	91.3	2	31	46-118
16	4-NITROPHENOL	1ML	200	225.2	112.6	216.2	108.1	112.6	108.1	4	50	10-80
17	2,4-DINITROTOLUENE	1ML	100	151.3	151.3	147.1	147.1	151.3	147.1	3	38	24-96
20	PENTACHLORPHENOL	1ML	200	133.7	66.8	134.0	67	66.8	67.0	0	50	9-103
22	PYRENE	1ML	100	144.5	144.5	150.3	150.3	144.5	150.3	4	31	26-127

* USEPA SW-846. AMRL acceptance values derived from historical data
This is for sediment matrix spikes where the final volume is 1 ml.

SURROGATE RECOVERY SEMI-VOLATILE COMPOUNDS

Contractor:	MDNR
Contract ID:	Amtox '96
Date Collected:	9/19-10/3/96
Date Received:	10/10/96
Date Extracted:	10/24/96
Date Analyzed:	12/3/96
Instrument:	Finnigan MAT Incos 50
Analyst:	RJM II
Method:	USEPA 8270 modified
Data File Path:	f:\organics\analysis\bna\sed\qc\surr
Data File:	amtox.xls
Historical Data File:	

AMRL Log Number	NBZ (ug/ml	% Recov	FBP(ug/ml	% Recov	TPH(ug/ml	%Recov	PHL(ug/ml	%Recov	2FP(ug/ml)	%Recov	TBP(ug/ml	%Recov
BLK1024	28.177	28.2	86.369	86.4	76.94	76.9	60.185	30.1	121.335	60.7	146.71	73.4
50182	38.37	38.4	102.804	102.8	80.801	80.8	79.357	39.7	151.083	75.5	142.403	71.2
50183	35.5	35.5	96.076	96.1	80.924	80.9	76.248	38.1	155.171	77.6	149.137	74.6
50184	20.224	20.2	93.077	93.1	81.779	81.8	58.161	29.1	46.752	23.4	147.21	73.6
50185	39.838	39.8	99.501	99.5	83.348	83.3	82.796	41.4	56.597	28.3	139.944	70.0
50186	39.346	39.3	100.895	100.9	78.578	78.6	78.896	39.4	155.21	77.6	129.629	64.8
50187	39.324	39.3	100.661	100.7	83.178	83.2	76.491	38.2	150.968	75.5	146.464	73.2
50188	37.082	37.1	101.357	101.4	74.057	74.1	77.48	38.7	51.392	25.7	134.319	67.2
50189	33.299	33.3	95.521	95.5	77.039	77.0	69.381	34.7	126.944	63.5	131.331	65.7
50190	36.258	36.3	92.098	92.1	76.427	76.4	73.766	36.9	137.501	68.8	118.921	59.5
50191	38.07	38.1	94.263	94.3	78.185	78.2	77.828	38.9	158.061	79.0	134.154	67.1
50192	39.359	39.4	97.194	97.2	81.54	81.5	79.407	39.7	165.825	82.9	133.504	66.8
MS1024	43.409	43.4	103.877	103.9	85.448	85.4	84.153	42.1	165.156	82.6	152.403	76.2
MS1024d	38.642	38.6	101.847	101.8	81.351	81.4	80.568	40.3	148.081	74.0	146.491	73.2

Compound	QC Limit *
Nitrobenzene (NBZ)	23-120
2-Fluorobiphenyl (FBP)	30-115
Terphenyl (TPH)	18-137
Phenol (PHL)	24-113
2-Fluorophenol (2FP)	25-121
2,4,6-Tribromophenol (TBP)	19-122

* USEPA SW-846 Table 8. AMRL Acceptance Values Based on Historical Data

This template is for a BNA sediment extraction with a 1 ml final volume

SURROGATE RECOVERY SEMI-VOLATILE COMPOUNDS

Contractor:	MDNR
Contract ID:	Amtox '96
Date Collected:	9/19-10/3/96
Date Received:	10/10/96
Date Extracted:	10/24/96
Date Analyzed:	12/3/96
Instrument:	Finnigan MAT Incos 50
Analyst:	RJM II
Method:	USEPA 8270 modified
Data File Path:	f:\organics\analysis\bna\sed\qc\surr
Data File:	amtox.xls
Historical Data File:	

	NBZ	FBP	TPH	PHL	2FP	TBP
Sample #	% Recov	% Recov	%Recov	%Recov	%Recov	%Recov
BLK1024	28.2	86.4	76.9	30.1	60.7	73.4
50182	38.4	102.8	80.8	39.7	75.5	71.2
50183	35.5	96.1	80.9	38.1	77.6	74.6
50184	20.2	93.1	81.8	29.1	23.4	73.6
50185	39.8	99.5	83.3	41.4	28.3	70.0
50186	39.3	100.9	78.6	39.4	77.6	64.8
50187	39.3	100.7	83.2	38.2	75.5	73.2
50188	37.1	101.4	74.1	38.7	25.7	67.2
50189	33.3	95.5	77.0	34.7	63.5	65.7
50190	36.3	92.1	76.4	36.9	68.8	59.5
50191	38.1	94.3	78.2	38.9	79.0	67.1
50192	39.4	97.2	81.5	39.7	82.9	66.8
MS1024	43.4	103.9	85.4	42.1	82.6	76.2
MS1024d	38.6	101.8	81.4	40.3	74.0	73.2

Compound	QC Limit *
Nitrobenzene (NBZ)	23-120
2-Fluorobiphenyl (FBP)	30-115
Terphenyl (TPH)	18-137
Phenol (PHL)	24-113
2-Fluorophenol (2FP)	25-121
2,4,6-Tribromophenol (TBP)	19-122

* USEPA SW-846 Table 8. AMRL Acceptance Values Based on Historical Data

This template is for a BNA sediment extraction with a 1 ml final volume

AMRL

ORGANICS ANALYSIS DATA SHEET

POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Method Blank
Contract No.:	363831	Sample No.:	BLK1024
Date Collected:	N/A	Matrix:	Glassware
Date Received:	N/A	Sample wt.(g):	
Date Extracted:	10/24/96	Wet Wt:	
Date Analyzed:	12/03/96	Dry Wt:	
Instrument:	Finnigan MAT Incos-50	Pan Wt:	
Analyst:	RJM II	% Moisture:	#DIV/0!
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL Data File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	blk1024.xls		

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			#DIV/0!	#DIV/0!	4.60E+00
208-96-8	Acenaphthalene			#DIV/0!	#DIV/0!	5.90E+00
83-32-9	Acenaphthene			#DIV/0!	#DIV/0!	9.90E+00
86-73-7	Fluorene			#DIV/0!	#DIV/0!	9.90E+00
85-01-8	Phenanthrene			#DIV/0!	#DIV/0!	9.20E+00
120-12-7	Anthracene			#DIV/0!	#DIV/0!	9.90E+00
206-44-0	Fluoranthene			#DIV/0!	#DIV/0!	1.06E+01
129-00-0	Pyrene			#DIV/0!		1.06E+01
56-55-3	Benzo(a)anthracene			#DIV/0!		1.78E+01
218-01-9	Chrysene			#DIV/0!		1.45E+01
205-99-2	Benzo(b)fluoranthene			#DIV/0!		1.39E+01
207-08-9	Benzo(k)fluoranthene			#DIV/0!		1.39E+01
50-32-8	Benzo(a)pyrene			#DIV/0!		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			#DIV/0!		1.65E+01
53-70-3	Dibenz(a,h)anthracene			#DIV/0!	#DIV/0!	1.78E+01
191-24-2	Benzo(g,h,i)perylene			#DIV/0!	#DIV/0!	1.65E+01

BDL - Below detection limit.

J - Compound detected below the calculated method detection limit.

B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Method Blank
Contract No.:	363831	Sample No.:	BLK1024
Date Collected:	9/26/96	Matrix:	Glassware
Date Received:	10/15/96	Sample wt.(g):	
Date Extracted:	10/24/96	Wet Wt:	
Date Analyzed:	12/03/96	Dry Wt:	
Instrument:	Finnigan MAT Incos-50	Pan Wt:	
Analyst:	RJM II	% Moisture:	#DIV/0!
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL Data File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	blk1024.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: MDNR
Contract ID: AMTOX '96
Contract No.: 363831
Date Collected: 09/27/96
Date Received: 10/10/96
Date Extracted: 10/24/96
Date Analyzed: 12/03/96
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: f:\organics\analysis\pah\mstplate\sed\amtox
AMRL Data File: 50192.xls

Laboratory: Organics
Sample ID: Brooms Island
Sample No.: 50192
Matrix: Sediment
Sample wt.(g): 30.6
Wet Wt: 18.7
Dry Wt: 12.7
Pan Wt: 1.59
% Moisture: 35.3
GPC(yes=2,no=1) 2
Data Released By: Rob McDaniel II

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		[illegible].52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Brooms Island
Contract No.:	363831	Sample No.:	50192
Date Collected:	09/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.6
Date Extracted:	10/24/96	Wet Wt:	18.7
Date Analyzed:	12/03/96	Dry Wt:	12.7
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	35.3
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50192.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: MDNR
Contract ID: AMTOX '96
Contract No.: 363831
Date Collected: 09/27/96
Date Received: 10/10/96
Date Extracted: 10/24/96
Date Analyzed: 12/03/96
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: f:\organics\analysis\pah\mstplate\sed\amtox
AMRL Data File: 50191.xls

Laboratory: Organics
Sample ID: Jack Bay
Sample No.: 50191
Matrix: Sediment
Sample wt.(g): 30.2
Wet Wt: 15.7
Dry Wt: 9.81
Pan Wt: 1.59
% Moisture: 41.9
GPC(yes=2,no=1) 2
Data Released By: Rob McDaniel II

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Jack Bay
Contract No.:	363831	Sample No.:	50191
Date Collected:	09/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.2
Date Extracted:	10/24/96	Wet Wt:	15.7
Date Analyzed:	12/03/96	Dry Wt:	9.81
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	41.9
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50191.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Buzzard Island
Contract No.:	363831	Sample No.:	50190
Date Collected:	09/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30
Date Extracted:	10/24/96	Wet Wt:	11.8
Date Analyzed:	12/03/96	Dry Wt:	4.57
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	70.9
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50190.xls		

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Buzzard Island
Contract No.:	363831	Sample No.:	50190
Date Collected:	09/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30
Date Extracted:	10/24/96	Wet Wt:	11.8
Date Analyzed:	12/03/96	Dry Wt:	4.57
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	70.9
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50190.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: MDNR
Contract ID: AMTOX '96
Contract No.: 363831
Date Collected: 09/27/96
Date Received: 10/10/96
Date Extracted: 10/24/96
Date Analyzed: 12/03/96
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: f:\organics\analysis\pah\mstplate\sed\amtox
AMRL Data File: 50189.xls

Laboratory: Organics
Sample ID: Chalk Point
Sample No.: 50189
Matrix: Sediment
Sample wt.(g): 30
Wet Wt: 11.5
Dry Wt: 4.59
Pan Wt: 1.6
% Moisture: 69.7
GPC(yes=2,no=1) 2
Data Released By: Rob McDaniel II

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Chalk Point
Contract No.:	363831	Sample No.:	50189
Date Collected:	09/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30
Date Extracted:	10/24/96	Wet Wt:	11.5
Date Analyzed:	12/03/96	Dry Wt:	4.59
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.6
Analyst:	RJM II	% Moisture:	69.7
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50189.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: MDNR
Contract ID: AMTOX '96
Contract No.: 363831
Date Collected: 09/26/96
Date Received: 10/10/96
Date Extracted: 10/24/96
Date Analyzed: 12/03/96
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: f:\organics\analysis\pah\mstplate\sed\amtox
AMRL Data File: 50188.xls

Laboratory: Organics
Sample ID: CH-2
Sample No.: 50188
Matrix: Sediment
Sample wt.(g): 30.5
Wet Wt: 17.5
Dry Wt: 7.62
Pan Wt: 1.61
% Moisture: 62.2
GPC(yes=2,no=1) 2
Data Released By: Rob McDaniel II

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	CH-2
Contract No.:	363831	Sample No.:	50188
Date Collected:	09/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.5
Date Extracted:	10/24/96	Wet Wt:	17.5
Date Analyzed:	12/03/96	Dry Wt:	7.62
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	62.2
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50188.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	CH-4
Contract No.:	363831	Sample No.:	50187
Date Collected:	09/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.1
Date Extracted:	10/24/96	Wet Wt:	16.4
Date Analyzed:	12/03/96	Dry Wt:	7.17
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	62.5
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50187.xls		

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL

ORGANICS ANALYSIS DATA SHEET

POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	CH-4
Contract No.:	363831	Sample No.:	50187
Date Collected:	09/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.1
Date Extracted:	10/24/96	Wet Wt:	16.4
Date Analyzed:	12/03/96	Dry Wt:	7.17
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	62.5
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50187.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: MDNR
Contract ID: AMTOX '96
Contract No.: 363831
Date Collected: 09/26/96
Date Received: 10/10/96
Date Extracted: 10/24/96
Date Analyzed: 12/03/96
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: f:\organics\analysis\pah\mstplate\sed\amtox
AMRL Data File: 50186.xls

Laboratory: Organics
Sample ID: CH-5
Sample No.: 50186
Matrix: Sediment
Sample wt.(g): 30.3
Wet Wt: 14
Dry Wt: 5.2
Pan Wt: 1.59
% Moisture: 70.8
GPC(yes=2,no=1) 2
Data Released By: Rob McDaniel II

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	CH-5
Contract No.:	363831	Sample No.:	50186
Date Collected:	09/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.3
Date Extracted:	10/24/96	Wet Wt:	14
Date Analyzed:	12/03/96	Dry Wt:	5.2
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	70.8
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50186.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	CH-6
Contract No.:	363831	Sample No.:	50185
Date Collected:	09/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.8
Date Extracted:	10/24/96	Wet Wt:	15.8
Date Analyzed:	12/03/96	Dry Wt:	6.1
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.6
Analyst:	RJM II	% Moisture:	68.4
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50185.xls		

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg`dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	CH-6
Contract No.:	363831	Sample No.:	#####
Date Collected:	09/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.8
Date Extracted:	10/24/96	Wet Wt:	15.8
Date Analyzed:	12/03/96	Dry Wt:	6.1
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.6
Analyst:	RJM II	% Moisture:	68.4
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50185.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Poropotank River
Contract No.:	363831	Sample No.:	50184
Date Collected:	10/03/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.1
Date Extracted:	10/24/96	Wet Wt:	12.9
Date Analyzed:	12/03/96	Dry Wt:	4.36
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	75.6
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50184.xls		

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR
Contract ID:	AMTOX '96
Contract No.:	363831
Date Collected:	10/03/96
Date Received:	10/10/96
Date Extracted:	10/24/96
Date Analyzed:	12/03/96
Instrument:	Finnigan MAT Incos-50
Analyst:	RJM II
Method:	USEPA 8270 modified
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox
AMRL Data File:	50184.xls

Laboratory:	Organics
Sample ID:	Poropotank River
Sample No.:	50184
Matrix:	Sediment
Sample wt.(g):	30.1
Wet Wt:	12.9
Dry Wt:	4.36
Pan Wt:	1.61
% Moisture:	75.6
GPC(yes=2,no=1)	2
Data Released By:	Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Pleasurehouse Creek
Contract No.:	363831	Sample No.:	50183
Date Collected:	09/19/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.6
Date Extracted:	10/24/96	Wet Wt:	27.4
Date Analyzed:	12/03/96	Dry Wt:	22.4
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	19.2
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50183.xls		

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Lynnhaven Sand
Contract No.:	363831	Sample No.:	50183
Date Collected:	09/19/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.6
Date Extracted:	10/24/96	Wet Wt:	27.4
Date Analyzed:	12/03/96	Dry Wt:	22.4
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	19.2
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50183.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: MDNR
Contract ID: AMTOX '96
Contract No.: 363831
Date Collected: 9/19/96
Date Received: 10/10/96
Date Extracted: 10/24/96
Date Analyzed: 12/03/96
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: f:\organics\analysis\pah\mstplate\sed\amtox
AMRL Data File: 50182.xls

Laboratory: Organics
Sample ID: Lynnhaven Mud
Sample No.: 50182
Matrix: Sediment
Sample wt.(g): 30.6
Wet Wt: 12.4
Dry Wt: 6.64
Pan Wt: 1.59
% Moisture: 53.2
GPC(yes=2,no=1) 2
Data Released By: Rob McDaniel II

CAS #	Compound	Blk Conc. (ug/ml)	Smp Conc. (ug/ml)	Sample Conc. (ug/kg dry)	Tag	Det. Limit (ug/kg dry)
91-20-3	Naphthalene			0.00E+00		4.60E+00
208-96-8	Acenaphthalene			0.00E+00		5.90E+00
83-32-9	Acenaphthene			0.00E+00		9.90E+00
86-73-7	Fluorene			0.00E+00		9.90E+00
85-01-8	Phenanthrene			0.00E+00		9.20E+00
120-12-7	Anthracene			0.00E+00		9.90E+00
206-44-0	Fluoranthene			0.00E+00		1.06E+01
129-00-0	Pyrene			0.00E+00		1.06E+01
56-55-3	Benzo(a)anthracene			0.00E+00		1.78E+01
218-01-9	Chrysene			0.00E+00		1.45E+01
205-99-2	Benzo(b)fluoranthene			0.00E+00		1.39E+01
207-08-9	Benzo(k)fluoranthene			0.00E+00		1.39E+01
50-32-8	Benzo(a)pyrene			0.00E+00		1.52E+01
193-39-5	Indeno(1,2,3-c,d)pyrene			0.00E+00		1.65E+01
53-70-3	Dibenz(a,h)anthracene			0.00E+00		1.78E+01
191-24-2	Benzo(g,h,i)perylene			0.00E+00		1.65E+01

BDL - Below detection limit.
J - Compound detected below the calculated method detection limit.
B - Compound detected in the QC Blank.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	AMTOX '96	Sample ID:	Lynnhaven Mud
Contract No.:	363831	Sample No.:	50182
Date Collected:	9/19/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.6
Date Extracted:	10/24/96	Wet Wt:	12.4
Date Analyzed:	12/03/96	Dry Wt:	6.64
Instrument:	Finnigan MAT Incos-50	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	53.2
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pah\mstplate\sed\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50182.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
	None Detected			

SURROGATE RECOVERY ORGANOCHLORINE COMPOUNDS

Contractor: MDNR
Contract ID: Amtox '96
Date Collected: 9/19-10/3/96
Date Received: 10/10/96
Date Extracted: 11/20/96
Date Analyzed: 12/13/96
Instrument: PE Autosystem
Analyst: RJM II
Method: USEPA 8081 modified
Data File Path: f:\organics\analysis\pest\data\amtox
Data File: surr.xls
Historical Data File:
GPC(1=no,2-yes): 2

Surrogate Recovery Limits: 60-15-%

AMRL Log No.	TCMX Added (ng/ml) FV	DCB Added (ng/ml) FV	TCMX Conc. (ng/ml) FV	DCB Conc. (ng/ml) FV	TCMX Percent Recovery	DCB Percent Recovery
blk1120	400	400	120	175	60	87.5
50182	400	400	114	132	57	66
50183	400	400	148	220	74	110
50184	400	400	181	183	90.5	91.5
50185	400	400	154	212	77	106
50186	400	400	196	199	98	99.5
50187	400	400	175	197	87.5	98.5
50188	400	400	179	177	89.5	88.5
50189	400	400	166	229	83	114.5
50190	400	400	175	172	87.5	86
50191	400	400	141	176	70.5	88
50192	400	400	168	188	84	94
ms1120	400	400	144	198	72	99
ms1120d	400	400	136	208	68	104
	400	400			0	0
	400	400			0	0

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	Method Spike
Contract No.:	363831	Sample No.:	MS1120d
Date Collected:	N/A	Matrix:	Sediment
Date Received:	N/A	Sample wt. (g):	30.08
Date Extracted:	11/20/96	Wet Wt:	17.44
Date Analyzed:	12/13/96	Dry Wt:	14.31
Instrument:	PE Autosystem	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	19.7725837
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	ms1120d.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.36E+02		C	3.00E-03
391-84-6	alpha-BHC	BDL		U	7.14E-01
391-85-7	beta-BHC	2.4E-01	J	C	5.59E-01
58-89-9	Lindane	1.2E+00		C	6.16E-01
391-86-8	delta-BHC	4.3E-01	J	C	1.06E+00
76-44-8	Heptachlor	1.6E+00		C	8.19E-01
309-00-2	Aldrin	1.6E+00		C	6.08E-01
1024-57-3	Heptachlor Epoxide	4.4E-02	J	C	5.70E-01
959-98-8	Endosulfan I	2.6E-01	J	C	8.59E-01
60-57-1	Dieldrin	3.4E-01	J	C	8.98E-01
72-55-9	4,4'-DDE	2.9E+00		C	5.28E-01
72-20-8	Endrin	5.2E+00		C	1.24E+00
33213-65-9	Endosulfan II	BDL		U	8.59E-01
72-54-8	4,4'-DDD	4.2E-01	J	C	4.69E-01
7421-93-4	Endrin Aldehyde	4.0E+00		C	1.50E+00
1031-07-8	Endosulfan Sulfate	7.3E-01	J	C	1.50E+00
50-29-3	4,4'-DDT	6.1E+00		C	3.42E+00
53494-70-5	Endrin Ketone	1.8E+00		C	1.24E+00
72-43-5	Methoxychlor	2.6E+00	J	C	5.00E+00
1770-80-5	DCB (surr)	2.08E+02		C	

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AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	Method Spike
Contract No.:	363831	Sample No.:	MS1120
Date Collected:	N/A	Matrix:	Sediment
Date Received:	N/A	Sample wt.(g):	30.51
Date Extracted:	11/20/96	Wet Wt:	17.44
Date Analyzed:	12/13/96	Dry Wt:	14.31
Instrument:	PE Autosystem	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	19.7725837
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	ms1120.xls		

CAS #	Compound	Sample Conc. (ug/kg)dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.44E+02		C	3.00E-03
391-84-6	alpha-BHC	2.9E-01	J	C	7.14E-01
391-85-7	beta-BHC	2.0E-01	J	C	5.59E-01
58-89-9	Lindane	1.2E+00		C	6.16E-01
391-86-8	delta-BHC	2.8E-01	J	C	1.06E+00
76-44-8	Heptachlor	1.2E+00		C	8.19E-01
309-00-2	Aldrin	1.3E+00		C	6.08E-01
1024-57-3	Heptachlor Epoxide	4.1E-02	J	C	5.70E-01
959-98-8	Endosulfan I	2.2E-01	J	C	8.59E-01
60-57-1	Dieldrin	5.1E-01	J	C	8.98E-01
72-55-9	4,4'-DDE	3.0E+00		C	5.28E-01
72-20-8	Endrin	5.6E+00		C	1.24E+00
33213-65-9	Endosulfan II	BDL		U	8.59E-01
72-54-8	4,4'-DDD	3.5E-01	J	C	4.69E-01
7421-93-4	Endrin Aldehyde	5.0E+00		C	1.50E+00
1031-07-8	Endosulfan Sulfate	1.0E+00	J	C	1.50E+00
50-29-3	4,4'-DDT	6.2E+00		C	3.42E+00
53494-70-5	Endrin Ketone	2.4E+00		C	1.24E+00
72-43-5	Methoxychlor	4.2E+00	J	C	5.00E+00
1770-80-5	DCB (surr)	1.98E+02		C	

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AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	Method Blank
Contract No.:	363831	Sample No.:	blk1120
Date Collected:	9/19-10/3/96	Matrix:	Glassware
Date Received:	10/10/96	Sample wt.(g):	1
Date Extracted:	11/20/96	Wet Wt:	1
Date Analyzed:	12/13/96	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	0
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	blk1120.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.20E+02		C	3.00E-03
391-84-6	alpha-BHC	3.1E+00		C	7.14E-01
391-85-7	beta-BHC	1.8E+00		C	5.59E-01
58-89-9	Lindane	BDL			6.16E-01
391-86-8	delta-BHC	1.4E+01		U	1.06E+00
76-44-8	Heptachlor	BDL		U	8.19E-01
309-00-2	Aldrin	BDL		U	6.08E-01
1024-57-3	Heptachlor Epoxide	4.6E-01	J	C	5.70E-01
959-98-8	Endosulfan I	4.2E+00			8.59E-01
60-57-1	Dieldrin	1.3E+01			8.98E-01
72-55-9	4,4'-DDE	5.5E+00		C	5.28E-01
72-20-8	Endrin	5.9E+01			1.24E+00
33213-65-9	Endosulfan II	8.2E+00		C	8.59E-01
72-54-8	4,4'-DDD	BDL		U	4.69E-01
7421-93-4	Endrin Aldehyde	1.1E+02		C	1.50E+00
1031-07-8	Endosulfan Sulfate	BDL		U	1.50E+00
50-29-3	4,4'-DDT	BDL		U	3.42E+00
53494-70-5	Endrin Ketone	4.0E+01		C	1.24E+00
72-43-5	Methoxychlor	1.4E+02		C	5.00E+00
1770-80-5	DCB (surr)	1.75E+02		C	
	Total PCBs	2.1E+00	J		2.06E+01

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BDL - Below detection limit

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	Brooms Island
Contract No.:	363831	Sample No.:	50192
Date Collected:	9/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.46
Date Extracted:	11/20/96	Wet Wt:	18.72
Date Analyzed:	12/13/96	Dry Wt:	12.67
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	35.31815528
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50192.xls		

CAS #	Compound	Sample Conc. (ug/kg)dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.68E+02		C	3.00E-03
60-57-1	Dieldrin	3.6E-01	J	C	8.98E-01
72-55-9	4,4'-DDE	4.5E-01	J	C	5.28E-01
72-54-8	4,4'-DDD	2.5E-01	J		4.69E-01
50-29-3	4,4'-DDT	3.1E+00		C	1.24E+00
1770-80-5	DCB (surr)	1.88E+02		C	
	Total PCBs	BDL			2.06E+01

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J - Compound detected below calculated method detection limit
BDL - Below detection limit

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	Jack Bay
Contract No.:	363831	Sample No.:	50191
Date Collected:	9/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.16
Date Extracted:	11/20/96	Wet Wt:	15.74
Date Analyzed:	12/13/96	Dry Wt:	9.81
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	41.90812721
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50191.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.41E+02		C	3.00E-03
60-57-1	Dieldrin	6.7E-01	J		8.98E-01
72-55-9	4,4'-DDE	5.6E-01		C	5.28E-01
72-54-8	4,4'-DDD	8.2E-02	J		4.69E-01
50-29-3	4,4'-DDT	4.6E+00		C	1.24E+00
1770-80-5	DCB (surr)	1.76E+02		C	
	Total PCBs	BDL			2.06E+01

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BDL - Below detection limit

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	Buzzard Island
Contract No.:	363831	Sample No.:	50190
Date Collected:	9/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.2
Date Extracted:	11/20/96	Wet Wt:	11.79
Date Analyzed:	12/13/96	Dry Wt:	4.57
Instrument:	PE Autosystem	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	70.92337917
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50190.xls		

CAS #	Compound	Sample Conc. (ug/kg)dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.75E+02		C	3.00E-03
60-57-1	Dieldrin	9.9E-01			8.98E-01
72-55-9	4,4'-DDE	1.1E+00			5.28E-01
72-54-8	4,4'-DDD	BDL		U	4.69E-01
50-29-3	4,4'-DDT	6.1E+00		C	1.24E+00
1770-80-5	DCB (surr)	1.72E+02		C	
	Total PCBs	BDL			2.06E+01

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AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID;	Amtox '96	Sample ID:	Chalk Point
Contract No.:	363831	Sample No.:	50189
Date Collected:	9/27/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.09
Date Extracted:	11/20/96	Wet Wt:	11.46
Date Analyzed:	12/13/96	Dry Wt:	4.59
Instrument:	PE Autosystem	Pan Wt:	1.6
Analyst:	RJM II	% Moisture:	69.67545639
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50189.xls		

CAS #	Compound	Sample Conc. (ug/kg)dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.66E+02		C	3.00E-03
60-57-1	Dieldrin	1.8E+00		C	8.98E-01
72-55-9	4,4'-DDE	3.0E+00		C	5.28E-01
72-54-8	4,4'-DDD	BDL		U	4.69E-01
50-29-3	4,4'-DDT	3.9E+01		C	1.24E+00
1770-80-5	DCB (surr)	2.29E+02		C	
	Total PCBs	1.1E+00	J		2.06E+01

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AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	CH-2
Contract No.:	363831	Sample No.:	50188
Date Collected:	9/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	29.92
Date Extracted:	11/20/96	Wet Wt:	17.53
Date Analyzed:	12/13/96	Dry Wt:	7.62
Instrument:	PE Autosystem	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	62.24874372
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50188.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.79E+02		C	3.00E-03
60-57-1	Dieldrin	2.4E+00		C	8.98E-01
72-55-9	4,4'-DDE	1.4E+00		C	5.28E-01
72-54-8	4,4'-DDD	3.6E-01	J	C	4.69E-01
50-29-3	4,4'-DDT	4.3E+00		C	1.24E+00
1770-80-5	DCB (surr)	1.77E+02		C	
	Total PCBs	1.5E-01	J		2.06E+01

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AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	CH-4
Contract No.:	363831	Sample No.:	50187
Date Collected:	9/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.01
Date Extracted:	11/20/96	Wet Wt:	16.42
Date Analyzed:	12/13/96	Dry Wt:	7.17
Instrument:	PE Autosystem	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	62.45779878
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50187.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.75E+02		C	3.00E-03
60-57-1	Dieldrin	1.6E+00			8.98E-01
72-55-9	4,4'-DDE	2.3E+00		C	5.28E-01
72-54-8	4,4'-DDD	4.5E-01	J	C	4.69E-01
50-29-3	4,4'-DDT	5.5E+00		C	1.24E+00
1770-80-5	DCB (surr)	1.97E+02		C	
	Total PCBs	1.9E-01	J		2.06E+01

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AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	CH-5
Contract No.:	363831	Sample No.:	50186
Date Collected:	9/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.51
Date Extracted:	11/20/96	Wet Wt:	13.95
Date Analyzed:	12/13/96	Dry Wt:	5.2
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	70.79288026
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50186.xls		

CAS #	Compound	Sample Conc. (ug/kg)dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.96E+02		C	3.00E-03
60-57-1	Dieldrin	1.5E+00		C	8.98E-01
72-55-9	4,4'-DDE	1.8E+00		C	5.28E-01
72-54-8	4,4'-DDD	6.8E-01		C	4.69E-01
50-29-3	4,4'-DDT	8.4E+00		C	1.24E+00
1770-80-5	DCB (surr)	1.99E+02		C	
	Total PCBs	BDL			2.06E+01

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BDL - Below detection limit

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	CH-6
Contract No.:	363831	Sample No.:	50185
Date Collected:	9/26/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	29.9
Date Extracted:	11/20/96	Wet Wt:	15.83
Date Analyzed:	12/13/96	Dry Wt:	6.1
Instrument:	PE Autosystem	Pan Wt:	1.6
Analyst:	RJM II	% Moisture:	68.37666901
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50185.xls		

CAS #	Compound	Sample Conc. (ug/kg)dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.54E+02		C	3.00E-03
60-57-1	Dieldrin	3.4E+00			8.98E-01
72-55-9	4,4'-DDE	5.1E+00		C	5.28E-01
72-54-8	4,4'-DDD	BDL		U	4.69E-01
50-29-3	4,4'-DDT	6.3E+01		C	1.24E+00
1770-80-5	DCB (surr)	2.12E+02		C	
	Total PCBs	BDL			2.06E+01

U - Compound not confirmed by secondary GC column analysis
C - Compound confirmed by secondary GC column analysis, but concentration not sufficient for GC/MS confirmation
M - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, but failed GC/M
P - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, and GC/MS confi
J - Compound detected below calculated method detection limit
BDL - Below detection limit

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	Poropotank River
Contract No.:	363831	Sample No.:	50184
Date Collected:	10/03/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.29
Date Extracted:	11/20/96	Wet Wt:	12.9
Date Analyzed:	12/13/96	Dry Wt:	4.36
Instrument:	PE Autosystem	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	75.6421612
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50184.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.81E+02		C	3.00E-03
60-57-1	Dieldrin	4.6E+00		C	8.98E-01
72-55-9	4,4'-DDE	1.3E+01		C	5.28E-01
72-54-8	4,4'-DDD	BDL		U	4.69E-01
50-29-3	4,4'-DDT	BDL			1.24E+00
1770-80-5	DCB (surr)	1.83E+02		C	
	Total PCBs	BDL			2.06E+01

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C - Compound confirmed by secondary GC column analysis, but concentration not sufficient for GC/MS confirmation
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P - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, and GC/MS confi
J - Compound detected below calculated method detection limit
BDL - Below detection limit

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	LYNNHAVEN SAND
Contract No.:	363831	Sample No.:	50183
Date Collected:	9/19/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	30.59
Date Extracted:	11/20/96	Wet Wt:	27.38
Date Analyzed:	12/13/96	Dry Wt:	22.43
Instrument:	PE Autosystem	Pan Wt:	1.61
Analyst:	RJM II	% Moisture:	19.20838184
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50183.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.48E+02		C	3.00E-03
60-57-1	Dieldrin	2.3E-01	J		8.98E-01
72-55-9	4,4'-DDE	1.2E-01	J	C	5.28E-01
72-54-8	4,4'-DDD	BDL		U	4.69E-01
50-29-3	4,4'-DDT	5.8E+00		C	1.24E+00
1770-80-5	DCB (surr)	2.20E+02		C	
	Total PCBs	BDL			2.06E+01

U - Compound not confirmed by secondary GC column analysis
C - Compound confirmed by secondary GC column analysis, but concentration not sufficient for GC/MS confirmation
M - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, but failed GC/M
P - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, and GC/MS confi
J - Compound detected below calculated method detection limit
BDL - Below detection limit

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	MDNR	Laboratory:	Organics
Contract ID:	Amtox '96	Sample ID:	LYNNHAVEN MUD
Contract No.:	363831	Sample No.:	50182
Date Collected:	9/19/96	Matrix:	Sediment
Date Received:	10/10/96	Sample wt.(g):	29.97
Date Extracted:	11/20/96	Wet Wt:	12.38
Date Analyzed:	12/13/96	Dry Wt:	6.64
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Moisture:	53.197405
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	f:\organics\analysis\pest\data\amtox	Data Released By:	Rob McDaniel II
AMRL Data File:	50182.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg)
62-53-3	TCMX (surr)	1.14E+02		C	3.00E-03
60-57-1	Dieldrin	9.0E-01	J		8.98E-01
72-55-9	4,4'-DDE	3.9E-01	J	C	5.28E-01
72-54-8	4,4'-DDD	BDL			4.69E-01
50-29-3	4,4'-DDT	3.4E+00		C	1.24E+00
1770-80-5	DCB (surr)	1.32E+02		C	
	Total PCBs	BDL			20.6

U - Compound not confirmed by secondary GC column analysis
C - Compound confirmed by secondary GC column analysis, but concentration not sufficient for GC/MS confirmation
M - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, but failed GC/M
P - Compound confirmed by secondary GC column analysis; concentration sufficient for GC/MS analysis, and GC/MS confi
J - Compound detected below calculated method detection limit
BDL - Below detection limit

APPENDIX B

Water quality conditions reported in test chambers during all water column tests. Test species were *Cyprinodon variegatus* (Cv) and *Eurytemora affinis* (Ea)

Water quality parameters reported during ambient toxicity tests in 1996.

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
10/01/96	Ea	CONTROL	7.9	14	7.93	----
		CH2	8.1	14	7.83	----
		CH4	7.5	14	7.70	----
		CH5	7.9	14	7.82	----
		CH6	7.8	14	7.76	----
		PCP	7.4	14.5	7.84	----
		PBZ	7.8	13.5	7.74	----
		PJB	7.9	13.5	7.75	----
		PBR	7.8	14.0	7.75	----
10/01/96	Cv	CONTROL	7.9	14	7.93	----
		CH2	8.1	14	7.83	----
		CH4	7.5	14	7.70	----
		CH5	7.9	14	7.82	----
		CH6	7.8	14	7.76	----
		PCP	7.4	14.5	7.84	----
		PBZ	7.8	13.5	7.74	----
		PJB	7.9	13.5	7.75	----
		PBR	7.8	14.0	7.75	----
10/02/96	Ea	CONTROL	8.5	14	8.28	24.5
		CH2	8.6	14	8.32	24.1
		CH4	8.0	14	8.16	24.5
		CH5	8.5	14	8.28	24.3
		CH6	8.3	14	8.17	24.1
		PCP	7.9	14	8.13	24.0
		PBZ	8.4	14	8.27	24.2

		PJB	8.2	14	8.21	24.4
		PBR	8.4	14	8.27	24.4
10/02/96	Cv	CONTROL	7.0	14	7.95	24.1
		CH2	7.1	14	7.95	24.1
		CH4	6.9	14	7.84	24.3
		CH5	7.1	14	7.82	24.5
		CH6	7.25	13.5	7.84	24.4
		PCP	7.15	14.5	7.97	24.5
		PBZ	7.05	14	7.94	24.3
		PJB	6.8	14	7.85	24.2
		PBR	7.1	14	7.92	24.5
10/03/96	Ea	CONTROL	9.5	15	8.50	24.3
		CH2	7.5	14	8.21	24.7
		CH4	9.2	15	8.37	24.7
		CH5	9.7	15	8.56	24.4
		CH6	9.3	14	8.43	24.6
		PCP	9.2	15	8.41	24.3
		PBZ	9.8	14	8.56	24.6
		PJB	9.4	14	8.41	24.8
		PBR	9.6	15	8.48	24.5
10/03/96	Cv	CONTROL	6.4	14	7.74	24.5
		CH2	6.9	14	7.83	24.4
		CH4	6.2	14	7.51	24.1
		CH5	6.9	14	7.68	24.5
		CH6	6.6	14	7.54	24.4
		PCP	6.8	15	7.77	24.5
		PBZ	6.2	14	7.59	24.5
		PJB	6.8	14	7.73	24.5

		PBR	6.2	14	7.53	24.6
10/04/96	Ea	CONTROL	11.0	15	8.71	24.6
		CH2	7.1	14	7.88	24.6
		CH4	7.2	15	7.94	24.5
		CH5	10.5	15	8.73	24.5
		CH6	10.4	14	8.64	24.6
		PCP	6.8	14	8.06	24.0
		PBZ	7.6	14	8.23	24.5
		PJB	7.0	15	7.96	24.4
		PBR	6.9	15	8.04	24.5
10/04/96	Cv	CONTROL	6.3	14	7.71	24.0
		CH2	6.7	14	8.00	24.1
		CH4	6.0	14	7.55	24.1
		CH5	7.2	14	7.88	24.4
		CH6	6.4	14	7.51	24.2
		PCP	7.8	15	8.12	24.1
		PBZ	6.2	14	7.68	23.7
		PJB	6.6	14	7.83	24.2
		PBR	5.9	14	7.54	24.3
10/05/96	Ea	CONTROL	9.6	14	8.65	23.9
		CH2	7.3	15	8.02	23.9
		CH4	7.4	15	8.02	24.2
		CH5	7.9	15	8.31	23.9
		CH6	9.1	15	8.59	23.9
		PCP	7.2	14	7.97	24.0
		PBZ	7.5	15	8.10	24.1
		PJB	7.4	15	8.02	23.9
		PBR	7.3	15	7.97	23.7

10/05/96	Cv	CONTROL	6.2	14	7.80	24.1
		CH2	6.9	15	7.85	23.3
		CH4	5.9	15	7.52	24.1
		CH5	6.9	15	7.77	23.7
		CH6	6.3	14	7.49	23.9
		PCP	7.3	15	8.05	23.9
		PBZ	6.3	14	7.63	23.9
		PJB	6.3	15	7.69	24.0
		PBR	5.7	14	7.56	24.3
10/06/96	Ea	CONTROL	9.5	15	8.58	23.9
		CH2	8.0	15	8.18	24.2
		CH4	8.4	15	8.21	24.2
		CH5	8.5	15	8.35	24.3
		CH6	9.4	15	8.61	24.5
		PCP	8.2	15	8.17	24.1
		PBZ	8.3	15	8.17	24.3
		PJB	7.9	15	8.14	24.2
		PBR	8.2	15	8.30	24.1
10/06/96	Cv	CONTROL	6.0	14	7.80	24.3
		CH2	6.5	15	7.83	24.4
		CH4	5.8	15	7.60	24.3
		CH5	6.4	15	7.60	24.3
		CH6	5.9	15	7.53	24.3
		PCP	8.40	15	8.26	24.3
		PBZ	5.9	14	7.74	24.5
		PJB	6.1	15	7.85	24.5
		PBR	5.6	14	7.60	24.0
10/07/96	Ea	CONTROL	10.2	15	8.53	24.3

		CH2	9.9	16	8.40	24.6
		CH4	10.2	15	8.47	24.6
		CH5	9.2	15	8.36	24.6
		CH6	9.8	15	8.58	24.4
		PCP	8.6	15	8.21	24.6
		PBZ	8.7	15	8.26	24.4
		PJB	8.1	15	8.10	24.4
		PBR	9.3	16	8.34	24.3
10/07/96	Cv	CONTROL	5.4	15	7.53	24.7
		CH2	6.0	16	7.65	24.3
		CH4	6.4	16	7.50	24.5
		CH5	-----	16	7.65	24.3
		CH6	5.3	16	7.35	24.6
		PCP	8.4	16	8.18	24.7
		PBZ	6.5	16	7.77	24.8
		PJB	7.5	16	7.92	24.6
		PBR	5.5	16	7.49	24.4
10/08/96	Ea	CONTROL	8.8	15	8.34	24.2
		CH2	8.5	15	8.22	24.3
		CH4	9.5	15	8.45	24.4
		CH5	8.1	15	8.18	24.2
		CH6	8.7	15	8.31	23.8
		PCP	7.8	16	8.14	24.3
		PBZ	7.6	16	8.08	24.4
		PJB	7.6	16	8.08	24.3
		PBR	8.1	15	8.17	24.3
10/08/96	Cv	CONTROL	5.1	15	7.59	23.7
		CH2	5.7	15	7.57	24.5

		CH4	5.8	15	7.55	24.4
		CH5	5.8	15	7.45	24.5
		CH6	5.6	15	7.36	24.4
		PCP	7.6	16	8.18	24.2
		PBZ	6.4	16	7.86	24.4
		PJB	6.6	16	7.94	24.6
		PBR	5.9	15	7.56	24.4
10/09/96	Ea	CONTROL	8.6	15	8.35	24.6
		CH2	8.8	16	8.28	24.8
		CH4	9.8	15	8.54	24.5
		CH5	8.0	15	8.10	24.8
		CH6	8.9	16	8.32	24.9
		PCP	7.6	16	8.12	24.4
		PBZ	7.6	16	8.08	25.0
		PJB	8.2	16	8.18	24.8
		PBR	8.4	16	8.24	24.8
10/09/96	Cv	CONTROL	4.8	15	7.49	25.0
		CH2	5.2	16	7.46	24.8
		CH4	5.3	15	7.49	24.6
		CH5	5.1	15	7.31	24.1
		CH6	5.6	15	7.20	24.8
		PCP	7.6	16	8.16	24.6
		PBZ	7.5	16	8.00	24.9
		PJB	6.5	16	7.82	24.7
		PBR	6.2	14	7.64	24.3

APPENDIX C

Summary of fish species by station and gear type.
Total abundance for each species at all stations is also presented.

STATION	SPECIES	SEINE CATCH	TRAWL CATCH
CH2	Alewife	12	
	Atlantic menhaden	1	
	Atlantic silverside	1585	
	Banded killifish	6	
	Bay anchovy	162	4
	Blueback herring	328	
	Gizzard shad	5	
	Hickory shad	4	
	Inland silverside	6	
	Mummichog	24	
	Pumpkinseed	12	
	Striped bass	214	
	White perch	2155	9
	Yellow perch	1	
CH4	Atlantic silverside	1822	
	Bay anchovy	15	2
	Blueback herring	3	
	Bluespotted sunfish	1	
	Gizzard shad	1	
	Inland silverside	5	
	Mummichog	7	
	Rough silverside	2	
	Silvery minnow	1	
	Spottail shiner	54	
	Striped bass	46	1
	Striped killifish	4	
	White perch	802	2

STATION	SPECIES	SEINE CATCH	TRAWL CATCH
	Yellow perch	4	1
CH5	Atlantic needlefish	3	
	Atlantic silverside	1092	
	Bay anchovy		17
	Blueback herring	75	
	Bluegill	1	
	Channel catfish	30	
	Gizzard shad	2	
	Inland silverside	1	
	Mummichog	3	
	Pumpkinseed	1	
	Rough silverside	6	
	Spottail shiner	7	
	Striped bass	71	4
	Striped killifish	29	
	White perch	373	8
CH6	Alewife	2	
	Atlantic silverside	213	
	Bay anchovy	5	24
	Blueback herring	129	
	Channel catfish	4	1
	Gizzard shad	4	
	Golden shiner	1	
	Hickory shad	2	
	Inland silverside	10	
	Mummichog	26	
	Spottail shiner	23	

STATION	SPECIES	SEINE CATCH	TRAWL CATCH
	Striped bass	5	3
	Tesselated darter	5	
	White perch	494	9
	Yellow perch	16	
PJB	Alewife	2	
	Atlantic needlefish	3	
	Atlantic silverside	158	
	Bay anchovy	157	21
	Bluefish	1	
	Cownose ray	1	
	Inland silverside	6	
	Mummichog	51	
	Rough silverside	83	
	Sheepshead minnow	1	
	Spot	1	
	Striped bass	4563	3
	Striped killifish	97	
	White perch	13884	1
PCP	Alewife	6	
	American shad	3	
	Atlantic menhaden	13	
	Atlantic silverside	5169	
	Banded killifish	1	
	Bay anchovy	267	7
	Blueback herring	2	
	Gizzard shad	2	
	Hickory shad	1	

STATION	SPECIES	SEINE CATCH	TRAWL CATCH
	Hogchoker	1	2
	Inland silverside	318	
	Mummichog	20	
	Naked goby	1	
	Silvery minnow	4	
	Spot	4	
	Striped bass	207	2
	Striped killifish	20	
	Weakfish		3
	White perch	3715	22
	Yellow perch	1	
PBZ	Alewife	2	
	Atlantic menhaden	7	
	Atlantic silverside	4470	
	Banded killifish	2	
	Bay anchovy	328	4
	Hogchoker		1
	Inland silverside	37	
	Mosquitofish	1	
	Mummichog	74	
	Spot	19	
	Spottail shiner	3	
	Striped bass	545	
	Striped killifish	27	
	Weakfish		1
	White perch		2690
	Winter flounder	1	
PBR	Atlantic needlefish	5	
	Atlantic silverside	2722	

STATION	SPECIES	SEINE CATCH	TRAWL CATCH
	Bay anchovy		182
	Bluefish	2	
	Hogchoker	2	
	Inland silverside	82	
	Mummichog	269	
	Northern pipefish	5	
	Silvery minnow	5	
	Spot	25	3
	Striped bass	1233	1
	Striped killifish	13	
	White perch	4709	9

Species	Abundance
White perch	18961
Atlantic silverside	17231
Striped bass	6898
Bay anchovy	1195
Blueback herring	537
Mummichog	474
Inland silverside	465
Striped killifish	224
Rough silverside	91
Spottail shiner	87
Spot	52
Channel catfish	95
Alewife	34
Yellow perch	23
Atlantic menhaden	21
Gizzard shad	14
Pumpkinseed	13
Atlantic needlefish	11

Species	Abundance
Silvery minnow	10
Banded killifish	9
Hickory shad	7
Hogchoker	6
Tessellated darter	5
Northern pipefish	5
Weakfish	4
Bluefish	3
American shad	3
Winter flounder	1
Sheepshead minnow	1
Naked goby	1
Mosquitofish	1
Golden shiner	1
Cownose ray	1
Bluespotted sunfish	1
Bluegill	1

APPENDIX D

Abundance of benthic species by station.

STATION	SPECIES	ABUNDANCE (per m^2)
CH6	*Polydora cornuta*	864
	Cyathura polita	455
	Rangia cuneata	23
	Tubificoides spp.	432
	Axarus spp.	227
	Tanytarsus spp.	227
	Marenzelleria viridis	91
	Carinoma tremaphorus	23
	Coelotanypus spp.	23
	Dicrotendipes spp.	136
	Gammarus spp.	114
	Imm. Tubificid w/o Cap. Chaete	91
	Nais variabilis	91
	Corophium lacustre	68
	Harnischia spp.	45
	Procladius spp.	45
	Aulodrilus pigueti	45
	Cryptochironomus spp.	45
	Limnodrilus hoffmeisteri	45
	Nais simplex	45
	Orthocladius spp.	45
	Polypedilum spp.	45
	Chiridotea almyra	23
	Chironomidae pupae	23
CH2	*Leptocheirus plumulosus*	227
	Cyathura polita	439
	Rangia cuneata	379
	Tubificoides spp.	894
	Macoma balthica	182

STATION	SPECIES	ABUNDANCE (per m^2)
	Ablabesmyia spp.	15
	Marenzelleria viridis	106
	Carinoma tremaphorus	61
	Coelotanypus spp.	197
	Monoculodes sp. 1	30
	Bothrioneurum vejdovskyanum	15
	Edotea triloba	15
	Chiridotea almyra	15
	Macoma mitchelli	61
	Heteromastus filiformis	15
	Littoridinops tenuipes	15
CH5	*Polydora cornuta*	45
	Littoridinops tenuipes	455
	Cyathura polita	23
	Rangia cuneata	295
	Marenzelleria viridis	23
	Carinoma tremaphorus	91
	Coelotanypus spp.	23
	Gammarus spp.	23
	Harnischia spp.	23
	Procladius spp.	23
	Streblospio benedicti	45
	Macoma mitchelli	23
	Mytilopsis leucophaeata	23
CH4	*Polydora cornuta*	68
	Littoridinops tenuipes	159
	Cyathura polita	45
	Rangia cuneata	136
	Marenzelleria viridis	45

STATION	SPECIES	ABUNDANCE (per m^2)
	Carinoma tremaphorus	23
	Coelotanypus spp.	91
	Streblospio benedicti	23
	Macoma mitchelli	23
	Heteromastus filiformis	23
	Stylochus ellipticus	23
PCP	*Streblospio benedicti*	3924
	Tubificoides spp.	3681
	Cyathura polita	909
	Macoma balthica	773
	Rangia cuneata	682
	Polydora cornuta	318
	Marenzellereria virdis	151
	Edotea triloba	106
	Neanthes succinea	106
	Carinoma tremaphoros	91
	Hypereteone heteropoda	91
	Macoma mitchelli	61
	Corophium lacustre	45
	Littoridinops tenuipes	45
	Leptocheirus plumulosus	30
	Rhithropanopeus harrisi	30
	Coelotanypus spp.	15
	Heteromastus filiformis	15
	Monoculodes sp. 1	15
	Palaemonetes spp.	15
PBZ	*Tubificoides spp.*	91
	Cyathura polita	23
	Macoma balthica	1136

STATION	SPECIES	ABUNDANCE (per m^2)
	Neanthes succinea	23
	Carinoma tremaphoros	23
	Macoma mitchelli	45
	Bothrioneurum vejdovskyanum	15
PJB	*Streblospio benedicti*	3341
	Tubificoides spp.	1568
	Cyathura polita	68
	Macoma balthica	523
	Marenzellereria virdis	364
	Neanthes succinea	1386
	Carinoma tremaphoros	136
	Hypereteone heteropoda	182
	Macoma mitchelli	341
	Corophium lacustre	23
	Leptocheirus plumulosus	6591
	Heteromastus filiformis	659
	Edwardsia elegans	136
	Euplana gracilis	23
	Gemma gemma	23
	Glycinde solitaria	23
	Mulinia lateralis	23
PBR	*Tubificoides spp.*	258
	Leucon americanus	242
	Mulinia lateralis	197
	Leptocheirus plumulosus	182
	Streblospio benedicti	151
	Macoma mitchelli	121
	Neanthes succinea	121
	Carinoma tremaphoros	15.2