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Ambient Toxicity Testing in Chesapeake Bay

Year 7 Report

Chesapeake Bay Program

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Year 7 Final Report
March 2000

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, Maryland Department of Natural Resources and Versar Inc 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 Alan Messing of Old Dominion Universities Applied Marine Research Laboratory. Margaret McGinty of Maryland Department of Natural Resources was responsible for the fish community assessments and Ananda Ranasinghe of Versar Inc. conducted the benthic community assessments. Raymond Alden was responsible for the water and sediment index calculations. This report summarizes data from the seventh year of a seven-year ambient toxicity testing program. The U. S. Environmental Protection Agencies Chesapeake Bay Program Office supported this study.

ABSTRACT

Data presented in this report were collected during the seventh 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 late summer/early fall of 1997 at eight stations in the following areas: Elizabeth River (four stations) and South 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 data with *Eurytemora affinis* showed that survival was significantly reduced at the two downstream stations in the South River. Other endpoints from the sheepshead tests (survival and growth) and coot clam tests (percent normal shell development from two separate tests) were not significantly different than the controls based on univariate analysis. Results from multivarite analysis of water column data showed some degree of toxicity for most of the sites in the South River. Metals were reported in the water column at concentrations suspected to be toxic at various South River sites. Mercury concentrations of 0.47 ug/L exceeded the marine chronic criteria of 0.025 ug/L at the upstream site. Chromium concentrations of 6.18 ug/L at the upstream site were also higher than ambient concentrations but less than the marine chronic criteria. Nickel concentrations of 13.8 ug/L exceeded the marine chronic criteria of 8.3 ug/L at one of the downstream sites. Chromium concentrations of 45.7 ug/L were also above expected background concentrations and only slightly less than the criteria of 50 ug/L at this site. Copper concentrations of 3.3 ug/L at the downstream site exceeded the EPA marine chronic criteria of 2.9 ug/L but were less than Maryland's estuarine criteria of 6.1 ug/L.

Water column toxicity was generally low at all four Elizabeth River sites based on univariate analysis of data from the three water column tests. However, multivariate analysis showed that the Western Branch (WB) site had a higher degree of toxicity when compared with other sites tested in this river. Concentrations of metals in the water column were generally low in the Elizabeth River with a few exceptions. Copper concentrations of 3.4 ug/L at the Elizabeth River South Branch site (SB) were slightly higher than the EPA marine chronic criteria but lower than Maryland's estuarine criteria. Somewhat elevated concentrations of chromium (12.8 ug/L) were also reported at SB. Metals concentrations were generally lower at the Elizabeth River East Branch (EB) and mainstem

sites (EL). Copper concentrations of 3.1 ug/L at the Elizabeth River West Branch (WB) were only slightly higher than the EPA marine chronic criteria

Sediment toxicity for the South River sites showed that *L. dytiscus* survival and *S. benedicti* growth were significantly different from controls at all four sites. Survival of *C. variegatus* and *S. benedicti* was also reduced at the upstream site. Multivariate analysis also showed higher toxicity at the upstream sites. Potentially toxic concentrations of various contaminants were reported in South River sediments. The pesticides Heptachlor Epoxide, Chlordane, and Endrin Aldehyde were reported at all four sites. DDE and DDT concentrations exceeding ER-L values were reported at the upstream and downstream sites. The highest number of pesticides (7) was reported at the upstream site (The most toxic site based on univariate analysis). Polynuclear Aromatic Hydrocarbon (PAH) contamination in the South River was generally less severe than the Elizabeth River. Two to six PAHs were detected at the various stations and only fluoranthene at one of the downstream sites exceeded the ER-L value (Effects Range - Low value as defined by Long et al., 1995). These data do not suggest a strong link between PAH exposure and biological effects in sediment. Total bulk metal concentrations were variable among the South River sites. Exceedences of ER-L values occured for five to eight metals at the three upstream sites. Nickel exceeded the ER-M value (Effect Range - Median value as defined by Long et al., 1995) at the downstream site but concentrations of the other metals were generally low at this site. The highest chromium concentration (183 ug/g) at one of the downstream sites corresponds with the high chromium concentrations reported in the water column at this station (46 ug/L). All South River sites had SEM/AVS ratios less than one thus suggesting that toxicity due to metals is unlikely.

Sediment toxicity data for the Elizabeth river showed that *L. dytiscus* survival and *S. benedicti* growth were significantly different from controls at all four sites. In addition, *S. benedicti* survival was also significantly reduced at the WB (Western Branch) site. Results from the multivariate analysis showed some but a modest degree of relative toxicity at all sites. The the WB site had the highest degree of toxicity. Potentially toxic concentrations of various contaminants in sediments were reported for various sites in the Elizabeth River. The pesticides Chlordane and Endrin Aldehyde were detected in the sediment of all four sites. Endosulfan sulfonate was detected at the Southern Branch (SB), Eastern Branch (EB) and Western Branch (WB); Heptachlor was detected at SB and mainstem (EL). Total DDT concentrations exceeding the ER-L values were reported at EB and WB. The total number of pesticides detected by site were as follows: EL (3), SB (4), EB (6) and WB (9). The WB site ,which had the highest number of pesticides detected, also had the highest degree of sediment toxicity as three endpoints from the four tests species were different than the controls. The number of detected PAHs at the four sites were as follows: WB (4, with no exceedences of ER-L or ER-M values), EB (4, with three PAHs exceeding the ER-L values), SB (10, with five PAHs exceeding the ER-L values) and EL (11, with two PAHs exceeding the ER-L values and 6 exceeding the ER-M values). Althought the most contaminated site for PAHs was EL the toxicity at this site was not significantly higher than the other three sites. Total bulk metals concentrations were fairly consistent among sites as four to five metals exceeded the ER-L values and only one metal (mercury) exceeded the ER-M value at EL. All sites except EL had SEM/AVS ratios greater than one thus suggesting that metal toxicity may be possible at SB, EB, and WB.

Results from the fish IBI analysis from seining showed that three of the four sites in the South River had IBI scores below the the reference condition. Trawl index scores for fish also ranged from poor to fair at all four South River sites. The Elizabeth River sites could not be sampled for fish by seining due to the presence of the macroalgae, *Ulva latuca*. Trawl index scores for the Elizabeth River were poor at SB and WB, fair at EL and good at EB. The Benthic Index of Biotic Integrity (B-IBI) showed that three of the South River sites were severely degraded or degraded and one site was not degraded. All four Elizabeth River sites were classifed as degraded or severely degraded based on B-IBI scores.

In summary, the sediment toxicity data, fish IBI data and the benthic IBI data from the South River suggest that the two upstream stations are impaired due to contaminants or other stressors. The water column toxicity data for the South River suggest some toxicity at the three downstream sites. Due to the transient and ephemeral nature of contaminants in water, downstream biological effects resulting from upstream sources is not unusual.

A final analysis of the toxicity and community metric data from the Elizabeth River shows that the water column toxicity data (multivariate analysis) showed effects at the WB site, fish community data shows effects at the SB and WB and the sediment toxicity data/benthic B-IBI data suggested toxicity/biological impairment at all four sites. The close agreement between the sediment toxicity data and the benthic community data suggest that the contaminant problems in the Elizabeth River are primarily in the sediment.

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

Anthropogenic activities in the rapidly growing Chesapeake Bay watershed have prompted concerns about the relationship between contaminants (including adverse water quality such as reduced dissolved oxygen) and biological effects on resident aquatic biota. Information derived from the loading of toxic chemicals and/or chemical monitoring studies (exposure data) are not adequate for assessing the ecological 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 and ecologically relevant 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 in the Chesapeake Bay.

Various state and federal agencies have supported studies designed to address the link between contaminants and adverse effects on living aquatic resources in the ambient environment of 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 considered 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 stressful conditions in the ambient environment resulting from point and non-point sources.

The ambient toxicity testing approach is 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).

Previous ambient toxicity assessments in the Chesapeake Bay (1990-1996) 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; Hall et al., 1998). General conclusions to date have shown that 54% of the time water column tests conducted at 41 stations (16 rivers and harbors with multiple years of testing at some sites) 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 61% of the ambient tests at 41 stations conducted during the seven year period (1990 - 1996). 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 Effects Range - Median as defined by Long et al., 1995 (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 Elizabeth River and four stations in the South River. The fish and benthic community assessments were new components added to the ambient toxicity testing program in 1996 and continued in 1997 to provide field data for assessing 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 1990-1996 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 seventh year of this study were to:

- assess the toxicity of ambient estuarine water and sediment during the late summer/early fall of 1997 at the four stations in the Elizabeth River and four stations in the South 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 1997 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 for selecting study sites in the Elizabeth River and South River are presented below (Figure 3-1). The Elizabeth River was selected for the following reasons: (1) previous ambient toxicity data from this program have only been collected at one site in this "Region of Concern" in 1990; therefore, ambient toxicity data are very limited on a spatial scale and (2) ambient toxicity baseline data are needed for the Elizabeth River and are supported by the Elizabeth River Project in order to measure the progress of the watershed action Plan in reducing/eliminating toxicity. Coordinates for the four Elizabeth River stations were as follows: ER-SB (36 48 42 x 76 17 20), ER-EB (36 50 16 x 76 14 32), ER-EL (36 50 55 x 76 17 48) and ER-WB (36 51 32 x 76 20 25) (Figure 3-1).

The South River was selected for the following reasons: (1) this ecologically important river has not been sampled during previous ambient toxicity sampling efforts and (2) data collected by Maryland Department of Natural Resouces suggest that stressful conditions (sedimentation and/or contaminants) may exist for fish communities due to urban development (Margaret McGinty, personal communication). Coordinates for the four South River stations were as follows: SR-1 (38 58 07 x 76 35 59), SR-2 (38 56 52 x 76 34 22), SR-3 (38 55 43 x 76 31 31) and SR-4 (38 54 42 x 76 29 35) (Figure 3-1).

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 late summer/early fall of 1997: 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 six 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 six 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. All samples were preserved with ultrex grade nitric acid. 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 were 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

Four animals were used to assess the potential toxicity of estuarine sediments: eggs of the sheepshead minnow *(Cyprinodon variegatus)*; two amphipods *(Lepidactylus dytiscus* and *Leptocheirus plumulosus)*; and a polychaete worm *(Streblospio benedicti)*.

3.3.2 Test Procedures

All tests, with the exception of the *C. variegatus* egg test, were conducted for 10 days at 25°C and monitored daily. Daily monitoring of the sheepshead egg test included an assessment of egg and larval mortality, hatching success, and water quality parameters (Hall *et al.*, 1991). The monitoring continued until the test was terminated, at either two days following hatching of all control eggs or at 10 days, whichever occurred first. On day 10 of the *S. benedicti, L. dytiscus* and *L. plumulosus* tests, all replicate vessels were sieved to remove test animals from the sediment. Surviving animals were counted, returned to the original test containers, and monitored daily for an additional 10 days. At day 20, all site replicates were sieved once more to obtain counts of surviving animals. Survivors were preserved to facilitate collection of length and weight measurements.

Test sediment samples were collected from four sites in the Elizabeth River, Virginia (ER-SB, ER-EB, ER-WB, and ER-EL) and four sites in the South River, Maryland (SR1, SR2, SR3, and SR4). Control sediments for each tested species consisted of native sediments in which the test organisms were cultured or from which they were collected. The animals were placed in species-specific control sediments to compare their responses to those of animals exposed to sediments from the test sites.

Reference sediments were used to control for potential mortality occurring as a result of non-toxic geochemical and physical characteristics of the sediment. These include Total Organic Carbon (TOC) and particle size composition. Because of the large range in particle size distributions observed both within and between test sites in past studies, two reference sediments were used with each organism. These were selected to bracket the sediment particle sizes found at the test sites; *i.e.*, one reference sediment had a higher percentage of sand than the most sandy test site, and one reference sediment had a lower percentage of sand than the least sandy test site. Sites selected for reference and/or control sediments were Lynnhaven sand, Lynnhaven mud, and Poropatank mud. Lynnhaven mud was used as the control sediment for *C. variegatus* eggs and *S. benedicti*, Lynnhaven sand was used as the control for *L. dytiscus*, and Poropatank sediment was used as the control for *L. plumulosus.* Lynnhaven sand (99.3% sand) and Poropotank sediment (2.27% sand) bracketed the particle size profile of all test samples, and were suitable for reference sediments as well. Particle size analyses were performed on each of the 5 field replicates from all test sites to determine sand, silt, and clay content.

Culture and maintenance procedures used for *S. benedicti* and *L. dytiscus* are as described in Hall *et al.* (1991). Culture, maintenance, and test procedures for *C. variegatus* eggs and *L. plumulosus* are described in Hall *et al.* (1993).

3.3.3 Statistical Analysis of Sediment Data

The objective of the study was to evaluate the potential toxicity of ambient sediments by comparing all test endpoints of each species to the endpoints observed in control sediments. This approach is essentially similar to that used in the previous six years of the study (Hall *et al.*, 1992). Statistical differences between the endpoints for each species in control versus ambient sediments were evaluated *via* ANOVA (Analysis of Variance). *A priori* tests of each endpoint in a given treatment were contrasted to control responses to discern which sediments differed from control endpoints. Mortality data were arcsine transformed prior to statistical analyses. Length and weight were expressed as percentage of change from the mean initial length and weight measurements of each test animal. Evaluation of total mortality for *C. variegatus* eggs was computed by adding egg mortality, larval mortality, and unhatched eggs remaining at the termination of the test. Unhatched eggs were included in the total mortality variable, because previous observations revealed the probability of hatching (and thus survival) decreases essentially to zero by test termination. Toxicity was inferred in test sediments with endpoints that were significantly lower than those observed for control sediments.

3.3.4 Sample Collection, Handling and Storage

General sediment collection, handling, and storage procedures described in Hall *et al.* (1991) were used in this study. Samples were collected at each site by Applied Marine Research Laboratory (AMRL) and University of Maryland personnel and returned to the laboratory for testing. Sediments were collected September 24-25, 1997, by petite ponar grab. True field replicates were maintained separately and transported to the laboratory. Sediment was collected at each station by first randomly identifying 5 grab sample locations within a 100 meter square grid. At each location a discrete field replicate was collected for bioassays and stored on ice, while a separate subset from the same ponar grab was placed into a handling container. Subsamples from all 5 random grab locations within the station were placed into the handling container, homogenized, and distributed into sample containers designated for chemical analyses. All samples were transported on ice in coolers, out of direct sunlight. Bioassay samples were held in refrigerators at 4°C until initiation of the toxicity tests. Samples for chemical analysis were stored as required for all analyses.

3.3.5 Quality Assurance

All quality assurance procedures were submitted previously to the sponsoring agency, and were implemented during sediment collection and analysis. Toxicity test control and reference sediments were used as described in Section 3.3.2. Laboratory quality assurance procedures for organic and inorganic chemical analyses, and for sediment pore water analyses, followed USEPA Standard Quality Assurance Guidelines.

Static acute non-renewal, water-only reference toxicant tests were performed for each species used for sediment toxicity testing. Cadmium chloride was used as a reference toxicant because there is an established data base for this chemical for all species used. Reference toxicant information was used to verify the health and sensitivity of the test animals.

3.3.6 Contaminant and Sediment Quality Evaluations

Contaminants were evaluated concurrently with toxicity tests. Quantification of suspected contaminants provides valuable insights if high concentrations of potentially toxic contaminants are observed in conjunction with biological effects.

Sediment sample collection for organic and inorganic contaminants analysis is described in Section 3.3.4. Organic and inorganic contaminant analytical and quality control results are listed in Appendix A. PAHs were extracted and analyzed in accordance with SW-846 Methods 3550, 3640, and 8270 (USEPA, 1994). Pesticides and Aroclors were extracted and analyzed in accordance with SW-846 Methods 3350, 3640, and 8081 (USEPA, 1994).

Sediment samples were also analyzed for acid volatile sulfides (AVS), Total Organic Carbon (TOC), ammonia, nitrite, and sulfides occurring in sediment pore water. Samples analyzed for TOC 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). Details of the analytical procedures for both AVS and TOC are described in Hall *et al.* (1991). Pore water samples were extracted from sediment using a nitrogen press. All pore water samples were filtered and frozen until analyses were conducted. Details of the methods are described in Hall *et al.* (1991).

Bulk metals analyses were performed for all samples. Sediments were digested according to Method 3050 in EPA/SW-846. Mercury was digested and analyzed according to Method 245.1 and tin was analyzed according to Method 282.2 in Methods for Chemical Analysis of Water and Wastes (USEPA-600/4-79-020). Arsenic and selenium were analyzed in accordance with APHA (1995), using a modification of Method 3114B. Aluminum, cadmium, chromium, copper, lead, nickel, and zinc were analyzed according to EPA/SW-846. Sediments were also analyzed for Simultaneously Extractable Metals (SEM). The sample for the SEM analysis was obtained from the AVS procedure mentioned above. 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, and was then diluted to volume with deionized water. The concentrations of the SEMs were determined by the same analytical methods as bulk metals. The concentrations were then converted to micro moles per gram dry sediment and summed to yield total SEM. SEM results were used in conjunction with the AVS data to estimate the potential toxicity of the sediment due to metals.

3.4 Analysis of Seven 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

All sites were sampled monthly for fish assemblages during the summer index period (July, August, and September, 1997). This period reflects the time of greatest fish species diversity and abundance in the Chesapeake Bay due to the function of the estuary as a spawning and nursery habitat for anadromous, marine, and estuarine resident species.

Sites on the South River were sampled inshore using a 30.5 m x 1.2 m beach seine with 6.4 mm mesh. The seine was pulled with the tide employing the quarter sweep method. Two seine hauls were conducted per site with a 30 minute interval between each haul 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. Seine data were not collected from Elizabeth River. Several sites were deemed sampleable, however, macroalgae (*Ulva latuca*) abundance precluded efficient sampling.

In the channel adjacent to the seining areas, fish were sampled using a 3.1 m otter or box trawl with 12.8 mm stretch mesh and 50.8 cm by 25.4 cm doors. All sites on both the South River and the Elizabeth River were sampled with a single trawl tow pulled with the tide at two knots for five minute.

All fish captured in the seine and trawl were identified to species, counted, and minimum and maximum length recorded for each species. Age of game and commercial species was also recorded. Scales were collected for fish when age determination could not be made in the field. When field identification was not possible, specimens were retained for later laboratory evaluation.

Water quality parameters were sampled using a Hydrolab H20. Water temperature, pH, dissolved oxygen, conductivity, and salinity were measured at bottom, mid-water and surface depth profiles near the trawl area for each site. Water clarity was measured with a Secchi disc. 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 prior to leaving the sampling site. Data sheets were again proofed in the laboratory for errors and omissions. Data were keypunched into ASCII files, then compared to the original field 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 (IBI) 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.

Nine metrics were used to calculate the IBI score by site. The metrics were divided into three categories: *Richness Measures* - total number of species, number of species caught in 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 and ranked into thirds and assigned a value of 5, 3, or 1. All metrics in the upper third were given a five; middle third a three; and lower third a 1. Planktivores were ranked in reverse because increasing trends in abundance are quantitatively 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. 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 existing data 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 1.33), fair (mean rank between 0.67 and 1.33), and poor (mean rank less than 0.67).

3.6 Benthic Index of Biotic Integrity

3.6.1 Data Collection

Benthic samples for the Ambient Toxicity study were collected at the eight sites during the summer of 1997. Surface and bottom water temperature, conductivity, salinity, dissolved oxygen concentration (DO), and pH were measured at each site. Three biological samples were collected at each site using a Young Grab which samples an area of 440 cm^2 to a depth of 10 cm. The samples were seived through a 0.5 mm screen using an elutriative process. Organisms retained on the screen were transferred to labeled jars and preserved in 10% buffered formalin stained with rose bengal (a vital stain used to aid separation of organisms from sediment and detritus).

Two sub-samples containing approximately 120 ml of surface-sediment were collected for grain-size and carbon analysis from an additional grab sample at each site. They were frozen until processed in the laboratory.

3.6.2 Laboratory Processing

Organisms were sorted from detritus under dissecting microscopes, identified to the lowest practical taxonomic level, and counted. Oligochaetes and chironomids were mounted on slides, examined under a compound microscope, and identified to genus and species. Ash-free dry weight biomass was measured for each species by drying the organisms to a constant weight at 60°C followed by ashing in a muffle furnace at 500°C for four hours.

Silt-clay composition was determined for one of the two sediment sub-samples collected at each sampling site. The other sample was archived for quality assurance purposes (Scott et al. 1988). Sand and silt-clay particles were separated by wet-sieving through a 63μ stainless steel sieve and weighed using the procedures described by Plumb (1981) and Buchanan (1984).

3.6.3 Data Analysis and Benthic IBI Calculations

Analyses were performed in the context of the Chesapeake Bay Program's Benthic Community Restoration Goals which use the Benthic Index of Biotic Integrity (B-IBI) to measure goal attainment. The B-IBI and the Chesapeake Bay Benthic Community Restoration Goals are described below.

The B-IBI is a multiple-attribute index developed to identify the degree to which a benthic assemblage meets the Chesapeake Bay Program's Benthic Community Restoration Goals (Ranasinghe et al. 1994, updated by Weisberg et al. 1997). The B-IBI provides a means for comparing the relative condition of benthic invertebrate assemblages across different habitats. It also provides a validated mechanism for integrating several benthic community attributes indicative of "health" into a single number that measures overall benthic community condition.

The B-IBI is scaled from 1 to 5, and sites with values of 3 or more are considered to meet the Restoration Goals. The index is calculated by scoring each of several attributes as either 5, 3, or 1 depending on whether the value of the attribute approximates, deviates slightly from, or deviates strongly from values at the best reference sites in similar habitats, and then averaging these scores across attributes. The criteria for assigning these scores are numeric and habitat-dependant.

Benthic community condition was classified into three levels based on the B-IBI. Values less than or equal to 2 were classified as severely degraded; values from 2 to less than 3.0 were classified as degraded; and values of 3.0 or more were classified as meeting the goal.

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 10/1/97 to 10/09/97 are presented in Tables 4.1 to 4.4. Based on univariate analysis, survival of *Eurytemora* was significantly reduced at two of the South River stations (SR-3 and SR-4) but not at the other six stations (Tables 4.1). Reproduction and maturation of *Eurytemora* was not significantly reduced at any of the stations (Table 4.4). Sheepshead minnow survival and dry weight was not reduced at any of the stations (Table 4.1 and 4.2). The percent normal development for the coot clam was also not reduced at any of the stations (Table 4.3).

4.1.2 Contaminants Data

Inorganic contaminants data from the eight stations are presented in Table 4.5. Metals concentrations were generally higher in the South River than the Elizabeth River. Mercury concentrations of 0.47 ug/L exceeded the marine chronic criteria of 0.025 ug/L at SR-1. Chromium concentrations of 6.18 ug/L at SR-1 were also higher than ambient concentrations but less than the marine chronic criteria. Nickel concentrations of 13.8 ug/L exceeded the marine chronic criteria of 8.3 ug/L at SR-2. Chromium concentrations of 45.7 ug/L were also above expected background concentrations and only slightly less than the criteria of 50 ug/L. Copper concentrations of 3.3 ug/L at SR-4 exceeded the EPA marine chronic criteria of 2.9 ug/L but were less than Maryland's estuarine criteria of 6.1 ug/L. Copper concentrations of 3.4 ug/L at the Elizabeth River South Branch site (SB) were slightly higher than the EPA marine chronic criteria but lower than Maryland's estuarine criteria. Somewhat elevated concentrations of chromium (12.8 ug/L) were also reported at SB. Metals concentrations were generally low at the Elizabeth River East Branch (EB) and mainstem sites (EL). Copper concentrations of 3.1 ug/L at the Elizabeth River West Branch (WB) were only slightly higher than the EPA marine chronic criteria.

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 of these parameters also 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 six years for all species except the coot clam, where four years of data were available. The sheepshead minnow LC50 of 1.34 mg/L is within the range reported for the first six years (0.51 to 2.3 mg/L). The LC50 for *Eurytemora* (0.261 mg/L) is slightly higher than the highest value reported during the previous six years but this value is still within an acceptable range (within a factor of 1.5). The EC50 for the Coot clam (0.082 mg/L) is similar to the highest value of

0.069 mg/L reported from year 5. 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

Results from sediment analyses include toxicity data, sediment chemistry data, and results of reference toxicant tests.

4.2.1 Toxicity Data

Survival data from sediment toxicity tests are presented in Tables 4.8 through 4.11. For species in which survival is affected by the percent of sand, silt, and clay in the sediment, predicted mortalities were adjusted using the results of particle size analyses performed on all replicates for each test site. There was substantial variation in particle size/composition between replicates of test sites, and between test sites (Table 4.12). For the 20-day tests, mean control survival for all species at day 10 was greater than 90%, and greater than 83% at day 20, except for *Leptocheirus plumulosus*, which was 49% at day 20. It is unlikely that this is a result of test animal fitness, since survival was >96% at day 10 for more than half the sediments tested. Additionally, survival at 20 days was 83% in sediment from SR4, suggesting that animal health at test initiation was not the cause of the control mortalities. Overall mean survival for the *C. variegatus* egg test was 90% in control sediment (Lynnhaven mud).

The only *C. variegatus* egg survival endpoints that differed from controls were observed in sediment from SR1, which exhibited reduced overall survival (70%), and elevated percentage of dead eggs (26%). Particle size adjusted *L. dytiscus* survival was significantly different from controls at days 10 and 20 in SR1 and SR2 South River sediments, and also in SB, EB, and EL Elizabeth River sediments. *Leptocheirus plumulosus* survival was not significantly different from control sediment in any of the test or reference sediments at day 10, but survival was significantly different from controls at day 20 in sediment from Elizabeth River stations SB, EL, and WB. Particle size adjusted *S. benedicti* survival was significantly different from control survival on day 10 in sediment from site WB, and from control survival at day 20 in sediment from SR1 and WB.

Results of growth analyses for the amphipods (*L. dytiscus* and *L. plumulosus)* and *S. benedicti* are presented in Tables 4.13-4.15. Analysis of *L. dytiscus* and *L. plumulosus* growth data indicated no significant differences in weight or length for any test sediments when compared to controls. *S. benedicti* lengths were significantly different from controls in sediment from all sites except SR3, SB, and Poropotank Mud. *S. benedicti* weight differed significantly from controls in all sediments except Poropotank Mud.

4.2.2 Sediment Chemistry Data

Several pesticides were detected in all sediments, including reference and control sediments (Table 4.16). Chlordane and endrin aldehyde were detected in all sediments, with the highest concentrations detected in sediment from the Elizabeth River (site EL), which had concentrations of 19.7 and 55.6 µg/kg dry weight, of chlordane and endrin aldehyde, respectively. Chlordane concentrations were lowest in sediment from South River station SR4 (3.5 µg/kg dry wt.), while endrin aldehyde was lowest in Lynnhaven Sand (6.9 µg/kg dry wt.). Mean concentrations of chlordane were slightly higher at the Elizabeth River stations (mean concentration of 14.0 µg/kg dry wt.) than in the South River stations (mean concentration of 10.5 µg/kg dry wt.); however, chlordane concentrations at all test sites were comparable to that of the Poropotank River control sediment (17.2 µg/kg dry wt.). Total DDT was detected in excess of the ER-L value at stations SR1 and SR4 in the South River (17.8 and 4.3 µg/kg dry wt., respectively) and at stations EB and WB in the Elizabeth River (24.3 and 3.1 µg/kg dry wt., respectively). At stations SR1, SR4, and WB, DDE was the only DDT congener detected, whereas at station EB, DDD was the only congener.

The test site with the greatest number of different pesticides detected was WB. At this site, lindane, delta-BHC, heptachlor epoxide, chlordane, endosulfan II, endrin aldehyde, endosulfan sulfate, and 4,4'- DDE were all detected (Table 4.16). The test site with the least apparent pesticide contamination was EL; only heptachlor, chlordane and endrin aldehyde were detected at this site. A comparison among control sites showed that the greatest number of pesticides were detected in Poropotank River sediment. The pesticides detected were beta-BHC (8.6 µg/kg dry wt.), delta-BHC (18.5 µg/kg dry wt.), dieldrin (10.6 ug/kg dry wt.), chlordane (17.2 µg/kg dry wt.), and endrin aldehyde (19.2 µg/kg dry wt.). The control site with fewest pesticides was Lynnhaven Sand, with only chlordane and endrin aldehyde detected (7.6 and 6.9 µg/kg dry wt., respectively).

Polynuclear Aromatic Hydrocarbons (PAHs) were detected in all samples (Table 4.17). The greatest number and concentrations of PAHs were observed for Elizabeth River stations (Table 4.17). At site EL, the ER-M concentration was exceeded by acenaphthylene, phenanthrene, pyrene, benzo (a) anthracene, chrysene, and benzo (a) pyrene. The [∑PAH] at EL of 83,107 µg/kg dry wt. was nearly twice the ER-M concentration. The WB site was the only Elizabeth River Station that did not exceed an ER-L for any PAH. South River sites had fewer numbers and lower concentrations of PAHs detected. Fluoranthene at Site SR2 (852 µg/kg dry wt.) was the only PAH exceeding the ER-L for all South River sites. SR1 had the fewest numbers and lowest concentrations of PAHs for all South River test sites. The only control sediment to exceed an ER-L for PAHs was Lynnhaven Mud, with a fluoranthene concentration of 614 µg/kg dry wt. Fluoranthene was the only PAH detected in Poropotank sediment and was present at a concentration of 118 µg/kg dry wt. Fluoranthene was detected at all sites except for SB, EL, and WB in the Elizabeth River.

The toxicity of non-ionic organic chemicals presented above is related to the organic content of the sediment. At present there is no readily accessible data base for comparison of TOC normalized data, therefore the TOC analysis from this study was included for future comparisons. TOC analysis results are listed in Table 4.18. Percentage TOC (by dry wt.) ranged from 0.07% for Lynnhaven Sand to 4.6% for Poropotank Mud. TOC values varied the most in South River sediments, from 0.52% at SR4 to 4.3% at SR2. TOC values among the Elizabeth River sites were relatively consistent, and ranged from 1.7% at WB to 4.0 at EB.

Inorganic analysis results for bulk metals are listed in Table 4.19. Sediments from all test sites exceed ER-L values for at least one metal. South River sites had slightly more metals exceeding ER-L concentrations than those observed in Elizabeth River sites. The Ni concentration observed for SR4 sediment (62.2 µg/g dry wt.) exceeded the ER-M. Site EL in the Elizabeth River had a Hg concentration of 0.961 µg/g dry wt., which also exceeded the ER-M. Arsenic exceeded the ER-L at all sites with the exception of SR4, Lynnhaven Sand, and Lynnhaven Mud. Poropotank sediment had As and Pb concentrations of 15.14 and 55.4 µg/g dry wt., respectively, and were the only two metals to exceed ER-L values for any control site.

The results of SEM/AVS analyses are listed in Table 4.20, and include the SEM/AVS ratio used to predict metal bioavailability in sediments. If the ratio is greater than one then toxicity is predicted. It should also be noted that if the total concentration of metals is very low then toxic effects may not be observed. If the SEM/AVS ratio is less than one it is assumed that toxic effects may not be observed as lower ratios are associated with reduced metal bioavailability. Ratios ranged from 0.019 for Lynnhaven sand to 2.136 for site EB in the Elizabeth River. Three stations in the Elizabeth River had SEM/AVS ratios greater than one thus suggesting potential metal toxicity (SB, EB, and WB). SEM concentrations are given in Table 4.21. The mean sum of all SEM values were generally higher for the Elizabeth River Stations that the South River stations.

Sediment pore water was analyzed for naturally occurring toxicants such as ammonia, nitrate and sulfide at all stations and the controls (Table 4.22). Ranges for the various parameters were: ammonia (2.96 to 21.73 mg/L), nitrite (0.0005 to 0.0309 mg/L) and sulfide (0.009 mg/L to 0.2676 mg/L). Ammonia concentrations were converted to percent unionized ammonia (toxic form) with values ranging from 0.12 to 0.84 mg/L. Unionized ammonia concentration were generally higher in the South River than the Elizabeth River.

4.2.3 Reference Toxicant Data

The relative sensitivities of each set of test organisms was evaluated by using cadmium chloride reference toxicant tests (Table 4.23). All test LC50s were within the ranges of previous tests. The data suggest that the test organisms were healthy and the test results were valid.

4.3 Fish Index of Biotic Integrity

4.3.1 Fish Community

A summary of the fish data for all sites on the South River (using seine and trawl data) showed that 3361 individuals representing 24 species were captured. Atlantic menhaden, Atlantic silverside and Bay anchovy were the most dominant species, representing 77% of the total catch (Appendix C). Data from the Elizabeth River (trawl only) sites showed that 291 individuals representing 7 species were captured. Atlantic croaker, Bay anchovy and Weakfish were the most dominant species, representing 96% of the catch (Appendix C).

Individual metric values for all South River stations are presented in Table 4.24. Station SR-2 showed a significantly lower total abundance in comparison to SR-1, SR-3, and SR-4. Total number of species captured per station in the South River was somewhat similar ranging from 12 to 17, with the highest number of species captured at station SR-3. Species richness measures (number of species comprising 90% of catch) were moderately variable ranging from 2 at station SR-4 to 7 at station SR-2. The number of species captured in the bottom trawl were comparable at all South River stations except SR-2, where only 1 species was captured. Trophic measures showed the proportion of planktivores at all South River stations to be clearly dominant over carnivores and benthivores.

Fish IBI scores for the South River were 29 for sites 1 and 2, 39 at site 3, and 27 at site 4 (Table 4.25). Compared to the reference conditions, site 3 is the only site to meet the reference standard of 31 or better. Table 4.26 shows the mean IBI scores for all sites from 1989 to 1997. The mean scores show a slight improvement in scores along the downstream gradient.

The trawl index scores in Table 4.27 displays the trawl index scores for both river systems. The South River scores ranged from 0.33 (poor) to 1.33 (fair). The upstream sites (1 and 2) scored poor and the lower sites (3 and 4) scored fair. The Elizabeth River scores ranged from 0.33 (poor) to 2.00 (good). The South and West branches were classified as poor, the maintem as fair, and the East Branch as good.

4.3.2 Water Quality

Summer mean dissolved oxygen concentrations at all stations on the Elizabeth River met the requirements recommended by the U.S. Environmental Protection Agency's Chesapeake Bay Program Office. Only two out of four stations on the South River met these requirements. Mean dissolved oxygen values were greater than 5.0 mg/L above the pycnocline and greater than 3.0 mg/L below the pycnocline at all stations except SR-1 and SR-2 (Table 4.28). Summer mean Secchi depth measurements were below the criteria for SAV recovery (0.97m) at all sites on the South River except station SR-3 (Table 4.29). In comparison, secchi depth measurements on the Elizabeth River were above the SAV recovery criteria for all sites except ER-EB (Table 4.29).

4.4 Benthic Index of Biotic Integrity

Water quality measurements, sediment composition, species abundances, species biomass and benthic IBI scores for each site are presented in Appendix D. The mean number of taxa (11.3 to 15.7) and mean abundance measurements (2,219 to 4,719 per sq. meter) in the Elizabeth River were generally higher than the South River (mean number of taxa was 0 to 12; mean abundance 0 to 6,114 per sq. meter) There were no benthic species collected at the South River (SR-2) site.

The B-IBI scores for the Elizabeth River ranged from severely degraded at EB (1.67) to degraded at the other three sites (2.33 to 2.67) (Table 4.30) Benthic communities in the South River were severely degraded at SR-1 and SR-2 (1.0), degraded at SR-3 (2.33) and met the restoration goal at SR-4. These data suggest that the two upstream stations in the South River had impaired benthic communities but the condition of these benthic communities improved as you move down river.

SECTION 5
DISCUSSION

5.1 Elizabeth 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 Elizabeth River sites generally showed minimal toxicity based on univariate analysis. However, the multivariate analysis showed toxicity at the WB site. The link between inorganic contaminants and biological effects is generally weak since concentrations of metals in the water column from all four Elizabeth River sites were very low. Concentrations of chromium (12.8 ug/L) at SB and copper (~ 3 ug/L at WB and SB) were above background concentrations. Sediment toxicity data for the Elizabeth river showed that *L. dytiscus* survival and *S. benedicti* growth were significantly different from controls at all four sites. In addition, *S. benedicti* survival was also significantly reduced at the WB (Western Branch) site. Results from the multivariate analysis showed some degree of toxicity at all sites with the highest toxicity reported at the WB site (a similar result reported from the water column toxicity data). Potentially toxic concentrations of various contaminants in sediments were reported for various sites in the Elizabeth River. The pesticides Chlordane and Endrin Aldehyde were detected in the sediment of all four sites. Endosulfan Sulfonate was detected at SB, EB and WB; Heptachlor was detected at SB and EL. Total DDT exceeding the ER-L values of Long et al. (1995) were reported at EB and WB. The total number of pesticides detected by site were as follows: EL (3), SB (4), EB (6) and WB (9). The WB (western Branch) ,which had the highest number of pesticides detected, also had the highest degree of sediment toxicity as three endpoints from the four tests species were different than the controls.

The number of detected PAHs at the four sites were as follows: WB (4, with no exceedences of ER-L or ER-M values), EB (4, with three PAHs exceeding the ER-L values), SB (10, with five PAHs exceeding the ER-L values) and EL (11, with two PAHs exceeding the ER-L values and 6 exceeding the ER-M values). Althought the most contaminated site for PAHs was EL the toxicity at this site was not significantly higher than the other three sites.

Total bulk metals concentrations were fairly consitent among sites as four to five metal exceeded the ER-L values and only one metal (mercury) exceeded the ER-M value at EL. All sites except EL had SEM/AVS ratios greater than one thus suggesting that metal toxicity may be possible at SB, EB, and WB.

Fish data from the Elizabeth River show that there is not a established gradient of effects in the river. Based on the trawl index information, the Southern Branch (SB) and Western Branch (WB) (highest water and sediment toxicity) showed depressed fish communities. The Eastern Branch (EB) and mainstem (EL) showed good and fair communities, respectively. The water quality measures reported during fish sampling did not always support the fish measures. The site with the lowest trawl index score did show the lowest dissolved oxygen concentration, but the highest secchi depth. Conversely, the site that showed the highest trawl score, showed adequate dissolved oxygen, but the lowest secchi depth. The fish communities at the four Elizabeth sites were variable and there was no consistent stressor that could explain the suboptimal communities.

The Benthic IBI data showed that three sites were degraded (EL, SB, and WB) and one site was severely degraded (EB). The benthic community data are in general agreement spatially as some degree of impairment was reported at all sites (Table 5.1). The fish community data and the benthic community data only agree for the SB and WB sites where some degree of impairment was reported for both biological communities (Table 5.1). Based on the B-IBI values, the benthos seem to be responding somewhat differently to the ambient conditions of the Elizabeth River than the fish. 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 from sediment contaminants such as PAHs, pesticides and metals consistently reported in all Elizabeth River sites. 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 (sites EB and EL) are areas where the benthic community is depressed. 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 the various Elizabeth River sites. 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 biological community metric data shows that the water column toxicity data (multivariate analysis) showed effects at the WB site, fish community data shows effects at the SB and WB and the sediment toxicity data/benthic B-IBI data suggested toxicity/biological impairment at all sites (Table 5.1). The close agreement between the sediment toxicity data and the benthic community data suggest that the contaminant problems in the Elizabeth River are primarily in the sediment. These data support previous ambient toxicity data from 1990 in the Southern Branch of the Elizabeth River (near the Atlantic Woods Industries) where a high degree of toxicity was reported in the sediment (Hall et al., 1991).

5.2 South River

A discussion of the South 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 in the south River showed *Eurytemora* survival was significantly reduced at SR-3 and SR-4. Significant effects from endpoints with other water column test species was not reported based on univariate analysis. However, multivariate analysis suggested effects at the three downstream sites (SR-2, SR-3 and SR-4). Various metals (copper, mercury and nickel) exceeding water quality criteria were reported in the South River. Concentrations of chromium (46 ug/L) that were clearly above ambient conditions but slightly below the water quality criteria (50 ug/L) were also reported.

Sediment toxicity for the South River sites showed that *L. dytiscus* survival and *S. benedicti* growth were significantly different from controls at all four sites. Survival of *C. variegatus* and *S. benedicti* was also reduced at SR-1. Multivariate analysis showed effects at the two upstream sites (SR-1 and SR-2). Potentially toxic concentrations of various contaminants were reported in South River sediments. The pesticides Heptachlor Epoxide, Chlordane, and Endrin Aldehyde were reported at all four sites. DDE and DDT concentrations exceeding ER-L values were reported at SR-1 and SR-4. The total number of pesticides detected by site rnaged from 4 to 7. The SR-1 site, which had the highest degree of sediment toxicity, also had the highest number of pesticides detected.

PAH contamination in the South River was generally less severe than the Elizabeth River. Two to six PAHs were detected at the various stations and only fluoranthene at SR-2 exceeded the ER-L value. These data do not suggest a strong link between PAH exposure and biological effects in sediment.

Total bulk metal concentrations were variable among the South River sites. Exceedences of ER-L values occured for eight metals at SR-2, six metals at SR-3 and five metals at SR-1. Nickel exceeded the ER-M value at SR-4 but concentrations of the other metals were generally low at this site. The highest chromium concentration (183 ug/g) at SR-2 corresponds with the high chromium concentrations reported in the water column at this station (46 ug/L). All South River sites had SEM/AVS ratios less than one thus suggesting that toxicity due to metals is unlikely.

Fish community data and concurrent water quality information for the South River suggest that the biological habitat conditions are not meeting the prescribed reference standards. Historical information supports this pattern as degraded conditions have been reported to follow a gradient from upstream to downstream. Habitat conditions are generally poor upstream and improve downstream where there is an increase tidal influence. Carmichael, et al, 1992b , showed a correlation between land use and water quality, and water quality and bottom trawl diversity. The correlation suggested that urbanized areas (greater than 21% urban), had a degrading effect on the water quality and fish assemblage. The South River watershed, which is highly urbanized (21.85%) is likely responding to these urbanization effects.

The benthic IBI data showed that the three upstream sites were severely degraded or degraded (SR-1, SR-2 and SR-3) while the downstream site meets the restoration goal (SR-4). There is also a clear trend for benthic IBI scores gradually increasing (improving) from upstream to downstream. Both the fish and benthic community data suggest impairment for the two upstream sites but these data are in contrast for the two downsteam sites. The predatory actions of reasonably healthy fish communities at SR-3 maybe influencing (impairing) benthic communities at this site. At SR-4, the stressed fish community may not be impairing the benthic community and therefore the community is relatively healthy. The different results for the fish and benthic communities may also be related to temporal scale issues (fish respond to larger scale problems, benthos to smaller scale problems) or stressor types (fish generally respond to water soluble contaminants, benthos respond to sediment contaminants). As discussed above in Section 5.1 for the Elizabeth River, the lack of agreement between the benthic and fish IBI data at the two downstream sites does not detract from the value of these data in measuring the status of biological communities.

In summary, the sediment toxicity data, fish IBI data and the benthic IBI data suggest that the two upstream South River stations are impaired due to contaminants or other stressors (Table 5.1). The water column toxicity data for the South River also suggest some toxicity at the three downstream sites. Due to the transient and ephemeral nature of contaminants in water, downstream biological effects resulting from upstream sources is not unusual.

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, 1996 and 1997 experiments are summarized in Figures 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, and 6.7, 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.

The results of the 1997 studies are presented in Figure 6.7. Samples were collected in the South and Elizabeth River. The water from all sites in both rivers displayed significant differences in Toxicity Index values compared to the control conditions. Three of the sites on the South River (SR-2, SR-3 and SR-4) exhibited a moderate degree of toxicity. Toxicity Index values ranked in the top third of all values observed since ambient toxicity testing was initiated in 1990. *Eurytemora affinis* survival was significantly reduced at all three of these sites. Site SR-1 was somewhat lower in toxicity. The Toxicity Index values for all sites in the Elizabeth River ranked in the top half of the data sets collected to date, but the relative toxicities of most sites were much lower than the level observed during the 1990 in the Elizabeth River (see discussion of sediment data below). Normal development of coot clam larvae was the most impacted endpoint for these sites. While the index values from all sites in the Elizabeth River were significantly greater than the control conditions, the Western Branch site showed the highest degree of toxicity, ranking 6th from the top among all sites tested since 1990.

A summary of the seven year water column data base using the Toxicity Index analysis (Figures 6.8 and 6.9) indicated the following ranking of toxicity for the various sites:

- the sites (and dates tested) displaying the greatest water column toxicity were as follows:
  - Baltimore Harbor, Sparrows Point (1994)
  - Patuxent River, Broomes Island (1996)
  - Willoughby Bay (1995)

- Middle River (1994)
- Pamunkey River, below West Point in the York River basin (1995)
- Elizabeth River (1990) and Western Branch site (WB) (1997)
- Chester River, Site CH-5, Skillet Point (1996)

- the sites that displayed a low to moderate degree of water column toxicity were:
  - Chester River,Site CH-2, Tams Point (1996)
  - South River; Site SR-2, SR-3 and SR-4 (1997)
  - James River, above and below Newport News (1995)
  - Elizabeth River, Mainstem (EL) (1997)
  - Chester River, Site CH-4, Melton Point (1996)
  - Patuxent River, Buzzard Island (1996)
  - Wye River, Manor House site (1991)
  - Elizabeth River; Southern Branch (SB) and Eastern Branch (EB) (1997)
  - South River, SR-1 (1997)
  - Patapsco River (1990)
  - Magothy River, Gibson Island site (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)
  - Baltimore Harbor; Bear Creek, Middle Branch, Northwest Harbor and Outer Harbor sites (1994)
  - Chester River, Site CH-6, Scotts Point (1996)
  - Patuxent River, Chalk Point (1996)
  - Severn River (1994)
  - York River, above Cheatham Annex (1995)

- the sites that displayed no significant water column toxicity were:
  - Baltimore Harbor, Curtis Bay (1994)
  - Magothy River, South Ferry (1994)
  - Wye River (1990, 1992-3)
  - Patuxent River, Jack Bay (1996)
  - Nanticoke River, Bivalve and Sandy Hill Beach sites (1992-3)
  - Potomac River; Dalgren (1990, 1991), Freestone Point (1990), Indian Head (1990), Morgantown (1990, 1991), and Possum Point (1990)
  - 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, 1996 and 1997 studies are summarized in Figures 6.10 through 6.16, 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 6.10 - 6.16.

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 6.10). 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 6.11). 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 6.12). 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.*, 1994). 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 (Figure 6.13a and 6.13b). The Sassafras River sites displayed no sediment toxicity (Figure 6.13a). The Magothy River sites exhibited slight to moderate toxicity, particularly for the South Ferry site, which was highly variable (Figure 6.13a). 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; Figure 6.13b). 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 (Figure 6.14). 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 6.15). 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.

The 1997 studies were conducted at four sites in the South River and four stites in the Elizabeth River (Figure 6.16). While there was significant sediment toxicity at six of the eight sites, the degree of toxicity was moderately low. South River sites 1 and 2 displayed the highest level of toxicity, but Toxicity Index values only ranged from 7 to 12%. *Streblospio benedicti* survival and growth, *Leptocheirus plumulosus* growth and fish egg hatching success were the endpoints that were most affected in the experiments conducted at these sites. Conversely, SR-3 and SR-4 (downstream sites in the South River) displayed no significant toxicity.

The sediments from all the Elizabeth River sites displayed significant but low levels of toxicity (Figure 6.16). Clearly, the toxicity of the Elizabeth River sediments studied in 1997 was considerably less than the degree of toxicity detected at one Elizabeth River site in 1990 (Hall et al., 1991). The toxicity of the sediments has decreased during the intervening seven years and/or the toxicity of the sediments is highly patchy. There has been a considerable degree of management effort focused on the Elizabeth River during the 1990s (e. g. the Elizabeth River Project; pollution control actions of the Virginia Department of Environmental Quality; activities associated with the Region of Concern status of the Cheapeake Bay Program), so it is entirely possible that the degree of contamination/toxicity has significantly decreased. However, it should be noted that the Elizabeth River site studied in 1990 was selected because it was expected to be extremely contaminanted and served as a positive control during the developmental phases of the Ambient Toxicity Testing Program. The 1990 samples were taken in the proximity of a Superfund site that was highly contaminated were creosote (PAHs). The 1997 samples were taken to be more representative of the Elizabeth River mainstem and its three tributary branches. Thus, the apparent decrease of toxicity may have been due to site selection in a patchy system. Nonetheless, the more representative 1997 samples indicate that the overall toxicity of the sediments in relatively modest.

A summary of the six year sediment data base using the Toxicity Index analysis (Figures 6.17 and 6.18) 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)
  - Baltimore Harbor, Northwest Harbor, Bear Creek, Sparrows Point, Curtis Bay, and Middle Branch sites (1994)
  - James River Basin, Willoughby Bay site (1995)
  - Chester River ; Sites CH-5, Skillet Point and CH-6, Scotts Point (1996)
  - Magothy River, South Ferry site (1994)
  - Potomac River; Possum Point and Dahlgren sites (1990)

- the sites that displayed a low to moderate degree of sediment toxicity were:
  - Patapsco River sites (1990, 1991)
  - Potomac River; Freestone Point (1990) and Dahlgren (1991)
  - Chester River, Site CH2, Tams Point (1996)
  - South River, SR-1 (1997)
  - Severn River, Annapolis site (1994)
  - Wye River, Manor House site (1991)
  - Chester River, Site CH-4, Melton Point (1996)
  - James River site, below Newport News (1995)
  - Patuxent River, Buzzard Island site (1996)
  - Baltimore Harbor, Outer Harbor site (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:
  - Magothy River, Gibson Island site (1994)

- Wye River, Manor House site (1990)
- South River, SR-2 (1997)
- Potomac River; Morgantown (1990, 1991) and Indian Head (1990) sites
- Elizabeth River; Mainstem (EL), Western Branch (WB), Eastern Branch (EB) and Southern Branch (SB) (1997)

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

  - Middle River; Frog Mortar and Wilson Point sites (1992-3)
  - Sassafras River; Betterton and Turner Creek sites (1994)
  - Wye River; Quarter Creek and Manor House sites (1992-3)
  - South River; SR-3 and SR-4 (1997)
  - Patuxent River; Broomes Island, Jack Bay, and Chalk Point sites (1996)
  - Nanticoke River; Bivalve and Sandy Hill Beach sites (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, family, spawning location and residency of fish captured at the eight sampling locations.

SPECIES NAME	TROPHIC	FAMILY	SPAWN LOCATION	RESIDENCY
American eel *Alosa pseudoharengus*	Benthic	Anguillidae	Marine	Non-resident
Atlantic croaker *Micropogonias undulatus*	Benthic	Sciaenidae	Marine	Non-resident
Atlantic menhaden *Brevoortia tyrannus*	Planktivore	Clupeidae	Marine	Non-resident
Atlantic needlefish *Strongylura marina*	Carnivore	Belonidae	Marine	Non-resident
Atlantic silverside *Menidia menidia*	Planktivore	Atherinidae	Estuarine	Resident
Bay anchovy *Anchoa mitchelli*	Planktivore	Engraulidae	Estuarine	Resident
Bluefish *Pomatomus saltatrix*	Carnivore	Pomatomidae	Marine	Non-resident
Carp *Cyprinus carpio*	Benthic	Cyprinidae	Freshwater	Resident
Chain pickerel *Esox Niger*	Carnivore	Esocidae	Freshwater	Resident
Gizzard shad *Dorosoma cepedianum*	Planktivore	Clupeidae	Freshwater	Resident
Hogchoker *Trinectes maculatus*	Benthic	Solidae	Estuarine	Resident
Inland silverside *Menidia beryllina*	Planktivore	Atherinidae	Estuarine	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
Silver Perch *Bairdiella chrysura*	Benthic	Sciaenidae	Marine	Non-resident
Spot *Leiostomus xanthurus*	Benthic	Sciaenidae	Marine	Non-resident

Striped anchovy *Anchoa hepsetus*	Planktivore	Engraulidae	Marine	Non-resident
Striped bass *Morone saxatilis*	Carnivore	Moronidae	Freshwater Anadromous	Non-resident
Striped killifish *Fundulus majalis*	Planktivore	Cyprinodontidae	Estuarine	Resident
Summer Flounder *Paralichthys dentatus*	Carnivore	Bothidae	Marine	Non-resident
Threespine stickleback *Gasterosteus aculeatus*	Planktivore	Gasterosteidae	Estuarine	Resident
Weakfish *Cynoscion regalis*	Carnivore	Sciaenidae	Marine	Non-resident
White perch *Morone americana*	Carnivore	Moronidae	Freshwater Anadromous	Non-resident
Yellow perch *Perca flavescens*	Carnivore	Percidae	Freshwater Anadromous	Resident

Table 4.1 Survival data from 8-d toxicity tests with *E. affinis* and sheepshead minnow larvae at 8 stations from 10/01/97 to 10/09/97.

		Cumulative Percent Survival Per Day							
Species	Station	1	2	3	4	5	6	7	8
E. affinis	Control	-	-	-	-	-	-	-	90
	ER-WB	-	-	-	-	-	-	-	65
	ER-EL	-	-	-	-	-	-	-	64
	ER-EB	-	-	-	-	-	-	-	88
	ER-SB	-	-	-	-	-	-	-	64
	SR-1	-	-	-	-	-	-	-	55
	SR-2	-	-	-	-	-	-	-	73
	SR-3	-	-	-	-	-	-	-	18*
	SR-4	-	-	-	-	-	-	-	35*
Sheepshead	Control	100	100	100	100	100	100	100	100
minnow	ER-WB	100	100	100	100	100	100	100	98
	ER-EL	100	100	100	100	100	100	98	98
	ER-EB	100	100	100	100	100	100	100	98
	ER-SB	100	100	100	100	100	100	100	100
	SR-1	100	100	100	93	88	88	88	85
	SR-2	100	100	100	100	100	100	100	100
	SR-3	100	100	100	100	100	100	100	100
	SR-4	100	100	100	100	100	98	98	98

*Indicates significant difference from control value ($P<0.05$).

Table 4.2 Growth data from sheepshead minnow larvae from the 10/01/97 to 10/09/97 experiments.

		Sheepshead larvae dry weight (initial weight at day 0=0.13 mg).	
Station	n at d8	(mg at d=8)	±S.E.
CONTROL	44	1.40	0.033
ER-WB	41	1.63	0.056
ER-EL	42	1.53	0.065
ER-EB	40	1.77	0.086
ER-SB	44	1.60	0.075
SR-1	35	1.10	0.264
SR-2	46	1.51	0.064
SR-3	41	1.63	0.038
SR-4	40	1.31	0.190

Table 4.3 Percent normal shell development from two 48h coot clam embryo/larval tests conducted from 10/04/97 to 10/06/97 (test 1) and 10/10/97 to 10/12/97 (test 2).

	Test 1		Test 2	
Station	Percent Normal	±S.E.	Percent Normal	±S.E.
CONTROL	95.6	0.83	92.3	1.42
ER-WB	92.3	1.91	92.7	1.63
ER-EL	92.1	1.57	91.8	0.83
ER-EB	90.6	3.17	91.8	0.46
ER-SB	87.4	1.02	90.0	1.26
SR-1	89.5	2.58	92.0	0.61
SR-2	93.5	0.67	88.2	0.25
SR-3	94.4	2.20	92.7	2.29
SR-4	94.7	1.03	91.2	0.36

Table 4.4 Survival, reproduction and maturation data for *Eurytemora* after 8d tests at 8 stations from 10/01/97 to 10/09/97.

Station	Mean Percent Survival	±S.E.	Mean Percent Gravid Female	±S.E.	Mean Percent Immature	±S.E.
CONTROL	89.6	7.89	0.0	0.00	92.0	0.32
ER-WB	65.1	13.50	34.7	12.30	12.8	6.26
ER-EL	64.1	18.60	8.2	5.89	12.2	5.31
ER-EB	88.4	3.89	52.0	5.70	6.4	2.20
ER-SB	63.9	21.90	28.9	10.70	5.8	5.77
SR-1	54.6	16.00	39.0	19.50	8.1	4.23
SR-2	72.8	6.48	15.0	5.00	25.0	5.00
SR-3	18.5*	6.42	0.0	0.00	22.9	15.70
SR-4	35.4*	6.25	26.7	9.03	12.5	7.98

*Indicates significant difference from control value (P<0.05).

Table 4.5 Inorganic contaminants data from the 8 stations sampled during the fall of 1997 (10/01/97 - 10/09/97). 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							
	SR1	SR2	SR3	SR4	SB	EB	EL	WB
As (-)	0.59	0.51	0.36	0.28	1.13	0.82	1.36	1.74
Cd (9.3)	0.32	1.01	0.19	<0.13	0.71	0.603	0.45	0.29
Cr (50)	6.18	45.7	1.5	2.46	12.8	1.64	1.73	<1.00
Cu (2.9)	1.10	1.5	<1.00	<u>3.30</u>*	<u>3.4</u>*	1.60	2.10	<u>3.10</u>*
Pb (8.5)	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Hg (0.025)	<u>0.47</u>	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Ni (8.3)	3.32	<u>13.8</u>	3.24	3.14	2.76	<1.00	2.48	<1.00
Se (71)	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.17
Zn (86)	<25	<25	<25	<25	<25	<25	<25	<25

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

Table 4.6 Water quality parameters reported in the field during sample collection in the fall of 1997.

Date	Station	Temp (C)	Salinity (ppt)	Cond. (umhos/cm)	Dissolved oxygen	pH
9-30-97	ER-SB	22.9	20.8	30800	-	7.75
	ER-EB	21.0	20.8	30900	-	7.77
	ER-EL	21.9	22.0	32800	-	7.75
	ER-WB	20.9	22.4	32000	-	7.90
	SR1	20.0	12.0	16000	8.2	7.58
	SR2	20.0	12.0	19000	8.4	7.72
	SR3	20.0	14.0	20500	8.5	7.77
	SR4	20.0	14.5	21000	8.6	7.86
10-3-97	ER-SB	21.3	21.5	32000	6.3	7.54
	ER-EB	19.2	21.0	30000	7.1	7.62
	ER-EL	20.9	22.5	33000	6.1	7.56
	ER-WB	20.0	22.0	32000	7.1	7.72
	SR1	17.5	12.0	16500	8.8	7.62
	SR2	18.0	12.5	17500	8.6	7.72
	SR3	17.5	14.0	19500	8.8	7.88
	SR4	17.5	14.5	20500	9.2	7.96
10-6-97	ER-SB	22.7	21.5	33000	6.9	7.80
	ER-EB	21.4	20.5	31000	6.8	7.79
	ER-EL	21.9	21.0	33000	7.0	7.80
	ER-WB	21.0	22.0	33000	7.5	7.97
	SR1	21.0	12.0	17500	8.2	7.64
	SR2	20.5	12.5	18000	8.0	7.78
	SR3	20.0	12.5	19500	8.4	7.92
	SR4	20.0	14.5	21000	8.6	7.98

Table 4.7 Toxicity data (48h LC50s or EC50s mg/L) from 1997 reference toxicant tests conducted with cadmium chloride for the three test species. Previous values from years 1 thru 6 are reported.

			Previous 48h LC50 values					
Date	Species	48h LC50	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6
10/15/97	Sheepshead minnow	1.34	0.51	1.54	1.18	0.71	1.03	2.30
11/05/97	E. affinis	.261	.021	0.095	.120	.143	.192	.126
10/15/97	Coot clam	.082[a]	-----	-----	.005[a]	.008[a]	.069[a]	.040[a]

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

Table 4.8 Survival data from *C. variegatus* at the eight stations.

Species	Station	% Survival	% Hatched	% Dead Fish	% Dead Eggs
C. variegatus					
	SR1	70.00*	74.00*	5.08	26.00*
	SR2	82.00	84.00	2.22	16.00
	SR3	92.00	92.00	0.00	8.00
	SR4	98.00	98.00	0.00	2.00
	SB	90.00	88.00	0.00	8.00
	EB	88.00	88.00	0.00	12.00
	EL	84.00	86.00	0.00	14.00
	WB	86.00	86.00	0.00	14.00
	LS (R)	98.00	98.00	0.00	2.00
	LM (C)	90.00	90.00	0.00	10.00
	PM (R)	92.00	92.00	0.00	8.00

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. "(R)" = Reference, "(C)"= Control. "SE" = Standard Error.

Species	% Survival							
L. dytiscus	Day 10				Day 20			
Station	**Unadjusted**	**SE**	**Adjusted**	**SE**	**Unadjusted**	**SE**	**Adjusted**	**SE**
SR1	36.00*	13.55	46.81*	13.38	14.00*	10.42	34.00*	16.57
SR2	17.00*	2.55	24.90*	3.68	5.00*	1.58	14.21*	2.52
SR3	54.00*	5.57	81.80	8.59	21.00*	2.92	75.17	10.63
SR4	85.00	6.52	90.82	4.62	49.00*	10.42	68.92	9.46
SB	48.00*	4.36	59.27*	4.66	6.25*	1.25	27.45*	4.17
EB	48.00*	8.15	63.96*	10.29	8.00*	3.39	42.65*	10.44
EL	31.00*	4.00	41.84*	3.50	8.00*	3.39	21.99*	5.01
\WB	56.00*	11.34	69.58	15.20	12.00*	4.36	56.69	20.38
LS (C)	91.00	6.78	91.57	6.54	87.00	6.04	87.74	5.80
PM (R)	54.00*	6.00	80.80	6.60	16.00*	2.92	69.42	9.83

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. "(R)" = Reference, "(C)"= Control. "SE" = Standard Error.

Species		% Survival			
		Day 10		Day 20	
L. plumulosus					
	Station	**Mean**	**SE**	**Mean**	**SE**
	SR1	90.00	7.58	30.00	9.62
	SR2	96.00	1.87	37.00	10.07
	SR3	96.00	1.87	56.00	10.05
	SR4	94.00	4.00	83.00	12.31
	SB	84.00	7.31	20.00*	9.49
	EB	93.00	2.55	24.00	4.30
	EL	84.00	6.00	7.00*	2.55
	WB	76.00	19.07	20.00*	6.52
	LS (R)	83.00	4.36	78.00	4.06
	PM (C)	96.00	1.87	49.00	7.97

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

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

Table 4.11 Survival data from *S. benedicti* at the eight stations. "(R)" = Reference, "(C)"= Control. "SE" = Standard Error.

Species	% Survival							
S. benedicti	Day 10				Day 20			
Station	**Unadjusted**	**SE**	**Adjusted**	**SE**	**Unadjusted**	**SE**	**Adjusted**	**SE**
SR1	85.00	8.37	86.29	7.24	35.00*	9.08	37.43*	8.01
SR2	85.00	6.52	85.00	6.52	75.00	6.71	75.00	6.71
SR3	87.00	4.36	87.00	4.36	79.00	5.79	79.00	5.79
SR4	88.00	3.74	92.00	4.90	76.00	2.92	85.00	6.32
SB	94.00	2.92	94.00	2.92	86.00	3.67	86.00	3.67
EB	89.00	5.10	89.00	5.10	82.00	4.06	82.00	4.06
EL	85.00	4.18	86.49	4.84	79.00	4.30	82.72	4.99
WB	54.00*	16.00	54.00*	16.00	51.00*	16.16	51.00*	16.16
LM (C)	96.00	2.45	96.00	2.45	83.00	3.74	83.00	3.74
LS (R)	72.00	9.82	85.47	6.76	60.00	9.08	81.12	7.23
PM (R)	92.00	5.15	92.00	5.15	84.00	5.79	84.00	5.79

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.

Station	Replicate	%SAND	%SILT	%CLAY
Lynnhaven Sand		99.3254	0.0000	0.6746
Lynnhaven Mud		29.3575	43.1728	27.4697
Poropatank		2.2682	20.1414	77.5904
SB	1	58.2380	20.6257	21.1363
SB	2	59.8110	14.2993	25.8897
SB	3	54.8144	15.3935	29.7921
SB	4	34.4744	24.2972	41.2285
SB	5	41.0905	11.0083	47.9012
EB	1	44.1134	40.7165	15.1701
EB	2	25.6410	51.8648	22.4942
EB	3	55.6721	16.9025	27.4254
EB	4	17.5305	36.4176	46.0519
EB	5	21.6687	41.0652	37.2662
EL	1	70.3107	8.6396	21.0498
EL	2	56.9430	13.1550	29.9020
EL	3	14.1496	30.8361	55.0144
EL	4	0.9626	44.6912	54.3462
EL	5	0.5534	30.1310	69.3157
WB	1	96.1040	1.1783	2.7177
WB	2	30.1116	26.1683	43.7201
WB	3	25.4505	27.0088	47.5407
WB	4	51.7372	29.9243	18.3385
WB	5	16.2830	38.9284	44.7886
SR1	1	24.1866	27.2174	48.5960
SR1	2	74.9934	6.2516	18.7549
SR1	3	4.4424	33.2927	62.2649
SR1	4	4.5990	35.7974	59.6036
SR1	5	9.6912	35.1772	55.1316
SR2	1	19.1298	37.9732	42.8970
SR2	2	16.0079	26.9932	56.9989
SR2	3	12.3850	26.4487	61.1662
SR2	4	13.4326	34.1349	52.4325
SR2	5	6.9083	33.3669	59.7248
SR3	1	6.2473	39.2570	54.4957
SR3	2	18.5739	34.8667	46.5593
SR3	3	4.2679	33.0456	62.6865
SR3	4	4.4075	29.0231	66.5694
SR3	5	4.0140	32.8734	63.1126
SR4	1	85.5833	5.2731	9.1436
SR4	2	76.4262	11.7760	11.7977
SR4	3	64.2603	20.4576	15.2821
SR4	4	68.9391	16.2806	14.7802
SR4	5	96.1632	-0.1485	3.9853

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 at the start of the test. Weight and length for each site are the mean of the surviving animals for each replicate. "(R)" = Reference, "(C)"= Control.

Site	Number of True Replicates	Weight (mg)	S.E.	Length (mm)	S.E.
L. dytiscus					
Initial	5	0.280	0.0109	3.904	0.05753
SR1	3	0.250	0.0774	4.336	0.3283
SR2	4	0.301	0.113	4.321	0.3129
SR3	5	0.324	0.0832	4.446	0.4339
SR4	5	0.316	0.0505	4.460	0.08617
SB	5	0.214	0.0636	3.997	0.4093
EB	4	0.146	0.0443	3.476	0.2394
EL	4	0.326	0.147	4.133	0.3853
WB	5	0.277	0.0765	3.917	0.3236
LS (C)	4	0.355	0.0259	4.369	0.09033
PM (R)	5	0.301	0.0586	4.249	0.1514

*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 SE of 5 replicates of 20 animals each at the start of the test. Weight and length for each site are the mean of the surviving animals from each replicate. "(R)" = Reference, "(C)"= Control.

Site	Number of True Replicates	Weight (mg)	S.E.	Length (mm)	S.E.
L. plumulosus					
Initial	5	0.104	0.00379	3.929	0.1034
SR1	5	0.168	0.00987	4.831	0.1577
SR2	5	0.153	0.00391	6.139	0.2004
SR3	5	0.175	0.00450	6.279	0.06233
SR4	5	0.210	0.00206	4.904	0.5262
SB	3	0.154	0.000958	4.520	0.09417
EB	5	0.195	0.0162	4.726	0.06564
EL	4	0.391	0.0963	4.664	0.1810
WB	4	0.192	0.0172	4.710	0.1657
LS (R)	5	0.192	0.00101	4.354	0.08183
PM (C)	5	0.230	0.00620	4.273	0.02725

*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 at the start of the test. Weight and length for each site are the mean of the surviving animals from each replicate. "(R)" = Reference, "(C)"= Control.

Site	Number of True Replicates	Weight (mg)	S.E.	Length (mm)	S.E.
S. benedicti					
Initial	5	0.0410	0.00888	4.349	0.5083
SR1	4	0.0588*	0.0105	3.587*	0.08408
SR2	5	0.0980*	0.00654	6.780*	0.2947
SR3	5	0.0943*	0.0132	6.852	0.3835
SR4	5	0.103*	0.00716	6.574*	0.2279
SB	5	0.102*	0.0112	7.195	0.3715
EB	5	0.0999*	0.00670	6.653*	0.3587
EL	5	0.109*	0.0106	6.128*	0.3442
WB	4	0.0530*	0.0161	5.376*	0.6867
LM (C)	5	0.135	0.00880	7.754	0.3409
LS (R)	5	0.0773*	0.00457	5.475*	0.1354
PM (R)	5	0.124	0.00472	7.599	0.2928

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

Table 4.16 Pesticide concentrations for sediment samples from the eight stations and the controls. (Note: single underlined values exceed "Effects Range-Low", and double underlined values exceed "Effects Range-Median" as defined in Long *et al.*, 1995). NL = Not Listed; - = Below detection limit; ND= Not Determined; a = observed below theoretical detection limit. All values in µg/kg dry wt.

				Sites										
Compound	Detection Limit	ERL	ERM	SR1	SR2	SR3	SR4	SB	EB	EL	WB	Lynnhaven Sand	Lynnhaven Mud	Poropotank
alpha-BHC	0.7	NL	NL	-	-	-	-	-	-	-	-	-	-	-
gamma-BHC (lindane)	0.6	NL	NL	-	15.1	-	-	-	-	-	2.1	-	-	-
Heptachlor	0.8	NL	NL	-	-	-	-	6.4	-	9.6	-	-	-	-
Aldrin	0.6	NL	NL	-	-	-	-	-	-	-	-	-	-	-
beta-BHC	0.6	NL	NL	-	-	-	-	-	-	-	-	-	-	8.6
delta-BHC	1.1	NL	NL	-	-	96.5	-	-	-	-	7.4	-	12.7	18.5
Heptachlor Epoxide	0.6	NL	NL	5.5	16.9	24.8	2.6	-	-	-	3.7	-	5.9	-
Endosulfan I	0.9	NL	NL	8.4	-	-	-	-	-	-	-	-	-	-
Chlordane	5.0	NL	NL	10.4	9.5	18.5	3.5 a	19.7	14.3	19.7	2.4 a	7.6	5.6	17.2
Dieldrin	0.9	NL	NL	8.8	5.6	-	-	-	3.9	-	-	-	-	10.6
Endrin	1.2	NL	NL	-	-	-	-	-	-	-	-	-	-	-
Endosulfan II	0.7	NL	NL	-	-	-	-	-	-	-	35.8	-	-	-
Endrin Aldehyde	2.4	NL	NL	30.4	33.5	27.4	7.0	49	17.9	55.6	11.5	6.9	8.4	19.2
Methoxychlor	5	NL	NL	-	-	-	-	-	-	-	-	-	-	-
Endosulfan Sulfate	1.5	NL	NL	-	-	-	-	41.5	5.4	-	5.6	-	-	-
Endrin Ketone	ND	NL	NL	-	13.7	-	-	-	-	-	-	-	-	-
Toxaphene	10.0	NL	NL	-	-	-	-	-	-	-	-	-	-	-
4,4'-DDE	0.5	2.2	27	17.8	-	-	4.3	-	-	-	3.1	-	-	-
4-4'-DDD	0.5	NL	NL	-	-	-	-	-	24.3	-	-	-	-	-
4-4'-DDT	3.4	NL	NL	-	-	-	-	-	-	-	-	-	-	-
Total DDT	*	1.58	46.1	17.8	-	-	4.3	-	24.3	-	3.1	-	-	-
Total PCBs	16.6	22.7	180	-	-	-	-	-	-	-	-	-	-	-

*Detection limit of Total DDT not available. Site concentration calculated as sum of 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT concentrations, with individual detection limits of 5.6, 2.8, 4.7 µg/kg dry wt., respectively.

Table 4.17 Polynuclear aromatic hydrocarbon (PAH) concentrations 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). NL = Not Listed; - = Below detection limit. All values in μg/kg dry wt.

				Sites										
Compound	Detection Limit	ERL	ERM	SR1	SR2	SR3	SR4	SB	EB	EL	WB	Lynnhaven Sand	Lynnhaven Mud	Poropotank
Naphthalene	4.6	160	2100	-	-	-	-	49.7	-	173	-	-	-	-
Acenaphthylene	5.9	44	640	-	-	-	-	129	-	3320	-	-	-	-
Acenaphthene	9.9	16	500	-	-	-	-	-	-	334	-	-	-	-
Fluorene	9.9	19	540	-	-	-	-	38.2	-	-	-	-	-	-
Phenanthrene	9.2	240	1500	-	-	150	30.6	382	84.1	3390	63.4	-	-	-
Anthracene	9.9	85.3	1100	-	-	-	-	307	-	-	-	-	-	-
Fluoranthene	10.6	600	5100	227	852	446	205	-	746	-	-	434	614	118
Pyrene	10.6	665	2600	-	289	238	-	779	-	15700	-	-	-	-
Benzo (a) anthracene	17.8	261	1600	84.6	196	88.1	17.7	104	270	12100	27.9	-	-	-
Chrysene	14.5	384	2800	-	-	-	-	-	-	4050	16.5	-	-	-
Benzo (b) fluoranthene	13.9	NL	NL	-	599	211	53.1	1000	-	23700	343	50.1	109	-
Benzo (k) fluoranthene	13.9	NL	NL	-	-	-	-	-	-	6650	-	-	-	-
Benzo (a) pyrene	15.2	430	1600	-	-	377	32.7	5950	881	11100	-	106	-	-
Indeno (1,2,3-c,d) pyrene	16.5	NL	NL	-	-	-	-	-	-	-	-	-	-	-
Dibenz (a,h) anthracene	17.8	63.4	260	-	-	-	-	-	-	-	-	-	-	-
Benzo (g,h,i) perylene	16.5	NL	NL	-	-	-	-	2810	-	2590	-	-	-	-
Total PAHs	NL	4022	44792	311.6	1936	1510.1	339.1	11549	1981.1	83107	450.8	590.1	723	118

Table 4.18 Total Organic Carbon (TOC) percentages for test and control sites. All data are based on sediment dry weight.

Site	Total Organic Carbon (%)
SR1	3.49
SR2	4.34
SR3	3.06
SR4	0.521
SB	2.39
EB	3.97
EL	3.24
WB	1.66
LS	0.073
LM	1.27
PM	4.65

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-Mediam" levels listed below as defined in Long et al 1995). NA = not available; -- = not listed; < = values were less than those listed. Detection limits are averages of all samples for each element.

	Contaminant (µg/g)										
Site	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Sn	Zn
SR1	28328	23.3	3.42	170	30.7	18.2	0.087	28.8	1.01	0.502	229
SR2	27850	27.2	2.89	183	80.1	61.4	0.168	50.5	2.846	1.45	353
SR3	33614	19.61	0.903	147	46.8	45.1	0.16	40	1.589	0.318	321
SR4	4805	4.42	0.343	36.6	3.93	10.3	0.026	62.2	0.152	0.401	38.9
SB	24561	16.19	0.665	41.7	69.9	70.8	0.67	17.5	0.448	0.591	198
EB	24956	12.17	0.928	43	79.2	89	0.407	21.8	0.511	0.824	334
EL	22597	10.72	1.07	40.8	77.8	111.9	0.961	17.8	0.335	6	333
WB	18396	9.55	2.15	34.4	58	51.8	0.221	10.5	0.229	1.19	384
Lynnhaven Sand	436	0.958	0.041	< 7.46	< 3.73	11.9	< 0.025	< 1.87	< 0.019	0.505	< 1.87
Lynnhaven Mud	11901	5.25	0.436	22.8	11.1	20.5	0.064	10.8	0.257	1.01	65.1
Poropotank	31056	15.14	0.572	55	19.6	55.4	< 0.047	19.3	0.482	2.56	139
Average Detection Limit	72.45	0.018	0.009	7.243	3.623	7.243	0.031	1.81	0.018	0.362	1.81
Effects range:											
Low	--	8.2	1.2	81	34	46.7	0.15	20.9	--	--	150
Median		70	9.6	370	270	218	0.71	51.6	--	--	410

Table 4.20 Average SEM and AVS values and the SEM:AVS ratio for sediment samples tested in 1997.

Sample ID	Mean AVS (µmol/g)	Mean SEM (µmol/g)	SEM/AVS Ratio
SR1	96.44	2.947	0.031
SR2	80.84	4.548	0.056
SR3	14.47	4.312	0.298
SR4	1.39	0.613	0.441
SB	2.26	3.870	1.712
EB	2.78	5.939	2.136
EL	12.97	5.513	0.425
WB	4.71	5.886	1.250
Lynnhaven Sand	0.98	0.107*	0.109*
Lynnhaven Mud	2.53	0.881	0.348
Poropotank	5.94	1.255	0.211

* Value is sum of the detection limits for all metals examined. The resulting SEM:AVS ratio is the theoretical maximum for this site.

Table 4.21 SEM analysis for test and control sediments. Concentrations for each metal are expressed in µmol per gram of sediment dry weight. Detection limits are averages of all sediments for each element.

Site	Cadmium Mean	Copper Mean	Lead Mean	Nickel Mean	Zinc Mean	Mercury Mean	Sum Mean
SR1	0.005	0.142	0.079	0.000	2.721	<0.00010	2.947
SR2	0.039	0.479	0.279	0.180	3.571	<0.00010	4.548
SR3	0.013	0.334	0.224	0.304	3.436	<0.00008	4.312
SR4	0.002	0.050	0.024	0.042	0.495	<0.00003	0.613
SB	0.006	0.858	0.349	0.059	2.599	<0.00005	3.870
EB	0.007	0.800	0.370	0.064	4.698	<0.00005	5.939
EL	0.010	0.405	0.447	0.069	4.582	<0.00004	5.513
WB	0.018	0.454	0.265	0.037	5.111	<0.00004	5.886
Lynnhaven Sand	<0.0022	<0.0191	<0.0117	<0.0103	<0.0093	<0.00003	*0.107
Lynnhaven Mud	0.006	0.075	0.034	0.000	0.765	<0.00012	0.881
Poropotank	0.000	0.113	0.107	0.000	1.036	<0.00006	1.255
Detection Limits	0.0044	0.0397	0.0244	0.0215	0.0193	0.00006	

* Value is sum of the detection limits for all metals examined.

Table 4.22 Chemical data for pore water extracted from test and control composite samples.

Site Name	Ammonia (mg/L)	Nitrite (mg/L)	Sulfide (mg/L)	Unionized Ammonia (mg/L)
SR1	16.49	0.0008	0.0748	0.6365
SR2	13.24	0.0015	0.2676	0.5315
SR3	6.86	0.0005	0.0220	0.2375
SR4	21.73	0.0031	0.0120	0.8390
SB	6.50	0.0006	0.0135	0.2250
EB	8.89	0.0005	0.0263	0.3076
EL	11.96	0.0012	0.0263	0.4445
WB	8.70	0.0005	0.0149	0.2726
Lynn Sand	2.96	0.0309	0.0106	0.1239
Lynn Mud	15.13	0.0008	0.2289	0.4599
Porop. Mud	8.84	0.0007	0.0092	0.3414

NOTE:* EPA criteria for continuous concentrations for saltwater aquatic life. Values for sediment exposure concentrations have not been determined.

Table 4.23 Reference toxicant data results from water only, reference toxicant tests for the seventh year of the ambient toxicity project. Test duration was 96 hours for all organisms except *C. variegatus*, which ran for 9 days. Cadmium chloride ($CdCl_2$) was used for all organisms.

Species	Toxicant	LC_{50} (mg/L)	95% CIs (mg/L)	Historic Mean LC_{50} (mg/L)
C. variegatus	$CdCl_2$	0.78	0.56-1.00	0.795
L. dytiscus	$CdCl_2$	0.71	0.42-1.03	2.975
S. benedicti	$CdCl_2$	2.19	1.42-2.98	3.819
L. plumulosus	$CdCl_2$	0.23	0.12-0.36	0.717

Table 4.24. Individual metric values for South River stations. Metrics were not calculated for the Elizabeth River sites, as beach seining was not conducted.

	South River Stations			
Metric	SR-1	SR-2	SR-3	SR-4
Total abundance with menhaden removed	916	207	914	702
Abundance estuarine individuals	743	68	665	656
Abundance anadromous individuals	90	51	73	3
Proportion of carnivores	0.11	0.26	0.05	0.02
Proportion of planktivores	0.85	0.49	0.86	0.95
Proportion of benthivores	0.04	0.25	0.09	0.03
Total number of species	15	14	17	12
Number of species captured in bottom trawl	3	1	4	4
Number of species comprising 90% of catch	4	7	5	2

Table 4.25. Fish IBI values for South River stations, 1997.

Year	Station	IBI Score
1997	SR-1	29
	SR-2	29
	SR-3	39
	SR-4	27

Table 4.26. Mean Fish IBI scores for South River stations, 1989 to 1997.

Station	IBI Score
SR-1	27
SR-2	28
SR-3	30
SR-4	31

Table 4.27. Trawl Index score and rating for each station sampled in the South and Elizabeth Rivers, 1997.

River	Station	Trawl Index Score	Rating
South	SR-1	0.67	Poor
	SR-2	0.33	Poor
	SR-3	1.00	Fair
	SR-4	1.33	Fair
Elizabeth	ER-SB	0.33	Poor
	ER-EB	2.00	Good
	ER-EL	1.33	Fair
	ER-WB	0.67	Poor

Table 4.28. Summer mean dissolved oxygen concentrations above and below the pycnocline for study sites.

River	Station	Above Pycnocline Mean DO (mg/L)	Below Pycnocline Mean DO (mg/L)
South	SR-1	4.5	1.4
	SR-2	6.2	1.4
	SR-3	8.2	3.5
	SR-4	7.9	5.6
Elizabeth	ER-SB	5.6	4.6
	ER-EB	5.9	5.3
	ER-EL	6.2	5.2
	ER-WB	6.6	5.2

Table 4.29. Mean Secchi depth by station. The habitat requirement for one meter restoration of SAV in the Chesapeake Bay for mesohaline and polyhaline habitat is 0.97 meters.

River	Station	Mean Secchi Depth (m)
South	SR-1	0.62
	SR-2	0.87
	SR-3	1.04
	SR-4	0.79
Elizabeth	ER-SB	1.41
	ER-EB	0.86
	ER-EL	1.19
	ER-WB	0.99

Table 4.30. B-IBI values and benthic community condition at 1997 ambient toxicity sites.

River	Station	B-IBI Value	Benthic Community Condition
Elizabeth River	EB	1.67	Severely Degraded
	EL	2.33	Degraded
	SB	2.67	Degraded
	WB	2.33	Degraded
South River	Station 1 (SR1)	1.00	Severely Degraded
	Station 2 (SR2)	1.00	Severely Degraded
	Station 3 (SR3)	2.33	Degraded
	Station 4 (SR4)	3.67	Meets Goal

Table 5.1. Comparison of toxicity results from water column and sediment toxicity tests (multivariate or univariate analysis), along with the fish and benthic IBI data for ambient stations tested in 1997. 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
ER-SB	N	Y	Y	Y
ER-EB	N	Y	N	Y
ER-WB	Y	Y	Y	Y
ER-EL	N	Y	N	Y
SR-1	N	Y	Y	Y
SR-2	Y	Y	Y	Y
SR-3	Y	N	N	Y
SR-4	Y	N	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 6.1-6.7. 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	1997
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	-
SOUTH RIVER - SR1 (42)	-	-	X
SOUTH RIVER - SR2 (43)	-	-	X
SOUTH RIVER - SR3 (44)	-	-	X
SOUTH RIVER - SR4 (45)	-	-	X
ELIZABETH RIVER - EL (46)	-	-	X
ELIZABETH RIVER - EB (47)	-	-	X
ELIZABETH RIVER - WB (48)	-	-	X
ELIZABETH RIVER - SB (49)	-	-	X

Table 6.2 Summary of comparisons of sediment RTRM indices for reference and test sites presented in Figures 6.10- 6.16. 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	1997
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	X
CHESTER RIVER CH4 (35)	-	X	X
CHESTER RIVER CH5 (36)	-	X	X
CHESTER RIVER CH6 (37)	-	X	X
PATUXENT RIVER BROOMES ISLAND (38)	-	O	O
PATUXENT RIVER JACK BAY (39)	-	O	O
PATUXENT RIVER BUZZARD ISLAND (40)	-	X	X
PATUXENT RIVER CHALK POINT (41)	-	O	O
SOUTH RIVER - SR1 (42)	-	-	X
SOUTH RIVER - SR 2 (43)	-	-	X
SOUTH RIVER - SR 3 (44)	-	-	O
SOUTH RIVER - SR 4 (45)	-	-	O
ELIZABETH RIVER - EL (46)	-	-	X
ELIZABETH RIVER - EB (47)	-	-	X
ELIZABETH RIVER - WB (48)	-	-	X
ELIZABETH RIVER - SB (49)	-	-	X

Figure 3.1 Eight stations sampled during the 1997 Ambient Toxicity Program.

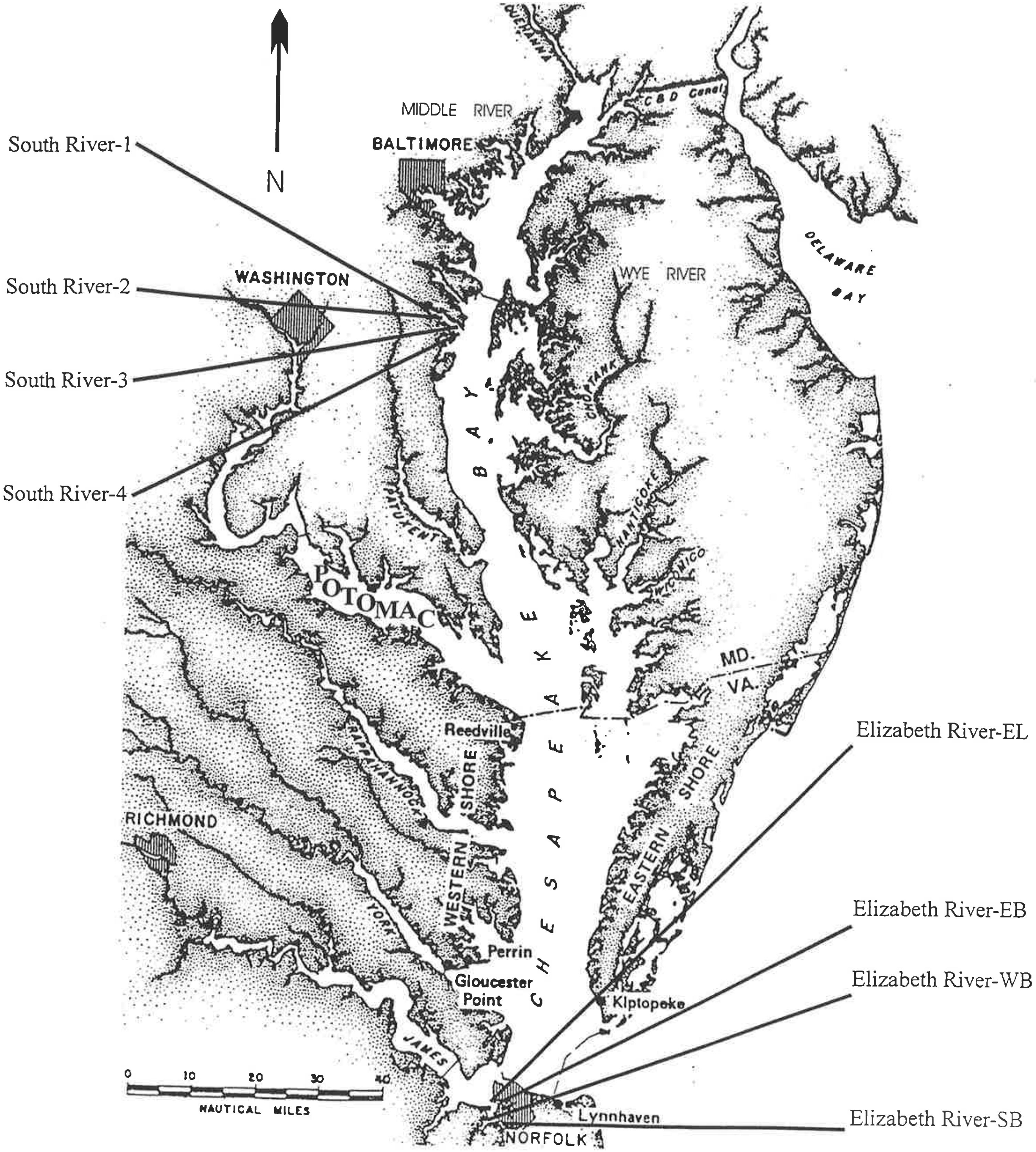


Figure 6.1 Toxicity Index results for the 1990 water column data. (See Section 3.4 for a detailed description of presentation.)

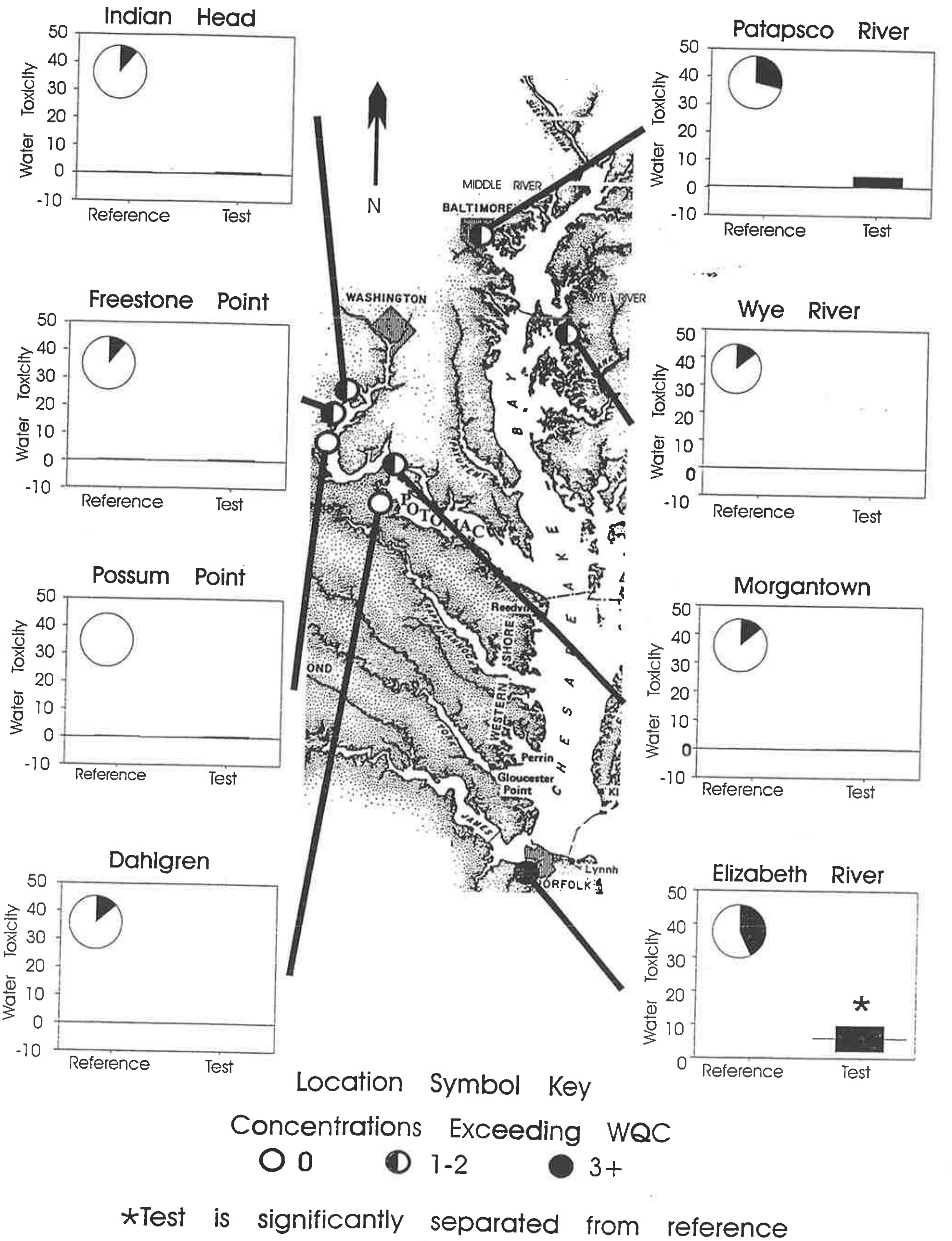


Figure 6.2 Toxicity Index results for the 1991 water column data. (See Section 3.4 for a detailed description of presentation.)

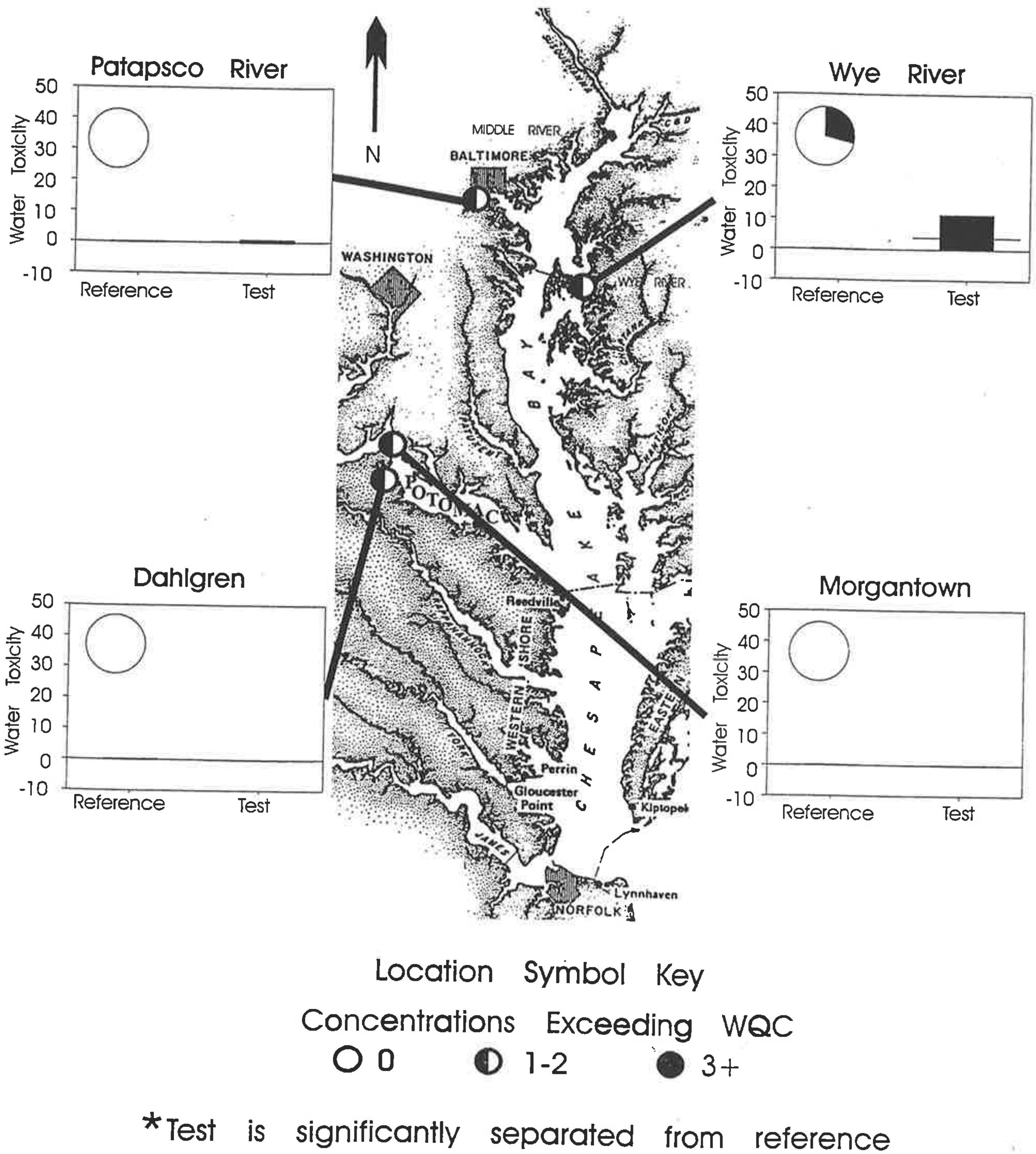


Figure 6.3 **Toxicity Index results for the 1992-1993 water column data. (See Section 3.4 for a detailed description of presentation.)**

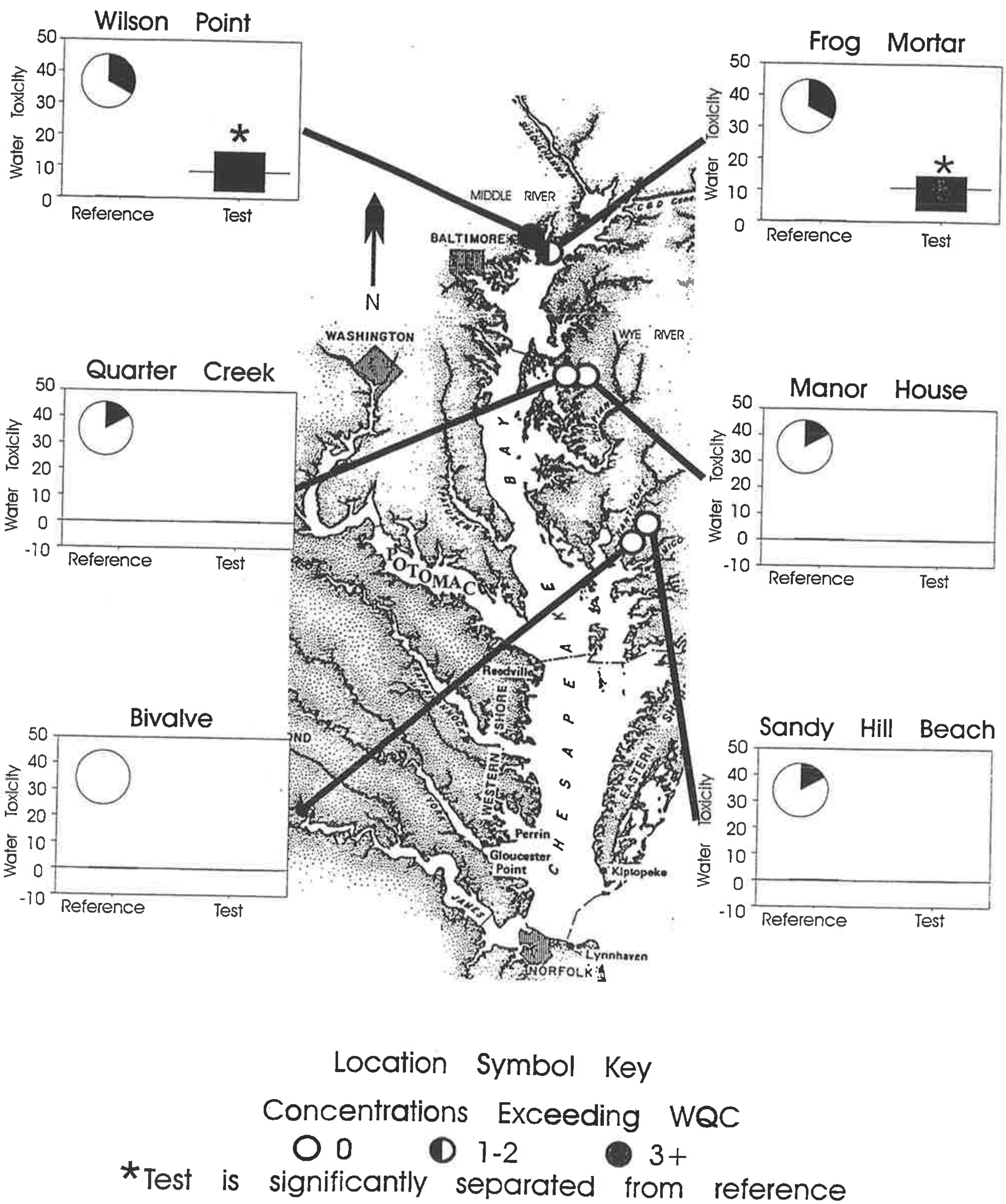


Figure 6.4a Toxicity Index results for the 1994 water column data for the Severn, Magothy and Sassafras Rivers. (See Section 3.4 for a detailed description of presentation.)

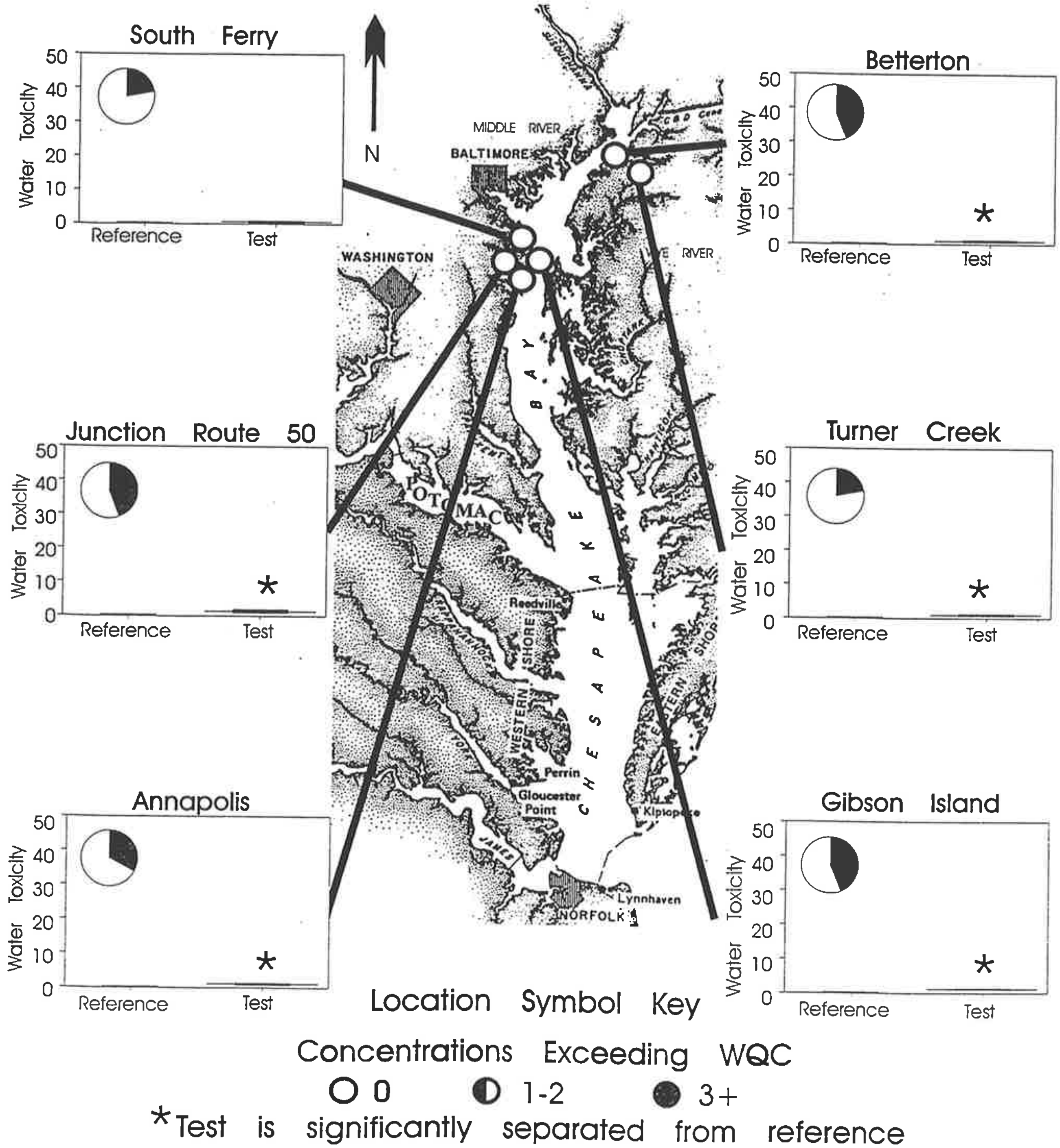


Figure 6.4b Toxicity Index results for the 1994 water column data for Baltimore Harbor sites. (See Section 3.4 for a detailed description of presentation.)

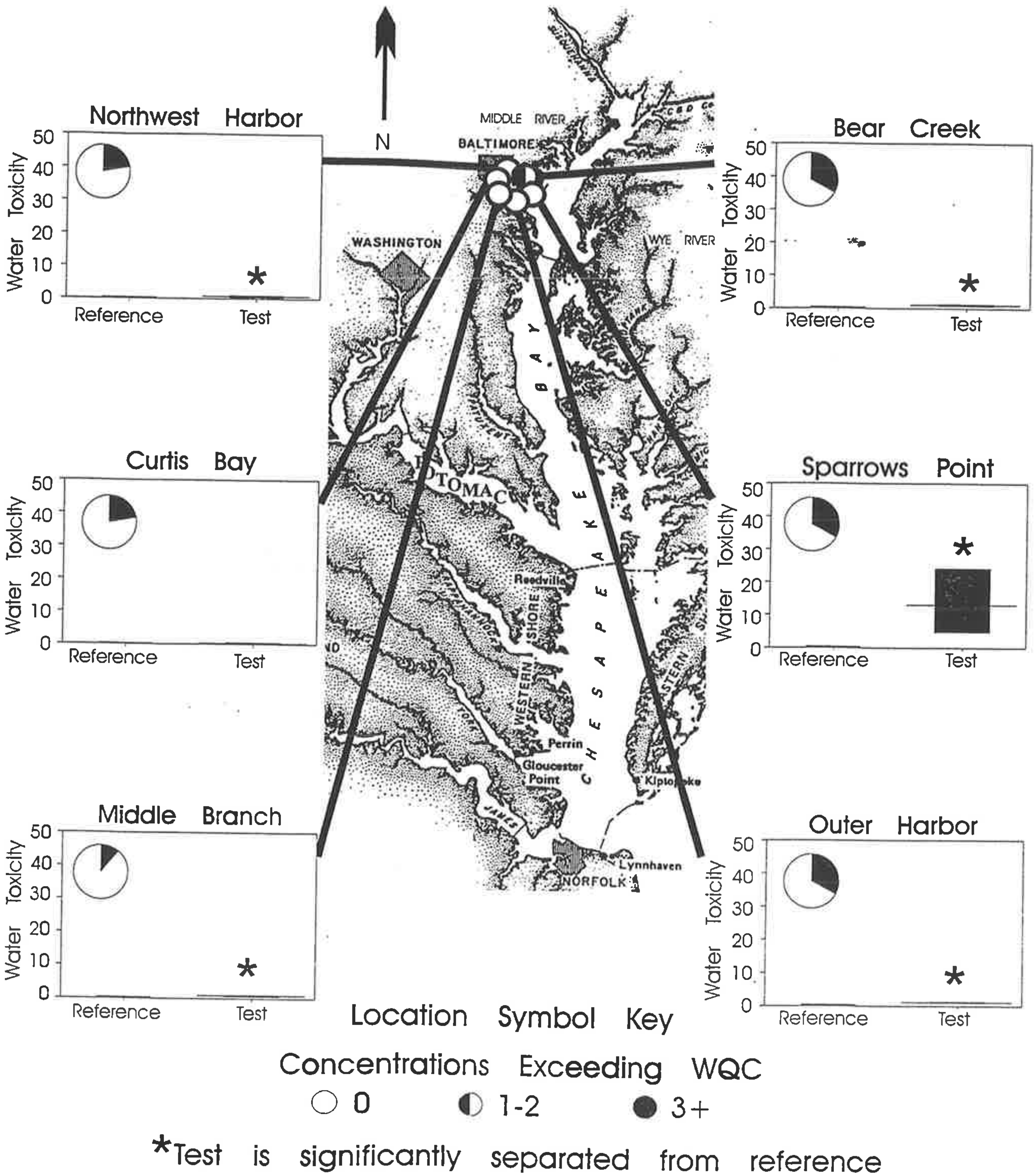


Figure 6.5 Toxicity Index results for the 1995 water column data. (See Section 3.4 for a detailed description of presentation.)

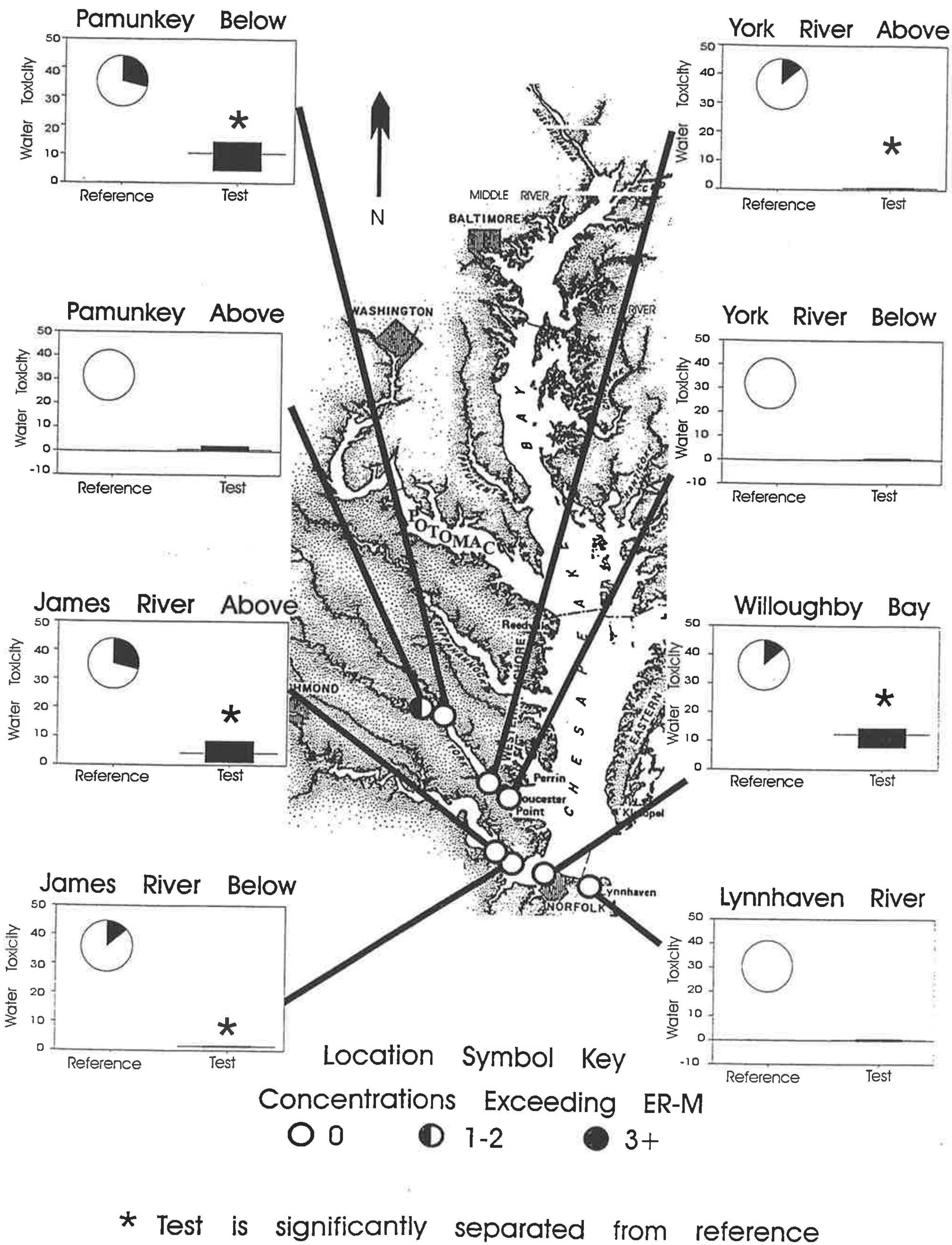


Figure 6.6 Toxicity Index results for the 1996 water column data. (See Section 3.4 for a detailed description of presentation.)

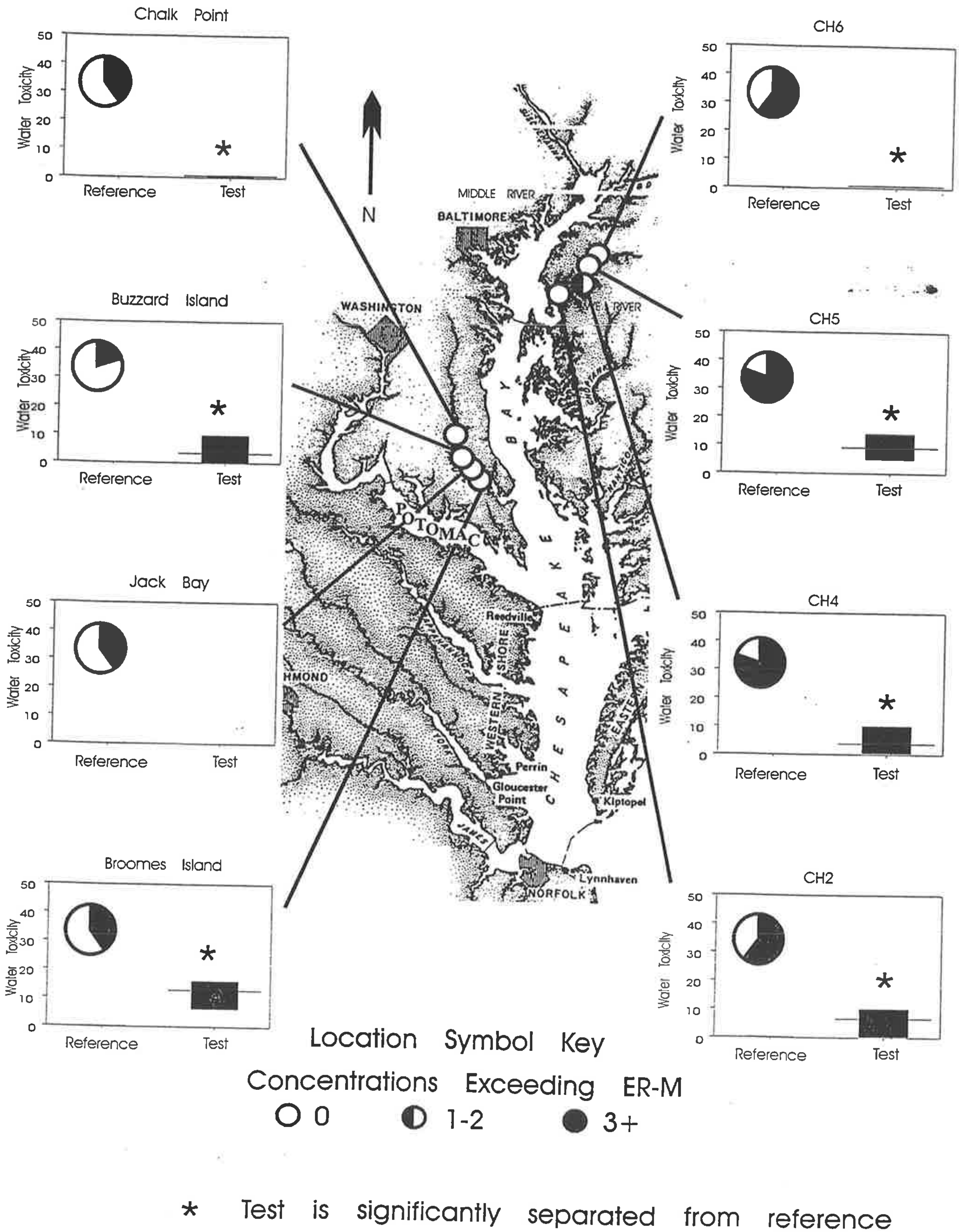


Figure 6.7 Toxicity Index results for the 1997 water column data. (See Section 3.4 for a detailed description of presentation)

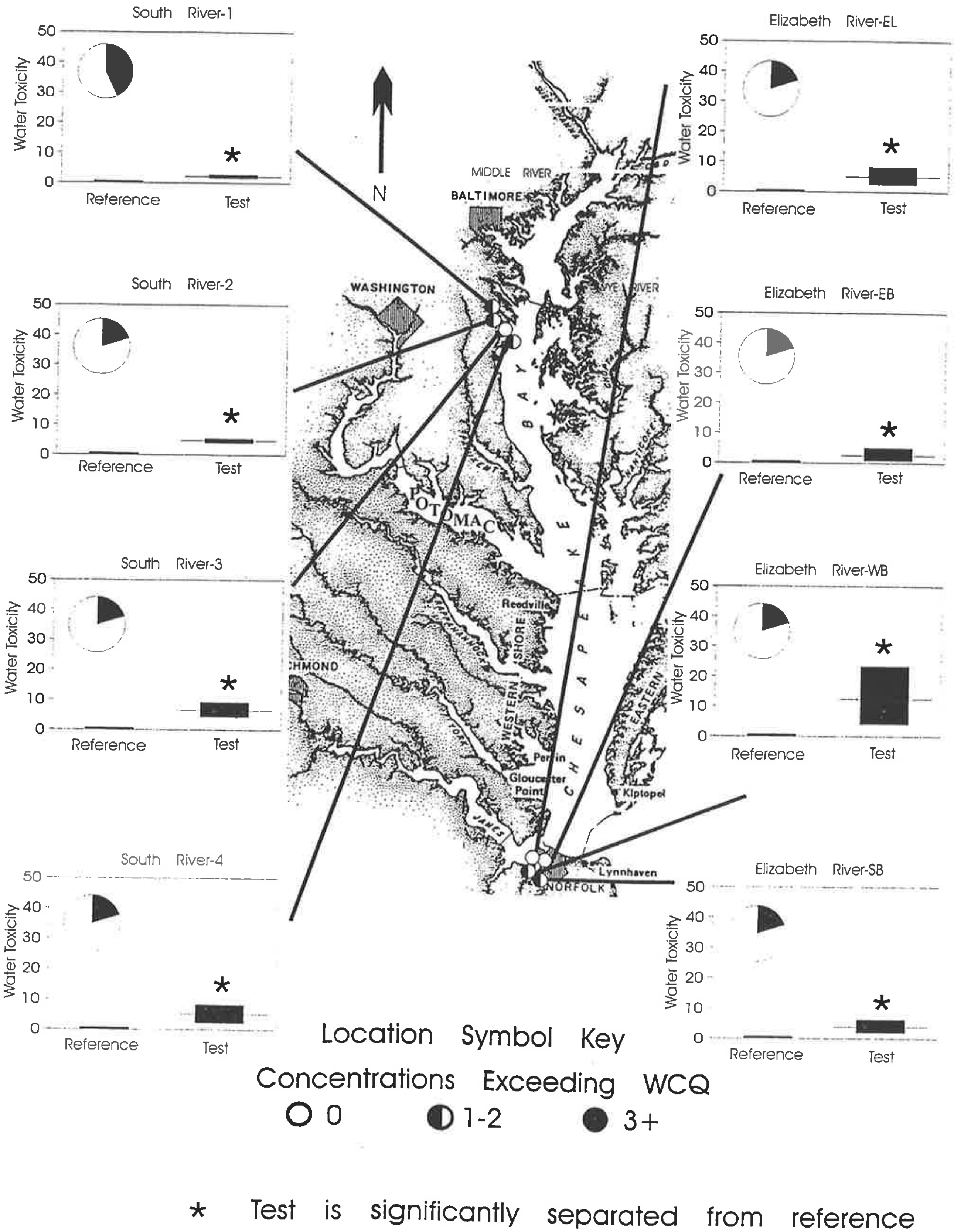


Figure 6.8 Summary of water column Toxicity Index results for 1990-1997. The sites are ranked according to median Toxicity Index values. The results are for the least toxic half of the sites in the data set. (See Figure 6.9 for remainder of ranked data.) Also shown are the 95% confidence limits for the 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.

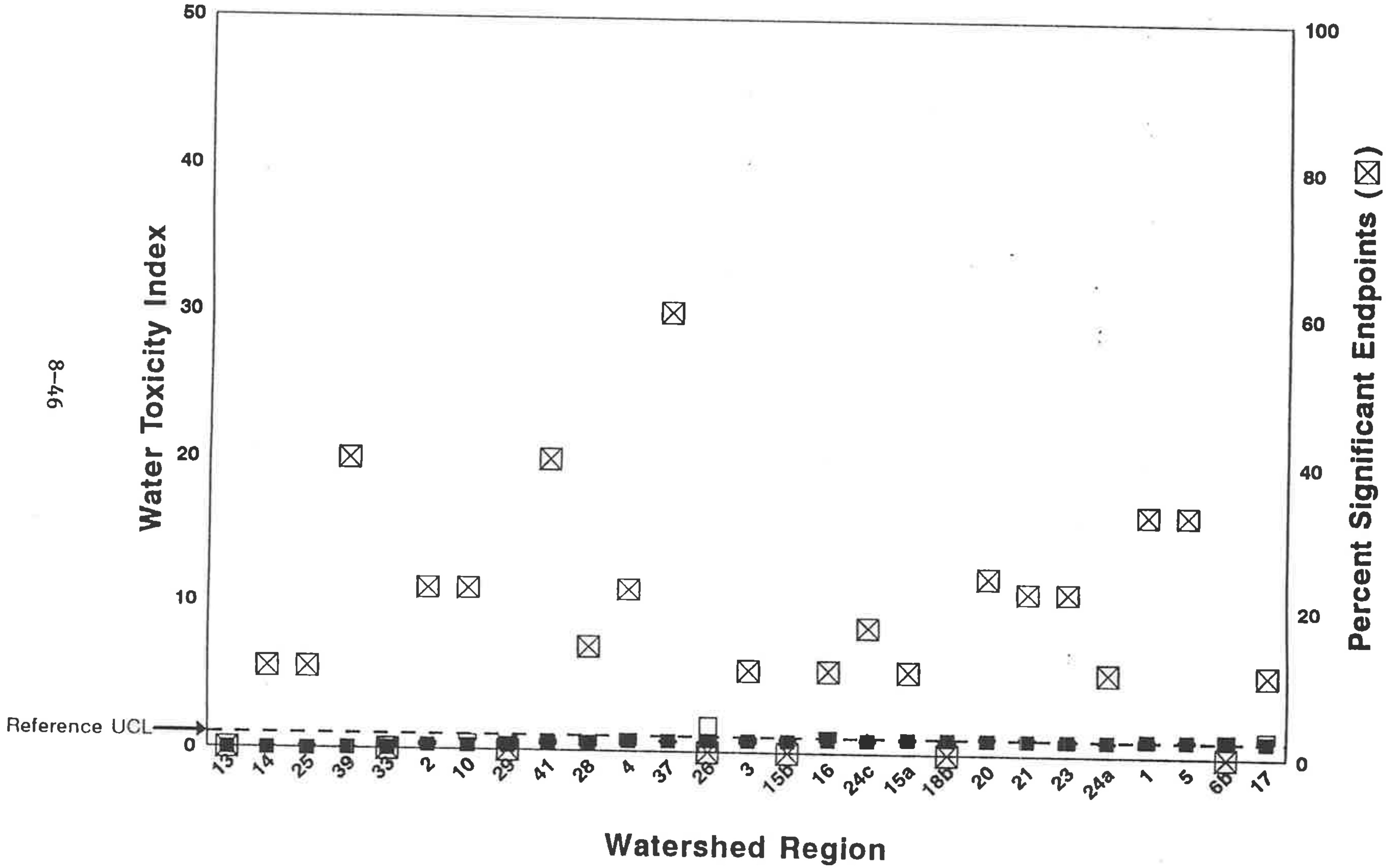


Figure 6.9 Summary of water column Toxicity Index results for 1990-1997. The sites are ranked according to median Toxicity Index values. The results are for the most toxic half of the sites in the data set . (See Figure 6.8 for remainder of ranked data.) Also shown are the 95% confidence limits for the 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.

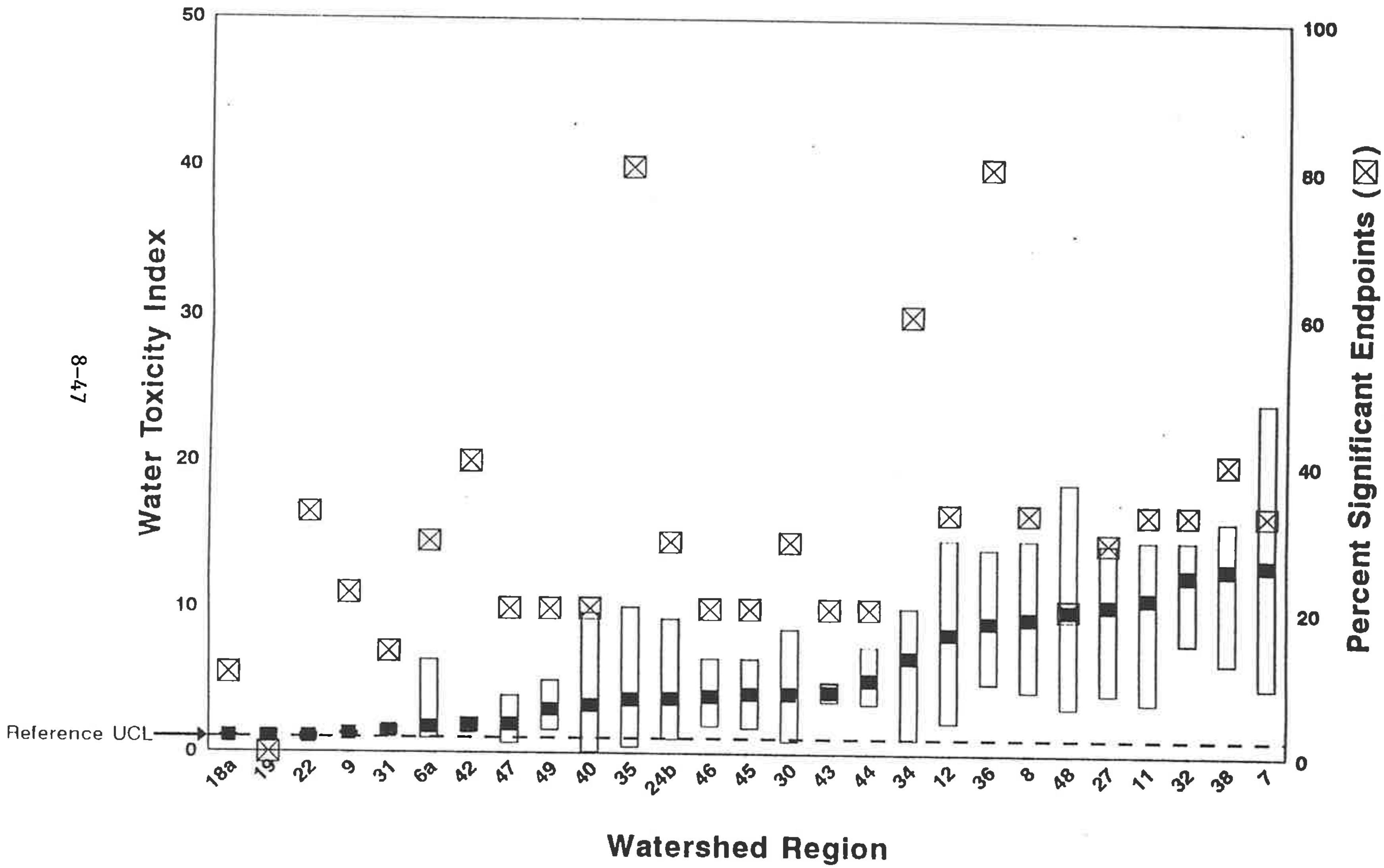


Figure 6.10 Toxicity Index results for the 1990 sediment data. (See Section 3.4 for a detailed description of presentation.)

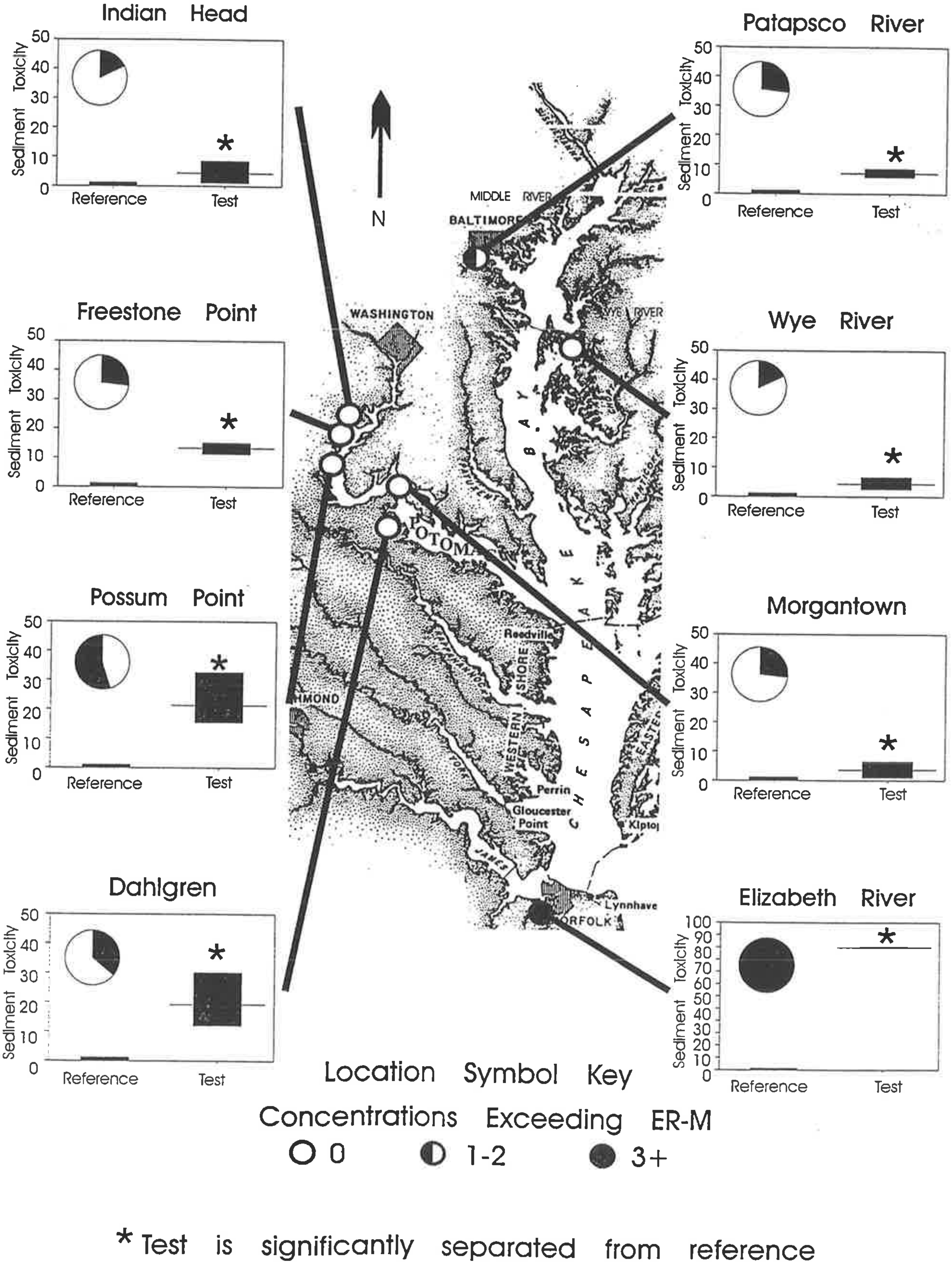


Figure 6.11 Toxicity Index results for the 1991 sediment data. (See Section 3.4 for a detailed description of presentation.)

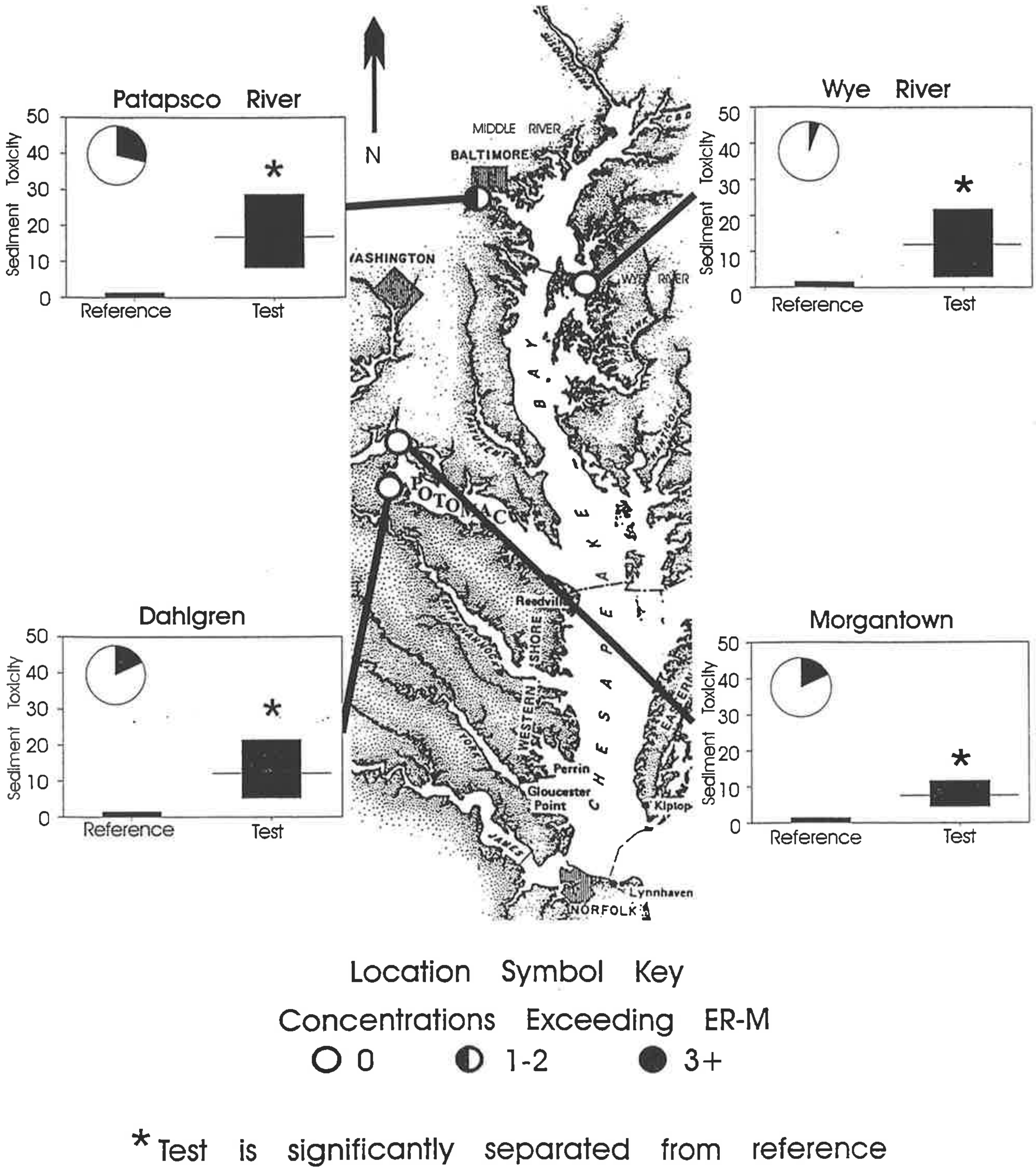


Figure 6.12 Toxicity Index results for 1992-1993 sediment data. (See Section 3.4 for a detailed description of presentation.)

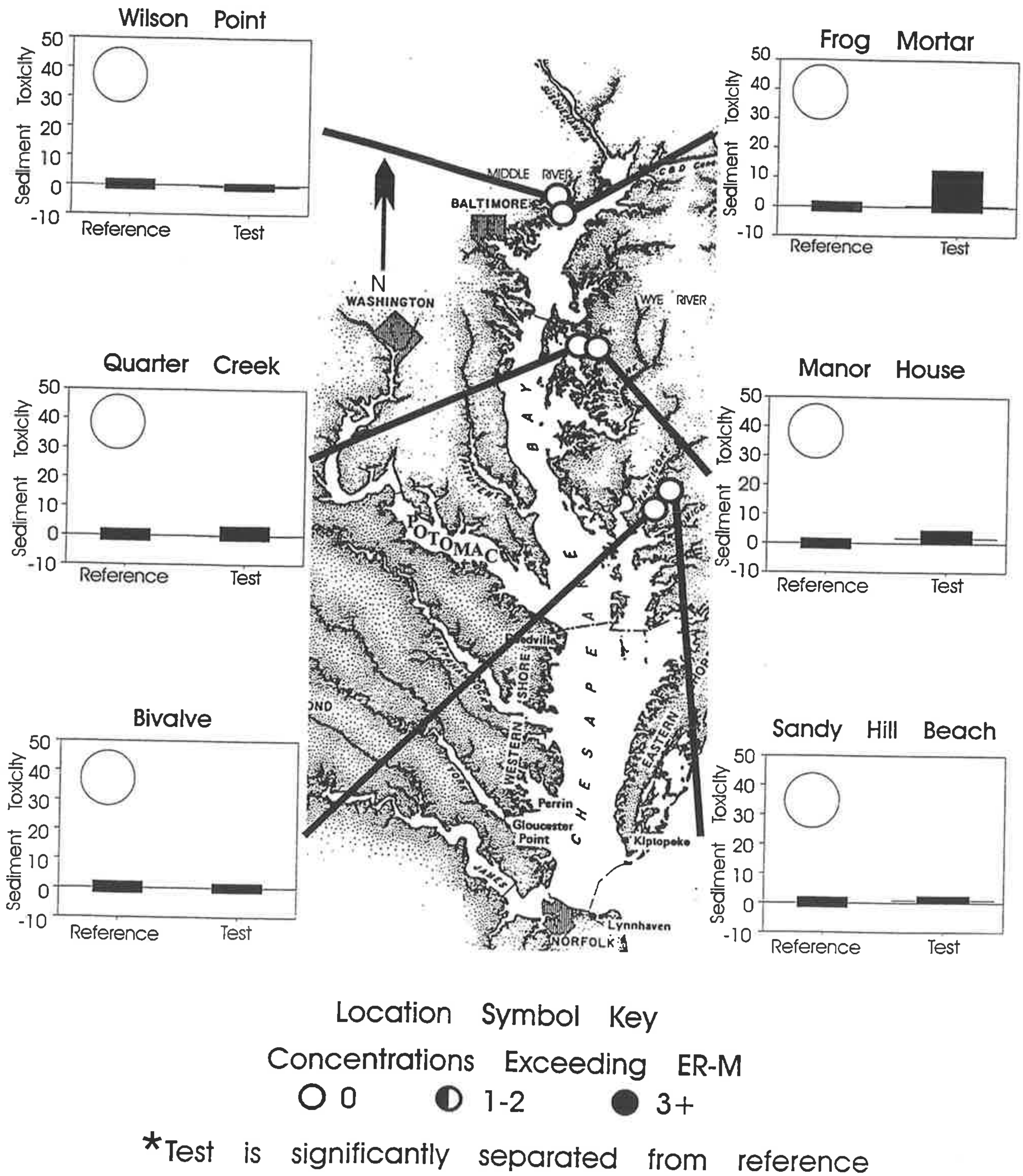


Figure 6.13a Toxicity Index results for the 1994 sediment data from the Severn, Magothy and Sassafras Rivers. (See Section 3.4 for a detailed description of presentation.)

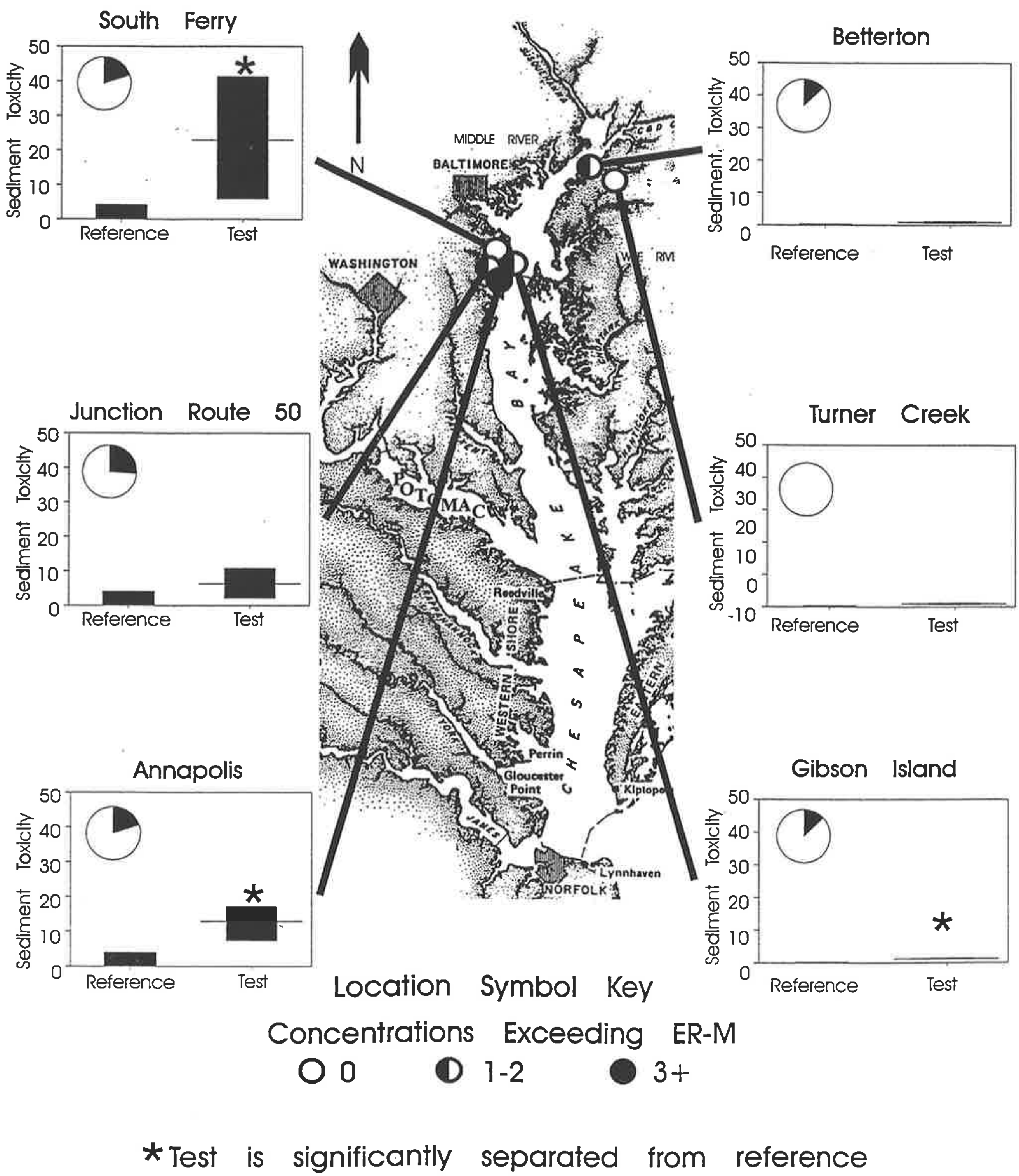


Figure 6.13b Toxicity Index results for the 1994 sediment data from Baltimore Harbor sites. (See Section 3.4 for a detailed description of presentation.)

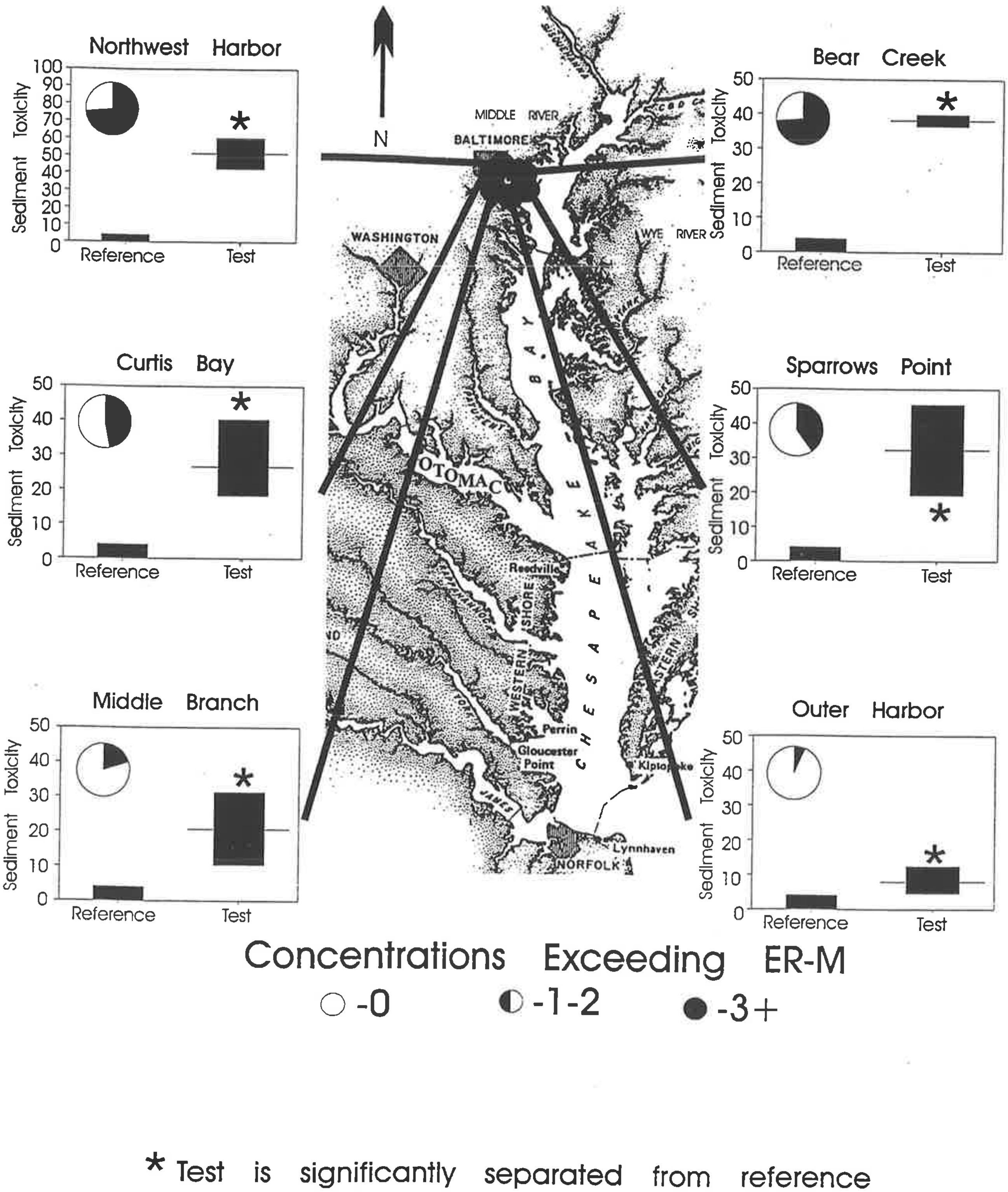


Figure 6.14 Toxicity Index results for the 1995 sediment data. (See Section 3.4 for detailed description of presentation.)

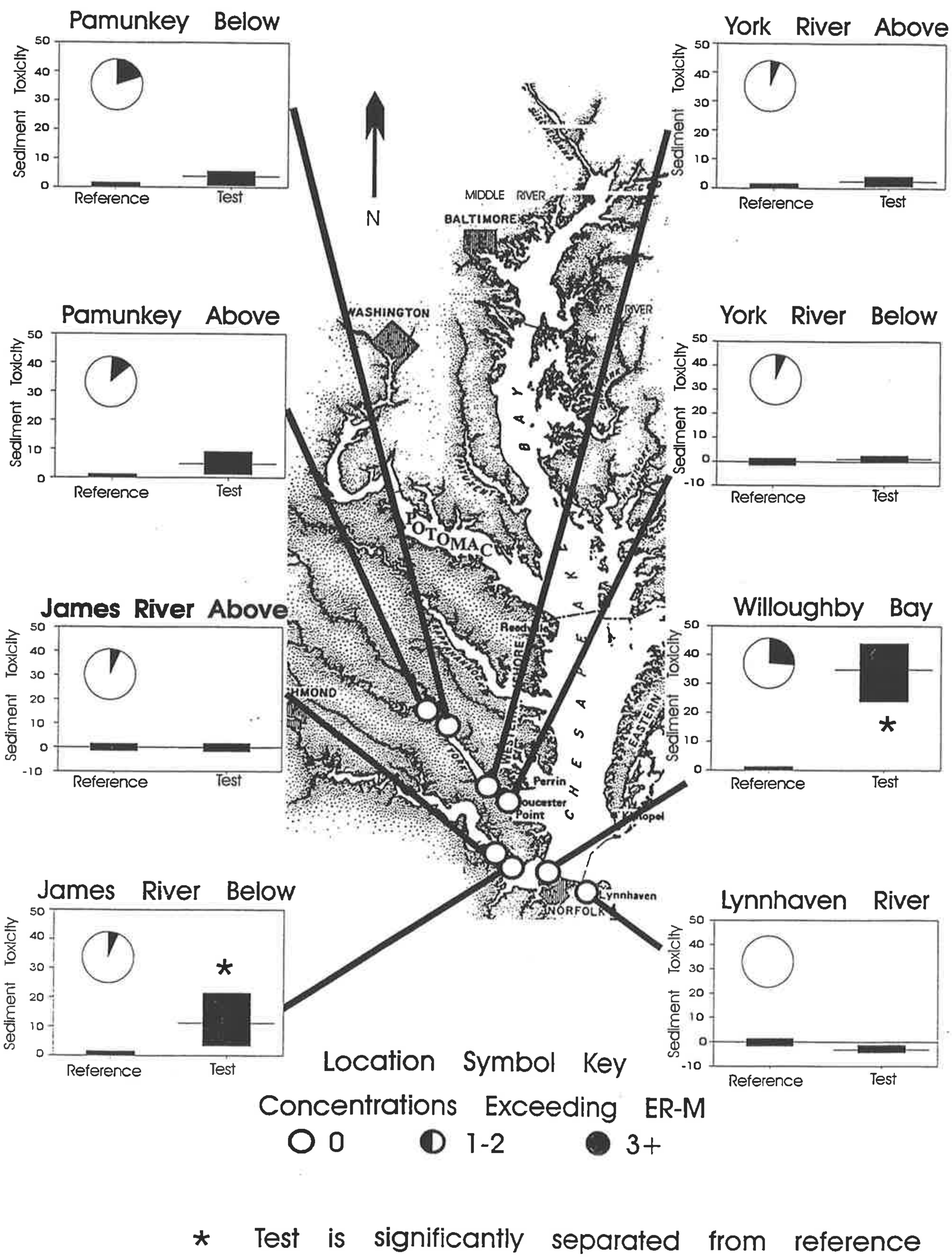


Figure 6.15 Toxicity Index results for the 1996 sediment data. (See Section 3.4 for a detailed description of presentation.)

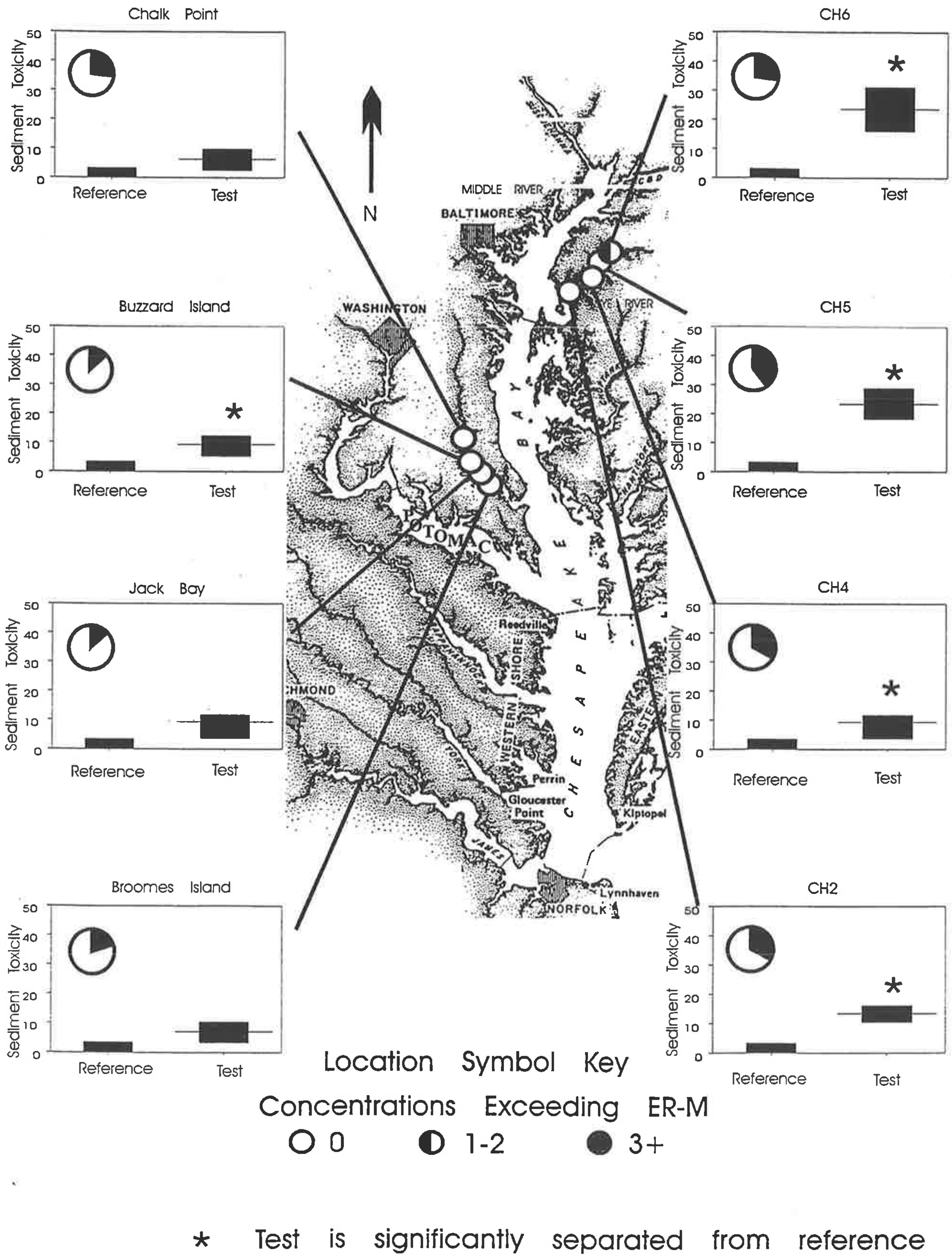


Figure 6.16 Toxicity Index results for the 1997 sediment data. (See Section 3.4 for a detailed description of presentation.)

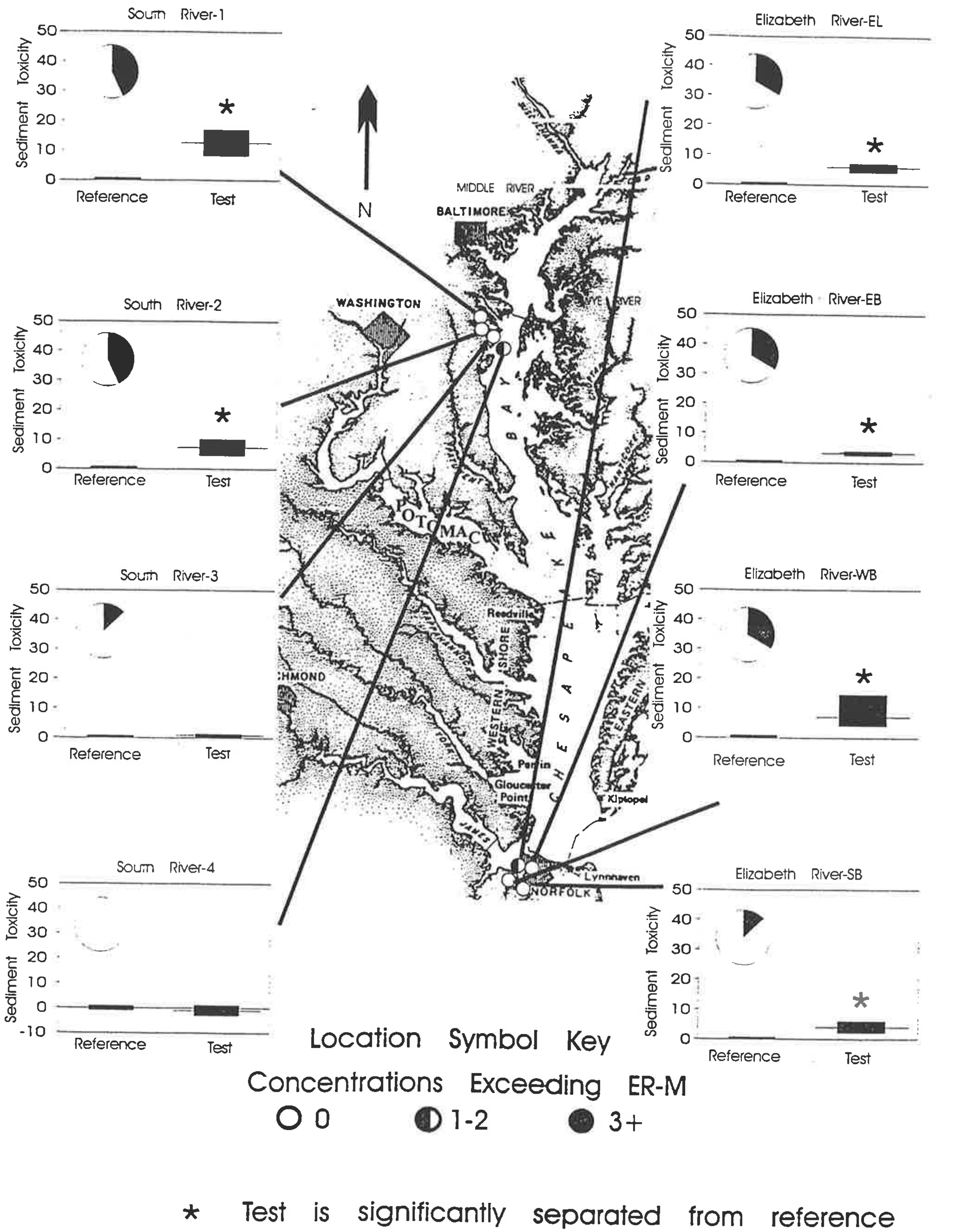


Figure 6.17 Summary of sediment Toxicity Index results for 1990-1997. The sites are ranked according to median Toxicity Index values. The results are for the least toxic half of the sites in the data set . (See Figure 6.18 for remainder of ranked data.) Also shown are the 95% confidence limits for the 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 6.2.

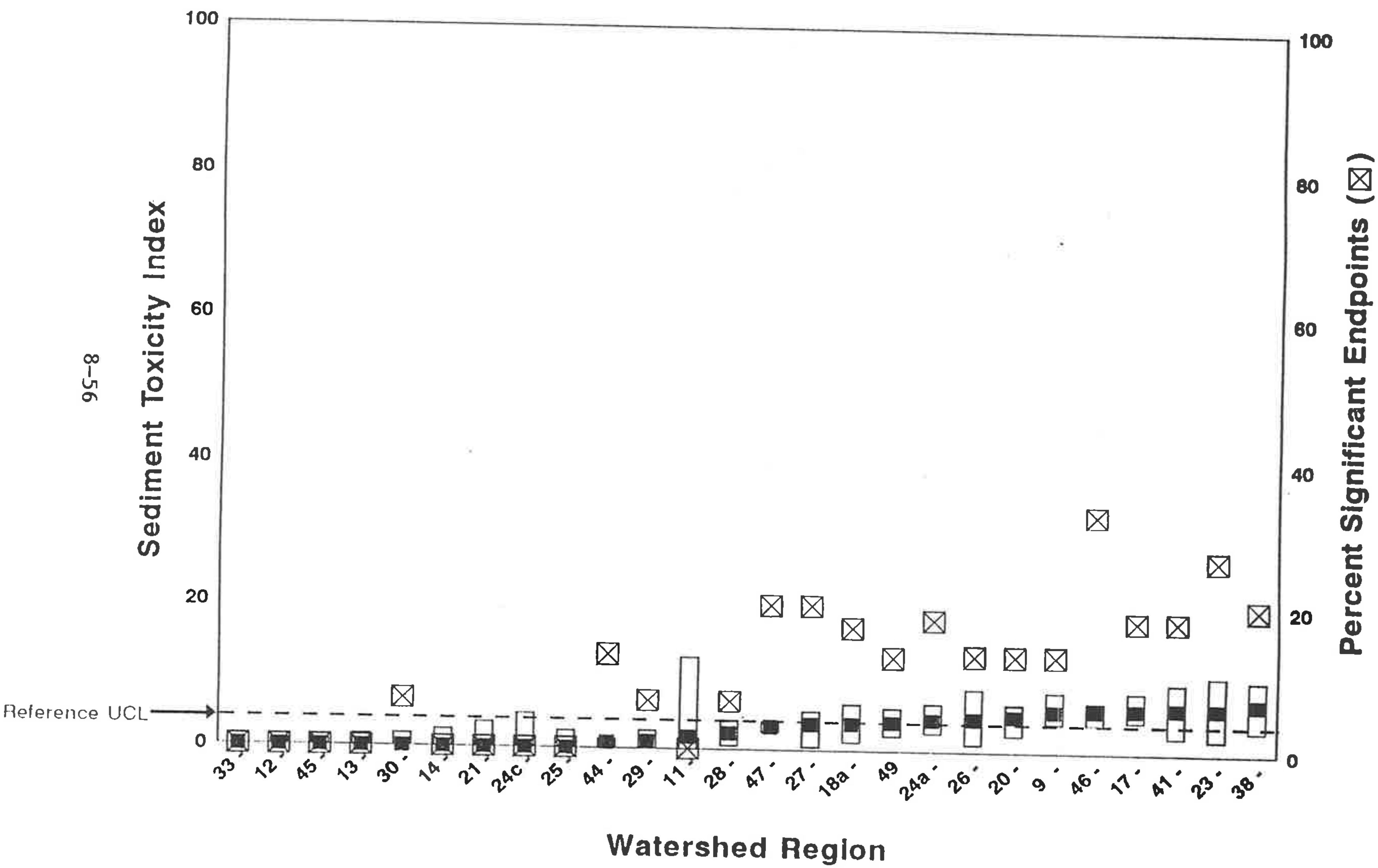
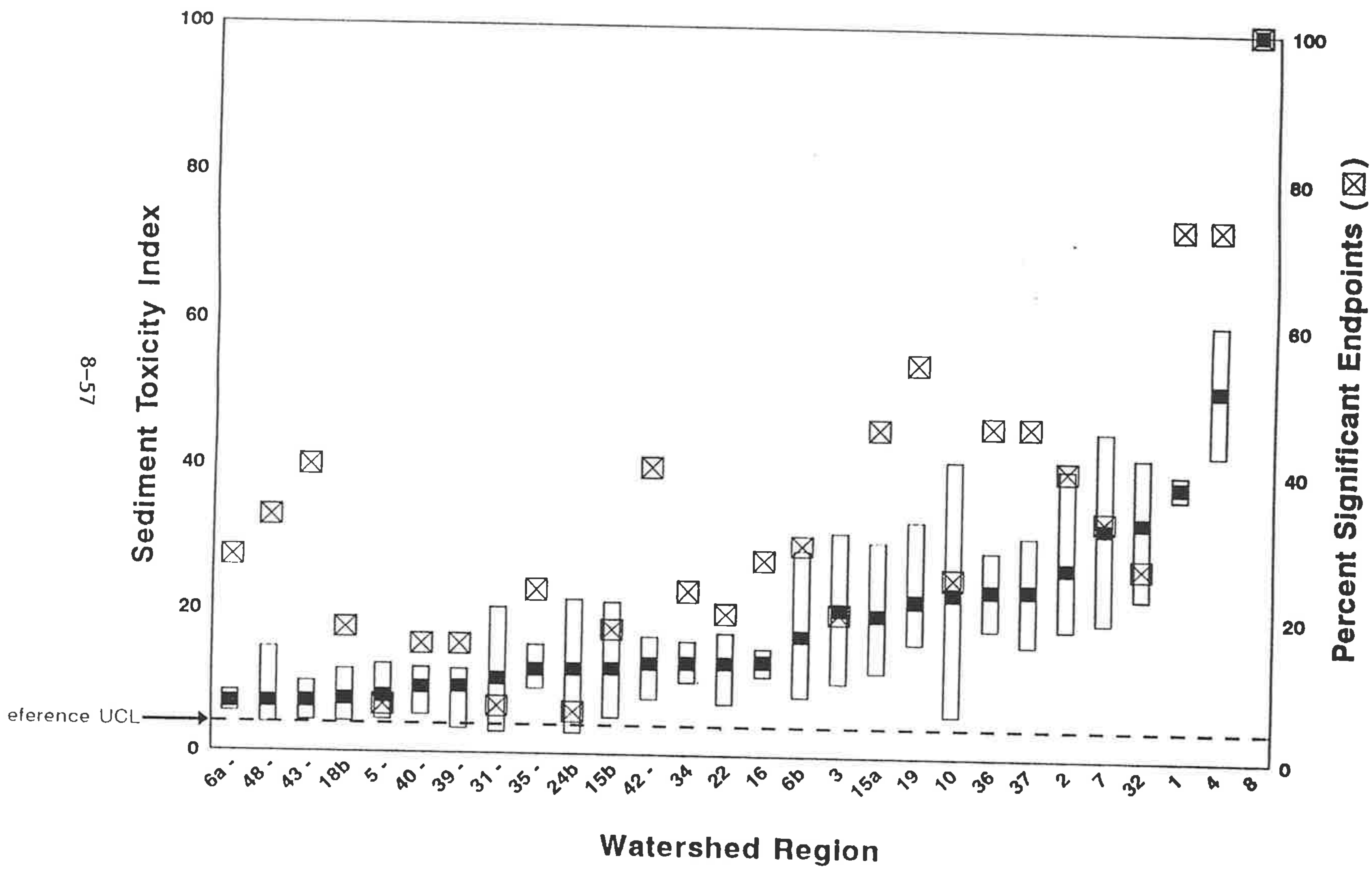


Figure 6.18 Summary of sediment Toxicity Index results for 1990-1997. The sites are ranked according to median Toxicity Index values. The results are for the most toxic half of the sites in the data set . (See Figure 6.17 for remainder of ranked data.) Also shown are the 95% confidence limits for the 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 6.2.



APPENDIX A

Pesticides and semi-volatile compounds data from sediment toxicity tests

SURROGATE RECOVERY SEMI-VOLATILE COMPOUNDS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Date Collected:	9/24-9/29/97
Date Received:	9/30/97
Date Extracted:	10/22/97
Date Analyzed:	11/24/97
Instrument:	Finnigan MAT Incos 50
Analyst:	RJM II
Method:	USEPA 8270 modified
Data File Path:	h:\organics\analysis\bna\data\atox97
Data File:	bsurr.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
Blk1022	27.2	27.2	28.3	28.3	91.8	91.8	51.4	25.7	52.0	26.0	78.5	39.2
50596	23.6	23.6	36.1	36.1	91.0	91.0	70.6	35.3	52.6	26.3	125.9	63.0
50597	29.9	29.9	37.8	37.8	112.6	112.6	67.6	33.8	57.3	28.7	100.9	50.4
50598	25.4	25.4	29.0	29.0	81.2	81.2	62.0	31.0	58.0	29.0	88.4	44.2
50599	33.3	33.3	36.6	36.6	141.8	141.8	64.0	32.0	66.5	33.3	112.5	56.3
50600	58.0	58.0	58.1	58.1	98.3	98.3	113.2	56.6	109.2	54.6	94.1	47.1
50601	57.6	57.6	57.7	57.7	45.6	45.6	92.7	46.3	111.2	55.6	130.1	65.0
50602	48.8	48.8	56.7	56.7	136.1	136.1	84.7	42.4	76.2	38.1	56.4	28.2
50603	45.5	45.5	45.0	45.0	103.5	103.5	68.9	34.4	74.3	37.2	90.9	45.4
50604	49.9	49.9	41.7	41.7	82.1	82.1	73.8	36.9	85.7	42.8	102.3	51.1
50605	38.3	38.3	43.3	43.3	113.1	113.1	64.3	32.2	64.8	32.4	99.5	49.7
50606	25.2	25.2	44.8	44.8	114.2	114.2	67.9	34.0	64.2	32.1	143.1	71.5
MS50604	55.2	55.2	62.3	62.3	119.0	119.0	106.8	53.4	120.8	60.4	134.0	67.0
MS50604d	54.9	54.9	56.2	56.2	123.3	123.3	105.4	52.7	149.3	74.6	170.4	85.2

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 ECAL ORGANICS DATA SHEET
MATRIX SPIKE RECOVERY SEMI-VOLATILE COMPOUNDS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Date Collected:	10/29/97
Date Received:	10/30/97
Date Extracted:	10/22/97
Date Analyzed:	11/24/97
Instrument:	Finnigan MAT Incos 50
Analyst:	RJM II
Method:	USEPA 8270 modified
Data File Path:	h:\labs\ecal\organics\analysis\bna\data\atox 97
Data File:	bspike.xls
Historical Data File:	

Spike Log #:	ms50604
Spike Dup Log #:	ms50604d
Sample Ref. #:	50604

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	75.2	37.6	77.1	38.6	37.6	38.6	3	40	27-123
5	PHENOL	1ML	200	96.7	48.3	89.3	44.7	48.3	44.7	8	42	12-89
6	1,4-DICHLOROBENZENE	1ML	100	47.1	47.1	45.8	45.8	47.1	45.8	3	28	36-97
7	N-NITROSO-DI-N-PROPYLAMINE	1ML	100	56.1	56.1	50.4	50.4	56.1	50.4	11	38	41-116
10	1,2,4-TRICHLOROBENZENE	1ML	100	77.7	77.7	80.7	80.7	77.7	80.7	4	28	39-98
11	4-CHLORO-3-METHYLPHENOL	1ML	200	122.0	61	111.1	55.5	61.0	55.5	9	42	23-97
15	ACENAPHTHENE	1ML	100	76.9	76.9	106.3	106.3	76.9	106.3	32	31	46-118
16	4-NITROPHENOL	1ML	200	171.9	85.9	164.6	82.3	85.9	82.3	4	50	10-80
17	2,4-DINITROTOLUENE	1ML	100	105.6	105.6	65.2	65.2	105.6	65.2	47	38	24-96
20	PENTACHLORPHENOL	1ML	200	263.4	131.7	186.1	93	131.7	93.0	34	50	9-103
22	PYRENE	1ML	100	40.0	40	33.3	33.3	40.0	33.3	18	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 ORGANOCHLORINE PESTICIDE COMPOUNDS

Contractor:	US EPA CBP	Manufacturer:	Supelco
Contract ID:	Amtox 97	Parent ID:	P2736
Date Collected:	09/24-10/10/97	WS ID:	1830
Date Received:	09/30 & 10/10/97	Date Made:	10/03/97
Date Extracted:	10/29/97	Amount Added:	1 ml
Date Analyzed:	11/20/97	Concentration:	400 ng/ml
Instrument:	PE Autosystem		
Analyst:	RJM II		
Method:	USEPA 8081 modified		
Data File Path:	h:\labs\ecal\organics\analysis\pest\data\atox97		
Data File:	psurrsed.xls		
Historical Data File:	pest\qc\history\surr\090897.xls		

AMRL Log Number	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
blk1029	400	400	236.7	368.1	59.2	92.0
50596	400	400	273.0	364.6	68.3	91.2
50597	400	400	260.4	447.1	65.1	111.8
50598	400	400	317.8	446.3	79.4	111.6
50599	400	400	427.5	352.4	106.9	88.1
50600	400	400	367.6	451.6	91.9	112.9
50601	400	400	477.4	385.2	119.3	96.3
50602	400	400	440.2	458.5	110.1	114.6
50603	400	400	479.1	313.0	119.8	78.3
50604	400	400	645.2	467.4	161.3	116.9
50605	400	400	414.3	363.7	103.6	90.9
50606	400	400	332.0	273.0	83.0	68.3
ms50604	400	400	331.4	374.5	82.9	93.6
ms50604d	400	400	321.6	418.4	80.4	104.6

QC Advisory Limits(USEPA CLP 1991): 60-150%

AMRL ECAL ORGANICS DATA SHEET
MATRIX SPIKE RECOVERY ORGANOCHLORINE COMPOUNDS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Date Collected:	09/29/97
Date Received:	09/30/97
Date Extracted:	10/29/97
Date Analyzed:	11/20/97
Instrument:	PE Autosystem
Analyst:	RJM II
Method:	USEPA 8081 modified
Data File Path:	h:\...\analysis\pest\data\atox97
Data File:	psedspik.xls
Historical Data File:	pest\qc\history\spike\50604.xls

Spike Log #:	ms50604
Spike Dup Log #:	ms50604d
Sample Ref. #:	50604
Manufacturer:	Supelco
Parent ID:	P2733
WS ID:	1731
Date Made:	4/29/97
Amount Added:	1ml
Concentration:	100-400ng/ml

Compound	Spike Conc. ng/ml	Sample ng/ml	MS Conc. ng/ml	MSD Conc. ng/ml	MS % Recovery	MSD % Recovery	% RPD	QC LIMITS * % RPD	% Rec.
Lindane (g-BHC)	100	0	107.7	96.3	107.7	96.3	11	50	46-127
Heptachlor	100	0	103.6	95.9	103.6	95.9	8	31	35-130
Aldrin	100	0	124.0	75.2	124.0	75.2	49	43	34-132
Dieldrin	400	0	341.3	318.1	85.3	79.5	7	38	31-134
Endrin	400	0	425.8	421.8	106.4	105.5	1	45	42-139
4,4'-DDT	400	0	462.2	497.5	115.5	124.4	7	50	23-134

* 1991 CLP Statement of Work advisory limits.

Comments:

AMRL ECAL ORGANICS DATA SHEET
SURROGATE RECOVERY SEMI-VOLATILE COMPOUNDS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Date Collected:	9/30/97
Date Received:	10/3/97
Date Extracted:	10/6/97
Date Analyzed:	11/12/97
Instrument:	Finnigan MAT Incos 50
Analyst:	RJM II
Method:	USEPA 8270 modified
Data File Path:	h:\labs\ecal\ambtox\97\data\organics\bna
Data File:	wsurr.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
Blk1006	66.29	66.29	57.74	57.74	93.93	93.93	70.60	35.30	91.90	45.95	139.78	69.89
50607	61.34	61.34	54.14	54.14	90.17	90.17	83.67	41.83	82.89	41.45	158.60	79.30
50608	56.97	56.97	50.54	50.54	79.63	79.63	50.53	25.27	48.42	24.21	115.66	57.83
MS50607	61.19	61.19	54.15	54.15	90.71	90.71	79.20	39.60	74.48	37.24	123.21	61.61
MS50607d	64.05	64.05	53.98	53.98	90.62	90.62	81.80	40.90	79.20	39.60	156.21	78.10

Compound	QC Limit *
Nitrobenzene (NBZ)	35-114
2-Fluorobiphenyl (FBP)	43-116
Terphenyl (TPH)	33-141
Phenol (PHL)	10-94
2-Fluorophenol (2FP)	21-100
2,4,6-Tribromophenol (TBP)	10-123

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

This template is for a BNA water extraction with a1 ml final volume

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

Contractor: US EPA CBP
Contract ID: Amtox 97
Date Collected: 09/30/97
Date Received: 10/03/97
Date Extracted: 10/06/97
Date Analyzed: 11/12/97
Instrument: Finnigan MAT Incos 50
Analyst: RJM II
Method: USEPA 8270 modified
Data File Path: h:\labs\ecal\ambtox\97\data\organics\bna
Data File: wspike.xls
Historical Data File:

Spike Log #: ms50607
Spike Dup Log #: ms50607d
Sample Ref. #: 50607

Reference Number	Compound	Sample ug/l	MS Conc. ug/l	MSD Conc. ug/l	MS % Recovery	MSD % Recovery	% RPD	QC LIMITS * % RPD	% Rec.
4	2-CHLOROPHENOL	200	72.4	81.2	36.2	40.6	11	40	27-123
5	PHENOL	200	82.4	84.8	41.2	42.4	3	42	12-89
6	1,4-DICHLOROBENZENE	100	66.0	54.4	66.0	54.4	19	28	36-97
7	N-NITROSO-DI-N-PROPYLAMINE	100	78.1	79.9	78.1	79.9	2	38	41-116
10	1,2,4-TRICHLOROBENZENE	100	131.8	111.5	131.8	111.5	17	28	39-98
11	4-CHLORO-3-METHYLPHENOL	200	194.9	203.0	97.4	101.5	4	42	23-97
15	ACENAPHTHENE	100	75.6	73.2	75.6	73.2	3	31	46-118
16	4-NITROPHENOL	200	75.5	52.6	37.8	26.3	36	50	10-80
17	2,4-DINITROTOLUENE	100	118.4	110.2	118.4	110.2	7	38	24-96
20	PENTACHLORPHENOL	200	142.0	143.8	71.0	71.9	1	50	9-103
22	PYRENE	100	72.6	73.6	72.6	73.6	1	31	26-127

* USEPA SW-846. AMRL acceptance values derived from historical data
This template is for water matrix spikes with a final volume of 1ml.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	Method Blank
Contract No.:	363832	Sample No.:	blk1022
Date Collected:	N/A	Matrix:	Glassware
Date Received:	N/A	Sample wt.(g):	N/A
Date Extracted:	10/22/97		
Date Analyzed:	11/24/97		
Instrument:	Finnigan MAT Incos-50		
Analyst:	RJM II	% Moisture:	N/A
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	1
AMRL File Path:	h:\labs\ecal\organics\analysis\bna\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	blk1022.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:	US EPA CBP
Contract ID:	Amtox 97
Contract No.:	363832
Date Collected:	09/25/97
Date Received:	09/30/97
Date Extracted:	10/22/97
Date Analyzed:	11/24/97
Instrument:	Finnigan MAT Incos-50
Analyst:	RJM II
Method:	USEPA 8270 modified
AMRL File Path:	h:\labs\ecal\organics\analysis\bna\data\atox97
AMRL Data File:	b50596.xls

Laboratory:	Organics
Sample ID:	SR1
Sample No.:	50596
Matrix:	Sediment
Sample wt.(g):	29.9
% Moisture:	74.4
GPC(yes=2,no=1)	1
Data Released By:	Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
206-44-0	Fluoranthene	227	10.6	
56-55-3	Benzo(a)anthracene	84.6	17.8	

AMRL

ORGANICS ANALYSIS DATA SHEET

POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: US EPA CBP
Contract ID: Amtox 97
Contract No.: 363832
Date Collected: 09/25/97
Date Received: 09/30/97
Date Extracted: 10/22/97
Date Analyzed: 11/24/97
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: h:\labs\ecal\organics\analysis\bna\data\atox97
AMRL Data File: b50597.xls

Laboratory: Organics
Sample ID: SR2
Sample No.: 50597
Matrix: Sediment
Sample wt.(g): 30.4

% Moisture: 81
GPC(yes=2,no=1) 1
Data Released By: Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
206-44-0	Fluoranthene	852	10.6	
129-00-0	Pyrene	289	10.6	
56-55-3	Benzo(a)anthracene	196	17.8	
205-99-2	Benzo(b)fluoranthene	599	13.9	

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: US EPA CBP
Contract ID: Amtox 97
Contract No.: 363832
Date Collected: 09/25/97
Date Received: 09/30/97
Date Extracted: 10/22/97
Date Analyzed: 11/24/97
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: h:\labs\ecal\organics\analysis\bna\data\atox97
AMRL Data File: b50598.xls

Laboratory: Organics
Sample ID: SR3
Sample No.: 50598
Matrix: Sediment
Sample wt.(g): 30.4

% Moisture: 73
GPC(yes=2,no=1) 1
Data Released By: Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
85-01-8	Phenanthrene	150	9.2	
206-44-0	Fluoranthene	446	10.6	
129-00-0	Pyrene	238	10.6	
56-55-3	Benzo(a)anthracene	88.1	17.8	
205-99-2	Benzo(b)fluoranthene	211	13.9	
50-32-8	Benzo(a)pyrene	377	15.2	

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	SR4
Contract No.:	363832	Sample No.:	50599
Date Collected:	09/25/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	30
Date Extracted:	10/22/97		
Date Analyzed:	11/24/97		
Instrument:	Finnigan MAT Incos-50		
Analyst:	RJM II	% Moisture:	29
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	1
AMRL File Path:	h:\labs\ecal\organics\analysis\bna\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	b50599.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
85-01-8	Phenanthrene	30.6	9.2	
206-44-0	Fluoranthene	205	10.6	
56-55-3	Benzo(a)anthracene	17.7	17.8	J
205-99-2	Benzo(b)fluoranthene	53.1	13.9	
50-32-8	Benzo(a)pyrene	32.7	15.2	

J - Compound detected below the calculated method detection limit.

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: US EPA CBP
Contract ID: Amtox 97
Contract No.: 363832
Date Collected: 09/24/97
Date Received: 09/30/97
Date Extracted: 10/22/97
Date Analyzed: 11/24/97
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: h:\labs\ecal\organics\analysis\bna\data\atox97
AMRL Data File: b50600.xls

Laboratory: Organics
Sample ID: SB-B-01
Sample No.: 50600
Matrix: Sediment
Sample wt.(g): 30.3
% Moisture: 52.9
GPC(yes=2,no=1) 1
Data Released By: Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
91-20-3	Naphthalene	49.7	4.6	
208-96-8	Acenaphthalene	129	5.9	
86-73-7	Fluorene	38.2	9.9	
85-01-8	Phenanthrene	382	9.2	
120-12-7	Anthracene	307	9.9	
129-00-0	Pyrene	779	10.6	
56-55-3	Benzo(a)anthracene	104	17.8	
205-99-2	Benzo(b)fluoranthene	1000	13.9	
50-32-8	Benzo(a)pyrene	5950	15.2	
191-24-2	Benzo(g,h,i)perylene	2810	16.5	

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	EB-B-01
Contract No.:	363832	Sample No.:	50601
Date Collected:	09/24/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	30.1
Date Extracted:	10/22/97		
Date Analyzed:	11/24/97		
Instrument:	Finnigan MAT Incos-50		
Analyst:	RJM II		
Method:	USEPA 8270 modified	% Moisture:	58.8
AMRL File Path:	h:\labs\ecal\organics\analysis\bna\data\atox97	GPC(yes=2,no=1)	1
AMRL Data File:	b50601.xls	Data Released By:	Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
85-01-8	Phenanthrene	84.1	9.2	
206-44-0	Fluoranthene	746	10.6	
56-55-3	Benzo(a)anthracene	270	17.8	
50-32-8	Benzo(a)pyrene	881	15.2	

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Contract No.:	363832
Date Collected:	09/24/97
Date Received:	09/30/97
Date Extracted:	10/22/97
Date Analyzed:	11/24/97
Instrument:	Finnigan MAT Incos-50
Analyst:	RJM II
Method:	USEPA 8270 modified
AMRL File Path:	h:\labs\ecal\organics\analysis\bna\data\atox97
AMRL Data File:	b50602.xls

Laboratory:	Organics
Sample ID:	EL-F-01
Sample No.:	50602
Matrix:	Sediment
Sample wt.(g):	30.5
% Moisture:	60.1
GPC(yes=2,no=1)	1
Data Released By:	Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
91-20-3	Naphthalene	173	4.6	
208-96-8	Acenaphthalene	3320	5.9	
83-32-9	Acenaphthene	334	9.9	
85-01-8	Phenanthrene	3390	9.2	
129-00-0	Pyrene	15700	10.6	
56-55-3	Benzo(a)anthracene	12100	17.8	
218-01-9	Chrysene	4050	14.5	
205-99-2	Benzo(b)fluoranthene	23700	13.9	
207-08-9	Benzo(k)fluoranthene	6650	13.9	
50-32-8	Benzo(a)pyrene	11100	15.2	
191-24-2	Benzo(g,h,i)perylene	2590	16.5	

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor: US EPA CBP
Contract ID: Amtox 97
Contract No.: 363832
Date Collected: 09/24/97
Date Received: 09/30/97
Date Extracted: 10/22/97
Date Analyzed: 11/24/97
Instrument: Finnigan MAT Incos-50
Analyst: RJM II
Method: USEPA 8270 modified
AMRL File Path: h:\labs\ecal\organics\analysis\bna\data\atox97
AMRL Data File: b50603.xls

Laboratory: Organics
Sample ID: WB-A-01
Sample No.: 50603
Matrix: Sediment
Sample wt.(g): 29.8

% Moisture: 51.9
GPC(yes=2,no=1) 1
Data Released By: Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
85-01-8	Phenanthrene	63.4	9.2	
56-55-3	Benzo(a)anthracene	27.9	17.8	
218-01-9	Chrysene	16.5	14.5	
205-99-2	Benzo(b)fluoranthene	343	13.9	

AMRL

ORGANICS ANALYSIS DATA SHEET

POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	Lynn Sand
Contract No.:	363832	Sample No.:	50604
Date Collected:	09/29/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	30.4
Date Extracted:	10/22/97		
Date Analyzed:	11/24/97		
Instrument:	Finnigan MAT Incos-50		
Analyst:	RJM II	% Moisture:	19.8
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	1
AMRL File Path:	h:\labs\ecal\organics\analysis\bna\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	b50604.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
206-44-0	Fluoranthene	434	10.6	
205-99-2	Benzo(b)fluoranthene	50.1	13.9	
50-32-8	Benzo(a)pyrene	106	15.2	

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Contract No.:	363832
Date Collected:	09/29/97
Date Received:	09/30/97
Date Extracted:	10/22/97
Date Analyzed:	11/24/97
Instrument:	Finnigan MAT Incos-50
Analyst:	RJM II
Method:	USEPA 8270 modified
AMRL File Path:	h:\labs\ecal\organics\analysis\bna\data\atox97
AMRL Data File:	b50605.xls

Laboratory:	Organics
Sample ID:	Lynn Mud
Sample No.:	50605
Matrix:	Sediment
Sample wt.(g):	30.2
% Moisture:	47.3
GPC(yes=2,no=1)	1
Data Released By:	Rob McDaniel II

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
206-44-0	Fluoranthene	614	10.6	
205-99-2	Benzo(b)fluoranthene	109	13.9	

AMRL
ORGANICS ANALYSIS DATA SHEET
POLYNUCLEAR AROMATIC HYDROCARBONS ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	Poropotank
Contract No.:	363832	Sample No.:	50606
Date Collected:	10/10/97	Matrix:	Sediment
Date Received:	10/10/97	Sample wt.(g):	30.2
Date Extracted:	10/22/97		
Date Analyzed:	11/24/97		
Instrument:	Finnigan MAT Incos-50		
Analyst:	RJM II	% Moisture:	78.5
Method:	USEPA 8270 modified	GPC(yes=2,no=1)	1
AMRL File Path:	h:\labs\ecal\organics\analysis\bna\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	b50606.xls		

CAS NUMBER	COMPOUND	Conc. (ug/kg) dry	Det. Limit (ug/kg) dry	Tag
206-44-0	Fluoranthene	118	10.6	

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	Method Blank
Contract No.:	363832	Sample No.:	blk1029
Date Collected:	N/A	Matrix:	Glassware
Date Received:	N/A	Sample wt.(g):	1
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	0
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	blk1029.xls		

CAS #	Compound	Sample Conc. (ng/ml) FV	Tag	Tag	Detection Limit (ng/ml) FV
877-09-8	TCMX (Surr.)	236.7		C	ND
319-84-6	alpha-BHC	BDL			24.0
58-89-9	gamma-BHC (lindane)	BDL			19.0
76-44-8	Heptachlor	BDL		U	28.0
309-00-2	Aldrin	BDL		U	20.0
319-85-7	beta-BHC	BDL		U	21.0
319-86-8	delta-BHC	23.6	J	C	36.0
1024-57-3	Heptachlor Epoxide	41.7		C	19.0
959-98-8	Endosulfan I	BDL			30.0
5103-71-9	Chlordane	26.7		C	25.0
72-55-9	4,4'-DDE	BDL			18.0
60-57-1	Dieldrin	74.6		C	43.0
72-20-8	Endrin	BDL			42.0
72-54-8	4,4'-DDD	BDL		U	16.0
33213-65-9	Endosulfan II	BDL			25.5
50-29-3	4,4'-DDT	BDL			116.0
7421-93-4	Endrin Aldehyde	BDL			81.0
72-43-5	Methoxychlor	BDL		U	151.0
1031-07-8	Endosulfan Sulfate	BDL			200.0
53494-70-5	Endrin Ketone	BDL			25.0
2051-24-3	DCB (Surr)	368.1		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

ND- Not Determined
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/MS confirmation
P - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, and GC/MS confirmed presence
J - Compound detected below calculated method detection limit
BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL

ORGANICS ANALYSIS DATA SHEET

ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	VA DEQ
Contract ID:	Amtox 97
Contract No.:	363832
Date Collected:	N/A
Date Received:	N/A
Date Extracted:	10/07/97
Date Analyzed:	11/13/97
Instrument:	PE Autosystem
Analyst:	RJM II
Method:	USEPA 8081 modified
AMRL File Path:	h:\labs\ecal\organics\analysis\pest\data\amtox97
AMRL Data File:	blk1007.xls

Laboratory:	Organics
Sample ID:	Method Blank
Sample No.:	Blk1007
Matrix:	Water

Data Released By: Rob McDaniel II

CAS #	Compound	Sample Conc. (ug/L)	Tag	Tag	Detection Limit (ug/L)
877-09-8	TCMX (Surr.)	157.52		C	ND
319-84-6	alpha-BHC	BDL		U	10
58-89-9	gamma-BHC (lindane)	BDL			10
76-44-8	Heptachlor	BDL			1.9
309-00-2	Aldrin	BDL		U	1.9
319-85-7	beta-BHC	BDL		U	4.2
319-86-8	delta-BHC	BDL		U	3.1
1024-57-3	Heptachlor Epoxide	BDL			2.2
959-98-8	Endosulfan I	BDL			10
5103-71-9	Chlordane	8.04	J	C	50
72-55-9	4,4'-DDE	BDL			5.6
60-57-1	Dieldrin	BDL		U	2.5
72-20-8	Endrin	BDL			10
72-54-8	4,4'-DDD	BDL		U	2.8
33213-65-9	Endosulfan II	11.77		C	10
50-29-3	4,4'-DDT	BDL			4.7
7421-93-4	Endrin Aldehyde	BDL			10
72-43-5	Methoxychlor	BDL			10
1031-07-8	Endosulfan Sulfate	BDL		U	5.6
53494-70-5	Endrin Ketone	BDL			25
2051-24-3	DCB (Surr)	192.05		C	ND
80001-35-2	Toxaphene	BDL			0.5
12674-11-2	Aroclor 1016	BDL			0.5
11104-28-2	Aroclor 1221	BDL			0.5
11141-16-5	Aroclor 1232	BDL			0.5
53469-21-9	Aroclor 1242	BDL			0.5
12672-29-6	Aroclor 1248	BDL			0.5
11097-69-1	Aroclor 1254	BDL			0.5
11096-82-5	Aroclor 1260	BDL			0.5

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J - Compound detected below calculated method detection limit
BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	Matrix Spike
Contract No.:	363832	Sample No.:	50604
Date Collected:	09/29/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	30.01
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	80.16
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	ms50604.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	331.44		C	ND
319-84-6	alpha-BHC	BDL			0.71
58-89-9	gamma-BHC (lindane)	107.74		C	0.62
76-44-8	Heptachlor	103.62		U	0.82
309-00-2	Aldrin	123.96		U	0.61
319-85-7	beta-BHC	BDL		C	0.56
319-86-8	delta-BHC	46.81			1.06
1024-57-3	Heptachlor Epoxide	BDL		C	0.57
959-98-8	Endosulfan I	BDL		C	0.86
5103-71-9	Chlordane	63.81			5.00
72-55-9	4,4'-DDE	43.94		C	0.53
60-57-1	Dieldrin	341.28		C	0.90
72-20-8	Endrin	425.78		U	1.24
72-54-8	4,4'-DDD	BDL		U	0.47
33213-65-9	Endosulfan II	BDL			0.75
50-29-3	4,4'-DDT	462.19			3.42
7421-93-4	Endrin Aldehyde	78.18			2.41
72-43-5	Methoxychlor	BDL		C	5.00
1031-07-8	Endosulfan Sulfate	BDL		C	1.50
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	374.46			ND
80001-35-2	Toxaphene	BDL			10.00
12574-11-2	Aroclor 1016	BDL			16.60
11104-28-2	Aroclor 1221	BDL			16.60
11141-16-5	Aroclor 1232	BDL			16.60
53469-21-9	Aroclor 1242	BDL			16.60
12672-29-6	Aroclor 1248	BDL			16.60
11097-69-1	Aroclor 1254	BDL			16.60
11096-82-5	Aroclor 1260	BDL			16.60

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J - Compound detected below calculated method detection limit
BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	Matrix Spike Dup.
Contract No.:	363832	Sample No.:	50604
Date Collected:	09/29/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	30.09
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	80.16
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	ms50604d.xls		

CAS #	Compound	Sample Conc. (ng/ml) FV	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	325.63		C	ND
319-84-6	alpha-BHC	BDL		U	0.71
58-89-9	gamma-BHC (lindane)	96.27		C	0.62
76-44-8	Heptachlor	95.86			0.82
309-00-2	Aldrin	75.15			0.61
319-85-7	beta-BHC	BDL		C	0.56
319-86-8	delta-BHC	BDL			1.06
1024-57-3	Heptachlor Epoxide	BDL		U	0.57
959-98-8	Endosulfan I	BDL		C	0.86
5103-71-9	Chlordane	60.87			5.00
72-55-9	4,4'-DDE	83.82		C	0.53
60-57-1	Dieldrin	318.12		C	0.90
72-20-8	Endrin	421.84		U	1.24
72-54-8	4,4'-DDD	BDL		U	0.47
33213-65-9	Endosulfan II	BDL			0.75
50-29-3	4,4'-DDT	497.51		C	3.42
7421-93-4	Endrin Aldehyde	129.70			2.41
72-43-5	Methoxychlor	BDL		C	5.00
1031-07-8	Endosulfan Sulfate	BDL		C	1.50
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	418.43			ND
80001-35-2	Toxaphene	BDL			10.00
12574-11-2	Aroclor 1016	BDL			16.60
11104-28-2	Aroclor 1221	BDL			16.60
11141-16-5	Aroclor 1232	BDL			16.60
53469-21-9	Aroclor 1242	BDL			16.60
12672-29-6	Aroclor 1248	BDL			16.60
11097-69-1	Aroclor 1254	BDL			16.60
11096-82-5	Aroclor 1260	BDL			16.60

ND- Not Determined
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/MS confirmation
P - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, and GC/MS confirmed presence
J - Compound detected below calculated method detection limit
BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	SR1
Contract No.:	363832	Sample No.:	50596
Date Collected:	09/25/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	29.89
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	25.65
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	p50596.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	273..0		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	BDL		U	0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL			0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	BDL		U	1.1
1024-57-3	Heptachlor Epoxide	5.5		C	0.6
959-98-8	Endosulfan I	8.4		C	0.9
5103-71-9	Chlordane	10.4		C	5.0
72-55-9	4,4'-DDE	17.8		C	0.5
60-57-1	Dieldrin	8.8		C	0.9
72-20-8	Endrin	BDL			1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL			3.4
7421-93-4	Endrin Aldehyde	30.4		C	2.4
72-43-5	Methoxychlor	BDL		U	5.0
1031-07-8	Endosulfan Sulfate	BDL			1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	364.6		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

ND- Not Determined
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J - Compound detected below calculated method detection limit
BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Contract No.:	363832
Date Collected:	09/25/97
Date Received:	09/30/97
Date Extracted:	10/29/97
Date Analyzed:	11/20/97
Instrument:	PE Autosystem
Analyst:	RJM II
Method:	USEPA 8081 modified
AMRL File Path:	h:\...\analysis\pest\data\atox97
AMRL Data File:	p50597.xls

Laboratory:	Organics
Sample ID:	SR2
Sample No.:	50597
Matrix:	Sediment
Sample wt.(g):	30.08
Wet Wt:	1
Dry Wt:	1
Pan Wt:	1.59
% Dry Weight:	18.96
GPC(yes=2,no=1)	2
Data Released By:	Rob McDaniel II

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	260.3		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	15.1		C	0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL			0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	BDL		U	1.1
1024-57-3	Heptachlor Epoxide	16.9		C	0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	9.5		C	5.0
72-55-9	4,4'-DDE	BDL			0.5
60-57-1	Dieldrin	5.6		C	0.9
72-20-8	Endrin	BDL		U	1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL		U	3.4
7421-93-4	Endrin Aldehyde	33.5		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	BDL			1.5
53494-70-5	Endrin Ketone	13.7		C	ND
2051-24-3	DCB (Surr)	447.1		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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MDL for multi-component analytes based on lowest point of calibration

AMRL

ORGANICS ANALYSIS DATA SHEET

ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor: US EPA CBP
Contract ID: Amtox 97
Contract No.: 363832
Date Collected: 09/25/97
Date Received: 09/30/97
Date Extracted: 10/29/97
Date Analyzed: 11/20/97
Instrument: PE Autosystem
Analyst: RJM II
Method: USEPA 8081 modified
AMRL File Path: h:\...\analysis\pest\data\atox97
AMRL Data File: p50598.xls

Laboratory: Organics
Sample ID: SR3
Sample No.: 50598
Matrix: Sediment
Sample wt.(g): 30.07
Wet Wt: 1
Dry Wt: 1
Pan Wt: 1.59
% Dry Weight: 27.05
GPC(yes=2,no=1) 2
Data Released By: Rob McDaniel II

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	317..8		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	BDL		U	0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL			0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	96.5		C	1.1
1024-57-3	Heptachlor Epoxide	24.8		C	0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	18.5		C	5.0
72-55-9	4,4'-DDE	BDL			0.5
60-57-1	Dieldrin	BDL		U	0.9
72-20-8	Endrin	BDL		U	1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL			3.4
7421-93-4	Endrin Aldehyde	27.4		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	BDL			1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	446.3		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Contract No.:	363832
Date Collected:	09/25/97
Date Received:	09/30/97
Date Extracted:	10/29/97
Date Analyzed:	11/20/97
Instrument:	PE Autosystem
Analyst:	RJM II
Method:	USEPA 8081 modified
AMRL File Path:	h:\...\analysis\pest\data\atox97
AMRL Data File:	p50599.xls

Laboratory:	Organics
Sample ID:	SR4
Sample No.:	50599
Matrix:	Sediment
Sample wt.(g):	30.04
Wet Wt:	1
Dry Wt:	1
Pan Wt:	1.59
% Dry Weight:	71.04
GPC(yes=2,no=1)	2
Data Released By:	Rob McDaniel II

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	427.5		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	BDL		U	0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL			0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	BDL		U	1.1
1024-57-3	Heptachlor Epoxide	2.6		C	0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	3.5	J	C	5.0
72-55-9	4,4'-DDE	4.3		C	0.5
60-57-1	Dieldrin	BDL			0.9
72-20-8	Endrin	BDL		U	1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL			3.4
7421-93-4	Endrin Aldehyde	7.0		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	BDL			1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	352.4		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	SB-B-01
Contract No.:	363832	Sample No.:	50600
Date Collected:	09/24/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	30.25
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	47.11
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	p50600.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	367.6		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	BDL		U	0.6
76-44-8	Heptachlor	6.4		C	0.8
309-00-2	Aldrin	BDL		U	0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	BDL		U	1.1
1024-57-3	Heptachlor Epoxide	BDL			0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	19.7		C	5.0
72-55-9	4,4'-DDE	BDL			0.5
60-57-1	Dieldrin	BDL		U	0.9
72-20-8	Endrin	BDL			1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL		U	3.4
7421-93-4	Endrin Aldehyde	49.0		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	41.5		C	1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	451.6		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Contract No.:	363832
Date Collected:	09/24/97
Date Received:	09/30/97
Date Extracted:	10/29/97
Date Analyzed:	11/20/97
Instrument:	PE Autosystem
Analyst:	RJM II
Method:	USEPA 8081 modified
AMRL File Path:	h:\...\analysis\pest\data\atox97
AMRL Data File:	p50601.xls

Laboratory:	Organics
Sample ID:	EB-B-01
Sample No.:	50601
Matrix:	Sediment
Sample wt.(g):	29.99
Wet Wt:	1
Dry Wt:	1
Pan Wt:	1.59
% Dry Weight:	41.18
GPC(yes=2,no=1)	2
Data Released By:	Rob McDaniel II

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	477.4		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	BDL		U	0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL			0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	BDL		U	1.1
1024-57-3	Heptachlor Epoxide	BDL		U	0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	14.3		C	5.0
72-55-9	4,4'-DDE	BDL			0.5
60-57-1	Dieldrin	3.9		C	0.9
72-20-8	Endrin	BDL			1.2
72-54-8	4,4'-DDD	24.3		C	0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL		U	3.4
7421-93-4	Endrin Aldehyde	17.9		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	5.4		C	1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	385.2		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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P - Compound confirmed by secondary GC column analysis, concentration sufficient for GC/MS analysis, and GC/MS confirmed presence
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BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	EL-F-01
Contract No.:	363832	Sample No.:	50602
Date Collected:	09/24/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	30.14
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	39.91
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	p50602.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	440.2		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	BDL			0.6
76-44-8	Heptachlor	9.6		C	0.8
309-00-2	Aldrin	BDL		U	0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	BDL		U	1.1
1024-57-3	Heptachlor Epoxide	BDL		U	0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	19.7		C	5.0
72-55-9	4,4'-DDE	BDL			0.5
60-57-1	Dieldrin	BDL		U	0.9
72-20-8	Endrin	BDL			1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL		U	3.4
7421-93-4	Endrin Aldehyde	55.6		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	BDL		U	1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	458.5		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

ND- Not Determined
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J - Compound detected below calculated method detection limit
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MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	WB-A-01
Contract No.:	363832	Sample No.:	50603
Date Collected:	09/24/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	29.94
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	48.1
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	p50603.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	479.1		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	2.1		C	0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL		U	0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	7.4		C	1.1
1024-57-3	Heptachlor Epoxide	3.7		C	0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	2.4	J	C	5.0
72-55-9	4,4'-DDE	3.1		C	0.5
60-57-1	Dieldrin	BDL			0.9
72-20-8	Endrin	BDL			1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	35.8		C	0.7
50-29-3	4,4'-DDT	BDL		U	3.4
7421-93-4	Endrin Aldehyde	11.5		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	5.6		C	1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	313.0		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP
Contract ID:	Amtox 97
Contract No.:	363832
Date Collected:	09/29/97
Date Received:	09/30/97
Date Extracted:	10/29/97
Date Analyzed:	11/20/97
Instrument:	PE Autosystem
Analyst:	RJM II
Method:	USEPA 8081 modified
AMRL File Path:	h:\...\analysis\pest\data\atox97
AMRL Data File:	p50604.xls

Laboratory:	Organics
Sample ID:	Lynn Sand
Sample No.:	50604
Matrix:	Sediment
Sample wt.(g):	30.42
Wet Wt:	1
Dry Wt:	1
Pan Wt:	1.59
% Dry Weight:	80.16
GPC(yes=2,no=1)	2
Data Released By:	Rob McDaniel II

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	645.2		M	ND
319-84-6	alpha-BHC	BDL			0.7
58-89-9	gamma-BHC (lindane)	BDL			0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL		U	0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	BDL		U	1.1
1024-57-3	Heptachlor Epoxide	BDL			0.6
959-98-8	Endosulfan I	BDL			0.9
5103-71-9	Chlordane	7.6		C	5.0
72-55-9	4,4'-DDE	BDL			0.5
60-57-1	Dieldrin	BDL			0.9
72-20-8	Endrin	BDL		U	1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL			3.4
7421-93-4	Endrin Aldehyde	6.9		C	2.4
72-43-5	Methoxychlor	BDL		U	5.0
1031-07-8	Endosulfan Sulfate	BDL			1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	467.4		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	Lynn Mud
Contract No.:	363832	Sample No.:	50605
Date Collected:	09/29/97	Matrix:	Sediment
Date Received:	09/30/97	Sample wt.(g):	30.15
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	52.71
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	p50605.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	414.3		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	BDL		U	0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL			0.6
319-85-7	beta-BHC	BDL		U	0.6
319-86-8	delta-BHC	12.7		C	1.1
1024-57-3	Heptachlor Epoxide	5.9		C	0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	5.6		C	5.0
72-55-9	4,4'-DDE	BDL			0.5
60-57-1	Dieldrin	BDL		U	0.9
72-20-8	Endrin	BDL		U	1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL			3.4
7421-93-4	Endrin Aldehyde	8.4		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	BDL			1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	363.7		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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BDL - Below detection limit
MDL for multi-component analytes based on lowest point of calibration

AMRL
ORGANICS ANALYSIS DATA SHEET
ORGANOCHLORINE PESTICIDE and PCB ANALYSIS

Contractor:	US EPA CBP	Laboratory:	Organics
Contract ID:	Amtox 97	Sample ID:	Poropotank
Contract No.:	363832	Sample No.:	50606
Date Collected:	10/10/97	Matrix:	Sediment
Date Received:	10/10/97	Sample wt.(g):	29.98
Date Extracted:	10/29/97	Wet Wt:	1
Date Analyzed:	11/20/97	Dry Wt:	1
Instrument:	PE Autosystem	Pan Wt:	1.59
Analyst:	RJM II	% Dry Weight:	21.51
Method:	USEPA 8081 modified	GPC(yes=2,no=1)	2
AMRL File Path:	h:\...\analysis\pest\data\atox97	Data Released By:	Rob McDaniel II
AMRL Data File:	p50606.xls		

CAS #	Compound	Sample Conc. (ug/kg) dry	Tag	Tag	Detection Limit (ug/kg) dry
877-09-8	TCMX (Surr.)	332.0		C	ND
319-84-6	alpha-BHC	BDL		U	0.7
58-89-9	gamma-BHC (lindane)	BDL		U	0.6
76-44-8	Heptachlor	BDL			0.8
309-00-2	Aldrin	BDL			0.6
319-85-7	beta-BHC	8.6		C	0.6
319-86-8	delta-BHC	18.5		C	1.1
1024-57-3	Heptachlor Epoxide	BDL			0.6
959-98-8	Endosulfan I	BDL		U	0.9
5103-71-9	Chlordane	17.2		C	5.0
72-55-9	4,4'-DDE	BDL			0.5
60-57-1	Dieldrin	10.6		C	0.9
72-20-8	Endrin	BDL		U	1.2
72-54-8	4,4'-DDD	BDL			0.5
33213-65-9	Endosulfan II	BDL		U	0.7
50-29-3	4,4'-DDT	BDL			3.4
7421-93-4	Endrin Aldehyde	19.2		C	2.4
72-43-5	Methoxychlor	BDL			5.0
1031-07-8	Endosulfan Sulfate	BDL			1.5
53494-70-5	Endrin Ketone	BDL			ND
2051-24-3	DCB (Surr)	273.0		C	ND
80001-35-2	Toxaphene	BDL			10.0
12574-11-2	Aroclor 1016	BDL			16.6
11104-28-2	Aroclor 1221	BDL			16.6
11141-16-5	Aroclor 1232	BDL			16.6
53469-21-9	Aroclor 1242	BDL			16.6
12672-29-6	Aroclor 1248	BDL			16.6
11097-69-1	Aroclor 1254	BDL			16.6
11096-82-5	Aroclor 1260	BDL			16.6

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MDL for multi-component analytes based on lowest point of calibration

APPENDIX B

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

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
10/01/97	Ea	CONTROL	7.1	22	8.03	23.0
		ER-WB	7.0	23	7.99	25.4
		ER-EL	6.8	22	7.97	24.9
		ER-EB	6.8	22	8.01	25.7
		ER-SB	6.8	22	8.06	26.2
		SR-1	6.8	22	7.91	25.6
		SR-2	6.8	22	8.04	25.4
		SR-3	6.7	22	7.98	25.6
		SR-4	6.9	22	8.08	25.5
10/01/97	Cv	CONTROL	7.1	22	8.03	23.0
		ER-WB	7.0	23	7.99	25.4
		ER-EL	6.8	22	7.97	24.9
		ER-EB	6.8	22	8.01	25.7
		ER-SB	6.8	22	8.06	26.2
		SR-1	6.8	22	7.91	25.6
		SR-2	6.8	22	8.04	25.4
		SR-3	6.7	22	7.98	25.6
		SR-4	6.9	22	8.08	25.5
10/02/97	Ea	CONTROL	6.5	23	8.13	24.8
		ER-WB	6.7	23	8.05	24.9
		ER-EL	6.5	23	8.04	25.0
		ER-EB	6.6	22	8.05	24.7
		ER-SB	6.7	22	8.09	24.9
		SR-1	6.6	22	8.02	25.0
		SR-2	6.7	22	8.11	24.9

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
		SR-3	6.7	23	8.09	25.0
		SR-4	6.7	22	8.07	25.0
10/02/97	Cv	CONTROL	5.9	22	7.92	25.2
		ER-WB	6.2	23	7.90	24.9
		ER-EL	6.2	23	7.85	25.0
		ER-EB	6.2	22	7.90	24.9
		ER-SB	6.3	22	7.96	24.9
		SR7.0-1	6.4	22	7.92	25.2
		SR-2	6.2	22	7.94	24.6
		SR-3	6.4	22	7.94	24.9
		SR-4	6.2	22	7.95	25.0
10/03/97	Ea	CONTROL	8.0	22	8.45	25.2
		ER-WB	7.0	23	8.23	25.2
		ER-EL	7.4	22	8.31	25.3
		ER-EB	7.7	22	8.39	25.1
		ER-SB	7.3	22	8.39	25.1
		SR-1	7.0	22	8.23	25.2
		SR-2	6.8	22	8.16	25.1
		SR-3	6.9	22	8.22	25.1
		SR-4	6.2	22	8.10	25.0
10/03/97	Cv	CONTROL	6.1	22	7.94	25.1
		ER-WB	6.1	23	7.90	24.6
		ER-EL	6.1	23	7.88	25.5
		ER-EB	6.3	22	7.87	24.7
		ER-SB	6.4	22	7.93	24.8
		SR-1	6.3	22	7.92	25.2

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
		SR-2	6.1	22	7.90	24.9
		SR-3	6.5	6.5	22	7.96
		SR-4	6.0	22	7.91	25.1
10/04/97	Ea	CONTROL	9.2	23	8.49	25.0
		ER-WB	7.9	23	8.21	25.2
		ER-EL	9.1	23	8.34	25.0
		ER-EB	8.2	23	8.32	25.0
		ER-SB	8.4	23	8.30	25.2
		SR-1	7.0	22	8.02	25.1
		SR-2	7.5	22	8.10	25.2
		SR-3	7.8	23	8.15	25.1
		SR-4	8.0	22	8.18	25.0
10/04/97	Cv	CONTROL	5.8	22	7.79	25.0
		ER-WB	5.6	23	7.68	24.8
		ER-EL	6.4	22	7.85	25.3
		ER-EB	5.7	22	7.69	24.6
		ER-SB	6.1	22	7.81	24.8
		SR-1	6.6	22	7.92	25.1
		SR-2	5.6	22	7.75	24.3
		SR-3	6.5	23	7.91	25.1
		SR-4	5.7	22	7.76	25.0
10/04/97	Ml	CONTROL	7.1	22	7.89	22.6
		ER-WB	7.2	23	7.96	24.9
		ER-EL	7.1	23	7.91	23.3
		ER-EB	7.2	22	8.02	24.6
		ER-SB	7.3	23	7.95	24.4

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
		SR-1	6.7	22	7.96	23.9
		SR-2	7.3	22	7.99	23.9
		SR-3	7.4	22	7.95	24.9
		SR-4	7.5	22	7.93	25.4
10/05/97	Ea	CONTROL	8.3	23	8.43	25.3
		ER-WB	7.4	23	8.17	25.0
		ER-EL	8.3	23	8.31	25.4
		ER-EB	7.8	22	8.28	25.4
		ER-SB	7.6	23	8.25	25.3
		SR-1	7.1	22	8.08	25.3
		SR-2	7.2	22	8.14	25.4
		SR-3	7.4	23	8.16	25.4
		SR-4	7.1	22	8.12	25.1
10/05/97	Cv	CONTROL	5.0	22	7.69	25.0
		ER-WB	5.4	22	7.62	24.9
		ER-EL	5.2	22	7.68	25.0
		ER-EB	5.0	22	7.62	25.0
		ER-SB	5.2	22	7.73	25.1
		SR-1	5.3	22	7.81	24.9
		SR-2	4.9	22	7.68	25.1
		SR-3	5.4	22	7.78	25.0
		SR-4	5.2	22	7.64	24.7
10/06/97	Ea	CONTROL	8.8	22	8.57	25.4
		ER-WB	8.1	23	8.30	25.5
		ER-EL	8.8	23	8.51	25.3
		ER-EB	8.4	22	8.45	25.5

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
		ER-SB	7.7	23	8.24	25.4
		SR-1	8.9	22	8.38	25.5
		SR-2	8.4	22	8.32	25.6
		SR-3	8.4	22	8.43	25.6
		SR-4	7.8	22	8.25	25.5
10/06/97	Cv	CONTROL	5.3	22	7.66	25.4
		ER-WB	5.6	23	7.67	25.5
		ER-EL	6.2	23	7.77	25.2
		ER-EB	5.6	22	7.64	25.5
		ER-SB	6.8	22	7.95	25.3
		SR-1	6.6	22	7.89	25.4
		SR-2	6.4	22	7.86	25.6
		SR-3	7.0	22	7.99	25.3
		SR-4	6.1	22	7.82	25.4
10/06/97	Ml	CONTROL	7.3	22	8.05	25.5
		ER-WB	7.3	22	7.95	25.7
		ER-EL	7.3	23	7.90	25.6
		ER-EB	7.0	23	7.92	25.5
		ER-SB	7.2	22	7.89	25.4
		SR-1	7.1	22	7.92	25.5
		SR-2	6.9	22	7.93	25.4
		SR-3	6.8	22	7.87	25.2
		SR-4	7.0	22	7.90	25.1
10/07/97	Ea	CONTROL	8.5	23	8.32	25.2
		ER-WB	6.9	23	7.98	25.3
		ER-EL	8.1	23	8.21	25.2

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
		ER-EB	7.3	23	8.10	25.2
		ER-SB	7.4	23	8.09	25.3
		SR-1	8.2	23	8.20	25.3
		SR-2	8.0	22	8.19	25.3
		SR-3	8.1	22	8.23	25.1
		SR-4	7.79	22	8.15	25.2
10/07/97	Cv	CONTROL	5.7	22	7.66	25.2
		ER-WB	5.8	23	7.72	25.4
		ER-EL	6.6	23	7.90	25.0
		ER-EB	5.7	22	7.68	25.3
		ER-SB	6.2	23	7.88	25.1
		SR-1	6.9	22	8.01	25.5
		SR-2	6.5	22	7.88	25.4
		SR-3	7.5	22	8.08	25.5
		SR-4	6.1	22	7.81	25.4
10/08/97	Ea	CONTROL	8.6	23	8.35	25.1
		ER-WB	7.3	23	8.06	25.4
		ER-EL	8.6	24	8.40	25.2
		ER-EB	7.5	22	8.03	25.3
		ER-SB	7.5	23	8.14	25.3
		SR-1	8.7	23	8.35	25.1
		SR-2	8.1	22	8.22	25.3
		SR-3	7.9	23	8.33	25.3
		SR-4	8.0	22	8.25	25.0
10/08/97	Cv	CONTROL	4.9	22	7.51	25.2
		ER-WB	5.3	23	7.61	25.3

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
		ER-EL	5.0	23	7.54	25.0
		ER-EB	5.3	22	7.60	25.4
		ER-SB	5.1	22	7.56	24.8
		SR-1	6.7	22	7.87	25.3
		SR-2	6.8	22	7.84	25.0
		SR-3	7.3	22	7.99	25.3
		SR-4	5.6	22	7.69	25.2
10/09/97	Ea	CONTROL	8.8	23	8.45	25.5
		ER-WB	7.3	23	8.18	25.5
		ER-EL	8.0	24	8.25	25.4
		ER-EB	7.2	22	8.11	25.5
		ER-SB	8.3	22	8.31	25.5
		SR-1	8.2	23	8.41	25.4
		SR-2	7.1	22	8.23	25.5
		SR-3	8.0	24	8.33	25.3
		SR-4	7.9	23	8.30	25.3
10/09/97	Cv	CONTROL	4.4	22	7.57	25.2
		ER-WB	5.5	23	7.71	25.
		ER-EL	5.0	23	7.67	25.3
		ER-EB	4.7	22	7.55	25.3
		ER-SB	4.2	23	7.56	25.3
		SR-1	5.9	22	7.87	25.4
		SR-2	6.5	22	7.96	25.7
		SR-3	5.9	22	7.83	25.2
		SR-4	5.0	22	7.69	25.7

Date	Test Species	Station	DO (mg/L)	Sal (ppt)	pH	T (C)
10/10/97	Ml	CONTROL	7.0	22	8.09	25.0
		ER-WB	7.6	23	7.96	25.0
		ER-EL	7.8	22	7.96	25.0
		ER-EB	7.2	22	8.04	25.0
		ER-SB	7.9	22	7.96	25.0
		SR-1	7.5	22	7.89	25.0
		SR-2	7.9	22	7.94	25.0
		SR-3	7.6	22	7.92	25.0
		SR-4	7.9	22	7.95	25.0
10/12/97	Ml	CONTROL	7.4	22	8.14	25.6
		ER-WB	7.2	23	7.99	25.6
		ER-EL	7.0	22	8.01	25.4
		ER-EB	6.7	22	8.00	25.3
		ER-SB	7.8	22	8.09	25.6
		SR-1	7.2	22	7.97	25.7
		SR-2	7.1	22	8.05	25.6
		SR-3	7.5	22	8.02	25.5
		SR-4	7.4	22	8.02	25.5

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
SR-1	Atlantic croaker	19	
	Atlantic needlefish	2	
	Atlantic silverside	59	
	Bay anchovy	25	626
	Bluefish	1	1
	Carp	1	
	Chain pickerel	3	
	Gizzard shad	7	
	Inland silverside	28	
	Mummichog	32	
	Spot	20	
	Striped bass	3	
	Striped killifish	1	
	White perch	86	1
	Yellow perch	1	
SR-2	Atlantic croaker	37	
	Atlantic menhaden	1	
	Atlantic silverside	27	
	Bay anchovy		4
	Bluefish	1	
	Gizzard shad	2	
	Inland silverside	30	
	Mummichog	31	
	Pumpkinseed	1	
	Spot	14	
	Striped bass	5	
	Striped killifish	6	
	White perch	46	
	Yellow perch	3	

STATION	SPECIES	SEINE CATCH	TRAWL CATCH
SR- 3	American eel	7	
	Atlantic croaker	46	3
	Atlantic menhaden	621	
	Atlantic silverside	69	13
	Bay anchovy	88	456
	Gizzard shad	5	
	Hogchoker	4	
	Inland silverside	36	
	Mummichog	11	
	Northern pipefish	18	
	Spot	76	1
	Striped bass	8	
	Striped killifish	5	
	Summer flounder	1	
	Threespine stickleback	1	
	White perch	65	
	Yellow perch	1	
SR- 4	Atlantic croaker	15	3
	Atlantic needlefish	1	
	Atlantic silverside	351	
	Bay anchovy	28	274
	Bluefish	9	
	Gizzard shad	3	
	Naked goby		1
	Northern pipefish	1	
	Spot	2	1
	Striped anchovy	9	
	Striped bass	3	
	Striped killifish	1	

STATION	SPECIES	SEINE CATCH	TRAWL CATCH
ER-SB	Bay anchovy		1
ER-EB	Atlantic croaker		13
	Bay anchovy		45
	Hogchoker		2
	Silver perch		1
	Spot		4
	Weakfish		22
ER-EL	Atlantic croaker		2
	Bay anchovy		63
	Hogchoker		1
	Naked goby		2
	Spot		1
	Weakfish		2
ER-WB	Atlantic croaker		1
	Bay anchovy		131

APPENDIX D

Water quality measurements, sediment composition, species abundances species biomass, and B-IBI values and scores for each site

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

Watershed: Elizabeth River
Gear: Young Grab

Station: Eastern Branch
Habitat: Polyhaline Mud
Sampled Area: 0.044 sq.m

Date: September 29, 1997

BOTTOM ENVIRONMENT

Depth (m): 3.0
Dissolved Oxygen (mg/l): 5.4

Salinity (ppt): 20.50
Sediment Silt-Clay (%): 58.90

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.67 | Condition: Severely Degraded | # Attributes Scored: 6

	Value	Score
Shannon-Weiner Index	2.95	3
Abundance (#/m2)	3076	3
Biomass (g/m2)	0.50	1
Carnivore-Omnivore Abundance (%)	10.31	1
Deep Deposit Feeder Abundance (%)	59.12	

	Value	Score
Pollution Indicative Species Abundance (%)	24.43	
Pollution Indicative Species Biomass (%)	28.59	1
Pollution Sensitive Species Abundance (%)	30.00	
Pollution Sensitive Species Biomass (%)	22.80	1

BENTHIC ABUNDANCE (per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Tubificoides spp.	886	1364	886	1045.5	275.55	886	1364	33.3
Mediomastus ambiseta	432	795	795	674.2	209.95	432	795	54.8
Streblospio benedicti	136	523	500	386.4	216.80	136	523	67.1
Paraprionospio pinnata	364	295	364	340.9	39.36	295	364	78.0
Acteocina canaliculata	205	23	45	90.9	99.07	23	205	80.9
Leucon americanus	159	45	68	90.9	60.13	45	159	83.8
Spiochaetopterus costarum	68	114	91	90.9	22.73	68	114	86.7
Leitoscoloplos spp.		114	114	75.8	65.61	0	114	89.1
Glycinde solitaria	45		68	37.9	34.72	0	68	90.3
Heteromastus filiformis	68	23	23	37.9	26.24	23	68	91.5

Continued . . .

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES
(Station: Eastern Branch Contd.)

BENTHIC ABUNDANCE (per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Eteone heteropoda			91	30.3	52.49	0	91	92.5
Neanthes succinea		91		30.3	52.49	0	91	93.5
Nemertinea	45	45		30.3	26.24	0	45	94.4
Podarkeopsis levifuscina	45		23	22.7	22.73	0	45	95.2
Rictaxis punctostriatus	23	45		22.7	22.73	0	45	95.9
Astyris lunata		45		15.2	26.24	0	45	96.4
Edotea triloba			45	15.2	26.24	0	45	96.9
Macoma balthica			45	15.2	26.24	0	45	97.3
Parahesione luteola		45		15.2	26.24	0	45	97.8
Polydora cornuta		45		15.2	26.24	0	45	98.3
Alpheus heterochaelis		23		7.6	13.12	0	23	98.6
Diopatra cuprea		23		7.6	13.12	0	23	98.8
Gammarus spp.			23	7.6	13.12	0	23	99.0
Gastropoda			23	7.6	13.12	0	23	99.3
Phyllodoce arenae	23			7.6	13.12	0	23	99.5
Pleusymtes glaber		23		7.6	13.12	0	23	99.8
Turbellaria		23		7.6	13.12	0	23	100.0
Total Abundance	2500	3705	3205	3136.4	605.16	2500	3705	
Number of Taxa	13	19	15	15.7	3.06	13	19	27

BENTHIC BIOMASS (Grams per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Paraprionospio pinnata	0.0909	0.0909	0.1136	0.0985	0.0131	0.0909	0.1136	18.3
Alpheus heterochaelis		0.1818		0.0606	0.1050	0.0000	0.1818	29.6
Leitoscoloplos spp.		0.1364	0.0227	0.0530	0.0731	0.0000	0.1364	39.4
Acteocina canaliculata	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	43.7

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES
(Station: Eastern Branch Contd.)

BENTHIC BIOMASS (Grams per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Heteromastus filiformis	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	47.9
Leucon americanus	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	52.1
Mediomastus ambiseta	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	56.3
Spiochaetopterus costarum	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	60.6
Streblospio benedicti	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	64.8
Tubificoides spp.	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	69.0
Diopatra cuprea		0.0455		0.0152	0.0262	0.0000	0.0455	71.8
Glycinde solitaria	0.0227		0.0227	0.0152	0.0131	0.0000	0.0227	74.6
Nemertinea	0.0227	0.0227		0.0152	0.0131	0.0000	0.0227	77.5
Podarkeopsis levifuscina	0.0227		0.0227	0.0152	0.0131	0.0000	0.0227	80.3
Rictaxis punctostriatus	0.0227	0.0227		0.0152	0.0131	0.0000	0.0227	83.1
Astyris lunata		0.0227		0.0076	0.0131	0.0000	0.0227	84.5
Edotea triloba			0.0227	0.0076	0.0131	0.0000	0.0227	85.9
Eteone heteropoda			0.0227	0.0076	0.0131	0.0000	0.0227	87.3
Gammarus spp.			0.0227	0.0076	0.0131	0.0000	0.0227	88.7
Gastropoda			0.0227	0.0076	0.0131	0.0000	0.0227	90.1
Macoma balthica			0.0227	0.0076	0.0131	0.0000	0.0227	91.5
Neanthes succinea		0.0227		0.0076	0.0131	0.0000	0.0227	93.0
Parahesione luteola		0.0227		0.0076	0.0131	0.0000	0.0227	94.4
Phyllodoce arenae	0.0227			0.0076	0.0131	0.0000	0.0227	95.8
Pleusymtes glaber		0.0227		0.0076	0.0131	0.0000	0.0227	97.2
Polydora cornuta		0.0227		0.0076	0.0131	0.0000	0.0227	98.6
Turbellaria		0.0227		0.0076	0.0131	0.0000	0.0227	100.0
Total Biomass	0.3636	0.7955	0.4545	0.5379	0.2277	0.3636	0.7955	

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

Watershed: Elizabeth River
Gear: Young Grab

Station: Mainstem
Habitat: Polyhaline Mud
Sampled Area: 0.044 sq.m

Date: September 5, 1997

BOTTOM ENVIRONMENT

Depth (m): 8.0
Dissolved Oxygen (mg/l): 5.4

Salinity (ppt): 19.50
Sediment Silt-Clay (%): 73.48

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.33

Condition: Degraded

\# Attributes Scored: 6

	Value	Score
Shannon-Weiner Index	3.04	3
Abundance (#/m2)	2212	5
Biomass (g/m2)	0.55	3
Carnivore-Omnivore Abundance (%)	14.35	1
Deep Deposit Feeder Abundance (%)	50.96	

	Value	Score
Pollution Indicative Species Abundance (%)	25.42	
Pollution Indicative Species Biomass (%)	27.57	1
Pollution Sensitive Species Abundance (%)	47.88	
Pollution Sensitive Species Biomass (%)	26.85	1

BENTHIC ABUNDANCE (per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Mediomastus ambiseta	409	841	705	651.5	220.74	409	841	29.4
Paraprionospio pinnata	364	500	455	439.4	69.43	364	500	49.1
Tubificoides spp.	432	614	227	424.2	193.29	227	614	68.3
Acteocina canaliculata	114	159	68	113.6	45.45	68	159	73.4
Spiochaetopterus costarum	114	136	91	113.6	22.73	91	136	78.5
Streblospio benedicti	45	159	114	106.1	57.20	45	159	83.3
Glycinde solitaria	136	136	23	98.5	65.61	23	136	87.7
Loimia medusa	114	68	45	75.8	34.72	45	114	91.1
Leitoscoloplos spp.	45	23	45	37.9	13.12	23	45	92.8
Heteromastus filiformis	23	23	23	22.7	0.00	23	23	93.9

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES (Station: Mainstem Contd.)

BENTHIC ABUNDANCE (per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Podarkeopsis levifuscina	23		45	22.7	22.73	0	45	94.9
Eteone heteropoda		23	23	15.2	13.12	0	23	95.6
Leucon americanus	23		23	15.2	13.12	0	23	96.2
Nemertinea		45		15.2	26.24	0	45	96.9
Phyllodoce arenae	45			15.2	26.24	0	45	97.6
Rictaxis punctostriatus			45	15.2	26.24	0	45	98.3
Sigambra tentaculata		23	23	15.2	13.12	0	23	99.0
Anachis obesa	23			7.6	13.12	0	23	99.3
Macoma balthica	23			7.6	13.12	0	23	99.7
Neanthes succinea		23		7.6	13.12	0	23	100.0
Total Abundance	1932	2773	1955	2219.7	479.07	1932	2773	
Number of Taxa	15	14	15	14.7	0.58	14	15	20

BENTHIC BIOMASS (Grams per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Paraprionospio pinnata	0.0455	0.1818	0.1364	0.1212	0.0694	0.0455	0.1818	21.6
Leitoscoloplos spp.	0.0909	0.0909	0.1818	0.1212	0.0525	0.0909	0.1818	43.2
Glycinde solitaria	0.0227	0.0455	0.0455	0.0379	0.0131	0.0227	0.0455	50.0
Mediomastus ambiseta	0.0227	0.0227	0.0455	0.0303	0.0131	0.0227	0.0455	55.4
Acteocina canaliculata	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	59.5
Heteromastus filiformis	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	63.5
Loimia medusa	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	67.6
Spiochaetopterus costarum	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	71.6
Streblospio benedicti	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	75.7
Tubificoides spp.	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	79.7
Eteone heteropoda		0.0227	0.0227	0.0152	0.0131	0.0000	0.0227	82.4

Continued . . .

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES (Station: Mainstem Contd.)

BENTHIC BIOMASS (Grams per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Leucon americanus	0.0227		0.0227	0.0152	0.0131	0.0000	0.0227	85.1
Nemertinea		0.0455		0.0152	0.0262	0.0000	0.0455	87.8
Podarkeopsis levifuscina	0.0227		0.0227	0.0152	0.0131	0.0000	0.0227	90.5
Sigambra tentaculata		0.0227	0.0227	0.0152	0.0131	0.0000	0.0227	93.2
Anachis obesa	0.0227			0.0076	0.0131	0.0000	0.0227	94.6
Macoma balthica	0.0227			0.0076	0.0131	0.0000	0.0227	95.9
Neanthes succinea		0.0227		0.0076	0.0131	0.0000	0.0227	97.3
Phyllodoce arenae	0.0227			0.0076	0.0131	0.0000	0.0227	98.6
Rictaxis punctostriatus			0.0227	0.0076	0.0131	0.0000	0.0227	100.0
Total Biomass	0.4318	0.5909	0.6591	0.5606	0.1166	0.4318	0.6591	

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

Watershed: Elizabeth River
Gear: Young Grab

Station: Southern Branch
Habitat: Polyhaline Sand
Sampled Area: 0.044 sq.m

Date: September 5, 1997

BOTTOM ENVIRONMENT

Depth (m): 10.0
Dissolved Oxygen (mg/l): 3.9

Salinity (ppt): 21.00
Sediment Silt-Clay (%): 14.96

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.67 | Condition: Degraded | # Attributes Scored: 6

	Value	Score
Shannon-Weiner Index	2.29	1
Abundance (#/m2)	4697	5
Biomass (g/m2)	0.68	1
Carnivore-Omnivore Abundance (%)	9.61	
Deep Deposit Feeder Abundance (%)	43.53	5
Pollution Indicative Species Abundance (%)	48.24	
Pollution Indicative Species Biomass (%)	10.32	3
Pollution Sensitive Species Abundance (%)	3.58	1
Pollution Sensitive Species Biomass (%)	10.60	

BENTHIC ABUNDANCE (per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Streblospio benedicti	1636	2136	2773	2181.8	569.54	1636	2773	46.2
Tubificoides spp.	659	682	1659	1000.0	570.90	659	1659	67.4
Heteromastus filiformis	1114	341	955	803.0	408.04	341	1114	84.4
Nemertinea	182	273	114	189.4	79.82	114	273	88.4
Leitoscoloplos spp.	68	227	159	151.5	79.82	68	227	91.7
Eteone heteropoda	68	91	68	75.8	13.12	68	91	93.3
Mediomastus ambiseta	45	68	68	60.6	13.12	45	68	94.5
Capitella capitata complex	68	68	23	53.0	26.24	23	68	95.7
Glycinde solitaria	91	23	45	53.0	34.72	23	91	96.8
Podarkeopsis levifuscina	45	68	45	53.0	13.12	45	68	97.9

Continued

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES
(Station: Southern Branch Contd.)

BENTHIC ABUNDANCE (per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Cyathura polita		45	91	45.5	45.45	0	91	98.9
Stylochus ellipticus	23		23	15.2	13.12	0	23	99.2
Corophium lacustre		23		7.6	13.12	0	23	99.4
Laeonereis culveri			23	7.6	13.12	0	23	99.5
Loimia medusa		23		7.6	13.12	0	23	99.7
Phyllodoce arenae			23	7.6	13.12	0	23	99.8
Polydora cornuta			23	7.6	13.12	0	23	100.0
Total Abundance	4000	4068	6091	4719.7	1187.99	4000	6091	
Number of Taxa	11	13	15	13.0	2.00	11	15	17

BENTHIC BIOMASS (Grams per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Heteromastus filiformis	0.1818	0.0682	0.4773	0.2424	0.2112	0.0682	0.4773	34.4
Leitoscoloplos spp.	0.0227	0.2955	0.1591	0.1591	0.1364	0.0227	0.2955	57.0
Streblospio benedicti	0.0227	0.0455	0.0682	0.0455	0.0227	0.0227	0.0682	63.4
Nemertinea	0.0227	0.0909	0.0227	0.0455	0.0394	0.0227	0.0909	69.9
Tubificoides spp.	0.0227	0.0455	0.0227	0.0303	0.0131	0.0227	0.0455	74.2
Capitella capitata complex	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	77.4
Eteone heteropoda	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	80.6
Glycinde solitaria	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	83.9
Mediomastus ambiseta	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	87.1
Podarkeopsis levifuscina	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	90.3
Cyathura polita		0.0227	0.0227	0.0152	0.0131	0.0000	0.0227	92.5
Stylochus ellipticus	0.0227		0.0227	0.0152	0.0131	0.0000	0.0227	94.6
Corophium lacustre		0.0227		0.0076	0.0131	0.0000	0.0227	95.7
Laeonereis culveri			0.0227	0.0076	0.0131	0.0000	0.0227	96.8

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES (Station: Southern Branch Contd.)

BENTHIC BIOMASS (Grams per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Loimia medusa		0.0227		0.0076	0.0131	0.0000	0.0227	97.8
Phyllodoce arenae			0.0227	0.0076	0.0131	0.0000	0.0227	98.9
Polydora cornuta			0.0227	0.0076	0.0131	0.0000	0.0227	100.0
Total Biomass	0.4091	0.7273	0.9773	0.7045	0.2848	0.4091	0.9773	

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

Watershed: Elizabeth River
Gear: Young Grab

Station: Western Branch
Habitat: High Mesohaline Mud
Sampled Area: 0.044 sq.m

Date: September 5, 1997

BOTTOM ENVIRONMENT

Depth (m): 4.0
Dissolved Oxygen (mg/l): 6.2

Salinity (ppt): 17.00
Sediment Silt-Clay (%): 53.15

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.33 Condition: Degraded # Attributes Scored: 6

	Value	Score
Shannon-Weiner Index	2.09	3
Abundance (#/m2)	3826	3
Biomass (g/m2)	0.41	1
Carnivore-Omnivore Abundance (%)	2.89	1
Deep Deposit Feeder Abundance (%)	55.66	

	Value	Score
Pollution Indicative Species Abundance (%)	33.13	
Pollution Indicative Species Biomass (%)	16.32	3
Pollution Sensitive Spécies Abundance (%)	55.74	
Pollution Sensitive Species Biomass (%)	30.44	3

BENTHIC ABUNDANCE (per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Mediomastus ambiseta	3727	1750	591	2022.7	1585.87	591	3727	52.9
Streblospio benedicti	1636	1227	386	1083.3	637.31	386	1636	81.2
Tubificoides spp.	250	159	68	159.1	90.91	68	250	85.3
Paraprionospio pinnata	136	91	159	128.8	34.72	91	159	88.7
Glycinde solitaria	159	45	23	75.8	73.06	23	159	90.7
Spiochaetopterus costarum	136		68	68.2	68.18	0	136	92.5
Phoronis spp.	114		91	68.2	60.13	0	114	94.3
Heteromastus filiformis	68	23	68	53.0	26.24	23	68	95.6
Leitoscoloplos spp.	68	23	23	37.9	26.24	23	68	96.6
Gemma gemma			91	30.3	52.49	0	91	97.4

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES
(Station: Western Branch Contd.)

BENTHIC ABUNDANCE (per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Podarkeopsis levifuscina	68			22.7	39.36	0	68	98.0
Macoma spp.	23	45		22.7	22.73	0	45	98.6
Leucon americanus		45		15.2	26.24	0	45	99.0
Mercenaria mercenaria			45	15.2	26.24	0	45	99.4
Acteocina canaliculata	23			7.6	13.12	0	23	99.6
Neanthes succinea			23	7.6	13.12	0	23	99.8
Nemertinea		23		7.6	13.12	0	23	100.0
Total Abundance	6409	3432	1636	3825.8	2410.63	1636	6409	
Number of Taxa	12	10	12	11.3	1.15	10	12	17

BENTHIC BIOMASS (Grams per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Macoma spp.	0.0227	0.3636		0.1288	0.2037	0.0000	0.3636	31.5
Paraprionospio pinnata	0.0227	0.0227	0.0682	0.0379	0.0262	0.0227	0.0682	40.7
Leitoscoloplos spp.	0.0227	0.0227	0.0455	0.0303	0.0131	0.0227	0.0455	48.1
Mediomastus ambiseta	0.0455	0.0227	0.0227	0.0303	0.0131	0.0227	0.0455	55.6
Glycinde solitaria	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	61.1
Heteromastus filiformis	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	66.7
Spiochaetopterus costarum	0.0455		0.0227	0.0227	0.0227	0.0000	0.0455	72.2
Streblospio benedicti	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	77.8
Tubificoides spp.	0.0227	0.0227	0.0227	0.0227	0.0000	0.0227	0.0227	83.3
Phoronis spp.	0.0227		0.0227	0.0152	0.0131	0.0000	0.0227	87.0
Acteocina canaliculata	0.0227			0.0076	0.0131	0.0000	0.0227	88.9
Gemma gemma			0.0227	0.0076	0.0131	0.0000	0.0227	90.7
Leucon americanus		0.0227		0.0076	0.0131	0.0000	0.0227	92.6
Mercenaria mercenaria			0.0227	0.0076	0.0131	0.0000	0.0227	94.4

Continued

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES (Station: Western Branch Contd.)

BENTHIC BIOMASS (Grams per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Neanthes succinea			0.0227	0.0076	0.0131	0.0000	0.0227	96.3
Nemertinea		0.0227		0.0076	0.0131	0.0000	0.0227	98.1
Podarkeopsis levifuscina	0.0227			0.0076	0:0131	0.0000	0.0227	100.0
Total Biomass	0.3182	0.5682	0.3409	0.4091	0.1382	0.3182	0.5682	

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

Watershed: South River
Gear: Young Grab

Station: SR1
Habitat: Low Mesohaline
Sampled Area: 0.044 sq.m

Date: August 28, 1997
Time: 10:09

BOTTOM ENVIRONMENT

Depth (m): 2.0
Dissolved Oxygen (mg/l): 1.5

Salinity (ppt): 10.20
Sediment Silt-Clay (%): 45.46

Temperature (C): 25.67
Total Carbon (%): 4.44

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.00

Condition: Severely Degraded

Attributes Scored: 5

	Value	Score
Shannon-Weiner Index	1.21	1
Abundance (#/m2)	265	1
Biomass (g/m2)	0.01	1
Carnivore-Omnivore Abundance (%)	3.92	
Deep Deposit Feeder Abundance (%)	35.35	

	Value	Score
Pollution Indicative Species Abundance (%)	64.65	1
Pollution Indicative Species Biomass (%)	63.42	
Pollution Sensitive Species Abundance (%)	0.00	
Pollution Sensitive Species Biomass (%)	0.00	1

BENTHIC ABUNDANCE (per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Streblospio benedicti	68	205	205	159.1	78.73	68	205	60.0
Tubificoides spp.	45	91	136	90.9	45.45	45	136	94.3
Tanypus spp.			45	15.2	26.24	0	45	100.0
Total Abundance	114	295	386	265.2	138.87	114	386	
Number of Taxa	2	2	3	2.3	0.58	2	3	3

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BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

(Station: SR1 Contd.)

BENTHIC BIOMASS (Grams per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Streblospio benedicti	0.0023	0.0045	0.0114	0.0061	0.0047	0.0023	0.0114	66.7
Tubificoides spp.	0.0045	0.0011	0.0023	0.0027	0.0017	0.0011	0.0045	95.8
Chironomidae larvae			0.0011	0.0004	0.0007	0.0000	0.0011	100.0
Total Biomass	0.0068	0.0057	0.0148	0.0091	0.0050	0.0057	0.0148	

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

Watershed: South River	Station: SR2	
Gear: Young Grab	Habitat: Low Mesohaline	Date: August 28, 1997
	Sampled Area: 0.044 sq.m	Time: 9:22

BOTTOM ENVIRONMENT

Depth (m): 3.8	Salinity (ppt): 11.30	Temperature (C): 25.06
Dissolved Oxygen (mg/l): 0.5	Sediment Silt-Clay (%): 50.14	Total Carbon (%): 6.08

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 1.00 Condition: Severely Degraded # Attributes Scored: 5

	Value	Score
Shannon-Weiner Index	0.00	1
Abundance (#/m2)	0	1
Biomass (g/m2)	0.00	1
Carnivore-Omnivore Abundance (%)	0.00	
Deep Deposit Feeder Abundance (%)	0.00	

	Value	Score
Pollution Indicative Species Abundance (%)	100.00	1
Pollution Indicative Species Biomass (%)	100.00	
Pollution Sensitive Species Abundance (%)	0.00	
Pollution Sensitive Spécies Biomass (%)	0.00	1

BENTHIC ABUNDANCE (per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
No organisms found								
Total Abundance	0	0	0	0.0	0.00	0	0	
Number of Taxa	0	0	0	0.0	0.00	0	0	0

BENTHIC BIOMASS (Grams per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
No organisms found								
Total Biomass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

Station: SR3

Watershed: South River | Habitat: High Mesohaline Mud | Date: August 28, 1997
Gear: Young Grab | Sampled Area: 0.044 sq.m | Time: 10:51

BOTTOM ENVIRONMENT

Depth (m): 4.5 | Salinity (ppt): 12.00 | Temperature (C): 24.90
Dissolved Oxygen (mg/l): 5.4 | Sediment Silt-Clay (%): 92.75 | Total Carbon (%): 3.42

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 2.33 | Condition: Degraded | # Attributes Scored: 6

	Value	Score
Shannon-Weiner Index	1.78	1
Abundance (#/m2)	447	1
Biomass (g/m2)	0.34	1
Carnivore-Omnivore Abundance (%)	14.30	3
Deep Deposit Feeder Abundance (%)	72.23	

	Value	Score
Pollution Indicative Species Abundance (%)	17.67	
Pollution Indicative Species Biomass (%)	0.33	5
Pollution Sensitive Species Abundance (%)	9.76	
Pollution Sensitive Species Biomass (%)	42.13	3

BENTHIC ABUNDANCE (per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Tubificoides spp.	250	114	409	257.6	147.87	114	409	57.6
Imm. Tubificid w/o Cap. Chaete	68		182	83.3	91.85	0	182	76.3
Macoma balthica		23	136	53.0	73.06	0	136	88.1
Carinoma tremaphoros	45	45	23	37.9	13.12	23	45	96.6
Neanthes succinea	23			7.6	13.12	0	23	98.3
Streblospio benedicti		23		7.6	13.12	0	23	100.0
Total Abundance	386	205	750	447.0	277.73	205	750	
Number of Taxa	4	4	4	4.0	0.00	4	4	6

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BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

(Station: SR3 Contd.)

BENTHIC BIOMASS (Grams per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Macoma balthica		0.0386	0.7682	0.2689	0.4328	0.0000	0.7682	80.0
Carinoma tremaphoros	0.0614	0.0727	0.0500	0.0614	0.0114	0.0500	0.0727	98.2
Tubificoides spp.	0.0011	0.0023	0.0091	0.0042	0.0043	0.0011	0.0091	99.4
Neanthes succinea	0.0023			0.0008	0.0013	0.0000	0.0023	99.7
Oligochaeta	0.0011		0.0011	0.0008	0.0007	0.0000	0.0011	99.9
Streblospio benedicti		0.0011		0.0004	0.0007	0.0000	0.0011	100.0
Total Biomass	0.0659	0.1148	0.8284	0.3364	0.4268	0.0659	0.8284	

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

Station: SR4

Watershed: South River — Habitat: High Mesohaline Sand — Date: August 28, 1997
Gear: Young Grab — Sampled Area: 0.044 sq.m — Time: 12:15

BOTTOM ENVIRONMENT

Depth (m): 3.7	Salinity (ppt): 12.30	Temperature (C): 24.43
Dissolved Oxygen (mg/l): 6.3	Sediment Silt-Clay (%): 31.31	Total Carbon (%): 0.75

BENTHIC INDEX OF BIOTIC INTEGRITY

B-IBI Score: 3.67 — Condition: Meets Goal — # Attributes Scored: 6

	Value	Score
Shannon-Weiner Index	2.75	3
Abundance (#/m2)	4856	3
Biomass (g/m2)	3.15	5
Carnivore-Omnivore Abundance (%)	20.55	3
Deep Deposit Feeder Abundance (%)	52.15	

	Value	Score
Pollution Indicative Species Abundance (%)	6.11	5
Pollution Indicative Species Biomass (%)	0.18	
Pollution Sensitive Species Abundance (%)	27.88	3
Pollution Sensitive Species Biomass (%)	83.06	

BENTHIC ABUNDANCE (per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Heteromastus filiformis	1159	1750	2023	1643.9	441.48	1159	2023	33.6
Tubificoides spp.	341	205	1977	840.9	986.48	205	1977	50.9
Marenzelleria viridis	636	932	636	734.8	170.58	636	932	65.9
Cyathura polita	636	455	545	545.5	90.91	455	636	77.1
Macoma mitchelli	523	341	250	371.2	138.87	250	523	84.7
Carinoma tremaphoros	455	250	318	340.9	104.15	250	455	91.6
Imm. Tubificid w/o Cap. Chaete	386			128.8	223.07	0	386	94.3
Streblospio benedicti	136	114	136	128.8	13.12	114	136	96.9
Neanthes succinea	23	23	114	53.0	52.49	23	114	98.0
Hypereteone heteropoda	45		23	22.7	22.73	0	45	98.4
Macoma balthica	23	23	23	22.7	0.00	23	23	98.9

BOTTOM ENVIRONMENT AND BENTHOS, SUMMER 1997 (CRUISE 1:1997/98)
AMBIENT TOXICITY SITES

(Station: SR4 Contd.)

BENTHIC ABUNDANCE (per sq. meter) - Contd.

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Edotea triloba	23	23		15.2	13.12	0	23	99.2
Odostomia engonia			45	15.2	26.24	0	45	99.5
Edwardsia elegans		23		7.6	13.12	0	23	99.7
Laeonereis culveri	23			7.6	13.12	0	23	99.8
Leptocheirus plumulosus			23	7.6	13.12	0	23	100.0
Total Abundance	4409	4136	6114	4886.3	1071.56	4136	6114	
Number of Taxa	13	11	12	12.0	1.00	11	13	16

BENTHIC BIOMASS (Grams per sq. meter)

	Rep 1	Rep 2	Rep 3	Mean	Std.Dev	Min	Max	Cum %
Marenzelleria viridis	1.4000	2.3659	1.6182	1.7947	0.5066	1.4000	2.3659	56.9
Cyathura polita	0.6705	0.3386	0.8182	0.6091	0.2456	0.3386	0.8182	76.2
Macoma balthica	0.2250	0.1432	0.2864	0.2182	0.0718	0.1432	0.2864	83.1
Heteromastus filiformis	0.1545	0.2068	0.2727	0.2114	0.0592	0.1545	0.2727	89.8
Macoma mitchelli	0.2045	0.1227	0.0750	0.1341	0.0655	0.0750	0.2045	94.0
Carinoma tremaphoros	0.1273	0.1068	0.1364	0.1235	0.0151	0.1068	0.1364	97.9
Neanthes succinea	0.0182	0.0023	0.0500	0.0235	0.0243	0.0023	0.0500	98.7
Tubificoides spp.	0.0068	0.0045	0.0500	0.0205	0.0256	0.0045	0.0500	99.3
Oligochaeta	0.0227			0.0076	0.0131	0.0000	0.0227	99.6
Streblospio benedicti	0.0068	0.0045	0.0023	0.0045	0.0023	0.0023	0.0068	99.7
Edotea triloba	0.0068	0.0011		0.0027	0.0037	0.0000	0.0068	99.8
Edwardsia elegans		0.0068		0.0023	0.0039	0.0000	0.0068	99.9
Leptocheirus plumulosus			0.0045	0.0015	0.0026	0.0000	0.0045	99.9
Hypereteone heteropoda	0.0011		0.0023	0.0011	0.0011	0.0000	0.0023	100.0
Laeonereis culveri	0.0023			0.0008	0.0013	0.0000	0.0023	100.0
Odostomia engonia			0.0011	0.0004	0.0007	0.0000	0.0011	100.0
Total Biomass	2.8466	3.3034	3.3170	3.1557	0.2678	2.8466	3.3170	