Toxicity Assessment Of Sediment Samples Collected From North Carolina Streams

United States Geological Survey Final Report for the
North Carolina Department of Environment and Natural Resources

Final Report CERC-8335-FY03-20-01

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November 29, 2002

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Abstract

The objective of this study was to evaluate the toxicity of sediments from 9 watersheds in North Carolina, USA. A 42-d sediment toxicity test was used in this assessment (28 d of sediment exposure followed by 14 d of water-only exposure) with the amphipod *Hyalella azteca*. Endpoints measured were survival, growth, and reproduction. A total of 30 sediment sampling stations were selected based on the results of previous studies that observed a gradient of impairment to benthic communities. Toxic effects on amphipod survival were observed in only 10% of the samples from these watersheds. Amphipod survival was significantly reduced relative to the control sediment in one sample both on Day 28 and Day 35. Amphipod length on Day 28 was significantly reduced relative to the control sediment in one sample. Reproduction (number of young/female) was also significantly reduced in only one of the sediment samples relative to the control. There were no significant rank correlations between toxicity endpoints and the physical or chemical characteristics of the sediment samples ($p > 0.002$). Sediment samples tested in these exposures had high sand and low TOC and would not be expected to accumulate high levels of contaminants. The probability of observing toxic effects was evaluated using exceedances of probable effects concentrations (PECs), the concentration of a given chemical above which adverse effects in sediments would be expected to frequently occur in field-collected sediments. For sediment samples with multiple contaminants, PECs can be averaged to derive a PEC quotient (PEC-Q) to describe the level of chemical contamination and the probably of a toxic effect of that sample. None of the individual PECs or other freshwater sediment quality guidelines (SQGs) were

exceeded for any of the chemical groups analyzed for in of the sediment samples. A 50% incidence of toxicity has been previously reported in a database for sediment tests with *H. azteca* at a mean PEC-Q of 0.63 and a 20% incidence of toxicity at a mean PEC-Q of 0.22 in 28-d exposures. None of the sediment samples from these streams exceeded a mean quotient of 0.22. Results of this study indicate that contaminants in sediments were not elevated to concentrations that would be expected to be toxic to *H. azteca* in chronic exposures. Therefore, impacts on benthic communities at sites where sediments were collected may have been due to water-borne chemicals or abiotic factors independent of contaminants in sediment.

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Acknowledgments

We thank the following individuals for their assistance on the project Eric Brunson, Eugene Greer, Doug Hardesty, Chris Ivey, Mike Paris, Ning Wang, and David Whites. We wish to thank the personnel of North Carolina Department of Environment and Natural Resources for identification of sampling locations and for the collection of the sediment samples. We would like to thank John Besser and Jim Blose for their helpful comments on the manuscript. This work was supported, in part, through an agreement between the United States Geological Survey and the North Carolina Department of Environment and Natural Resources.

Introduction

To improve their knowledge of impaired streams and facilitate their restoration, the North Carolina Division of Water Quality (DWQ) initiated the Watershed Assessment and Restoration Project (WARP) project. The focus of the project has been to evaluate eleven watersheds across the state from 2000 to 2002. Each of these watersheds contains streams considered impaired based on an inability to support healthy benthic macroinvertebrate communities. The reasons for this impairment were unknown prior to the study. Project staff are using a range of methods to collect data relevant to the determination of the likely reasons for impairment, including: benthic community sampling, habitat evaluation, chemical monitoring, toxicity analyses, and watershed evaluations (Jim Blose, DWQ, personal communication).

The goal of the DWQ project is to provide the foundation for future water quality restoration activities in the eleven watersheds in North Carolina by: (1) identifying the most likely causes of biological impairment (such as degraded habitat or specific pollutants in water or sediment); (2) identifying the major watershed activities and sources of pollution contributing to those causes (such as storm water runoff from particular urban or rural areas, stream bank erosion, or hydrologic modification); and (3) developing a watershed strategy that recommends restoration activities and best management practices to address these problems and improve the biological condition of the impaired streams.

Although some of the streams are currently unable to support acceptable benthic macroinvertebrate communities, these streams were not selected for sediment toxicity testing for this reason alone. Either an evaluation of macroinvertebrate community composition at these locations or results of a midge deformity test indicate potential toxic impacts (Lenat 1993).

The objective of the present study was to determine if contaminants in sediments at these sites were elevated to toxic concentrations. Thus, 30 sediment samples from 9 watersheds, 26 which were selected based on impaired condition of the benthic community, were selected for evaluation with chronic whole-sediment toxicity tests using the amphipod *Hyalella azteca* (USEPA 2000a, ASTM 2001).

Materials And Methods

Sample Collection, Handling, and Storage

Sediment samples were collected by personnel from the North Carolina Department of Environment and Natural Resources. Sediments were collected from 15 sites (2 samples/site) in North Carolina (Figure 1) in three batches on July 16 and 17, 2001 (12 samples), August 7 to August 13, 2001 (12 samples), and October 8 and October 10, 2001 (6 samples; Figure 1). Samples were collected from either: (1) impaired streams for which impacts on the benthic community were observed (26 samples from 13 sites); or 2) from streams where the benthic communities were not impaired (4 samples from 2 sites). This second group includes Upper Barton Creek (UBUB01), a stream in a suburbanizing area, and the South Fork Mills River (MRSM01), a small headwaters stream located in the Pisgah National Forest that has likely not experienced significant human impacts other than past logging and the ubiquitous atmospheric deposition (Table 1).

Two samples were collected from each sample site, targeting two distinct areas: (1) sandy areas (denoted by a station number ending in “S” or “1) with moderate water velocity and (2) depositional areas (denoted by a station number ending in “D” or “2”) where finer sediments are more likely to accumulate. Higher concentrations of contaminants in sediment would be more likely at these depositional sites, though these areas are not directly sampled for macroinvertebrates. All sediment samples were collected using a 500 ml high-density polyethylene (HDPE) dipper (ladle) from about the upper 5 cm of the sediment surface. Each sediment sample was a composite of 4 to 8 grabs to obtain a minimum of 2 L of sediment/station for toxicity testing and physical analyses of sediments. An additional sub-sample was collected from the composite sample for chemical analysis by the state of North Carolina.

Samples were held in the dark on ice at 4^o C in HDPE containers before shipment to the Columbia Environmental Research Center (CERC) in Columbia, MO. Samples arriving at CERC were assigned an in-house CERC designation code (Table 1). The control sediment used for these tests was collected from West Bearskin Lake (Ankley et al. 1994, Ingersoll et al. 1998). All sediment toxicity tests were started within one month of sample collection from the field. Sediments were not sieved to remove indigenous organisms; however, large indigenous organisms and large debris were physically removed (using forceps) during homogenization of samples in the laboratory.

Culturing of Test Organisms

Amphipods were mass cultured at 23°C with a luminance of about 800 lux using 80-L glass aquaria containing 50 L of CERC well water (hardness 283 mg/L as $CaCO_3$, alkalinity 255 mg/L as $CaCO_3$, pH 7.8; Ingersoll et al. 1998). Artificial substrates were placed in the amphipod culture aquaria (six 20 cm sections/aquarium of "coiled-web material"; 3M Corp., Saint Paul, MN). Amphipods used to start the tests were obtained by collecting amphipods that passed through a #35 U.S. Standard size (500-um opening) and were collected on a #40 (425-um opening) sieve placed under water (ASTM 2001, Ingersoll et al. 2001). Amphipods were held in 3 L of water with gentle aeration and with a small amount of Tetramin® and a maple leaf for 24 hours before the start of the test. Use of this sieving method resulted in mean amphipod lengths at the start of the exposure of 2.1 mm (0.08 standard error of the mean (SE)), 2.1 mm (0.07 SE), and 1.8 mm (0.06 SE) for the three batches of sediment respectively.

Sediment Exposures

Test sediments were homogenized in a stainless steel bowl using a plastic spoon and added to exposure beakers 1 d before test organisms were added (Day -1). Subsamples of sediment were then collected for pore-water isolation and physical characterizations.

Toxicity tests with *Hyalella azteca* were conducted for a total of 42 d (28 d of sediment exposure followed by 14 d of water-only exposure; Ingersoll et al. 1998 USEPA 2000a ASTM 2001). Endpoints measured in the amphipod exposures included survival and growth (length) on Day 28, survival on Day 35, and survival and growth on Day 42, and reproduction (number of young/female produced from Day 28 to Day 42). The purpose of transferring surviving amphipods from sediment to water at Day 28 is to monitor reproduction. At about Day 28, amphipods used to start the exposures begin to go into amplexus followed by release of their first brood (Ingersoll et al. 1998).

Amphipods were exposed to 100 ml of sediment with 175 ml of overlying water in 300-ml beakers with a total of eight replicates/treatment. Four replicates were used for Day 28 survival and growth and 4 replicates for Day 28 to 42 survival, growth and reproduction. The photoperiod was 16 h light: 8 h dark at an intensity of about 200 lux at the surface of the exposure beakers and the exposure temperature was 23^{o} C. Each beaker received 2-volume additions/d of overlying water starting on Day -1 (Zumwalt et al. 1994). Diluters cycled every 4 h (± 15 min) with each diluter cycle delivering 50 ml of water to each beaker. Tests were started on Day 0 by placing 10 amphipods into each beaker using an eyedropper. Amphipods in each beaker were fed 1.0 ml of Yeast-Cerophyll-trout chow (YCT; 1.7 to 1.9 g/L) in a water suspension daily (USEPA 2000 ASTM 2001). Beakers were observed daily for the presence of animals, signs of animal activity (i.e., burrowing), and to monitor test conditions (mainly water clarity).

On Day 28, amphipods were isolated from each beaker by pouring off most of the overlying water, gently swirling the remaining overlying water and upper layer of sediment and washing the sediment through a No. 50 (300-um opening) US Standard stainless steel sieve. The materials that were retained on the sieve were washed into a glass pan and the surviving amphipods were removed. Amphipods from four of the replicates from each sediment were counted and preserved in 8% sugar formalin for subsequent length measurements (Kemble et al. 1994; Ingersoll et al. 1998).

Amphipods from the remaining four replicates from each sediment sample were placed in a 300-ml beaker containing 175 ml of overlying water and a 3 cm x 3 cm piece of “coiled-web material” (3M Corp., Saint Paul, MN). Each beaker received two volume additions of water and 1.0 ml of the YCT suspension daily. Reproduction of amphipods was measured on Days 35 and 42 by counting the number of young in each of these water-only beakers. Production of young amphipods in these beakers was monitored by removing and counting the adults and young in each beaker. On Day 35, the adults were returned to the same water-only beakers. On Day 42, adult amphipods were preserved with sugar formalin for growth and sex determination (mature male amphipods were distinguished by the presence of an enlarged second gnathopod).

Length of amphipods was measured along the dorsal surface from the base of the first antenna to the tip of the third uropod along the curve of the dorsal surface. Amphipod length measurements were made using an EPIX imaging system (PIXCI® SV4 imaging board and XCAP software; EPIX Inc., Buffalo Grove, IL) connected to a computer and a microscope (Ingersoll et al. 2001).

About 170 ml of pore water was isolated from sediment samples by centrifugation at 5200 rpm (7000 g) for 15 min at 4°C (Kemble et al. 1994). Immediately after pore water was isolated, dissolved oxygen, pH, alkalinity, temperature, conductivity, total ammonia, and hardness were measured using methods outlined in Kemble et al. (1994; Table 2). About 20 to 50 ml of pore water was used to measure ammonia and a similar volume of pore water was used to measure the other water quality characteristics. A wide range in the water quality characteristics of the pore water was observed (both across watersheds and within a watershed) for pH (6.3 to 10.1), alkalinity (44 to 310 mg/L as $CaCO_3$), hardness (10 to 235 mg/L as $CaCO_3$), dissolved oxygen (2.5 to 8.9 mg/L), conductivity (599 to 3090 umho/cm), total ammonia (0.21 to 5.74 mg/L), and unionized ammonia (<0.0001 to 0.33 mg/L; Table 2). Pore water could not be isolated from samples NC-06, NC-12, NC-25, and NC-27 due to the high sand content of these samples.

Conductivity, pH, alkalinity, hardness, dissolved oxygen, and total ammonia were measured in overlying test water on Day 0 (the day amphipods were stocked), Day 28, and Day 42 of the exposure. Conductivity and dissolved oxygen, in overlying water were also measured weekly. Methods used to characterize overlying water quality in the whole-sediment tests are described in Kemble et al. (1994). Temperature in the water baths holding the exposure beakers was monitored daily. Overlying water pH, alkalinity, total hardness, conductivity and total ammonia measurements were similar among treatments pH (8.1 to 8.4), alkalinity (237 to 317 mg/L as $CaCO_3$), hardness (256 to 286 mg/L as $CaCO_3$), dissolved oxygen (5.7 to 7.5 mg/L), conductivity (607 to 650 :mho/cm), total ammonia (0.03 to 0.37 mg/L), and unionized ammonia (0.0003 to 0.0043 mg/L; Table 3). Dissolved oxygen measurements in overlying waters were at or above the acceptable level of 2.5 mg/L in all treatments throughout the study (ASTM 2001, USEPA 2000a).

Physical characterization of sediment samples

Physical characterization of sediments included: (1) percentage water (Kemble et al. 1994), (2) particle size analysis using a hydrometer (Foth et al. 1982; Gee and Bauder 1986; Kemble et al. 1994), and (3) total organic carbon using a coulometric titration method (Cahill et al. 1987; Kemble et al. 1994). Precision and accuracy of the coulometric technique used were tested against National Bureau of Standards and Standard Reference Materials (NBS-SRM) with an error of less than 0.03% of the excepted values (Cahill et al. 1987).

Chemical Characterization of Sediment Samples

Chemical analyses of sediment samples included: (1) total metals, (2) chlorinated pesticides (CPs), (3) polychlorinated biphenyls (PCBs), (4) base/neutral and acid organics, and (5) current use pesticides (samples 19 to 24 were not tested for current use pesticides). Chemical analyses were conducted by the University of North Carolina State Department of Environmental and Molecular Toxicology (pesticides and PCBS), Paradigm Analytical Laboratory (metals), and Environmental Chemists, Inc. (Base/Neutral and Acid Organics). For more details of chemical analysis methods, see USEPA (1998).

Data Analyses

Statistical analyses for the amphipod exposures were conducted using one-way analysis of variance (ANOVA) at p = 0.05 for all endpoints except length which was analyzed using a one-way nested ANOVA at p = 0.05 (amphipods nested within a beaker; Snedecor and Cochran 1982). Before statistical analyses were performed, all data were tested for normality. Data for 28-d amphipod length (round 3) had a normal distribution and were not transformed before statistical analysis. Amphipod length data (42-d length round 1 and 28-d length round 2) were log-transformed before statistical analysis. Amphipod reproduction data (number of young/female) for Rounds 2 and 3 were square-root transformed before statistical analysis. Variance among treatment means for all other endpoint data was heterogeneous, a rank analysis of variance was performed and mean differences were determined using a T-test on ranked means (at p = 0.05). A sample was designated as toxic when mean survival, growth, or reproduction was significantly reduced relative to the control sediment.

Spearman rank correlation procedures were also used to evaluate relationships between the responses of amphipods exposed to the field-collected sediments and the physical and chemical sediment characteristics. Statistical significance for the rank correlations was established at 0.002 for all comparisons to minimize experiment-wise error (Bonferroni method; Snedecor and Cochran 1982). All statistical analyses were performed with Statistical Analysis System programs (SAS 2001).

Probable effect concentrations (PECs) or other types of sediment quality guidelines were used to assess the relationship between sediment chemistry and toxicity. The PECs are effect-based sediment quality guidelines that were established as concentrations of individual chemicals above which adverse effects in sediments are expected to frequently occur in field-collected sediments (MacDonald *et al.* 2000). Mean quotients based on PECs were calculated to provide an overall measure of chemical contamination and to support an evaluation of the combined effects of multiple contaminants in sediments (MacDonald *et al.* 2000, USEPA 2000b, Ingersoll *et al.* 2001).

We were interested in equally weighting the contribution of metals, PAHs, and PCBs in the evaluation of sediment chemistry and toxicity assuming that each of these three diverse groups of chemicals exert some form of collective toxic action. For this reason, we first calculated an average PEC-Q for up to seven metals in a sample based on dry weight concentrations of arsenic, cadmium, chromium, copper, lead, nickel, and zinc. A mean quotient was then calculated for each sample by summing the average quotient for metals, the quotient for total PAHs, and the quotient for total PCBs, and then dividing this sum by three (n = 3 quotients/sample; see Ingersoll *et al.* 2001 for additional details on the procedure used to calculate mean PEC-Q). Use of this approach for calculating the quotients was selected to avoid over-weighting the influence of an individual chemical (i.e., a single metal) on the combined mean quotient (USEPA 2000b).

In calculating concentrations of total PCBs or total PAHs, half the detection limit was used for compounds reported below the detection limit (Ingersoll et al. 2001). If the concentration was below the detection limit but above the PEC, this value was excluded from the calculation of the PEC-Q (and for evaluation by Spearman rank correlation).

Results and Discussion

Physical and Chemical Characteristics of sediment samples

A broad range in grain size and TOC was observed in the sediment samples collected from the assessment areas (Table 4). However, sediments were generally sandy and had a relatively low organic carbon content. Water content of sediments ranged from 13% for sediment from Sample NC-12 to 59% for sediment from Sample NC-24. Sediment organic carbon content ranged from <0.01% in sediment from NC-06 to 2.85% in sediment from Samples NC-24 and NC-30 (Table 4). Classification of the sediment samples for grain size varied from sample to sample but 28 of 30 samples were classified as some type of sand (loamy sand, sand, or sandy loam) while the control sediment was classified as a loam (Table 4).

Concentrations of total metals in sediment samples are listed in Table 5. Antimony, arsenic, selenium, and silver were below detection limits in all 30 sediment samples (detection limits ranged from 0.024 to 13.60 mg/kg; Table 5). Sediment from Sample NC-14 had the highest concentrations of 7 of the 12 metals detected. Sediment from Sample NC-14 had the highest concentrations of total cadmium, chromium, copper, iron, manganese, nickel and total zinc. The highest concentration of lead was measured in the sediment samples from Sample NC-16 and the highest mercury concentration was from the Sample NC-22 sediment sample. While detectable, all of the metals for which there is a PEC value (Table 6), were below these guideline numbers (MacDonald et al. 2000).

Concentrations of all chlorinated pesticides (CPs) analyzed for were below detection limits (0.05 ng/g) in sediment samples from 14 of the assessment samples (Table 7). Eight of the nine CPs detected were detected in less than half the samples. Only 4,4' DDE was detected in over half the samples (16 of 30). Sediment from Sample

NC-09 had the highest 4,4' DDT concentration, sediment from Sample NC-03 the highest 4,4' DDD concentration and the Sample NC-02 sediment sample had the highest 4,4' DDE (Table 7). Concentrations of total PCBs in sediment samples were all below 7 ng/g (Table 8) and concentrations did not exceed the PEC of 676 ng/g for any of the sediment samples. The highest concentration of total PCBs was 6.25 ng/g in the sediment sample from Sample NC-02 (Table 8) which is less than 1% of the PEC of 676 ng/g for total PCBs (Table 6).

Concentrations of measured base/neutral and acid organics in samples are listed in Table 9. Concentrations of these compounds were below detection limits (detection limits ranged from 179 to 3100 ng/g) for all compounds measured in the samples with the exception of fluoranthene in samples from Samples NC-15 and NC-16, and pyrene in samples from Samples NC-14, NC-15, and NC-16. None of the detectable concentrations of fluoranthene or pyrene measured in the sediment samples exceeded PEC values (Table 6). Total PAH concentrations were below the PEC value 22800 ng/g in all of the samples (Table 6).

Concentrations of pesticides were below detection limits (0.05 ng/g) for 30 of the 37 pesticides analyzed for in the sediment samples (Table 10). Only chlorpyrifos (6 of 24) and simazine (4 of 24) were detected in four or more of the samples. Sediment from NC-03 had the highest concentration of chlorpyrifos (12.0 ng/g). Sample NC-18 had the highest concentrations of both simazine (4.6 ng/g) and chlorothalonil (5 ng/g). The sediment sample from Sample NC-09 had the highest concentration of carbaryl (7.5 ng/g; Table 10). Atazine was highest in the sediment sample from NC-02 (6.1 ng/g). Chlorpyrifos was the only “new use” pesticides analyzed for in this study that we were able to locate an SQG value for in the literature (Table 6). The chlorpyrifos concentration from the NC-03 sediment sample was the only detectable chlorpyrifos concentration which exceeded the SQG value of 5.3 ug/g of organic carbon However, this sample was not identified as toxic.

Ingersoll et al. (2001) reported a 50% incidence of toxicity at a mean PEC-Q of 0.63 and a 20% incidence of toxicity at a mean PEC-Q of 0.22 in 28-d sediment exposures with *H. azteca*. Mean PEC-Q's for the North Carolina sediments were below 0.22 for all 30 of the of the sediment samples (Table 11). Results of these evaluations using mean PEC-Q indicate that none of the sediments from the assessment sites would be predicted to be toxic to *H. azteca* in 28-d sediment exposures.

In addition to the PECs reported in MacDonald et al. (2000) for metals, PAHs, PCBs and select OCs, additional SQGs were compiled in Table 6 from a variety of additional sources. These SQGs included values for additional metals, PAHs, PCBs and select OCs. None of the concentrations measuered in the sediment samples exceeded these additional SQGs listed in Table 6. However, detection limits for 11 of the base/neutral and acid organics exceeded the reported SQGs, because of this, these data were not included in these PEC-Q or SQG analyses.

Sediment Exposures

Survival of amphipods in the West Bearskin control sediment ranged from 91% to 98% for the three batches of sediments tested. Survival of amphipods at Day 28 identified 1 sample (NC-22) as toxic based on a significant reduction in survival compared to the control (Table 12). However, amphipod survival in this sample was greater than the minimum control survival of 80% for test acceptability (USEPA 2000a; ASTM 2001; Table 12). Amphipod survival at Day 35 also identified only 1 sample as toxic (NC-15). However, survival of amphipods was not significantly reduced in this sample on either Day 28 or Day 42. At Day 42, there were no significant reductions of amphipod survival compared to the control (Table 12). Body length of amphipods at Day 28 was significantly reduced compared to the control in only 1 of the 30 samples (NC-09). This sediment sample also had significantly reduced reproduction (number of young/female) compared to the control (Site NC-09; Table 12). Body length of amphipods at Day 42 was not significantly reduced compared to the control in any of the samples (Table 12).

Indigenous organisms recovered at the end of the 28-d sediment exposure included oligochaetes, clams, ephemeroptera, chironomids, and plecoptera. Amphipods were observed in amplexus in the control sediment and about half of the test sediment treatments at Day 28. This indicates that amphipods in most of sediments evaluated were reproductively mature at the end of the sediment exposure.

Comparison of Sediment Characteristics to Toxicity Responses

Relationships of physical characteristics of sediments to toxicity were evaluated using Spearman Rank correlation. The results of this evaluation indicated that there were no significant correlations between survival, growth (length) or reproduction and the grain size, TOC, water quality characteristics of the pore water, or chemical characteristics of the sediment samples. Previous studies (USEPA 2000a; ASTM 2001, Kemble et al. 2002) have also found that sediment particle size and TOC did not affect the response of *H. azteca* in 28-d sediment exposures. The lack of correlation of toxicity with chemical constituents may have resulted from the relatively low levels of contaminant concentrations and relatively small differences in survival, growth, or reproduction of amphipods among the sediments tests.

In addition the relationship between biological responses and total PCBs, total PAHs, average PEC-Q for metals, or the mean PEC-Q was also evaluated using Spearman Rank correlation analysis. The results of this evaluation showed there were no significant correlations between PEC-Qs and biological responses of amphipods. This lack of correlation may have resulted from the relatively low levels in contaminant concentrations relative to the changes in survival, growth, or reproduction of amphipods.

The sample from Sample NC-14 had the highest measured pyrene concentration, and exceeded the PEC for this compound. However, this sample was not toxic to the amphipods. Sample NC-09 was designated as toxic (base on a reduction in length at Day 28 and a reduction in the number of young per female) and had the highest concentration of carbaryl (7.5 ng/g). Sediment from sample NC-22, which had reduced survival at Day 28 relative to the control had the highest Hg concentration. However, this value did not exceed the PEC value for Hg.

Summary

Sediment samples from North Carolina streams have been designated as impaired based on benthic community analysis. To our knowledge, this is the first study in which benthic community analysis was used for selecting sediment samples for subsequent toxicity testing. Sediment samples from North Carolina were generally not toxic to amphipods. Amphipod survival identified only 3 of the 30 sediment samples as toxic based on at least one of the endpoints evaluated (reduced survival, growth or reproduction relative to the control). Only one sample (NC-09) had significant toxic effects on more than one endpoint.

Sediment chemistry and toxicity data were evaluated using consensus-based probable effect concentrations (PECs), probable effect concentration quotients (PEC-Qs) or other sediment quality guidelines (SQGs) available in the literature. Results of these analyses using available SQGs indicate sediments from the streams evaluated in North Carolina would not be predicted to be toxic to *H. azteca* in 28-d exposures. Sediments from the assessment areas generally had high levels of sand and low TOC. Partitioning of contaminants to these sediments would be expected to be low given the high concentrations of sand and low levels of TOC (ASTM 2001). The observed toxicity in this study may have been caused by: (1) a chemical in the sediment samples which was not analyzed for, (2) a chemical or chemicals for which there is no PEC or SQG, (3) or stress of animals from handling (i.e, the Day 35 survival sample). Results of this study indicate that concentrations of contaminants in sediments were not toxic in chronic sediment exposures. Hence, the impacts observed on benthos were probably not related to the contaminants in sediments at these locations. Additional analyses with samples from stations in North Carolina containing higher concentrations of toxic chemicals are needed to better compare benthic community surveys to the responses of *H. azteca* in laboratory toxicity tests.

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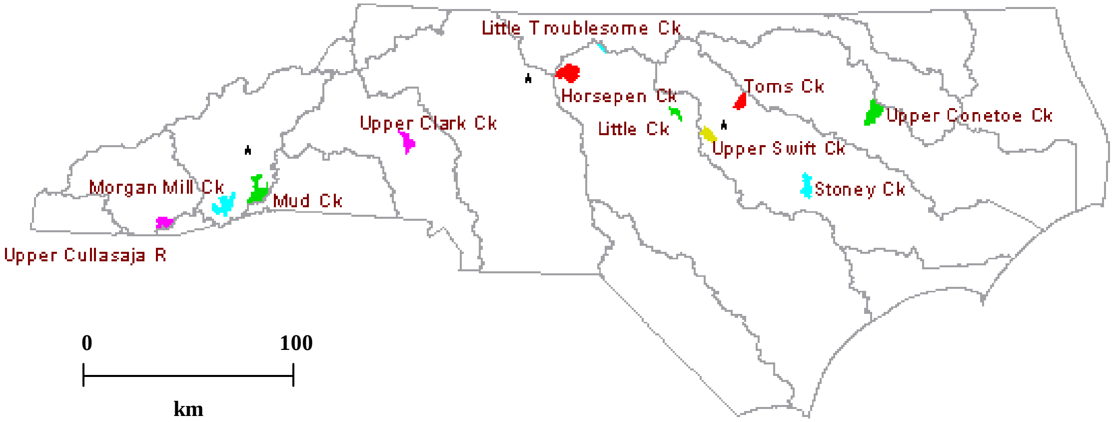

Figure 1. Location of sampling sites in North Carolina.

Table 1. Identification numbers for North Carolina sediment samples used to conduct toxicity tests.

Site Location	Station Code	CERC #	Round	Benthos Impacted
NA	NA	Control	1	
Upper Barton Creek	UBUB01S	NC-01	1	
Upper Barton Creek	UBUB01D	NC-02	1	
Swift Creek - Holly Springs Rd	SWSC01D	NC-03	1	*
Swift Creek - Holly Springs Rd	SWSC01S	NC-04	1	*
HorsePen Creek – Ballinger Rd	HPHP02T2	NC-05	1	*
HorsePen Creek – Ballinger Rd	HPHP02T1	NC-06	1	*
HorsePen Creek - Bledsoe Rd	HPHP04T2	NC-07	1	*
HorsePen Creek - Bledsoe Rd	HPHP04T1	NC-08	1	*
Clear Creek - Mills Gap Rd	MUCC31D	NC-09	1	*
Clear Creek - Mills Gap Rd	MUCC31S	NC-10	1	*
Clear Creek - Nix Rd	MUCC19D	NC-11	1	*
Clear Creek - Nix Rd	MUCC19S	NC-12	1	*
NA	NA	Control	2	
Little Troublesome Creek @ Freeway Dr.	LTLT03 -T1	NC-13	2	*
Little Troublesome Creek @ Freeway Dr.	LTLT03 -T2	NC-14	2	*
Little Creek - Pinhurst Dr	LCLC01-S	NC-15	2	*
Little Creek - Pinhurst Dr	LCLC01-D	NC-16	2	*
Swift Creek - Ritter Park	SWSC02-S	NC-17	2	*
Swift Creek - Ritter Park	SWSC02-D	NC-18	2	*
South Fork Mills River	MRSM01-S	NC-19	2	
South Fork Mills River	MRSM01-D	NC-20	2	
Mill Creek - Brookside Lane	CRMC02-S	NC-21	2	*
Mill Creek - Brookside Lane	CRMC02- D	NC-22	2	*
Cullasaja River - US64	CRCR01-S	NC-23	2	*
Cullasaja River- US64	CRCR01-D	NC-24	2	*
NA	NA	Control	3	
Conetoe Creek @ 64 Business	CTCC02S	NC-25	3	*
Conetoe Creek @ 64 Business	CTCC02D	NC-26	3	*
Mud Creek - Erkwood Road	MUMC01S	NC-27	3	*
Mud Creek - Erkwood Road	MUMC01D	NC-28	3	*
Mud Creek - US-25	MUMC34S	NC-29	3	*
Mud Creek - US-25	MUMC34D	NC-30	3	*

Table 2. Measured pore-water water quality characteristics for sediment samples from North Carolina - Round 1. (NM = not measured)

Sample Number	D.O. (mg/L)	Conductivity (umho@25^{o}C)	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	pH	Total ammonia (mg/L)	Unionized ammonia (mg/L)
Control	6.4	436	175	191	6.3	2.62	0.0001
NC-01	8.9	544	80	80	7.6	0.82	0.0013
NC-02	6.8	576	72	80	7.1	1.87	0.0010
NC-03	7.6	217	52	60	6.7	0.77	0.0002
NC-04	8.9	216	42	80	6.9	0.29	0.0001
NC-05	5.5	712	212	160	7.4	2.39	0.0019
NC-06	NM	NM	NM	NM	NM	NM	NM
NC-07	5.6	537	136	120	7.2	2.21	0.0012
NC-08	7.6	335	120	80	7.4	0.42	0.0004
NC-09	5.1	339	114	60	7.3	0.99	0.0006
NC-10	8.2	143	140	70	6.9	0.21	0.0001
NC-11	5.2	334	138	60	6.8	1.75	0.0004
NC-12	NM	NM	NM	NM	NM	NM	NM

Table 2 (cont). Measured pore-water water quality characteristics for sediment samples from North Carolina – Round 2. (NM = not measured)

Sample Number	D.O. (mg/L)	Conductivity (umhos/cm@25^{o}C)	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	pH	Total ammonia (mg/L)	Unionized ammonia (mg/L)
Control	6.4	436	175	191	6.3	2.62	0.0001
NC-13	6.3	334	146	150	7.5	1.33	0.0016
NC-14	2.5	644	235	310	7.1	4.26	0.0017
NC-15	7.8	NM	146	144	7.8	1.36	0.0031
NC-16	5.1	446	180	214	7.5	2.58	0.0033
NC-17	6.4	331	124	150	7.6	2.85	0.0037
NC-18	2.9	444	155	183	7.1	3.14	0.0013
NC-19	4.8	276	NM	NM	6.8	3.37	0.0006
NC-20	3.4	282	175	134	6.6	0.66	0.0001
NC-21	7.2	67	150	44	6.8	0.48	0.0001
NC-22	2.7	400	145	190	6.8	1.30	0.0003
NC-23	7.8	212	10	146	10.1	0.77	0.3343
NC-24	2.9	208	215	130	6.8	1.71	0.0003

Table 2 (cont). Measured pore-water water quality characteristics for sediment samples from North Carolina – Round 3. (NM = not measured)

Sample Number	D.O. (mg/L)	Conductivity (umhos/cm@25^{o}C)	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	pH	Total ammonia (mg/L)	Unionized ammonia (mg/L)
Control	6.4	436	175	191	6.3	2.62	0.0001
NC-25	NM	NM	NM	NM	NM	NM	NM
NC-26	5.7	314	70	100	6.6	5.740	0.0006
NC-27	NM	NM	NM	NM	NM	NM	NM
NC-28	4.4	264	70	116	6.6	1.370	0.0002
NC-29	8.9	172	NM	NM	9.1	1.640	0.0536
NC-30	4.2	518	180	284	7.0	4.730	0.0012

Table 3. Mean measured overlying water quality characteristics for exposures with sediment samples from North Carolina - Round 1.

Sample Number	Temperature (^oC)	D.O. (mg/L)	Conductivity (umhos/cm@25^oC)	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	pH	Total Ammoia (mg/L)	Unionized ammonia (mg/L)
Control	23	7.4	620	277	254	8.2	0.128	0.0009
NC-01	23	6.2	623	284	317	8.1	0.241	0.0018
NC-02	23	6.9	624	282	249	8.2	0.202	0.0018
NC-03	23	7.0	632	277	266	8.4	0.150	0.0043
NC-04	23	7.1	611	259	246	8.3	0.052	0.0005
NC-05	23	5.9	620	278	254	8.2	0.140	0.0008
NC-06	23	7.1	616	275	242	8.3	0.073	0.0006
NC-07	23	6.1	629	256	246	8.3	0.366	0.0041
NC-08	23	6.9	622	276	246	8.3	0.105	0.0010
NC-09	23	5.9	607	276	239	8.1	0.097	0.0005
NC-10	23	7.2	613	257	244	8.3	0.035	0.0004
NC-11	23	5.7	608	270	242	8.1	0.314	0.0013
NC-12	23	7.1	620	276	241	8.3	0.036	0.0003

Table 3. Mean measured overlying water quality characteristics for exposures with sediment samples from North Carolina - Round 2.

Sample Number	Temperature (^oC)	D.O. (mg/L)	Conductivity (umhos/cm@25^{o}C)	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	pH	Total Ammoia (mg/L)	Unionized ammonia (mg/L)
Control	23	7.4	620	277	254	8.2	0.128	0.0009
NC-13	23	7.3	621	277	250	8.3	0.174	0.0025
NC-14	23	6.9	627	276	251	8.3	0.179	0.0017
NC-15	23	7.5	629	286	253	8.4	0.072	0.0011
NC-16	23	6.9	630	275	248	8.3	0.138	0.0016
NC-17	23	7.1	625	278	251	8.4	0.130	0.0020
NC-18	23	6.8	627	280	250	8.3	0.158	0.0013
NC-19	23	7.1	635	271	248	8.4	0.302	0.0032
NC-20	23	6.9	625	271	250	8.3	0.139	0.0012
NC-21	23	7.2	628	276	248	8.4	0.140	0.0015
NC-22	23	6.5	626	276	249	8.2	0.217	0.0014
NC-23	23	7.4	625	275	243	8.4	0.213	0.0022
NC-24	23	7.0	621	271	246	8.3	0.280	0.0024

Table 3. Mean measured overlying water quality characteristics for exposures with sediment samples from North Carolina - Round 3.

Sample Number	Temperature (^oC)	D.O. (mg/L)	Conductivity (umhos/cm@25^{o}C)	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	pH	Total Ammoia (mg/L)	Unionized ammonia (mg/L)
Control	23	7.4	629	270	239	8.3	0.157	0.0014
NC-25	23	7.0	639	275	239	8.3	0.159	0.0013
NC-26	23	6.6	623	270	237	8.2	0.144	0.0007
NC-27	23	7.3	636	285	257	8.3	0.032	0.0003
NC-28	23	6.9	631	268	244	8.3	0.068	0.0005
NC-29	23	7.2	636	275	244	8.2	0.089	0.0006
NC-30	23	6.6	650	276	241	8.2	0.178	0.0009

Table 4. Physical characteristics of sediment samples from North Carolina at the start of whole-sediment tests - Round 1.

Sample Number	TOC (%)	Water (%)	Particle Size (%)			Sediment Class
			Sand	Silt	Clay	
Control	1.25	40	53	17	30	Loam
NC-01	0.10	23	82	14	4	Loamy Sand
NC-02	1.39	34	68	20	12	Sandy Clay Loam
NC-03	0.07	23	72	16	12	Sandy Loam
NC-04	0.06	17	84	14	2	Loamy Sand
NC-05	0.34	31	68	18	14	Sandy Loam
NC-06	<0.01	23	84	14	2	Loamy Sand
NC-07	0.87	36	48	22	30	Loam
NC-08	0.06	20	84	16	0	Loamy Sand
NC-09	1.74	45	54	20	26	Sandy Clay Loam
NC-10	0.24	21	84	14	2	Loamy Sand
NC-11	2.47	53	40	24	35	Loam
NC-12	0.6	13	57	17	26	Sandy Loam

Table 4. Physical characteristics of sediment samples from North Carolina at the start of whole-sediment tests - Round 2.

Sample Number	TOC (%)	Water (%)	Particle Size (%)			Sediment Class
			Sand	Silt	Clay	
Control	1.25	40	53	17	30	Loam
NC-13	0.07	25	83	12	5	Loamy Sand
NC-14	1.32	46	58	20	22	Sandy Loam
NC-15	0.04	24	86	12	2	Sand
NC-16	0.38	28	76	15	9	Sandy Loam
NC-17	0.04	22	80	14	6	Loamy Sand
NC-18	0.59	31	60	11	29	Sandy Loam
NC-19	0.23	26	86	12	2	Loamy Sand
NC-20	1.55	46	75	14	11	Sandy Loam
NC-21	0.17	28	84	13	3	Loamy Sand
NC-22	2.45	48	70	19	11	Sandy Loam
NC-23	0.19	27	86	12	2	Loamy Sand
NC-24	2.85	59	66	16	18	Sandy Loam

Table 4. Physical characteristics of sediment samples from North Carolina at the start of whole-sediment tests - Round 3.

Sample Number	TOC (%)	Water (%)	Particle Size (%)			Sediment Class
			Sand	Silt	Clay	
Control	1.25	40	53	17	30	Loam
NC-25	0.19	14	84	15	1	Loamy Sand
NC-26	2.85	30	76	14	10	Loamy Sand
NC-27	0.19	22	87	11	2	Sandy Loam
NC-28	0.83	40	66	15	19	Sandy Loam
NC-29	0.14	27	83	11	6	Sandy Loam
NC-30	1.01	57	52	19	29	Clay Loam

Table 5. Total metals (mg/kg dry weight) concentrations measured in sediment samples from North Carolina (ND = Not detected).

	NC-01	NC-02	NC-03	NC-04	NC-05	NC-06	NC-07	NC-08	NC-09	NC-10
Aluminum	1210	5770	2600	1590	5950	5940	8690	3120	15100	2990
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	0.6	ND	ND	1.0	1.0	1.1	0.9	0.9	ND
Chromium	4.4	15.4	4.3	ND	43.6	14.8	17.7	51.2	5.8	ND
Copper	1.9	7.0	2.5	ND	14.2	17.3	21.1	3.3	4.1	ND
Iron	2770	10100	5080	2850	17900	11800	15000	17900	11600	3040
Lead	ND	3.9	4.7	ND	7.2	7.5	9.6	5.9	10.0	2.6
Manganese	124	290	145	119	365	404	447	324	273	149
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	0.1	ND
Nickel	ND	5.9	ND	ND	5.6	5.0	6.5	ND	ND	ND
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	2.0	ND	3.8	ND
Zinc	7.5	27.9	18.9	12.2	55.5	61.1	58.6	22	51.5	11.2

Table 5. Total metals (mg/kg dry weight) concentrations measured in sediment samples from North Carolina (ND = Not detected).

	NC-11	NC-12	NC-13	NC-14	NC-15	NC-16	NC-17	NC-18	NC-19	NC-20
Aluminum	18000	2030	5910	24700	3280	3530	1230	7710	2890	9160
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	1.1	ND	ND	1.0	ND	ND	ND	ND	ND	ND
Cadmium	1.2	ND	0.5	2.1	0.6	0.4	ND	0.8	ND	0.6
Chromium	6.9	ND	17.9	56.9	12.4	8.4	2.5	8.3	2.9	8.6
Copper	3.9	ND	4.8	23.9	6.6	7.5	2.0	8.1	2.5	4.2
Iron	14100	1960	6980	27000	11100	6320	2730	11700	2610	7600
Lead	11.3	ND	6.9	46.7	10.4	62.1	2.6	9.2	ND	ND
Manganese	340	182	162	519	310	237	111	457	90	107
Mercury	ND	ND	ND	0.1	ND	<0.1	ND	ND	ND	ND
Nickel	ND	ND	8.6	26.2	6.2	3.4	ND	ND	ND	4.7
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	6.2	ND	2.0	5.4	ND	ND	ND	ND	ND	ND
Zinc	69.4	10.4	22.7	153	29.6	35.6	9.9	45.5	8.7	24

Table 5. Total metals (mg/kg dry weight) concentrations measured in sediment samples from North Carolina (ND = Not detected).

	NC-21	NC-22	NC-23	NC-24	NC-25	NC-26	NC-27	NC-28	NC-29	NC-30
Aluminum	4670	15300	4070	25900	659	2250	2690	11500	4300	14300
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	0.3	1.1	0.3	1.6	ND	ND	ND	0.298	ND	0.474
Chromium	ND	12.5	4.4	17.3	ND	ND	ND	5.08	ND	5.35
Copper	1.8	13.0	2.5	12.7	1.75	2.73	2.55	3.76	1.33	4.26
Iron	4830	14600	4440	20200	370	1090	2480	6950	3120	9450
Lead	3.0	13.9	ND	8.7	ND	4.0	2.7	5.7	3.9	11
Manganese	139	306	136	414	4.5	3.1	75.3	120	75.6	211
Mercury	ND	1.0	ND	0.1	ND	ND	ND	ND	ND	ND
Nickel	ND	8.8	ND	11.6	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	28.9	104	18.9	104	3.9	18.8	9.3	27.5	20.7	66.5

Table 6. List of SQGs used to evaluate sediment chemistry and toxicity.

Chemical	Detection limit range	PEC or Comparable SQG
Metals (mg/kg)		
Antimony	1.15 – 2.72	25[1]
Arsenic	5.76 – 13.6	33[2]
Cadmium	0.23 – 0.93	5[2]
Chromium	2.3 – 5.44	110[2]
Copper	1.15 – 2.72	150[2]
Iron	2.9 – 6.8	40,000[3]
Lead	1.73 – 4.08	130[2]
Manganese	0.3 – 0.7	1100[3]
Mercury	0.024 – 2.03	1.1[2]
Nickel	0.34 – 6.80	49[2]
Silver	0.58 – 1.36	2.2[4]
Zinc	0.6 – 1.4	460[2]
Pesticides (ug/g)		
Aldrin	0.05	80[3]
Alpha-BHC	0.05	100[3]
Beta-BHC	0.05	210[3]
Lindane	0.05	5[2]
Dieldrin	0.05	62[2]
Sum DDD	0.05	28[2]
Sum DDE	0.05	31[2]
Sum DDT	0.05	63[2]
Sum of DDT+DDD+DDE	0.05	572[2]
Endrin	0.05	1300
Heptachlor Epoxide	0.05	16[2]
Mirex	0.05	14[4]
Total PCBs	0.05	676[2]
Chlorpyrifos[10]	0.05	5.3[5]

Table 6. (cont.) List of SQGs used to evaluate sediment chemistry and toxicity.

Chemical	Detection limit range	PEC or Comparable SQG
base/neutral & acid organics (ug/g)		
Acenaphthlene	175 – 756	89[6]
Acenaphthylene	175 – 756	128[6]
Anthracene	175 – 756	845[2]
Fluorene	175 – 756	536[2]
Naphthalene	175 – 756	561[2]
2-methylnapthalene	175 – 756	201[6]
Phenanthrene	175 – 756	1170[2]
Benzo(a)anthracene	175 – 756	1050[2]
Benzo(a)pyrene	175 – 756	1450[2]
Benzo(b)fluoranthene	175 – 756	13400[7]
Benzo(k)fluoranthene	175 – 756	13400[3]
Benzo(g,h,i)perylene	175 – 756	3200[3]
Chrysene	175 – 756	1290[2]
Benzo(a,h)perylene	175 – 756	135[2]
Fluoranthene	175 – 756	2230[2]
Indeno(1,2,3 cd)pyrene	175 – 756	3200[2]
Pyrene	175 – 756	1520[2]
Total PAHs		22800[2]
Benzoic acid	701- 1200	6500[8]
Dibenzofuran	175-756	580[8]
1,2-Dichlorobenzene	175-756	23[8]
1,4-Dichlorobenzene	180-1511	90[8]
2,4-Dimethylphenol	175-756	290[8]
Dimethylphthlate	175-756	530[8]
Di-n-Butylphthalate	175-756	17000[8]
Di-n-octylphthalate	175-756	45000[8]
Diethylphthalate	175-756	1100[8]
2-methylphenol	180-1511	6700[8]
Pentachlorophenol	175-3100	200[9]
Phenol	175-1511	12000[8]
1,2,4 Trichlorobenzene	175-756	18[8]

[1] Long, ER, Morgan LG 1991.

[2] MacDonald, DD Ingersoll CG Berger TA 2000.

[3] Persaud, D.R., R. Jaagumag, and A. Hayton. 1993.

[4] MacDonald, D.D. and M. MacFarlene 1999.

[5] New York State Department of Environmental Conservation 1999.

[6] Canadian Council of Ministers of the Environment (CCME) 1999.

[7] There are no guideline value for Benzo(b)fluoranthene “similar as below” assumes the similarity of the chemical structure of Benzo(b)fluoranthene with Benzo(k)fluoranthene would yield a similar quantitative structure activity relationships (QSARs) as it relates to toxicity, therefore he effect level concentration that were derived for Benzo(k)fluoranthene would also apply to Benzo(b)fluoranthene.

[8] Sediment Management Standards, Chapter 173-204 WAC, Washington State Department of Ecology. April 1991.

[9] Janisch 1990.

[10] Units = ug/gOC

Table 7. Concentrations (ng/g dry weight) of chlorinated pesticides measured in sediment samples from North Carolina (ND = Not detected).

	NC-01	NC-02	NC-03	NC-04	NC-05	NC-06	NC-07	NC-08	NC-09	NC-10
Alpha BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
hexachlorobenzene	ND	1.65	0.35	ND	ND	ND	ND	ND	2.82	ND
Heptachlor	ND	0.16	ND	ND	ND	ND	ND	ND	0.35	ND
heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha chlordane	ND	0.60	0.23	ND	ND	ND	ND	ND	0.77	ND
gamma chlordane	ND	1.12	0.67	ND	0.39	ND	ND	ND	2.31	ND
trans-nonachlor	ND	0.37	ND	ND	0.14	ND	ND	ND	1.40	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	0.39	ND	ND	0.45	ND	0.67	ND	0.62	ND
alpha endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endrin aldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	0.14	0.27	ND	0.09	ND	ND	ND	0.31	ND
4,4'-DDD	ND	0.87	1.15	ND	0.13	ND	0.55	ND	1.12	ND
4,4'-DDE	ND	6.84	4.21	ND	1.60	ND	2.10	ND	2.50	ND
2,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum of DDTs	ND	7.85	5.63	ND	1.82	ND	2.65	ND	3.93	ND

Table 7. Concentrations (ng/g dry weight) of chlorinated pesticides measured in sediment samples from North Carolina (ND = Not detected).

	NC-11	NC-12	NC-13	NC-14	NC-15	NC-16	NC-17	NC-18	NC-19	NC-20
alpha BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
hexachlorobenzene	ND	ND	ND	ND	ND	0.39	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha chlordane	0.35	ND	ND	ND	ND	0.44	ND	0.42	ND	ND
gamma chlordane	0.67	0.21	ND	ND	ND	0.80	ND	0.86	ND	0.74
trans-nonachlor	0.40	ND	ND	ND	ND	0.19	ND	0.15	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endrin aldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	0.09	ND	ND	ND	ND
4,4'-DDD	0.17	ND	ND	ND	ND	0.14	ND	ND	ND	0.26
4,4'-DDE	0.79	0.38	ND	0.35	ND	1.60	ND	1.26	ND	0.91
2,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum of DDTs	0.96	0.38	ND	0.35	ND	1.83	ND	1.26	ND	1.17

Table 7. Concentrations (ng/g dry weight) of chlorinated pesticides measured in sediment samples from North Carolina (ND = Not detected).

	NC-21	NC-22	NC-23	NC-24	NC-25	NC-26	NC-27	NC-28	NC-29	NC-30
alpha BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
hexachlorobenzene	ND	ND	ND	0.30	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	0.72	ND	ND
heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha chlordane	ND	ND	ND	0.15	ND	ND	ND	1.20	ND	0.72
gamma chlordane	ND	ND	ND	0.80	ND	0.52	ND	4.80	ND	1.85
trans-nonachlor	ND	ND	ND	0.20	ND	ND	ND	0.95	ND	0.47
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	0.72	ND	ND	ND	ND	ND	ND	ND	ND
alpha endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endrin aldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	0.58	ND	0.20	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	2.30	ND	0.85	ND	1.41	ND	2.74	ND	2.10
2,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum of DDTs	ND	2.88	ND	1.05	ND	1.41	ND	2.74	ND	2.10

Table 8. Concentrations (ng/g dry weight) of polychlorinated biphenyls (PCBs) in sediment samples from North Carolina (ND = Not detected).

	NC-01	NC-02	NC-03	NC-04	NC-05	NC-06	NC-07	NC-08	NC-09	NC-10
PCB 8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 52	ND	0.16	ND	ND	ND	ND	ND	ND	ND	ND
PCB 44	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 66	ND	0.27	ND	ND	ND	ND	0.15	ND	ND	ND
PCB 101	ND	0.85	ND	ND	0.35	ND	0.51	ND	ND	ND
PCB 77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 118	ND	1.14	0.97	ND	0.28	ND	0.58	ND	0.37	ND
PCB 153	ND	1.41	ND	ND	0.47	ND	0.39	ND	0.60	ND
PCB 105	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 138	ND	1.15	1.80	ND	0.64	ND	1.15	ND	0.44	ND
PCB 126	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 187	ND	0.37	1.61	ND	ND	ND	ND	ND	ND	ND
PCB 128	ND	0.16	ND	ND	ND	ND	0.16	ND	ND	ND
PCB 180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 170	ND	0.55	1.47	ND	ND	ND	ND	ND	ND	ND
PCB 195	ND	0.20	ND	ND	ND	ND	ND	ND	ND	ND
PCB 206	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 209	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum of PCBs	ND	6.26	5.85	ND	1.74	ND	2.94	ND	1.41	ND

Table 8. Concentrations (ng/g dry weight) of polychlorinated biphenyls (PCBs) in sediment samples from North Carolina (ND = Not detected).

	NC-11	NC-12	NC-13	NC-14	NC-15	NC-16	NC-17	NC-18	NC-19	NC-20
PCB 8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 52	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 44	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 66	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 101	ND	ND	ND	0.36	ND	ND	ND	ND	ND	0.51
PCB 77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 118	ND	ND	ND	0.70	ND	0.77	ND	0.42	ND	0.74
PCB 153	0.27	ND	ND	0.81	ND	0.62	ND	0.33	ND	1.08
PCB 105	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 138	ND	ND	ND	0.45	ND	0.90	ND	0.26	ND	1.02
PCB 126	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 187	ND	ND	ND	ND	ND	0.40	ND	ND	ND	0.25
PCB 128	ND	ND	ND	0.16	ND	ND	ND	ND	ND	ND
PCB 180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 170	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 195	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 206	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 209	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum of PCBs	0.27	ND	ND	2.48	ND	2.69	ND	1.01	ND	3.60

Table 8. Concentrations (ng/g dry weight) of polychlorinated biphenyls (PCBs) in sediment samples from North Carolina (ND = Not detected).

	NC-21	NC-22	NC-23	NC-24	NC-25	NC-26	NC-27	NC-28	NC-29	NC-30
PCB 8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 52	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 44	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 66	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 101	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.23
PCB 77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 118	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.30
PCB 153	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.45
PCB 105	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 138	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.36
PCB 126	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 187	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 128	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 170	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 195	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 206	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 209	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sum of PCBs	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.34

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-01	NC-02	NC-03	NC-04	NC-05	NC-06	NC-07	NC-08	NC-09	NC-10
Acenaphthlene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i,)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic Acid	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Bis(2-Chloroethoxy)methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-Chloroethyl)ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-Chloroisopropyl)ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroanilime	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-01	NC-02	NC-03	NC-04	NC-05	NC-06	NC-07	NC-08	NC-09	NC-10
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3’-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3,-c,d)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-01	NC-02	NC-03	NC-04	NC-05	NC-06	NC-07	NC-08	NC-09	NC-10
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3&4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
4-Methylphenol	NM	NM	NM	NM	NM	NM	NM	NM	ND	ND
N-nitrosodi-n-propylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-11	NC-12	NC-13	NC-14	NC-15	NC-16	NC-17	NC-18	NC-19	NC-20
Acenaphthlene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i,)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic Acid	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
Bis(2-Chloroethoxy)methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-Chloroethyl)ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-Chloroisopropyl)ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroanilime	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-11	NC-12	NC-13	NC-14	NC-15	NC-16	NC-17	NC-18	NC-19	NC-20
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3’-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	228	480	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3,-c,d)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-11	NC-12	NC-13	NC-14	NC-15	NC-16	NC-17	NC-18	NC-19	NC-20
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3&4-Methylphenol	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
4-Methylphenol	NM	NM	NM	NM	NM	NM	NM	NM	ND	ND
N-nitrosodi-n-propylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
3-Nitroaniline	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
4-Nitroaniline	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	1063	198	486	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-21	NC-22	NC-23	NC-24	NC-25	NC-26	NC-27	NC-28	NC-29	NC-30
Acenaphthlene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i,)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic Acid	NM	NM	NM	NM	ND	ND	NM	NM	NM	NM
Bis(2-Chloroethoxy)methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-Chloroethyl)ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-Chloroisopropyl)ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	ND	ND	ND	ND	202	190	ND	ND	ND	ND
4-Chloroanilime	NM	NM	NM	NM	ND	ND	NM	NM	NM	NM
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	NM	NM	NM	NM	ND	ND	NM	NM	NM	NM
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-Butylphthalate	ND	ND	ND	ND	1820	1740	ND	ND	ND	ND
Di-n-octylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-21	NC-22	NC-23	NC-24	NC-25	NC-26	NC-27	NC-28	NC-29	NC-30
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	NM	NM	NM	NM	ND	ND	NM	NM	NM	NM
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	NM	NM	NM	NM	ND	ND	NM	NM	NM	NM
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3,-c,d)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Concentrations (ng/g dry weight) of base/neutral and acid organics in sediment samples from North Carolina (ND = Not detected, NM = Not measured).

	NC-21	NC-22	NC-23	NC-24	NC-25	NC-26	NC-27	NC-28	NC-29	NC-30
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3&4-Methylphenol	NM	NM	NM	NM	469	986	NM	NM	NM	NM
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodi-n-propylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	NM	NM	NM	NM	ND	ND	NM	NM	NM	NM
3-Nitroaniline	NM	NM	NM	NM	ND	ND	NM	NM	NM	NM
4-Nitroaniline	NM	NM	NM	NM	ND	ND	NM	NM	NM	NM
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 10. Concentrations (ng/g dry weight) of pesticides in sediment samples from North Carolina streams (ND = Not detected, NM = Not measured).

	NC-01	NC-02	NC-03	NC-04	NC-05	NC-06	NC-07	NC-08	NC-09	NC-10
2,6-diethylanaline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Atrazine	ND	6.1	ND	ND	3.7	ND	2.6	ND	ND	ND
Benfluralin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbaryl	ND	ND	3.6	ND	ND	ND	ND	ND	7.5	ND
Carbofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorothalonil	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorpyrifos	ND	ND	12.0	ND	ND	ND	ND	ND	5.1	ND
Cyanazine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dacthal	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Deethylatrazine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Deisopropylatrazine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazinion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethoate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Disulfoton	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPTC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethalfluralin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethoprop	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fenamiphos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Flumetralin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fonofos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 10. Concentrations (ng/g dry weight) of pesticides in sediment samples from North Carolina streams (ND = Not detected, NM = Not measured).

	NC-01	NC-02	NC-03	NC-04	NC-05	NC-06	NC-07	NC-08	NC-09	NC-10
Methyl parathion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metolachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metribuzin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Monlinate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Napropamide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pebulate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pendimethalin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Permethrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Prometon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Prometryn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Simazine	ND	ND	2.40	ND	ND	ND	ND	ND	ND	ND
Tebuthiuron	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Terbufos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trifluralin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 10. Concentrations (ng/g dry weight) of pesticides in sediment samples from North Carolina streams (ND = Not detected, NM = Not measured).

	NC-11	NC-12	NC-13	NC-14	NC-15	NC-16	NC-17	NC-18	NC-19	NC-20
2,6-diethylanaline	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Alachlor	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Atrazine	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Benfluralin	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Butylate	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Carbaryl	1.4	ND	ND	ND	ND	ND	ND	ND	NM	NM
Carbofuran	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Chlorothalonil	ND	ND	ND	ND	ND	ND	ND	5.0	NM	NM
Chlorpyrifos	3.6	ND	ND	ND	ND	ND	ND	2.9	NM	NM
Cyanazine	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Dacthal	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Deethylatrazine	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Deisopropylatrazine	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Diazinion	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Dimethoate	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Disulfoton	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
EPTC	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Ethalfluralin	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Ethoprop	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Fenamiphos	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Flumetralin	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Fonofos	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Malathion	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM

Table 10. Concentrations (ng/g dry weight) of pesticides in sediment samples from North Carolina streams (ND = Not detected, NM = Not measured).

	NC-11	NC-12	NC-13	NC-14	NC-15	NC-16	NC-17	NC-18	NC-19	NC-20
Methyl parathion	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Metolachlor	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Metribuzin	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Monlinate	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Napropamide	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Pebulate	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Pendimethalin	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Permethrin	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Prometon	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Prometryn	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Simazine	ND	ND	ND	ND	ND	ND	ND	4.6	NM	NM
Tebuthiuron	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Terbufos	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM
Trifluralin	ND	ND	ND	ND	ND	ND	ND	ND	NM	NM

Table 10. Concentrations (ng/g dry weight) of pesticides in sediment samples from North Carolina streams (ND = Not detected, NM = Not measured).

	NC-21	NC-22	NC-23	NC-24	NC-25	NC-26	NC-27	NC-28	NC-29	NC-30
2,6-diethylanaline	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Alachlor	NM	NM	NM	NM	ND	ND	ND	ND	NM	NM
Atrazine	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Benfluralin	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Butylate	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Carbaryl	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Carbofuran	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Chlorothalonil	NM	NM	NM	NM	ND	ND	ND	1.6	ND	ND
Chlorpyrifos	NM	NM	NM	NM	ND	2.5	ND	11.4	ND	ND
Cyanazine	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Dacthal	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Deethylatrazine	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Deisopropylatrazine	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Diazinion	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Dimethoate	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Disulfoton	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
EPTC	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Ethalfluralin	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Ethoprop	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Fenamiphos	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Flumetralin	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Fonofos	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Malathion	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND

Table 10. Concentrations (ng/g dry weight) of pesticides in sediment samples from North Carolina streams (ND = Not detected, NM = Not measured).

	NC-21	NC-22	NC-23	NC-24	NC-25	NC-26	NC-27	NC-28	NC-29	NC-30
Methyl parathion	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Metolachlor	NM	NM	NM	NM	ND	4.2	ND	ND	ND	ND
Metribuzin	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Monlinate	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Napropamide	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Pebulate	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Pendimethalin	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Permethrin	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Prometon	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Prometryn	NM	NM	NM	NM	ND	3.0	ND	2.4	ND	ND
Simazine	NM	NM	NM	NM	ND	2.8	ND	1.6	ND	ND
Tebuthiuron	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Terbufos	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND
Trifluralin	NM	NM	NM	NM	ND	ND	ND	ND	ND	ND

Table 11. Mean probable effects concentration quotients (PEC-Qs) for sediment samples from North Carolina streams.

Sample Number	Mean of three groups PEC-Qs	Mean Metals PEC	PAH's PEC-Q	PCBs PEC-Q
NC-01	0.037	0.035	0.067	0.007
NC-02	0.065	0.093	0.087	0.013
NC-03	0.043	0.044	0.070	0.015
NC-04	0.032	0.028	0.062	0.007
NC-05	0.065	0.120	0.067	0.008
NC-06	0.071	0.143	0.061	0.007
NC-07	0.077	0.142	0.080	0.010
NC-08	0.066	0.123	0.067	0.007
NC-09	0.061	0.077	0.097	0.008
NC-10	0.030	0.019	0.063	0.007
NC-11	0.076	0.112	0.107	0.007
NC-12	0.036	0.030	0.072	0.007
NC-13	0.085	0.094	0.154	0.007
NC-14	0.213	0.351	0.279	0.009
NC-15	0.042	0.084	0.034	0.007
NC-16	0.073	0.133	0.075	0.010
NC-17	0.035	0.033	0.065	0.007
NC-18	0.058	0.095	0.070	0.008
NC-19	0.033	0.031	0.062	0.007
NC-20	0.064	0.075	0.100	0.016
NC-21	0.038	0.043	0.062	0.007
NC-22	0.075	0.154	0.065	0.007
NC-23	0.039	0.043	0.069	0.007
NC-24	0.100	0.186	0.104	0.007
NC-25	0.020	0.027	0.024	0.007
NC-26	0.023	0.038	0.024	0.007
NC-27	0.021	0.031	0.024	0.007
NC-28	0.030	0.054	0.027	0.007
NC-29	0.022	0.034	0.024	0.007
NC-30	0.037	0.081	0.023	0.008

Table 12. Response of *Hyalella azteca* in 28-d exposures to sediment samples from North Carolina and a West Bearskin control sediment (Round 1). Means (Standard error of the means in parentheses) with an asterisk within a column for a sediment are significantly less than the control (p <0.05).

Sample Number	28-d Survival	28-d Length	35-d Survival	42-d Survival	42-d Length	# of young Per Female
Control	91 (3.98)	4.50 (0.06)	85 (5.00)	85 (5.00)	5.22 (0.12)	6.20 (2.03)
NC-01	93 (4.12)	5.05 (0.06)	95 (2.89)	88 (4.79)	5.54 (0.08)	10.28 (1.34)
NC-02	83 (4.12)	5.26 (0.06)	88 (4.79)	90 (4.08)	5.85 (0.08)	11.20 (0.14)
NC-03	98 (1.64)	4.79 (0.06)	98 (2.50)	95 (5.00)	5.16 (0.09)	7.70 (1.74)
NC-04	98 (1.64)	4.44 (0.06)	95 (2.76)	94 (2.26)	5.02 (0.09)	6.50 (0.97)
NC-05	93 (1.64)	4.53 (0.06)	95 (2.89)	93 (4.79)	5.43 (0.07)	4.53 (1.36)
NC-06	96 (1.83)	4.73 (0.05)	98 (2.27)	98 (2.27)	5.26 (0.07)	7.20 (0.88)
NC-07	95 (2.67)	4.82 (0.06)	90 (4.08)	88 (4.79)	5.60 (0.10)	11.63 (2.22)
NC-08	91 (3.98)	5.00 (0.07)	83 (7.50)	78 (7.50)	5.78 (0.11)	24.35 (10.46)
NC-09	86 (5.32)	3.34 (0.11)*	85 (6.45)	83 (7.50)	4.87 (0.10)	0.40 (0.40)*
NC-10	94 (2.63)	4.28 (0.07)	93 (4.79)	92 (4.79)	5.43 (0.11)	7.90 (1.86)
NC-11	96 (2.63)	4.89 (0.07)	93 (4.79)	93 (4.79)	5.59 (0.08)	7.00 (1.24)
NC-12	91 (5.15)	4.83 (0.10)	90 (7.07)	88 (6.33)	5.63 (0.10)	9.15 (1.64)
p-values	0.6	<0.0001	0.320	0.297	<0.0001	0.0009

Table 12. Response of *Hyalella azteca* in 28-d exposures to sediment samples from North Carolina and a West Bearskin control sediment (Round 2). Means (Standard error of the means in parentheses) with an asterisk within a column for a sediment are significantly less than the control (p <0.05).

Sample Number	28-d Survival	28-d Length	35-d Survival	42-d Survival	42-d Length	# of young Per Female
Control	98 (1.01)	4.49 (0.05)	98 (1.64)	95 (1.80)	5.25 (0.06)	8.28 (1.11)
NC-13	96 (2.63)	4.66 (0.07)	95 (5.00)	95 (5.00)	5.39 (0.09)	7.10 (0.44)
NC-14	98 (1.64)	4.37 (0.05)	93 (4.79)	93 (4.79)	5.30 (0.08)	4.90 (0.93)
NC-15	90 (3.27)	5.01 (0.08)	85 (2.89)*	85 (2.89)	5.94 (0.11)	7.40 (2.26)
NC-16	98 (1.64)	5.03 (0.10)	98 (2.50)	98 (2.50)	5.51 (0.07)	6.05 (0.43)
NC-17	91 (2.95)	4.66 (0.08)	91 (3.69)	88 (4.55)	5.75 (0.11)	5.45 (1.44)
NC-18	91 (2.95)	4.83 (0.08)	93 (2.50)	93 (2.50)	5.53 (0.08)	5.73 (0.99)
NC-19	96 (1.83)	4.91 (0.07)	98 (2.50)	98 (2.50)	5.72 (0.09)	9.58 (2.76)
NC-20	98 (1.64)	4.74 (0.07)	98 (2.50)	98 (2.50)	5.16 (0.08)	8.38 (0.43)
NC-21	98 (1.64)	4.60 (0.08)	93 (2.50)	95 (2.89)	5.05 (0.07)	6.93 (0.29)
NC-22	89 (2.27)*	4.66 (0.06)	95 (2.89)	98 (2.50)	5.49 (0.10)	5.80 (0.76)
NC-23	90 (4.63)	4.65 (0.06)	88 (6.29)	88 (6.29)	5.39 (0.09)	7.85 (0.92)
NC-24	96 (2.63)	4.43 (0.06)	88 (9.46)	88 (9.46)	5.07 (0.07)	4.68 (0.74)
p-values	0.015	<0.0001	0.354	0.355	<0.0001	0.218

Table 12. Response of *Hyalella azteca* in 28-d exposures to sediment samples from North Carolina and a West Bearskin control sediment (Round 3). No significant differences were observed among sediment types (p <0.05).

Sample Number	28-d Survival	28-d Length	35-d Survival	42-d Survival	42-d Length	# of young Per Female
Control	96 (2.63)	4.29 (0.06)	95 (2.89)	95 (2.89)	5.27 (0.09)	5.08 (0.92)
NC-25	99 (1.25)	4.92 (0.06)	100 (0.00)	100 (0.00)	5.54 (0.10)	6.25 (1.02)
NC-26	95 (2.67)	4.61 (0.10)	98 (2.50)	95 (2.89)	5.44 (0.12)	3.05 (0.93)
NC-27	94 (3.24)	4.85 (0.09)	90 (4.08)	90 (4.08)	5.34 (0.07)	10.05 (1.87)
NC-28	98 (2.50)	4.50 (0.08)	95 (5.00)	93 (4.79)	5.32 (0.09)	2.95 (0.70)
NC-29	95 (2.67)	4.46 (0.11)	100 (0.00)	100 (0.00)	5.37 (0.09)	4.48 (0.29)
NC-30	95 (3.78)	4.45 (0.10)	100 (0.00)	93 (2.43)	5.18 (0.08)	2.75 (0.93)
p-values	0.884	<0.0001	0.161	0.191	0.116	0.002