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METALS IN NEW JERSEY'S PINELANDS NATIONAL RESERVE SEDIMENTS, SURFACE WATER AND BIOTA: AN EMPHASIS ON MERCURY

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services, Region 5
New Jersey Field Office
Pleasantville, New Jersey 08232

April 1998

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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April 9, 1998

Thomas H. Hupf, Environmental Project Manager
Environmental Branch, ACT-434
Federal Aviation Administration
William J. Hughes Technical Center
Atlantic City International Airport, New Jersey 08405

Dear Mr. Hupf:

The U.S. Fish and Wildlife Service's (Service) New Jersey Field Office is pleased to submit the enclosed final report entitled, *"Metals in New Jersey's Pinelands National Reserve Sediments, Surface Water and Biota: an Emphasis on Mercury."* This study was designed to further assess mercury contamination discovered during the Service's ecological risk assessment of the William J. Hughes Technical Center (U.S. Fish and Wildlife Service, 1996). This final report is submitted pursuant to the requirements under Task 7 of the Interagency Agreement Number DTFA03-92-Z-00025.

Thank you for your continued cooperation on this project, please contact me if you have any questions regarding this final report.

Sincerely,

Clifford G. Day

Clifford G. Day
Supervisor

Enclosure

METALS IN NEW JERSEY'S PINELANDS NATIONAL RESERVE SEDIMENTS, SURFACE WATER AND BIOTA: AN EMPHASIS ON MERCURY

Prepared by:

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Preparer / Project Biologist: Mark R. Roberts
Preparer / Assistant Project Leader: Robert A. Frakes, Ph.D.
Project Leader: Clifford G. Day

April 1998

PREFACE

The information presented in this report documents baseline metals information in the surface water, sediment, and various trophic levels of biota in the Pinelands National Reserve (Pinelands) of southern New Jersey. Many of the methodologies and quality assurance procedures that were implemented during this field investigation were previously reported by the U.S. Fish and Wildlife Service (Service) (USFWS 1996a). This Pinelands investigation was designed to document baseline contaminant concerns, particularly for mercury contamination affecting fish and wildlife resources inhabiting the unique Pinelands region. Additionally, this investigation was conducted to aid in deriving a mercury clean-up criterion for the Federal Aviation Administration's William J. Hughes Technical Center Superfund site.

Study design, implementation, and reporting were completed by Environmental Contaminants personnel in the Service's New Jersey Field Office (NJFO). Funding for the project was provided by the Service and the Federal Aviation Administration's (FAA) William J. Hughes Technical Center. Valuable sample collection assistance, including the use of a barge electrofishing unit, was provided by the USEPA Region II Environmental Services Division. A special thanks to Mr. James Kurtenbach of the USEPA for his advice and assistance with sample collection is warranted. This investigation was funded by the Service and the FAA. Results of this study will be used to satisfy requirements under Task 7 of the Interagency Agreement Number DTFA03-92-Z-00025.

The Service requests that no part of this report be taken out of context, and if reproduced, the document should appear in its entirety. The use of trade names in this report is solely for identification purposes and does not constitute an endorsement by the federal government.

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I. INTRODUCTION

A. BACKGROUND

In recognition of the national significance of the resources of the Pinelands region of New Jersey, Congress, through Section 502 of the National Parks and Recreation Act of 1978, established the approximate one-million-acre Pinelands National Reserve (Pinelands), the nation's first National Reserve. Additionally, the Pinelands has been designated as a Biosphere Reserve under the "Man and Biosphere Program" of the United Nations Educational, Scientific, and Cultural Organization. The wetlands of the Pinelands support a unique assemblage of flora and fauna specifically adapted to the unusual chemical and hydrological properties of the Pinelands. The Pinelands provides habitat for many species of migratory birds, including waterfowl, as well as provides important breeding and nesting habitat for many less transient federal trust resources.

Technical data on the nature and extent of chemical contaminants in sediments and biota of the streams comprising the Pinelands are limited. The New Jersey Department of Environmental Protection has documented high levels of mercury in fish fillets statewide, with the highest concentrations occurring in predator fish within and adjacent to the Pinelands, where the surface water pH was less than 6.0 (Academy of Natural Sciences of Philadelphia (ANSP) 1994). The majority of the sites included in the above investigation were lakes, reservoirs, and large rivers. Mercury levels were high enough to prompt health warnings, advising the human population to avoid consuming fish in many locations (NJDEP and NJDOH 1995). The Service, in conducting an Ecological Risk Assessment (ERA) for contaminated sites at the Federal Aviation Administration (FAA) William J. Hughes Technical Center, concluded that highly elevated mercury levels in whole-body fish and sediments in the South Branch of Absecon Creek resulted in severe risk to piscivorous wildlife (USFWS 1996a). Additionally, high levels of mercury are sufficiently widespread throughout the northeast region to prompt the Service's Hudson River / New York Bight Ecosystem Team to adopt action strategies to delineate the extent of mercury contamination and to determine the risk to Service trust resources (USFWS 1996b).

In nature, mercury exists in three primary forms: elemental, inorganic, and methylated. The species of mercury in sediments and water depends upon a variety of sediment factors and water alkalinity, hardness, pH, ionic composition and available particulate matter (Winfrey and Rudd 1990). The production of methylmercury from inorganic mercury is the primary factor affecting uptake into biota (Wiener 1995). Although relatively little methylmercury is found in freshwater and sediments, the percentage of methylmercury increases progressively with biotic trophic level to where nearly 99 percent of mercury accumulated in fish is methylmercury (Wiener 1995). It is the methylmercury that biomagnifies in the food chain. Studies have shown that freshwater mercury methylation rates are driven by sulfate-reducing bacteria (Gilmour et al. 1992) and are dependent upon dissolved organic carbon content, and water column stratification within the system (i.e., epilimnion and hypolimnion) (Gilmour 1995). Other factors influencing methylation and mercury accumulation include impoundment surface-to-volume ratio, water temperature, and sediment retention time (Bodaly et al. 1993).

B. OBJECTIVES

Since the low pH and other chemical factors of the Pinelands water may enhance the methylation of mercury, it was viewed imperative to document background concentrations prior to deciding on a reasonable clean-up criterion for contaminated sites in southern New Jersey. The above information strongly suggested the need for further investigation to obtain definitive metal concentrations, especially mercury, in sediments and biota within relatively nonimpacted streams of the unique Pinelands region. Therefore, this investigation was designed with three objectives:

(1) determine baseline metal concentrations in sediments, surface water and biota from streams located within the Pinelands National Reserve;

(2) determine if mercury is present in forage species at levels of concern to piscivorous wildlife; and,

(3) based on the above, establish a clean-up criterion for mercury that is protective of federal trust resources, and that can be used for management of contaminated sites in southern New Jersey.

II. LITERATURE REVIEW

A. REVIEW OF MERCURY TOXICITY

The most toxic and bioavailable form of mercury is methylmercury, which is highly stable and accumulates in biological tissues (Huckabee et al. 1979, Giesy et al. 1994). Inorganic mercury can be converted to methylmercury through biological and chemical processes (Huckabee et al. 1979). Once mercury has become methylated, it is lipid soluble and has properties that allow it to easily penetrate membranes in living organisms (Beijer and Jernelov 1979). Almost 100 percent of the ingested dose of methylmercury in food is absorbed (Scheuhammer 1989). While the factors governing distribution of mercury in the body are poorly understood, transport of mercury appears to be dependent on mercury speciation, pH, and liposolubility (Boudou and Ribeyre 1983).

Methylmercury can enter the body by way of the gastrointestinal tract, respiratory tract, skin, and mucus membranes (Elhassani 1983, as cited in Eisler 1987). Once absorbed, methylmercury is able to cross the blood-brain interface and the placenta. In wildlife, mercury causes a variety of effects. It is mutagenic, teratogenic, and causes embryocidal, cytochemical, and histopathological effects (Eisler 1987).

1. Mammals

Among mammals, the mink has been intensely studied to determine the effects of mercury exposure. Mink susceptibility to mercury poisoning has been documented in feeding trials which provide a range of effect levels that are not easily interpreted. These data document high mercury toxicity and suggest that mercury toxicity may be influenced by a number of exposure variables (i.e., form of mercury, and presence of antagonistic compounds). Inorganic mercuric chloride fed to mink at a concentration of 10 ppm in the diet caused no adverse effects on survival and reproduction after five months (Aulerich et al. 1974). Studies of methylmercury provide discordant findings. Jernelov et al. (1976), for example, found no symptoms of methylmercury poisoning in mink that were fed contaminated pike (*Esox lucius*) containing 5.7 ppm mercury for a 100-day period. Conversely, dietary methylmercuric chloride concentrations as low as 1.8 ppm caused severe toxicity (anorexia, weight loss, ataxia, splaying of the hind legs, irregular vocalization, and convulsions) in studies by Wobeser et al. (1976). Aulerich et al. (1974) found that commercial mink diets containing 5 ppm methylmercury caused lethality in adult mink.

Few of the above studies have taken into account the influence of other compounds in the diet, which may have altered the expression of toxicity. The presence of known mercury antagonists (i.e., polythiol resins, selenium salts, Vitamin E), which have been shown to influence mercury toxicity to a large degree, have rarely been adequately considered (Magos and Webb 1979, Elhassani 1983; as cited in Eisler 1987). Selenium, for example, has been demonstrated to protect algae, aquatic invertebrates, birds, and mammals from the adverse effects of mercury (Magos and Webb 1979, Scheuhammer 1987, Chang et al. 1981, Satoh et al. 1985, and Cuvin-Aralar et al. 1991). Furthermore, Turner and Swick (1983) estimated that the presence of selenium could reduce mercury accumulation in pike by as much as 5 to 10 percent.

Noting the uncertainty associated with assigning a reference toxicity value for mercury, a team from the National Biological Survey, University of Massachusetts, Wellington Science Center, Michigan Department of Natural Resources, and USFWS calculated a dietary no adverse effects concentration for mink. Using data generated by Wren et al. (1986) and Wobeser et al. (1976), Giesy et al. (1994) suggested that the dietary no adverse effects concentration (based on lethality of adult mink fed fish tissue) ranges from 0.05 ppm to 1.0 ppm, and selected the more conservative 0.05 ppm for use in their assessment.

Lowest mercury Lowest Observed Adverse Effect Level dose rates (LOAELs) for neurological, renal, developmental, and immunological effects were identified ranging in dose from 0.046 mg/kg/day to 0.5 mg/kg/day. Methylmercury that was fed to cats (*Felis domesticus*) over two years caused impaired hopping reaction and degeneration of dorsal root ganglia at 0.046 mg/kg/day and 0.074 mg/kg/day, respectively. The associated No Observed Adverse Effect Levels (NOAEL) was 0.02 mg/kg/day (Charbonneau et al. 1976). Rats that were fed methylmercury at 0.08 mg/kg/day developed cytoplasmic masses in proximal tubule cells of the kidney (Fowler 1972, as cited in ATSDR 1992). Dogs dosed at 0.1 mg/kg/day to 0.25 mg/kg/day during pregnancy had a high incidence of stillbirths (Khera 1979, as cited in Eisler 1987). A dietary methylmercuric chloride dose rate of 0.25 mg/kg/day caused an increased incidence of eye defects in developing rat fetuses and the NOAEL was estimated to be 0.05 mg/kg/day (Khera and Tabacova 1973, as cited in ATSDR 1992). Reduced killer T-cell activity and decreased thymus weight have been associated with a dietary dose of 0.5 mg/kg/day in mice (Ilback 1991, as cited in ATSDR 1992). As stated previously, Giesey et al. (1994) selected a dietary concentration of 0.05 ppm dose rate of (0.012 mg/kg/day) as the no adverse effects concentration for mink. In summary, NOAEL dose rates based on the above discussion for mammals, include 0.012 - 0.24 mg/kg/day (mink), 0.02 mg/kg/day (cat), and 0.05 mg/kg/day (rat).

2. Birds

Many bird species have been evaluated to determine the lethal and sublethal effects of mercury. Eisler (1987) summarized LD_{50} concentration ranges in the body (mg/kg body weight) for methylmercury of 2.2 to 23.5, 11.0 to 27.0, and 12.6 to 37.5 for mallards, Japanese quail, and house sparrows, respectively. Dietary concentrations of methylmercury causing 50 percent mortality in Japanese quail were 31.0 ppm to 47.0 ppm (Hill 1981).

Sublethal effects on birds include impaired growth, development, metabolism, and reproduction. Black ducks that were fed diets containing 3.0 ppm methylmercury for 28 weeks had elevated liver and kidney weights and experienced reproductive inhibition (Finley and Stendell 1978). In multi-generational mallard studies, Heinz (1979) documented reduced reproductive success, abnormal egg laying behavior, and hyper-responsiveness to fright stimulus following dietary mercury exposure of 5 ppm. The no adverse effects concentration was 0.5 ppm (0.03 mg/kg/day). In juvenile European starlings, dietary concentrations of 1.1 ppm (0.21 mg/kg/day) mercury for eight weeks have been associated with kidney lesions (Nicholson and Osborn 1984). Predatory birds, such as the red-tailed hawk, are also susceptible to mercury toxicity. Red-tailed hawks have been found to experience mortality following 1.12 mg/kg/day exposure over a four week period (Fimreite and Karstad 1971).

B. EXISTING CRITERIA FOR METALS

A wide variety of environmental criteria for mercury and the other metals have been published by various government agencies; however, the following are considered to be the most scientifically reliable and applicable to the general Pinelands region.

1. Surface Water

Ambient Water Quality Criteria (AWQC) published by the USEPA (1986) are designed to be protective of aquatic life. The freshwater chronic mercury AWQC value is 0.012 ug/L. Existing AWQCs for the other metals are shown in Table 1.

Table 1. Selected Criteria for Metals in Surface Water, Sediments and Biota.

Metal	Freshwater Chronic AWQC[1] ug/L	Sediment LEL[2] ppm dry weight	Sediment SEL[2] ppm dry weight	Aquatic Invertebrates[3] ppm wet weight	Freshwater Fish[4] mean ppm wet weight	Freshwater Fish[4] 85th percent ppm wet weight
Aluminum	-	-	-	-	-	-
Antimony	1600	-	-	-	-	-
Arsenic	190	6	33	0.8	0.14	0.27
Barium	-	-	-	-	-	-
Beryllium	5.3	-	-	-	-	-
Boron	-	-	-	-	-	-
Cadmium	1.1	0.6	10	1	0.03	0.05
Chromium	210	26	110	4	-	-
Cobalt	-	-	-	-	-	-
Copper	12	16	110	6	0.65	1.0
Iron	1000	2%	4%	-	-	-
Lead	3.2	31	250	2	0.11	0.22
Magnesium	-	-	-	-	-	-
Manganese	-	460	1100	-	-	-
Mercury	0.012	0.2	2	0.2	0.10	0.17
Molybdenum	-	-	-	-	-	-
Nickel	160	16	75	2	-	-
Selenium	35	-	-	0.8	0.42	0.73
Silver	0.12	-	-	-	-	-
Thallium	40	-	-	-	-	-
Tin	-	-	-	-	-	-
Titanium	-	-	-	10	-	-
Zinc	110	120	820	40	21.7	34.2

[1]Ambient Water Quality Criteria (USEPA 1986).

[2]LEL=low effect level; SEL= severe effect level (Persaud et al. 1993).

[3]NYDEC 1996; assumed 80% moisture.

[4]Schmitt and Brumbaugh 1990.

2. Sediments

Many published sediment criteria are available; however, two credible sources were considered to determine the range of potential effects from metals in Pinelands sediment. The Provincial Sediment Quality Guidelines (PSQG) (Persaud et al. 1993) provide a range for predicting adverse ecological effects from sediment concentrations of contaminants. The PSQGs are a set of numerical guidelines developed by the Ontario Ministry of the Environment for the protection of sediment dwelling (benthic) species (Persaud et al. 1993). Since benthic organisms respond to a variety of stress-inducing factors, they integrate physical, chemical, and biological phenomena and serve as indicators of aquatic community health. The PSQG guidelines define three levels of chronic ecotoxic effects of contaminants on benthic organisms. These levels are: (1) no effect level (NEL); (2) lowest effect level (LEL); and, (3) severe effect level (SEL). The NEL is the level at which no toxic effects have been observed in aquatic organisms. No biomagnification through the food chain is expected at the no effect level. The LEL indicates a level of sediment contamination that can be tolerated by the majority of benthic organisms. The SEL indicates the level at which a pronounced disturbance of the sediment dwelling community is expected. For discussion purposes, mercury sediment concentrations of 0, 0.2, and 2.0 mg/kg dry weight correspond to the NEL, LEL and SEL, respectively (Persaud et al. 1993). LELs and SELs for other metals are listed in Table 1.

Long and Morgan (1990) assembled effects-based data for coastal and estuarine sediments using a weight-of-evidence approach. Calculations of effects-based sediment criteria are presented using: (1) equilibrium partitioning (which is based on ambient water quality criteria and the water / sediment partitioning coefficient); (2) the spiked-sediment bioassay approach (which involves exposing organisms to pristine sediments spiked in the laboratory with known amounts of chemicals and observing mortality and / or sublethal effects); and, (3) several methods that evaluate concurrently collected sediment and biological data. Concentrations of contaminants are calculated which represent the lower tenth percentile (Effects Range-Low, ER-L) and median (Effects Range-Median, ER-M) concentrations producing an adverse effect in aquatic organisms. The ER-L concentrations are the concentrations above which adverse effects may begin or are predicted among sensitive life stages and / or species as determined in sublethal tests. The ER-M values for contaminants are the concentrations above which effects were frequently observed or predicted among most species. The mercury ER-L and ER-M concentrations are 0.15 and 1.3 mg/kg dry weight, respectively.

3. Aquatic Insect Larvae

Criteria for aquatic invertebrates are not generally available or universally accepted. Contaminant levels of concern are, however, published by the New York State Department of Environmental Conservation (NYDEC) based on continuous sampling of four selected macroinvertebrates (caddisflies, hellgrammites, crayfish, and mollusks) at 373 monitoring sites over the period 1972 to 1996. The NYDEC levels of concern are those concentrations which exceed the State mean plus 2.57 standard deviations from the mean (NYDEC, 1996). The NYDEC level of concern for mercury in caddisfly larvae and hellgrammites is 1.0 mg/kg dry weight (approximately 0.2 mg/kg wet weight). Levels of concern for dragonfly larvae were not available. Invertebrate levels of concern for other metals can be found in Table 1.

4. Fish

As with aquatic invertebrates, no published references have been universally accepted for the interpretation of tissue contaminant levels in fish. Mean and 85th percentile contaminant concentrations published for 1984 by the National Contaminant Biomonitoring Program (NCBP) provided a mechanism to evaluate whole-body fish residues. The NCBP database documents concentrations in whole fish composites (three to five adult specimens) collected at 109 stations throughout the U.S. (Schmitt and Brumbaugh 1990). Contaminant concentrations reported in the NCBP are representative of national background concentrations of contaminants in fish. The mean and 85th percentile mercury background concentrations for the U.S. were reported as 0.10 and 0.17 mg/kg wet weight, respectively. NCBP values for other metals are listed in Table 1.

The USEPA also published a national study of chemical residues in fish tissue collected between 1986 and 1989 (USEPA 1992). The primary objective of the USEPA study was different than the NCBP, as the USEPA selected sites that were expected to show some level of contamination. Sampling of 374 total sites revealed the maximum, mean and median mercury concentration in fish as 1.8, 0.26, and 0.17 ppm wet weight, respectively (USEPA 1992).

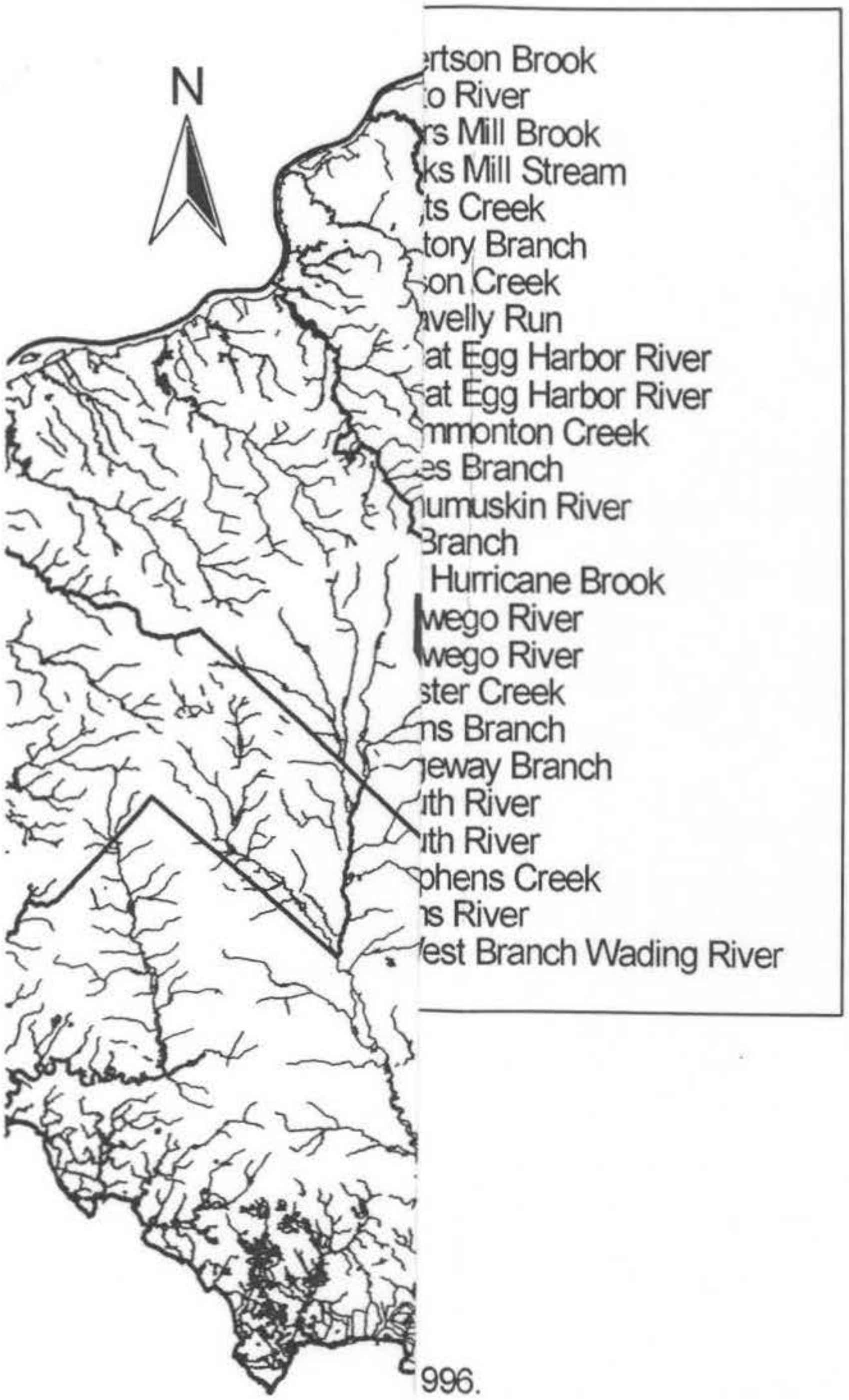
III. METHODS

A. SAMPLING PROTOCOL

All samples were collected in the Pinelands National Reserve from late July to early September, 1996. General water chemistry data, surface water, sediments, and biota were collected from 25 stream stations widely distributed throughout the Pinelands (Figure 1). Sample stations were selected with the following criteria, in descending order of importance: (1) water quality was nonimpacted, based upon NJDEP (1996) or an on-site qualitative macroinvertebrate assessment; (2) targeted biota were present; and, (3) stream was wadable with reasonable public access. Benthic invertebrates and fish from two trophic levels (forage and predator) were targeted at each station (i.e., four biota samples per station). Most biota samples were analyzed as composite samples, with only a few bass and pickerel analyzed individually. The following specific samples and associated analyses were targeted for each station.

1. Water Chemistry

Temperature, pH, dissolved oxygen, conductivity, and total dissolved solids were recorded at each of the 25 stations.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2. Surface Water

One surface water grab sample was collected at each of the 25 stations by submerging a container in a slow-moving section of water. Water samples were collected upstream of bridges or road crossings, and prior to other activities that could disturb sediment. The sample was collected in a pre-acidified, plastic, 1-liter container, temporarily held in a field cooler at 4° C, and stored in a refrigerator until shipment to the analytical laboratory.

3. Sediment

One composite sediment sample was collected at each of the 25 stations. A minimum of three individual sediment grabs were collected along the length of the stream course needed to collect biota (generally 50 to 150 meters). Sediments to 15 centimeters in depth were collected using a stainless steel spoon and homogenized in a stainless steel mixing bowl. Sampling was conducted in depositional areas to increase the likelihood of detecting any contaminants that were present in the system.

4. Benthic Invertebrates

Two composite benthic invertebrate larvae samples were targeted at each of the 25 sampling stations described above. The dragonfly larvae (Cordulegastridae), representing a predator, and caddisfly larvae (Hydropsychidae), representing a filter-feeder, were the primary target organisms for this investigation because of their anticipated abundance. Where the target organisms were not available, another forage or predatory invertebrate family was sampled. Benthic invertebrate larvae were collected within 100 meters of sediment sampling sites, using seines or kick nets. Following capture, larvae were placed in precleaned plastic holding containers (VWR Scientific) and later sorted with stainless steel forceps in a plastic tray filled with site water. Benthic invertebrate larvae were then transferred to pre-cleaned, 125 ml glass jars to form family-specific composite samples.

5. Fish

Two composite samples of at least five fish per composite were targeted at each of the 25 stations. The mudminnow (*Umbra pygmaea*), representing a forage fish, and the chain pickerel (*Esox niger*), representing a predatory fish, were the target organisms for this analysis because of their anticipated abundance. Where the target organisms were not available, another forage or predatory fish species was sampled. Additionally, site-specific decisions were made when the five fish minimum was not obtained; less than five fish were submitted on occasion. Fish were collected within 100 meters of sediment sampling sites, using electrofishing gear, seines, or kick nets. Following capture, fish were placed in styrofoam coolers or plastic minnow buckets containing site water. Weights and lengths of individual predatory fish within a composite sample were recorded; this was not done with forage fish due to their small size. Fish samples were composited by species in the field to meet minimum weight requirements for chemical analyses. On a few occasions, large fish were transported to the field laboratory for dissection prior to placing in the sample jars.

B. SAMPLING CONTAINERS AND STORAGE

Sampling containers, unless otherwise specified, were glass, Superfund-analyzed, I-Chem containers with teflon-lined closures. In general, stainless steel sampling equipment was used to collect sediment and plastic bags and containers were used to temporarily hold biota until transfer to the permanent holding jars. Unless otherwise specified, all composited samples were temporarily held in a field cooler at 4° C during the sampling day, then frozen at -20° C in a freezer until shipment to the analytical laboratory.

C. DECONTAMINATION PROCEDURES

All stainless steel sampling equipment used during this investigation was subjected to the following decontamination procedure:

1. wash with ambient or tap water;
2. wash and scrub with low phosphate detergent;
3. distilled water rinse;
4. ten percent nitric acid rinse;
5. double rinse with distilled water;
6. air dry; and,
7. for vehicular transport, wrap with aluminum foil (shiny side out).

D. CHAIN OF CUSTODY AND SAMPLE DOCUMENTATION

Samples collected and processed during this investigation followed the Service's standard documentation and chain-of-custody procedures. All samples were shipped with the Department of the Interior, USFWS, Division of Law Enforcement Chain of Custody Form. All sample vessels were secured with a custody seal indicating the date of collection and signed by the collector. In addition to the chain-of-custody forms, each sample collected was recorded on a Service specimen collection form and maintained in the project logbook. All essential routine information (e.g., site name, sample station number, name of collector, date, time, sample matrix, sample depth, method of collection, grab or composite, species, and general weather conditions), as well as any problems or concerns, were recorded.

E. SAMPLE SHIPMENT

All samples were shipped to the analytical laboratory according to protocol outlined in USFWS (1990). Basically, tissue and sediment samples were shipped on dry ice via overnight mail to facilitate residue analyses within the USEPA mandated 28-day holding time for biological tissues (USEPA 1993). Chilled water samples were shipped to the contract laboratory via overnight mail on blue ice packs.

F. SAMPLE ANALYSIS

Priority Pollutant metals analyses were performed at Hazleton Environmental Services (HES), Madison, Wisconsin using the USEPA Contract Laboratory Program (CLP) protocols. Sediment samples were also characterized for percent moisture, total organic carbon (TOC) and grain size. Sample analyses included procedural blanks, duplicates, and spiked samples as described in USFWS (1990). Preparation and analysis of tissue samples was conducted via methods described in USFWS (1996a) and included percent lipid and percent moisture determinations.

G. DATA VALIDATION AND STATISTICS

The CLP data qualifiers used by HES are found in Appendix A. All data were subjected to internal QA/QC validation procedures by HES. In addition, the Patuxent Analytical Control Facility (PACF) QA officer reviewed the contract laboratory data for accuracy (as measured by spike recovery analysis) and precision (as measured by duplicate sample analysis). The quality assurance reports will be kept on file in the NJFO and are available upon request.

The use of qualified data for quantitative risk assessment is subject to much controversy. Appropriate use of qualified data is largely based on USEPA guidance and best professional judgement. The USEPA document entitled, "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual," (USEPA 1989) was consulted to determine appropriate use of qualified data.

1. CLP data qualifiers

The only CLP qualified data considered unsuitable for use are those data qualified as "A." No results were qualified "A" by HES for any Pinelands sample. Those CLP results qualified as "U" and "J" are considered questionable (USEPA 1989). Data qualified as "U" were presented as non-detects (nd) in this report. Data qualified as "J" were used in this study.

2. Validation data qualifiers

Only data qualified with an "R" are considered unsuitable for use (USEPA 1989). No results in this study were qualified "R" via the independent data validation process. Furthermore, USEPA (1989) indicates that validation data qualified with a "U" or "N" are considered questionable. Data qualified as "U" were presented as non-detects (nd) in this report. Data qualified as "N" were used in this study.

T-tests were utilized with an alpha level of 0.01 to determine statistical significance. Non-detects were assumed to be present at one-half the detection limit for statistical calculations.

H. ECOLOGICAL RISK ASSESSMENT

Several methods were employed to determine if mercury concentrations found in sediments, surface water and biota may be causing adverse effects to aquatic and terrestrial life dependent upon Pinelands streams. An initial comparison to selected ecological criteria (Table 1) was conducted to qualitatively determine the potential for adverse ecological impacts from existing mercury concentrations in the Pinelands. If criteria for ecological effects were exceeded, risk-based evaluation was performed to determine the potential for higher trophic level impacts. Finally, all Pinelands data were used to develop "background" concentrations of mercury throughout this unique region and statistical comparisons to the mercury-impacted FAA Superfund site (South Branch of Absecon Creek) were undertaken to determine the magnitude of the impact at that site. Specific methods used to determine potential for adverse ecological effects from mercury concentrations were as follows.

1. Comparison to Mercury Criteria

The criteria selected for use in this study were discussed above (Section II.B.) and are presented in Table 1. All insect larvae collected in the Pinelands were compared to the NYDEC (1996) mercury criterion of 1.0 mg/kg dry weight. For ease of comparison, this dry weight value was converted to 0.2 mg/kg wet weight, assuming 80 percent moisture for collected benthic invertebrates.

2. Ecological Risk Assessment (ERA) Modeling

Calculations were performed using ERA modeling to estimate the potential for adverse effects to piscivorous wildlife from mercury concentrations found in the Pinelands streams. The ERA model used to estimate ecological risk for this Pinelands investigation was developed by the Service and previously used in estimating risk to indicator species at the FAA Superfund site (USFWS 1996a). Hazard quotients (HQs) were calculated for selected indicator species using data collected from each station. An HQ is a ratio of the exposure dose for a given contaminant / site / indicator species divided by the toxicity reference dose for that contaminant and species. In general, HQs below 1.0 indicate little or no risk to receptor species. Above 1.0, the greater the HQ, the greater the predicted risk. The ERA methodology, including components of the basic model, is described briefly below. A more detailed description of the model, including lists of assumptions and discussion of uncertainty, may be found in USFWS (1996a).

a. <u>Indicator species selection</u>

Indicator species characteristic of the Pinelands region and representing the highest trophic level of the aquatic foodweb were selected for use in this model. Indicator species selected were the mink (*Mustela vison*), Black duck (*Anas rubripes*), green heron (*Butorides striatus*), and belted kingfisher (*Ceryle alcyon*). The exposure model described below contains variables such as food intake, incidental sediment and water ingestion rate, body weight, and exposure duration for each indicator species. Appendix B shows the values for these variables that were selected for each indicator species.

b. Exposure model

The potential exposure dose (dose) was determined by evaluating two pathways: (1) dietary ingestion of prey; and, (2) incidental ingestion from other sources. In this exposure model, incidental ingestion included ingestion of sediment and surface water. The dietary ingestion calculation included an area use factor (AF), which represents the fractional exposure to the contaminated area based on indicator species home range, preferred feeding areas, and habitat suitability. Dietary and incidental ingestion pathways were considered the primary contributors to exposure. Inhalation and dermal exposures were not quantified in this assessment. Dietary ingestion (DI) is the daily dose (mg/kg/day) of a contaminant (i) that is ingested in the diet by each modeled indicator species. To compute DI, it was first necessary to determine the dietary contaminant concentration (Cp) for each of indicator species. A weighted Cp was estimated to account for relative contributions from multiple components of the indicator species' diet. The relative contribution for each prey species was computed by multiplying the measured whole-body concentration times the fraction of the indicator species' diet that the prey species forms (PD). The relative proportion of each prey species in the diet of each indicator species was based on professional judgement, life history, and site-specific forage availability. The Cp is represented by the following equation:

$$Cp = [RC_1 \text{ X } PD_1] + [RC_2 \text{ X } PD_2] + \ldots + [RC_n \text{ X } PD_n]$$

where:

Cp = Weighted dietary contaminant concentration (mg/kg).

RC_1 = Measured contaminant concentration in prey species 1 (mg/kg).

RC_2 = Measured contaminant concentration in prey species 2 (mg/kg).

PD_1 = Fraction of diet represented by prey species 1 (unitless).

PD_2 = Fraction of diet represented by prey species 2 (unitless).

n = number of prey species in the diet (limited to those that were captured and analyzed).

Prey contaminant concentrations were, therefore, based on the biota analyzed at each sampling site and the diet of each indicator species. The prey contaminant concentration for a piscivorous indicator species sometimes was based on the contaminant concentrations from prey of more than one trophic level (e.g., the Cp for mink is computed from contaminant concentrations in all fish species collected at a site, which generally included both forage and predator species).

The dietary ingestion dose of compound i (DI_i) was calculated by multiplication of: (1) the site- and indicator-specific Cp for compound i; (2) the species-specific ingestion rate (IRp); and, (3) an area use factor (AF), which reflects the fraction of the indicator species' time spent foraging in the area of concern. That product was then divided by the indicator species' body weight (BW) to obtain DI_i in mg/kg/day, as shown by the following equation:

$$DI_i = [Cp_i \times IRp \times AF]/BW$$

where:

DI_i	=	Dietary ingestion of compound i (mg/kg/day).
Cp_i	=	Weighted dietary concentration of compound i (mg/kg).
IRp	=	Daily food ingestion rate (kg/day).
AF	=	Indicator specific area use factor (unitless).
BW	=	Body weight (kg).

Incidental ingestion of compound i (II_i) (i.e., associated with foraging, preening, drinking, and cleaning activities) was calculated by multiplying the sediment and surface water concentrations of compound i by the estimated sediment and surface water ingestion rates for each indicator species. These products were summed and then divided by body weight to arrive at II_i in mg/kg/day, as follows:

$$II_i = \{([IRsd \times Csd_i] + [IRsw \times Csw_i]) \times AF\}/ BW$$

where:

II_i	=	Incidental ingestion of compound i (mg/kg/day).
IRsd	=	Ingestion rate of sediment (kg dry sediment/day)
Csd_i	=	Dry weight sediment concentration of compound i (mg/kg).

IRsw	=	Ingestion rate of surface water (L/day)
Csw_i	=	Surface water concentration of compound i (mg/L).
AF	=	Indicator specific area use factor (unitless).
BW	=	Body weight (kg).

The DI and II values were summed to calculate total ingestion dose as follows:

$$Dose_i = [DI_i + II_i]$$

where:

$Dose_i$	=	Total potential ingestion dose of compound i (mg/kg/day).
DI_i	=	Dietary ingestion dose of compound i (mg/kg/day).
II_i	=	Incidental sediment and surface water ingestion dose of compound i (mg/kg/day).

c. <u>Reference toxicity values</u>

The dose of 0.012 mg/kg/day was selected as the reference toxicity value for the mink. The NOAEL value estimated by Heinz (1979) (0.03 mg/kg/day) was selected as the avian toxicity reference dose.

3. Pinelands Mercury Levels Compared with the FAA Superfund Site

Samples collected in the area between Station 4 (near Tilton Road) and Station 9 (near the Upper Atlantic City Reservoir) in the study by USFWS (1996a) were used to represent "the FAA" for making statistical comparisons to the Pinelands data. Such comparisons will help identify the magnitude of the mercury problem in the South Branch of Absecon Creek, and aid in determining a reasonable clean-up level.

IV. RESULTS

All raw data, including data qualifiers, can be found in Appendix C. Summary statistics for all inorganic analytes in surface water, sediment, caddisfly larvae, dragonfly larvae, hellgrammites, forage fish, and predatory fish can be found in Tables 5 through 11.

Table 2. Samples Collected in the Pinelands National Reserve and Submitted for Metals Analysis, Summer 1996.

Sample Site (Stream and Location)	Site Abbreviation	Water	Sediment	INVERTEBRATES				
				Caddisfly larvae		Hellgrammites	Dragonfly larvae	
				Hydropsychidae	Limnephilidae	Corydalidae	Cordulegastridae	Other
Albertson Brook @ Rt. 206	ALBBR	√	√				√ (20)	
Batsto River @ Carranza Rd.	BATRI	√	√		√ (200)	√ (64)		
Burrs Mill Brook @ Burrs Mill Rd.	BURBR	√	√	√ (200)[1]		√ (75)		
Clarks Mill Stream @ Rt. 575	CLAST	√	√	√ (150)				√ (25)[2]
Elliots Creek @ Bremans Ave.	ELLCR	√	√			√ (45)	√ (60)	
Factory Branch @ Whiting/Lacey Rd.	FACBR	√	√	√ (500)		√ (88)		
Gibson Creek @ Rt. 50	GIBCR	√	√	√ (600)		√ (200)	√ (40)	
Gravelly Run @ Rt. 559	GRARN	√	√		√ (110)		√ (25)	
Great Egg Harbor River @ New Freedom Rd.	GRER1	√	√		√ (70)	√ (70)		
Great Egg Harbor River @ Williamst/Winslow Rd.	GRER2	√	√	√ (500)			√ (23)	
Hammonton Creek @ Columbia Rd.	HAMCR	√	√	√ (250)		√ (58)		
Lakes Branch @ Cain Mill (Blue Anchor) Rd.	LAKBR	√	√	√ (400)				
Manumuskin River @ Bennetts Mill	MANRI	√	√	√ (350)		√ (145)		
Mill Branch @ Poormans Parkway	MILBR	√	√	√ (275)			√ (30)	
Old Hurricane Brook @ Beckerville Rd.	OLDBR	√	√	√ (450)	√ (115)	√ (195)		
Oswego River @ Martha Furnace Rd.	OSWR1	√	√					√ (35)[3]
Oswego River @ Rt. 679	OSWR2	√	√			√ (65)		
Oyster Creek @ Rt. 532	OYSCR	√	√	√ (250)		√ (92)		
Plains Branch @ Jenkins Rd.	PLABR	√	√					√ (70)[4]
Ridgeway Branch @ Lakehurst-Ridgeway Rd.	RIDBR	√	√		√ (103)		√ (25)	
South River @ Estelle Ave.	SOUR1	√	√	√ (450)			√ (75)	
South River @ Rt. 552	SOUR2	√	√		√ (66)		√ (25)	
Stephens Creek @ Eleventh Ave.	STECR	√	√	√ (250)			√ (60)	
Toms River @ Coventry Rd.	TOMRI	√	√		√ (150)	√ (54)		
W. Br. Wading River @ Godfrey Bridge	WBWAD	√	√			√ (21)		
	Total Samples	25	25	13	7	13	10	3
[1]Number in parentheses represents total number of individuals in composite sample.								
[2]Aeshnidae, [3]Gomphidae, [4]mixture								

samples1.xls

Table 2, cont. Samples Collected in the Pinelands National Reserve and Submitted for Metals Analysis, Summer 1996.

Sample Site (Stream and Location)	Site Abbreviation	FORAGE FISH						PREDATOR FISH		
		Mudminnows	Banded Sunfish	Blackbanded Sunfish	Pirate Perch	Mud Sunfish	Forage Fish Mixture	Chain Pickerel	Redfin Pickerel	1 Bass
Albertson Brook @ Rt. 206	ALBBR	√ (12)						√ (4)		√ (1)
Batsto River @ Carranza Rd.	BATRI		√ (5)							
Burrs Mill Brook @ Burrs Mill Rd.	BURBR			√ (10)				√ (2)		
Clarks Mill Stream @ Rt. 575	CLAST						√ (29)	√ (2)		
Elliots Creek @ Bremans Ave.	ELLCR	√ (21)								
Factory Branch @ Whiting/Lacey Rd.	FACBR	√ (7)	√ (10)					√ (1)	√ (3)	
Gibson Creek @ Rt. 50	GIBCR					√ (10)			√ (1)	
Gravelly Run @ Rt. 559	GRARN	√ (20)						√ (5)		
Great Egg Harbor River @ New Freedom Rd.	GRER1	√ (12)						√ (2)		
Great Egg Harbor River @ Williamst/Winslow Rd.	GRER2	√ (18)						√ (4)		
Hammonton Creek @ Columbia Rd.	HAMCR				√ (5)			√ (2)		
Lakes Branch @ Cain Mill (Blue Anchor) Rd.	LAKBR	√ (21)		√ (7)						√ (2)
Manumuskin River @ Bennetts Mill	MANRI	√ (25)				√ (4)		√ (5)		
Mill Branch @ Poormans Parkway	MILBR	√ (21)						√ (1)		
Old Hurricane Brook @ Beckerville Rd.	OLDBR								√ (4)	
Oswego River @ Martha Furnace Rd.	OSWR1		√ (14)			√ (4)		√ (1)		
Oswego River @ Rt. 679	OSWR2	√ (27)	√ (16)					√ (3)		
Oyster Creek @ Rt. 532	OYSCR		√ (8)							
Plains Branch @ Jenkins Rd.	PLABR		√ (8)					√ (1)		
Ridgeway Branch @ Lakehurst-Ridgeway Rd.	RIDBR	√ (29)						√ (3)		
South River @ Estelle Ave.	SOUR1				√ (13)			√ (4)		
South River @ Rt. 552	SOUR2	√ (13)						√ (4)		
Stephens Creek @ Eleventh Ave.	STECR	√ (10)						√ (1)		
Toms River @ Coventry Rd.	TOMRI	√ (17)						√ (1)		
W. Br. Wading River @ Godfrey Bridge	WBWAD	√ (36)	√ (14)						√ (3)	
	Total Sample	15	7	2	2	3	1	18	4	2
[1]Number in parentheses represents total number of individuals in composite sample.										
[2]Aeshnidae, [3]Gomphidae, [4]mixture										

samples2.xls

Table 3. Size Parameters of Predatory Fish Collected in the Pinelands National Reserve, Summer 1996.

Sample Site	Predatory Fish Species	Number in Sample	Individual Lengths (mm)	Individual Weights (g)
ALBBR	*Esox niger*	4	336, 292, 279, 241	219, 157, 128, 75
ALBBR	*Micropterus salmoides*	1	260	246
BATRI	None	None	None	None
BURBR	*Esox niger*	2	405, 398	436, 385
CLAST	*Esox niger*	2	280, 260	98, 94
ELLCR	None	None	None	None
FACBR	*Esox niger*	1	285	137
FACBR	*Esox americanus*	3	204, 190, 178	48, 43, 41
GIBCR	*Esox americanus*	1	254	90
GRARN	*Esox niger*	5	317, 298, 279, 267, 235	200, 171, 104, 104, 80
GRER1	*Esox niger*	2	368, 267	321, 98
GRER2	*Esox niger*	4	387, 381, 318, 298	357, 322, 188, 147
HAMCR	*Esox niger*	2	229, 215	64, 47
LAKBR	*Micropterus salmoides*	2	445, 368	925, 655
MANRI	*Esox niger*	5	127, 120, 114, 111, 76	12, 9, 6, 7, 4
MILBR	*Esox niger*	1	279	138
OLDBR	*Esox americanus*	4	223, 197, 190, 178	66, 47, 46, 33
OSWR1	*Esox niger*	1	140	15
OSWR2	*Esox niger*	3	279, 222, 190	115, 54, 39
OYSCR	None	None	None	None
PLABR	*Esox niger*	1	330	228
RIDBR	*Esox niger*	3	184, 181, 152	33, 34, 22
SOUR1	*Esox niger*	4	215, 178, 165, 163	53, 27, 20, 20
SOUR2	*Esox niger*	4	292, 209, 190, 172,	148, 48, 32, 30
STECR	*Esox niger*	1	318	170
TOMRI	*Esox niger*	1	348	233
WBWAD	*Esox americanus*	3	133, 127, 108	15, 9, 8

Table 4. General Water Chemistry of Streams in the Pinelands National Reserve, Summer 1996

Stream and Location	Temperature (°C)	Dissolved O_2 (mg/L)	pH	Conductivity (us/cm)	Total dissolved solids (mg/L)
Albertson Brook @ Rt. 206	19.8	7.45	6.40	98.6	49.4
Batsto River @ Carranza Rd.	18.6	5.70	4.62	47.0	23.5
Burrs Mill Brook @ Burrs Mill Rd.	20.7	5.81	4.15	53.2	26.7
Clarks Mill Stream @ Rt. 575	19.6	8.40	4.40	71.2	35.6
Elliots Creek @ Bremans Ave.	16.7	8.00	4.25	74.4	37.2
Factory Branch @ Whiting/Lacey Rd.	20.6	4.95	4.40	44.1	22.1
Gibson Creek @ Rt. 50	15.8	8.25	4.33	30.9	15.5
Gravelly Run @ Rt. 559	14.5	8.45	4.00	38.6	19.3
Great Egg Harbor River @ New Freedom Rd.	18.5	5.10	4.55	57.2	28.6
Great Egg Harbor River @ Williamst/Winslow Rd.	18.0	7.35	5.95	64.8	32.4
Hammonton Creek @ Columbia Rd.	20.1	7.15	6.00	87.1	46.3
Lakes Branch @ Cain Mill (Blue Anchor) Rd.	23.5	3.65	5.50	46.4	23.2
Manumuskin River @ Bennetts Mill	18.5	4.72	4.15	39.4	19.8
Mill Branch @ Poormans Parkway	17.6	8.38	4.65	38.5	19.2
Old Hurricane Brook @ Beckerville Rd.	17.5	7.35	4.05	47.8	23.9
Oswego River @ Martha Furnace Rd.	22.0	7.32	4.08	40.9	20.4
Oswego River @ Rt. 679	26.5	7.45	4.18	37.4	18.7
Oyster Creek @ Rt. 532	22.0	6.10	4.12	49.7	24.9
Plains Branch @ Jenkins Rd.	21.2	5.40	4.15	40.2	20.2
Ridgeway Branch @ Lakehurst-Ridgeway Rd.	20.0	6.45	4.35	52.4	21.3
South River @ Estelle Ave.	15.8	7.40	4.40	81.8	40.6
South River @ Rt. 552	17.4	7.95	4.65	53.3	26.6
Stephens Creek @ Eleventh Ave.	17.3	7.30	4.25	28.9	14.5
Toms River @ Coventry Rd.	20.0	7.90	5.25	97.6	48.9
W. Br. Wading River @ Godfrey Bridge	21.7	7.95	4.22	27.3	13.6
AVERAGE	19.4	6.88	4.60	53.9	26.9
MINIMUM	14.5	3.65	4.00	27.3	13.6
MAXIMUM	26.5	8.45	6.40	98.6	49.4
STD DEV	2.7	1.34	0.67	20.5	10.5

Table 5. Metal Concentrations (ug/L) in Surface Waters of the Pinelands National Reserve, Summer 1996.

Metal	No. detected / no. analyzed	Detection limit	Mean[a,b]	Minimum	Maximum	Standard deviation
Aluminum	25 / 25	--	238	92.5	500	112
Antimony	0 / 25	19.2	--	nd	nd	--
Arsenic	7 / 25	1.00	--	nd	1.58	--
Barium	25 / 25	--	30.5	11.5	101	19.4
Beryllium	25 / 25	--	0.149	0.094	0.272	0.050
Boron	25 / 25	--	36.2	19.5	60.9	10.6
Cadmium	0 / 25	1.55	--	nd	nd	--
Chromium	0 / 25	2.15	--	nd	nd	--
Cobalt	2 / 25	1.55	--	nd	2.98	--
Copper	22 / 25	2.00	3.10	nd	5.19	1.117
Iron	25 / 25	--	1067	159	3300	905
Lead	23 / 25	1.00	1.84	nd	4.72	0.799
Magnesium	25 / 25	--	906	301	2250	546
Manganese	25 / 25	--	13.8	4.94	33.1	7.48
Mercury	23 / 25	0.02	0.060	nd	0.112	0.033
Molybdenum	0 / 25	2.50	--	nd	nd	--
Nickel	3 / 25	5.25	--	nd	9.76	--
Selenium	0 / 25	2.00	--	nd	nd	--
Silver	0 / 25	3.05	--	nd	nd	--
Thallium	0 / 25	2.00	--	nd	nd	--
Tin	0 / 25	50.0	--	nd	nd	--
Titanium	23 / 25	0.750	1.39	nd	3.47	0.667
Zinc	25 / 25	--	25.7	10.3	92.3	17.3

[a]Mean calculated only for contaminants detected in at least one-half of samples.

[b]Non-detects assumed to be present at one-half detection limit.

Table 6. Sediment Composition, Pinelands National Reserve, Summer 1996

Stream and Location	Percent Sand	Percent Silt	Percent Clay	Percent Total Organic Carbon
Albertson Brook @ Rt. 206	61	37	2	24.2
Batsto River @ Carranza Rd.	74	22	4	33.7
Burrs Mill Brook @ Burrs Mill Rd.	72	24	4	8.6
Clarks Mill Stream @ Rt. 575	79	13	8	13.6
Elliots Creek @ Bremans Ave.	75	16	9	15.6
Factory Branch @ Whiting/Lacey Rd.	92	4	4	4.8
Gibson Creek @ Rt. 50	60	18	22	28.5
Gravelly Run @ Rt. 559	86	8	6	13.9
Great Egg Harbor River @ New Freedom Rd.	65	22	13	58.8
Great Egg Harbor River @ Williamst/Winslow Rd.	92	2	6	9.6
Hammonton Creek @ Columbia Rd.	86	8	6	8.0
Lakes Branch @ Cain Mill (Blue Anchor) Rd.	84	12	4	3.0
Manumuskin River @ Bennetts Mill	88	8	5	20.6
Mill Branch @ Poormans Parkway	52	37	11	17.7
Old Hurricane Brook @ Beckerville Rd.	92	4	5	53.3
Oswego River @ Martha Furnace Rd.	88	8	5	11.4
Oswego River @ Rt. 679	92	4	4	3.0
Oyster Creek @ Rt. 532	92	4	4	14.5
Plains Branch @ Jenkins Rd.	55	10	35	38.6
Ridgeway Branch @ Lakehurst-Ridgeway Rd.	92	4	5	17.5
South River @ Estelle Ave.	77	17	7	24.2
South River @ Rt. 552	79	16	6	37.3
Stephens Creek @ Eleventh Ave.	87	9	5	16.3
Toms River @ Coventry Rd.	92	4	5	10.0
W. Br. Wading River @ Godfrey Bridge	92	4	4	6.5
AVERAGE	80.2	12.6	7.6	19.7
MINIMUM	52	2	2	3.0
MAXIMUM	92	37	35	58.8
STD DEV	12.8	9.8	7.0	14.8

Table 7. Metal Concentrations in Sediments (mg/kg dry weight) of the Pinelands National Reserve, Summer 1996.

Metal	No. detected / no. analyzed	Detection limit	Mean[a,b]	Minimum	Maximum	Standard deviation
Aluminum	25 / 25	--	4817	1730	12100	2206
Antimony	0 / 25	16.1 - 69.0	--	nd	nd	--
Arsenic	18 / 25	0.59 - 1.5	2.78	nd	23.1	4.57
Barium	25 / 25	--	86.5	22.0	214	58.8
Beryllium	25 / 25	--	0.754	0.139	2.90	0.595
Boron	23 / 25	9.8 - 12.7	15.3	nd	46.7	10.4
Cadmium	1 / 25	1.3 - 5.6	--	nd	1.83	--
Chromium	24 / 25	6.0	10.2	nd	31.0	5.49
Cobalt	9 / 25	1.8 - 5.6	--	nd	10.0	--
Copper	25 / 25	--	13.2	5.86	30.1	7.75
Iron	25 / 25	--	9518	1270	76400	14659
Lead	25 / 25	--	38.0	18.0	83.5	17.5
Magnesium	25 / 25	--	461	61.2	2530	468
Manganese	25 / 25	--	21.7	6.44	60.9	11.8
Mercury	25 / 25	--	0.161	0.042	0.399	0.099
Molybdenum	0 / 25	2.1 - 9.0	--	nd	nd	--
Nickel	12 / 25	4.4 - 18.9	--	nd	14.7	--
Selenium	4 / 25	0.84 - 3.1	--	nd	6.46	--
Silver	2 / 25	2.5 - 11.0	--	nd	6.53	--
Thallium	0 / 25	0.84 - 3.6	--	nd	nd	--
Tin	0 / 25	41.8 - 180	--	nd	nd	--
Titanium	25 / 25	--	313	62.7	2290	438
Zinc	25 / 25	--	50.4	13.9	142	34.7

[a]Mean calculated only for contaminants detected in at least one-half of samples.

[b]Non-detects assumed to be present at one-half detection limit.

Table 8. Metal Concentrations in Caddisfly Larvae (mg/kg wet weight), Pinelands National Reserve, Summer 1996.

Metal	No. detected / no. analyzed	Detection limit	Mean[a,b]	Minimum	Maximum	Standard deviation
Aluminum	20 / 20	--	53.6	19.0	112	27.9
Antimony	0 / 20	0.38 - 0.47	--	nd	nd	--
Arsenic	20 / 20	--	0.266	0.069	1.60	0.366
Barium	20 / 20	--	9.32	3.36	23.7	5.77
Beryllium	20 / 20	--	0.009	0.002	0.038	0.008
Boron	20 / 20	--	0.693	0.264	1.45	0.269
Cadmium	8 / 20	0.031	--	nd	0.111	--
Chromium	20 / 20	--	0.287	0.128	0.724	0.176
Cobalt	20 / 20	--	0.335	0.059	1.25	0.406
Copper	20 / 20	--	2.51	0.997	4.12	0.913
Iron	20 / 20	--	433	68.3	2080	474
Lead	20 / 20	--	1.99	0.390	4.82	1.29
Magnesium	20 / 20	--	167	51.5	296	90.5
Manganese	20 / 20	--	8.59	0.832	37.4	10.8
Mercury	20 / 20	--	0.070	0.009	0.229	0.050
Molybdenum	18 / 20	0.05 - 0.06	0.174	nd	0.601	0.144
Nickel	20 / 20	--	0.368	0.134	1.14	0.283
Selenium	18 / 20	0.13	0.271	nd	0.799	0.178
Silver	6 / 20	0.06	--	nd	0.354	--
Thallium	0 / 20	0.13	--	nd	nd	--
Tin	2 / 20	1.0 - 1.2	--	nd	1.17	--
Titanium	20 / 20	--	0.959	0.167	2.17	0.658
Zinc	20 / 20	--	31.4	10.1	74.7	20.0

[a]Mean calculated only for contaminants detected in at least one-half of samples.

[b]Non-detects assumed to be present at one-half detection limit.

Table 9. Metal Concentrations in Dragonfly Larvae (mg/kg wet weight), Pinelands National Reserve, Summer 1996.

Metal	No. detected / no. analyzed	Detection limit	Mean[a,b]	Minimum	Maximum	Standard deviation
Aluminum	13 / 13	--	33.4	14.7	99.7	23.0
Antimony	0 / 13	0.38	--	nd	nd	--
Arsenic	11 / 13	0.065	0.171	nd	0.703	0.171
Barium	13 / 13	--	0.921	0.458	1.93	0.403
Beryllium	13 / 13	--	0.005	0.002	0.016	0.004
Boron	13 / 13	--	0.466	0.242	0.820	0.201
Cadmium	7 / 13	0.031	0.038	nd	0.098	0.027
Chromium	13 / 13	--	0.884	0.117	2.89	0.912
Cobalt	11 / 13	0.031	0.088	nd	0.232	0.061
Copper	13 / 13	--	4.26	2.67	6.77	1.11
Iron	13 / 13	--	290	43.4	1330	347
Lead	13 / 13	--	0.446	0.170	0.852	0.196
Magnesium	13 / 13	--	106	74.9	145	18.5
Manganese	13 / 13	--	1.35	0.316	5.86	1.79
Mercury	13 / 13	--	0.122	0.047	0.229	0.064
Molybdenum	7 / 13	0.050	0.205	nd	0.705	0.224
Nickel	12 / 13	0.105	1.02	nd	3.38	1.08
Selenium	13 / 13	--	0.496	0.200	0.738	0.158
Silver	7 / 13	0.061	0.060	nd	0.115	0.031
Thallium	0 / 13	0.13	--	nd	nd	--
Tin	1 / 13	1.00	--	nd	1.03	--
Titanium	13 / 13	--	1.74	0.410	4.68	1.22
Zinc	13 / 13	--	17.6	13.4	20.9	2.64

[a]Mean calculated only for contaminants detected in at least one-half of samples.

[b]Non-detects assumed to be present at one-half detection limit.

Table 10. Metal Concentrations in Hellgrammites (mg/kg wet weight), Pinelands National Reserve, Summer 1996.

Metal	No. detected / no. analyzed	Detection limit	Mean[a,b]	Minimum	Maximum	Standard deviation
Aluminum	13 / 13	--	26.8	11.6	81.4	18.6
Antimony	0 / 13	0.38	--	nd	nd	--
Arsenic	12 / 13	0.067	0.162	nd	0.414	0.110
Barium	13 / 13	--	1.18	0.360	4.93	1.17
Beryllium	10 / 13	0.001	0.003	nd	0.007	0.002
Boron	13 / 13	--	0.663	0.147	2.93	0.711
Cadmium	6 / 13	0.031	--	nd	0.074	--
Chromium	13 / 13	--	0.326	0.071	0.801	0.200
Cobalt	12 / 13	0.031	0.116	nd	0.409	0.134
Copper	13 / 13	--	3.04	1.23	4.91	0.880
Iron	13 / 13	--	270	68.6	525	168
Lead	13 / 13	--	0.591	0.139	1.20	0.294
Magnesium	13 / 13	--	215	117	287	47.0
Manganese	13 / 13	--	2.81	0.558	12.2	3.89
Mercury	13 / 13	--	0.118	0.023	0.272	0.068
Molybdenum	12 / 13	0.04	0.132	nd	0.291	0.074
Nickel	13 / 13	--	0.396	0.109	1.19	0.339
Selenium	13 / 13	--	0.421	0.208	0.967	0.208
Silver	7 / 13	0.061	0.059	nd	0.104	0.028
Thallium	0 / 13	0.13	--	nd	nd	--
Tin	1 / 13	0.800 - 1.00	--	nd	1.07	--
Titanium	13 / 13	--	0.478	0.141	1.13	0.283
Zinc	13 / 13	--	20.6	12.1	27.9	3.67

[a]Mean calculated only for contaminants detected in at least one-half of samples.

[b]Non-detects assumed to be present at one-half detection limit.

Table 11. Metal Concentrations in Forage Fish (mg/kg wet weight), Pinelands National Reserve, Summer 1996.

Metal	No. detected / no. analyzed	Detection limit	Mean[a,b]	Minimum	Maximum	Standard deviation
Aluminum	30 / 30	--	3.86	1.55	11.1	2.12
Antimony	1 / 30	0.38	--	nd	0.384	--
Arsenic	17 / 30	0.07 - 0.33	0.108	nd	0.246	0.070
Barium	30 / 30	--	25.9	2.91	111	21.9
Beryllium	30 / 30	--	0.003	0.001	0.009	0.002
Boron	30 / 30	--	0.325	0.091	1.01	0.187
Cadmium	15 / 30	0.03	0.045	nd	0.179	0.044
Chromium	30 / 30	--	0.588	0.200	3.16	0.638
Cobalt	27 / 30	0.03	0.062	nd	0.115	0.026
Copper	30 / 30	--	0.936	0.335	2.36	0.612
Iron	30 / 30	--	42.3	15.2	133	28.2
Lead	30 / 30	--	5.18	0.127	31.7	6.61
Magnesium	30 / 30	--	336	157	475	65.1
Manganese	30 / 30	--	1.59	0.695	3.54	0.880
Mercury	30 / 30	--	0.194	0.034	0.472	0.115
Molybdenum	7 / 30	0.05	--	nd	0.109	--
Nickel	13 / 30	0.10	--	nd	0.443	--
Selenium	30 / 30	--	0.562	0.236	1.19	0.244
Silver	3 / 30	0.06	--	nd	0.500	--
Thallium	1 / 30	0.13	--	nd	0.143	--
Tin	26 / 30	0.8 - 2.0	1.79	nd	8.44	1.83
Titanium	22 / 30	0.015	0.044	nd	0.135	0.040
Zinc	30 / 30	--	44.6	9.35	89.4	18.0

[a]Mean calculated only for contaminants detected in at least one-half of samples.

[b]Non-detects assumed to be present at one-half detection limit.

A. SAMPLES COLLECTED

Table 2 reflects all samples that were collected and submitted to Hazleton Environmental Services for chemical analysis. Twenty-five sediment and surface water samples were collected and submitted, as well as 100 biota samples. The breakdown of biological samples analyzed was 54 fish samples (30 of forage fish and 24 of predatory fish) and 46 benthic invertebrate larvae samples (20 of filter-feeding invertebrates and 26 of predatory invertebrates).

Forage fish composite samples included 15 mudminnow *(Umbra pygmaea)*, 7 banded sunfish *(Enneacanthus obesus)*, 2 blackbanded sunfish *(Enneacanthus chaetodon)*, 2 pirate perch *(Aphredoderus sayanus)*, 3 mud sunfish *(Acantharchus pomotis)*, and 1 mixed species. Predator fish samples included 18 chain pickerel *(Esox niger)*, 4 redfin pickerel *(Esox americanus)*, and 2 largemouth bass *(Micropterus salmoides)*. Weights and lengths of individual predatory fish forming composite samples may be found in Table 3.

Filter-feeding invertebrate larvae included 13 composite samples of caddisfly larvae in the family Hydropsychidae, and 7 composite samples of family Limnephilidae. Predator invertebrate larvae samples included 13 composite samples of hellgrammites (family Corydalidae) and 13 composite dragonfly larvae samples (including 10 of family Cordulegastridae, 1 of family Aeshnidae, 1 of family Gomphidae, and 1 mixed family composite) (Table 2).

B. METALS CONCENTRATIONS AND OTHER PARAMETERS

1. Surface Water

General *in situ* water chemistry results can be found in Table 4. Mean conductivity of streams sampled in the Pinelands was 54.0 micro siemens (us)/cm (range 27.3 to 98.6); temperature averaged 19.4 °C (range 14.5 to 26.5); pH averaged 4.6 (range 4.0 to 6.4); dissolved oxygen averaged 6.9 mg/L (range 3.7 to 8.5); and, total dissolved solids averaged 26.9 mg/L (range 13.6 to 49.4).

Concentrations of 23 metals in surface water are shown in Table 5. Eight of the metals were not detected in any sample, while another eight were detected in all 25 samples. None of the metals exceeded their respective AWQC, except mercury, iron and lead (see Table 1). The mean mercury concentration in Pinelands streams exceeded the AWQC (0.012 ug/L) by five-fold. Twenty-threeof 25 samples exceeded this criterion for the protection of chronically exposed aquatic life. The remaining two samples were reported as non-detects. Since the detection limit for mercury in surface water was 0.02 ug/L, it is impossible to determine if these two samples also exceeded the criterion. The mean iron concentration in surface water slightly exceeded the AWQC for iron. Lead exceeded the AWQC slightly at only one station of 25.

2. Sediments

Sediment samples were characteristic of the Pinelands region of southern New Jersey in that they were high in sand content. Mean percentages of sand, silt, and clay were 80.2, 12.6, and 7.6, respectively. Mean percent total organic carbon in sediment samples was 19.7 (Table 6).

Concentrations of 23 metals in Pinelands sediments are shown in Table 7. Those metals not detected in water also tended to be undetectable in sediment. The exception was chromium, which was not detected in water but was found in 24 of 25 sediment samples. None of the metal concentrations in sediment exceeded an SEL, except for iron at one location (Appendix C). Several other metals including mercury occasionally exceeded an LEL; however, the mean concentrations of all metals except lead were below the LEL. Lead concentrations in sediment exceeded the LEL at 15 of 25 sites (60 percent), and the mean lead concentration (38 ppm) in Pinelands sediments was slightly greater than the LEL (31 ppm). The mercury LEL of 0.2 mg/kg (Table 1) was exceeded in sediment from seven of the 25 sites (28 percent).

3. Benthic Invertebrates

Metal concentrations in benthic invertebrates are shown in Tables 8, 9 and 10. The benthic invertebrate mercury criterion used for comparative purposes was 0.20 mg/kg wet weight (Table 1). Of the 46 invertebrate samples analyzed, only 5 (11 percent) exceeded this criterion, which represents a "level of concern" in New York State (NYDEC 1996). The breakdown of those 5 samples that exceeded the criterion was 1 caddisfly larvae sample (5 percent), 1 hellgrammite sample (8 percent), and 3 dragonfly samples (23 percent). Generally, the caddisfly larvae contained less mercury than the predatory hellgrammite or dragonfly larvae, due largely to position in the food chain.

The only other metals that frequently exceeded an NYDEC level of concern (Table 1) were zinc in caddisfly larvae (7 of 20 samples) and lead in caddisfly (9 of 20 samples). However, the mean concentrations of all metals in all three invertebrate groups sampled were below the levels of concern.

4. Fish

Metal concentrations in forage fish and predatory fish are shown in Tables 11 and 12, respectively. The NCBP mean and 85th percentile mercury concentrations of 0.10 and 0.17 ppm wet weight, respectively (Schmitt and Brumbaugh 1990), were exceeded by the means for both forage and predatory fish in Pinelands streams. The USEPA mean for contaminated sites of 0.26 mg mercury per kg wet weight (USEPA 1992) was exceeded by 27 of the 54 fish samples (50 percent). Forage fish samples exceeded the NCBP and USEPA means in 67 and 30 percent of the samples, respectively. Predatory fish samples exceeded the NCBP and USEPA means in 96 and 75 percent of the samples, respectively. On average, predatory fish contained about three times the mercury levels of forage fish (Figure 2).

Table 12. Metal Concentrations in Predatory Fish (mg/kg wet weight), Pinelands National Reserve, Summer 1996.

Metal	No. detected / no. analyzed	Detection limit	Mean[a,b]	Minimum	Maximum	Standard deviation
Aluminum	23 / 23	--	1.65	0.70	3.27	0.61
Antimony	3 / 24	0.37	--	nd	0.479	--
Arsenic	17 / 24	0.07 - 0.33	0.124	nd	0.367	0.083
Barium	24 / 24	--	8.54	1.53	21.6	5.48
Beryllium	24 / 24	--	0.003	0.002	0.005	0.001
Boron	24 / 24	--	0.310	0.119	1.26	0.251
Cadmium	1 / 24	0.030	--	nd	0.038	--
Chromium	24 / 24	--	0.380	0.222	0.625	0.106
Cobalt	12 / 24	0.030	0.030	nd	0.065	0.017
Copper	23 / 23	--	0.469	0.299	1.36	0.230
Iron	24 / 24	--	14.7	7.38	35.0	6.61
Lead	23 / 24	0.064	0.986	nd	3.44	0.982
Magnesium	24 / 24	--	352	242	445	44.9
Manganese	24 / 24	--	1.57	0.553	3.89	0.804
Mercury	24 / 24	--	0.552	0.083	1.30	0.322
Molybdenum	0 / 24	0.05	--	nd	nd	--
Nickel	7 / 24	0.10	--	nd	0.731	--
Selenium	24 / 24	--	0.542	0.175	0.962	0.207
Silver	0 / 24	0.06	--	nd	nd	--
Thallium	1 / 24	0.13	--	nd	0.137	--
Tin	24 / 24	--	1.96	1.29	8.26	1.42
Titanium	10 / 24	0.015	--	nd	0.582	--
Zinc	24 / 24	--	42.4	13.8	96.5	15.7

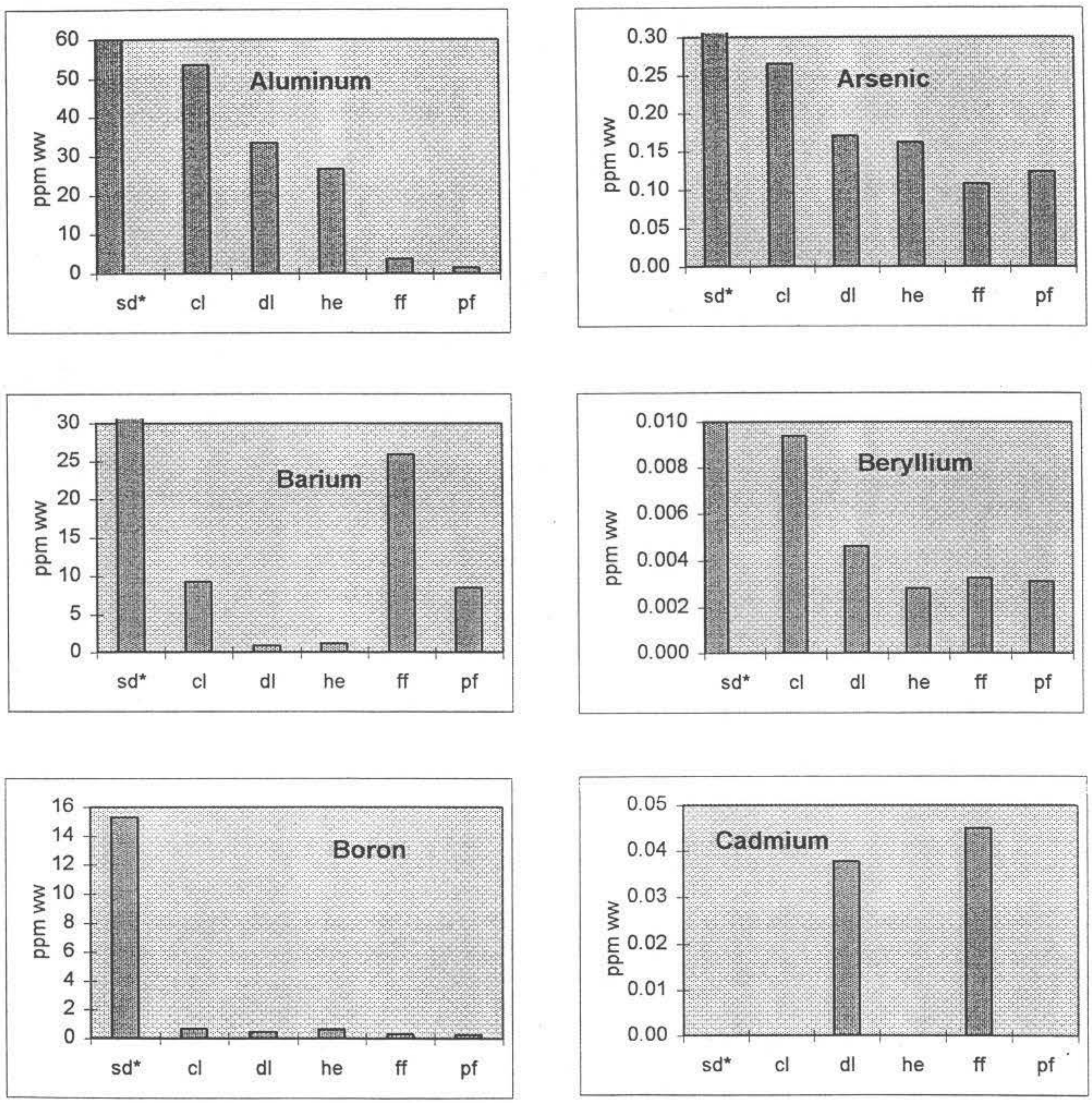
[a]Mean calculated only for contaminants detected in at least one-half of samples.

[b]Non-detects assumed to be present at one-half detection limit.

Table 13. Mercury Hazard Quotients Calculated for Four Receptor Species at 25 Stream Sampling Locations in the Pinelands National Reserve.

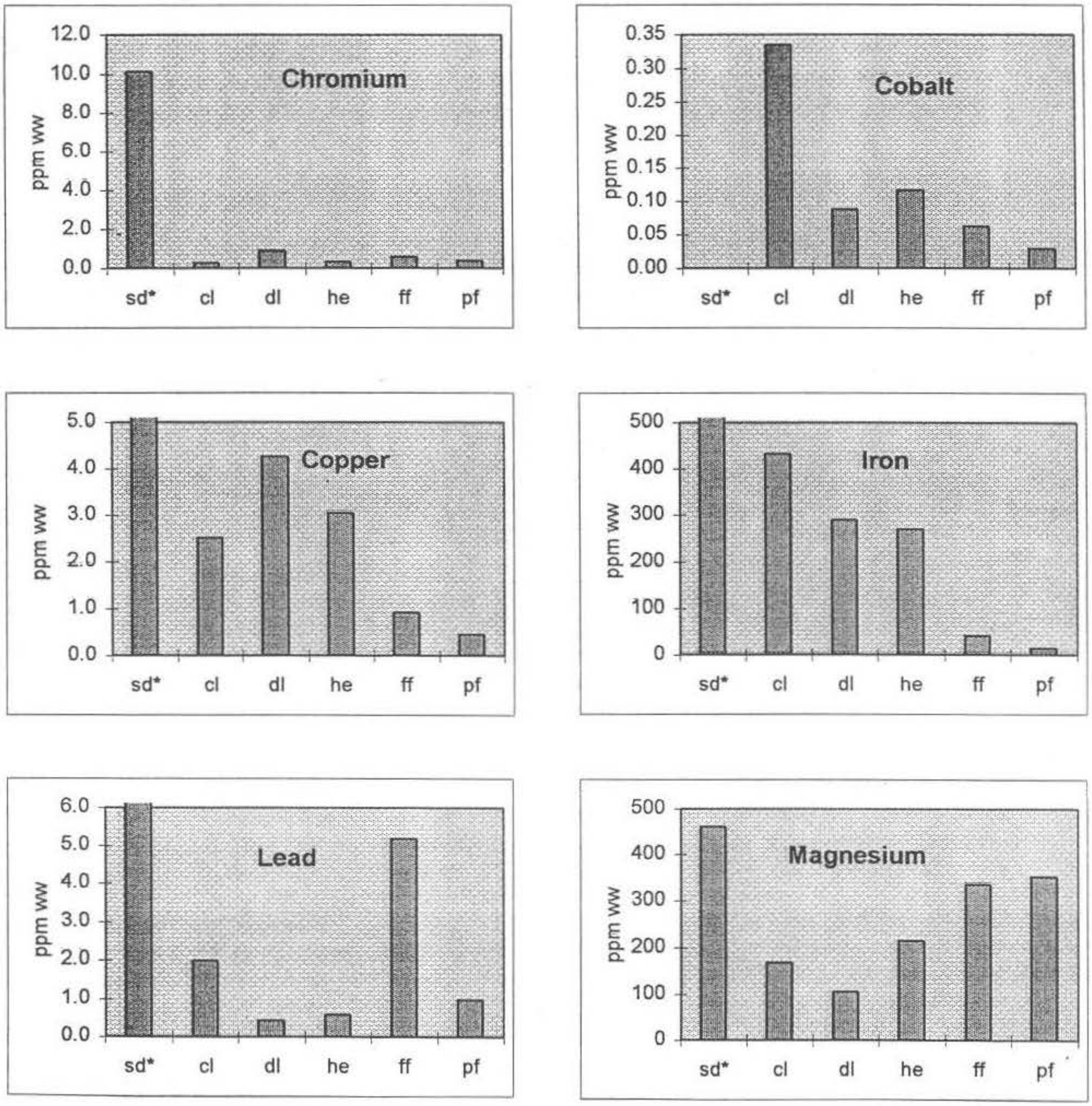
STREAM	HAZARD QUOTIENTS Mink	Black Duck	Green Heron	Belted Kingfisher
ALLBR	12.17	0.27	2.20	2.95
BATRI	1.43	0.03	0.39	1.31
BURBR	11.08	0.29	2.90	5.42
CLAST	10.69	0.31	2.84	6.49
ELLCR	5.00	0.48	1.33	4.44
FACBR	9.93	0.29	2.59	6.08
GIBCR	10.30	0.14	2.71	5.82
GRARN	10.24	0.24	2.72	5.20
GRER1	4.70	0.12	1.30	2.46
GRER2	5.56	0.13	1.47	2.71
HAMCR	6.12	0.13	1.65	2.47
LAKBR	10.70	0.17	0.92	3.07
MANRI	2.63	0.20	0.71	2.75
MILBR	6.05	0.09	1.62	2.82
OLDBR	10.25	0.19	2.68	NA
OSWR1	5.91	0.27	1.57	4.80
OSWR2	6.33	0.21	1.74	2.16
OYSCR	9.23	0.34	2.42	8.08
PLABR	12.08	0.15	3.18	4.87
RIDBR	3.06	0.23	0.81	2.21
SOUR1	2.22	0.11	0.65	1.11
SOUR2	4.28	0.12	1.13	2.37
STECR	2.30	0.08	0.62	1.15
TOMRI	2.66	0.06	0.70	1.32
WBWAD	3.42	0.28	0.94	2.58
MEAN	6.73	0.20	1.67	3.53
STD DEV	3.56	0.10	0.87	1.91
MINIMUM	1.43	0.03	0.39	1.11
MAXIMUM	12.17	0.48	3.18	8.08

Figure 2. Comparison of metal concentrations in sediments and aquatic biota in streams of the Pinelands National Reserve.



sd=sediment,cl=caddisfly larvae, dl=dragonfly larvae, he=helgrammites, ff=forage fish, pf=predator fish; *sediment concentrations are given as dry weight; all biota are wet weight.

Figure 2 (cont.)



metals.xls

Figure 2 (cont.)

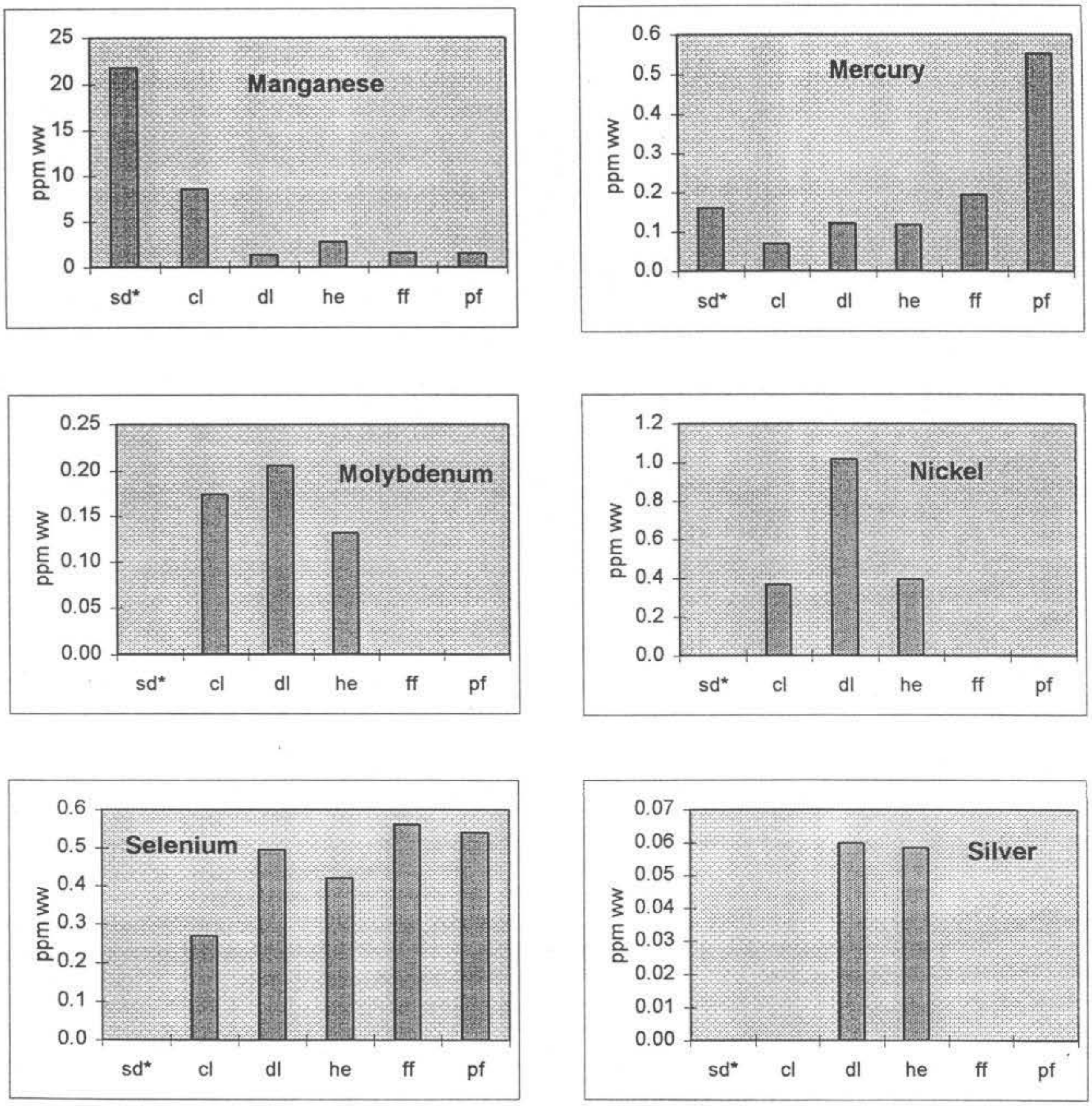
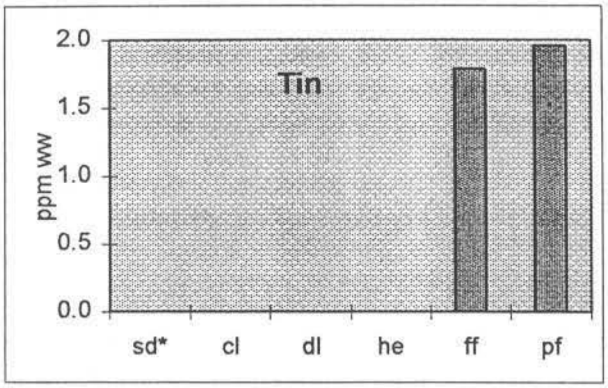
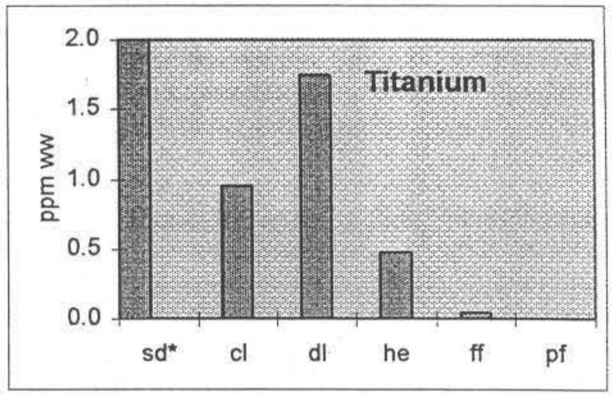
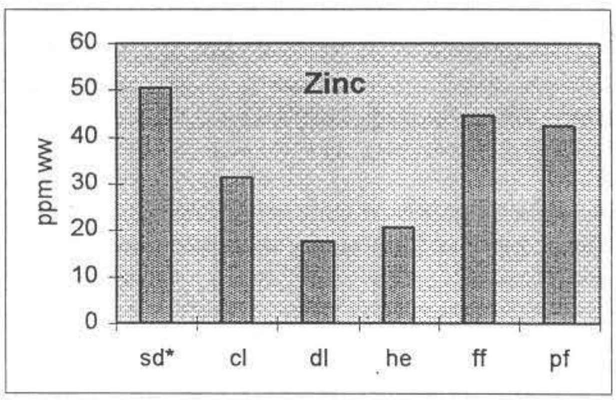


Figure 2 (cont.)







metals.xls

As was the case with benthic invertebrates, lead and zinc were the only metals besides mercury that appeared to be elevated in Pinelands fish. Twenty-nine of 30 forage fish composite samples (97 percent) exceeded the criterion for lead in fish. The average lead concentration in forage fish was more than 23-fold higher than the 85th percentile lead concentration reported for U.S. fish by Schmitt and Brumbaugh (1990) (Table 1). Predatory fish contained only about one-fifth as much lead as forage fish (Figure 2). Although much lower, the mean lead level in predatory fish still exceeded the NCBP 85th percentile by a wide margin. Twenty-two of 24 predatory fish samples (92 percent) exceeded this criterion.

In contrast to lead and mercury, zinc levels were about the same regardless of fish trophic level (Figure 2). Zinc levels only slightly exceeded the NCBP 85th percentile.

C. ECOLOGICAL RISK MODELING

Mercury hazard quotients were calculated for mink, black duck, green heron and belted kingfisher at each of the 25 Pinelands sampling stations. Hazard quotients were not calculated for the other metals. Results of the mercury risk modeling can be found in Table 13, and the individual spreadsheets can be found in Appendix D. The highest HQ calculated was relatively low at 12.2. The mink had the highest HQ of all the indicator species, with a mean HQ value of 6.7 for the 25 Pinelands stations. The black duck was not at risk of adverse effects from consumption of mercury-contaminated prey at any of the 25 stations, as all HQs for that species were below 1.0. Additionally, little risk was posed to green heron and belted kingfisher throughout the Pinelands region, as mean HQs were 1.7 and 3.5, respectively.

V. DISCUSSION

A. METALS CONCENTRATIONS

1. Surface Water

Nearly all stations in the Pinelands exceeded the mercury criterion for the protection of aquatic life, and the mean mercury concentration for Pinelands streams was five times higher than the AWQC. The apparent seriousness of this finding is somewhat mitigated by the following: (1) most streams were not impacted based upon macroinvertebrate composition (NJDEP 1996); (2) most streams contained a healthy diversity of aquatic insect larvae including pollution intolerant species; (3) mercury concentrations in surface water have been confirmed to be somewhat elevated throughout the northeast; and, (4) mercury concentrations in ground water have been confirmed to be somewhat elevated in the Cohansey aquifer (USGS, unpubl. data), which underlies the Pinelands area and drives the hydrologic regime in most of the Pinelands streams and rivers. Furthermore, the maximum concentration detected in this investigation (0.11 ug/L) was only slightly higher than the threshold for lethality to sensitive aquatic organisms (0.1 ug/L) reported by Eisler (1987). Nevertheless, mercury levels in Pinelands streams are clearly elevated, and this undoubtedly contributes to the above normal concentrations observed in aquatic biota, especially predatory fish.

The high iron levels observed were expected and do not represent an anthropogenic source. Pinelands streams and sediments are well-known for their naturally-occurring iron deposits, which once supported a thriving bog-iron industry. Iron levels observed may be considered as natural background for the area.

2. Sediments

The mean concentration of 0.16 mg/kg appears to be representative of background sediment mercury concentrations in southern New Jersey. The total mercury concentrations in sediments from throughout the Pinelands area were less than expected. Although some of the higher levels show potential for adverse effects to aquatic life, the maximum value of 0.4 ppm was only slightly higher than the low-effects levels for freshwater or marine systems (0.15-0.2 ppm), and was well below the ER-M (1.3 ppm) and SEL (2 ppm). Based upon the total mercury concentrations documented from the 25 Pineland stations, no point-sources or areas representing significant contamination were identified.

Based on a comparison with criteria, lead levels in Pinelands sediments would appear to be elevated. However, the levels observed are comparable to those measured by the Service elsewhere in New Jersey (USFWS, 1994; 1997b) and do not represent unusual lead levels.

3. Benthic Invertebrates

The comparative criteria selected for benthic invertebrates, and exceedances thereof, should be viewed with caution. The criteria were developed from New York State data and may not be reflective of valid "levels-of-concern" for Pinelands invertebrates. Regardless, the comparison does suggest that only a few streams in the Pinelands contain benthic organisms with elevated mercury levels. Based upon the invertebrate tissue levels detected, none of the streams are believed to be impacted by direct point source inputs of mercury.

No explanation can be offered at this time for the elevated lead and zinc levels in some caddisfly samples. Lead and zinc levels in caddisfly larvae did not seem to be related to sediment levels of these metals. Lead and zinc showed the same general pattern of distribution across trophic levels (Figure 2) in that concentrations tended to be greater in representatives of low trophic levels than they were in predator species.

4. Fish

Comparing fish residues to published criteria and other studies presents several fundamental problems. First, it has been documented that mercury uptake into biota is related to many local variables, most importantly the various water chemistry parameters that influence mercury methylation rates. Second, mercury concentration is strongly correlated to age and size of specific species of fish (ANSP 1994). Third, fish samples are analyzed as either whole-body or fillets, and direct comparison of results from these two methods is generally not appropriate. Fourth, since methylmercury is a strong biomagnifier, trophic level is an important factor to consider when comparing mercury concentrations in one species with those in another.

As such, only generalizations can be made when comparing the results of a specific local investigation (i.e., this Pinelands investigation) to the selected National databases. Fish within the northeastern U.S. generally have higher mercury concentrations than those of other geographic regions (USEPA 1992). This fact was certainly confirmed in this investigation, as the mean predatory fish concentration of 0.55 ppm in the Pinelands equalled approximately the 85th percentile for fish from contaminated sites selected by the USEPA in their national study (USEPA 1992), and was well above the 85th percentile reported by the NCBP (Schmitt and Brumbaugh, 1990). Even the smaller forage fish, which are lower on the food chain, exceeded the 85th percentile reported by the NCBP (Schmitt and Brumbaugh, 1990). Therefore, it is evident that fish in the Pinelands streams contain elevated mercury concentrations relative to other parts of the country.

This investigation and the State's primary mercury investigation (ANSP 1994) revealed that the Pinelands fish contained high levels of mercury; however, direct comparison between the two investigations should not be made for several of the aforementioned reasons. The ANSP (1994) found much higher concentrations of mercury in fish tissue throughout the Pinelands region than were found in this study. The primary reason for this finding was that ANSP (1994) collected fish that were generally much larger than the fish collected in this investigation. Possible explanations for this difference in fish size are that: (1) we sampled relatively small, wadable streams that may not have had the necessary requirements for the development and sustainability of large fish; (2) due to the relatively pristine nature of the streams sampled, very few of the larger, nonindigenous species were present, and, (3) low conductivity of the larger, deeper streams may have limited the available electrical power and thus reduced our efficiency in collecting the largest and strongest predatory fishes in the system. Nonetheless, our sampling effort met the objectives of the investigation in that the samples collected were representative of fish species inhabiting small tributaries and streams of the Pinelands region.

Lead levels were also extremely elevated in Pinelands fish; however, lead showed a pattern opposite that of mercury in that it tended to be highest in the lower trophic levels (i.e, caddisfly larvae and forage fish) (Figure 2). In the case of fish, this difference may be related, in part, to the very different behavior of the two metals once absorbed. Methyl mercury accumulates primarily in fat and muscle tissue, whereas lead is deposited mainly in bone. The only metal showing a similar distribution across trophic levels was barium (Figure 2), also a bone-seeking element. The lack of a similar distribution for other metals with high sediment concentrations (such as iron and aluminum) argues against this observation being an artifact of feeding behavior or direct sediment ingestion.

Lead levels in Pinelands water and sediment did not appear to be sufficiently elevated to account for the unusually high levels detected in fish. Increased bioavailability due to the acidity of Pinelands streams is a possible contributing factor. Elucidation of other potential factors accounting for high fish lead levels should be the subject of future investigations.

B. ECOLOGICAL RISK MODELING

Results of the ERA modeling for mercury revealed that piscivorous birds and mammals feeding in Pinelands streams are at or slightly above the threshold for potential adverse health effects (i.e., HQs between 1 and 10). The toxicity reference values used in this modeling were theoretically "safe" levels (i.e., NOAELs) from chronic toxicity studies; therefore, HQs less than 10 are viewed as representing some, albeit minimal, potential for risk. It could be argued that since the threshold for adverse effects in piscivorous wildlife has been reached, and mercury continues to enter the unique Pinelands system, piscivorous wildlife will, at some time in the future, begin to show adverse chronic impacts from mercury. Of course, if mercury inputs could be identified and curtailed, and current concentrations could be stabilized, then minimal ecological impacts from mercury throughout the Pinelands could be expected. It is with this in mind that regulatory agencies need to devote time and effort to identifying primary mercury inputs to this relatively pristine southern New Jersey ecosystem. Additionally, developing an ecologically protective clean-up level, for use on identified contaminated sites within the Pinelands, will certainly assist in minimizing potential for adverse effects in fish and wildlife resources.

C. PINELANDS MERCURY LEVELS COMPARED WITH THE FAA SUPERFUND SITE

The mean concentrations of mercury found in biota and sediments of the South Branch of Absecon Creek on the FAA Technical Center (USFWS 1996a) were significantly higher (at $p<.01$) than those found in this Pinelands investigation (Table 14). In fact, the mean concentration of mercury in sediments of the South Branch (Stations 4 to 9; USFWS 1996a) was two orders of magnitude higher than mean mercury levels in Pinelands sediment, indicating a mercury contamination problem at the FAA. Comparisons of caddisfly larvae, dragonfly larvae, forage fish and predatory fish revealed similar higher mercury concentrations in FAA biota when compared to the respective Pinelands biota (Table 14). The fish whole-body concentration of 3.5 ppm (USFWS 1996a) and the fish fillet concentration of 8.9 ppm (ANSP 1994), both found on the FAA Technical Center, represent some of the highest mercury concentrations reported for fish in the country. Likewise, mean HQs for indicator species using the FAA site were significantly higher than respective HQs for indicator species feeding in Pinelands streams (Table 14). Based upon these comparisons, one can conclude that a historic or current point source of mercury has impacted the South Branch of Absecon Creek.

Table 14. Comparison of Mean Mercury Levels and Hazard Quotients for the South Branch of Absecon Creek, FAA William J. Hughes Technical Center, with those of the Pinelands National Reserve.

	Hg Level or Hazard Quotient		
Matrix Sampled / Receptor Species	FAA Technical Center[1]	Pinelands National Reserve	Statistical Difference[2]
Surface Water (ug/L)	0.06	0.06	No
Sediment (mg/kg dry weight)	15.4	0.16	Yes
Caddisfly Larvae (mg/kg wet weight)	0.90	0.07	Yes
Dragonfly Larvae (mg/kg wet weight)	1.0	0.12	Yes
Forage Fish (mg/kg wet weight)	1.6	0.19	Yes
Predatory Fish (mg/kg wet weight)	3.0	0.55	Yes
Mink Hazard Quotient	74.2	6.7	Yes
Black Duck Hazard Quotient	2.6	0.2	Yes
Green Heron Hazard Quotient	24.5	1.7	Yes
Belted Kingfisher Hazard Quotient	81.1	3.5	Yes

Notes:

[1]Based on USFWS (1996) sampling stations 4-9 on the South Branch of Absecon Creek.

[2]t-test; $p < 0.01$.

In light of the above, the FAA should immediately proceed with the regulatory process mandated by the USEPA to have the contaminated area of the South Branch (Stations 4 through 9; see USFWS 1996a) designated an "area-of-concern" for the FAA Superfund Site. Fortunately, the Service is currently conducting a detailed mercury delineation in the section of stream in which the point-source is suspected (USFWS 1997a). The FAA mercury delineation, as well as previous sampling in the contaminated section of stream, should be included by the FAA and USEPA in developing the remedial investigation. In fact, with the completion of the Service's mercury delineation, sufficient information will be available to complete the remedial investigation. The following section will aid in determining a reasonable clean-up level to be included as part of the feasibility study for this potential "area-of-concern."

D. DERIVATION OF A MERCURY CLEAN-UP CRITERION

Many issues must be considered in deriving a clean-up level for a specific area or deciding which areas warrant remedial action, including: (1) what form of mercury is the primary contaminant; (2) in what matrix is the mercury located; (3) what is (are) the mercury concentration(s); (4) what are the probable risks at the concentrations present; (5) what are background concentrations; (6) what are the specific factors affecting mercury methylation and bioaccumulation; (7) what specific land uses are involved (i.e., public vs. private, developed vs. undeveloped, urban vs. residential); (8) what is the fish and wildlife habitat quality of the affected area; and, (9) what resources are available to implement the clean-up, both in manpower and funds?

Many regulatory agencies have established clean-up criteria for soils; however, criteria for sediment remediation have not been universally accepted or applied. The derivation of a sediment clean-up level can be approached from a variety of ways, ranging from a scientifically-based method to a risk management decision method. The following sections will discuss some possible approaches for deriving a sediment clean-up level for mercury-contaminated sites in Southern New Jersey.

1. Selection of an Effects-based Concentration

As indicated earlier, several broad-based mercury "effect concentrations" are provided in the literature. These criteria were derived by studying the effects of mercury on the aquatic invertebrate community; therefore, risk implications to the terrestrial vertebrate community (i.e., mammals and birds) cannot be readily assessed. Each effects-based criterion has advantages and disadvantages from a scientific standpoint. Basically, selecting the NOAA ER-L (0.15 mg/kg) (Long and Morgan 1990) or the low effect level (LEL) of 0.20 mg/kg suggested by Persaud et al. (1993) for the protection of sediment-dwelling (benthic) species would probably prevent most adverse effects on fish and aquatic resources, while selecting the NOAA ER-M of 1.3 mg/kg or the severe effects level (SEL) of 2.0 mg/kg suggested by Persaud et al. (1993) would result in continued likelihood of adverse effects in the aquatic community.

2. Backcalculation from HQs to Determine an Acceptable Concentration

The HQs presented in Table 13 were calculated from site-specific Pinelands data to determine potential risk to piscivorous and insectivorous wildlife. The results showed that there was little overall potential for risk since the HQs for black duck were all under 1.0 and the mean HQs for the mink, green heron and belted kingfisher were less than 10.0. Assuming sufficient time for the FAA aquatic system to reach equilibrium after remediation, one could easily use the model discussed previously in this report to backcalculate a range of sediment concentrations that would accompany the varying levels of risk to piscivorous wildlife.

It was assumed that the mean mercury concentrations found in surface water, invertebrates, fish and sediments in FAA streams after remediation of the mercury sources there would eventually be proportional to those in Pinelands streams where there are no point sources of mercury, although it is not clear how long the adjustment to equilibrium between the various environmental compartments might take. To provide a range, HQs of 1, 10, and the Pinelands mean HQ for each indicator species were included in this backcalculation. Therefore, mercury sediment clean-up levels (mg/kg) were calculated using the "safe" risk level (i.e., HQ of 1.0), the "background" risk level (i.e., mean Pinelands HQ), and a level of risk above which adverse effects to wildlife are likely (i.e., HQ of 10), as shown below:

Species	HQ = 1	Background HQ	HQ = 10
Mink	0.024	0.16	0.24
Green heron	0.096	0.16	0.96
Belted kingfisher	0.046	0.16	0.46
Black duck	0.81	0.16	8.1

This backcalculation method is wholly dependent upon the assumed equilibrium relationships between mercury concentrations in fish, fish prey and sediments. The reason that background mercury levels are higher than "safe" levels (i.e., HQ=1) is largely due to the elevated mercury found in the fish inhabiting the Pinelands system/(the basis of risk calculations), the fact that mercury is highly toxic, and the use of conservative assumptions in the ERA model. Although somewhat conservative, and not without uncertainty, this backcalculation methodology does indicate that a mercury sediment clean-up criterion for the protection of piscivorous wildlife in the Pinelands should be no higher than about 0.2 mg/kg for mammals and 0.5 mg/kg for birds.

3. Establishment of a Pinelands Background Level

As indicated earlier, one of the primary objectives of this investigation was to establish baseline or background mercury concentrations for the Pinelands National Reserve. Sampling 25 diverse stream stations throughout the Pinelands resulted in a mean mercury sediment concentration of 0.16 mg/kg. The maximum sediment concentration was 0.40 mg/kg. Selecting a mercury clean-up criterion between 0.16 and 0.40 mg/kg for contaminated sites in the Pinelands region would result in the remediated site being representative of background conditions existing within the Pinelands.

VI. CONCLUSIONS AND RECOMMENDATIONS

- With the exception of mercury, lead and possibly zinc, metal concentrations measured in sediment, water and biota of the Pinelands National Reserve rarely exceeded criteria and/or are considered to represent natural background for the region.

- As expected, Pinelands mercury concentrations for water, fish and some sediments were elevated compared to selected criteria. Also as expected for a lipophilic, bioaccumulative contaminant, mercury levels increased with higher trophic levels. Nevertheless, mercury levels measured in pinelands biota are expected to pose little, if any, risk for piscivorous wildlife.

- Mercury levels and ecological risks on the FAA Technical Center were significantly higher than those found in this Pinelands investigation. A historic or current point source input of mercury is suspected in the South Branch of Absecon Creek between Tilton Road (Station 4) and the Atlantic City Upper Reservoir (Station 9). The results of the mercury surface water and sediment delineation planned by USFWS (1997a) will provide detailed information on the extent and levels of contamination. It may also help pinpoint potential sources. Existing information is sufficient to determine that some level of remedial action is warranted; most notable are sediment concentrations up to 68 ppm and fish whole-body concentrations of up to 3.5 ppm wet weight. Primary focus should be placed on identifying and eliminating the source of mercury in the South Branch of Absecon Creek. Secondary focus should be placed on determining which portions of the South Branch of Absecon Creek may warrant clean-up. Final focus should be directed at the effective and timely remediation of mercury contaminated sediments in those areas.

- Various methods were used to aid in deriving a mercury clean-up criterion for contaminated sites in the Pinelands Region of Southern New Jersey. All methods show that a reasonable, scientifically-based, and ecologically protective level would be 0.2 mg/kg. Obviously, a higher level may be selected based on site-specific, risk management decisions. A clean-up level of 0.4 mg/kg would represent the upper limit of background for the area, and a level of 0.5 mg/kg would still be protective of piscivorous birds.

- An unexpected result of this study was the discovery of unusually high levels of lead in predatory and forage fish from Pinelands streams. These extremely high levels in fish were not accompanied by correspondingly high levels in water or sediment. Although lead concentrations in sediments frequently exceeded criteria, the levels of this common contaminant were similar to levels measured elsewhere in New Jersey. Further studies are recommended to elucidate factors accounting for high lead levels in Pinelands fish.

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Appendix A

Contract Laboratory Program (CLP) Data Qualifiers.

Appendix A

Contract Laboratory Program (CLP) Data Qualifiers.

Inorganic Qualifiers

Concentration Qualifiers

B - This flag indicates that the reported value was obtained from a reading that was less than the contract required detection limit, but greater than the instrument detection limit.

U - This flag indicates that the analyte was analyzed for, but not detected.

Quantitation Qualifiers

E - This flag indicates that the reported value was estimated because of the presence of interference. An explanatory note must be included under comments on the cover page (if the problem applies to all samples), or on the specific Form I (if the problem was an isolated case).

M - This flag indicates that the duplicate injection precision was not met.

N - This flag indicates that the spiked sample recovery was not within control limits.

S - This flag indicates that the reported value was determined by the Method of Standard Additions (MSA).

W - This flag indicates that the post-digestion spike for Atomic Adsorption (AA) analysis was out of control limits (85 to 115 percent), while the sample absorbance was less than 50 percent of spike absorbance.

* - This flag indicates that the duplicate analysis was not within control limits.

+ - This flag indicates that the correlation coefficient for the MSA was less than 0.995.

Appendix B

Indicator Species Exposure Factors
Used in Ecological Risk Assessment Calculations

Appendix B. Indicator Species Exposure Factors Used in Ecological Risk Assessment Calculations.

SPECIES	BODY WEIGHT (g)	WATER INGESTION (L/day)	SEDIMENT INGESTION (g/day)[1]	FOOD INGESTION (g/day)
Mustela vison	974 - Hornshaw et al. (1983)	0.097 - Calder and Braun (1983)	14.1 - Beyer et al. (1994)	225 - Giesy et al. (1994)
Butorides striatus	212 - Hartman (1961)	0.021 - Calder and Braun (1983)	3.49 - Beyer et al. (1994)	31.8 - Junior (1972)[2]
Ceryle alcyon	136 - Brooks and Davis (1987)	0.015 - Calder and Braun (1983)	7.48 - Beyer et al. (1994)	68.0 - Alexander (1977)
Anas rubripes	1100 - Palmer (1976)	0.063 - Calder and Braun (1983)	1.24 - Beyer et al. (1994)	61.9 - Nagy (1987)

Notes:

[1]Sediment ingestion rates estimated from Beyer et al. (1994) using closely related species.

[2]Food ingestion rate estimated from reported striated heron value.

Area use factor (AF) =1.0.

Appendix C

Raw Analytical Results of Samples Collected in the Pinelands National Reserve, Summer 1996

Appendix C-1. Pinelands Surface Water Raw Data, Summer 1996.

Contaminant	ALBBR		BATRI		BURBR		CLAST		ELLCR		FACBR		GIBCR		GRARN	
Aluminum	158		375		319		278		441		194		157		109	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	ND		1.4	B	1.58	B	1.27	BW	ND		1.33	B	ND		ND	
Barium	45.4	B	21.4	B	37.2	B	49.7	B	48.2	B	11.5	B	16.2	B	23.1	B
Beryllium	0.116	B	0.117	B	0.148	B	0.15	B	0.15	B	0.094	B	0.115	B	0.175	B
Boron	39.3		22.8	B	31.4		46.9		50.5		35.5		31.1		24.3	B
Cadmium	ND		ND		ND		ND		ND		ND		ND		ND	
Chromium	ND		ND		ND		ND		ND		ND		ND		ND	
Cobalt	ND		ND		ND		ND		2.98	B	ND		ND		ND	
Copper	3.19	B	2.15	B	3.02	B	4.21	B	3.17	B	3.41	B	2.44	B	5.19	B
Iron	823		3270		1330		300		490		277		180		204	
Lead	1.37	B	2.49	B	1.56	B	1.42	B	ND		1.24	B	ND		1.81	B
Magnesium	1850	B	1160	B	701	B	1180	B	1380	B	391	B	479	B	662	B
Manganese	12.4	E	12.5	E	20.6	E	16.8	E	15.7	E	5.56	BE	7.76	E	13.8	E
Mercury	0.112	B	0.046	B	ND		0.038	B	0.075	B	0.059	B	ND		0.111	B
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	ND		ND		ND		5.62	B	ND		ND		ND		9.76	B
Selenium	ND		ND		ND		ND		ND		ND		ND		ND	
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND		ND		ND		ND	
Titanium	0.878	B	1.64	B	1.98	B	1.16	B	1.5	B	1.09	B	0.906	B	ND	
Zinc	29.3	E	20		23.9		14.1		17.4		11.2		92.3		49.5	

Notes:
1. All values reported in ug/L.

Appendix C-1. Pinelands Surface Water Raw Data, Summer 1996.

Contaminant	GRER1		GRER2		HAMCR		LAKBR		MANRI		MILBR		OLDBR		OSWR1	
Aluminum	457		163		118		149		500		92.5	B	169		182	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	1.07	B	ND		ND		ND		ND		ND		ND		ND	
Barium	28.3	B	38.2	B	27.7	B	30.2	B	24.1	B	13.5	B	21.2	B	16.1	B
Beryllium	0.184	B	0.212	B	0.155	B	0.116	B	0.244	B	0.098	B	0.136	B	0.098	B
Boron	37.8		34.1		60.9		53.3		29.6		33.2		19.5	B	25.6	
Cadmium	ND		ND		ND		ND		ND		ND		ND		ND	
Chromium	ND		ND		ND		ND		ND		ND		ND		ND	
Cobalt	ND		ND		ND		ND		1.89	B	ND		ND		ND	
Copper	4.54	B	3.14	B	3.77	B	2.52	B	3.61	B	ND		3.01	B	2.69	B
Iron	1280		2380		590		905		951		159		397		1060	
Lead	4.72		2.1	B	1.87	B	2.29	B	2	B	1.62	B	2.01	B	1.76	B
Magnesium	974	B	1370	B	1450	B	1550	B	581	B	406	B	473	B	301	B
Manganese	26.4	E	18.8	E	7.39	BE	11.5	E	11	E	4.94	BE	10.6	E	8.33	E
Mercury	0.052	B	0.093	B	0.099	B	0.101	B	0.045	B	0.101	B	0.044	B	0.036	B
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	ND		ND		ND		ND		ND		ND		ND		ND	
Selenium	ND		ND		ND		ND		ND		ND		ND		ND	
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND		ND		ND		ND	
Titanium	3.47	B	1.65	B	0.808	B	1.27	B	2.24	B	1.51	B	0.916	B	1.09	B
Zinc	32		30.3		28.6		19.5	E	23.2		13.6	E	19.7		11.7	

Notes:
1. All values reported in ug/L.

Appendix C-1. Pinelands Surface Water Raw Data, Summer 1996.

Contaminant	OSWR2		OYSCR		PLABR		RIDBR		SOUR1		SOUR2		STECR		TOMRI		WBWAD	
Aluminum	152		258		257		276		223		270		137		308		218	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	ND		ND		ND		1.08	B	ND		ND		ND		ND		1.22	B
Barium	21.3	B	20.7	B	11.9	B	19.6	B	101		56.3	B	27.5	B	38.7	B	12.5	B
Beryllium	0.098	B	0.111	B	0.11	B	0.132	B	0.272	B	0.212	B	0.138	B	0.229	B	0.117	B
Boron	42.8		29.2		54.7		33.1		29.3		32.6		26.8		38		42.9	
Cadmium	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Chromium	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Cobalt	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Copper	3.79	B	2.68	B	4.39	B	2.47	B	ND		3.02	B	ND		2.96	B	5.01	B
Iron	1240		502		882		2350		1100		782		194		1730		3300	
Lead	1.52	B	1.77	B	1.98	B	2.85	B	1.09	B	1.79	B	1.72	B	2.11	B	1.8	B
Magnesium	351	B	588	B	338	B	669	B	2250	B	1430	B	460	B	1290	B	367	B
Manganese	9.7	E	8.36	E	5.82	BE	20.4	E	29.3	E	14	E	6.6	BE	33.1	E	13.6	E
Mercury	0.099	B	0.021	B	0.028	B	0.047	B	0.039	B	0.043	B	0.05	B	0.043	B	0.107	B
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	ND		ND		ND		ND		ND		ND		ND		ND		8.49	B
Selenium	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Silver	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Titanium	ND		1.82	B	1.75	B	2.28	B	1.03	B	1.12	B	0.796	B	1.61	B	1.6	B
Zinc	31.4	E	11.8		11.9		35.7		21.3		17.8		10.3		20.9		45.7	E

Notes:
1. All values reported in ug/L.

Appendix C-2. Pinelands Sediment Raw Data, Summer 1996.

Contaminant	ALBBR		BATRI		BURBR		CLAST		ELLCR		FACBR		GIBCR		GRARN	
Aluminum	4570		6090		6510		4270		6930		3200		6620		4840	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	ND		3.9	B	1.72	B	1.89	B	1.67	B	0.699	B	ND		1.25	B
Barium	178		40.3	B	49.4	B	58.2	B	46.7	B	22	B	117	B	172	B
Beryllium	1.2	B	0.482	B	0.4	B	0.496	B	0.458	B	0.139	B	0.939	B	1.49	B
Boron	10.2	B	15.2	B	9.33	B	8.57	B	9.52	B	5.62	B	ND		16.4	B
Cadmium	ND		ND		ND		ND		ND		ND		ND		ND	
Chromium	9.25		7.53	B	15.5		8.02	B	10.5		14.3		11.9	B	8.31	B
Cobalt	5.51	B	ND		ND		ND		ND		ND		ND		8.56	B
Copper	14.9	B	16.2	B	12.2	B	10.2	B	12.2	B	6.76	B	14.1	B	9.52	B
Iron	7210		4120		7760		11100		5310		2700		3280		9010	
Lead	27		35		65.5		38.8		20		22.6		52.1		48.2	
Magnesium	678	B	351	B	2530	B	246	B	320	B	232	B	580	B	431	B
Manganese	23.9		16.2		35.5		12.4	B	9.17	B	16.4		24.9		33.1	
Mercury	0.129		0.087		0.076		0.278		0.151		0.058		0.165		0.271	
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	10.1	B	12.1	B	7.82	B	10.2	B	11.2	B	ND		ND		14.3	B
Selenium	2.71	B	ND		ND		1.93	B	ND		ND		ND		ND	
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND		ND		ND		ND	
Titanium	206		347		328		106		62.7	B	370		115	B	302	
Zinc	14.7	B	65.4		45.1		21.2		24.2		13.9		43.2		74.2	

Notes:

1. All values reported in mg/kg dry weight.

Appendix C-2. Pinelands Sediment Raw Data, Summer 1996.

Contaminant	GRER1		GRER2		HAMCR		LAKBR		MANRI		MILBR		OLDBR		OSWR1		OSWR2	
Aluminum	6160		2660		5370		3100		4660		6250		1730		2300		12100	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	3.17	B	ND		1.53	B	1.68	B	1.78	B	ND		ND		6.62		23.1	
Barium	134	B	58.5	B	90.2	B	29.7	B	37.2	B	214	B	49.5	B	27.7	B	116	B
Beryllium	1.15	B	0.585	B	0.563	B	0.204	B	0.641	B	1.36	B	0.423	B	0.214	B	0.833	B
Boron	34.3	B	12.3	B	8.92	B	9.59	B	15.4	B	23.8	B	13.8	B	7.22	B	31.8	B
Cadmium	ND		ND		ND		ND		ND		ND		ND		1.83	B	ND	
Chromium	9.91	B	6.06	B	12		12		4.45	B	12.9		5.29	B	8.84		31	
Cobalt	ND		2.56	B	1.85	B	1.83	B	ND		4.05	B	ND		1.91	B	10	B
Copper	30.1	B	9.36	B	30.1		7.12	B	6.2	B	14.3	B	5.86	B	7.31	B	27.8	B
Iron	8030		1270		5770		5580		4190		9070		1820		22300		76400	
Lead	83.5		27.5		38.2		18.6		18.1		45.3		35.1		18		66.7	
Magnesium	601	B	301	B	300	B	265	B	326	B	894	B	204	B	61.2	B	506	B
Manganese	38.5		18.8		25.3		10.9		9.29	B	34.1		20.9		6.44	B	23.1	
Mercury	0.34		0.098		0.275		0.058		0.139		0.19		0.069		0.147		0.399	
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	ND		7.13	B	ND		6.76	B	ND		13.9	B	ND		ND		14.3	B
Selenium	ND		ND		ND		ND		ND		3.53	B	ND		ND		ND	
Silver	ND		ND		6.53		3.5	B	ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND		ND		ND		ND		ND	
Titanium	150		345		214		165		110		361		797		170		167	
Zinc	120		41.4		45.6		28.4		48.2		35.7		36.3		23.2		142	

Notes:
1. All values reported in mg/kg dry weight.

Appendix C-2. Pinelands Sediment Raw Data, Summer 1996.

Contaminant	OYSCR		PLABR		RIDBR		SOUR1		SOUR2		STECR		TOMRI		WBWAD	
Aluminum	3990		5280		2220		7000		4820		4020		2530		3200	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	ND		2.23	B	0.791	B	3.41	B	2.12	B	ND		1.23	B	6.86	B
Barium	28.1	B	85.5	B	73.2	B	128	B	107	B	213	B	34.6	B	52.8	B
Beryllium	0.248	B	0.827	B	0.457	B	2.9	B	0.958	B	1.27	B	0.406	B	0.212	B
Boron	ND		46.7	B	13.4	B	12.4	B	29.7	B	16.8	B	6.05	B	14.4	B
Cadmium	ND		ND		ND		ND		ND		ND		ND		ND	
Chromium	12	B	14.5	B	8.7		5.72	B	4.65	B	ND		6.89		10.6	
Cobalt	ND		ND		ND		ND		ND		ND		1.44	B	ND	
Copper	13.1	B	29.3	B	8.74	B	9.39	B	8.2	B	9.33	B	6.49	B	10.3	B
Iron	3300		3140		2790		8910		12700		3530		6250		12400	
Lead	41.8		23.8		43.3		49.9		31.8		57.7		19.2		22.7	
Magnesium	237	B	410	B	314	B	364	B	365	B	594	B	181	B	238	B
Manganese	18	B	14.3	B	60.9		20.3		22.1		20.4	B	14.8		13.3	
Mercury	0.115		0.192		0.042		0.295		0.092		0.099		0.047		0.214	
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	ND		ND		8.12	B	14.7	B	ND		ND		ND		ND	
Selenium	ND		6.46	B	ND		ND		ND		ND		ND		ND	
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND		ND		ND		ND	
Titanium	236		107	B	2290		188		138		132	B	224		204	
Zinc	18.4	B	29.4	B	50.3		120		62.6		92.5		37.1		26.7	

Notes:
1. All values reported in mg/kg dry weight.

Appendix C-3. Pinelands Caddisfly Larvae Raw Data, Summer 1996.

Contaminant	BATRI-C		BURBR-C		CLAST-C		FACBR-C		GIBCR-C		GRARN-C		GRER1-C		GRER2-C	
Aluminum	68.9		87.6		74.3		54.2		44.4		19		19.3		46.2	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	0.303	BW	0.069	BW	0.219	BW	0.106	BW	0.106	BW	0.086	BW	0.283	BW	0.152	BW
Barium	3.98		6.99		7.42		6.59		3.36		13.4		11.9		5.13	
Beryllium	0.006	B	0.008	B	0.004	B	0.002	B	0.006	B	0.005	B	0.004	B	0.013	B
Boron	0.419	B	0.588		0.705		0.573		0.639		0.829		0.679		0.264	B
Cadmium	ND		ND		ND		ND		ND		ND		0.048	B	0.072	
Chromium	0.416		0.347		0.168		0.192		0.174		0.136		0.174		0.589	
Cobalt	0.059	B	0.178	B	0.704		0.076	B	0.06	B	0.127	B	0.128	B	1.21	
Copper	4.12		3.12		2.1		2.02		0.997		3.42		3.57		1.38	
Iron	735		737		596		354		68.4		90		68.6		296	
Lead	2.31		0.39		0.883		0.967		2.38		2.19		4.82		1.95	
Magnesium	283		207		121		115		51.5		287		280		84.5	
Manganese	4.16	E	2.97	E	2.99	E	1.33	E	0.852	E	8.75		9.2		30.9	
Mercury	0.009	B	0.109		0.11		0.142		0.049		0.077		0.038		0.056	
Molybdenum	0.601	B	0.282	B	0.099	B	0.068	B	ND		0.119	B	0.13	B	0.288	B
Nickel	0.416		0.249	B	0.189	B	0.157	B	0.181	B	0.14	B	0.22	B	1.14	
Selenium	0.359	S	0.499	S	0.419	S	0.364	S	0.34	S	0.162	BW	0.143	BW	0.16	B
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		1.17		ND		ND		ND		ND		ND		ND	
Titanium	0.401	B	1.79		1.24		2.17		1.63		0.34	B	0.185	B	0.563	B
Zinc	53.6	E	26.9	E	19.3	E	19	E	10.1	E	49.4		58.1		11.8	

Notes:

1. All values reported in mg/kg wet weight.

Appendix C-3. Pinelands Caddisfly Larvae Raw Data, Summer 1996.

Contaminant	HAMCR-C		LAKBR-C		MANRI-C		MILBR-C		OLDBR-C		OLDBR-L		OYSCR-C		RIDBR-C	
Aluminum	73.5		62.8	E	112		41.4	E	48.9		19		64		22.2	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	0.206	BW	1.6	S	0.928	S	0.073	BW	0.097	BW	0.134	BW	0.082	BW	0.187	BW
Barium	4.66		8.52		5.22		7.48		6.26		11.8		4.92		8.49	
Beryllium	0.013	B	0.014	B	0.014	B	0.012	B	0.005	B	0.004	B	0.004	B	0.004	B
Boron	0.487	B	1.22		0.417	B	1.45		0.671		0.641		0.521		0.661	
Cadmium	0.052		ND		ND		0.066		0.066		ND		ND		ND	
Chromium	0.199		0.56		0.237		0.128		0.199		0.18		0.222		0.724	
Cobalt	1.25		0.857		0.101	B	0.109	B	0.08	B	0.126	B	0.152	B	0.093	B
Copper	2.18		1.8		2.21		1.67		1.94		3.53		2.63		3.81	
Iron	377		2080		1070		190		153		68.3		553		294	
Lead	1.25		0.825		2.61		0.641		2.99		4.69		1.04		3.78	
Magnesium	98		106		114		97.8		94.5		278		128		296	
Manganese	24.4		19.5	E	0.832		1.77	E	1.37		9.16		1.76	E	4.63	
Mercury	0.057		0.09	N	0.102		0.044	N	0.08		0.042		0.229		0.038	
Molybdenum	0.11	B	0.151	B	0.126	B	0.052	B	0.068	B	0.141	B	0.205	B	0.439	B
Nickel	0.261	B	0.356	B	0.188	B	0.154	B	0.418		0.213	B	0.134	B	0.993	
Selenium	0.171	BW	ND		0.165	B	0.197	BW	0.438	S	0.151	BW	0.799	S	0.137	BW
Silver	0.13		0.065	B	0.063	B	0.178		ND		ND		0.074	B	ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND		ND		1.08		ND	
Titanium	0.495	B	0.839	B	2.08		0.929	B	0.838	B	0.18	B	1.18		0.639	B
Zinc	17.3		13.5		21.7		13.9		20.2		57.4		24.4	E	59.6	

Notes:

1. All values reported in mg/kg wet weight.

Appendix C-3. Pinelands Caddisfly Larvae Raw Data, Summer 1996.

Contaminant	SOUR1-C		SOUR2-C		STECR-C		TOMRI-C	
Aluminum	107		23.1		44		39.8	
Antimony	ND		ND		ND		ND	
Arsenic	0.286	BW	0.165	BW	0.084	BW	0.147	BW
Barium	18		23.7		7.13		21.4	
Beryllium	0.038	B	0.007	B	0.015	B	0.01	B
Boron	0.825		0.606		0.863		0.81	
Cadmium	0.111	*	0.035	B	ND		0.078	
Chromium	0.188		0.226		0.171		0.515	
Cobalt	0.233	B	0.139	B	0.075	B	0.947	
Copper	1.62		2.87		1.76		3.51	
Iron	428		140		119		251	
Lead	1.21		1.88		0.863		2.22	
Magnesium	80		246		86		295	
Manganese	3.51	E	5.42		0.946	E	37.4	
Mercury	0.038		0.034		0.032		0.033	
Molybdenum	ND		0.21	B	0.08	B	0.263	B
Nickel	0.445	B	0.402		0.35	B	0.763	
Selenium	0.331	S	ND		0.293	BS	0.156	BW
Silver	ND		0.354		ND		ND	
Thallium	ND		ND		ND		ND	
Tin	ND		ND		ND		ND	
Titanium	1.52		0.167	B	1.66		0.326	B
Zinc	18.7	E	42.3		16.3	E	74.7	

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-4. Pinelands Dragonfly Larvae Raw Data, Summer 1996.

Contaminant	ALBBR-D		CLAST-D		ELLCR-D		GIBCR-D		GRARN-D		GRER2-D		MILBR-D		OSWR1-D	
Aluminum	34.1	E	32.5		99.7		35.7		15		17.5		14.7		38.1	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	0.104	BW	0.198	B	0.224	BW	0.086	BW	ND		0.146	BW	ND		0.703	S
Barium	0.464	B	0.907	B	1.16	B	1.27	B	0.659	B	0.817	B	1.24	B	0.743	B
Beryllium	0.004	B	0.003	B	0.005	B	0.003	B	0.004	B	0.004	B	0.005	B	0.002	B
Boron	0.655		0.408	B	0.576		0.82		0.248	B	0.368	B	0.269	B	0.758	
Cadmium	0.04	B	0.036	B*	0.062	*	0.038	B*	0.098		ND		ND		ND	
Chromium	0.119		0.117		0.208		0.183		0.269		1.16		0.126		1.88	
Cobalt	0.177	B	0.104	B	0.061	B	ND		0.048	B	0.232	B	0.056	B	0.107	B
Copper	3.63		3.26		6.77		4.62		4.45		4.26		3.03		4	
Iron	138		349		553		74.2		45.4		116		43.4		1330	
Lead	0.17	B	0.403		0.448	M	0.735		0.304		0.852		0.19	B	0.495	
Magnesium	89.3		121		106		107		97.9		111		74.9		115	
Manganese	4.78	E	0.434	E	0.316	E	0.582	E	0.843		5.86		0.397	E	0.563	
Mercury	0.141	N	0.209		0.229		0.077		0.163		0.082		0.047	N	0.142	
Molybdenum	ND		ND		ND		ND		0.059	B	0.286	B	ND		0.385	B
Nickel	0.206	B	ND		0.146	B	0.195	B	0.365	B	1.35		0.123	B	1.8	
Selenium	0.468	S	0.529	S	0.712	S	0.564	S	0.391	S	0.235	BW	0.738	S	0.516	
Silver	0.075	B	0.064	B	0.072	B	ND		ND		0.115		0.084	B	0.107	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		1.03		ND		ND		ND		ND		ND	
Titanium	1		0.41	B	1.09		1.64		0.782	B	4.68		0.781	B	1.09	
Zinc	14.1		16.2	E	20.9	E	19.9	E	19.9		18.6		15.6		15.6	

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-4. Pinelands Dragonfly Larvae Raw Data, Summer 1996.

Contaminant	PLABR-D		RIDBR-D		SOUR1-D		SOUR2-D		STECR-D	
Aluminum	43.3		17.1		48.1		23.8		15.1	
Antimony	ND		ND		ND		ND		ND	
Arsenic	0.129	BW	0.212	BW	0.096	BW	0.146	BW	0.11	BW
Barium	0.589	B	0.458	B	1.93	B	0.851	B	0.886	B
Beryllium	0.002	B	0.003	B	0.016	B	0.004	B	0.005	B
Boron	0.397	B	0.416	B	0.637		0.242	B	0.27	B
Cadmium	ND		ND		0.056	*	ND		0.068	*
Chromium	0.154		2.89		1.52		1.07		1.8	
Cobalt	ND		0.098	B	0.107	B	0.065	B	0.053	B
Copper	2.67		5.49		4.29		3.72		5.22	
Iron	208		324		336		194		55.7	
Lead	0.526		0.523		0.419		0.466		0.267	M
Magnesium	114		145		118		83.8		89.9	
Manganese	0.344	E	0.979		1.24	E	0.582		0.682	E
Mercury	0.078		0.208		0.07		0.093		0.05	
Molybdenum	ND		0.705	B	0.375	B	0.243	B	0.468	B
Nickel	0.119	B	3.38		1.97		1.28		2.28	
Selenium	0.541	S	0.616	S	0.504	S	0.2	BW	0.44	S
Silver	ND		0.08	B	ND		ND		ND	
Thallium	ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND	
Titanium	1.11		3.36		1.81		2.62		2.31	
Zinc	16.8	E	20.8		20.6	E	13.4		16.5	E

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-5. Pinelands Hellgrammite Raw Data, Summer 1996.

Contaminant	BATRI-H		BURBR-H		ELLCR-H		FACBR-H		GIBCR-H		GRER1-H		HAMCR-H		MANRI-H	
Aluminum	19.8		17.2		81.4		22.5		38.2		17.5		15.2		38.5	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	0.197	BW	0.159	BW	0.184	BW	0.091	BW	ND		0.103	BW	0.082	BW	0.355	BW
Barium	0.679	B	0.725	B	1.15	B	1.38	B	1.11	B	1.16	B	0.505	B	1.13	B
Beryllium	0.002	B	ND		0.005	B	0.002	B	ND		0.004	B	0.007	B	0.004	B
Boron	0.328	B	0.435	B	0.422	B	0.147	B	0.453	B	0.606		0.391	B	0.309	B
Cadmium	ND		ND		ND		ND		0.042	B*	0.047	B	0.044		ND	
Chromium	0.396		0.138		0.205		0.191		0.191		0.424		0.071	B	0.801	
Cobalt	0.048	B	ND		0.082	B	0.053	B	0.035	B	0.3	B	0.409		0.062	B
Copper	4.91		3.64		3.4		3.33		3.08		2.84		1.23		3.27	
Iron	410		229		349		128		78.6		132		85.9		480	
Lead	0.269		1.2		0.545		0.307		0.556		0.712		0.701		0.692	
Magnesium	218		225		244		281		287		240		117		211	
Manganese	0.651	E	0.653	E	0.819	E	1.08	E	1.44	E	7.59		8.38		0.724	
Mercury	0.023		0.194		0.272		0.169		0.082		0.072		0.068		0.105	
Molybdenum	0.186	B	0.111	B	0.062	B	0.068	B	0.06	B	0.179	B	ND		0.291	B
Nickel	0.878		0.109	B	0.125	B	0.134	B	0.117	B	0.449		0.154	B	1.19	
Selenium	0.541	S	0.393	S	0.474	S	0.46	S	0.443	S	0.208	BW	0.233	BW	0.246	BW
Silver	ND		ND		ND		0.067	B	0.081	B	0.091	B	0.104		0.081	B
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	ND		ND		ND		1.07		ND		ND		ND		ND	
Titanium	0.228	B	0.454	B	0.639	B	1.13		0.912	B	0.453	B	0.141	B	0.584	B
Zinc	19.7	E	20.3	E	22	E	22.1	E	27.9	E	20.8		12.1		21.2	

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-5. Pinelands Hellgrammite Raw Data, Summer 1996.

Contaminant	OLDBR-H		OSWR2-H		OYSCR-H		TOMRI-H		WBWAD-H	
Aluminum	18.4		11.6	E	20.4		33.6		14.4	E
Antimony	ND		ND		ND		ND		ND	
Arsenic	0.136	BS	0.126	BW	0.065	BW	0.161	BW	0.414	BW
Barium	0.747	B	0.366	B	0.36	B	4.93		1.04	B
Beryllium	0.002	B	0.002	B	0.002	B	0.005	B	ND	
Boron	0.492	B	0.735		0.4	B	2.93		0.97	
Cadmium	0.05		ND		0.054	*	0.074		ND	
Chromium	0.385		0.236		0.365		0.591		0.249	
Cobalt	0.041	B	0.041	B	0.045	B	0.331	B	0.049	B
Copper	2.33		2.62		2.45		2.56		3.81	
Iron	68.6		498		263		267		525	
Lead	0.552		0.139	B	0.512		1.05		0.452	
Magnesium	229		165		211		201		161	
Manganese	1		0.558	E	0.779	E	12.2		0.715	E
Mercury	0.139		0.105	N	0.127		0.033		0.143	N
Molybdenum	0.178	B	0.106	B	0.185	B	0.173	B	0.098	B
Nickel	0.532		0.171	B	0.457		0.616		0.22	B
Selenium	0.563	S	0.478	S	0.967	S	0.223	B	0.249	B
Silver	0.083	B	0.071	B	ND		ND		ND	
Thallium	ND		ND		ND		ND		ND	
Tin	ND		ND		ND		ND		ND	
Titanium	0.315	B	0.229	B	0.347	B	0.472	B	0.311	B
Zinc	21.8		19		19.1	E	24.3		17.3	

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-6. Pinelands Forage Fish Raw Data, Summer 1996.

Contaminant	ALBBR-F		BATRI-F		BURBR-F		CLAST-F		ELLCR-F		FACBR-F		FACBR-M		GIBCR-F	
Aluminum	3.06		2.34		3.32		6.31		6.25		3.45		3.64		3.58	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	0.213	BW	0.1	BW	ND		ND		ND		0.085	BW	ND		ND	
Barium	6.4		3.65		17.2		10.3		23.5		19.7		111		31.4	
Beryllium	0.005	B	0.001	B	0.002	B	0.002	B	0.002	B	0.002	B	0.002	B	0.002	B
Boron	0.244	B	0.241	B	0.331	B	0.186	B	0.28	B	0.524		1.01		0.287	B
Cadmium	ND		ND		0.076		0.04	B	ND		0.166		0.058	B	0.125	
Chromium	0.307		0.603		0.428		0.412		0.299		0.56		0.516		0.49	
Cobalt	0.056	B	ND		0.031	B	0.043	B	0.042	B	0.095	B	0.102	B	0.062	B
Copper	0.567		0.593		0.443		2.15		0.933		1.88		0.802		0.833	
Iron	20.3		34.2		27		31.6		43.7		25.8		32.9		19.2	
Lead	3.46		1.25		3.23		0.863		6.61		7.11		31.7		3	
Magnesium	329		326	N	409	N	321	N	326	N	383	N	444	N	475	N
Manganese	3.54	E	0.738	E	1.54	E	1.46	E	0.904	E	3.5	E	1.94	E	3.06	E
Mercury	0.163		0.069		0.317		0.359		0.25		0.335		0.382		0.331	
Molybdenum	ND		0.066	B	ND		ND		ND		0.052	B	ND		ND	
Nickel	0.346	B	0.137	B	ND		0.173	B	0.11	B	ND		ND		0.148	B
Selenium	0.48	S	0.686	S	0.494	S	0.59	S	0.405	S	0.429	S	0.921	S	0.42	S
Silver	ND		0.168	N	ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		0.143	B	ND	
Tin	8.34		1.65		1.72		1.24		1.38		1.5		2		1.62	
Titanium	0.015	B	ND		ND		0.091	B	0.065	B	0.04	B	0.018	B	ND	
Zinc	43.2	E	22.8	E	36.8	E	28.7	E	53	E	42.3	E	89.4	E	24.5	E

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-6. Pinelands Forage Fish Raw Data, Summer 1996.

Contaminant	GRARN-F		GRER1-F		GRER2-F		HAMCR-F		LAKBR-F		LAKBR-B		MANRI-F		MANRI-M	
Aluminum	2.86		2.04		1.92	B	3.81		2.43		1.55	B	2.72		3.61	
Antimony	ND		ND		ND		ND		0.384	B	ND		ND		ND	
Arsenic	ND		ND		ND		ND		0.128	BW	ND		0.096	BW	0.079	BW
Barium	39.7		13.4		19.3		3.7		24.5		2.91		39.8		18	
Beryllium	0.003	B	0.001	B	0.004	B	0.003	B	0.004	B	0.003	B	0.004	B	0.004	B
Boron	0.329	B	0.462	B	0.385	B	0.248	B	0.253	B	0.225	B	0.228	B	0.183	B
Cadmium	ND		0.036	B	0.033	B	ND		ND		ND		ND		0.043	B
Chromium	1.44		0.336		0.304		0.447		0.327		0.2		0.239		0.425	
Cobalt	0.088	B	0.055	B	0.067	B	0.049	B	0.051	B	0.029	B	0.086	B	0.06	B
Copper	0.618		0.571		0.485		2.35		0.786		0.335		0.707		0.592	
Iron	29.2		23.6		25.6		15.2		60		22.6		35.1		30.8	
Lead	6.98		2.43		1.15		0.64		0.415		0.127	B	4.96		2.47	
Magnesium	227	N	377	N	321	N	296	N	319		157		255	N	390	N
Manganese	1.23	E	2.27	E	1.41	E	1.38	E	1.46	E	0.998	E	0.706	E	1.26	E
Mercury	0.282		0.11		0.152		0.118		0.105		0.251		0.092		0.208	
Molybdenum	ND		ND		ND		ND		ND		0.052	B	ND		ND	
Nickel	0.144	B	ND		ND		ND		ND		0.126	B	ND		ND	
Selenium	0.38		0.487	S	0.236	B	0.406		0.29	B	0.289	B	0.319	B	0.291	B
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	1.31		ND		1.2		1.33		1.12		ND		1.37		1.76	
Titanium	0.122	B	ND		ND		0.042	B	0.125	B	0.013	B	0.058	B	ND	
Zinc	53.5		79.7	E	54.2		13		55.1	E	9.35	E	46.4		29.7	

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-6. Pinelands Forage Fish Raw Data, Summer 1996.

Contaminant	MILBR-F		OSWR1-F		OSWRI-M		OSWR2-F		OSWR2-B		OYSCR-F		PLABR-F		RIDBR-F	
Aluminum	2.65		5.9		11.1		2.02		3.9		4.96		8.14		3.34	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	0.076	BW	0.221	BW	0.238	BW	0.166	BW	0.161	BW	ND		0.112	BW	0.246	BW
Barium	5.83		42.8		49.6		38.6		18.9		14.2		15.2		16.3	
Beryllium	0.004	B	0.004	B	0.005	B	0.004	B	0.003	B	0.003	B	0.002	B	0.003	B
Boron	0.091	B	0.108	B	0.199	B	0.117	B	0.242	B	0.388	B	0.357	B	0.371	B
Cadmium	ND		0.086		0.087		ND		0.045	B	0.042	B	0.179		ND	
Chromium	0.305		0.307		0.462		2.32		0.364		0.458		0.478		0.26	
Cobalt	0.054	B	0.115	B	0.106	B	0.067	B	0.083	B	ND		0.087	B	0.031	B
Copper	0.493		0.611		0.566		1.36		0.741		2.28		0.876		0.934	
Iron	19.6		59.9		68.9		124		78.7		52.9		44		44.5	
Lead	5.28		2.48		3.95		8.25		2.38		3.9		18.7		4.77	
Magnesium	325		323	N	408	N	322		353		430	N	397	N	288	N
Manganese	3.44	E	1.63	E	3.16	E	0.784	E	1.18	E	1.22	E	1.65	E	0.695	E
Mercury	0.148		0.259		0.285		0.133		0.038		0.472		0.271		0.128	
Molybdenum	ND		0.109	B	ND		ND		0.082	B	0.057	B	0.082	B	ND	
Nickel	0.127	B	ND		ND		0.199	B	ND		ND		ND		ND	
Selenium	0.706		1.19	S	1.14	S	0.641		0.704		0.847	S	0.71	S	0.87	S
Silver	ND		ND		ND		ND		ND		ND		ND		0.217	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	8.44		1.44		1.52		1.24		1.4		1.38		1.79		1.13	
Titanium	0.024	B	0.023	B	0.024	B	0.026	B	ND		0.106	B	0.09	B	0.061	B
Zinc	43.7	E	46.4		43.6		57.4	E	36.8	E	33	E	60.6	E	50.2	

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-6. Pinelands Forage Fish Raw Data, Summer 1996.

Contaminant	SOUR1-F		SOUR2-F		STECR-F		TOMRI-F		WBWAD-F		WBWAD-B	
Aluminum	6.92		1.78	B	2.41		2.5		2.74	B	6.66	
Antimony	ND		ND		ND		ND		ND		ND	
Arsenic	ND		0.072	BW	ND		0.164	BE	0.142	BW	0.119	BW
Barium	9.77		27.3		25.1		63.6		42		22.6	
Beryllium	0.003	B	0.004	B	0.002	B	0.004	B	0.009	B	0.004	B
Boron	0.551		0.475	B	0.584		0.153	B	0.508	B	0.177	B
Cadmium	ND		ND		0.034	B	ND		ND		0.061	
Chromium	0.39		0.27		0.824		0.276		3.16		0.428	
Cobalt	0.065	B	0.068	B	0.059	B	0.087	B	ND		0.071	B
Copper	0.78		0.537		0.686		0.743		2.36		0.482	
Iron	28.6		22.3		24.9		48.2		133		42.5	
Lead	0.251		2.05		0.799		4.65		17.2		4.46	
Magnesium	329	N	290	N	341	N	283	N	307		331	
Manganese	0.804	E	1.09	E	1.28	E	0.885	E	0.908	E	1.51	E
Mercury	0.034		0.132		0.058		0.074		0.105		0.158	
Molybdenum	ND		ND		ND		ND		ND		ND	
Nickel	0.148	B	ND		0.328	B	0.118	B	0.443	B	ND	
Selenium	0.516	S	0.315	B	0.581	S	0.469	S	0.572		0.475	
Silver	ND		ND		0.5	N	ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND	
Tin	1.03		1.41		ND		1.59		ND		1.3	
Titanium	0.029	B	0.135	B	ND		0.074	B	0.035	B	0.034	B
Zinc	15.1	E	50.8		59.3	E	55.7		59.9	E	42.7	E

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-7. Pinelands Predatory Fish Raw Data, Summer 1996.

Contaminant	ALBBR-P		ALBBR-L		BURBR-P		CLAST-P		FACBR-P		FACBR-R		GIBCR-P		GRARN-P	
Aluminum	2.34		3.27		1.13	B	1.41	B	0.762	B	1.8	B	2.08		1.16	B
Antimony	ND		ND		ND		ND		ND		ND		ND		0.451	B
Arsenic	0.146	BW	0.127	BW	ND		ND		0.068	BW	0.075	BW	ND		0.142	BW
Barium	6.8		13.8		4.85		8.59		5.63		19.9		11.1		11.2	
Beryllium	0.004	B	0.003	B	0.003	B	0.002	B	0.002	B	0.003	B	0.002	B	0.004	B
Boron	0.259	B	0.279	B	0.779		0.347	B	0.2	B	0.24	B	0.518		0.33	B
Cadmium	ND		ND		ND		ND		ND		ND		ND		ND	
Chromium	0.32		0.511		0.285		0.562		0.318		0.372		0.403		0.388	
Cobalt	0.065	B	0.054	B	ND		ND		ND		0.043	B	ND		0.05	B
Copper	0.535		0.882		0.315		0.367		0.427		0.421		0.382		0.496	
Iron	22		19.4		14.2		13.1		9.38		24.4		12.7		8.29	
Lead	0.473	S	0.223	S	0.283		0.474		0.64		2.45		0.851		2.84	
Magnesium	361		445		356	N	426	N	349	N	359	N	412	N	352	N
Manganese	3.89	E	1.72	E	1.06	E	1.22	E	1.26	E	1.26	E	1.41	E	1.66	E
Mercury	0.689		1.02		0.825		0.717		0.783		0.855		0.718		0.748	
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	0.107	B	0.155	B	ND		ND		0.104	B	ND		ND		ND	
Selenium	0.313	B	0.422	S	0.384	S	0.485	S	0.553	S	0.5	S	0.514	S	0.41	
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		0.137	B	ND		ND		ND	
Tin	8.26		2.01		1.58		1.83		1.57		1.63		1.53		1.48	
Titanium	0.063	B	0.053	B	ND		ND		ND		ND		ND		0.016	B
Zinc	45.3	E	13.8	E	34	E	37.9		30.1	E	34.9	E	57.5	E	54.8	

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-7. Pinelands Predatory Fish Raw Data, Summer 1996.

Contaminant	GRER1-P		GRER2-P		HAMCR-P		LAKBR-P		MANRI-P		MILBR-P		OLDBR-P		OSWR1-P	
Aluminum	1.11	B	1.07	B	1.77	B	437		2.2		1.67	B	2.22		1.97	B
Antimony	ND		ND		0.479	B	ND		ND		ND		0.4	B	ND	
Arsenic	0.089	BW	0.161	BW	ND		0.067	BW	0.105	BW	0.124	BW	0.139	BW	0.367	BW
Barium	2.88		3.95		3.52		4.18		14.6		17.6		21.6		11.1	
Beryllium	0.003	B	0.003	B	0.004	B	0.003	B	0.005	B	0.004	B	0.004	B	0.004	B
Boron	0.233	B	0.185	B	0.204	B	0.157	B	0.135	B	0.219	B	0.52		0.204	B
Cadmium	ND		ND		ND		ND		ND		ND		0.038	B	ND	
Chromium	0.392		0.312		0.586		0.625		0.269		0.43		0.308		0.222	
Cobalt	0.041	B	0.054	B	ND		ND		0.033	B	0.031	B	0.04	B	0.052	B
Copper	0.353		0.557		1.36		16.5		0.466		0.336		0.417		0.404	
Iron	7.83		12.1		13.4		25		14.8		11.9		13.3		35	
Lead	0.228		1.08	S	0.164	B	ND		1.16		0.363		3.44		1.11	
Magnesium	349	N	327	N	350	N	381		296	N	346		322	N	242	N
Manganese	2.58	E	3.02	E	2.31	E	2.14	E	0.997	E	1.22	E	2.53	E	0.553	E
Mercury	0.336		0.413		0.483		1.3		0.083		0.457		0.528		0.349	
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	ND		ND		0.731		0.193	B	ND		0.567		ND		ND	
Selenium	0.267	B	0.306	B	0.446	S	0.962	S	0.175	B	0.825	S	0.753	S	0.913	S
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	1.66		2.07		1.62		3.69		1.53		1.36		1.48		1.29	
Titanium	ND		ND		ND		0.582	B	0.022	B	0.036	B	ND		ND	
Zinc	45.1		46.6		47.8		17.7	E	39.9		39.2	E	35.5		37	

Notes:
1. All values reported in mg/kg wet weight.

Appendix C-7. Pinelands Predatory Fish Raw Data, Summer 1996.

Contaminant	OSWR2-P		PLABR-P		RIDBR-P		SOUR1-P		SOUR2-P		STECR-P		TOMRI-P		WBWAD-P	
Aluminum	2.22		1.81	B	1.29	B	2.15		1.25	B	1.22	B	0.7	B	1.45	B
Antimony	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	0.149	BW	ND		0.159	BW	ND		0.247	BW	ND		0.236	BW	0.205	BW
Barium	5.98		7.06		4.27		5.33		5.01		7.57		1.53	B	6.89	
Beryllium	0.003	B	0.002	B	0.003	B	0.002	B	0.003	B	0.002	B	0.003	B	0.004	B
Boron	0.181	B	0.269	B	0.2	B	0.18	B	0.119	B	1.26		0.202	B	0.21	B
Cadmium	ND		ND		ND		ND		ND		ND		ND		ND	
Chromium	0.379		0.45		0.256		0.337		0.299		0.395		0.415		0.286	
Cobalt	ND		ND		ND		ND		0.034	B	ND		ND		0.039	B
Copper	0.299		0.308		0.349		0.496		0.369		0.428		0.336		0.491	
Iron	20.3		11.1		11.9		11.2		9.44		9.31		7.38		15.3	
Lead	0.24	W	2.89		1		0.334		0.562		0.39		0.515		1.93	S
Magnesium	418		397	N	313	N	324	N	344	N	349	N	314	N	327	
Manganese	0.704	E	1.02	E	0.99	E	0.958	E	1.21	E	1.2	E	1.75	E	0.956	E
Mercury	0.741		0.96		0.185		0.16		0.301		0.168		0.196		0.229	
Molybdenum	ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	ND		ND		ND		ND		ND		0.12	B	ND		ND	
Selenium	0.69	S	0.773	S	0.754	S	0.475	S	0.494	S	0.4	S	0.577	S	0.606	
Silver	ND		ND		ND		ND		ND		ND		ND		ND	
Thallium	ND		ND		ND		ND		ND		ND		ND		ND	
Tin	1.62		1.7		1.38		1.58		1.7		1.49		1.64		1.29	
Titanium	0.083	B	ND		0.047	B	ND		0.026	B	ND		ND		0.035	B
Zinc	53	E	46.6	E	42.8		48.9	E	51.1		96.5	E	29.4		33.3	E

Notes:
1. All values reported in mg/kg wet weight.

Appendix D

Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

ALBBR-S	ALBBR-W	ALBBR-F	ALBBR-SU	ALBBR-O	ALBBR-P	ALBBR-L	ALBBR-D	ALBBR-CF	ALBBR-H
0.129	0.112	0.163	NA	NA	0.689	1.02	0.141	NA	NA
1	2	3	4	5	6	7	8	9	10
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.624	0.144147844	0.000010864	0.0018189	0.001878608	0.146026452	0.012	12.168871
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.141	0.007934455	0.000007056	0.00015996	0.000151833	0.008086287	0.03	0.2695429
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.426	0.0639	0.000002352	0.00045021	0.002134726	0.066034726	0.03	2.2011575
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.163	0.0815	0.00000168	0.00096492	0.007107353	0.088607353	0.03	2.9535784

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

BATRI-S	BATRI-W	BATRI-MD	BATRI-F	BATRI-O	BATRI-PI	BATRI-BA	BATRI-DF	BATRI-C	BATRI-H
0.087	0.046	NA	0.069	NA	NA	NA	NA	0.009	0.023
11	12	13	14	15	16	17	18	19	20
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.069	0.015939425	0.000004462	0.0012267	0.001264027	0.017203452	0.012	1.433620979
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.016	0.000900364	0.000002898	0.00010788	0.000100707	0.001001071	0.03	0.03336903
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.069	0.01035	0.000000966	0.00030363	0.001436774	0.011786774	0.03	0.392892453
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.069	0.0345	0.00000069	0.00065076	0.004790074	0.039290074	0.03	1.309669118

Appendix D Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1998.

BURBR-S	BURBR-W	BURBR-MU	BURBR-F	BURBR-O	BURBR-P	BURBR-BA	BURBR-DF	BURBR-C	BURBR-H
0.076	0	NA	0.317	NA	0.825	NA	NA	0.109	0.194
21	22	23	24	25	26	27	28	29	30
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.571	0.131904517	0	0.0010716	0.001100205	0.133004723	0.012	11.0837269
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.1515	0.008525318	0	0.00009424	8.56727E-05	0.008610991	0.03	0.28703303
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.571	0.08565	0	0.00026524	0.001251132	0.086901132	0.03	2.896704403
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.317	0.1585	0	0.00056848	0.00418	0.16268	0.03	5.422666667

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

CLAST-S	CLAST-W	CLAST-MU	CLAST-SU	CLAST-F	CLAST-P	CLAST-BA	CLAST-D	CLAST-C	CLAST-HE
0.278	0.038	NA	NA	0.359	0.717	NA	0.209	0.11	NA
31	32	33	34	35	36	37	38	39	40
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.538	0.124281314	0.000003686	0.0039198	0.00402822	0.128309534	0.012	10.69246116
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.1595	0.0089755	0.000002394	0.00034472	0.000315558	0.009291058	0.03	0.309701939
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.538	0.0807	0.000000798	0.00097022	0.004580274	0.085280274	0.03	2.842675786
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.359	0.1795	0.00000057	0.00207944	0.015294191	0.194794191	0.03	6.493139706

ELLCR-S	ELLCR-W	ELLCR-F	ELLCR-SU	ELLCR-O	ELLCR-PI	ELLCR-BA	ELLCR-D	ELLCR-CF	ELLCR-H
0.151	0.075	0.25	NA	NA	NA	NA	0.229	NA	0.272
41	42	43	44	45	46	47	48	49	50
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.25	0.05775154	0.000007275	0.0021291	0.002193403	0.059944944	0.012	4.995411961
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.2505	0.014096318	0.000004725	0.00018724	0.000174514	0.014270832	0.03	0.475694394
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.25	0.0375	0.000001575	0.00052699	0.002493231	0.039993231	0.03	1.333107704
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.25	0.125	0.000001125	0.00112948	0.008313272	0.133313272	0.03	4.443775735

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

FACBR-S	FACBR-W	FACBR-M	FACBR-F	FACBR-O	FACBR-PX	FACBR-BA	FACBR-DF	FACBR-C	FACBR-H
0.058	0.059	0.382	0.335	NA	0.819	NA	NA	0.142	0.169
51	52	53	54	55	56	57	58	59	60
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.512	0.118275154	0.000005723	0.0008178	0.000845506	0.11912066	0.012	9.92672168
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.1555	0.008750409	0.000003717	0.00007192	6.87609E-05	0.00881917	0.03	0.293972333
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.512	0.0768	0.000001239	0.00020242	0.000960656	0.077760656	0.03	2.592021855
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.3585	0.17925	0.000000885	0.00043384	0.003196507	0.182446507	0.03	6.081550245

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

GIBCR-S	GIBCR-W	GIBCR-MU	GIBCR-F	GIBCR-O	GIBCR-P	GIBCR-BA	GIBCR-D	GIBCR-C	GIBCR-H
0.165	0	NA	0.331	NA	0.718	NA	0.077	0.049	0.082
61	62	63	64	65	66	67	68	69	70
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.5245	0.121162731	0	0.0023265	0.002388604	0.123551335	0.012	10.29594456
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.069333333	0.003901576	0	0.0002046	0.000186	0.004087576	0.03	0.136252525
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.5245	0.078675	0	0.00057585	0.002716274	0.081391274	0.03	2.713042453
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.331	0.1655	0	0.0012342	0.009075	0.174575	0.03	5.819166667

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

GRARN-S	GRARN-W	GRARN-F	GRARN-SU	GRARN-O	GRARN-P	GRARN-BA	GRARN-D	GRARN-C	GRARN-HE
0.271	0.111	0.282	NA	NA	0.748	NA	0.163	0.077	NA
71	72	73	74	75	76	77	78	79	80
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.515	0.118968172	0.000010767	0.0038211	0.003934155	0.122902328	0.012	10.24186063
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.12	0.006752727	0.000006993	0.00033604	0.000311848	0.007064575	0.03	0.235485848
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.515	0.07725	0.000002331	0.00094579	0.004472269	0.081722269	0.03	2.724075629
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.282	0.141	0.000001665	0.00202708	0.014917243	0.155917243	0.03	5.197241422

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

GRER1-S	GRER1-W	GRER1-F	GRER1-SU	GRER1-O	GRER1-P	GRER1-BA	GRER1-DR	GRER1-C	GRER1-H
0.34	0.052	0.11	NA	NA	0.336	NA	NA	0.038	0.072
81	82	83	84	85	86	87	88	89	90
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.223	0.051514374	0.000005044	0.004794	0.00492715	0.056441524	0.012	4.703460301
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.055	0.003095	0.000003276	0.0004216	0.000386251	0.003481251	0.03	0.116041697
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.223	0.03345	0.000001092	0.0011866	0.005602321	0.039052321	0.03	1.301744025
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.11	0.055	0.00000078	0.0025432	0.018705735	0.073705735	0.03	2.456857843

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

GRER2-S	GRER2-W	GRER2-F	GRER2-SU	GRER2-O	GRER2-P	GRER2-BA	GRER2-D	GRER2-C	GRER2-HE
0.098	0.093	0.152	NA	NA	0.413	NA	0.082	0.056	NA
91	92	93	94	95	96	97	98	99	100
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.2825	0.06525924	0.000009021	0.0013818	0.001427948	0.066687188	0.012	5.557265657
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.069	0.003882818	0.000005859	0.00012152	0.000115799	0.003998617	0.03	0.133287242
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.2825	0.042375	0.000001953	0.00034202	0.001622514	0.043997514	0.03	1.466583805
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.152	0.076	0.000001395	0.00073304	0.005400257	0.081400257	0.03	2.713341912

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

HAMCR-S	HAMCR-W	HAMCR-MU	HAMCR-SU	HAMCR-F	HAMCR-P	HAMCR-BA	HAMCR-DF	HAMCR-C	HAMCR-H
0.275	0.099	NA	NA	0.118	0.483	NA	NA	0.057	0.068
101	102	103	104	105	106	107	108	109	110
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.3005	0.069417351	0.000009603	0.0038775	0.003990866	0.073408217	0.012	6.117351386
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.0625	0.003517045	0.000006237	0.000341	0.00031567	0.003832715	0.03	0.127757182
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.3005	0.045075	0.000002079	0.00095975	0.004536929	0.049611929	0.03	1.653730975
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.118	0.059	0.000001485	0.002057	0.015135919	0.074135919	0.03	2.471197304

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

LAKBR-S	LAKBR-W	LAKBR-F	LAKBR-B	LAKBR-0	LAKBR-PI	LAKBR-P	LAKBR-DF	LAKBR-C	LAKBR-HE
0.058	0.101	0.105	0.251	NA	NA	1.3	NA	0.09	NA
111	112	113	114	115	116	117	118	119	120
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.552	0.1275154	0.000009797	0.0008178	0.000849689	0.128365089	0.012	10.69709078
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.09	0.005064545	0.000006363	0.00007192	7.11664E-05	0.005135712	0.03	0.171190394
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.178	0.0267	0.000002121	0.00020242	0.000964816	0.027664816	0.03	0.922160535
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.178	0.089	0.000001515	0.00043384	0.00320114	0.09220114	0.03	3.073371324

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

MANRI-S	MANRI-W	MANRI-F	MANRI-M	MANRI-O	MANRI-P	MANRI-BA	MANRI-DF	MANRI-C	MANRI-H
0.139	0.045	0.092	0.208	NA	0.083	NA	NA	0.102	0.105
121	122	123	124	125	126	127	128	129	130
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.127666667	0.029491786	0.000004365	0.0019599	0.002016699	0.031508486	0.012	2.625707136
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.1035	0.005824227	0.000002835	0.00017236	0.000159268	0.005983495	0.03	0.199449848
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.127666667	0.01915	0.000000945	0.00048511	0.002292712	0.021442712	0.03	0.714757075
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.15	0.075	0.000000675	0.00103972	0.007649963	0.082649963	0.03	2.754998775

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

MILBR-S	MILBR-W	MILBR-F	MILBR-SU	MILBR-O	MILBR-P	MILBR-BA	MILBR-D	MILBR-C	MILBR-HE
0.19	0.101	0.148	NA	NA	0.457	NA	0.047	0.044	NA
131	132	133	134	135	136	137	138	139	140
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.3025	0.069879363	0.000009797	0.002679	0.002760572	0.072639935	0.012	6.053327943
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.0455	0.002560409	0.000006363	0.0002356	0.000219966	0.002780375	0.03	0.092679182
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.3025	0.045375	0.000002121	0.0006631	0.003137835	0.048512835	0.03	1.617094497
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.148	0.074	0.000001515	0.0014212	0.01046114	0.08446114	0.03	2.815371324

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

OLDBR-S	OLDBR-W	OLDBR-MU	OLDBR-SU	OLDBR-O	OLDBR-P	OLDBR-BA	OLDBR-DF	OLDBR-CX	OLDBR-H
0.069	0.044	NA	NA	NA	0.528	NA	NA	0.061	0.139
141	142	143	144	145	146	147	148	149	150
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.528	0.121971253	0.000004268	0.0009729	0.001003253	0.122974505	0.012	10.24787543
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.1	0.005627273	0.000002772	0.00008556	8.03018E-05	0.005707575	0.03	0.190252485
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.528	0.0792	0.000000924	0.00024081	0.001140255	0.080340255	0.03	2.678008491
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		NA	NA	NA	NA	NA	NA	0.03	NA

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

OSWR1-S	OSWR1-W	OSWR1-MU	OSWR1-F	OSWR1-O	OSWR1-P	OSWR1-BA	OSWR1-D	OSWR1-CF	OSWR1-HE
0.147	0.036	NA	0.259	0.285	0.349	NA	0.142	NA	NA
151	152	153	154	155	156	157	158	159	160
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI + II)	Toxicity	Hazard Quotient
		0.297666667	0.068762834	0.000003492	0.0020727	0.002131614	0.070894448	0.012	5.907870637
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI + II)	Toxicity	Hazard Quotient
		0.142	0.007990727	0.000002268	0.00018228	0.000167771	0.008158498	0.03	0.271949939
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI + II)	Toxicity	Hazard Quotient
		0.297666667	0.04465	0.000000756	0.00051303	0.002423519	0.047073519	0.03	1.569117296
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI + II)	Toxicity	Hazard Quotient
		0.272	0.136	0.00000054	0.00109956	0.008088971	0.144088971	0.03	4.802965686

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

OSWR2-S	OSWR2-W	OSWR2-F	OSWR2-B	OSWR2-O	OSWR2-P	OSWR2-BA	OSWR2-DF	OSWR2-CF	OSWR2-H
0.399	0.099	0.133	0.038	NA	0.741	NA	NA	NA	0.105
161	162	163	164	165	166	167	168	169	170
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.304	0.070225873	0.000009603	0.0056259	0.005785937	0.07601181	0.012	6.334317505
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.105	0.005908636	0.000006237	0.00049476	0.000455452	0.006364088	0.03	0.212136273
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.304	0.0456	0.000002079	0.00139251	0.00657825	0.05217825	0.03	1.739275
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.0855	0.04275	0.000001485	0.00298452	0.021955919	0.064705919	0.03	2.156863971

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

OYSCR-S	OYSCR-W	OYSCR-MU	OYSCR-F	OYSCR-O	OYSCR-PI	OYSCR-BA	OYSCR-DF	OYSCR-C	OYSCR-H
0.115	0.021	NA	0.472	NA	NA	NA	NA	0.229	0.127
171	172	173	174	175	176	177	178	179	180
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.472	0.109034908	0.000002037	0.0016215	0.001666876	0.110701783	0.012	9.225148614
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.178	0.010016545	0.000001323	0.0001426	0.000130839	0.010147385	0.03	0.338246152
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.472	0.0708	0.000000441	0.00040135	0.001895241	0.072695241	0.03	2.423174686
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.472	0.236	0.000000315	0.0008602	0.006327316	0.242327316	0.03	8.077577206

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

PLABR-S	PLABR-W	PLABR-MU	PLABR-F	PLABR-O	PLABR-P	PLABR-BA	PLABR-D	PLABR-CF	PLABR-HE
0.192	0.028	NA	0.271	NA	0.96	NA	0.078	NA	NA
181	182	183	184	185	186	187	188	189	190
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.6155	0.142184292	0.000002716	0.0027072	0.002782255	0.144966546	0.012	12.08054552
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.078	0.004389273	0.000001764	0.00023808	0.00021804	0.004607313	0.03	0.153577091
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.6155	0.092325	0.000000588	0.00067008	0.003163528	0.095488528	0.03	3.182950943
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.271	0.1355	0.00000042	0.00143616	0.010563088	0.146063088	0.03	4.868769608

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

RIDBR-S	RIDBR-W	RIDBR-F	RIDBR-SU	RIDBR-O	RIDBR-P	RIDBR-BA	RIDBR-D	RIDBR-C	RIDBR-HE
0.042	0.047	0.128	NA	NA	0.185	NA	0.208	0.038	NA
191	192	193	194	195	196	197	198	199	200
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.1565	0.036152464	0.000004559	0.0005922	0.000612689	0.036765153	0.012	3.063762748
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.123	0.006921545	0.000002961	0.00005208	5.00373E-05	0.006971583	0.03	0.232386091
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.1565	0.023475	0.000000987	0.00014658	0.000696071	0.024171071	0.03	0.805702358
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.128	0.064	0.000000705	0.00031416	0.002315184	0.066315184	0.03	2.210506127

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

SOUR1-S	SOUR1-W	SOURI-MU	SOURI-SU	SOUR1-F	SOUR1-P	SOURI-BA	SOUR1-D	SOUR1-C	SOURI-HE
0.295	0.039	NA	NA	0.034	0.16	NA	0.07	0.038	NA
201	202	203	204	205	206	207	208	209	210
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.097	0.022407598	0.000003783	0.0041595	0.004274418	0.026682015	0.012	2.223501283
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.054	0.003038727	0.000002457	0.0003658	0.000334779	0.003373506	0.03	0.112450212
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.097	0.01455	0.000000819	0.00102955	0.004860231	0.019410231	0.03	0.647007704
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.034	0.017	0.000000585	0.0022066	0.016229301	0.033229301	0.03	1.107643382

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

SOUR2-S	SOUR2-W	SOUR2-F	SOUR2-SU	SOUR2-O	SOUR2-P	SOUR2-BA	SOUR2-D	SOUR2-C	SOUR2-HE
0.092	0.043	0.132	NA	NA	0.301	NA	0.093	0.034	NA
211	212	213	214	215	216	217	218	219	220
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.2165	0.050012834	0.000004171	0.0012972	0.00133611	0.051348944	0.012	4.279078628
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.0635	0.003573318	0.000002709	0.00011408	0.000106172	0.00367949	0.03	0.122649667
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.2165	0.032475	0.000000903	0.00032108	0.001518788	0.033993788	0.03	1.133126258
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.132	0.066	0.000000645	0.00068816	0.005064743	0.071064743	0.03	2.368824755

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

STECR-S	STECR-W	STECR-F	STECR-SU	STECR-O	STECR-P	STECR-BA	STECR-D	STECR-C	STECR-HE
0.099	0.05	0.058	NA	NA	0.168	NA	0.05	0.032	NA
221	222	223	224	225	226	227	228	229	230
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.113	0.026103696	0.00000485	0.0013959	0.001438142	0.027541838	0.012	2.295153149
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.041	0.002307182	0.00000315	0.00012276	0.000114464	0.002421645	0.03	0.080721515
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.113	0.01695	0.00000105	0.00034551	0.001634717	0.018584717	0.03	0.619490566
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.058	0.029	0.00000075	0.00074052	0.005450515	0.034450515	0.03	1.14835049

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

TOMRI-S	TOMRI-W	TOMRI-F	TOMRI-SU	TOMRI-O	TOMRI-P	TOMRI-BA	TOMRI-DF	TOMRI-C	TOMRI-H
0.047	0.043	0.074	NA	NA	0.196	NA	NA	0.033	0.033
231	232	233	234	235	236	237	238	239	240
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.135	0.031185832	0.000004171	0.0006627	0.000684672	0.031870504	0.012	2.655875342
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.033	0.001857	0.000002709	0.00005828	5.54445E-05	0.001912445	0.03	0.063748152
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.135	0.02025	0.000000903	0.00016403	0.000777986	0.021027986	0.03	0.700932862
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.074	0.037	0.000000645	0.00035156	0.002589743	0.039589743	0.03	1.319658088

Appendix D. Spreadsheets of Mercury Hazard Quotients Calculated From Pinelands Data Collected During Summer 1996.

WBWAD-S	WBWAD-W	WBWAD-F	WBWAD-B	WBWAD-O	WBWAD-P	WBWAD-BA	WBWAD-DF	WBWAD-CF	WBWAD-H
0.214	0.107	0.105	0.158	NA	0.229	NA	NA	NA	0.143
241	242	243	244	245	246	247	248	249	250
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Mink	0.225	0.974	0	0.097	0.0141				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.164	0.03788501	0.000010379	0.0030174	0.003108603	0.040993613	0.012	3.416134411
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Black Duck	0.0619	1.1	0	0.063	0.00124				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.143	0.008047	0.000006741	0.00026536	0.000247365	0.008294365	0.03	0.276478818
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
Green Heron	0.0318	0.212	0	0.021	0.00349				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.164	0.0246	0.000002247	0.00074686	0.003533524	0.028133524	0.03	0.937784119
		Hazard Quotient Calculations							
Species	Ing. rate	Body weight	Soil Ing rate	SW Ing rate.	Sed. Ing rate.				
	kg/day	kg	kg/day	L/day	kg/day				
B. Kingfisher	0.068	0.136	0	0.015	0.00748				
		Diet (Cp) Conc.	Diet Ing. (DI)	Water Ing.	Sediment Ing.	Incident Ing. (II)	Total Dose (DI+II)	Toxicity	Hazard Quotient
		0.1315	0.06575	0.000001605	0.00160072	0.011781801	0.077531801	0.03	2.584393382