An Evaluation of Sediment Quality Conditions in Presque Isle Bay Area of Concern, Pennsylvania

Technical Report - Preliminary Draft

Prepared for:

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Development of Delisting Targets for the Presque Isle Bay Area of Concern, Pennsylvania

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Chapter 1 Introduction

1.0 Study Area

Presque Isle Bay is located in northwestern Pennsylvania on the southern shore of Lake Erie (Figure 1). Overall, the drainage basin is about 66 km^2 in area, and includes much of the City of Erie as well as portions of Mill Creek, Summit, Greene, and Harbor Creek townships. The Presque Isle Bay watershed consists of the Bay itself, the Mill Creek watershed (including Garrison Run, the Cascade Creek watershed, the Scott Run watershed, and the aquatic habitats within Presque Isle Bay State Park. Mill Creek drains an area of about 34 km^2, while Cascade Creek drains an area of roughly 16 km^2.

Over time, much of the watershed draining into the Bay has become urbanized, with heavy manufacturing industries coexisting within residential and commercial neighborhoods. The pattern of multiple land use is illustrated by the percentage of the drainage basin that is classified into each of the following categories: residential (57%); open area (16%); commercial (11%); public (8%); and, industrial (7%; Potomac-Hudson 1991).

Past waste disposal practices had resulted in the discharge of industrial and domestic wastewater to the Bay or to the streams and tributaries draining into the Bay. Until changes were made to the City of Erie's wastewater treatment, collection, and conveyance system, untreated industrial, commercial, and residential wastewater escaping from combined sewer overflows was discharged to the Bay. Because approximately 80% of the watershed is a developed, urban area, the Bay received high concentrations of pollutants from stormwater runoff. While many pollutants released to the Bay from such past practices have decayed through natural biodegradation processes, substances like heavy metals and more persistent organics remain in the sediment. Additionally, the geography and geology of the Bay make it a natural “settling” basin for solids. Most of the pollutants that enter the Bay in runoff become entrapped in the sediments.

1.1 Role of Sediments in Aquatic Ecosystems

The particulate materials that lie below the water in ponds, lakes, stream, rivers, and other aquatic systems are called sediments (ASTM 2004). Sediments represent essential elements of aquatic ecosystems because they support both autotrophic and heterotrophic organisms. Autotrophic (which means self-nourishing) organisms are those that are able to synthesize food from simple inorganic substances (e.g., carbon dioxide, nitrogen, and phosphorus) and the sun's energy. Green plants, such as algae, bryophytes (e.g., mosses and liverworts), and aquatic macrophytes (e.g., sedges, reeds, and pond weed), are the main autotrophic organisms in freshwater ecosystems. In contrast, heterotrophic (which means other-nourishing) organisms utilize, transform, and decompose the materials that are synthesized by autotrophic organisms (i.e., by consuming or decomposing autotrophic and other heterotrophic organisms). Some of the important heterotrophic organisms that can be present in aquatic ecosystems include bacteria, epibenthic, and infaunal invertebrates, fish, amphibians, and reptiles. Birds and mammals can also represent important heterotrophic components of aquatic food webs (i.e., through the consumption of aquatic organisms).

Sediments support the production of food organisms in several ways. For example, hard- bottom sediments, which are characteristic of fast-flowing streams and are comprised largely of gravels, cobbles, and boulders, provide stable substrates to which periphyton (i.e., the algae that grows on rocks) can attach and grow. Soft sediments, which are common in ponds, lakes, estuaries, and slower-flowing sections of rivers and streams, are comprised largely of sand, silt, and clay. Such sediments provide substrates in which aquatic macrophytes can root and grow. The nutrients that are present in the sediments can also nourish aquatic macrophytes. By providing habitats and nutrients for aquatic plants, sediments support autotrophic production (i.e., the production of green plants) in aquatic systems. Sediments can also support prolific bacterial communities. Bacteria represent important elements of aquatic ecosystems because they decompose organic matter (e.g., the organisms that die and accumulate on the surface of the sediment) and, in so doing, release nutrients to the water column and increase bacterial biomass. Bacteria represent the primary heterotrophic producers in aquatic ecosystems. The role that sediments play in supporting primary productivity (both autotrophic and heterotrophic) is essential because green plants and bacteria represent the foundation of food webs upon which all other aquatic organisms depend (i.e., they are consumed by many other aquatic species).

In addition to their role in supporting primary productivity, sediments also provide essential habitats for many sediment-dwelling invertebrates and benthic fish. Some of these invertebrate species live on the sediments (termed epibenthic species), while others live in the sediments (termed infaunal species). Both epibenthic and infaunal invertebrate species consume plants, bacteria, and other organisms that are associated with the sediments. Invertebrates represent important elements of aquatic ecosystems because they are consumed by a wide range of wildlife species, including amphibians, reptiles, fish, birds, and mammals. For example, virtually all fish species consume aquatic invertebrates during all or a portion of their life cycle. In addition, many birds consume aquatic invertebrates during either their aquatic (e.g., dippers and sand pipers) or emergent (e.g., swallows) portions of their life cycle. Similarly, aquatic invertebrates represent important food sources for both amphibians (e.g., frogs and salamanders) and reptiles (e.g., turtles and snakes). Therefore, sediments are of critical importance to many wildlife species due to the role that they play in terms of the production of aquatic invertebrates.

Importantly, sediments can also provide habitats for many wildlife species during portions of their life cycle. For example, a variety of fish species utilize sediments for spawning and incubation of their eggs and alevins (e.g., trout, salmon, and whitefish). In addition, juvenile fish often find refuge from predators in sediments and in the aquatic vegetation that is supported by the sediments. Furthermore, many amphibian species burrow into the sediments in the fall and remain there throughout the winter months, such that sediments provide important overwintering habitats. Therefore, sediments play a variety of essential roles in terms of maintaining the structure (i.e., assemblage of organisms in the system) and function (i.e., the processes that occur in the system) of aquatic ecosystems.

1.2 Sediment Quality Issues and Concerns

Traditionally, concerns relative to the management of aquatic resources in freshwater systems have focused primarily on water quality. However, the importance of sediments in determining the harmful effects of chemical contaminants on aquatic organisms (including plants, invertebrates, amphibians, and reptiles), wildlife (amphibians, reptiles, fish, birds, and mammals), or human health has become more apparent in recent years (Long and Morgan 1991; Ingersoll *et al.* 1997). Specifically, sediment quality is important because many toxic contaminants (such as metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, chlorophenols, and pesticides), found in only trace amounts in water, can accumulate to elevated levels in sediments. As such, sediments can serve both as reservoirs and as potential sources of contaminants to the water column. In addition, sediment-associated contaminants have the potential to adversely affect sediment-dwelling organisms (e.g., by causing direct toxicity or altering benthic invertebrate community structure; Chapman 1989). Therefore, sediment quality data (i.e., information on the concentrations of chemical substances) provide essential information for evaluating ambient environmental quality conditions in freshwater systems (i.e., determining if sediments, sediment-dwelling organisms, wildlife, or human health have been injured by releases of oil or discharges of other hazardous substances into the environment).

Releases of hazardous substances from both historic and ongoing contaminant sources have resulted in the release of a variety of toxic and/or bioaccumulative substances into receiving water systems within the Presque Isle Bay watershed. Some of the substances that have been released include total organic carbon (TOC), nutrients, metals, oil and grease, polycyclic aromatic hydrocarbons (PAHs), phthalates, pesticides, and polychlorinated biphenyls (PCBs; Bright 1988; Polls *et al.* 1993; Hoke *et al.* 1993; Dorkin 1994; Ingersoll and MacDonald 1999). While some of these substances remain in the water column, many others are known to accumulate in sediments. The results of sediment quality assessments conducted over the past 20 years indicate that many of these substances occur or have occurred at elevated concentrations in sediments within Presque Isle Bay (Applied Biology Inc. 1982; Aqua Tech Environmental 1986; Rice 1991; Obert 1993; Gannett-Fleming, Inc. 1993; Cullinan and Crecelius 1995; West 1994; West *et al.* 1994; USEPA 2000a; Wellington 2002; Diz 2002; PADEP 2003). The presence of elevated concentrations of contaminants in aquatic sediments represents an environmental concern because:

- Bed sediments provide essential and productive habitats for communities of sediment-dwelling organisms, including epibenthic and infaunal organisms. These organisms include such species as scuds (amphipods), mayflies (ephemeropterans), stoneflies (plecopterans), caddisflies (trichopterans), dragonflies, damselflies (odonatans), midges (dipterans), water fleas (cladocerans), worms (oligochaetes), snails (gastropods), and clams (bivalves);
- Sediment-dwelling organisms (including epibenthic and infaunal organisms) are important elements of freshwater ecosystems, representing important sources of food for many fish and other wildlife species;
- The presence of sediment-associated contaminants in freshwater ecosystems can be harmful to sediment-dwelling organisms and wildlife species; and,
- Certain sediment-associated contaminants can bioaccumulate in the tissues of aquatic organisms and, as a result, pose a potential hazard to those species that consume aquatic organisms, including wildlife and humans.

1.3 Purpose of the Report

Under the Great Lakes Water Quality Agreement, a total of 43 areas of concern (AOCs) have been identified within the Great Lakes basin, based on the presence of conditions that impair the beneficial uses of aquatic ecosystems. The guidelines for listing geographic areas with degraded environmental conditions as AOC or delisting such AOCs once environmental conditions have improved, were established by the International Joint Commission in 1987 (IJC 1991; 1997). These 14 guidelines were used to identify 42 of the AOCs that were listed. In contrast to the other AOCs, Presque Isle Bay was designated as the 43^{rd} Great Lakes AOC in 1991 after concerned citizens from Erie, PA petitioned for its' inclusion. Preliminary studies conducted in 1993 identified two beneficial use impairments for the Bay: 1) restrictions on dredging activities; and, 2) fish tumors or other deformities. The Bay's sediments are contaminated with low levels of PAHs and heavy metals.

Since the 1980s, Pennsylvania Department of Environmental Protection (PADEP) and its partners have collected information on sediment quality conditions within the Bay. More specifically, sediment chemistry data were collected at a number of locations in the Bay in 1982, 1986, 1990, 1994, 2000, and 2003. In addition, whole-sediment toxicity tests were conducted on samples collected within the Presque Isle Bay AOC. Ancillary data [e.g., tissue residue levels in fish, incidence of external deformities, and frequency of orocutaneous and liver neoplasms, etc.] have also been collected to provide a better understanding of environmental quality conditions within the Presque Isle Bay AOC. Based on the results of these investigations, it is apparent that sediment quality conditions have improved substantially over the past two decades and that conditions may be sufficient to facilitate delisting of one or both of the two existing beneficial use impairments. Therefore, after more than 10 years of study, PADEP, in conjunction with the AOC's Public Advisory Committee (PAC), determined that monitored natural attenuation, rather than active remediation within the AOC, would provide the most cost-effective basis for restoring beneficial uses in the study area. As a result, Presque Isle Bay was designated an AOC in the Recovery Stage in 2002.

Under the Great Lakes Water Quality Agreement, restoration of the Great Lakes AOCs has been identified as a high priority, long-term goal. However, not one of the 26 AOCs on the U.S. side of the border has been delisted, nor has any specific beneficial use impairment in these AOCs been delisted. Of the 26 American AOCs, 15 have identified restrictions on dredging as a beneficial use impairment. The International Joint Commission (IJC 1991) guidelines indicate that an impairment of the dredging beneficial use has occurred when the concentrations of contaminants in sediments exceed standards, criteria, or guidelines such that restrictions on dredging or disposal activities are imposed. In addition, the IJC (1991) established delisting criteria for the restrictions on dredging activities beneficial use impairment. The IJC (1991) guidelines indicate that the dredging beneficial use has been restored when concentrations of contaminants in sediments do not exceed the above described standards, criteria, or guidelines. While these general guidelines are useful, establishing narrative and numerical delisting targets (i.e., quantitative or measurable targets) is an AOC-specific exercise. Accordingly, there is a need to establish AOC-specific delisting targets that define, for each sediment quality indicator and metric (see Chapter 4 for more information), the conditions that need to be met in Presque Isle Bay to restore the beneficial uses of the aquatic ecosystem.

This report is intended to support petitioning for delisting of Presque Isle Bay as a Great Lakes AOC. More specifically, this document presents the results of an assessment of temporal trends in sediment quality conditions in Presque Isle Bay. In addition, the results of a preliminary assessment of risks to ecological receptors posed by exposure to contaminated sediments in the Bay is presented. To provide the PAC and its partners with the information needed to evaluate the status and trends in sediment quality conditions:

- Introduction (Chapter 1);
- Background and History (Chapter 2)
- Conceptual Site Model of the Presque Isle Bay Ecosystem (Chapter 3);
- Study Approach (Chapter 4);

- Assessment of Trends in Sediment Quality Conditions in Presque Isle Bay (Chapter 5);
- Assessment of Risks to Ecological Receptors in Presque Isle Bay (Chapter 6);
- Summary and Conclusions (Chapter 7); and,
- References Cited (Chapter 8).

Definitions of many of the terms that have been used in this document are provided in the Glossary of Terms and the List of Acronyms that appear at the beginning of this report.

Chapter 2 Background and History

2.0 Introduction

This study was conducted to support the development of delisting targets for the restrictions on dredging beneficial use impairment in Presque Isle Bay. Because the establishment of delisting targets is an AOC-specific exercise, it is important to have an understanding of the site and the events that result in the listing of Presque Isle Bay as a Great Lakes AOC. Accordingly, this chapter provides a description of the study area and chronicles the events that led to its listing in 1991.

2.1 Description of Study Area

Presque Isle Bay is located in the northwestern corner of Pennsylvania on the southern shore of Lake Erie (Figure 1). It is about 4.5 miles long, 1.5 miles across at its widest point, and has an average depth of about 20 feet. A 7-mile long, re-curved sand spit named Presque Isle forms the Bay. The western end of the Bay is closed and provides access to the park. The southeastern end of the Bay connects to Lake Erie through a narrow channel that is maintained by the U.S. Army Corp of Engineers. This channel allows commercial shipping traffic and recreational boaters to enter the Bay from the lake.

Presque Isle State Park borders the northern edge of the Bay. The Isle is composed of sand and glacial sediments and has a continuous series of ponds, lagoons and lakes of which some connect directly with the Bay. The Isle contains a wide variety of animal habitats and records exist for over 320 bird species, 47 mammal species, and 30 amphibian and reptile species. Many of these are included on Pennsylvania's list of Species of Special Concern. The site is also considered one of the top birding hotspots in the country.

The bulk of the Presque Isle Bay watershed is on the other side of the Bay. It is approximately 25 square miles in area and includes much of the City of Erie, as well as portions of Mill Creek, Summit, Greene, and Harbor Creek Townships. Erie is the third largest city in Pennsylvania with a population of just over 100,000. Mill Creek Township has over 52,000 residents. Over time, much of the watershed draining into the Bay has become urbanized with heavy manufacturing industries coexisting within residential and commercial neighborhoods. The primary tributaries are Mill Creek (including Garrison Run) and Cascade Creek, which together account for about two-thirds of the water flowing into the Bay.

Past waste disposal practices had resulted in the discharge of industrial and domestic wastewater to the Bay or to the streams and tributaries draining into the Bay. Until changes were made to the City of Erie's wastewater treatment, collection, and conveyance system, untreated industrial, commercial, and residential wastewater escaping from combined sewer overflows was discharged to the Bay. Because approximately 80% of the watershed is a developed urban area, the Bay received high concentrations of pollutants from stormwater runoff. While many pollutants released to the Bay from such past practices have decayed through natural biodegradation processes, substances like heavy metals and more persistent organics (e.g., PAHs) remain in the sediment. Additionally, the geography and geology of the Bay make it a natural "settling" basin for solids. As a result, most of the pollutants that enter the Bay in runoff become entrapped in the sediments.

2.2 History

As early as 1984, the United States Fish and Wildlife Service (USFWS) began receiving reports of brown bullheads (*Ameiurus nebulosus*) with external sores and lesions being caught by fishermen from Presque Isle Bay. In January 1988, members of the Erie County Environmental Coalition (the Coalition) petitioned the Science Advisory Board of the International Joint Commission (IJC) to designate the Bay as an AOC. Formed in 1983, the Coalition included members from various local organizations such as the League of Women Voters, the Erie County Sportsman Association, the Benedictine Sisters, and the Presque Isle Audubon Society. The intent of the Coalition in seeking the designation was to focus attention on, and to secure funding for, the Bay in order to enhance the environmental and economic quality of life in the watershed.

In December 1988, Erie's City and County governments formed the Erie Harbor Improvement Council. Members were appointed and included representatives from business, industry, academia, development, government, and civic and environmental groups. The goal of the council was to clean up Presque Isle Bay by the year 2008. The objectives of the Council were to ensure that Pennsylvania met its responsibilities under the Great Lakes Water Quality Agreement (GLWQA) and to ultimately provide an action plan to clean up the Bay, restore impaired uses, and enhance economic revitalization. There motto, "A Swimmable Bay in 20 Years", emphasized the determination and resolve of the Council.

Presque Isle Bay was designated the 43rd AOC in 1991 in response to the concerns raised by the Coalition. The Erie Harbor Improvement Council was dissolved in 1991 and its members became the PADEP PAC for the Bay. The reasons for listing the Bay were not cited in the designation so the first step for the PAC was to determine which of the IJC's 14 beneficial uses were actually or potentially impaired. Using existing data and information, a preliminary analysis identified 16 chemicals of potential concern (COPCs) in the sediment, including ten heavy metals (arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc), nutrients (phosphorus and total kjeldahl nitrogen), chemical oxygen demand, cyanide, oil and grease, and volatile organics. Polycyclic aromatic hydrocarbons were also found in the sediments (Potomac-Hudson 1991). No impairments to the water column or fish and wildlife were indicated. Based upon a limited analysis of existing data, PADEP believed that two of the 14 beneficial uses were potentially impaired: (1) fish tumors and other deformities; and, (2) restrictions on dredging.

In 1993, a Remedial Action Plan (RAP) was submitted to the IJC (PADER and PIB PAC 1992). The RAP analysis confirmed what was already known about the Bay. Available data was compared to the IJC's AOC Listing Guidelines (IJC 1991) to identify impaired beneficial uses. Analysis of data generated prior to 1990 clearly indicated impairments based upon the guidelines for fish tumors and other deformities and restrictions on dredging. Additionally, the available data, or lack of data, left questions regarding two other potential impairments: (1) degradation of phytoplankton and zooplankton populations; and, (2) beach closings.

Based upon the impaired uses evaluation, the only COPCs identified were those that were associated with sediment. No water column impairments were indicated. Fish impairments, if environmentally caused, were believed to be related to the sediment contamination; however, no correlation was made between sediment contamination and tumor rates. Sediment chemistry data were compared with readily-available benchmarks (USEPA 1977). The results of this evaluation indicated that the 16 COPCs identified in the preliminary report were present at levels of concern. In addition, although no standards for PAHs existed, the levels of these compounds in Bay sediments were thought to be elevated relative to other sides in the Great Lakes. Therefore, PAHs were included as COPCs.

An update to the RAP was submitted to the IJC in 1995 (PADEP 1995). The update summarized new information and data on the beneficial use impairments and responded to comments and questions received from the IJC and the United States Environmental Protection Agency (USEPA) on the RAP. Once again, studies done by PADEP, USEPA, USFWS, the Erie County Department of Health (ECDH), and others confirmed the evaluation of impaired uses in the Bay. Sediment contamination and tumors in brown bullheads were the biggest concerns. Regarding COPCs, both sediment and brown bullhead data indicated that PAHs could be of greater concern than the heavy metals. The main source for the contaminants appeared to be the in-place sediments, as no correlation was found between water and sediment contaminant concentrations (PADEP 2002).

Additional studies were conducted to answer questions regarding the two potential beneficial use impairments identified in the 1993 RAP: (1) degradation of phytoplankton and zooplankton populations; and, (2) beach closings. A seasonal study of the phytoplankton and zooplankton population of the Bay conducted by USEPA in 1992 and 1993 concluded that water samples collected from the Bay did not appear to adversely affect the populations (PADEP 2002). On the basis of this information and an analysis of conditions in the Bay, PADEP concluded that the degradation of phytoplankton and zooplankton populations beneficial use was not impaired (Obert and Wellington 1995).

The 1993 RAP cited a limited impairment for the beach closing beneficial use at the mouth of the Mill Creek Tube and possibly at other creek and stormwater inputs to the Bay. Subsequent sampling and analysis for bacterial contamination by PADEP and personnel from the Presque Isle State Park over a six-week period in 1993 did not find bacteria in concentrations above the state's water quality standard for bathing beaches. The ECDH has and continues to take monthly samples at the Water Quality Network station located in the open Bay waters between the points where Cascade and Mill creeks enter the Bay, directly in front of the public dock at Dobbins Landing. Bacterial concentrations have been consistently below the state's standard of 200 fecal coliform per 100 milliliter. While there are no designated bathing beaches in the Bay, there are no restrictions on its use for full body recreation based upon bacterial contamination. Based upon this information, the continued monitoring done by the ECDH, and the improvements to the City of Erie's combined sewer overflows, PADEP concluded that no major impairment existed for water contact recreation in the Bay and therefore, the beach closing beneficial use was no longer considered impaired.

The remaining two beneficial use impairments identified in the 1993 RAP, (1) fish tumors and other deformities; and, (2) restrictions on dredging, were still of concern following the 1995 RAP update. However, monitoring data collected thereafter (i.e., Wellington 2002; Diz 2002) indicated that sediment quality conditions were improving in the Bay. In addition, these newer data suggested that hot spots relative to sediment contamination were not readily apparent in the Bay. Rather, Bay sediments appeared to exhibit broad, low level contamination, primarily with metals and PAHs. As a result, PADEP, in conjunction with the AOC's PAC, determined that monitored natural attenuation, rather than active remediation within the AOC, would provide the most cost-effective basis for restoring beneficial uses in the study area. As a result, Presque Isle Bay was designated an AOC in the Recovery Stage in 2002.

Chapter 3 Conceptual Site Model of the Presque Isle Bay Ecosystem

3.0 Introduction

Development of a conceptual model represents an important component of ecological risk/hazard assessments because it enhances the level of understanding regarding the relationships between human activities and ecological receptors at the site under consideration. Specifically, the conceptual model describes key relationships between stressors and assessment endpoints. In so doing, the conceptual model provides a framework for predicting effects on ecological receptors and a template for generating risk questions and testable hypotheses (USEPA 1997; 1998). The conceptual model also provides a means of highlighting what is known and what is not known about a site. In this way, the conceptual model provides a basis for identifying data gaps and designing monitoring programs to acquire the information necessary to complete the assessment.

Conceptual models consist of two main elements, including: a set of hypotheses that describe predicted relationships between stressors, exposures, and assessment endpoint responses (along with a rationale for their selection); and, diagrams that illustrate the relationships presented in the risk hypotheses. The following sections of this chapter summarize information on the sources and releases of COPCs, the fate and transport of these substances, the pathways by which ecological receptors are exposed to the COPCs, and the potential effects of these substances on the ecological receptors that occur in the vicinity of Presque Isle Bay. In turn, this information is used to develop a series of hypotheses that provide predictions regarding how ecological receptors will be exposed to and respond to the COPCs.

3.1 Sources and Releases of Contaminants

There are a number of natural and anthropogenic sources of toxic and bioaccumulative substances in the Presque Isle Bay watershed. Anthropogenic sources of environmental contaminants in the watershed include industrial wastewater discharges, municipal wastewater treatment plant discharges, stormwater discharges, surface water recharge by contaminated groundwater, non-point source discharges, spills associated with production and transport activities, and deposition of substances that were originally released into the atmosphere. To support the development of a Stage I RAP for Presque Isle Bay, an evaluation of pollutant sources and transport mechanisms was conducted for the Pennsylvania Department of Environmental Resources (Potomac-Hudson 1991). The results of this evaluation indicated:

- Six significant permitted industrial point source dischargers (i.e., permitted under the National Pollutant Discharge Elimination System; NPDES) released, on average, 124 million gallons per day (MGD) of runoff, wastewater, and/or cooling water directly to Presque Isle Bay or to storm sewers or tributaries to Presque Isle Bay. These dischargers included Pennsylvania Electric Company, GAF Building Materials Corporation, Erie Forge and Steel, United-Erie, Inc., Pyramid Industries, and Urick Foundary Company;
- Three NPDES permitted municipal wastewater or water treatment plants released, on average, 1.3 MGD of treated wastewater or filter backwash water to Presque Isle Bay. These dischargers included Chestnut Street Water Treatment Plant, Presque Isle Bay State Park, and the West Filtration Plant (Sommerheim); and,
- A total of 47 combined sewer overflows released 3.1 million gallons of raw sanitary sewage and untreated industrial effluent during an average storm event to the Mill Creek/Garrison Run drainage system (i.e., 38 combined sewage outflows; CSOs), to Cascade Creek (i.e., 1 CSO), or to Presque Isle

Bay via small, unnamed tributaries, drainage ways, or outfall sewer lines (i.e., 8 CSOs).

In recent years, industrial wastewater has been largely redirected to Erie's sewer system. In 1991, roughly 18.6 MGD of industrial effluent were discharged to the sewer from 39 industrial users (Potomac-Hudson 1991. Additionally, two properties in the vicinity of Presque Isle Bay (Mill Creek Dump and Presque Isle State Park) are listed in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) as containing potentially uncontrolled hazardous wastes that require investigation (i.e., NPL listed sites) and at least one facility in the area is subject to regulation under the Resource Conservation and Recovery Act (RCRA), which means that hazardous wastes are generated, transported, treated, stored, or disposed of at the site (USEPA see USEPA Web site at http://www.epa.gov/). Although it is difficult to evaluate contributions of contaminants from other sources, surface run-off, groundwater contamination, and atmospheric deposition have all been identified as potential sources of contaminants to Presque Isle Bay (Potomac-Hudson 1991).

3.2 Identification of Chemicals of Potential Concern

Identification of COPCs represents an essential element of the risk/hazard assessment process (USEPA 1998). When used together, information on historic and current uses of the site, on regional land use patterns, on the characteristics of effluent and stormwater discharges in the vicinity of the site provides a reliable basis for identifying the preliminary COPCs at a site. However, data on the physical/chemical properties of each of those substances and historical sediment chemistry data should also be considered for further refining the preliminary list of COPCs (MacDonald and Ingersoll 2002).

In this study, the results of the review of background information (Potomac-Hudson 1991) was used as a primary basis for developing the preliminary list of COPCs in Presque Isle Bay. More specifically, COPCs that were considered to be causing or contributing to beneficial use impairments in Presque Isle Bay included metals (As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Ni, and Zn), chemical oxygen demand, total kjeldahl nitrogen, total phosphorus, cyanide, PAHs, oil and grease, and volatile solids. However, a review of the sediment quality investigations that have been conducted since the background report was published indicates that the preliminary list of COPCs should be expanded to include several additional metals (Al, Hg, and Sb), phthalates (bis-2-ethylhexyl phthalate; BEHP), PCBs, DDT, chlordane, dieldrin, endrin, nitrosamines (NDMA and NDPA), and polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs; Table 1).

3.3 Environmental Fate of Chemicals of Potential Concern

Upon release into aquatic ecosystems, the COPCs partition into environmental media (i.e., water, sediment, soil, and/or biota) in accordance with their physical and chemical properties and the characteristics of the receiving water body. As a result of such partitioning, elevated levels of COPCs can occur in surface water (including the surface microlayer), sediments, and/or the tissues of aquatic organisms. Accordingly, information on the environmental fate can be used to classify the COPCs into three groups, including bioaccumulative substances (i.e., substances that accumulate in the tissues of aquatic organisms), toxic substances that partition into sediment, toxic substances that partition into surface waters (MacDonald *et al.* 2000).

Because this study was focused on evaluating the restrictions on dredging beneficial use impairment, an effort was made to identify the toxic COPCs that partition into sediment and bioaccumulative COPCs (toxic COPCs that partition into surface water represent the other major classification of COPCs). Information on the environmental fate and transport of the COPCs identified above provided a basis for classifying them into these two groups, as follows (Table 2):

Toxic COPCs that Partition in Sediment:

- Metals (Al, Sb, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Mn, Ni, Sb, and Zn);
- Cyanide;
- PAHs;
- Oil and grease;
- Phthalates (BEHP);
- PCBs; and,
- Organochlorine pesticides (DDTs, chlordane, dieldrin, endrin).

Bioaccumulative COPCs:

- Metals (Cd, Hg, and Pb);
- PCBs;
- Organochlorine pesticides (DDTs, chlordane, dieldrin, endrin); and,
- PCDDs/PCDFs.

3.4 Potential Exposure Pathways

Once released to the environment, there are three pathways through which ecological receptors can be exposed to COPCs. These routes of exposure include direct contact with contaminated environmental media, ingestion of contaminated environmental media, and inhalation of contaminated air. For bioaccumulative substances, the ingestion of contaminated prey species represents the most important route of exposure for the majority of aquatic organisms and aquatic-dependent wildlife species. Direct contact with contaminated water and/or contaminated sediment and ingestion of contaminated sediment also represent a relevant, but less important exposure route for many aquatic organisms.

For toxic substances that partition into sediments, direct contact with contaminated sediments and pore water) represents the most important route of exposure for exposure for most aquatic organisms. However, ingestion of contaminated sediments can also represent an important exposure pathway for certain aquatic organisms (e.g., polychaetes that process sediments to obtain food) and aquatic-dependent wildlife species (e.g., sediment-probing birds, such as sandpipers).

For toxic substances that partition into surface water, direct contact with contaminated water represents the most important route of exposure for aquatic organisms (i.e., uptake through the gills and/or through the skin). For aquatic-dependent wildlife species, ingestion of contaminated water represents the principal route of exposure to toxic substances that partition into surface water.

3.5 Ecological Receptors Potentially at Risk

There are a wide variety of ecological receptors that could be exposed to contaminated environmental media in Presque Isle Bay. The aquatic species that occur in the Bay can be classified into six main groups, including microbiota (e.g., bacteria, fungi and protozoa), aquatic plants (including phytoplankton, periphyton, aquatic macrophytes, and riparian plants), aquatic invertebrates (including zooplankton and benthic invertebrates), fish, amphibians, and reptiles. Bird and mammals represent the principal aquatic-dependent wildlife species that occur in Presque Isle Bay.

Based on the review of the available information, Presque Isle Bay supports diverse assemblages of aquatic organisms and aquatic-dependent wildlife. For example, Diz (2002) reported that sediment-dwelling organisms included (in order of abundance):

oligochaetes, zebra mussels (*Dreissena sp.*), gastropods, amphipods, midges, isopods, leaches, nematodes, other bivalves (other than zebra mussels), caddisflies, turbellarians, mayflies, ostracods, and beatles (coleopterans). In addition, 16 fish species have been documented to spawn and rear in Presque Isle Bay (Goodyear *et al.* 1982), while another 24 are known to utilize habitats within the Bay during some portion of their life history (PFC 1988). Some of the key sportfish species that are pursued within the Bay are listed in Table 2. Although relatively little wildlife habitat exists along the south shore of Presque Isle Bay, wetland and upland habitats within Presque Isle State Park are utilized by many species of amphibians, reptiles, birds, and mammals throughout much of their life cycles, including at least 320 bird species, 47 mammalian species, and 30 amphibian species. Waterfowl and other migratory bird species also utilize these habitats seasonally.

The COPCs in the Presque Isle Bay were classified into three categories based on their predicted environmental fate (MacDonald *et al.* 2000). By considering this information, in conjunction with the exposure pathways that apply to these groups of COPCs, it is possible to identify the receptors that are potentially at risk due to exposure to contaminated environmental media. For bioaccumulative substances, the groups of aquatic organisms that are most likely to be exposed to tissue-associated contaminants include benthic invertebrates, carnivorous fish, amphibians, and reptiles. The groups of aquatic-dependent wildlife species that may be exposed to bioaccumulative substances include insectivorous birds, sediment-probing birds, carnivorous wading birds, piscivorus birds, piscivorus mammals, and omnivorous mammals.

Toxic substances that partition into sediments pose a potential risk to a variety of aquatic organisms and aquatic-dependent wildlife species. The groups of aquatic organisms that are most likely to be exposed to sediment-associated contaminants include decomposers (i.e., microbiota), aquatic plants, benthic invertebrates, benthic fish, and amphibians. Although reptiles can come in contact with contaminated sediments, it is unlikely that significant dermal uptake would occur. Sediment-probing birds are the principal group of aquatic-dependent wildlife species that are exposed to sediment-associated contaminants.

For toxic substances that partition into surface water, aquatic plants, aquatic invertebrates, fish, and amphibians represent the principal groups of exposed aquatic organisms. Although ingestion represents a potential exposure route for both birds and mammals, this pathway is likely to represent a relatively minor source of exposure for aquatic-dependent wildlife species.

3.6 Risk Questions/Testable Hypotheses

The following risk questions are intended to provide a basis for selecting indicators of sediment quality conditions in Presque Isle Bay that will provide the necessary and sufficient information to determine if beneficial uses are being protected and conserved:

1. **Survival, Growth, and Reproduction of Aquatic Invertebrates**
   - Are the levels of contaminants in whole sediments from Presque Isle Bay greater than benchmarks for the survival, growth, or reproduction of aquatic invertebrates?
   - Is the survival, growth or reproduction of aquatic invertebrates exposed to whole sediments from Presque Isle Bay significantly lower than that in reference sediments?
   - Is the structure of aquatic invertebrate communities in Presque Isle Bay sediments outside the normal range (i.e., 95th percentile) for aquatic invertebrate communities in reference areas?

2. **Survival, Growth and Reproduction of Fish**
   - Are the levels of contaminants in whole sediments from Presque Isle Bay greater than benchmarks for the survival, growth, or reproduction of fish?
   - Is the survival, growth or reproduction of fish exposed to surface water or sediments from Presque Isle Bay significantly lower than that for reference media?
   - Is the frequency of deformities, deformities, fin erosion, lesions, and tumors (DELT) abnormalities significantly higher in fish from Presque Isle Bay than in fish from reference areas?
   - Are the levels of contaminants in fish tissues from Presque Isle Bay greater than critical tissue values for the survival, growth, or reproduction of fish?

3. **Survival, Growth and Reproduction Birds**
   - Does the daily dose of contaminants received by birds from consumption of the tissues of prey species and from other media at Presque Isle Bay exceed the toxicity reference values (TRVs) for survival, growth or reproduction of birds?
   - Are the concentrations of contaminants in bird eggs from Presque Isle Bay greater than benchmarks for the survival, growth, or reproduction of birds?
   - Is the reproduction of birds utilizing the habitats in the vicinity of Presque Isle Bay significantly impaired compared to that measured for reference areas?

4. **Survival, Growth and Reproduction of Mammals**
   - Does the daily dose of contaminants received by mammals from consumption of the tissues of prey species and from other media at

Presque Isle Bay exceed the TRVs for survival, growth or reproduction of mammals?

Although microorganisms, aquatic plants, amphibians, and reptiles are important receptor groups in Presque Isle Bay, insufficient information on the toxicity of sediment-associated COPCs is available to determine the risks that Bay COPCs pose to these species.

3.7 Conceptual Model Diagram

A diagram of the conceptual site model for Presque Isle Bay that will guide the selection of measurement endpoints (i.e., indicators and metrics) for assessing the status of sediment quality conditions in the Bay is provided in Figure 2.

Chapter 4 Study Approach

4.0 Introduction

This chapter describes the approach that was used to assess the current status and temporal trends in sediment quality conditions in Presque Isle Bay. More specifically, the information presented in the chapter in intended to answer the following questions:

- Have the concentrations of toxic or bioaccumulative substances in PIB sediments increased, decreased, or remained the same since the bay was listed as a Great Lakes AOC in 1991?
- Are the concentrations of toxic or bioaccumulative substances in PIB sediments currently sufficient to pose unacceptable risks to ecological receptors, including sediment-dwelling organisms, benthic fish, and/or aquatic-dependent wildlife?

With these objectives in mind, a step-wise approach was used to assess changes in sediment quality conditions over time and to evaluate the risks that contaminated sediments pose to ecological receptors in the study area, which included:

- Identification of chemicals of potential concern;
- Identification of the receptors of interest (ROI) relative to exposure to contaminated sediments;
- Identification of the key indicators of sediment quality conditions (i.e., lines of evidence), metrics, and associated targets (benchmarks or toxicity thresholds) for assessing adverse effects on each ROI;
- Collection, evaluation, and collation of data and information on each indicator of sediment injury;

- Assessment of temporal trends in sediment quality conditions; and,
- Assessment of risks to sediment-dwelling organisms, benthic fish, and aquatic-dependent wildlife.

Each of these steps in the process are described in more detail in the following sections.

4.1 Identification of Chemicals of Potential Concern

Identification of COPCs represents an essential element of the sediment quality assessment process. In this study, COPCs were identified by reviewing several key studies that have been conducted within the Study area (i.e., Potomac-Hudson Engineering, Inc. 1991; USFWS 1991; Gannett Fleming, Inc. 1993; PADEP 1993; West *et al.* 1994; ECDOH 2002). Any substances that were identified as COPCs in these studies were included on the lists of the toxic and bioaccumulative COPCs that were compiled to support this investigation (Table 1). Chapter 3 provides additional information on the procedures that were used to identify COPCs in the study area.

4.2 Identification of Receptors of Interest within the Study area

The second step in the sediment quality assessment process involved identification of the key receptor groups that were to be considered in the investigation. Exposure to contaminated sediments can adversely affect a number of aquatic and aquatic-dependent receptor groups, including the microbial community, aquatic plant community, invertebrate community, fish community, and aquatic-dependent wildlife (i.e., amphibians, reptiles, sediment-probing birds, insectivorous birds, carnivorous wading birds, piscivorous birds, omnivorous mammals, and piscivorous mammals).

In this assessment, the receptors of interest included a subset of candidate receptor groups to focus the evaluation on the biological resources that were most likely to be adversely affected by contaminated sediments, including:

- Sediment-dwelling organisms (i.e., benthic macroinvertebrates);
- Fish (e.g., suckers, bullheads, etc.); and,
- Aquatic-dependent birds (including sediment-probing birds such as sandpipers and piscivorus birds such as herons, kingfishers, mergansers) and piscivorus mammals (e.g., mink, otters) that occur or could occur in the study area.

These receptor groups were selected because they tend to be the most sensitive to the toxic and/or bioaccumulative substances that accumulate in bed sediments. Although other receptor groups could be adversely affected by exposure to contaminated sediments (e.g., microbial communities, aquatic plant communities, etc.), emphasis on the more sensitive receptor groups will ensure that any sediment management activities that are ultimately considered will also provide adequate protection for the groups of receptors that tend to be less sensitive to contaminant challenges.

4.3 Identification of Indicators of Sediment Injury and Associated Targets

The third step in the sediment assessment process involves the identification of key indicators of sediment quality conditions. As three primary receptors groups were identified for consideration in this investigation, it was necessary to identify the indicators, metrics, and associated targets that would be used to conduct a preliminary assessment of sediment quality conditions relative to each receptor group, including sediment-dwelling organisms, benthic fish, and aquatic-dependent wildlife.

4.3.1 Sediment-Dwelling Organisms

For sediment-dwelling organisms, two key indicators of sediment quality conditions were used to support the preliminary assessment of sediment injury in the Study area, including:

- Whole-sediment chemistry; and,
- Whole-sediment toxicity.

Metrics are the variables that are measured to provide information on the status of an indicator of sediment quality conditions. For whole-sediment chemistry, the concentrations of the toxic and bioaccumulative COPCs in whole-sediment samples (typically expressed on a dry weight-normalized basis or an organic carbon-normalized basis) were identified as the metrics of primary interest. The metrics that support interpretation of the whole-sediment chemistry data include total organic carbon (TOC), acid volatile sulfides (AVS), grain size, and pore-water chemistry (e.g., ammonia, hydrogen sulfide). For whole-sediment toxicity, the survival and growth of amphipods (*Hyalella azteca*) in 10-day or 28-day toxicity tests, survival and growth of midges *(Chironomus tentans*) in 10-d toxicity tests, survival of mayflies *(Hexagenia limbata*)in 10-d toxicity tests, and survival of water fleas (*Daphnia magna*) in 28-h, 96-h, and 7-d toxicity tests were considered to be the metrics of primary interest.

The targets that were used to assess sediment quality conditions were selected to identify whole-sediment samples that have COPC concentrations sufficient to frequently adversely affect sediment-dwelling organisms. Accordingly, consensus-based probable effect concentrations or comparable sediment quality guidelines were adopted as the selected benchmarks for assessing the potential effects of COPCs on sediment dwelling organisms (Table 2). Individual sediment samples were designated as having COPC concentrations sufficient to adversely affect sediment-dwelling organisms if the mean PEC-Q was greater than 0.63 (i.e., the probability of observing significantly reduced survival or growth of amphipods, *Hyalella azteca*, in 28-d toxicity tests was >50% when mena PEC-Qs exceeded this level; USEPA 2000). Whole-sediment samples with mean PEC-Qs that were associated with low (<20%; mean PEC-Q of <0.22) and moderate (i.e., 20-50%; mean PEC-Q of 0.22 - 0.63) probability of observing toxicity were also identified. Whole-sediment samples were designated as toxic if they were demonstrated to be significantly toxic to one or more toxicity test organism, based on one or more measurement endpoints.

4.3.2 Benthic Fish

Two primary lines of evidence were used to adverse effects on benthic fish, associated with exposure to contaminated sediments in the study area, including:

- Whole-sediment chemistry;
- Whole-sediment toxicity; and,
- Tissue chemistry.

For whole-sediment chemistry, the dry weight-normalized concentrations of the toxic COPCs in whole-sediment samples were identified as the metrics of primary interest. The ERMs that were developed by Long *et al.* (1995) were selected preferentially as the sediment chemistry targets for assessing the potential for sediment quality conditions to fish associated with exposure to contaminated sediments; sediment quality advisory levels (SQALs; USEPA 1997), probable effect concentrations (PELs; CCME 1999), or high risk thresholds (HRTs; USEPA 1993) were selected when ERMs were not available (Table 4). In this study, whole-sediment samples with concentrations of six or more COPCs exceeding the selected toxicity thresholds were designated as having conditions sufficient to adversely affect fish (Long and MacDonald 1998).

The ERMs were selected as the toxicity thresholds for assessing sediment quality conditions to fish for several reasons. First, although the ERMs were developed primarily to evaluate the effects of sediment-associated COPCs on sediment-dwelling organisms, the underlying database that was used to derive the ERMs included matching data on sediment chemistry and adverse effects in fish. Second, the results of toxicity tests conducted on invertebrates and fish using splits of samples from the same sampling site indicate that fish and invertebrates may exhibit similar levels of sensitivity to sediment-associated COPCs. For example, examination of the freshwater SedTox database (USEPA 2000) revealed that there were 22 samples for which matching toxicity data were available for amphipods and fish (Burton 1994; Ingersoll *et al.* 1996). Evaluation of these data revealed that eight of these whole-sediment samples were toxic to *Hyalella azteca* in 10-d or 28-d exposures (endpoint: survival). All of these samples were found to be toxic to fathead minnows (*Pimephales promelas*) in 10-d exposures (elutriate) or rainbow trout (*Oncorhynchus gairdneri*) in 28-d exposures (whole sediment; endpoint: survival). Similarly, none of the 14 whole-sediment samples that were not toxic to amphipods were found to be toxic to these fish species. Therefore, the results of the invertebrate and fish toxicity tests were in consistent agreement, even though the magnitude of toxicity differed between two groups of receptors.

Whole-sediment samples that were found to be significantly toxic to fathead minnows (*Pimephales promelas*; relative to control or reference conditions) were considered to have sediment quality conditions sufficient to adversely affect benthic fish.

Numerical targets were also established to support interpretation of the data on the concentrations of COPCs in fish tissues (Table 4). In 1999, the Society of Environmental Toxicology and Chemistry published a database that provided a means of establishing linkages between tissue residues and biological effects for aquatic organisms exposed to inorganic and organic chemicals (Jarvinen and Ankley 1999). The information contained in this database was reviewed to identify toxicity thresholds (i.e., lowest observed adverse effect levels; LOAELs) for several classes of COPCs. While LOAELs were reported in the toxicological database for a total of five tissues types (including whole body, epaxial muscle, liver, and eggs), the benchmarks for muscle tissue were reported preferentially in Table 4 since all of the data from PIB were for fish epaxial muscle. When benchmarks for epaxial muscle were not available, a whole body benchmark was selected. Fish tissue samples were considered to have chemical characteristics sufficient to adversely affect fish if the concentrations of one or more bioaccumulative COPCs (expressed on a wet weight basis) exceeded the selected toxicity thresholds.

4.3.3 Aquatic-Dependent Wildlife

For aquatic-dependent wildlife, three lines of evidence were used to assess sediment quality conditions associated with indirect exposure to sediment-associated contaminants (i.e., bioaccumulation of COPCs in the food web and associated dietary exposure). These lines of evidence were evaluated using two types of data, including;

- Whole-sediment chemistry; and,
- Fish tissue chemistry.

For whole-sediment chemistry, the concentrations of bioaccumulative COPCs in whole-sediment samples were identified as the primary metrics of interest. The numerical sediment quality criteria (SQC) for bioaccumulative substances that were promulgated by the New York State Department of Environmental Conservation (1999) for the protection of aquatic-dependent wildlife were selected as the targets for whole-sediment chemistry (Table 5). These SQCs define the concentrations of bioacumulative COPCs that, if exceeded, are predicted to result in bioaccumulation in fish tissues to such an extent that tolerable daily intakes of these substances for piscivorus wildlife could be exceeded. Conditions sufficient to adversely affect aquatic-dependent wildlife were considered to exist if the concentrations of one or more bioaccumulative COPCs in whole-sediment samples (expressed on an organic carbon-normalized basis) exceeded these SQCs.

For tissue chemistry, the concentrations of bioaccumulative COPCs in fish tissues were identified as essential metrics. The associated targets for tissue chemistry (i.e., LOAELs for dietary exposure to COPCs) were selected primarily from the toxicity reference values that were promulgated by Sample *et al.* (1996; Table 6). In some cases (e.g., TCDD), the results of other investigations were used to refine the toxicity reference values (e.g., USEPA 1993; Tillitt *et al.* 1996) and derive more applicable LOAELs. The toxicity thresholds for piscivorus birds and piscivorus mammals were compared to COPC concentrations in epaxial muscle. Conditions sufficient to adversely affect aquatic-dependent wildlife were considered to exist if the concentrations of one or more bioaccumulative COPCs in fish tissues exceeded these LOAELs. Because wildlife species tend to consumer the whole organism and because COPC concentrations tend to be lower in muscle than in whole body tissues, this approach is likely to underestimate risks to wildlife species.

4.4 Compilation of Data and Information to Support an Assessment of Sediment Quality Conditions in Presque Isle Bay

In the fourth step of the process, the available information on the sediment quality conditions in the study area was assembled, including sediment chemistry, biological effects, and related data specific to the study area. Importantly, PADEP provided hard copies of a number of reports that contained candidate data sets, along with electronic versions of the underlying data.

All of the data sets that were retrieved during the course of the study were critically reviewed to determine their applicability to the assessment of sediment quality conditions in the study area. The criteria that were used to evaluate each of the candidate data sets are described in Appendix 1 of this report. The data sets that contained information on the study area and met the selection criteria were incorporated into a relational database in MS Access format. These data were subsequently fully verified against the original data source.

Several types of data were compiled as part of this study. First, the information on the chemical composition of whole sediments was compiled for both surficial and sub-surface sediment samples. In addition, the available information on the toxicity of whole sediments to invertebrates and fish was assembled. Information on the composition of benthic invertebrate community was also compiled from the results of studies that had been conducted within the study area. Furthermore, data on the concentrations of COPCs in fish tissues were compiled in the database, when available. Other relevant data, such as information on conventional indicators of sediment quality conditions (i.e., ammonia, total organic carbon, and dissolved oxygen), were also obtained from the studies that were assembled on the study area.

In a number of studies, additional sediment samples were collected and/or analysed as part of the quality assurance program. In this report, field replicate samples were treated as unique samples in the data analyses (i.e., by providing information on the small scale spatial variability in sediment quality conditions). By comparison, laboratory split samples were treated as duplicates and averaged to support subsequent data analysis.

To support subsequent interpretation of the sediment chemistry data, the total concentrations of several chemical classes were determined for each sediment sample. Specifically, the concentrations of total PAHs were calculated by summing the concentrations of up to 13 individual PAHs, including acenaphthene, acenaphthylene, anthracene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene, benz(a)anthracene, dibenz(a,h)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene. For PCBs, the concentrations of total PCBs were determined using various procedures, depending on how the data were reported in the original study. If only the concentrations of total PCBs was reported in the study, then those values were used directly. If the concentrations of various Aroclors (e.g., Aroclor1242, Aroclor 1248) were reported, then the concentrations of the various Aroclors were summed to determine the concentration of total PCBs. When the concentrations of individual congeners were reported, these values were summed to determine total PCB concentrations. For DDTs, the concentrations of p,p'-DDD and o,p'-DDD, p,p'-DDE and o,p'-DDE, and p,p'-DDT and o,p'-DDT were summed to calculate the concentrations of sum DDD, sum DDE, and, sum DDT, respectively. Total DDTs was calculated by summing the concentrations of sum DDD, sum DDE, and, sum DDT. Finally, the concentrations of total chlordane were determined by summing the concentrations of alpha- and gamma-chlordane isomers. If only the concentrations of total chlordane was reported in the study, then those values were used directly. In calculating the total concentrations of the various chemical classes, less than detection limit values were assigned a value of one-half of the detection, except when the detection limit was greater than the consensus-based probable effect concentration (PEC; or an alternate sediment quality guideline if a PEC was not available). In this latter case, the less than detection limit result was not used in the calculation of the total concentration of the substance.

To support the compilation and subsequent analysis of the information on sediment quality conditions in the study area, a relational project database was developed in MS Access format. All of the chemistry, toxicity, and benthic community data compiled in the database were georeferenced to facilitate mapping and spatial analysis using geographic information system (GIS)-based applications (i.e., ESRI's ArcView and Spatial Analyst programs). The database structure made it possible to retrieve data in several ways, including by data type (i.e., chemistry vs. toxicity), by sediment horizon (i.e., surficial vs. sub-surface sediments), by reach (i.e., Presque Isle Bay vs. Presque Isle Ponds), and by date (i.e., data collected prior to 1992 vs. data collected in 1992 or later). As such, the database facilitated a variety of different types of data analyses.

4.5 Assessment of Temporal Trends in Sediment Quality Conditions

The goal of this element of the analysis plan was to determine if temporal trends in sediment quality conditions were evident in Presque Isle Bay. The first step in this process involved identification of indicator COPCs that could be used to determine if concentrations are changing over time in Presque Isle Bay. Because metals and PAHs have been identified as the primary COPCs in this AOC, two metals (cadmium and lead), two low molecular weight PAHs (naphthalene and phenanthrene) and two high molecular weight PAHs (benzo(a)pyrene and fluoranthene) were selected as key indicators of sediment quality conditions in the bay. Next, the available data on each COPC for each year between 1982 and 2003 were compiled and summarized. More specifically, the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentile concentrations for each year were calculated (following log-transformation of the underlying, bay-wide data). These summarized data were then presented in box-whisker plots to facilitate identification of temporal trends.

The results of the preliminary analysis of temporal variability indicated that within-year variability in COPC concentrations was substantial in the bay. As this within-year variability reflects the spatial variability in COPC concentrations in Presque Isle Bay, it was hypothesized that the influence of spatial variability on within-year variability could be reduced by limiting the analysis to the data for the routine monitoring stations that have been sampled repeatedly in the bay (i.e., PIB-01, PIB-02, PIB-05, PIB-07, PIB-08, PIB-09, PIB-14, PIB-15, PIB-16, PIB-18, and PIB-20; Figure xxx). As was the case in the previous analysis, the available data on each of the selected COPCs for these stations were compiled and summarized for each year between 1982 and 2003. Again, the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentile concentrations for each year were calculated (following log-transformation of the underlying, bay-wide data). These summarized data were then presented in box-whisker plots to facilitate identification of temporal trends.

While reducing the number of stations that were considered in the trend analysis tended to reduce within-year variability (thereby improving our ability to discriminate temporal trends), spatial variability was still greater than year-to-year variability in the concentrations of selected COPCs. For this reason, a third analysis was conducted using data on the concentrations of the selected COPCs from individual routine monitoring stations in Presque Isle Bay (i.e., PIB-01, PIB-02, PIB-05, PIB-07, PIB-08, PIB-09, PIB-14, PIB-15, PIB-16, PIB-18, and PIB-20). The available data on each of the selected COPCs for these stations were compiled and summarized for each year between 1982 and 2003. Again, the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentile concentrations for each year were calculated (following log-transformation of the underlying, bay-wide data). These summarized data were then presented in box-whisker plots to facilitate identification of temporal trends.

4.5 Assessment of Risks to Ecological Receptors in Presque Isle Bay

The goal of this assessment was to evaluate the potential effects on ecological receptors that could result from exposure to contaminated sediments in Presque Isle Bay. More specifically, an ecological risk assessment framework was used to evaluate the potential effects of contaminated sediments sediment-dwelling organisms, benthic fish, and aquatic-dependent wildlife utilizing habitats within Presque Isle Bay. For sediment-dwelling organisms, the proportion of samples with conditions indicative of degraded sediment quality conditions were calculated for each of several lines of evidence (e.g., whole-sediment chemistry) and summarized for each geographic area (as per Ingersoll and MacDonald 1999; MacDonald *et al.* 2000; MacDonald and Ingersoll 2004). Then, the results of this assessment were tabulated to reflect multiple lines of evidence for each reach and AOC. A similar approach was used to assess sediment quality conditions to benthic fish and aquatic-dependent wildlife.

To facilitate assessment of risks to ecological receptors associated with exposure to sediments or biological tissues from the Presque Isle Bay AOC, the study area was divided into three sub-areas. More specifically, risks to sediment-dwelling organisms, benthic fish and aquatic-dependent wildlife were evaluated for Presque Isle Bay, Presque Isle ponds, and the near-shore areas of Lake Erie. The available sediment-chemistry, sediment-toxicity, and tissue-chemistry data were further split according to the year in which the samples were collected, with data collected between 1982 and 1991 considered to reflect historic conditions (i.e., prior to listing as an AOC) and the data collected between 1992 and 2003 considered to reflect contemporary conditions (i.e., post-listing as an AOC) conducted for two time periods. Finally, the data on surficial and sub-surface sediment samples were evaluated separately. The procedures that were used to assess risk to each group of ecological receptors are described in the following section of this chapter.

4.5.1 Assessment of Risks to Sediment-Dwelling Organisms

In this study, sediment quality conditions were considered to be degraded sufficiently to adversely affect sediment-dwelling organisms if one or more of the following conditions were observed:

- The mean PEC-quotients (Mean PEC-Qs) calculated for two or more sediment samples exceeded 0.63 (USEPA 2000; Table 3; the probability of observing significantly reduced survival or growth of amphipods in 28-d toxicity tests is >50% in samples with these chemical characteristics; it was assumed that impaired survival or growth in a 28-d toxicity would result in impaired survival, growth, and reproduction in longer-term exposures);
- The equilibrium partitioning sediment benchmarks toxic units (ESB-TUs) calculated for two or more sediment samples exceeded 1.0 (USEPA 2003; sensitive benthic organisms may be unacceptably affected when ESB-TUs exceed this level);

- The concentrations of simultaneously extracted divalent metals (SEM, including Cd, Cu, Pb, Ni, and Zn) exceed the concentration of acid volatile sulfide in two or more sediment samples (Ankley *et al.* 1996; metals could contribute toxicity to benthic organisms when SEM-AVS > 0.0, when expressed on a molar concentration basis); or,
- Significantly reduced survival or growth (as compared to control or reference samples) of amphipods (*Hyalella azteca*), midges (*Chironomus dilutus*), mayflies (*Hexagenia limbata*), or water fleas (*Daphnia magna*) in two or more sediment samples, based on the results of whole-sediment toxicity tests (ranging in duration from 96-h to 28-d).

In this study, surficial sediment was defined as any sample collected from the surface of the sediment to a depth of less than or equal to 30 cm (i.e., one foot). Sub-surface sediment was defined as any sample collected from a depth below the surface of the sediment or any sample that has a lower depth greater than 30 cm (i.e., a 0-40 cm sample interval was considered to be a sub-surface sample).

4.5.2 Assessment of Risks to Benthic Fish

Conditions sufficient to adversely affects fish (i.e., associated with direct and indirect exposure to contaminated sediments) were considered to exist within the study area if one or more of the following was observed:

- Six or more COPCs were measured in two or more sediment samples at concentrations in excess of selected toxicity thresholds for fish (i.e., the benchmarks for whole-sediment chemistry; Table 4);
- Significantly reduced survival or growth (as compared to control or reference samples) of fathead minnow (*Pimephales promelas*) in two or more samples, based on the results of whole-sediment toxicity test; or,

- One or more COPCs was measured in two or more fish tissue samples at concentrations in excess of selected toxicity thresholds for fish (i.e., the critical body burdens for fish; Table 5).

4.5.3 Assessment of Risks to Aquatic-Dependent Wildlife

Conditions sufficient to adversely affect aquatic-dependent wildlife (i.e., associated with indirect exposure to contaminated sediments) were considered to have existed within the study area if one or more of the following was observed:

- One or more COPCs was measured in two or more sediment samples at concentrations in excess of selected toxicity thresholds for piscivorus wildlife (i.e., the benchmarks for whole-sediment chemistry; Table 6);
- One or more COPCs was measured in two or more fish-tissue samples at concentrations in excess of selected toxicity thresholds for avian species that consume aquatic organisms (Table 7); or,
- One or more COPCs was measured in two or more fish-tissue samples at concentrations in excess of the selected toxicity thresholds for piscivorus mammals (Table 7).

Chapter 5 Assessment of Trends in Sediment Quality Conditions in Presque Isle Bay

5.0 Introduction

The results of the assessment of temporal trends in sediment quality conditions are presented in Figures 2 to 27.

Chapter 6 Assessment of Risks to Ecological Receptors in Presque Isle Bay

6.0 Introduction

The results of the preliminary assessment of risks to sediment-dwelling organisms, benthic fish, and aquatic-dependent wildlife are presented in Table 20 to 50 and Figure 28 to 59.

Chapter 7 References Cited

To be generated

Appendix 1. Criteria for Evaluating Candidate Data Sets

A.1 Introduction

In recent years, the Great Lakes National Program Office (USEPA), United States Geological Survey, National Oceanic and Administration, Minnesota Pollution Control Agency, Florida Department of Environmental Protection, British Columbia Ministry of Water, Air, and Land Protection, MacDonald Environmental Sciences Ltd., and EVS Consultants have been developing several databases with matching sediment chemistry and sediment toxicity data to support evaluations of the predictive ability of numerical sediment quality guidelines (SQGs) in the Great Lakes Basin and elsewhere in North America (Field *et al.* 1999; USEPA 2000a; Crane *et al.* 2000). In addition, various project-specific databases have been developed to facilitate access to and analysis of data sets to support natural resource damage assessments and ecological risk assessments at sites with contaminated sediments (MacDonald and Ingersoll 2000; Crane *et al.* 2000; MacDonald *et al.* 2001a; 2001b; Ingersoll *et al.* 2001; MacDonald *et al.* 2002a). The goal of these initiatives has been to collect and collate the highest quality data sets for assessing sediment quality conditions at contaminated sites and evaluating numerical SQGs. To assure that the data used in these assessments met the associated data quality objectives (DQOs), all of the candidate data sets were critically evaluated before inclusion in the database. However, the screening process was also designed to be flexible to assure that professional judgement could also be used when necessary in the evaluation process. In this way, it was possible to include as many data sets as possible and, subsequently, use them to the extent that the data quality and quantity dictate.

The following criteria for evaluating candidate data sets were established in consultation with an *ad hoc* Science Advisory Group on Sediment Quality Assessment (which is comprised of representatives of federal, provincial, and state government agencies, consulting firms, and non-governmental organizations located throughout North America and elsewhere worldwide). These criteria were used to evaluate candidate data sets for inclusion in the Calcasieu Estuary database, which was used as a basis for assessing sediment injury in the Assessment Area.

A.2 Criteria for Evaluating Whole-Sediment, Pore-Water, and Tissue Chemistry

Data on the chemical composition of whole sediments, pore water, and biological tissues are of fundamental importance in assessments of sediment quality conditions. For this reason, it is essential to ensure that high quality data are generated and used to support such sediment quality assessments. In this respect, data from individual studies are considered to be acceptable if:

- Samples were collected from any sediment horizon (samples representing surficial sediments are most appropriate for assessing effects on sediment-dwelling organisms and other receptors, while samples of sub-surface sediments are appropriate for assessing potential effects on sediment-dwelling organisms and other receptors, should these sediments become exposed; ASTM 2001a; ASTM 2001d; USEPA 2000b);
- Appropriate procedures were used for collecting, handling, and storing sediments (e.g., ASTM 2001b; 2001c; USEPA 2001) and samples of other media types;

- The concentrations of a variety of all chemicals of potential concern (COPCs) were measured in samples;
- Appropriate analytical methods were used to generate chemistry data. The methods that are considered to be appropriate included United States Environmental Protection Agency (USEPA) approved methods, other standardized methods [e.g., American Society for Testing and Materials (ASTM) methods, SW-846 methods], or methods that have been demonstrated to be equivalent or superior to standard methods; and,
- Data quality objectives were met. The criteria that are used to evaluate data quality included:

  (i) the investigator indicated that DQOs had been met;

  (ii) analytical detection limits were reported and lower than the probable effect concentrations (PECs) (however, detection limits < threshold effect concentration (TEC) are preferred);

  (iii) accuracy and precision of the chemistry data were reported and within acceptable ranges for the method;

  (iv) sample contamination was not noted (i.e., analytes were not detected at unacceptable concentrations in method blanks); and,

  (v) the results of a detailed independent review indicated that the data were acceptable and/or professional judgement indicated that the data set was likely to be of sufficient quality to be used in the assessment (i.e., in conjunction with author communications and/or other investigations).

A.3 Criteria for Evaluating Biological Effects Data

Data on the effects of contaminated sediments on sediment-dwelling organisms and other aquatic species provide important information for evaluating the severity and extent of sediment contamination. Data from individual studies are considered to be acceptable for this purpose if:

- Appropriate procedures were used for collecting, handling, and storing sediments (e.g., ASTM 2001b; USEPA 2000b; 2001); Sediments were not frozen before toxicity tests were initiated (ASTM 2001a; 2001e);
- The responses in the negative control and/or reference groups were within accepted limits (i.e., ASTM 2001a; 2001c; 2001d; 2001e; 2001f; 2001g; USEPA 2000a);
- Adequate environmental conditions were maintained in the test chambers during toxicity testing (i.e., ASTM 2001a; 2001d; USEPA 2000a);
- The endpoint(s) measured were ecologically-relevant (i.e., likely to influence the organism's viability in the field) or indicative of ecologically-relevant endpoints; and,
- Appropriate procedures were used to conduct bioaccumulation tests (ASTM 2001c).

Additional guidance is presented in USEPA (1994) for evaluating the quality of benthic community data generated as part of a sediment quality assessment. These criteria include collection of replicate samples, resorting at least 10% of the samples, and independent checks of taxonomic identification of specimens. Guidance is presented in USEPA (2000c) and in Schmidt *et al.* (2000) for evaluating the quality of fish health and fish community data.

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Table 1. Identification of chemicals of potential concern in the Presque Isle Bay Area of Concern.

Chemical of Potential Concern (COPC)	Toxic COPCs in Whole Sediments	Bioaccumulative COPCs in Whole Sediments	Reference
Metals (mg/kg DW)			
Aluminum	Y		Obert (1993)
Antimony	Y		Wellington (2002)
Arsenic	Y		Potomac-Hudson (1991)
Barium	Y		Potomac-Hudson (1991)
Cadmium	Y	Y	Potomac-Hudson (1991)
Chromium	Y		Potomac-Hudson (1991)
Copper	Y		Potomac-Hudson (1991)
Iron	Y		Potomac-Hudson (1991)
Lead	Y	Y	Potomac-Hudson (1991)
Manganese	Y		Potomac-Hudson (1991)
Mercury (Methyl mercury)	Y	Y	Gannett Fleming Inc. (1993)
Nickel	Y		Potomac-Hudson (1991)
Silver	Y		Potomac-Hudson (1991)
Zinc	Y		Potomac-Hudson (1991)
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)			
Acenaphthene			
Acenaphthylene	Y		Potomac-Hudson (1991)
Anthracene	Y		Potomac-Hudson (1991)
Benz(a)anthracene	Y		Potomac-Hudson (1991)
Benzo(a)pyrene	Y		Potomac-Hudson (1991)
Chrysene	Y		Potomac-Hudson (1991)
Dibenz(a,h)anthracene	Y		Potomac-Hudson (1991)
Fluoranthene	Y		Potomac-Hudson (1991)
Fluorene	Y		Potomac-Hudson (1991)
2-Methylnaphthalene	Y		Potomac-Hudson (1991)
Naphthalene	Y		Potomac-Hudson (1991)
Phenanthrene	Y		Potomac-Hudson (1991)
Pyrene	Y		Potomac-Hudson (1991)
Total PAHs	Y		Potomac-Hudson (1991)
Polychlorinated Biphenyls (PCBs; µg/kg DW)			
Total PCBs	Y	Y	Rice (1991)
Total PCBs		Y	
Aroclor 1016		Y	
Aroclor 1242		Y	
Aroclor 1248	Y	Y	
Aroclor 1254	Y	Y	West *et al.* (1994)
Aroclor 1260		Y	West *et al.* (1994)
Aroclor 1268		Y	

Table 1. Identification of chemicals of potential concern in the Presque Isle Bay Area of Concern.

Chemical of Potential Concern (COPC)	Toxic COPCs in Whole Sediments	Bioaccumulative COPCs in Whole Sediments	Reference
Pesticides/Herbicides (µg/kg DW)			
Chlordane	Y	Y	West *et al.* (1994)
Sum DDD	Y	Y	West *et al.* (1994)
Sum DDE	Y	Y	West *et al.* (1994)
Sum DDT	Y	Y	West *et al.* (1994)
Total DDT	Y	Y	West *et al.* (1994)
Dieldrin	Y	Y	Rice (1991)
Endrin	Y	Y	West *et al.* (1994)
Phthalates (µg/kg DW)			
Bis(2-ethylhexyl)phthalate	Y		Gannett Fleming Inc. (1993)
PCDDs and PCDFs (ng/kg DW)			
2,3,7,8-TCDD Toxic Equivalents (TEQs)[1]		Y	USEPA (2000)
Other COPCs (µg/kg DW)			
Chemical Oxygen Demand	Y		Potomac-Hudson (1991)
Cyanide	Y		Potomac-Hudson (1991)
Nitrosamines	Y		Obert (1993)
NDMA	Y		Obert (1993)
NPMA	Y		Obert (1993)
Oil and Grease	Y		Potomac-Hudson (1991)
Total Kjeldahl Nitrogen	Y		Potomac-Hudson (1991)
Total Phosphorus	Y		Potomac-Hudson (1991)
Total Volatile Solids	Y		Potomac-Hudson (1991)

Note: Reference identifies the first study to have identified a substance as a COPC in Presque Isle Bay; other studies may have confirmed the COPC.

Table 2. Selected toxicity thresholds for whole sediment for evaluating the effects of chemicals of potential concern on the benthic invertebrate community.

Chemical of Potential Concern (COPC)	Selected Toxicity Thresholds	Type	Source
Metals (mg/kg DW)			
Aluminum	58000	ERM	Ingersoll et al. 1996
Antimony	25.0	SEL	NYSDEC 1994
Arsenic	33.0	PEC	MacDonald *et al.* 2000
Barium	60	HTP	USEPA 1977
Cadmium	4.98	PEC	MacDonald *et al.* 2000
Chromium	111	PEC	MacDonald *et al.* 2000
Copper	149	PEC	MacDonald *et al.* 2000
Iron	250000	PEL	Ingersoll et al. 1996
Lead	128	PEC	MacDonald *et al.* 2000
Manganese	1200	PEL	Ingersoll et al. 1996
Mercury	1.06	PEC	MacDonald *et al.* 2000
Nickel	48.6	PEC	MacDonald *et al.* 2000
Silver	2.2	SEL	NYSDEC 1994
Zinc	459	PEC	MacDonald *et al.* 2000
SEM-AVS	0.0		Ankley *et al.* 1996
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)			
Acenaphthene	88.9	PEL	CCME 1999
Acenaphthylene	128	PEL	CCME 1999
Anthracene	845	PEC	MacDonald *et al.* 2000
Benz(a)anthracene	1050	PEC	MacDonald *et al.* 2000
Benzo(a)pyrene	1450	PEC	MacDonald *et al.* 2000
Chrysene	1290	PEC	MacDonald *et al.* 2000
Dibenz(a,h)anthracene	135	PEL	CCME 1999
Fluoranthene	2230	PEC	MacDonald *et al.* 2000
Fluorene	536	PEC	MacDonald *et al.* 2000
2-Methylnaphthalene	201	PEL	CCME 1999
Naphthalene	561	PEC	MacDonald *et al.* 2000
Phenanthrene	1170	PEC	MacDonald *et al.* 2000
Pyrene	1520	PEC	MacDonald *et al.* 2000
Total PAHs	22800	PEC	MacDonald *et al.* 2000
ESBTUs[1]	1.0	FCV	USEPA 2003
Polychlorinated Biphenyls (PCBs; µg/kg DW)			
Total PCBs	676	PEC	MacDonald *et al.* 2000
Aroclor 1248	2400	TET (@ 4% OC)	MEQ/EC 1992
Aroclor 1254	340	PEL	CCME 1999

Table 2. Selected toxicity thresholds for whole sediment for evaluating the effects of chemicals of potential concern on the benthic invertebrate community.

Chemical of Potential Concern (COPC)	Selected Toxicity Thresholds	Type	Source
Organochlorine Pesticides (µg/kg DW)			
Chlordane (total)	17.6	PEC	MacDonald *et al.* 2000
Sum DDD	28.0	PEC	MacDonald *et al.* 2000
Sum DDE	31.3	PEC	MacDonald *et al.* 2000
Sum DDT	62.9	PEC	MacDonald *et al.* 2000
DDT (total)[2]	572	PEC	MacDonald *et al.* 2000
Dieldrin	61.8	PEC	MacDonald *et al.* 2000
Endrin (total)[3]	207	PEC	MacDonald *et al.* 2000
Phthalates (µg/kg DW)			
Bis(2-ethylhexyl)phthalate	4788	SC (@ 4% OC)	Newell 1989
Other COPCS (µg/kg DW)			
Cyanide	0.25	HTP	USEPA 1977
PEC-Q			
20% probability of toxicity	0.22	PEC	MacDonald *et al.* 2000
50% probability of toxicity	0.63	PEC	MacDonald *et al.* 2000

DW = dry weight; NB = no benchmark available; ERM = effects range median;
SEL = severe effect level; PEC = probable effect concentration; HPT = heavily polluted threshold;
PEL = probable effect level; FCV = final chronic value; OC = organic carbon; TET = toxic effect threshold;
SQAL = sediment quality advisory level; FTT = freshwater toxicity threshold; SC = sediment criterion.

SEM-AVS = Simultaneously Extracted Metals minus Acid Volatile Sulphides
ESBTU = Equilibrium Partitioning Sediment Benchmark Toxic Units; BHC = Benzene hexachloride;
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.
PEC-Q = Probable Effect Concentration Quotient

NYSDEC = New York State Department of Environmental Conservation; USEPA = United States Environmental Protection Agency
CCME = Canadian Council of Ministers of the Environment; MEQ/EC = Ministere de l'Environnement du Quebec/Environment Canada

[1]For a list of substances that should be used to calculate ESBTUs see Table xx. In this study, ESBTUs were calculated using data on 13 parent PAHs.
[2]Total DDT is the sum of 6 isomers.
[3]Total endrin is the sum of endrin aldehyde and ketone.

Table 3. The 34 polycyclic aromatic hydrocarbons used to calculate equilibrium partitioning sediment benchmark toxic units (ESBTUs; USEPA 2003)

Acenaphthene*
Acenaphthylene
Anthracene*
Benz(a)anthracene*
C1-benzanthracenes/chrysenes
C2-benzanthracenes/chrysenes
C3-benzanthracenes/chrysenes
C4-benzanthracenes/chrysenes
Benzo(a)pyrene*
Benzo(b)fluoranthene
Benzo(e)pyrene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene*
Dibenz(a,h)anthracene
Fluoranthene*
Fluorene*
C1-fluorenes
C2-fluorenes
C3-fluorenes
Indeno(1,2,3-c,d)pyrene
Naphthalene*
C1-naphthalenes
C2-naphthalenes
C3-naphthalenes
C4-naphthalenes
C1-pyrenes/fluoranthenes
Perylene
Phenanthrene*
C1-phenanthrenes/anthracenes
C2-phenanthrenes/anthracenes
C3-phenanthrenes/anthracenes
C4-phenanthrenes/anthracenes
Pyrene*

Note: In this study, a total of 10 substances (*) were used to calculate EST-TUs for sediment samples from Presque Isle Bay. The calculated ESB-TU value was then multiplied by 2.63, based on the average ratio of ESB-TUs for 34 substances: ESB-TUs for 10 substances for samples from Presque Isle Bay. Use of the short list of PAHs facilitated calculation of ESB-TUs for most of the samples for which PAH concentrations were reported.

Table 4. Selected toxicity thresholds for whole sediment for evaluating the effects of chemicals of potential concern on the fish community.

Chemicals of Potential Concern (COPCs)	Selected Benchmarks	Type	Source
Metals (mg/kg DW)			
Aluminum	NB		
Antimony	25	ERM	Long and Morgan 1991
Arsenic	70	ERM	Long *et al.* 1995
Barium	NB		
Cadmium	9.6	ERM	Long *et al.* 1995
Chromium	370	ERM	Long *et al.* 1995
Copper	270	ERM	Long *et al.* 1995
Iron	NB		
Lead	218	ERM	Long *et al.* 1995
Manganese	NB		
Mercury	0.71	ERM	Long *et al.* 1995
Nickel	51.6	ERM	Long *et al.* 1995
Silver	3.7	ERM	Long *et al.* 1995
Zinc	410	ERM	Long *et al.* 1995
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)			
Acenaphthene	500	ERM	Long *et al.* 1995
Acenaphthylene	640	ERM	Long *et al.* 1995
Anthracene	1100	ERM	Long *et al.* 1995
Benz(a)anthracene	1600	ERM	Long *et al.* 1995
Benzo(a)pyrene	1600	ERM	Long *et al.* 1995
Chrysene	2800	ERM	Long *et al.* 1995
Dibenz(a,h)anthracene	260	ERM	Long *et al.* 1995
Fluoranthene	5100	ERM	Long *et al.* 1995
Fluorene	540	ERM	Long *et al.* 1995
2-Methylnaphthalene	670	ERM	Long *et al.* 1995
Naphthalene	2100	ERM	Long *et al.* 1995
Phenanthrene	1500	ERM	Long *et al.* 1995
Pyrene	2600	ERM	Long *et al.* 1995
Total PAHs	44792	ERM	Long *et al.* 1995
ESBTUs[1]	1.0		USEPA 2003
Polychlorinated Biphenyls (PCBs; µg/kg DW)			
Total PCBs	180	ERM	Long *et al.* 1995
Aroclor 1248	NB		
Aroclor 1254	340	PEL	CCME 1999
Organochlorine Pesticides (µg/kg DW)			
Chlordane (total)	6	ERM	Long and Morgan 1991
Sum DDD	20	ERM	Long and Morgan 1991
Sum DDE	15	ERM	Long and Morgan 1991

Table 4. Selected toxicity thresholds for whole sediment for evaluating the effects of chemicals of potential concern on the fish community.

Chemicals of Potential Concern (COPCs)	Selected Benchmarks	Type	Source
Organochlorine Pesticides (µg/kg DW; cont.)			
Sum DDT	7	ERM	Long and Morgan 1991
DDT (total)[2]	46.1	ERM	Long *et al.* 1995
Dieldrin	8	ERM	Long and Morgan 1991
Endrin (total)[3]	45	ERM	Long and Morgan 1991
Phthalates (µg/kg DW)			
Bis(2-ethylhexyl)phthalate	NB		
Other COPCS (µg/kg DW)			
Cyanide	NB		

DW = dry weight; NB = no benchmark available; ERM = effects range median;
PEL = probable effects level; SQAL = sediment quality advisory level; OC = organic carbon.

SEM-AVS = Simultaneously Extracted Metals - Acid Volatile Sulfides
ESBTU = Equilibrium Partitioning Sediment Benchmark Toxic Units; BHC = Benzene hexachloride;
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.
PEC-Q = Probable Effect Concentration Quotient

[1]For a list of substances that should be used to calculate ESBTUs see Table xx. In this study, ESBTUs were calculated using data on 13 parent PAHs.

[2]Total DDT is the sum of 6 isomers.

[3]Total endrin is the sum of endrin aldehyde and ketone.

Table 5. Summary of critical body burdens of selected COPCs in fish tissues. These toxicity thresholds identify concentrations of COPCs that are associated with adverse effects in freshwater, estuarine, or marine fish species.

Chemical of Potential Concern (COPC)	Lowest Observed Adverse Effect Level in Fish Muscle Tissue	Source
Metals (mg/kg WW)		
Cadmium	0.13 [1]	Westernhagen *et al.* 1980
Lead	NB	
Mercury (methyl mercury)	0.7	Niimi and Kissoon 1994
Polychlorinated Biphenyls (PCBs; µg/kg WW)		
Total PCBs	1100 [2]	Orn *et al.* 1998
Aroclor 1016	NB	
Aroclor 1242	NB	
Aroclor 1248	NB	
Aroclor 1254	1530 [3]	Berlin *et al.* 1981
Aroclor 1260	NB	
Aroclor 1268	NB	
Organochlorine Pesticides (µg/kg WW)		
Aldrin + Dieldrin	NB	
Chlordane (total)	NB	
Sum DDD	NB	
Sum DDE	NB	
Sum DDT	NB	
DDT (total) [4]	165 [5]	Pandian and Bhaskaran 1983
Dieldrin	NB	
Endrin (total) [6]	120	Bennett and Day 1970
PCDDs and PCDFs (ng/kg WW)		
2,3,7,8-TCDD Toxic Equivalents (TEQs)	116 [3]	Walker *et al.* 1994

WW = wet weight; NB = no benchmark available.

DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene;
DDT = Dichlorodiphenyltrichloroethane; PCDD = Polychlorinated dibenzo-*p* -dioxin;
PCDF = Polychorinated dibenzofuran; TCDD = Tetrachlorodibenzo-*p* -dioxin.

[1]Converted from dry weight to wet weight (0.2 factor; Stephen *et al.* 1985).
[2]Benchmark was for whole body, but was applied to muscle tissue (resulted in signficantly reduced ovary weight).
[3]Benchmark was for whole body, but was applied to muscle tissue.
[4]Total DDT is the sum of 6 isomers.
[5]The LOEL for Total DDT is the arithmetic mean of the range of values provided.
[6]Total endrin is the sum of endrin aldehyde and ketone.

Table 6. Selected bioaccumulation-based sediment quality criteria (SQC) for the protection of aquatic-dependent wildlife (from NYSDEC 1999).

Chemical of Potential Concern (COPC)	Selected SQCs	Water Type
Metals (mg/kg OC)		
Cadmium	NB	
Lead	NB	
Mercury (Methyl mercury)	NB	
Polychlorinated Biphenyls (PCBs; µg/kg OC)		
Total PCBs	1400	FW/SW
Aroclor 1016	NB	
Aroclor 1242	NB	
Aroclor 1248	NB	
Aroclor 1254	NB	
Aroclor 1260	NB	
Aroclor 1268	NB	
Organochlorine Pesticides (µg/kg OC)		
Aldrin + dieldrin	770	FW/SW
Chlordane (total)	6	FW/SW
Sum DDD	NB	
Sum DDE	NB	
Sum DDT	NB	
DDT (total)[1]	1000	FW/SW
Dieldrin	NB	
Endrin (total)[2]	800	FW
PCDDs and PCDFs (ng/kg OC) [3]		
2,3,7,8-TCDD Toxic Equivalents (TEQs) - mammalian	833	FW/SW
2,3,7,8-TCDD Toxic Equivalents (TEQs) - avian	7000	FW/SW

OC = organic carbon; NB = no benchmark available; FW = freshwater; SW = saltwater.

DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene;
DDT = Dichlorodiphenyltrichloroethane; PCDD = Polychlorinated dibenzo-*p* -dioxin;
PCDF = Polychorinated dibenzofuran; TCDD = Tetrachlorodibenzo-*p* -dioxin.

[1]Total DDT is the sum of 6 isomers.

[2]Total endrin is the sum of endrin aldehyde and ketone.

[3]The selected benchmarks are the high risk thresholds from USEPA 1993 (high risk concentrations were derived from TCDD doses expected to cause 50 to 100% mortality in embryos and young of sensitive species).

Table 7. Summary of toxicity thresholds for aquatic-dependent wildlife for chemicals of potential concern in Presque Isle Bay. Toxicity thresholds identify the concentrations of COPCs in fish that represent lowest observed adverse effect levels (LOAELs) for various groups of wildlife receptors (with focal species in parentheses; from Sample *et al.* 1996).

Chemical of Potential Concern (COPC)	Avian Receptor Groups	Mammalian Receptor Groups
	Piscivorous *(Kingfisher)*	Piscivorus Mammals *(Otter)*
Metals (mg/kg WW)		
Cadmium	39	39
Lead	NB	NB
Mercury (Methyl mercury)	0.13	0.13
Polychlorinated Biphenyls (PCBs; µg/kg WW)		
Total PCBs	NB	720
Aroclor 1016	NB	18000
Aroclor 1242	NB	1400[A]
Aroclor 1248	NB	600[A]
Aroclor 1254	3600	600[A]
Aroclor 1260	NB	NB
Aroclor 1268	NB	NB
Organochlorine Pesticides (µg/kg WW)		
Aldrin + Dieldrin	NB	NB
Chlordane (total)	21000	20000
Sum DDD	NB	NB
Sum DDE	NB	NB
Sum DDT	NB	NB
DDT (total)[1]	55	16000
Dieldrin	NB	810
Endrin (total)[2]	200	2000
PCDDs and PCDFs (ng/kg WW)		
2,3,7,8-TCDD Toxic Equivalents (TEQs)	60[B]	12.6[C]

WW = wet weight.

DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene;
DDT = Dichlorodiphenyltrichloroethane; PCDD = Polychlorinated dibenzo-*p* -dioxin;
PCDF = Polychorinated dibenzofuran; TCDD = Tetrachlorodibenzo-*p* -dioxin.

[A]This benchmark is from (Chapman 2003).

[B]This benchmark is the high risk thresholds from USEPA (1993; high risk concentrations were derived from TCDD doses expected to cause 50 to 100% mortality in embryos and young of sensitive species).

[C]This benchmark is from Tillitt *et al. (* 1996).

[1]Total DDT is the sum of 6 isomers.

[2]Total endrin is the sum of endrin aldehyde and ketone.

Table 8. Summary of whole-sediment chemistry data for surficial sediment samples from Presque Isle Bay: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	14	3214	4938	11271	16179	18072	25885	29473	1897	29870
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	31	1.65	2.03	2.64	15.0	18.4	22.6	29.8	1.10	39.1
Barium	23	16.3	51.4	58.4	82.0	118	227	288	13.0	442
Cadmium	31	1.60	3.16	3.53	6.32	8.44	10.6	11.3	0.0	12.0
Chromium	31	9.10	17.4	26.9	45.0	63.3	77.8	90.3	4.13	105
Copper	31	17.8	35.0	65.3	81.0	104	183	198	8.97	225
Iron	31	8710	15136	19579	26754	34736	44105	56449	5032	66234
Lead	31	21.4	51.2	94.3	120	161	188	208	6.39	224
Manganese	31	170	300	359	392	603	765	904	88.9	1022
Mercury	31	0.0005	0.0005	0.013	0.328	0.523	0.657	0.700	0.001	0.722
Nickel	31	15.6	26.6	36.9	51.0	61.7	81.5	109	8.0	117
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	31	171	200	275	324	367	491	626	41.8	684
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	14	18.0	38.0	54.2	96.3	178	216	232	4.00	259
Acenaphthylene	14	19.9	36.5	69.7	99.5	109	126	168	7.00	254
Anthracene	23	50.0	50.0	50.0	134	371	595	744	20.0	917
Benz(a)anthracene	23	150	150	150	408	836	1273	1485	52.0	1729
Benzo(a)pyrene	23	50.0	50.0	50.0	417	696	1302	1611	50.0	2040
Chrysene	14	277	570	603	868	1260	1781	1951	72.0	2281
Dibenz(a,h)anthracene	14	36.7	64.3	93.9	124	184	315	342	16.0	370
Fluoranthene	23	150	150	150	1014	2506	3499	4619	150	5123
Fluorene	23	75.9	88.7	145	150	166	316	328	8.00	438
2-Methylnaphthalene	14	46.1	115	151	215	265	566	745	8.00	894
Naphthalene	23	101	117	150	150	211	271	507	8.00	1441
Phenanthrene	23	50.0	50.0	173	599	1635	2514	2819	50	2990
Pyrene	23	100	100	100	867	2313	2784	3730	100	4049
Total PAHs	14	2203	4289	5499	10102	13899	16717	18156	670	19414

Table 8. Summary of whole-sediment chemistry data for surficial sediment samples from Presque Isle Bay: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	9	228	236	340	420	460	722	1202	220	2000
Aroclor 1248	17	50.0	50.0	50.0	50.0	1000	1000	1000	50.0	1000
Aroclor 1254	9	50.0	50.0	50.0	50.0	50.0	102	417	50.0	1700
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	9	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Dieldrin	1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Endrin (total)	23	15.0	15.0	15.0	20.0	20.0	20.0	20.0	15.0	20.0
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	9	1000	1000	1000	1000	1000	1000	1000	1000	1000
Other COPCs (mg/kg DW)										
Cyanide	9	0.540	0.540	0.560	0.670	1.06	1.94	2.72	0.54	3.70

n = number of samples; NDA = no data available; DW = dry weight.
Surface = upper depth 0 cm and lower depth ≤30 cm.

Table 9. Summary of whole-sediment chemistry data for sub-surface sediment samples from Presque Isle Bay: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Barium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Cadmium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chromium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Copper	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Iron	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Lead	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Manganese	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Mercury	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Nickel	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Acenaphthylene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benz(a)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benzo(a)pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chrysene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dibenz(a,h)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluoranthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluorene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
2-Methylnaphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Naphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phenanthrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Total PAHs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

Table 9. Summary of whole-sediment chemistry data for sub-surface sediment samples from Presque Isle Bay: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1254	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Subsurface = upper depth >0 cm or lower depth >30 cm.

Table 10. Summary of whole-sediment chemistry data for surficial sediment samples from Presque Isle Bay: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	62	867	1074	2942	9500	12031	17329	18946	671	24378
Antimony	25	0.920	1.08	1.40	2.25	6.75	139	188	0.80	213
Arsenic	103	2.00	2.62	8.51	16.4	20.3	27.8	46.2	0.500	169
Barium	99	3.50	13.6	54.5	90.0	120	151	160	2.50	302
Cadmium	112	0.700	0.700	1.30	5.00	7.92	9.19	9.80	0.40	11.9
Chromium	103	3.24	6.06	22.2	41.7	57.65	67.7	74.3	2.10	131
Copper	113	1.78	8.50	46.0	74.4	97.0	105	115	1.60	172
Iron	86	2930	3852	16174	29600	41400	46750	48049	1970	63909
Lead	113	7.00	14.2	61.5	99.4	140	169	193	2.50	242
Manganese	82	51.0	67.0	154	519	593	785	972	33.3	8750
Mercury	102	0.0500	0.050	0.122	0.267	0.443	0.611	0.765	0.013	3.20
Nickel	113	2.88	7.56	20.0	43.6	55.6	70.2	80.0	2.60	100
Silver	4	0.454	0.510	0.690	0.944	1.12	1.17	1.18	0.400	1.20
Zinc	113	16.3	45.3	178	278	387	550	642	14.0	862
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	41	5.90	15.0	43.0	81.1	109	181	373	4.50	2500
Acenaphthylene	47	10.4	43.4	61.9	102	140	528	1462	6.30	2000
Anthracene	48	27.3	50.0	50.0	196	294	335	390	12.0	496
Benz(a)anthracene	68	50.0	51.6	165	573	1071	1409	1986	50.0	10100
Benzo(a)pyrene	68	50.0	85.6	165	750	1295	1867	2102	50.0	20000
Chrysene	68	88.9	165	165	780	1339	2200	3810	50.0	10600
Dibenz(a,h)anthracene	47	8.50	12.3	50.0	222	264	392	472	8.50	1000
Fluoranthene	70	165	165	786	1357	2340	3671	5165	132	11400
Fluorene	48	13.7	46.8	50.0	125	173	204	225	8.20	900
2-Methylnaphthalene	1	84.3	84.3	84.3	84.3	84.3	84.3	84.3	84.3	84.3
Naphthalene	48	19.9	50.0	50.0	147	228	281	324	3.10	510
Phenanthrene	68	65.8	165	165	630	1049	1666	2393	50.0	4300
Pyrene	68	165	176	1003	1820	2410	3650	6239	50.0	12400
Total PAHs	48	1121	3246	5823	9336	11549	17822	43268	613	101000

Table 10. Summary of whole-sediment chemistry data for surficial sediment samples from Presque Isle Bay: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	26	26.3	64.5	189	258	329	564	613	6.33	623
Aroclor 1248	27	2.35	2.35	2.35	2.35	13.6	247	298	2.35	310
Aroclor 1254	27	35.2	49.8	62.5	188	247	260	286	10.3	304
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	20	0.145	0.195	1.60	2.99	4.74	7.10	9.28	0.050	13.5
Sum DDD	20	1.70	1.80	5.45	9.40	10.6	12.5	13.7	0.350	14.0
Sum DDE	20	2.28	2.49	8.75	10.0	10.9	12.2	12.9	0.700	13.5
Sum DDT	20	0.339	0.484	0.500	1.80	2.15	2.80	2.84	0.150	3.80
DDT (total)	20	4.44	4.79	15.30	21.6	23.5	25.8	28.3	1.20	28.7
Dieldrin	20	0.247	0.250	1.55	2.15	3.45	4.64	7.42	0.200	10.0
Endrin (total)	20	0.400	0.400	1.98	3.15	3.82	4.54	4.90	0.400	4.90
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	24	165	165	165	165	1053	1415	2094	82.1	2780
	0	0	0	0	0	0	0	0	0	0
Other COPCs (mg/kg DW)										
Cyanide	1	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700

n = number of samples; NDA = no data available; DW = dry weight.
Surface = upper depth 0 cm and lower depth ≤30 cm.

Table 11. Summary of whole-sediment chemistry data for sub-surface sediment samples from Presque Isle Bay: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Barium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Cadmium	20	0.500	0.500	0.741	3.85	6.39	7.48	9.30	0.500	9.40
Chromium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Copper	20	25.9	28.7	33.7	67.9	83.5	100	105	25.0	116
Iron	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Lead	20	18.5	20.0	40.1	73.0	151	167	179	4.00	189
Manganese	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Mercury	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Nickel	20	35.9	36.0	37.7	55.4	70.8	90.0	100	35.0	106
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	20	183	187	239	454	595	684	689	180	776
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	47	0.496	0.600	0.600	17.1	92.0	538	1394	0.175	6800
Acenaphthylene	57	0.750	0.750	0.750	50.0	300	1839	2593	0.138	11900
Anthracene	57	0.555	0.750	2.30	50.0	79.6	187	383	0.229	1000
Benz(a)anthracene	57	0.850	0.850	8.40	50.0	400	704	1387	0.670	3700
Benzo(a)pyrene	57	0.550	0.550	7.30	50.0	226	684	937	0.515	2810
Chrysene	57	9.65	20.8	32.3	75.2	600	2239	3846	2.63	29300
Dibenz(a,h)anthracene	57	0.480	0.551	2.82	50.0	50.0	133	153	0.0905	573
Fluoranthene	57	3.03	5.53	18.1	319	1060	3945	6170	0.580	14000
Fluorene	57	0.433	0.800	6.09	50.0	50.0	164	592	0.160	11200
2-Methylnaphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Naphthalene	57	1.42	3.55	8.18	50.0	50.5	243	256	0.624	382
Phenanthrene	57	4.85	9.44	21.8	125	657	3061	6034	0.560	8600
Pyrene	57	3.59	6.37	16.3	196	953	2196	4456	0.680	15100
Total PAHs	57	29.0	55.4	115	2673	8800	29111	39949	10.9	70900

Table 11. Summary of whole-sediment chemistry data for sub-surface sediment samples from Presque Isle Bay: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1254	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Subsurface = upper depth >0 cm or lower depth >30 cm.

Table 12. Summary of whole-sediment chemistry data for surficial sediment samples from Presque Isle Ponds: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	1	1260	1260	1260	1260	1260	1260	1260	1260	1260
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	1	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06
Barium	1	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16
Cadmium	1	0	0	0	0	0	0	0	0	0
Chromium	1	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
Copper	1	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92
Iron	1	3708	3708	3708	3708	3708	3708	3708	3708	3708
Lead	1	0	0	0	0	0	0	0	0	0
Manganese	1	65.1	65.1	65.1	65.1	65.1	65.1	65.1	65.1	65.1
Mercury	1	0	0	0	0	0	0	0	0	0
Nickel	1	3.38	3.38	3.38	3.38	3.38	3.38	3.38	3.38	3.38
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	1	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.8
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acenaphthylene	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Anthracene	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benz(a)anthracene	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Benzo(a)pyrene	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Chrysene	1	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Dibenz(a,h)anthracene	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluoranthene	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Fluorene	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2-Methylnaphthalene	1	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Naphthalene	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Phenanthrene	1	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Pyrene	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Total PAHs	1	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0

Table 12. Summary of whole-sediment chemistry data for surficial sediment samples from Presque Isle Ponds: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1254	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	1	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Surface = upper depth 0 cm and lower depth ≤30 cm.

Table 13. Summary of whole-sediment chemistry data for sub-surface sediment samples from Presque Isle Ponds: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Barium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Cadmium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chromium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Copper	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Iron	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Lead	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Manganese	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Mercury	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Nickel	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Acenaphthylene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benz(a)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benzo(a)pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chrysene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dibenz(a,h)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluoranthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluorene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
2-Methylnaphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Naphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phenanthrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Total PAHs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

Table 13. Summary of whole-sediment chemistry data for sub-surface sediment samples from Presque Isle Ponds: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1254	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Subsurface = upper depth >0 cm or lower depth >30 cm.

Table 14. Summary of whole-sediment chemistry data for surficial sediment samples from Presque Isle Ponds: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	30	1298	1365	1659	7140	7910	8776	9605	465	15600
Antimony	1	161	161	161	161	161	161	161	161	161
Arsenic	35	5.10	6.77	9.70	101	130	172	207	3.70	234
Barium	31	5.29	7.70	10.3	120	143	161	205	3.50	238
Cadmium	20	0.70	0.70	0.70	1.09	5.90	8.01	8.14	0.700	9.00
Chromium	35	3.64	4.16	6.32	38.1	42.6	51.0	53.6	1.50	66.7
Copper	35	1.80	1.80	5.03	59.0	67.0	75.6	80.8	1.75	99.5
Iron	34	5257	5755	7623	55419	78950	94543	111041	1830	117000
Lead	35	7.00	7.00	9.22	110	123.50	150	164	7.00	176
Manganese	34	77.4	89.9	128	805	1730	1983	2355	32.9	2460
Mercury	35	0.050	0.050	0.050	0.329	0.436	0.522	0.595	0.015	3.31
Nickel	34	2.75	2.86	5.82	16.0	23.6	53.3	55.7	2.00	59.1
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	35	21.1	22.8	34.0	209	240	258	274	8.10	419
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Acenaphthylene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benz(a)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benzo(a)pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chrysene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dibenz(a,h)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluoranthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluorene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
2-Methylnaphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Naphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phenanthrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Total PAHs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

Table 14. Summary of whole-sediment chemistry data for surficial sediment samples from Presque Isle Ponds: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1254	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Surface = upper depth 0 cm and lower depth ≤30 cm.

Table 15. Summary of whole-sediment chemistry data for sub-surface sediment samples from Presque Isle Ponds: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Barium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Cadmium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chromium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Copper	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Iron	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Lead	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Manganese	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Mercury	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Nickel	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Acenaphthylene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benz(a)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benzo(a)pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chrysene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dibenz(a,h)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluoranthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluorene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
2-Methylnaphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Naphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phenanthrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Total PAHs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

Table 15. Summary of whole-sediment chemistry data for sub-surface sediment samples from Presque Isle Ponds: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1254	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Subsurface = upper depth >0 cm or lower depth >30 cm.

Table 16. Summary of whole-sediment chemistry data for surficial sediment samples from nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	1	9206	9206	9206	9206	9206	9206	9206	9206	9206
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	14	1.38	1.56	1.72	5.93	11.1	12.9	14.3	1.11	17.0
Barium	8	12.7	16.0	20.6	24.5	28.4	38.8	40.9	10.0	43.2
Cadmium	14	0.250	0.250	0.85	2.10	3.04	3.71	4.33	0.250	5.35
Chromium	14	4.51	5.99	9.24	15	34.1	39.6	40.8	3.70	41.9
Copper	14	12.8	18.9	25.0	33.7	39.6	44.4	46.0	7.50	48.3
Iron	14	12520	15889	17287	19406	23794	25905	27548	8080	30574
Lead	14	10.2	12.3	14.5	25.7	62.7	74.1	76.5	7.50	76.5
Manganese	14	175	213	256	290	344	472	494	124	510
Mercury	14	0.001	0.001	0.001	0.025	0.057	0.103	0.151	0.001	0.211
Nickel	14	14.4	18.6	19.0	24.9	39.6	47.3	57.2	9.00	80.4
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	14	56.4	74.0	77.0	98.5	149	161	169	34.0	184
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	1	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0
Acenaphthylene	1	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0
Anthracene	8	50.0	50.0	50.0	50.0	50.0	66.4	92.2	50.0	128
Benz(a)anthracene	8	150	150	150	150	150	222	351	150	554
Benzo(a)pyrene	8	50.0	50.0	50.0	50.0	50.0	102	233	50.0	532
Chrysene	6	50.0	50.0	50.0	50.0	50.0	175	326	50.0	606
Dibenz(a,h)anthracene	1	117	117	117	117	117	117	117	117	117
Fluoranthene	8	150	150	150	150	150	274	552	150	1110
Fluorene	8	114	132	150	150	150	150	150	98.0	150
2-Methylnaphthalene	1	118	118	118	118	118	118	118	118	118
Naphthalene	8	150	150	150	150	150	185	235	150	300
Phenanthrene	8	50.0	50.0	50.0	50.0	50.0	107	260	50.0	629
Pyrene	8	100	100	100	100	100	168	305	100	556
Total PAHs	1	4855	4855	4855	4855	4855	4855	4855	4855	4855

Table 16. Summary of whole-sediment chemistry data for surficial sediment samples from nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	13	50.0	50.0	50.0	50.0	1000	1000	1000	50.0	1000
Aroclor 1254	7	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	7	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	8	15.0	15.0	15.0	15.0	15.0	16.4	18.1	15.0	20.0
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	7	1000	1000	1000	1000	1000	1000	1000	1000	1000
Other COPCs (mg/kg DW)										
Cyanide	7	0.246	0.273	0.320	0.330	0.387	0.880	1.303	0.220	1.820

n = number of samples; NDA = no data available; DW = dry weight.
Surface = upper depth 0 cm and lower depth ≤30 cm.

Table 17. Summary of whole-sediment chemistry data for sub-surface sediment samples from nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Barium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Cadmium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chromium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Copper	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Iron	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Lead	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Manganese	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Mercury	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Nickel	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Acenaphthylene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benz(a)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Benzo(a)pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chrysene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dibenz(a,h)anthracene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluoranthene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Fluorene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
2-Methylnaphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Naphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phenanthrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Pyrene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Total PAHs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

Table 17. Summary of whole-sediment chemistry data for sub-surface sediment samples from nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1254	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Subsurface = upper depth >0 cm or lower depth >30 cm.

Table 18. Summary of whole-sediment chemistry data for surficial sediment samples from nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals										
Aluminum	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	5	2.77	3.06	4.1	5.84	8.79	14.34	16.82	2.49	19.7
Barium	3	6.50	7.04	8.90	13.0	19.83	25.44	27.63	6.0	30.0
Cadmium	5	0.26	0.27	0.30	0.70	1.50	2.60	3.07	0.25	3.60
Chromium	5	2.19	2.40	3.10	7.20	14.9	29.62	37.10	2.0	46.4
Copper	5	1.06	1.35	2.50	11.0	26.9	38.50	43.35	0.8	48.8
Iron	5	4086	4435	5670	15200	29900	34723	36498	3765	38363
Lead	5	1.67	1.86	2.50	7.0	15.0	31.94	40.90	1.50	52.3
Manganese	5	70.3	77.5	104	215	386	585	672	63.7	772
Mercury	5	0.013	0.013	0.013	0.060	0.243	0.253	0.256	0.013	0.259
Nickel	5	3.24	3.74	5.60	11	18.7	31.7	37.7	2.80	44.8
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	5	12.1	14.7	25.6	60.6	108	145	160	10.0	177
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	4	0.291	0.333	0.469	1.70	7.39	22.6	32.4	0.250	46.1
Acenaphthylene	4	0.404	0.459	0.640	0.847	3.53	19.7	33.4	0.350	56.0
Anthracene	4	1.19	1.52	2.87	5.23	16.11	67.6	107.9	0.90	172
Benz(a)anthracene	7	6.24	9.28	17.65	165	165	270	390	4.10	563
Benzo(a)pyrene	7	3.80	4.49	8.79	165	165	258	360	3.20	502
Chrysene	7	11.8	17.6	32.7	165	165	282	422	7.80	631
Dibenz(a,h)anthracene	4	0.722	0.978	1.99	3.07	8.79	40.3	65.8	0.50	107
Fluoranthene	7	17.63	23.97	44.58	165.00	310.36	831	1083	12.9	1413
Fluorene	4	0.751	1.04	2.25	4.50	13.05	45.7	68.7	0.50	103
2-Methylnaphthalene	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Naphthalene	4	1.98	2.28	3.40	5.71	20.80	113	197	1.70	342
Phenanthrene	7	8.27	12.4	21.3	165	165	338	579	5.40	991
Pyrene	7	18.3	26.3	52.9	165	379	1028	1167	12.6	1326
Total PAHs	4	60.8	73.6	130	202	524	2319	3808	50.2	6252

Table 18. Summary of whole-sediment chemistry data for surficial sediment samples from nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	3	8.43	8.63	9.24	10.4	25.7	43.72	52.1	8.24	62.0
Aroclor 1248	3	2.35	2.35	2.35	2.35	2.35	2.35	2.35	2.35	2.35
Aroclor 1254	3	2.71	3.11	4.58	8.3	25.7	49.14	60.9	2.35	75.4
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	3	0.0549	0.0598	0.0747	0.100	0.196	0.257	0.278	0.0500	0.300
Sum DDD	3	0.073	0.096	0.168	0.30	1.01	1.61	1.84	0.0500	2.10
Sum DDE	3	0.095	0.142	0.296	0.60	1.37	1.99	2.24	0.0500	2.50
Sum DDT	3	0.250	0.250	0.250	0.250	0.369	0.446	0.473	0.2500	0.500
DDT (total)	3	0.648	0.697	0.855	1.15	2.55	3.79	4.29	0.600	4.85
Dieldrin	3	0.095	0.142	0.296	0.600	1.12	1.50	1.65	0.0500	1.80
Endrin (total)	3	0.373	0.397	0.470	0.600	0.96	1.21	1.30	0.350	1.40
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	3	165	165	165	165	165	165	165	165	165
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Surface = upper depth 0 cm and lower depth ≤30 cm.

Table 19. Summary of whole-sediment chemistry data for sub-surface sediment samples from nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Metals (mg/kg DW)										
Aluminum	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Antimony	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Arsenic	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Barium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Cadmium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Chromium	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Copper	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Iron	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Lead	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Manganese	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Mercury	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Nickel	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Silver	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Zinc	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)										
Acenaphthene	6	0.500	0.533	0.803	2.23	17.9	32.1	32.9	0.469	33.8
Acenaphthylene	6	0.443	0.516	0.693	0.750	8.46	19.2	21.4	0.373	23.7
Anthracene	6	0.884	1.27	2.54	5.07	41.6	76.1	78.1	0.565	80.2
Benz(a)anthracene	6	4.40	5.33	7.87	13.2	111	237	262	3.61	289
Benzo(a)pyrene	6	1.72	1.92	2.57	6.89	64.6	158	192	1.53	234
Chrysene	6	9.63	11.0	17.18	31.6	147	294	324	8.46	358
Dibenz(a,h)anthracene	6	0.516	0.532	0.621	1.59	15.4	36.0	42.5	0.500	50.1
Fluoranthene	6	14.0	16.1	22.9	34.8	240	550	627	12.1	716
Fluorene	6	0.643	0.862	1.76	3.34	30.9	60.6	60.7	0.450	60.8
2-Methylnaphthalene										
Naphthalene	6	1.07	1.37	2.20	4.45	45.2	110	129	0.811	150
Phenanthrene	6	4.13	5.29	9.48	19.0	185	398	426	3.18	455
Pyrene	6	13.6	16.1	23.4	30.9	209	473	533	11.5	602
Total PAHs	6	53.1	62.3	93.0	154	1110	2451	2736	45.2	3053

Table 19. Summary of whole-sediment chemistry data for sub-surface sediment samples from nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	n	5th	10th	25th	50th	75th	90th	95th	min	max
Polychlorinated Biphenyls (PCBs; µg/kg DW)										
Total PCBs	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1248	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Aroclor 1254	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)										
Chlordane (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDD	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDE	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Sum DDT	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
DDT (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Dieldrin	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Endrin (total)	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Phthalates (µg/kg DW)										
Bis(2-ethylhexyl)phthalate	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Other COPCs (mg/kg DW)										
Cyanide	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA

n = number of samples; NDA = no data available; DW = dry weight.
Subsurface = upper depth >0 cm or lower depth >30 cm.

Table 20. Proportion of surface and sub-surface sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie that are associated with a low (<20%; mean PEC-Q of <0.22), moderate (20-50%; mean PEC-Q of 0.22-0.63), and high (>50%; mean PEC-Q of >0.63) probability of observing toxicity to amphipods in 28-day exposures (survival or growth).

Area	Horizon	Time Period	Number of Samples	Number of Samples with <20% Probability of Toxicity[1] (%)	Number of Samples with 20 - 50% Probability of Toxicity[2] (%)	Number of Samples with >50% Probability of Toxicity[3,4] (%)
Presque Isle Bay	surface	1982-1991	31	2 (6%)	11 (35%)	18 (58%)
		1992-2003	138	27 (20%)	64 (46%)	47 (34%)
	subsurface	1982-1991	NDA	NDA	NDA	NDA
		1992-2003	57	34 (60%)	9 (16%)	14 (25%)
Presque Isle Ponds	surface	1982-1991	1	1 (100%)	0 (0%)	0 (0%)
		1992-2003	35	10 (29%)	2 (6%)	23 (66%)
	subsurface	1982-1991	NDA	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA	NDA
Lake Erie	surface	1982-1991	14	5 (36%)	9 (64%)	0 (0%)
		1992-2003	9	8 (89%)	1 (11%)	0 (0%)
	subsurface	1982-1991	NDA	NDA	NDA	NDA
		1992-2003	6	6 (100%)	0 (0%)	0 (0%)
Inland Reference	surface	1982-1991	NDA	NDA	NDA	NDA
		1992-2003	3	1 (33%)	2 (67%)	0 (0%)
	subsurface	1982-1991	NDA	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA	NDA

DW = dry weight; n = number of samples; NB = no benchmark; NDA = no data available; PEC-Q = probable effect concentration-quotient.
Surface = upper depth 0 cm and lower depth ≤30 cm; subsurface = upper depth >0 cm or lower depth >30 cm.

Note: Based on applying the selected toxicity thresholds to whole-sediment samples.

[1]Sediment samples with Mean PECQ value < 0.22 have a less than 20% probability of toxicity to marine amphipods.

[2]Sediment samples with Mean PECQ values between 0.22 and 0.63 have 20-50% probability of toxicity to marine amphipods.

[3]Sediment samples with Mean PECQ values > 0.63 have >50% probability of toxicity to marine amphipods.

[4]*Indicates that two or more samples, separated by at least 100 feet, had mean PEC-Qs values that exceeded 0.63 (providing evidence that whole-sediment chemistry is sufficient to injure sediment-dwelling organisms).

Table 21. Proportion of surficial and sub-surface sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with polycyclic aromatic hydrocarbon (PAH) concentrations sufficient to adversely affect sediment-dwelling organisms, as indicated by equilibrium partitioning sediment benchmark toxic units (ESBTUs) >1.0 (USEPA 2003).

Area	Horizon	Time Period	Number of Samples	Number of Samples with ESTBU Values >1.0	Percent of Samples with PAH Concentrations Sufficient to Adversely Affect Sediment-Dwelling Organisms[2]
Presque Isle Bay	surface	1982-1991	14	2	14%
		1992-2003	43	13	30%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	20	18	90%
Presque Isle Ponds	surface	1982-1991	1	0	0%
		1992-2003	NDA	NDA	NDA
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Lake Erie	surface	1982-1991	1	1	100%
		1992-2003	3	2	67%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Inland Reference	surface	1982-1991	NDA	NDA	NDA
		1992-2003	1	0	0%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA

NDA = no data available.
Surface = upper depth 0 cm and lower depth ≤30 cm; subsurface = upper depth >0 cm or lower depth >30 cm.

Table 22. Proportion of surficial and sub-surface sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with concentrations of divalent metals that could adversely affect sediment-dwelling organisms, as indicated by an SEM-AVS of >0.0 (Ankley *et al.* 1996).

Area	Horizon	Time Period	Number of Samples	Number of Samples with SEM-AVS >0.0	Percent of Samples with Metal Concentrations Sufficient to Adversely Affect Sediment-Dwelling Organisms[2]
Presque Isle Bay	surface	1982-1991	NDA	NDA	NDA
		1992-2003	10	0	0%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Presque Isle Ponds	surface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Lake Erie	surface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Inland Reference	surface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA

NDA = no data available; SEM-AVS = simultaneously extracted metals-acid volatile sulfide.

Surface = upper depth 0 cm and lower depth ≤30 cm; subsurface = upper depth >0 cm or lower depth >30 cm.

Table 23. Frequency of exceedance of the selected toxicity thresholds for the protection of the benthic community, in surficial sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Units	Frequency of Exceedance of Selected Toxicity Thresholds		
			Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals					
Aluminum	58000	mg/kg DW	0% (n=62)	0% (n=30)	NDA
Antimony	25.0	mg/kg DW	20% (n=25)	100% (n=1)	NDA
Arsenic	33.0	mg/kg DW	7% (n=103)	63% (n=35)	0% (n=5)
Barium	60	mg/kg DW	72% (n=99)	65% (n=31)	0% (n=3)
Cadmium	4.98	mg/kg DW	52% (n=112)	35% (n=20)	0% (n=5)
Chromium	111	mg/kg DW	1% (n=103)	0% (n=35)	0% (n=5)
Copper	149	mg/kg DW	2% (n=113)	0% (n=35)	0% (n=5)
Iron	250000	mg/kg DW	0% (n=86)	0% (n=34)	0% (n=5)
Lead	128	mg/kg DW	32% (n=113)	23% (n=35)	0% (n=5)
Manganese	1200	mg/kg DW	2% (n=82)	32% (n=34)	0% (n=5)
Mercury	1.06	mg/kg DW	3% (n=102)	3% (n=35)	0% (n=5)
Nickel	48.6	mg/kg DW	43% (n=113)	15% (n=34)	0% (n=5)
Silver	2.2	mg/kg DW	0% (n=4)	NDA	NDA
Zinc	459	mg/kg DW	14% (n=113)	0% (n=35)	0% (n=5)
Polycyclic Aromatic Hydrocarbons (PAHs)					
Acenaphthene	88.9	µg/kg DW	39% (n=41)	NDA	0% (n=4)
Acenaphthylene	128	µg/kg DW	30% (n=47)	NDA	0% (n=4)
Anthracene	845	µg/kg DW	0% (n=48)	NDA	0% (n=4)
Benz(a)anthracene	1050	µg/kg DW	26% (n=68)	NDA	0% (n=7)
Benzo(a)pyrene	1450	µg/kg DW	18% (n=68)	NDA	0% (n=7)
Chrysene	1290	µg/kg DW	26% (n=68)	NDA	0% (n=7)
Dibenz(a,h)anthracene	135	µg/kg DW	57% (n=47)	NDA	0% (n=4)
Fluoranthene	2230	µg/kg DW	27% (n=70)	NDA	0% (n=7)
Fluorene	536	µg/kg DW	2% (n=48)	NDA	0% (n=4)
2-Methylnaphthalene	201	µg/kg DW	0% (n=1)	NDA	NDA
Naphthalene	561	µg/kg DW	0% (n=48)	NDA	0% (n=4)

Table 23. Frequency of exceedance of the selected toxicity thresholds for the protection of the benthic community, in surficial sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Units	Frequency of Exceedance of Selected Toxicity Thresholds		
			Presque Isle Bay	Presque Isle Ponds	Lake Erie
PAHs (cont.)					
Phenanthrene	1170	µg/kg DW	18% (n=68)	NDA	0% (n=7)
Pyrene	1520	µg/kg DW	60% (n=68)	NDA	0% (n=7)
Total PAHs	22800	µg/kg DW	8% (n=66)	NDA	0% (n=7)
Polychlorinated Biphenyls (PCBs)					
Total PCBs	676	µg/kg DW	0% (n=26)	NDA	0% (n=3)
Aroclor 1248	2400	µg/kg DW (at 4% OC)	0% (n=27)	NDA	0% (n=3)
Aroclor 1254	340	µg/kg DW	0% (n=27)	NDA	0% (n=3)
Organochlorine Pesticides					
Chlordane (total)	17.6	µg/kg DW	0% (n=20)	NDA	0% (n=3)
Sum DDD	28.0	µg/kg DW	0% (n=20)	NDA	0% (n=3)
Sum DDE	31.3	µg/kg DW	0% (n=20)	NDA	0% (n=3)
Sum DDT	62.9	µg/kg DW	0% (n=20)	NDA	0% (n=3)
DDT (total)	572	µg/kg DW	0% (n=20)	NDA	0% (n=3)
Dieldrin	61.8	µg/kg DW	0% (n=20)	NDA	0% (n=3)
Endrin (total)	207	µg/kg DW	0% (n=20)	NDA	0% (n=3)
Phthalates					
Bis(2-ethylhexyl)phthalate	4788	µg/kg DW (at 4% OC)	0% (n=24)	NDA	0% (n=3)
Other COPCs					
Cyanide	0.25	mg/kg DW	100% (n=1)	NDA	NDA

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.

[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 24. Frequency of exceedance of the selected toxicity thresholds for the protection of the benthic community, in sub-surface sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Units	Frequency of Exceedance of Selected Toxicity Thresholds		
			Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals					
Aluminum	58000	mg/kg DW	NDA	NDA	NDA
Antimony	25.0	mg/kg DW	NDA	NDA	NDA
Arsenic	33.0	mg/kg DW	NDA	NDA	NDA
Barium	60	mg/kg DW	NDA	NDA	NDA
Cadmium	4.98	mg/kg DW	30% (n=20)	NDA	NDA
Chromium	111	mg/kg DW	NDA	NDA	NDA
Copper	149	mg/kg DW	0% (n=20)	NDA	NDA
Iron	250000	mg/kg DW	NDA	NDA	NDA
Lead	128	mg/kg DW	30% (n=20)	NDA	NDA
Manganese	1200	mg/kg DW	NDA	NDA	NDA
Mercury	1.06	mg/kg DW	NDA	NDA	NDA
Nickel	48.6	mg/kg DW	60% (n=20)	NDA	NDA
Silver	2.2	mg/kg DW	NDA	NDA	NDA
Zinc	459	mg/kg DW	45% (n=20)	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs)					
Acenaphthene	88.9	µg/kg DW	26% (n=47)	NDA	0% (n=6)
Acenaphthylene	128	µg/kg DW	30% (n=57)	NDA	0% (n=6)
Anthracene	845	µg/kg DW	2% (n=57)	NDA	0% (n=6)
Benz(a)anthracene	1050	µg/kg DW	9% (n=57)	NDA	0% (n=6)
Benzo(a)pyrene	1450	µg/kg DW	2% (n=57)	NDA	0% (n=6)
Chrysene	1290	µg/kg DW	14% (n=57)	NDA	0% (n=6)
Dibenz(a,h)anthracene	135	µg/kg DW	9% (n=57)	NDA	0% (n=6)
Fluoranthene	2230	µg/kg DW	14% (n=57)	NDA	0% (n=6)
Fluorene	536	µg/kg DW	7% (n=57)	NDA	0% (n=6)
2-Methylnaphthalene	201	µg/kg DW	NDA	NDA	NDA
Naphthalene	561	µg/kg DW	0% (n=57)	NDA	0% (n=6)

Table 24. Frequency of exceedance of the selected toxicity thresholds for the protection of the benthic community, in sub-surface sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Units	Frequency of Exceedance of Selected Toxicity Thresholds		
			Presque Isle Bay	Presque Isle Ponds	Lake Erie
PAHs (cont.)					
Phenanthrene	1170	µg/kg DW	14% (n=57)	NDA	0% (n=6)
Pyrene	1520	µg/kg DW	19% (n=57)	NDA	0% (n=6)
Total PAHs	22800	µg/kg DW	16% (n=57)	NDA	0% (n=6)
Polychlorinated Biphenyls (PCBs)					
Total PCBs	676	µg/kg DW	NDA	NDA	NDA
Aroclor 1248	2400	µg/kg DW (at 4% OC)	NDA	NDA	NDA
Aroclor 1254	340	µg/kg DW	NDA	NDA	NDA
Organochlorine Pesticides					
Chlordane (total)	17.6	µg/kg DW	NDA	NDA	NDA
Sum DDD	28.0	µg/kg DW	NDA	NDA	NDA
Sum DDE	31.3	µg/kg DW	NDA	NDA	NDA
Sum DDT	62.9	µg/kg DW	NDA	NDA	NDA
DDT (total)	572	µg/kg DW	NDA	NDA	NDA
Dieldrin	61.8	µg/kg DW	NDA	NDA	NDA
Endrin (total)	207	µg/kg DW	NDA	NDA	NDA
Phthalates					
Bis(2-ethylhexyl)phthalate	4788	µg/kg DW (at 4% OC)	NDA	NDA	NDA
Other COPCS					
Cyanide	0.25	mg/kg DW	NDA	NDA	NDA

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.

[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 25. Frequency of exceedance of the selected toxicity thresholds for the protection of the benthic community, in surficial sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Units	Frequency of Exceedance of Selected Toxicity Thresholds		
			Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals					
Aluminum	58000	mg/kg DW	0% (n=14)	0% (n=1)	0% (n=1)
Antimony	25.0	mg/kg DW	NDA	NDA	NDA
Arsenic	33.0	mg/kg DW	6% (n=31)	0% (n=1)	0% (n=14)
Barium	60	mg/kg DW	74% (n=23)	0% (n=1)	0% (n=8)
Cadmium	4.98	mg/kg DW	61% (n=31)	0% (n=1)	7% (n=14)
Chromium	111	mg/kg DW	0% (n=31)	0% (n=1)	0% (n=14)
Copper	149	mg/kg DW	16% (n=31)	0% (n=1)	0% (n=14)
Iron	250000	mg/kg DW	0% (n=31)	0% (n=1)	0% (n=14)
Lead	128	mg/kg DW	45% (n=31)	0% (n=1)	0% (n=14)
Manganese	1200	mg/kg DW	0% (n=31)	0% (n=1)	0% (n=14)
Mercury	1.06	mg/kg DW	0% (n=31)	0% (n=1)	0% (n=14)
Nickel	48.6	mg/kg DW	55% (n=31)	0% (n=1)	7% (n=14)
Silver	2.2	mg/kg DW	NDA	NDA	NDA
Zinc	459	mg/kg DW	16% (n=31)	0% (n=1)	0% (n=14)
Polycyclic Aromatic Hydrocarbons (PAHs)					
Acenaphthene	88.9	µg/kg DW	57% (n=14)	0% (n=1)	0% (n=1)
Acenaphthylene	128	µg/kg DW	14% (n=14)	0% (n=1)	0% (n=1)
Anthracene	845	µg/kg DW	4% (n=23)	0% (n=1)	0% (n=8)
Benz(a)anthracene	1050	µg/kg DW	13% (n=23)	0% (n=1)	0% (n=8)
Benzo(a)pyrene	1450	µg/kg DW	9% (n=23)	0% (n=1)	0% (n=8)
Chrysene	1290	µg/kg DW	29% (n=14)	0% (n=1)	0% (n=6)
Dibenz(a,h)anthracene	135	µg/kg DW	43% (n=14)	0% (n=1)	0% (n=1)
Fluoranthene	2230	µg/kg DW	30% (n=23)	0% (n=1)	0% (n=8)
Fluorene	536	µg/kg DW	0% (n=23)	0% (n=1)	0% (n=8)
2-Methylnaphthalene	201	µg/kg DW	64% (n=14)	0% (n=1)	0% (n=1)
Naphthalene	561	µg/kg DW	4% (n=23)	0% (n=1)	0% (n=8)

Table 25. Frequency of exceedance of the selected toxicity thresholds for the protection of the benthic community, in surficial sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Units	Frequency of Exceedance of Selected Toxicity Thresholds		
			Presque Isle Bay	Presque Isle Ponds	Lake Erie
PAHs (cont.)					
Phenanthrene	1170	µg/kg DW	35% (n=23)	0% (n=1)	0% (n=8)
Pyrene	1520	µg/kg DW	43% (n=23)	0% (n=1)	0% (n=8)
Total PAHs	22800	µg/kg DW	0% (n=14)	0% (n=1)	0% (n=1)
Polychlorinated Biphenyls (PCBs)					
Total PCBs	676	µg/kg DW	11% (n=9)	NDA	NDA
Aroclor 1248	2400	µg/kg DW (at 4% OC)	0% (n=17)	NDA	0% (n=13)
Aroclor 1254	340	µg/kg DW	11% (n=9)	NDA	0% (n=7)
Organochlorine Pesticides					
Chlordane (total)	17.6	µg/kg DW	NDA	NDA	NDA
Sum DDD	28.0	µg/kg DW	NDA	NDA	NDA
Sum DDE	31.3	µg/kg DW	NDA	NDA	NDA
Sum DDT	62.9	µg/kg DW	NDA	NDA	NDA
DDT (total)	572	µg/kg DW	0% (n=9)	NDA	0% (n=7)
Dieldrin	61.8	µg/kg DW	0% (n=1)	NDA	NDA
Endrin (total)	207	µg/kg DW	0% (n=23)	0% (n=1)	0% (n=8)
Phthalates					
Bis(2-ethylhexyl)phthalate	4788	µg/kg DW (at 4% OC)	0% (n=9)	NDA	0% (n=7)
Other COPCs					
Cyanide	0.25	mg/kg DW	100% (n=9)	NDA	86% (n=7)

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.

[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 26. Frequency of exceedance of the selected toxicity thresholds for the protection of the benthic community, in sub-surface sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Units	Frequency of Exceedance of Selected Toxicity Thresholds		
			Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals					
Aluminum	58000	mg/kg DW	NDA	NDA	NDA
Antimony	25.0	mg/kg DW	NDA	NDA	NDA
Arsenic	33.0	mg/kg DW	NDA	NDA	NDA
Barium	60	mg/kg DW	NDA	NDA	NDA
Cadmium	4.98	mg/kg DW	NDA	NDA	NDA
Chromium	111	mg/kg DW	NDA	NDA	NDA
Copper	149	mg/kg DW	NDA	NDA	NDA
Iron	250000	mg/kg DW	NDA	NDA	NDA
Lead	128	mg/kg DW	NDA	NDA	NDA
Manganese	1200	mg/kg DW	NDA	NDA	NDA
Mercury	1.06	mg/kg DW	NDA	NDA	NDA
Nickel	48.6	mg/kg DW	NDA	NDA	NDA
Silver	2.2	mg/kg DW	NDA	NDA	NDA
Zinc	459	mg/kg DW	NDA	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs)					
Acenaphthene	88.9	µg/kg DW	NDA	NDA	NDA
Acenaphthylene	128	µg/kg DW	NDA	NDA	NDA
Anthracene	845	µg/kg DW	NDA	NDA	NDA
Benz(a)anthracene	1050	µg/kg DW	NDA	NDA	NDA
Benzo(a)pyrene	1450	µg/kg DW	NDA	NDA	NDA
Chrysene	1290	µg/kg DW	NDA	NDA	NDA
Dibenz(a,h)anthracene	135	µg/kg DW	NDA	NDA	NDA
Fluoranthene	2230	µg/kg DW	NDA	NDA	NDA
Fluorene	536	µg/kg DW	NDA	NDA	NDA
2-Methylnaphthalene	201	µg/kg DW	NDA	NDA	NDA
Naphthalene	561	µg/kg DW	NDA	NDA	NDA

Table 26. Frequency of exceedance of the selected toxicity thresholds for the protection of the benthic community, in sub-surface sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Units	Frequency of Exceedance of Selected Toxicity Thresholds		
			Presque Isle Bay	Presque Isle Ponds	Lake Erie
PAHs (cont.)					
Phenanthrene	1170	µg/kg DW	NDA	NDA	NDA
Pyrene	1520	µg/kg DW	NDA	NDA	NDA
Total PAHs	22800	µg/kg DW	NDA	NDA	NDA
Polychlorinated Biphenyls (PCBs)					
Total PCBs	676	µg/kg DW	NDA	NDA	NDA
Aroclor 1248	2400	µg/kg DW (at 4% OC)	NDA	NDA	NDA
Aroclor 1254	340	µg/kg DW	NDA	NDA	NDA
Organochlorine Pesticides					
Chlordane (total)	17.6	µg/kg DW	NDA	NDA	NDA
Sum DDD	28.0	µg/kg DW	NDA	NDA	NDA
Sum DDE	31.3	µg/kg DW	NDA	NDA	NDA
Sum DDT	62.9	µg/kg DW	NDA	NDA	NDA
DDT (total)	572	µg/kg DW	NDA	NDA	NDA
Dieldrin	61.8	µg/kg DW	NDA	NDA	NDA
Endrin (total)	207	µg/kg DW	NDA	NDA	NDA
Phthalates					
Bis(2-ethylhexyl)phthalate	4788	µg/kg DW (at 4% OC)	NDA	NDA	NDA
Other COPCs					
Cyanide	0.25	mg/kg DW	NDA	NDA	NDA

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.

[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 27. Proportion of surficial sediment samples from the Presque Isle Bay AOC and nearshore areas of Lake Erie with conditions sufficient to adversely effect sediment-dwelling organisms based upon toxicity to one or more species [1].

Area	Time Period	Endpoint	Number of Samples	Number of Toxic Samples	Percent of Toxic Samples
Presque Isle Bay	1982-1991	Survival	NDA	NDA	NDA
	1992-2003	Survival	21	11	52%
	1982-1991	Survival or Growth	NDA	NDA	NDA
	1992-2003	Survival or Growth	21	13	62%
Presque Isle Ponds	1982-1991	Survival	NDA	NDA	NDA
	1992-2003	Survival	1	1	100%
	1982-1991	Survival or Growth	NDA	NDA	NDA
	1992-2003	Survival or Growth	1	1	100%
Lake Erie	1982-1991	Survival	12	3	25%
	1992-2003	Survival	2	0	0%
	1982-1991	Survival or Growth	12	3	25%
	1992-2003	Survival or Growth	2	0	0%
Inland Reference Sites	1982-1991	Survival	NDA	NDA	NDA
	1992-2003	Survival	NDA	NDA	NDA
	1982-1991	Survival or Growth	NDA	NDA	NDA
	1992-2003	Survival or Growth	NDA	NDA	NDA

NDA = no data available.

[1]Tests include 10-d *Chironomus tentans,* S and G; 48-h *Daphnia magna,* S; 96-h *Daphnia magna* , S; 7-d *Daphnia magna,* S; 96-h *Hexagenia limbata,* S; 10-d *Hyalella azteca,* S and G; 28-d *Hyalella azteca,* S and G.
S = survival; G = growth; d = day; h = hour.

Table 28. Abundance of selected taxa (mean ± SD) and benthic community strucuture (mean ± SD) observed in sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with mean PEC-Qs of <0.22, 0.22 to 0.63 and >0.63.

Taxanomic Group/BICS Metric	Probable Effect Concentration-Quotient (PEC-Q) Range		
	< 0.22	**≥ 0.22 to ≤ 0.63**	**> 0.63**
Amnicola limnosa	0 (n=3)	38 ± 35.5 (n=5)	NDA
Amphipoda	50.3 ± 71.4 (n=3)	79.4 ± 157 (n=5)	73.7 ± 86.6 (n=10)
Arachnidae	0 ± (n=3)	22.8 ± 20.8 (n=5)	NDA
Bivalvia	321 ± 312 (n=3)	635 ± 373 (n=5)	12.6 ± 20.8 (n=10)
Ceratopogonidae	25.3 ± 29 (n=3)	68.2 ± 76.3 (n=5)	NDA
Chironomidae	498 ± 448 (n=3)	979 ± 596 (n=5)	453 ± 197 (n=10)
Coleoptera	NDA	NDA	0.63 ± 1.99 (n=10)
Dreissena	37.7 ± 65.2 (n=3)	295 ± 409 (n=5)	886 ± 1460 (n=10)
Ephemeroptera	NDA	NDA	3.15 ± 4.45 (n=10)
Gastropoda	NDA	NDA	518 ± 824 (n=10)
Hirudinea	0 (n=3)	11.4 ± 25.5 (n=5)	17.7 ± 28.3 (n=10)
Isopoda	NDA	NDA	46.6 ± 82.3 (n=10)
Nematoda	NDA	NDA	15.1 ± 21.5 (n=10)
Oligochaeta	3960 ± 4530 (n=3)	1060 ± 1710 (n=5)	1180 ± 1680 (n=10)
Ostracoda	56.7 ± 98.1 (n=3)	87.2 ± 114 (n=5)	3.15 ± 9.96 (n=10)
Plecoptera	NDA	NDA	0 ± (n=10)
Polychaeta	0 (n=3)	129 ± 163 (n=5)	NDA
Trichoptera	25.3 ± 43.9 (n=3)	41.6 ± 55.6 (n=5)	10.1 ± 13.3 (n=10)
Turbellaria	NDA	NDA	0.63 ± 1.99 (n=10)
Community Structure			
Diversity	1.56 ± 0.75 (n=3)	2.31 ± 0.276 (n=5)	NDA
Evenness	0.557 ± 0.15 (n=3)	0.772 ± 0.0864 (n=5)	NDA
Number of Individuals	284 ± 285 (n=3)	186 ± 184 (n=5)	NDA
Number of Taxa	19.7 ± 12.3 (n=3)	21.2 ± 7.69 (n=5)	NDA
Species Richness	3.4 ± 2.14 (n=3)	3.99 ± 0.869 (n=5)	NDA
Sum EPT Taxa	25.3 ± 43.9 (n=3)	41.6 ± 55.6 (n=5)	13.2 ± 14.7 (n=10)
Total Abundance	5690 ± 5700 (n=3)	3720 ± 3680 (n=5)	NDA

NDA = no data available; BICS = benthic invertebrate community structure; n = number of samples; SD = standard deviation; EPT = ephemeroptera, plecoptera, tricoptera.

Table 29. Control-adjusted survival (mean + SD) of toxicity test organisms exposed to sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with mean PEC-Qs of <0.22, 0.22 to 0.63 and >0.63.

Species Tested	Exposure Duration	Probable Effect Concentration-Quotient (PEC-Q) Range		
		< 0.22	> 0.22 to < 0.63	> 0.63
Toxicity				
Chironomus tentans	10-day	NDA	NDA	86.4 + 7.36 (n=10)
Daphnia magna	48-hour	91.5 + 11.1 (n=4)	95.6 + 11 (n=8)	NDA
Daphnia magna	7-day	NDA	NDA	82 + 19.9 (n=10)
Daphnia magna	96-hour	NDA	91.2 + 19.6 (n=6)	NDA
Hexagenia limbata	96-hour	NDA	97.3 + 4.66 (n=6)	NDA
Hyalella azteca	10-day	83.9 + 44.1 (n=4)	86.6 + 13.8 (n=8)	NDA
Hyalella azteca	28-day	NDA	NDA	88.5 + 24.5 (n=10)

NDA = no data available; n = number of samples; SD = standard deviation.

Table 30. Abundance of selected taxa (mean ± SD) and benthic community structure (mean ± SD) observed in sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with mean PEC-Qs of <0.1, 0.1 to <0.5, 0.5 to <1.0 and >1.0.

Taxanomic Group/BICS Metric	Probable Effect Concentration-Quotient (PEC-Q) Range			
	<0.1	0.1 - <0.5	0.5 - <1.0	>1.0
Amnicola limnosa	0 (n=1)	25.3 ± 37.4 (n=6)	38 (n=1)	NDA
Amphipoda	0 (n=1)	91.3 ± 140 (n=6)	85.7 ± 122 (n=5)	51.5 ± 44.6 (n=6)
Arachnidae	0 (n=1)	15.8 ± 22.2 (n=6)	19 (n=1)	NDA
Bivalvia	0 (n=1)	649 ± 313 (n=6)	51.7 ± 109 (n=5)	18.9 ± 25.2 (n=6)
Ceratopogonidae	0 (n=1)	53.7 ± 69.1 (n=6)	95 (n=1)	NDA
Chironomidae	0 (n=1)	971 ± 527 (n=6)	479 ± 173 (n=5)	450 ± 219 (n=6)
Coleoptera	NDA	NDA	0 ± (n=4)	1.05 ± 2.57 (n=6)
Dreissena	0 (n=1)	249 ± 384 (n=6)	1250 ± 1980 (n=5)	448 ± 683 (n=6)
Ephemeroptera	NDA	NDA	6.3 ± 5.14 (n=4)	1.05 ± 2.57 (n=6)
Gastropoda	NDA	NDA	996 ± 1220 (n=4)	200 ± 147 (n=6)
Hirudinea	0 (n=1)	9.5 ± 23.3 (n=6)	8.82 ± 12.3 (n=5)	22.2 ± 35.8 (n=6)
Isopoda	NDA	NDA	70.9 ± 106 (n=4)	30.5 ± 68.6 (n=6)
Nematoda	NDA	NDA	15.8 ± 31.5 (n=4)	14.7 ± 15.3 (n=6)
Oligochaeta	964 (n=1)	2640 ± 3530 (n=6)	654 ± 583 (n=5)	1480 ± 2140 (n=6)
Ostracoda	0 (n=1)	101 ± 107 (n=6)	6.3 ± 14.1 (n=5)	0 (n=6)
Plecoptera	NDA	NDA	0 (n=4)	0 (n=6)
Polychaeta	0 (n=1)	97.7 ± 161 (n=6)	57 (n=1)	NDA
Trichoptera	0 (n=1)	47.3 ± 51.7 (n=6)	16.4 ± 16.4 (n=5)	3.15 ± 5.27 (n=6)
Turbellaria	NDA	NDA	1.58 ± 3.15 (n=4)	0 (n=6)
Community Structure				
Diversity	0.98 (n=1)	2.14 ± 0.481 (n=6)	2.4 (n=1)	NDA
Evenness	0.55 (n=1)	0.688 ± 0.153 (n=6)	0.85 (n=1)	NDA
Number of Individuals	56 (n=1)	275 ± 224 (n=6)	79 (n=1)	NDA
Number of Taxa	6 (n=1)	23.7 ± 7.26 (n=6)	17 (n=1)	NDA
Species Richness	1.24 (n=1)	4.21 ± 1.02 (n=6)	3.66 (n=1)	NDA
Sum EPT Taxa	0 (n=1)	47.3 ± 51.7 (n=6)	21.4 ± 17 (n=5)	4.2 ± 5.14 (n=6)
Total Abundance	1120 (n=1)	5490 ± 4490 (n=6)	1580 (n=1)	NDA

NDA = no data available; BICS = benthic invertebrate community structure; n = number of samples; SD = standard deviation; EPT = ephemeroptera, plecoptera, tricoptera.

Table 31. Control-adjusted survival (mean ± SD) of toxicity test organisms exposed to sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with mean PEC-Qs of <0.1, 0.1 to <0.5, 0.5 to <1.0 and >1.0.

Species Tested	Exposure Duration	Probable Effect Concentration-Quotient (PEC-Q) Range			
		<0.1	0.1 - <0.5	0.5 - <1.0	>1.0
Toxicity					
Chironomus tentans	10-day	NDA	NDA	87.2 ± 9.37 (n=4)	85.9 ± 6.64 (n=6)
Daphnia magna	48-hour	NDA	93.5 ± 10.9 (n=11)	102 (n=1)	NDA
Daphnia magna	7-day	NDA	NDA	75 ± 25.2 (n=4)	86.7 ± 16.3 (n=6)
Daphnia magna	96-hour	NDA	89 ± 21.1 (n=5)	102 (n=1)	NDA
Hexagenia limbata	96-hour	NDA	97.6 ± 5.16 (n=5)	95.9 (n=1)	NDA
Hyalella azteca	10-day	107 ± 0 (n=2)	79.7 ± 27 (n=9)	96.6 (n=1)	NDA
Hyalella azteca	28-day	NDA	NDA	94.5 ± 5.41 (n=4)	84.6 ± 31.9 (n=6)

NDA = no data available; n = number of samples; SD = standard deviation.

Table 32. Proportion of surficial sediment samples from the Presque Isle Bay AOC and nearshore areas of Lake Erie with conditions sufficient to adversely effect sediment-dwelling organisms based upon toxicity to individual species.

Area	Time Period	Endpoint	Species	Duration	Number of Samples	Number of Toxic Samples	Percent of Toxic Samples
Presque Isle Bay	1992-2003	Survival	*Daphnia magna*	7-d	10	2	20%
	1992-2003	Survival or growth	*Daphnia magna*	7-d	10	2	20%
	1992-2003	Survival	*Chironomus tentans*	10-d	11	3	27%
	1992-2003	Survival or growth	*Chironomus tentans*	10-d	11	5	45%
	1992-2003	Survival	*Hyalella azteca*	10-d	10	5	50%
	1992-2003	Survival or growth	*Hyalella azteca*	10-d	10	5	50%
	1992-2003	Survival	*Hyalella azteca*	28-d	11	1	9%
	1992-2003	Survival or growth	*Hyalella azteca*	28-d	11	1	9%
Presque Isle Ponds	1992-2003	Survival	*Daphnia magna*	7-d	1	1	100%
	1992-2003	Survival or growth	*Daphnia magna*	7-d	1	1	100%
	1992-2003	Survival	*Chironomus tentans*	10-d	1	0	0%
	1992-2003	Survival or growth	*Chironomus tentans*	10-d	1	0	0%
	1992-2003	Survival	*Hyalella azteca*	28-d	1	0	0%
	1992-2003	Survival or growth	*Hyalella azteca*	28-d	1	0	0%
Lake Erie	1982-1991	Survival	*Daphnia magna*	48-h	12	3	25%
	1982-1991	Survival or growth	*Daphnia magna*	48-h	12	3	25%
	1982-1991	Survival	*Daphnia magna*	96-h	6	2	33%
	1982-1991	Survival or growth	*Daphnia magna*	96-h	6	2	33%
	1982-1991	Survival	*Hexagenia limbata*	96-h	6	0	0%
	1982-1991	Survival or growth	*Hexagenia limbata*	96-h	6	0	0%
	1992-2003	Survival	*Hyalella azteca*	10-d	2	0	0%
	1992-2003	Survival or growth	*Hyalella azteca*	10-d	2	0	0%

Table 33. Summary of sediment quality conditions relative to the potential for adverse effects on sediment-dwelling organisms in the Presque Isle Bay Area of Concern and the nearshore areas of Lake Erie (% of samples showing adverse effects).

Area	Horizon	Time Period	Indicator of Adverse Effects on Sediment-Dwelling Organisms: Whole-Sediment Chemistry			Whole-Sediment Toxicity	Number of Lines of Evidence Demonstrating Adverse Effects on Sediment-Dwelling Organisms
			PEC-Qs >0.63	ESBTU >1.0	SEM - AVS >0.0	Significant Toxicity[1]	
Presque Isle Bay	surface	1982-1991	58% (n=31)	14% (n=14)	NDA	NDA	2
		1992-2003	34% (n=138)	30% (n=43)	0% (n=10)	62% (n=21)	3
	subsurface	1982-1991	NDA	NDA	NDA	NDA	0
		1992-2003	25% (n=57)	90% (n=20)	NDA	NDA	2
Presque Isle Ponds	surface	1982-1991	0% (n=1)	0% (n=1)	NDA	NDA	0
		1992-2003	66% (n=35)	NDA	NDA	100% (n=1)	2
	subsurface	1982-1991	NDA	NDA	NDA	NDA	0
		1992-2003	NDA	NDA	NDA	NDA	0
Lake Erie	surface	1982-1991	0% (n=14)	100% (n=1)	NDA	25% (n=12)	2
		1992-2003	0% (n=9)	67% (n=3)	NDA	0% (n=2)	1
	subsurface	1982-1991	NDA	NDA	NDA	NDA	0
		1992-2003	0% (n=6)	NDA	NDA	NDA	0
Inland Reference	surface	1982-1991	NDA	NDA	NDA	NDA	0
		1992-2003	0% (n=3)	0% (n=1)	NDA	NDA	0
	subsurface	1982-1991	NDA	NDA	NDA	NDA	0
		1992-2003	NDA	NDA	NDA	NDA	0

PEC-Q = probable effect concentration-quotient; ESBTU = equilibrium partitioning sediment benchmark toxic unit;
SEM-AVS = simultaneously extracted metals-acid volatile sulfide; NDA = no data available; n = number of samples.
Surface = upper depth 0 cm and lower depth ≤30 cm; subsurface = upper depth >0 cm or lower depth >30 cm.

[1]Considering survival or growth to one or more toxicity test organisms.

Table 34. Proportion of surficial sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with conditions sufficient to adversely affect fish [i.e., concentrations of six or more chemicals of potential concern (COPCs) exceed the selected toxicity thresholds].

Area	Horizon	Time Period	Number of Samples	Number of Samples with Concentrations of 6 or more COPCs > Selected Toxicity Thresholds	Percent of Samples with WS Chemistry Sufficient to Adversely Affect Fish[1]
Presque Isle Bay	surface	1982-1991	31	3	10%
		1992-2003	138	9	7%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	57	5	9%
Presque Isle Ponds	surface	1982-1991	1	0	0%
		1992-2003	35	0	0%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Lake Erie	surface	1982-1991	14	0	0%
		1992-2003	9	0	0%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	6	0	0%
Inland Reference	surface	1982-1991	NDA	NDA	NDA
		1992-2003	3	0	0%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA

NDA = no data available.

Surface = upper depth 0 cm and lower depth ≤30 cm; subsurface = upper depth >0 cm or lower depth >30 cm.

[1]Based on applying the selected toxicity thresholds to whole-sediment samples.

Table 35. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in surficial sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Frequency of Exceedance of Selected Toxicity Thresholds		
		Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Aluminum	NB	NB	NB	NB
Antimony	25	NDA	NDA	NDA
Arsenic	70	0% (n=31)	0% (n=1)	0% (n=14)
Barium	NB	NB	NB	NB
Cadmium	9.6	16% (n=31)	0% (n=1)	0% (n=14)
Chromium	370	0% (n=31)	0% (n=1)	0% (n=14)
Copper	270	0% (n=31)	0% (n=1)	0% (n=14)
Iron	NB	NB	NB	NB
Lead	218	6% (n=31)	0% (n=1)	0% (n=14)
Manganese	NB	NB	NB	NB
Mercury	0.71	6% (n=31)	0% (n=1)	0% (n=14)
Nickel	51.6	48% (n=31)	0% (n=1)	7% (n=14)
Silver	3.7	NDA	NDA	NDA
Zinc	410	16% (n=31)	0% (n=1)	0% (n=14)
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)				
Acenaphthene	500	0% (n=14)	0% (n=1)	0% (n=1)
Acenaphthylene	640	0% (n=14)	0% (n=1)	0% (n=1)
Anthracene	1100	0% (n=23)	0% (n=1)	0% (n=8)
Benz(a)anthracene	1600	4% (n=23)	0% (n=1)	0% (n=8)
Benzo(a)pyrene	1600	9% (n=23)	0% (n=1)	0% (n=8)
Chrysene	2800	0% (n=14)	0% (n=1)	0% (n=6)
Dibenz(a,h)anthracene	260	21% (n=14)	0% (n=1)	0% (n=1)
Fluoranthene	5100	4% (n=23)	0% (n=1)	0% (n=8)
Fluorene	540	0% (n=23)	0% (n=1)	0% (n=8)
2-Methylnaphthalene	670	14% (n=14)	0% (n=1)	0% (n=1)
Naphthalene	2100	0% (n=23)	0% (n=1)	0% (n=8)

Table 35. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in surficial sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Frequency of Exceedance of Selected Toxicity Thresholds		
		Presque Isle Bay	Presque Isle Ponds	Lake Erie
PAHs (µg/kg DW; cont.)				
Phenanthrene	1500	35% (n=23)	0% (n=1)	0% (n=8)
Pyrene	2600	13% (n=23)	0% (n=1)	0% (n=8)
Total PAHs	44792	0% (n=14)	0% (n=1)	0% (n=1)
Polychlorinated Biphenyls (PCBs; µg/kg DW)				
Total PCBs	180	100% (n=9)	NDA	NDA
Aroclor 1248	NB	NB	NB	NB
Aroclor 1254	340	11% (n=9)	NDA	0% (n=7)
Organochlorine Pesticides (µg/kg DW)				
Chlordane (total)	6	NDA	NDA	NDA
Sum DDD	20	NDA	NDA	NDA
Sum DDE	15	NDA	NDA	NDA
Sum DDT	7	NDA	NDA	NDA
DDT (total)	46.1	0% (n=9)	NDA	0% (n=7)
Dieldrin	8	100% (n=1)	NDA	NDA
Endrin (total)	45	0% (n=23)	0% (n=1)	0% (n=8)
Phthalates				
Bis(2-ethylhexyl)phthalate	NB	NB	NB	NB
Other COPCs				
Cyanide	NB	NB	NB	NB

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.

[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 36. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in sub-surface sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Frequency of Exceedance of Selected Toxicity Thresholds		
		Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Aluminum	NB	NB	NB	NB
Antimony	25	NDA	NDA	NDA
Arsenic	70	NDA	NDA	NDA
Barium	NB	NB	NB	NB
Cadmium	9.6	NDA	NDA	NDA
Chromium	370	NDA	NDA	NDA
Copper	270	NDA	NDA	NDA
Iron	NB	NB	NB	NB
Lead	218	NDA	NDA	NDA
Manganese	NB	NB	NB	NB
Mercury	0.71	NDA	NDA	NDA
Nickel	51.6	NDA	NDA	NDA
Silver	3.7	NDA	NDA	NDA
Zinc	410	NDA	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)				
Acenaphthene	500	NDA	NDA	NDA
Acenaphthylene	640	NDA	NDA	NDA
Anthracene	1100	NDA	NDA	NDA
Benz(a)anthracene	1600	NDA	NDA	NDA
Benzo(a)pyrene	1600	NDA	NDA	NDA
Chrysene	2800	NDA	NDA	NDA
Dibenz(a,h)anthracene	260	NDA	NDA	NDA
Fluoranthene	5100	NDA	NDA	NDA
Fluorene	540	NDA	NDA	NDA
2-Methylnaphthalene	670	NDA	NDA	NDA
Naphthalene	2100	NDA	NDA	NDA

Table 36. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in sub-surface sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1982-1991.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Frequency of Exceedance of Selected Toxicity Thresholds		
		Presque Isle Bay	Presque Isle Ponds	Lake Erie
PAHs (µg/kg DW; cont.)				
Phenanthrene	1500	NDA	NDA	NDA
Pyrene	2600	NDA	NDA	NDA
Total PAHs	44792	NDA	NDA	NDA
Polychlorinated Biphenyls (PCBs; µg/kg DW)				
Total PCBs	180	NDA	NDA	NDA
Aroclor 1248	NB	NB	NB	NB
Aroclor 1254	340	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)				
Chlordane (total)	6	NDA	NDA	NDA
Sum DDD	20	NDA	NDA	NDA
Sum DDE	15	NDA	NDA	NDA
Sum DDT	7	NDA	NDA	NDA
DDT (total)	46.1	NDA	NDA	NDA
Dieldrin	8	NDA	NDA	NDA
Endrin (total)	45	NDA	NDA	NDA
Phthalates				
Bis(2-ethylhexyl)phthalate	NB	NB	NB	NB
Other COPCs				
Cyanide	NB	NB	NB	NB

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.

[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 37. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in surficial sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Frequency of Exceedance of Selected Toxicity Thresholds		
		Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Aluminum	NB	NB	NB	NB
Antimony	25	20% (n=25)	100% (n=1)	NDA
Arsenic	70	3% (n=103)	57% (n=35)	0% (n=5)
Barium	NB	NB	NB	NB
Cadmium	9.6	6% (n=112)	0% (n=20)	0% (n=5)
Chromium	370	0% (n=103)	0% (n=35)	0% (n=5)
Copper	270	0% (n=113)	0% (n=35)	0% (n=5)
Iron	NB	NB	NB	NB
Lead	218	3% (n=113)	0% (n=35)	0% (n=5)
Manganese	NB	NB	NB	NB
Mercury	0.71	7% (n=102)	3% (n=35)	0% (n=5)
Nickel	51.6	34% (n=113)	12% (n=34)	0% (n=5)
Silver	3.7	0% (n=4)	NDA	NDA
Zinc	410	20% (n=113)	3% (n=35)	0% (n=5)
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)				
Acenaphthene	500	5% (n=41)	NDA	0% (n=4)
Acenaphthylene	640	11% (n=47)	NDA	0% (n=4)
Anthracene	1100	0% (n=48)	NDA	0% (n=4)
Benz(a)anthracene	1600	9% (n=68)	NDA	0% (n=7)
Benzo(a)pyrene	1600	13% (n=68)	NDA	0% (n=7)
Chrysene	2800	6% (n=68)	NDA	0% (n=7)
Dibenz(a,h)anthracene	260	26% (n=47)	NDA	0% (n=4)
Fluoranthene	5100	6% (n=70)	NDA	0% (n=7)
Fluorene	540	2% (n=48)	NDA	0% (n=4)
2-Methylnaphthalene	670	0% (n=1)	NDA	NDA
Naphthalene	2100	0% (n=48)	NDA	0% (n=4)

Table 37. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in surficial sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Frequency of Exceedance of Selected Toxicity Thresholds		
		Presque Isle Bay	Presque Isle Ponds	Lake Erie
PAHs (µg/kg DW; cont.)				
Phenanthrene	1500	13% (n=68)	NDA	0% (n=7)
Pyrene	2600	22% (n=68)	NDA	0% (n=7)
Total PAHs	44792	5% (n=66)	NDA	0% (n=7)
Polychlorinated Biphenyls (PCBs; µg/kg D				
Total PCBs	180	81% (n=26)	NDA	0% (n=3)
Aroclor 1248	NB	NB	NB	NB
Aroclor 1254	340	0% (n=27)	NDA	0% (n=3)
Organochlorine Pesticides (µg/kg DW)				
Chlordane (total)	6	25% (n=20)	NDA	0% (n=3)
Sum DDD	20	0% (n=20)	NDA	0% (n=3)
Sum DDE	15	0% (n=20)	NDA	0% (n=3)
Sum DDT	7	0% (n=20)	NDA	0% (n=3)
DDT (total)	46.1	0% (n=20)	NDA	0% (n=3)
Dieldrin	8	5% (n=20)	NDA	0% (n=3)
Endrin (total)	45	0% (n=20)	NDA	0% (n=3)
Phthalates				
Bis(2-ethylhexyl)phthalate	NB	NB	NB	NB
Other COPCs				
Cyanide	NB	NB	NB	NB

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.

[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 38. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in sub-surface sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Frequency of Exceedance of Selected Toxicity Thresholds		
		Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Aluminum	NB	NB	NB	NB
Antimony	25	NDA	NDA	NDA
Arsenic	70	NDA	NDA	NDA
Barium	NB	NB	NB	NB
Cadmium	9.6	0% (n=20)	NDA	NDA
Chromium	370	NDA	NDA	NDA
Copper	270	0% (n=20)	NDA	NDA
Iron	NB	NB	NB	NB
Lead	218	0% (n=20)	NDA	NDA
Manganese	NB	NB	NB	NB
Mercury	0.71	NDA	NDA	NDA
Nickel	51.6	55% (n=20)	NDA	NDA
Silver	3.7	NDA	NDA	NDA
Zinc	410	60% (n=20)	NDA	NDA
Polycyclic Aromatic Hydrocarbons (PAHs; µg/kg DW)				
Acenaphthene	500	11% (n=47)	NDA	0% (n=6)
Acenaphthylene	640	18% (n=57)	NDA	0% (n=6)
Anthracene	1100	0% (n=57)	NDA	0% (n=6)
Benz(a)anthracene	1600	5% (n=57)	NDA	0% (n=6)
Benzo(a)pyrene	1600	2% (n=57)	NDA	0% (n=6)
Chrysene	2800	7% (n=57)	NDA	0% (n=6)
Dibenz(a,h)anthracene	260	4% (n=57)	NDA	0% (n=6)
Fluoranthene	5100	11% (n=57)	NDA	0% (n=6)
Fluorene	540	7% (n=57)	NDA	0% (n=6)
2-Methylnaphthalene	670	NDA	NDA	NDA
Naphthalene	2100	0% (n=57)	NDA	0% (n=6)

Table 38. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in sub-surface sediment samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie: 1992-2003.

Chemical of Potential Concern (COPC)	Selected Toxicity Threshold[1]	Frequency of Exceedance of Selected Toxicity Thresholds		
		Presque Isle Bay	Presque Isle Ponds	Lake Erie
PAHs (µg/kg DW; cont.)				
Phenanthrene	1500	14% (n=57)	NDA	0% (n=6)
Pyrene	2600	9% (n=57)	NDA	0% (n=6)
Total PAHs	44792	4% (n=57)	NDA	0% (n=6)
Polychlorinated Biphenyls (PCBs; µg/kg DW)				
Total PCBs	180	NDA	NDA	NDA
Aroclor 1248	NB	NB	NB	NB
Aroclor 1254	340	NDA	NDA	NDA
Organochlorine Pesticides (µg/kg DW)				
Chlordane (total)	6	NDA	NDA	NDA
Sum DDD	20	NDA	NDA	NDA
Sum DDE	15	NDA	NDA	NDA
Sum DDT	7	NDA	NDA	NDA
DDT (total)	46.1	NDA	NDA	NDA
Dieldrin	8	NDA	NDA	NDA
Endrin (total)	45	NDA	NDA	NDA
Phthalates				
Bis(2-ethylhexyl)phthalate	NB	NB	NB	NB
Other COPCs				
Cyanide	NB	NB	NB	NB

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane.

[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 39. Proportion of surficial sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with conditions sufficient to adversely effect fish based upon toxicity to fathead minnows, *Pimephales promelas,* in 96-hour tests.

Area	Time Period	Endpoint	Number of Samples	Number of Toxic Samples	Percent of Toxic Samples
Presque Isle Bay	1982-1991	Survival	NDA	NDA	NDA
	1992-2003	Survival	NDA	NDA	NDA
	1982-1991	Survival or growth	NDA	NDA	NDA
	1992-2003	Survival or growth	NDA	NDA	NDA
Presque Isle Ponds	1982-1991	Survival	NDA	NDA	NDA
	1992-2003	Survival	NDA	NDA	NDA
	1982-1991	Survival or growth	NDA	NDA	NDA
	1992-2003	Survival or growth	NDA	NDA	NDA
Lake Erie	1982-1991	Survival	12	0	0%
	1992-2003	Survival	NDA	NDA	NDA
	1982-1991	Survival or growth	12	0	0%
	1992-2003	Survival or growth	NDA	NDA	NDA
Inland Reference Sites	1982-1991	Survival	NDA	NDA	NDA
	1992-2003	Survival	NDA	NDA	NDA
	1982-1991	Survival or growth	NDA	NDA	NDA
	1992-2003	Survival or growth	NDA	NDA	NDA

NDA = no data available.

Table 40. Proportion of fish tissue samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with conditions sufficient to adversely affect fish [i.e., concentrations of one or more chemicals of potential concern (COPCs) exceed the selected toxicity thresholds].

Area	Time Period	Number of Samples	Number of Samples with Concentrations of 1 or more COPCs > Selected Toxicity Thresholds	Percent of Samples with Tissue Chemistry Sufficient to Adversely Affect Fish[1]
Presque Isle Bay	1982-1991	NDA	NDA	NDA
	1992-2003	2	2	100%
Presque Isle Ponds	1982-1991	NDA	NDA	NDA
	1992-2003	2	0	0%
Lake Erie	1982-1991	NDA	NDA	NDA
	1992-2003	1	1	100%
Inland Reference	1982-1991	NDA	NDA	NDA
	1992-2003	NDA	NDA	NDA

NDA = no data available.

[1]Based on applying the selected toxicity thresholds to fillet fish tissue samples.

Table 41. Frequency of exceedance of the selected toxicity thresholds for the protection of the fish community, in fish tissue samples from Presque Isle Bay: 1992-2003.

Chemical of Potential Concern (COPC)	Frequency of Exceedance of Selected Toxicity			
	Selected Toxicity Threshold[1]	Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Cadmium	0.13	50% (n=2)	0% (n=2)	100% (n=1)
Lead	NB	NB	NB	NB
Mercury (Methyl mercury)	0.7	50% (n=2)	0% (n=2)	0% (n=1)
Polychlorinated Biphenyls (PCBs; µg/kg DW)				
Total PCBs	1100	0% (n=2)	0% (n=2)	0% (n=1)
Aroclor 1016	NB	NB	NB	NB
Aroclor 1242	NB	NB	NB	NB
Aroclor 1248	NB	NB	NB	NB
Aroclor 1254	1530	NDA	NDA	NDA
Aroclor 1260	NB	NB	NB	NB
Aroclor 1268	NB	NB	NB	NB
Organochlorine Pesticides (µg/kg DW)				
Aldrin + Dieldrin	NB	NB	NB	NB
Chlordane (total)	NB	NB	NB	NB
Sum DDD	NB	NB	NB	NB
Sum DDE	NB	NB	NB	NB
Sum DDT	NB	NB	NB	NB
DDT (total)	165	NDA	NDA	NDA
Dieldrin	NB	NB	NB	NB
Endrin (total)	120	NDA	NDA	NDA
PCDDs and PCDFs (µg/kg DW)				
2,3,7,8-TCDD Toxic Equivalents (TEQs)	116	NDA	NDA	NDA

DW = dry weight; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane;
PCDD = Polychlorinated dibenzo-*p*- dioxin; PCDF = Polychlorinated dibenzofuran.

[1]Selected toxicity thresholds apply to whole body or fillet fish tissue samples.

Table 42. Summary of sediment quality conditions relative to the potential for adverse effects on fish in the Presque Isle Bay Area of Concern and the nearshore areas of Lake Erie (% of samples showing adverse effects).

Area	Horizon	Time Period	Indicator of Adverse Effects on Fish			Number of Lines of Evidence Demonstrating Adverse Effects on Fish
			Whole-Sediment Chemistry	Whole-Sediment Toxicity	Fish Tissue Chemistry	
Presque Isle Bay	surface	1982-1991	10% (n=31)	NDA	NDA	1
		1992-2003	7% (n=138)	NDA	100% (n=2)	2
	subsurface	1982-1991	NDA	NDA	NA	0
		1992-2003	9% (n=57)	NDA	NA	1
Presque Isle Ponds	surface	1982-1991	0% (n=1)	NDA	NDA	0
		1992-2003	0% (n=35)	NDA	100% (n=2)	1
	subsurface	1982-1991	NDA	NDA	NA	0
		1992-2003	NDA	NDA	NA	0
Lake Erie	surface	1982-1991	0% (n=14)	0% (n=12)	NDA	0
		1992-2003	0% (n=9)	NDA	100% (n=1)	1
	subsurface	1982-1991	NDA	NDA	NA	0
		1992-2003	0% (n=6)	NDA	NA	0
Inland Reference	surface	1982-1991	NDA	NDA	NDA	0
		1992-2003	0% (n=3)	NDA	NDA	0
	subsurface	1982-1991	NDA	NDA	NA	0
		1992-2003	NDA	NDA	NA	0

NA = not applicable; NDA = no data available.
Surface = upper depth 0 cm and lower depth ≤30 cm; subsurface = upper depth >0 cm or lower depth >30 cm.

Table 43. Proportion of surficial sediment samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with conditions sufficient to adversely affect aquatic-dependent wildlife [i.e., concentrations of one or more chemicals of potential concern (COPCs) exceed the selected toxicity thresholds].

Area	Horizon	Time Period	Number of Samples	Number of Samples with Concentrations of 1 or more COPCs > Selected Toxicity Thresholds	Percent of Samples with WS Chemistry Sufficient to Adversely Affect Aquatic-Dependent Wildlife[1]
Presque Isle Bay	surface	1982-1991	10	8	80%
		1992-2003	36	34	94%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Presque Isle Ponds	surface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Lake Erie	surface	1982-1991	NDA	NDA	NDA
		1992-2003	2	1	50%
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
Inland Reference	surface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA
	subsurface	1982-1991	NDA	NDA	NDA
		1992-2003	NDA	NDA	NDA

Surface = upper depth 0 cm and lower depth ≤30 cm; subsurface = upper depth >0 cm or lower depth >30 cm.

[1]Based on applying the selected toxicity thresholds to whole-sediment samples.

Table 44. Frequency of exceedance of the selected toxicity thresholds for the protection of aquatic-dependent wildlife, in surficial sediment samples from Presque Isle Bay: 1982-1991.

Chemical of Potential Concern (COPC)	Frequency of Exceedance of Selected Toxicity Thresholds			
	Selected Toxicity Threshold[1]	Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Cadmium	NB	NB	NB	NB
Lead	NB	NB	NB	NB
Mercury (Methyl mercury)	NB	NB	NB	NB
Polychlorinated Biphenyls (PCBs; µg/kg DW)				
Total PCBs	1400	100% (n=8)	NDA	NDA
Aroclor 1016	NB	NB	NB	NB
Aroclor 1242	NB	NB	NB	NB
Aroclor 1248	NB	NB	NB	NB
Aroclor 1254	NB	NB	NB	NB
Aroclor 1260	NB	NB	NB	NB
Aroclor 1268	NB	NB	NB	NB
Organochlorine Pesticides (µg/kg DW)				
Aldrin + Dieldrin	770	50% (n=2)	NDA	NDA
Chlordane (total)	6	NDA	NDA	NDA
Sum DDD	NB	NB	NB	NB
Sum DDE	NB	NB	NB	NB
Sum DDT	NB	NB	NB	NB
DDT (total)	1000	NDA	NDA	NDA
Dieldrin	NB	NB	NB	NB
Endrin (total)	800	0% (n=7)	NDA	NDA
PCDDs and PCDFs				
2,3,7,8-TCDD Toxic Equivalents (TEQs) - mammalian	833	NDA	NDA	NDA
2,3,7,8-TCDD TEQs - avian	7000	NDA	NDA	NDA

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane;
TCDD = Tetrachlorodibenzo-*p*-dioxin; PCDD = Polychlorinated dibenzo-*p*-dioxin; PCDF = Polychlorinated dibenzofuran.

Surface = upper depth 0 cm and lower depth ≤30 cm.
[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 45. Frequency of exceedance of the selected toxicity thresholds for the protection of aquatic-dependent wildlife, in surficial sediment samples from Presque Isle Bay: 1992-2003.

Chemical of Potential Concern (COPC)	Frequency of Exceedance of Selected Toxicity Thresholds			
	Selected Toxicity Threshold[1]	Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Cadmium	NB	NB	NB	NB
Lead	NB	NB	NB	NB
Mercury (Methyl mercury)	NB	NB	NB	NB
Polychlorinated Biphenyls (PCBs; µg/kg DW)				
Total PCBs	1400	100% (n=24)	NDA	100% (n=1)
Aroclor 1016	NB	NB	NB	NB
Aroclor 1242	NB	NB	NB	NB
Aroclor 1248	NB	NB	NB	NB
Aroclor 1254	NB	NB	NB	NB
Aroclor 1260	NB	NB	NB	NB
Aroclor 1268	NB	NB	NB	NB
Organochlorine Pesticides (µg/kg DW)				
Aldrin + Dieldrin	770	0% (n=19)	NDA	0% (n=2)
Chlordane (total)	6	100% (n=16)	NDA	NDA
Sum DDD	NB	NB	NB	NB
Sum DDE	NB	NB	NB	NB
Sum DDT	NB	NB	NB	NB
DDT (total)	1000	5% (n=20)	NDA	0% (n=2)
Dieldrin	NB	NB	NB	NB
Endrin (total)	800	0% (n=20)	NDA	0% (n=2)
PCDDs and PCDFs				
2,3,7,8-TCDD Toxic Equivalents (TEQs) - mammalian	833	82% (n=11)	NDA	NDA
2,3,7,8-TCDD TEQs - avian	7000	0% (n=11)	NDA	NDA

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane; TCDD = Tetrachlorodibenzo-*p*-dioxin; PCDD = Polychlorinated dibenzo-*p*-dioxin; PCDF = Polychlorinated dibenzofuran.

Surface = upper depth 0 cm and lower depth ≤30 cm.
[1]Selected toxicity thresholds apply to whole-sediment samples.

Table 46. Proportion of fish tissue samples from the Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with conditions sufficient to adversely affect piscivorous birds [i.e., concentrations of one or more chemicals of potential concern (COPCs) exceed the selected toxicity thresholds].

Area	Time Period	Number of Samples	Number of Samples with Concentrations of 1 or more COPCs > Selected Toxicity Thresholds	Percent of Samples with Tissue Chemistry Sufficient to Adversely Effect Birds[1]
Presque Isle Bay	1982-1991	NDA	NDA	NDA
	1992-2003	2	1	50%
Presque Isle Ponds	1982-1991	NDA	NDA	NDA
	1992-2003	2	1	50%
Lake Erie	1982-1991	NDA	NDA	NDA
	1992-2003	1	1	100%
Inland Reference	1982-1991	NDA	NDA	NDA
	1992-2003	NDA	NDA	NDA

[1]Based on applying the selected toxicity thresholds for piscivorous birds to fish muscle tissue samples.

Table 47. Frequency of exceedance of the selected toxicity thresholds for the protection of piscivorus birds, in fish tissue samples from Presque Isle Bay: 1992-2003.

Chemical of Potential Concern (COPC)	Frequency of Exceedance of Selected Toxicity Thresholds			
	Selected Toxicity Threshold[1]	Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Cadmium	39	0%(n=2)	0% (n=2)	0% (n=1)
Lead	NB	NB	NB	NB
Mercury (Methyl mercury)	0.13	50%(n=2)	50% (n=2)	100% (n=1)
Polychlorinated Biphenyls (PCBs; µg/kg DW)				
Total PCBs	NB	NB	NB	NB
Aroclor 1016	NB	NB	NB	NB
Aroclor 1242	NB	NB	NB	NB
Aroclor 1248	NB	NB	NB	NB
Aroclor 1254	3600	NDA	NDA	NDA
Aroclor 1260	NB	NB	NB	NB
Aroclor 1268	NB	NB	NB	NB
Organochlorine Pesticides (µg/kg DW)				
Aldrin + Dieldrin	NB	NB	NB	NB
Chlordane (total)	21000	NDA	NDA	NDA
Sum DDD	NB	NB	NB	NB
Sum DDE	NB	NB	NB	NB
Sum DDT	NB	NB	NB	NB
DDT (total)	55	NDA	NDA	NDA
Dieldrin	NB	NB	NB	NB
Endrin (total)	200	NDA	NDA	NDA
PCDDs and PCDFs (µg/kg DW)				
2,3,7,8-TCDD Toxic Equivalents (TEQs)	60	NDA	NDA	NDA

DW = dry weight; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene; DDT = Dichlorodiphenyltrichloroethane;
PCDD = Polychlorinated dibenzo-*p*-dioxin; PCDF = Polychlorinated dibenzofuran; TCDD = Tetrachlorodibenzo-*p*-dioxin.

[1]Based on applying the selected toxicity thresholds for piscivorous birds to fish muscle tissue samples.

Table 48. Proportion of fish tissue samples from Presque Isle Bay Area of Concern and nearshore areas of Lake Erie with conditions sufficient to adversely affect piscivorus mammals [i.e., concentrations of one or more chemicals of potential concern (COPCs) exceed the selected toxicity thresholds].

Area	Time Period	Number of Samples	Number of Samples with Concentrations of 1 or more COPCs > Selected Toxicity Thresholds	Percent of Samples with Tissue Chemistry Sufficient to Adversely Affect Piscivorous Mammals[1]
Presque Isle Bay	1982-1991	NDA	NDA	NDA
	1992-2003	2	1	50%
Presque Isle Ponds	1982-1991	NDA	NDA	NDA
	1992-2003	2	1	50%
Lake Erie	1982-1991	NDA	NDA	NDA
	1992-2003	1	1	100%
Inland Reference	1982-1991	NDA	NDA	NDA
	1992-2003	NDA	NDA	NDA

[1]Selected toxicity thresholds apply to fish muscle tissue samples.

Table 49. Frequency of exceedance of the selected toxicity thresholds for the protection of piscivorus mammals, in fish tissue samples from Presque Isle Bay: 1992-2003.

Chemical of Potential Concern (COPC)	Frequency of Exceedance of Selected Toxicity Thresholds			
	Selected Toxicity Threshold[1]	Presque Isle Bay	Presque Isle Ponds	Lake Erie
Metals (mg/kg DW)				
Cadmium	39	0%(n=2)	0% (n=2)	0% (n=1)
Lead	NB	NB	NB	NB
Mercury (Methyl mercury)	0.13	50%(n=2)	50% (n=2)	100% (n=1)
Polychlorinated Biphenyls (PCBs; µg/kg DW)				
Total PCBs	720	0%(n=2)	0% (n=2)	0% (n=1)
Aroclor 1016	18000	NDA	NDA	NDA
Aroclor 1242	1400	NDA	NDA	NDA
Aroclor 1248	600	NDA	NDA	NDA
Aroclor 1254	600	NDA	NDA	NDA
Aroclor 1260	NB	NB	NB	NB
Aroclor 1268	NB	NB	NB	NB
Organochlorine Pesticides (µg/kg DW)				
Aldrin + Dieldrin	NB	NB	NB	NB
Chlordane (total)	20000	NDA	NDA	NDA
Sum DDD	NB	NB	NB	NB
Sum DDE	NB	NB	NB	NB
Sum DDT	NB	NB	NB	NB
DDT (total)	16000	NDA	NDA	NDA
Dieldrin	810	NDA	NDA	NDA
Endrin (total)	2000	NDA	NDA	NDA
PCDDs and PCDFs (µg/kg DW)				
2,3,7,8-TCDD Toxic Equivalents (TEQs)	12.6	NDA	NDA	NDA

DW = dry weight; OC = organic carbon; n = number of samples; NB = no benchmark; NDA = no data available.
DDD = Dichlorodiphenyldichloroethane; DDE = Dichlorodiphenyldichloroethylene;
DDT = Dichlorodiphenyltrichloroethane; TCDD = Tetrachlorodibenzo-*p*-dioxin.

[1]Selected toxicity thresholds apply to fish muscle tissue samples.

Table 50. Summary of sediment quality conditions relative to the potential for adverse effects on wildlife in the Presque Isle Bay Area of Concern and the nearshore areas of Lake Erie.

Area	Horizon	Time Period	Indicator of Adverse Effects on Wildlife (receptor affected)			Number of Lines of Evidence Demonstrating Adverse Effects on Wildlife
			Whole-Sediment Chemistry (birds/mammals)	Fish Tissue Chemistry (birds)	Fish Tissue Chemistry (mammals)	
Presque Isle Bay	surface	1982-1991	80% (n=10)	NDA	NDA	1
		1992-2003	94% (n=36)	50% (n=2)	50% (n=2)	3
	subsurface	1982-1991	NDA	NA	NA	0
		1992-2003	NDA	NA	NA	0
Presque Isle Ponds	surface	1982-1991	NDA	NDA	NDA	0
		1992-2003	NDA	50% (n=2)	50% (n=2)	2
	subsurface	1982-1991	NDA	NA	NA	0
		1992-2003	NDA	NA	NA	0
Lake Erie	surface	1982-1991	NDA	NDA	NDA	0
		1992-2003	50% (n=2)	100% (n=1)	100% (n=1)	3
	subsurface	1982-1991	NDA	NA	NA	0
		1992-2003	NDA	NA	NA	0
Inland Reference	surface	1982-1991	NDA	NDA	NDA	0
		1992-2003	NDA	NDA	NDA	0
	subsurface	1982-1991	NDA	NA	NA	0
		1992-2003	NDA	NA	NA	0

NA= not applicable; NDA = no data available.
Surface = upper depth 0 cm and lower depth $\leq$30 cm; subsurface = upper depth >0 cm or lower depth >30 cm.

Figure 1. Map of the Presque Isle Bay Area of Concern (AOC).

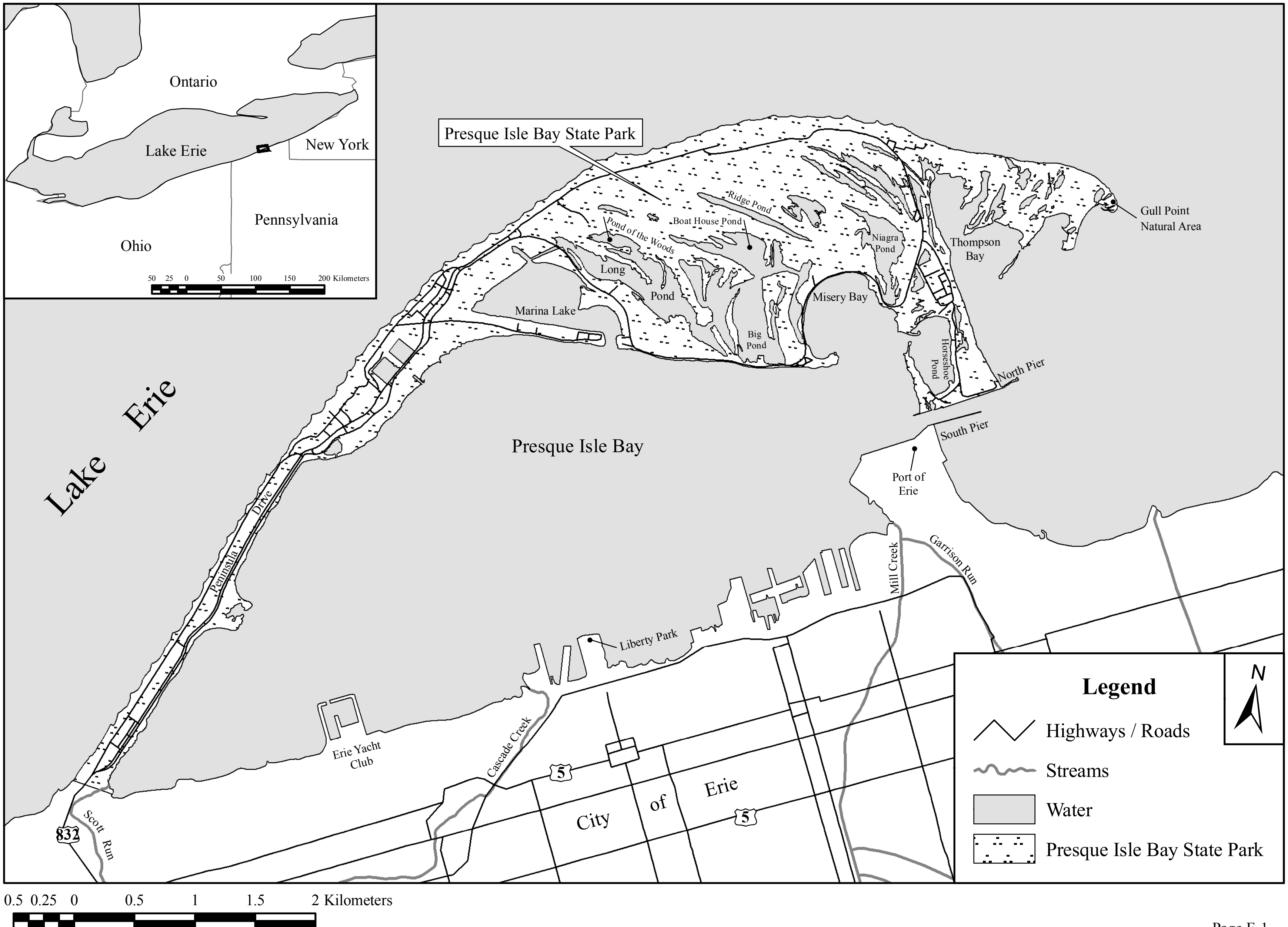


Figure 2. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the locations of sampling stations for 1982 - 1991 by study.

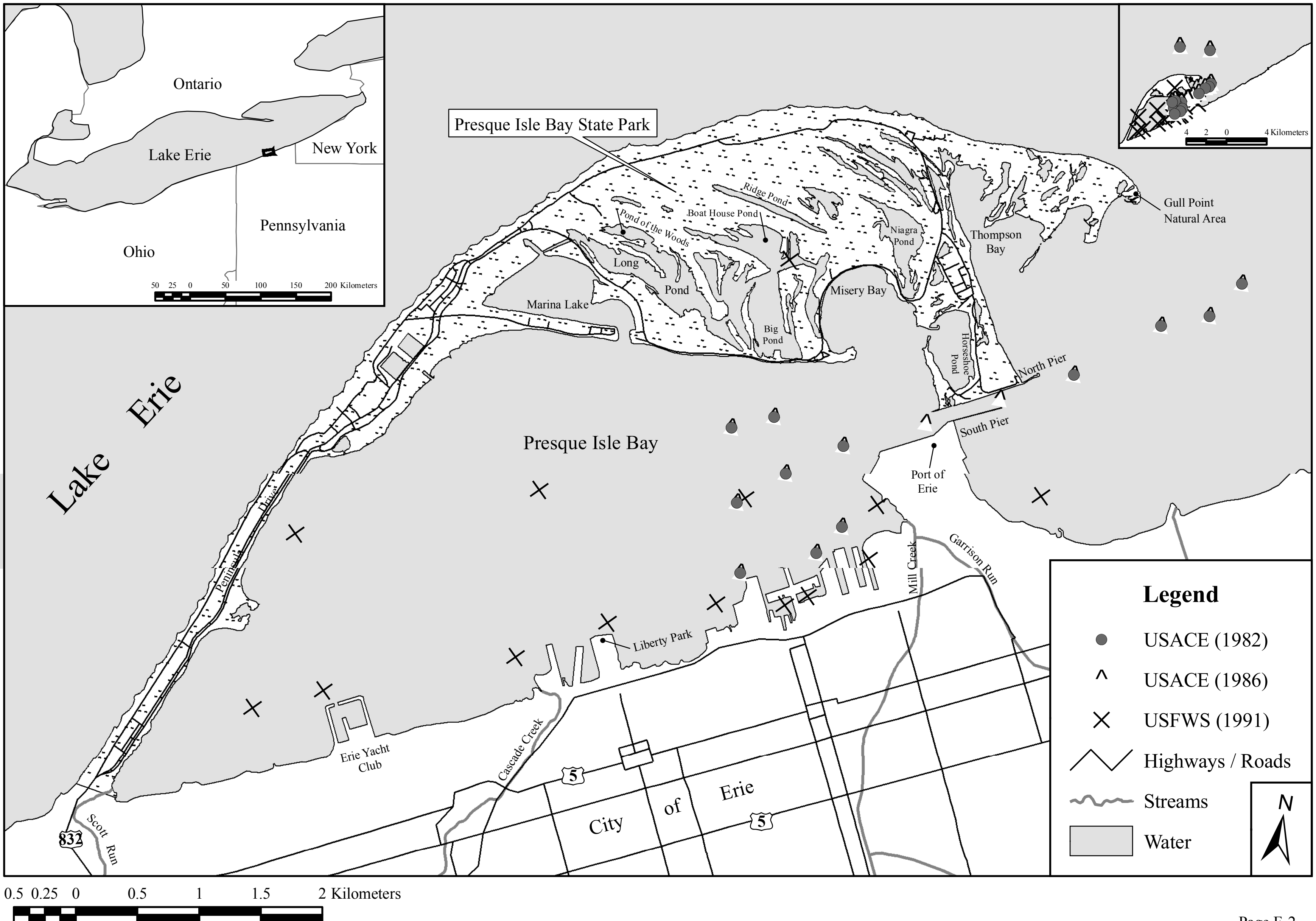


Figure 3. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the locations of sampling stations for 1992 - 2003 by study.

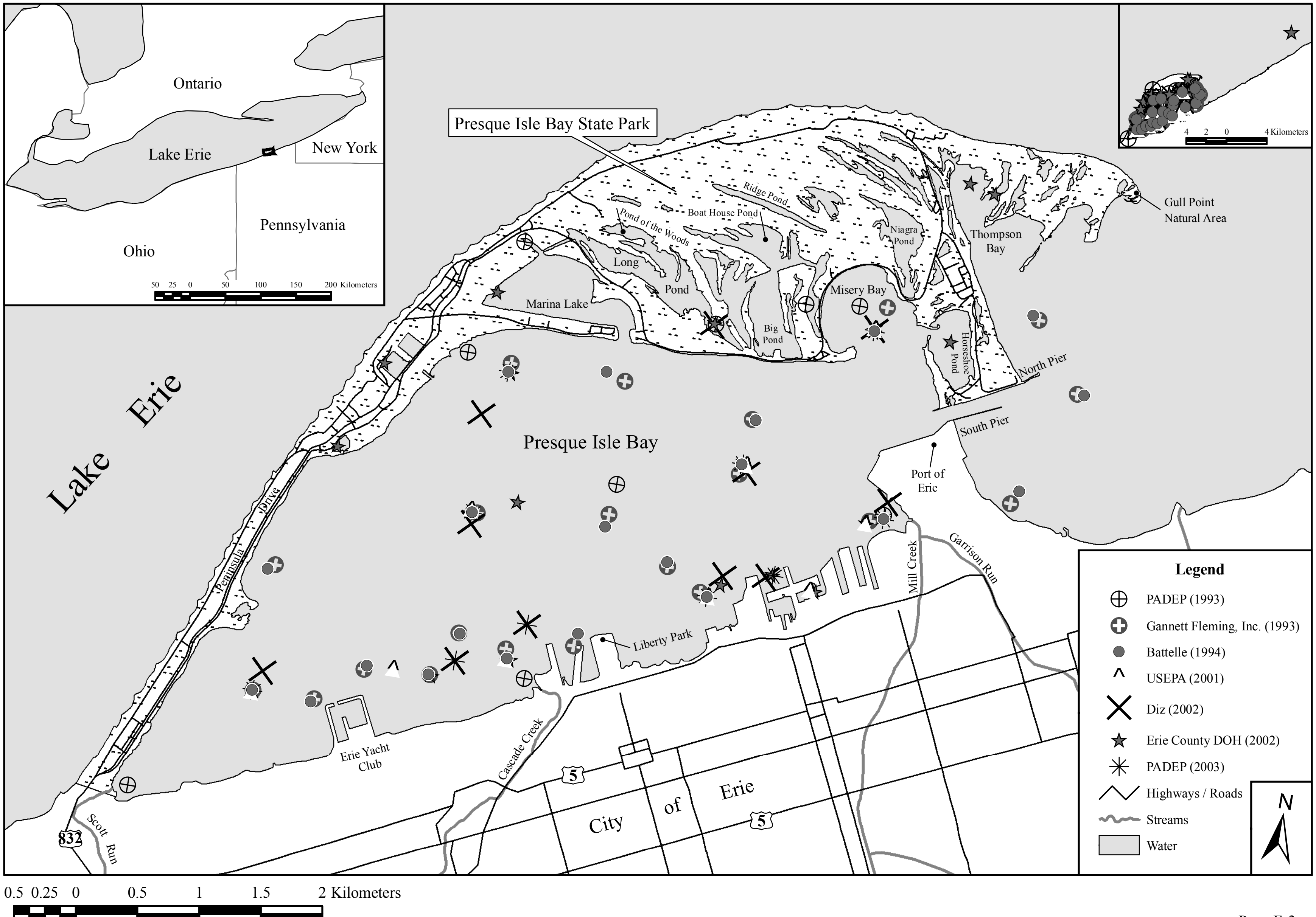
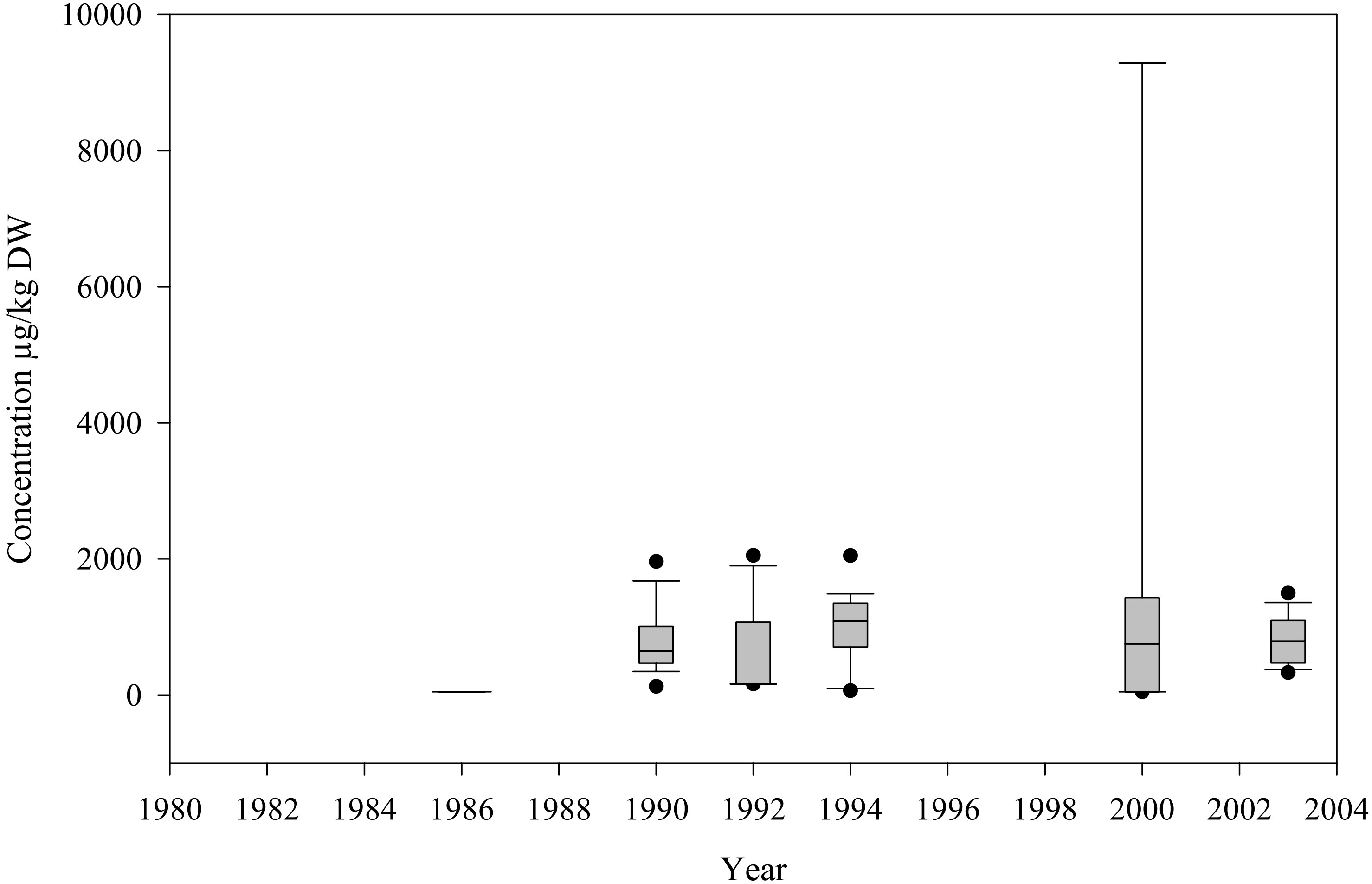


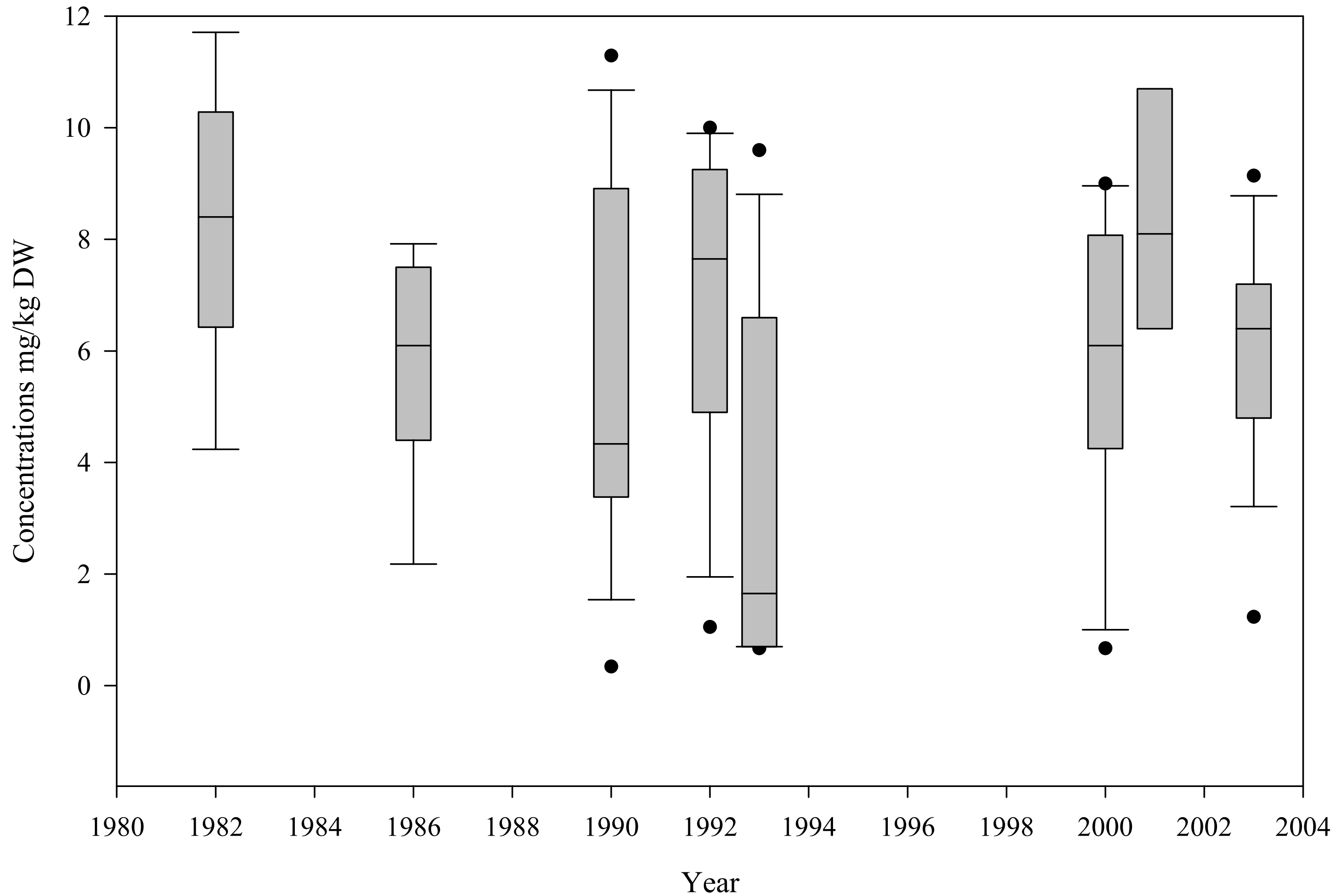
Figure 4. Temporal trends in the concentrations of benzo(a)pyrene in the Presque Isle Bay sediments: data includes all surficial sediment samples collected in the basin between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentile.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

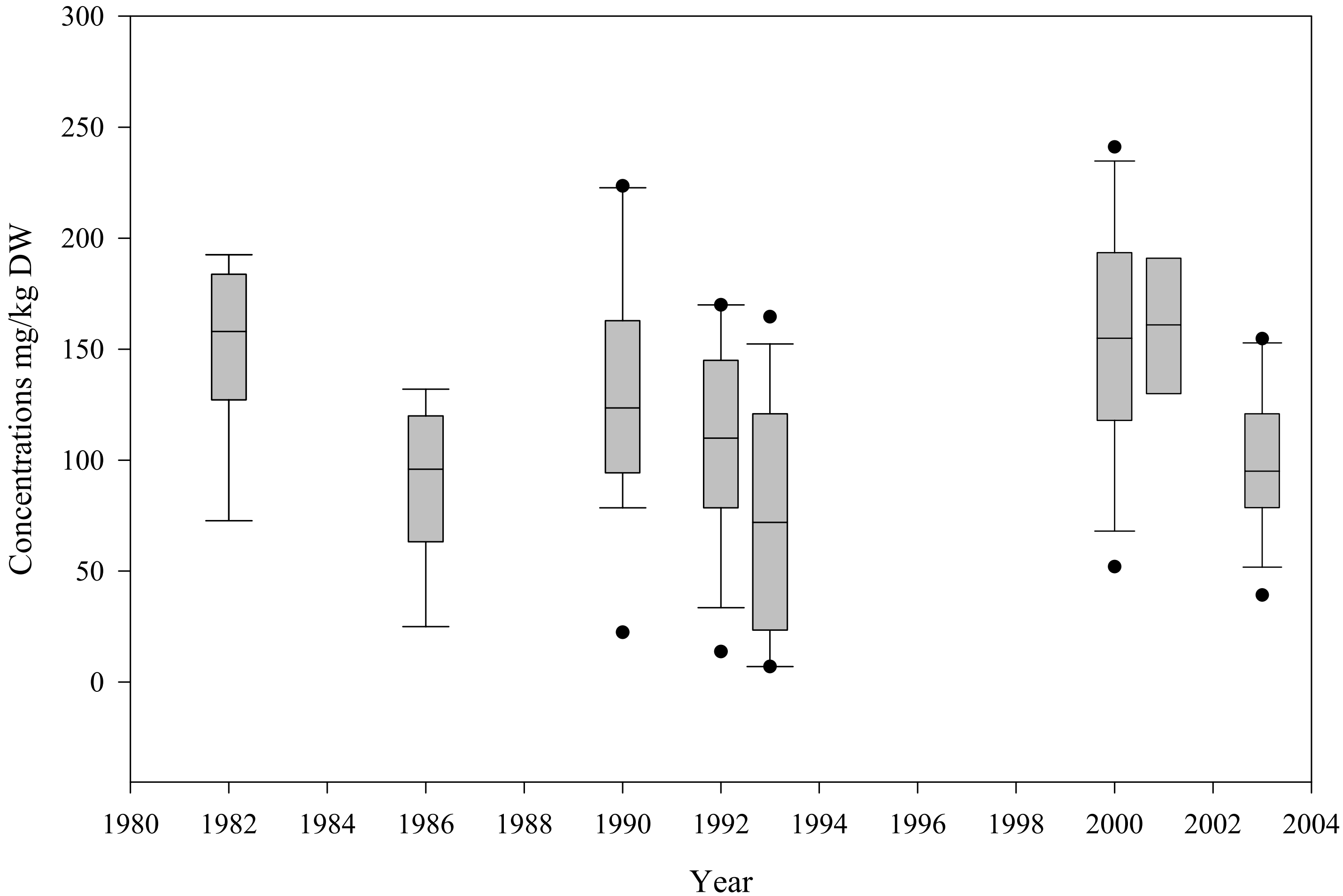
Figure 5. Temporal trends in the concentrations of cadmium in Presque Isle Bay sediments: data includes all surficial sediment samples collected in the basin between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentile.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

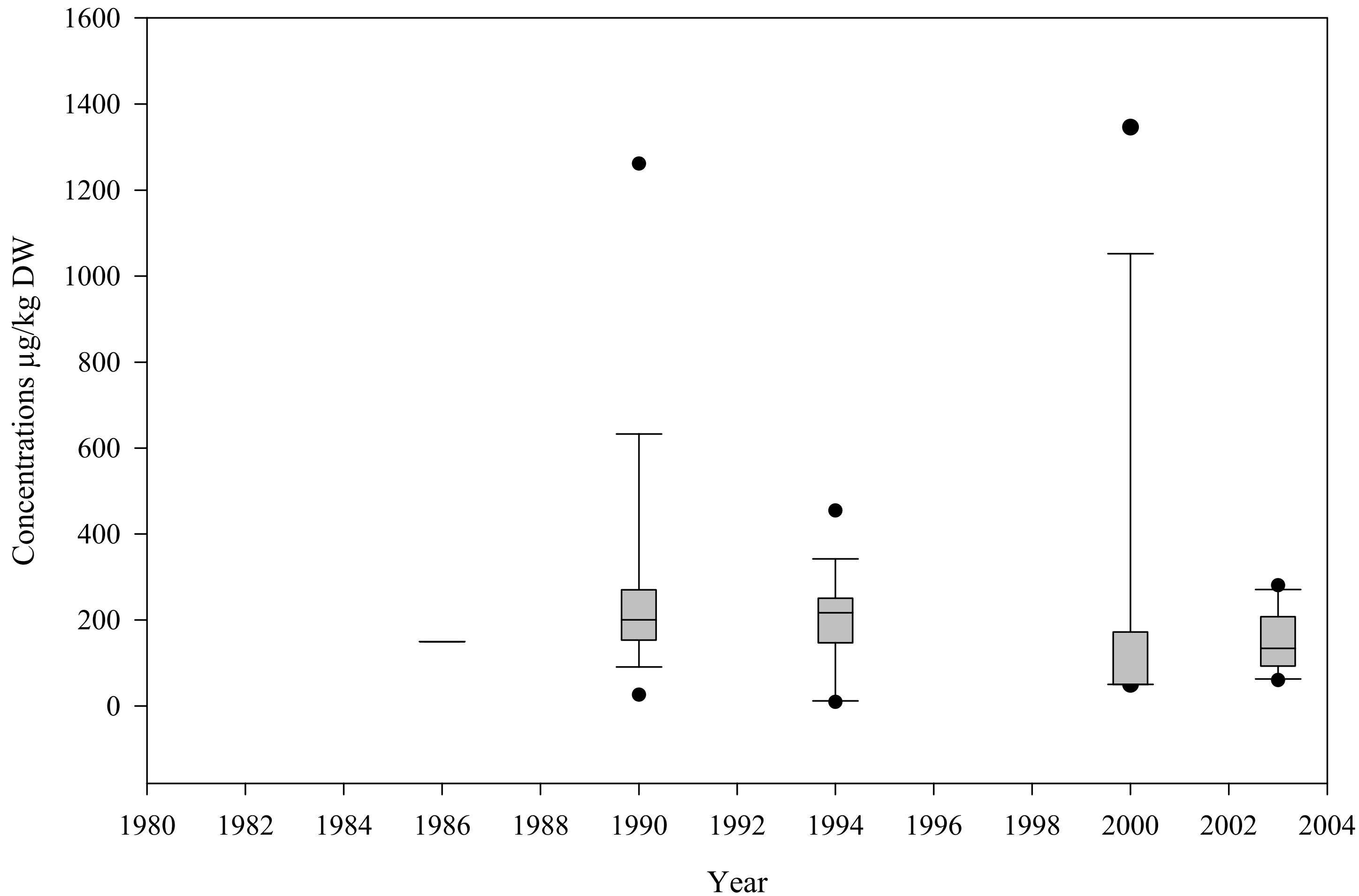
Figure 6. Temporal trends in the concentrations of lead in Presque Isle Bay sediments: data includes all surficial sediment samples collected in the basin between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentile.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

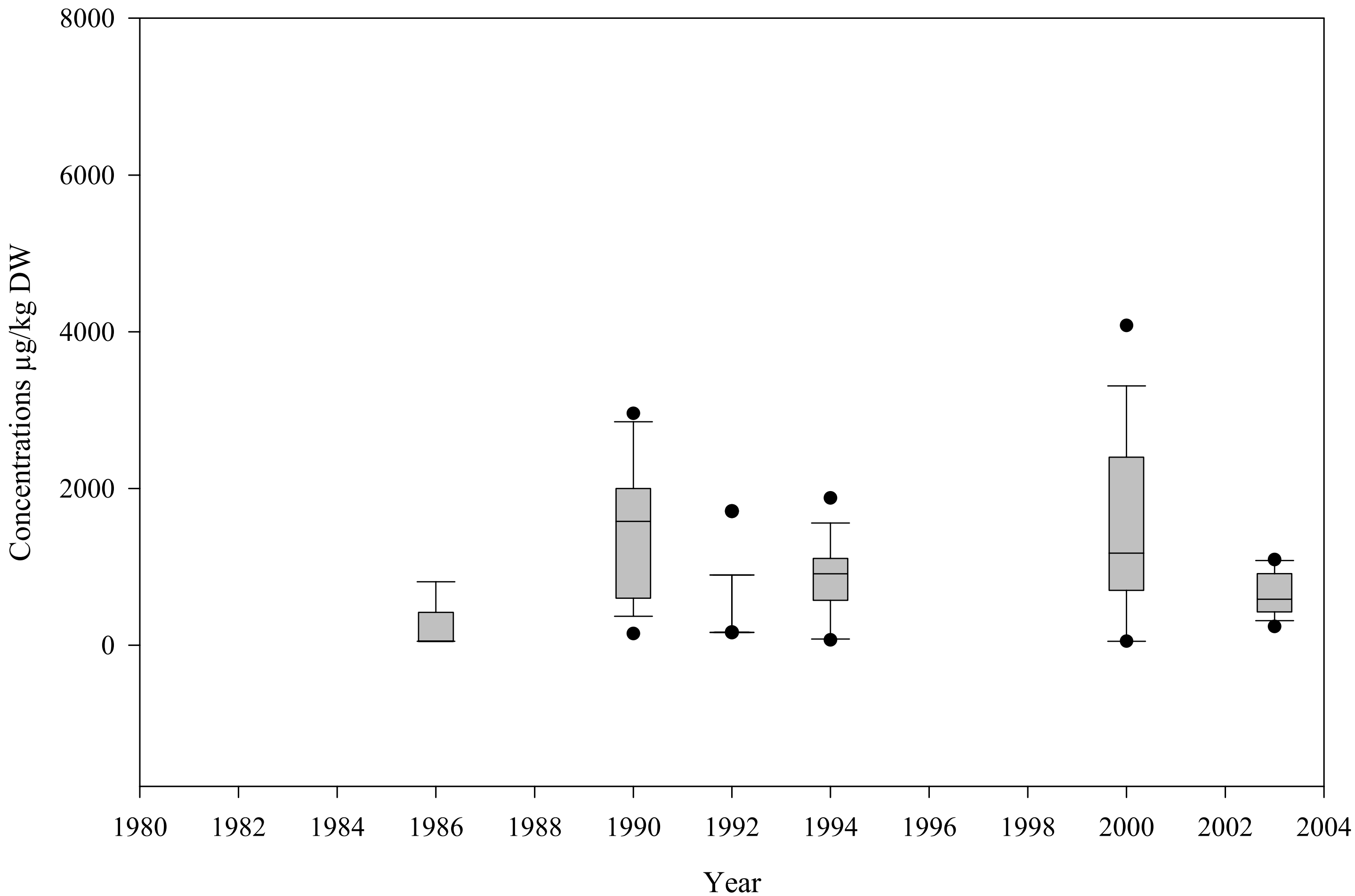
Figure 7. Temporal trends in the concentrations of naphthalene in Presque Isle Bay sediments: data includes all surficial sediment samples collected in the basin between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentile.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

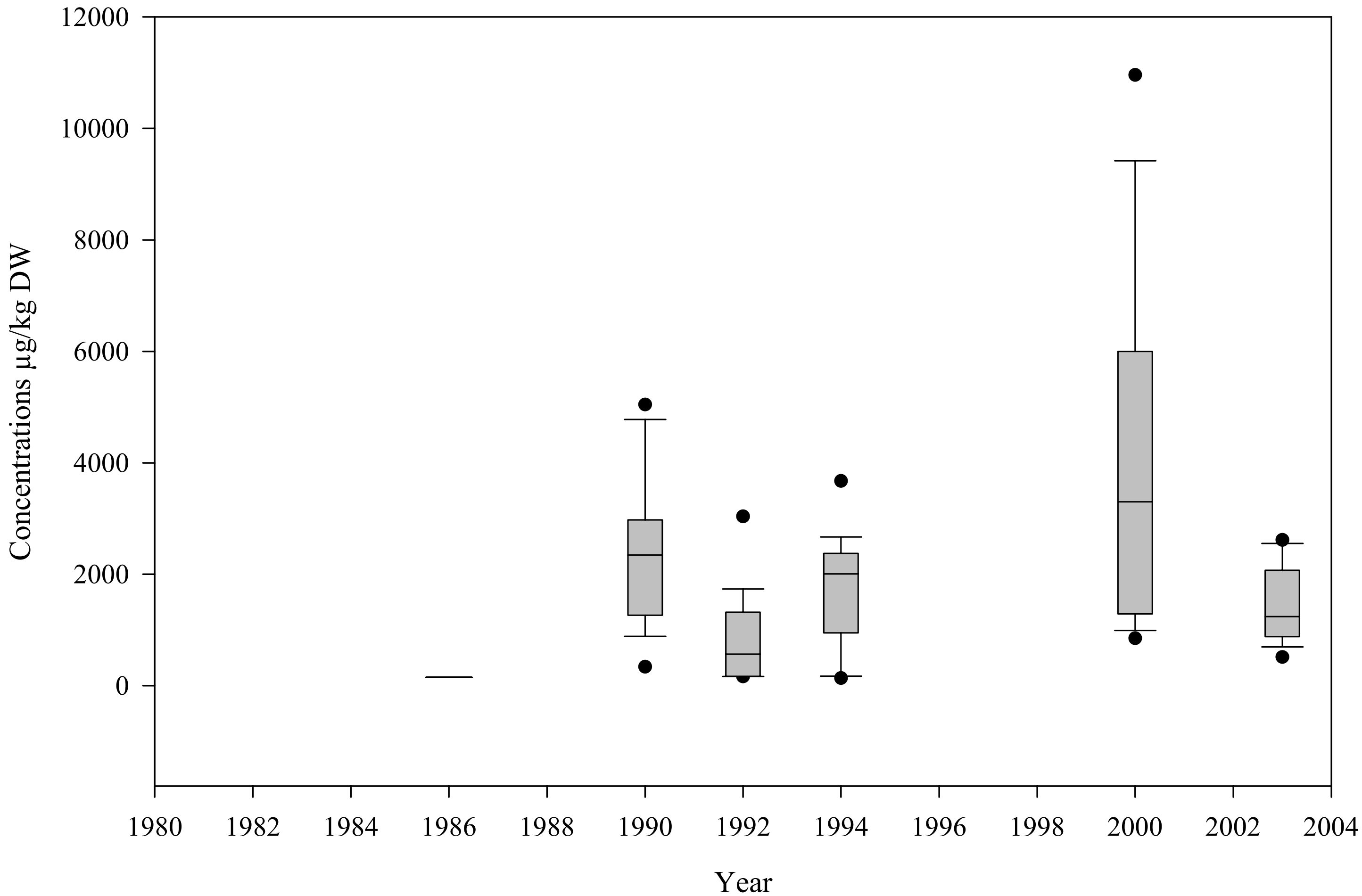
Figure 8. Temporal trends in the concentrations of phenanthrene in Presque Isle Bay sediments: data includes all surficial sediment samples collected in the basin between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentile.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

Figure 9. Temporal trends in the concentrations of fluoranthene in Presque Isle Bay sediments: data includes all surficial sediment samples collected in the basin between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentile.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

Figure 10. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the location of routine sampling sites (collected between 1982 and 2003) used in the temporal trend analysis.

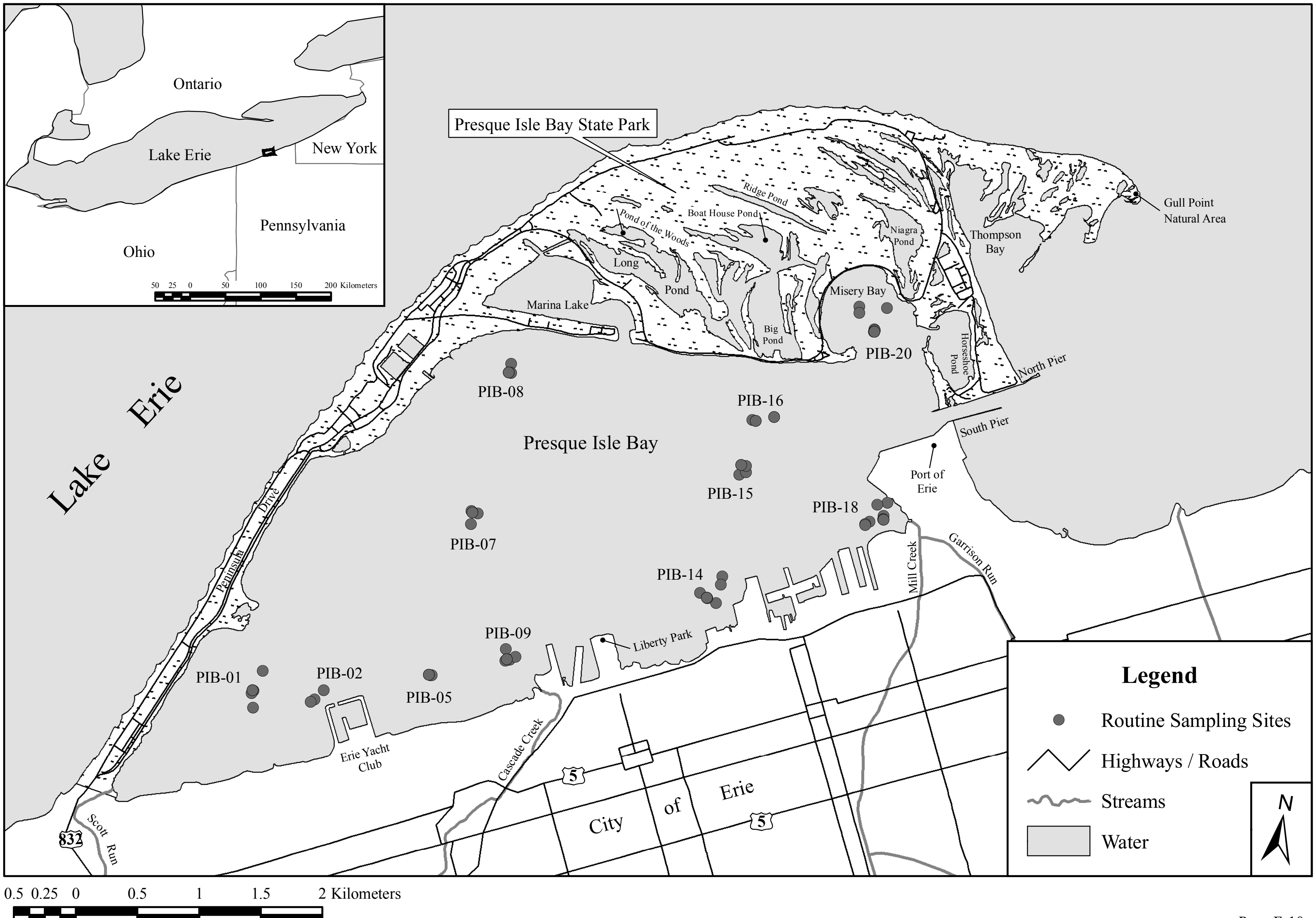
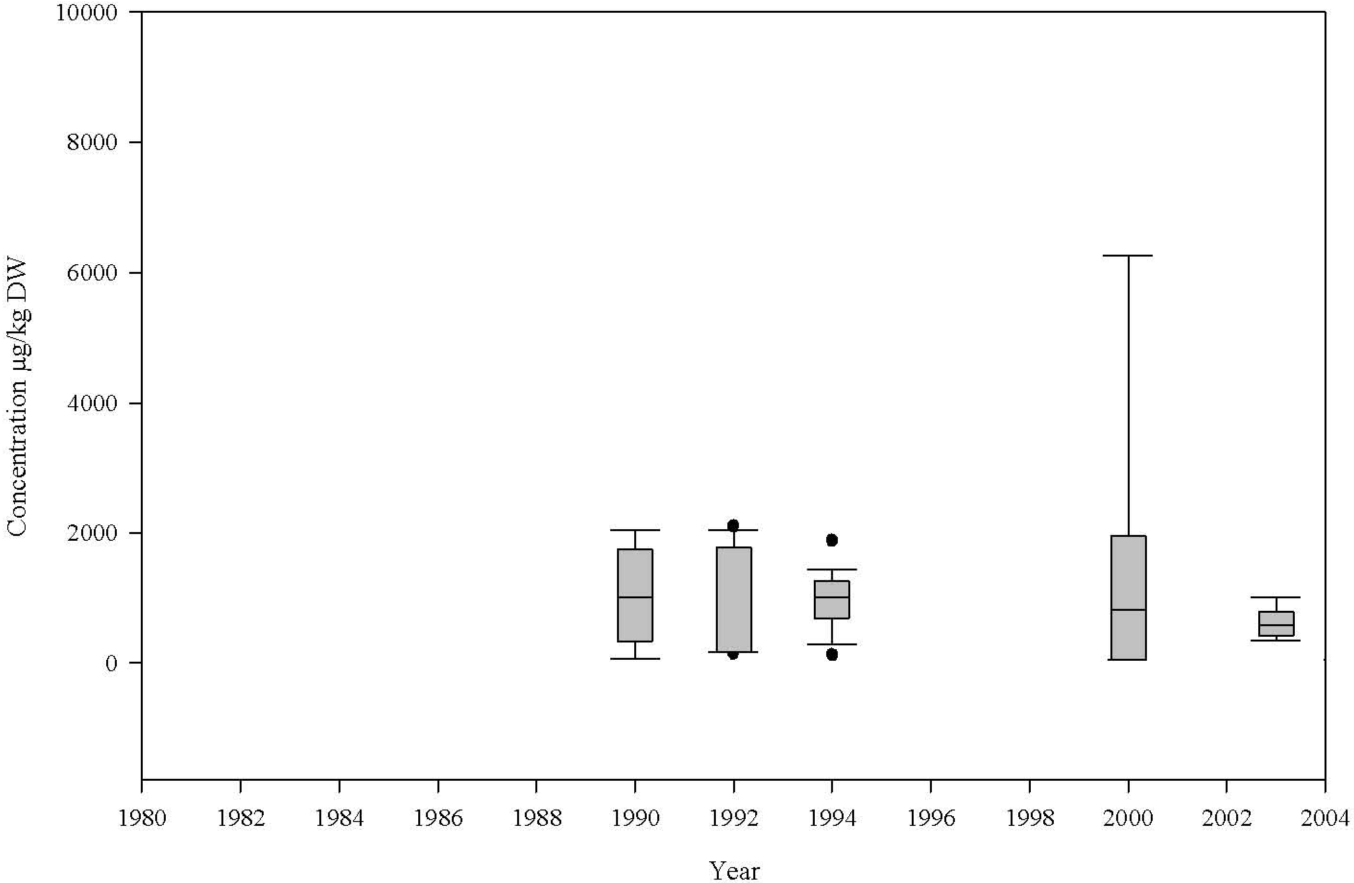


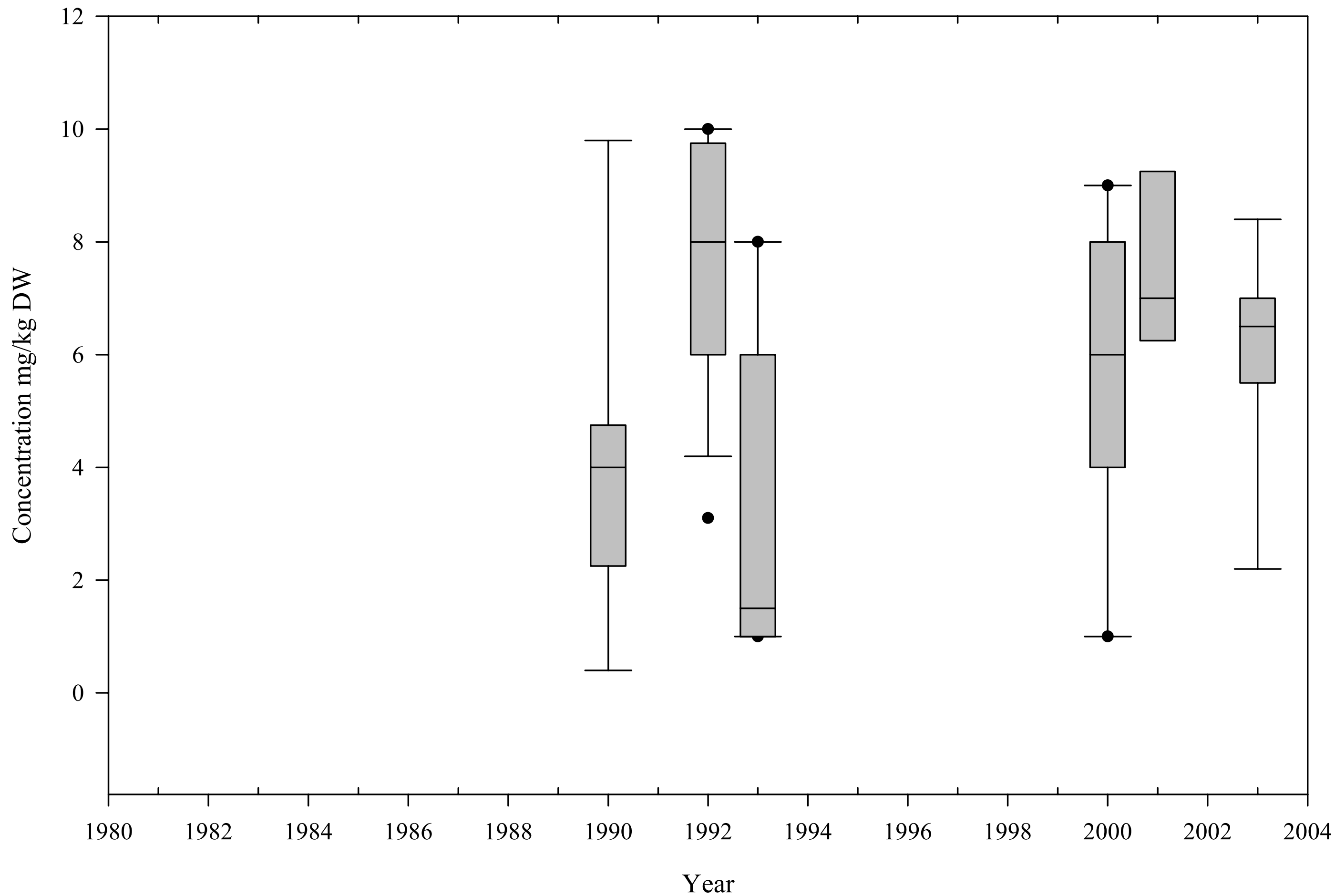
Figure 11. Temporal trends in the concentrations of benzo(a)pyrene in Presque Isle Bay sediments: data includes all surficial sediment samples collected at routine monitoring stations between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentile.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

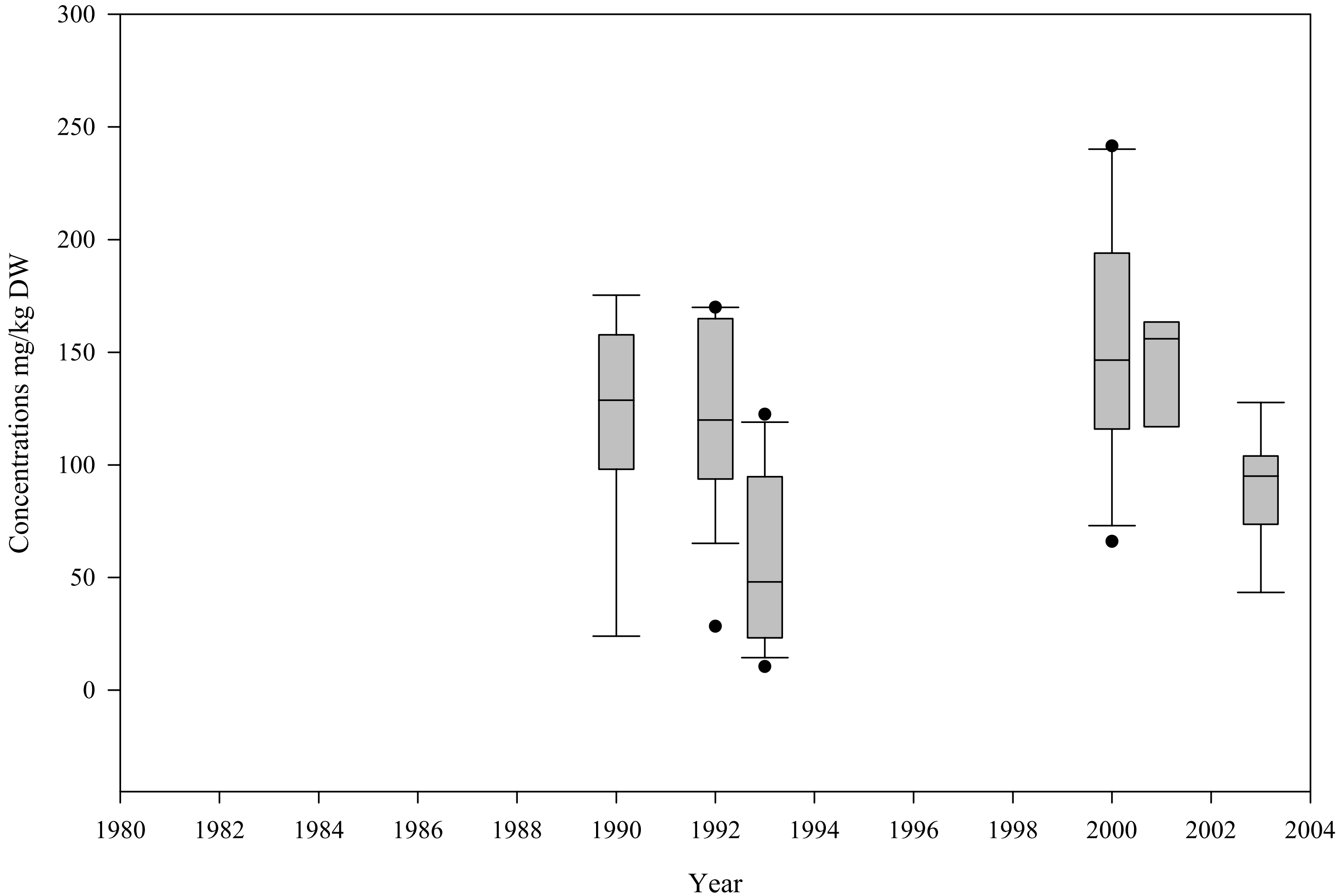
Figure 12. Temporal trends in the concentrations of cadmium in Presque Isle Bay sediments: data includes all surficial sediment samples collected at routine monitoring stations between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentiles.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

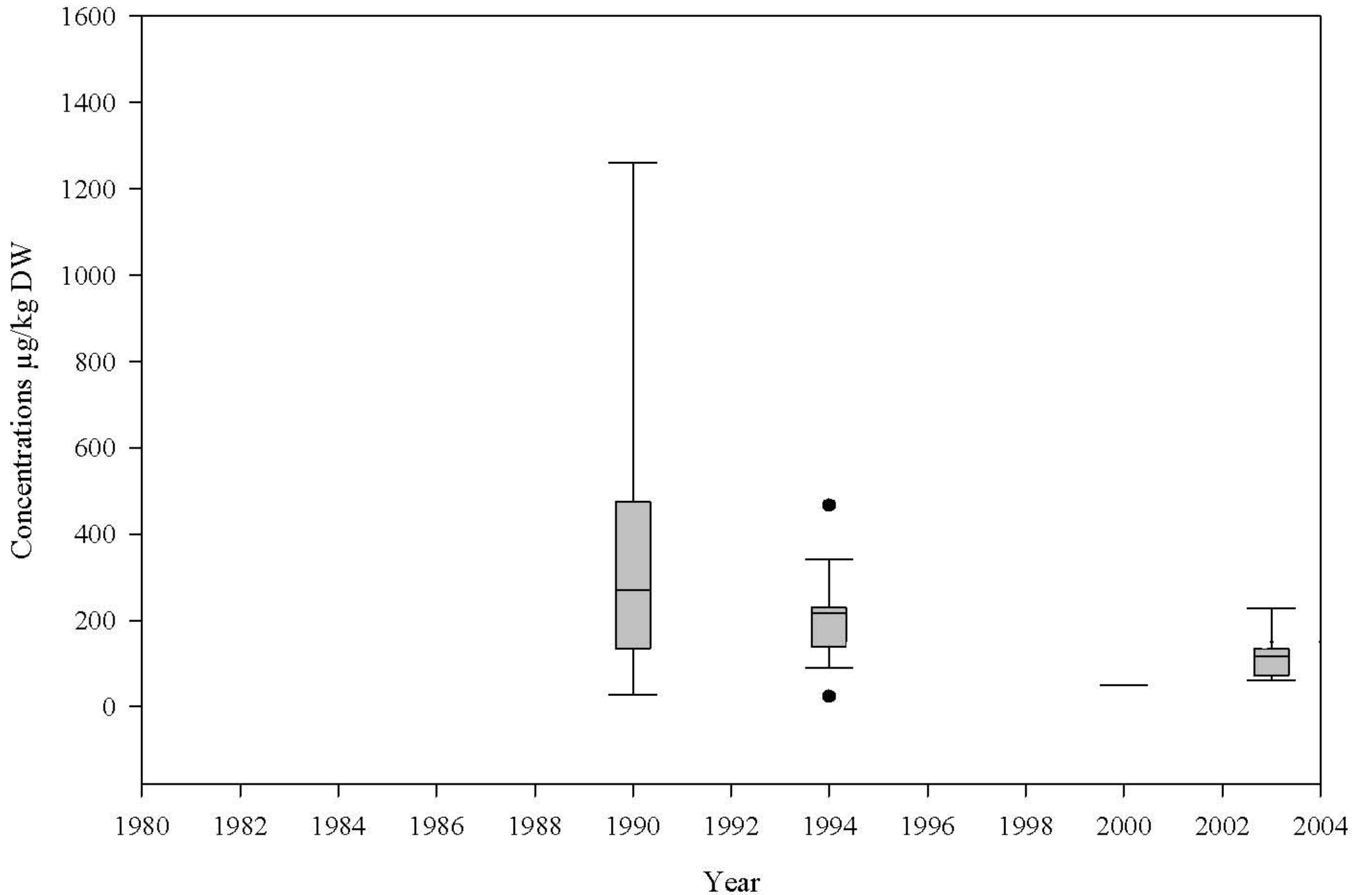
Figure 13. Temporal trends in the concentrations of lead in Presque Isle Bay sediments: data includes all surficial sediment samples collected at routine monitoring stations between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentiles.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma plot is unable to compute a percentile point, that set of points is not drawn.

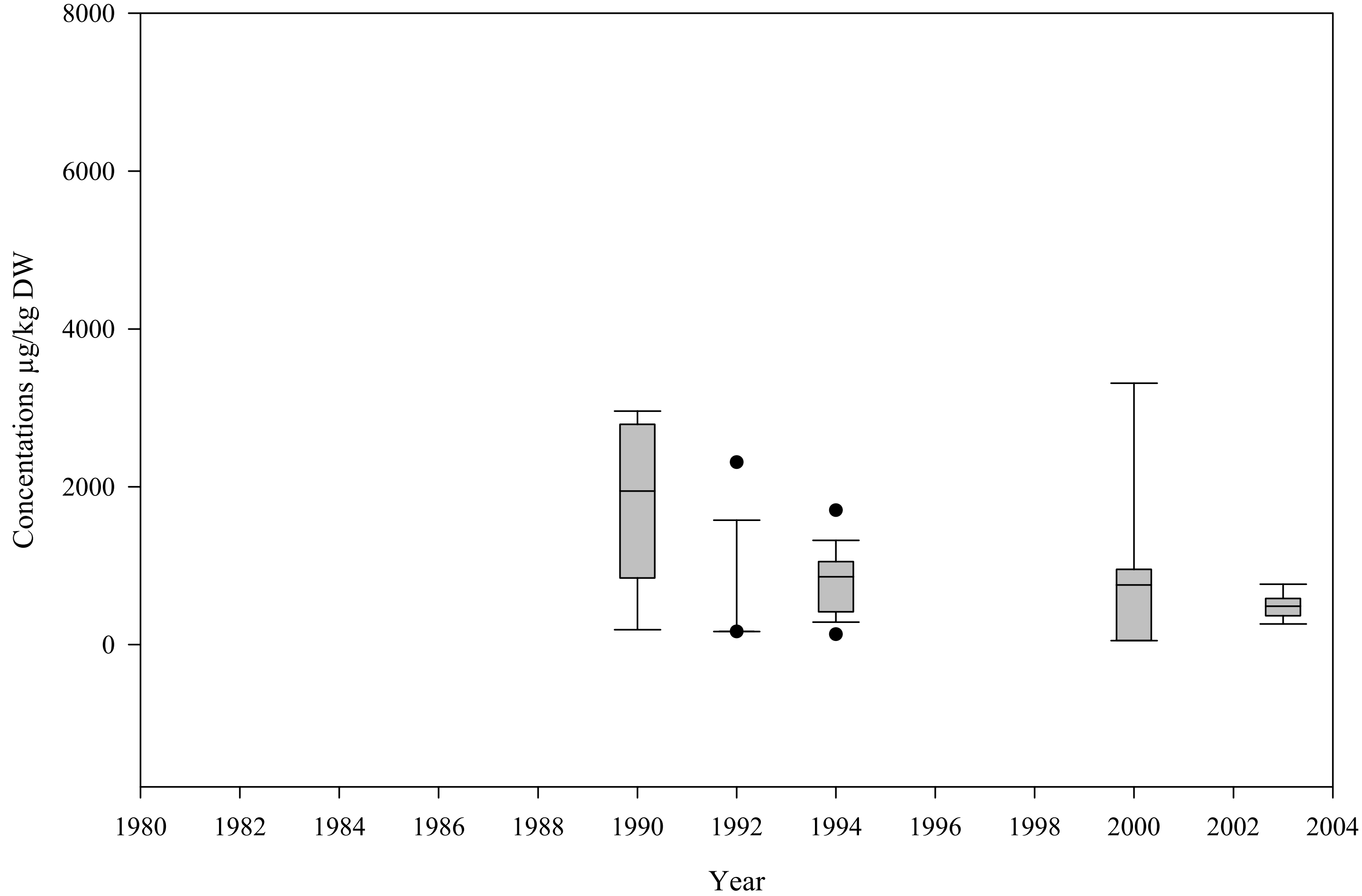
Figure 14. Temporal trends in the concentrations of naphthalene in Presque Isle Bay sediments: data includes all surficial sediment samples collected at routine monitoring stations between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentiles.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma Plot is unable to compute a percentile point, that set of points is not drawn.

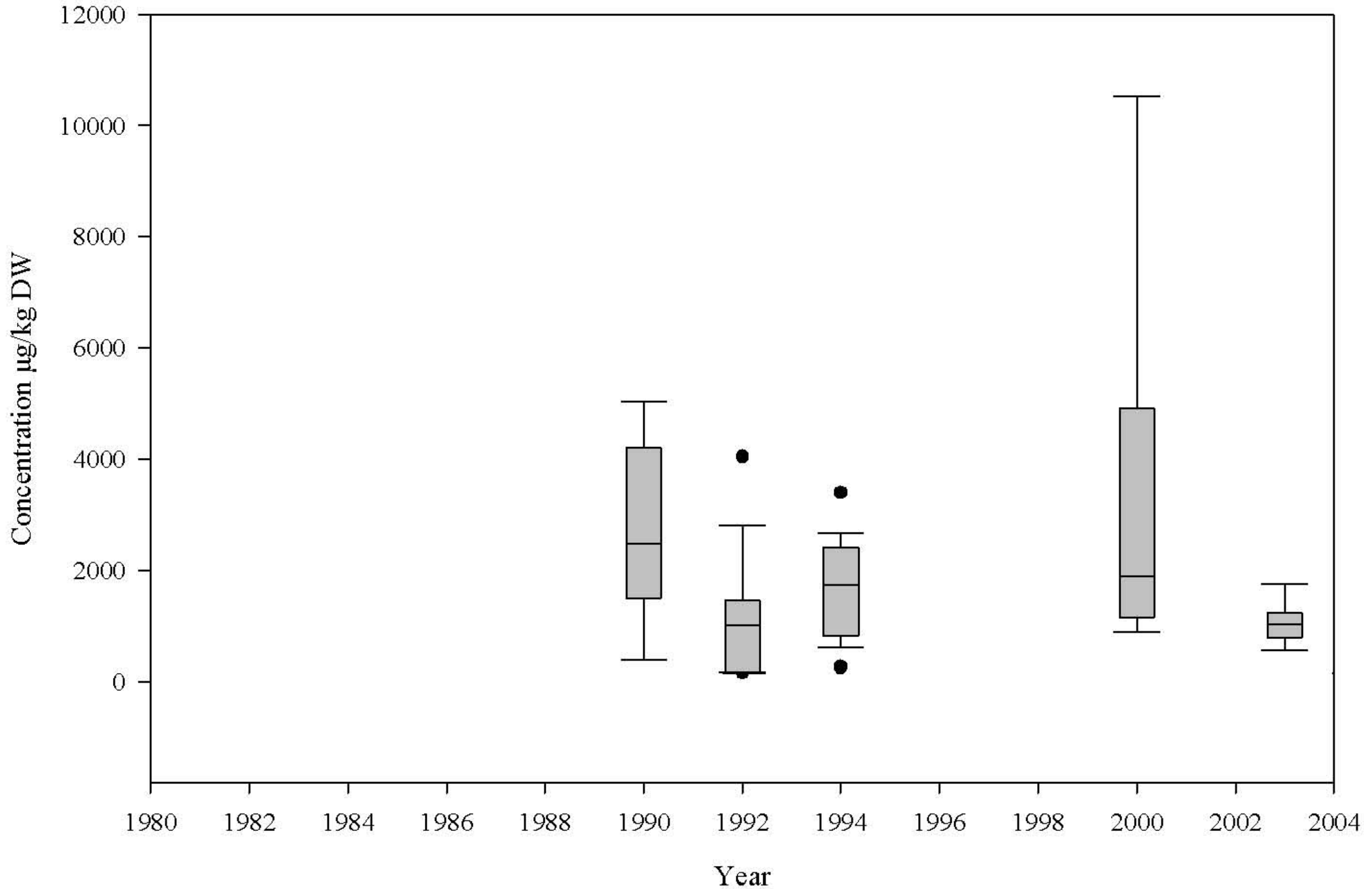
Figure 15. Temporal trends in the concentrations of phenanthrene in Presque Isle Bay sediments: data includes all surficial sediment samples collected at routine monitoring stations between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentiles.

A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma Plot is unable to compute a percentile point, that set of points is not drawn.

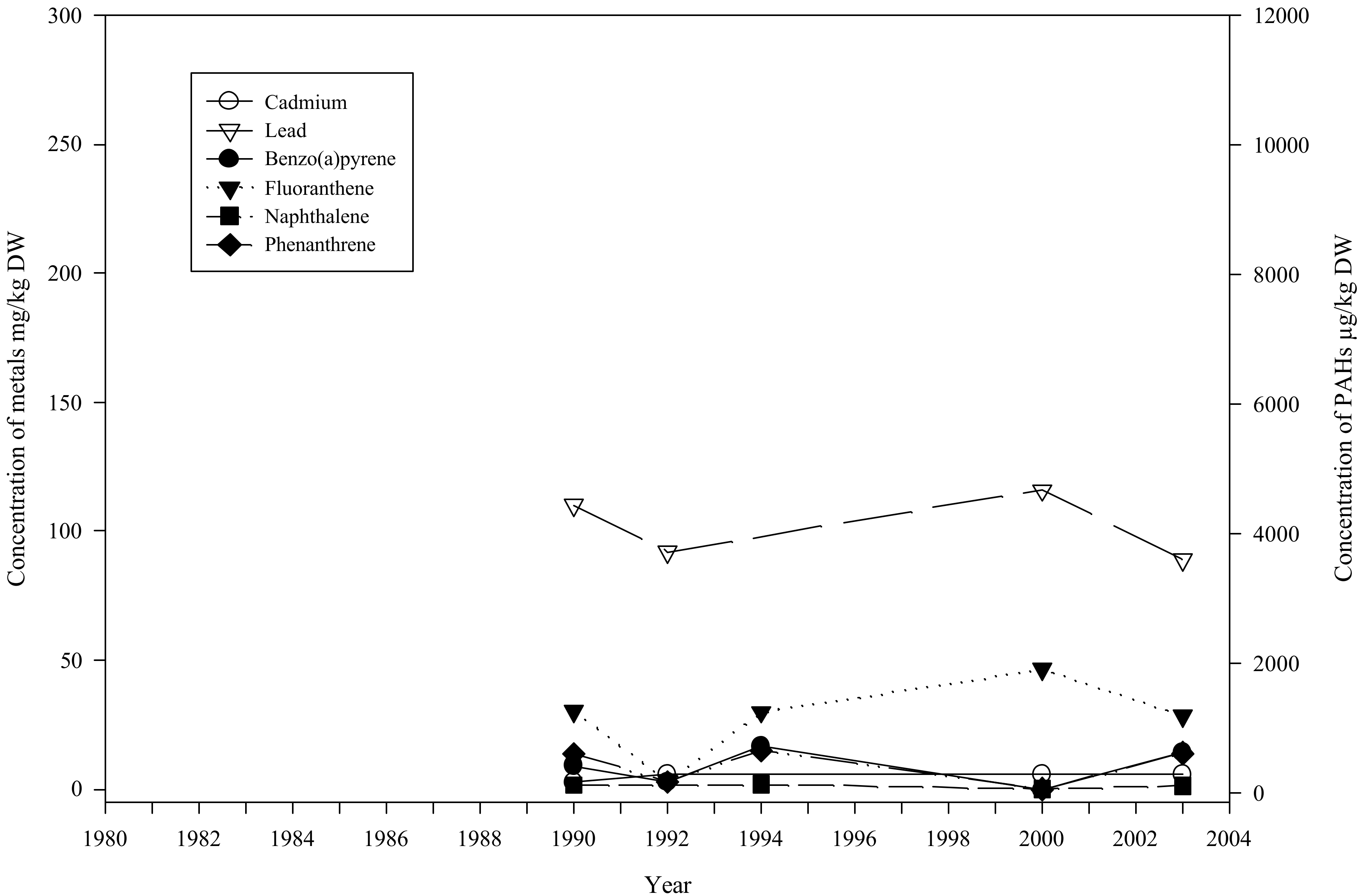
Figure 16. Temporal trends in the concentrations of fluoranthene in Presque Isle Bay sediments: data includes all surficial sediment samples collected at routine monitoring stations between 1982 and 2003.



Note: Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Dots represent the 95th and 5th percentiles.

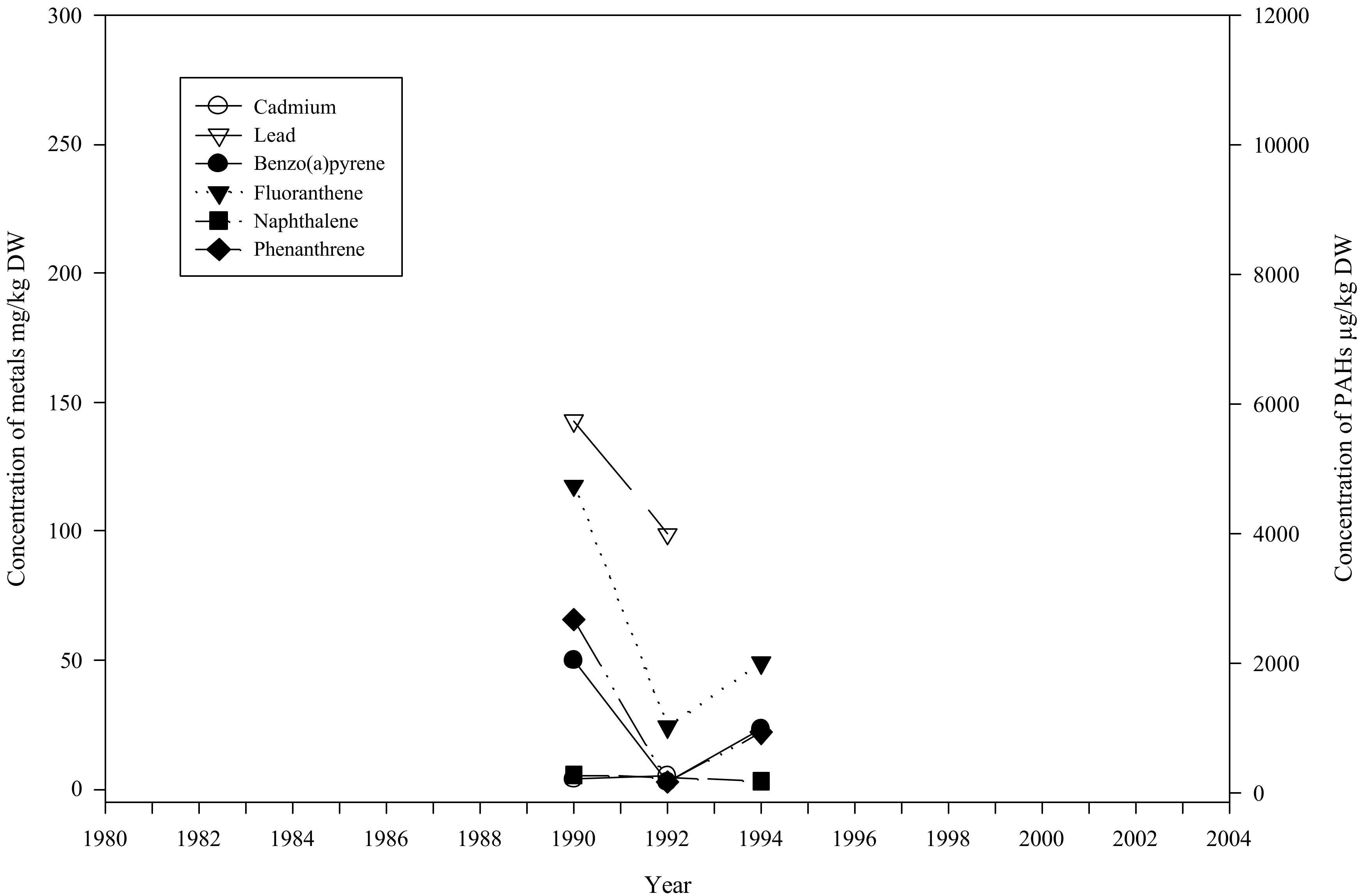
A mimium number of data points is required to compute each set of percentiles. At least three points are required to compute the 25th and 75th percentiles, five points to compute the 10th percentile, and six points to compute the 5th, 90th and 95th percentiles. If Sigma Plot is unable to compute a percentile point, that set of points is not drawn.

Figure 17. Temporal trends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sediment samples from spatially clustered stations corresponding to station PIB 01 (Gannett Fleming, Inc., 1993)



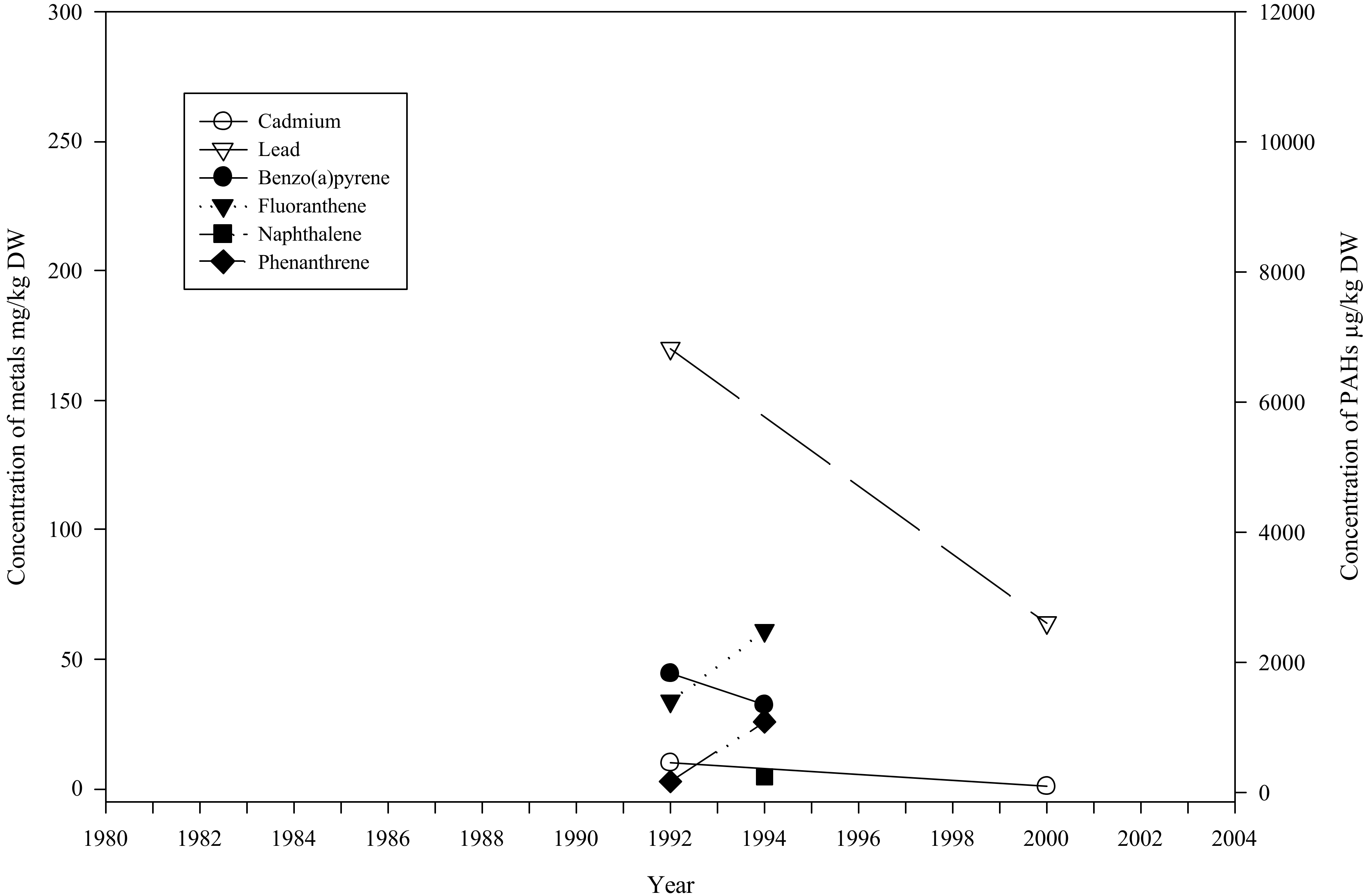
Note: values represent the median where there were multiple samples for the year.

Figure 18. Temporal trends in whole-sediment chemistry in Presque Isle Bay: includes surficial sediment data for spatially clustered stations corresponding to station PIB 02 (Gannet Fleming, Inc., 1993)



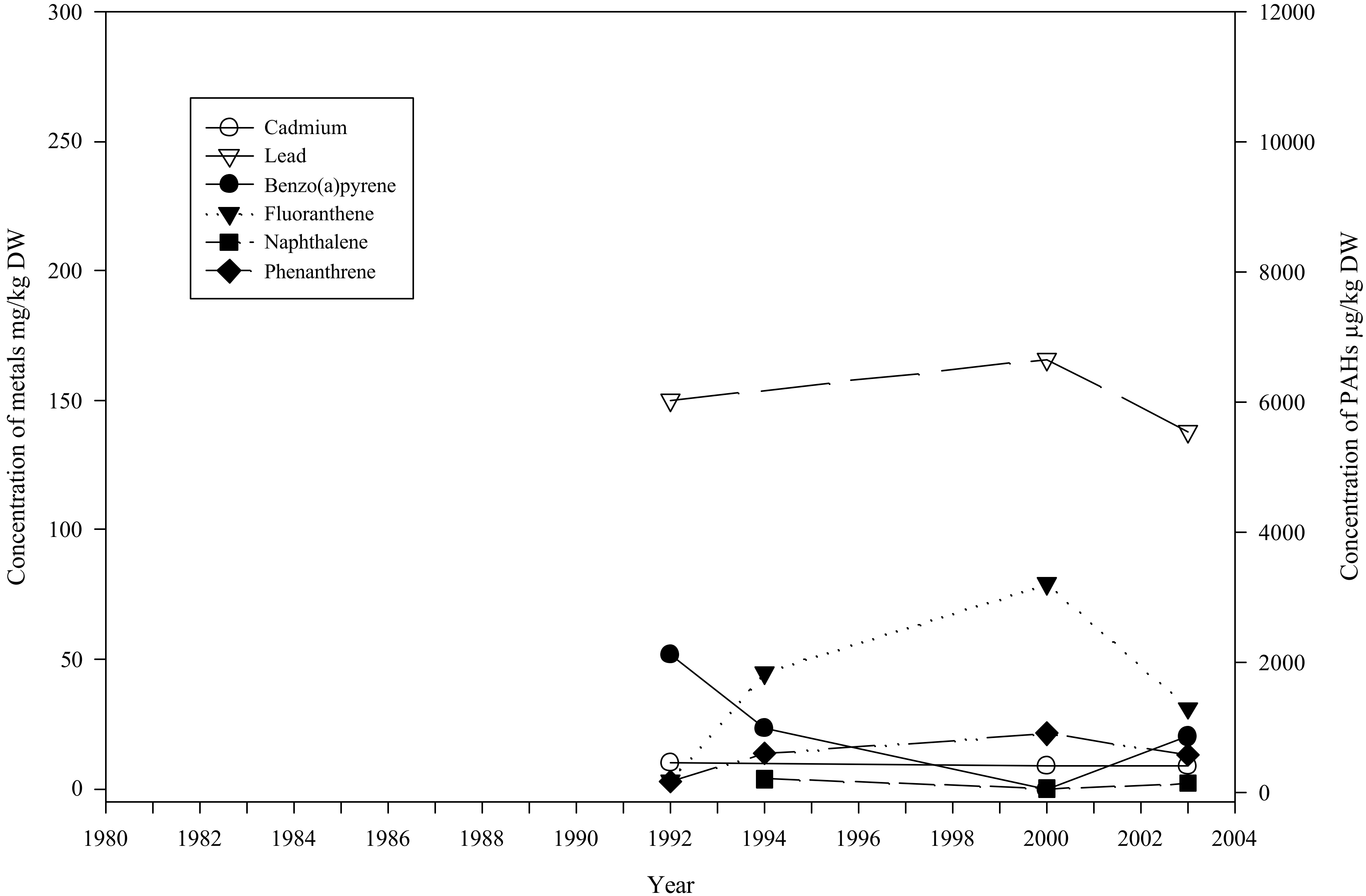
Note: values represent the median where there were multiple samples for the year.

Figure 19. Temporal trends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sediment samples from spatially clustered stations corresponding to station PIB 05 (Gannett Fleming, Inc., 1993)



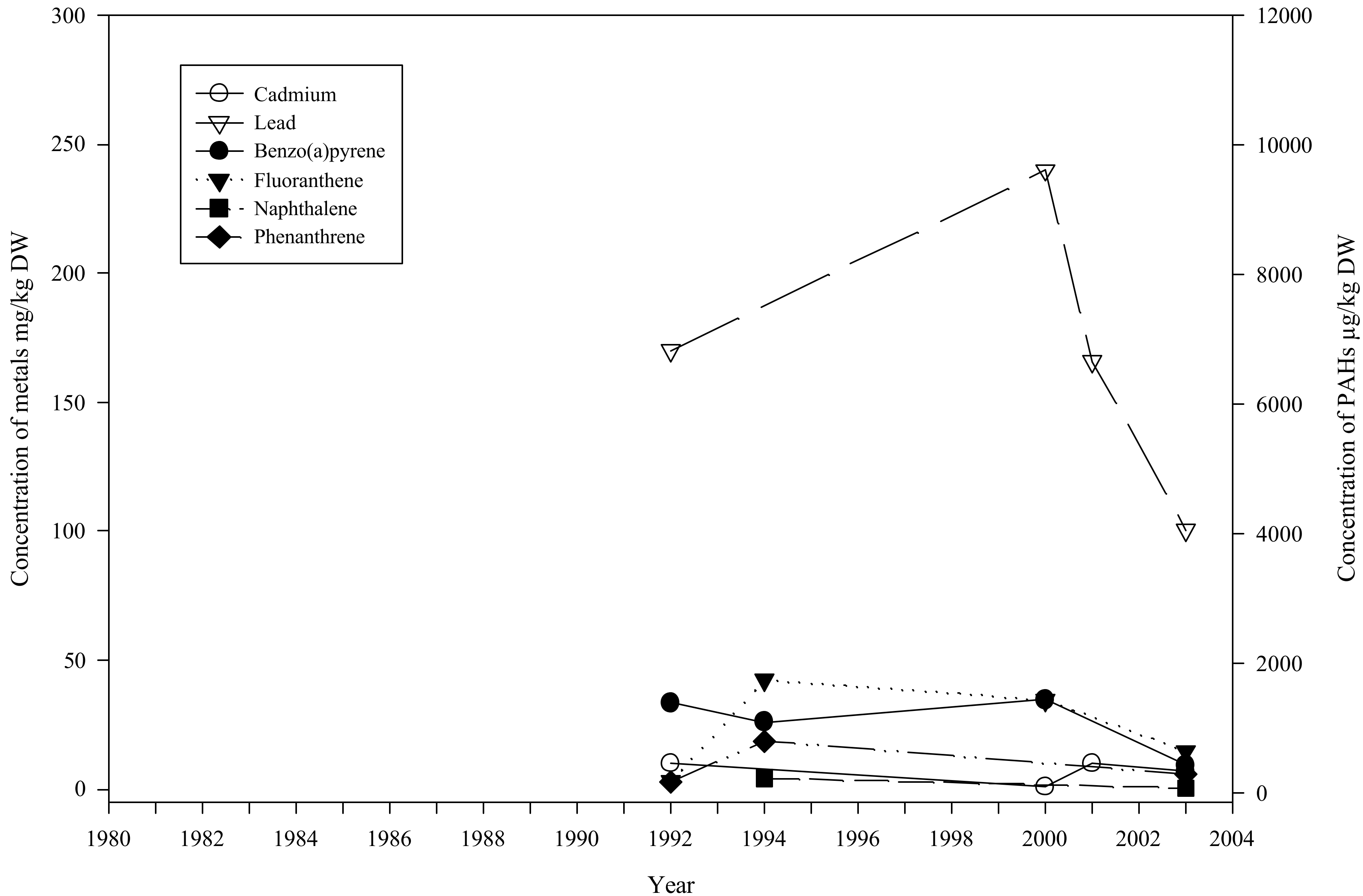
Note: values represent the median where there were multiple samples for the year.

Figure 20. Temporal trends in whole-sediment chemistry in Presque Ilse Bay: includes surficial sediment data for spatially clustered stations corresponding to station PIB 07 (Gannett Fleming, Inc., 1993)



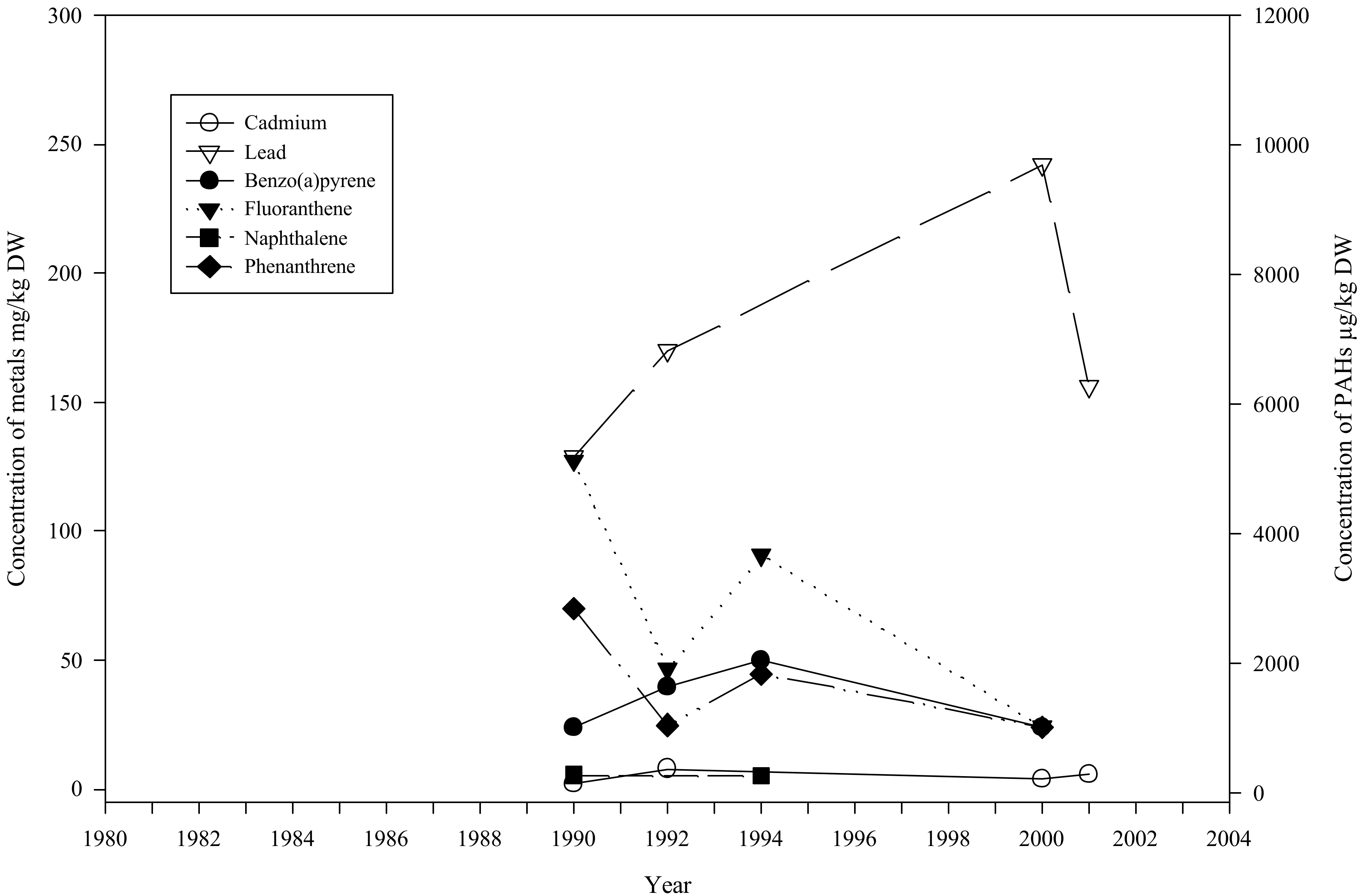
Note: values represent the median where there were multiple samples for the year.

Figure 21. Temporal trends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sedment samples from spatially clustered statins corresponding to station PIB 08 (Gannett Fleming, Inc., 1993)



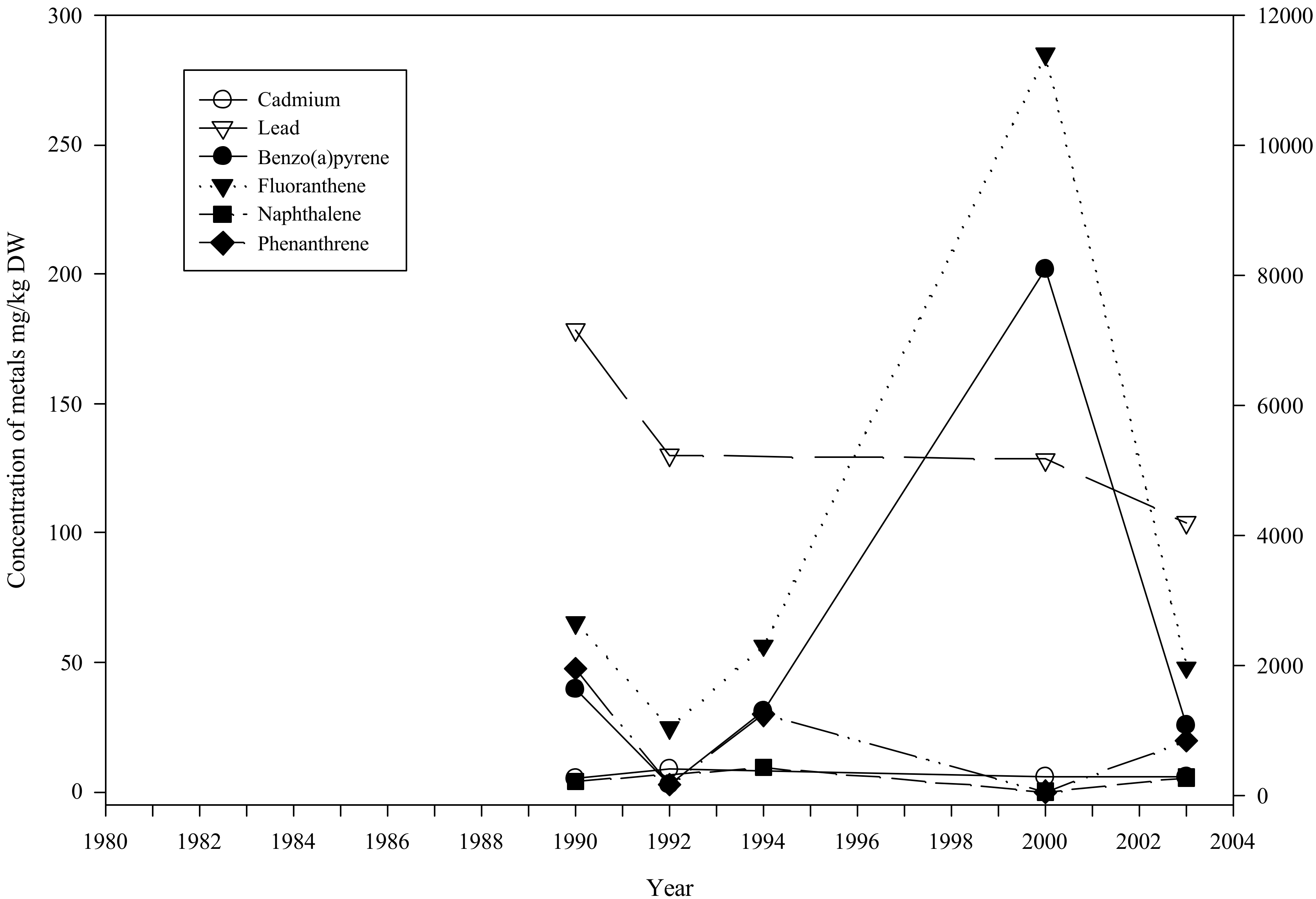
Note: values represent the median where there were multiple samples for the year.

Figure 22. Temporal trends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sediment samples from spatially clustered stations corresponding to station PIB 09 (Gannett Fleming, Inc., 1993)



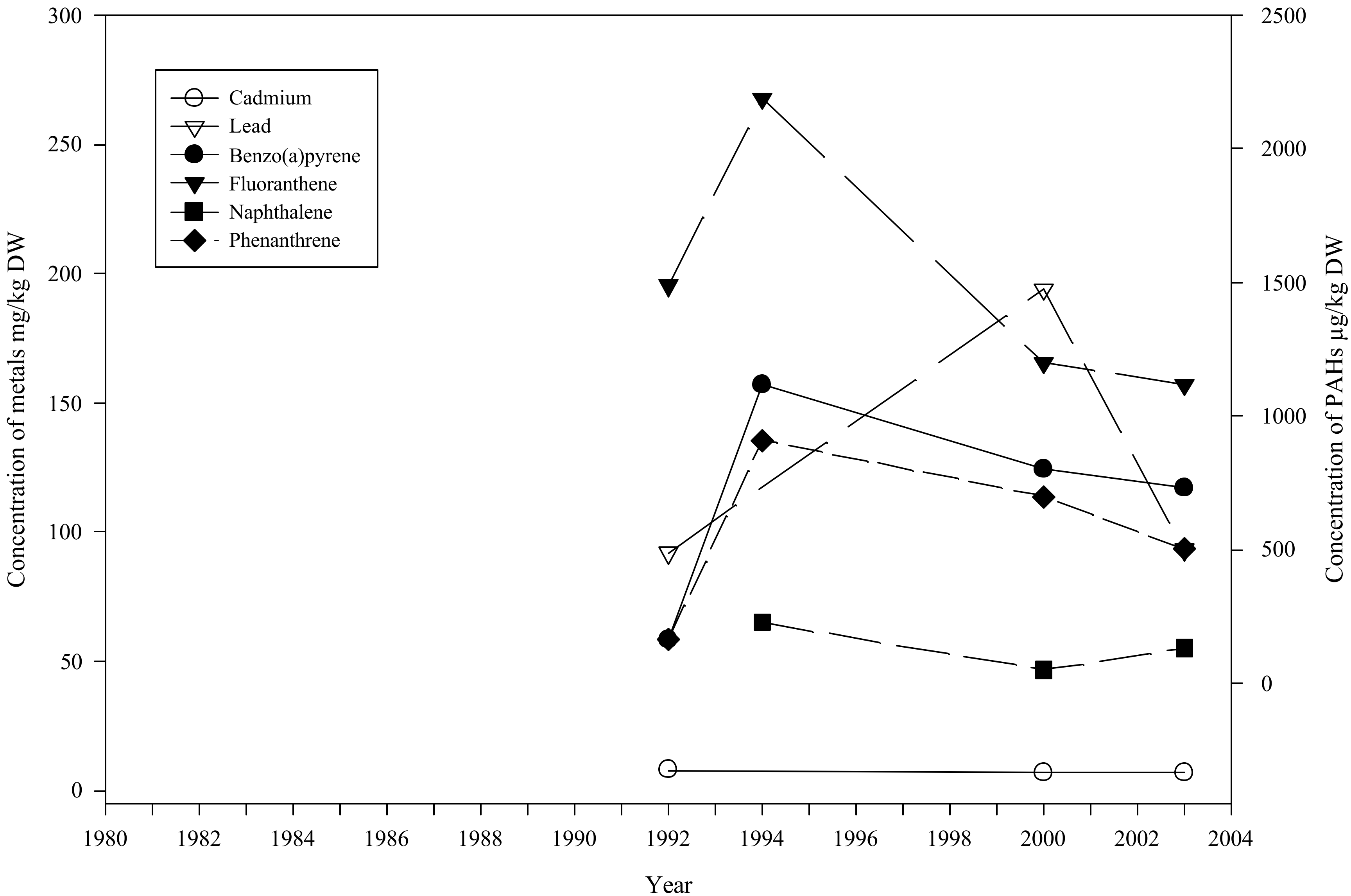
Note: values represent the median where thre were multiple samples for the year.

Figure 23. Temporal trends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sediment samples from spatially clustered stations corresponding to station PIB 14 (Gannett Fleming, Inc., 1993)



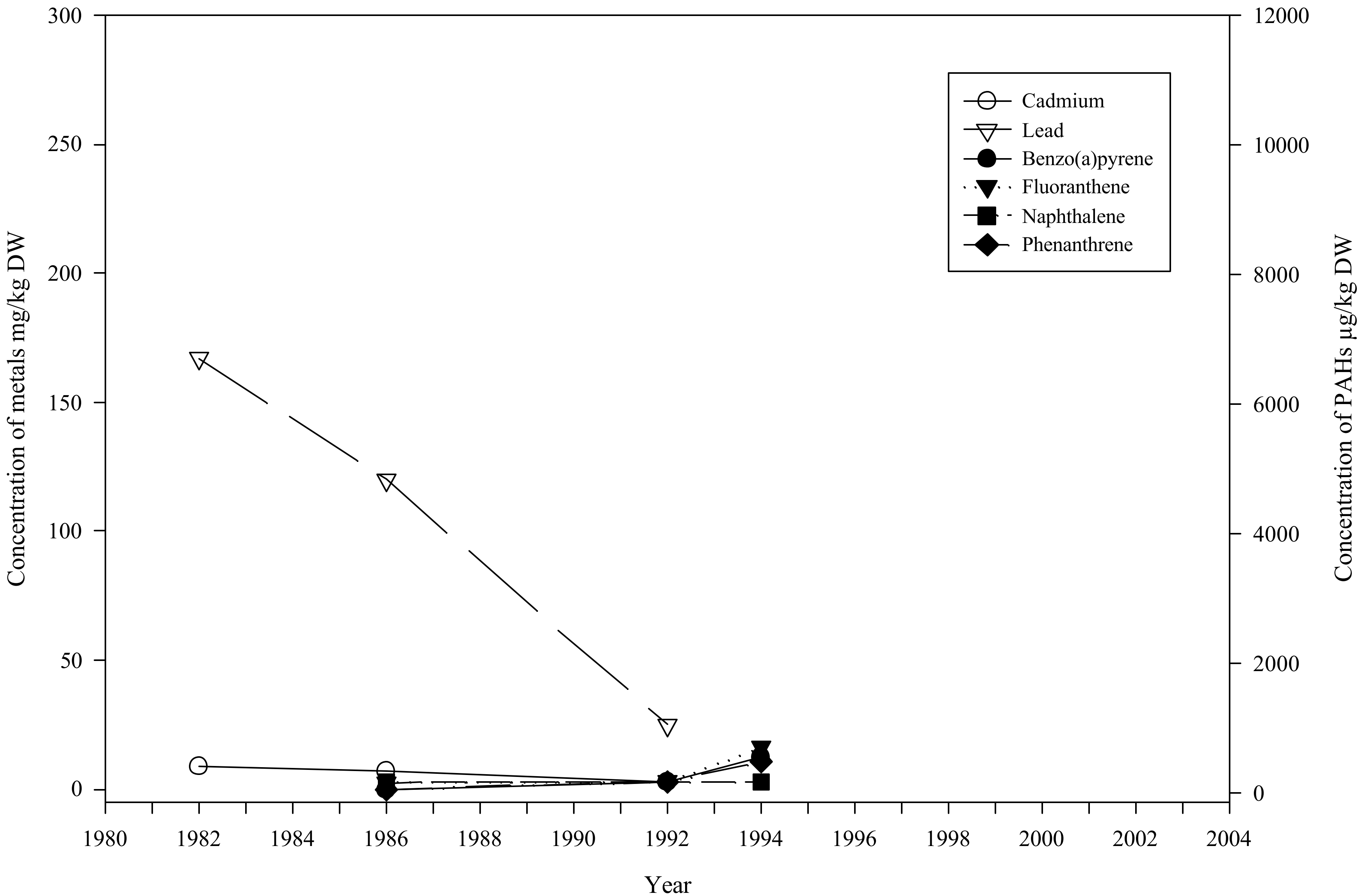
Note: values represent the median where there were multiple samples for the year.

Figure 24. Temporal tends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sediment samples from spatially clustered stations corresponding to station PIB 15 (Gannett Fleming, Inc., 1993)



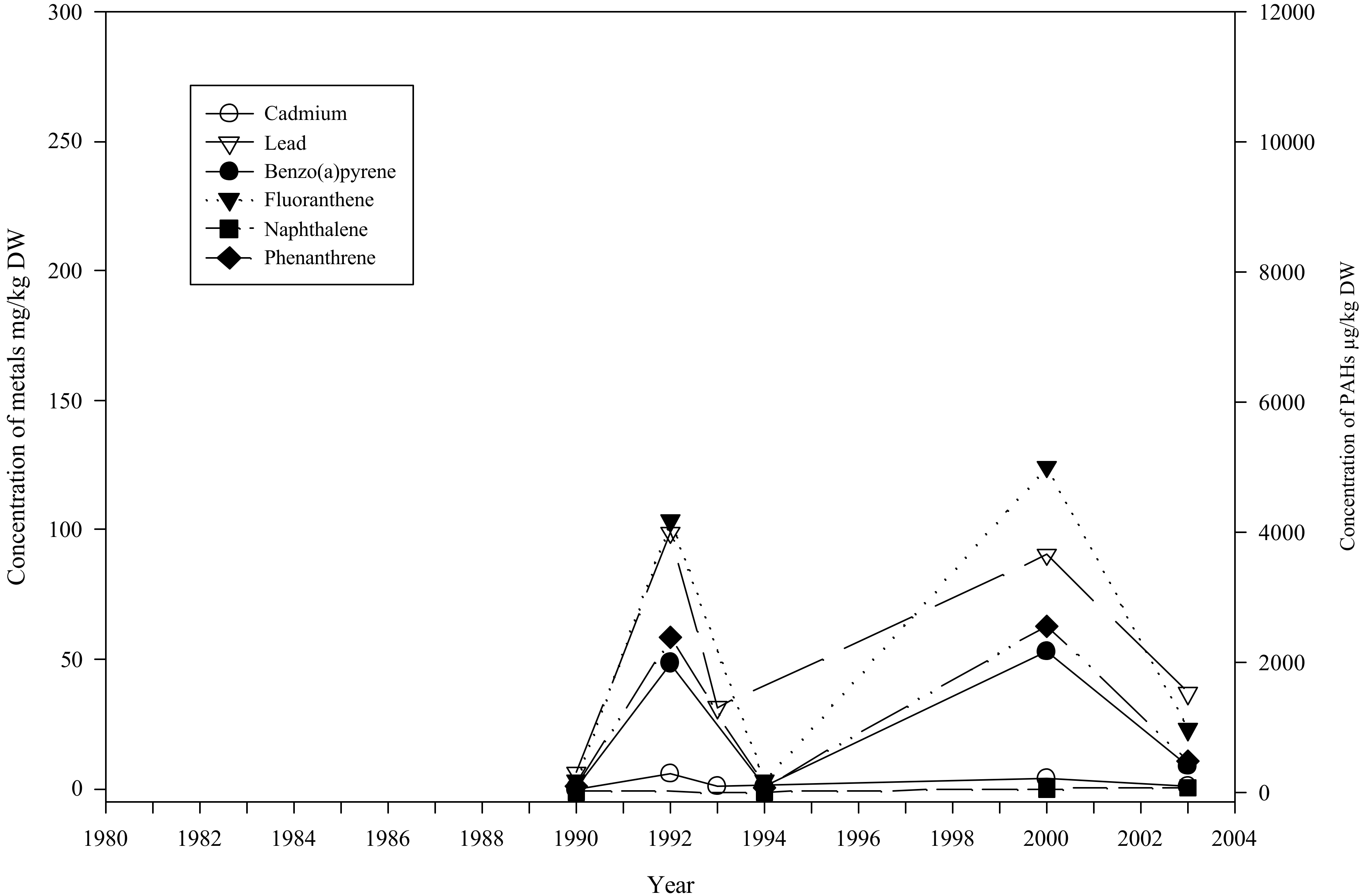
Note: values represent the median where there were multiple samples for the year.

Figure 25. Temporal trends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sediment samples from spatially clustered stations corresponding to station PIB 16 (Gannett Fleming, Inc., 1993)



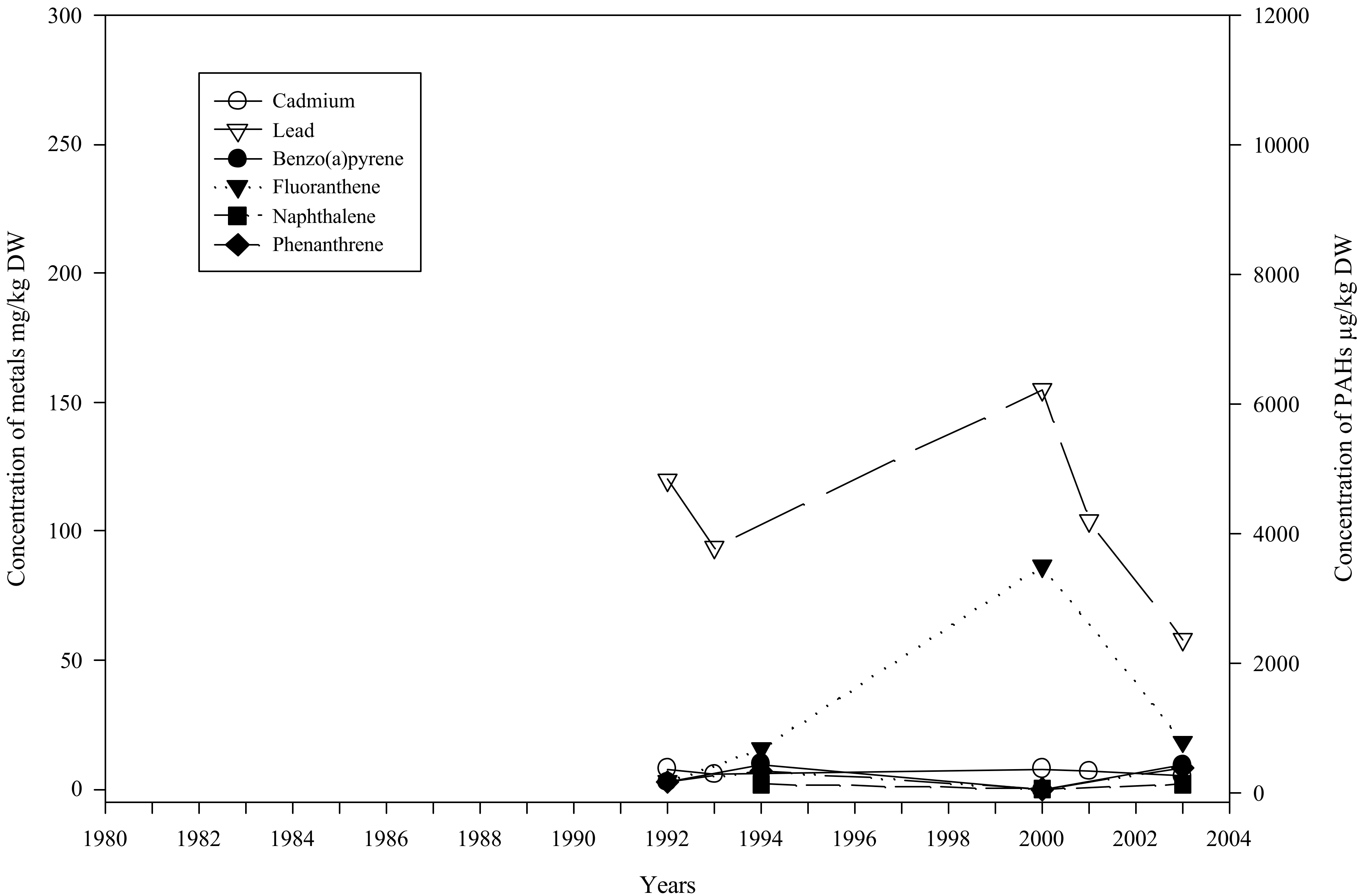
Note: values represent the median where there were multiple samples for the year.

Figure 26. Temporal trends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sediment samples from spatially clustered stations corresponding to station PIB 18 (Gannett Fleming, Inc., 1993)



Note: values represent the median where there were multiple samples ofr the year.

Figure 27. Temporal trends in whole-sediment chemistry in Presque Isle Bay: data includes surficial sediment samples from spatially clustered stations corresponding to station PIB 20 (Gannett Fleming, Inc., 1993)



Note: values represent the median where there were multiple samples for the year.

Figure 28. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial sediment samples with low (<20%; mean PEC-Q of <0.22), moderate (20-50%; mean PEC-Q of 0.22-0.63), and high (>50%; mean PEC-Q of >0.63) probabilities of observing toxicity to freshwater amphipods in 28-d exposures: 1982-1991.

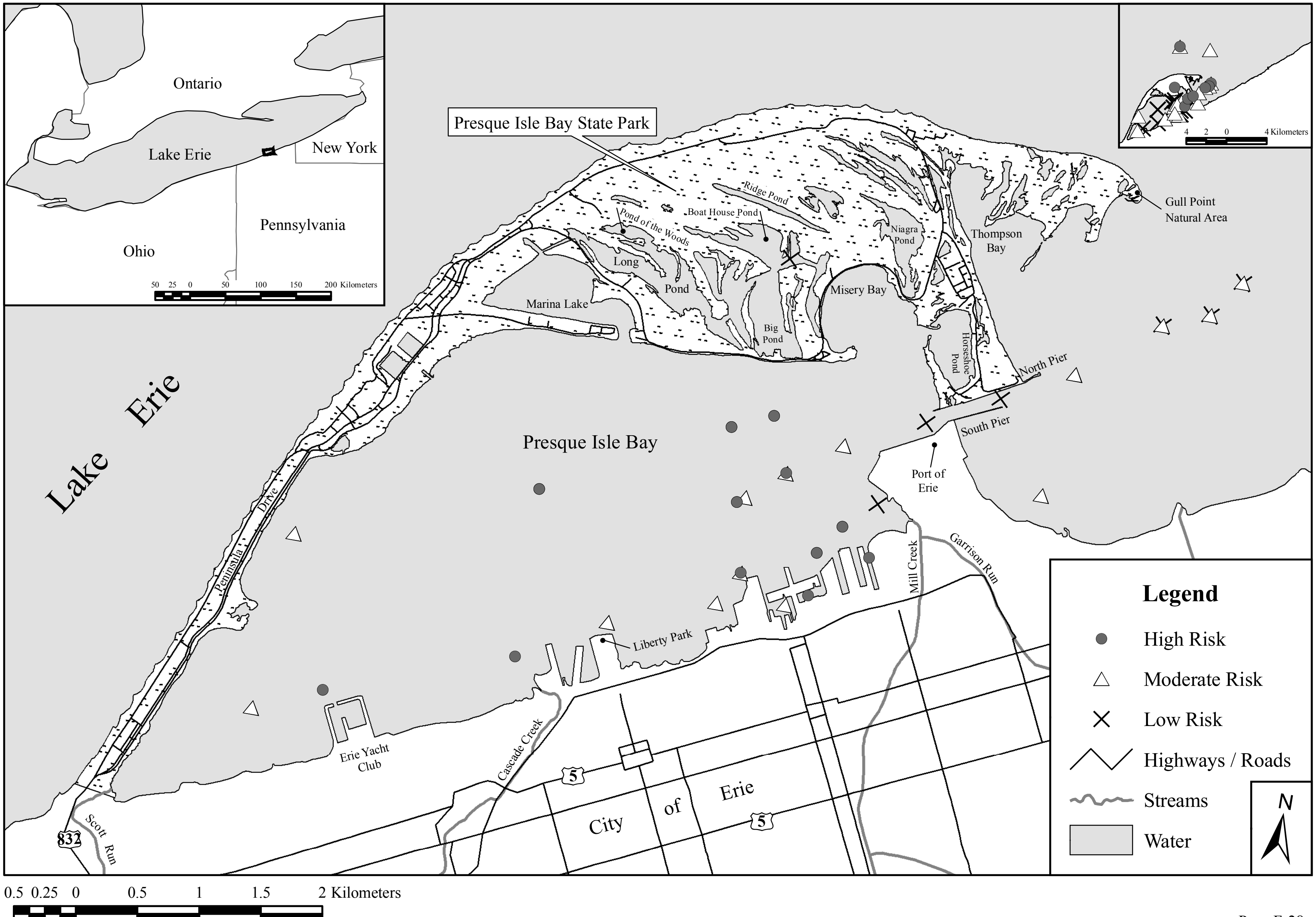


Figure 29. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of sub-surficial sediment samples with low (<20%; mean PEC-Q of <0.22), moderate (20-50%; mean PEC-Q of 0.22-0.63), and high (>50%; mean PEC-Q of >0.63) probabilities of observing toxicity to freshwater amphipods in 28-d exposures: 1982-1991.

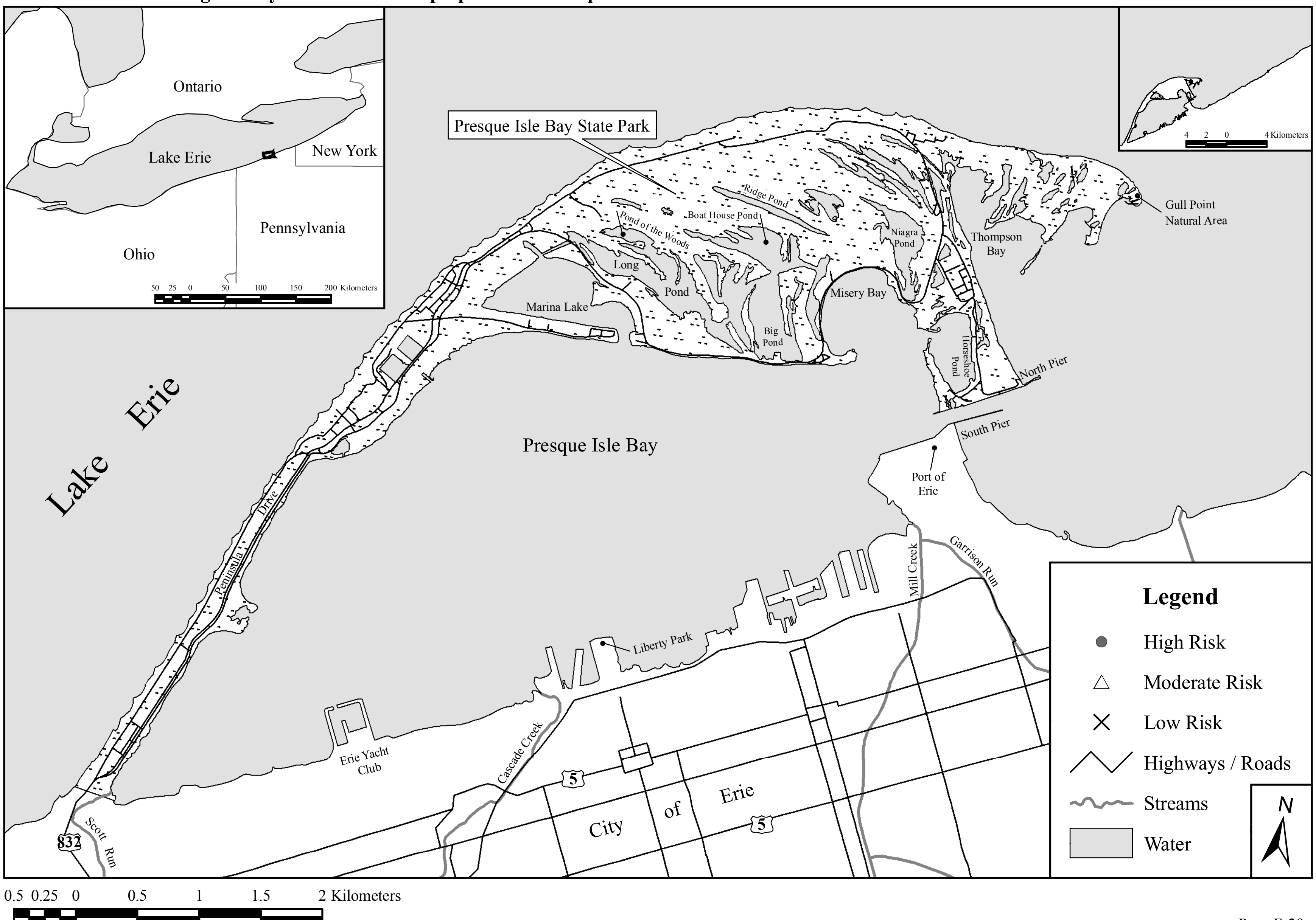


Figure 30. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial sediment samples with low (<20%; mean PEC-Q of <0.22), moderate (20-50%; mean PEC-Q of 0.22-0.63), and high (>50%; mean PEC-Q of >0.63) probabilities of observing toxicity to freshwater amphipods in 28-d exposures: 1992-2003.

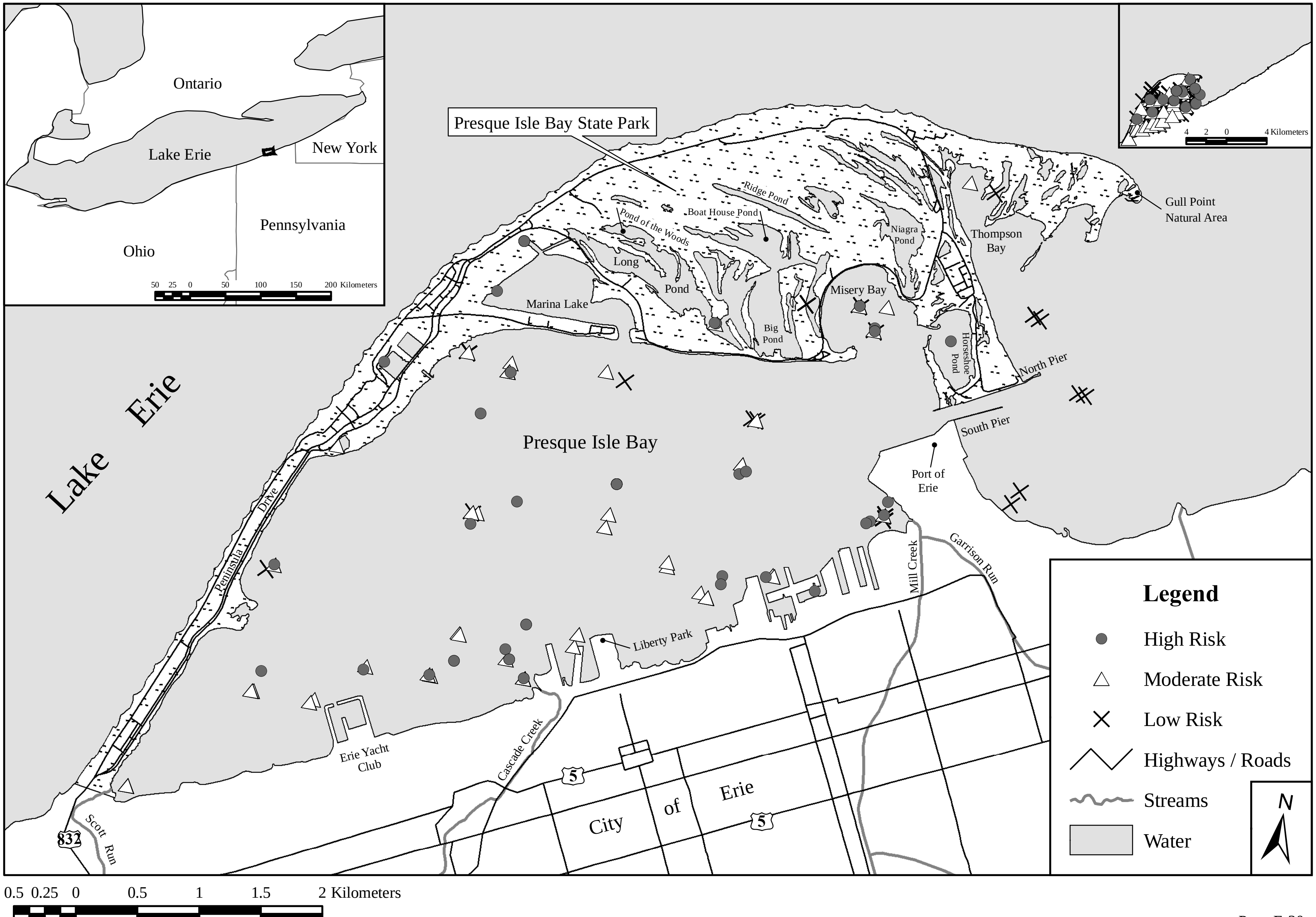


Figure 31. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of sub-surficial sediment samples with low (<20%; mean PEC-Q of <0.22), moderate (20-50%; mean PEC-Q of 0.22-0.63), and high (>50%; mean PEC-Q of >0.63) probabilities of observing toxicity to freshwater amphipods in 28-d exposures: 1992-2003.

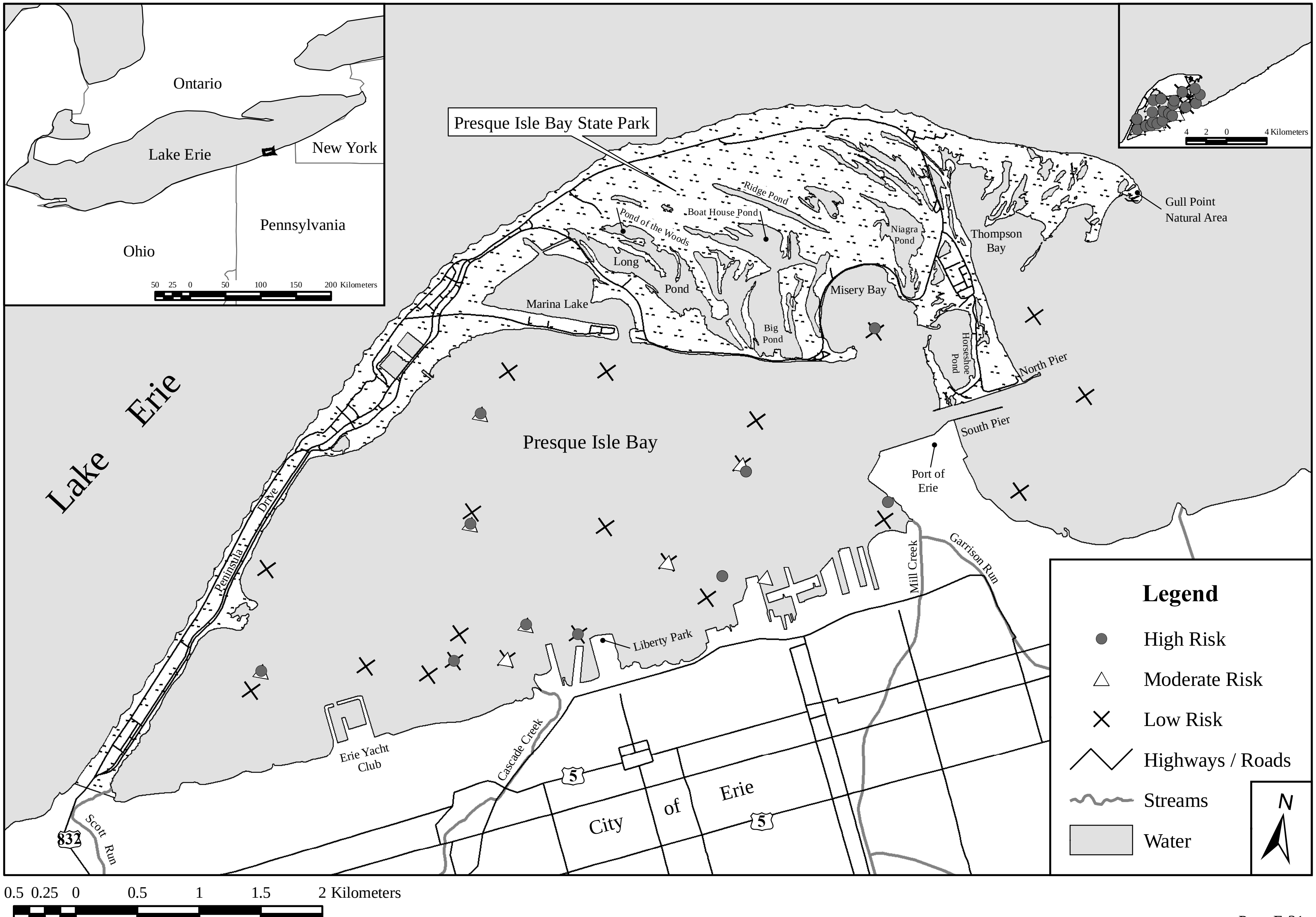


Figure 32. Map of the Presque Isle Bay AOC showing the distribution of surficial sediment samples with polycyclic aromatic hydrocarbons (PAHs) concentrations sufficient to adversely affect sediment-dwelling organisms, as indicated by ESBTUs > 1.0 (USEPA 2003): 1982-1991.

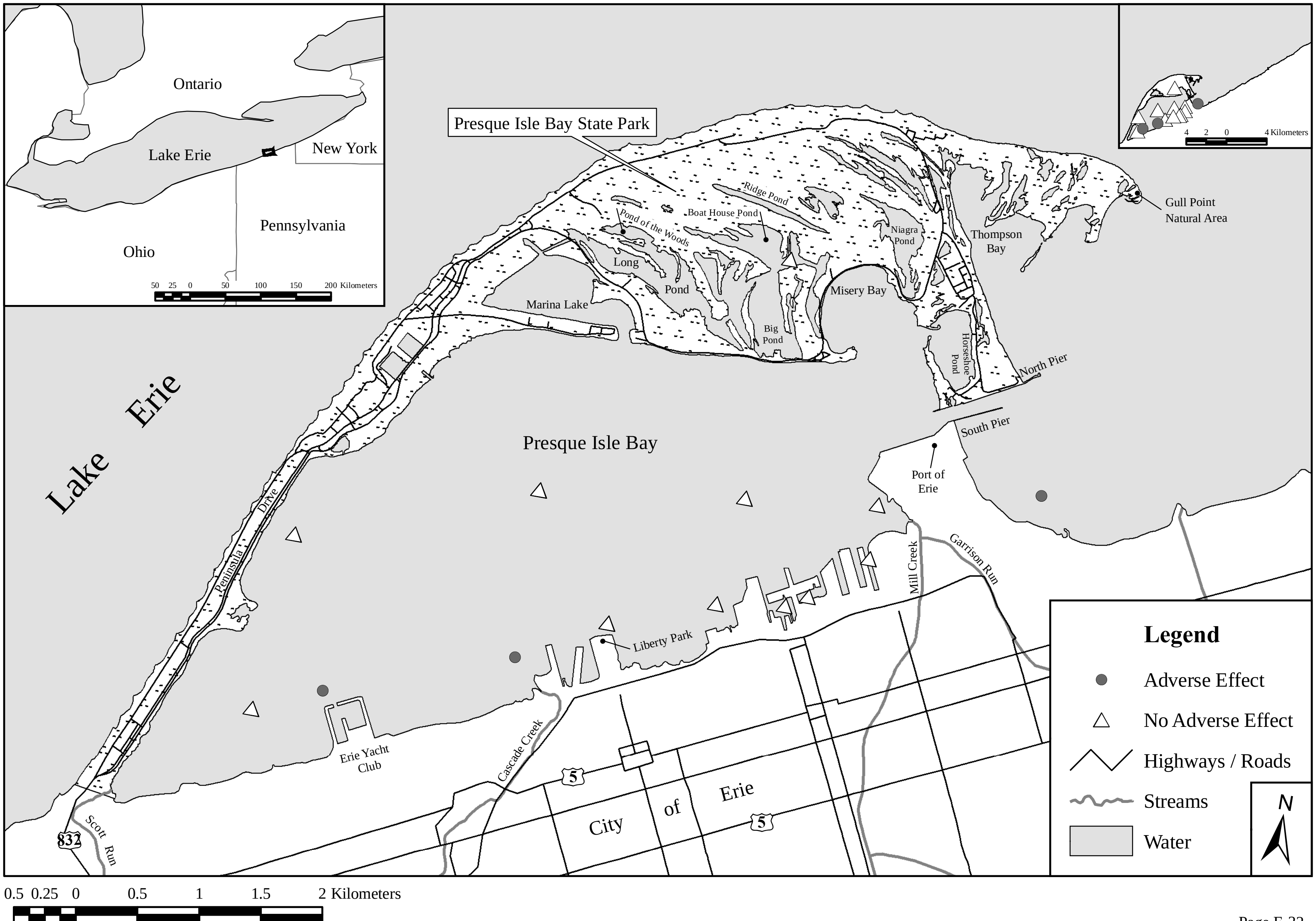


Figure 33. Map of the Presque Isle Bay AOC showing the distribution of sub-surficial sediment samples with polycyclic aromatic hydrocarbons (PAHs) concentrations sufficient to adversely affect sediment-dwelling organisms, as indicated by ESBTUs > 1.0 (USEPA 2003): 1982-1991.

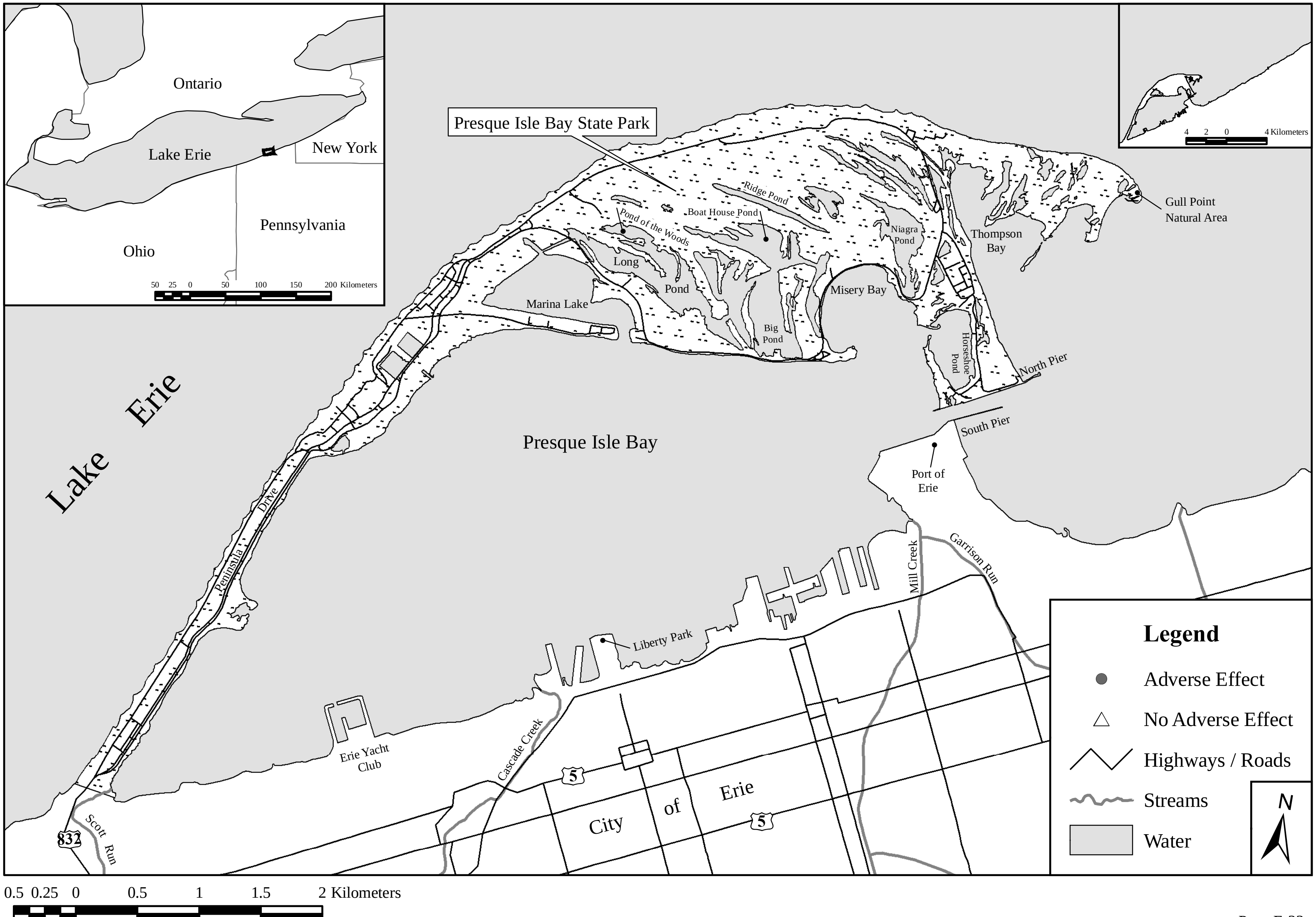


Figure 34. Map of the Presque Isle Bay AOC showing the distribution of surficial sediment samples with polycyclic aromatic hydrocarbons (PAHs) concentrations sufficient to adversely affect sediment-dwelling organisms, as indicated by ESBTUs >1.0 (USEPA 2003) for 1992-2003.

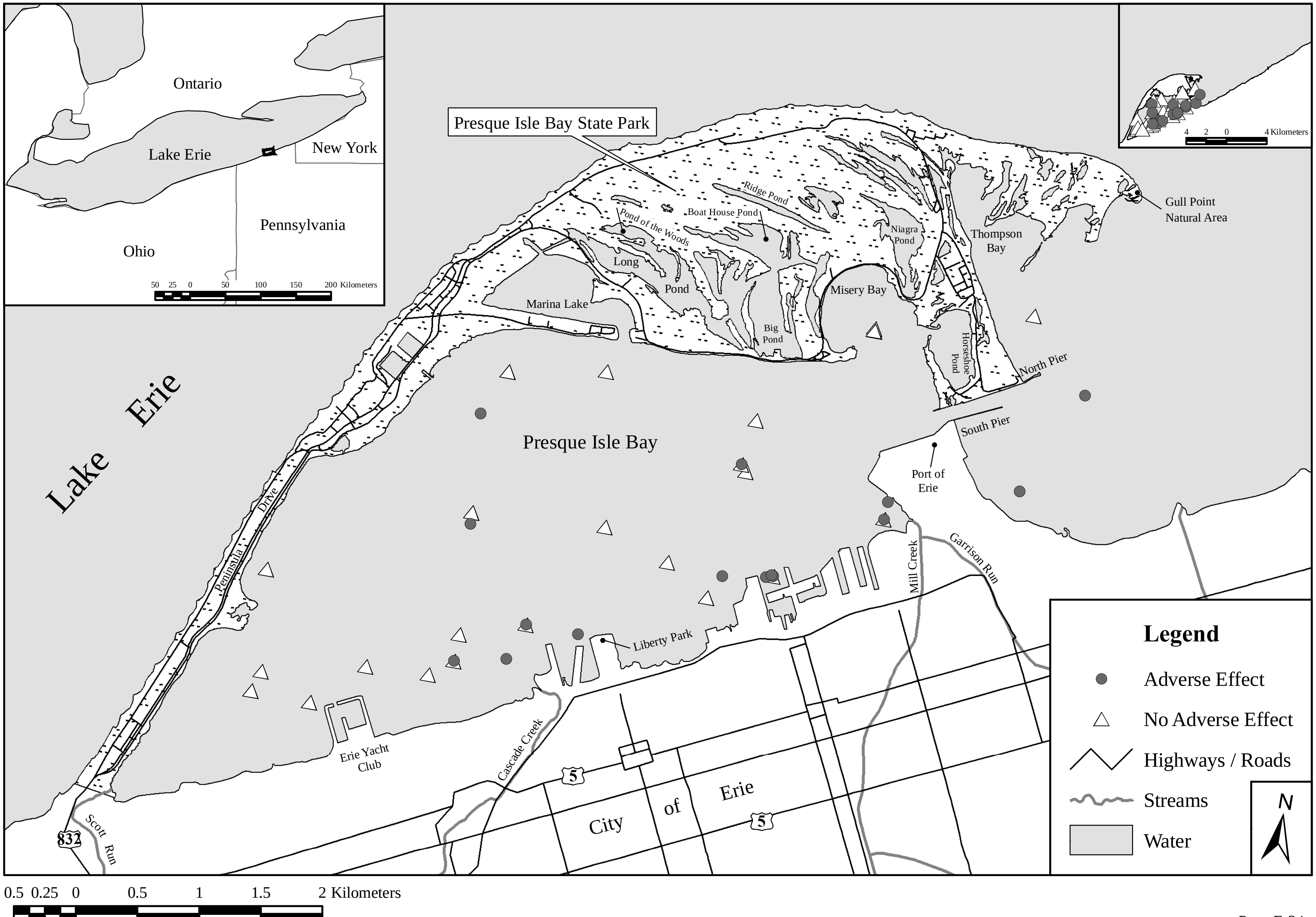


Figure 35. Map of the Presque Isle Bay AOC showing the distribution of sub-surficial sediment samples with polycyclic aromatic hydrocarbons (PAHs) concentrations sufficient to adversely affect sediment-dwelling organisms, as indicated by ESBTUs > 1.0 (USEPA 2003): 1992-2003.

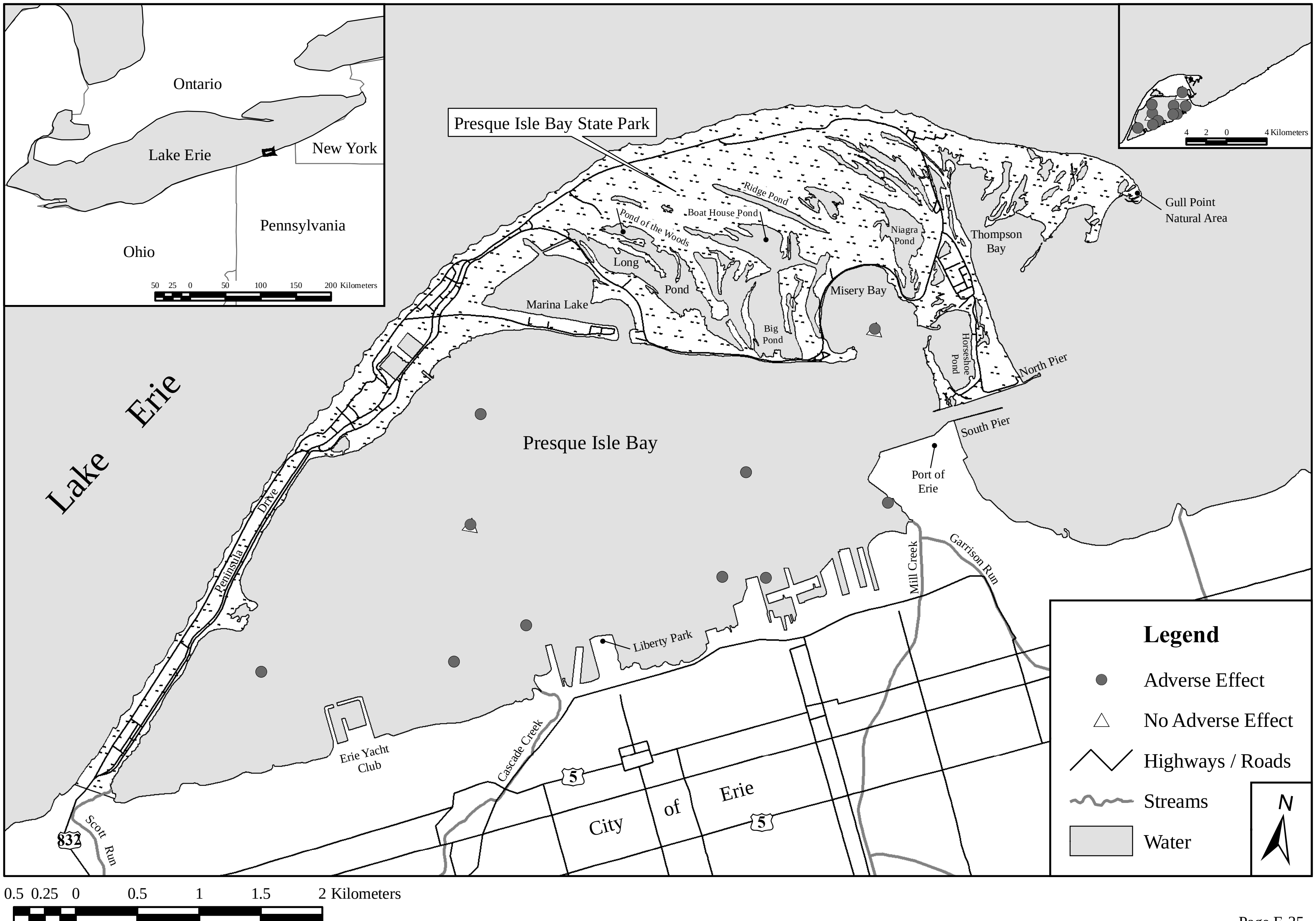


Figure 36. Map of the Presque Isle Bay AOC showing the distribution of surficial sediment samples with concentrations of divalent metals sufficient to adversely affect sediment-dwelling organisms, as indicated by SEM-AVS > 0.0 (Ankley et al. 1996): 1982-1991.

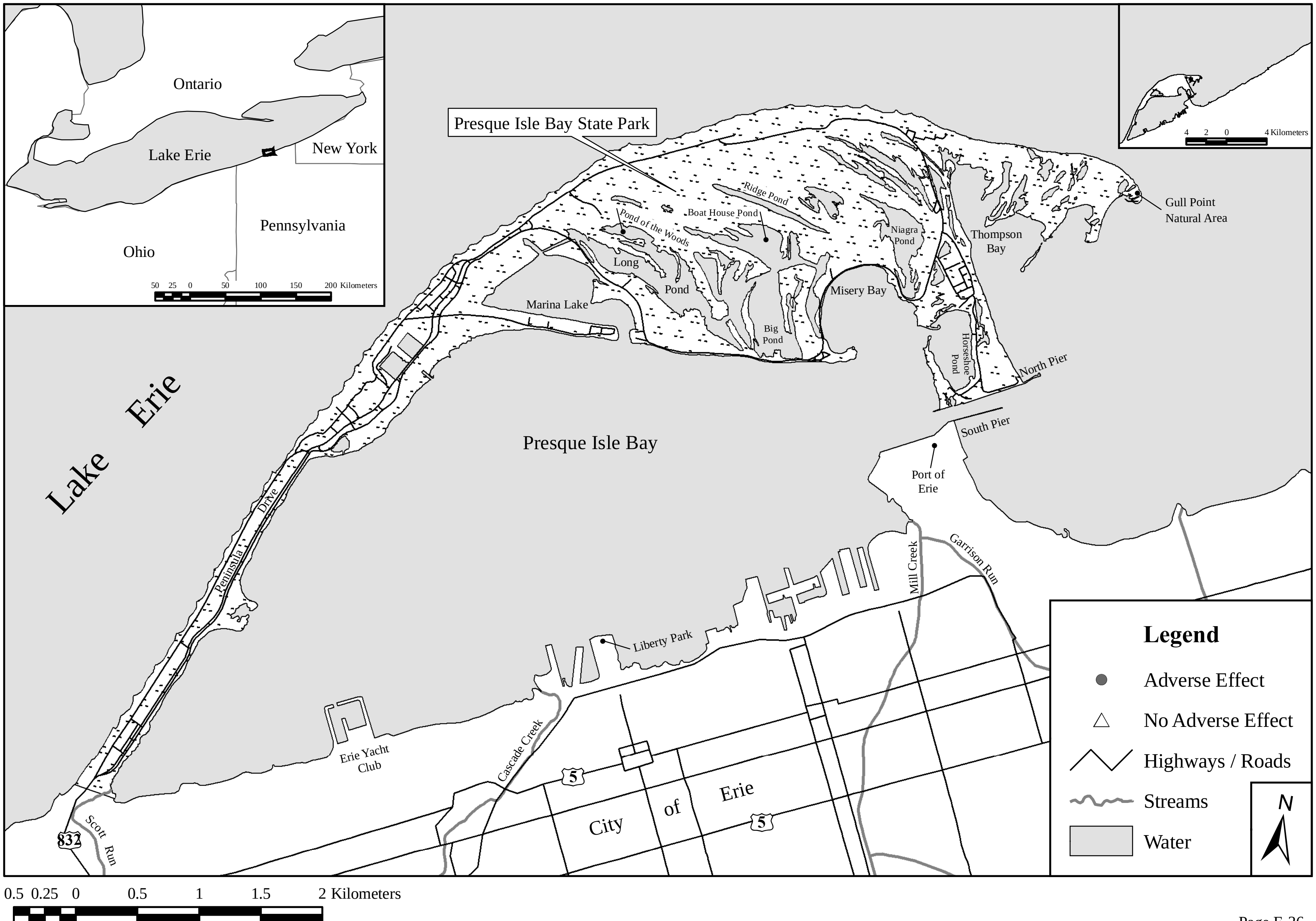


Figure 37. Map of the Presque Isle Bay AOC showing the distribution of sub-surficial sediment samples with concentrations of divalent metals sufficient to adversely affect sediment-dwelling organisms, as indicated by SEM-AVS > 0.0 (Ankley et al. 1996): 1982-1991.

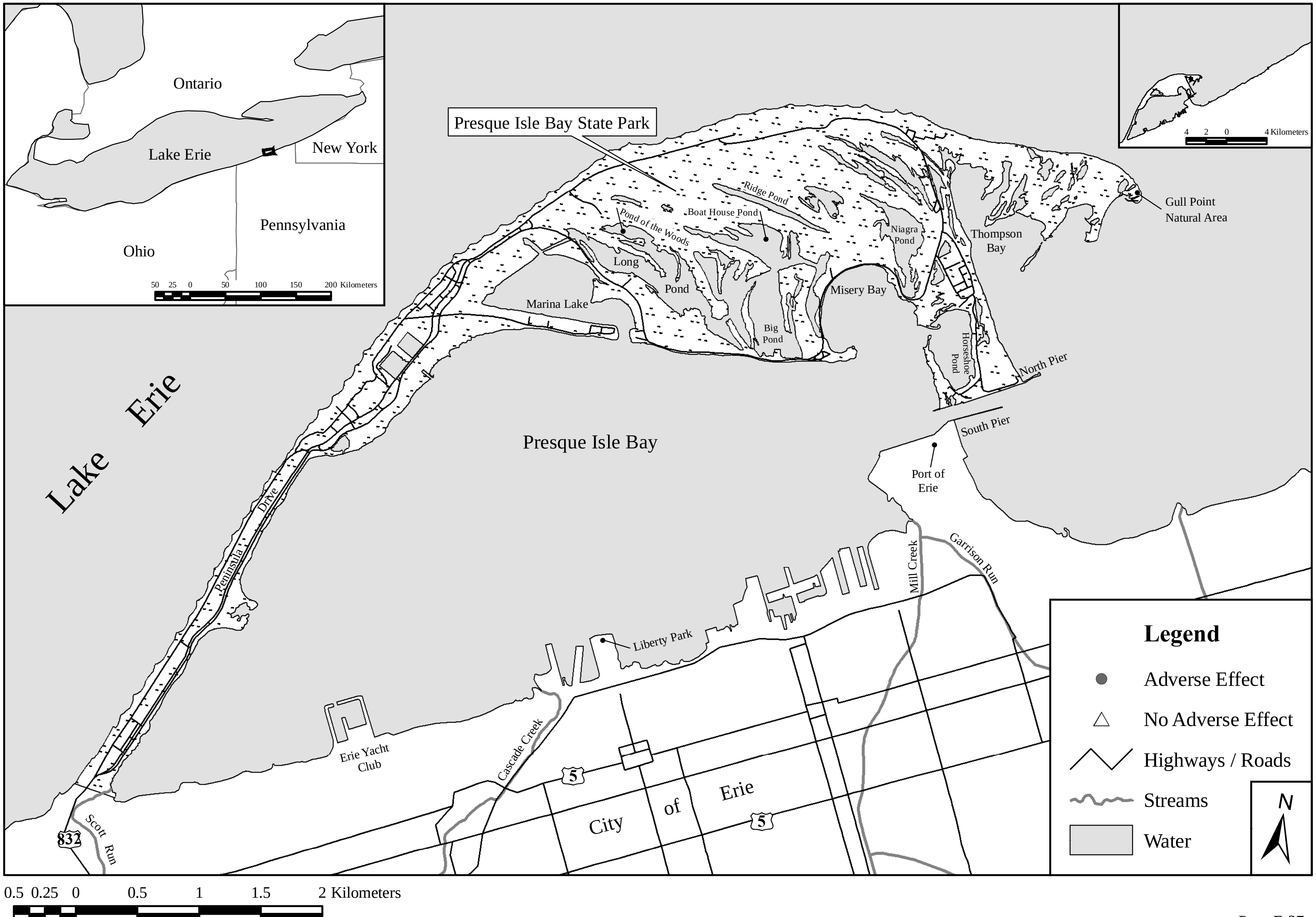


Figure 38. Map of the Presque Isle Bay AOC showing the distribution of surficial sediment samples with concentrations of divalent metals sufficient to adversely affect sediment-dwelling organisms, as indicated by SEM-AVS > 0.0 (Ankley et al. 1996): 1992-2003.

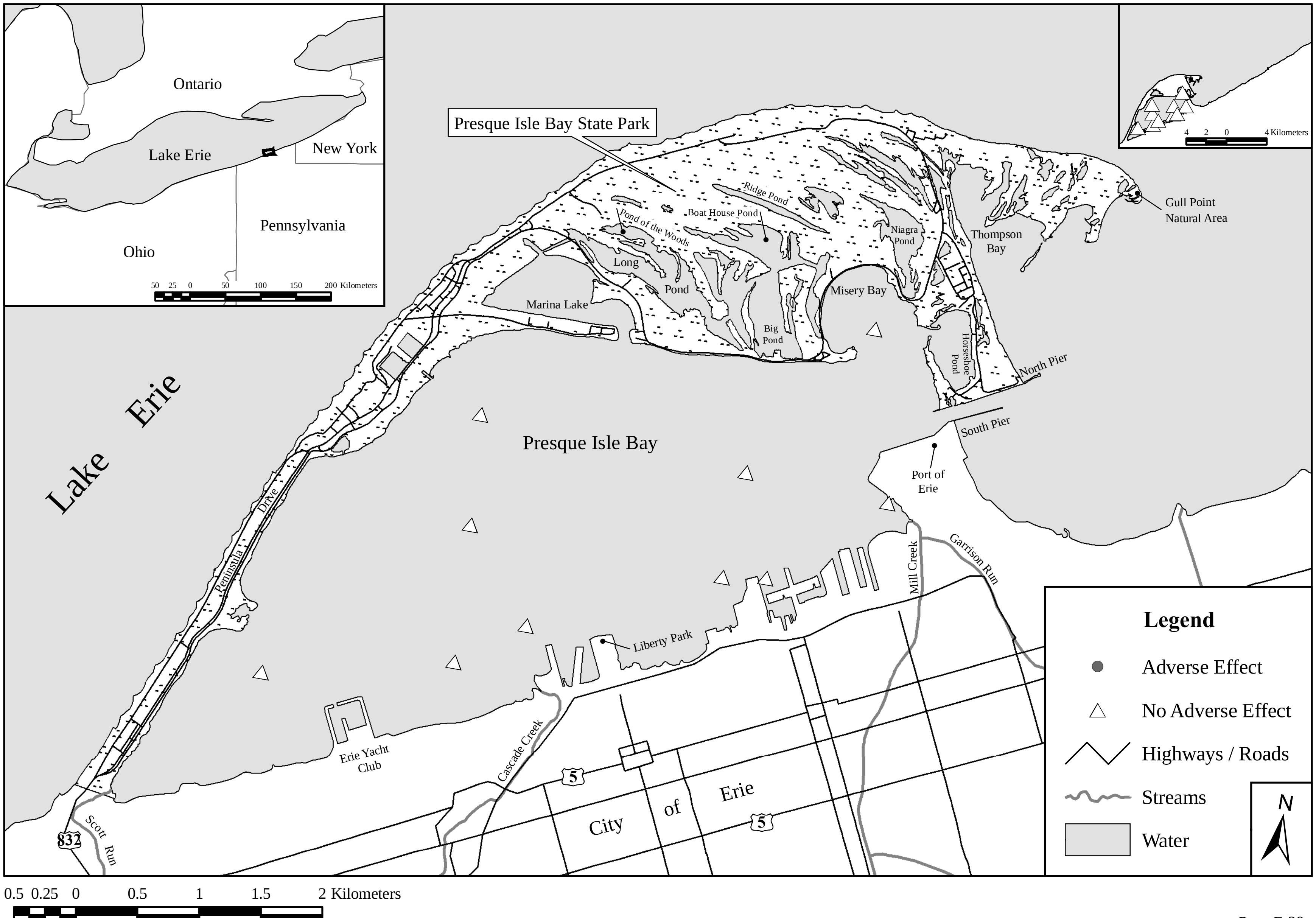


Figure 39. Map of the Presque Isle Bay AOC showing the distribution of sub-surficial sediment samples with concentrations of divalent metals sufficient to adversely affect sediment-dwelling organisms, as indicated by SEM-AVS > 0.0 (Ankley et al. 1996): 1992-2003.

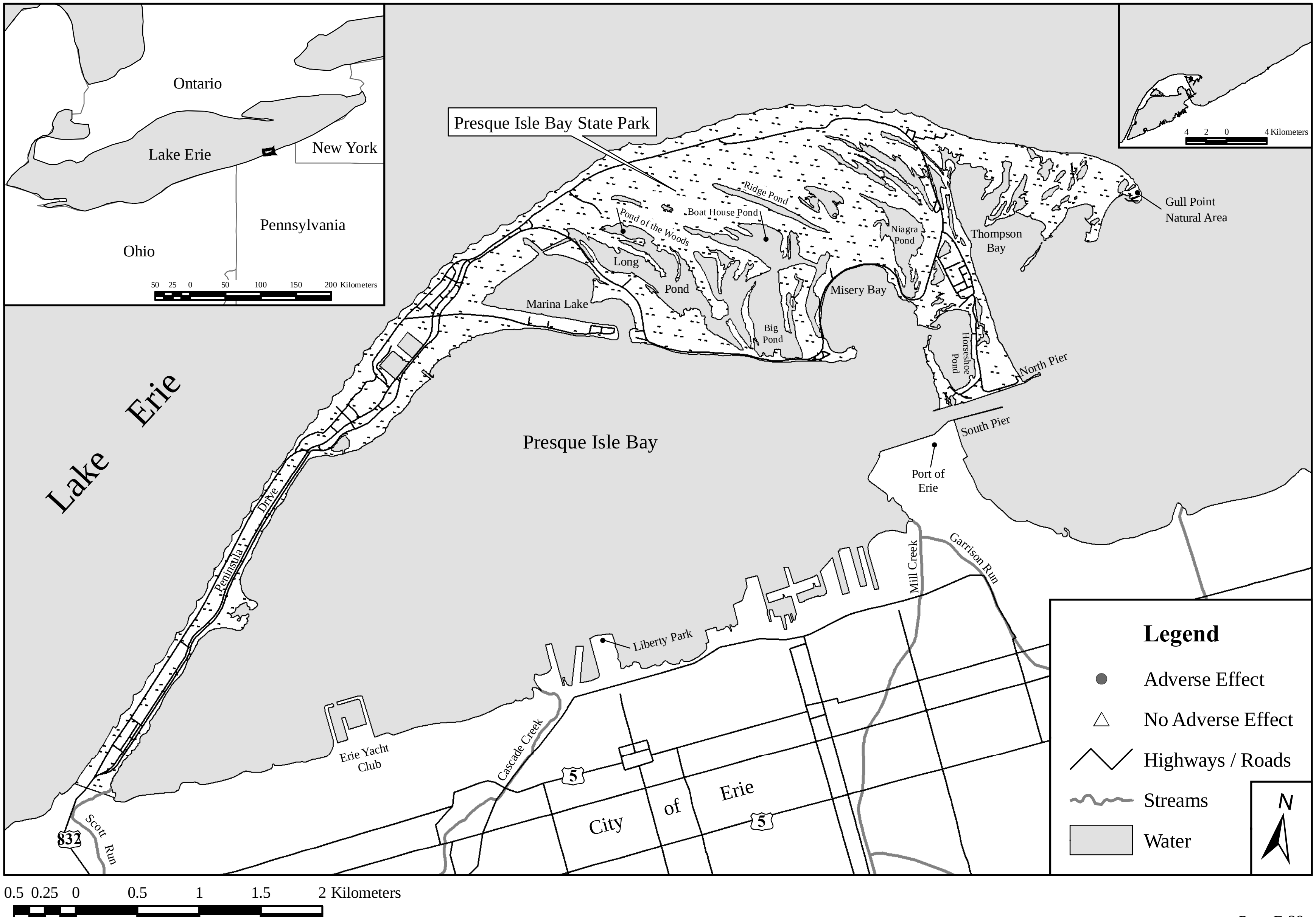


Figure 40. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial sediment samples that were toxic to one or more invertebrate species (endpoint: survival): 1982-1991.

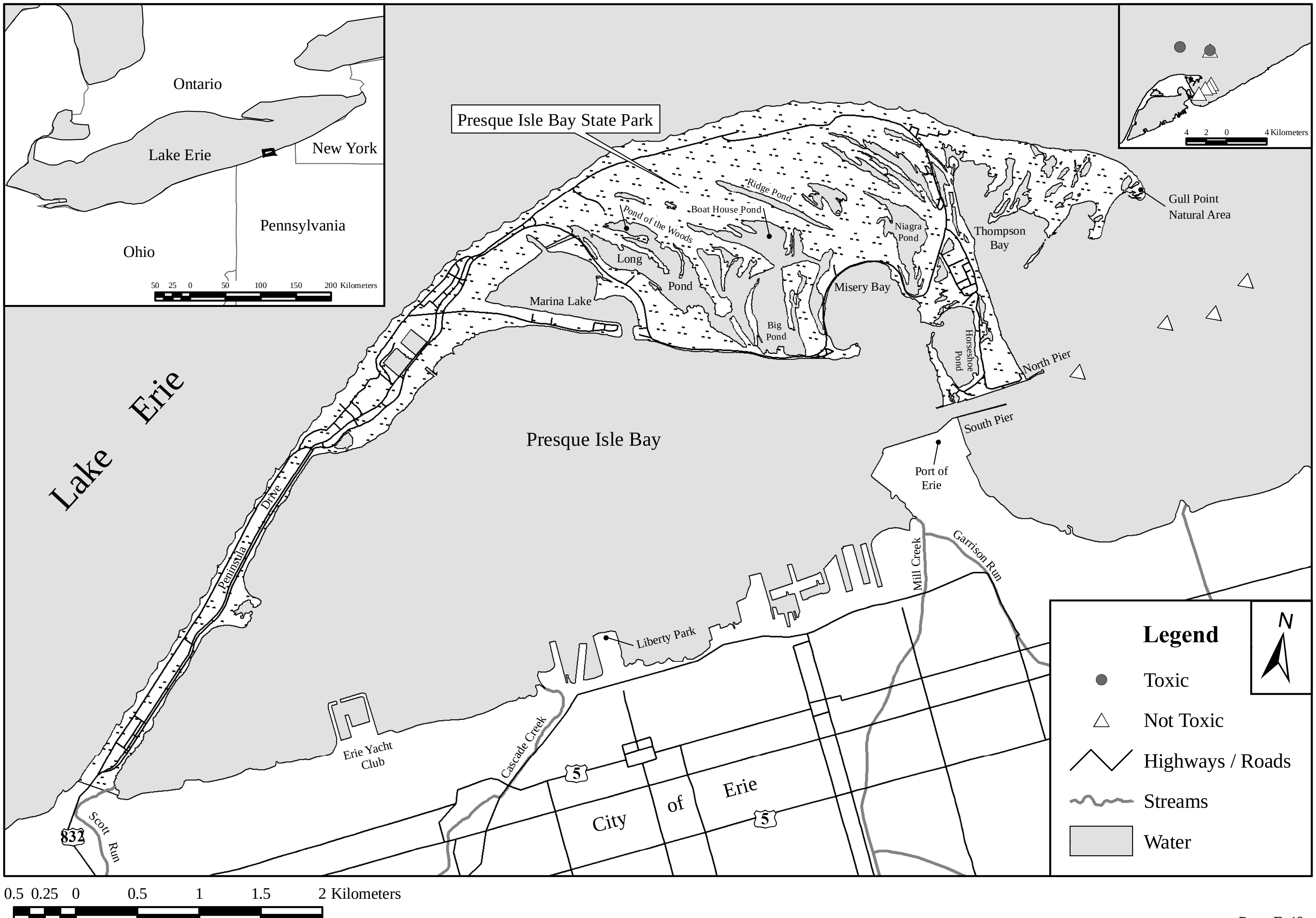


Figure 41. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial sediment samples that were toxic to one or more invertebrate species (endpoint: survival or growth): 1982-1991.

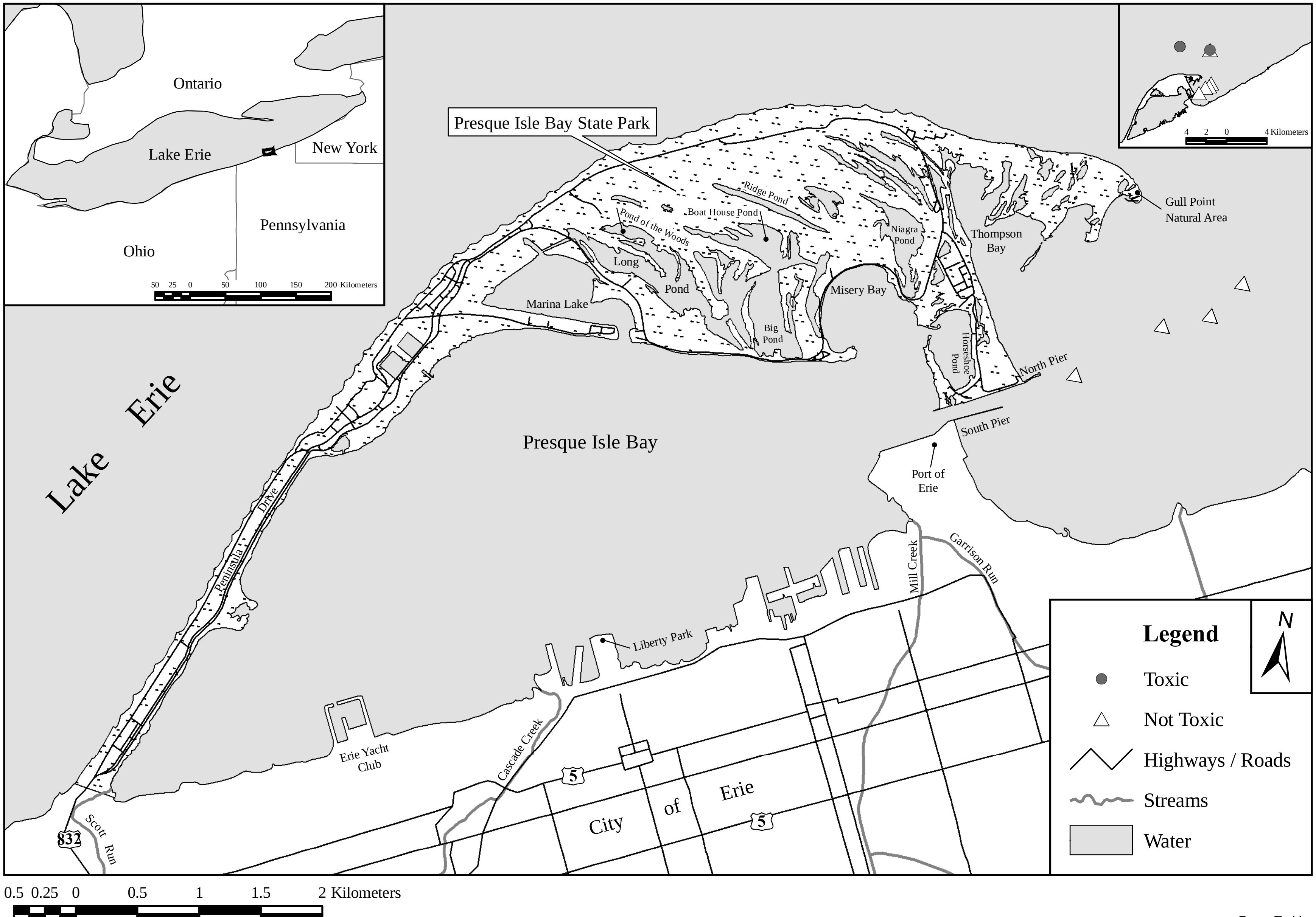


Figure 42. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial sediment samples that were toxic to one or more invertebrate species (endpoint: survival): 1992-2003.

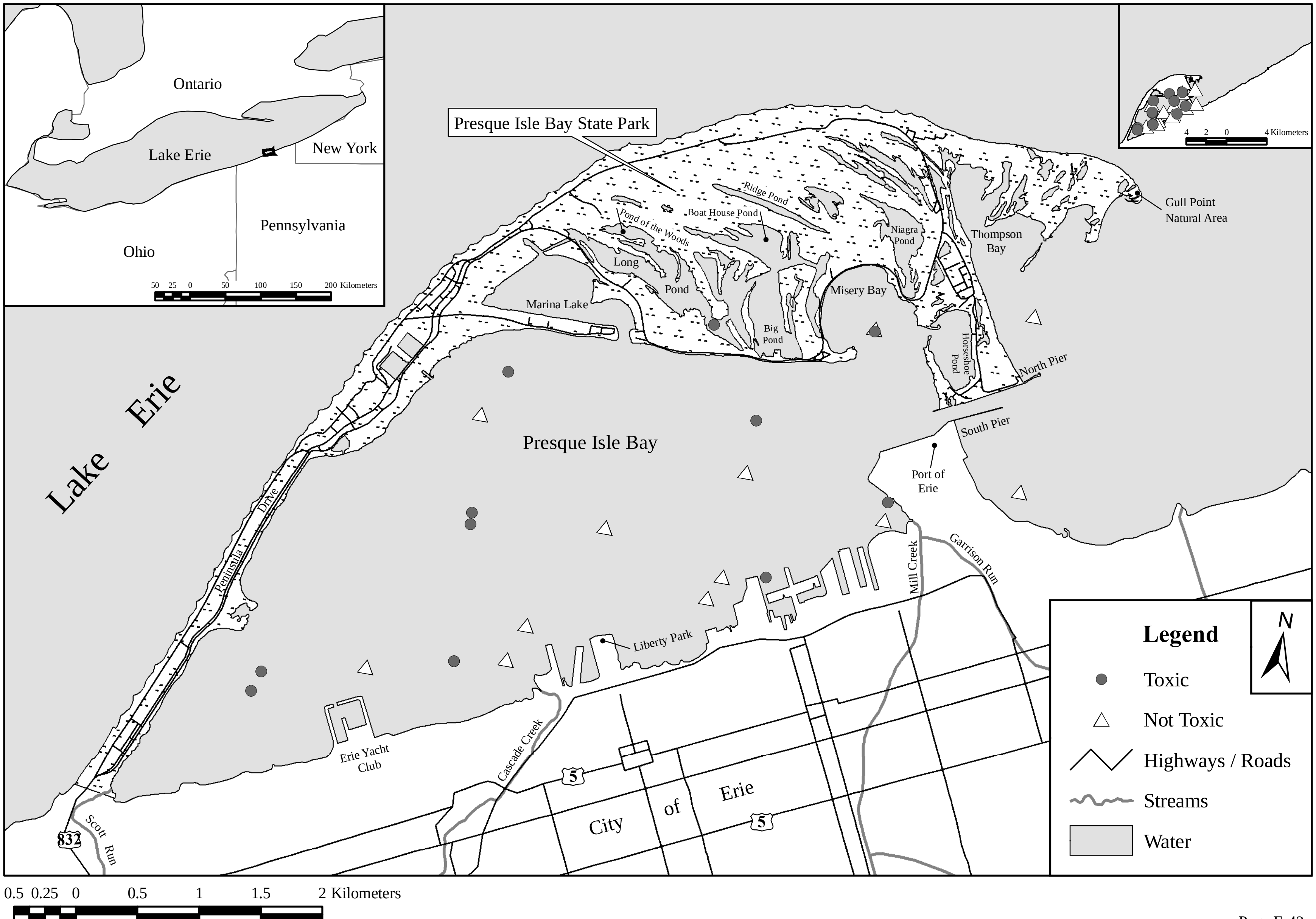


Figure 43. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial sediment samples that were toxic to one or more invertebrate species (endpoint: survival or growth): 1992-2003.

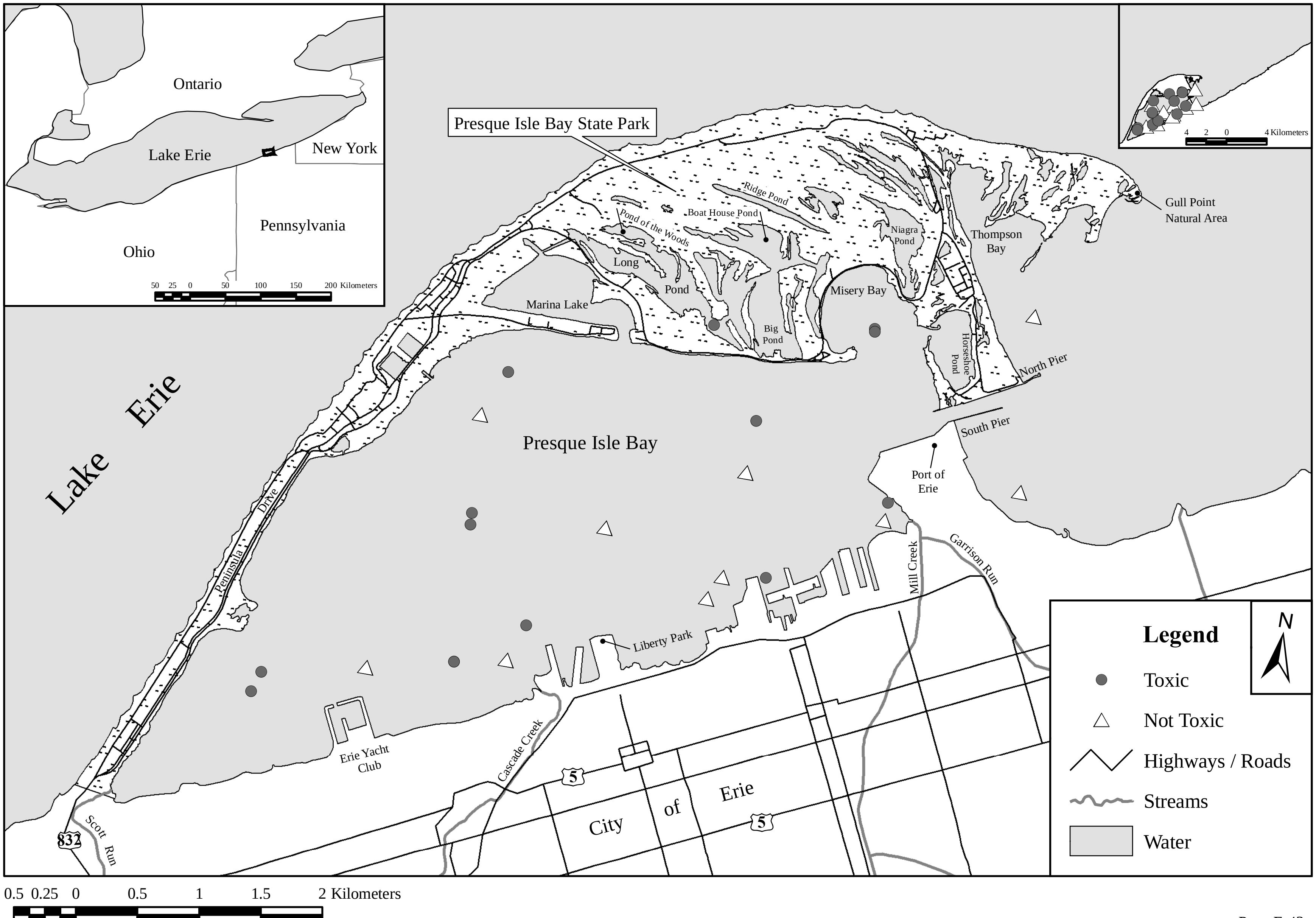


Figure 44. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial sediment samples that were toxic to the amphipod *Hyallela Azteca* in 28 day tests (endpoint: survival): 1982-1991.

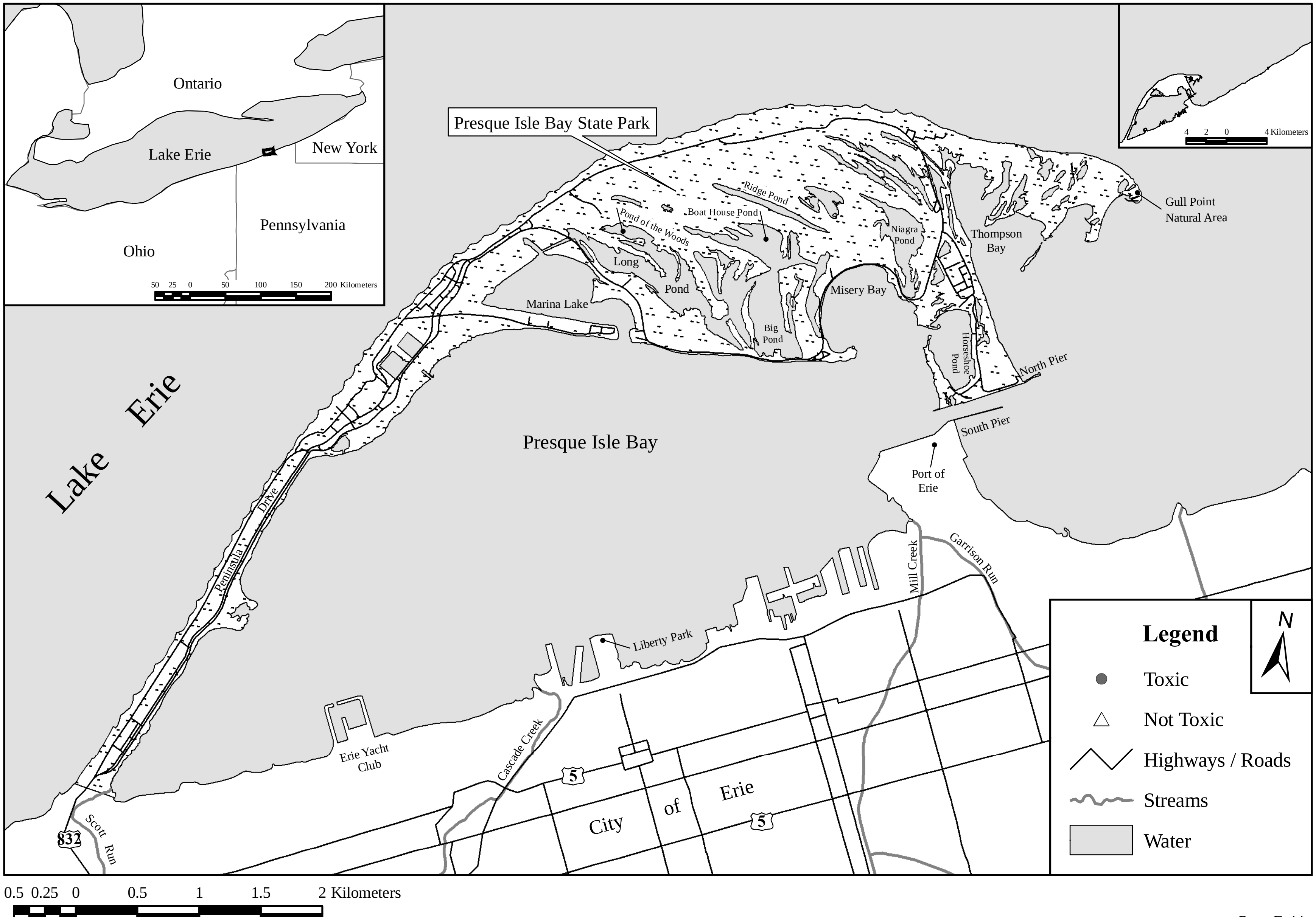


Figure 45. Map of the Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial sediment samples that were toxic to the amphipod *Hyallela Azteca* in 28 day tests (endpoint: survival): 1992-2003.

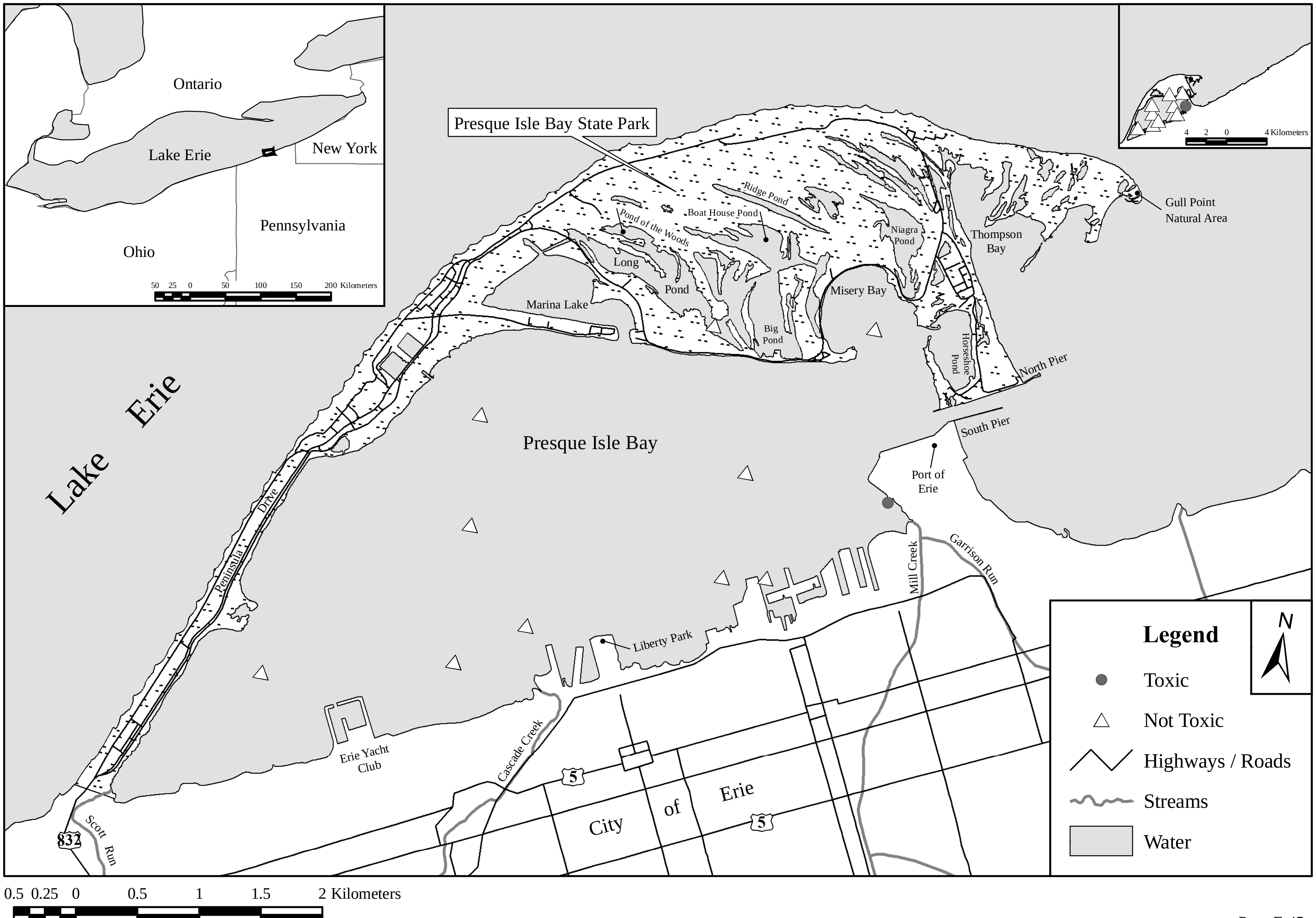


Figure 46. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial whole-sediment samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect fish (i.e., concentrations of six or more COPCs exceed the selected toxicity thresholds for whole-sediment samples): 1982-1991.

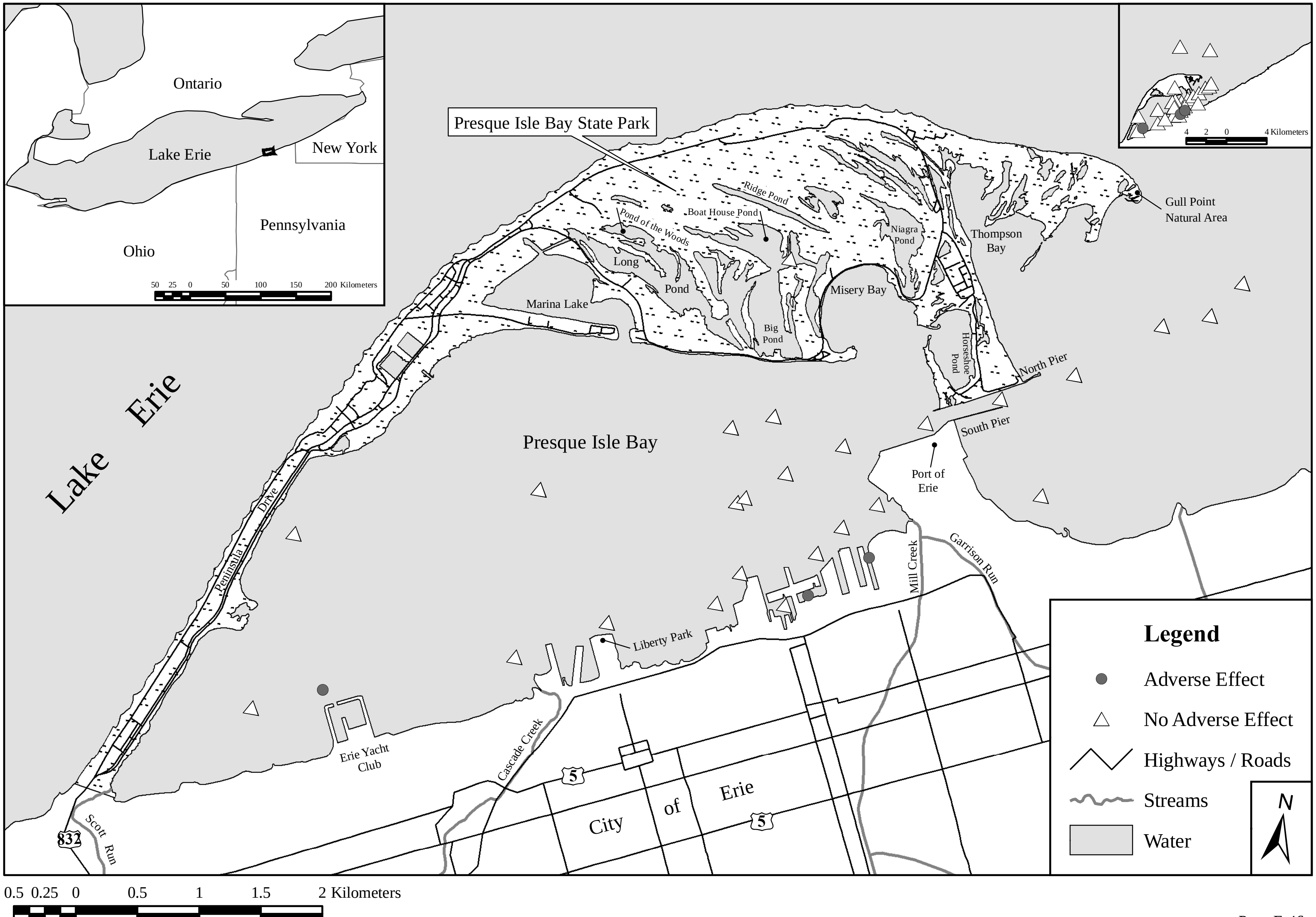


Figure 47. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of sub-surficial whole-sediment samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect fish (i.e., concentrations of six or more COPCs exceed the selected toxicity thresholds for whole-sediment samples): 1982-1991.

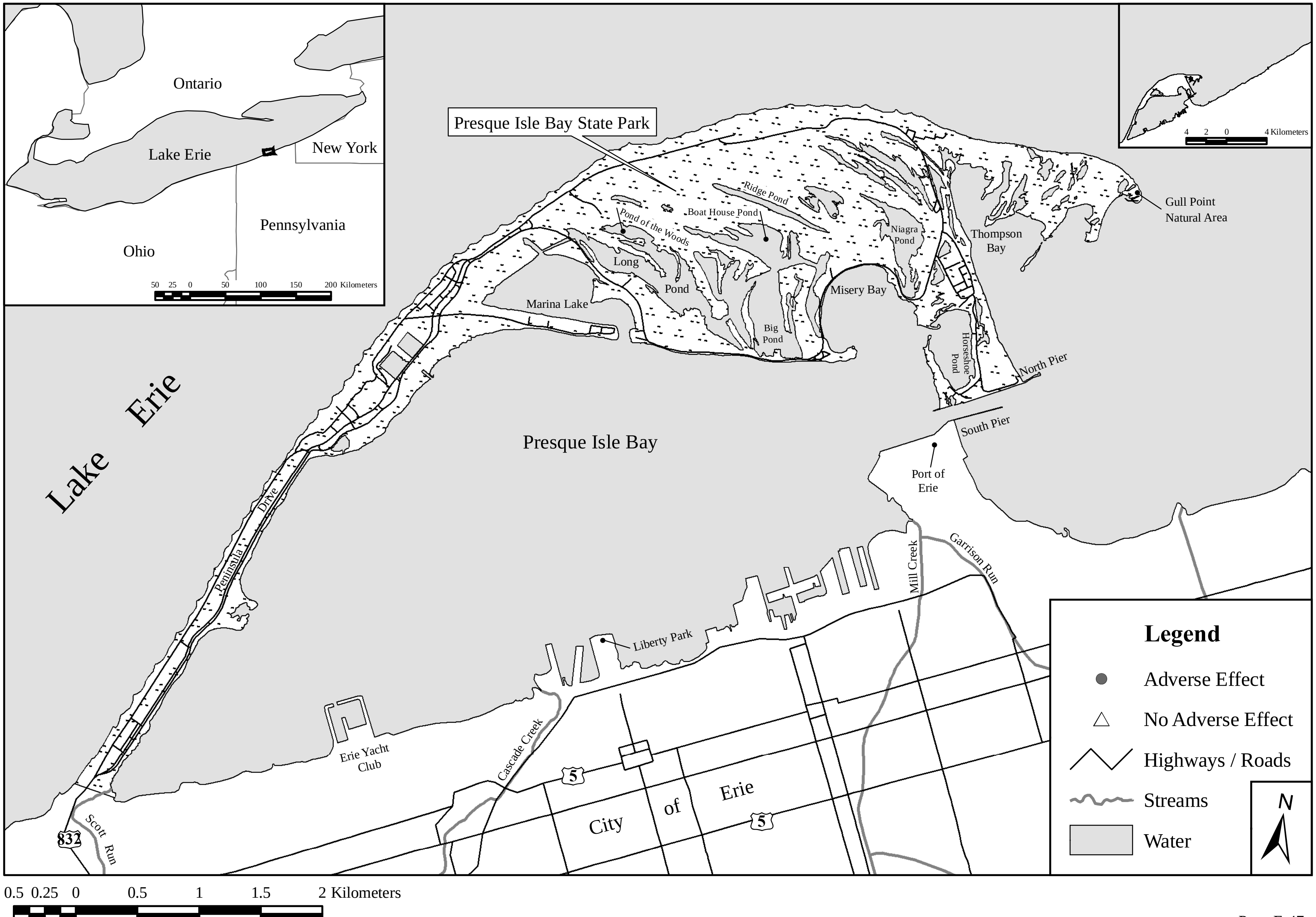


Figure 48. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial whole-sediment samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect fish (i.e., concentrations of six or more COPCs exceed the selected toxicity thresholds for whole-sediment samples): 1992-2003.

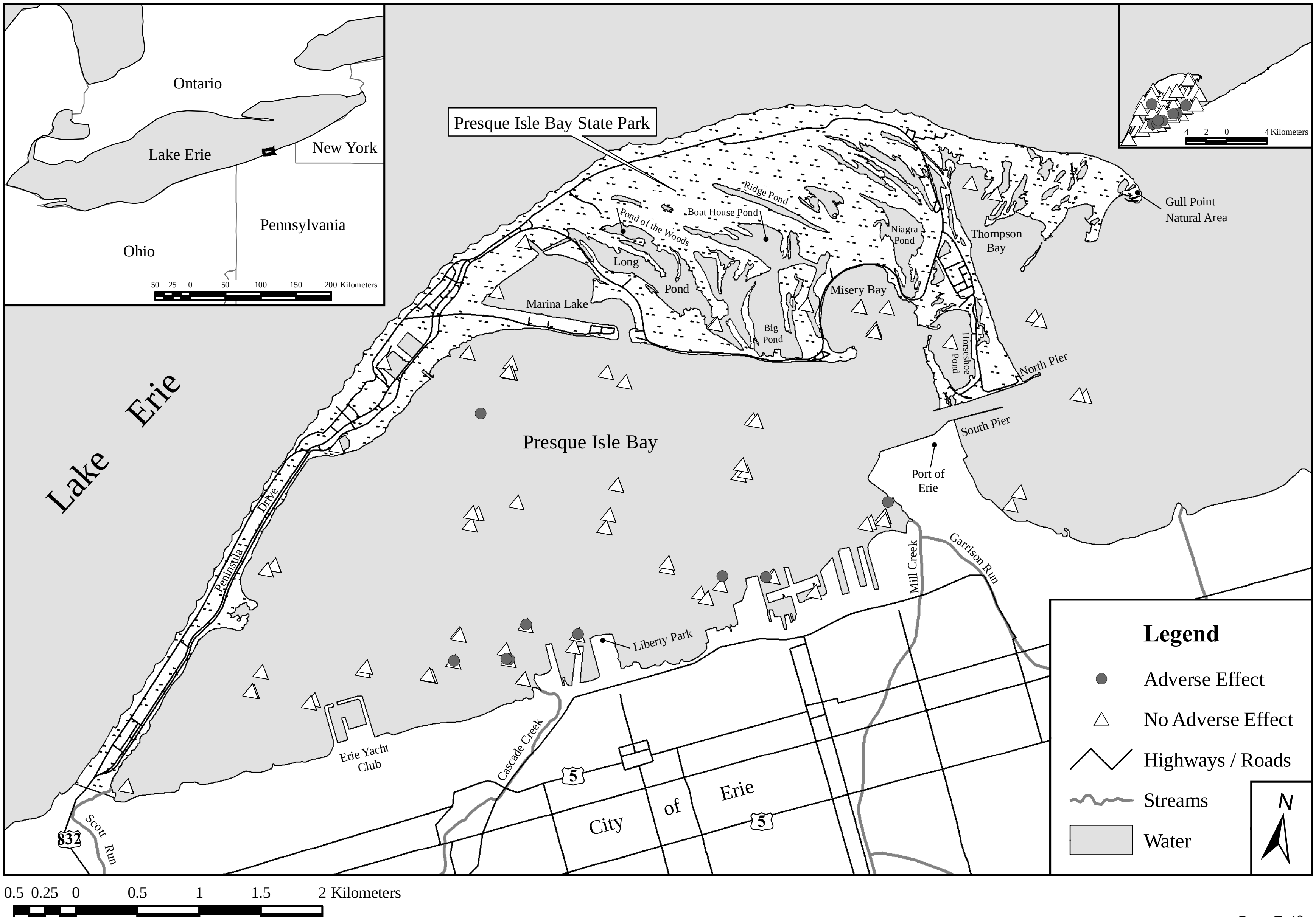


Figure 49. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of sub-surficial whole-sediment samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect fish (i.e., concentrations of six or more COPCs exceed the selected toxicity thresholds for whole-sediment samples): 1992-2003.

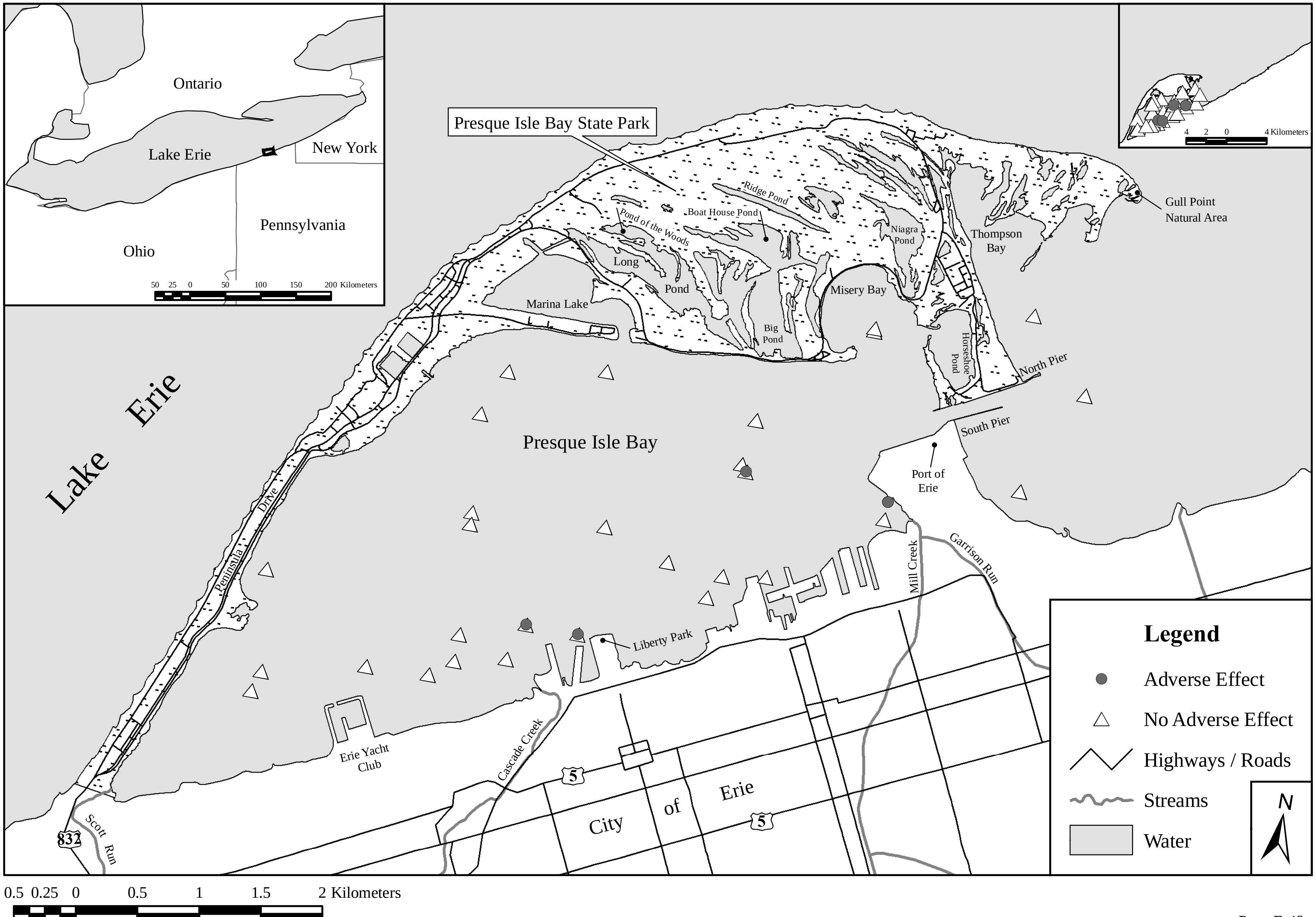


Figure 50. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of fish tissue samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect fish (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds: whole body or fillet fish tissue samples): 1982-1991.

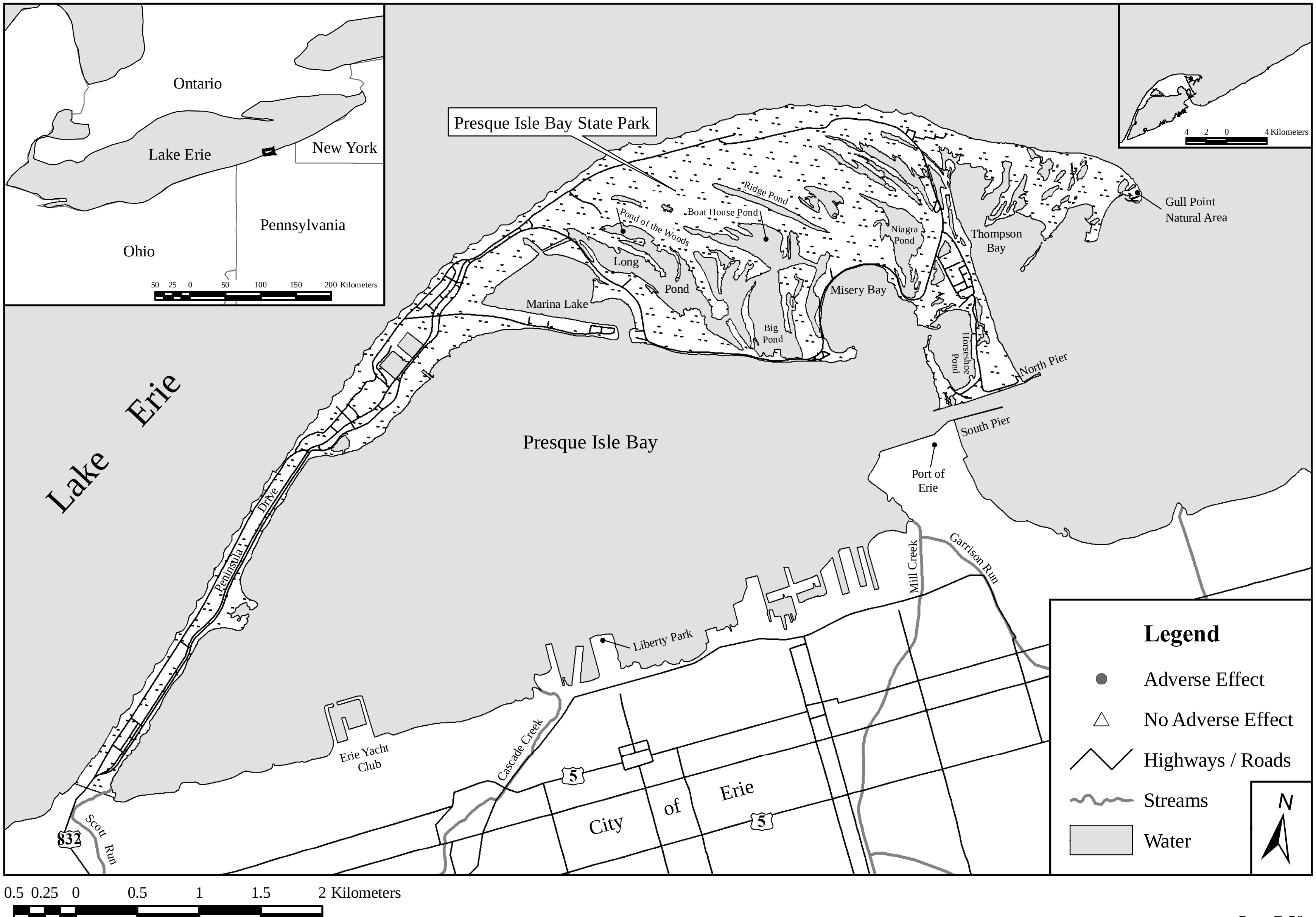


Figure 51. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of fish tissue samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect fish (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for whole body or fillet fish tissue samples): 1992-2003.

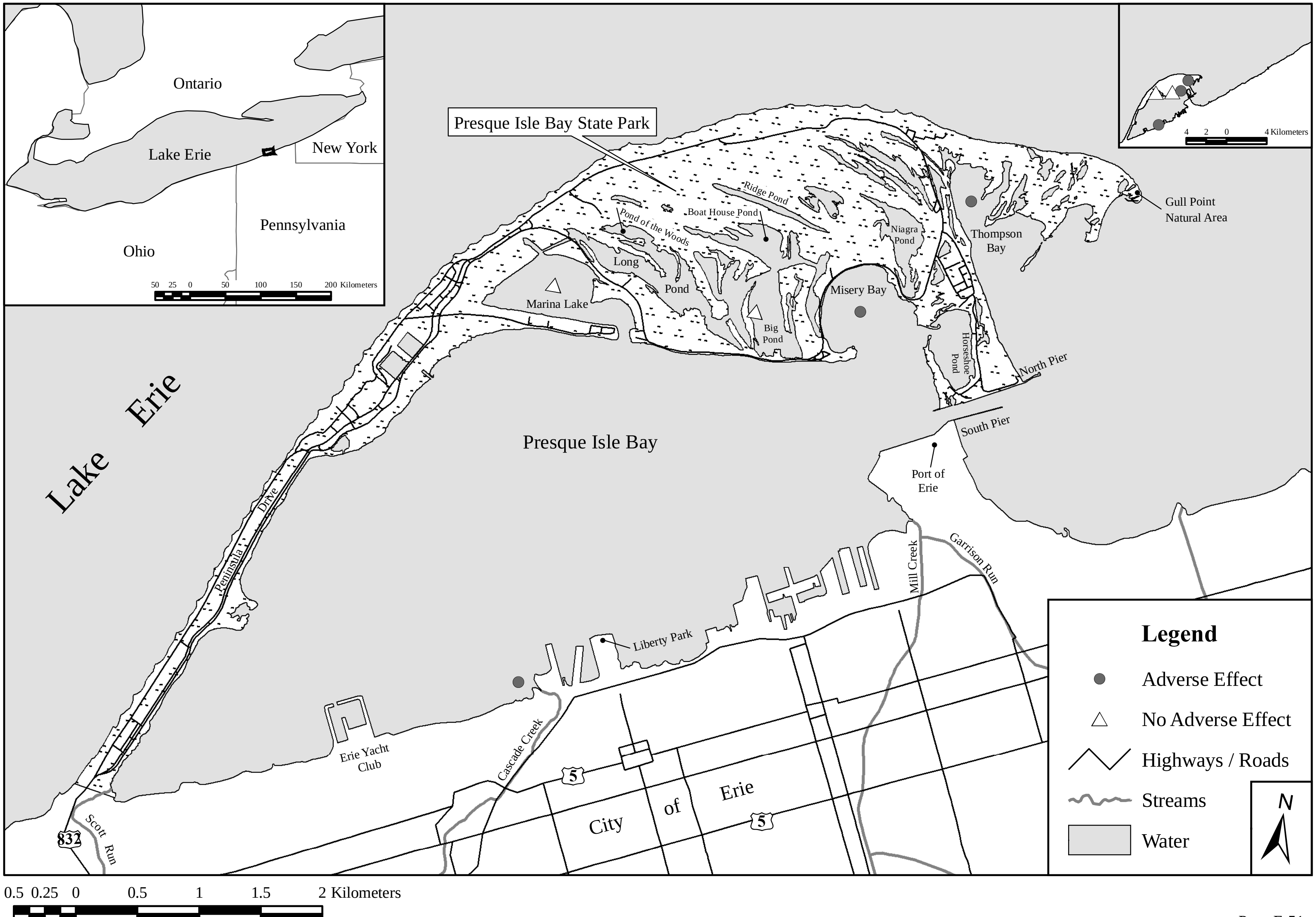


Figure 52. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial whole-sediment samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect aquatic-dependent wildlife (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for whole-sediment samples): 1982-1991.

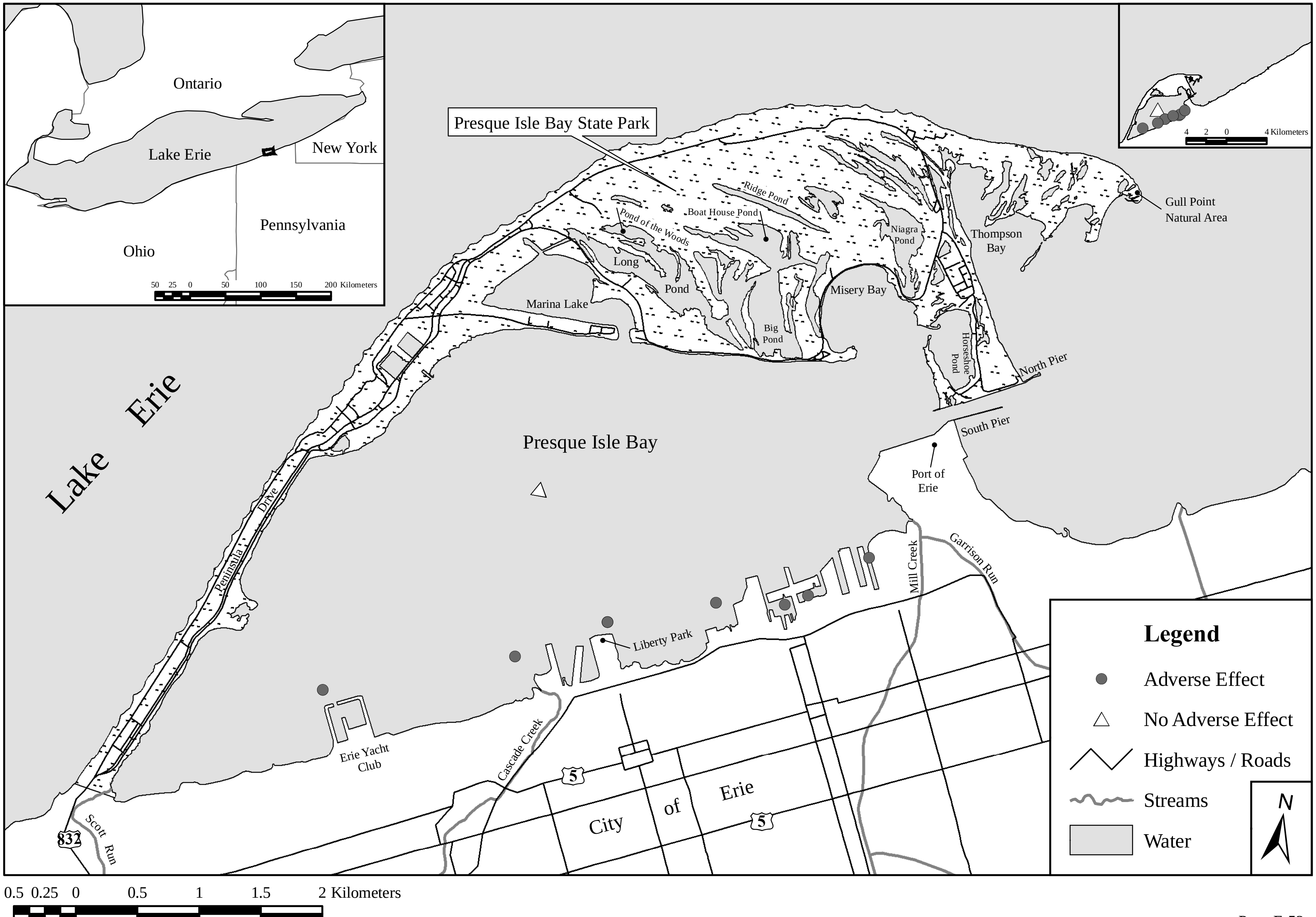


Figure 53. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of sub-surficial whole-sediment samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect aquatic-dependent wildlife (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for whole-sediment samples): 1982-1991.

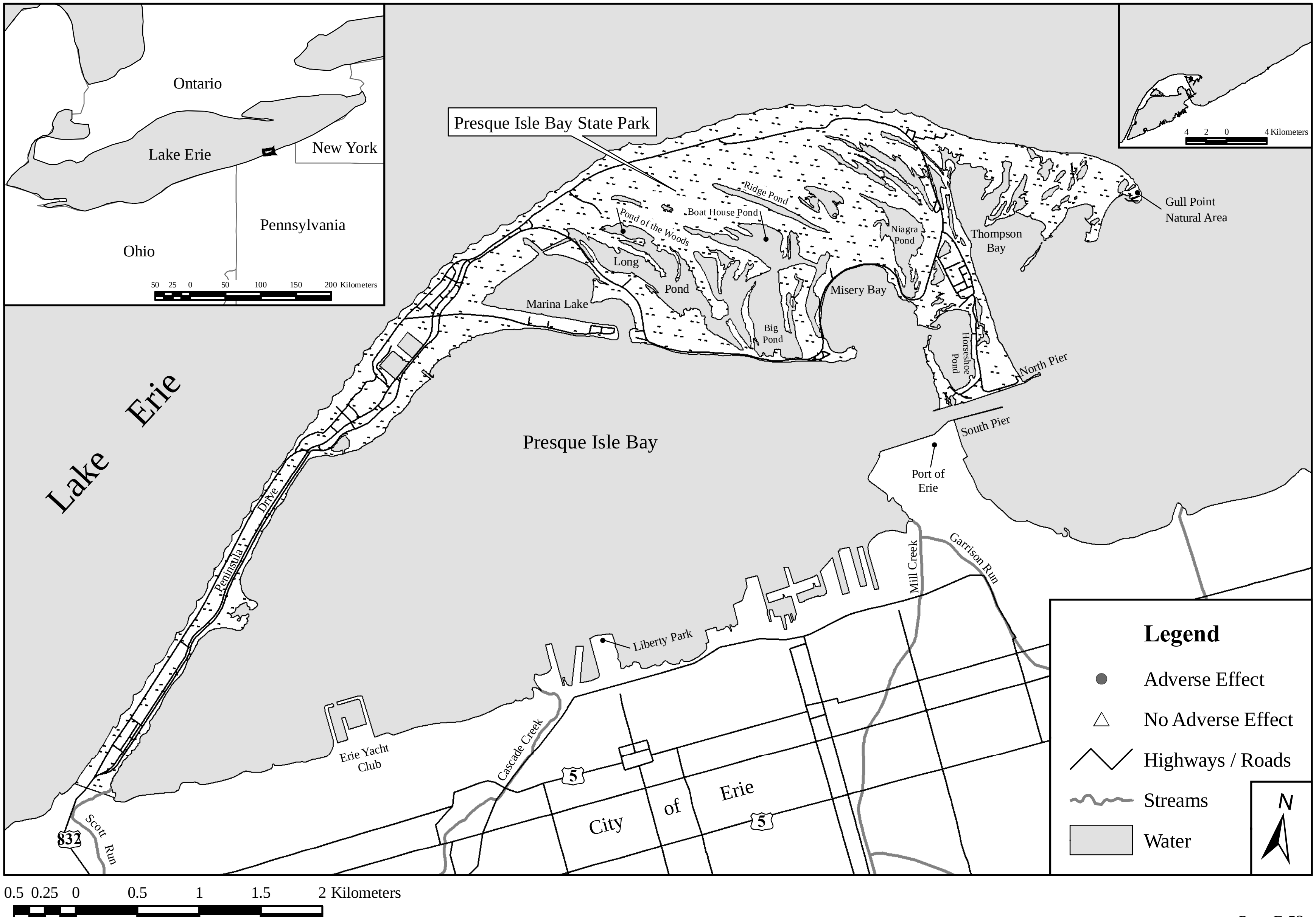


Figure 54. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of surficial whole-sediment samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect aquatic-dependent wildlife (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for whole-sediment samples): 1992-2003.

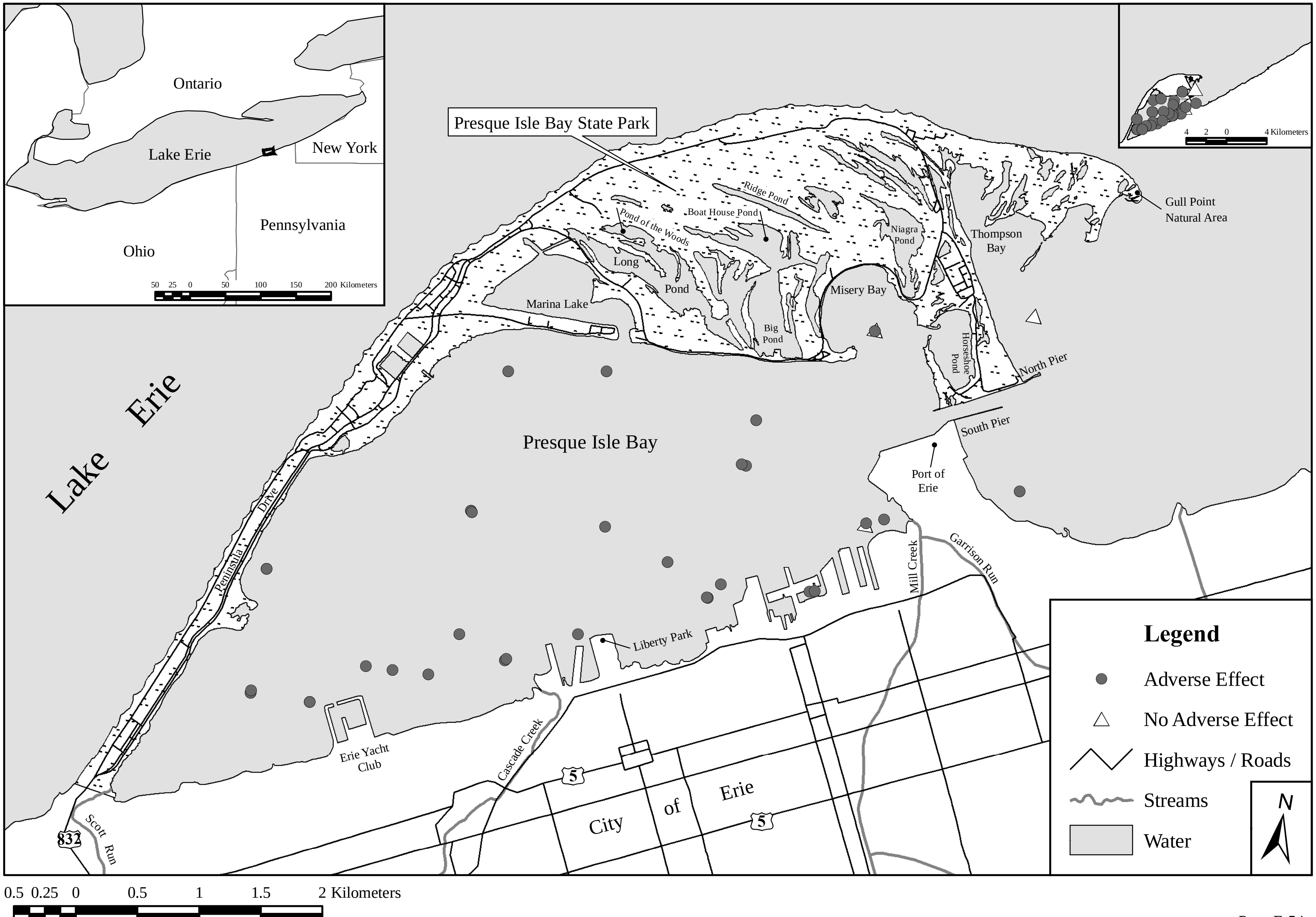


Figure 55. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of sub-surficial whole-sediment samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect aquatic-dependent wildlife (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for whole-sediment samples): 1992-2003.

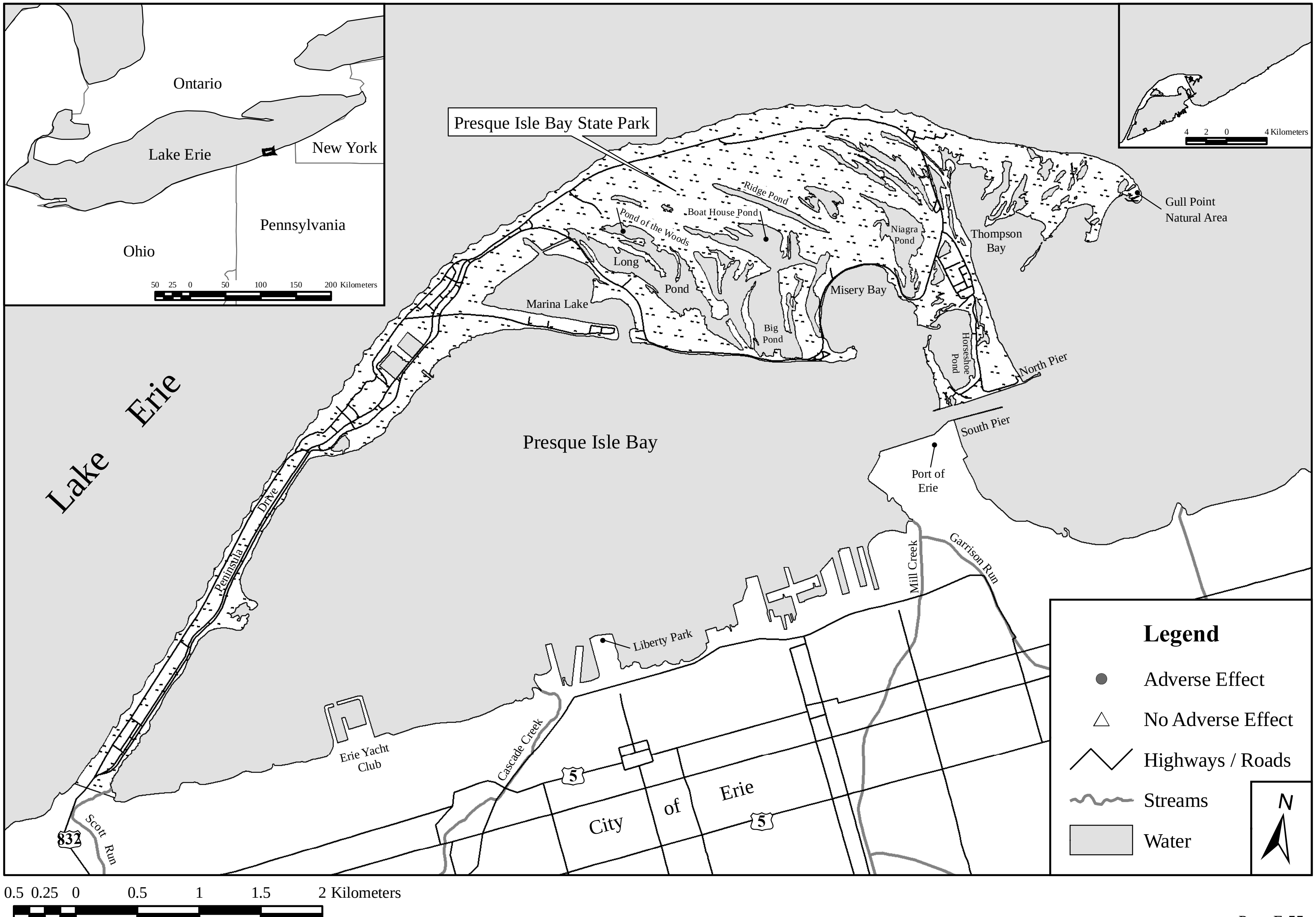


Figure 56. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of fish tissue samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect piscivorous birds (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for fish tissue samples): 1982-1991.

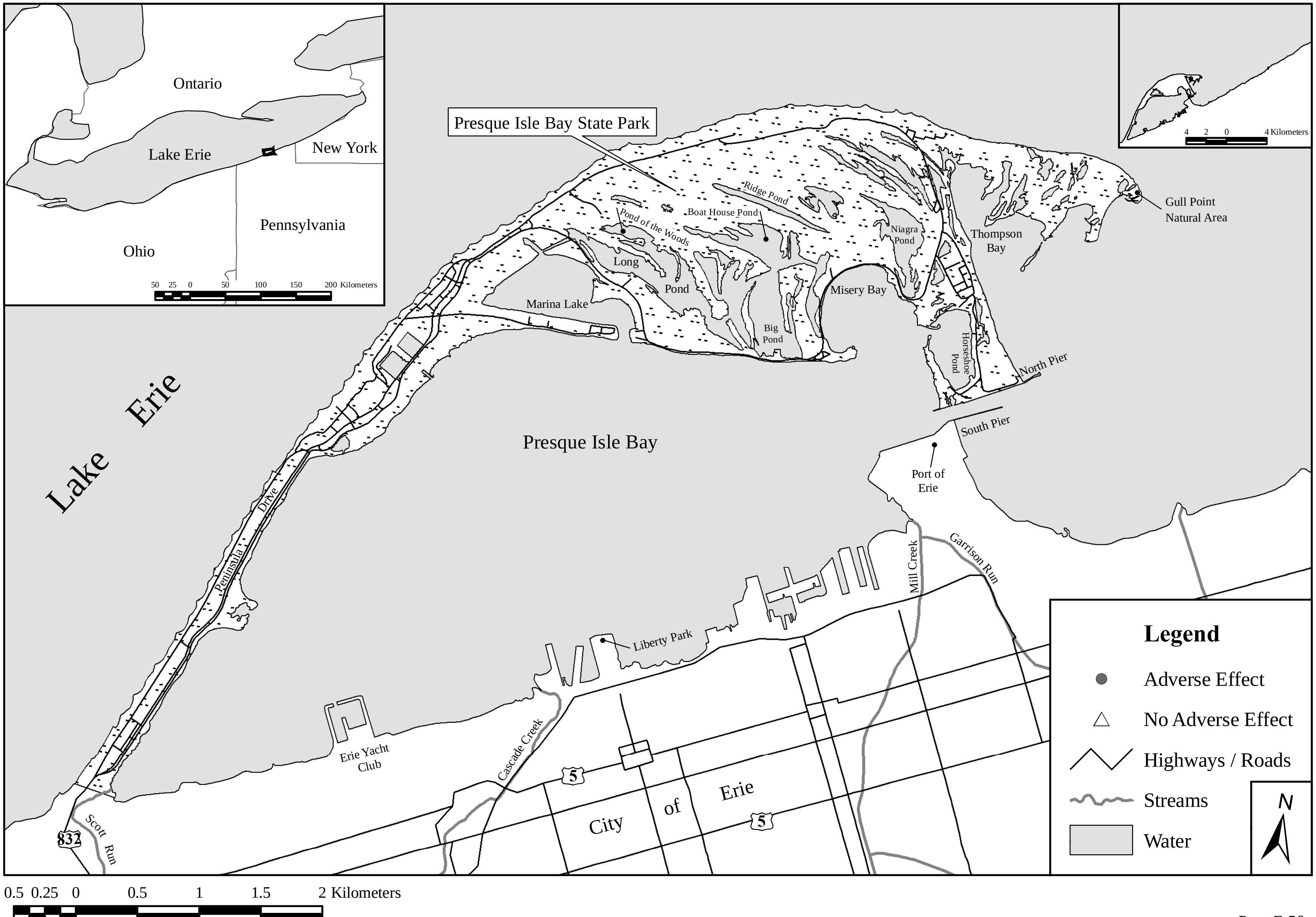


Figure 57. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of fish tissue samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect piscivorous birds (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for fish tissue samples): 1992-2003.

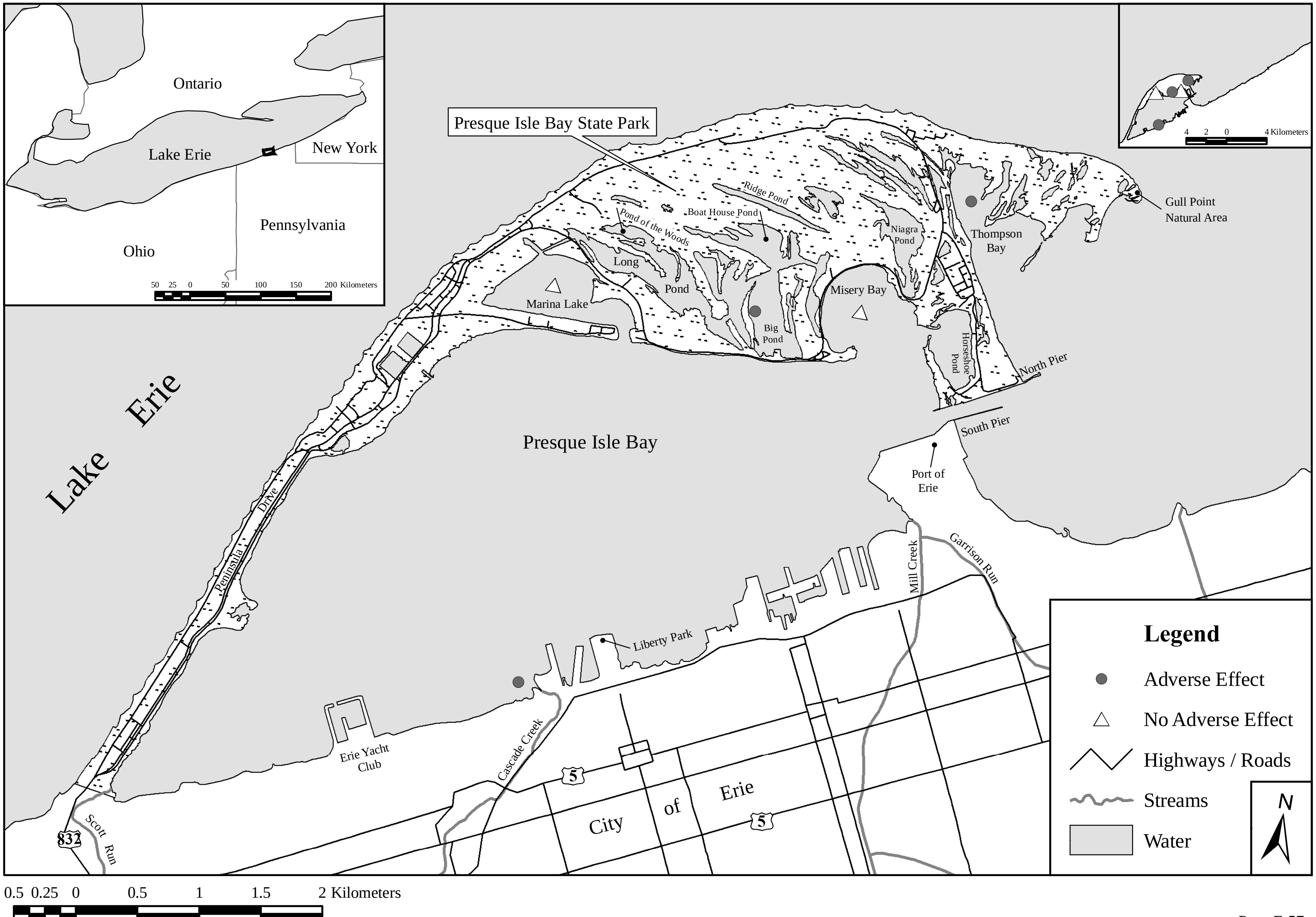


Figure 58. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of fish tissue samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect piscivorous mammals (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for fish muscle tissue samples): 1982-1991.

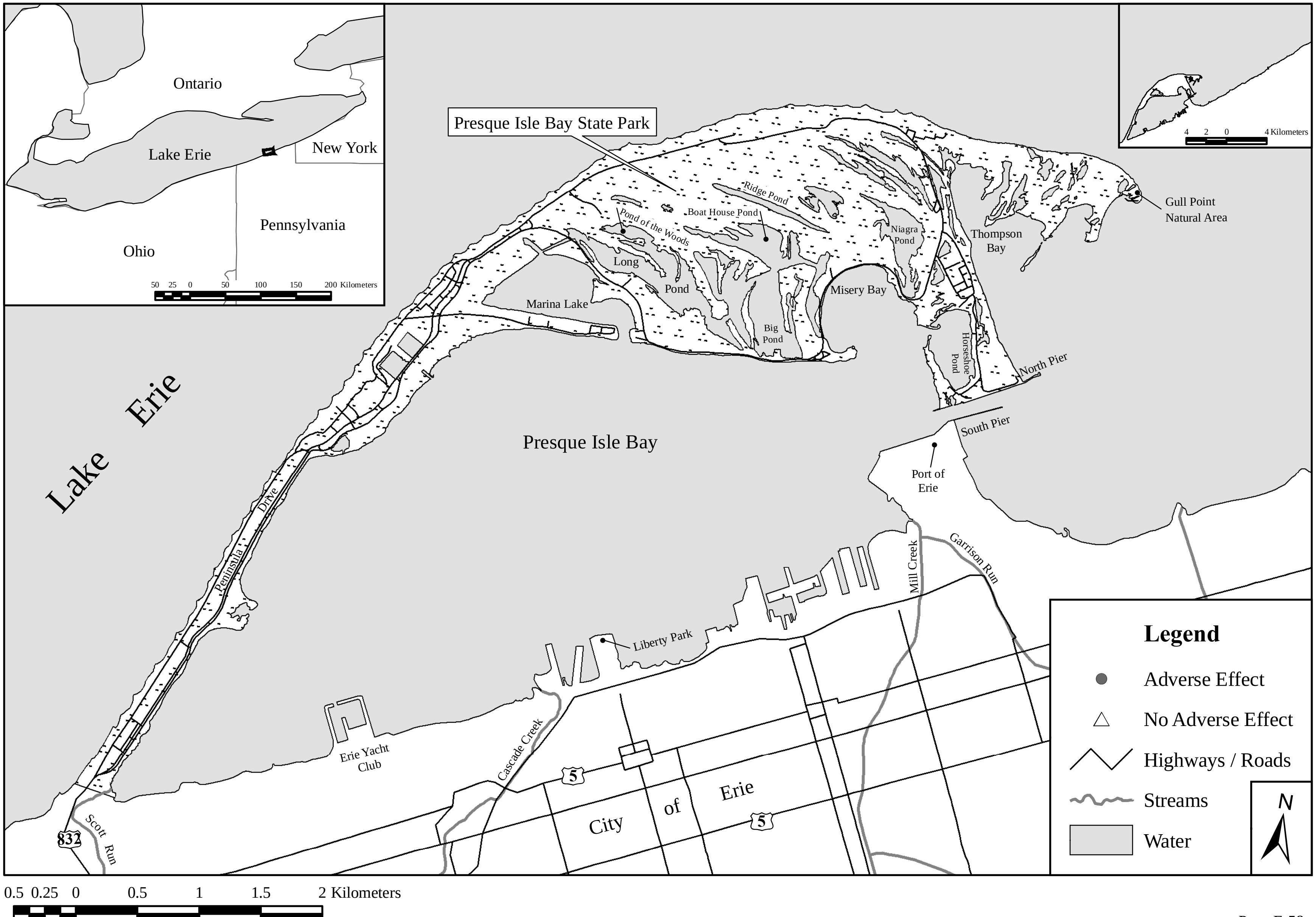


Figure 59. Map of Presque Isle Bay AOC and nearshore areas of Lake Erie showing the distribution of fish tissue samples with concentrations of chemicals of potential concern (COPCs) sufficient to adversely affect piscivorous mammals (i.e., concentrations of one or more COPCs exceed the selected toxicity thresholds for fish muscle tissue samples): 1992-2003.