# Gulfwatch
# 2005 Data Report:

## FIFTEENTH YEAR OF THE GULF OF MAINE ENVIRONMENTAL MONITORING PLAN

*June 2007*

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**Prepared for**
**Gulf of Maine Council on the Marine Environment**
**June 2007**

**By:** Christian Krahforst[1], Stephen Jones[2], Peter Wells[3], Gareth Harding[4], Louise White[5], Peter Hennigar[3], Jamie Aube[3], Guy Brun[3], James Stahlnecker[6], Natalie Landry[7], and Peter Vass[4], and Darrel Taylor[8]

[1] Massachusetts Bays National Estuary Program, Boston, MA, USA;
[2] University of New Hampshire, Durham, NH, USA;
[3] Environment Canada, Atlantic Region, Canada;
[4] Department of Fisheries and Oceans, Maritimes Region, Canada;
[5] Ecosystems Research, Halifax, NS, Canada;
[6] Maine Department of Environmental Protection, Augusta, Maine, USA;
[7] New Hampshire Department of Environmental Services, Concord, NH, USA.
[8] Nova Scotia Environment, Halifax, NS, CA

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# 1.0 INTRODUCTION

This report summarizes the metals and organic contaminant data associated with the collection and analyses of blue mussel (*Mytilus edulis*) tissue from selected sites along the Gulf of Maine Region for 2005. This data is also compared with analytical results from earlier Gulfwatch results beginning in 1993. Statistical analyses are generally limited to fundamental descriptive measures of replicates from each sampling site and include: averages, geometric means, and appropriate measures of variance. The primary purpose of this report is to present the analytical results, show apparent trends in the data, identify potential outliers, and lead users towards further investigations.

## *1.1 PROGRAMMATIC RATIONALE*

The Gulf of Maine is the region of the North Atlantic Ocean that extends from Cape Sable, Nova Scotia, through New Brunswick, Maine, and New Hampshire to Cape Cod, Massachusetts, and includes the Bay of Fundy and Georges Bank. The combined productivity of seaweed, salt marsh grasses, and phytoplankton make it one of the world's most productive ecosystems supporting a vast array of animal species, including some of great commercial importance. Commercial fisheries are region's principal income-generating enterprise. Tourism is also economically important to coastal communities and marine aquaculture is rapidly expanding. Increases in coastal populations and industrial and residential development have contributed to the deteriorating quality of portions of the Gulf's coastal environment (Crawford and Sowles 1992, Dow and Braasch 1996). One important factor resulting from human activities is the steady input of toxic chemicals into the estuarine and coastal environments, despite efforts to improve pollution treatment. Many of these anthropogenic chemicals are bioaccumulated as they transfer through the food chain and have been found in organisms to be elevated above natural levels (Shaw et al., 2003; Aguilar et al., 2002; Weisbrod et al., 2000). Furthermore, some of these environmental contaminants may also be present at toxic concentrations, and thus induce adverse biological effects on productivity, reproduction and survival of marine organisms and humans (Kawaguchi et al. 1999, Wells and Rolston 1991).

To protect water quality and commercial uses in the Gulf of Maine, the *Agreement on the Conservation of the Marine Environment of the Gulf of Maine* was signed in December 1989 by the premiers of Nova Scotia and New Brunswick and the governors of Maine, New Hampshire and Massachusetts; establishing the Gulf of Maine

Council on the Marine Environment. The overarching mission of this council is to maintain and enhance the Gulf's marine ecosystem, its natural resources and environmental quality. To help meet the council's mission statement, The Gulf of Maine Environmental Monitoring Committee was formed and charged with the development of the Gulf of Maine Environmental Monitoring Plan. The monitoring plan is based on a mission statement provided by the Council:

**It is the mission of the Gulf of Maine Environmental Quality Monitoring Program to provide environmental resource managers with information to support sustainable use of the Gulf and allow assessment and management risk to public and environmental health from current and potential threats.**

Three monitoring goals were established to meet the mission statement:

(1) To provide information on the status, trends, and sources of risk to the marine environment in the Gulf of Maine;
(2) To provide information on the status, trends and sources of marine based human health risks in the Gulf of Maine; and
(3) To provide appropriate and timely information to environmental and resource managers that will allow both efficient and effective management action and evaluation of such action.

In support of the mission and as a first step towards meeting the desired goals, the Gulfwatch Program was established to measure exposure to chemical contamination Gulf-wide.

### *1.2 GULFWATCH OBJECTIVES*

Gulfwatch is presently a program in which the blue mussel, *Mytilus edulis*, is used as an indicator for habitat exposure to organic and inorganic contaminants. Bivalves such as *M. edulis* continue to be successfully used as an indicator organism in environmental monitoring programs throughout the world (McIntosh et al., 2004; Glynn et al., 2004; Airas, 2003; Monirith et al., 2003, O'Connor, 2002; NAS, 1980; NOAA, 1991; Widdows and Donkin, 1992; O'Connor and Lauenstein, 2006) to identify variation in chemical contamination between sites, and contribute to the understanding of trends in chemical contamination (NOAA, 1991; O'Connor, 1998; Widdows et al., 1995). The blue mussel was selected as an indicator organism for the Gulfwatch program for the following reasons:

(1) Mussels are abundant within and across each of the 5 jurisdictions (Nova Scotia and New Brunswick, CA; and the U.S. states of Massachusetts, New Hampshire and Maine) bordering the Gulf and they are easy to collect and process.
(2) Blue mussels have been comparatively well studied and reported in the scientific and technical literature.
(3) Mussels are a commercially important human food source and may be used to monitor human exposure to chemical contamination.
(4) Mussels are sedentary, thereby eliminating the complications in interpretation of results introduced by mobile species.
(5) Mussels are suspension feeders that pump large volumes of water and concentrate many chemicals in their tissues. Therefore, the presence of trace contamination is easier to document, and the measurement of chemicals in bivalve tissue provides an assessment of biologically available contamination that is not always apparent from measurement of contamination in environmental matrices such as water, sediment, and suspended particles).

Throughout the history of the program, Gulfwatch has refined its approach to using mussels as bioindicators of anthropogenic contamination. During the first two years of the program (1991 & 1992), both transplanted and native mussels sampled from areas adjacent to the transplant sites were analyzed for organic and inorganic contaminants (GOMC, 1992). Transplanted mussels were initially collected from relatively pristine sites in each jurisdiction, relocated to targeted sites (for a myriad of reasons) and held there for approximately 60 days. Because of the logistics and the analytical costs, however, only two sites per jurisdiction were monitored each year using this transplant technique. Transplants provided an assessment of the short-term exposure to (on the order of weeks to months) whereas sampling of native mussels provided more of an assessment of long-term exposure to bioavailable contaminants (on the order of months to a year). An objective of the first two years (1991 and 1992) of the Gulfwatch program was to evaluate the feasibility of the project crossing both national and state boundaries and the level of cooperation required for collecting comparative data from different locations along the Gulf of Maine. Having met this objective, the program recognized more monitoring sites were needed throughout the Gulf of Maine in order to adequately assess the degree and extent of contamination of the region. As such a sampling scheme involving a three-year rotation of sites was implemented in 1993 and continues to date (with modifications). The sites included in the Gulfwatch monitoring program consists of two general categories; test sites where suspected or known contamination exists, and reference sites that were thought to be free of any known contaminant source. One location in each jurisdiction was designated as a benchmark station and is continually re-sampled each year. The sampling design implemented in 1993 added additional stations thereby increasing the ability to characterize contaminants within the subregions of the coastal Gulf of Maine and the potential for identifying unforeseen environmental contamination. Additionally, transplant experiments were to be conducted at two sites within each jurisdiction during the last year of each three-year sampling cycle. This 3-year cycle was initiated and repeated for the next nine (9) years to allow assessments of both short-term and long-term contaminant exposure of the Gulf of Maine.

In 1996, regional scientists independently conducted a five-year review of the program for the Gulf of Maine Council. The feasibility of continuing transplant studies (Jones et al., 1998) was evaluated and abandoned from the program, citing the cost of performing transplant experiments, the low rate of return, missing data, and complications with the interpretation of the data. In 1998, additional sites in New Hampshire and New Brunswick were added to the program to increase the spatial coverage within the Gulf of Maine and to target subregions where Gulfwatch stations were sparsely distributed. Sampling of the New Hampshire sites was conducted in conjunction with the New Hampshire Gulfwatch program. The New Brunswick sites were located in the Saint John Harbor, adjacent to an urban setting and a region of concern for petroleum and sewage-born contaminants. Expanded sampling in New Hampshire was conducted during the 2005 sampling season. The expanded sampling in New Hampshire conducted during the later part of the 9-year cycle offered an opportunity to evaluate exposure to contaminants at a more local scale with that of the GOM region.

In addition to documenting the level of contaminants in mussel tissue, biological variables, including shell growth and condition index, were determined as a measure of the organism's stress and its relationship to different concentrations of contaminant burden. Growth is often one of the most sensitive measures of the effect of a contaminant on an organism (Sheehan, 1984; Sheehan et al., 1984; Howells et al., 1990). Specifically, shell growth has often been used as a measure of environmental quality and pollution effects. The rate of growth is a fundamental measure of physiological fitness/performance (Widdows and Donkin, 1992; Salazar and Salazar, 1995) and, therefore, a direct integrative measure of impairment to physiology.

Gulfwatch uses the condition index (CI) traditionally engaged by shellfishery biologists (Widdows, 1985) as an indicator of the physiological status of mussels. CI relates the tissue's wet weight to shell volume. Because gonadal weight is a significant contributor to total body weight just prior to spawning, CI generally reflects differences in the reproductive state of sampled mussels. Since gonadal material tends to have low concentrations of metals (LaTouche and Mix, 1981), tissue metal concentrations may be reduced in mussels having a high CI due to ripened gonads. Organic contaminants, however, would tend to partition into both somatic and gonadal lipids, and may be less impacted by changes in CI that are due to the presence of ripe gametes. Variable amounts of ripe gametes have been found in some mussel populations even in late fall (Kimball, 1994) when Gulfwatch sampling occurs. Granby and Spliid (1995) found a significant negative correlation between PAHs and CI but no correlation between PCB or DDE concentration and CI. Regardless, the relationship between CI and contaminant concentrations should be considered in more in depth analyses of GULFWATCH data.

# 2.0 METHODS

## *2.1 2005 SAMPLING LOCATIONS*

The 2005 Gulf of Maine Gulfwatch mussel survey continues the period following the original 9-year sampling design of the Program (see Sowles et al., 1997). With the exception of MEKN, all the other benchmark stations (MASN, MECC, NBHI, and NSDI) were sampled. And all of the other sites visited in 2005 have now been sampled more than three times and provide added value to temporal analyses of Gulfwatch data. A total of 17 stations were sampled in 2005. Two additional sites were again sampled in New Hampshire for contaminants in clams and oysters: NHMG and NHNI, respectively. These New Hampshire sites are sampled as part of the New Hampshire Gulfwatch Program and are included as a preliminary comparative measure of contaminant accumulation in other organisms. The stations sampled during the 2005 season are presented in Table 1 with reference to site locations in Fig. 1.

## *2.2 FIELD AND LABORATORY PROCEDURES*

Details regarding the mussel collection, measurement, and sample preparation are published in Sowles et al. (1997) and are summarized briefly here. Gulfwatch attempts to control confounding variables by collecting organisms within a specific size range, at the same site, at similar tidal levels and similar times of the year after major spawning has occurred. The mussels collected were intended to be *Mytilus edulis*. However, a related species, *Mytilus trossulus*, was identified in some Bay of Fundy samples (Mucklow, 1996). Gulfwatch results could be confounded by inadvertent selection of the wrong species by field personnel. To alleviate this problem, a description of *M. edulis* was developed for the Gulfwatch program using shell criteria such as length:height ratio, internal color, weight, and location and size of the adductor scars (Jones et al., 1998).

Field sampling occurred between October and mid-November. Mussels were collected from four discrete areas within a segment of the shoreline to be representative of mussel bed at each site. Using a polycarbonate gauge or a ruler, four (4) replicates of 45-50 mussels having 50-60 mm shell length were placed in field containers and transported in coolers with ice packs to labs for processing. One half of those mussels predestined for organic analysis were wrapped in pre-combusted aluminum foil prior to placing in field containers. Mussels were not depurated prior to processing.

From each replicate (typically 4 for each Gulfwatch station), soft tissue from 20 mussels were combined to form a composite for trace metals and an additional 20 for the analyses of organic contaminants. Mussels were washed with DI water in the laboratory to remove any external growth, sediment and debris. Excess seawater was removed from their mantles. Individual mussels were then measured to the nearest 0.1mm for length (anterior umbo to posterior growing lip) and their soft tissue was removed and combined in their respective organic or metals composite. In addition to shell length, shell height, width (mm), and soft tissue wet weight (to the nearest 0.01g) were typically performed on three (3) subsets of ten mussels destined for the metal analysis composite to allow for the calculation of CI. The CI was calculated using the following formula (after Seed, 1968):

*Condition index (CI) = wet tissue weight (mg) / [length (mm) * width (mm) * height (mm)]*

All samples for trace metal and organic contaminant analysis were placed in pre-cleaned or quality-assured bottles (Sowles et al., 1997). These composite samples (20 mussels/composite; 4 composites/station) were capped, labelled and stored at -15°C for 3-6 months prior to analysis. Gulfwatch sample identification numbers, field replicates, species and dates collected are summarized in Appendix A.

**TABLE 1.** Gulf of Maine Gulfwatch study site locations sampled in 2005.

| Jurisdiction | Site Code | **Site Name** | **Site Type** | **W Longitude (decimal degrees)** | **N Latitude (decimal degrees)** |
|---|---|---|---|---|---|
| **Massachusetts** | | | | | |
| | MASN | Sandwich | Benchmark | 70.4789 | 41.7639 |
| | MAPY | Plymouth – Manomet Point | 3-year rotation | 70.5383 | 41.9283 |
| **New Hampshire** | | | | | |
| | NHMG | Middle Ground (*clam samples*) | Expanded GULFWATCH | 70.8900 | 42.8233 |
| | NHHS | Hampton/Seabrook Harbor | 3-year rotation | 70.8163 | 42.8972 |
| | NHNM | North Mill Pond | Occasional | 70.7600 | 43.0750 |
| | NHDP | Dover Point | 3-year rotation | 70.8267 | 43.1196 |
| | NHNI | Nannie Island (*oyster samples*) | Expanded GW | 070.8471 | 43.1344 |
| **Maine** | | | | | |
| | MECC | Clark's Cove | Benchmark | 70.7244 | 43.0774 |
| | MEPH | Portland Harbor | 3-year rotation | 70.2590 | 43.6392 |
| | MERY | Royal River | 3-year rotation | 70.1455 | 43.7970 |
| | MEFP | Penobscot River | 3-year rotation | 68.8102 | 44.4695 |
| | MEPI | Pickering Island | 3-year rotation | 68.7332 | 44.2605 |
| **New Brunswick** | | | | | |
| | NBHI | Hospital Island | Benchmark | 67.0082 | 45.1205 |
| | NBTC | Tin Can Beach | Occasional | 66.0570 | 45.2625 |
| **Nova Scotia** | | | | | |
| | NSBC | Broad Cove | 3-year rotation | 65.8308 | 44.6653 |
| | NSDI | Digby | Benchmark | 64.7523 | 44.6170 |
| | NSBP | Barrington Passage | Occassional | 65.6342 | 43.5217 |

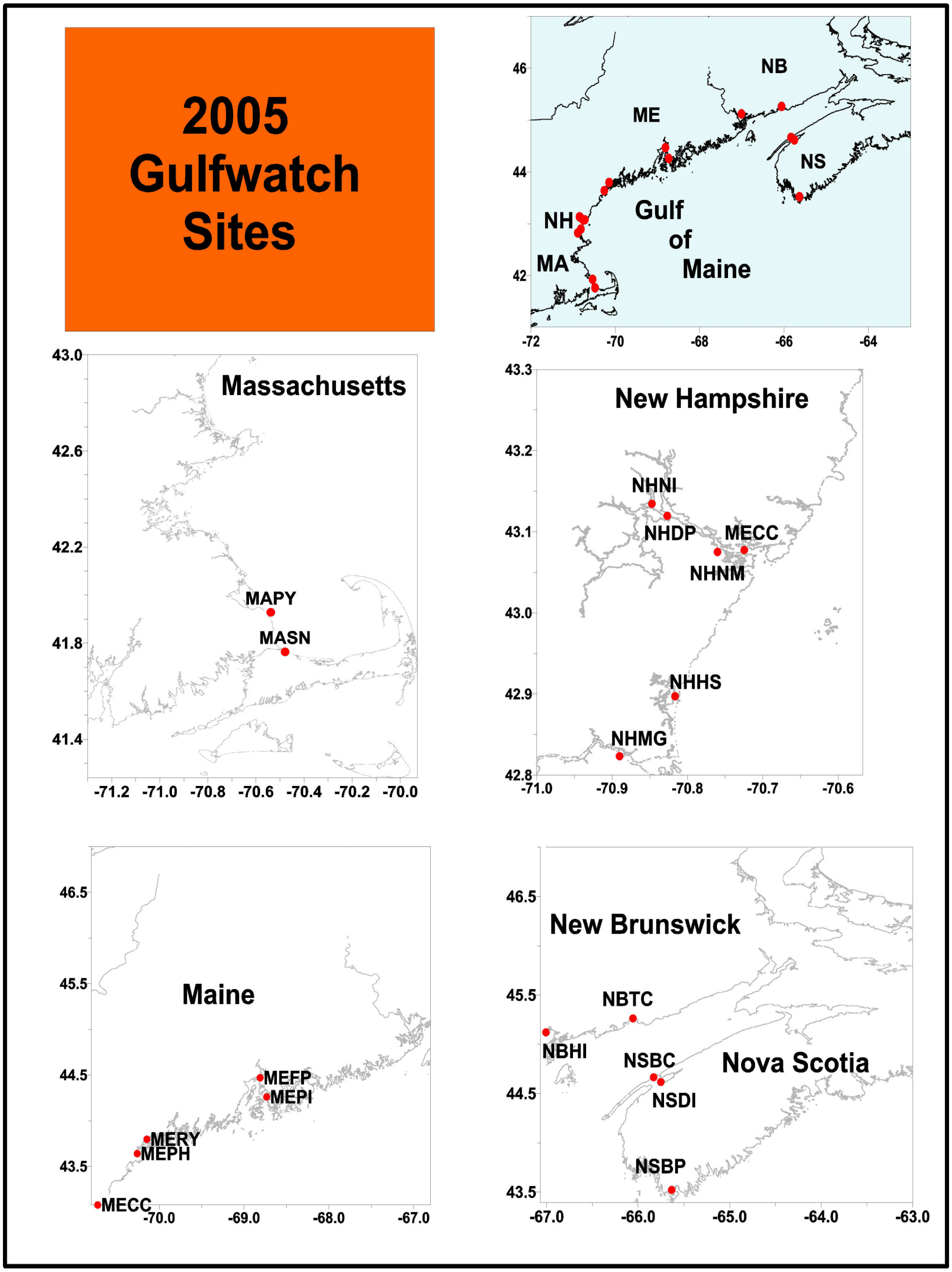


**Figure 1.** Locations along the Gulf of Maine of Gulfwatch sampling sites, 2005.

## *2.3 Analytical Procedures*

Analytical procedures used followed those reported for the previous years (Jones et al. 1998, Chase et al., 2001). An overview of the analytical methods used for the 2005 samples for both organic and inorganic analytes is detailed below. Table 2 contains a summary of trace metal and organic compounds determined from tissue samples of collected organisms (primarily *M. edulis*).

### 2.3.1 Metals

Samples collected during 2005 were analyzed by Battelle Marine Sciences Laboratory (MSL, Sequim, WA) for inorganic contaminants. The samples were analyzed for the requisite ten metals: silver (Ag), aluminum (Al), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn).

Digested samples were analyzed for Hg by cold-vapor atomic absorption spectroscopy (CVAA) according to Battelle SOP MSL-I-016 *Total Mercury in Tissues and Sediments by Cold Vapor Atomic Absorption*, which is based on EPA Method 245.6 *Determination of Mercury in Tissue by Cold Vapor Atomic Absorption Spectrometry*. Digested samples were analyzed for Al, Cr, Cu, Fe, Ni, and Zn using inductively coupled plasma optical emissions spectroscopy (ICP-OES) according to Battelle SOP MSL-I-033 *Determination of Elements in Aqueous and Digestate Samples by ICP-OES*. This procedure is based on two methods (EPA Method 6010B and 200.7) modified and adapted for analysis of low level samples. Digested samples were analyzed for Ag, Cd, and Pb using inductively coupled plasma-mass spectrometry (ICP-MS) according to Battelle SOP MSL-I-022, *Determination of Elements in Aqueous and Digestate Samples by ICP/MS*. This procedure is based on two methods modified and adapted for analysis of low-level solid sample digestates: EPA Method 1638, *Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma-Mass Spectrometry* and EPA Method 200.8, *Determination of Trace Elements in Water and Wastes by Inductively Coupled Plasma – Mass Spectrometry.* Method detection limits (MDL) reported by MSL for the metals, in most cases, were greater than an order of magnitude lower than HETL . The MSL reported MDLs (µg/g dry weight) were as follows; Ag, 0.01; Cd, 0.01; Cr, 0.05; Cu, 0.1; Fe, 1.5; Hg, 0.005; Ni, 0.05; Pb, 0.02; and Zn, 0.3; Al, 0.5. A summary of method detection limits and reporting limits are further presented in Appendix B. A copy of the MSL QA/QC report is reprinted in end of Appendix C (Section C5).

### 2.3.2 Organic Contaminants

Organic contaminants in  mussel samples were analyzed at the Environment Canada Environmental Quality Laboratory in Moncton, New Brunswick. The analyte detection limits ranged from 4 -15 ng/g for polycyclic aromatic hydrocarbons and from 1-4 ng/g for PCB congeners and chlorinated pesticides (Appendix D). Eighteen of the PCB congeners identified and quantified correspond to congeners monitored by the National Oceanographic and Atmospheric Administration's (NOAA) National Status and Trends (NS&T) Program in the U.S.A. Other organic compounds (i.e., PAH and organochlorine compounds) selected for analysis are also consistent, for the most part, with NOAA National Status and Trends mussel monitoring (NOAA, 1989).

A description of the full analytical protocol and accompanying performance based QA/QC procedures are found in Sowles et al. (1997), and more comprehensively in Jones et al. (1998). Briefly, tissue samples were extracted by homogenization with an organic solvent and a drying agent. Solvent extracts were obtained by vacuum filtration, and biomatrix interference was separated from target analytes in extracts through size exclusion chromatography. Purified extracts were subjected to silica gel liquid chromatography, which provided a non-polar PCB/chlorinated pesticides fraction and a polar chlorinated pesticide fraction. PCBs and pesticides were analyzed by high-resolution dual column gas chromatography/electron capture detection (HRGC/ECD). Following PCB and pesticide analysis, the two fractions were combined and the resulting extract was analyzed for aromatic hydrocarbons by high-resolution gas chromatography/mass spectrometry (HRGC/MS).

**TABLE 2.** Inorganic and organic compounds analyzed in mussel tissue from the Gulf of Maine, 2005.

| INORGANIC CONTAMINANTS | | |
|---|---|---|
| Metals<br>Ag, Al, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Zn | | |
| ORGANIC CONTAMINANTS | | |
| *Aromatic Hydrocarbons($\Sigma PAH_{24}$)* | *Chlorinated Pesticides* | |
| Naphthalene | Hexachlorobenzene (HCB) | |
| 1-Methylnaphthalene | γ-Hexachlorocyclohexane (γ-HCH) | |
| | α-Hexachlorocyclohexane (γ-HCH) | |
| 2-Methylnaphthalene | Heptachlor | |
| Biphenyl | Heptachlor epoxide | |
| 2,6-Dimethylnaphthalene | Aldrin | |
| Acenaphthylene | cis-Chlordane | |
| | γ-Chlordane | |
| Acenaphthalene | trans-Nonachlor | |
| 2,3,5-Trimethylnaphthalene | Dieldrin | |
| Fluorene | α-Endosulfan | |
| Phenanthrene | β-Endosulfan | |
| Anthracene | Endrin | |
| | Metoxychlor | |
| 1-Methylphenanthrene | | |
| Fluoranthene | *DDT and Homologues* | |
| Pyrene | 2,4’-DDE | 4,4’-DDE |
| Benzo [a] anthracene | 2,4’-DDD | 4,4’-DDD |
| Chrysene | 2,4’-DDT | 4,4’-DDT |
| Benzo [b] fluoranthene | | |
| Benzo [k] fluoranthene | *PCB Congeners ($\Sigma PCB_{22}$)* | |
| Benzo [e] pyrene | PCB 8, PCB 18, PCB 28, PCB 29, | |
| | PCB 44, PCB 50, PCB 52, PCB 66, | |
| Benzo [a] pyrene | PCB 77, PCB 87, PCB 101, PCB 105, | |
| Perylene | PCB 118, PCB 128, PCB 138, PCB 153, | |
| Indo [1,2,3-cd] pyrene | PCB 170, PCB 180, PCB 187, PCB 195, | |
| Dibenze [a,h] | PCB 206, PCB 209 | |
| anthracene Benzo | | |
| [g,h,I] perylene | | |

## 2.4 *QUALITY ASSURANCES / QUALITY CONTROL*

Standard operating procedures for the analysis of mussel samples and related laboratory quality control performance criteria are described in *Gulfwatch Project Standard Procedures: Field and Laboratory (GOMCME August 1997).* Quality assurance provisions described in the manual serve as a guide for the generation of acceptable analytical data for the Gulfwatch program. The quality control results, when compared to Gulfwatch data quality objectives, also present users of the data measures of accuracy and precision among the sampling years as well as a comparative measure with that of other environmental contaminant monitoring programs.

Appendix C contains the trace metal contaminant QC sample results and a brief QA/QC summary for the 2005 Gulfwatch samples, and Appendix D contains the organic contaminant QC sample results and summary for the 2005 Gulfwatch samples. Laboratory QC measures reported in Appendices C and D include procedural blanks, duplicate sample analyses, contaminant surrogate sample spikes, sample matrix spikes, and the analysis of certified reference material. The analytical laboratory performance of the 2005 National Institute of Standards and Technology organic contaminants intercalibration exercise (Schantz et al., 2006) is also summarized in Appendix D.

## 2.5 *STATISTICAL METHODS AND DATA ANALYSIS*

Total PAH ($\Sigma PAH_{24}$), total PCB ($\Sigma PCB_{24}$) and total chlorinated pesticides ($\Sigma TPEST_{21}$) values were calculated from the sum of all individual compounds or congeners that had values greater than the detection limit for the compound. Beginning in 2002, Gulfwatch included four additional pesticides (α-HCH, γ-Chlordane, endrin, and metoxychlor) in the analyses of organic contaminants. Total DDT ($\Sigma DDT_6$) is the sum of 2,4-DDT and 4,4-DDT and homologues (2,4-DDE, 4,4-DDE, 2,4-DDD and 4,4-DDD). Several tissue samples for metals and organics were below the detection level. Variables in which all replicate measurements were below the detection limit were treated as zero and recorded as not-detected (ND). However, if at least two of the replicates were greater than the detection limit, then the other replicates were treated as having a value equal to ½ the method detection limit (MDL).

From each site, arithmetic means, standard deviations (SD) and geometric means were calculated for all metal and organic contaminants. Analytical replicates (e.g., repeat analyses of a field replicate) were not used in the computation of the above statistical parameters. Graphs of the mean concentrations (±SD) are presented for all stations sampled. For comparative purposes in Section 3 (Results and Discussion), Gulfwatch data is compared with the geometric mean plus the $85^{th}$ percentile of *M. edulis* data from the National Status and Trends' Musselwatch Program (NS&T) of the National Ocean and Atmospheric Administration. For interpretive purposes, Clark Cove, Maine (MECC) serves as the benchmark site for the group of New Hampshire sites because of its location in the Great Bay / Piscataqua River watershed and, therefore, is more comparable to the other sites in New Hampshire. Gulfwatch data for the stations sampled in 2005 are summarized beginning from 1993 in graphic form, along with all annual data for the 5 benchmark sites, in order to help evaluate general temporal trends of contaminant exposure along the rim of the Gulf of Maine.

# 3.0 RESULTS AND DISCUSSION

## *3.1 FIELD OPERATIONS AND LOGISTICS*

Sampling of *Mytilus edulis* from the traditional 3-year rotational stations continued in 2005 (Table 3). As mentioned in the previous section, two additional sites were sampled in New Hampshire during 2005 for soft-shell clams and oysters (NHMG and NHNI, respectively) and analyzed for contaminants along with the traditional blue mussel tissue samples. Several stations (i.e. "Benchmark Stations") along the Gulfwatch region have now been visited annually from 1993-2005 and many of the "3-year Rotational" sites have now been revisited at least four (4) times over the 12 years of the Program. Overall, mussels were collected at 15 sites in 2005. Mussels from each station - at four (4) locations within each site - were collected and processed (prepared soft tissue composites of each station replicate; measured for linear dimensions and wet weight for the determation of Condition Index) by volunteers from each jurisdiction. (See section 2.2.). The tissue composites were frozen and delivered to the University of New Hampshire prior to shipping to the analytical laboratories. (Note, the Canadian samples desitined for organic analyses were delivered directly to Environmental Canada in Moncton, since the organic analyses are performed there.) Appropriate field and initial sample preparation information from each jurisdiction were forwarded to the Program Coordinators shortly after collection and composite preparations.

**TABLE 3.** List of Stations sampled in 2005 along with the years previously visited.

| Massachusetts | Site Name | Years Sampled: 1993 - 2005 |
|---|---|---|
| MAPY | Plymouth - Manomet Point | 1993, 1999, 2002, 2005 |
| MASN | Sandwich | 1993 - 2005 |
| **New Hampshire** | | |
| NHMG | Middle Ground - *Clams* | 2001, 2002, 2005 |
| NHHS | Hampton / Seabrook Estuary | 1993, 1995, 1996, 1999-2005 |
| NHNM | North Mill Pond | 1998, 2000, 2002, 2005 |
| NHDP | Dover Point | 1994, 1996[⊥], 1997, 1998, 2000-2005 |
| NHNI | Nannie Island | 2001, 2002, 2005 |
| MECC | Clarks Cove ME | 1993 -2005 |
| **Maine** | | |
| MEPH | Portland Harbor | 1994, 1997, 2000, 2003, 2005 |
| MERY | Royal River | 1993, 1996, 1999, 2002, 2005 |
| MEFP | Penobscot River | 1993, 1996, 1999, 2002, 2005 |
| MEPI | Pickering Island | 1993, 1996, 1999, 2002, 2005 |
| **New Brunswick** | | |
| NBHI | Hospital Island | 1993 - 2005 |
| NBTC | Tin Can Beach | 1998, 2004, 2005 |
| **Nova Scotia** | | |
| NSDI | Digby | 1993, 1994, 1996 - 2005 |
| NSBC | Broad Cove | 1993, 1996, 1999, 2002, 2005 |
| NSBP | Barrington Passage | 1994, 2005 |

### *3.2 TRACE METAL CONCENTRATIONS*

Table 4 contains the metal concentrations summaries (geometric and arithmetic means ± SD, µg/g dry weight) for mussels from all site composites taken in 2005. All summary statistics were generated using the field replicate values. In most cases there were four field replicates taken from each site. Analyses of some of the samples yielded concentrations at or below method detection limits (MDL). Metal and organic contaminants concentrations for each individual composite sample (field replicates) are further detailed in Appendix E.

In addition, metal concentrations for all mussels are also reported as medians (MD) plus the $85^{th}$ percentile ($85^{th}$ P) in Table 5 to allow for a program-level comparison with NOAA National Status and Trends (NS&T) concentrations. Table 6 provides the median and the 85th percentile data of the national Mussel Watch data from the years 1991 through 1996 (O'Connor, 1998; http://ccmaserver.nos.noaa.gov/) and, for reported metals for 2005. Most of the summarized Gulfwatch metals concentrations were comparable to the NS&T MD + 85th P summary data, with the exception of some of the samples for Pb and Hg.. Pb and Hg in Gulfwatch samples, both of which are thought to have significant atmospheric component to their loading to the Gulf of Maine, have typically been elevated compared to NOAA NS&T data.

**TABLE 4**. Summary of tissue metal concentrations (μg $g^{-1}$ dry wt) for Gulfwatch mussels in 2005. The arithmetic mean ($M_A$ ± SD) and geometric mean ($M_G$) of all indigenous mussels is given; (n=4 replicates/sample). All summary statistics were computed from all individual replicate data points.

| Site | | Ag | Cd | Cr | Cu | Fe | Ni | Pb | Zn | Al | Hg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MASN | $Mean_A$ | 0.379 | 1.06 | 1.15 | 7.05 | 472 | 1.10 | 4.01 | 92 | 475 | 0.115 |
| | SD | 0.082 | 0.09 | 0.12 | 0.28 | 132 | 0.09 | 0.38 | 4 | 282 | 0.007 |
| | $Mean_G$ | 0.372 | 1.05 | 1.14 | 7.05 | 459 | 1.10 | 4.00 | 92 | 426 | 0.115 |
| MAPY | $Mean_A$ | 0.267 | 1.69 | 1.71 | 7.83 | 503 | 1.45 | 4.01 | 116 | 357 | 0.209 |
| | SD | 0.197 | 0.06 | 0.12 | 2.02 | 29 | 0.08 | 0.08 | 22 | 32 | 0.009 |
| | $Mean_G$ | 0.227 | 1.69 | 1.70 | 7.67 | 502 | 1.45 | 4.01 | 114 | 356 | 0.208 |
| NHHS | $Mean_A$ | 0.041 | 2.14 | 1.28 | 6.27 | 374 | 0.94 | 2.01 | 117 | 376 | 0.152 |
| | SD | 0.007 | 0.20 | 0.14 | 0.30 | 70 | 0.03 | 0.41 | 7 | 145 | 0.002 |
| | $Mean_G$ | 0.040 | 2.13 | 1.28 | 6.26 | 369 | 0.94 | 1.98 | 117 | 355 | 0.152 |
| NHNM | $Mean_A$ | 0.073 | 2.71 | 1.88 | 7.94 | 474 | 1.32 | 3.84 | 162 | 243 | 0.358 |
| | SD | 0.008 | 0.09 | 0.12 | 0.71 | 134 | 0.06 | 0.29 | 17 | 22 | 0.022 |
| | $Mean_G$ | 0.072 | 2.70 | 1.87 | 7.91 | 462 | 1.32 | 3.83 | 161 | 243 | 0.358 |
| NHDP | $Mean_A$ | 0.048 | 2.52 | 2.67 | 6.71 | 465 | 1.53 | 2.07 | 128 | 308 | 0.336 |
| | SD | 0.005 | 0.10 | 0.31 | 0.09 | 33 | 0.42 | 0.09 | 10 | 28 | 0.015 |
| | $Mean_G$ | 0.048 | 2.52 | 2.66 | 6.71 | 464 | 1.50 | 2.06 | 128 | 307 | 0.336 |
| MECC | $Mean_A$ | 0.044 | 2.17 | 2.34 | 6.64 | 571 | 1.35 | 4.09 | 133 | 433 | 0.304 |
| | SD | 0.003 | 0.24 | 0.16 | 0.59 | 28 | 0.10 | 0.92 | 9 | 16 | 0.034 |
| | $Mean_G$ | 0.043 | 2.16 | 2.34 | 6.62 | 570 | 1.35 | 4.01 | 133 | 433 | 0.303 |
| MEPH | $Mean_A$ | 0.046 | 1.89 | 1.76 | 8.64 | 761 | 1.39 | 6.58 | 160 | 464 | 0.286 |
| | SD | 0.012 | 0.16 | 0.27 | 0.99 | 262 | 0.28 | 0.64 | 17 | 152 | 0.052 |
| | $Mean_G$ | 0.045 | 1.88 | 1.74 | 8.60 | 728 | 1.37 | 6.55 | 159 | 445 | 0.282 |
| MERY | $Mean_A$ | 0.040 | 1.34 | 1.78 | 7.58 | 761 | 1.45 | 1.88 | 99 | 994 | 0.135 |
| | SD | 0.003 | 0.13 | 0.17 | 0.40 | 72 | 0.16 | 0.25 | 10 | 149 | 0.012 |
| | $Mean_G$ | 0.040 | 1.33 | 1.77 | 7.57 | 759 | 1.44 | 1.87 | 98 | 986 | 0.135 |
| MEFP | $Mean_A$ | 0.055 | 2.48 | 2.39 | 6.54 | 750 | 1.59 | 2.24 | 90 | 496 | 0.568 |
| | SD | 0.012 | 0.12 | 0.04 | 0.36 | 37 | 0.07 | 0.19 | 5 | 62 | 0.015 |
| | $Mean_G$ | 0.054 | 2.47 | 2.39 | 6.53 | 750 | 1.59 | 2.24 | 90 | 493 | 0.568 |

**TABLE 4.** (Continued)

| Site | | Ag | Cd | Cr | Cu | Fe | Ni | Pb | Zn | Al | Hg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MEPI | $Mean_A$ | 0.055 | 2.00 | 1.51 | 5.33 | 449 | 1.36 | 1.52 | 91 | 420 | 0.156 |
| | SD | 0.007 | 0.31 | 0.09 | 0.33 | 42 | 0.16 | 0.21 | 10 | 104 | 0.018 |
| | $Mean_G$ | 0.054 | 1.98 | 1.51 | 5.32 | 447 | 1.36 | 1.51 | 91 | 408 | 0.155 |
| NBHI | $Mean_A$ | 0.080 | 1.55 | 1.08 | 5.57 | 296 | 0.86 | 0.79 | 96 | 333 | 0.119 |
| | SD | 0.024 | 0.10 | 0.08 | 0.55 | 29 | 0.05 | 0.09 | 16 | 69 | 0.005 |
| | $Mean_G$ | 0.077 | 1.54 | 1.08 | 5.55 | 295 | 0.86 | 0.79 | 95 | 327 | 0.119 |
| NBTC | $Mean_A$ | 0.032 | 2.51 | 2.44 | 6.34 | 1065 | 1.93 | 2.17 | 71 | 1285 | 0.275 |
| | SD | 0.003 | 0.18 | 0.18 | 0.16 | 133 | 0.13 | 0.19 | 7 | 212 | 0.017 |
| | $Mean_G$ | 0.031 | 2.51 | 2.44 | 6.34 | 1059 | 1.92 | 2.17 | 71 | 1273 | 0.274 |
| NSDI | $Mean_A$ | 0.044 | 1.99 | 1.92 | 5.41 | 732 | 1.42 | 3.82 | 131 | 704 | 0.154 |
| | SD | 0.005 | 0.07 | 0.21 | 0.27 | 111 | 0.03 | 0.70 | 16 | 130 | 0.007 |
| | $Mean_G$ | 0.043 | 1.99 | 1.91 | 5.41 | 726 | 1.42 | 3.77 | 130 | 695 | 0.154 |
| NSBC | $Mean_A$ | 0.056 | 2.22 | 2.10 | 5.56 | 727 | 1.67 | 2.05 | 77 | 551 | 0.148 |
| | SD | 0.037 | 0.24 | 0.08 | 0.14 | 27 | 0.04 | 0.22 | 10 | 31 | 0.008 |
| | $Mean_G$ | 0.049 | 2.21 | 2.10 | 5.56 | 727 | 1.67 | 2.04 | 77 | 551 | 0.148 |
| NSBP | $Mean_A$ | 0.014 | 1.52 | 1.41 | 6.68 | 306 | 0.93 | 3.32 | 130 | 206 | 0.126 |
| | SD | 0.002 | 0.13 | 0.09 | 0.37 | 21 | 0.06 | 0.49 | 10 | 19 | 0.010 |
| | $Mean_G$ | 0.014 | 1.51 | 1.41 | 6.67 | 306 | 0.93 | 3.29 | 130 | 205 | 0.126 |

**TABLE 5**. Gulf of Maine Median (using the means of field replicates for each site)/85th Percentile values; 2002-2005.

| | | **Ag** | **Cd** | **Cr** | ***Cu** | **Fe** | **Ni** | **Pb** | **Zn** | **Al** | **Hg** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **2002** | **Median** | 0.1 | 1.8 | 1.2 | 7.0 | 383 | 1.3 | 2.8 | 88 | 148 | 0.2 |
| | **85th P** | 0.1 | 2.3 | 2.0 | 8.6 | 514 | 1.7 | 4.6 | 141 | 200 | 0.7 |
| **2003** | **Median** | 0.07 | 1.5 | 2.1 | | 407 | 1.7 | 2.2 | 71 | 375 | 0.14 |
| | **85th P** | 0.13 | 1.9 | 3.5 | | 708 | 2.3 | 4.7 | 105 | 617 | 0.26 |
| **2004** | **Median** | 0.06 | 1.7 | 1.8 | 7.2 | 521 | 1.7 | 2.6 | 83 | 490 | 0.14 |
| | **85th P** | 0.11 | 2.0 | 2.6 | 8.9 | 858 | 1.9 | 6.2 | 108 | 635 | 0.30 |
| **2005** | **Median** | 0.05 | 2.0 | 1.8 | 6.6 | 503 | 1.4 | 2.2 | 116 | 433 | 0.16 |
| | **85th P** | 0.08 | 2.5 | 2.4 | 7.8 | 758 | 1.6 | 4.0 | 132 | 666 | 0.33 |

*GULFWATCH copper values for 2003 are suspected to be elevated due to sample processing and/or storage container artifacts as indicated by analytical laboratory notes and unusually high variances of the analyses of field replicates. These results will be analyzed using archived samples and reported at a later date.

**TABLE 6**. Median metal concentrations (and 85$^{th}$ percentile) reported by the NOAA Status & Trends program (1991-1996). Also given are the 2002/2003 national median values for select metals reported in O'Connor and Lauenstien, 2006. NA= not analysed, NR= not reported.

| | | **Ag** | **Cd** | **Cr** | **Cu** | **Fe** | **Ni** | **Pb** | **Zn** | **Al** | **Hg** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NS&T 1991 | Median, | 0.08 | 2.3 | 1.4 | 8.8 | 400 | 2.1 | 0.8 | 130 | 280 | 0.11 |
| | 85th P | 0.48 | 5.4 | 2.7 | 11.7 | 790 | 3.6 | 3.6 | 200 | 653 | 0.24 |
| NS&T 1992 | Median, | 0.09 | 2.1 | 1.4 | 8.6 | 338 | 2.1 | 0.7 | 120 | 210 | 0.10 |
| | 85th P | 0.55 | 4.5 | 3.5 | 10.1 | 690 | 3.9 | 2.3 | 170 | 510 | 0.23 |
| NS&T 1993 | Median, | 0.05 | 2.5 | 1.2 | 8.4 | 340 | 1.6 | 0.8 | 120 | 120 | 0.11 |
| | 85th P | 0.85 | 4.7 | 2.7 | 10.5 | 673 | 2.7 | 2.9 | 200 | 280 | 0.20 |
| NS&T 1994 | Median, | 0.12 | 2.0 | 1.2 | 8.7 | 350 | 1.5 | 1.0 | 120 | 350 | 0.10 |
| | 85th P | 0.56 | 4.3 | 2.2 | 10.5 | 774 | 2.8 | 2.7 | 170 | 1100 | 0.21 |
| NS&T 1995 | Median, | 0.05 | 2.4 | 1.8 | 8.4 | 607 | 2.0 | 0.7 | 115 | 480 | 0.11 |
| | 85th P | 0.76 | 4.4 | 5.2 | 12.6 | 1615 | 3.5 | 2.4 | 169 | 1577 | 0.23 |
| NS&T 1996 | Median, | NA | 1.9 | 1.1 | 7.3 | 424 | 1.6 | 0.8 | 102 | 340 | 0.11 |
| | 85th P | NA | 4.2 | 3.1 | 9.9 | 985 | 3.3 | 2.4 | 148 | 1020 | 0.20 |
| NS&T 2002/2003 | Median, | NR | 2.1 | NR | 8.0 | NR | 1.8 | 0.77 | 110 | NR | 0.10 |

Monitored trace metals were detected at all Gulfwatch sites. Comparison of Gulfwatch 2005 geometric means of concentrations observed at each station to NOAA Status & Trends (NS&T) median + 85$^{th}$ P values serves as a measure the region's condition relative to the national level. For comparison, the 1996 NS&T statistics are used. Seven (7) Gulfwatch sites located throughout the region were considered elevated with respect to Pb relative to the national NS&T levels (Table 7). This represents lightly less than 50% of the Gulfwatch sites (7/15) sampled for the period report here exceeded this national standard for Pb. Twenty percent (20%) of the 2005 sites exceeded the NS&T value for Hg; all located in the U.S. Trace metals for which a sites exceeded the 1996 NS&T MD + 85$^{th}$ P value, when viewed with nearby Gulfwatch sites, suggest highly localized sources of these contaminants.

**TABLE 7.** Sample means from Gulfwatch sites 2005 that exceeded the NOAA Status & Trends Mussel Watch Program's 1996 national median + 85$^{th}$ percentile value.

| Pb | Hg |
|---|---|
| MASN | NHNM |
| MAPY | MECC |
| NHNM | MEFP |
| MECC | |
| MEPH | |
| NSDI | |
| NSBP | |

### *3.3 Organic Contaminants Concentrations*

The total concentration (arithmetic mean ± SD, ng/g dry weight) of detectable polynuclear aromatic hydrocarbons ($\Sigma PAH_{22}$), polychlorinated biphenyls ($\Sigma PCB_{24}$) and organochlorine pesticides ($\Sigma TPEST_{17}$) measured in blue mussel tissue samples of indigenous mussels collected during 2005 are presented in Table 8. Station arithmetic means are reported here only, since geometric means were essentially equivalent to the arithmetic means. Individual analyte concentrations of each compound class for each field replicate are reported by station and given in Appendix F.

Further, overall gulf-wide medians (MD) and the 85$^{th}$ percentile of the organic contaminant concentrations for indigenous mussels are also reported to allow for a program-level comparison with NOAA National Status and Trends concentrations (Table 9). The Gulfwatch $\Sigma PCB_{22}$ median is not directly comparable to NOAA's Mussel Watch $\Sigma PCB$ median values since the NOAA Mussel Watch PCB data is determined from 18 congeners, while Gulfwatch included an additional 4 congeners in the $\Sigma PCB_{22}$. Further, co-eluting congeners (PCB-5, -15, -90, -95, -132, -190, and -208) are included in the Gulfwatch PCB analyses, and contribute to some extent to the summary statistics. However, the Gulfwatch $\Sigma PCB_{18}$ median and 85$^{th}$ percentile was calculated by summing the 18 common congeners (and those co-eluting congeners) and then multiplied by two (2) to be consistent with the NS&T reporting. The 2005 Gulfwatch overall average concentrations for summary organic contaminant (PAH, PCB, and chlorinated pesticides) statistics are summarized below and compared with the 2002/2003 NS&T median values (Table 9).

None of the Gulfwatch sites sampled in 2005 exceeded the NS&T median value + the 85$^{th}$ percentile summary statistics for ΣPAH. One site, located in the NH Great Bay Estuary (NHNM), did exceed the NS&T 85$^{th}$ percentile for PAHs. One additional site (MEPH) was twice the national median level, but below the Gulfwatch "elevated" criteria. For PCBs and chlorinated pesticides, all other sites had average summary organic contaminant concentrations at or below the NS&T median values + the 85$^{th}$ percentiles.

**TABLE 8.** Arithmatic mean ($M_A$), standard deviation (SD), and geometric mean ($M_G$) tissue organic contaminant concentrations (ng/g dry weight) from mussels collected by the Gulfwatch Program, 2005. ND = not detected, and NA = not applicable.

| Site | Statistic | $\sum PAH_{24}$ | $\sum PCB_{22}$ | $\sum Pest_{21}$ | $\sum OrgPest_{15}$ | $\sum DDTs_6$ |
|---|---|---|---|---|---|---|
| MASN | $M_A$ | 89 | 20.6 | 17.4 | 3.9 | 13.5 |
| | SD | 17 | 5.1 | 0.8 | 1.3 | 0.8 |
| | $M_G$ | 88 | 20.1 | 17.4 | 3.7 | 13.5 |
| MAPY | $M_A$ | 189 | 32.7 | 5.7 | 1.3 | 4.4 |
| | SD | 60 | 5.3 | 1.9 | 2.2 | 0.7 |
| | $M_G$ | 183 | 32.4 | 5.5 | NA | 4.4 |
| NHHS | $M_A$ | 99 | 9.3 | 7.4 | ND | 7.4 |
| | SD | 16 | 1.9 | 4.2 | NA | 4.2 |
| | $M_G$ | 98 | 9.2 | 6.5 | NA | 6.5 |
| NHNM | $M_A$ | 1108 | 50.5 | 41.1 | 1.7 | 39.4 |
| | SD | 72 | 29.1 | 4.5 | 1.2 | 3.7 |
| | $M_G$ | 1106 | 38.6 | 40.9 | NA | 39.3 |
| NHDP | $M_A$ | 566 | 34.2 | 11.9 | 2.7 | 9.2 |
| | SD | 146 | 6.8 | 2.3 | 1.0 | 1.5 |
| | $M_G$ | 553 | 33.7 | 11.7 | 2.5 | 9.1 |
| MECC | $M_A$ | 275 | 31.6 | 8.0 | 2.4 | 5.6 |
| | SD | 49 | 3.5 | 3.7 | 3.9 | 1.8 |
| | $M_G$ | 272 | 31.5 | 7.4 | NA | 5.4 |
| MEPH | $M_A$ | 889 | 35.5 | 13.4 | 0.9 | 12.5 |
| | SD | 162 | 5.0 | 2.6 | 1.9 | 1.9 |
| | $M_G$ | 877 | 35.2 | 13.3 | NA | 12.4 |
| MERY | $M_A$ | 91 | 12.6 | 11.3 | 0.5 | 10.8 |
| | SD | 16 | 4.3 | 1.7 | 1.0 | 1.4 |
| | $M_G$ | 90 | 11.9 | 11.1 | NA | 10.7 |
| MEFP | $M_A$ | 187 | 14.4 | 7.2 | ND | 7.2 |
| | SD | 22 | 4.1 | 1.2 | NA | 1.2 |
| | $M_G$ | 186 | 14.0 | 7.1 | NA | 7.1 |

**Table 8** (continued)

| Site | Statistic | $\sum PAH_{24}$ | $\sum PCB_{22}$ | $\sum Pest_{21}$ | $\sum OrgPest_{15}$ | $\sum DDTs_6$ |
|---|---|---|---|---|---|---|
| MEPI | $M_A$ | 18 | ND | ND | ND | ND |
| | SD | 28 | NA | NA | NA | NA |
| | $M_G$ | NA | NA | NA | NA | NA |
| NBHI | $M_A$ | 21 | ND | 3.0 | ND | 3.0 |
| | SD | 19 | NA | 2.2 | NA | 2.2 |
| | $M_G$ | NA | NA | NA | NA | NA |
| NBTC | $M_A$ | 187 | 4.6 | 18.3 | ND | 18.3 |
| | SD | 51 | 2.1 | 1.8 | NA | 1.8 |
| | $M_G$ | 181 | 4.3 | 18.2 | NA | NA |
| NSBC | $M_A$ | 316 | ND | 2.1 | 2.1 | ND |
| | SD | 40 | NA | 1.7 | 1.7 | NA |
| | $M_G$ | 314 | NA | 2.0 | 2.0 | NA |
| NSDI | $M_A$ | 136 | ND | 0.8 | 0.5 | 0.5 |
| | SD | 9 | NA | 1.7 | 0.9 | 0.9 |
| | $M_G$ | 136 | NA | NA | NA | NA |
| NSBP | $M_A$ | 509 | ND | 1.0 | ND | 1.0 |
| | SD | 54 | NA | 1.2 | NA | 1.2 |
| | $M_G$ | 506 | NA | NA | NA | NA |

**TABLE 9.** Median summary organic contaminant concentrations (and $85^{th}$ percentile) for the 2002-2005 Gulfwatch samples. NOAA Status and Trend national summary data (1986-1999 and 2002/2003) provided for comparative purposes. Values are ng/g dry weight.

| | Gulfwatch 2002 Median ($85^{th}$ P)*2 | Gulfwatch 2003 Median ($85^{th}$ P) | Gulfwatch 2004 Median ($85^{th}$ P) | Gulfwatch 2005 Median ($85^{th}$ P) | NS&T (1986-1999)† Median ($85^{th}$ P ) | NS&T (2002/2003)‡ Median |
|---|---|---|---|---|---|---|
| $\Sigma PAH_{24}$ | 46 (265) | 72 (195) | 92 (377) | 187 (560) | 320 (1100) | 220 |
| *$\Sigma PCB_{18}$ | 58 (224) | 60 (254) | 24 (138) | 25 (66) | 110 (500) | 50 |
| $\Sigma TPEST_{21}$ | 6 (13) | 8 (25) | 5 (17) | 7 (17) | 48 (192) | 18 |
| $\Sigma DDTs_6$ | 6 (12) | 5 (15) | 4 (14) | 7 (13) | 31 (140) | 13 |

† Compiled from O'Connor, 2002

‡Compiled from O'Connor and Lauenstein, 2006

*$\sum PCB_{18}$ *twice* the sum of concentrations of eighteen congeners (and co-eluting congeners): PCB8, PCB18, PCB28 PCB44, PCB52, PCB66, PCB101, PCB105, PCB118, PCB128, PCB138, PCB153, PCB170, PCB180, PCB187, PCB195, PCB206, and PCB209 computed for comparative purposes with the NOAA Mussel Watch Program (O'Connor, 2002).

$\sum$DDTs: The sum of concentrations of DDTs and their metabolites, DDEs and DDDs.

# 4.0 2005 DISTRIBUTIONS OF CONTAMINANTS IN *MYTILUS EDULIS*

## *4.1 SPATIAL PATTERNS*

Figures 2 to 11 show the concentration of the metals measured in the tissue of *M. edulis* collected by the Gulfwatch Program in 2005. The data is displayed by sampling year and by the geographic location beginning clockwise around the GOM from Sandwich, Massachusetts and ending with the southern-most station in Nova Scotia (See Fig. 1 above). Overall, the concentrations of most metals were relatively evenly distributed around the Gulf of Maine, with no apparent spatial trends and an occasional hot spot of elevated concentrations. Exceptions to this general pattern and further details for metals and organic contaminants are noted in the following individual sections.

### 4.1.1 Silver (Ag)

Silver concentrations ranged from 0.14 µg/g dry weight in NSBP to 0.38 µg/g dry weight in southern most portion of the region (MASN) (Table 4; Figure 2). Historically, Sandwich, MA (MASN), has been one of the more contaminated sites, with respect to Ag. Elevated silver concentrations in sediments and water column have been shown to coincide with regions receiving municipal sewage (Sanudo-Wlhelmy and Flegal, 1992; Buchholz ten Brink et al., 1997). Because of silver's use in the photographic and jewelry industries, part of the coastal waters of Massachusetts have been up to 1000 times more concentrated in Ag than in northern coastal Gulf of Maine waters (Krahforst and Wallace 1996) although these traditional sources are becoming less in their contribution to loading because of improved reclaimation methods in waste streams and more stringent requirements for discharge to wastewater treatment facilities. The higher levels observed for MASN may have been a function of transport and deposition of sewage-derived particles from Boston Harbor (Bothner et al. 1993) that were sequestered in Cape Cod Bay sediments and taken up by mussels. Recent coastal management practices associated with the Boston Harbor cleanup (source load reduction and movement of the major outfall further offshore) may be important to understanding changes in the body burden of Ag in mussels collected in coastal Massachusetts waters, especially at MASN. The changes in Ag concentrations since 1993 are depicted in Fig. 27 in the later section 4.2.2 and show a temporal decline at the Sandwich benchmark site.

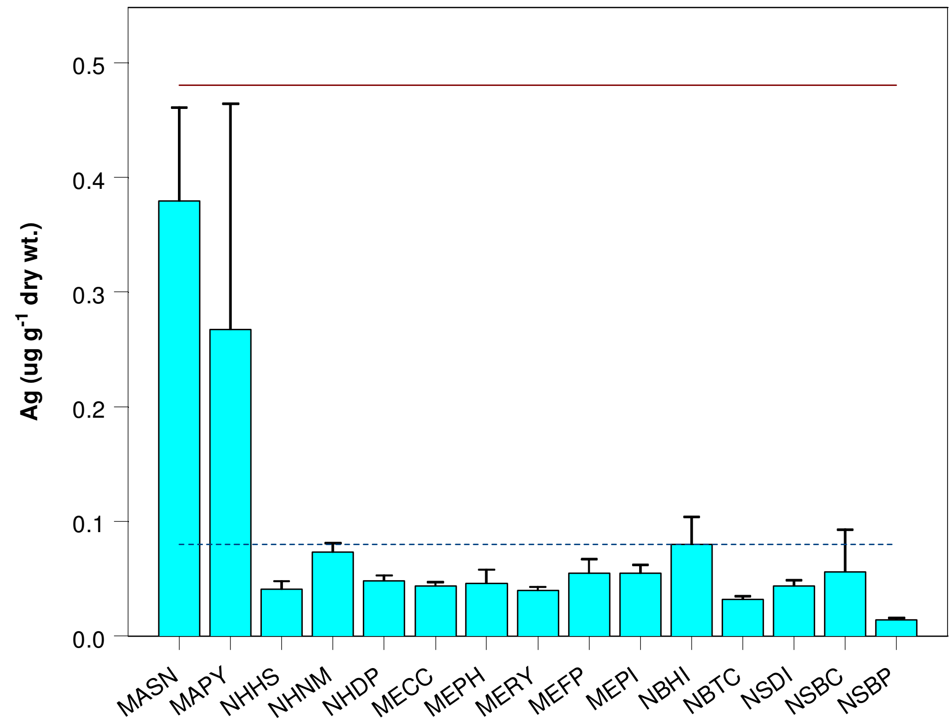


**Figure 2.** Distribution of silver tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites in 2005. Dashed line = 1991 Mussel Watch National median; Solid line = 1991 Mussel Watch National 85$^{th}$ Percentile.

### 4.1.2 Cadmium (Cd)

Cadmium was rather uniformly distributed among the Gulfwatch 2005 stations reflecting the control natural coastal sediments and ubiquitous non-point sources may play on Cd bio-availability in the Gulf of Maine. Sediments can act as a major pollutant reservoir because metals and other contaminants can bind to the sediments and become bioavailable to the rest of the food chain. Cadmium is mainly delivered to the aquatic environment from airborne chemicals that are both natural and man-made and include sources from fossil fuel burning, industrial airborne chemicals, auto exhausts, intensive agriculture, and forestry. Localized sources of Cd from industrial waste associated with the production of batteries, plating, stabilizers, and nuclear energy production may have more importance as sources of exposure for *M. edulis* collected in the New Hampshire Great Bay Estuary system and possibly the Penobscot River in Maine and Tin Can Beach in New Brunswick because of a higher degree or legacy of industrialization at these sites.

The concentration of cadmium in mussel tissue ranged from 1.06 µg/g dry weight at Sandwich, MA (MASN) to 2.71 µg/g dry weight at the North Mill pond site in NH (NHNM) (Table 4; Figure 3).

### 4.1.3 Chromium (Cr)

The median Cr concentration in mussel soft tissue for the Gulf of Maine for 2005 was comparable to observations reported for previous Gulfwatch years (~2 µg/g dry weight). No sites for 2005 exceeded the national Mussel Watch comparative criteria (NS&T MD + PC85). The lowest mean concentration observed in 2005 by Gulfwatch (1.08 µg/g dry weight) occurred at the Hospital Island site in New Brunswick (NBHI). Highest station mean values were observed at NHDP (2.67 µg/g dry weight), NBTC (2.44 µg/g dry weight), and MEFP (2.39 µg/g dry weight). These data are listed in Table 4 and shown in Figure 4 below.

Chromium is the primary agent used in tanning processes and was discharged with untreated tannery wastes throughout much of this century. Chromium persists in the environment as shown by elevated concentrations in the sediments near such sources (Capuzzo, 1974; NCCOSC, 1997). During the 19$^{th}$ and 20$^{th}$ centuries, coastal New Hampshire was one of the hide tanning centers of the United States. High Cr concentrations were also observed in coastal sediments along the Gulf of Maine by other investigators (Mayer and Fink, 1990).

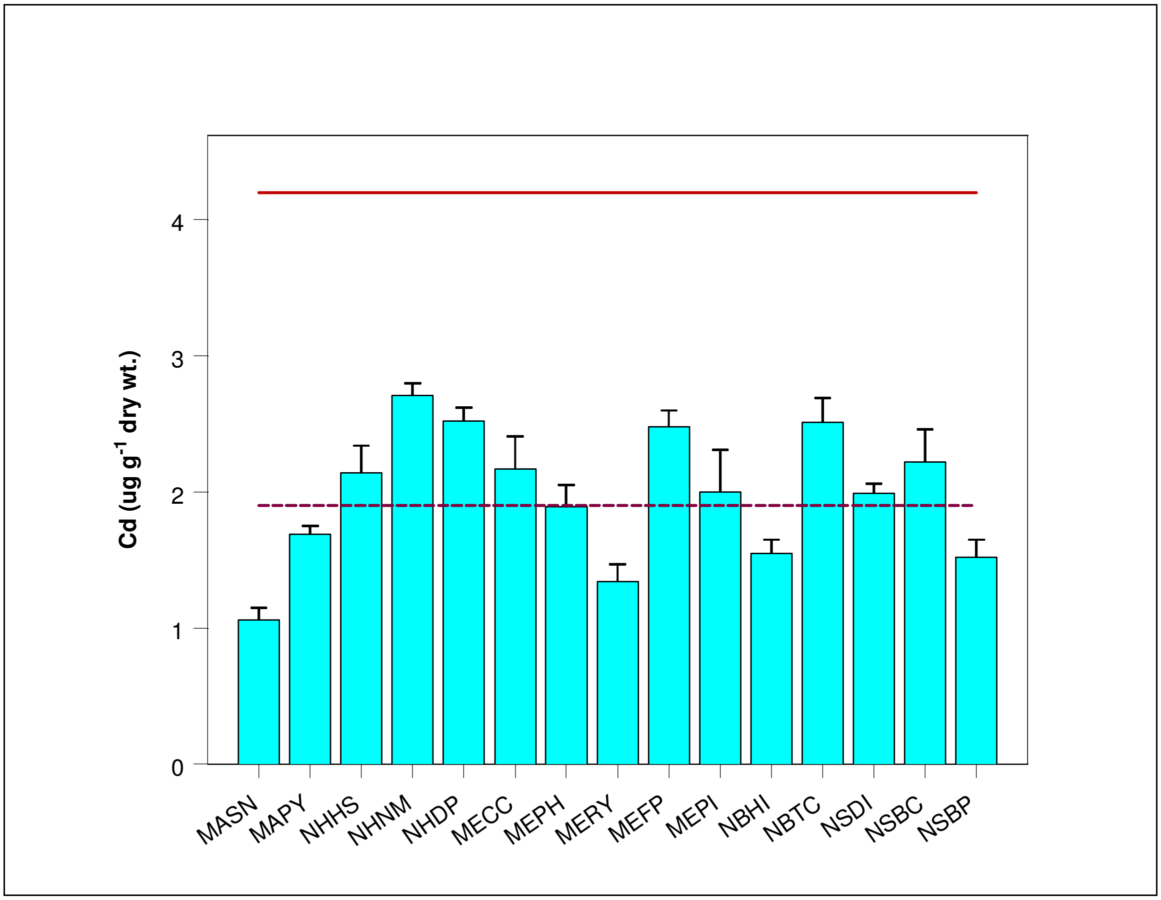


**Figure 3.** Distribution of cadmium tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites in 2005. Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85$^{th}$ Percentile.

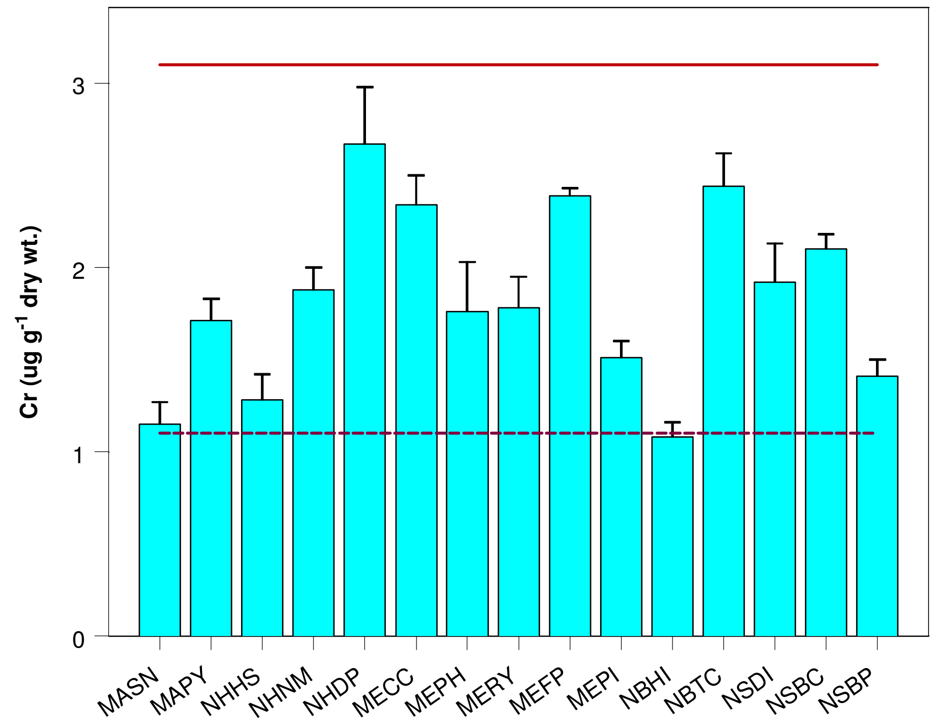


**Figure 4**. Distribution of chromium tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites 2005. Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85th Percentile.

### 4.1.4 Copper (Cu)

For this reporting period, the concentration of copper in *M. edulis* ranged from 5.33 µg/g dry wt at the Pickering Island site in Maine (MEPI) to 8.64 µg/g dry wt at the Portland Harbor site, also in ME (MEPH) (Table 4; Figure 5). Cu in 2005 Gulfwatch samples were fairly uniform in distribution throughout the study region.

### 4.1.5 Iron and Aluminium (Fe & Al)

For 2005, the highest concentrations for both Al and Fe were generally found at the Tin Can Beach site in New Brunswick (Table 4; Figures 6 and 7). Mean concentrations of Fe ranged from 296 µg/g dry weight at the Hospital Island site (NBHI) to 1065 µg/g dry wt at the Tin Can Beach site (NBTC); both sites in NB. The site mean concentrations for Al ranged from 296 µg/g dry wt at the Barrington Point site in NS (NSBP) to 1285 µg/g dry wt, also at the Tin Can Beach site (NBTC) in NB. Consistent with results from previous years, the sites with the lowest and highest Fe concentrations generally coincided. Because of their high abundance in crustal material (Wedepohl, 1995), Al and Fe may serve as a potential measure of sediment-associated metals captured along with mussel tissue composite preparation. The concern within the Gulfwatch program is that the observed elevated levels of some trace metals may be a function of sediment that had been incorporated into the samples (sediment material attached to mussel tissue or contained within mussel's gut). Sites where resuspension during windy storm events or intensive tidal action occur (such as NBTC in the Bay of Fundy) may be more susceptible to sediment captured within their respective composites.

Aluminium values may prove valuable for correcting metal concentrations in mussel tissue to better reflect exposure of *M. edulis* to contamination. Average Metal-to-Al ratios can be derived from crustal abundances reported in literature (Wedepohl, 1995) and the potential crustal contribution may be removed from the metal concentrations of each sample to strengthen the analysis of metal contamination in the Gulf of Maine. This correction may be used to estimate metal tissue levels corrected for gut content included in total digestion of tissue samples.

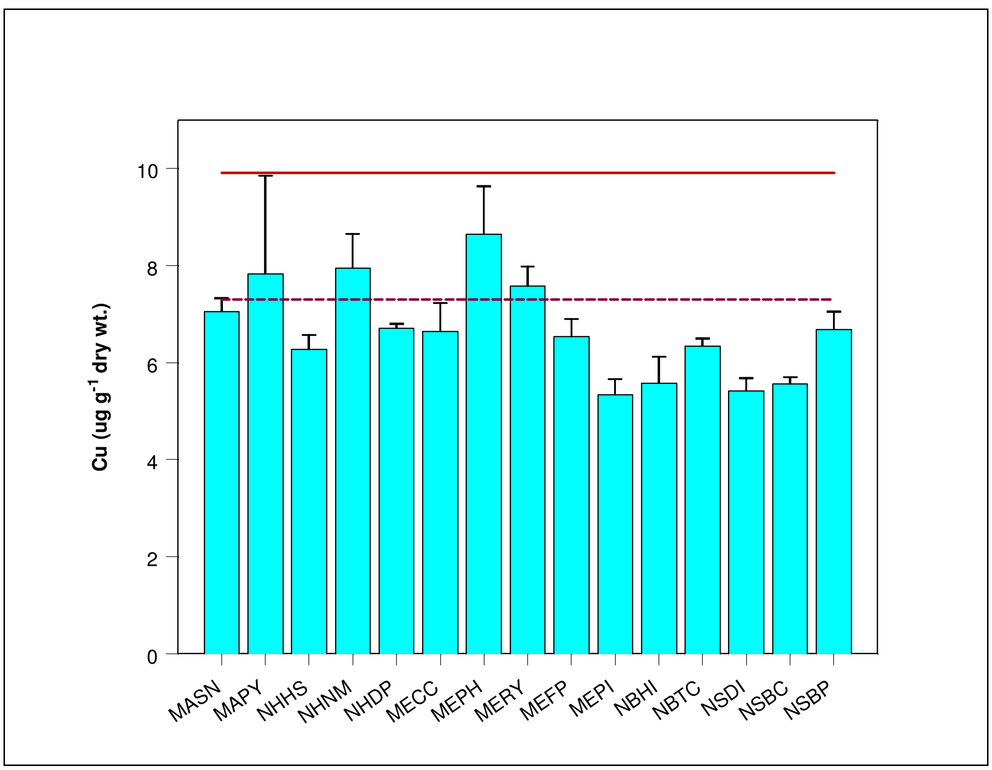


**Figure 5.** Distribution of copper tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites in 2005. Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85$^{th}$ Percentile.

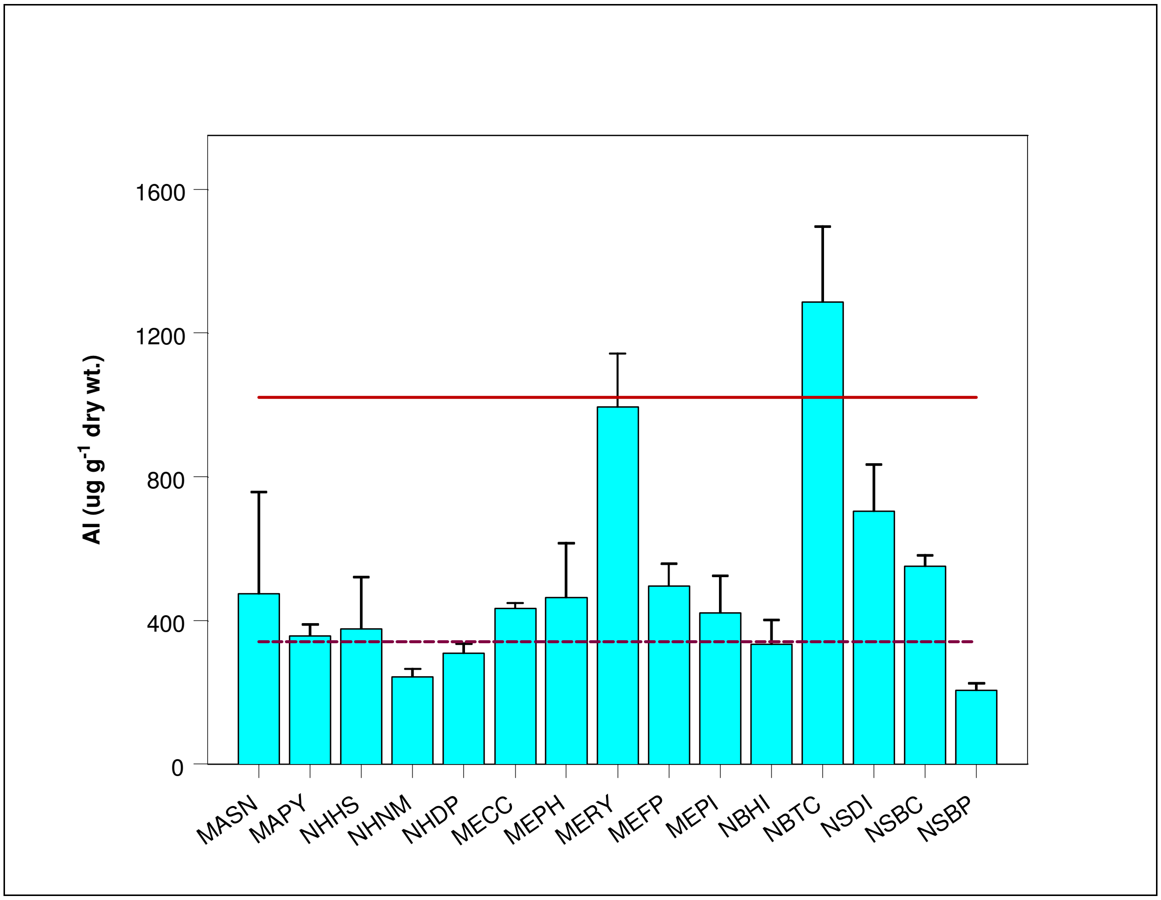


**Figure 6.** Distribution of aluminum tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites in 2005. Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85th Percentile.

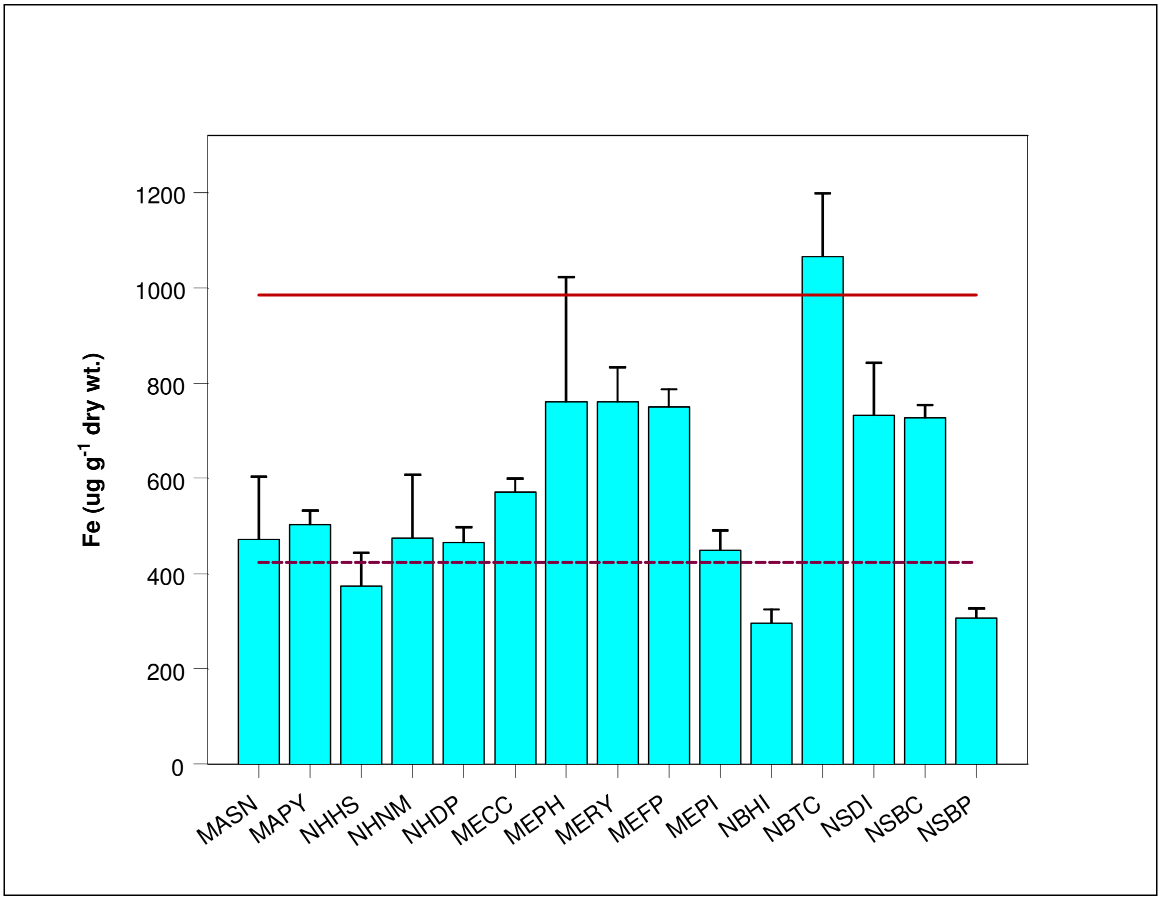


**Figure 7.** Distribution of iron tissue concentrations (arithmetic mean +/- SD, μg/g dry weight) in mussels at Gulfwatch sites in 2005. Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85$^{th}$ Percentile.

### 4.1.6 Nickel (Ni)

Nickel in Gulfwatch samples 2005 exhibited relatively uniform distribution in the Gulf of Maine region. The concentration of site means for nickel ranged from 0.86 μg/g dry wt at the Hospital Island site, NB (NBHI) to 1.93 μg/g dry wt at the Tin Can Beach, NB site (NBTC), (Table 4; Figure 8). Higher levels of Ni observed at NBTC may be related to the associated crustal material due to high resuspension in the Bay of Fundy as evidenced by the corresponding elevated concentrations observed for Al and Fe.

### 4.1.7 Lead (Pb)

The site mean concentrations of lead ranged from a low value of 0.79 μg/g dry wt at Hospital Island site, NB, (NBHI), to 6.58 μg/g dry wt at the Portland Harbor site, ME (MEPH) (Table 4, Figure 9). The observed Pb site mean at the Portland Harbor, ME site exceeded the NS&T MD + PC85 value of 4.34 μg/g dry wt. The highest Pb GW concentrations historically are observed in mussels collected from heavily-industrialized harbors of the region (see data from past years for inner Boston Harbor (MAIH). In addition, six (6) addition sites (MASN, MAPY, NHNM, MECC, NSDI, and NSBP) had mean concentrations that exceeded the National Mussel Watch 85th percentile.

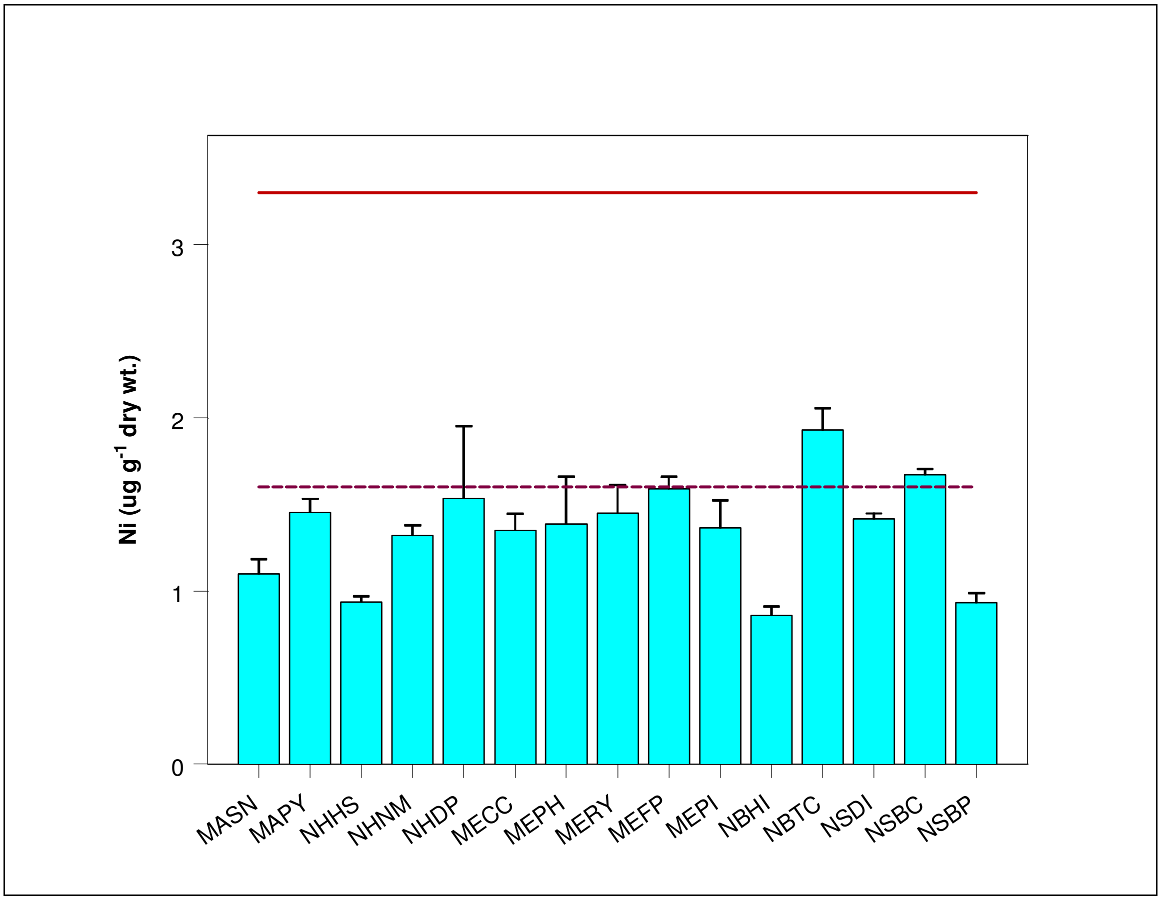


**Figure 8.** Distribution of nickel tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites in 2005**.** Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85th Percentile.

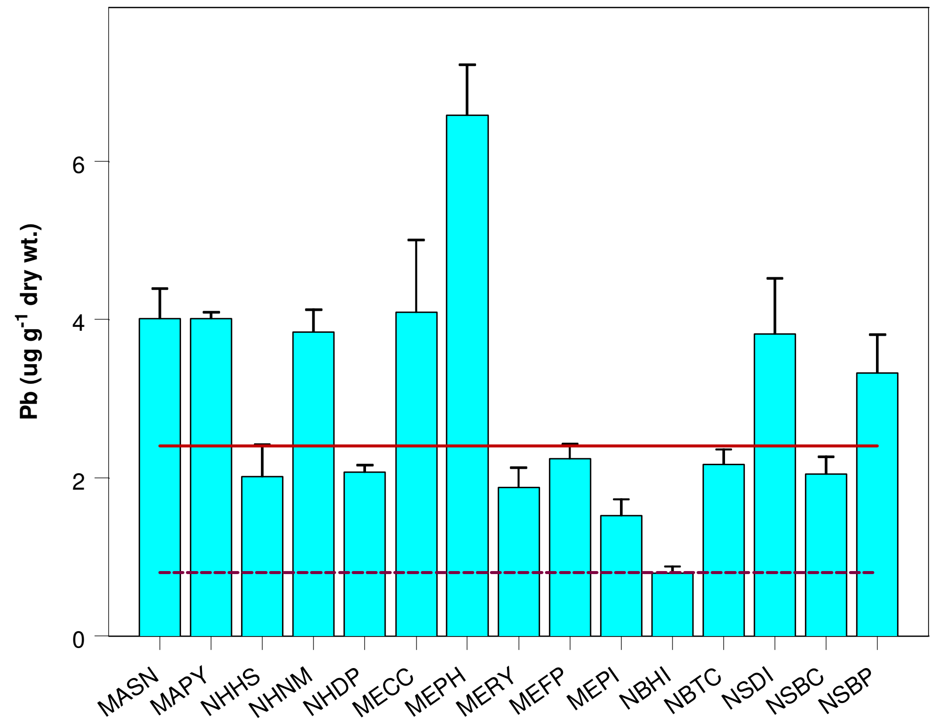


**Figure 9.** Distribution of lead tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites in 2005. Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85$^{th}$ Percentile.

### 4.1.8 Zinc (Zn)

Zinc contamination is fairly ubiquitous in our environment. Concentrations generally reflect human activity associated with tire wear, galvanized materials and industrial waste discharges. The concentration of zinc ranged from a value of 71 µg/g dry wt at the Tin Can Beach site, NS (NBTC) to 162 µg/g dry wt at the North Mill Pond site, NH (NHNM). (Table 4; Figure 10). For 2005, two stations (NHNM and MEPH) had site means that exceeded the NS&T 85$^{th}$ national value.

### 4.1.9 Mercury (Hg)

Mercury was detected in all *M. edulis* collected from all the stations of Gulfwatch in 2005. The lowest mean concentration of Hg in mussel tissue for 2005 was 0.007 µg/g dry wt. at the Sandwich, MA site (MASN) (Table 4; Figure 11). Three (3) Gulfwatch sites from 2005 (see Table 7 above) exceeded the NS&T MD + PC85 value of 0.35µg/g dry wt. In addition, 3 sites (MECC, MEPH, and NBTC) exceeded the national NS&T

PC85 value.  Overall for 2005, the mussel Hg levels from New Hampshire sites were generally greater than sites in other jurisdictions.  Mussels from the reference station for NH, which is located within the Great Bay Estuary but along the Maine coast (MECC), had levels of Hg comparable to the remaining Great Bay Estuary sites.  As with previous years, the consistently higher Hg in the Great Bay Estuary system warrants further evaluation of Hg loading and its transport to and fate in adjacent coastal waters.

There are several known historical Hg sources in the Gulf of Maine (Jones 2004, NCCOSC, 1997).  Mean values of Hg in *Mytilus* spp. from coastal regions world-wide range from 0.1 to 0.4 µg/g dry wt (Kennish, 1997), but can be much higher in areas like the south-west Pacific, where sites average as much as 2.7 µg Hg/g dry wt (Fowler, 1990).  The 2005 GOM-wide median and 85$^{th}$ Percentile for Hg is 0.16 and 0.33 µg/g dry wt, respectively and compares well with previous years.   In a review of the first five years of the Gulfwatch program, tissue concentrations of Hg were discussed as being unusually high and a possible concern for human health (Tripp et al., 1997).

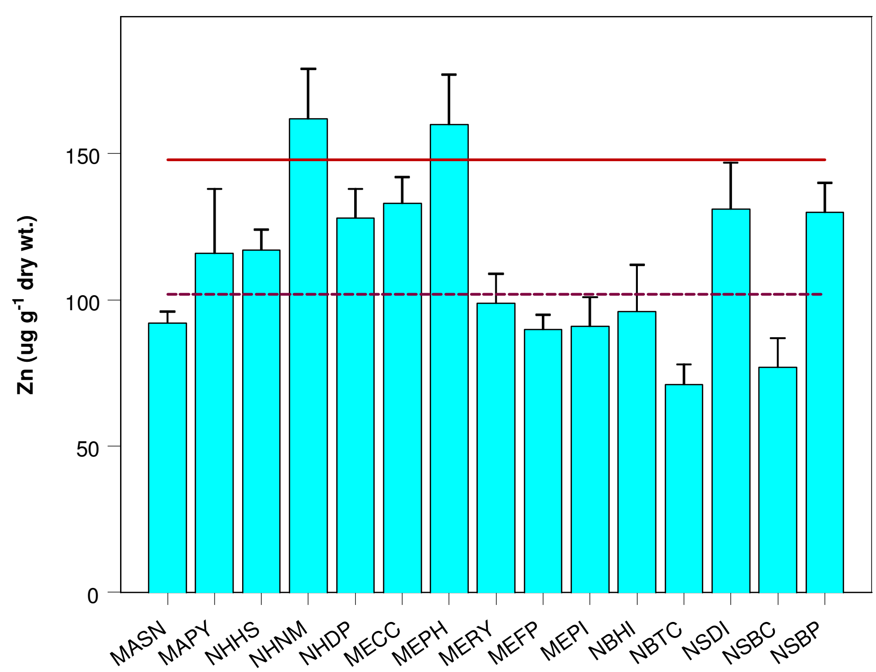


**Figure 10.**  Distribution of zinc tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites in 2005. Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85$^{th}$ Percentile.

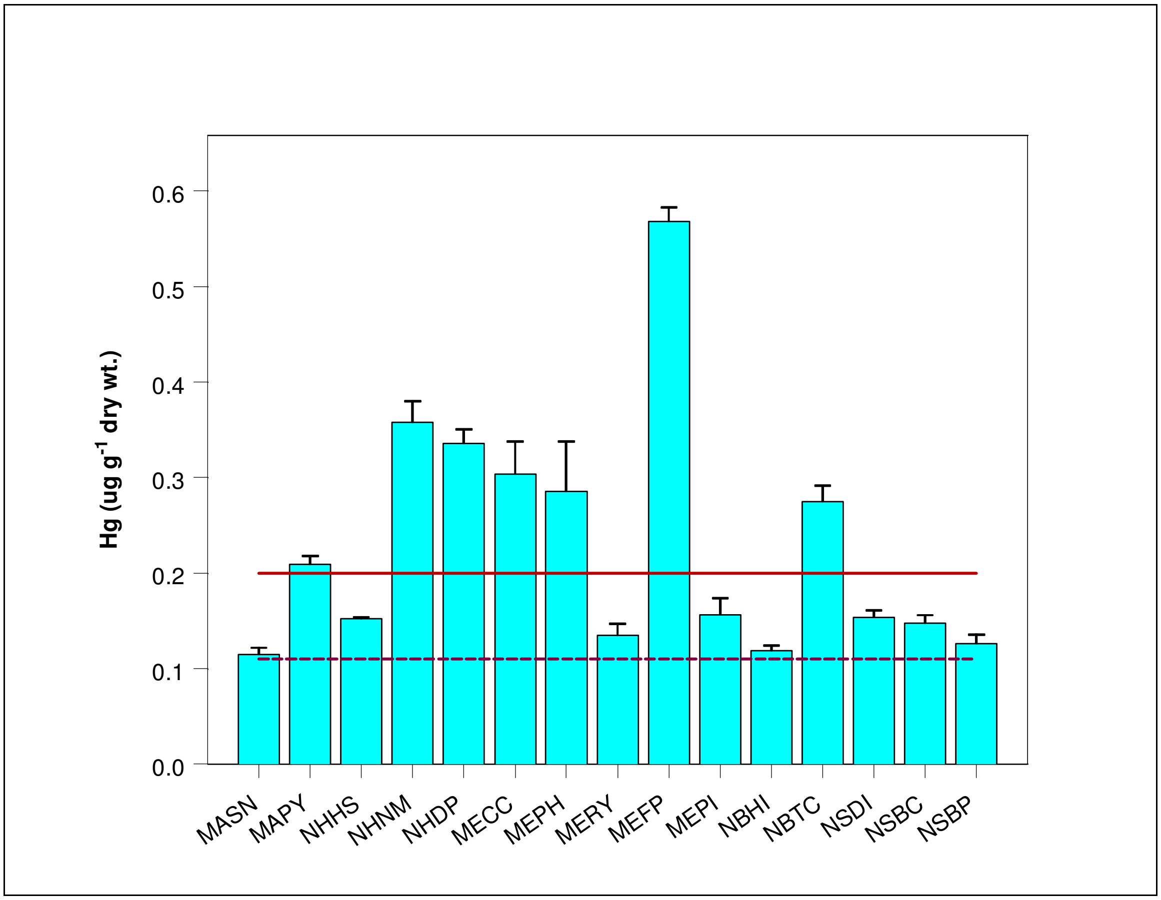


**Figure 11.** Distribution of mercury tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch sites in 2005. Dashed line = 1996 Mussel Watch National median; Solid line = 1996 Mussel Watch National 85$^{th}$ Percentile.

### 4.1.10 Organic Contaminants

Analyte categories of organic contaminant were detected at all US sites (except the Pickering Island site in ME). The pattern of higher $\Sigma PAH_{24}$, $\Sigma PCB_{22}$, $\Sigma TPEST_{17}$ and $\Sigma DDT_6$ concentrations in the south-western Gulf compared to the north-eastern Gulf (Table 8, Figs. 12-15) continues as observed from the previous results of Gulfwatch data (Jones et al., 2005). This is particularly so for $\Sigma PAH_{24}$, $\Sigma PCB_{22}$, and $\Sigma DDT_6$ concentrations, where higher concentrations were observed in mussels collected at many of the US sites.

$\Sigma PAH_{24}$ site mean concentrations ranged from 18 ng/g dry wt at the Pickering Island site in ME (MEPI) to 1108 ng/g dry wt at North Mill Pond site, NH (Table 8; Figure 12). None of the 2005 GW sites exceeded the NS&T MD + 85P concentrations for $\Sigma PAH_{24}$,

$\Sigma PCB_{22}$ concentrations ranged from non-detectable levels in many of the NS and NB sites to 50.5 ng/g dry wt at the North Mill Pond site, NH (NHNM) (Table 8; Figure 13). All 2005 $\Sigma PCB_{22}$ were below the national NS&T MD + 85P value. Detectable concentrations of $\Sigma PCB_{22}$ were observed in all of the US sites, and one the Tin Can Beach site, New Brunswick (NBTC). Highest levels of $\Sigma PCB_{22}$ concentrations were observed in the urbanized estuaries of Massachusetts, followed by most of Great Bay Estuary sites including the nearby reference site in Maine (MECC). The median $\Sigma PCB_{22}$ are shown in Figure 13 to be well below the national median from the Mussel Watch Program. However, this is misleading in that the NS&T MD + 85P value is derived as a factor of 2 from their observed values to better reflect the point that typical PCB analyses capture only a portion (~ 50%) of the congeners that exists in the environment (O'Connor, 2002).

Detectable concentrations of $\Sigma TPEST_{21}$ in 2005 ranged from 0.8 ng/g dry wt at the Digby Island, NS to 41.1 ng/g dry wt at the North Mill Pond site in NH (NHNM) (Table 8; Figure 14). As in previous reports, $\Sigma DDT_6$ and its biodegradation products were the main contributors to total detectable organochlorine pesticides, and exhibited the same spatial pattern with highest levels observed to the southwest, as seen for $\Sigma TPEST_{21}$ (Table 8, Figure 15). Both $\Sigma TPEST_{21}$ and $\Sigma DDT_6$ mean values for 2005 were below the national NS&T median values of 48 and 31 ng/g dry wt., respectively.

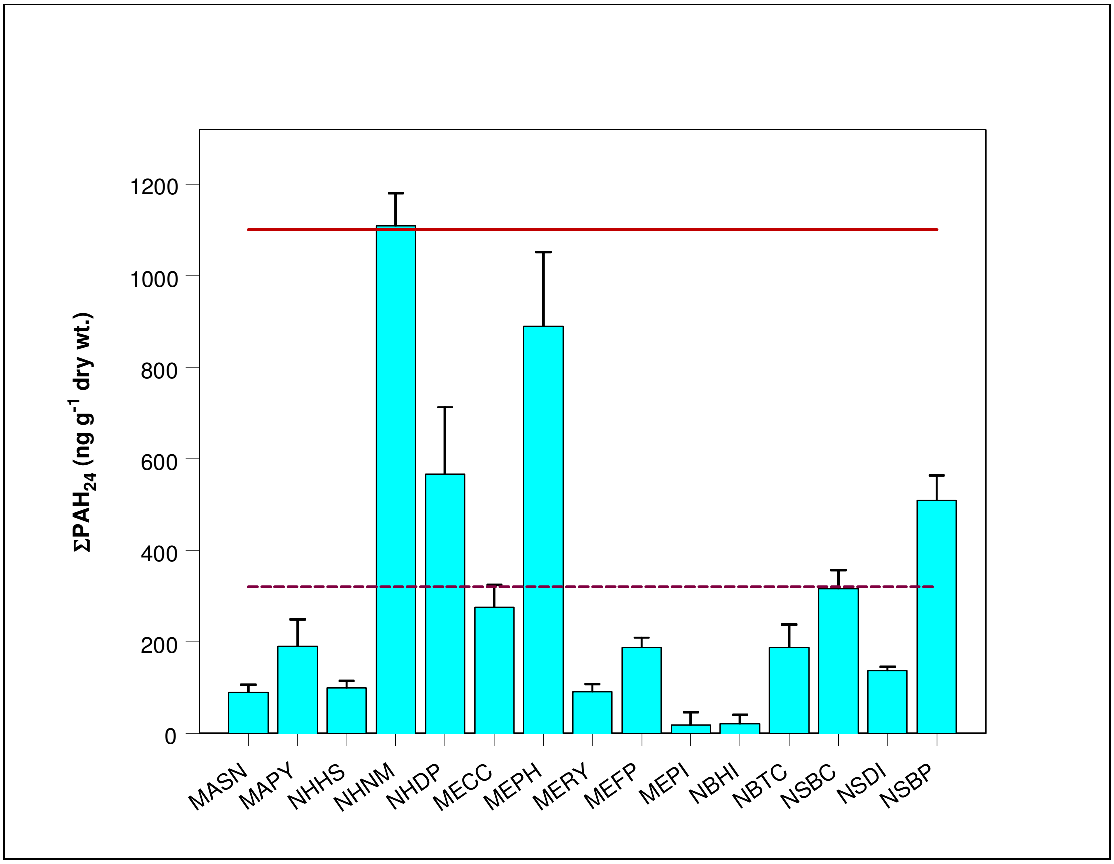


**Figure 12**. Distribution of ∑PAH$_{24}$ tissue concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulfwatch sites during 2005. Dashed line = 1986-1999 Mussel Watch National median; Solid line = 1986-1999 Mussel Watch National 85$^{th}$ Percentile.

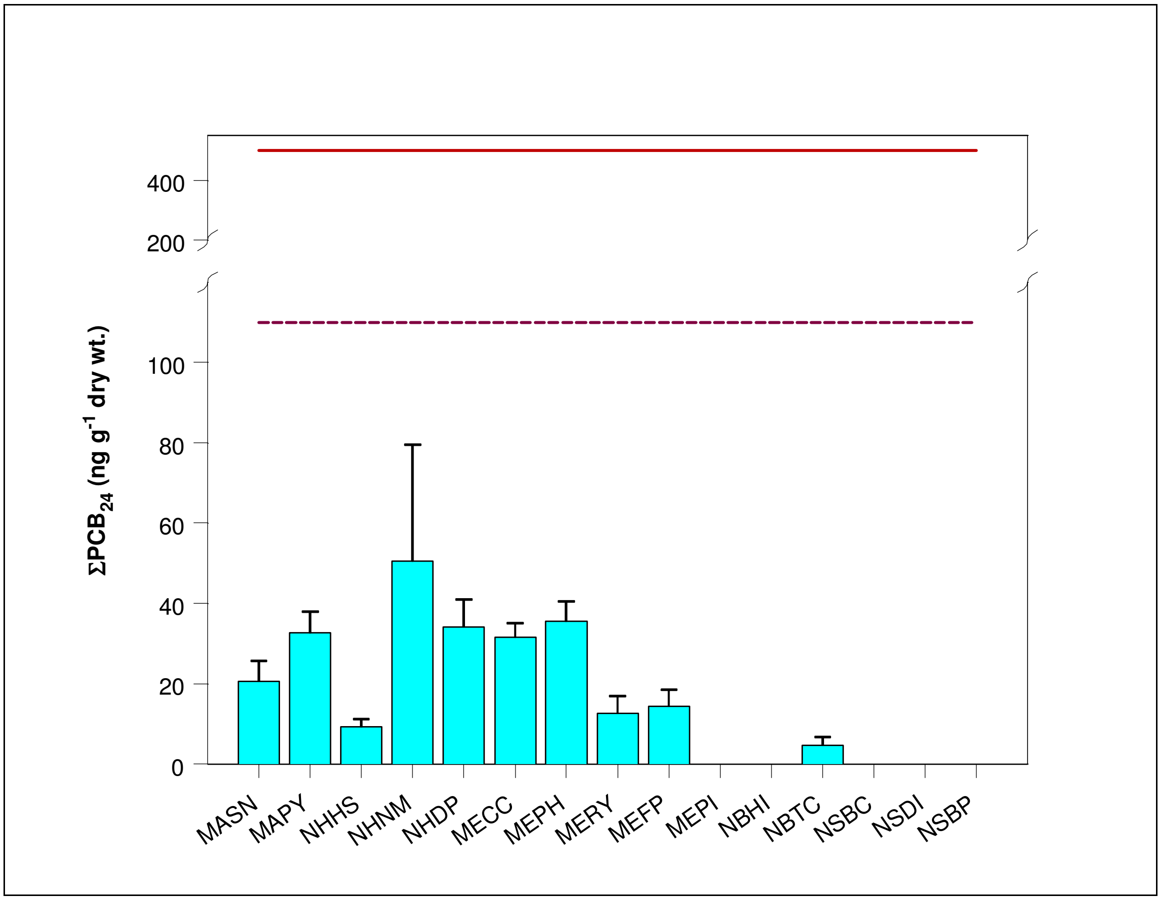


**Figure 13**. Distribution of $\sum PCB_{24}$ tissue concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulfwatch sites during 2005. Dashed line = 1986-1999 Mussel Watch National median; Solid line = 1986-1999 Mussel Watch National 85$^{th}$ Percentile.

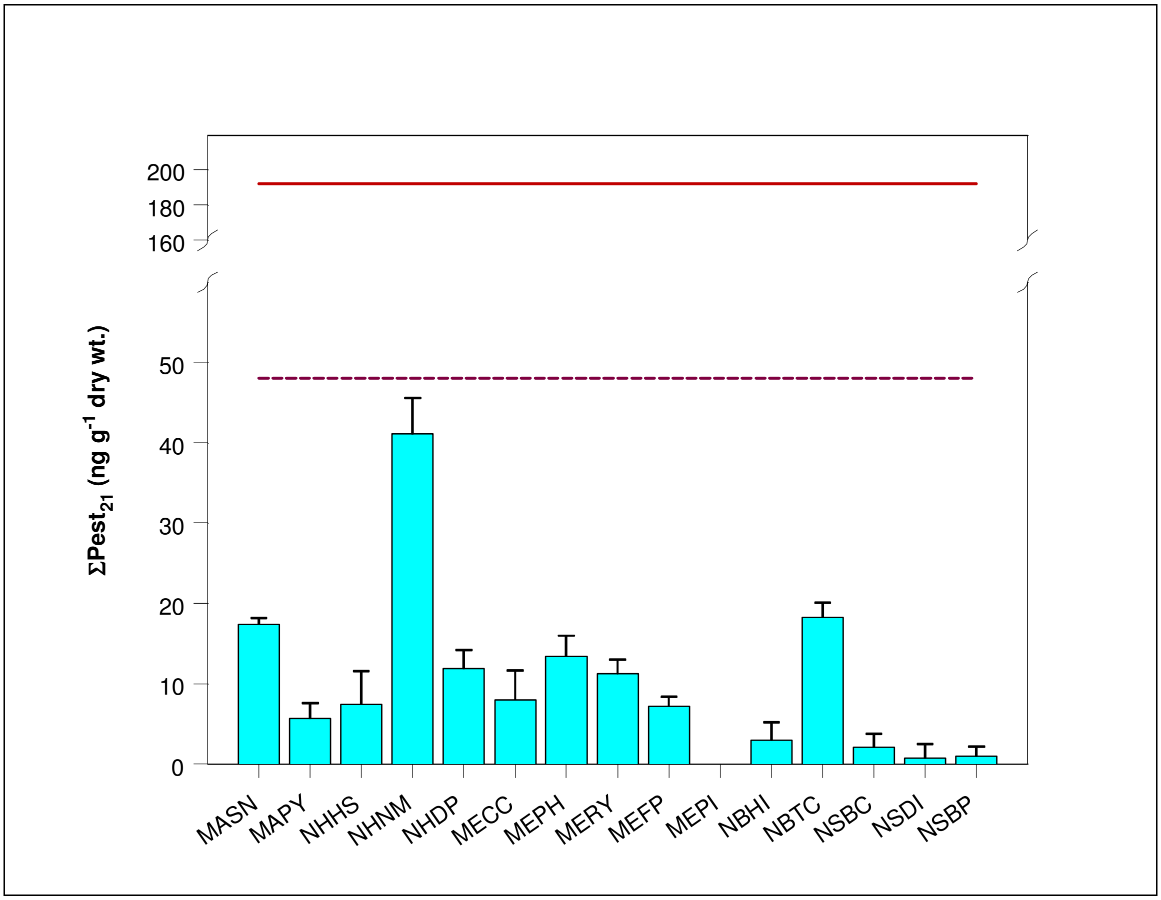


**Figure 14.** Distribution of $\sum TPEST_{21}$ tissue concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulfwatch sites during 2005. Dashed line = 1986-1999 Mussel Watch National median; Solid line = 1986-1999 Mussel Watch National 85$^{th}$ Percentile.

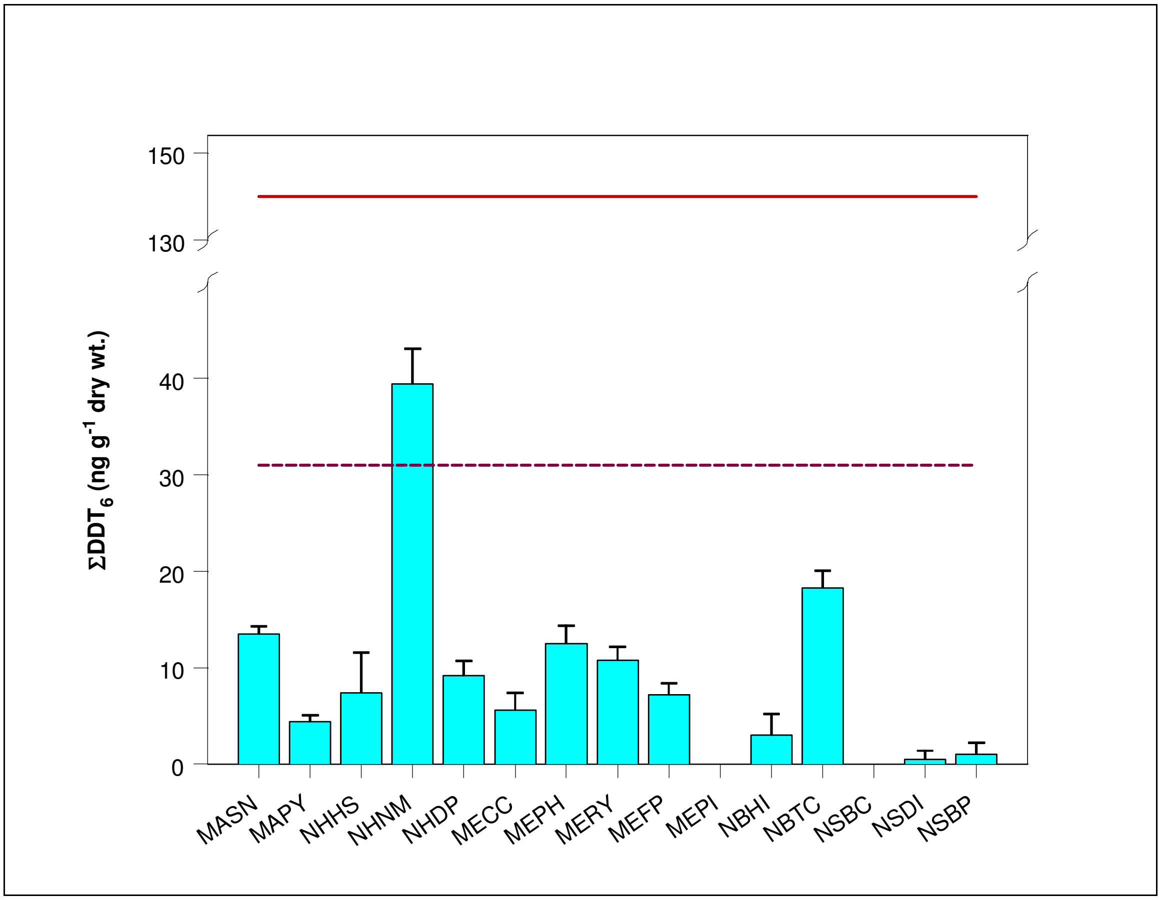


**Figure 15.** Distribution of $\sum DDT_6$ tissue concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulfwatch sites during 2005. Dashed line = 1986-1999 Mussel Watch National median; Solid line = 1986-1999 Mussel Watch National 85$^{th}$ Percentile.

### *4.2 Temporal Patterns*

This section presents the distribution of contaminants categories in mussel tissue collected from "rotational" and benchmark sites along the Gulf of Maine inclusive to 2005 since the beginning of the Program in 1993. All of the sites reported here (except for NSBP) have now been sampled by the Gulfwatch Program at least three times (Table 3) as prescribed by sampling design of the 9-year Gulfwatch Program. Rotational sites are those locations that were sampled every three years and are grouped into three sets of stations that began in 1993, 1994, and 1995. The temporal distribution (along with a group of occasionally-visited sites – see Table 1A-C) of rotational site means (+1 SD) are plotted for each contaminant at individual sites in Figures 16-26. The distribution of contaminants at the 5 benchmark sites (MASN, MECC, MEKN, NBHI, and NSDI), those that were scheduled for sampling each year to 2005, are shown in Figures 27-40. In general, the plots are arranged beginning with the Sandwich, MA and continuing in a clockwise manner around the Gulf of Maine ending with Yarmouth, NS. For plotting purposes, each non-detectable value was assigned ½ the MDL value and used as the lower limit of each concentration axis to help visualize any potential temporal trends.

### 4.2.1 3-Year Rotational Sites.

For the 3-year rotational sites, there were examples of apparent temporal trends either increasing or decreasing for each metal and suites of organic chemicals. In some cases the trends were nullified by extreme within year variability rather than the result of temporal differences (e.g., Cd at MEPH, Fig. 16A, top-right panel) and also serve to draw attention to unusual variability in replicate analyses which are provided in the Appendices. Of note is the apparent decline in Hg through 2005 in ~ 60% of the 15 sites along the Gulf of Maine; the apparent increases in ∑PAH at MAPY (Fig 16C) and NHNM (Fig. 18C); and the apparent decline in ∑Pest (and ∑DDT at MEPH, Fig 20C). Changes in ∑Pest levels at most sites can be attributed to changes in the amount of DDT and DDT homologues; as these species tended to dominate the suite of pesticides monitored by the Gulfwatch Program. Formal trend analyses of the Gulfwatch data is an important next step to discerning temporal changes in contaminant exposure to blue mussels in the Gulf of Maine and is beyond the scope of this data report.

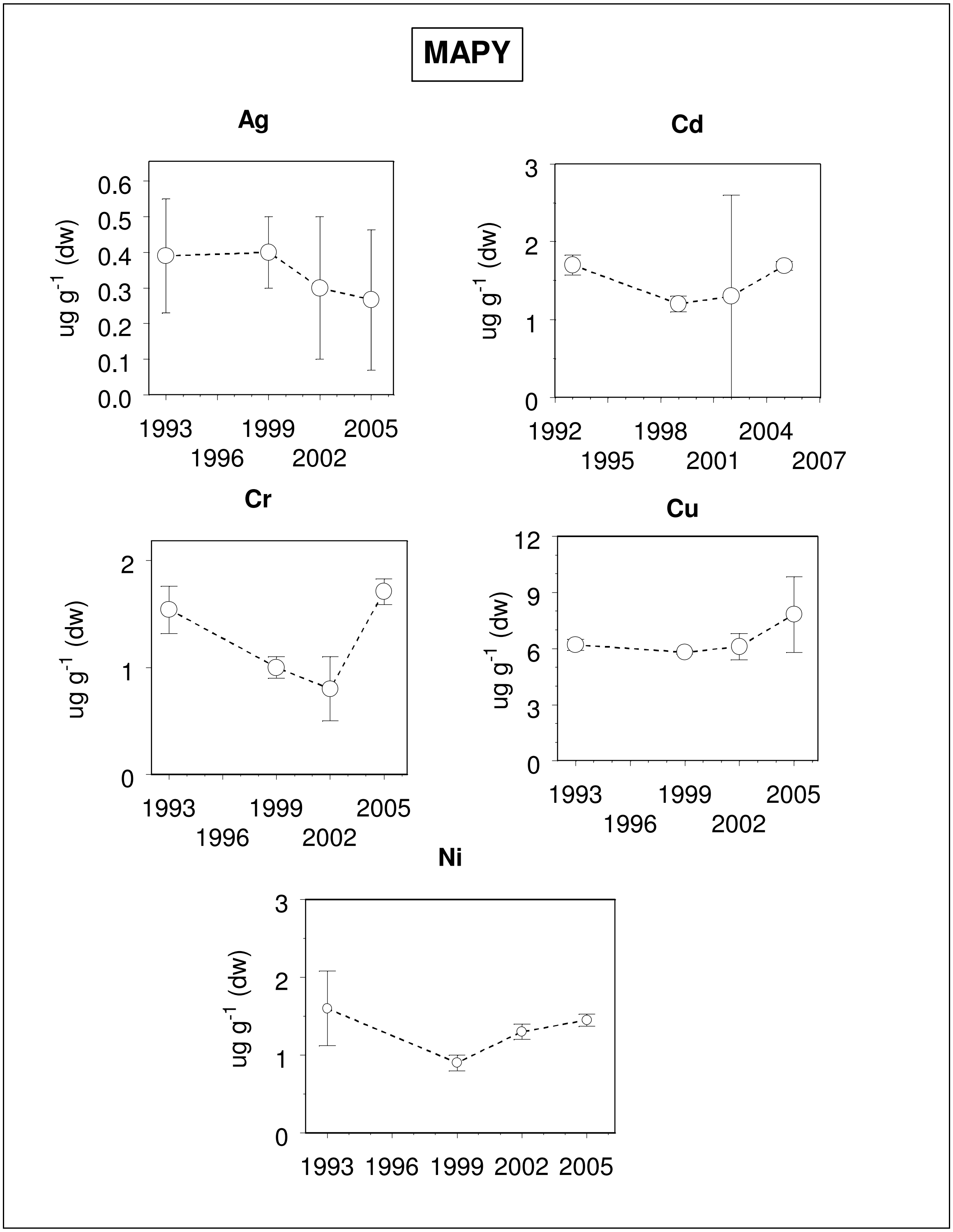


**Figure 16A**. Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, μg/g dry weight) in mussels collected at the MAPY Gulfwatch site from selected years during the period from 1993 - 2005.

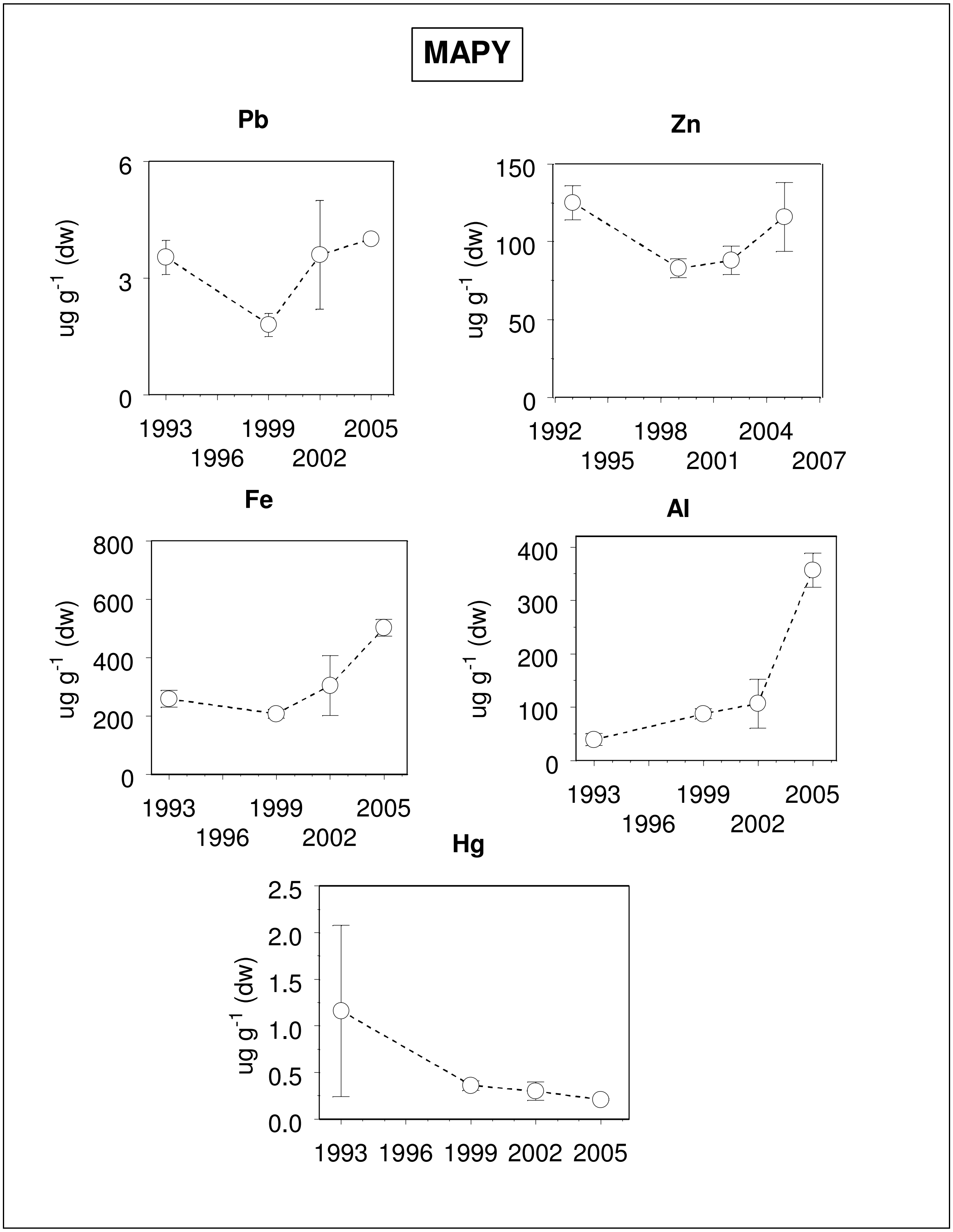


**Figure 16B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MAPY Gulfwatch site from selected years during the period from 1993 - 2005.

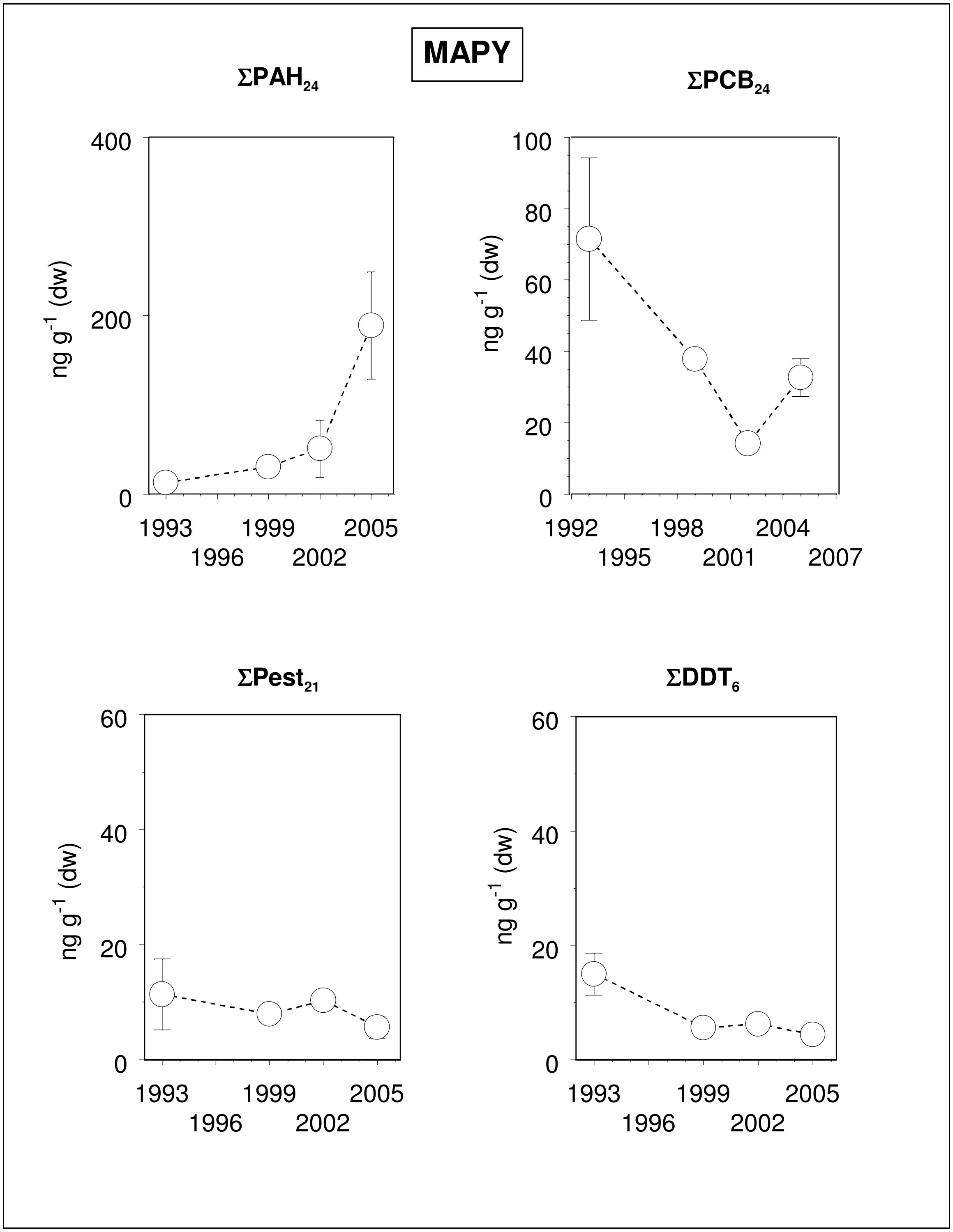


**Figure 16C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the MAPY Gulfwatch site from selected years during the period from 1993-2005.

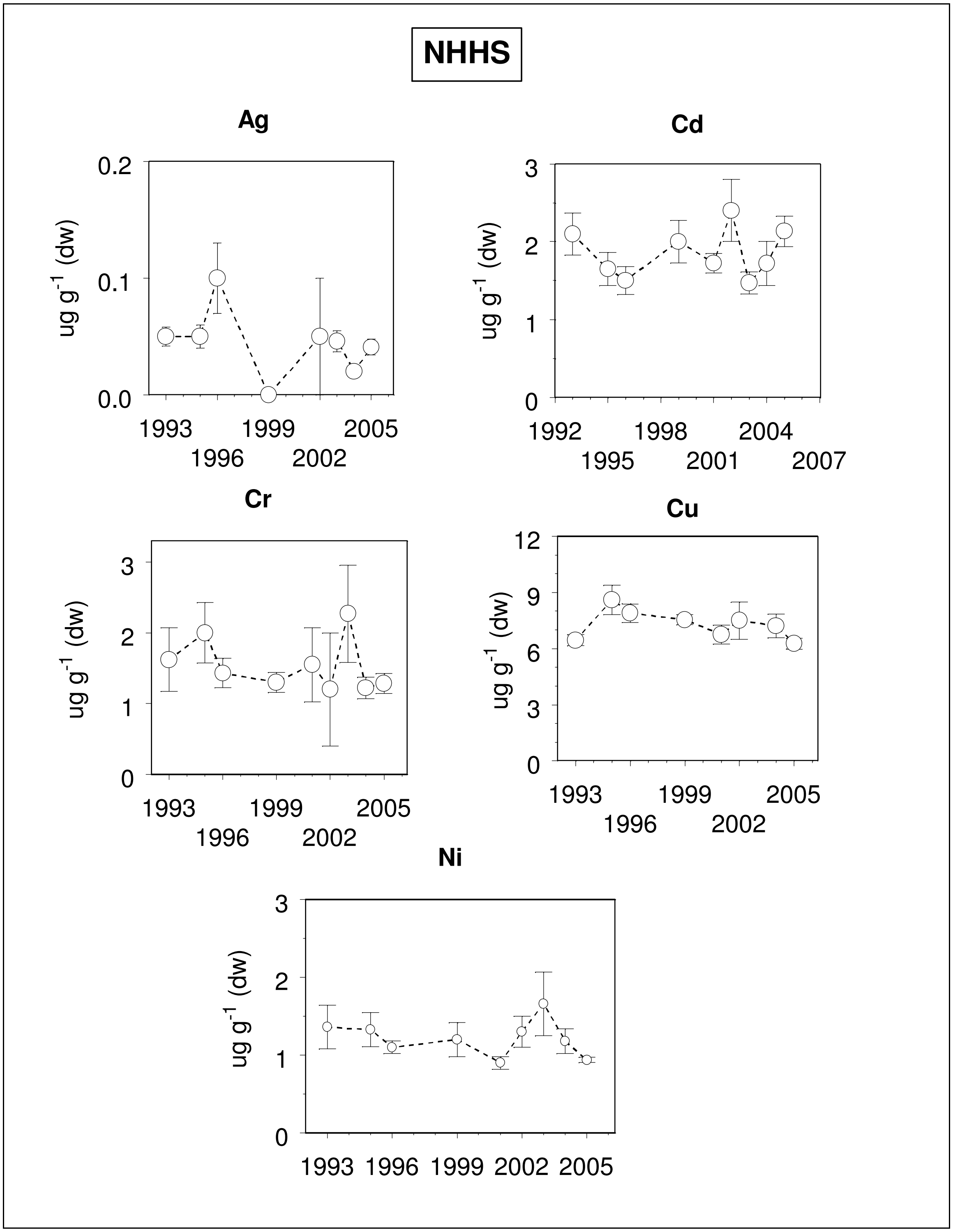


**Figure 17A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NHHS Gulfwatch site from selected years during the period from 1993-2005.

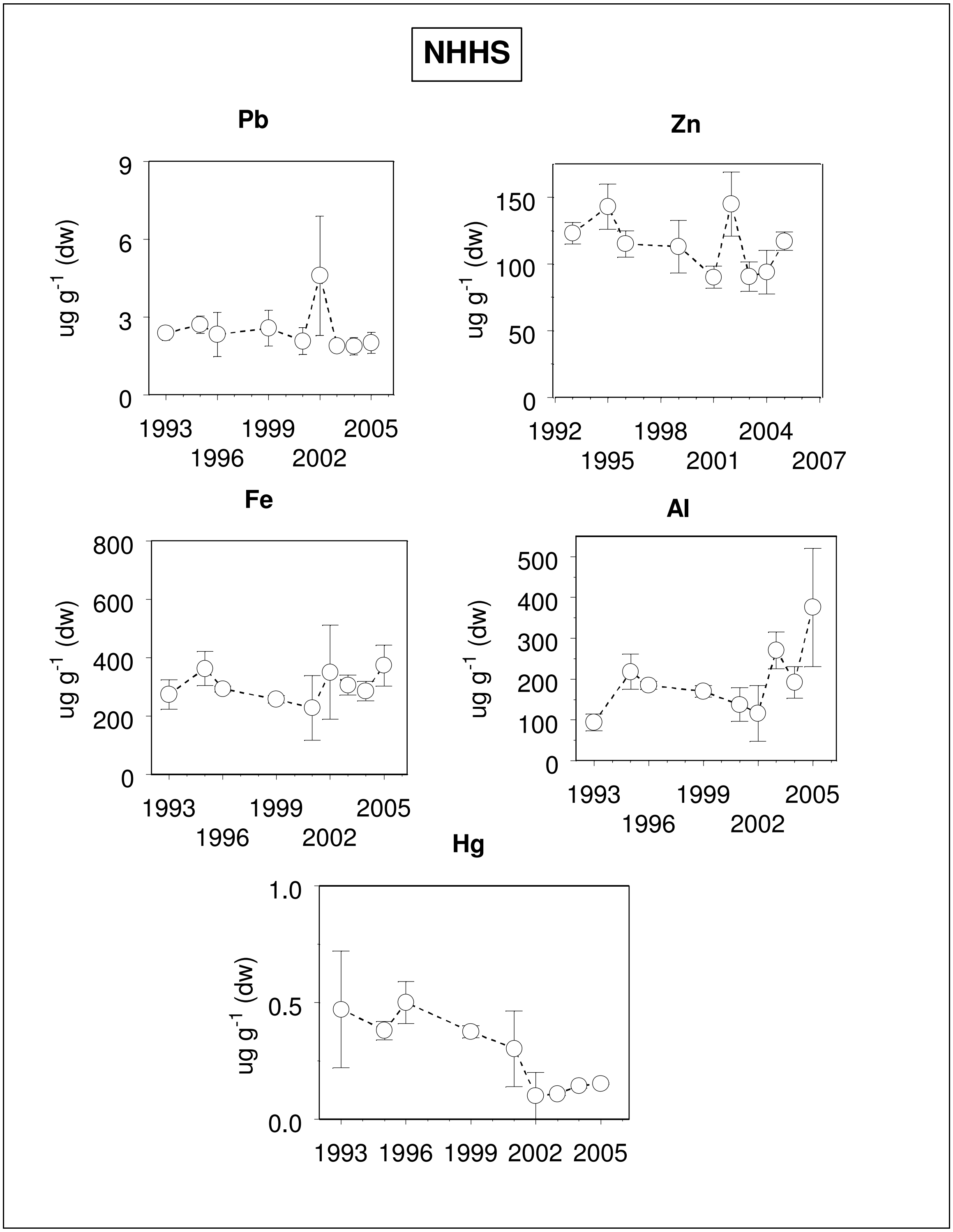


**Figure 17B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NHHS Gulfwatch site from selected years during the period from 1993-2005.

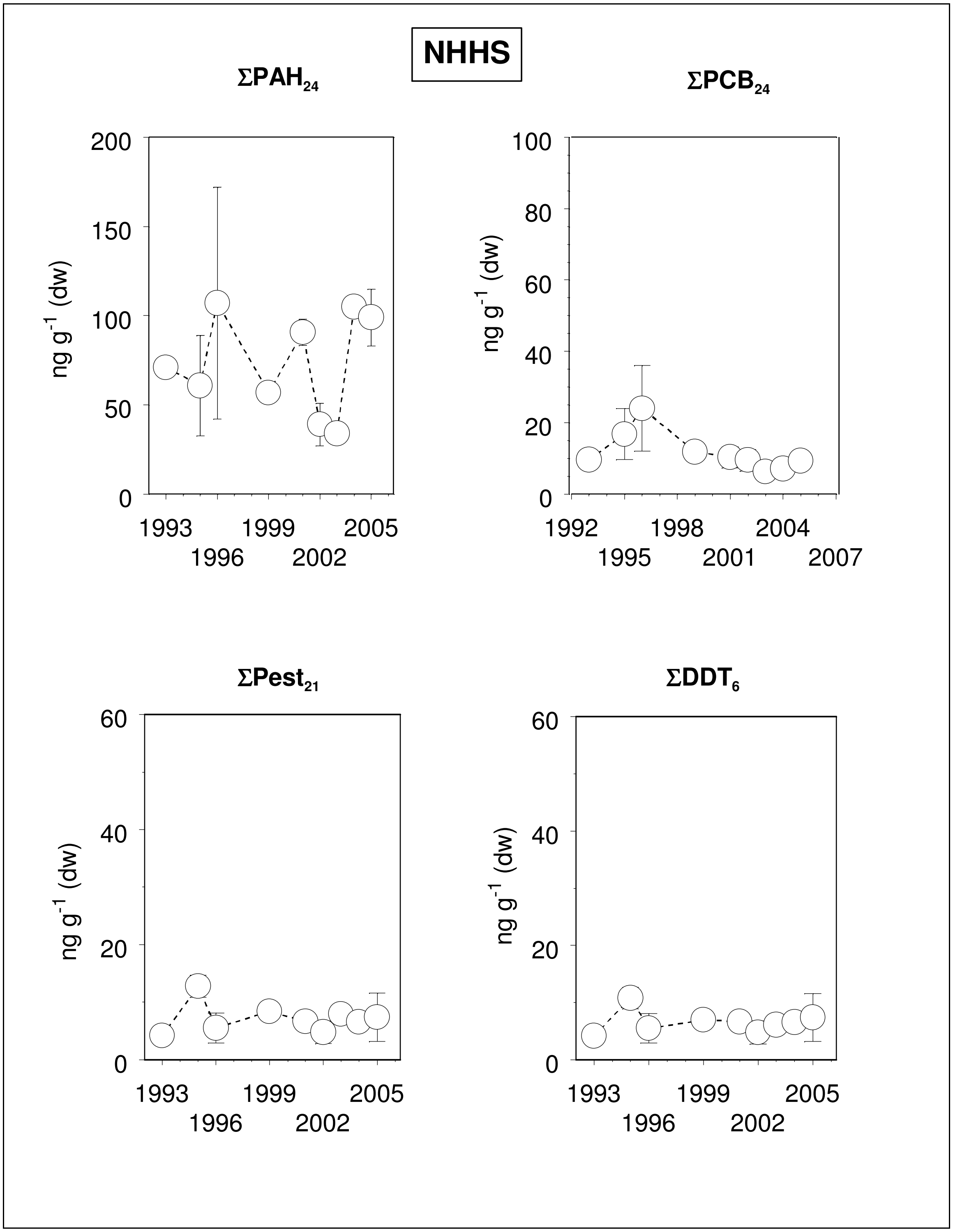


**Figure 17C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the NHHS Gulfwatch site from selected years during the period from 1993-2005.

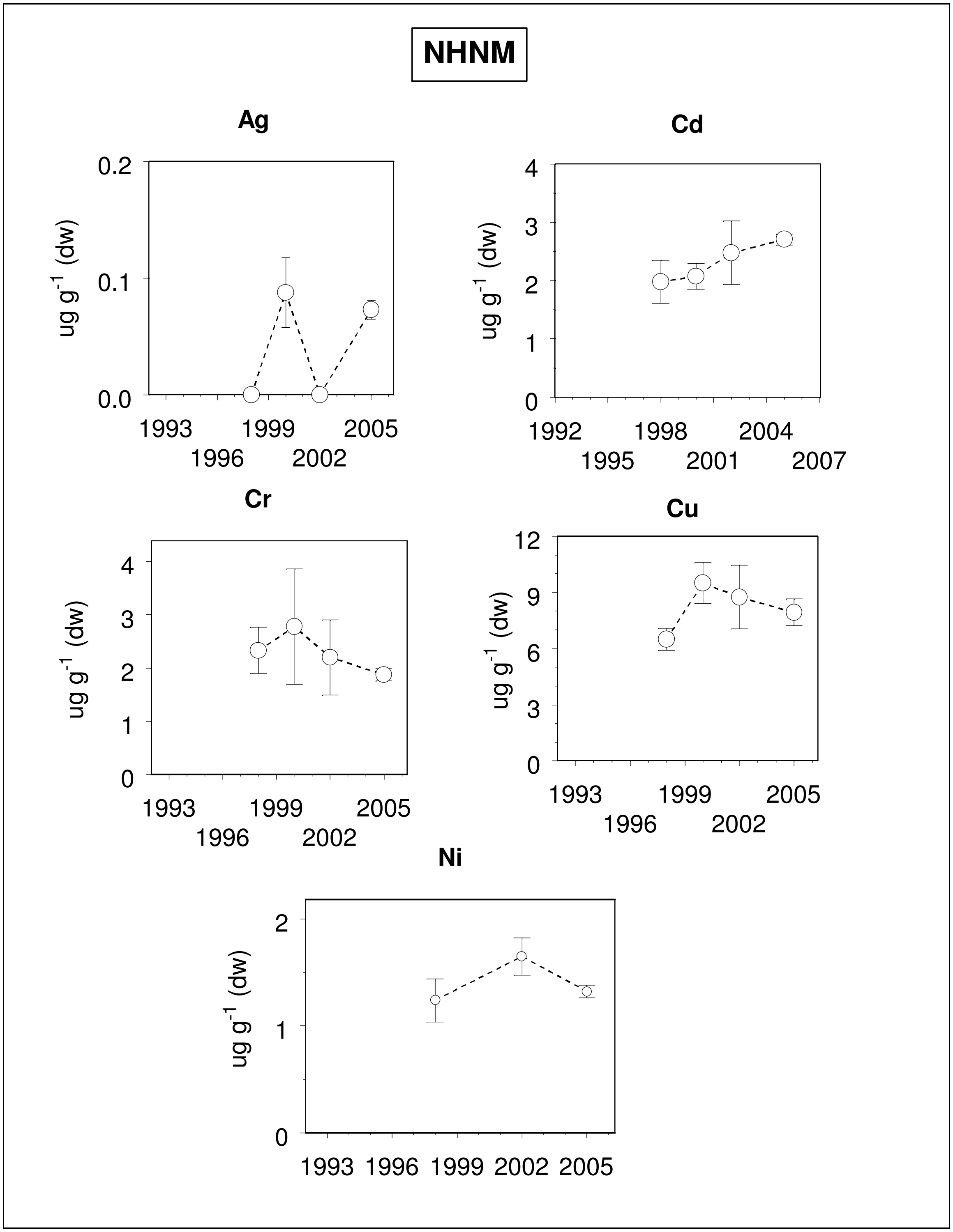


**Figure 18A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NHNM Gulfwatch site from selected years during the period from 1993-2005. Cu and Cr values determined on the 2003 samples are omitted due to suspected contamination.

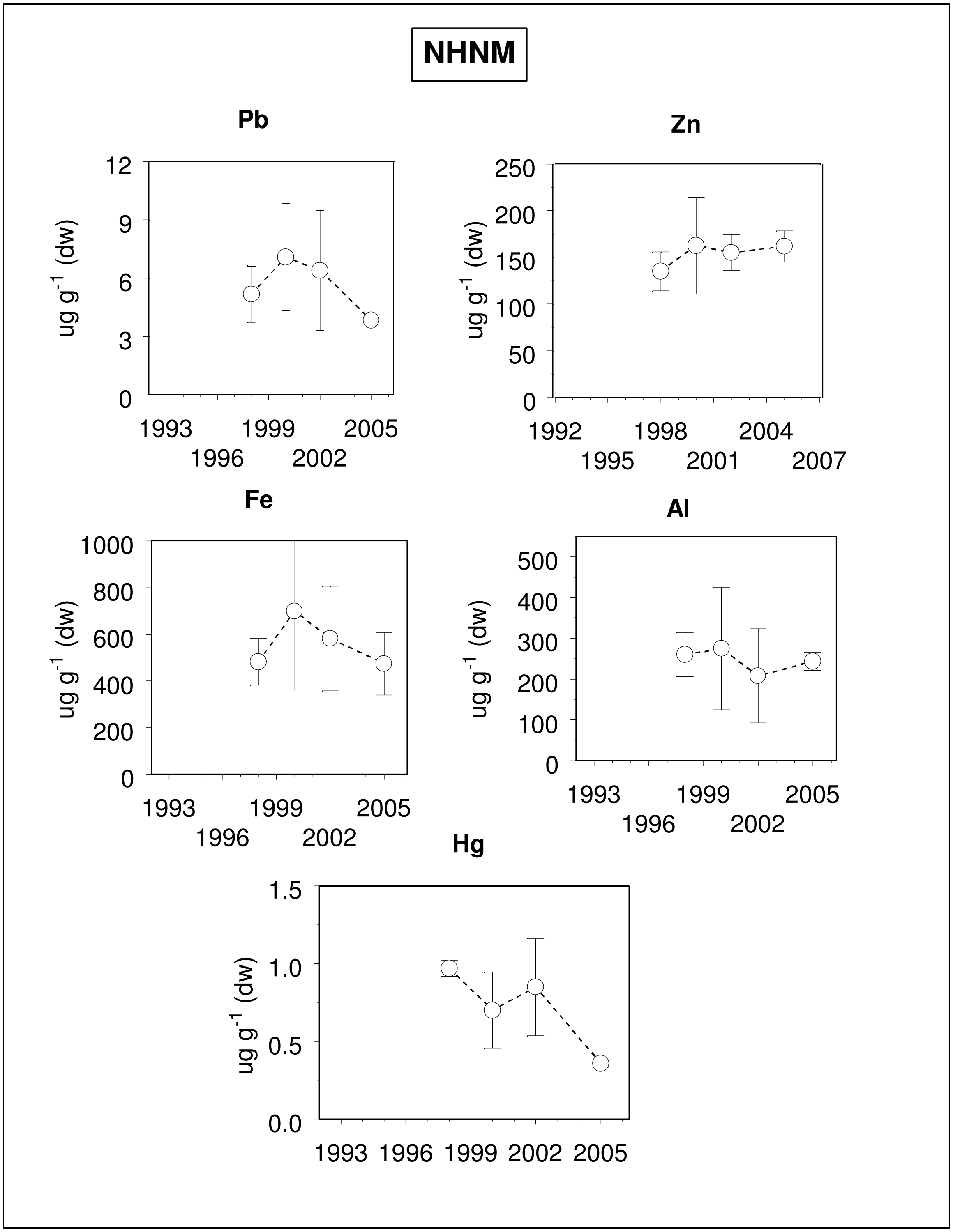


**Figure 18B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NHNM Gulfwatch site from selected years during the period from 1993-2005.

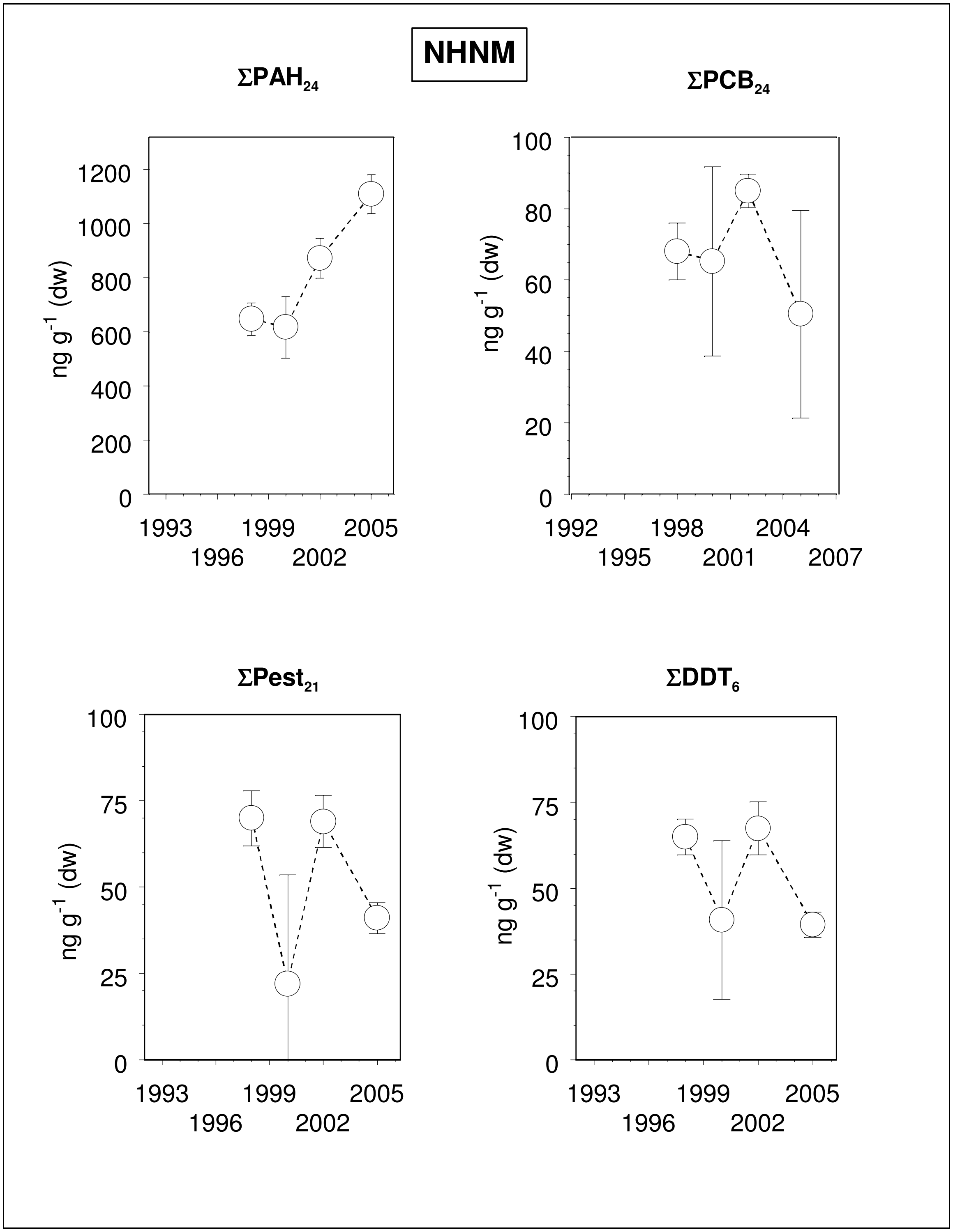


**Figure 18C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the NHNM Gulfwatch site from selected years during the period from 1993-2005.

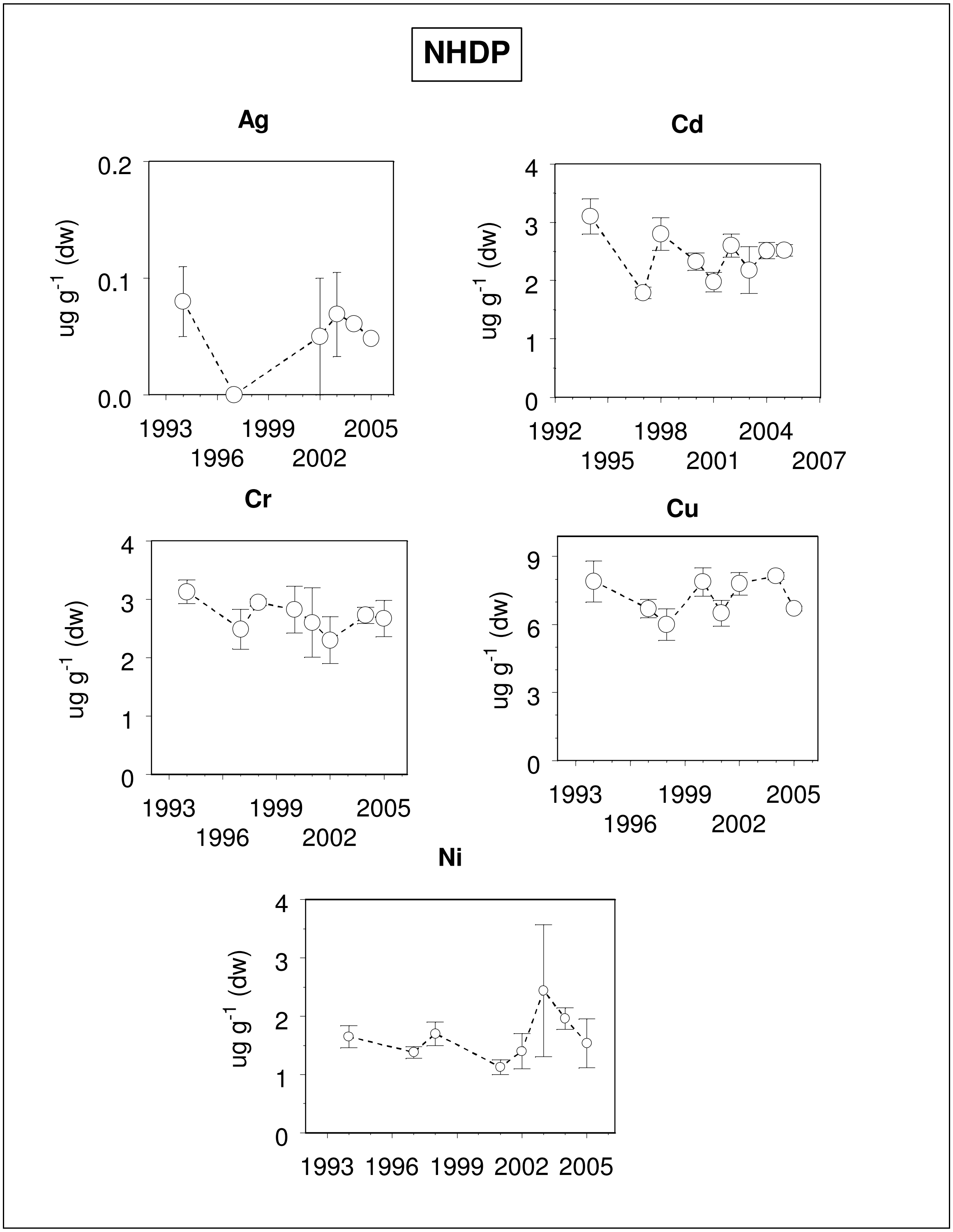


**Figure 19A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NHDP Gulfwatch site from selected years during the period from 1993-2005. Cu and Cr values determined on the 2003 samples are omitted due to suspected contamination.

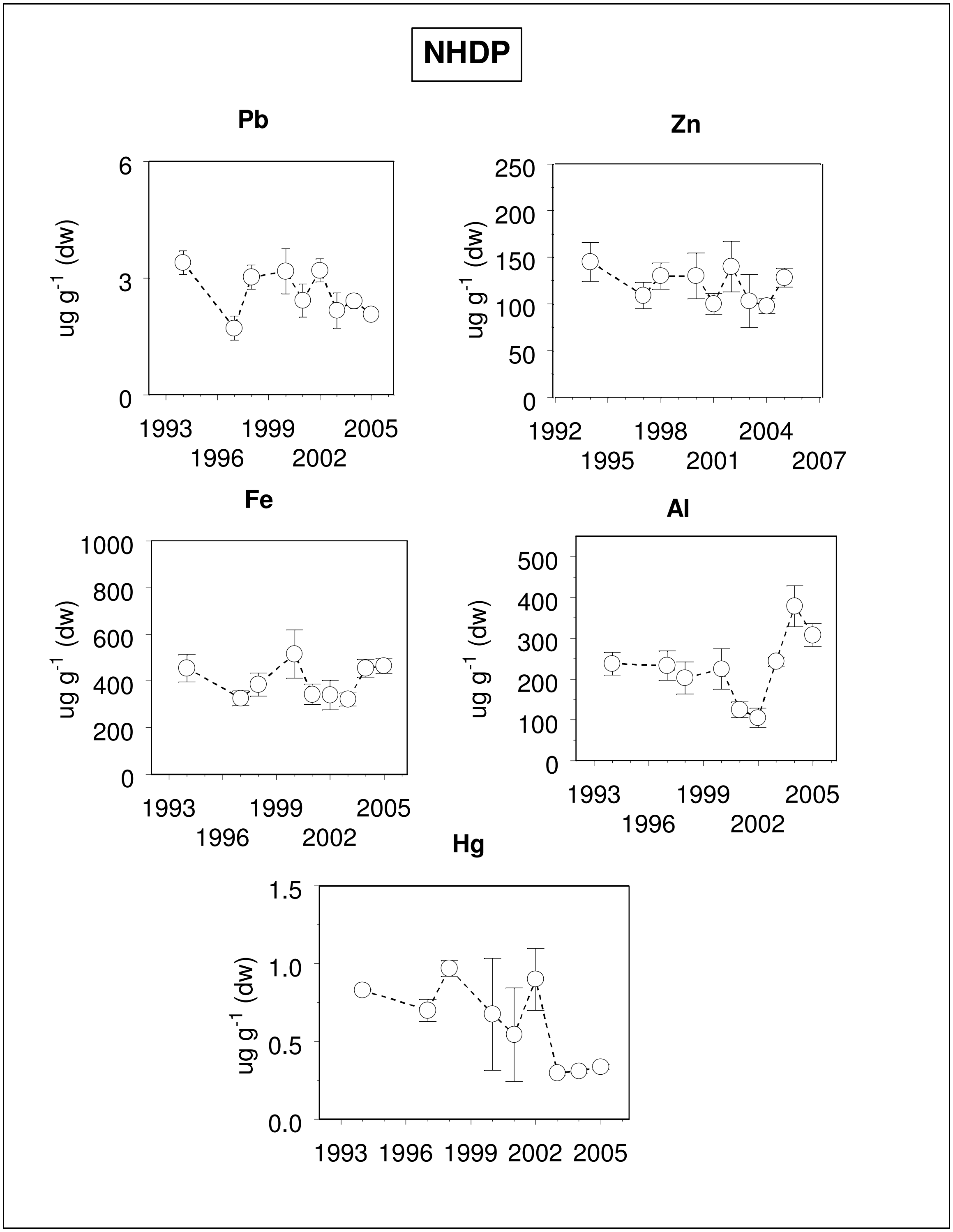


**Figure 19B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NHDP Gulfwatch site from selected years during the period from 1993-2005.

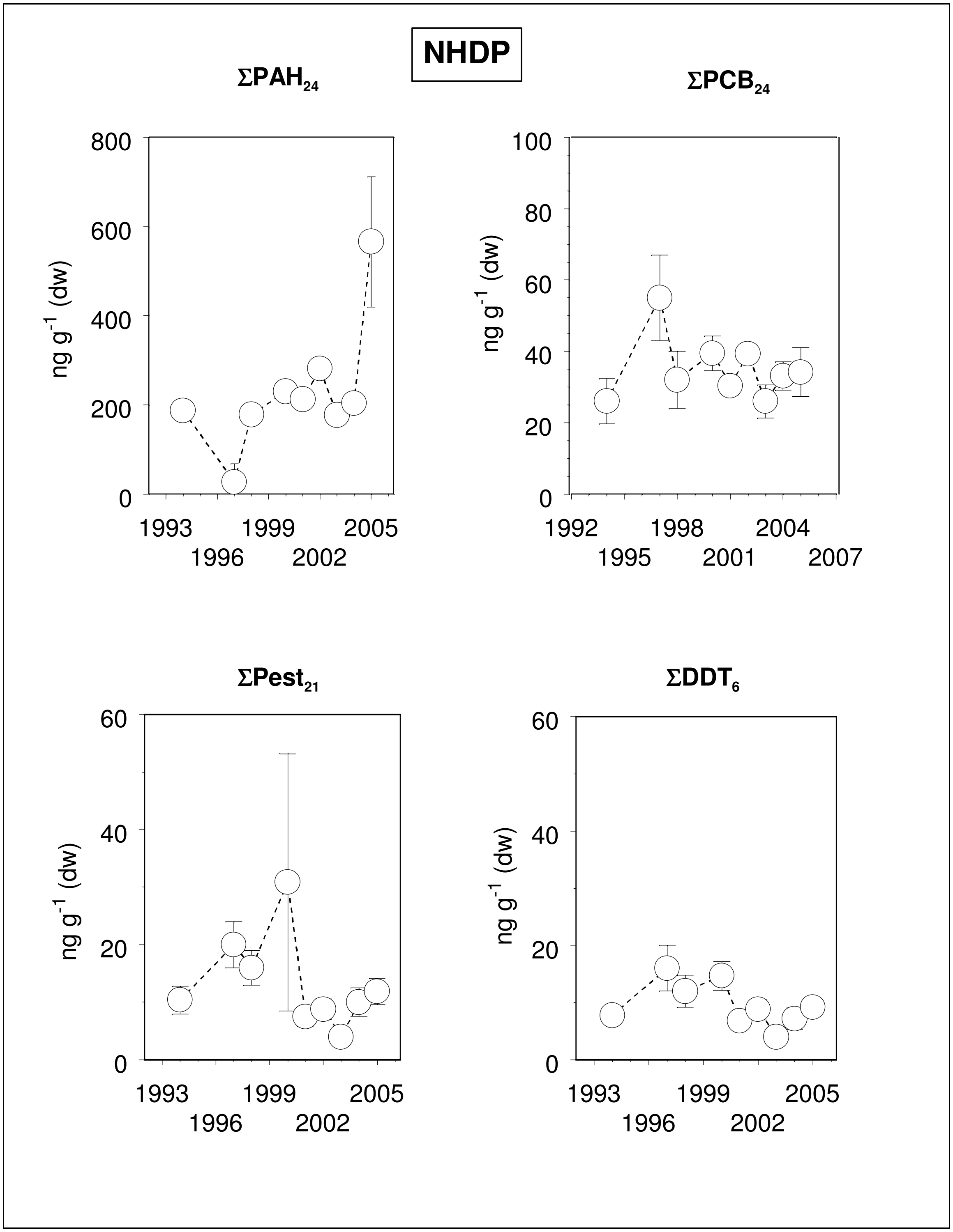


**Figure 19C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the NHDP Gulfwatch site from selected years during the period from 1993-2004.

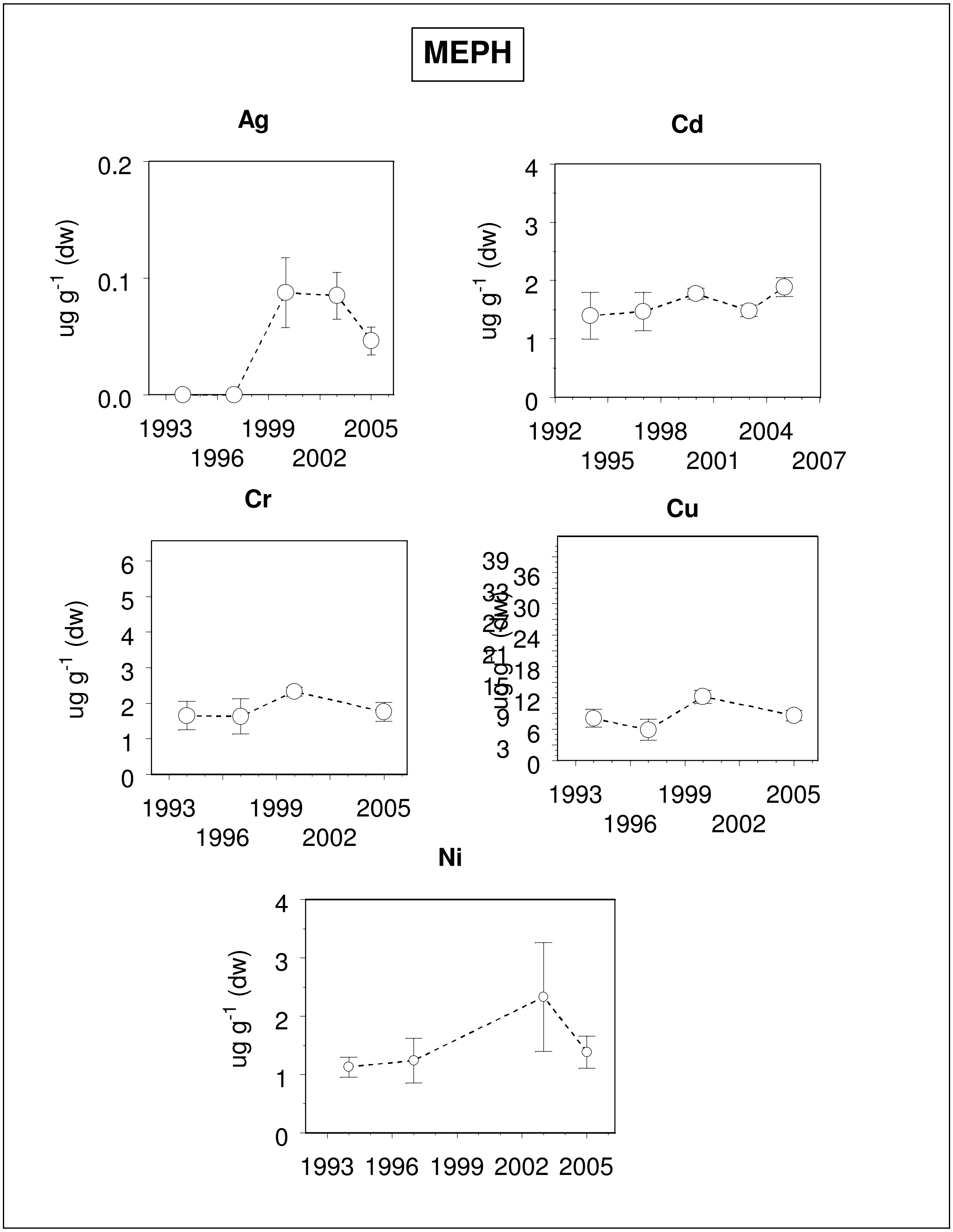


**Figure 20A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MEPH Gulfwatch site from selected years during the period from 1993-2005. Cu and Cr values determined on the 2003 samples are omitted due to suspected contamination.

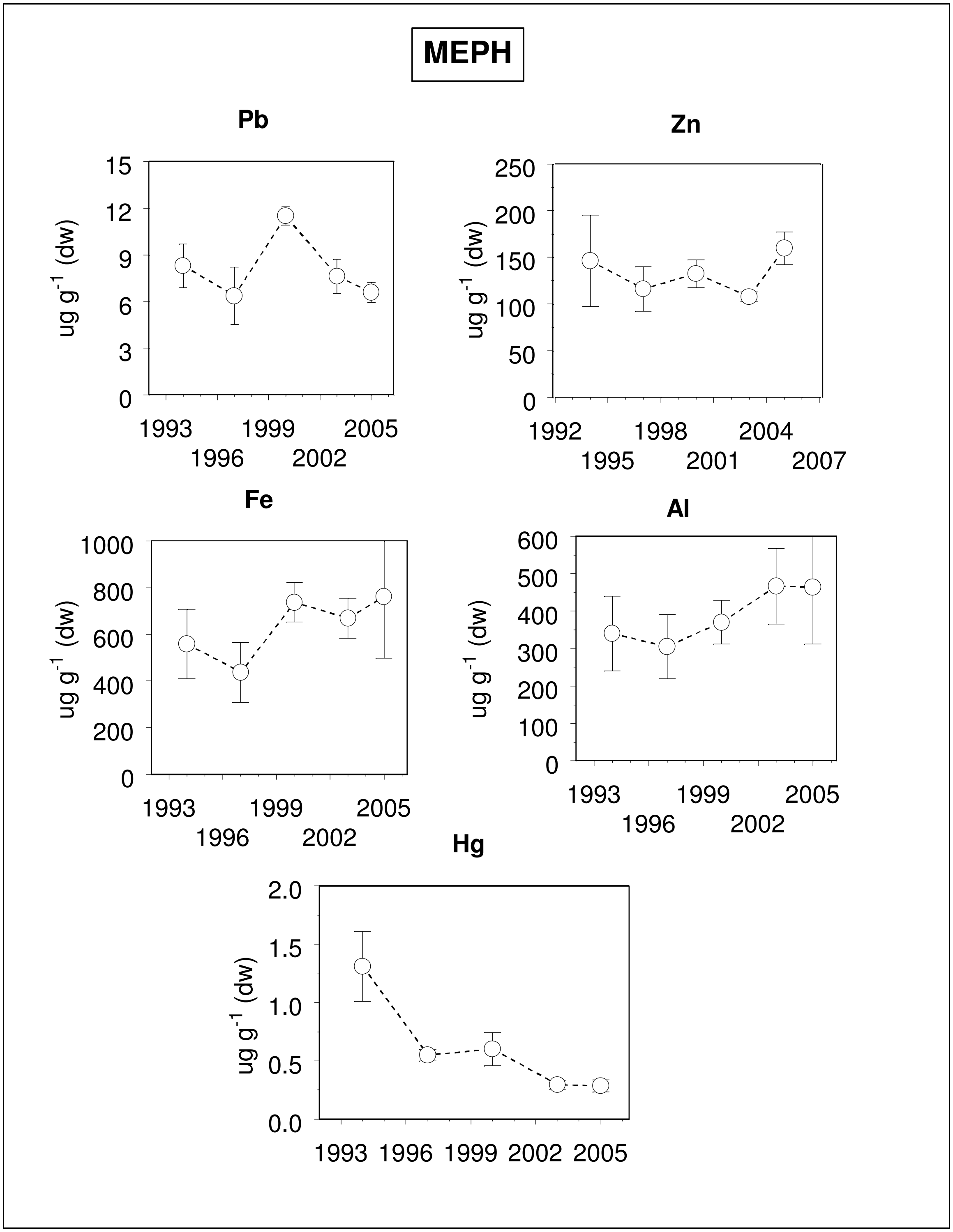


**Figure 20B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MEPH Gulfwatch site from selected years during the period from 1993-2005.

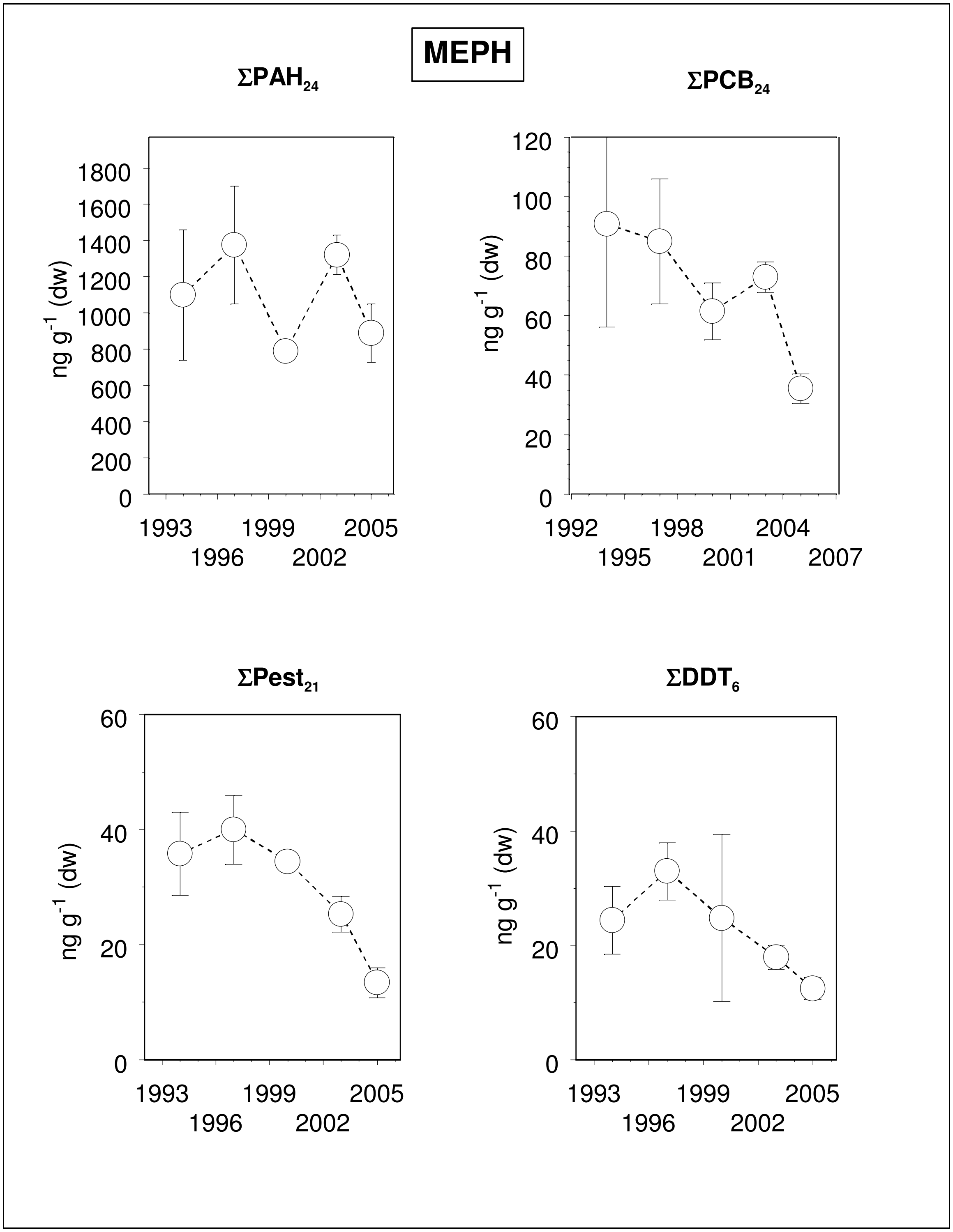


**Figure 20C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the MEPH Gulfwatch site from selected years during the period from 1993-2005.

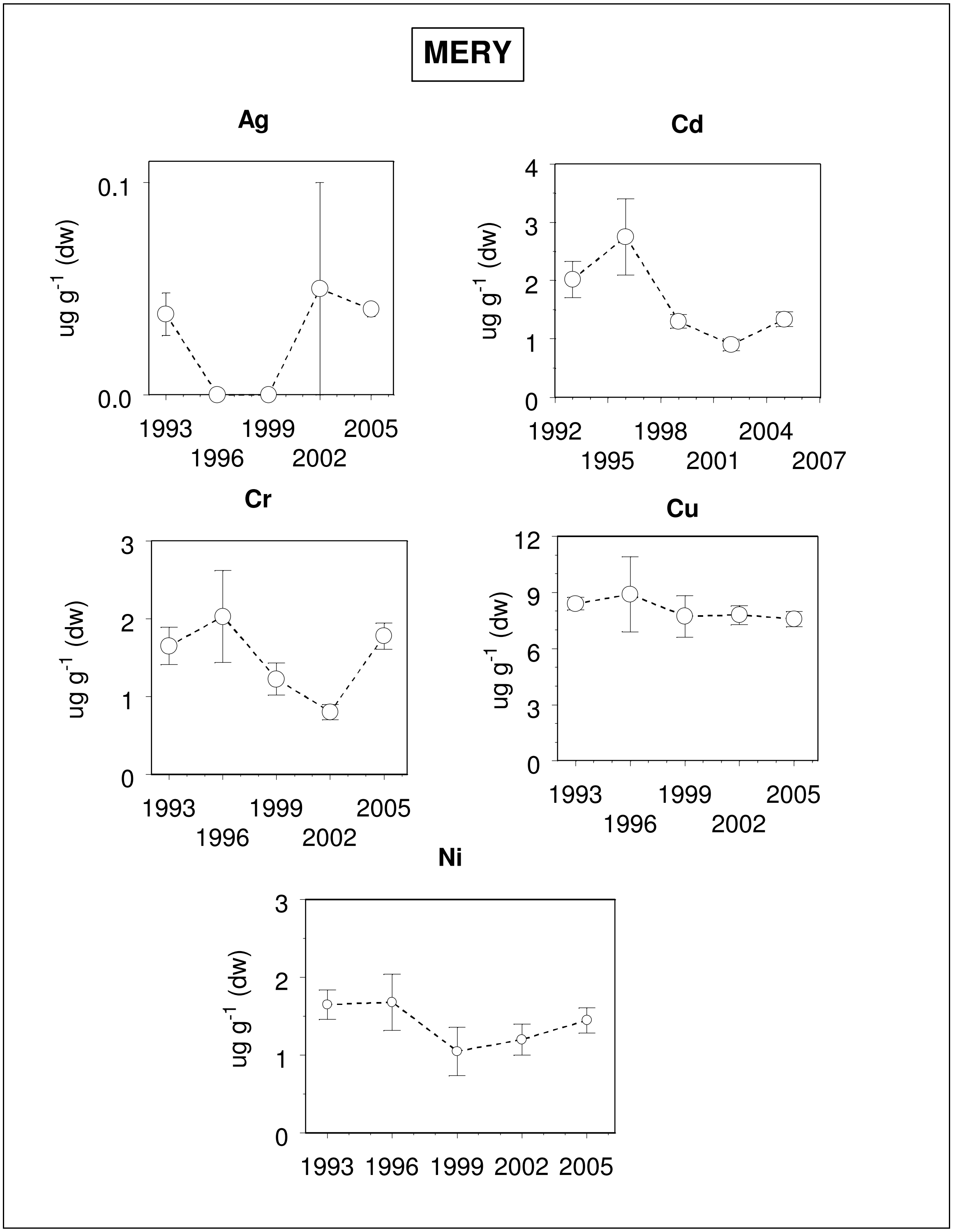


**Figure 21A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MERY Gulfwatch site from selected years during the period from 1993-2004. Cu and Cr values determined on the 2003 samples are omitted due to suspected contamination.

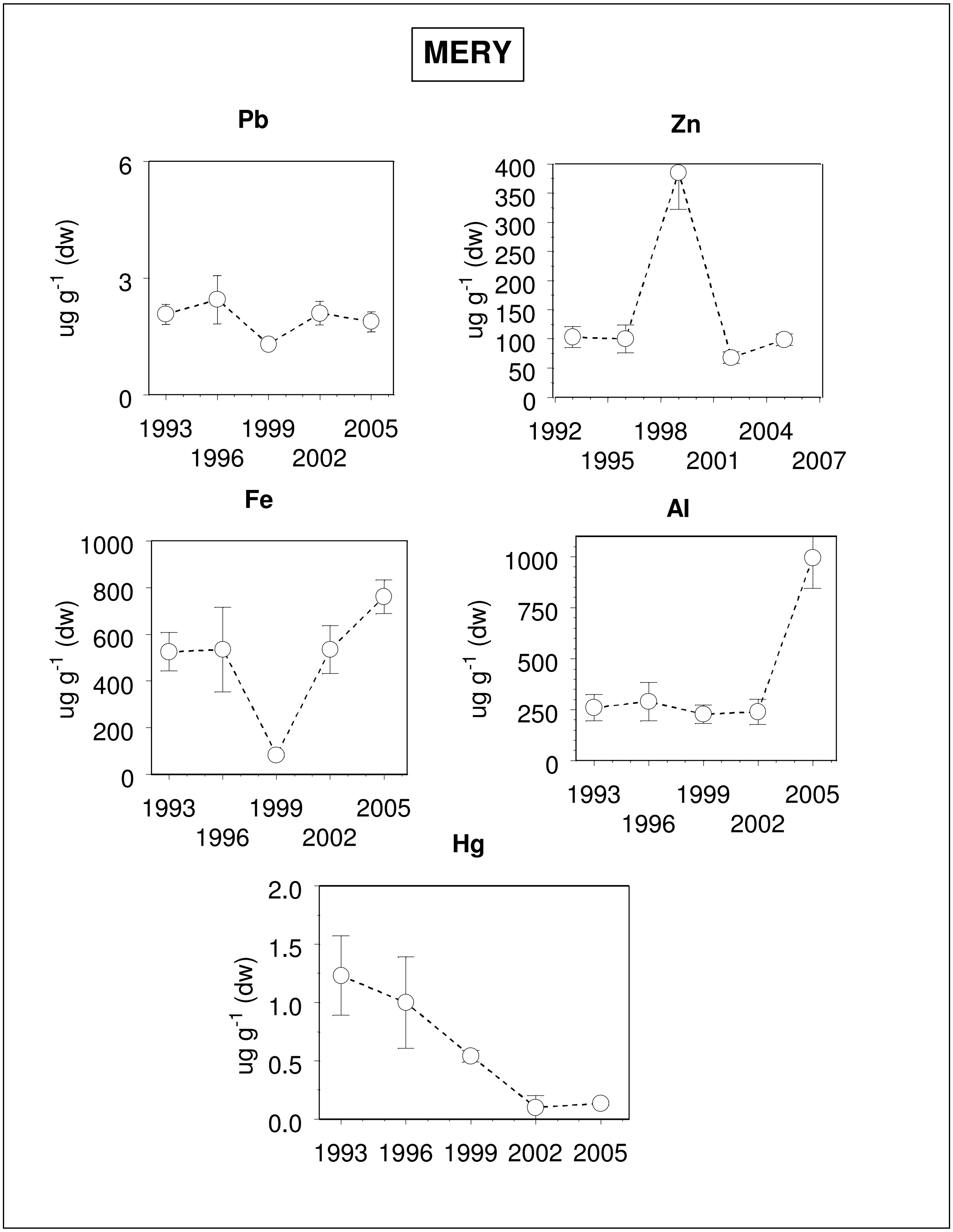


**Figure 21B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MERY Gulfwatch site from selected years during the period from 1993-2005.

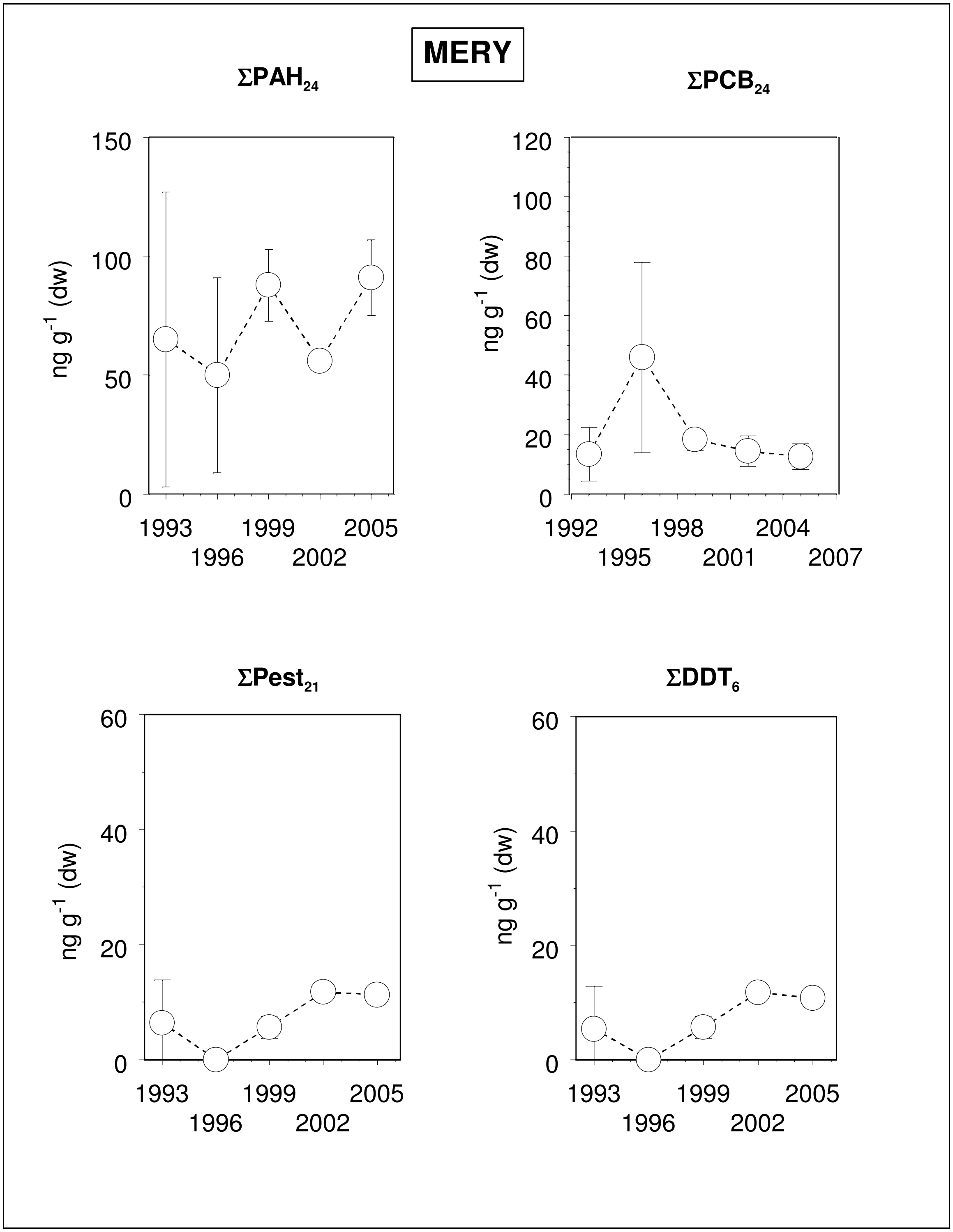


**Figure 21C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the MERY Gulfwatch site from selected years during the period from 1993-2005.

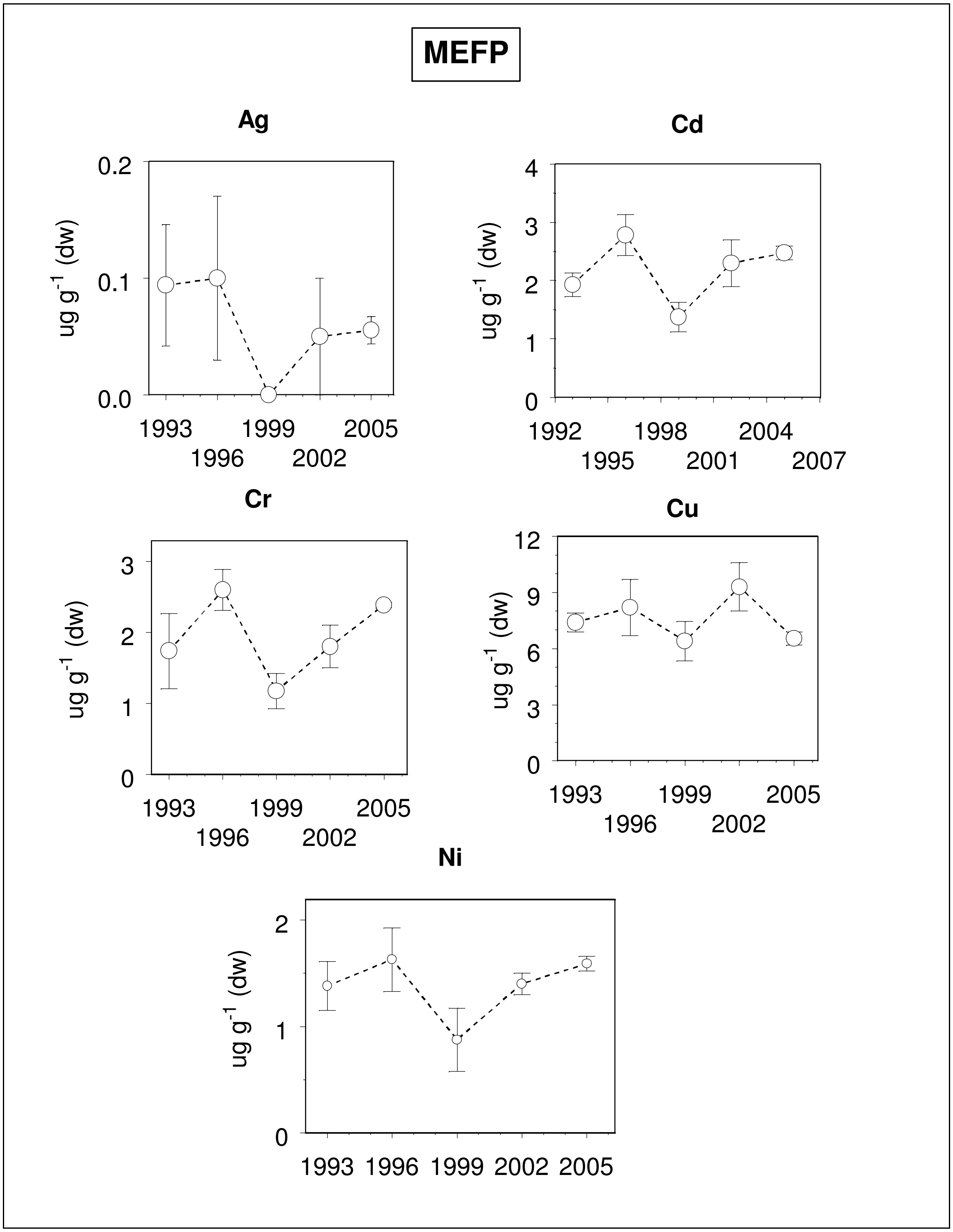


**Figure 22A**. Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MEFP Gulfwatch site from selected years during the period from 1993-2005.

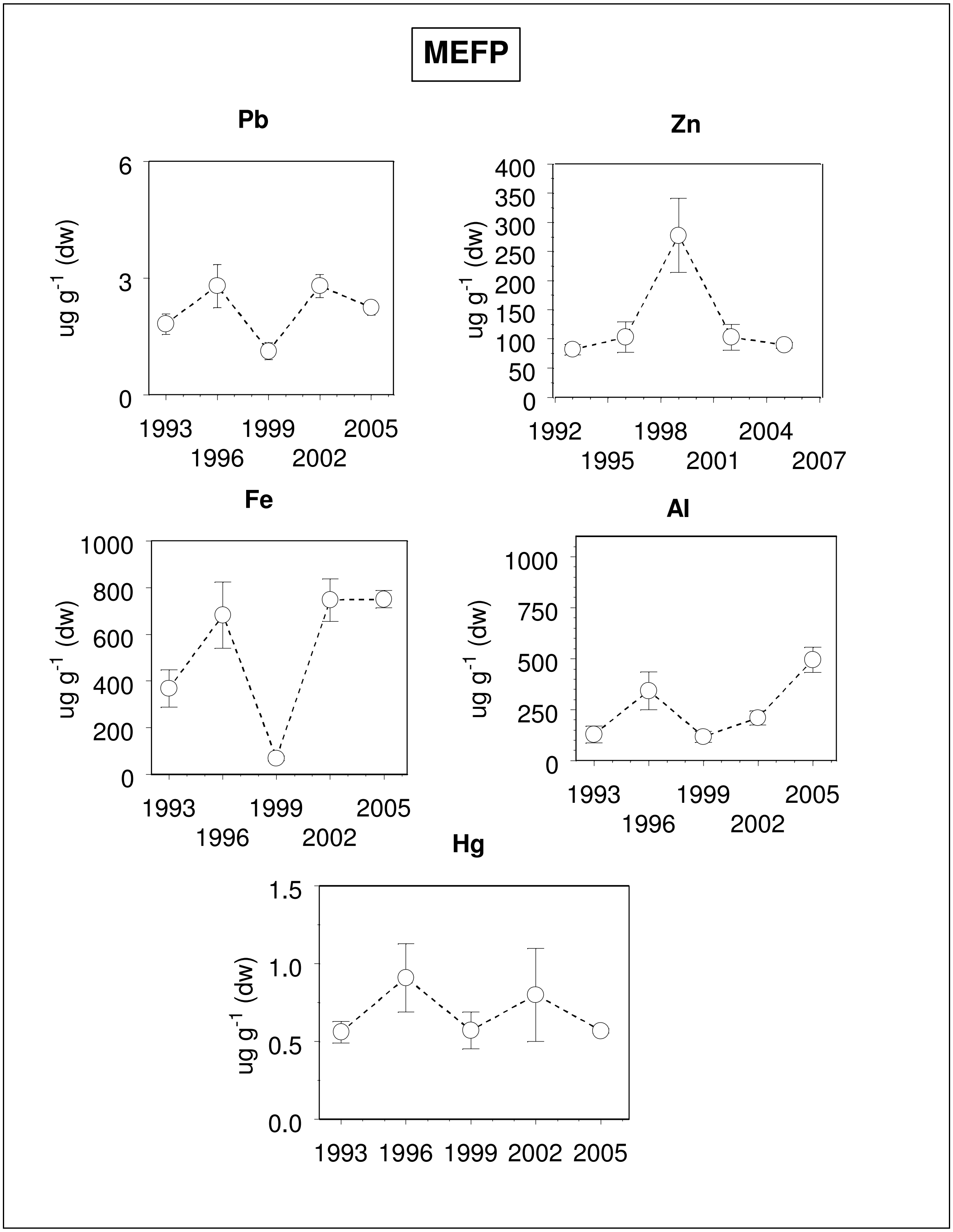


**Figure 22B**. Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MEFP Gulfwatch site from selected years during the period from 1993-2005.

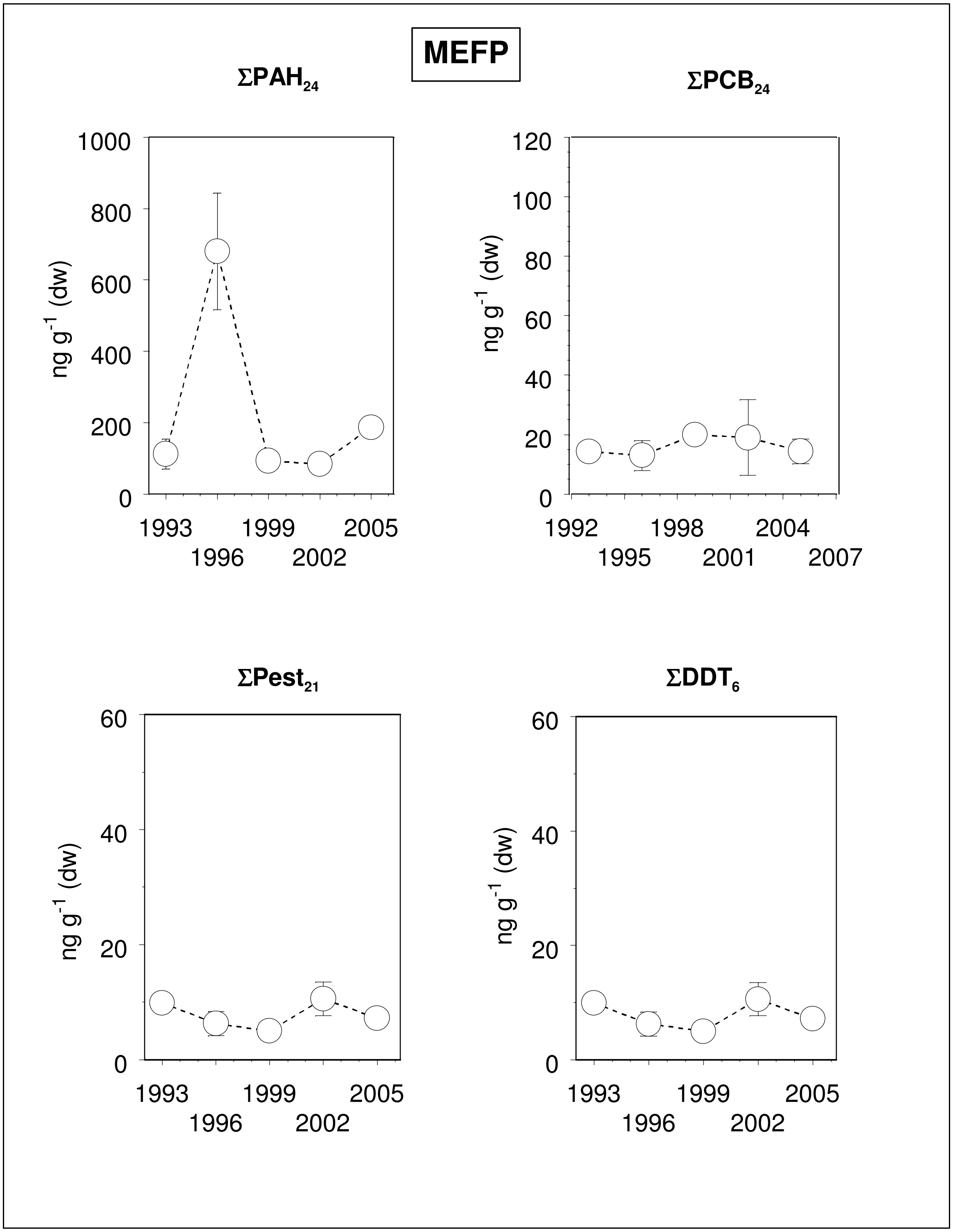


**Figure 22C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the MEFP Gulfwatch site from selected years during the period from 1993-2005.

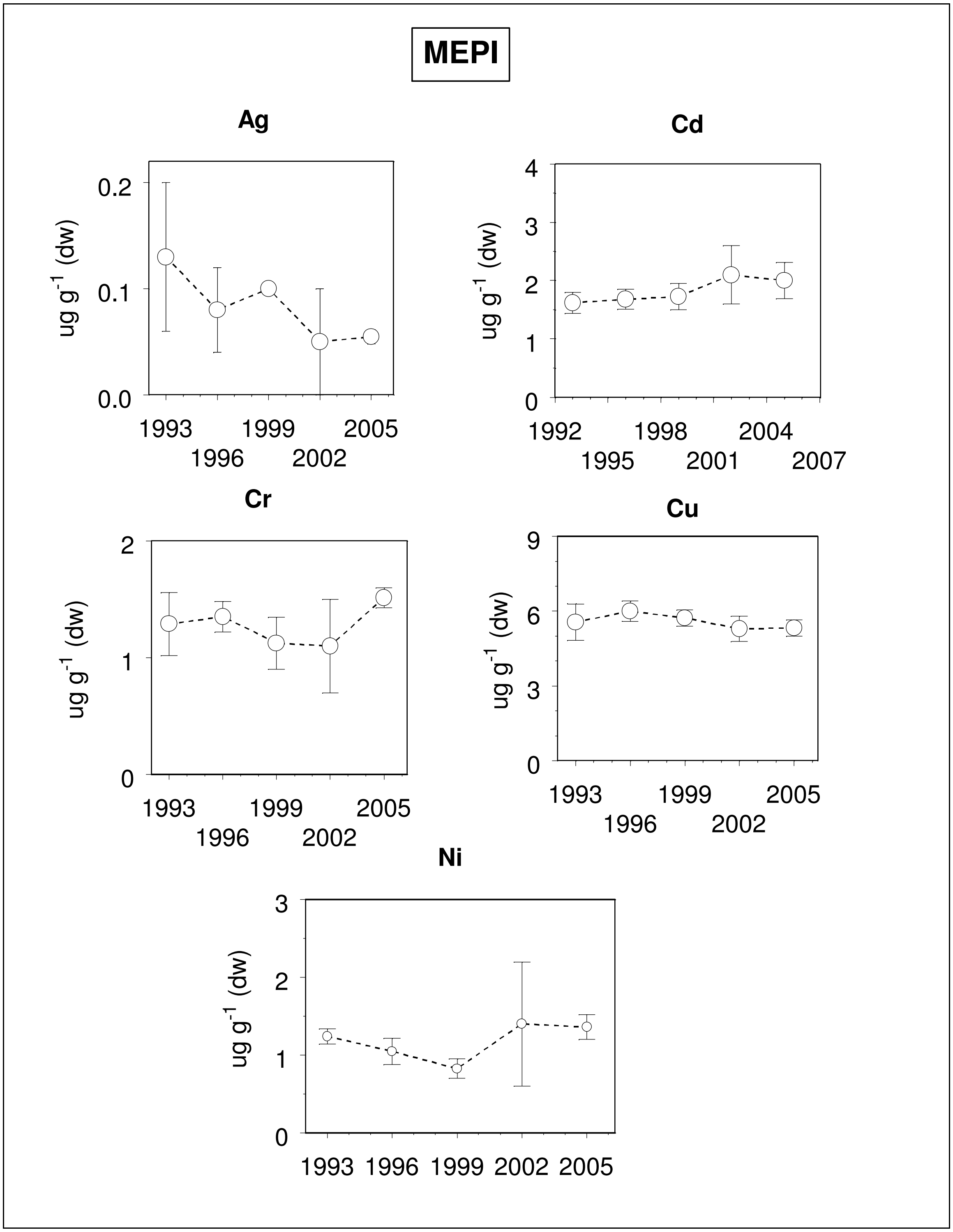


**Figure 23A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MEPI Gulfwatch site from selected years during the period from 1993-2005.

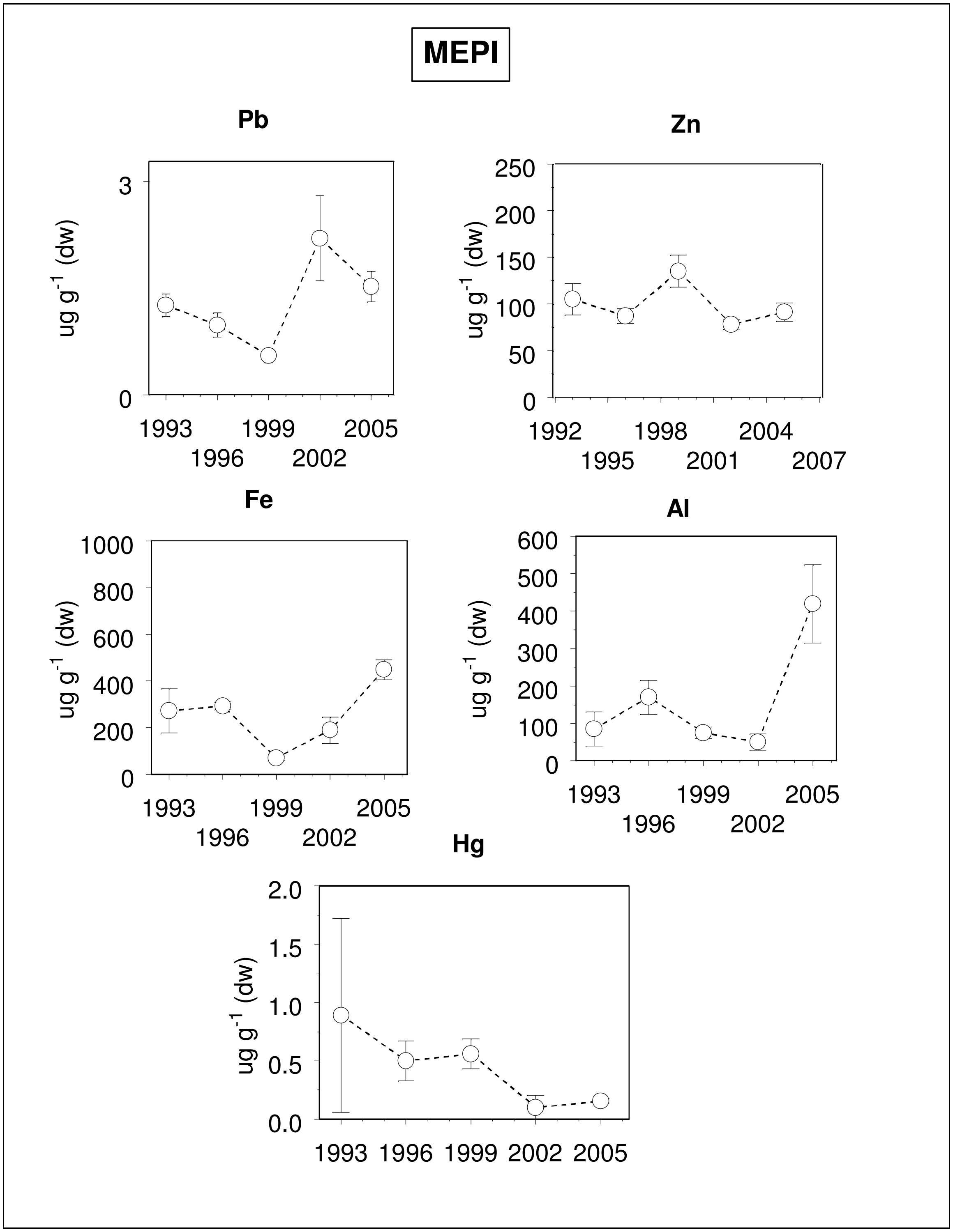


**Figure 23B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the MEPI Gulfwatch site from selected years during the period from 1993-2005.

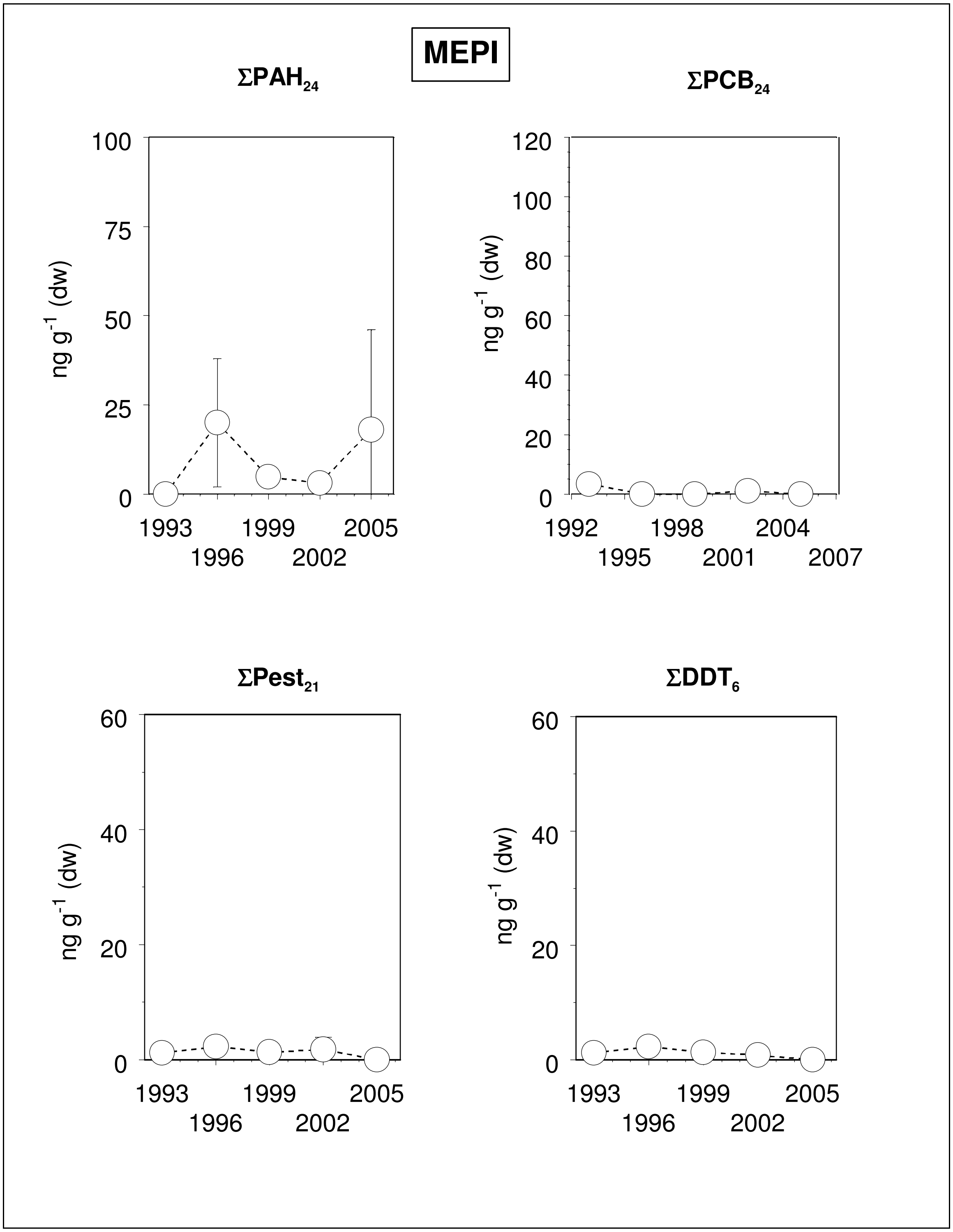


**Figure 23C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the MEPI Gulfwatch site from selected years during the period from 1993-2005.

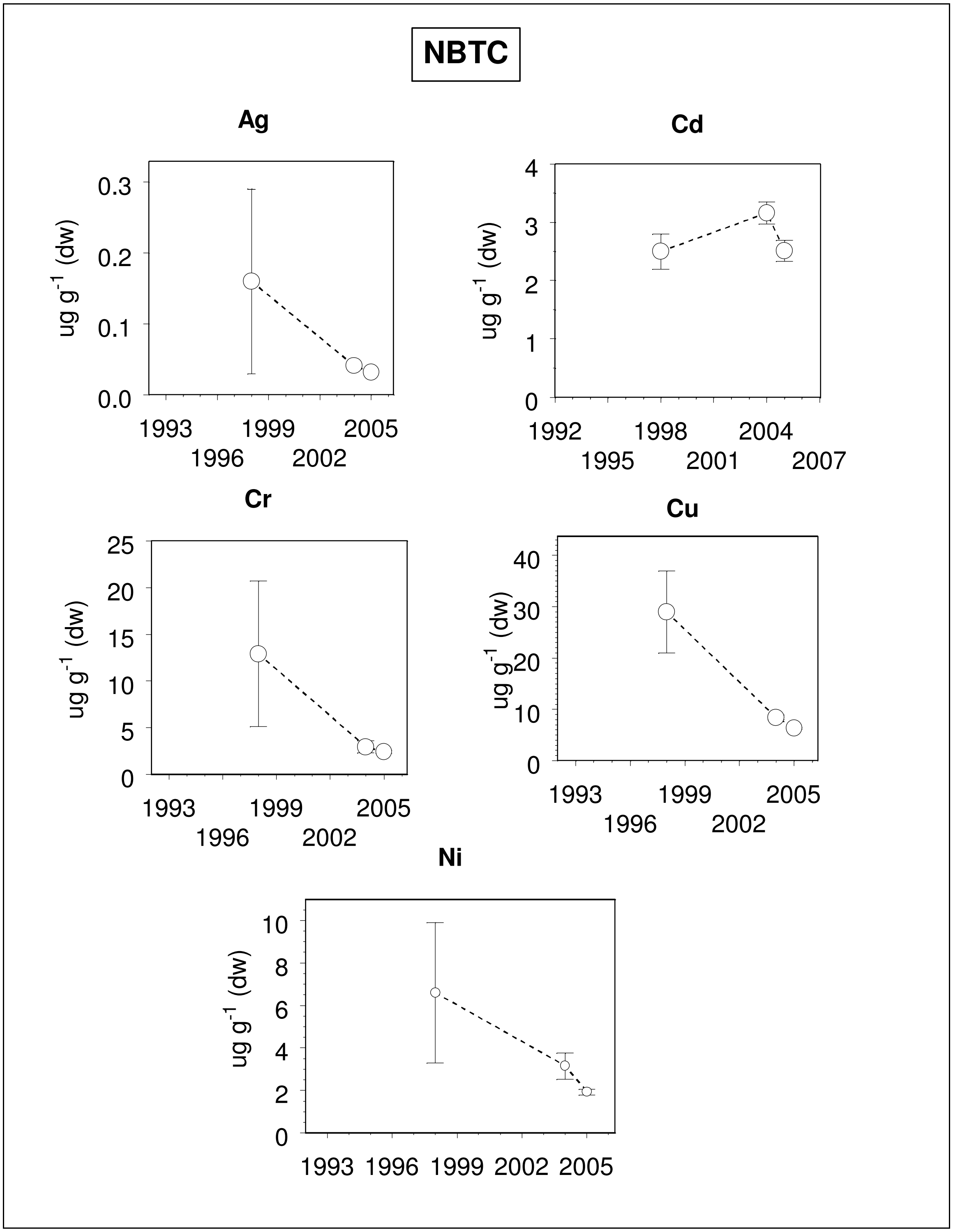


**Figure 24A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NBTC Gulfwatch site from selected years during the period from 1993-2005.

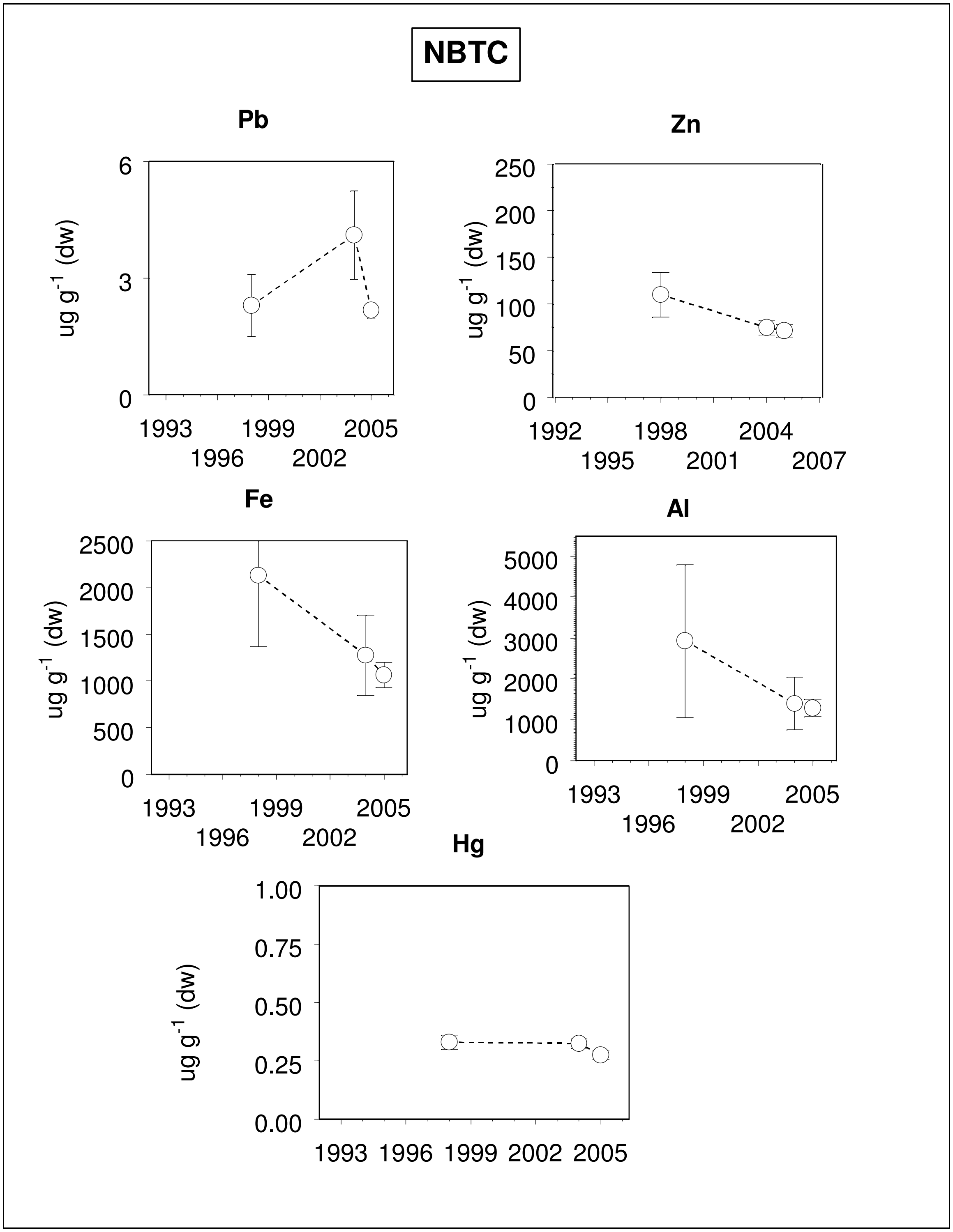


**Figure 24B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NBTC Gulfwatch site from selected years during the period from 1993-2004.

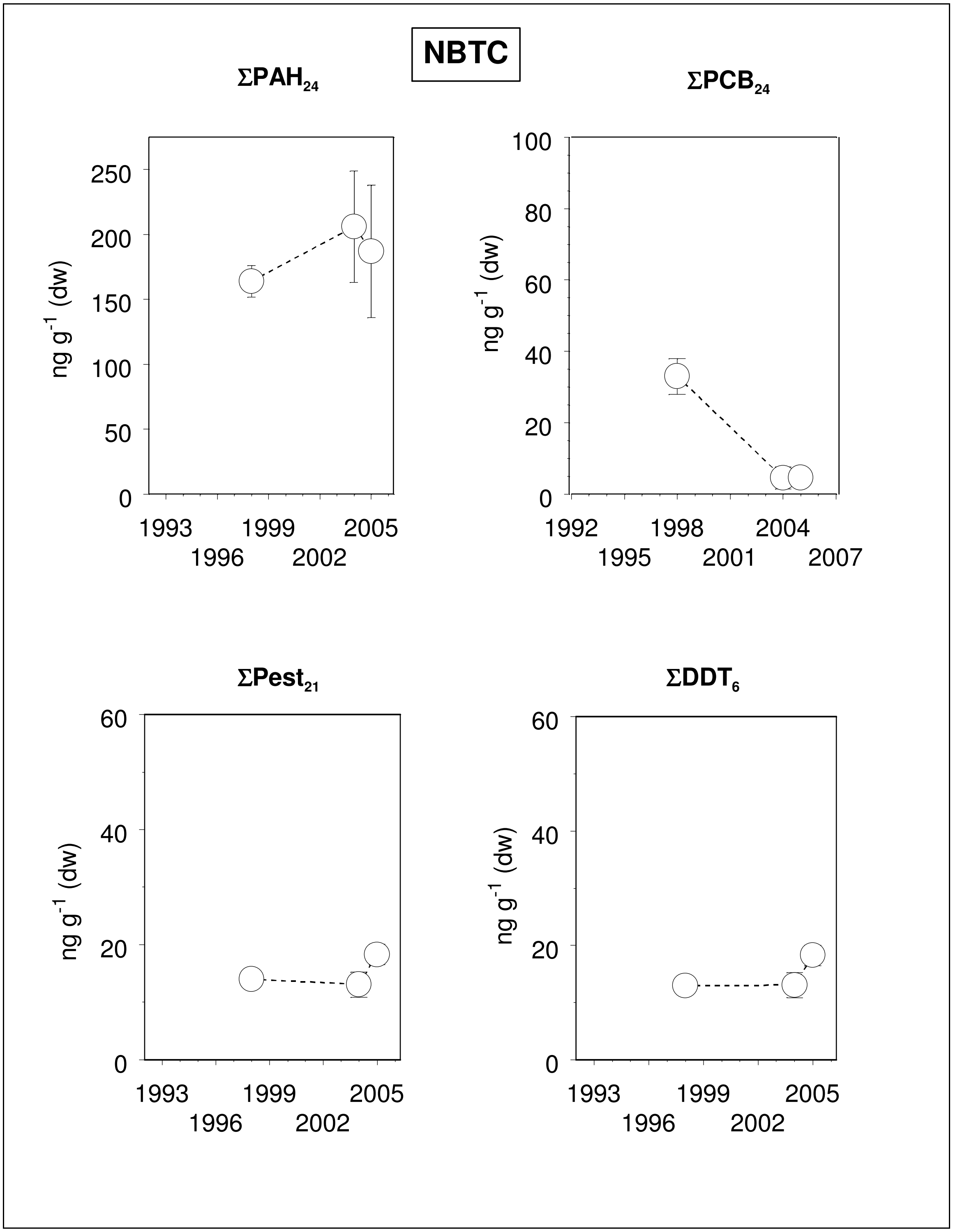


**Figure 24C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the NBTC Gulfwatch site from selected years during the period from 1993-2005.

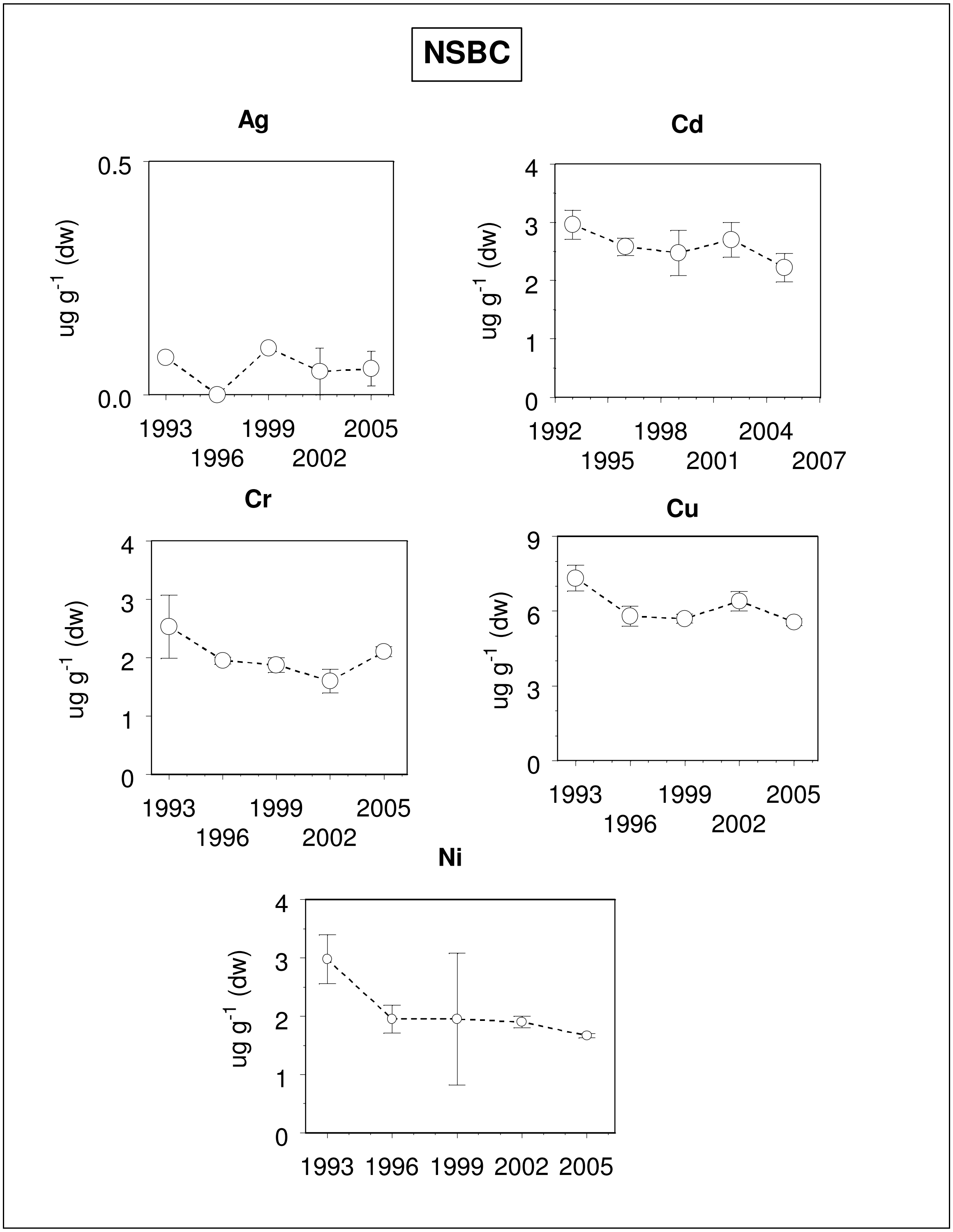


**Figure 25A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NSBC Gulfwatch site from selected years during the period from 1993-2005.

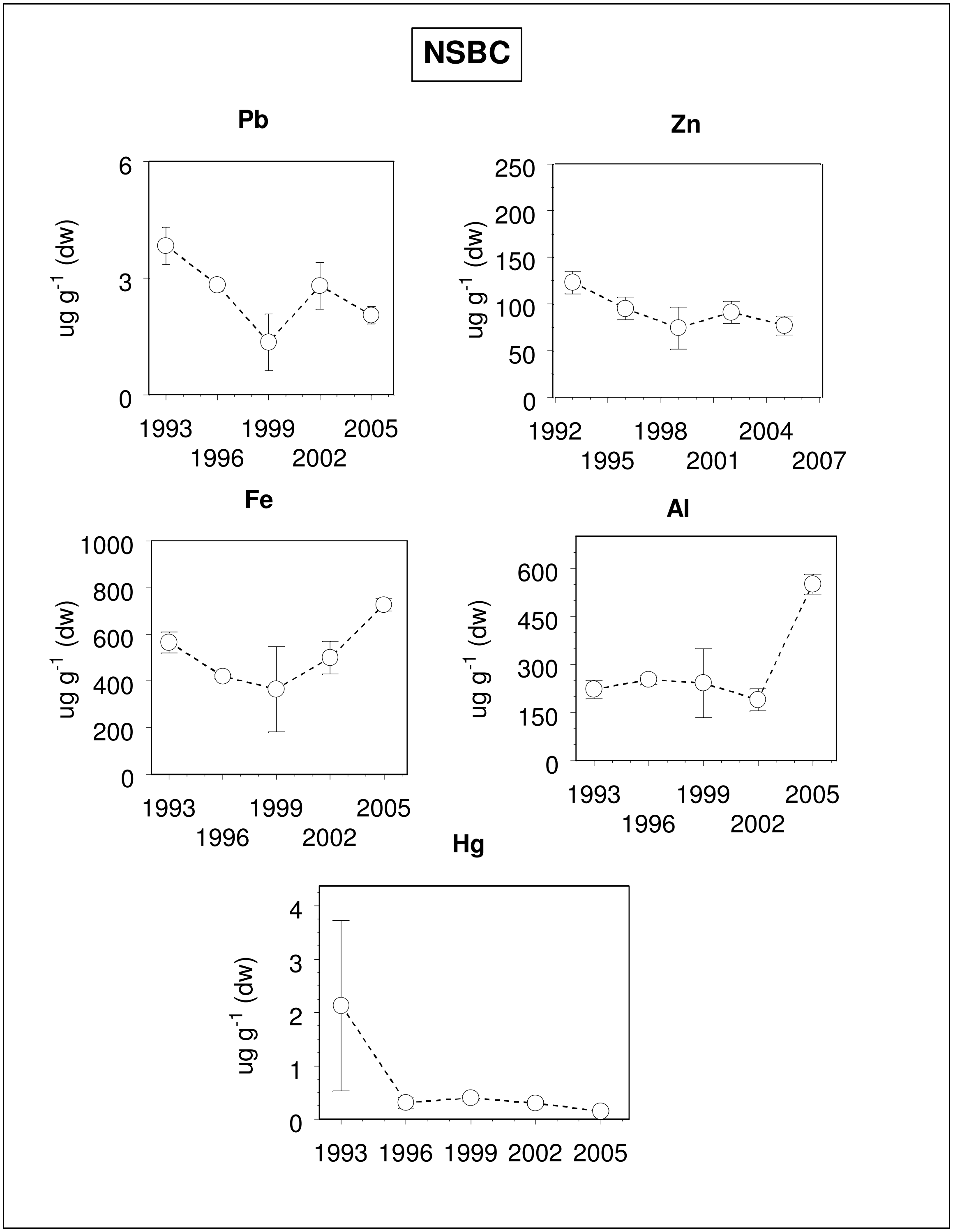


**Figure 25B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NSBC Gulfwatch site from selected years during the period from 1993-2005.

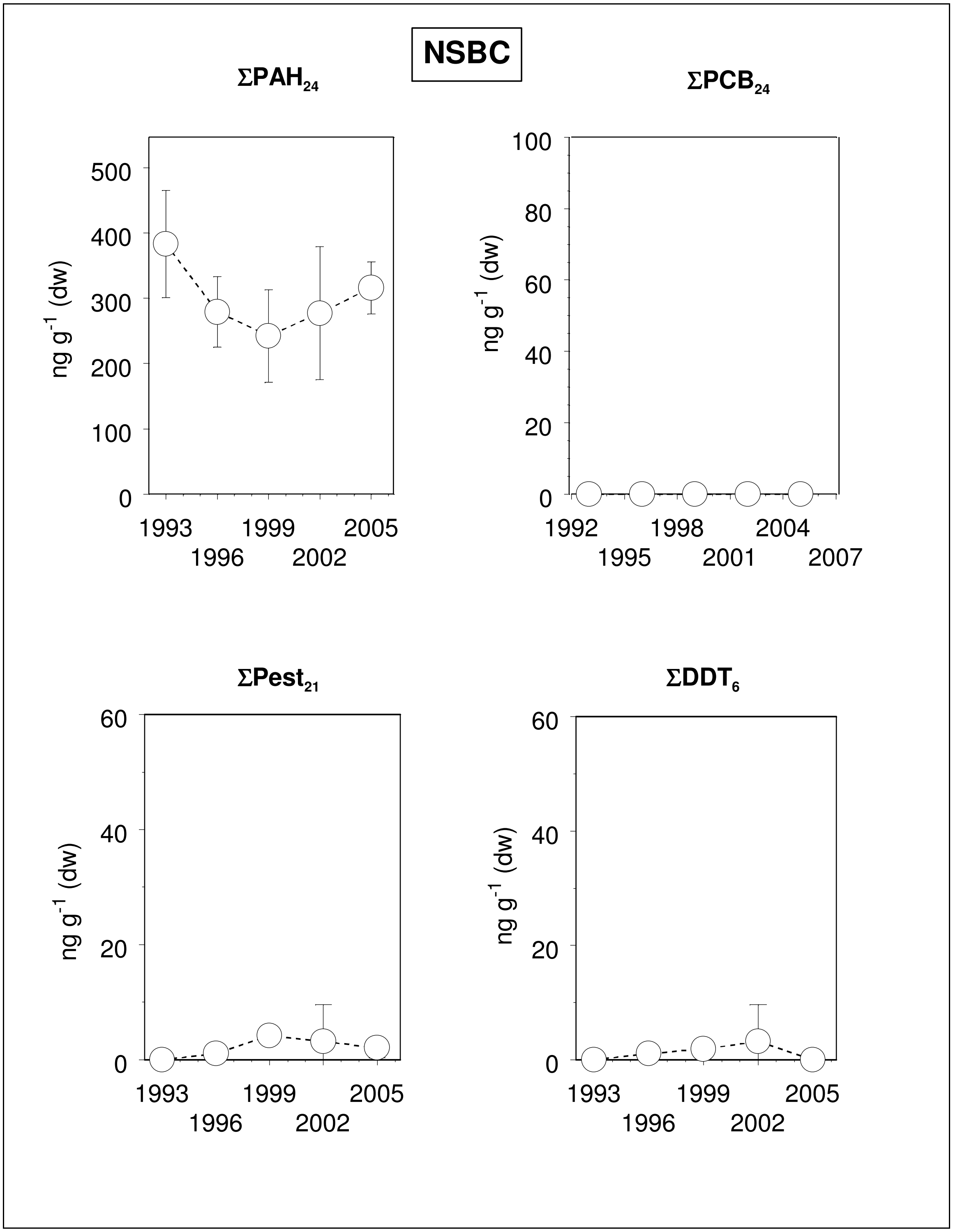


**Figure 25C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the NSBC Gulfwatch site from selected years during the period from 1993-2005.

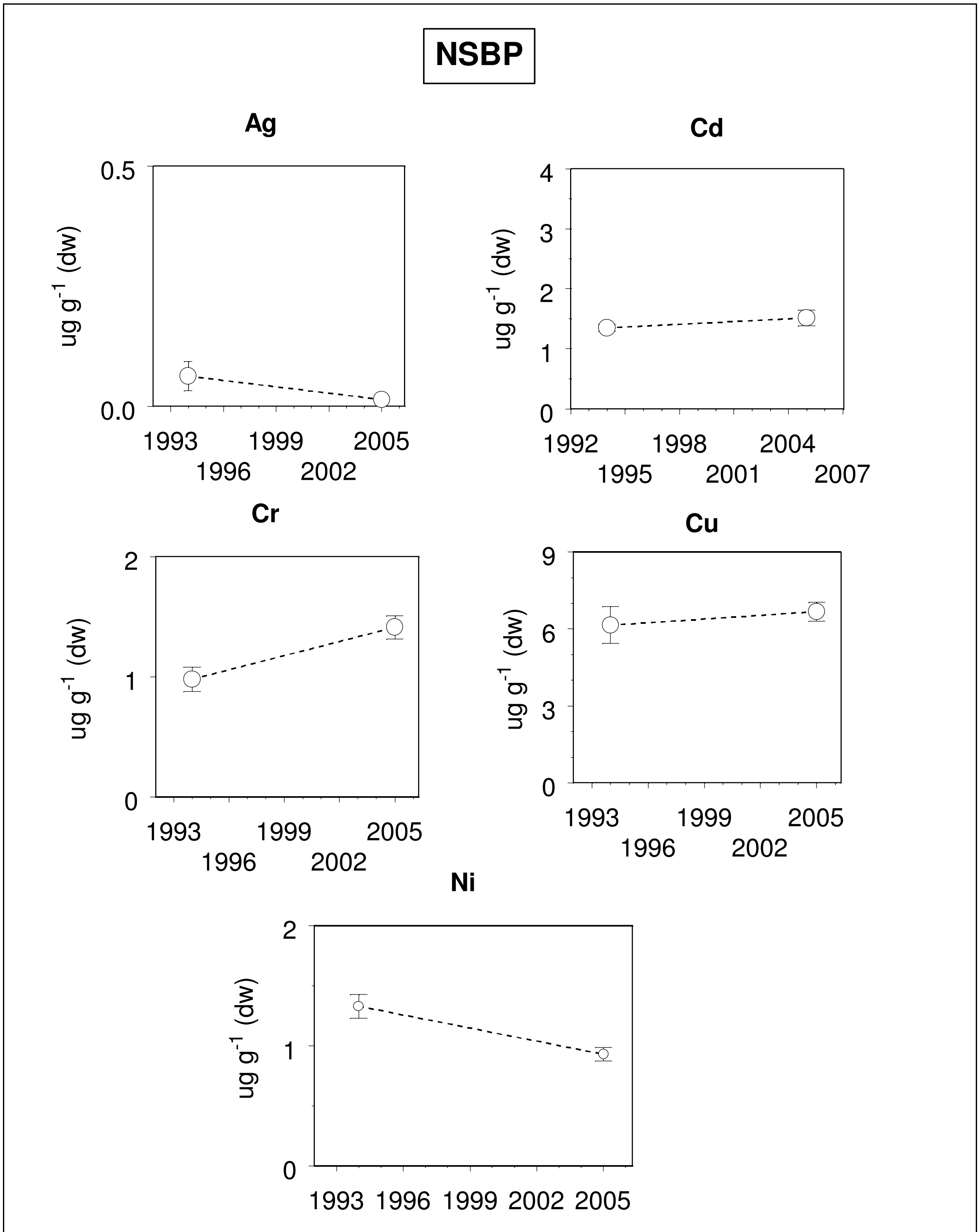


**Figure 26A.** Distribution of metals (Ag, Cd, Cr, Cu, Ni) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NSBP Gulfwatch site from selected years during the period from 1993-2005.

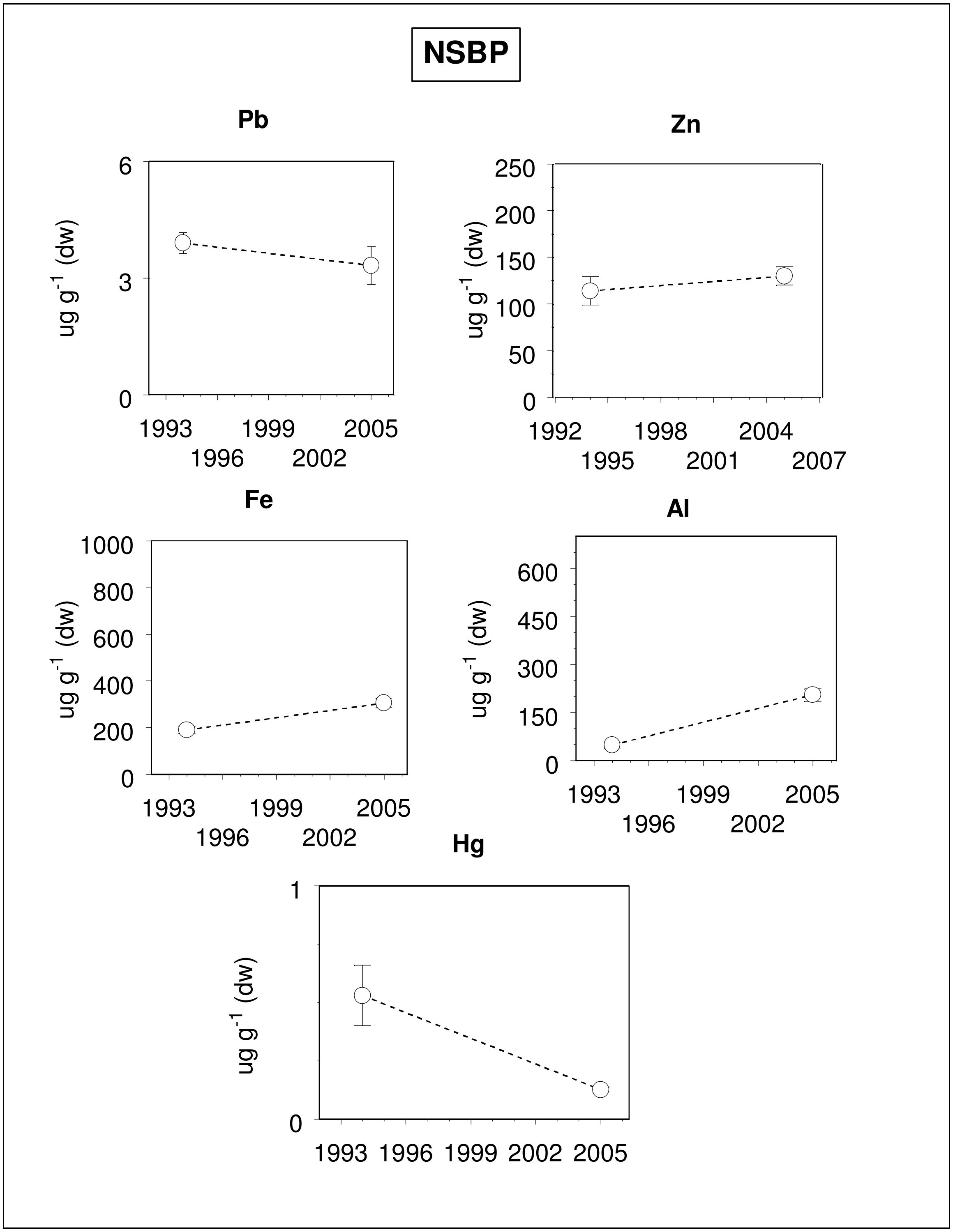


**Figure 26B.** Distribution of metals (Pb, Zn, Fe, Al, and Hg) concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels collected at the NSBP Gulfwatch site from selected years during the period from 1993-2005.

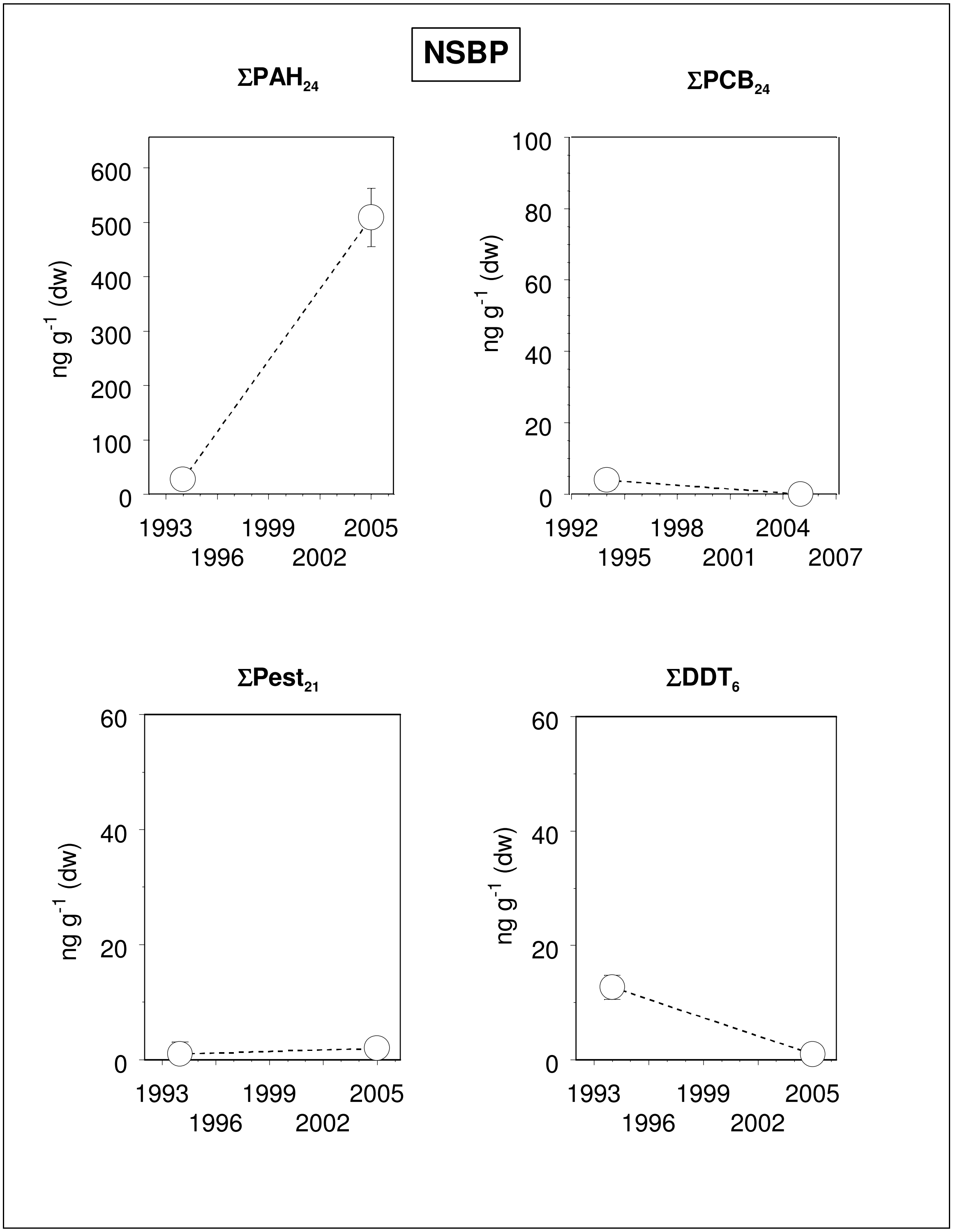


**Figure 26C.** Distribution of selected organic contaminant concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels collected at the NSBP Gulfwatch site from selected years during the period from 1993-2005.

### 4.2.2 Benchmark Sites.

Five benchmark sites that were scheduled for sampling each year in addition to the rotational sites are plotted for the 1993-2005 Program period below. These plots show contaminant-specific changes observed at the individual benchmark sites beginning in with Sandwich, MA and continuing north and east in similar to the manner used above with the rotational sites (Figures 27-40). Many of metals showed decreasing trends during this period (e.g. Ag at MASN, Fig. 27). Statistically significant decreases for several contaminants over time were reported in Jones et al. (in press) using the full 1993-2001 database for benchmark sites and have not included the 2002-2005 data. A site were apparent trends may exist are at Sandwich, MA (MASN) for Ag and Hg.

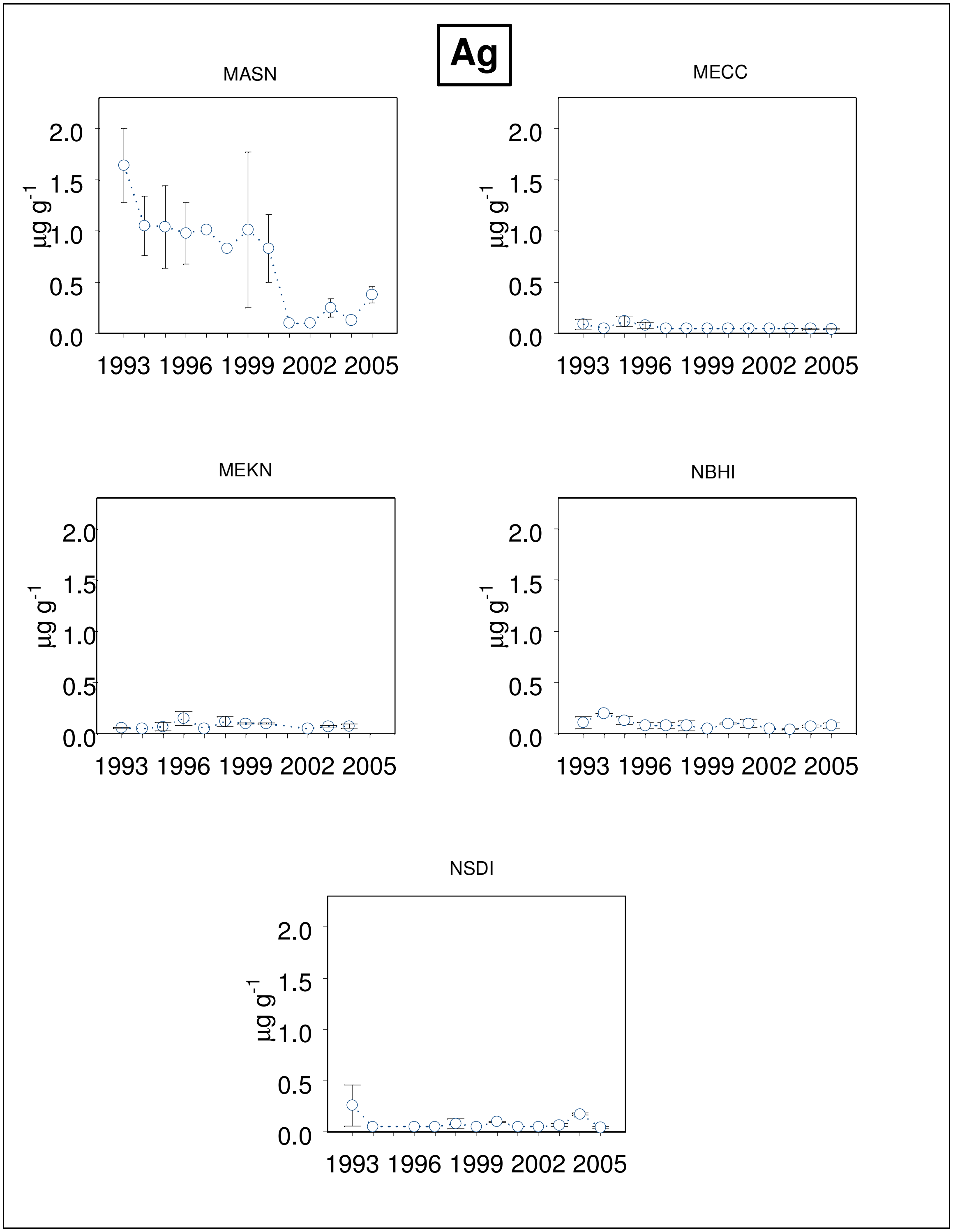


**Figure 27**. Distribution of silver tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

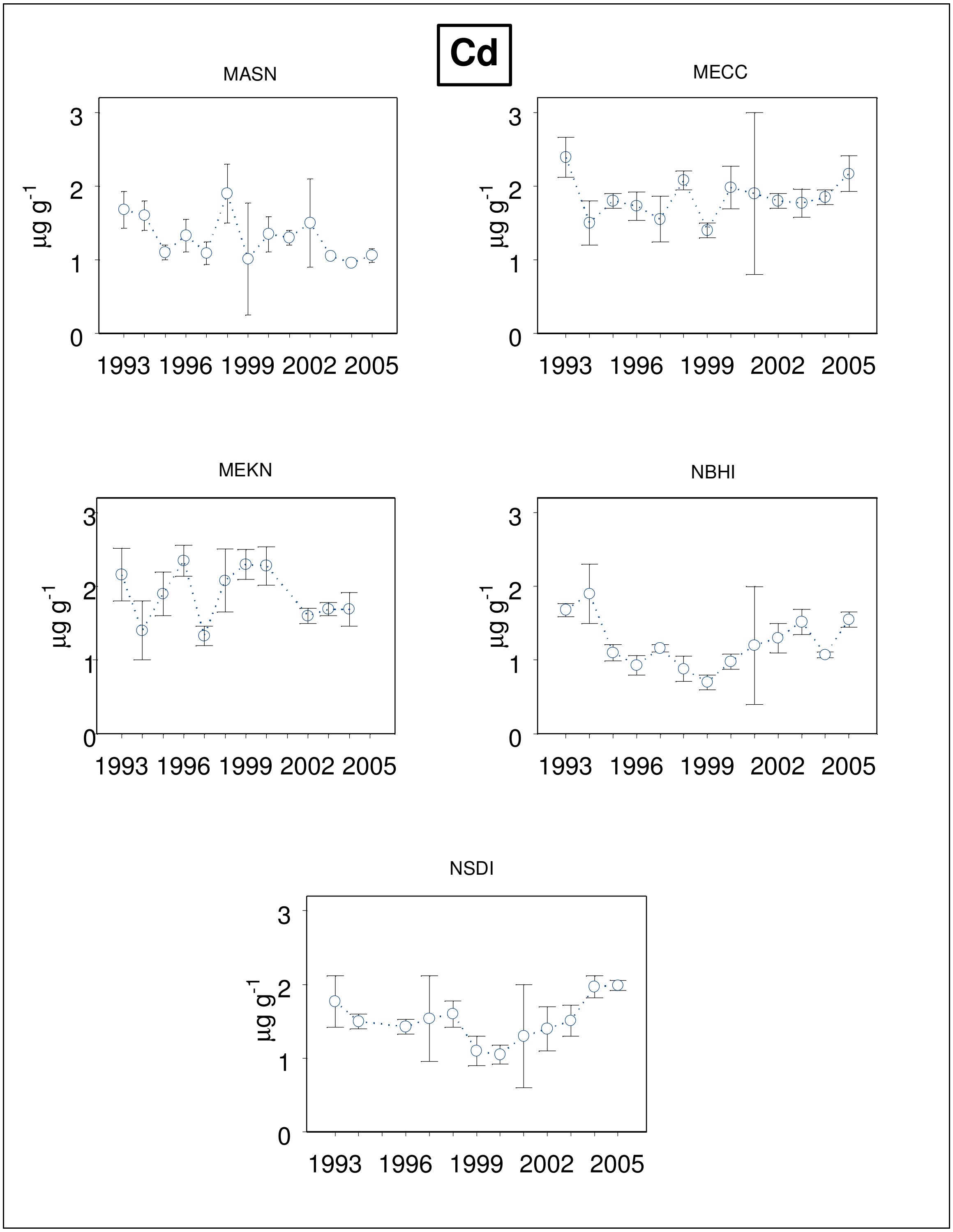


**Figure 28**. Distribution of cadmium tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

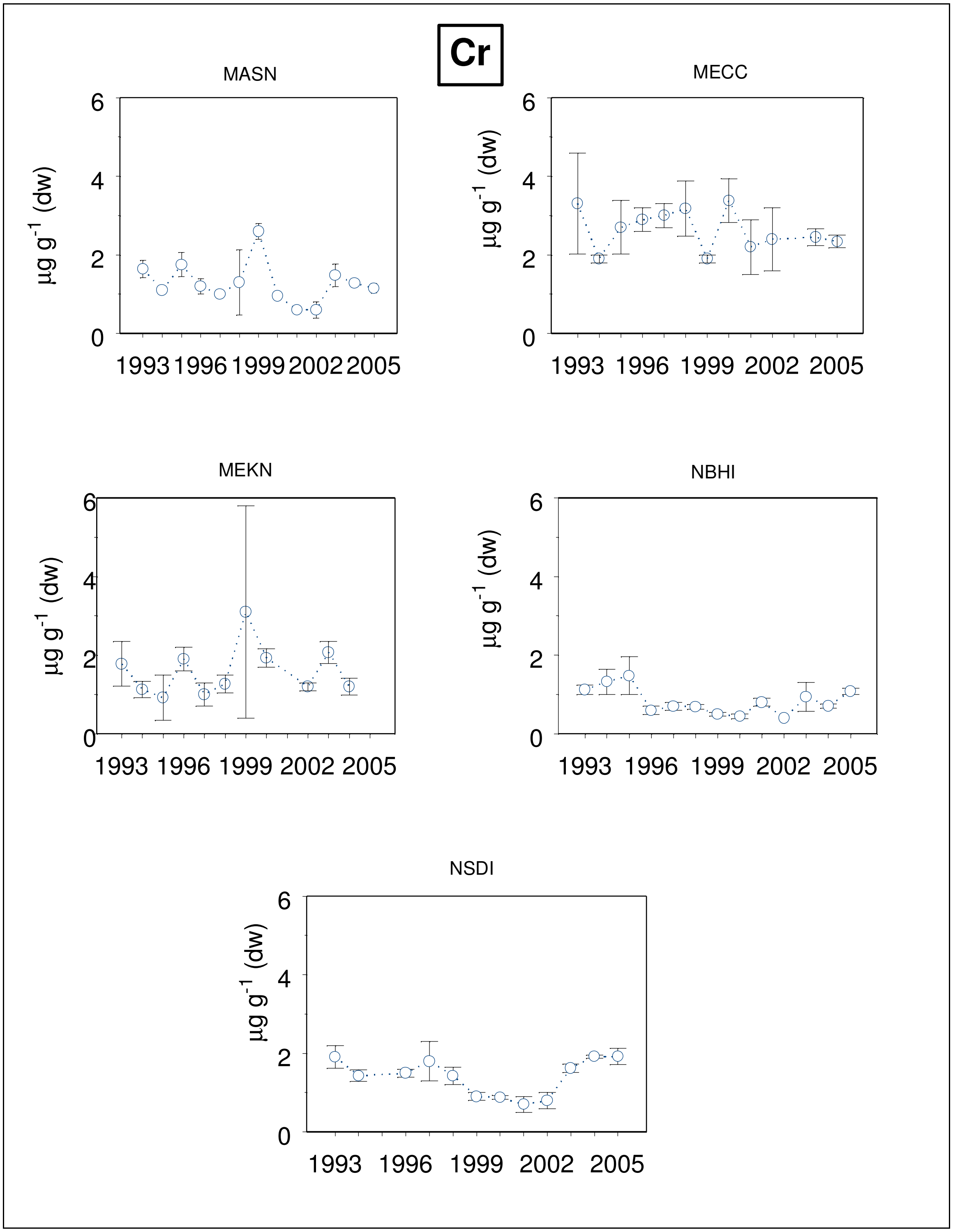


**Figure 29.** Distribution of chromium tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

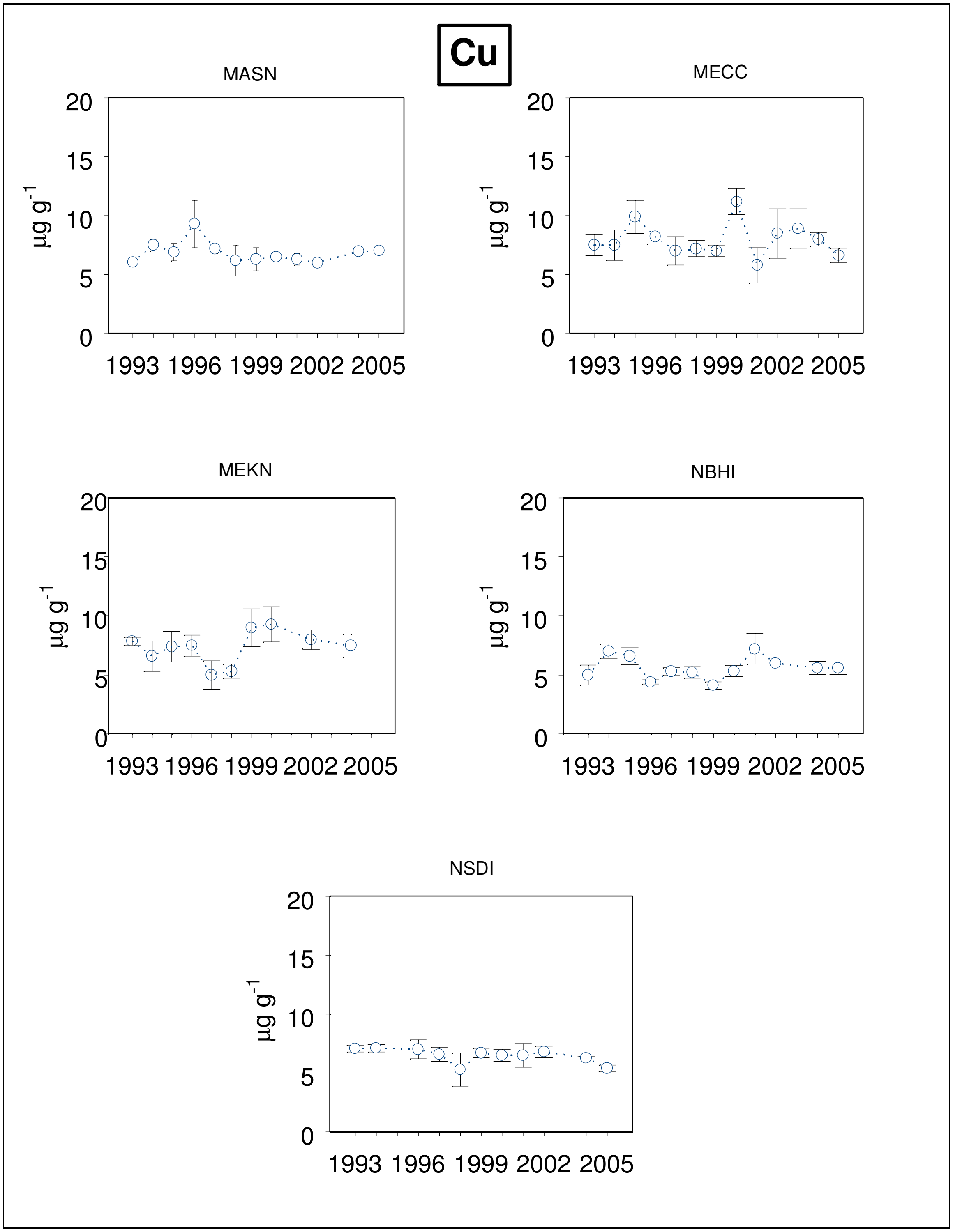


**Figure 30**. Distribution of copper tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005**.**

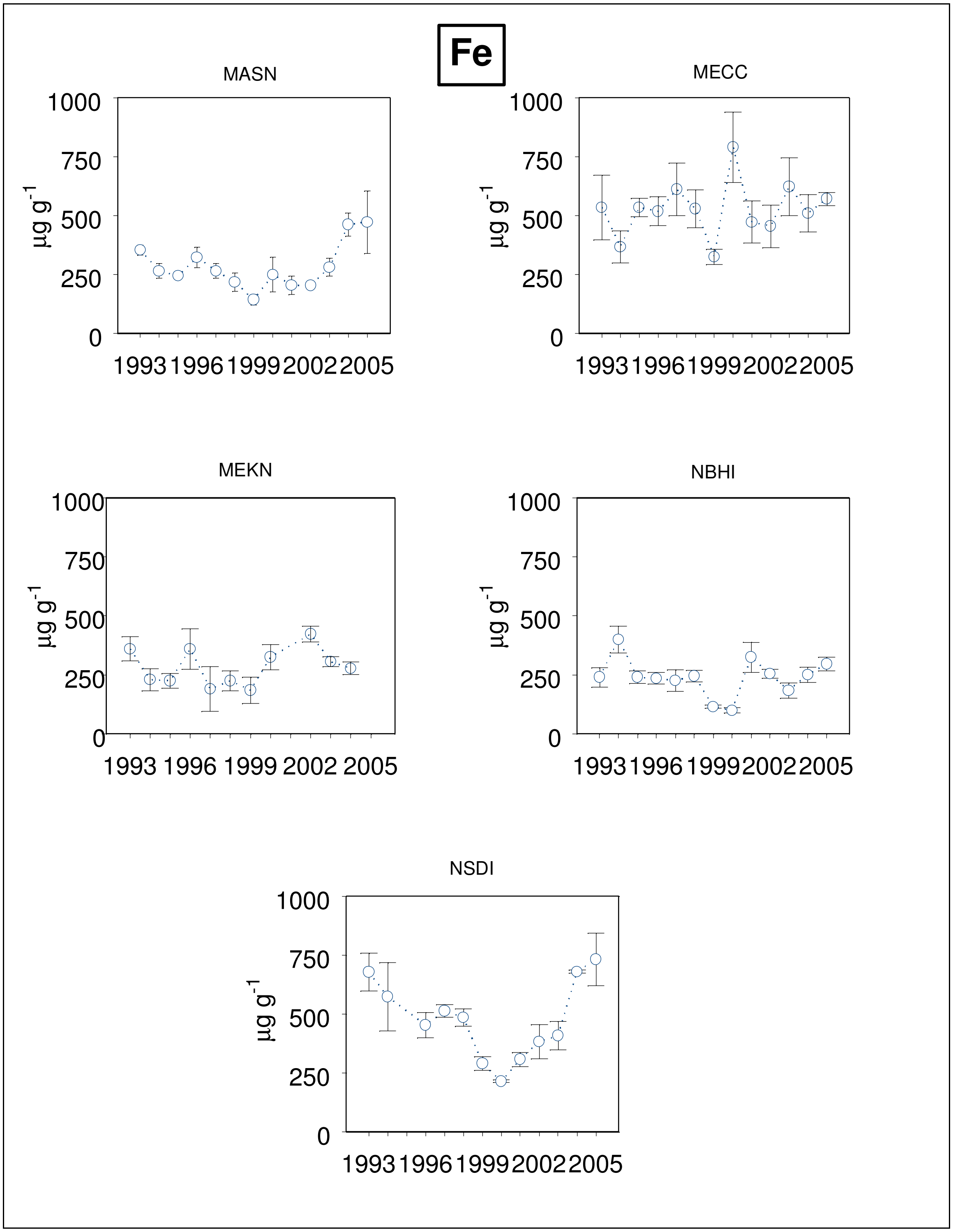


**Figure 31**. Distribution of iron tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

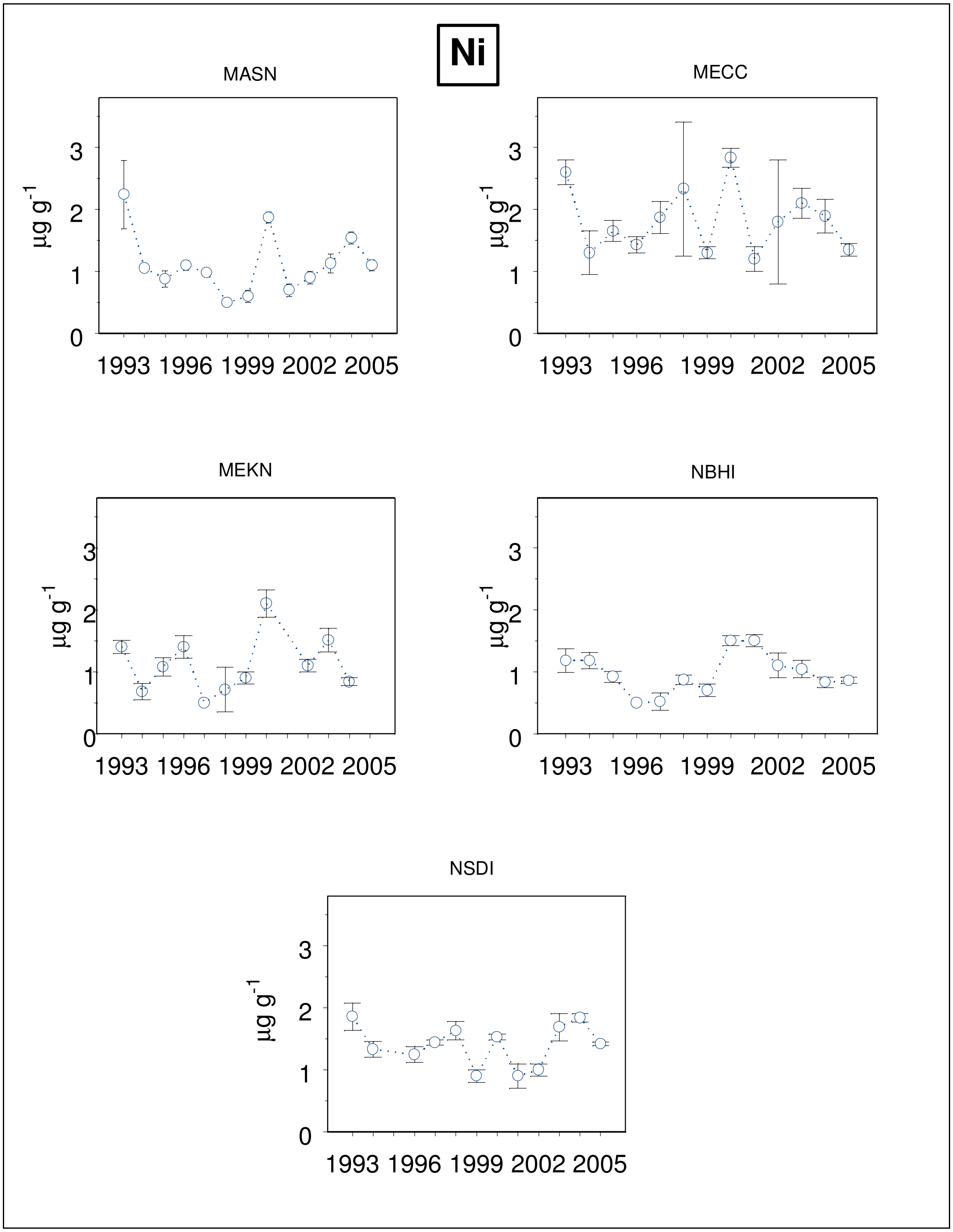


**Figure 32**. Distribution of nickel tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

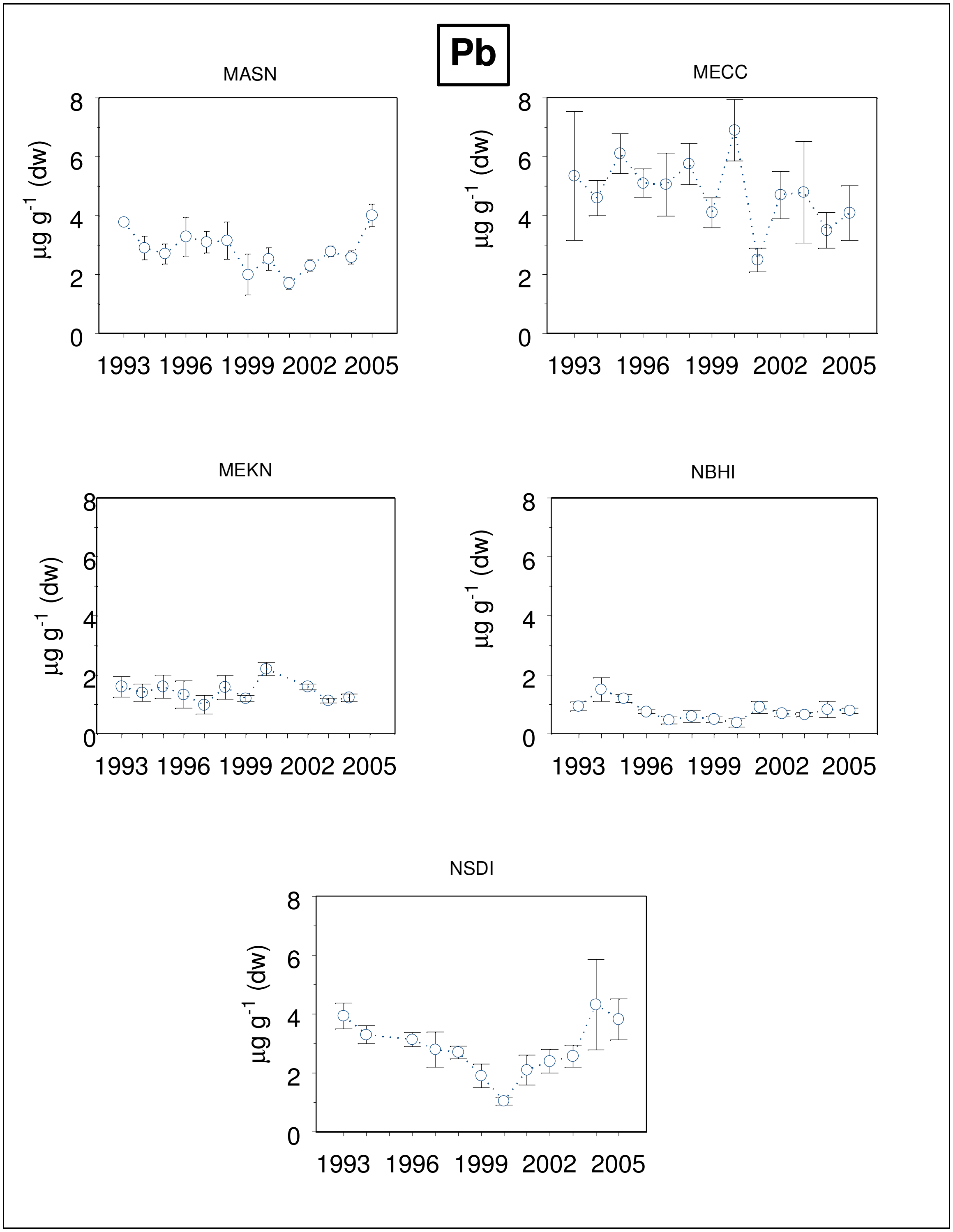


**Figure 33**. Distribution of lead tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

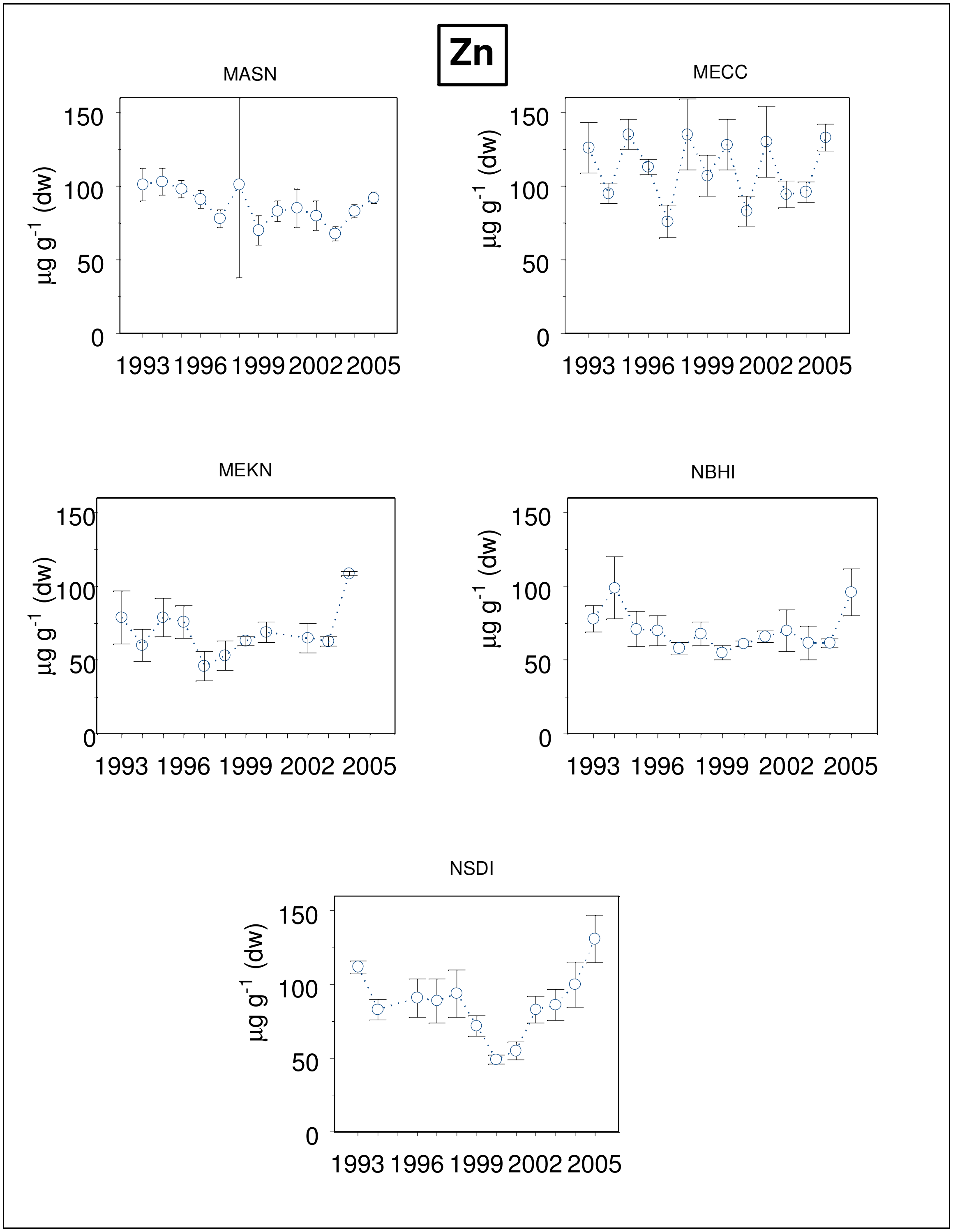


**Figure 34**. Distribution of zinc tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

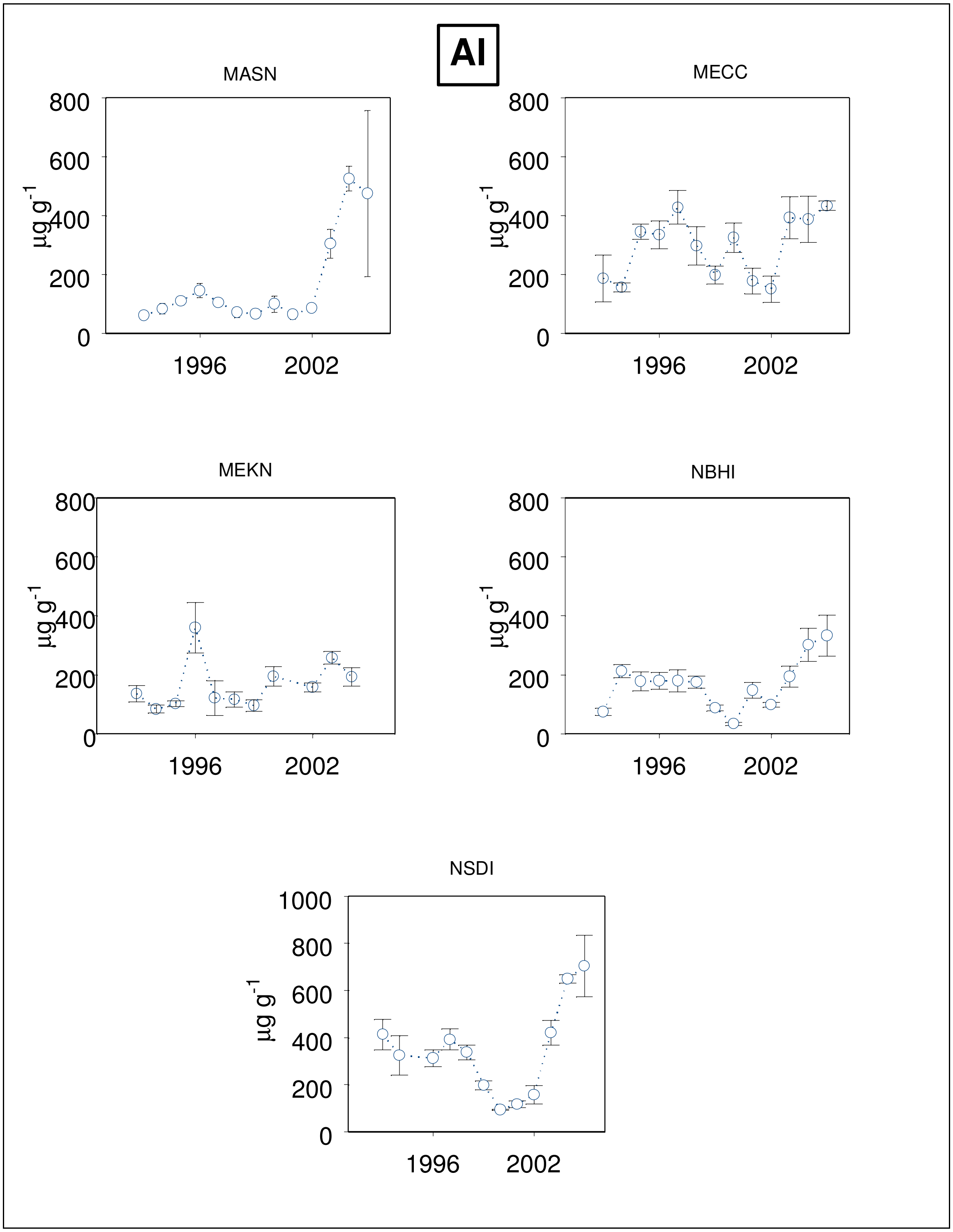


**Figure 35**. Distribution of aluminum tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

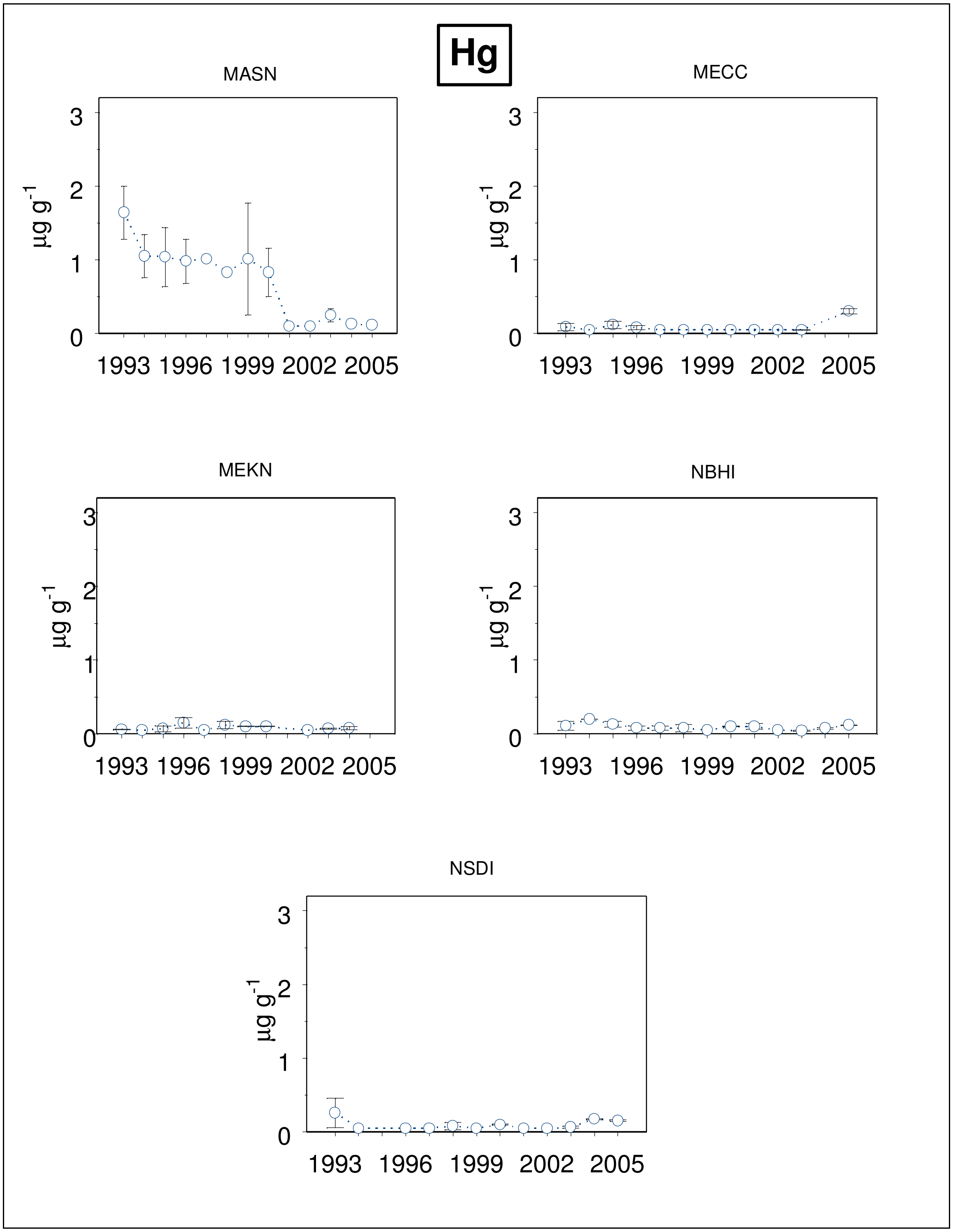


**Figure 36.** Distribution of mercury tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulfwatch benchmark sites in 1993-2005.

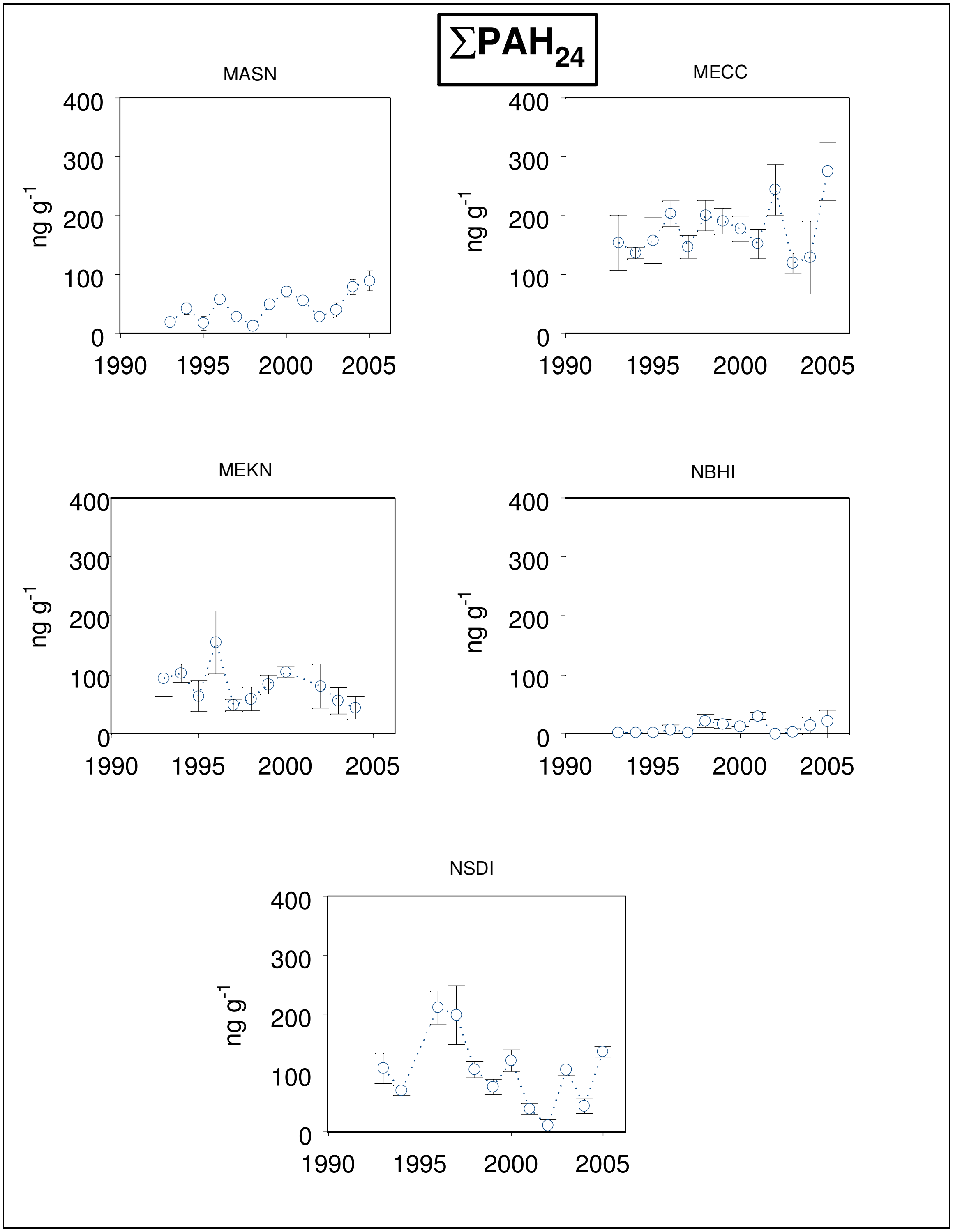


**Figure 37.** Distribution of ΣPAH24 tissue concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulfwatch benchmark sites in 1993- 2005.

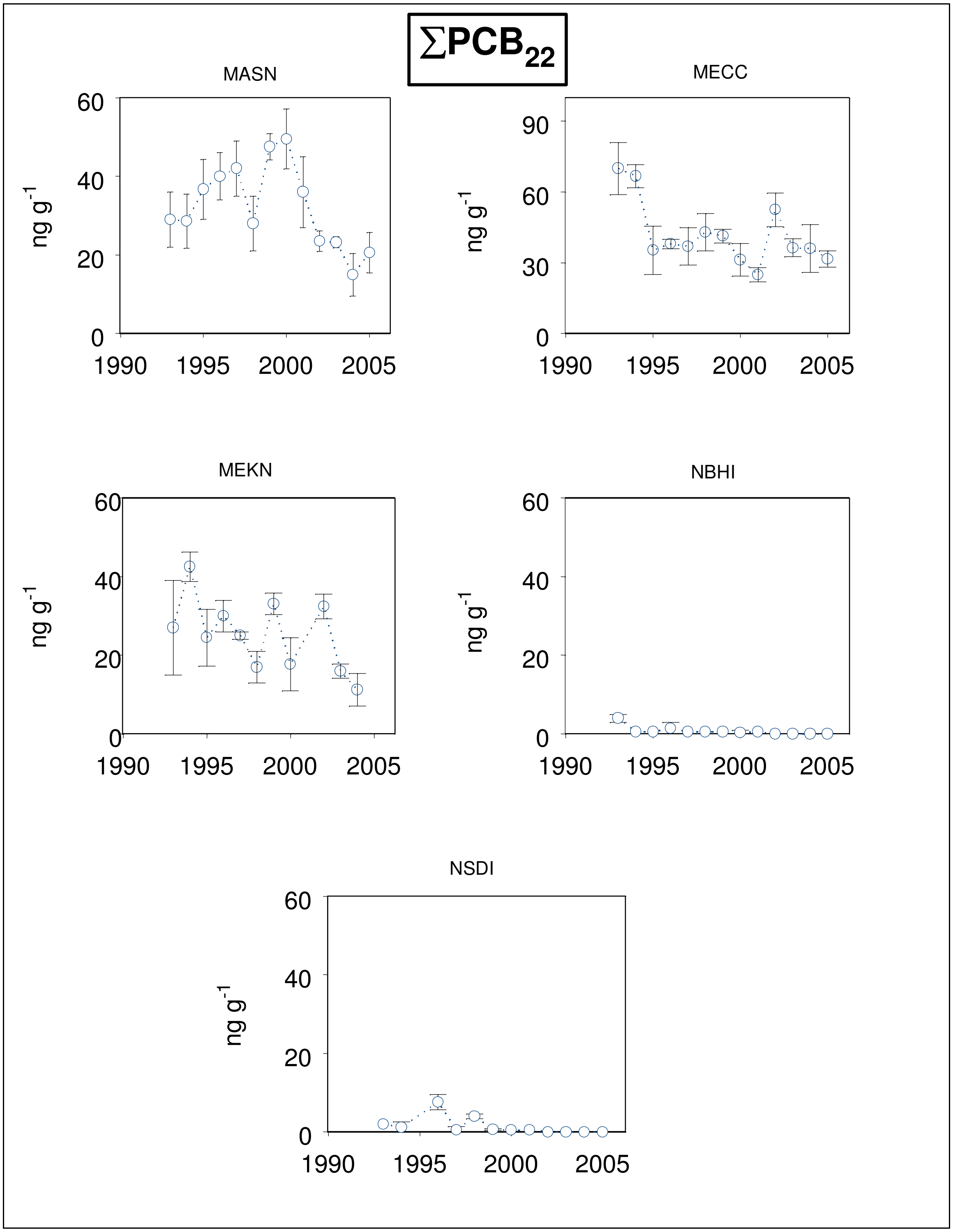


**Figure 38.** Distribution of $\Sigma PCB_{22}$ tissue concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulfwatch benchmark sites in 1993- 2005. Note different scale for MECC.

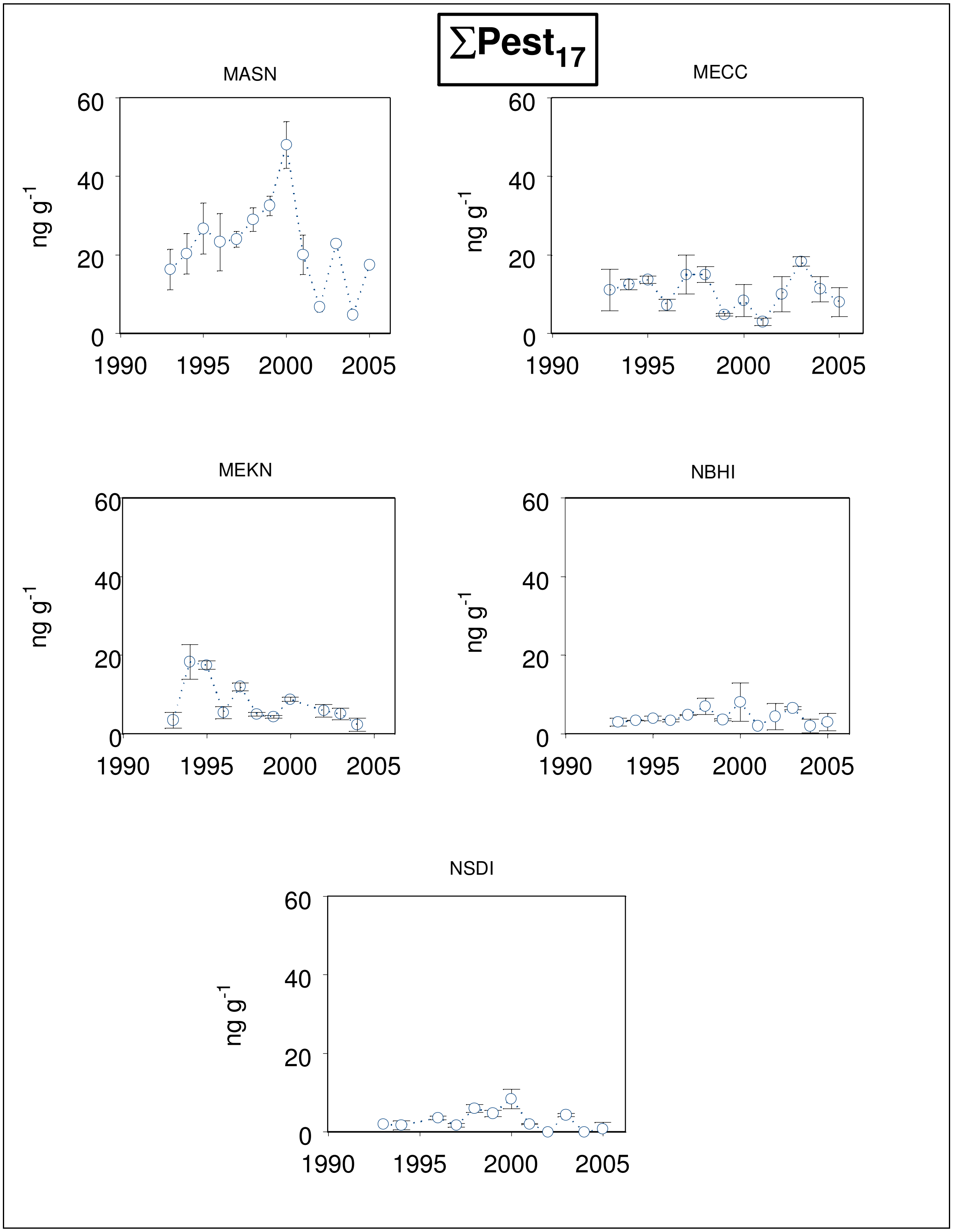


**Figure 39.** Distribution of $\Sigma PEST_{17}$ tissue concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulfwatch benchmark sites in 1993 - 2005.

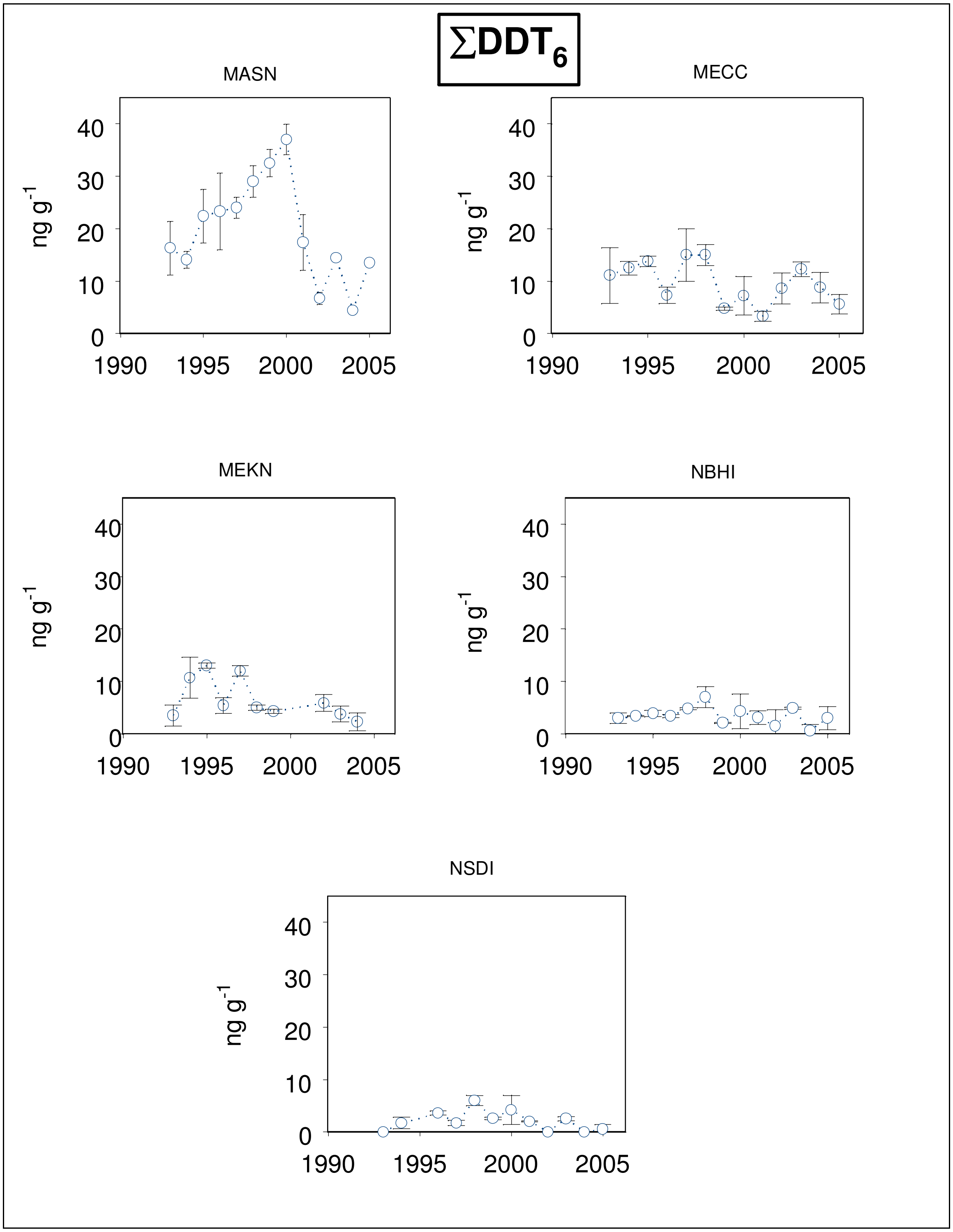


**Figure 40.** Distribution of $\Sigma DDT_6$ tissue concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulfwatch benchmark sites in 1993- 2005.

## *4.3 DRY WEIGHT AND LIPID FRACTIONS*

Lipid content and percent dry weights (represented as % solids) were determined on sub samples of composites, typically between 5-10 g of wet tissue, after drying to a constant weight at $100^0$C. The mean (+ 1SD) percent of solids and lipids as a function of tissue mass are plotted in Figs. 41 and 42 respectively. Percent solids were typically near 10-15% of the overall tissue mass. Percent lipid content was typically between 5-10% of the tissue mass. O'Conner and Lauenstein (2005) report an average of about 8% lipid content for the mussels collected by the NOAA Mussel Watch program which is above the 5.9% observed for the Gulfwatch Program for 2005.

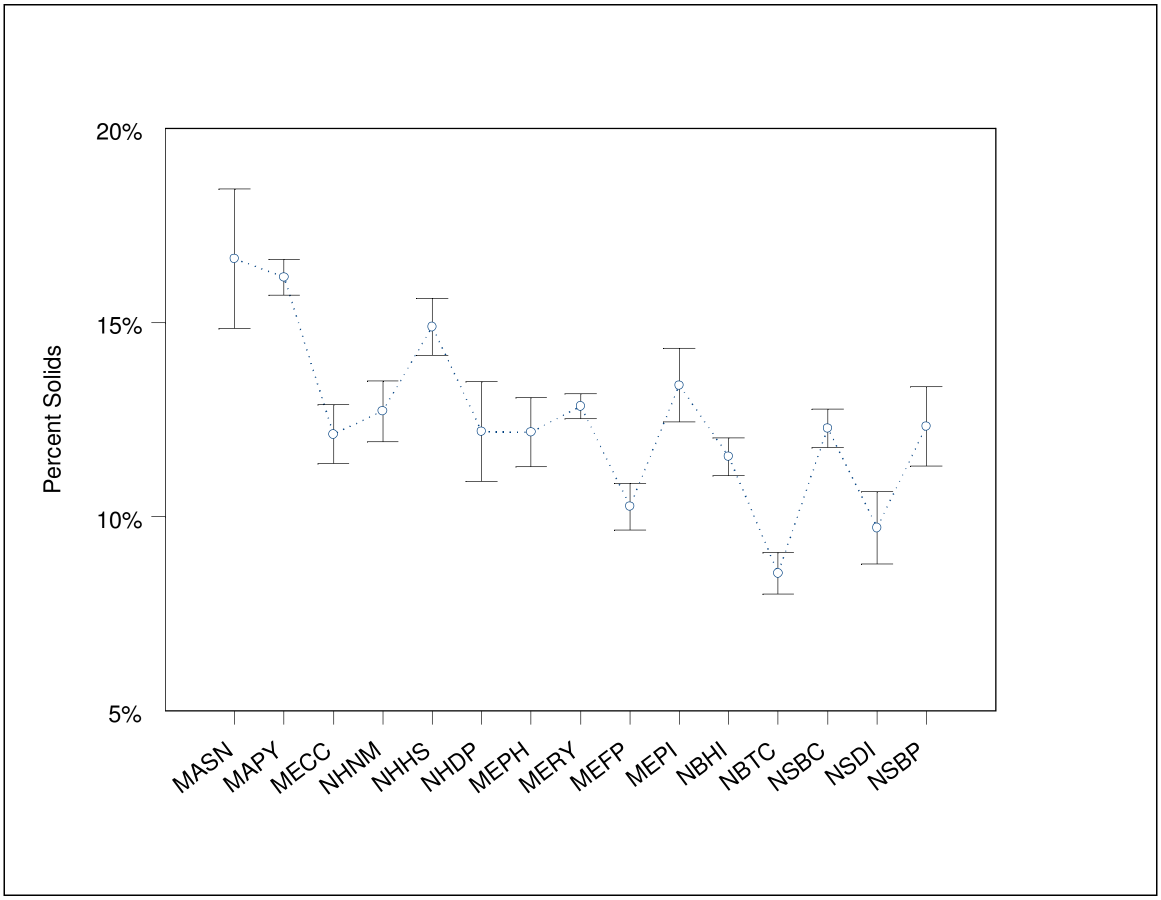


**Figure 41.** Mean (and standard deviation) of % solids in Gulfwatch mussels collected during 2005.

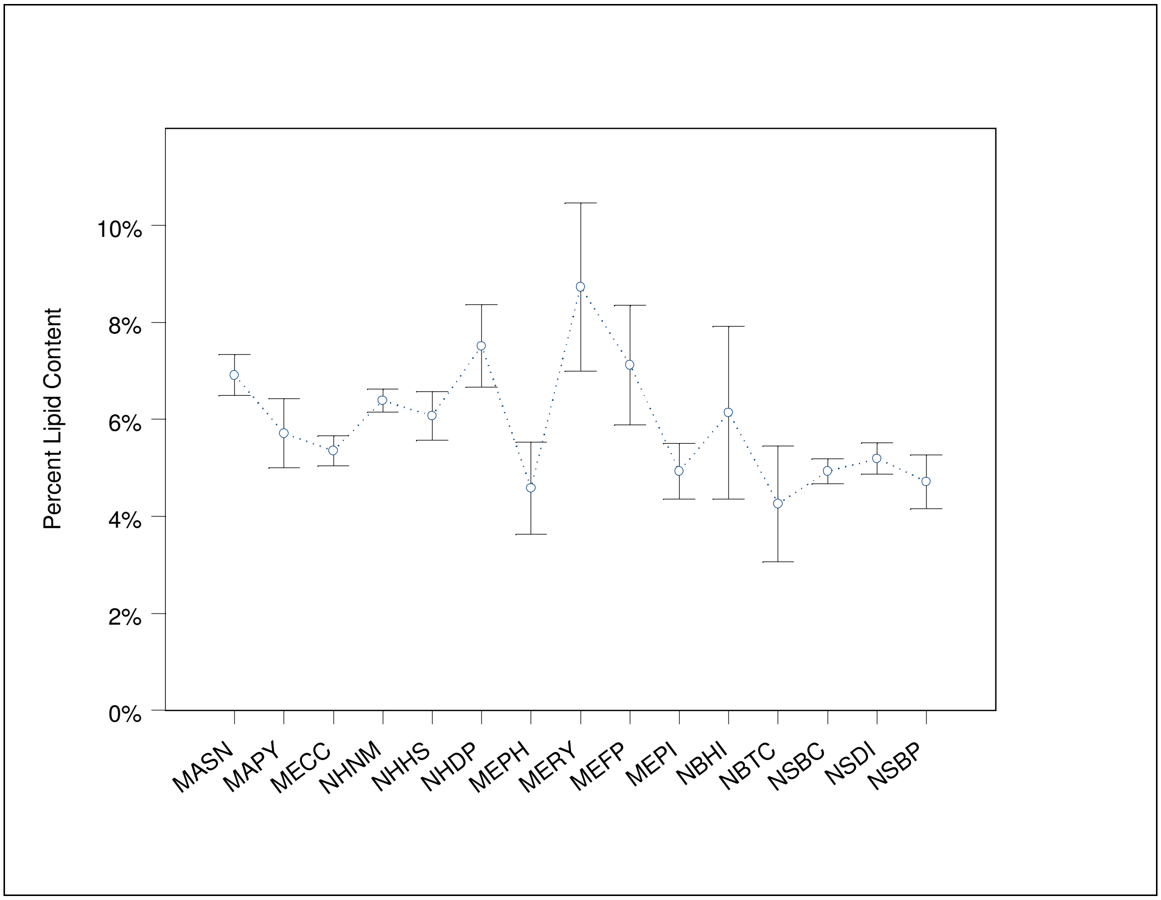


**Figure 42.** Mean (and standard deviation) of lipid content (%) in Gulfwatch mussels collected during 2005.

### 4.4 *SHELL LENGTH AND CONDITION INDEX*

Table 10 contains a summary of the morphological measurements and condition indices for mussels collect at each site in 2005.

#### 4.4.1 Shell Morphology and Weight

Gulfwatch field collection protocol recommends collecting *M. edulis* within the length range of 50-60 mm. The Gulfwide mean shell length (±SD) from the 2005 sites was XX.X ± X.X (Table 10, Fig. 43). Analysis of variance on height and width, and to a lesser extent, wet weight, on the mussels collected among the 2005 sites were not significant ($p<0.05$) and suggest no significant differences in the morphology of mussels collected among sites in during 2005. The mussels collected at Tin Can Beach (NBTC) had smaller shell dimensions than the other sites which may be due to their ??.

#### 4.4.2 Condition Index

Mean condition indices (CI) calculated from morphological measurements of 2005 Gulfwatch mussels are also listed in Table 10 and shown in Figure 44. The mean CI (±SD) for mussels from all Gulfwatch sites was 0.XX (±0.0X). ANOVA performed on CI means was significant ($p<0.05$). An analysis of covariance (ANCOVA) on wet weight using shell height and width as covariates was performed to evaluate the CI differences observed between the New Brunswick and remaining Gulfwatch samples during 2005. The ANCOVA revealed significant differences in the covariates of shell wet weights and to a lesser extent, shell height.

**TABLE 10** Morphometric determinations abd statistics (Mean, standard deviation) on mussels collected along the Gulf Maine, 2005 Gulfwatch

| Station | CI | $SD_{CI}$ | | L | $SD_L$ | H | $SD_H$ | W | $SD_W$ |
|---|---|---|---|---|---|---|---|---|---|
| MASN | 0.158 | 0.027 | (n=30) | 54.3 | 2.7 | 22.6 | 1.5 | 28.3 | 1.9 |
| MAPY | 0.138 | 0.030 | (n=20) | 53.9 | 3.3 | 26.1 | 3.2 | 29.7 | 2.9 |
| NHHS | 0.158 | 0.059 | (n=30) | 54.0 | 2.6 | 27.0 | 2.1 | 26.0 | 2.3 |
| NHNM | 0.158 | 0.023 | (n=30) | 54.3 | 2.6 | 27.9 | 1.3 | 22.1 | 1.8 |
| NHDP | 0.154 | 0.021 | (n=30) | 54.4 | 2.6 | 27.7 | 1.7 | 22.3 | 1.6 |
| MECC | 0.123 | 0.024 | (n=30) | 55.1 | 2.3 | 28.9 | 1.8 | 22.3 | 1.8 |
| MEPH | | | n=10 | | | | | | |
| MERY | | | n=10 | | | | | | |
| MEFP | | | NA | | | | | | |
| MEPI | | | n=10 | | | | | | |
| NBHI | 0.184 | 0.044 | n=80 | 55.4 | 4.3 | 22.2 | 2.3 | 27.7 | 2.5 |
| NBTC | 0.293 | 0.035 | n=80 | 52.9 | 3.4 | 20.2 | 1.7 | 25.9 | 1.9 |
| NSDI | 0.169 | 0.042 | n=80 | 54.7 | 2.3 | 22.4 | 2.2 | 29.3 | 2.2 |
| NSBC | 0.158 | 0.028 | n=80 | 54.3 | 2.5 | 23.9 | 1.8 | 28.5 | 2.2 |
| NSBP | 0.152 | 0.029 | n=80 | 54.9 | 2.7 | 21.5 | 1.6 | 30.8 | 2.3 |

**Figure 43**. Mean (and standard deviation) of length of Gulfwatch mussels collected during 2005.

**Figure 44.** Mean (and standard deviation) condition index (CI) of Gulfwatch mussels collected during 2005.

## 5.0 2005 GULFWATCH SUMMARY

The 2005 Gulfwatch field season essentially extended the sampling to four additional years beyond the original 9-year sampling design. Monitoring of contaminants in the soft tissue of *M. edulis* from Massachusetts to Nova Scotia during this 13 year period continues to add information over time for the evaluation of temporal trends of contaminant exposure of aquatic organisms in the Gulf of Maine. Most reference sites now have as much as 13 years of data while rotational sites have been sampled up to 5 times over this period. Temporal and spatial analyses of the data are beyond the scope of Gulfwatch data reporting. Detailed analysis of the 9-year program has been completed and is under external evaluation as of this writing and will contribute to our understanding of contaminant issues in the Region with the additional 2002-2005 data.

The recovery of the more recalcitrant metals (i.e., Al, Cr, Ni) from certified reference material improved in 2003 and continued in 2005 with the acquisition of metal analytical services from Battelle Marine Science Laboratory, WA. Therefore, temporal analyses of these metals must consider the QA/QC data of digestion methods used prior to 2003 to when the Gulfwatch Program began in 1993.

Given the above caveats, many of the metals monitored at the 3-year rotational sites appear to be lower than previously observed, especially for Hg. In a broad sense, organic contaminants seem to indicate increases over the 12 year sampling period. Some local areas that have been sampled on a rotational basis appear to have significant increasing trends for PAH and some pesticides. The greater temporal resolution provided by the annual sampling of reference sites show metal contamination to be decreasing and organic contaminantion remaining constant or increasing for the Gulf of Maine in general. Particularly, silver concentrations appear to have significantly decreased in recent samples collected at the Sandwich, MA site (MASN) and may be related to source reduction in wastewater effluents and/or relocation of the Massachusetts Water Resource Authority's wastewater discharge in Massachusetts Bay. PAHs at sites Plymoth, MA (MAPY) and North Mill Pond, NH (NHNM) also seemed to be increasing. Many of the organic contaminants where higher in MA waters and are related, in part, to the influence of highly industrialized and densely populated watersheds that drain into these waters.

The NH Great Bay Estuary received greater spatial resolution in the sampling design as Gulfwatch progressed through the 12-year program due in large part by the recognition of the value of the Gulfwatch Program and contributions of resources by the New Hampshire Department of Environmental Services. NH added additional sites through their own initiative and have demonstrated the utility of using mussels as contaminant indicators at smaller spatial scales (Jones et al., 2001).

Overall, the Gulfwatch data to date show the more urban estuaries (Portland Harbor and, from previous annual report summaries, Boston Harbor, Pines River, etc) to be the most contaminated, especially for Pb, DDT, and PCBs, among the sites collected on any given year. From a national perspective, the GOM region is somewhat elevated (near or above the NS&T 85$^{th}$ percentile) for Pb and Hg. Mussels from the Great Bay Estuary, NH, still remain relatively more contaminated with respect to mercury (considering previous Gulfwatch results). However, an apparent decline in Hg contamination is suggested at all the Gulfwatch benchmark sites (Fig. 67). Detailed trend and spatial analysis is underway such that meaningful descriptions of contamination in the Gulf of Maine can be made available to coastal environmental managers of the region.

Gulfwatch is in the process of evaluating its program and has taken steps to improve analytical results, reporting, and redesign of sampling to better evaluate contamination in Gulf of Maine, and meet the needs of coastal management for present and emerging issues. The value of long term environmental monitoring is evident from the analysis of the present data set. Local hot spots like Portland Harbor, ME (MEPH), the Tin Can Beach, NB (NBTC), and the Great Bay Estuary system along the NH-ME jurisdictional boundary for selected contaminants, point to the need for more focused monitoring at the sub regional scale.

Coastal monitoring programs like Gulfwatch provide valuable measures, which can enable managers to better understand the environmental condition of the Gulf of Maine with respect to contaminants and biological exposure and help reveal the direction that coastal ecosystems may be heading. Gulfwatch results provide a geographically intensive perspective on relative contaminant exposure in the region, ranging from relatively pristine coastal waters to highly polluted urban estuaries. Through continued analyses, the Program continues to add to the temporal and spatial perspective that is necessary for determining trends and impacts of anthropogenic perturbation in the Gulf of Maine. As such, Gulfwaatch provides a unique and invaluable source of information for resource managers who make decisions on issues related to toxic contamination in the near coastal waters of the Gulf of Maine. It is anticipated that the Gulfwatch program will be used as guidance for improved monitoring of the current contamination and extend monitoring to address new and emerging contaminant concerns of coastal resource managers.

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## 7.0 REFERENCES


Aguilar, A., A. Borrell, P.J.H. Reijnders. 2002 Geographic and temporal variation in levels of organochlorine contaminants in marine mammals. *Mar. Environ. Res.* **53**, 425-452.

Airas, S. 2003. Trace metal concentrations in blue mussels *Mytilus edulis* (L.) in Byfjorden and the coastal areas of Bergen. M.S. Thesis. Institute for Fisheries and Marine Biology, University of Bergen, Bergen, Norway.

Bothner, M.H., M. Bucholtz ten Brink, C.M. Paramenter, W.M. d'Angelo & M.W. Doughten. 1993. *The distribution of silver and other metals in sediments from Massachusetts and Cape Cod Bays*. U.S. Geological Survey Open-File Report 93-725.

Buchholtz ten Brink, M., F.T. Manheim, J.C. Hathaway, S.H. Jones, L.G. Ward, P.F. Larsen, B.W. Tripp & G.T. Wallace. 1997. *Gulf of Maine Contaminated Sediment Database: Draft final report*. Regional Marine Research Program for the Gulf of Maine, Orono, ME.

Buchholtz ten Brink, M.R., F.T. Manheim & M.H. Bothner. 1996. *Contaminants in the Gulf of Maine: What's here and should we worry?* In: The Health of the Gulf of Maine Ecosystem: Cumulative Impacts of Multiple Stressors. Regional Association for Research on the Gulf of Maine (RARGOM) Report 96-1. April 30, 1996. 181 pp. plus appendices.

Canadian Shellfish Sanitation Program (CSSP), 1992. Action levels and tolerances and other values for poisonous or deleterious substances in seafood. Appendix III. Manual of Operations. Fisheries and Oceans and Environment Canada.

Capuzzo, J.M. 1974. *The impact of chromium accumulation in an estuarine environment*. Ph.D.Thesis. University of New Hampshire, Durham, NH. 170p.

Capuzzo, J.M. 1996. Biological effects of toxic chemical contaminants in the Gulf of Maine. In *Proceedings of the Gulf of Maine Ecosystem Dynamics Scientific Symposium and Workshop*. Ed G.T. Wallace and E.F. Braasch, pp. 183-192. Regional Association for Research in the Gulf of Maine, Hanover, NH.

Crawford, R. & J. Sowles. 1992. *Gulfwatch Project - Standard procedures for field sampling, measurement and sample preparation. Gulfwatch Pilot Period 1991-1992.* The Gulf of Maine Council on the Marine Environment, State Planning Office, Augusta, ME. 12p.

DiFranco, J., Bacon L. , Mower B. & Courtemanch D. 1995. *Fish tissue contamination in Maine Lakes - Data Report*. Maine Department of Environmental Protection. Augusta, ME.

Dow, D. & E. Braasch. 1996. *The Health of the Gulf of Maine Ecosystem: Cumulative Impacts of Multiple Stressors*. D. Dow and E. Braasch (Eds). Regional Association for Research on the Gulf of Maine (RARGOM) Report 96-1. April 30, 1996. 181 pp. plus appendices.

Dumouchel, F. & P. Hennigar, 1995. *Canadian Shellfish Contaminants Monitoring QA/QC Analytical Guidelines*. Laboratory Managers' Committee, Environment Canada. July, 1995.

Environment Canada 1986. *Polynuclear aromatic hydrocarbons and heterocyclic aromatic compounds in Sydney Harbour, Nova Scotia. A 1986 survey*. Surveill. Rep. EPS-5-AR-88-7, Atlantic Region: 41p.

Evers, D.C., Reaman P., Kaplan J. and Paruk J. 1996. *North American Loon Biomonitoring Program: 1995 Field Season Final Report - 1989-95 Comprehensive Report*. Biodiversity, Inc. Paradise, MI.

Fowler, S.W. 1990. Critical review of selected heavy metal and chlorinated hydrocarbon concentrations in the marine environment. *Marine Environmental Research*, **29**, 1.

Glynn, D.E., E. McGovern, L.Tyrrell, B. McHugh, E. Monaghan, and J. Costello. 2004. A review of trace metals and chlorinated hydrocarbon concentrations in shellfish from Irish waters, 1993-2002. *In*: Book of Abstracts. 5th International Conference in Molluscan Shellfish Safety, 14-18 June, 2004. Galway, Ireland. P. 149.

GOMC, Gulf of Maine Council on the Marine Environment 1992. *Evaluation of Gulfwatch 1992: second year of the Gulf of Maine Environmental Monitoring Plan*. The Gulf of Maine Council on the Marine Environment. State Planning Office, Augusta, Me.

GOMC, Gulf of Maine Council on the Marine Environment 1996. *Evaluation of Gulfwatch 1993: third year of the Gulf of Maine Environmental Monitoring Plan*. The Gulf of Maine Council on the Marine Environment. State Planning Office, Augusta, Me.

GOMC, Gulf of Maine Council on the Marine Environment 1997. *Evaluation of Gulfwatch 1996 - Sixth Year of the Gulf of Maine Environmental Monitoring Plan.* The Gulf of Maine Council on the Marine Environment, State Planning Office, Augusta, ME.

Granby, K. & N.H. Spliid 1995. Hydrocarbons and organochlorines in common mussels from the Kattegat and the Belts and their relation to condition indicies. *Mar. Pollut. Bull.* **30**: 74-82.

Howells, G., D. Calamari, J. Gray & P.G. Wells 1990. An analytical approach to the assessment of long-term effects of low levels of contaminants in the marine environment. *Mar. Poll. Bull.* **21**: 371-375.

Jones, S.H., M. Chase, J. Sowles, P. Hennigar, N. Landry, P.G. Wells, G.C.H. Harding, C. Krahforst and G.L. Brun. 2001. Monitoring for toxic contaminants in *Mytilus edulis* from New Hampshire and the Gulf of Maine. J. Shellfish Res. 20: 1203-1214.

Jones, S.H. 2004. Contaminants and Pathogens. pp. 33-41, In: The Tides of Change Across the Gulf. An Environmental Report on the Gulf of Maine and Bay of Fundy. Pesch, G.G. and P.G. Wells (Eds.). Gulf of Maine Council on the Marine Environment, Concord, NH.

Jones, S. H., M. Chase, J. Sowles, P. Hennigar, W. Robinson, G. Harding, R. Crawford, D. Taylor, K. Feeman, J. Pederson, L. Mucklow, and K. Coombs. 1998. Evaluation of Gulfwatch: the first five years. The Gulf of Maine Council on the Marine Environment, State Planning Office, Augusta, ME.

Kawaguchi, T., D. Porter, D. Bushek & B. Jones. 1999. Mercury in the American oyster *Crassostrea virginica* in South Carolina, U.S.A., and public health concerns. *Mar. Poll. Bull.* **38**: 324-327.

Kennish, M.J. 1997. *Practical Handbook of Estuarine and Marine Pollution*. CRC Press, Boca Raton, FL.

Kimball, D.M. 1994. The reproductive cycle in three populations of the blue mussel, *Mytilus edulis*, from Boston Harbor and Cape Code Bay. PhD Dissertation, University of Massachusetts, Boston, Boston, MA.

Kveseth, K., B. Sortland & T. Bokn. 1982. Polycyclic aromatic hydrocarbons in sewage, mussels, and tap water. *Chemosphere* **11**: 623-639.

Krahforst, C.F. & Wallace, G.T. 1996. Source estimates and the partitioning of silver and other trace metals in Massachusetts coastal waters. In *4th International Conference on Transport, Fate, and Effects of Silver in the Environment*. Ed. A.W. Anden and W.T. Bober. University of Wisconsin Sea Grant, Madison, Wisconsin.

Krahforst, C. F. (in prep.) Comparative Biogeochemistry of Silver and Other Selected Metals in Coastal Waters Near Massachusetts, U.S.A. Ph.D.Thesis. University of Massachusetts, Boston, MA. 270p.

LaTouche, Y.D. & M.C. Mix. 1981. Seasonal variation in soft tissue weights and trace metal burdens in the bay mussel, *Mytilus edulis. Bull. Environ. Contamin. Toxicol.* **27**: 821-828.

Mayer, L.M. & Fink, L.K. Jr. 1990. Granulometric dependence of chromium accumulation in estuarine sediments in Maine. *Estuarine and Coastal Marine Science* **11**, 491-503.

McIntosh, A.D., J. Petrie, L. Webster, X. Bredzinski, and C.F. Moffat. 2004. Measurements of chemical contamination in shellfish from Scottish waters. *In*: Book of Abstracts. 5th International Conference in Molluscan Shellfish Safety, 14-18 June, 2004. Galway, Ireland. P. 153.

Monirith, I., D. Ueno, S. Takahashi, H. Nakata, A. Sudaryanto, A. Subramanian, S. Karrupiah, A. Ismail, M. Muchtar, J. Zheng, B. Richardson, M. Prudente, N.D. Hue, T.S. Tana, A. Tkalin, and S.Tanabe. 2003. Asia-Pacific mussel watch: monitoring contamination of persistent organochlorine compounds in coastal waters of Asian countries. Mar. Poll. Bull. **46**: 281-300.

Mucklow, L. 1996. Effects of season and species on physiological condition and contaminant burdens in mussels (*Mytilus edulis* L. and *Mytilus trossulus* G.) Implications for Mussel Watch programs. Master of Environmental Studies Thesis, Dalhousie University, Halifax, N.S. 142 p.

NAS (National Academy of Sciences) 1980. The International Mussel Watch. National Academy of Sciences. Washington D.C. 248p.

Nelson, J.I. Jr. 1986. The presence of mercury, chromium, lead, nickel, copper and zinc in the Great Bay Estuarine System, New Hampshire. M.S. thesis. Dept. of Civil Engineering, Univ. of New Hampshire, Durham.

NESCAUM. 1998. Northeast States/Eastern Canadian Provinces Mercury Study, February, 1998.

NHDES, New Hampshire Department of Environmental Services 1998. *State of New Hampshire: 1998 Section 305(b) Water Quality Report*. New Hampshire Department of Environmental Services, Concord, NH.

New Hampshire Estuaries Project (NHEP). 2000. A technical characterization of estuarine and coastal New Hampshire. Jones, S.H. (Ed.). New Hampshire Estuaries Project, Portsmouth, NH.

NOAA, National Oceanic and Atmospheric Administration. 1989. *A summary of data on tissue contamination from the first three years (1986-1988) of the mussel watch project*. National Status and Trends Program for Marine Environmental Quality Progress Report. NOAA Technical Memorandum NOS OMA 49.

NOAA (National Oceanic and Atmospheric Administration), 1991. Mussel Watch Worldwide Literature Survey - 1991. NOAA Technical Memorandum NOS ORCA 63. Rockville, MD. 143 pp.

O'Connor, T.P. 1998. Mussel Watch Results from 1986 to 1996. *Marine Pollution Bulletin* **37(1-2)**, 14-19.

O'Connor, T.P. 2002. National distribution of chemical concentrations in mussels and oysters in the USA. *Mar. Environ. Res.* **53,** 117-143.

O'Connor, T.P and G.G. Lauenstein. 2005. Status and trend of copper concentrations in mussels and oysters in the USA. *Mar. Chem*. **97**, 49-59.

O'Connor, T.P and G.G. Lauenstein. 2006. Trends in chemical concentrations in mussels and oysters collected along the US coast: update to 2003. *Mar. Environ. Res.* **62**, 261-285.

Rainio, K., R.R. Linko, & L. Ruotsila. 1986. Polycyclic aromatic hydrocarbons in mussels and fish from the Finnish Archipelago Sea. *Bull. Environ. Contam. Toxicol*. 37:337-343.

Robinson, W.E., D.K. Ryan & G.T. Wallace. 1993. Gut contents: A significant contaminant of *Mytilus edulis* whole body metal concentrations. *Arch. Environ. Contam. Toxicol.* 25: 415-421.

Salazar, B.M. & S.M. Salazar . 1995. In situ bioassays using transplanted mussels: I. Estimating chemical exposure and bioeffects with bioaccumulation and growth. In, Environmental Toxicology and Risk Assessment. Vol. 3. American Society for Testing and Materials (ASTM STP 1218) Philadelphia. Pp 216-241.

Sanudo-Wlhemly, S.A. & A.R. Flegal 1992. Anthropogenic silver in the southern California Bight: a new tracer of sewage in coastal waters. *Environ. Sci. Technol.* **26**: 2147-2151.

SAS. 1990. *SAS/STAT Users Guide Volume 2, GLM-VARCOMP*. North Carolina: SAS Institute Inc. pp. 951-986.

Schantz, M.M., J.R. Kucklick, R.M. Parris, D.L. Poster, and S.A. Wise. 2006. NIST Intercomparison Exercise Program for Organic Contaminants in the Marine Environment: Description and Results of the 2005 Organic Intercomparison Exercises. National Institute of Standards and Technology, NISTIR 7340.

Seed, R. 1968. Factors influencing shell shape in *Mytilus edulis* L. *Journal of the Marine Biological Association U.K.* **48**, 561-584.

Shaw, S.D., D. Brenner, C.A. Mahaffey, S. De Guise, C.R. Perkins, G.C. Clark, M.S. Denison, and G.T. Waring. 2003. Persistent organic pollutants and immune function in US Atlantic coast harbor seals (*Phoca vitulina concolor*). *Organohalogen Componds* **62**, 220-223.

Sheehan, P.J. 1984. Effects on individuals and populations. In, *Effects of pollutants at the ecosystem level*. J. Wiley and sons, eds. Chichester, U.K. pp. 23-50.

Sheehan, P.J., D.R. Miller, G.C. Butler & P. Bordeau 1984. *Effects of pollutants at the ecosystem level*. J. Wiley and sons, eds. Chichester, U.K. pp. 23-50.

Tripp, B.W., M. Bothner, J. Farrington, A. Giblin, J. McDowell, and P. Shelley. 1997. Final Report: Evaluation of the Gulfwatch Program. http://www.gulfofmaine.org/library/gulfwatch/GW-eval.pdf

USEPA, (U.S. Environmental Protection Agency). 1993. *EMAP-Estuarine, Quality Assurance Project Plan 1993 Virginian Province*. US Report EPA/600/x91/xxx.

USFDA (United States Food and Drug Administration). 1990. U.S. Food and Drug Administration Shellfish Sanitation Branch, Washington, D.C.

USFDA, (U.S. Food and Drug Administration). 1993. *Guidance documents for Cadmium, chromium, lead and nickel*. Center for Food Safety and Applied Nutrition U.S. Food and Drug Administration, Washington, D.C.

Welch, L. 1994. *Contaminant burdens and reproductive rates of bald eagles breeding in Maine*. M.S. Thesis. U. Maine, Orono, ME.

Wells, P.G. & Rolston, S.J. 1991. *Health of our Oceans. A status report on Canadian Marine Environmental Quality. Conservation and Protection*. Environment Canada, Ottawa, ON. And Dartmouth, N.S.

Weisbrod, A., D. Shea, M. Moore, and J. Stegeman. 2000. Organochlorine exposure and bioaccumulation in the endangered Northwest Atlantic right whale (*Eubalaena glacialis*) population. *Environ. Tox. Chem.* **19**, 654-666.

Wells, P.G., Keizer, P.D., Martin, J.L., Yeats, P.A., Ellis, K.M. and Johnston, D.W. 1997. The Chemical Environment of the Bay of fundy. In *Bay of Fundy Issues: A scientific overview. Environment Canada - Atlantic Region, Occasional Report No. 8* Chapter 3. Ed. J.A. Percy, P.G. Wells and A. Evans, pp. 37-61. Environment Canada, Dartmouth, N.S.

White, L., S. Jones, P. Wells, G. Brun, G. Harding, P. Hennigar, C. Krahforst, D. Page, J. Schwartz, S. Shaw, D. Taylor, and P. Trowbridge. 2007. The Nine-Year Gulfwatch Program 1993-2001: A Review of the Results & Program Design. Gulf of Maine Council on the Marine Environment, Concord, NH.

Widdows, J. 1985. Physiological measurements. In: The effects of stress and pollution on marine animals. B.L. Bayne, D.A. Brown, K. Burns, D.R. Dixon, A. Ivanovici, D.R. Livingstone, D.M. Lowe, M.N. Moore, A.R.D. Stebbing & J. Widdows, eds. Praeger Publishers, New York. Pp 3-39.

Widdows, J. & P. Donkin. 1992. Mussels and environmental contaminants: Bioaccumulation and physiological aspects. *In*: Gosling, E. (ed.) The mussel *Mytilus*: Ecology, physiology, genetics and culture. New York: Elsevier Science Publishers. pp. 383-424.

Widdows, J., Donkin, P., Brinsley, M.D., Evans, S.V., Salkeld, P.N., Franklin, A., Law, R.J. & Waldock, M.J. 1995. Scope for growth and contaminant levels in North Sea mussels *Mytilus edulis*. *Marine Ecology Progressive Series* **127**,131-148.

# APPENDIX A

## Sample Collection Information

**TABLE A.1** 2005 Gulfwatch Sample identification numbers, replicates, species, and collection dates.

| Gulfwatch Sample ID | Field Replicate # | Species | Collection Date |
|---|---|---|---|
| MASN1N051103 | MASN-1 | mussels | 11/03/2005 |
| MASN2N051103 | MASN-2 | | |
| MASN3N051103 | MASN-3 | | |
| MASN4N051103 | MASN-4 | | |
| MAPY1N051106 | MAPY-1 | mussels | 11/06/2005 |
| MAPY2N051106 | MAPY-2 | | |
| MAPY3N051106 | MAPY-3 | | |
| NHMG1N051024 | NHMG-1 | soft shell clams | 10/24/2005 |
| NHMG2N051024 | NHMG-2 | | |
| NHHS1N051108 | NHHS-1 | mussels | 11/08/2005 |
| NHHS2N051108 | NHHS-2 | | |
| NHHS3N051108 | NHHS-3 | | |
| NHHS4N051108 | NHHS-4 | | |
| NHNM1N051024 | NHNM-1 | mussels | 10/24/2005 |
| NHNM2N051024 | NHNM-2 | | |
| NHNM3N051024 | NHNM-3 | | |
| NHNM4N051024 | NHNM-4 | | |
| NHDP1N051108 | NHDP-1 | mussels | 11/08/2005 |
| NHDP2N051108 | NHDP-2 | | |
| NHDP3N051108 | NHDP-3 | | |
| NHDP4N051108 | NHDP-4 | | |
| NHNI1N051024 | NHNI-1 | oysters | 10/24/2005 |
| NHNI2N051024 | NHNI-2 | | |
| MECC1N051108 | MECC-1 | mussels | 11/08/2005 |
| MECC2N051108 | MECC-2 | | |
| MECC3N051108 | MECC-3 | | |
| MECC4N051108 | MECC-4 | | |
| MEPH1N102405 | MEPH-1 | mussels | 10/24/2005 |
| MEPH2N102405 | MEPH-2 | | |
| MEPH3N102405 | MEPH-3 | | |
| MEPH4N102405 | MEPH-4 | | |
| MERY1N110805 | MERY-1 | mussels | 11/08/2005 |
| MERY2N110805 | MERY-2 | | |
| MERY3N110805 | MERY-3 | | |
| MERY4N110805 | MERY-4 | | |
| MEFP1N111005 | MEFP-1 | mussels | 11/10/2005 |
| MEFP2N111005 | MEFP-2 | | |
| MEFP3N111005 | MEFP-3 | | |
| MEFP4N111005 | MEFP-4 | | |

**Table A.1** (Continued).

| Gulfwatch Sample ID | Field Replicate # | Species | Collection Date |
|---|---|---|---|
| MEPI1N102705 | MEPI-1 | mussels | 10/27/2005 |
| MEPI2N102705 | MEPI-2 | | |
| MEPI3N102705 | MEPI-3 | | |
| MEPI4N102705 | MEPI-4 | | |
| NBHI1N051209 | NBHI-1 | mussels | 12/09/2005 |
| NBHI2N051209 | NBHI-2 | | |
| NBHI3N051209 | NBHI-3 | | |
| NBHI4N051209 | NBHI-4 | | |
| NBTC1N051207 | NBTC-1 | mussels | 12/07/2005 |
| NBTC2N051207 | NBTC-2 | | |
| NBTC3N051207 | NBTC-3 | | |
| NBTC4N051207 | NBTC-4 | | |
| NSDI1N051108 | NSDI-1 | mussels | 11/08/2005 |
| NSDI2N051108 | NSDI-2 | | |
| NSDI3N051108 | NSDI-3 | | |
| NSDI4N051108 | NSDI-4 | | |
| NSBC1N051108 | NSBC-1 | mussels | 11/08/2005 |
| NSBC2N051108 | NSBC-2 | | |
| NSBC3N051108 | NSBC-3 | | |
| NSBC4N051108 | NSBC-4 | | |
| NSBP1N051020 | NSBP-1 | mussels | 10/20/2005 |
| NSBP2N051020 | NSBP-2 | | |
| NSBP3N051020 | NSBP-3 | | |
| NSBP4N051020 | NSBP-4 | | |

## APPENDIX B

## 2005 Methods Detection Limits

For organic analysis, method detection limits (MDL) are estimated following the U.S Environmental Protection Agency's procedure for the determination of method detection limits described in the US Federal Register (40 CFR part 136 appendix B). Briefly, this method uses the standard deviation of replicate analyses of low level spiked mussel tissue. Analyte MDLs are calculated at a 95% confidence level, rather than the 99% confidence level specified in 40 CFR part 136 Appendix B. Tables B-1 and B-2 list the MDLs for the respective contaminants monitored for 2005.

**TABLE B.1. Organic Analytical Methods Detection Limits (ng/g dry wt.)**

| **PAH** | | **PCB congener** | | **Pesticide** | |
|---|---|---|---|---|---|
| Naphthalene | <10 | 8 ; 5 | <2.8 | a_BHC | <2.0 |
| 2-Methyl-naphthalene | <8 | 18 ; 15 | <2.7 | HCB | <2.4 |
| 1-Methyl-naphthalene | <10 | 28 ; | <2.2 | g-HCH(Lindane) | <1.5 |
| Biphenyl | <7 | 29 ; | <2.4 | Heptachlor | <2 |
| 2,6-Dimethyl naphthalene | <8 | 44 ; | <2.4 | Aldrin | <1.5 |
| Acenaphthylene | <11 | 50 ; | <2 | HeptachlorEpoxide | <1.8 |
| Acenaphthene | <8 | 52 ; | <2.3 | g-Chlordane | <1.5 |
| 2,3,5-Trimemethyl naphthalene | <7 | 66 ; 95 | <2.2 | o,p'-DDE | <1.0 |
| Fluorene | <7 | 77 ; | <2.2 | a-Endosulfan | <1.5 |
| Phenanthrene | <6 | 87 ; | <1.9 | cis-Chlordane | <1.2 |
| Anthracene | <10 | 101 ; 90 | <2.3 | t-Nonachlor | <1.4 |
| 1-Methyl phenanthrene | <12 | 105 ; | <2 | p,p'_DDE | <1.8 |
| Fluoranthene | <14 | 118 ; | <2.1 | Dieldrin | <1.4 |
| Pyrene | <9 | 128 ; | <1.4 | o,p'-DDD | <4.0 |
| Benzo(a)anthracene | <6 | 138 ; | <2 | Endrin | <2.2 |
| Chrysene | <6 | 153 ; 132 | <1.9 | b-Endosulfan | <3.4 |
| Benzo(b)fluoranthene | <6 | 170 ; 190 | <1.9 | p,p'-DDD | <2 |
| Benzo(k)fluoranthene | <4 | 180 ; | <1.9 | o,p'-DDT | <2.8 |
| Benzo(e)pyrene | <7 | 187 ; | <1.7 | p,p'-DDT | <2.5 |
| Benzo(a)pyrene | <4 | 195 ; 208 | <1.7 | | |
| Perylene | <5 | 206 ; | <1.8 | | |
| Indeno(123cd)pyrene | <7 | 209 ; | <1.8 | | |
| Dibenzo(ah)anthrace | <11 | | | | |
| Benzo(ghi)perylene | <15 | | | | |

**TABLE B.2**. 2005 Metal Methods Detection Limits (µg/g dry wt.)

| Ag | Cd | Cr | Cu | Fe | Ni | Pb | Zn | Hg | Al |
|---|---|---|---|---|---|---|---|---|---|
| 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.05 | 0.02 | 0.3 | 0.005 | 0.5 |

# APPENDIX C Summary of Trace Metal Analysis Quality Assurance/Quality Control for 2005

## C.1 ACCURACY

### C.1.1 Standard Reference Materials

Accuracy refers to the agreement between the amount of a component measured by the test method and the amount actually present. The quality assurance protocol for the Gulfwatch project sets the accuracy criteria of ±25% for trace metals of the certified value of a standard reference material (SRM). Certified values are reported by the NRC (National Research Council) or NIST (National Institute of Standards and Technology). Standard reference materials with values >10 times the detection limits were used to verify the accuracy of the analytical methods. The NRC standard, DORM-2 (dogfish muscle and liver tissue), and NIST standard 2976 (blue mussel tissue) were used to certify accuracy in the metals analysis. Overall mean SRM recoveries for the metals analyzed ranged from 72 -124% (Table C.1.1). For all metals, only 1 of the 80 SRM recoveries (for Al) that were below the ±25% of the certified value criteria.

**TABLE C.1.1** Analyses of standard reference materials for trace metals (ug/g dry mass basis) associated with the 2005 analyses performed by Battelle MSL, Sequim, WA.

| | Ag | Cd | Cr | Cu | Fe | Ni | Pb | Zn | Al | Hg |
|---|---|---|---|---|---|---|---|---|---|---|
| NIST SRM 2976 | 0.01 | 0.810 | 0.570 | 3.81 | 184 | 0.802 | 1.23 | 161 | 139 | 0.0698 |
| | 0.01 | 0.814 | 0.608 | 3.59 | 181 | 0.762 | 1.19 | 149 | 142 | 0.0650 |
| | 0.01 | 0.840 | 0.576 | 3.70 | 176 | 0.790 | 1.22 | 149 | 146 | 0.0659 |
| | 0.01 | 0.797 | 0.595 | 3.77 | 178 | 0.795 | 1.17 | 148 | 142 | 0.0636 |
| *Certified/Reference value* | 0.011 | 0.82 | 0.5 | 4.02 | 171 | 0.93 | 1.19 | 137 | 134 | 0.0610 |
| *Range* | ±0.005 | ±0.2 | ±0.16 | ±0.33 | ±4.9 | 0.12 | ±0.18 | ±13 | ±34 | ±0.0036 |
| Recovery: | **91%** | **99%** | **114%** | **95%** | **108%** | **103%** | **86%** | **118%** | **104%** | **114%** |
| Recovery: | **91%** | **99%** | **122%** | **89%** | **106%** | **100%** | **82%** | **109%** | **106%** | **107%** |
| Recovery: | **100%** | **102%** | **115%** | **92%** | **103%** | **103%** | **85%** | **109%** | **109%** | **108%** |
| Recovery: | **91%** | **97%** | **119%** | **94%** | **104%** | **98%** | **86%** | **108%** | **106%** | **104%** |
| **Mean % Recovery** | **93%** | **99%** | **117%** | **93%** | **105%** | **101%** | **85%** | **111%** | **106%** | **108%** |
| **RSD** | **5%** | **2%** | **3%** | **2%** | **2%** | **2%** | **2%** | **5%** | **2%** | **4%** |
| **NRC CRM DORM2** | 0.0384 | 0.0427 | 30.1 | 2.32 | 148 | 0.0764 | 16.5 | 26.2 | 7.81 | 4.60 |
| | 0.0425 | 0.0433 | 34.2 | 1.99 | 158 | 0.0640 | 18.7 | 24.5 | 8.45 | 4.77 |
| | 0.0335 | 0.0434 | 34.2 | 2.28 | 159 | 0.0809 | 18.7 | 24.9 | 8.37 | 4.64 |
| | 0.0331 | 0.0422 | 31.0 | 2.37 | 149 | 0.0688 | 16.9 | 26.6 | 11.0 | 4.73 |
| *Certified/Reference value* | 0.041 | 0.043 | 34.7 | 2.34 | 142 | 0.065 | 19.4 | 25.6 | 10.9 | 4.64 |
| *Range* | ±0.013 | ±0.008 | ±5.5 | ±0.16 | ±10 | ±0.007 | ±3.10 | ±2.3 | ±1.70 | ±0.26 |
| Recovery: | **94%** | **99%** | **87%** | **99%** | **104%** | **118%** | **85%** | **102%** | **72%** | **99%** |
| Recovery: | **104%** | **101%** | **98%** | **85%** | **111%** | **98%** | **97%** | **96%** | **78%** | **103%** |
| Recovery: | **82%** | **101%** | **98%** | **97%** | **112%** | **124%** | **96%** | **97%** | **77%** | **100%** |
| Recovery: | **81%** | **98%** | **89%** | **101%** | **105%** | **106%** | **87%** | **104%** | **101%** | **102%** |
| **Mean % Recovery** | **90%** | **100%** | **93%** | **96%** | **108%** | **112%** | **91%** | **100%** | **82%** | **101%** |
| **RSD** | **11%** | **1%** | **6%** | **7%** | **4%** | **12%** | **6%** | **4%** | **13%** | **2%** |

NIST 2976: National Institute of Standards and Technology Trace Organics and,Trace elements and methylmercury in Mussel Tissue (*Mytilus edulis*); DORM2: Trace elements in Dogfish (*Squalus acanthias*) mussel from the National Research Council of Canada.

### C.1.2 Blank and Matrix Spikes

Blank and matrix spikes are another prescribed measurement of accuracy of the Gulfwatch Program. Matrix spikes recoveries between 75 -125% are considered as meeting the DQO of the Program. Matrix spikes ranged from 86-119% and averaged 103 (+/- 4)% over all the batches. All matrix spike results were all within acceptable criteria (Table C.1.2.2).

**Table C.1.2.1** Blank spike results reported by Battelle Marine Sciences Laboratory for the 2005 metals analyses

| | Ag | Cd | Cr | Cu | Fe | Ni | Pb | Zn | Al | Hg |
|---|---|---|---|---|---|---|---|---|---|---|
| LCS1 | 1.94 | 2.02 | 2.12 | 2.00 | 27.0 | 2.09 | 2.06 | 27.0 | 26.1 | 1.99 |
| Blank1 | 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.02 | 0.05 | 0.3 | 1.3 | 0.005 |
| Spike concentration | *2.0* | *2.0* | *2.0* | *2.0* | *25* | *2.0* | *2.0* | *25* | *25* | *2.0* |
| RECOVERY | **97%** | **101%** | **106%** | **100%** | **108%** | **105%** | **103%** | **108%** | **104%** | **100%** |
| | | | | | | | | | | |
| LCS2 | 1.91 | 2.02 | 2.12 | 1.99 | 27.4 | 2.07 | 1.99 | 27.2 | 27.9 | 2.067 |
| Blank2 | 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.02 | 0.05 | 0.3 | 0.571 | 0.005 |
| Spike concentration | 2.0 | *2.0* | *2.0* | *2.0* | *25* | *2.0* | *2.0* | *25* | *25* | *2.0* |
| | **96%** | **101%** | **106%** | **100%** | **110%** | **104%** | **100%** | **109%** | **109%** | **103%** |
| | | | | | | | | | | |
| LCS3 | | 2.09 | 2.16 | 2.09 | 25.9 | 2.10 | 2.12 | 26.6 | 26.6 | 1.94 |
| Blank3 | 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.02 | 0.05 | 0.3 | 0.627 | 0.005 |
| Spike concentration | *2.0* | *2.0* | *2.0* | *2.0* | *25* | *2.0* | *2.0* | *25* | *25* | *2.0* |
| RECOVERY | **93%** | **105%** | **108%** | **105%** | **104%** | **105%** | **106%** | **106%** | **104%** | **97%** |
| | | | | | | | | | | |
| LCS4 | 1.93 | 2.01 | 2.14 | 2.05 | 27.0 | 2.00 | 2.06 | 26.7 | 26.5 | 1.96 |
| Blank4 | 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.02 | 0.05 | 0.3 | 0.726 | 0.0057 |
| Spike concentration | *2.0* | *2.0* | *2.0* | *2.0* | *25* | *2.0* | *2.0* | *25* | *25* | *2.0* |
| RECOVERY | **97%** | **101%** | **107%** | **103%** | **108%** | **100%** | **103%** | **107%** | **103%** | **98%** |

**Table C.1.2.2** Matrix spike results reported by Battelle Marine Sciences Laboratory for the 2005 metals analyses. SL = Insufficient spiking level relative to native metal concentrations; see blank spikes and SRMs for accuracy.

| | **Ag** | **Cd** | **Cr** | **Cu** | **Fe** | **Pb** | **Ni** | **Zn** | **Al** | **Hg** |
|---|---|---|---|---|---|---|---|---|---|---|
| MECC1 | 1.89 | 12.0 | 12.7 | 17.4 | 847 | 15.7 | 10.9 | 357 | 741 | 2.41 |
| | 0.0456 | 2.18 | 2.28 | 7.36 | 541 | 4.18 | 1.37 | 146 | 455 | 0.314 |
| *Spike conc* | 2.02 | 9.90 | 9.90 | 9.90 | 208 | 9.90 | 9.90 | 208 | 208 | 2.01 |
| **% Recovery** | **91%** | **99%** | **106%** | **101%** | **SL** | **116%** | **96%** | **101%** | **SL** | **104%** |
| MECC2 | 1.73 | 11.2 | 11.5 | 15.9 | 783 | 14.3 | 9.85 | 327 | 637 | 2.31 |
| | 0.0458 | 2.48 | 2.57 | 6.86 | 603 | 5.34 | 1.46 | 127 | 416 | 0.339 |
| *Spike conc* | 1.96 | 9.21 | 9.21 | 9.21 | 193 | 9.21 | 9.21 | 193 | 193 | 1.96 |
| **% Recovery** | **86%** | **95%** | **97%** | **98%** | **93%** | **97%** | **91%** | **104%** | **115%** | **101%** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NHMG1 | 2.42 | 2.46 | 14.4 | 20.1 | 3711 | 15.2 | 11.2 | 308 | 3262 | 2.06 |
| | 0.680 | 0.504 | 3.95 | 10.4 | 3363 | 4.72 | 1.83 | 89.2 | 1980 | 0.0930 |
| *Spike conc* | 1.96 | 1.96 | 9.90 | 9.90 | 208 | 9.90 | 9.90 | 208 | 208 | 1.96 |
| **% Recovery** | ***89%*** | ***100%*** | ***105%*** | ***98%*** | **SL** | ***106%*** | ***95%*** | ***105%*** | **SL** | ***100%*** |
| | | | | | | | | | | |
| NSBC1 | 1.77 | 4.42 | 11.8 | 15.0 | 911 | 4.16 | 10.7 | 300 | 752 | 2.02 |
| | 0.0394 | 2.52 | 2.03 | 5.54 | 689 | 2.26 | 1.69 | 77.4 | 509 | 0.140 |
| *Spike conc* | 1.96 | 1.96 | 9.78 | 9.78 | 205 | 1.96 | 9.78 | 205 | 205 | 1.96 |
| **% Recovery** | ***88%*** | ***97%*** | ***100%*** | ***97%*** | ***108%*** | ***97%*** | ***92%*** | ***108%*** | ***119%*** | ***96%*** |

## C.2 PRECISION

Precision refers to the reproducibility of a method when it is repeated under controlled conditions. For this assessment, the Gulfwatch Program uses the relative percent difference (RPD) of duplicate samples as a test of precision. The RPD of laboratory duplicates should be less than 25% for all metals. Results of duplicate comparisons from 3 samples are listed in Tables C.2.1-2. The RPD between laboratory duplicates ranged from near 0-14%, with a mean of 4.2%. The RPDs all duplicates were well within acceptable limits.

**TABLE C.2.1.** Replicate metals analysis (µg/g) for 2005 samples performed by Battelle Marine Sciences Laboratory (MSL). RPD = relative % difference

| | Ag | Cd | Cr | Cu | Fe | Pb | Ni | Zn | Al | Hg |
|---|---|---|---|---|---|---|---|---|---|---|
| MECC3N | 0.0406 | 1.91 | 2.33 | 6.29 | 557 | 3.60 | 1.34 | 132 | 427 | 0.298 |
| MECC3DUP | 0.0388 | 1.84 | 2.37 | 6.33 | 551 | 3.58 | 1.33 | 130 | 477 | 0.295 |
| **Mean** | **0.0397** | **1.88** | **2.35** | **6.3** | **554** | **3.59** | **1.33** | **131** | **452** | **0.297** |
| **RPD** | ***5%*** | ***4%*** | ***2%*** | ***1%*** | ***1%*** | ***1%*** | ***1%*** | ***2%*** | ***11%*** | ***1%*** |
| | | | | | | | | | | |
| MASN3N | 0.475 | 1.12 | 1.06 | 6.74 | 336 | 3.91 | 1.05 | 97.1 | 285 | 0.122 |
| MASN3NDUP | 0.439 | 1.07 | 1.01 | 6.52 | 360 | 3.78 | 1.02 | 96.4 | 267 | 0.108 |
| | | | | | | | | | | |
| **Mean** | **0.457** | **1.10** | **1.04** | **6.6** | **348** | **3.85** | **1.03** | **97** | **276** | **0.115** |
| **RPD** | ***8%*** | ***5%*** | ***4%*** | ***3%*** | ***7%*** | ***3%*** | ***3%*** | ***1%*** | ***7%*** | ***11%*** |
| | | | | | | | | | | |
| NSBC2N | 0.0348 | 1.96 | 2.03 | 5.61 | 752 | 1.78 | 1.71 | 65.7 | 585 | 0.151 |
| NSBC2NDUP | 0.0331 | 1.89 | 1.99 | 5.62 | 776 | 1.74 | 1.66 | 64.6 | 675 | 0.137 |
| | | | | | | | | | | |
| **Mean** | **0.0340** | **1.93** | **2.01** | **5.6** | **764** | **1.76** | **1.68** | **65** | **630** | **0.144** |
| **RPD** | ***5%*** | ***4%*** | ***2%*** | ***0%*** | ***3%*** | ***2%*** | ***3%*** | ***2%*** | ***14%*** | ***10%*** |

## C.3 BLANKS

Four digestion procedure blanks were reported for trace metal analysis. All of the blanks, with the exception of Al, were non-detectable. Table C.3.1 summarizes percent of non-detectable blanks and presents the mean (and RSD) of the blanks observed above the reported instrumental detection limit.

**TABLE C.3.1.** MSL reported analysis of mussel preparation blanks for 2005.

| Blank | Ag | Cd | Cr | Cu | Fe | Ni | Pb | Zn | Al | Hg |
|---|---|---|---|---|---|---|---|---|---|---|
| B1 | 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.02 | 0.05 | 0.3 | 0.500 | 0.005 |
| B2 | 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.02 | 0.05 | 0.3 | 0.571 | 0.005 |
| B3 | 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.02 | 0.05 | 0.3 | 0.627 | 0.005 |
| B4 | 0.01 | 0.01 | 0.05 | 0.1 | 1.5 | 0.02 | 0.05 | 0.3 | 0.726 | 0.0057 |

## C.4 COMPLETENESS

100% of samples collected (17 of 17 samples; 66 individual replicates) were analyzed successfully. All of the SRMs met the data quality objectives of the Program. All matrix spikes were within control limits and all the RPDs for laboratory duplicates were within precision limits.

## C.5 BATTELLE QUALITY ASSURANCE/QUALITY CONTROL NARRATIVE FOR 2005 SAMPLES

**PROJECT:** Gulf of Maine 2006
**PARAMETER:** Metals (Ag, Al, Cd, Cr, Cu, Fe, Hg, Ni, Pb, and Zn)
**LABORATORY:** Battelle Marine Sciences Laboratory (MSL), Sequim, Washington
**MATRIX:** Tissue

**SAMPLE CUSTODY AND PROCESSING:** Sixty three tissue samples were received at MSL on 05/05/06. All samples were received in good condition (i.e., containers were intact and cooler temperature was acceptable). The samples were collected in glass jars with metals lids. The optimal container for the analysis of metals in tissue samples is a pre-cleaned glass jar with a plastic lid or pre-cleaned plastic container. The samples are considered minimally impacted as no rust was noticed on the metal lids. A representative split of each sample was transferred to a pre-cleaned, tarred plastic jar to allow determination of percent moisture. The samples were assigned a Battelle Central File (CF) identification number (2565). All project information was entered into Battelle's laboratory information and sample tracking system.

| **Chemistry Lab IDs:** | **2565*1-63** |
|---|---|
| **Description** | *Tissue* |
| **Collection dates** | 2001 (see table for dates) |
| **Laboratory arrival date** | 05/05/06 |
| **Cooler temperatures,** on arrival | -15°C |
| **Digestion** (aqua regia) | 06/07/06 |
| **CVAA analysis** (Hg) | 06/14/06 and 06/16/06 |
| **ICP-OES analysis** (Al, Cr, Cu, Fe, Ni, and Zn) | 06/19/06 and 06/20/06 |
| **ICP-MS analysis** (Ag, Cd, and Pb) | 06/14/06 and 06/15/06 |

**QA/QC DATA QUALITY OBJECTIVES:**

| Analyte | Analytical Method | Range of Recovery | SRM Accuracy | Relative Precision | Method Detection Limit (μg/g dry weight)[(a)] | Reporting Limit (μg/g dry weight)[(b)] |
|---|---|---|---|---|---|---|
| Silver | ICP-MS | 75-125% | ≤25% | ≤25% | 0.01 | 0.03 |
| Aluminum | ICP-OES | 75-125% | ≤25% | ≤25% | 0.5 | 2 |
| Cadmium | ICP-MS | 75-125% | ≤25% | ≤25% | 0.01 | 0.03 |
| Chromium | ICP-OES | 75-125% | ≤25% | ≤25% | 0.05 | 0.2 |
| Copper | ICP-OES | 75-125% | ≤25% | ≤25% | 0.1 | 0.3 |
| Iron | ICP-OES | 75-125% | ≤25% | ≤25% | 1.5 | 5 |
| Mercury | CVAA | 75-125% | ≤25% | ≤25% | 0.005 | 0.02 |
| Nickel | ICP-OES | 75-125% | ≤25% | ≤25% | 0.05 | 0.2 |
| Lead | ICP-MS | 75-125% | ≤25% | ≤25% | 0.02 | 0.06 |
| Zinc | ICP-OES | 75-125% | ≤25% | ≤25% | 0.3 | 1 |

(a) MDL determined annually using seven replicates of a tissue matrix spiked at an appropriate concentration.
(b) RL determined as 3.18* MDL

**METHODS:** The samples were analyzed for nine metals including silver (Ag), aluminum (Al), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn). Tissue samples were digested according to Battelle SOP MSL-I-024, *Mixed Acid Tissue Digestion*. An approximately 500-mg aliquot of each dried, homogeneous sample was combined with nitric and hydrochloric acids (aqua regia) in a Teflon vessel and heated in an oven at 130ºC (±10ºC) for a minimum of eight hours. After heating and cooling, deionized water was added to the acid-digested tissue to achieve analysis volume and the digestates were submitted for analysis by three methods.

Digested samples were analyzed for Hg by cold-vapor atomic absorption spectroscopy (CVAA) according to Battelle SOP MSL-I-016, *Total Mercury in Tissues and Sediments by Cold Vapor Atomic Absorption*, which is based on EPA Method 245.6, *Determination of Mercury in Tissue by Cold Vapor Atomic Absorption Spectrometry*.

Digested samples were analyzed for Al, Cr, Cu, Fe, Ni, and Zn using inductively coupled plasma optical emissions spectroscopy (ICP-OES) according to Battelle SOP MSL-I-033, *Determination of Elements in Aqueous and Digestate Samples by ICP-OES*. This procedure is based on two methods modified and adapted for analysis of low level samples: EPA Method 6010B and 200.7.

Digested samples were analyzed for Ag, Cd, and Pb using inductively coupled plasma-mass spectrometry (ICP-MS) according to Battelle SOP MSL-I-022, *Determination of Elements in Aqueous and Digestate Samples by ICP/MS*. This procedure is based on two methods modified and adapted for analysis of low-level solid sample digestates: EPA Method 1638, *Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma-Mass Spectrometry* and EPA Method 200.8, *Determination of Trace Elements in Water and Wastes by Inductively Coupled Plasma – Mass Spectrometry.*

All results were determined and reported in units of µg/g on a dry-weight basis.

**HOLDING TIMES:** Samples were archived frozen prior to arrival at MSL. The samples were freeze dried within 30 days of receipt and analyzed within six months.

**DATA QUALIFIERS:** Sample concentrations were evaluated and flagged to the following criteria:

U Analyte not detected greater than the MDL, MDL reported with qualifier

J Analyte detected greater than the MDL, but less than the RL

* Duplicate analysis not within QC criterion of ≤25% relative percent difference.

N QC sample outside QC criterion of ±25% recovery

SL Insufficient spiking level relative to native sample concentration.

**METHOD BLANK:** One method blank was analyzed with every 20 field samples. Analytes were not detected above the RL.

**LABORATORY** One blank spike/laboratory control sample (LCS) was analyzed with every 20 field

| | |
|---|---|
| **CONTROL SAMPLE/BLANK SPIKE ACCURACY:** | samples. LCS recoveries were within the QC acceptance criterion of 75-125% recovery for all metals. |
| **MATRIX SPIKE ACCURACY:** | One tissue sample was processed with a matrix spike in each batch of 20 field samples. Matrix spike recoveries were within the QC acceptance criterion of 75-125% recovery for all metals except two matrix spikes for Al and Fe. The spiking level for Al and Fe was insufficient relative to native sample concentrations to be used for evaluating accuracy. Acceptable accuracy was demonstrated in the LCS and SRM quality control samples. |
| **REPLICATE PRECISION:** | One set of laboratory duplicates was analyzed for every 20 field samples. Precision was expressed as the relative standard difference (RPD) between replicate results. The RPD values were within the QC criterion of ≤25% for all metals. |
| **STANDARD REFERENCE MATERIAL ACCURACY:** | Standard reference material (SRM) accuracy was expressed as the percent recovery between the measured and certified concentrations. Reference values are provided for evaluation purposes.<br><br>SRM 2976 Mussel Tissue and SRM DORM-2 Dogfish Tissue were digested and analyzed with this set of samples. Multiple SRMs were selected because no single SRM is certified for all metals of interest at appropriate concentration ranges.<br><br>SRM 2976 is certified for Cd, Cu, Fe, Hg, Pb, and Zn. The percent recoveries were within QC acceptance criterion of 75-125% recovery for all metals.<br><br>The metals in SRM DORM-2 certified greater than the RL are Ag, Al, Cd, Cr, Cu, Fe, Hg, Ni, and Zn. The percent recoveries were within the QC acceptance criterion for all metals except one replicate for Al (72%). All other measures of accuracy and precision were within the QC criteria. |

# APPENDIX D Summary of 2005 Organic Contaminant Analysis Assurance/Quality Control

## D.1 ACCURACY

### D.1.1 Standard Reference Materials and NIST Intercalibration

The quality assurance protocol for the Gulfwatch project sets the accuracy criteria of ±30% for organic contaminants certified value of a standard reference material (SRM). Certified values are reported by the NIST (National Institute of Standards and Technology). Standard reference materials with values >10 times the detection limits were used to verify the accuracy of the analytical methods. A "Mussel Tissue XII" homogenate were used to certify accuracy of PCB, PAH and chlorinated pesticide analyses. These data are from Gulfwatch's participation in the 2005 NIST Intercomparison Exercise Program for Organic Contaminants in the Marine Environment (Schantz et al., 2006). Accuracy was assessed by NIST using a z-score index:

$$\text{z-score } [25\%] = (x-X)/\sigma$$

where:

- x – individual laboratory result
- X – certified/assigned value of SRM/Fish Homogenate
- σ – 25% of target value (X) substituted for standard deviation (σ = 0.025 X, see Schantz et al., 2005).

The z-score groups the results into three categories: satisfactory ($|z| \leq 2$) , questionable ($2<|z| \leq 3$) and unsatisfactory ($|z| \geq 3$).

Table D.1.1.1 - D.1.1.3 list the analytical results of mussel homogenate XII and NIST SRM 2977 from the NIST 2005 Intercalibration exercise conducted in conjunction with the 2005 sample analyses for PCB, PAH and chlorinated pesticides, respectively. Performance for organic contaminant accuracy and precision for mussel homogenate XII are summarized in Table D.1.1.4.

**TABLE D.1.1.1** PCB mean concentrations and relative standard deviation (RSD) of the analysis of mussel homongenate XII and SRM 2977 (mussle tissue) from the National Institute for Standards and Technology 2005 Intercomparison Exercise for organic contaminants. (Schantz et al., 2006)

| | Mussel XII (ng/g wet wt.) | | | | SRM 2977 (ng/g wet wt.) | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | RSD% | Assigned value | RSD% | Mean | RSD% | Cert. Value | 95% CL |
| PCB 8 | <2.8 | NA | 2.56 | 23.5 | <2.8 | | 2.10 | 0.15 |
| PCB 18 | 4.00 | 2.5 | 5.71 | 32.8 | <2.7 | | 2.65 | 0.30 |
| PCB 28 | 20.4 | 5.9 | 23.2 | 19.7 | 4.00 | 18.0 | 5.37 | 0.44 |
| PCB 44 | 20.2 | 3.1 | 31.4 | 35.7 | <2.4 | | 3.25 | 0.63 |
| PCB 52 | 37.7 | 4.6 | 46.6 | 22.9 | 4.50 | 19.0 | 8.37 | 0.54 |
| PCB 66 | 74.0 | 5.4 | 48.4 | 25.6 | 2.65 | 2.7 | 3.64 | 0.32 |
| PCB 101 | 98.5 | 3.0 | 88.1 | 16.3 | 6.27 | 17.8 | 11.2 | 1.2 |
| PCB 105 | 37.1 | 3.1 | 31.1 | 16.9 | 2.53 | 16.0 | 3.76 | 0.49 |
| PCB 118 | 101 | 4.0 | 79.9 | 19.9 | 6.27 | 14.8 | 10.5 | 1.0 |
| PCB 128 | 13.3 | 2.6 | 13.0 | 17.0 | <1.9 | | 2.49 | 0.28 |
| PCB 138 | 91.8 | 3.0 | 64.1 | 23.3 | 7.83 | 16.0 | No Target | |
| PCB 153 | 86.3 | 2.4 | 85.7 | 34.5 | 6.83 | 16.4 | 14.1 | 1.0 |
| PCB 170 | 2.20 | 0.0 | 1.80 | 21.0 | <1.8 | | 2.95 | 0.23 |
| PCB 180 | 6.90 | 6.6 | 9.29 | 33.5 | 3.27 | 18.7 | 6.79 | 0.67 |
| PCB 187 | 17.9 | 8.1 | 18.0 | 22.0 | 2.60 | 0.0 | 4.76 | 0.38 |
| PCB 195 | <1.8 | | No target | | <1.8 | | No target | |
| PCB 206 | <1.7 | | No target | | <1.7 | | No target | |
| PCB 209 | <1.7 | | No target | | <1.7 | | No target | |

**TABLE D.1.1.2** PAH mean concentrations and relative standard deviation (RSD) of the analysis of mussel homongenate XII and SRM 2977 (mussle tissue) from the National Institute for Standards and Technology 2005 Intercomparison Exercise for organic contaminants. (Schantz et al., 2006)

| | Mussel XII (ng/g wet wt.) | | | | SRM 2977 (ng/g wet wt.) | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | RSD% | Assigned value | RSD% | Mean | RSD | Cert. (Ref) Value | 95% CL |
| Naphthalene | 12.5 | 23.8 | 9.86 | 61.5 | 15.1 | 8.4 | (19) | 5 |
| 2-Methylnaphthalene | <10 | | 8.00 | 64.5 | 11.0 | | (18) | 5 |
| 1-Methylnaphthalene | <8 | | 3.66 | 66.6 | <8 | | (16) | 5 |
| Biphenyl | <7 | | 1.91 | 40.0 | <7 | | (6.8) | 0.6 |
| 2,6-Dimethylnaphthalene | <8 | | 4.67 | 61.0 | 14.6 | 19.8 | No target | |
| Acenaphthylene | <11 | | 3.72 | 64.6 | <11 | | No target | |
| Acenaphthene | <8 | | 2.93 | 75.4 | <8 | | (4.2) | 0.4 |
| Fluorene | <7 | | 3.64 | 45.1 | 8.43 | 7.2 | 10.2 | 0.4 |
| Phenanthrene | 88.5 | 10.5 | 88.7 | 20.2 | 31.6 | 6.0 | 35.1 | 3.8 |
| Anthracene | <10 | | 5.79 | 55.9 | <10 | | (8) | 4 |
| 1-Methylphenanthrene | 104 | 3.7 | 89.7 | 30.9 | 42.1 | 5.0 | (44) | 2 |
| Fluoranthene | 129 | 9.2 | 133 | 22.9 | 30.3 | 4.7 | 38.7 | 1.0 |
| Pyrene | 179 | 9.2 | 190 | 21.1 | 57.5 | 5.7 | 78.9 | 3.5 |
| Benzo [a] anthracene | 23.8 | 11.7 | 24.7 | 28.6 | 17.8 | 5.1 | 20.3 | 0.78 |
| Chrysene | 94.5 | 10.5 | 63.9 | 35.1 | 67.0 | 5.5 | (49) | 2 |
| Benzo [b] fluoranthene | 52.9 | 12.3 | 47.6 | 26.5 | 14.1 | 8.9 | 11.0 | 0.28 |
| Benzo [k] fluoranthene | 31.3 | 12.7 | 16.3 | 15.0 | 7.3 | 3.6 | 4 | 1 |
| Benzo [e] pyrene | 77.1 | 10.0 | 74.7 | 19.6 | 15.0 | 4.8 | 13.1 | 1.1 |
| Benzo [a] pyrene | 8.86 | 17.0 | 7.25 | 36.6 | 7.13 | 4.3 | 8.35 | 0.72 |
| Perylene | <5 | | 3.51 | 41.2 | <5 | | 3.50 | 0.76 |
| Indono [1,2,3-cd] pyrene | 19.5 | 9.8 | 15.1 | 42.4 | 8.90 | 4.1 | 4.84 | 0.81 |
| Dibenz [a,h] anthracene | <11 | | No target | | <11 | | 1.41 | 0.19 |
| Benza [g,h,i] perylene | 23.9 | 10.0 | 24.6 | 25.8 | <15 | | 9.53 | 0.43 |

**TABLE D.1.1.3** Chlorinated pesticide mean concentrations and relative standard deviation (RSD) of the analysis of mussel homongenate XII and SRM 2977 (mussle tissue) from the National Institute for Standards and Technology 2005 Intercomparison Exercise for organic contaminants. (Schantz et al., 2006)

| Mussel XII (ng/g wet wt.) | | | | | SRM 2977 (ng/g wet wt.) | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | RSD% | Assigned value | RSD% | Mean | RSD | Cert. Value | 95% CL |
| alpha-HCH | <2.0 | | No target | | <2.0 | | No target | |
| hexachlorobenzene | <2.5 | | No target | | <2.5 | | No target | |
| gamma-HCH | <1.5 | | No target | | <1.5 | | No target | |
| heptachlor | <2.0 | | No target | | <2.0 | | No target | |
| aldrin | 1.63 | 3.5 | No target | | <1.5 | | No target | |
| heptachlor epoxide | <2.0 | | No target | | <2.0 | | No target | |
| gamma-chlordane | 5.80 | 6.2 | 7.45 | 13.5 | 2.29 | 5.7 | No target | |
| 2,4'-DDE | <1.0 | | No target | | <1.0 | | No target | |
| endosulfan I | <1.5 | | No target | | <1.5 | | No target | |
| cis-chlordane | 8.43 | 9.5 | 12.1 | 27.9 | 1.10 | 0.0 | 1.42 | 0.13 |
| trans-nonachlor | 9.17 | 8.9 | 9.00 | 13.8 | <1.5 | | 1.43 | 0.10 |
| dieldrin | 7.23 | 13.8 | 6.70 | 65.9 | 4.87 | 7.8 | 6.04 | 0.52 |
| 4,4'-DDE | 23.0 | 2.3 | 33.9 | 22.4 | 4.97 | 13.7 | 12.5 | 1.6 |
| 2,4'-DDD | 7.70 | 1.8 | 8.04 | 35.5 | <4.0 | | 3.32 | 0.29 |
| endrin | <2.0 | | No target | | <2.0 | | No target | |
| endosulfan II | <3.4 | | No target | | <3.4 | | No target | |
| 4,4'-DDD | 18.3 | 5.7 | 21.7 | 49.6 | 2.43 | 8.6 | 4.30 | 0.38 |
| 2,4'-DDT | <3.0 | | No target | | <3.0 | | No target | |
| 4,4'-DDT | 2.50 | 0.0 | 4.27 | 17.8 | <2.5 | | 1.28 | 0.18 |
| mirex | <1.5 | | 1.68 | 37.6 | <1.5 | | No target | |

**TABLE D.1.1.4.** Intercalibration accuracy (z-scores, z[25]) performances summary on NIST SRM 2977 from the 2005 NIST intercomparison exercise for organic contaminants in the marine environment (Schantz, et al., 2006).

| PCB Performance | No. of Analytes | % | NIST Category | NIST Score | z (25%) |
|---|---|---|---|---|---|
| Quantitative | 10 | 40% | Satisfactory | <2 | 13 |
| Qualitative | 8 | 32% | Questionable | 2 to 3 | 1 |
| Not Determined | 7 | 28% | Unsatisfactory | >3 | 0 |
| **PAH Performance** | | | | | |
| Quantitative | 15 | 58% | Satisfactory | <2 | 12 |
| Qualitative | 8 | 31% | Questionable | 2 to 3 | 0 |
| Not Determined | 3 | 12% | Unsatisfactory | >3 | 1 |
| **Pesticide Performance** | | | | | |
| Quantitative | 9 | 36% | Satisfactory | <2 | 7 |
| Qualitiative | 11 | 44% | Questionable | 2 to 3 | 1 |
| Not Determined | 5 | 20% | Unsatisfactory | >3 | 0 |

SRM and NIST Intercalibration Accuracy Summary:

*PCB Congeners*: All quantifiable results (n=10) for NIST SRM 2977 were outside the certified lower 95% confidence interval (Table D.1.1.1). Forty percent of the requested congeners were quantified for the mussel homogenate XII (Table D.1.1.4) and all but one of these (PCB 66) analyzed met the NIST statisfactory category (Z score <2).

*PAHs*: All quantifiable results (n=15) for NIST SRM 2977, except for naphthalene, phenanthrene, and 1-methylphenanthrene were outside the certified or referenced 95% confidence interval (Table D.1.1.2). Fifty-eight percent of the requested PAHs were quantified for the mussel homogenate XII (Table D.1.1.4) and all but one of these (anthracene) analyzed met the NIST statisfactory category (Z score <2).

*Chlorinated Pesticides*: Ony 4 quantifiable results were available to assess the accuracy for NIST SRM 2977, and all of these (cis-chlordane, dieldrin, 4,4'-DDE, and 4,4'-DDD) were outside the certified or referenced 95% confidence interval (Table D.1.1.3). Thirty-six percent of the requested PAHs were quantified for the mussel homogenate XII (Table D.1.1.4) and all but one of these (4,4'-DDT: Z score =2) analyzed met the NIST statisfactory category (Z score <2).

## D.1.2 Matrix Spikes

The acceptable range for matrix spike recovery is 40-120%. The matrix spikes of organic compounds monitored by Gulfwatch are summarized in Table D.1.2.1-3 for PAHs, PCBs, and chlorinate pesticides, respectively.

**TABLE D.1.2.1** Percent recovery of 2005 Gulfwatch PAH matrix spikes

| PAH | | | | | | | | | | | | | Mean | %RSD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Naphthalene | 67% | 61% | 85% | 101% | 48% | 106% | 67% | 61% | 85% | 101% | 48% | 106% | 78% | 23% |
| 1-Methylnaphthalene | 76% | 80% | 82% | 95% | 83% | 100% | 76% | 80% | 82% | 95% | 83% | 100% | 86% | 9% |
| 2-Methylnaphthalene | 84% | 88% | 96% | 106% | 86% | 107% | 84% | 88% | 96% | 106% | 86% | 107% | 94% | 10% |
| Biphenyl | 93% | 91% | 93% | 100% | 102% | 105% | 93% | 91% | 93% | 100% | 102% | 105% | 97% | 6% |
| 2,6-Dimethylnaphthalene | 77% | 88% | 76% | 93% | 89% | 92% | 77% | 88% | 76% | 93% | 89% | 92% | 86% | 7% |
| Acenaphthylene | 90% | 96% | 85% | 106% | 105% | 102% | 90% | 96% | 85% | 106% | 105% | 102% | 97% | 9% |
| Acenaphthene | 92% | 105% | 85% | 106% | 109% | 104% | 92% | 105% | 85% | 106% | 109% | 104% | 100% | 9% |
| 2,3,5-Trimethylnaphthalene | 96% | 112% | 98% | 110% | 111% | 109% | 96% | 112% | 98% | 110% | 111% | 109% | 106% | 7% |
| Fluorene | 88% | 99% | 94% | 109% | 92% | 103% | 88% | 99% | 94% | 109% | 92% | 103% | 98% | 8% |
| Phenanthrene | 88% | 106% | 110% | 72% | 80% | 71% | 88% | 106% | 110% | 72% | 80% | 71% | 88% | 17% |
| Anthracene | 94% | 114% | 106% | 80% | 38% | 107% | 94% | 114% | 106% | 80% | 38% | 107% | 90% | 28% |
| 1-Methylphenanthracene | 113% | 114% | 96% | 123% | 120% | 104% | 113% | 114% | 96% | 123% | 120% | 104% | 112% | 10% |
| Fluoranthene | 95% | 97% | 54% | 45% | INT | 103% | 95% | 97% | 54% | 45% | INT | 103% | 79% | 27% |
| Pyrene | 89% | 100% | 110% | 132% | 123% | 106% | 89% | 100% | 110% | 132% | 123% | 106% | 110% | 15% |
| Benzo(a)Anthracene | 93% | 99% | 107% | 123% | 126% | 113% | 93% | 99% | 107% | 123% | 126% | 113% | 110% | 13% |
| Chrysene | 89% | 108% | 105% | 119% | 131% | 110% | 89% | 108% | 105% | 119% | 131% | 110% | 110% | 14% |
| Benzo(b)Fluoranthene | 87% | 119% | 109% | 108% | 137% | 97% | 87% | 119% | 109% | 108% | 137% | 97% | 110% | 17% |
| Benzo(k)Fluoranthene | 92% | 110% | 99% | 103% | 109% | 97% | 92% | 110% | 99% | 103% | 109% | 97% | 102% | 7% |
| Benzo(e)Pyrene | 92% | 138% | 113% | 70% | INT | INT | 92% | 138% | 113% | 70% | INT | INT | 103% | 29% |
| Benzo(a)Pyrene | 79% | 131% | 99% | 104% | INT | 98% | 79% | 131% | 99% | 104% | INT | 98% | 102% | 18% |
| Perylene | 88% | 93% | 104% | INT | INT | INT | 88% | 93% | 104% | INT | INT | INT | 95% | 8% |
| Indeno(1,2,3,4-cd)Pyrene | 105% | INT | 113% | INT | INT | INT | 105% | INT | 113% | INT | INT | INT | 109% | 6% |
| Dibenz(a,h)Anthracene | 87% | INT | 92% | INT | INT | INT | 87% | INT | 92% | INT | INT | INT | 89% | 4% |
| Benzo(ghi)Perylene | 106% | INT | 106% | INT | INT | INT | 106% | INT | 106% | INT | INT | INT | 106% | 0% |
| **Surrogate Recovery** | | | | | | | | | | | | | | |
| Napthalene-d8 | 76% | 86% | 76% | 89% | 81% | 87% | 76% | 86% | 76% | 89% | 81% | 87% | 83% | 6% |
| Acenaphthene-d10 | 90% | 98% | 90% | 99% | 99% | 104% | 90% | 98% | 90% | 99% | 99% | 104% | 97% | 6% |
| Phenanthrene-d10 | 96% | 107% | 104% | 88% | 85% | 76% | 96% | 107% | 104% | 88% | 85% | 76% | 93% | 12% |
| Fluoranthene-d10 | 90% | INT | 68% | 57% | INT | 101% | 90% | INT | 68% | 57% | INT | 101% | 79% | 20% |
| Chrysene-d12 | 94% | 114% | 104% | 114% | 118% | 109% | 94% | 114% | 104% | 114% | 118% | 109% | 109% | 9% |
| Benzo(a)pyrene-d12 | 98% | 123% | 108% | 74% | INT | INT | 98% | 123% | 108% | 74% | INT | INT | 101% | 21% |
| Benzo(g,h,i)perylene-d12 | 103% | INT | 108% | INT | INT | INT | 103% | INT | 108% | INT | INT | INT | 105% | 4% |

**TABLE D.1.2.2**. Gulfwatch 2005 PCB Matrix Spike Recoveries (%)

| PCB | | | | | | | | Mean | STD |
|---|---|---|---|---|---|---|---|---|---|
| #8,5 | 43% | 63% | 64% | 72% | 62% | 56% | 59% | 60% | 9% |
| #18,15 | 43% | 70% | 68% | 87% | 70% | 57% | 60% | 65% | 14% |
| #29 | 49% | 62% | 66% | 85% | 67% | 58% | 60% | 64% | 11% |
| #28 | 50% | 65% | 68% | 86% | 67% | 62% | 67% | 67% | 11% |
| #52 | 52% | 68% | 74% | 91% | 64% | 66% | 70% | 69% | 12% |
| #50 | 51% | 66% | 72% | 81% | 68% | 60% | 64% | 66% | 9% |
| #44 | 48% | 63% | 73% | 83% | 74% | 64% | 67% | 68% | 11% |
| #66,95 | 73% | 66% | 74% | 78% | 65% | 68% | 67% | 70% | 5% |
| #101,90 | 58% | 69% | 87% | 103% | 81% | 75% | 76% | 78% | 14% |
| #87 | 46% | 61% | 78% | 81% | 62% | 59% | 62% | 64% | 12% |
| #77 | 49% | 67% | 63% | 87% | 63% | 66% | 73% | 67% | 12% |
| #118 | 63% | 76% | 93% | 102% | 78% | 80% | 80% | 82% | 12% |
| #153,132 | 64% | 83% | 96% | 114% | 84% | 87% | 80% | 87% | 15% |
| #105 | 54% | 70% | 85% | 94% | 74% | 76% | 72% | 75% | 12% |
| #138 | 59% | 74% | 97% | 104% | 80% | 89% | 80% | 83% | 15% |
| #126 | 38% | 66% | 91% | 96% | 65% | 65% | 67% | 70% | 19% |
| #187 | 60% | 71% | 81% | 102% | 78% | 82% | 79% | 79% | 13% |
| #128 | 52% | 61% | 85% | 91% | 74% | 76% | 72% | 73% | 13% |
| #180 | 53% | 64% | 82% | 93% | 70% | 72% | 72% | 72% | 13% |
| #169 | 46% | 58% | 81% | 90% | 64% | 69% | 66% | 68% | 14% |
| #170,190 | 50% | 60% | 80% | 86% | 69% | 73% | 71% | 70% | 12% |
| #195,208 | 48% | 65% | 79% | 94% | 73% | 78% | 75% | 73% | 14% |
| #206 | 51% | 64% | 78% | 89% | 70% | 77% | 74% | 72% | 12% |
| #209 | 58% | 70% | 78% | 94% | 74% | 78% | 75% | 75% | 11% |
| Surrogate Recovery | | | | | | | | | |
| 103 | 59% | 66% | 78% | 94% | 79% | 73% | 75% | 75% | 11% |
| 198 | 58% | 64% | 83% | 96% | 74% | 78% | 74% | 75% | 12% |

**TABLE D.1.2.3** Quality Control Results for 2005 Pesticide Analysis

| Pesticide | | | | | | | | | | | Mean | SD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a_BHC | 39% | 53% | 62% | 70% | 81% | 66% | 62% | 39% | 53% | 62% | 62% | 13% |
| HCB | 55% | 68% | 66% | 84% | 71% | 65% | 71% | 55% | 68% | 66% | 69% | 9% |
| g-HCH(Lindane) | 62% | 90% | 68% | 90% | 95% | 85% | 85% | 62% | 90% | 68% | 82% | 12% |
| Heptachlor | 23% | 51% | 74% | 63% | 37% | 53% | 41% | 23% | 51% | 74% | 49% | 17% |
| Aldrin | 55% | 76% | 72% | 99% | 77% | 71% | 75% | 55% | 76% | 72% | 75% | 13% |
| HeptachlorEpoxide | 65% | 85% | 66% | 87% | 91% | 74% | 86% | 65% | 85% | 66% | 79% | 11% |
| g-Chlordane | 63% | 54% | 66% | 108% | 83% | 89% | 85% | 63% | 54% | 66% | 78% | 18% |
| o,p'-DDE | 75% | 65% | 75% | 102% | 70% | 99% | 76% | 75% | 65% | 75% | 80% | 14% |
| a-Endosulfan | 65% | 82% | 67% | 94% | 100% | 93% | 97% | 65% | 82% | 67% | 85% | 14% |
| cis-Chlordane | 57% | 89% | 74% | 86% | 91% | 83% | 74% | 57% | 89% | 74% | 79% | 12% |
| t-Nonachlor | 76% | 98% | 91% | 108% | 98% | 104% | 104% | 76% | 98% | 91% | 97% | 11% |
| p,p'_DDE | 75% | 101% | 116% | 135% | 106% | 109% | 104% | 75% | 101% | 116% | 107% | 18% |
| Dieldrin | 63% | 81% | 67% | 79% | 81% | 86% | 104% | 63% | 81% | 67% | 80% | 13% |
| o,p'-DDD | 56% | 63% | 73% | 58% | 61% | 79% | 98% | 56% | 63% | 73% | 70% | 15% |
| Endrin | 63% | 88% | 63% | 101% | 73% | 102% | 97% | 63% | 88% | 63% | 84% | 17% |
| b-Endosulfan | 39% | 47% | 49% | 50% | 68% | 75% | 76% | 39% | 47% | 49% | 58% | 15% |
| p,p'-DDD | 100% | 87% | 85% | 136% | 113% | 112% | 98% | 100% | 87% | 85% | 104% | 18% |
| o,p'-DDT | 74% | 91% | 96% | 101% | 78% | 101% | 127% | 74% | 91% | 96% | 95% | 18% |
| p,p'-DDT | 74% | 84% | 94% | 94% | 108% | 96% | 111% | 74% | 84% | 94% | 94% | 13% |
| Metoxychlor | 54% | 95% | 66% | 88% | 98% | 73% | 71% | 54% | 95% | 66% | 78% | 16% |
| Mirex | 59% | 72% | 73% | 103% | 89% | 84% | 89% | 59% | 72% | 73% | 81% | 14% |
| Surrogate Recovery | | | | | | | | | | | | |
| g-Chlordene | 52% | 67% | 61% | 81% | 73% | 61% | 65% | 66% | 9% | 52% | 67% | 61% |

Accuracy Summary for matrix spikes:

*PAH:* In general, matrix spike recoveries means all met the data quality objectives of the program (40-120%) as shown in Table D.1.2.1. Approximately 5% of individual analyses (highlighted in grey) fell outside of the targeted QA range, the majority of which exceeded 120%. Mean surrogate recoveries for selected analytes ranged from 83% to 109%.

*PCB:* Recovery of matrix spikes ranged from 38-114% for all matrix spikes. Matrix spike recoveries means all met targeted performance criteria of 40-120% (Table D.1.2.2). Only one individual analysis (for PCB 126) fell below the data quality objectives of the Program. Surrogate recoveries for congeners 103 and 198 averaged 75% (± 12%, n=20)

*Chlorinated Pesticides:* Recovery of matrix spikes and surrogates ranged from 9-135% (Table D.1.2.3). Only 10 individual analyses (~4%)where outside the targeted performance criteria of 40-120% and these were typically below 40%. Surrogate recoveries for g-Chlordene averaged 67% (± 61%, n=10) with one extremely low recovery = 9%.

D.2 PRECISION

**Relative Percent Differences for Duplicate Analyses**

The relative percent difference (RPD) for duplicate analyses on samples is another quality assurance exercise (Table D.2.1-3 for PAH, PCB, and pesticides, respectively). In some cases where samples are near the method detection limit one analysis would have a detectable value but the other duplicate would not. In these cases, the RPD was determined to be 0% since the actual RPD could not be determined. The analysis of duplicates should agree to within 25% of each other.

**TABLE D.2.1** PAH Duplicate analysis 2005 Gulfwatch mussel tissue concentrations (ng/g dry wt.)

| PAH | MAPY-3 | MAPY-3 | NHHS-4 | NHHS-4 | NHDP-4 | NHDP-4 | MEPH-1 | MEPH-1 |
|---|---|---|---|---|---|---|---|---|
| Naphthalene | 12.5 | 14.0 | <10 | <10 | <10 | <10 | <10 | 14.4 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 | <7 | <7 | 13.4 | <7 |
| Phenanthrene | 13.4 | 14.0 | 8.7 | 10.23 | 51.3 | 32.5 | 58.6 | 44.9 |
| Anthracene | <10 | <10 | <10 | <10 | 19.8 | 11.4 | 13.8 | 10.6 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 | INT | <12 | <12 | <12 |
| Fluoranthene | 32.9 | 36.5 | 19.0 | 21.58 | 105.9 | 69.4 | 193.0 | 139.8 |
| Pyrene | 26.0 | 27.6 | 16.9 | 19.94 | 160.1 | 101.4 | 190.3 | 139.9 |
| Benzo(a)Anthracene | 6.7 | 7.7 | <6 | 6.61 | 52.1 | 30.6 | 70.0 | 56.3 |
| Chrysene | 12.1 | 13.6 | 10.1 | 12.53 | 76.5 | 45.5 | 124.3 | 103.5 |
| Benzo(b)Fluoranthene | 8.2 | 8.7 | 7.9 | 9.12 | 54.0 | 30.9 | 111.6 | 89.3 |
| Benzo(k)Fluoranthene | 5.4 | 6.0 | 4.6 | 5.76 | 48.8 | 26.0 | 82.5 | 67.7 |
| Benzo(e)Pyrene | 10.3 | 10.6 | 10.9 | 13.20 | INT | 35.7 | 107.6 | 87.2 |
| Benzo(a)Pyrene | 4.3 | 4.4 | 5.6 | 7.11 | INT | 16.4 | 35.2 | 29.5 |
| Perylene | <5 | <5 | <5 | <5 | INT | 15.3 | 25.0 | 19.4 |
| Indeno(1,2,3,4-cd)Pyrene | <7 | 7.2 | <7 | <7 | INT | 8.8 | 27.4 | 19.9 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 | INT | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 | INT | <15 | <15 | <15 |
| Total | 131.8 | 150.2 | 83.6 | 106.1 | 568.7 | 423.9 | 1052.7 | 822.5 |
| **Mean$_A$** | **141.0** | | **94.9** | | **496.3** | | **937.6** | |
| **RPD** | **6.5%** | | **11.8%** | | **14.6%** | | **12.3%** | |

**TABLE D.2.1** (continued) PAH Duplicate analysis 2005 Gulfwatch mussel tissue concentrations (ng/g dry wt.)

| PAH | MEPH-4 | MEPH-4 | MEFP-4 | MEFP-4 | NSDI-4 | NSDI-4 |
|---|---|---|---|---|---|---|
| Naphthalene | 13.3 | <10 | 19.5 | 30.7 | <10 | 10.8 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 | <7 | <7 |
| Fluorene | 8.5 | <7 | <7 | <7 | <7 | <7 |
| Phenanthrene | 58.7 | 53.1 | 12.9 | 16.6 | 14.1 | 14.4 |
| Anthracene | 15.8 | 12.8 | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 | <12 | <12 |
| Fluoranthene | 142.6 | 168.2 | 18.3 | 24.8 | 28.0 | 28.2 |
| Pyrene | 183.3 | 173.2 | 26.2 | 38.2 | 22.1 | 20.2 |
| Benzo(a)Anthracene | 63.5 | 57.9 | 10.9 | 15.6 | 11.0 | 10.9 |
| Chrysene | 122.9 | 115.3 | 16.4 | 25.7 | 14.4 | 13.3 |
| Benzo(b)Fluoranthene | 82.8 | 87.2 | 19.3 | 27.1 | 15.3 | 14.7 |
| Benzo(k)Fluoranthene | 77.2 | 64.4 | 8.8 | 14.6 | 7.0 | 7.8 |
| Benzo(e)Pyrene | 66.1 | 97.5 | 14.8 | 24.1 | 13.7 | 13.4 |
| Benzo(a)Pyrene | 27.5 | 28.6 | 8.9 | 13.1 | 6.2 | 6.4 |
| Perylene | INT | 21.9 | 22.9 | 30.3 | 8.3 | 8.3 |
| Indeno(1,2,3,4-cd)Pyrene | INT | 20.9 | <7 | <7 | 8.2 | <7 |
| Dibenz(a,h)Anthracene | INT | <11 | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | INT | <15 | <15 | <15 | <15 | <15 |
| Total | 862.2 | 900.9 | 178.8 | 260.8 | 148.2 | 148.5 |
| **Mean$_A$** | **881.5** | | **219.8** | | **148.3** | |
| **RPD** | **2.2%** | | **18.7%** | | **0.1%** | |

**TABLE D.2.2 PCB** Duplicate analysis 2005 Gulfwatch mussel tissue concentrations (ng/g dry wt.)

| PCB Congener | MAPY-3 | MAPY-3 | NHHS-4 | NHHS-4 | NHDP-4 | NHDP-4 | NHNI-1 | NHNI-1 |
|---|---|---|---|---|---|---|---|---|
| 8;5 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| 18;15 | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 |
| 29 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| 50 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| 28 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| 52 | <2 | <2 | <2 | 2.8 | <2 | <2 | <2 | 2.5 |
| 44 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| 66;95 | 4.2 | 3.6 | 2.4 | 9.1 | <2.2 | <2.2 | 5.06 | <2.2 |
| 101;90 | 2.7 | 2.4 | <2.2 | 10.4 | 5.7 | 3.1 | 6.21 | 14.7 |
| 87 | <1.9 | <1.9 | <1.9 | 2.8 | <1.9 | <1.9 | <1.9 | 2.1 |
| 77 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| 118 | 3.9 | 3.3 | <2 | 9.8 | 5.2 | 3.0 | 5.82 | 14.8 |
| 153;132 | 8.4 | 6.5 | 3.0 | 16.1 | 9.7 | 5.6 | 10.21 | 22.5 |
| 105 | 2.0 | 1.5 | <1.4 | 2.8 | 1.6 | <1.4 | 2.16 | 2.6 |
| 138 | 7.1 | 5.5 | 2.6 | 15.6 | 8.8 | 5.2 | 6.42 | 16.9 |
| 126 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | 2.0 |
| 187 | 3.1 | 2.1 | <1.9 | 6.1 | 3.3 | 1.9 | 4.03 | 10.5 |
| 128 | <1.9 | <1.9 | <1.9 | 2.9 | <1.9 | <1.9 | <1.9 | 2.6 |
| 180 | <1.7 | <1.7 | <1.7 | 1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| 169 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| 170;190 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| 195;208 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| 206 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| 209 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| Total | 31.6 | 24.8 | 8.0 | 80.0 | 34.2 | 19.0 | 39.9 | 91.2 |
| **Mean$_A$** | **28.2** | | **44.0** | | **26.6** | | **65.5** | |
| **RPD** | **24%** | | **164%** | | **57%** | | **78%** | |

**TABLE D.2.2** (Continued) PCB Duplicate analysis 2005 Gulfwatch mussel tissue concentrations (ng/g dry wt.)

| PCB Congener | NHNI-2 | NHNI-2 | MEPH-4 | MEPH-4 | MEFP-4 | MEFP-4 | NSDI-4 | NSDI-4 |
|---|---|---|---|---|---|---|---|---|
| 8;5 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| 18;15 | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 |
| 29 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| 50 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| 28 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| 52 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |
| 44 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| 66;95 | 6.44 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| 101;90 | 8.28 | 5.9 | 7.4 | 7.4 | 2.6 | 3.5 | <2.2 | <2.2 |
| 87 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| 77 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| 118 | 8.25 | 5.7 | 5.2 | 5.4 | <2 | 2.3 | <2 | <2 |
| 153;132 | 13.85 | 9.4 | 9.8 | 10.2 | 5.5 | 7.4 | <2.1 | <2.1 |
| 105 | 2.84 | <1.4 | 1.6 | 1.7 | <1.4 | <1.4 | <1.4 | <1.4 |
| 138 | 8.66 | 6.4 | 9.5 | 9.8 | 4.4 | 6.0 | <2 | <2 |
| 126 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| 187 | 5.72 | 3.8 | 3.5 | 3.4 | <1.9 | 2.6 | <2 | <2 |
| 128 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| 180 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| 169 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| 170;190 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| 195;208 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| 206 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| 209 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| Total | 54.0 | 31.2 | 37.0 | 38.0 | 12.5 | 21.8 | 0.0 | 0.0 |
| **Mean$_A$** | **42.6** | | **37.5** | | **17.1** | | **0.0** | |
| **RPD** | **53%** | | **3%** | | **54%** | | **NA** | |

**TABLE D.2.3** Pesticide duplicate analysis 2005 Gulfwatch mussel tissue concentrations (ng/g dry wt.)

| Pesticide | MAPY-3 | MAPY-3 | NHHS-4 | NHHS-4 | NHDP-4 | NHDP-4 | NHNI-1 | NHNI-1 |
|---|---|---|---|---|---|---|---|---|
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 | 1.9 | 1.5 | 1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 | 1.4 | <1.2 | 2.4 | 3.0 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 | 2.2 |
| p,p'_DDE | 3.9 | 4.1 | 3.4 | 3.4 | 5.4 | 3.6 | 11.9 | 31.5 |
| Dieldrin | 3.9 | 3.9 | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | 2.4 | 3.6 | 2.3 | <2 | 10.2 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Total | 7.8 | 8.0 | 3.4 | 5.8 | 12.3 | 7.4 | 15.8 | 46.9 |
| **Mean$_A$** | **7.9** | | **4.6** | | **9.9** | | **31.4** | |
| **RPD** | **2.9%** | | **52.4%** | | **49.2%** | | **99.3%** | |

**TABLE D.2.3** (Continued) Pesticide duplicate analysis 2005 Gulfwatch mussel tissue concentrations (ng/g dry wt.)

| Pesticide | NHNI-2 | NHNI-2 | MEPH-4 | MEPH-4 | MEFP-4 | MEFP-4 |
|---|---|---|---|---|---|---|
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | 1.8 | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | 2.5 | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 16.6 | 11.5 | 5.4 | 5.4 | 4.4 | 5.8 |
| Dieldrin | <1.4 | 1.8 | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | 5.5 | 6.6 | 7.3 | 2.8 | 3.6 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Total | 16.6 | 23.1 | 12.1 | 12.7 | 7.2 | 9.4 |
| **Mean$_A$** | **19.9** | | **12.4** | | **8.3** | |
| **RPD** | **32.4%** | | **5.2%** | | **26.9%** | |

Precision (analysis of duplicates) Summary:

*PAHs*: All duplicate analyses of station replicates met the data quality objectives (relative percent difference ≤ 25%) of the Program (Table D.2.1).

*PCBs*: The RPD of duplicate analyses ranged from 3 -164% (Table D.2.2). Only 3 of the 8 duplicate analyses of station replicates met the data quality objectives (relative percent difference ≤ 25%) of the Program.

*Chlorinated Pesticides*: The RPD of duplicate analyses ranged from 3 -99% (Table D.2.3). Only 2 of the 7 duplicate analyses of station replicates met the data quality objectives (relative percent difference ≤ 25%) of the Program.

## D.3 Blanks

Blank analyses should ideally recover no detectable amounts of target compounds. For 2005 no discernible signal was observed for PAHs, PCBs, and PEST.

## D.4 Completeness

100% of samples collected (17 of 17 samples; 66 individual replicates) were completed successfully.

# APPENDIX E 2005 Trace Metal (and % solids) Data
## Gulfwatch Mussel Samples

**TABLES E**. Selected metals concentration (ug/g dry wt.) and % solids content observed in blue mussel tissue collected by Gulfwatch, 2005. Stations are ordered by year, essentially clockwise in rotation, south (Massachusetts) to north (to Nova Scotia).

**Table E.1** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at Sandwich, MA (MASN); 41.7645°N, 70.4840°W. **Benchmark Site**. #N-Dup represents duplicate analysis of site replicate.

| **MASN** | (µg/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *3N-Dup* | *4N* |
| **Ag** | 0.28 | 0.40 | 0.47 | 0.44 | 0.37 |
| **Cd** | 1.14 | 1.02 | 1.12 | 1.07 | 0.95 |
| **Cr** | 1.32 | 1.08 | 1.06 | 1.01 | 1.14 |
| **Cu** | 7.40 | 6.97 | 6.74 | 6.52 | 7.11 |
| **Fe** | 513 | 403 | 336 | 360 | 637 |
| **Ni** | 1.22 | 1.05 | 1.05 | 1.02 | 1.07 |
| **Pb** | 4.48 | 3.56 | 3.91 | 3.78 | 4.09 |
| **Zn** | 93.0 | 90.3 | 97.1 | 96.4 | 87.9 |
| **Al** | 392 | 331 | 285 | 267 | 893 |
| **Hg** | 0.120 | 0.108 | 0.122 | 0.108 | 0.110 |
| **%Solids** | 16.3 | 14.3 | 17.5 | 17.5 | 18.5 |

**Table E.2** 2005 Blue mussel tissue metal concentrations (µg/g dry wt.) in Massachusetts inner Plymouth-Manomet Point station (MAPY); 41.9283°N, 70.5383°W

| **MAPY** | (µg/g dry wt.) | | |
|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* |
| **Ag** | 0.15 | 0.49 | 0.16 |
| **Cd** | 1.68 | 1.64 | 1.75 |
| **Cr** | 1.70 | 1.60 | 1.83 |
| **Cu** | 6.55 | 10.2 | 6.76 |
| **Fe** | 524 | 469 | 515 |
| **Ni** | 1.36 | 1.50 | 1.50 |
| **Pb** | 3.92 | 4.05 | 4.06 |
| **Zn** | 97.0 | 139 | 111 |
| **Al** | 333 | 345 | 394 |
| **Hg** | 0.210 | 0.217 | 0.199 |
| **%Solids** | 15.7 | 16.6 | 16.2 |

**Table E.3** 2005 *soft-shell clam* tissue metal concentrations (µg/g dry wt.) at the Middle Ground site (expanded Gulfwatch), NH (NHMG); 42.8922°N, 70.8233°W

| **NHMG** | (µg/g dry wt.) | |
|---|---|---|
| *Replicate* | *1N* | *2N* |
| **Ag** | 0.68 | 0.48 |
| **Cd** | 0.50 | 0.34 |
| **Cr** | 3.95 | 2.96 |
| **Cu** | 10.4 | 10.4 |
| **Fe** | 3363 | 2341 |
| **Ni** | 1.83 | 1.60 |
| **Pb** | 4.72 | 3.68 |
| **Zn** | 89.2 | 90.3 |
| **Al** | 1980 | 1422 |
| **Hg** | 0.093 | 0.076 |
| **%Solids** | 14.5 | 14.8 |

**Table E.4** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at the Hampton/Seabrook estuary, NH site (NHHS); 42.8917°N, 70.8167°W

| **NHHS** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.05 | 0.04 | 0.04 | 0.03 |
| **Cd** | 1.95 | 2.40 | 2.16 | 2.03 |
| **Cr** | 1.16 | 1.17 | 1.35 | 1.45 |
| **Cu** | 6.63 | 6.37 | 6.14 | 5.94 |
| **Fe** | 309 | 335 | 382 | 469 |
| **Ni** | 0.90 | 0.92 | 0.96 | 0.97 |
| **Pb** | 1.62 | 1.91 | 2.58 | 1.91 |
| **Zn** | 120 | 120 | 107 | 121 |
| **Al** | 249 | 258 | 537 | 460 |
| **Hg** | 0.155 | 0.153 | 0.149 | 0.151 |
| **%Solids** | 15.4 | 14.5 | 15.6 | 14.1 |

**Table E.5** 2005 blue mussel tissue metal concentrations (µg/g dry wt.), North Mill Pond, NH (NHNM); 43.0750°N, 70.7600°W

| **NHNM** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.06 | 0.08 | 0.07 | 0.07 |
| **Cd** | 2.66 | 2.75 | 2.60 | 2.81 |
| **Cr** | 1.84 | 1.73 | 1.92 | 2.01 |
| **Cu** | 7.50 | 8.90 | 7.30 | 8.05 |
| **Fe** | 385 | 397 | 672 | 442 |
| **Ni** | 1.35 | 1.23 | 1.34 | 1.36 |
| **Pb** | 3.50 | 4.20 | 3.88 | 3.79 |
| **Zn** | 152 | 157 | 187 | 152 |
| **Al** | 219 | 233 | 268 | 254 |
| **Hg** | 0.358 | 0.377 | 0.328 | 0.370 |
| **%Solids** | 12.0 | 13.3 | 13.5 | 12.1 |

**Table E.6** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at Dover Point, NH (NHDP); 43.1196°N, 70.8267°W.

| **NHDP** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.05 | 0.05 | 0.05 | 0.04 |
| **Cd** | 2.64 | 2.50 | 2.40 | 2.54 |
| **Cr** | 3.10 | 2.71 | 2.46 | 2.42 |
| **Cu** | 6.78 | 6.80 | 6.62 | 6.63 |
| **Fe** | 454 | 512 | 458 | 436 |
| **Ni** | 1.46 | 2.14 | 1.19 | 1.35 |
| **Pb** | 2.05 | 2.13 | 1.94 | 2.14 |
| **Zn** | 139 | 131 | 128 | 115 |
| **Al** | 295 | 346 | 311 | 281 |
| **Hg** | 0.339 | 0.356 | 0.328 | 0.321 |
| **%Solids** | 11.0 | 11.6 | 14.0 | 12.2 |

**Table E.7** 2005 *oyster* tissue metal concentrations (µg/g dry wt.) at Nannie Island (expanded Gulfwatch) site (NHNI); 43.1344°N, 70.8471°W

| NHNI | (µg/g dry wt.) | |
|---|---|---|
| | *1N* | *2N* |
| **Ag** | 5.28 | 4.12 |
| **Cd** | 2.11 | 1.73 |
| **Cr** | 0.51 | 0.45 |
| **Cu** | 92.92 | 88.17 |
| **Fe** | 179 | 155 |
| **Ni** | 1.79 | 1.64 |
| **Pb** | 0.44 | 0.36 |
| **Zn** | 3235 | 2842 |
| **Al** | 132 | 87.2 |
| **Hg** | 0.172 | 0.163 |
| **%Solids** | 12.9 | 11.0 |

**Table E.8** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at Clark's Cove, ME (MECC); 43.0774°N, 70.7244°W. **Benchmark Site**. #N-Dup represents duplicate analysis of site replicate.

| MECC | (µg/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *3N-Dup* | *4N* |
| **Ag** | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 |
| **Cd** | 2.18 | 2.48 | 1.91 | 1.84 | 2.10 |
| **Cr** | 2.28 | 2.57 | 2.33 | 2.37 | 2.20 |
| **Cu** | 7.36 | 6.86 | 6.29 | 6.33 | 6.05 |
| **Fe** | 541 | 603 | 557 | 551 | 582 |
| **Ni** | 1.37 | 1.46 | 1.34 | 1.33 | 1.23 |
| **Pb** | 4.18 | 5.34 | 3.60 | 3.58 | 3.23 |
| **Zn** | 146 | 127 | 132 | 130 | 126 |
| **Al** | 455 | 416 | 427 | 477 | 433 |
| **Hg** | 0.319 | 0.340 | 0.298 | 0.295 | 0.259 |
| **%Solids** | 12.8 | 12.4 | 11.0 | 11.0 | 12.3 |

**Table E.9** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at Portland Harbor, ME (MEPH); 43.6392°N, 70.2590°W

| **MEPH** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.045 | 0.039 | 0.064 | 0.038 |
| **Cd** | 2.00 | 1.79 | 2.05 | 1.72 |
| **Cr** | 2.07 | 1.69 | 1.84 | 1.43 |
| **Cu** | 9.90 | 7.88 | 8.97 | 7.82 |
| **Fe** | 1081 | 599 | 864 | 501 |
| **Ni** | 1.75 | 1.27 | 1.41 | 1.11 |
| **Pb** | 7.20 | 6.21 | 7.03 | 5.86 |
| **Zn** | 135 | 160 | 175 | 168 |
| **Al** | 648 | 503 | 420 | 285 |
| **Hg** | 0.283 | 0.262 | 0.359 | 0.238 |
| **%Solids** | 10.9 | 12.5 | 12.5 | 12.8 |

**Table E.10** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at the Royal River site, ME (MERY); 43.7970°N, 70.1455°W

| **MERY** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.036 | 0.043 | 0.042 | 0.040 |
| **Cd** | 1.18 | 1.31 | 1.37 | 1.48 |
| **Cr** | 1.56 | 1.94 | 1.87 | 1.76 |
| **Cu** | 7.02 | 7.56 | 7.90 | 7.83 |
| **Fe** | 668 | 829 | 807 | 741 |
| **Ni** | 1.23 | 1.59 | 1.54 | 1.42 |
| **Pb** | 1.53 | 1.90 | 1.97 | 2.13 |
| **Zn** | 86.9 | 101 | 110 | 97.4 |
| **Al** | 813 | 1176 | 1012 | 977 |
| **Hg** | 0.117 | 0.142 | 0.145 | 0.137 |
| **%Solids** | 13.3 | 12.5 | 12.7 | 12.9 |

**Table E.11 2005 b**lue mussel tissue metal concentrations (µg/g dry wt.) at the Penobscot River site, ME (MEFP); 44.4695°N, 68.8102°W

| **MEFP** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.071 | 0.043 | 0.051 | 0.056 |
| **Cd** | 2.52 | 2.31 | 2.49 | 2.58 |
| **Cr** | 2.33 | 2.41 | 2.39 | 2.42 |
| **Cu** | 6.95 | 6.08 | 6.49 | 6.65 |
| **Fe** | 791 | 717 | 721 | 772 |
| **Ni** | 1.61 | 1.49 | 1.63 | 1.64 |
| **Pb** | 2.46 | 2.01 | 2.31 | 2.19 |
| **Zn** | 93.7 | 83.5 | 93.5 | 88.0 |
| **Al** | 454 | 467 | 474 | 588 |
| **Hg** | 0.553 | 0.560 | 0.574 | 0.586 |
| **%Solids** | 9.8 | 11.1 | 9.8 | 10.4 |

**Table E.12** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at the Pickering Island site, ME (MEPI); 44.2605°N, 68.7332°W

| **MEPI** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.049 | 0.049 | 0.063 | 0.058 |
| **Cd** | 2.33 | 1.73 | 2.20 | 1.74 |
| **Cr** | 1.56 | 1.46 | 1.61 | 1.42 |
| **Cu** | 5.65 | 4.87 | 5.34 | 5.45 |
| **Fe** | 410 | 469 | 499 | 417 |
| **Ni** | 1.45 | 1.26 | 1.54 | 1.20 |
| **Pb** | 1.82 | 1.47 | 1.49 | 1.31 |
| **Zn** | 83.0 | 83.3 | 103 | 96.4 |
| **Al** | 263 | 471 | 462 | 482 |
| **Hg** | 0.175 | 0.137 | 0.167 | 0.143 |
| **%Solids** | 12.5 | 14.6 | 12.8 | 13.7 |

**Table E.13** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at the Hospital Island site, NB (NBHI); 45.1205°N, 66.0082°W **Benchmark Site**

| **NBHI** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.104 | 0.049 | 0.092 | 0.074 |
| **Cd** | 1.55 | 1.41 | 1.63 | 1.59 |
| **Cr** | 1.01 | 1.02 | 1.12 | 1.17 |
| **Cu** | 5.98 | 4.77 | 5.69 | 5.83 |
| **Fe** | 260 | 325 | 311 | 286 |
| **Ni** | 0.82 | 0.89 | 0.92 | 0.80 |
| **Pb** | 0.81 | 0.68 | 0.91 | 0.77 |
| **Zn** | 114 | 76.1 | 99.7 | 94.9 |
| **Al** | 253 | 417 | 348 | 312 |
| **Hg** | 0.124 | 0.115 | 0.116 | 0.122 |
| **%Solids** | 11.7 | 11.0 | 11.4 | 12.1 |

**Table E.14** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at the Tin Can Beach site, NB (NBTC); 45.2625°N, 66.0570°W

| **NBTC** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.031 | 0.033 | 0.035 | 0.028 |
| **Cd** | 2.35 | 2.73 | 2.37 | 2.59 |
| **Cr** | 2.29 | 2.62 | 2.29 | 2.58 |
| **Cu** | 6.23 | 6.56 | 6.34 | 6.21 |
| **Fe** | 980 | 1232 | 939 | 1109 |
| **Ni** | 1.81 | 2.08 | 1.83 | 1.99 |
| **Pb** | 2.16 | 2.44 | 2.10 | 1.99 |
| **Zn** | 68.8 | 80.4 | 70.9 | 64.4 |
| **Al** | 1064 | 1272 | 1232 | 1573 |
| **Hg** | 0.283 | 0.294 | 0.264 | 0.257 |
| **%Solids** | 8.5 | 8.0 | 9.3 | 8.4 |

**Table E.15** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at the Braod Cove site, NS (NSBC); 44.6653°N, 65.8308°W. #N-Dup represents duplicate analysis of site replicate.

| **NSBC** | (µg/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *2N-Dup* | *3N* | *4N* |
| **Ag** | 0.04 | 0.03 | 0.03 | 0.11 | 0.04 |
| **Cd** | 2.52 | 1.96 | 1.89 | 2.11 | 2.30 |
| **Cr** | 2.03 | 2.03 | 1.99 | 2.19 | 2.16 |
| **Cu** | 5.54 | 5.61 | 5.62 | 5.71 | 5.38 |
| **Fe** | 689 | 752 | 776 | 741 | 726 |
| **Ni** | 1.69 | 1.71 | 1.66 | 1.64 | 1.63 |
| **Pb** | 2.26 | 1.78 | 1.74 | 1.94 | 2.20 |
| **Zn** | 77.4 | 65.7 | 64.6 | 75.1 | 89.7 |
| **Al** | 509 | 585 | 675 | 555 | 556 |
| **Hg** | 0.140 | 0.151 | 0.137 | 0.159 | 0.143 |
| **%Solids** | 12.3 | 12.4 | 12.4 | 12.8 | 11.6 |

**Table E.16** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at the Digby site, NS (NSDI); 44.6170°N, 64.7523°W **Benchmark Site**

| **NSDI** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.04 | 0.05 | 0.04 | 0.05 |
| **Cd** | 2.05 | 2.05 | 1.92 | 1.94 |
| **Cr** | 1.69 | 2.16 | 1.82 | 2.02 |
| **Cu** | 5.45 | 5.62 | 5.02 | 5.57 |
| **Fe** | 613 | 836 | 662 | 818 |
| **Ni** | 1.39 | 1.46 | 1.41 | 1.40 |
| **Pb** | 3.35 | 4.51 | 3.10 | 4.32 |
| **Zn** | 119 | 118 | 151 | 137 |
| **Al** | 569 | 814 | 617 | 816 |
| **Hg** | 0.156 | 0.164 | 0.147 | 0.150 |
| **%Solids** | 10.8 | 9.7 | 8.5 | 9.8 |

**Table E.17** 2005 blue mussel tissue metal concentrations (µg/g dry wt.) at the Barrington Passage site, NS (NSBP); 43.5217°N, 65.6342°W

| **NSBP** | (µg/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **Ag** | 0.013 | 0.014 | 0.017 | 0.013 |
| **Cd** | 1.66 | 1.59 | 1.38 | 1.43 |
| **Cr** | 1.37 | 1.39 | 1.55 | 1.34 |
| **Cu** | 6.34 | 6.80 | 7.14 | 6.43 |
| **Fe** | 282 | 299 | 331 | 312 |
| **Ni** | 0.87 | 1.00 | 0.95 | 0.90 |
| **Pb** | 3.72 | 3.71 | 2.70 | 3.16 |
| **Zn** | 131 | 117 | 141 | 131 |
| **Al** | 194 | 186 | 229 | 213 |
| **Hg** | 0.132 | 0.128 | 0.133 | 0.112 |
| **%Solids** | 11.2 | 11.8 | 13.5 | 12.8 |

# APPENDIX F Organic Contaminants (and % Lipids Content) in 2005 Gulfwatch Mussel Samples

**TABLES F.1** PAH concentration (ng/g dry wt.) and % lipid content observed in Mussel tissue collected by Gulfwatch, 2005. "Int." indicates the presence of interferences during analysis. Stations are ordered by year, essentially clockwise in rotation, south (Massachusetts) to north (to Nova Scotia).

**Table F.1.1** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at Sandwich, MA (MASN); 41.7645°N, 70.4840°W. **Benchmark Site**

| **MASN** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N.* | *2N.* | *3N* | *4N* |
| Naphthalene | 18.7 | 12.9 | <10 | 10.1 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 |
| Phenanthrene | 15.0 | 14.3 | 13.8 | 13.5 |
| Anthracene | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 |
| Fluoranthene | 25.6 | 25.2 | 22.7 | 22.0 |
| Pyrene | 17.6 | 16.6 | 15.2 | 16.7 |
| Benzo(a)Anthracene | <6 | <6 | <6 | <6 |
| Chrysene | 8.5 | 8.4 | 6.8 | 7.7 |
| Benzo(b)Fluoranthene | 6.1 | <6 | <6 | 7.4 |
| Benzo(k)Fluoranthene | <4 | <4 | <4 | <4 |
| Benzo(e)Pyrene | 10.1 | 9.0 | 7.4 | 10.1 |
| Benzo(a)Pyrene | 5.9 | 4.6 | <4 | 5.6 |
| Perylene | <5 | <5 | <5 | <5 |
| Indeno(1,2,3,4-cd)Pyrene | <7 | <7 | <7 | <7 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 7.19% | 6.91% | 7.22% | 6.31% |

**Table F.1.2** 2005 Blue mussel PAH concentrations (ng/g dry wt.) in Massachusetts inner Plymouth-Manomet Point station (MAPY); 41.9283°N, 70.5383°W

| **MAPY** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *3N-Dup* |
| Naphthalene | <10 | 14.6 | 12.5 | 14.0 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 |
| Phenanthrene | 15.8 | 16.2 | 13.4 | 14.0 |
| Anthracene | <10 | 15.4 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 |
| Fluoranthene | 45.2 | 61.5 | 32.9 | 36.5 |
| Pyrene | 35.2 | 40.6 | 26.0 | 27.6 |
| Benzo(a)Anthracene | 12.8 | 15.6 | 6.7 | 7.7 |
| Chrysene | 19.0 | 20.2 | 12.1 | 13.6 |
| Benzo(b)Fluoranthene | 13.6 | 13.7 | 8.2 | 8.7 |
| Benzo(k)Fluoranthene | 9.9 | 10.3 | 5.4 | 6.0 |
| Benzo(e)Pyrene | 16.4 | 10.6 | 10.3 | 10.6 |
| Benzo(a)Pyrene | 8.9 | 9.1 | 4.3 | 4.4 |
| Perylene | <5 | 23.3 | <5 | <5 |
| Indeno(1,2,3,4-cd)Pyrene | 8.1 | <7 | <7 | 7.2 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 5.88% | 6.32% | 4.93% | 5.63% |

**Table F.1.3** 2005 *soft-shell clam* tissue PAH concentrations (ng/g dry wt.) at the Middle Ground site (expanded Gulfwatch), NH (NHMG); 42.8922°N, 70.8233°W

| NHMG | (ng/g dry wt.) | |
|---|---|---|
| *Replicate* | *1N* | *2N* |
| Naphthalene | 14.8 | 17.4 |
| 1-Methylnaphthalene | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 |
| Biphenyl | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 |
| Acenaphthylene | <11 | <11 |
| Acenaphthene | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 |
| Fluorene | <7 | <7 |
| Phenanthrene | 18.7 | 42.0 |
| Anthracene | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 |
| Fluoranthene | 18.5 | 55.5 |
| Pyrene | 19.6 | 48.2 |
| Benzo(a)Anthracene | 8.2 | 25.3 |
| Chrysene | 12.0 | 29.9 |
| Benzo(b)Fluoranthene | 7.6 | 26.0 |
| Benzo(k)Fluoranthene | 6.2 | 24.0 |
| Benzo(e)Pyrene | 11.2 | 25.4 |
| Benzo(a)Pyrene | 9.7 | 28.9 |
| Perylene | <5 | 7.3 |
| Indeno(1,2,3,4-cd)Pyrene | <7 | <7 |
| Dibenz(a,h)Anthracene | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 |
| % Lipid | 3.07% | 3.15% |

**Table F.1.4** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at the Hampton/Seabrook estuary, NH site (NHHS); 42.8917°N, 70.8167°W. #N-Dup represents duplicate analysis of site replicate.

| **NHHS** | | | (ng/g dry wt.) | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| Naphthalene | <10 | <10 | <10 | <10 | <10 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 | <7 |
| Phenanthrene | 10.6 | 9.7 | 10.9 | 8.7 | 10.23 |
| Anthracene | <10 | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 | <12 |
| Fluoranthene | 22.5 | 18.4 | 20.7 | 19.0 | 21.58 |
| Pyrene | 20.7 | 18.3 | 20.8 | 16.9 | 19.94 |
| Benzo(a)Anthracene | 6.4 | <6 | 6.5 | <6 | 6.61 |
| Chrysene | 12.5 | 10.9 | 12.4 | 10.1 | 12.53 |
| Benzo(b)Fluoranthene | 10.5 | 8.3 | 9.7 | 7.9 | 9.12 |
| Benzo(k)Fluoranthene | 5.7 | 5.0 | 6.1 | 4.6 | 5.76 |
| Benzo(e)Pyrene | 13.5 | 11.6 | 14.9 | 10.9 | 13.20 |
| Benzo(a)Pyrene | 6.2 | 4.9 | 7.2 | 5.6 | 7.11 |
| Perylene | <5 | <5 | <5 | <5 | <5 |
| Indeno(1,2,3,4-cd)Pyrene | <7 | <7 | 7.6 | <7 | <7 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 | <15 |
| % Lipid | 6.31% | 6.61% | 5.89% | 5.47% | 6.04% |

**Table F.1.5** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at North Mill Pond, NH (NHNM); 43.0750°N, 70.7600°W.

| **NHNM** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| Naphthalene | 13.0 | <10 | 10.7 | 13.3 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | 11.6 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | 11.9 | 9.4 | 10.4 | 10.2 |
| Phenanthrene | 86.8 | 73.9 | 80.0 | 78.9 |
| Anthracene | 25.3 | 21.6 | 24.0 | 23.2 |
| 1-Methylphenanthracene | 18.0 | 15.4 | 17.5 | 19.9 |
| Fluoranthene | 145.8 | 145.5 | 149.4 | 157.1 |
| Pyrene | 237.4 | 210.8 | 235.2 | 240.4 |
| Benzo(a)Anthracene | 71.4 | 63.1 | 72.3 | 70.7 |
| Chrysene | 136.4 | 124.2 | 143.1 | 140.5 |
| Benzo(b)Fluoranthene | 109.6 | 93.5 | 112.5 | 107.6 |
| Benzo(k)Fluoranthene | 79.3 | 67.3 | 80.7 | 75.6 |
| Benzo(e)Pyrene | 101.5 | 91.9 | 101.5 | 105.2 |
| Benzo(a)Pyrene | 42.5 | 34.3 | 42.5 | 39.5 |
| Perylene | 31.0 | 25.7 | 29.0 | 27.7 |
| Indeno(1,2,3,4-cd)Pyrene | 30.5 | 22.8 | 28.9 | 30.9 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 6.30% | 6.34% | 6.19% | 6.73% |

**Table F.1.6** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at Dover Point, NH (NHDP); 43.1196$^{o}$N, 70.8267$^{o}$W #N-Dup represents duplicate analysis of site replicate.

| **NHDP** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| Naphthalene | <10 | <10 | 10.8 | <10 | <10 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 | <7 |
| Phenanthrene | 36.2 | 33.1 | 41.1 | 51.3 | 32.5 |
| Anthracene | 14.3 | 12.7 | 14.9 | 19.8 | 11.4 |
| 1-Methylphenanthracene | 15.6 | INT | <12 | INT | <12 |
| Fluoranthene | 75.3 | 76.0 | 114.1 | 105.9 | 69.4 |
| Pyrene | 144.5 | 128.1 | 182.2 | 160.1 | 101.4 |
| Benzo(a)Anthracene | 53.8 | 39.9 | 59.1 | 52.1 | 30.6 |
| Chrysene | 70.7 | 57.7 | 84.0 | 76.5 | 45.5 |
| Benzo(b)Fluoranthene | 37.1 | 35.4 | 57.4 | 54.0 | 30.9 |
| Benzo(k)Fluoranthene | 35.8 | 36.0 | 54.2 | 48.8 | 26.0 |
| Benzo(e)Pyrene | INT | 24.3 | 65.9 | INT | 35.7 |
| Benzo(a)Pyrene | INT | INT | 33.4 | INT | 16.4 |
| Perylene | INT | INT | 32.0 | INT | 15.3 |
| Indeno(1,2,3,4-cd)Pyrene | INT | INT | 21.2 | INT | 8.8 |
| Dibenz(a,h)Anthracene | INT | INT | <11 | INT | <11 |
| Benzo(ghi)Perylene | INT | INT | <15 | INT | <15 |
| % Lipid | 7.55% | 6.30% | 8.15% | 8.05% | 3.80% |

**Table F.1.7** 2002 *oyster* tissue PAH concentrations (ng/g dry wt.) at Nannie Island (expanded Gulfwatch) site (NHNI); 43.1344°N, 70.8471°W

| **NHNI** | (ng/g dry wt.) | |
|---|---|---|
| *Replicate* | *1N* | *2N* |
| Naphthalene | 58.1 | 21.6 |
| 1-Methylnaphthalene | 18.7 | 10.6 |
| 2-Methylnaphthalene | 29.2 | 16.8 |
| Biphenyl | <7 | <7 |
| 2,6-Dimethylnaphthalene | 14.1 | 11.5 |
| Acenaphthylene | 20.5 | 19.2 |
| Acenaphthene | 13.2 | 10.2 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 |
| Fluorene | 20.0 | 17.8 |
| Phenanthrene | 83.9 | 76.5 |
| Anthracene | 25.0 | 26.9 |
| 1-Methylphenanthracene | 14.0 | <12 |
| Fluoranthene | 82.7 | 73.9 |
| Pyrene | 98.5 | 77.2 |
| Benzo(a)Anthracene | 16.1 | 17.2 |
| Chrysene | 56.1 | 53.4 |
| Benzo(b)Fluoranthene | 25.2 | 24.5 |
| Benzo(k)Fluoranthene | 6.1 | 6.8 |
| Benzo(e)Pyrene | 25.5 | 21.1 |
| Benzo(a)Pyrene | <4 | 5.5 |
| Perylene | 9.1 | 6.4 |
| Indeno(1,2,3,4-cd)Pyrene | 8.3 | <7 |
| Dibenz(a,h)Anthracene | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 |
| % Lipid | 13.11% | 11.64% |

**Table F.1.8** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at Clark's Cove, ME (MECC); 43.0774°N, 70.7244°W. **Benchmark Site**

| **MECC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| Naphthalene | <10 | <10 | *<10* | <10 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 |
| Phenanthrene | 18.8 | 14.7 | 18.2 | 14.8 |
| Anthracene | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 |
| Fluoranthene | 44.7 | 32.6 | 35.3 | 34.2 |
| Pyrene | 74.6 | 59.2 | 62.9 | 54.6 |
| Benzo(a)Anthracene | 27.3 | 17.4 | 18.6 | 16.6 |
| Chrysene | 36.7 | 25.5 | 28.0 | 25.9 |
| Benzo(b)Fluoranthene | 32.8 | 21.0 | 22.5 | 20.6 |
| Benzo(k)Fluoranthene | 25.8 | 16.5 | 17.3 | 15.8 |
| Benzo(e)Pyrene | 34.3 | 25.2 | 27.2 | 25.3 |
| Benzo(a)Pyrene | 21.4 | 12.3 | 13.7 | 11.8 |
| Perylene | 15.3 | 11.8 | 11.0 | 10.2 |
| Indeno(1,2,3,4-cd)Pyrene | 15.0 | 10.8 | 9.9 | 10.9 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 5.16% | 5.57% | 5.65% | 5.02% |

**Table F.1.9** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at Portland Harbor, ME (MEPH); 43.6392°N, 70.2590°W. #N-Dup represents duplicate analysis of site replicate.

| **MEPH** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *1N-Dup* | *2N* | *3N* | *4N* |
| Naphthalene | <10 | 14.4 | 13.4 | <10 | 13.3 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 | <7 |
| Fluorene | 13.4 | <7 | 8.0 | <7 | 8.5 |
| Phenanthrene | 58.6 | 44.9 | 60.1 | 47.1 | 58.7 |
| Anthracene | 13.8 | 10.6 | 16.4 | 11.6 | 15.8 |
| 1-Methylphenanthracene | <12 | <12 | 15.5 | <12 | <12 |
| Fluoranthene | 193.0 | 139.8 | 149.9 | 113.7 | 142.6 |
| Pyrene | 190.3 | 139.9 | 194.1 | 142.2 | 183.3 |
| Benzo(a)Anthracene | 70.0 | 56.3 | 72.4 | 50.8 | 63.5 |
| Chrysene | 124.3 | 103.5 | 128.8 | 99.4 | 122.9 |
| Benzo(b)Fluoranthene | 111.6 | 89.3 | 114.1 | 78.3 | 82.8 |
| Benzo(k)Fluoranthene | 82.5 | 67.7 | 88.5 | 63.6 | 77.2 |
| Benzo(e)Pyrene | 107.6 | 87.2 | 80.2 | 47.8 | 66.1 |
| Benzo(a)Pyrene | 35.2 | 29.5 | 22.9 | 22.0 | 27.5 |
| Perylene | 25.0 | 19.4 | INT | INT | INT |
| Indeno(1,2,3,4-cd)Pyrene | 27.4 | 19.9 | INT | INT | INT |
| Dibenz(a,h)Anthracene | <11 | <11 | INT | INT | INT |
| Benzo(ghi)Perylene | <15 | <15 | INT | INT | INT |
| % Lipid | 4.66% | 4.74% | 5.87% | 3.71% | 4.07% |

**Table F.1.10** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at the Royal River site, ME (MERY); 43.7970$^{o}$N, 70.1455$^{o}$W

| **MERY** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| Naphthalene | <10 | 12.1 | 12.4 | 10.0 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | 11.2 |
| Phenanthrene | 17.4 | 11.9 | 11.0 | 12.7 |
| Anthracene | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 |
| Fluoranthene | <14 | <14 | <14 | 21.1 |
| Pyrene | 21.8 | 21.3 | 20.2 | 16.9 |
| Benzo(a)Anthracene | <6 | <6 | <6 | <6 |
| Chrysene | 9.9 | 11.3 | 12.3 | 13.1 |
| Benzo(b)Fluoranthene | 10.2 | 7.6 | 7.2 | 6.1 |
| Benzo(k)Fluoranthene | 5.6 | 5.9 | 5.7 | 5.9 |
| Benzo(e)Pyrene | <7 | <7 | <7 | <7 |
| Benzo(a)Pyrene | 6.8 | 10.1 | 5.2 | 9.1 |
| Perylene | 30.5 | INT | INT | INT |
| Indeno(1,2,3,4-cd)Pyrene | <7 | INT | INT | INT |
| Dibenz(a,h)Anthracene | <11 | INT | INT | INT |
| Benzo(ghi)Perylene | <15 | INT | INT | INT |
| % Lipid | 7.68% | 9.14% | 7.10% | 10.99% |

**Table F.1.11** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at the Penobscot River site, ME (MEFP); 44.4695°N, 68.8102°W. #N-Dup represents duplicate analysis of site replicate.

| **MEFP** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| Naphthalene | 32.9 | 28.7 | 16.4 | 19.5 | 30.7 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 | <7 |
| Phenanthrene | 9.2 | 9.5 | 14.0 | 12.9 | 16.6 |
| Anthracene | <10 | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 | <12 |
| Fluoranthene | 21.7 | 22.0 | 17.9 | 18.3 | 24.8 |
| Pyrene | 30.1 | 30.1 | 24.5 | 26.2 | 38.2 |
| Benzo(a)Anthracene | 13.3 | 12.5 | 11.0 | 10.9 | 15.6 |
| Chrysene | 22.1 | 20.2 | 18.5 | 16.4 | 25.7 |
| Benzo(b)Fluoranthene | 22.2 | 17.5 | 18.4 | 19.3 | 27.1 |
| Benzo(k)Fluoranthene | 14.1 | 14.2 | 12.2 | 8.8 | 14.6 |
| Benzo(e)Pyrene | <7 | <7 | 16.6 | 14.8 | 24.1 |
| Benzo(a)Pyrene | 10.9 | 13.0 | 9.1 | 8.9 | 13.1 |
| Perylene | 41.7 | INT | 23.1 | 22.9 | 30.3 |
| Indeno(1,2,3,4-cd)Pyrene | <7 | INT | <7 | <7 | <7 |
| Dibenz(a,h)Anthracene | <11 | INT | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | INT | <15 | <15 | <15 |
| % Lipid | 7.30% | 8.33% | 5.40% | 7.44% | 11.84% |

**Table F.1.12** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at the Pickering Island site, ME (MEPI); 44.2605°N, 68.7332°W

| **MEPI** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| Naphthalene | <10 | <10 | 15.2 | 17.8 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 |
| Phenanthrene | <6 | <6 | <6 | 7.4 |
| Anthracene | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | INT |
| Fluoranthene | <14 | <14 | <14 | <14 |
| Pyrene | <9 | <9 | <9 | <9 |
| Benzo(a)Anthracene | <6 | <6 | <6 | <6 |
| Chrysene | <6 | <6 | <6 | <6 |
| Benzo(b)Fluoranthene | <6 | <6 | <6 | <6 |
| Benzo(k)Fluoranthene | <4 | <4 | <4 | <4 |
| Benzo(e)Pyrene | <7 | <7 | <7 | <7 |
| Benzo(a)Pyrene | <4 | <4 | <4 | 6.6 |
| Perylene | <5 | <5 | <5 | 26.7 |
| Indeno(1,2,3,4-cd)Pyrene | <7 | <7 | <7 | <7 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 4.11% | 5.24% | 4.99% | 5.38% |

**Table F.1.13** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at the Hospital Island site, NB (NBHI); 45.1205°N, 66.0082°W **Benchmark Site**

| **NBHI** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| Naphthalene | 27.3 | <10 | 28.2 | 12.5 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 |
| Phenanthrene | 10.2 | <6 | <6 | <6 |
| Anthracene | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 |
| Fluoranthene | <14 | <14 | <14 | <14 |
| Pyrene | <9 | <9 | <9 | <9 |
| Benzo(a)Anthracene | <6 | <6 | <6 | <6 |
| Chrysene | <6 | <6 | <6 | <6 |
| Benzo(b)Fluoranthene | <6 | <6 | <6 | <6 |
| Benzo(k)Fluoranthene | <4 | <4 | <4 | <4 |
| Benzo(e)Pyrene | <7 | <7 | <7 | <7 |
| Benzo(a)Pyrene | 5.4 | <4 | <4 | <4 |
| Perylene | <5 | <5 | <5 | <5 |
| Indeno(1,2,3,4-cd)Pyrene | <7 | <7 | <7 | <7 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 6.55% | 3.65% | 6.46% | 7.89% |

**Table F.1.14** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at the Tin Can Beach site, NB (NBTC); 45.2625°N, 66.0570°W

| **NBTC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| Naphthalene | 28.8 | 24.9 | 26.3 | 15.2 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 |
| Phenanthrene | 17.1 | 24.7 | 42.0 | 13.4 |
| Anthracene | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 |
| Fluoranthene | 25.8 | 43.5 | 38.5 | 20.0 |
| Pyrene | 22.8 | 35.1 | 34.2 | 16.1 |
| Benzo(a)Anthracene | 12.9 | 16.6 | 12.8 | 7.6 |
| Chrysene | 15.2 | 19.1 | 15.1 | 11.8 |
| Benzo(b)Fluoranthene | 13.2 | 16.8 | 13.6 | 9.4 |
| Benzo(k)Fluoranthene | 7.8 | 9.0 | 8.1 | 4.6 |
| Benzo(e)Pyrene | 14.5 | 16.5 | 14.0 | 10.8 |
| Benzo(a)Pyrene | 8.8 | 17.5 | 7.7 | 5.8 |
| Perylene | 7.2 | 8.9 | 7.7 | 6.5 |
| Indeno(1,2,3,4-cd)Pyrene | <7 | <7 | <7 | <7 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 3.04% | 4.58% | 3.64% | 5.77% |

**Table F.1.15** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at the Broad Cove site, NS (NSBC); 44.6653°N, 65.8308°W

| **NSBC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| Naphthalene | <10 | <10 | <10 | 10.2 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | 8.2 | 9.1 |
| Phenanthrene | 38.6 | 36.9 | 58.7 | 59.2 |
| Anthracene | 14.8 | 13.7 | 17.2 | 16.0 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 |
| Fluoranthene | 67.3 | 69.6 | 77.8 | 77.8 |
| Pyrene | 52.9 | 51.9 | 63.6 | 57.4 |
| Benzo(a)Anthracene | 22.0 | 21.2 | 27.9 | 23.2 |
| Chrysene | 23.7 | 23.7 | 27.8 | 25.4 |
| Benzo(b)Fluoranthene | 17.1 | 16.1 | 19.1 | 16.4 |
| Benzo(k)Fluoranthene | 12.5 | 11.3 | 14.3 | 11.9 |
| Benzo(e)Pyrene | 18.2 | 18.1 | 19.8 | 19.5 |
| Benzo(a)Pyrene | 8.9 | 9.2 | 10.4 | 9.9 |
| Perylene | <5 | <5 | <5 | <5 |
| Indeno(1,2,3,4-cd)Pyrene | 8.4 | 8.3 | 10.3 | 10.1 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 4.93% | 4.92% | 4.62% | 5.25% |

**Table F.1.16** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at Digby, NS (NSDI); 44.6170°N, 64.7523°W **Benchmark Site.** #N-Dup represents duplicate analysis of site replicate.

| **NSDI** | | | (ng/g dry wt.) | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| Naphthalene | <10 | <10 | <10 | <10 | 10.8 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 | <7 |
| Phenanthrene | 13.2 | 13.1 | 13.5 | 14.1 | 14.4 |
| Anthracene | <10 | <10 | <10 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 | <12 |
| Fluoranthene | 23.6 | 25.0 | 25.1 | 28.0 | 28.2 |
| Pyrene | 18.0 | 18.4 | 19.8 | 22.1 | 20.2 |
| Benzo(a)Anthracene | 9.2 | 9.2 | 10.4 | 11.0 | 10.9 |
| Chrysene | 10.8 | 11.9 | 12.9 | 14.4 | 13.3 |
| Benzo(b)Fluoranthene | 12.6 | 11.6 | 15.5 | 15.3 | 14.7 |
| Benzo(k)Fluoranthene | 7.2 | 6.6 | 6.9 | 7.0 | 7.8 |
| Benzo(e)Pyrene | 12.1 | 12.0 | 12.5 | 13.7 | 13.4 |
| Benzo(a)Pyrene | 7.3 | 5.5 | 5.9 | 6.2 | 6.4 |
| Perylene | 7.7 | 6.8 | 7.3 | 8.3 | 8.3 |
| Indeno(1,2,3,4-cd)Pyrene | 7.9 | 7.7 | 7.8 | 8.2 | <7 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 | <15 |
| % Lipid | 5.00% | 5.59% | 5.30% | 4.87% | 5.80% |

**Table F.1.17** 2005 blue mussel tissue PAH concentrations (ng/g dry wt.) at the Barrington Passage site, NB (NSBP); 43.5217°N, 65.6342°W

| **NSBP** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| Naphthalene | 12.0 | 18.6 | 10.7 | 13.9 |
| 1-Methylnaphthalene | <8 | <8 | <8 | <8 |
| 2-Methylnaphthalene | <10 | <10 | <10 | <10 |
| Biphenyl | <7 | <7 | <7 | <7 |
| 2,6-Dimethylnaphthalene | <8 | <8 | <8 | <8 |
| Acenaphthylene | <11 | <11 | <11 | <11 |
| Acenaphthene | <8 | <8 | <8 | <8 |
| 2,3,5-Trimethylnaphthalene | <7 | <7 | <7 | <7 |
| Fluorene | <7 | <7 | <7 | <7 |
| Phenanthrene | 25.6 | 24.8 | 20.6 | 22.4 |
| Anthracene | 10.8 | 10.9 | <10 | <10 |
| 1-Methylphenanthracene | <12 | <12 | <12 | <12 |
| Fluoranthene | 129.3 | 134.8 | 101.1 | 120.0 |
| Pyrene | 97.9 | 87.0 | 75.0 | 81.3 |
| Benzo(a)Anthracene | 29.7 | 22.9 | 26.0 | 25.0 |
| Chrysene | 30.0 | 28.8 | 29.0 | 28.9 |
| Benzo(b)Fluoranthene | 26.9 | 20.6 | 24.3 | 23.0 |
| Benzo(k)Fluoranthene | 18.1 | 14.5 | 16.4 | 14.9 |
| Benzo(e)Pyrene | 22.5 | 22.2 | 18.5 | 21.7 |
| Benzo(a)Pyrene | 10.0 | 8.6 | 7.8 | 8.1 |
| Perylene | 149.4 | 122.4 | 107.6 | 118.4 |
| Indeno(1,2,3,4-cd)Pyrene | 11.0 | 9.9 | 9.6 | 11.0 |
| Dibenz(a,h)Anthracene | <11 | <11 | <11 | <11 |
| Benzo(ghi)Perylene | <15 | <15 | <15 | <15 |
| % Lipid | 5.50% | 4.68% | 4.47% | 4.22% |

**TABLES F.2** PCB concentration (ng/g dry wt.) observed in Mussel tissue collected by Gulfwatch, 2005. “Int.” indicates the presence of interferences during analysis. Stations are ordered by year, essentially clockwise in rotation, south (Massachusetts) to north (to Nova Scotia).

**Table F.2.1** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at Sandwich, MA (MASN); 41.7645°N, 70.4840°W. **Benchmark Site**

| **MASN** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | 4.1 | 3.0 | 3.8 | 4.1 |
| **101;90** | <2.2 | <2.2 | 2.3 | <2.2 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | 2.9 | 2.8 | 3.1 | 3.3 |
| **153;132** | 5.3 | 5.3 | 6.1 | 7.4 |
| **105** | <1.4 | <1.4 | 1.5 | 1.8 |
| **138** | 4.6 | 4.5 | 5.3 | 6.4 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <1.9 | <1.9 | 2.0 | 2.8 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.2** 2005 Blue mussel PCB concentrations (ng/g dry wt.) in Massachusetts inner Plymouth-Manomet Point station (MAPY); 41.9283$^{o}$N, 70.5383$^{o}$W. #N-Dup represents duplicate analysis of site replicate.

| **MAPY** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *3N-Dup* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | 4.5 | 4.0 | 4.2 | 3.6 |
| **101;90** | 3.0 | 2.3 | 2.7 | 2.4 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | 4.7 | 3.4 | 3.9 | 3.3 |
| **153;132** | 11.0 | 7.5 | 8.4 | 6.5 |
| **105** | 2.3 | 1.8 | 2.0 | 1.5 |
| **138** | 8.9 | 6.3 | 7.1 | 5.5 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | 4.0 | 2.8 | 3.1 | 2.1 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table E.2.3** 2005 *soft shell clam* tissue PCB concentrations (ng/g dry wt.) at the Middle Ground site (expanded Gulfwatch), NH (NHMG); 42.8922°N, 70.8233°W

| **NHMG** softshell clams | (ng/g dry wt.) | |
|---|---|---|
| *Replicate* | *1N* | *2N* |
| **8;5** | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 |
| **52** | <2 | <2 |
| **44** | <2.3 | <2.3 |
| **66;95** | 3.36 | 2.28 |
| **101;90** | <2.2 | <2.2 |
| **87** | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 |
| **118** | <2 | <2 |
| **153;132** | <2.1 | <2.1 |
| **105** | <1.4 | <1.4 |
| **138** | <2 | <2 |
| **126** | <1.9 | <1.9 |
| **187** | <1.9 | <1.9 |
| **128** | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 |

**Table E.2.4 2005** blue mussel tissue PCB concentrations (ng/g dry wt.) at the Hampton/Seabrook estuary, NH site (NHHS); 42.8917°N, 70.8167°W. #N-Dup represents duplicate analysis of site replicate.

| **NHHS** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 | 2.8 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | 2.9 | 2.6 | 2.3 | 2.4 | 9.1 |
| **101;90** | <2.2 | 2.3 | <2.2 | <2.2 | 10.4 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 | 2.8 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | <2 | <2 | <2 | 9.8 |
| **153;132** | 3.8 | 3.5 | 2.8 | 3.0 | 16.1 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 | 2.8 |
| **138** | 3.4 | 3.2 | 2.5 | 2.6 | 15.6 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <1.9 | <1.9 | <1.9 | <1.9 | 6.1 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 | 2.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 | 1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |

**Table E.2.5** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at North Mill Pond, NH (NHNM); 43.0750°N, 70.7600°W.

| **NHNM** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | 2.9 | 2.2 | 2.3 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | 7.5 | 6.0 | 5.7 | 2.5 |
| **101;90** | 10.4 | 8.7 | 7.7 | <2.2 |
| **87** | 2.7 | 2.1 | 1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | 9.7 | 8.3 | 7.0 | <2 |
| **153;132** | 15.5 | 13.2 | 11.4 | 3.1 |
| **105** | 3.0 | 2.2 | 2.0 | <1.4 |
| **138** | 14.9 | 12.9 | 11.4 | 2.9 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | 5.8 | 4.5 | 4.6 | <1.9 |
| **128** | 2.7 | 2.3 | 2.1 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.6** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at Dover Point, NH (NHDP); 43.1196$^{o}$N, 70.8267$^{o}$W #N-Dup represents duplicate analysis of site replicate.

| **NHDP** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | 4.9 | 5.1 | 7.0 | 5.7 | 3.1 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | 4.4 | 4.7 | 6.3 | 5.2 | 3.0 |
| **153;132** | 8.3 | 8.7 | 11.8 | 9.7 | 5.6 |
| **105** | <1.4 | 1.5 | 1.9 | 1.6 | <1.4 |
| **138** | 7.4 | 7.9 | 10.6 | 8.8 | 5.2 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | 2.9 | 3.0 | 4.0 | 3.3 | 1.9 |
| **128** | <1.9 | <1.9 | 1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.7** 2005 *oyster* tissue PCB concentrations (ng/g dry wt.) at Nannie Island (expanded Gulfwatch) site (NHNI); 43.1344°N, 70.8471°W

| **NHNI-**Oysters | (ng/g dry wt.) | |
|---|---|---|
| *Replicate* | *1N* | *2N* |
| **8;5** | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 |
| **52** | 2.5 | <2 |
| **44** | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 |
| **101;90** | 14.7 | 5.9 |
| **87** | 2.1 | <1.9 |
| **77** | <2.3 | <2.3 |
| **118** | 14.8 | 5.7 |
| **153;132** | 22.5 | 9.4 |
| **105** | 2.6 | <1.4 |
| **138** | 16.9 | 6.4 |
| **126** | 2.0 | <1.9 |
| **187** | 10.5 | 3.8 |
| **128** | 2.6 | <1.9 |
| **180** | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 |

**Table F.2.8** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at Clark's Cove, ME (MECC); 43.0774°N, 70.7244°W. **Benchmark Site**

| **MECC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | 4.5 | 3.2 | 3.1 | 3.2 |
| **101;90** | 4.8 | 3.9 | 4.5 | 4.0 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | 4.7 | 3.4 | 3.9 | 3.9 |
| **153;132** | 9.3 | 7.8 | 9.1 | 8.4 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | 8.9 | 6.8 | 8.0 | 7.0 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | 4.0 | 3.1 | 3.6 | 3.4 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.9** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at Portland Harbor, ME (MEPH); 43.6392°N, 70.2590°W. #N-Dup represents duplicate analysis of site replicate.

| **MEPH** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| **8;5** | <2.7 | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.2 | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.4 | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.3 | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2 | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2.3 | <2 | <2 | <2 | <2 |
| **44** | <2.2 | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | 6.1 | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | <1.9 | 7.6 | 6.1 | 7.4 | 7.4 |
| **87** | <2.3 | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | 4.8 | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | 8.8 | 6.0 | 4.5 | 5.2 | 5.4 |
| **153;132** | 1.9 | 12.0 | 8.3 | 9.8 | 10.2 |
| **105** | 8.9 | 1.7 | <1.4 | 1.6 | 1.7 |
| **138** | <1.9 | 10.7 | 8.2 | 9.5 | 9.8 |
| **126** | 3.1 | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <1.9 | 3.7 | 2.9 | 3.5 | 3.4 |
| **128** | <1.7 | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.8 | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.7 | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.10** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at the Royal River site, ME (MERY); 43.7970°N, 70.1455°W

| **MERY** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | 2.4 | 3.0 | <2.2 | 3.1 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | <2 | <2 | <2 |
| **153;132** | 5.0 | 5.8 | 4.1 | 6.4 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | 3.7 | 4.4 | 3.1 | 4.9 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <1.9 | 2.1 | <1.9 | 2.3 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.11** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at the Penobscot River site, ME (MEFP); 44.4695°N, 68.8102°W. #N-Dup represents duplicate analysis of site replicate.

| **MEFP** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | 2.6 | 3.2 | 2.5 | 2.6 | 3.5 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | 2.0 | <2 | <2 | 2.3 |
| **153;132** | 5.5 | 6.7 | 4.4 | 5.5 | 7.4 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | 4.6 | 5.5 | 3.6 | 4.4 | 6.0 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | 2.0 | 2.5 | <1.9 | <1.9 | 2.6 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.12** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at the Pickering Island site, ME (MEPI); 44.2605°N, 68.7332°W

| **MEPI** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | <2.2 | <2.2 | <2.2 | <2.2 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | <2 | <2 | <2 |
| **153;132** | <2.1 | <2.1 | <2.1 | <2.1 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | <2 | <2 | <2 | <2 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <1.9 | <1.9 | <1.9 | <1.9 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.13** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at the Hospital Island site, NB (NBHI); 45.1205°N, 66.0082°W **Benchmark Site**

| **NBHI** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | <2.2 | <2.2 | <2.2 | <2.2 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | <2 | <2 | <2 |
| **153;132** | <2.1 | <2.1 | <2.1 | <2.1 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | <2 | <2 | <2 | <2 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <1.9 | <1.9 | <1.9 | <1.9 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.14** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at the Tin Can Beach site, NB (NBTC); 45.2625°N, 66.0570°W

| **NBTC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | <2.2 | <2.2 | <2.2 | <2.2 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | <2 | <2 | <2 |
| **153;132** | 2.1 | 2.8 | 2.2 | 3.8 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | <2 | 2.2 | 2.2 | 3.3 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <1.9 | <1.9 | <1.9 | <1.9 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.15** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at the Broad Cove site, NS (NSBC); 44.6653°N, 65.8308°W

| **NSBC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | <2.2 | <2.2 | <2.2 | <2.2 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | <2 | <2 | <2 |
| **153;132** | <2.1 | <2.1 | <2.1 | <2.1 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | <2 | <2 | <2 | <2 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <2 | <2 | <2 | <2 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.16** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at Digby, NS (NSDI); 44.6170°N, 64.7523°W **Benchmark Site** #N-Dup represents duplicate analysis of site replicate.

| **NSDI** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | <2 | <2 | <2 | <2 |
| **153;132** | <2.1 | <2.1 | <2.1 | <2.1 | <2.1 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | <2 | <2 | <2 | <2 | <2 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <2 | <2 | <2 | <2 | <2 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 | <1.7 |

**Table F.2.17** 2005 blue mussel tissue PCB concentrations (ng/g dry wt.) at the Barrington Passage site, NB (NSBP); 43.5217°N, 65.6342°W

| **NSBP** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| **8;5** | <2.8 | <2.8 | <2.8 | <2.8 |
| **18;15** | <2.7 | <2.7 | <2.7 | <2.7 |
| **29** | <2.2 | <2.2 | <2.2 | <2.2 |
| **50** | <2.4 | <2.4 | <2.4 | <2.4 |
| **28** | <2.3 | <2.3 | <2.3 | <2.3 |
| **52** | <2 | <2 | <2 | <2 |
| **44** | <2.3 | <2.3 | <2.3 | <2.3 |
| **66;95** | <2.2 | <2.2 | <2.2 | <2.2 |
| **101;90** | <2.2 | <2.2 | <2.2 | <2.2 |
| **87** | <1.9 | <1.9 | <1.9 | <1.9 |
| **77** | <2.3 | <2.3 | <2.3 | <2.3 |
| **118** | <2 | <2 | <2 | <2 |
| **153;132** | <2.1 | <2.1 | <2.1 | <2.1 |
| **105** | <1.4 | <1.4 | <1.4 | <1.4 |
| **138** | <2 | <2 | <2 | <2 |
| **126** | <1.9 | <1.9 | <1.9 | <1.9 |
| **187** | <2 | <2 | <2 | <2 |
| **128** | <1.9 | <1.9 | <1.9 | <1.9 |
| **180** | <1.7 | <1.7 | <1.7 | <1.7 |
| **169** | <1.7 | <1.7 | <1.7 | <1.7 |
| **170;190** | <1.8 | <1.8 | <1.8 | <1.8 |
| **195;208** | <1.8 | <1.8 | <1.8 | <1.8 |
| **206** | <1.7 | <1.7 | <1.7 | <1.7 |
| **209** | <1.7 | <1.7 | <1.7 | <1.7 |

**TABLES F.3** Pesticide concentration (ng/g dry wt.) observed in Mussel tissue collected by Gulfwatch, 2005. "Int." indicates the presence of interferences during analysis. Stations are ordered by year, essentially clockwise in rotation, south (Massachusetts) to north (to Nova Scotia).

**Table F.3.1** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at Sandwich, MA (MASN); 41.7645°N, 70.4840°W. **Benchmark Site**

| **MASN** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | 2.4 | 2.7 | 2.6 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 7.6 | 7.4 | 8.4 | 8.6 |
| Dieldrin | 1.9 | 2.2 | 1.9 | 2.0 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | 5.1 | 5.7 | 5.4 | 5.9 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.2** 2005 Blue mussel pesticide concentrations (ng/g dry wt.) in Massachusetts inner Plymouth-Manomet Point station (MAPY); 41.9283°N, 70.5383°W. #N-Dup represents duplicate analysis of site replicate.

| **MAPY** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *3N-Dup* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 4.1 | 5.3 | 3.9 | 4.1 |
| Dieldrin | <1.4 | <1.4 | 3.9 | 3.9 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | <2 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.3** 2005 *soft shell clam* tissue pesticide concentrations (ng/g dry wt.) at the Middle Ground site (expanded Gulfwatch), NH (NHMG); 42.8922°N, 70.8233°W

| **NHMG** | (ng/g dry wt.) | |
|---|---|---|
| *Replicate* | *1* | *2* |
| a_BHC | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 |
| Heptachlor | <2 | <2 |
| Aldrin | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 |
| p,p'_DDE | <1.8 | <1.8 |
| Dieldrin | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 |
| o,p'-DDT | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 |

**Table F.3.4** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Hampton/Seabrook estuary site, NH (NHHS); 42.8917°N, 70.8167°W. #N-Dup represents duplicate analysis of site replicate.

| **NHHS** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | 2.8 | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 6.6 | 4.0 | 3.6 | 3.4 | 3.4 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | 4.0 | 2.6 | 2.5 | <2 | 2.4 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.5** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at North Mill Pond, NH (NHNM); 43.0750°N, 70.7600°W.

| **NHNM** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | 2.4 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | 1.5 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | 2.2 | <1.2 | 2.4 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 13.2 | 10.6 | 10.3 | 14.2 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | 8.5 | 7.1 | 7.0 | 7.4 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | 19.5 | 17.4 | 18.8 | 22.1 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.6** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at Dover Point, NH (NHDP); 43.1196°N, 70.8267°W #N-Dup represents duplicate analysis of site replicate.

| **NHDP** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | 1.5 | <1.5 | 2.0 | 1.9 | 1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | 1.2 | 1.2 | 1.6 | 1.4 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 5.0 | 5.0 | 6.9 | 5.4 | 3.6 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | 3.3 | 3.2 | 4.5 | 3.6 | 2.3 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.7** 2005 *oyster* tissue pesticide concentrations (ng/g dry wt.) at Nannie Island (expanded Gulfwatch) site (NHNI); 43.1344°N, 70.8471°W

| **NHNI** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *1N-Dup* | *2N* | *2N-Dup* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | 1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | 2.4 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | <1.8 | 11.9 | <1.8 | 16.6 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | <2 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.8** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at Clark's Cove, ME (MECC); 43.0774°N, 70.7244°W. **Benchmark Site**

| **MECC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | 1.4 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 4.6 | 3.6 | 4.3 | 3.9 |
| Dieldrin | <1.4 | <1.4 | 8.2 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | 3.0 | 3.0 | <2 | <2 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.9** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Portland Harbor site, ME (MEPH); 43.6392°N, 70.2590°W. #N-Dup represents duplicate analysis of site replicate.

| **MEPH** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | 2.4 | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | 1.4 | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 5.6 | 6.4 | 4.6 | 5.4 | 5.4 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | 6.7 | 8.7 | 6.0 | 6.6 | 7.3 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.10** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Royal River site, ME (MERY); 43.7970°N, 70.1455°W

| **MERY** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | 2.0 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 7.4 | 8.0 | 5.6 | 8.5 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | 3.2 | 3.3 | 3.2 | 3.7 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.11** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Penobscot River site, ME (MEFP); 44.4695°N, 68.8102°W. #N-Dup represents duplicate analysis of site replicate.

| **MEFP** | (ng/g dry wt.) | | | | |
|---|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* | *4N-Dup* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 4.1 | 4.9 | 3.3 | 4.4 | 5.8 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | 3.0 | 3.8 | 2.5 | 2.8 | 3.6 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.12** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Pickering Island site, ME (MEPI); 44.2605°N, 68.7332°W #N-Dup represents duplicate analysis of site replicate.

| **MEPI** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | <1.8 | <1.8 | <1.8 | <1.8 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | <2 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.13** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Hospital Island site, NB (NBHI); 45.1205°N, 66.0082°W **Benchmark Site**

| **NBHI** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | 1.2 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 2.5 | <1.8 | 2.8 | 2.7 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | 2.6 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.14** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Tin Can Beach site, NB (NBLN); 45.2625°N, 66.0570°W

| **NBTC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | 2.3 | 2.3 | <1.0 | 1.1 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 9.8 | 10.9 | 10.9 | 9.6 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | 5.0 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | 5.5 | 5.3 | 5.5 | 5.0 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.15** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Broad Cove site, NB (NSBC); 44.6653°N, 65.8308°W

| **NSBC** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | <1.8 | <1.8 | <1.8 | <1.8 |
| Dieldrin | 1.9 | 1.7 | 2.3 | 2.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | <2 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.16** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at Digby, NS (NSDI); 44.6170°N, 64.7523°W **Benchmark Site**

| **NSDI** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | <1.8 | <1.8 | 1.8 | <1.8 |
| Dieldrin | <1.4 | <1.4 | 1.5 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | <2 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |

**Table F.3.17** 2005 blue mussel tissue pesticide concentrations (ng/g dry wt.) at the Barrington Passage site, NS (NSBP); 43.5217°N, 65.6342°W

| **NSBP** | (ng/g dry wt.) | | | |
|---|---|---|---|---|
| *Replicate* | *1N* | *2N* | *3N* | *4N* |
| a_BHC | <2.0 | <2.0 | <2.0 | <2.0 |
| HCB | <2.4 | <2.4 | <2.4 | <2.4 |
| g-HCH(Lindane) | <1.5 | <1.5 | <1.5 | <1.5 |
| Heptachlor | <2 | <2 | <2 | <2 |
| Aldrin | <1.5 | <1.5 | <1.5 | <1.5 |
| HeptachlorEpoxide | <1.8 | <1.8 | <1.8 | <1.8 |
| g-Chlordane | <1.5 | <1.5 | <1.5 | <1.5 |
| o,p'-DDE | <1.0 | <1.0 | <1.0 | <1.0 |
| a-Endosulfan | <1.5 | <1.5 | <1.5 | <1.5 |
| cis-Chlordane | <1.2 | <1.2 | <1.2 | <1.2 |
| t-Nonachlor | <1.4 | <1.4 | <1.4 | <1.4 |
| p,p'_DDE | 2.0 | 2.0 | <1.8 | <1.8 |
| Dieldrin | <1.4 | <1.4 | <1.4 | <1.4 |
| o,p'-DDD | <4.0 | <4.0 | <4.0 | <4.0 |
| Endrin | <2.2 | <2.2 | <2.2 | <2.2 |
| b-Endosulfan | <3.4 | <3.4 | <3.4 | <3.4 |
| p,p'-DDD | <2 | <2 | <2 | <2 |
| o,p'-DDT | <2.8 | <2.8 | <2.8 | <2.8 |
| p,p'-DDT | <2.5 | <2.5 | <2.5 | <2.5 |
| Metoxychlor | <3.1 | <3.1 | <3.1 | <3.1 |
| Mirex | <1.5 | <1.5 | <1.5 | <1.5 |