EVALUATION OF *GULFWATCH* 1996

SIXTH YEAR OF THE GULF OF MAINE ENVIRONMENTAL MONITORING PLAN

December, 1997

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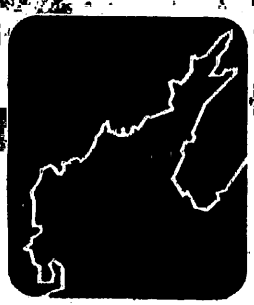

Gulf of Maine Council on the Marine Environment

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INTRODUCTION

RATIONALE

The Gulf of Maine 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 primary productivity of seaweeds, salt marsh grasses, and phytoplankton make it one of the worlds most productive system that supports a vast array of animal species, including many species of invertebrates, fish, seabirds, and marine mammals, some of great commercial importance. Commercial fisheries and aquaculture are its principal income generating enterprises, although tourism is very important source of income to many small coastal communities. As coastal populations around the Gulf and its watersheds have increased, agricultural lands have been converted to industrial and residential developments. Such changes in land use and increases in population have contributed to the deteriorating quality of sections of the coastal environment (GMCME, 1992; Dow and Braasch, 1996). Inputs from non-point source and point source pollution are a significant threat to the near shore environment of the Gulf (GMCME, 1992; Dow and Braasch, 1996). Growth in industrial activity during the 20th century has resulted in a rapid increase in inputs from chemicals, either mobilized or synthesized by man, into the estuarine and coastal environments. Many of these chemicals are bioaccumulated to concentrations significantly above ambient levels. Furthermore, some of these environmental contaminants may also be present at toxic concentrations, and thus induce adverse biological effects.

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 Monitoring Committee was formed and charged with the development of the Gulf of Maine Environmental Monitoring Plan (Hayden, 1991). 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 of 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, a project named Gulfwatch was established to measure chemical contamination Gulfwide.

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* have been successfully used as indicator organisms in environmental monitoring programs throughout the world (see NAS, 1980; NOAA, 1991; and Widdows and Donkin, 1992) to identify variation in chemical contaminants between sites, and contribute to the understanding of trends in coastal contamination (NOAA, 1991; O'Connor, 1992; O'Connor and Beliaeff, 1995; Widdows et al., 1995). The blue mussel was selected as the indicator organism for the Gulfwatch program for the following reasons:

(1) mussels are abundant within and across each of the 5 jurisdictions bordering the Gulf and they are easy to collect and process;
(2) much is known about mussel biology and physiology;
(3) mussels are a commercially important food source and therefore a measurement of the extent of chemical contamination is of public health concern;
(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 compartments (water, sediment, and suspended particles).

Gulfwatch has taken two approaches to using marine 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 (GMCME, 1992). Transplanted mussels were initially collected from relatively pristine sites in each jurisdiction, moved to sites selected for monitoring, and held there for approximately 60 days. Because of the logistics and the analytical costs, only two sites per jurisdiction could be monitored each year using this transplant technique. However, transplant experiments provided an assessment of the short-term exposure (on the order of weeks to months) to bioavailable contaminants throughout the region. In 1993 and 1994, only indigenous mussels were sampled, although a greater number of sites were monitored compared to the years when mussels were transplanted (GMCME, 1996a, 1996b). Sampling of native mussels provided an assessment of long-term exposure to bioavailable contaminants (on the order of months to a year). The 1996 sampling year followed the protocol for 1993 and 1994, sampling indigenous mussels from one to six sites in each jurisdiction.

In addition to documenting the level of contaminants in mussel tissue, biological variables, including shell growth and condition index, were measured as a means to determine the response of organisms to stress under 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). Shell growth has often been used as a measure of environmental quality and pollution effects as the rate of growth is a fundamental measure of physiological fitness/performance (Widdows and Donkin, 1992; Salazar and Salazar, 1995) and therefore, is a direct, integrative measure of the impairment of the organisms physiology. Condition index (CI) was used as an indicator of the physiological status of the mussels. It relates the tissue wet weight to shell volume and is a measure traditionally used by shellfishery biologists (Widdows, 1985). Because gonadal weight is a significant contributor to total body weight just prior to spawning, CI also reflects differences in the reproductive state of the 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. Since variable amounts of ripe gametes may be found in some mussel populations even in late fall (Kimball, 1994), the relationship between CI and contaminant concentrations must be carefully considered.

The objective of the first two years (1991 and 1992) of the Gulfwatch program was to evaluate the feasibility of the project and the level of cooperation required through collecting comparative data from different locations in the Gulf of Maine. The sites that were selected fell into two categories; test sites that were suspected or known to be contaminated and reference sites that were free of any known contaminant source. After the success of the pilot studies in 1991 and 1992, it was recognized that there should be a broader or Gulf-wide orientation of the mussel watch in addition to known contaminated and reference sites within each jurisdiction. As such, a three year cycle was initiated in 1993. In 1993 and 1994 the sample design was expanded as described above. Native mussels were sampled in as many as 7 new locations within each jurisdiction (state or province), where feasible, to increase the geographic coverage. However, one location in each jurisdiction was chosen as a baseline station, to be resampled every year. This approach increased the chance of locating unforseen environmental contamination. Transplant experiments were again conducted at two sites in each jurisdiction in 1995. This three-year cycle, with transplants being conducted at two sites during one year and indigenous mussels alone being sampled at 2-7 sites per jurisdiction during the other two years, will be repeated for the remaining years of the Gulfwatch Program. This sampling design will allow for the assessment of both short-term and long-term contaminant exposures.

METHODS

The 1996 Gulf of Maine mussel survey is the fourth year of the nine year sampling design (see Sowles et al., 1997). The 1996 sampling represents the first year of the second 3-year cycle. As such, stations that were sampled in 1996 were the same stations sampled in 1993. Therefore, in addition to spatial analysis, temporal analysis can be performed on the contaminant concentrations for all sites.

1996 SAMPLING LOCATIONS

The stations sampled in 1996 are shown in Figure 1 and Table 1. There were 3 sites in Massachusetts, 1 in New Hampshire, 6 in Maine, 3 in New Brunswick, and 5 in Nova Scotia, including 4 of the 5 benchmark sites from previous years to enable trend analysis: Sandwich, MA, Clark Cove, ME, Kennebec River, ME and Digby, NS. Unfortunately there were no mussels at the fifth benchmark site, Hospital Island, NB in 1996. As such, an alternate site at Chamcook, NB was chosen. Chamcook is located approximately 1.5 km away from Hospital Island, therefore it is in the same basin. As such one would expect that mussels at Chamcook would have been exposed to similar contaminants as mussels at Hospital Island.

FIELD PROCEDURES

Details regarding the mussel collection, measurement, and sample preparation are published in Sowles et al. (1997), however a summary of the procedures are given below.

The mussels collected were intended to be *M. edulis*. However, a similar species of *Mytilus*, *Mytilus trossulus*, was identified in some of the Bay of Fundy samples (GMCME, 1996a). This species has a slower growth rate than *M. edulis* and attains a maximum size of approximately 50-60 mm compared to 70 - 80 mm for the blue mussel (Bayne, 1976). These physiological differences result in species-specific differences in shell allometric growth. In addition, it has been shown that there are interspecific differences in concentrations of certain metal (Cu, Ni, Pb, Hg and Zn) and organic (ΣPAH_{24}) contaminants (Mucklow, 1996). Although an inter-species allometric gradient is present at all sites inhabited by both species, *M. trossulus* can often be distinguished from *M. edulis* by its higher shell length:height ratio (Lobel et al., 1990; Freeman et al., 1992; Mucklow, 1996).

All field sampling was conducted between September 15, 1996. and November 30, 1996.

Table 1. Gulf of Maine, Gulfwatch study site locations sampled in 1996.

CODE	SITE LOCATION	SAMPLE DATE	LATITUDE	LONGITUDE
MASN	Sandwich, MA	October 30	41° 45.0' N	70° 24.0' W
MAMH	Marblehead, MA	November 22	42° 29.9' N	70° 50.9' W
MAME	Merrimack River, MA	October 31	42° 48.5' N	70° 49.4' W
NHHS	Hampton / Seabrook Estuary, NH	September 30	42° 53.5' N	70° 49.0' W
MECC	Clark Cove, Me	October 2	43° 04.4' N	70° 43.4' W
MEBH	Brave Boat Harbor, ME	August 27	43° 05.6' N	70° 39.2' W
MERY	Royal River, ME	October 26	43° 47.8' N	70° 08.8' W
MEKN	Kennebec River, ME	October 4	43° 47.5' N	69° 47.6' W
MEFP	Fort Point, Penoboscot River, ME	October 7	44° 28.3' N	68° 48.9' W
MEPI	Pickering Island, ME	October 24	44° 15.6' N	68° 43.8' W
NBSC	St. Croix River, NB	October 21	45° 10.0' N	67° 09.7' W
NBCH	Chamcook, NB	October 31	45° 07.4' N	67° 03.2' W
NBLN	Letang Estuary, NB	October 18	45° 04.6' N	66° 48.0' W
NSFI	Five Islands, NS	October 7	45° 39.5' N	64° 06.7' W
NSDI	Digby, NS	October 4	44° 38.1' N	65° 44.7' W
NSBC	Broad Cove, NS	October 4	44° 40.1' N	65° 49.8' W
NSAG	Argyle, NS	October 4	43° 73.9' N	66° 14.3' W
NSYR	Yarmouth, NS	October 4	43° 81.8' N	65° 84.4' W

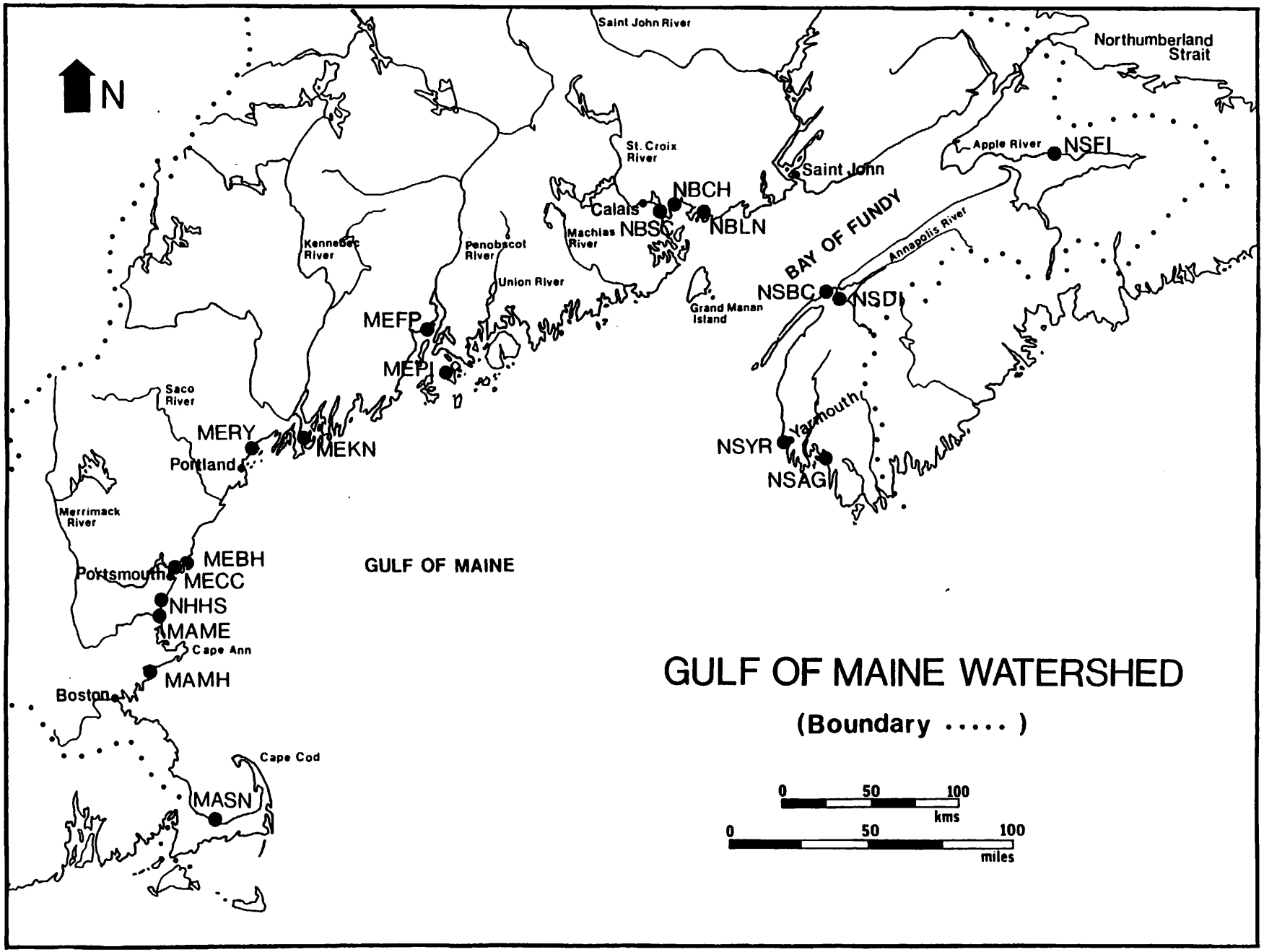

Figure 1. Location of Gulfwatch, 1996 stations in the Gulf of Maine.

Sampling was conducted as outlined in Sowles et al. (1997). Collection times were set to avoid collecting during or shortly after periods when stormwater runoff and wave resuspension of bottom sediment result in unusual uptake and accumulation of sediment in the mussel gut. Presence of sediment in the mussels was suspected to be the cause of the elevated concentrations of iron, aluminum and associated metals (Lobel et al., 1991; Robinson et al., 1993) in previous years (GMCME, 1994, 1996a, b, c).

Mussels were collected from 4 discrete areas within a segment of the shoreline that is representative of local water quality. Using a wooden gauge or a ruler, 45-50 mussels of 50-60 mm shell length were collected. The mussels were cleaned of all sediment, epibiota, and other accretions in clean seawater from the collection site, placed in clean glass containers, then transported to the lab in coolers.

LABORATORY PROCEDURES

In the laboratory, individual mussel lengths, widths and heights (as defined by Seed, 1968) were determined to the nearest 0.1 mm using vernier calipers. Using plastic or stainless steel wedges, mussels were shucked directly into appropriately prepared containers for metal and organic analysis, respectively (for details see Sowles et al., 1997). Composite samples (20 mussels/composite; 4 composites/station) were capped, labelled and stored in a freezer at $\leq$-15°C.

While a number of condition indices have been proposed over the years (Seed, 1968), the Gulfwatch Condition Index (CI) has been defined as:

$$CI = \text{tissue wet weight (mg)} / \text{length (mm)} * \text{width (mm)} * \text{height (mm)}$$

CI was determined for between 30 and 40 mussels, depending on the jurisdiction.

ANALYTICAL PROCEDURES

Analytical procedures used followed those reported for the previous years (GMCME, 1994, 1996a, b, c). Table 2 contains a summary of the metal and organic compounds measured.

Metals

Inorganic contaminants were analyzed at the State of Maine Health and Environmental Testing

TABLE 2. Inorganic and Organic contaminants analyzed in mussel tissues from the Gulf of Maine in 1996.

INORGANIC CONTAMINANTS

Metals

Ag, Al, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Zn

ORGANIC CONTAMINANTS

Aromatic Hydrocarbons

Naphthalene
1-Methylnaphthalene
2-Methynaphthalene
Biphenyl
2,6-Dimethylnaphthalene
Acenaphthylene
Acenaphthene
2,3,5-Trimethylnaphthalene
Fluorene
Phenanthrene
Anthracene
1-Methylphenanthrene
Flouranthene
Pyrene
Benzo [a] anthracene
Chrysene
Benzo [b] flouranthrene
Benzo [k] flouranthrene
Benzo [a] pyrene
Benzo [e] pyrene
Perylene
Indeno [1,2,3-cd] pyrene
Dibenzo [a,h] anthracene
Benzo [g,h,i] perylene

Chlorinated Pesticides

Hexachlorobenzene (HCB)
gamma-Benzenehexachloride (BHC)
Heptachlor
Heptachlor epoxide
Aldrin
Mirex
cis-Chlordane
trans-Nonachlor
Dieldrin
Alpha-Endosulfan
beta-Endosulfan

DDT and Homologues

2,4'-DDE	4,4'-DDE
2,4'-DDD	4,4'-DDD
2,4'-DDT	4,4'-DDT

PCB Congeners

PCB 8, PCB 18, PCB 28, PCB 29, PCB 44,
PCB 50, PCB 52, PCB 66, PCB 77,
PCB 87, PCB 101, PCB 105, PCB 118,
PCB 126, PCB 128, PCB 138, PCB 153,
PCB 169, PCB 170, PCB 180, PCB 187,
PCB 195, PCB 206, PCB 209

Laboratory (Augusta, ME). Analyses for mercury were done on a subsample of 1 to 2 g of wet tissue and measured by cold vapor atomic absorption on a Perkin Elmer Model 503 atomic absorption spectrometer. Analyses for all other metals were conducted on 5 to 10 g of wet tissue dried at 100 °C. Zinc and iron were measured by flame atomic absorption using a Perkin Elmer Model 1100 atomic absorption spectrometer. All remaining metals (Ag, Al, Cd, Cr, Cu, Ni and Pb) were run using Zeeman background corrected graphite furnace atomic absorption on a Varian Spectra AA 400. The analyte detection limit for the metals in µg/g dry weight are as follows; Ag, 0.1; Al, 3.0; Cd, 0.2; Cr, 0.3; Cu, 0.6; Fe, 6.0, Hg, 0.1, Ni, 1.2, Pb, 0.6; and Zn, 1.5.

Organics

The PAHs, PCBs and chlorinated pesticides in mussel samples (Table 2) were analysed by the Environment Canada, ECB laboratory in Moncton, NB. The chlorobiphenyls and PCDDs/PCDFs were analysed by Axys AnalyticalServices Ltd, Sidney, BC. The analyte detection limit for aromatic hydrocarbons was 10 ng/g (20-30 ng/g for some lower molecular weight aromatics) and < 2 ng/g for PCB congeners. Eighteen of the PCB congeners identified and quantified correspond to congeners analyzed by the National Oceanographic and Atmospheric Administration's (NOAA) National Status and Trends (NS&T) Program designated congeners. Other organic compounds selected for analysis are also consistent, for the most part, with NOAA National Status and Trends mussel monitoring (NOAA, 1989).

The analyses of mussel tissue samples follow the diagram shown in Figure 2 and are summarized below. A description of the full analytical protocol and accompanying performance based QA/QC procedures are found in Sowles et al. (1997).

Tissue samples were extracted by homogenization with an organic solvent and a drying agent. Solvent extracts were obtained by vacuum filtration, and biomatrix interferences were separated from target analytes in extracts by 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/Masspectrometry (HRGC/MS).

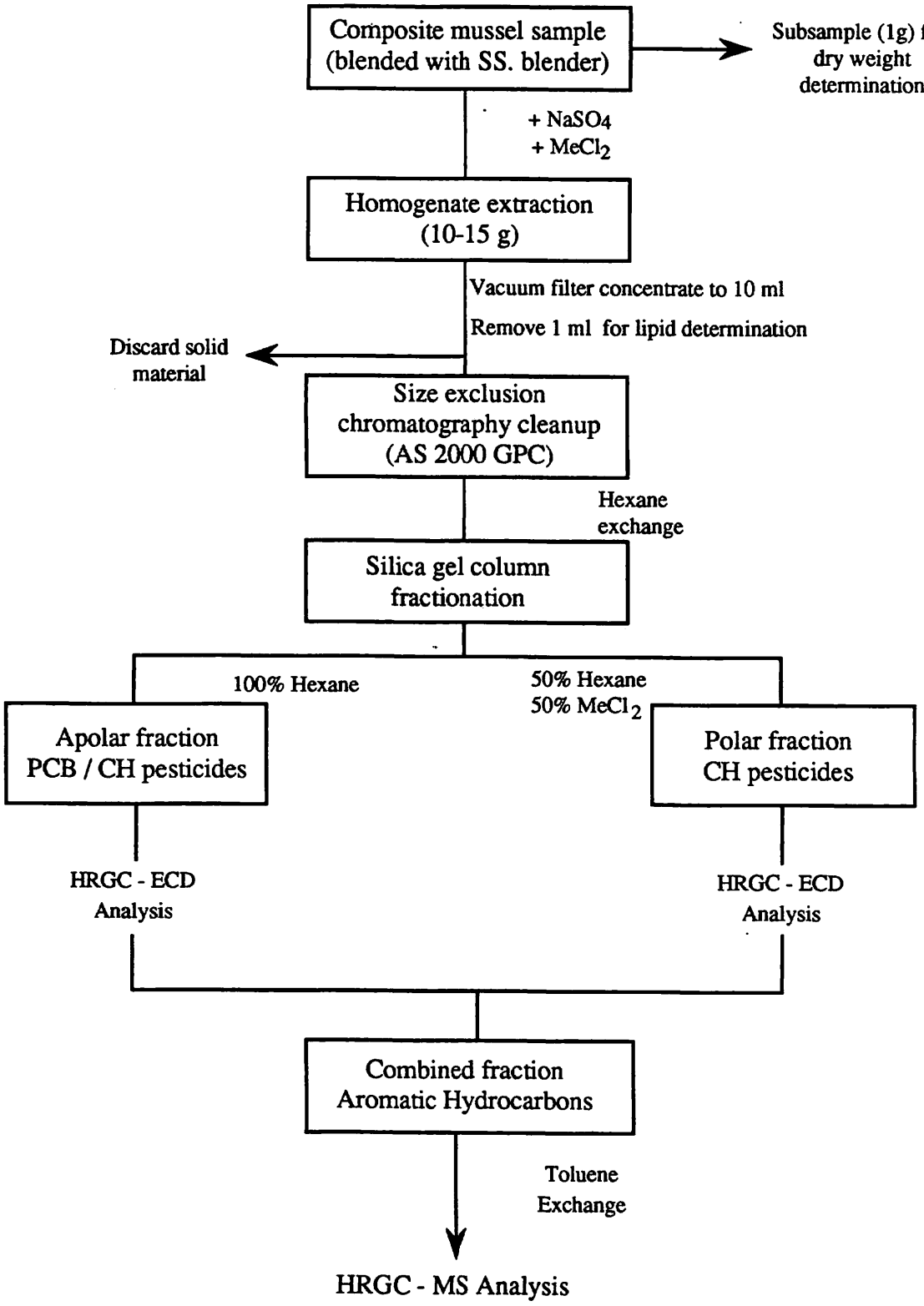

FIGURE 2. Analytical flow chart for organic analyte determination at the Environment Canada Laboratory in 19945 HRGC-MS, high resolution gas chromatography /massspectrometry; HRGC-ECD, high resolution dual column gas chromatography/electron capture detection; GPC, Gel permeation chromatography; SS., Stainless steel.

QUALITY ASSURANCES / QUALITY CONTROL

Standard laboratory procedures for metals incorporated method blanks, spike matrix samples, duplicate samples, surrogate addition and standard oyster tissue (SRM 1566A). The method blanks were inserted: three at the beginning of the run, one at the end, and six at various intervals during the run. Duplicate samples and matrix spike recoveries were conducted on 15% of the samples.

The Moncton laboratory participated in the NIST Status and Trends Intercomparison Marine Sediment Exercise IV and Bivalve Homogenate Exercise V. Internal quality control and method performance specifications are described in the Environment Canada Shellfish Surveillance Protocol (Sowles et al., 1997). The protocol includes mandatory QC measures with every sample batch including method blanks, spike matrix samples, duplicate samples, surrogate addition, and certified reference materials (SRM, 1974a). The protocol specifies the performance criteria relevant to method accuracy, precision, and detection limits and data reporting requirements for the analysis of organic contaminants in shellfish samples.

STATISTICAL METHODS

Data Analysis

All metal data were $\log_{10}$ transformed to correct for heterogeneity of variances. In several cases there were non-detectable (ND) data values. If all 4 replicates from a given site showed ND concentrations, the contaminant level was recorded as ND but, if at least one of the replicates was greater than the detection limit, then the other replicates were recorded as 1/2 the detection limit. Arithmetic means were used to summarize the results of replicate samples and are used in all subsequent tables and figures. In addition, geometric means were calculated for each metal for comparison with other data sets (O'Connor, 1992). The standard deviation(s) around the geometric mean (s_g) was calculated as:

$$s_g = \text{antilog}\,(s_l) = 10^{s_l}$$

where s_l = the standard deviation around the mean of the $\log_{10}$ transformed data (Snedecor and Cochran, 1967).

Total PAH (ΣPAH_{24}), total PCB (ΣPCB_{24}) and total pesticide ($\Sigma PEST_{17}$) values were

created from the sum of all individual compounds or congeners with values greater than the detection limit for the compound. Total DDT (ΣDDT_6) is the sum of o,p'-DDT and p,p'-DDT and homologues (o,p'-DDE, p,p'-DDE, o,p'-DDD and p,p'-DDD). Organic variables in which all replicate measurements were below the detection limit were treated as zero. All data were $\log_{10}$ (x+1) transformed to correct for non-normality. Arithmetic means were used to summarize the results of replicate samples and are used in all subsequent tables and figures. In addition, geometric means were calculated for regional comparison. The standard deviations around the geometric means were calculated as previously described.

Spatial Analysis

Arithmetic means and standard deviations of all values for each metal and organic contaminant at each station were calculated. Arithmetic means were calculated since, with a few exceptions, metals and organics at each station were normally distributed as demonstrated by applying Kolmogorov-Smirnov test using p=0.05 (SPSS, 1996). Graphs of the mean concentrations (±SD) are presented for all stations sampled. Differences in metal and organic contaminant concentrations among sites within each jurisdiction were analyzed using one-way analysis of variance (ANOVA), followed by Tukey-Kramer multiple comparison test of means. A probability of ≤ 0.05 was chosen as the level of significance. For analysis, Clark Cove, Maine (MECC) is discussed as being a New Hampshire site because it is located in the Great Bay/Piscataqua River watershed, and therefore more comparable to other sites in New Hampshire compared to other Maine sites.

Temporal Analysis

Temporal analysis was performed on both the benchmark sites (n=5 sites, n=4 years) and the 1996 sampling sites (n=13 sites, n=2 years). Tissue contaminant concentrations at the benchmark sites [MASN, MECC, MEKN, NBHI (NBCH), and NSDI] were analyzed for temporal trends using a repeated measures ANOVA. Contaminant concentrations from these sites from 1993 - 1996 were tested to determine whether the change in contaminant concentration (metal and organic) was consistent among sites given the initial differences in the various sites. As previously mentioned no mussels were found in 1996 at the New Brunswick benchmark site NBHI and, as such, an alternate site was sampled (NBCH). Tissue concentrations from NBCH were used in the temporal analysis for NBHI. While NBCH is located within 1.5 km of NBHI in the same basin

and probably exposed to the same contaminants, it must be noted that it is not the same site. As such, any significant differences among years in contaminant concentrations may be the result of differences in the two sites as opposed to true year differences. One-way ANOVA was performed on metal and organic contaminant concentrations using 1993-1995 concentrations at NBHI and 1996 concentrations at NBCH. Results of the analysis revealed that 2 metals (Cr and NI) and ΣPAH_{24} had concentrations that were significantly lower in 1996. As such, any conclusions regarding the status of these contaminants should be done with caution.

In addition to temporal analysis of benchmark sites, tissue concentrations from the 1996 sampling sites were compared to concentrations from samples at these sites taken in 1993. Concentrations in 1993 and 1996 were compared at each site using one-way ANOVA. A probability of ≤ 0.05 was chosen as the level of significance.

RESULTS AND DISCUSSION

FIELD OPERATIONS AND LOGISTICS

Field collection proceeded as planned in all jurisdictions with the exception of Massachusetts and New Brunswick. As mentioned previously, no mussels were found at the New Brunswick benchmark site at Hospital Island (NBHI) therefore an alternate site at Chamcook (NBCH) was used instead. Sampling problems were also encountered in Massachusetts. According to the sampling design for 1996 (see Sowles et al., 1997) 6 sites were scheduled to be sampled in 1996 (MASN, MAPY, MACO, MALI, MAMH, and MAME), however, only 3 sites were sampled (MASN, MAMH and MAME).

METAL CONTAMINANTS

Table 3 contains the metal concentrations (arithmetic mean ± SD, μg/g dry weight) for mussels from all sites sampled in 1996. Metal concentrations for each of the composite samples (n=4) are provided in Appendix A. Overall metal concentrations for indigenous mussels are given as geometric means (Table 3) to compare with NOAA (O'Connor, 1992) National Status and Trends program (NS&T) concentrations for Gulf of Maine sites (Table 4). All geometric means except Cu and Pb, were greater in Gulfwatch samples than in NOAA/NS&T samples. Moreover, the levels of Ag, Cd, and Hg were greater than the calculated "high value" (geometric mean plus one standard deviation) for NOAA mussels. Similar results were observed in previous reports (see GMCME, 1994, 1996a, b, c). This is striking, even given that half of the Gulfwatch stations were chosen as potentially contaminated areas and many NS&T stations were essentially reference stations that were chosen to avoid acute human activity or known sources of contamination. However, numerous NS&T sites are also located near larger metropolitan areas, including Boston, New York, San Francisco, Galveston, etc. The reasons for the elevated concentrations of Ag, Cd and Hg are not presently understood.

Spatial Variation in Metal Concentrations

Table 5 summarizes the metal concentrations for 23 Maine reference sites (Sowles, 1993). Figures 3 to 7 show the concentration of the metals measured in the tissue of *M. edulis* at the 1996

Table 3. Tissue metal concentrations (μg.g^{-1} dry weight, mean ± SD) for Gulfwatch mussels in 1996. The geometric mean of all indigenous mussels is given below. n = 4 relicates per sample.

Station	Ag	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Al	Fe
MASN	0.98±0.30^{A}	1.33±0.22^{A}	1.18±0.19^{A}	9.3±2.0^{A}	3.28±0.66^{A}	0.35±0.04^{A}	1.10±0.08^{A}	91±6^{A}	145±24^{AB}	323 ± 43^{A}
MAMH	0.25±0.14^{B}	1.35±0.13^{A}	2.83±0.30^{C}	7.1±0.4^{A}	3.55±0.44^{A}	0.55±0.06^{B}	1.30±0.08^{A}	110±14^{A}	228±39^{B}	365 ± 53^{A}
MAME	ND	1.90±0.42^{A}	1.83±0.34^{B}	6.6±1.6^{A}	3.13±0.62^{A}	0.54±0.17^{AB}	1.33±0.22^{A}	81±18^{A}	120±37^{A}	350 ± 77^{A}
NHHS	0.10±0.03^{A}	1.50±0.18^{A}	1.43±0.21^{A}	7.9±0.5^{A}	2.33±0.85^{A}	0.50±0.09^{A}	1.10±0.08^{A}	115±10^{A}	185±10^{A}	293 ± 10^{A}
MECC	0.08±0.03^{A}	1.73±0.19^{A}	2.88±0.33^{B}	8.2±0.6^{A}	5.10±0.48^{B}	0.86±0.31^{A}	1.43±0.13^{B}	113±5^{A}	335±47^{B}	518 ± 61^{B}
MEBH	0.30±0.09^{C}	1.70±0.18^{A}	1.50±0.08^{A}	6.6±0.5^{AB}	1.88±0.19^{BC}	0.42±0.08^{AB}	1.48±0.15^{AB}	110±12^{A}	290±8^{AB}	353 ± 21^{A}
MERY	ND	2.75±0.65^{B}	2.03±0.59^{AB}	8.9±2.0^{B}	2.45±0.62^{C}	1.00±0.39^{B}	1.68±0.36^{B}	100±24^{A}	290±95^{AB}	535 ± 182^{A}
MEKN	0.15±0.07^{B}	2.35±0.21^{B}	1.93±0.33^{AB}	7.5±0.9^{AB}	1.33±0.46^{AB}	0.67±0.30^{AB}	1.40±0.18^{AB}	76±11^{A}	188±64^{AB}	360 ± 86^{A}
MEFP	0.10±0.07^{AB}	2.78±0.35^{B}	2.60±0.29^{B}	8.2±1.5^{B}	2.80±0.55^{C}	0.91±0.22^{AB}	1.63±0.30^{B}	103±26^{A}	343±93^{A}	683 ± 142^{A}
MEPI	0.08±0.04^{AB}	1.68±0.17^{A}	1.35±0.13^{AB}	6.0±0.4^{AB}	0.98±0.17^{A}	0.50±0.17^{A}	1.05±0.17^{AB}	87±8^{A}	170±46^{AB}	293 ± 17^{A}
NBSC	0.08±0.03^{A}	1.48±0.17^{B}	1.33±0.10^{C}	5.8±0.4^{B}	1.40±0.22^{B}	0.52±0.07^{A}	1.68±0.15^{B}	106±12^{B}	395±27^{C}	578 ± 51^{C}
NBCH	0.08±0.03^{A}	0.93±0.13^{A}	0.63±0.05^{A}	4.4±0.2^{A}	0.75±0.06^{A}	0.41±0.12^{A}	ND	70±10^{A}	180±29^{A}	235 ± 25^{A}
NBLN	ND	1.38±0.05^{B}	1.05±0.06^{B}	6.7±0.2^{C}	1.50±0.12^{B}	0.40±0.07^{A}	0.95±0.10^{A}	105±13^{B}	288±41^{B}	383 ± 50^{B}
NSFI	ND	2.33±0.15^{BC}	1.73±0.13^{AB}	5.8±0.2^{A}	1.15±0.13^{A}	0.37±0.03^{AB}	1.75±0.06^{BC}	52±2^{A}	715±71^{D}	875 ± 90^{B}
NSDI	ND	1.43±0.10^{A}	1.53±0.10^{A}	7.0±0.8^{B}	3.13±0.24^{B}	0.38±0.19^{A}	1.25±0.13^{A}	91±13^{B}	313±36^{C}	453 ± 54^{A}
NSBC	ND	2.58±0.15^{C}	1.95±0.06^{B}	5.8±0.4^{A}	2.83±0.17^{B}	0.31±0.10^{A}	1.95±0.24^{C}	95±12^{B}	253±15^{BC}	420 ± 8^{A}
NSAG	ND	2.08± .24^{B}	1.58±0.10^{A}	6.6±0.3^{AB}	5.18±0.70^{C}	0.64±0.09^{B}	1.53±0.21^{AB}	78±6^{B}	160±18^{A}	475 ± 13^{A}
NSYR	0.23±0.09	2.00±0.14^{B}	1.63±0.17^{A}	7.7±0.7^{B}	4.10±0.63^{C}	0.65±0.02^{C}	1.78±0.25^{B}	123±15^{C}	218±55^{AB}	493 ± 42^{A}
Geo mean ±SD	1.12±1.18	1.78±1.34	1.62±1.44	6.89±1.20	2.27±1.96	0.53±1.41	1.36±1.28	93±1	244±1	421 ± 1

TABLE 4 . NOAA, National Status and Trends Mussel Watch summary statistics for the Gulf of Maine mussel samples collected in 1990 (µg/g dry weight) (NOAA 1989).

	Ag	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn
Geometric mean	0.22	203	1.10	1.39	10.3	312	0.13	1.18	2.97	92
"high value"*	0.51	387	1.52	2.78	11.6	482	0.31	1.72	6.75	113

* Logarithmic mean (geometric) plus one standard deviation (O'Connor 1992)

TABLE 5. Summary statistics for mussels collected at twenty-three Maine reference stations (µg/g dry weight) (Sowles, 1993). ME-RM = Arithmetic, reference, mean; ME-HV = Maine high value = Arithmetic mean plus three times the standard deviation.

	Ag	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn
ME-RM	0.12	-	1.75	1.53	6.9	-	0.12	1.80	2.60	89
SD	0.09	-	0.46	0.66	1.28	-	0.12	0.38	1.13	15.5
ME-HV	0.40	-	3.14	3.51	10.7	-	0.48	2.90	6.00	136

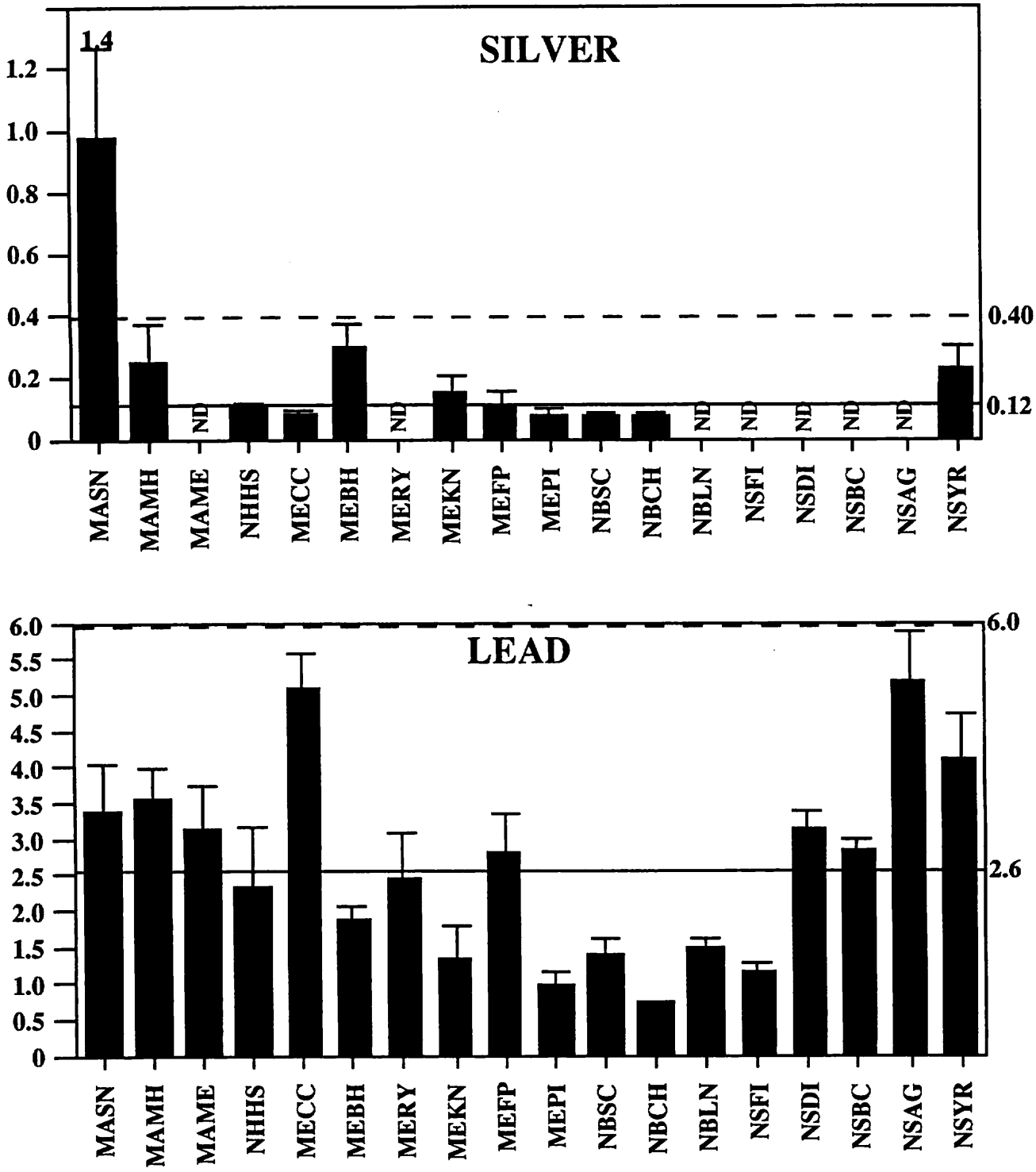

Figure 3. Distribution of silver and lead tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine stations in 1996. The reference mean, ME-RM (straight line) and the high value, ME-HV (dashed line) from the Maine reference data (Sowles, 1993) are shown for comparison. ND = not detectable.

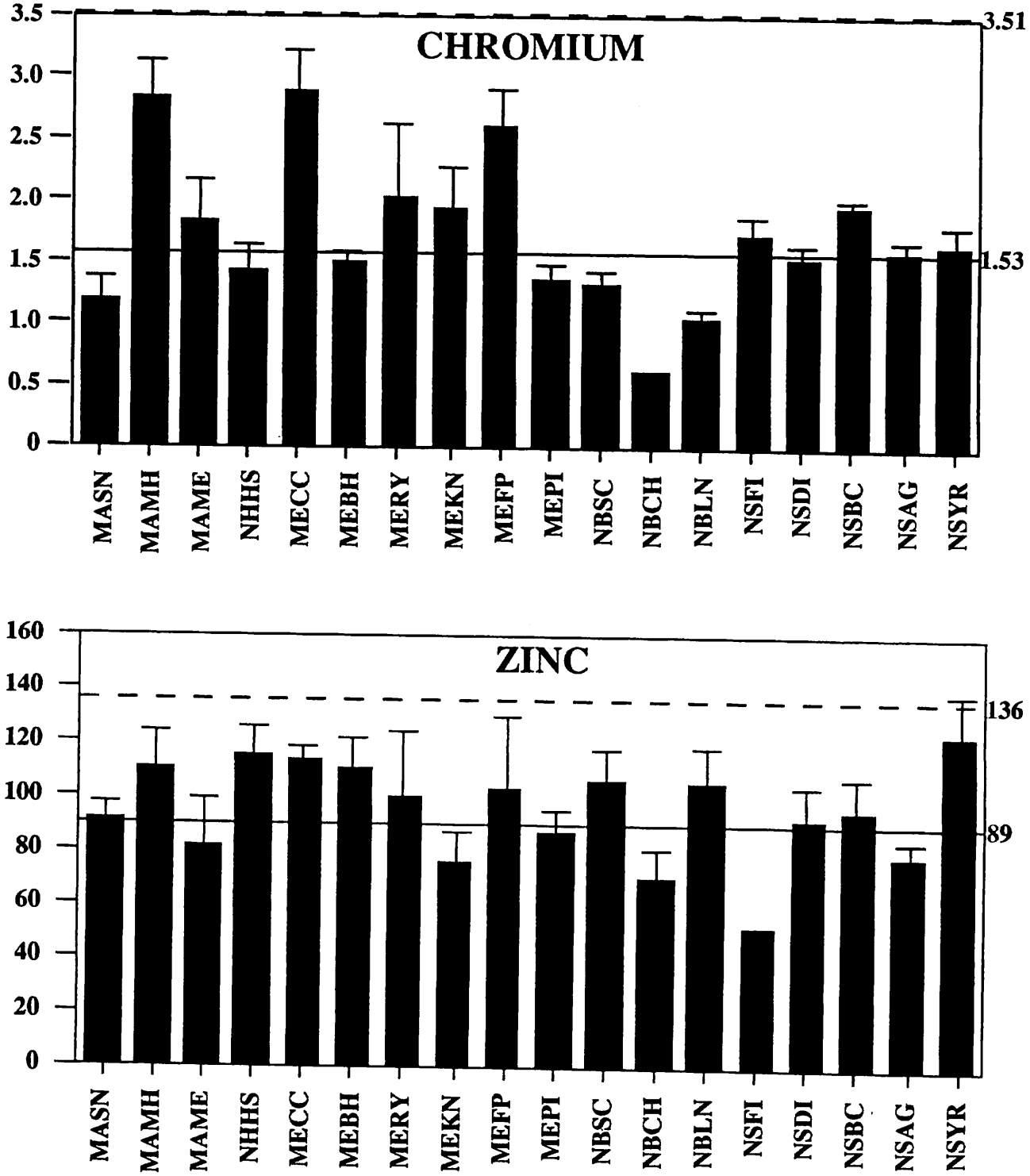

Figure 4. Distribution of chromium and zinc tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine stations in 1996. The reference mean, ME-RM (straight line) and the high value, ME-HV (dashed line) from the Maine reference data (Sowles, 1993) are shown for comparison. ND = not detectable.

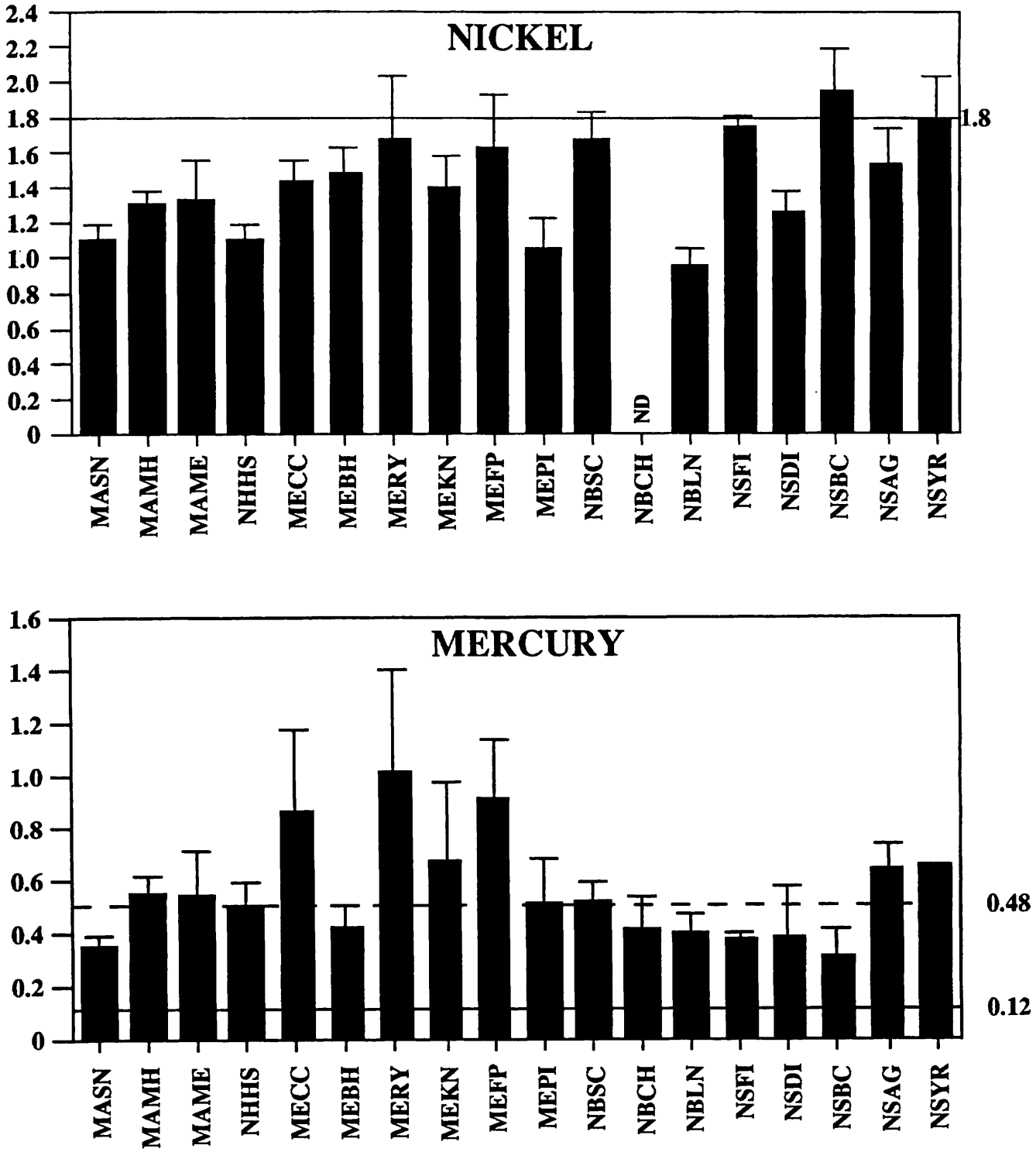

Figure 5. Distribution of nickel and mercury tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine stations in 1996. The reference mean, ME-RM (straight line) and the high value, ME-HV (dashed line) from the Maine reference data (Sowles, 1993) are shown for comparison. ND = not detectable.

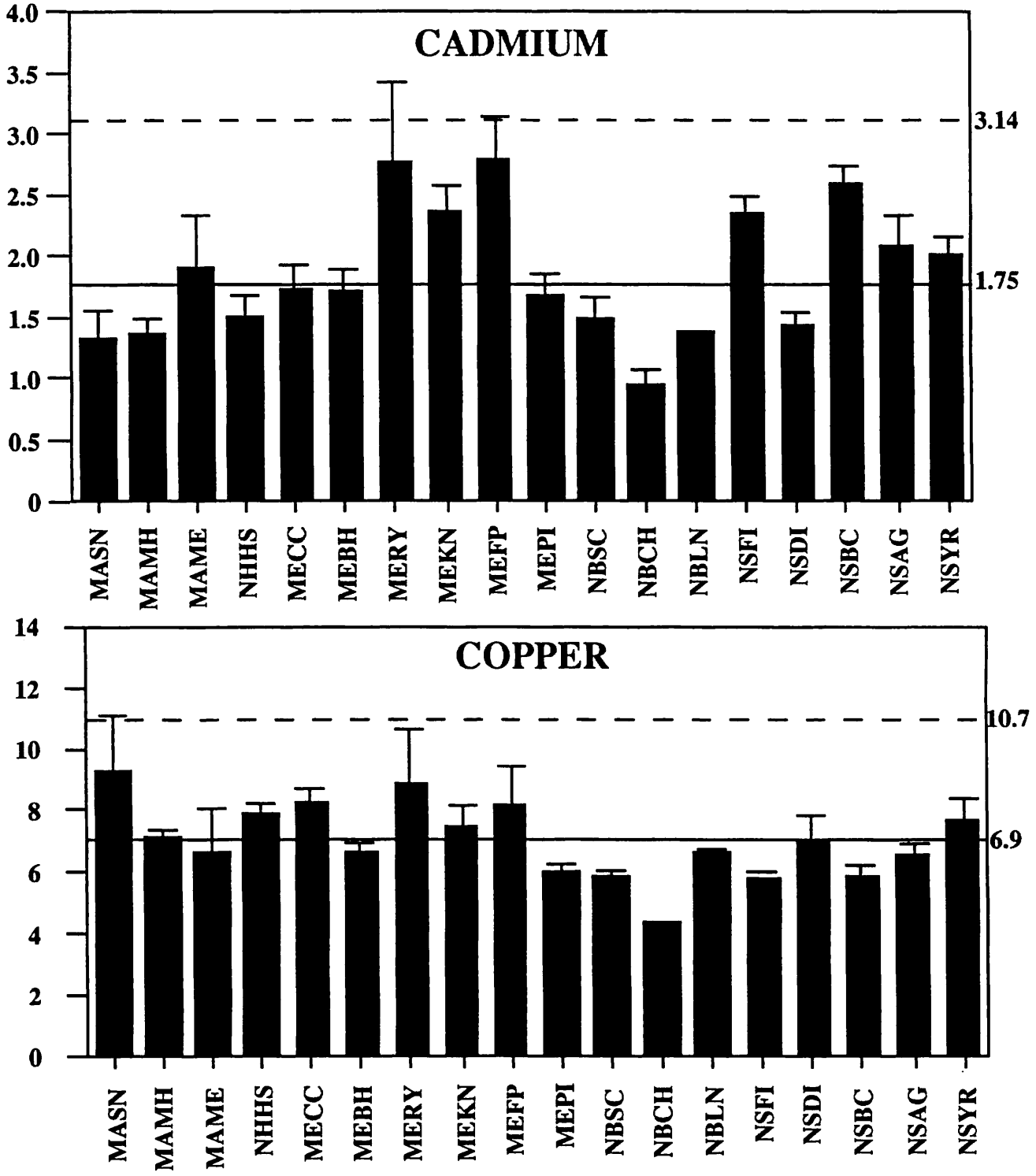

Figure 6. Distribution of cadmium and copper tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine stations in 196. The reference mean, ME-RM (straight line) and the high value, ME-HV (dashed line) from the Maine reference data (Sowles, 1993) are shown for comparison. ND = not detectable.

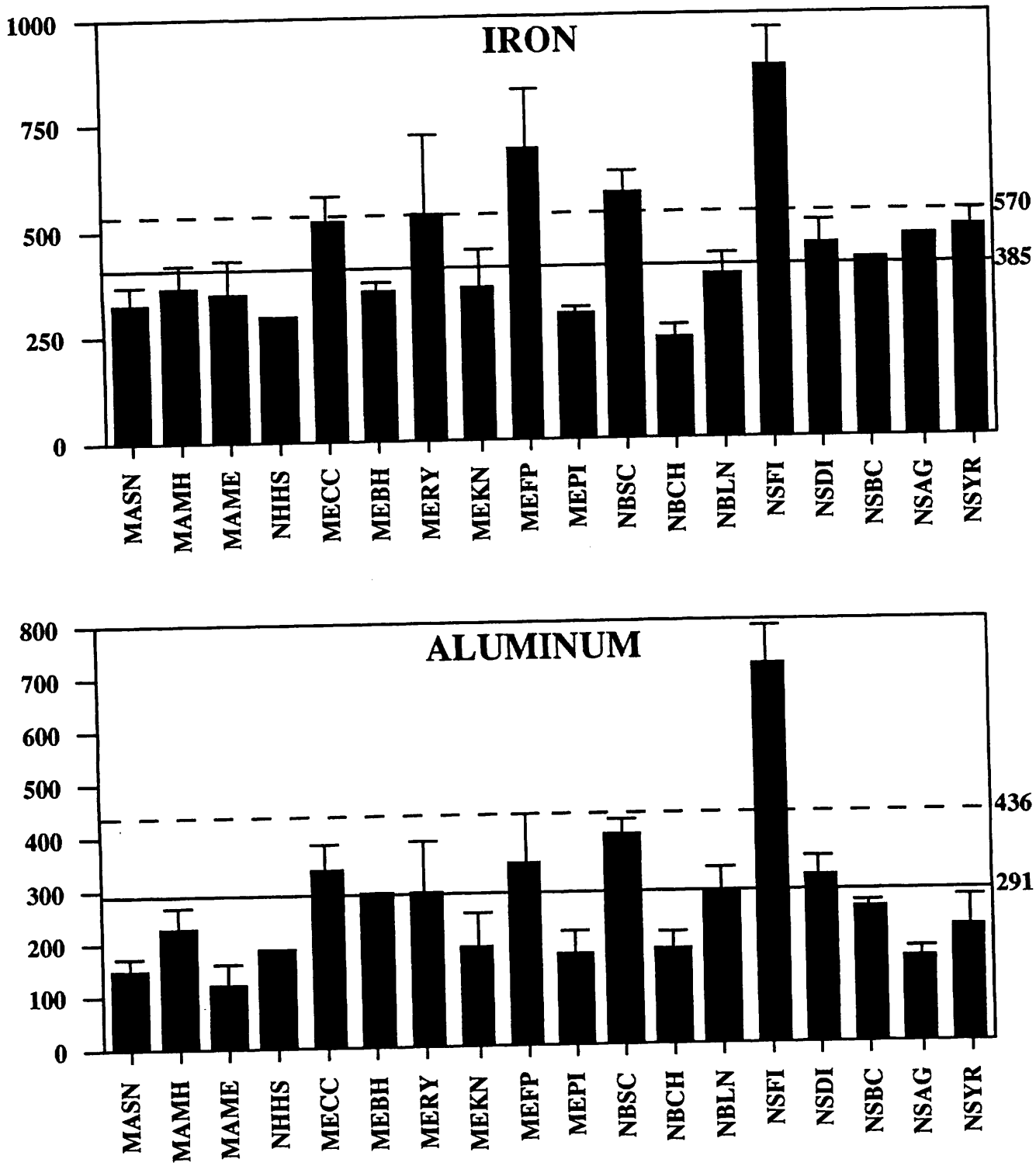

Figure 7. Distribution of iron and aluminum tissue concentrations (arithmetic mean +/- SD, μg/g dry weight) in mussels at the Gulf of Maine stations in 1997. The mean, (straight line) and the high value, (mean plus one standard deviation, dashed line) from the NS&T data (O'Connor, 1992) are shown for comparison.

sampling stations, arranged from south to north. The mean tissue metal concentrations at each of the Gulfwatch sites are compared to the two "benchmark" values for each metal previously reported from 23 Maine reference sites (Sowles, 1993): (1) the arithmetic mean for each metal concentration (Maine Reference Mean or ME-RM); and (2) the arithmetic mean plus three standard deviations (Maine High Value or ME-HV; referred to by Sowles (1993) as the "anomalous value"). These Maine reference stations are located in areas where anthropogenic contamination should be low. Maine Reference concentrations would therefore be expected to be lower than that observed at several of the Gulfwatch stations.

In Table 3, average metal concentrations at all sites were grouped by jurisdiction and ANOVA and Tukey Kramer tests were employed to examine differences among sites within a jurisdiction in 1996. Differences among all sites (18 stations throughout 5 jurisdictions) were not examined statistically. MECC is discussed as being a New Hampshire site because it is located in the Great Bay /Piscataqua River watershed, and therefore most comparable to other sites in New Hampshire.

Silver (Ag)

Elevated silver exposure concentrations have been shown to coincide with regions receiving municipal sewage (Sanudo-Wlhelmy and Flegal, 1992; Bucholtz ten Brink et al., 1996). Mussel tissue concentrations of Ag ranged from non-detected (ND) at 7 sites (MAME, MERY, NBLN, NSFI, NSDI, NSBC,NSAG) to 1.04 ± 0.40 µg/g dry weight at MASN (Table 3). As in previous reports (see GMCME, 1994, 1996a, b, c) the concentration of Ag in mussel tissue increases in concentration from north to south (Figure 3). Ag concentrations at MASN were significantly higher than all other sites in 1996 and exceed the Maine high value (ME-HV) of 0.40 µg/g dry weight for the Maine reference stations. This exceptionally high silver concentration at MASN was also observed in the Gulfwatch samples collected in 1993 to 1995, but not in the 1992 samples (GMCME, 1994). These high Ag concentrations are unusual since there are no POTW outfalls or industrial effluent in the area. Most sites examined in 1996 were below the Maine reference mean of 0.12 µg/g dry weight with the exception of MAMH , MEBH, MEKN and NSAG. Analysis of mussel tissue burdens within jurisdictions (Table 3) showed that with the exception of New Hampshire there were significant differences among sites in each jurisdiction.

Lead (Pb)

The concentration of lead ranged from a value of 0.75 ± 0.06 µg/g dry weight (NBCH) to 5.18±0.70 µg/g dry weight (NSAG) (Table 3, Figure 3). Mean concentrations of Pb in mussels from coastal regions typically range from 1 to 16 µg/g dry weight (Fowler, 1990). Half of the

sites sampled in 1996 exceed the Maine reference concentrations (ME-RM) of 2.6 ± 1.1 μg/g dry weight but no sites exceeded the ME-HV (6.00 μg/g dry weight). The close proximity to the Portsmouth Naval Shipyard may account for the elevated lead concentrations in mussels at the MECC site. The Jamaica landfill and defense reutilization and Marketing Office on Seavey Island, where waste plating sludge and lead batteries, respectively, were disposed and stored, have been identified as potential sources of lead contamination to Portsmouth Harbor (NCCOSC, 1994).

Table 3 show that there were significant differences between sites within all jurisdictions with the exception of Massachusetts. Concentrations of Pb were consistently low among sites in New Brunswick.

Chromium (Cr)

The concentration of chromium exceeded the ME-RM (1.53 ± 0.66 μg/g dry weight) at sites in all jurisdictions except New Brunswick, although not the ME-HV (3.51 μg/g dry weight). The lowest concentration was at NBCH (0.63 ± 0.05 μg/g dry weight) and the highest at MECC (2.88 ± 0.33 μg/g dry weight) (Table 3, Figure 4). Elevated concentrations at MECC probably reflect historical tanning industry discharges (Capuzzo et al., 1973; Jones et al., 1992). Concentrations of Cr were significantly higher in the Nova Scotia sites than sites sampled in Northern Maine and New Brunswick. Elevated concentrations of Cr have been found along the coast of Nova Scotia which are suspected to be the result of higher bedrock exposures (Wells et al., 1996). Analysis of the mussel tissue concentrations of Cr within each jurisdiction (Table 3) revealed that there were significant differences between sites in all jurisdictions.

Zinc (Zn)

Zinc concentrations generally reflect human activity associated with tire wear, galvanized materials and industrial discharges. Twelve sites representing all jurisdictions had concentrations greater than the ME-RM (89 ± 16 μg/g dry weight). No sites had concentrations greater than the ME-HV (136 μg/g dry weight) (Table 3, Figure 4). The lowest concentration of Zn measured was at NBCH (70±10 μg/g dry weight) and the highest was at NSYR (123±15 μg/g dry weight). Concentrations of zinc in bivalves of British estuaries often exceed 1000 μg/g dry weight, but many may be greater than 4000 μg/g dry weight in contaminated systems (Bryan et al., 1992). Analysis of the mussel tissue concentrations of Zn within each jurisdiction revealed that Massachusetts, New Hampshire and Maine had consistent concentrations of Zn among sites (Table 3).

Nickel (Ni)

The concentration of nickel ranged from ND at NBCH to 1.95 ± 0.24 µg/g dry weight at NSBC (Table 3, Figure 5), the only site that exceeded the ME-RM of 1.8 ± 0.4 µg/g dry weight. The highest concentrations of any jurisdiction were observed in Nova Scotia. Such higher concentrations in Nova Scotia may reflect the degree of exposed bedrock along the coast (Wells et al., 1996). Analysis of the mussel tissue concentrations of Ni within each jurisdiction (Table 3) revealed that the level of Ni varied greatly within jurisdictions. Only in Massachusetts were the levels of Ni consistent among sites.

Mercury (Hg)

The concentration of mercury in mussel tissue ranged from a value of 0.31 ± 0.10 µg/g dry weight at NSBC to 1.00 ± 0.39 µg/g dry weight at MERY (Table 3, Figure 5). Mercury exceeded the ME-RM of 0.12 ± 0.12 µg/g dry weight at all sites. MAMH, MAME, NHHS, MECC, MERY, MEKN, MEFP, MEPI, NBSC, NSAG, and NSYR exceeded the ME-HV of 0.48 µg/g dry weight. NHLH and MECC are located downstream from known historical mercury sources including the Portsmouth Naval Shipyard (NCCOSC, 1994). As previously discussed, the Hg concentrations in the Gulf mussels are unusually high and are a possible concern. Mean values of Hg in mussels (*Mytilus* spp.) from various coastal regions worldwide are about 0.1 to 0.4 µg/g dry weight (Kennish, 1997). Over half of the Gulfwatch sites sampled in 1996 exceed the upper limit of this estimate. Mytilids from some regions (e.g., northern Mediterranean and southwest Pacific) have Hg concentrations as high as 7.0 µg/g dry weight (Kennish, 1997). Recent studies have shown that a mercury problem exists in freshwater systems of the northeast and maritimes (Welch, 1994; DiFranco et al., 1995; and Evers et al., 1996), however, no coastal system has ever been known to be affected by Hg pollution. Analysis of the mussel tissue concentrations of Hg from sites within each jurisdiction (Table 3) showed that the level of Hg varied in all jurisdictions with the exception of New Hampshire and New Brunswick.

Cadmium (Cd)

Cadmium is widely used in industry for batteries, plating, stabilizers and as a neutron absorber in nuclear reactors. The concentration of cadmium in mussel tissue ranged from 0.93 ± 0.13 µg/g dry weight at NBCH to 2.78 ± 0.35 µg/g dry weight at MEFP (Table 3, Figure 6). Mean concentrations of cadmium in mussels (*Mytilus* sp.) from several coastal regions world wide range from approximately 1 to 5 µg/g dry weight (Fowler, 1990). All values were below the ME-RM of 1.75 ± 0.46 µg/g dry weight with the exception of MAME, MERY, MEKN, MEFP, NSFI,

NSBC, NSAG, and NSYR. No values exceeded the ME-HV (3.14 µg/g dry weight). Within the jurisdictions the concentration of Cd varied. There were significant differences among sites in Maine, New Brunswick, and Nova Scotia.

Copper (Cu)

The level of copper in mussel tissue ranged from 4.4 ± 0.2 µg/g dry weight at NBCH to 9.3 ± 2.0 µg/g dry weight at MASN (Table 3, Figure 6). Half of the sites exceeded the ME-RM (6.9 ± 1.6 µg/g dry weight). No sites exceeded the ME-HV (10.9 µg/g dry weight). Analysis of the mussel tissue level of Cu within each jurisdiction showed that the level of Cu was fairly consistent (Table 3). There were no significant differences among sites in Massachusetts or between sites in New Hampshire.

Iron (Fe) and Aluminum (Al)

The concentration of iron in mussel tissue ranged from 235 ± 25 µg/g dry weight at NBCH to 875 ± 90 µg/g dry weight at NSFI (Table 3, Figure 7). There were no reference values for Fe from Maine stations with which to compare our data. Analysis of the mussel tissue concentrations of Fe within jurisdictions (Table 3) showed that there were no significant differences among sites in Massachusetts but there were significant differences between sites in New Hampshire and among sites in Maine, New Brunswick, and Nova Scotia.

The concentration of aluminum in mussel tissue ranged from 120 ± 37 µg/g dry weight at MAME to 715 ± 71 µg/g dry weight at NSFI (Table 3, Figure 7). There were no reference values for Al from Maine stations with which to compare our data, but comparisons could be made to NS&T values. Analysis of the level of Al in mussel tissue within jurisdictions showed that the level of Al was not consistent in any jurisdiction.

High tissue concentrations of Fe and Al appear to be characteristic of NSFI, as similar results were observed in 1993-1995. In 1993 the concentrations of Fe and Al were 1360 ± 60 and 890 ± 183 µg/g dry weight respectively. In 1994, the concentrations of Fe and Al were 1033 ± 79 and 688 ± 31 µg/g dry weight respectively. Higher concentrations of Fe and Al tend to be consistent with elevated concentrations of suspended sediments at sites. This site is characterized by high levels of turbidity (GMCME, 1996a). High levels of sediment in the gut may also contribute to higher concentrations of other metals (Robinson et al., 1993).

Temporal Variation in Metal Concentrations

Benchmark sites

The repeated measures ANOVA comparing metal contaminant concentrations at each of the 5 sites (MASN, MECC, MEKN, NBHI and NSDI) showed that year was significant only for Hg (Table 6). Site was significant for the following metals: Ag, Cr, Cu, Zn, Al, and Fe. The concentration of Ag was higher at MASN, the concentrations of Cr, Pb, and Zn were highest at MECC, and the concentrations of Fe and Al were highest at NSDI. The year effect for Hg resulted from the decrease in Hg concentration at NBHI and NSDI after 1993. In 1993, there were analytical problems that may have contributed to higher Hg concentrations detected in that year. As such, the year effect for Hg may be a reflection of better analytical ability in 1994-96.

As a result of the small sample size used in the test (n=5 sites; n=4 years) a power analysis was performed on the results of the ANOVA to determine how likely the test was to detect true differences among populations. The power to detect site differences was generally > 0.70 which means that there was <30% chance that a type II error occurred [i.e., not rejecting the Ho (no significant differences among sites) when it is false] (Zar, 1984). As such we are confident of the results indicating site related differences. The only exceptions were Cu and Hg where the power was 0.1 meaning that there was a 99% chance a Type II error occurred. Unlike the power to detect site differences, the power to detect year differences was low, generally 0.2 meaning that there was a >80% chance that a Type II error occurred. The only exceptions were Hg and Ni where the chances that a Type II error occurred were 45 and 50%, respectively.

In a report currently being written that summarizes the results from the first five years of the Gulfwatch program (GMCME, 1997), the same analysis was performed on the benchmark data, although at that time only 3 years of data were used. The results of the site differences are similar to the previous report with the exception that Zn was significant in this report. However, year differences are different. In the five year report (GMCME, 1997), year effects were detected for Cr and Ni; the only year related difference in this report was detected for Hg. This is likely a reflection of the low power to detect year differences. These results will likely continue for many more years until sufficient temporal data has been collected. The addition of the 1996 samples has allowed us to increase the power to detect site differences in the majority of metals, however, not year differences.

Annual sites (1993 vs 1996)

Figures 8 to 12 show the concentrations of all metals at the 13 non-benchmark Gulfwatch sites

TABLE 6. Tissue metal concentrations (arithmetic mean ± standard deviation, μg/g dry weight) for Gulfwatch stations at Sandwich, MA (MASN), Clark Cove, ME (MECC), Kennebec River, ME (MEKN), Hospital Island, NB (NBHI), and Digby, NS (NSDI) for 1993 to 1996. Results of repeated measure ANOVA are shown below. *, indicates significance at $p \leq 0.05$.

SITE	Ag	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Al	Fe
MASN										
mean'93	1.64 (0.36)	1.68 (0.25)	1.64 (0.46)	6.1 (0.4)	3.78 (0.12)	0.77 (0.73)	2.24 (0.55)	101 (11)	61 (4)	354 (20)
mean'94	1.05 (0.29)	1.60 (0.20)	1.10 (0.10)	7.5 (0.5)	2.90 (0.40)	0.51 (0.10)	1.05 (0.06)	103 (9)	84 (18)	265 (31)
mean'95	1.04 (0.40)	1.08 (.10)	1.75 (0.31)	6.9 (0.7)	2.65 (0.34)	0.30 (0.03)	0.88 (0.13)	98 (6)	110 (14)	245 (6)
mean'96	0.98 (0.30)	1.33 (0.22)	1.18 (0.19)	9.3 (2.0)	3.38 (0.66)	0.35 (0.04)	1.10 (0.08)	91 (6)	145 (24)	323 (43)
MECC										
mean'93	0.10 (0.05)	2.39 (0.27)	3.31 (1.28)	7.5 (0.9)	5.35 (2.18)	0.74 (0.06)	2.60 (0.20)	126 (17)	187 (80)	535 (138)
mean'94	0.05 (0.00)	1.50 (0.30)	1.90 (0.10)	7.5 (1.3)	4.60 (0.60)	0.58 (0.10)	1.30 (0.35)	95 (7)	157 (15)	367 (67)
mean'95	0.12 (0.05)	1.80 (0.08)	3.33 (0.82)	9.9 (1.4)	6.05 (0.68)	0.56 (0.13)	1.65 (0.17)	135 (10)	345 (26)	535 (39)
mean'96	0.08 (0.03)	1.73 (0.19)	2.88 (0.33)	8.2 (0.6)	5.10 (0.48)	0.86 (0.31)	1.43 (0.13)	113 (5)	335 (47)	518 (61)
MEKN										
mean'93	0.06 (0.01)	2.16 (0.36)	1.78 (0.58)	7.9 (0.3)	1.60 (0.35)	0.61 (0.27)	1.40 (0.11)	79 (18)	136 (27)	360 (51)
mean'94	0.05 (0.00)	1.40 (0.40)	1.13 (0.20)	6.6 (1.3)	1.40 (0.30)	0.80 (0.10)	0.68 (0.13)	60 (11)	84.0 (13)	230 (47)
mean'95	0.07 (0.04)	1.90 (0.28)	1.53 (0.34)	7.4 (1.3)	1.55 (0.40)	0.53 (0.11)	1.08 (0.15)	79 (13)	103 (10)	225 (31)
mean'96	0.15 (0.07)	2.35 (0.21)	1.93 (0.33)	7.5 (0.9)	1.33 (0.46)	0.67 (0.30)	1.40 (0.18)	76 (11)	188 (64)	360 (86)
NBHI										
mean'93	0.11 (0.06)	1.68 (0.09)	1.12 (0.12)	5.0 (0.9)	0.94 (0.15)	2.11 (0.49)	1.18 (0.19)	78 (9)	75 (12)	240 (41)
mean'94	0.20 (0.00)	1.90 (0.40)	1.33 (0.30)	7.0 (0.6)	1.50 (0.40)	0.48 (0.10)	1.18 (0.13)	99 (21)	213 (22)	400 (56)
mean'95	0.13 (0.04)	1.09 (0.11)	1.48 (0.40)	6.6 (0.7)	1.15 (0.13)	0.27 (0.04)	0.92 (0.09)	71 (12)	410 (74)	240 (27)
mean'96	0.08 (0.03)	0.93 (0.13)	0.63 (0.16)	4.4 (0.2)	0.75 (0.06)	0.41 (0.12)	ND	70 (10)	180 (29)	235 (25)
NSDI										
mean'93	0.26 (0.20)	1.77 (0.35)	1.91 (0.29)	7.1 (0.3)	3.94 (0.43)	1.82 (1.22)	1.86 (0.22)	112 (4)	413 (65)	678 (80)
mean'94	ND	1.50 (0.10)	1.43 (0.20)	7.1 (0.3)	3.30 (0.30)	0.44 (0.01)	1.33 (0.13)	83 (7)	325 (84)	573 (145)
mean'95	0.06 (0.03)	1.53 (0.15)	1.60 (1.41)	7.1 (0.3)	3.25 (0.34)	0.47 (0.05)	1.48 (0.05)	96 (9)	303 (75)	480 (84)
mean'96	ND	1.43 (0.10)	1.53 (0.10)	7.0 (0.8)	3.13 (0.24)	0.38 (0.19)	1.25 (0.13)	91 (13)	313 (36)	453 (54)
p(site)	p<0.001*	p>0.20	p<0.005*	p>0.50	p<0.001*	p>0.50	p>0.10	p<0.005*	p<0.01*	p<0.005*
p(year)	p>0.20	p<0.20	p>0.20	p>0.50	p>0.50	p>0.02*	p>0.50	p>0.50	p>0.20	p>0.50

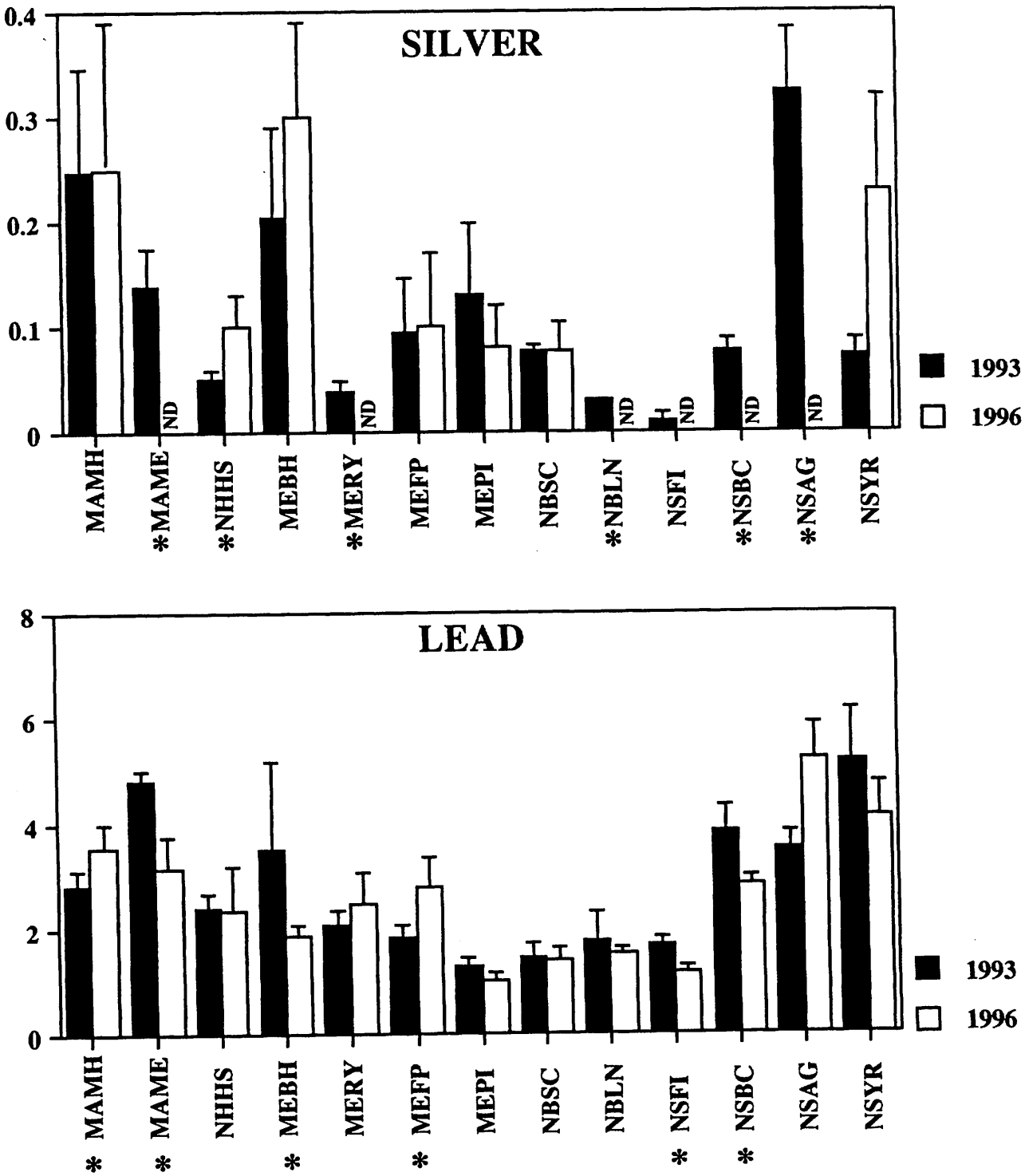

Figure 8. Distribution of silver and lead concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulf of Maine stations in 1993 and 1996. *, indicates a significant difference between years ($p<0.05$)

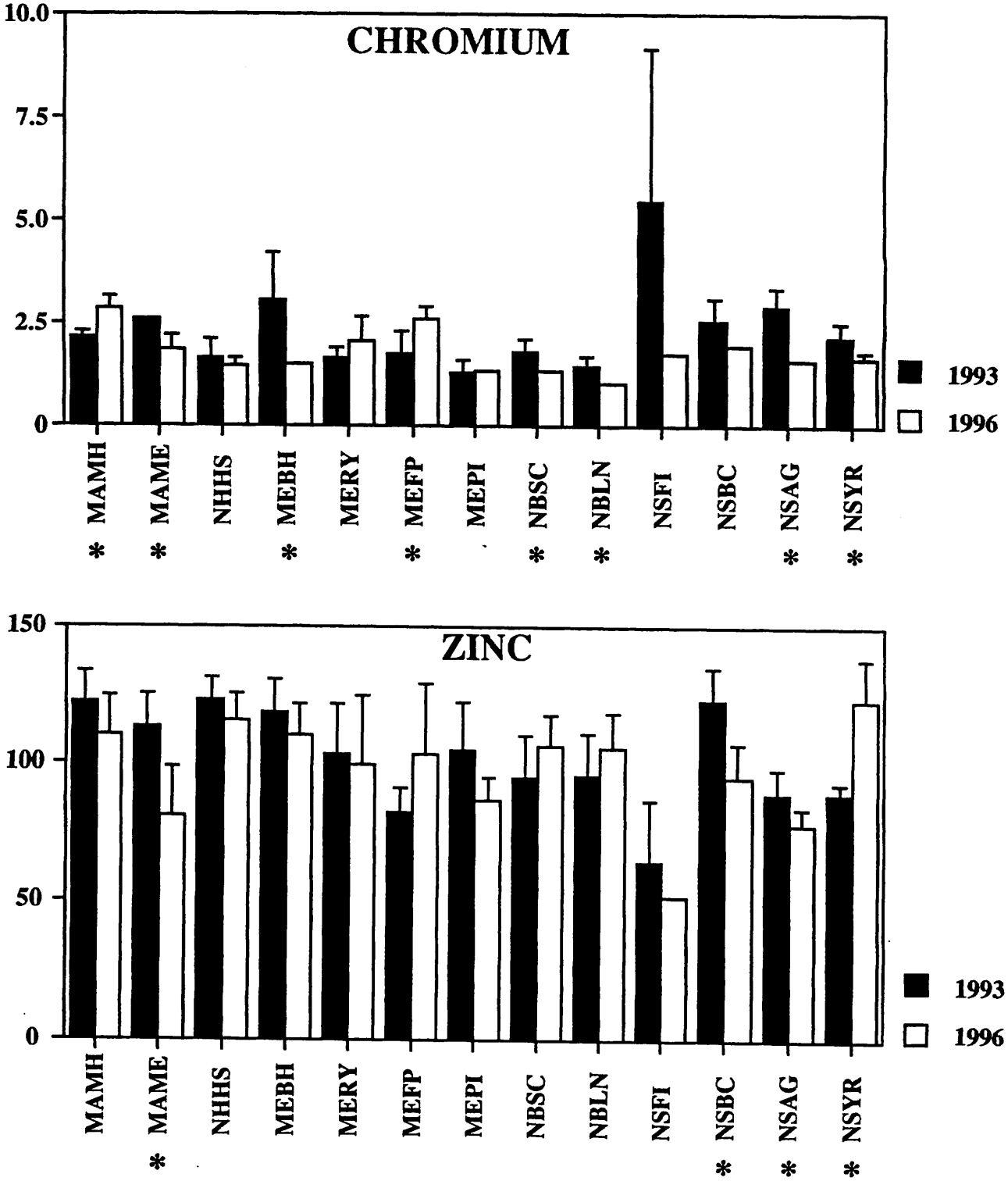

Figure 9. Distribution of chromium and zinc concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulf of Maine stations in 1993 and 1996. *, indicates a significant difference between years ($p<0.05$)

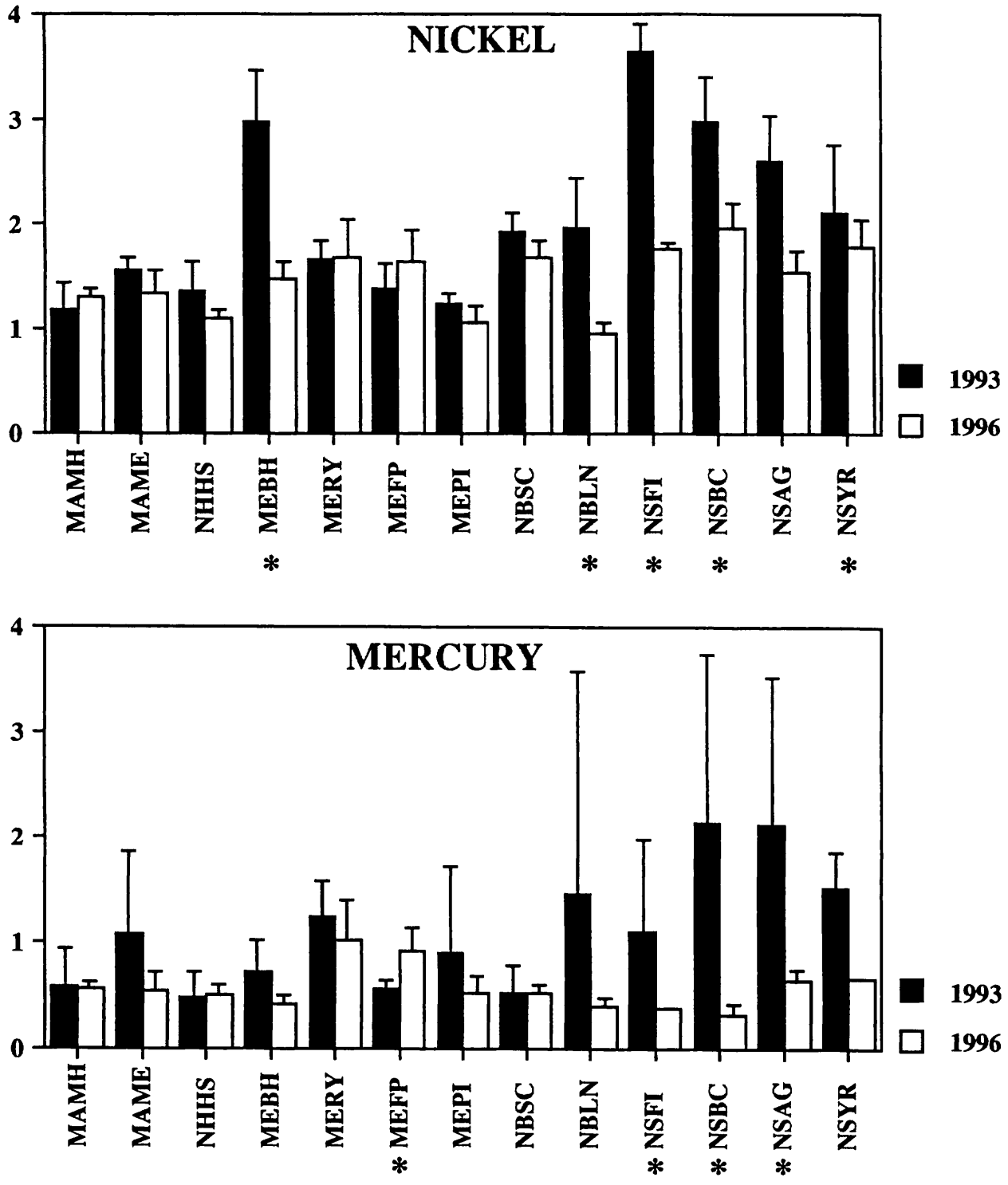

Figure 10. Distribution of nickel and mercury concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulf of Maine stations in 1993 and 1996. *, indicates a significant difference between years ($p<0.05$)

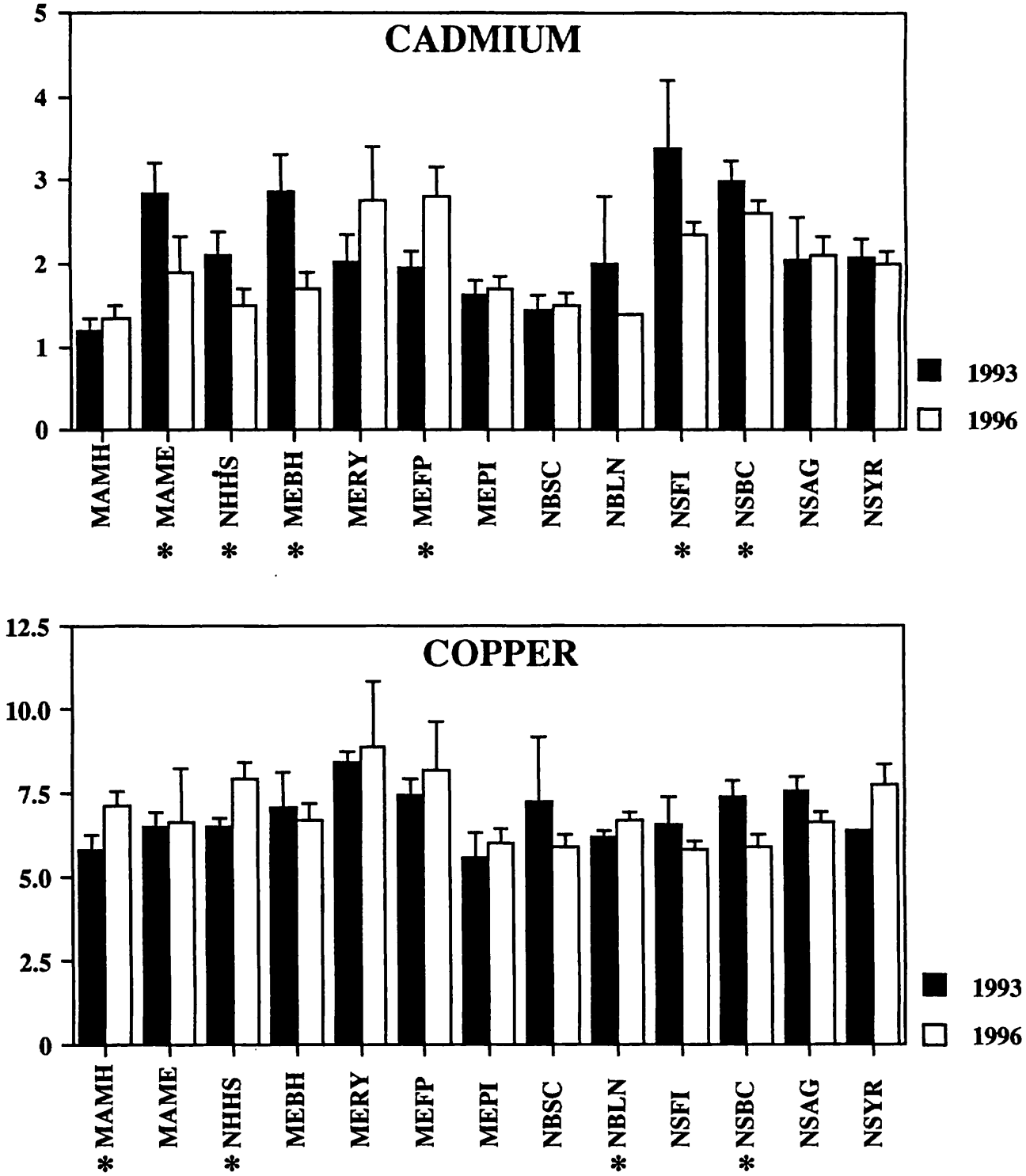

Figure 11. Distribution of cadmium and copper concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulf of Maine stations in 1993 and 1996. *, indicates a significant difference between years ($p<0.05$)

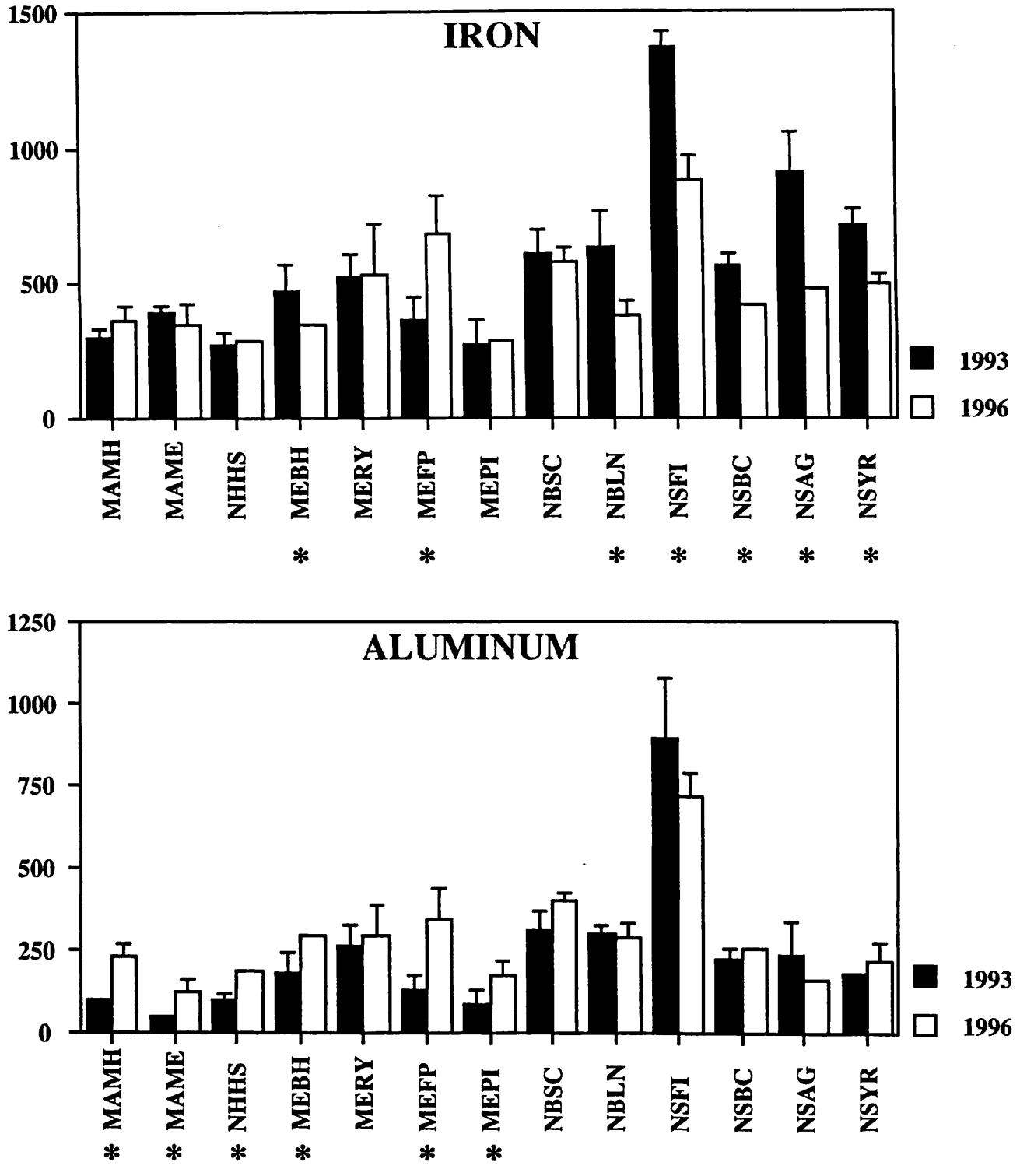

Figure 12. Distribution of iron and aluminum concentrations (arithmetic mean +/- SD, ng/g dry weight) in mussels at Gulf of Maine stations in 1993 and 1996. *, indicates a significant difference between years ($p<0.05$)

sampled in 1993 and 1996. Asterisks show sites in which a significant difference in concentration was detected. Significant differences between years were observed for all contaminants. With the exception of Cu, the majority of differences reveal significantly lower concentrations than observed in 1993. There were three sites which showed an increase in at least 2 metals: Fort Point, ME (MEFP) and Marblehead, MA (MAMH). At MEFP concentrations of the following metals were significantly higher in 1993 than 1996: Cd, Cr, Fe, Hg, and Pb. The significant increase in Fe may be indicative of elevated sediments levels in the tissue and thus account for elevated concentrations of some other metals. At MAMH, there were significantly higher concentrations of Cr, Cu and Pb and at NHHS there were significantly higher concentrations of Ag and Cu. There were 4 sites at which there were significant decreases in greater than half of the metals: Broad Cove, NS (NSBC); Boothbay Harbor, ME (MEBH); Merrimack River, MA (MAME); and Argyle Sound, NS (NSAG). At NSBC, there were significant decreases in all metals with the exception of Fe. There were significant decreases in 6 metals at MAMH and MEBH (MAMH: Ag, Al, Cd, Cr, Ni, Pb, and Zn; MEBH: Al, Cd, Cr, Fe, Ni, and Pb). At NSAG there significant decreases in 5 metals: Ag, Cr, Fe, Hg, and Zn.

ORGANIC CONTAMINANTS

The total concentration of polynuclear aromatic hydrocarbons (ΣPAH_{24}), polychlorinated biphenyl (ΣPCB_{24}) and organochlorine pesticides ($\Sigma TPEST_{17}$) measured in mussel tissue samples are presented in Table 7. Individual analyte concentrations of each compound class are provided in Appendices B, C and D.

Spatial Variation in Organic Concentrations

Figures 13 and 14 show the concentration of ΣPAH_{24} (Figure 13), ΣPCB_{24} (Figure 13), and $\Sigma TPEST_{17}$ (Figure 14) measured in tissue of *M. edulis* in the 1996 sampling stations. presented from south to north. Concentrations of contaminants were plotted on a log scale and the geometric mean $\pm$ 1 SD has been added for comparison purposes. Concentrations above the geometric mean + 1 SD are considered high. Table 8 contains a summary of the geometric means for each jurisdiction as well as an overall Gulf of Maine estimate. Geometric means of the ΣPAH_{24} concentrations range from non-detectable (12 ng/g) in New Brunswick, to 138 ng/g dry weight in New Hampshire. Sites in all jurisdictions with the exception of New Brunswick exceed the geometric mean + 1 SD (Figure 13). The geometric mean of ΣPCB_{24} ranges from 1.5 in Nova

TABLE 7. Tissue organic contaminant concentrations (arithmetic mean ± SD, ng/g dry weight) from mussels collected throughout the Gulf of Maine in 1996 and ANOVA of concentrations by jurisdiction. Same letter indicates no significant difference among sites within each jurisdiction. ND = nondetected.

LOCATION	ΣPAH_{24}	ΣPCB_{24}	$\Sigma TPEST_{17}$	$\Sigma OPEST_{11}$	ΣDDT_6
MASN	58 ± 8 A	40 ± 6 A	23.3 ± 7.3 B	3.6 ± 2.5 B	19.7 ± 4.9 B
MAMH	73 ± 30 A	41 ± 5 A	10.7 ± 2.9 A	0.53 ± 1.1 A	10.1 ± 1.9 A
MAME	358 ± 81 B	39 ± 8 A	9.8 ± 2.6 A	1.0 ± 1.2 A	8.8 ± 1.5 AB
NHHS	107 ± 65 A	24 ± 12 A	5.5 ± 2.6 A	ND	5.5 ± 2.6 A
MECC	203 ± 22 A	38 ± 2 B	7.3 ± 1.5 A	ND	7.3 ± 1.5 A
MEBH	ND A	ND A	0.58 ± 1.2 A	ND	0.58 ± 1.2 A
MERY	50 ± 41 BC	46 ± 32 C	ND A	ND	ND A
MEKN	155 ± 54 C	30 ± 4 C	5.4 ± 1.5 BC	ND	5.4 ± 1.5 BC
MEFP	680 ± 163 D	13 ± 5 B	6.3 ± 2.1 C	ND	6.3 ± 2.1 C
MEPI	20 ± 18 B	ND A	2.3 ± 0.28 B	ND	2.3 ± 0.28 B
NBSC	28 ± 37 B	27 ± 4 B	3.7 ± 1.5 A	ND	3.7 ± 1.5 A
NBCH	7 ± 8 A	1.4 ± 1.6 A	3.4 ± 0.27 A	ND	3.4 ± 0.27 A
NBLN	14 ± 5 AB	12 ± 7 B	5.7 ± 0.97 B	ND	5.7 ± 0.97 B
NSFI	41 ± 22 A	ND A	4.8 ± 1.9 C	ND	4.8 ± 1.9 C
NSDI	211 ± 28 B	7.6 ± 2.0 B	3.6 ± 0.40 BC	ND	3.6 ± 0.4 BC
NSBC	279 ± 54 B	ND A	1.13 ± 1.3 AB	ND	1.1 ± 1.3 AB
NSAG	60 ± 16 A	ND A	1.1 ± 1.3 AB	ND	1.1 ± 1.3 AB
NSYR	171 ± 53 B	ND A	0.53 ± 1.1 A	ND	0.53 ± 1.1 A

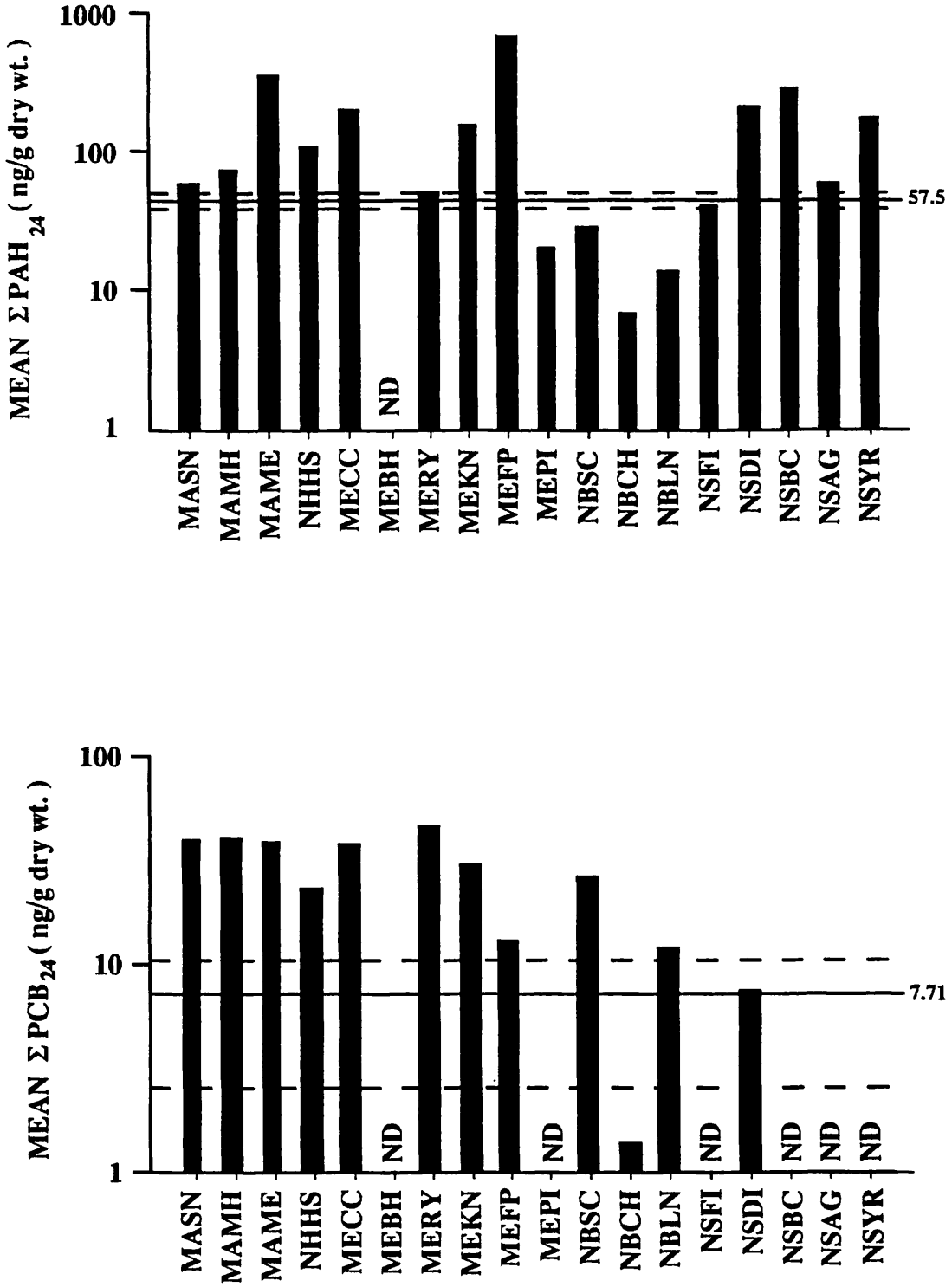

Figure 13. Log distribution of ΣPAH_{24} and ΣPCB_{24} tissue concentrations (arithmetic mean: ng/g dry weight) in indigenous mussels at the Gulf of Maine stations, 1996. Geometric mean (straight line) one standard deviation (dashed line) of all Gulf of Maine stations, 1996. ND = non detect.

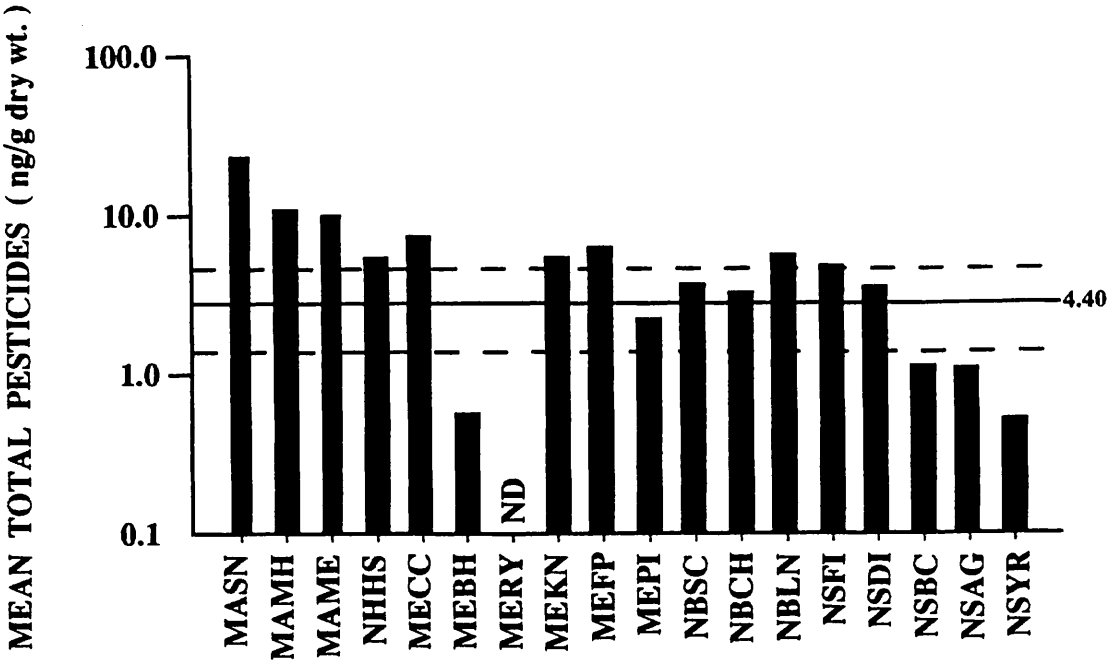

Figure 14. Log distribution of total pesticide ($\Sigma PEST_{17}$) tissue concentrations (arithmetic mean: ng/g dry weight) in indigenous mussels at the Gulf of Maine stations, 1996. Geometric mean (straight line) one standard deviation (dashed line) of all Gulf of Maine stations, 1996. ND = non detect.

TABLE 8. Geometric mean (±SD) of tissue organic contaminants for mussels within each jurisdiction and for all the Gulf of Maine, 1996 stations. ND, not detected

JURISDICTION	ΣPAH_{24}	ΣPCB_{24}	$\Sigma TPEST_{17}$	$\Sigma OPEST_{11}$	ΣDDT_6
Massachusetts	112 ± 2.4	39.6 ± 1.17	13.1 ± 1.55	1.16 ± 1.55	11.9 ± 1.46
New Hampshire	138 ± 1.8	27.9 ± 1.53	5.88 ± 1.46	ND	5.88 ± 1.46
Maine	34 ± 11	6.98 ± 5.46	2.86 ± 2.36	ND	2.86 ± 2.36
New Brunswick	12 ± 3.3	8.45 ± 3.52	4.05 ± 1.30	ND	4.05 ± 1.30
Nova Scotia	115 ± 2.3	1.53 ± 2.41	2.55 ± 2.10	ND	2.55 ± 2.10
Gulf of Maine	57.0 ± 5.55	7.41 ± 5.09	4.40 ± 2.44	1.16 ± 1.55	4.34 ± 2.38

Scotia, to 39.6 ng/g dry weight in Massachusetts. MASN, MAMH, MAME, NHHS, MECC, MERY, MEKN, MEFP, and NBSC all exceeded the geometric mean + 1 SD (Figure 13). The geometric mean of $\Sigma TPEST_{17}$ ranged from 2.6 ng/g dry weight in Nova Scotia to 11.9 ng/g dry weight in Massachusetts. MASN, MAPR, MAME, NHHS, MECC, MEKN, MEFP, and NBLN all exceeded the geometric mean + 1SD (Figure 14). Seven sites examined in 1996 (MASN, MAMH, MAME, NHHS, MECC, MEKN, and MEFP) exceeded the geometric mean + 1 SD in each of ΣPAH_{24}, ΣPCB_{24} and $\Sigma TPEST_{17}$.

In 1996, as in previous years, there is a general southward trend toward higher organic contaminant concentrations. This north-to-south increase in contaminant concentrations can be attributed to increasing population density and industrialization. This trend is most evident in the ΣPCB_{24} and $\Sigma TPEST_{17}$ (ΣDDT_6) data sets (Figure 13 and 14) which probably reflects the continued influence of historical use and deposition of these contaminants in sediments.

Table 7 shows the organic contaminant concentrations. Sites were grouped by jurisdiction and ANOVA and Tukey Kramer tests were employed to examine differences among sites within a jurisdiction.

Polyaromatic hydrocarbons

The concentration of ΣPAH_{24} in indigenous mussels ranged from ND at MEBH to 680 ± 163 ng/g dry weight at MEFP (Table 7, Figure 13). Some mean concentrations of ΣPAH_{24} were as high as those reported from areas influenced by oil spills and municipal sewage outfall (148 ng/g in Rainio et al., 1986; 63-1060 ng/g in Kveseth et al., 1982), but not as high as in industrialized areas affected by coking operations in Sydney Harbor NS (1400-16000 ng/g, in Environment Canada, 1986) or smelting operations in Saudafijord, Norway (5111 - 225,163 ng/g in Bjorseth et al., 1979).

The highest mean concentration of ΣPAH_{24} was measured at MEFP (680 ± 163 ng/g dry weight). This value is high in comparison to other sites in the 1996 Gulfwatch program, however, it is lower than reported previously in Boston Harbor (Dorchester Bay, 1865 ng/g; Deer Island, 2226 ng/g, in NOAA, 1989) and in Boston Harbor local areas (Hingham Bay, 744 ng/g in NOAA, 1989). High concentrations were also observed at MAME (358 ± 81 ng/g dry weight) and the Nova Scotia site; NSBC (279 ± 54 ng/g dry weight).

There were significant differences in ΣPAH_{24} within all jurisdictions with the exception of New Hampshire (Table X). In Massachusetts, MAME was higher than MASN and MAMH, and MEFP was significantly higher than all other sites in Maine.

Polychlorinated biphenyls

Mean ΣPCB_{24} concentrations in indigenous mussels ranged from ND to 46 ± 32 ng/g dry weight at MERY (Table 7, Figure 13). There were significant differences in ΣPCB_{24} within all jurisdictions with the exception of Massachusetts (Table 7). In New Hampshire, MECC was significantly higher than NHHS, and MEKN and MERY were significantly higher than MEBH, MEFP, and MEPI in Maine. In New Brunswick, NBCH was significantly lower than the other two sites, and NSDI was significantly higher than the other Nova Scotia sites.

Pesticides

The concentration of $\Sigma TPEST_{17}$ in indigenous mussels ranged from ND at MERY to 23 ± 7 ng/g dry weight at MASN (Table 7, Figure 14). In 1996 as in previous reports (GMCME, 1994, 1996a, b, c), ΣDDT_6 and its degenerative metabolites were the main contributors to total detectable pesticides. ΣDDT_6 the only contributor to $\Sigma TPEST_{17}$ in New Hampshire, Maine, New Brunswick and Nova Scotia. In Massachusetts a small proportion (5-15%) of $\Sigma TPEST_{17}$ was comprised of $\Sigma OPEST_{11}$ (Table 14). Analysis of each jurisdiction (Table 14) showed that there were significant differences in $\Sigma TPEST_{17}$ among sites in all jurisdictions with the exception of New Hampshire.

Temporal Variation in Organic Concentrations

Benchmark sites

The repeated measures ANOVA comparing organic contaminant concentrations at each of the 5 sites (MASN, MECC, MEKN, NBHI and NSDI) showed that year was significant only for ΣPAH_{24} (Table 9). Site was significant for all organic contaminants. The concentration of ΣPAH_{24} and ΣPCB_{24} was higher at MECC, whereas the concentration of $\Sigma TPEST_{17}$ was highest at MASN.

As a result of the small sample size used in the test (n=5 sites; n=4 years) a power analysis was performed on the results of the ANOVA to determine how likely the test was to detect true differences among populations. The power to detect site differences was generally >0.90 which means that there was <10% chance that a type II error occurred [i.e., not rejecting the Ho (no significant differences among sites) when it is false] (Zar, 1984). As such we are confident of the results indicating site related differences. Unlike the power to detect site differences, the power to detect year differences was low, generally 0.3 meaning that there was a >70% chance that a Type

TABLE 9. Tissue organic contaminant concentrations (arithmetic mean ± standard deviation, $ng.g^{-1}$ dry weight) for Gulfwatch stations at Sandwich, MA (MASN), Clark Cove, ME (MECC), Kennebec River, ME (MEKN), Hospital Island, NB (NBHI), and Digby, NS (NSDI) in 1993, 1994, 1995, and 1996. Results of repeated measure ANOVA are shown below. *, indicates significance at $p \leq 0.05$.

SITE	Σ PAH_{24}	Σ PCB_{25}	Σ DDT_6	ΣOther Pesticides	Σ $PEST_{17}$
MASN					
mean'93	19.0 (7.0)	28.8 (7.20)	15.0 (3.70)	1.20 (1.40)	16.3 (5.10)
mean'94	42.4 (9.8)	28.6 (6.92)	14.1 (1.58)	6.15 (3.51)	20.3 (5.06)
mean'95	17.5 (11.7)	36.8 (7.63)	22.4 (5.08)	4.40 (1.97)	26.8 (6.55)
mean'96	58.0 (8.3)	40.1 (6.3)	19.7 (4.9)	3.58 (2.49)	23.3 (7.24)
MECC					
mean'93	154 (47.0)	70.3 (10.7)	11.1 (5.30)	ND	11.1 (5.30)
mean'94	137 (9.54)	66.8 (4.79)	12.5 (1.29)	ND	12.5 (1.29)
mean'95	158 (38.8)	35.4 (10.20	13.8 (0.96)	ND	13.8 (0.96)
mean'96	203 (21.9)	37.6 (1.9)	7.3 (1.5)	ND	7.3 (1.5)
MEKN					
mean'93	94.0 (31.0)	27.3 (3.70)	3.50 (2.00)	ND	3.50 (2.00)
mean'94	103 (15.2)	42.5 (11.7)	10.7 (3.93)	7.58 (1.31)	18.3 (4.43)
mean'95	64.0 (25.6)	24.5 (7.19)	13.1 (0.49)	4.45 (0.61)	17.5 (1.00)
mean'96	155 (53.5)	29.8 (3.8)	5.4 (1.5)	ND	5.4 (1.5)
NBHI					
mean'93	ND	3.70 (1.20)	3.00 (1.00)	ND	3.00 (1.00)
mean'94	ND	ND	3.43 (0.10)	ND	3.43 (0.10)
mean'95	ND	ND	5.35 (0.59)	ND	3.86 (0.59)
mean'96	7.0 (8.1)	1.4 (1.6)	3.4 (0.3)	ND	3.4 (0.3)
NSDI					
mean'93	108 (26)	ND	ND	ND	ND
mean'94	70.5 (8.7)	1.2 (1.4)	1.7 (1.1)	ND	1.7 (1.1)
mean'95	128.5 (38.2)	3.0 (0.0)	1.8 (1.2)	ND	1.8 (1.2)
mean'96	211 (28.0)	7.6 (2.0)	3.6 (0.4)	ND	3.6 (0.4)
p (site)	p<0.001*	p>0.001*	p>0.001*	p<0.001*	p<0.001*
p (year)	p>0.02*	p>0.50	p>0.10	p>0.20	p>0.10

II error occurred. The only exceptions was ΣPAH_{24} where the chances that a Type II error occurred was only 22%. Concentrations of ΣPAH_{24} at benchmark sites appear to be showing a pattern of increased concentrations since 1993.

In a report currently being written that summarizes the findings of the first five years of the Gulfwatch program (GMCME, 1997), the same analysis was performed on the benchmark data, although at that time only 3 years of data were used. The results of the site differences in this study are similar to the previous report (GMCME, 1997). However, in the five year report (GMCME, 1997), no year effects were detected while in this report, year-related differences were detected for ΣPAH_{24}. The addition of the 1996 samples has allowed an increased power to detect year differences in ΣPAH_{24}, ΣPCB_{24}, and $\Sigma TPEST_{17}$.

Annual sites (1993 vs 1996)

Figure 15 to 17 show the concentrations of all organic contaminants at the 13 non-benchmark Gulfwatch sites sampled in 1993 and 1996. Asterisks show sites in which a significant difference in concentration was detected. Significant differences between years were observed for all contaminants. In general, the majority of differences reveal significantly higher concentrations than observed in 1993. The most significant changes were observed in ΣPAH_{24}. Concentrations of ΣPAH_{24} were significantly greater than 1993 concentrations at the following sites: MAME, MEFP, MEPI, NBSC, NBLN, NSFI, and NSAG.

Planar Chlorobiphenyls and Polychlorinated Dibenzo Dioxins and Furans

It has been known for some time that several of the possible 209 PCB congeners are biologically active with structural and toxic properties similar to the highly toxic 2,3,7,8 - tetrachlorodibenzo (p) dioxin (2,3,7,8-TCDD). These congeners generally are referred to as planar or coplanar chlorobiphenyls (CBs). Most if not all of the toxicity associated with PCB mixtures is thought to be due to these compounds. Because planar CBs concentrations in PCB Aroclor mixtures and in environment samples are typically much lower than that of other PCB congeners, many of the most toxic PCB congeners are not usually detected using standard methods of PCB analysis. The analysis of planar CBs requires rigorous clean up and specific fractionation techniques as well as the greater sensitivity and resolving power provided by high resolution gas mass-spectrometry.

The most toxic of PCB congeners are void of chlorine substitution at the ortho positions of the biphenyl molecule (non-ortho PCBs) and, therefore, can assume a planar configuration which

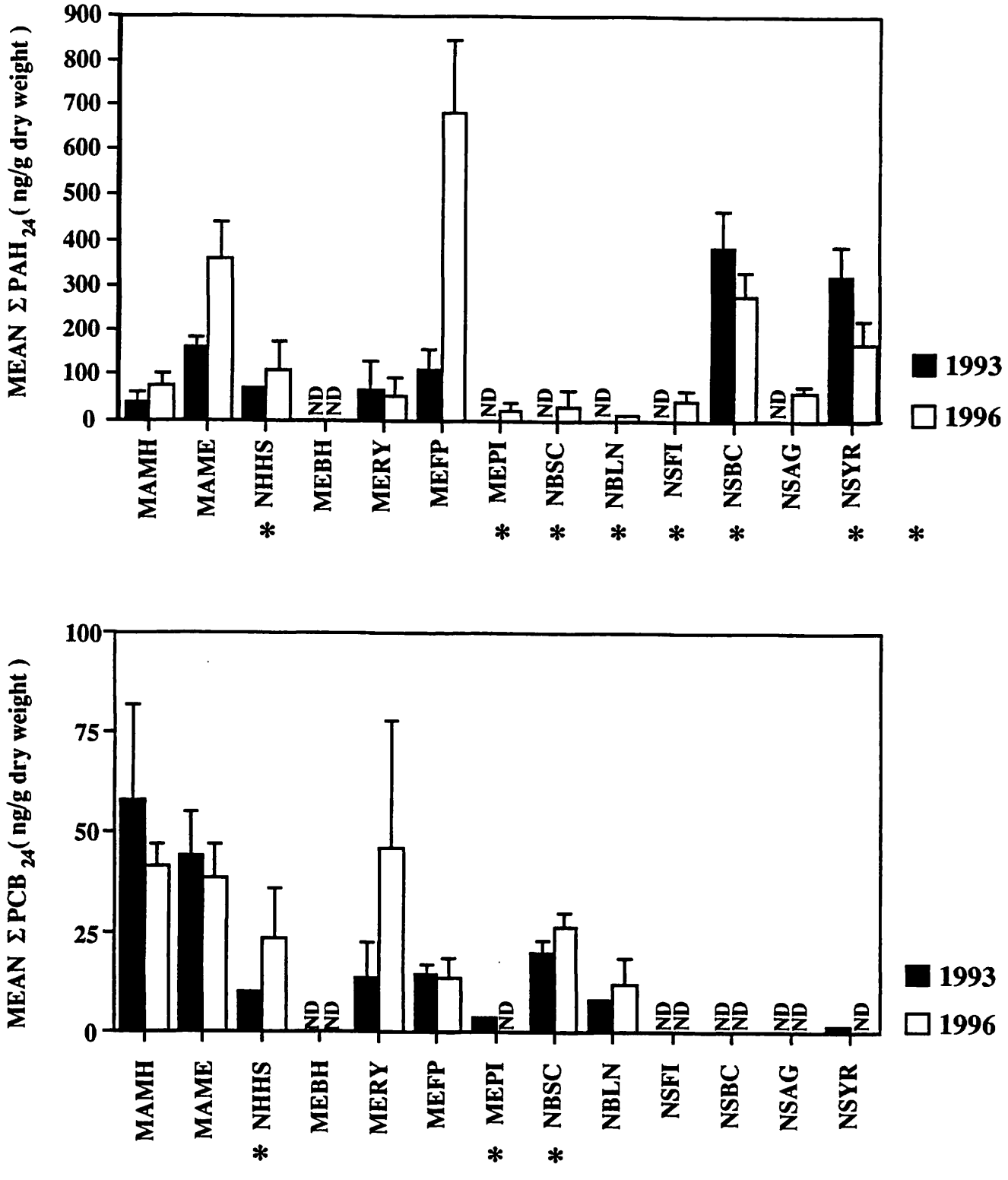

Figure 15. Log distribution of ΣPAH_{24} and ΣPCB_{24} tissue concentrations (arithmetic mean: ng/g dry weight) in indigenous mussels at the Gulf of Maine stations in 1993 and 1996. *indicates a significant difference between years ($p<0.05$).

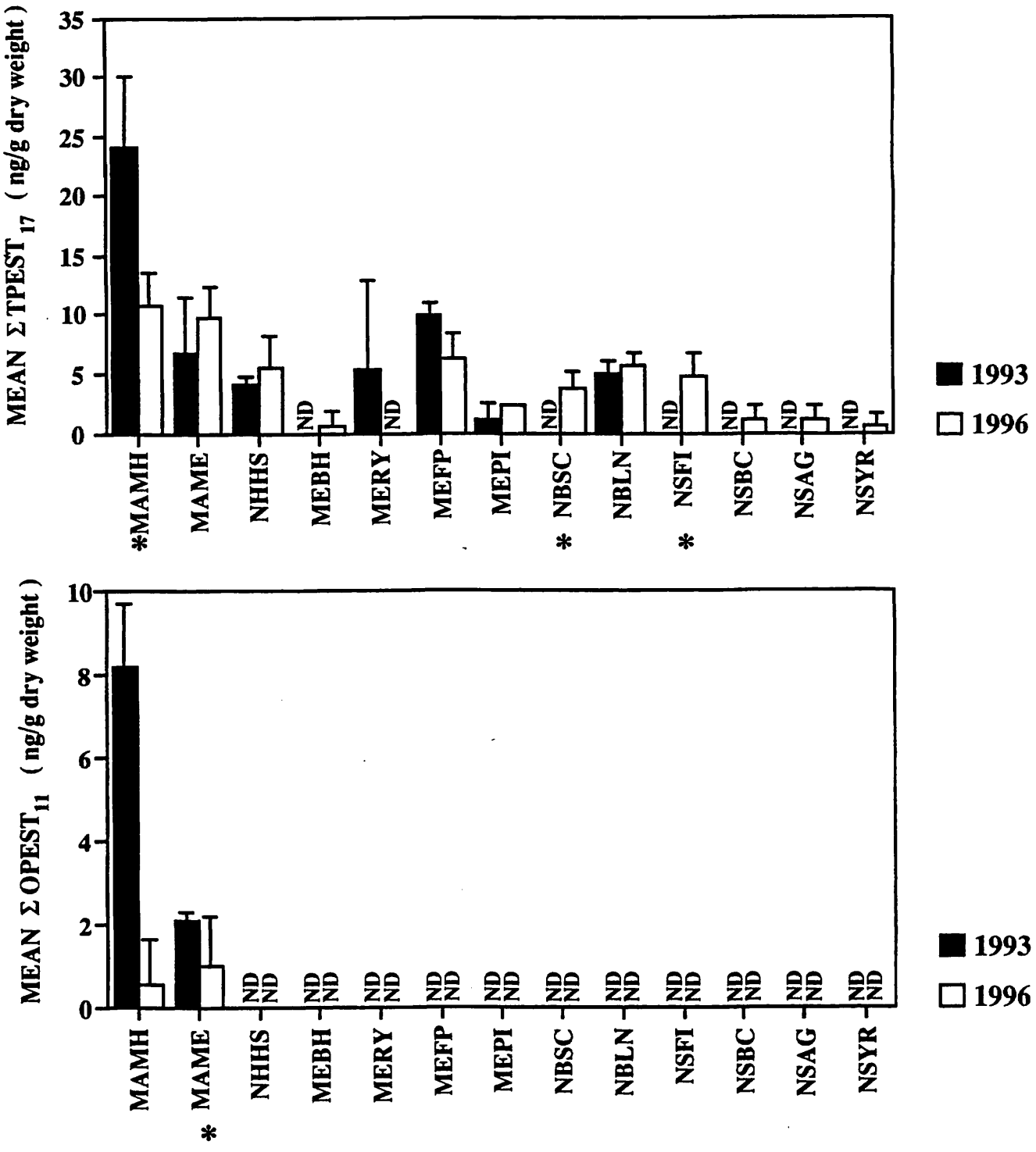

Figure 16. Log distribution of $\Sigma PEST_{17}$ and $\Sigma OPEST_{11}$ tissue concentrations (arithmetic mean: ng/g dry weight) in indigenous mussels at the Gulf of Maine stations in 1993 and 1996. *indicates a significant difference between years ($p<0.05$).

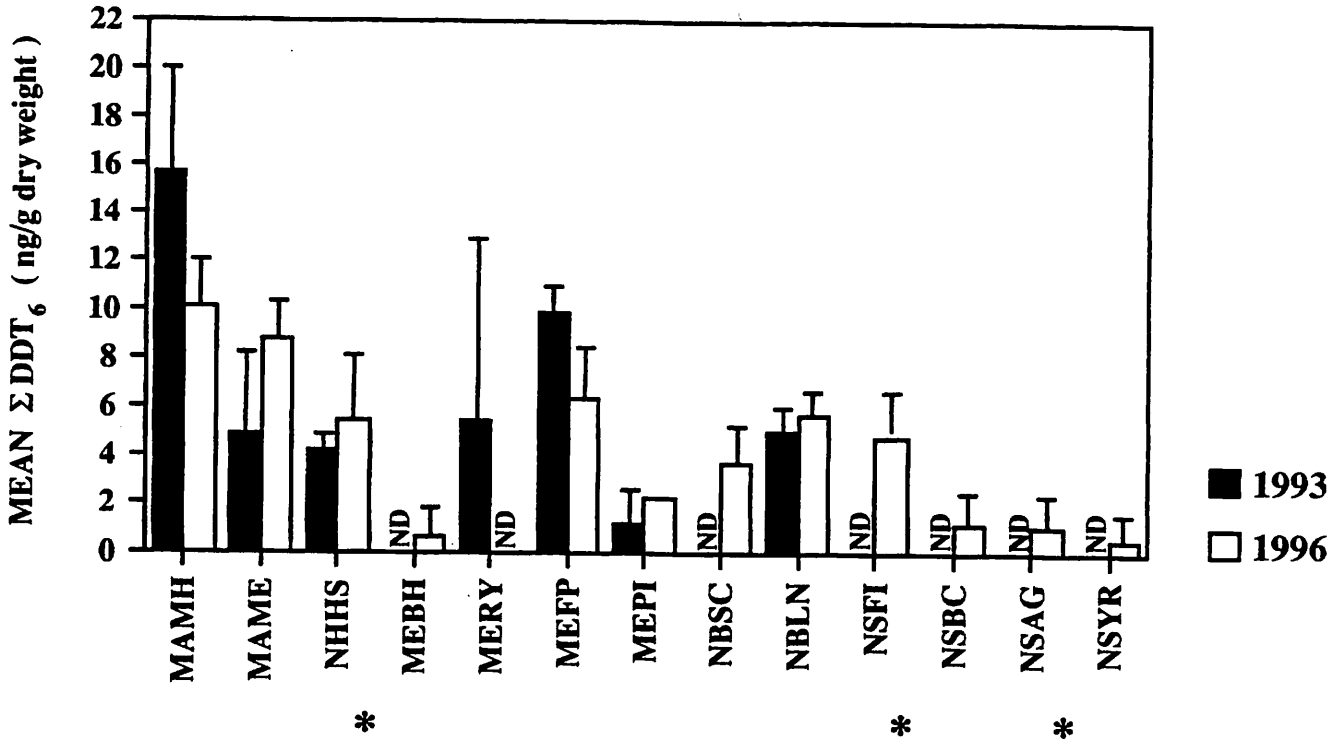

Figure 17. Log distribution of ΣDDT_6 tissue concentrations (arithmetic mean: ng/g dry weight) in indigenous mussels at the Gulf of Maine stations in 1993 and 1996. *indicates a significant difference between years ($p<0.05$).

is stereoisometrically similar to 2,3,7,8-TCDD. Other CBs with mono-ortho or di-ortho substitution also have been shown to demonstrate dioxin equivalent toxicity, but of varying and lesser degree than the non-ortho ones.

The toxicity of PCBs which has been known for some time mainly in terrestrial animals, includes hepatic damage, dermal disorders, reproductive toxicity, thymic atrophy, weight loss, immunotoxicity and teratogenicity (De Voogt et al., 1990). On a cellular level, structure-affinity relationships allow the binding of planar CBs and 2,3,7,8-TCDD to cytosolic receptors which are believed to mediate the enzyme induction properties and toxicity of these chemicals.

With respect to environmental measurements, DeBoer et al. (1993) reported planar CB-derived 2,3,7,8-TCDD toxic equivalent concentrations (TEQ) in cod liver from the southern North Sea, and TEQ concentrations in yellow eels from the Rhine and Meuse Rivers, Germany, which exceed the often used Canadian tolerance level of 20 pg/g for dioxins in fish and shellfish (Health Canada, 1993). In a recent Canadian study of lobster digestive glands from lobster in four maritime harbours of Atlantic Canada, PCB-derived TEQ concentrations were shown to exceed the Canadian tolerance level of 20 pg/g (King et al., 1996). In the latter study, the dioxin tolerance was exceeded by factors of 1-10 times while total PCB concentrations of the same samples did not exceed the Canadian PCB tolerance concentration of 2 µg/g wet weight.

There is a growing body of evidence suggesting PCDDs/PCDFs and planar CBs are responsible for much of the lethal and sublethal contaminant toxicity observed in aquatic biota and other animals at risk including mussel-consuming seabirds and marine mammals. Because there is limited environmental data relative to PCDD/PCDF and planar CB concentrations in environmental compartments of the Gulf of Maine, mussel samples collected from most Gulfwatch sites in 1996 were analysed for PCDD/PCDF and toxic CBs residues.

Table 10 contains non-ortho, mono-ortho and di-ortho CB mussel tissue concentrations from 17 Gulfwatch sites. Summed concentrations of non-ortho, mono-ortho and di-ortho CBs range from 98 to 1563 pg/g wet wt (797 to 13,800 pg/g dry wt). The highest concentration measured in mussels was at the MASN site in Massachusetts. Gulf-wide concentrations follow the same pattern of northerly decreasing contamination observed for total PCB concentrations in these samples (Table 7). Toxic CBs concentrations in mussels are generally below the method detection limits set for the standard list of PCB congeners given in Appendix C which were obtained using typical mussel watch methods of clean up/fractionation and analysis by high resolution GC-ECD.

Dioxin toxic equivalent concentrations (TEQ) for the CB concentrations in Table 10 are shown in Table 11 . TEQs were calculated using CB concentrations and the WHO interim toxic

Table 10. Chlorobiphenyl concentrations (pg/g wet wt) in mussel samples at 1996 Gulf of Maine sites.

Congener	MAME	MAMH	MASN	NHHS	MEBH	MECC	MEFP	MEPI	MERY
Non-ortho									
CB #77	48	28	38	10	3.8	16	3.0	3.6	1.8
CB #126	2.4	4.6	5.2	1.7	0.91	2.8	0.75	0.98(NDR)	0.39
CB #169	ND	ND	0.54	ND	ND	0.38	ND	ND	ND
Mono-ortho									
CB # 105	230	250	260	120	30	210	50	30	20
CB # 114	10	5	ND	ND	ND	20	ND	ND	ND
CB # 118	580	770	960	340	80	600	130	120	50
CB # 156	70	70	90	40	8	80	20	ND	8
CB # 189	ND	6	ND	ND	ND	ND	ND	ND	ND
Di-ortho									
CB #170	40	60	60	ND	ND	40	20	10	8
CB #180	120	130	150	50	20	130	80	40	10
Total									
pg/g wet weight	1100.4	1323.6	1563.7	561.7	142.7	1099.2	303.8	203.6	98.2
pg/g dry weight	13755.0	9454.3	11169.6	4320.8	1189.3	8455.2	3375.0	1696.7	1636.5

Congener	MEKN	NBLN	NBSC	NSAG	NSBC	NSDI	NSFI	NSYR
Non-ortho								
CB #77	6.7	9.0	9.9	2.9	2.9	6.6	2.9	4.0
CB #126	0.77	2.1	1.9	0.68 NDR	0.62	1.4	0.71	0.87
CB #169	ND	ND	ND	ND	ND	ND	ND	ND
Mono-ortho								
CB # 105	80	80	60	20	30	80	20	50
CB # 114	ND	ND	ND	ND	ND	ND	ND	ND
CB # 118	250	290	180	80	90	220	60	160
CB # 156	ND	40	50	ND	ND	ND	ND	ND
CB # 189	ND	ND	ND	ND	ND	ND	ND	ND
Di-ortho								
CB #170	40	20	60	10	ND	ND	ND	ND
CB #180	160	90	270	20	ND	ND	20	20
Total								
pg/g wet weight	537.5	531.1	631.8	132.9	123.5	308.0	103.6	234.9
pg/g dry weight	3839.1	3540.7	4860.0	1107.5	950.2	2200.0	797.0	1677.6

Table 11. Non-, mono- and di-ortho chlorobiphenyl TEQs in mussels at 1996 Gulf of Maine sites.

Congener	TEF*	MAME	MAMH	MASN	NHHS	MEBH	MECC	MEFP	MEPI	MERY
Non-ortho										
CB #77	0.0005	0.024	0.014	0.019	0.005	0.0019	0.008	0.0015	0.0018	0.0009
CB #126	0.1	0.24	0.46	0.52	0.17	0.091	0.28	0.075		0.039
CB #169	0.01			0.0054			0.0038			
Mono-ortho										
CB # 105	0.0001	0.023	0.025	0.026	0.012	0.003	0.021	0.005	0.003	0.002
CB # 114	0.0005	0.005	0.0025				0.01			
CB # 118	0.0001	0.058	0.077	0.096	0.034	0.008	0.06	0.013	0.012	0.005
CB # 156	0.0005	0.035	0.035	0.045	0.02	0.004	0.04	0.01		0.004
CB # 189	0.0001		0.0006							
Di-ortho										
CB #170	0.0001	0.004	0.006	0.006			0.004	0.002	0.001	0.0008
CB #180	0.00001	0.0012	0.0013	0.0015	0.0005	0.0002	0.0013	0.0008	0.0004	0.0001
Total (pg/g wet wt)		**0.39**	**0.62**	**0.72**	**0.24**	**0.11**	**0.43**	**0.11**	**0.02**	**0.05**

Congener	TEF*	MEKN	NBLN	NBSC	NSAG	NSBCN	NSDIN	NSFIN	NSYR
Non-ortho									
PCB #77	0.0005	0.00335	0.0045	0.00495	0.00145	0.00145	0.0033	0.00145	0.002
PCB #126	0.1	0.077	0.21	0.19		0.062	0.14	0.071	0.087
PCB #169	0.01								
Mono-ortho									
PCB # 105	0.0001	0.008	0.008	0.006	0.002	0.003	0.008	0.002	0.005
PCB # 114	0.0005								
PCB # 118	0.0001	0.025	0.029	0.018	0.008	0.009	0.022	0.006	0.016
PCB # 156	0.0005		0.02	0.025					
PCB # 189	0.0001								
		0	0	0	0	0	0	0	0
Di-ortho		0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0
PCB #170	0.0001	0.004	0.002	0.006	0.001				
PCB #180	0.00001	0.0016	0.0009	0.0027	0.0002			0.0002	0.0002
Total (pg/g wet wt)		**0.12**	**0.27**	**0.25**	**0.01**	**0.08**	**0.17**	**0.08**	**0.11**

* Toxic Equivalency Factor (Ahlborg et al 1994)

equivalency factors compiled by Alborg et al. (1994). TEQs in mussels from the 1996 sites range from 0.01 to 0.72 (pg/g wet wt). Relative to human health concerns, TEQs for all 1996 sites were well below the 2,3,7,8-TCDD Canadian tolerance level of 20 pg/g (wet wt). The greatest contributor to total TEQs in mussel samples is the planar non-ortho CB126 (62-81%) followed by non-ortho CB77 and the mono-ortho CB105. The highest TEQ concentrations are found in mussels from sites in Massachusetts (MASN, MAMH and MAME) followed by Maine (MECC) and sites in New Brunswick (NBLN and NBSC). A graphical representation of the TEQ distribution in samples collected from GOM sites in 1996 can be seen in Figure 18.

Polychlorinated dibenzo (p) dioxins (PCDD) and polychlorinated dibenzo (p) furan (PCDF) originate from natural as well as many anthropogenic sources. These include chemical-industrial sources such as industries manufacturing chlorinated chemicals, pulp and paper mills, dry cleaning distillation residues; thermal or combustion sources such as municipal waste incinerators, automobile exhaust, and burning of fossil fuel for thermal generation by homes and industry. All of these sources impact on coastal zone areas of the Gulf of Maine. Gulfwatch samples were analyzed for PCDD/PCDF residues and the results are given in appendix E. PCDD and PCDF concentrations in 1996 were very low or below the limits of detection (DL=0.2-0.8 pg/g wet wt) . Virtually no samples had detectable concentrations of the highly toxic 2,3,7,8-TCDD or any other dioxin congener chlorinated in the 2,3,7,8 positions with the exception of the less toxic 1,2,3,4,6,7,8 hepta- and octachloro congeners. On the other hand, low concentrations of 2,3,7,8-terachlorodibenzo(p) furan (2,3,7,8-TCDF) and other chlorinated TCDF congeners were detected in many samples, while higher chlorinated furans were not detected. Predominance of PCDF concentrations particularly 2,3,7,8-TCDF relative to TCDD congener concentrations can be indicative of pulp mill sources (Rappe at el., 1988) and/or of PCB contamination. PCDD/PCDF patterns typical of incineration sources were not clearly evident.

The spatial distribution of 1996 Gulfwatch mussel PCDD/PCDF TEQs is presented in Figure 18. TEQs were calculated using PCDD/PCDF concentrations (Appendix E) and international toxic equivalency factors (NATO., 1988). TEQ are very low throughout the Gulf as expected from the low PCDD/PCDF mussel concentrations. Most of the PCDD/PCDF toxicity present in samples is derived from PCDF tissue concentrations. The contribution of PCDD PCDF to total TEQ in mussels is 1-6 times lower than that derived from CBs. PCDD/PCDF TEQs do not appear to be correlated with CB TEQs or with total PCB concentrations measured in mussel (Table 7).

Summed CB and PCDD/PCDF TEQs in 1996 Gulfwatch samples are well below the 20 pg/g 2,3,7,8-TCDD tolerance level (Canadian) that is protective of human health for the consumption of seafood. It is noted that total PCB concentrations in mussels collected in 1996 (Table 7) are low

equivalency factors compiled by Alborg et al. (1994). TEQs in mussels from the 1996 sites range from 0.01 to 0.72 (pg/g wet wt). Relative to human health concerns, TEQs for all 1996 sites were well below the 2,3,7,8-TCDD Canadian tolerance level of 20 pg/g (wet wt). The greatest contributor to total TEQs in mussel samples is the planar non-ortho CB126 (62-81%) followed by mono-ortho CB 118 and CB156. The highest TEQ concentrations are found in mussels from sites in Massachusetts (MASN, MAMH and MAME) followed by Maine (MECC) and sites in New Brunswick (NBLN and NBSC). A graphical representation of the TEQ distribution in samples collected from GOM sites in 1996 can be seen in Figure 18.

Polychlorinated dibenzo (p) dioxins (PCDD) and polychlorinated dibenzo (p) furan (PCDF) originate from natural as well as many anthropogenic sources. These include chemical-industrial sources such as industries manufacturing chlorinated chemicals, pulp and paper mills, dry cleaning distillation residues; thermal or combustion sources such as municipal waste incinerators, automobile exhaust, and burning of fossil fuel for thermal generation by homes and industry; and reservoirs such as sweage sludge, compost and contaminated soils. All of these sources impact on coastal zone areas of the Gulf of Maine. Gulfwatch samples were analyzed for PCDD/PCDF residues and the results are given in Appendix E. PCDD and PCDF concentrations in 1996 were very low or below the limits of detection (DL=0.2-0.8 pg/g wet wt) . Virtually no samples had detectable concentrations of the highly toxic 2,3,7,8-TCDD or any other dioxin congener chlorinated in the 2,3,7,8 positions with the exception of the less toxic 1,2,3,4,6,7,8 hepta- and octachloro congeners. Conversely, low concentrations of 2,3,7,8-terachlorodibenzo(p) furan (2,3,7,8-TCDF) and other chlorinated TCDF congeners were detected in many samples, while higher chlorinated furans were not. Predominance of PCDF concentrations, particularly 2,3,7,8-TCDF relative to TCDD congener concentrations, can be indicative of pulp mill sources (Rappe at el., 1988) or PCB contamination (Hutzinger et al., 1974). PCDD/PCDF patterns typical of incineration sources were not evident.

The spatial distribution of 1996 Gulfwatch mussel PCDD/PCDF TEQs is presented in Figure 18. TEQs were calculated using PCDD/PCDF concentrations (Appendix E) and international toxic equivalency factors (NATO, 1988). TEQ are very low throughout the Gulf as expected from the low PCDD/PCDF mussel concentrations. Most of the PCDD/PCDF toxicity present in samples is derived from PCDF tissue concentrations. The contribution of PCDD PCDF to total TEQ in mussels is 1-6 times lower than that derived from CBs. PCDD/PCDF TEQs do not appear to be correlated with CB TEQs or with total PCB concentrations measured in mussel (Table 7).

Summed CB and PCDD/PCDF TEQs in 1996 Gulfwatch samples are well below the 20 pg/g 2,3,7,8-TCDD tolerance level (Canadian) that is protective of human health for the consumption of

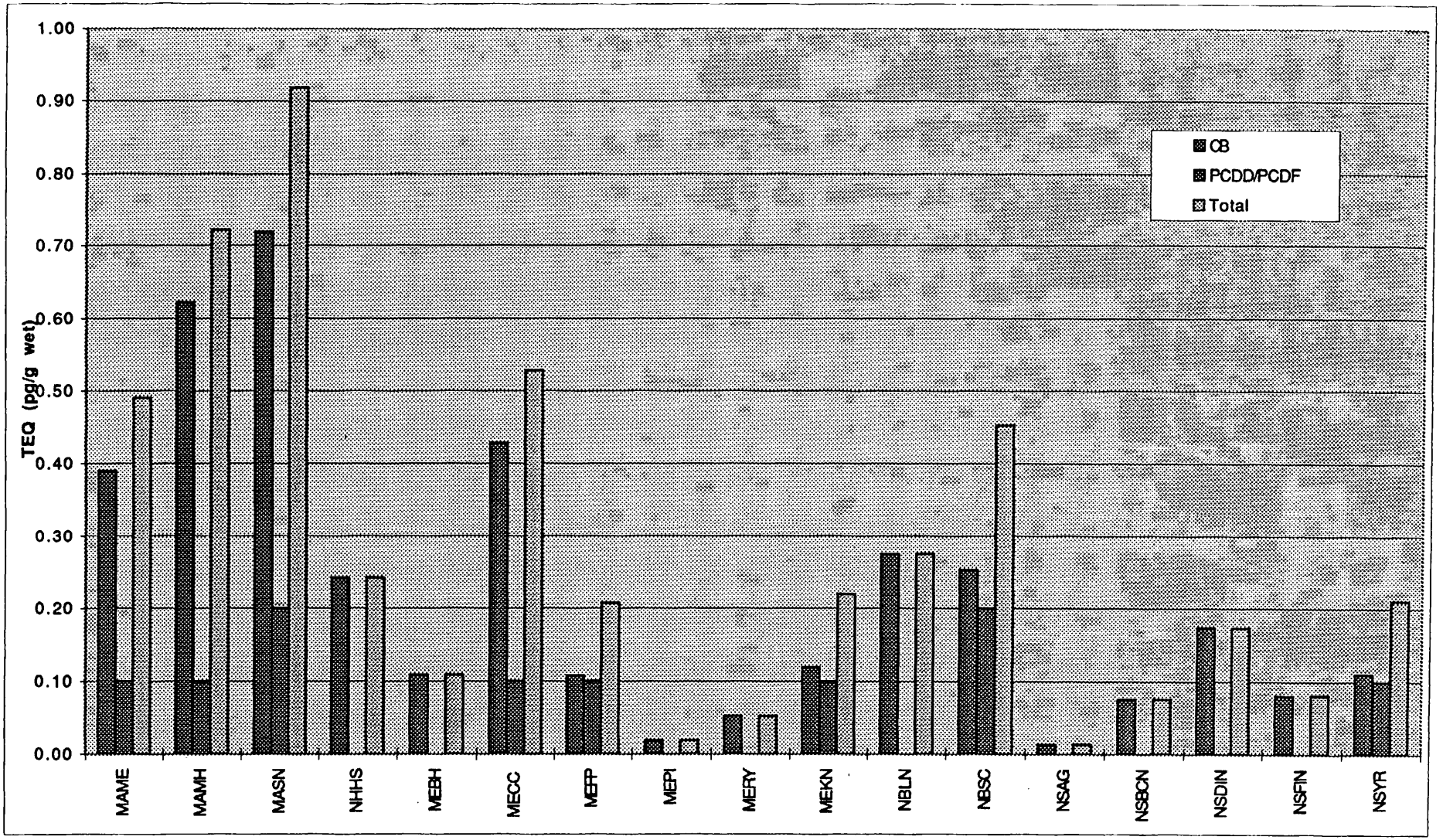

Figure 18. Distribution of CB and PCDD/PCDF Toxic Equavalency Concentrations (TEQ) in Mussels at 1996 Gulf of Maine Sites

seafood. It is noted that total PCB concentrations in mussels collected in 1996 (Table 7) are low relative to concentrations measured in Gulfwatch sites in previous years (410 ng/g; GMCME, 1996a) and to NS&T data (>1000 ng/g DW in Boston Harbor). Bergen et al. (1996) have reported that coplanar PCBs accumulate in mussels similarly to non-planar PCBs with the same numbers of chlorines. It may be speculated that if CB-TEQs are proportional to total PCB concentrations in mussels then PCB concentrations above 1000 ng/g (dry wt) could have CB TEQs in excess of human health tolerance. While total PCB concentrations may not exceed the 2000 ng/g (wet weight) tolerance of the US and Canada, summed TEQs could exceed the level considered protective of human health. It is noted that the additive TEF concept may overestimate toxicity on the basis of competitive binding at receptor sites by less or non-effective congeners (Safe et al., 1990).

The analysis of 1996 mussels for planar CBs and PCDDs/PCDFs provides a useful baseline of dioxin-related toxicity in Gulf of Maine mussels. However, given the low CB and PCDD/PCDF TEQs measured in 1996 and the high cost of these analysis, future analysis of mussels samples for PCDD/PCDF and planar CBs should be limited to sites where elevated PCB concentrations or other factors warrant these analyses.

Effects of an Oil Spill in the Great Bay Estuary

On July 1, 1996, there was an oil spill from the vessel *Provence* into the Piscataqua River. Approximately 1,000 gallons of #6 fuel oil was dispersed with water currents into nearby areas of the Great Bay Estuary. Fuel oils are known to contain a variety of PAHs, especially 2 to 4-ring PAHs, although hundreds of organic compounds, including larger PAHs, are present in all crude oils (Kennish, 1996). The Gulfwatch station NHDP at Dover Point, located at the confluence of the Piscataqua River and Little Bay approximately 2.5 miles upstream of the oil spill site, was sampled previously in 1994 and was to be sampled again in 1997. However, samples were collected in response to the oil spill in July and October, 1996, to determine if contaminants from the spill were taken up by mussels, and the degree of elimination of the contaminants after three months. The 1994 data serves as useful background information for assessing the degree of exposure of the 1996 mussel tissue samples to the oil spill contaminants.

Mussels were collected by standard methods at the same NHDP site used in 1994 on July 17 and October 1, 1996. The PAH found in mussel tissue samples collected in 1994, on July 16 (16d) and October 1 (3 mo.) are illustrated in Figure 19 and summarized in Table 12. The first 1996 sample was collected to determine short-term contamination from the spill, and the second for

Figure 19. PAH concentrations in mussel tissue from Dover Point, NH, before (NHDP-1994), 16 days after (NHDP-16d) and three months after (NHDP-3mo.) an oil spill.

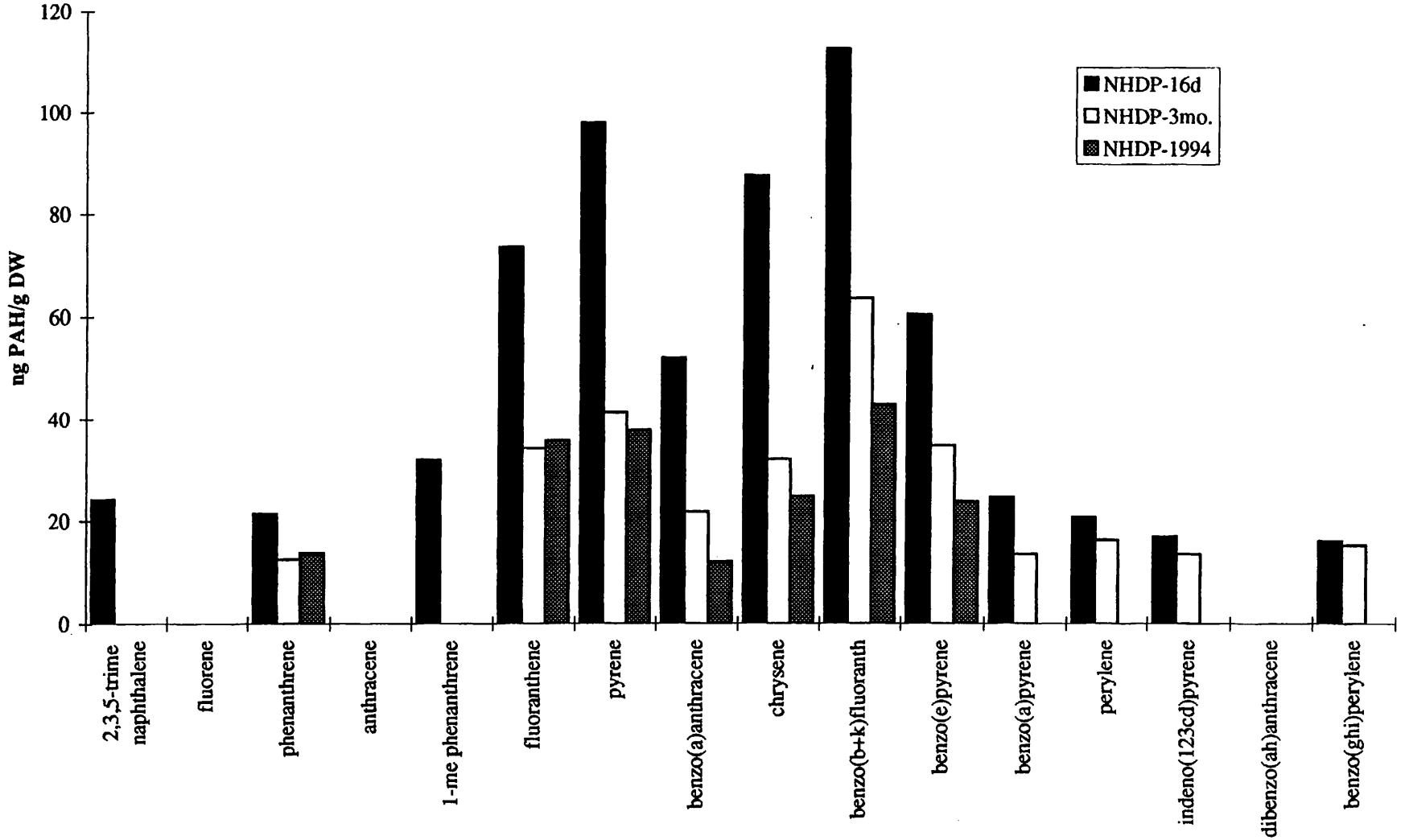

Table 12. Tissue concentrations (ng/g DW) of polyaromatic hydrocarbons in Mytilus edulis at sites in the Great Bay Estuary of Maine and New Hampshire in 1994 (NHDP-1994) and both 16 days (NHDP-16d) and 3 months (NHDP-3 mo.) after an oil spill.

PAH	NHDP-1994	NHDP-16d	NHDP-3 mo.
Naphthalene	<30	<30	<30
2-Me naphthalene	<30	<30	<30
1-Me-naphthalene	<30	<30	<30
Biphenyl	<20	<20	<20
2,6 diMe naphthalene	<20	<20	<20
acenaphthylene	<10	<10	<10
acenaphthene	<10	<10	<10
2,3,5-trime naphthalene	<20	24	<20
fluorene	<10	<10	<10
phenanthrene	14	21	13
anthracene	<10	<10	<10
1-me phenanthrene	<10	32	<10
fluoranthene	36	74	34
pyrene	38	98	41
benzo(a)anthracene	12	52	22
chrysene	25	88	32
benzo(b+k)fluoranthene	43	113	64
benzo(e)pyrene	24	60	35
benzo(a)pyrene	<10	25	14
perylene	<10	21	16
indeno(123cd)pyrene	<10	17	14
dibenzo(ah)anthracene	<10	<10	<10
benzo(ghi)perylene	<10	16	15
TOTAL	**187**	**639**	**298**

determination of longer-term contamination and to correspond to the standard sample collection period for Gulfwatch (September-October) for comparison to data from 1994 and from other sites. Samples were analyzed for PAHs, PCBs and chlorinated pesticides.

The PAH found in mussel tissue samples collected in 1994, on July 16 (16d) and October 1 (3 mo.) differed in individual and total PAH concentrations, patterns of PAHs and types of PAHs present. There were 13 different PAHs detected in the 16d samples, 11 in the 3 mo. samples and 7 in the 1994 samples. Two low molecular weight (MW) alkylated PAHs detected in the 16d samples were not detected in the 3 mo. and the 1994 samples, while the four PAHs with the highest MWs detected in 16d and 3 mo. samples were not detected in the 1994 samples. These patterns suggest that lower MW PAHs and alkylated naphthalenes were less available for uptake after the spill, or that they are eliminated from mussels more readily than the larger PAHs. The patterns also suggest that the higher MW PAHs from the spilled oil are more persistent. Weathering of PAHs in other oil spills have shown decreases in naphthalenes and greater stability of larger PAHs relative to other PAHs (Boehm et al., 1997; Brown et al., 1997). Elimination rates are slower for higher MW PAHs in mussels (Livingstone and Pipe, 1992).

All 13 PAHs detected in the 16d samples were present at higher concentrations than in both of the other samples, while only phenanthrene and fluoranthene concentrations in the 1994 samples were greater than in the 3 mo. samples. The average ΣPAH_{24} concentrations were 639, 298 and 187 ng/g DW for the 16d, 3 mo. and 1994 samples, respectively. ΣPAH_{24} concentrations for the 16d samples were significantly greater than the 3 mo. and 1994 samples, and the ΣPAH_{24} concentrations for the 3 mo. samples were significantly greater than the 1994 samples. Eight of the lower MW PAHs and indeno(123cd)pyrene were detected at significantly higher concentrations in the 16d compared to the 3 mo. samples. All concentrations for the lower MW PAHs in the 3 mo. and 1994 samples were not significantly different. However, the six PAHs with >5 rings detected in the 3 mo. samples had significantly higher concentrations than the 1994 samples.

NHDP mussel tissue samples were also analyzed for PCBs and chlorinated pesticides. The average ΣPCB_{24} concentrations of 64 ng/g DW for the 3 mo. sample and 46 ng/g DW for the 16d sample were not significantly different. Of the pesticides, only ΣDDT_6 was detected in both samples. The average concentrations of 3.4 and 1.9 ng/g DW for the 16d and 3 mo. samples, respectively, were not significantly different.

In addition to the samples collected at NHDP, samples were also collected on July 17, 1996, at a non-Gulfwatch site at Fox Point (NHFP) located ~2.5 k further into Little Bay to the west of NHDP. The average ΣPAH_{24} concentration was 1355 ng/g DW, more than twice as high as for the 16d sample and significantly greater than concentrations in any other sample. ΣPCB_{24},

$\Sigma PEST_{17}$ and ΣDDT_6 concentrations were not significantly different from concentrations in the tissue samples from NHDP. However, one of the four NHFP samples contained the only $\Sigma OPEST_{11}$ (4.1 ng chlordane and trans-nonachlor/g DW) detected in New Hampshire mussel samples in 1996. The elevated concentrations of PAHs in mussels at Fox Point compared to Dover Point may be related to the eventual distribution of the oil in the estuary after initial transport via water currents following the spill.

One sample of (twenty) oysters from NHFP was included for comparison and because they are recreationally harvested in the area. The ΣPAH_{24} concentration (1145 ng/g DW) was similar to the concentration for the NHFP mussels (1355 ng/g DW) but high compared to the NHDP samples. Thus, oysters also had elevated concentrations of PAHs 16 days after the oil spill, which occurred in July when shellfishing is closed in New Hampshire. In addition, the ΣPCB_{24} concentration (116 ng/g DW) was high compared to the mussels from both NHFP and NHDP. The $\Sigma PEST_{17}$ (39.5 ng/g DW) and ΣDDT_6 (33.2 ng/g DW) concentrations were much higher than the NHFP and NHDP mussels, and the oyster tissue also contained 6.3 ng/g $\Sigma OPEST_{11}$ (chlordane and trans-nonachlor).

ACCEPTABLE LEVELS AND STANDARDS OF MUSSEL CONTAMINATION

Limited information is available on human health effects of consumption of contaminated shellfish. Published tolerance or action levels for PAHs in commercial marine species are not available in Canada or in the United States. In marine areas where PAH contamination may be a human health concern, closure of commercial fisheries as a result of high contamination levels has been dealt with on a case by case basis. In general, most concentrations reported in the literature are on a wet weight basis in contrast to Gulfwatch dry weight values. To facilitate general comparisons with Gulfwatch values, an average moisture content of 85% has been applied to wet weight health values to derive dry weight equivalents.

All reported organic concentrations are within acceptable concentrations for those compounds that have established FDA Action Limits in fish and shellfish. PCB concentrations found in Gulfwatch mussels (Appendix C) are less than the action level of 13 ppm dry weight or 2 ppm wet weight (USFDA, 1990; CSSP, 1992). MERY had the highest concentrations of PCBs in mussels during the 1996 survey of 0.05 ± 0.03 ppm dry weight. Action levels for the pesticides dieldrin, aldrin, chlordane, heptachlor and heptachlor epoxide are 2.0 ppm dry weight or 0.3 ppm wet weight (USFDA, 1990). All of these pesticides were below detection concentrations in the 1996 mussel survey. The total DDT concentrations found are several orders-of-magnitude below the

action level of 33 ppm dry weight or 5 ppm wet weight (USFDA,1990; CSSP, 1992). Sandwich, MA had the highest level in 1996 of 0.02 ± 0.01 ppm dry weight. Canadian limits for agricultural chemicals exclusive of DDT are 0.67 ppm dry weight, or 0.1 ppm wet weight.

Admissible levels of methyl mercury, expressed as mercury, are less than 6.7 ppm dry weight or 1 ppm wet weight in the United States (USFDA, 1990) and less than 3.3 ppm dry weight or 0.5 ppm wet weight in Canada (CSSP, 1992). The highest concentration of mercury found in the 1996 Gulfwatch Project was 1.01 ± 0.39 ppm dry weight, at Royal River, Maine, which was well below both federal action concentrations.

Recently, a series of FDA "Guidance Documents" (USFDA, 1993) for cadmium, chromium, lead and nickel has been released in the United States to complement the FDA Mercury Action Level. These "alert" levels, however, are guidelines and by themselves do not warrant the issuance of health advisories. In Table 13, guidance concentrations are reported on both wet weight and dry weight bases and are compared to the highest observed concentration in any single replicate analyzed in the 1996 Gulfwatch project. No metal approached the guideline levels.

Table 13. A comparison of United States Food and Drug Administration guidelines for various metals with the Gulfwatch results.

Metal	Guideline (Wet weight)	Guideline (dry weight)	Highest Observed 1996 Gulfwatch value (dry weight)	Location
Cadmium	3.7 µg/g	25 µg/g	2.8 µg/g	Fort Point, ME
Chromium	13 µg/g	87 µg/g	2.9 µg/g	Clarke Cove, ME
Lead	1.7 µg/g	11.5 µg/g	5.2 µg/g	Argyle Sound, NS
Nickel	80 µg/g	533 µg/g	2.0 µg/g	Broad Cove, NS

The U.S. EPA has promulgated a series of "screening values" for three metals (Cd, Hg, Se), 11 organochlorine compounds, one chlorophenoxy herbicide, total PCBs and dioxins/dibenzofurans (EPA, 1993) which were derived using human health risk assessment procedures. The promulgated values are based on several exposure assumptions (70 kg man, an average consumption rate of 6.5 g/day), and either the most current Reference Dose (RfD) values for non-carcinogens or the most recent Slope Factor (SF) plus an acceptable lifetime cancer risk of

1 x 10-5 for the carcinogenic compounds listed. Exceedances of any of the screening values is meant to trigger a more in-depth assessment of actual human health risk. Applying these screening values to the Gulfwatch data provides yet another index of possible human health concern.

Mean concentrations of Cd, Hg and $\sum DDT_6$ at all 1996 Gulfwatch stations are well below the EPA Screening Values (EPA, 1993). The Screening Value for the $\sum PCB_{24}$ is exceedingly low (0.01 μg/g wet weight or approximately 0.07 μg/g dry weight; EPA, 1993). In 1996 no Gulfwatch sites exceeded this value.

MORPHOMETRIC COMPARISON

Table 14 contains a summary of the morphological measurements [length (mm), height (mm), width (mm), wet weight (g) and condition index (CI)] for indigenous mussels collected at each site.

Shell Morphology

The field protocol recommended the collection of mussels within the length range of 50 - 60 mm. The Gulfwide mean length (±SD) at the 18 sites was 55.0 ± 3.8 mm (Table 14; Figure 20). For the majority of sites, the mean length of mussels collected fell within the range of 50 - 60 mm. ANOVA on the length of mussels collected among sites was significant ($p<0.05$) suggesting that there were significant differences in length. This significant difference is a reflection of the size range available at the sites at the time of sampling.

Condition Index and Weight

Condition indices (CI) of indigenous mussels collected in 1996 are shown in Table 14 and Figure 21. The average CI (±SD) for all sites throughout the Gulf of Maine was 0.162 ± 0.054. ANOVA on the mean CI of all indigenous mussels was significant ($p<0.05$). The CI ranged from a value of 0.106 ± 0.023 at NSAG, to 0.263 ± 0.048 at MEKN. The CIs of all sites in Nova Scotia (NSFI, NSDI, NSBC, NSAG, and NSYR) were below the Gulf-wide mean. The CI varied in all jurisdictions with the exception of New Hampshire.

Analysis of covariance (ANCOVA) on wet weight, using length, height and width as covariates was performed among sites within each jurisdiction to determine the cause of the differences in CI. ANCOVA revealed that for all jurisdictions with the exception of New

Table 14. Morphometric characteristics (mean SD) of mussels collected at the Gulf of Maine, 1996 stations and ANOVA of measurements by jurisdiction. Same letter indicates no significant difference among sites within each jurisdiction. Overall mean for all stations given below. Wet wt. (adj) = wet wt. (g) adjusted for significant covariates (ANCOVA, $p<0.001$).

STATION	N	LENGTH (mm)	HEIGHT (mm)	WIDTH (mm)	WET WEIGHT (g)	WET WEIGHT (ADJ) (g)	CONDITION INDEX (CI)
MASN	30	59.3 ± 3.9C	29.3 ± 1.8B	24.7 ± 2.1B	8.84 ± 2.07B	8.08 ± 1.82B	0.205 ± 0.026B
MAMH	30	57.8 ± 2.6B	30.6 ± 1.5C	23.5 ± 1.1A	7.94 ± 1.11B	7.63 ± 1.05AB	0.191 ± 0.017AB
MAME	30	55.0 ± 3.1A	27.3 ± 1.5A	23.1 ± 2.0A	6.20 ± 1.18A	7.09 ± 1.50A	0.179 ± 0.022A
NHHS	30	52.9 ± 3.9A	28.0 ± 1.9A	21.4 ± 2.7A	5.71 ± 1.93A	5.75 ± 1.86A	0.180 ± 0.033A
MECC	30	54.5 ± 2.9B	28.8 ± 1.8B	21.4 ± 2.9A	5.56 ± 1.83A	5.02 ± 1.55A	0.162 ± 0.026A
MEBH	30	54.9 ± 3.7ABC	29.0 ± 3.4ABC	23.1 ± 2.1BC	6.25 ± 1.54A	6.08 ± 1.50A	0.168 ± 0.019A
MERY	30	54.3 ± 2.7A	29.8 ± 1.5C	22.5 ± 2.1ABC	9.41 ± 1.81C	9.33 ± 1.50C	0.259 ± 0.035C
MEKN	30	55.3 ± 2.7B	27.6 ± 1.5A	21.6 ± 1.9A	8.73 ± 2.16C	9.28 ± 2.35C	0.263 ± 0.048C
MEFP	30	54.4 ± 2.7AB	28.1 ± 1.5AB	21.9 ± 2.0AB	7.22 ± 1.67AB	7.76 ± 1.87B	0.217 ± 0.038B
MEPI	30	55.9 ± 2.7C	29.1 ± 1.8BC	23.8 ± 1.9C	8.42 ± 1.82BC	7.62 ± 1.58B	0.216 ± 0.043B
NBSC	30	49.9 ± 4.6A	22.6 ± 2.6A	19.0 ± 1.6A	3.55 ± 1.29A	4.45 ± 1.90A	0.166 ± 0.056A
NBCH	30	56.3 ± 3.8B	27.2 ± 2.2B	23.4 ± 2.1C	8.94 ± 1.99C	7.39 ± 1.50C	0.248 ± 0.031C
NBLN	30	51.8 ± 3.4A	25.9 ± 2.8B	21.9 ± 2.4B	5.58 ± 1.20B	5.49 ± 1.17B	0.191 ± 0.032B
NSFI	40	55.5 ± 3.0BC	29.5 ± 1.7B	23.8 ± 2.0CD	5.72 ± 1.62BC	5.26 ± 1.42CD	0.146 ± 0.033BC
NSDI	40	55.5 ± 2.6C	29.4 ± 2.2B	23.1 ± 2.0C	5.99 ± 1.23C	5.64 ± 1.12D	0.159 ± 0.026C
NSBC	40	55.9 ± 3.1C	31.2 ± 2.2C	25.0 ± 3.0D	5.00 ± 1.38B	4.26 ± 1.06B	0.114 ± 0.026A
NSAG	40	50.2 ± 3.6A	27.8 ± 2.3A	19.9 ± 2.3A	2.94 ± 0.85A	3.84 ± 1.39A	0.106 ± 0.023A
NSYR	40	54.4 ± 3.3B	30.2 ± 3.0BC	21.9 ± 1.8B	5.13 ± 1.61B	5.10 ± 1.59C	0.141 ± 0.034B
MEAN		55.0 ± 3.8	28.4 ± 2.0	22.5 ± 1.5	5.80 ± 2.32		0.162 ± 0.054

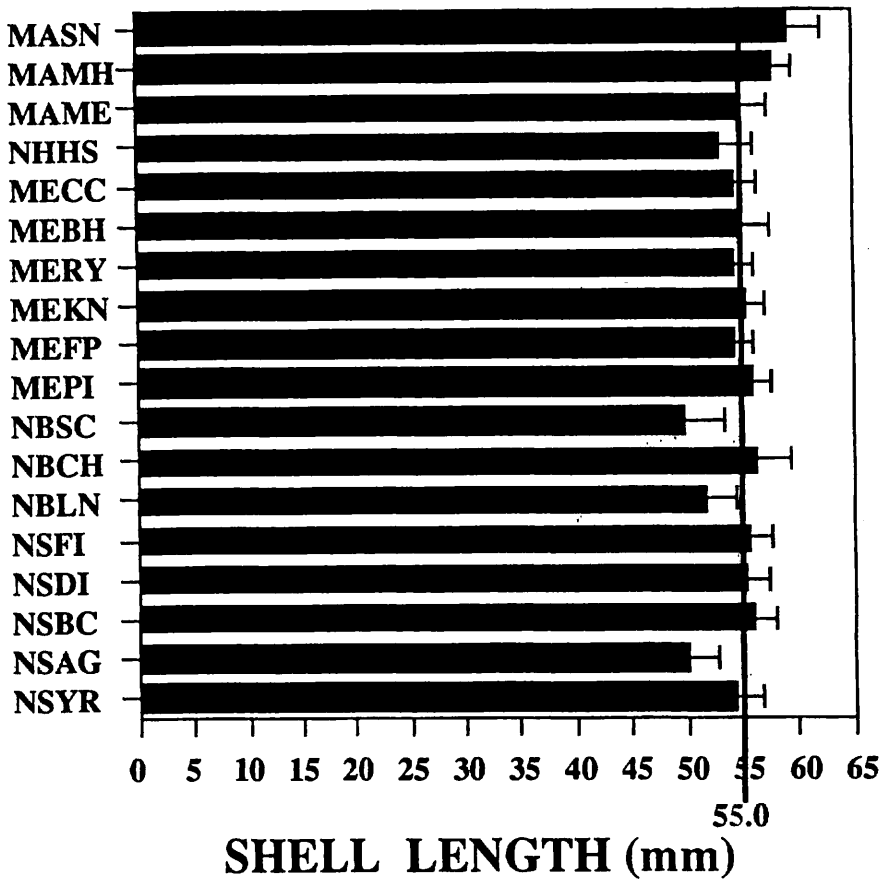

Figure 20. Mean length (±SD) of indigenous mussels collected at the Gulf of Maine stations, 1996, organized clockwise from south to north. Mean length of mussels from all sites is indicated by the straight line.

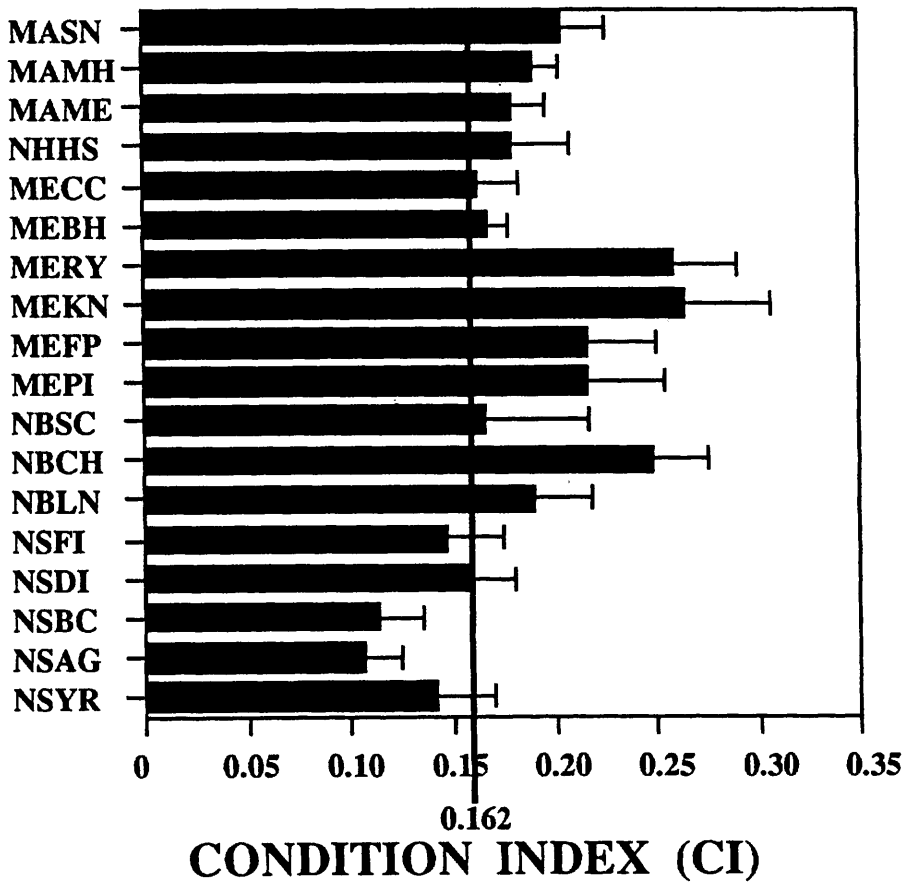

Figure 21. Mean condition indices (±SD) of indigenous mussels collected at the Gulf of Maine stations, 1996, organized clockwise from south to north. Mean condition index of mussels from all sites is indicated by the straight line.

Brunswick length, width, and height were all significant covariates. Width was the only significant covariate in New Brunswick. As a result, the wet weight among sites within each jurisdiction was adjusted for the covariates and then analyzed by ANOVA and Tukey Kramer test. Figure 22 and Table 14 show the adjusted mean weights for stations sampled in 1996. The Gulfwide mean wet weight (±SD) at the 18 sites was 5.80 ± 2.32 g. There was a significant relationship between adjusted wet weight and the CI at a given site ($p<0.05$).

CONCLUSIONS

The field season of 1996 represented the sixth Gulfwatch field season overall and the first year of the second three year rotation of the long-term plan in the Gulfwatch program. As part of the three year plan, the monitoring of indigenous mussels was carried out at prescribed sites that were previously sampled during 1994, in addition to the benchmark sites that are sampled yearly. Some trends for contaminant concentrations are beginning to emerge, especially for the benchmark sites. However, the relatively small number of sampling years results in relatively poor power to detect true differences. Nonetheless, the results remain important from in terms of determining a baseline for contaminant exposure concentrations in mussels. The continued occurrence of concentrations of Ag, Cd and Hg that are high compared to the rest of North America is a cause for concern. Atmospheric deposition is known to be a potentially significant source of contaminants, especially for mercury and cadmium (McAdie, 1994). However, there are no obvious explanations or confirmed sources for the elevated concentrations of these trace metals in mussels other than the existence of large population and industrial areas in some parts of the Gulf of Maine.

A few sites stood out relative contaminant concentrations. The MASN site has been considered a reference, or relatively uncontaminated site by the program. However, it is obvious that the consistently high concentration of Ag in mussel tissue from this site since 1993 suggests that there may be sources of contaminants near this site. In addition, concentrations of the organic contaminants, including CB and PCDD/PCDF, were all relatively high compared to other sites in 1996. In contrast, the NBCH site had the consistently lowest contaminant concentrations, which supports its consideration as an uncontaminated reference site. The continued detection of elevated concentrations of some contaminants at sites close to historical industrial sources (i.e, MECC) illustrates the long-term impacts that contaminants, probably associated with sediments, may have. Again, processing of mussels from sites like NSFI where elevated concentrations of Fe and Al are detected may require depuration for elimination of sediments from the tissue prior to analysis.

The expansion of contaminant analyses to include planar chlorobiphenyls and

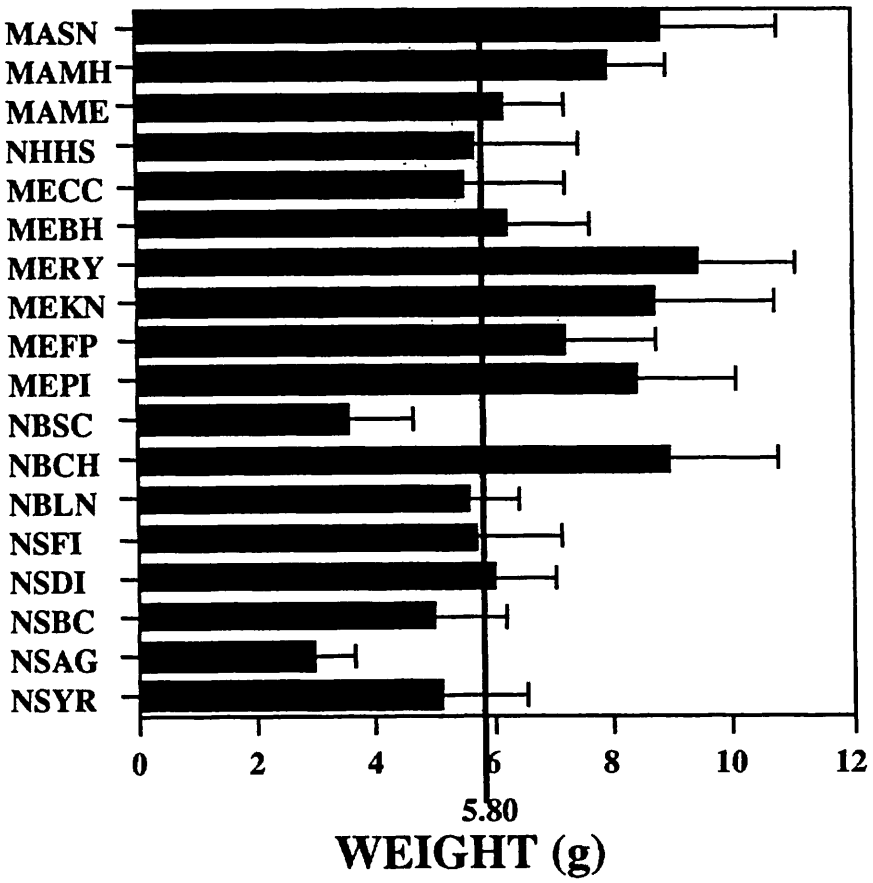

Figure 22. Mean wet weight (±SD) of indigenous mussels collected at the Gulf of Maine stations, 1996, organized clockwise from south to north. Mean weight of mussels from all sites is indicated by the straight line.

polychlorinated dibenzo dioxins and furans has provided a unique database for initial assessment of the bioexposure of these contaminants in the Gulf of Maine. The finding that the summed CB and PCDD/PCDF TEQs in 1996 Gulfwatch samples are well below the 20 pg/g 2,3,7,8-TCDD tolerance level (Canadian) that is protective of human health for the consumption of seafood is good news. Continued analysis of these contaminants would be expensive, and should only be conducted for sites where elevated concentrations would warrant further analyses. However, this response by the Gulfwatch program to address an emerging toxic contaminant issue serves as an invaluable baseline of information for further more detailed studies.

The use of the Gulfwatch program to provide information in response to an oil spill was also a new activity for the program. The findings for the oil spill in the Great Bay Estuary can serve as a small study that can help resource managers in both Maine and New Hampshire to understand the impacts and fate of the spilled oil. Having strategically located sampling sites in so many areas Gulfwide provides a baseline database for comparison to findings of studies conducted after such events as oil spills. The continued sampling in ensuing years will provide more long-term insight into the effects of the spill.

Coastal monitoring programs such as Gulfwatch provide a valuable measure of the current state of the coastal environment, for identifying future problems which may be prevented by early action, for determining trends in contamination over space and time, and for identifying potential sources of contamination. Gulfwatch results provide a geographically comprehensive, region-specific perspective on relative contaminant concentrations in both contaminated and pristine areas. As such, it is an unique and invaluable basis for making management decisions on issues relating to toxic contaminants. Continuation of the Gulfwatch program according to the ten year plan will provide the temporal perspective necessary to determine trends and impacts of remediation efforts.

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APPENDIX A. Tissue concentrations of trace metals in Mytilus edulis in the Gulf of Maine, 1995. (µg/g dry weight; mean and standard deviation (SD))

STATION	Ag	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn	%SOLID
					MASSACHUSETTS						
MASN1	1.30	160	1.2	1.3	12.0	330	0.34	1.1	2.9	98	12.7
MASN2	0.60	110	1.1	0.9	7.2	260	0.30	1.1	2.9	83	16.1
MASN3	0.90	160	1.6	1.3	9.2	360	0.39	1.2	4.3	92	11.3
MASN4	1.10	150	1.4	1.2	8.8	340	0.38	1.0	3.4	91	13.1
Mean	**0.98**	**145**	**1.3**	**1.2**	**9.3**	**323**	**0.35**	**1.1**	**3.4**	**91**	**13.3**
SD	0.30	24	0.2	0.2	2.0	43	0.04	0.1	0.7	6	2.0
MAMH1	0.19	270	1.4	3.2	6.9	420	0.50	1.4	4.1	110	12.0
MAMH2	0.17	190	1.3	2.5	6.6	320	0.58	1.3	3.3	100	13.3
MAMH3	0.17	200	1.5	2.7	7.2	320	0.50	1.3	3.7	130	12.3
MAMH4	0.46	250	1.2	2.9	7.6	400	0.62	1.2	3.1	100	13.2
Mean	**0.25**	**228**	**1.4**	**2.8**	**7.1**	**365**	**0.55**	**1.3**	**3.6**	**110**	**12.7**
SD	0.14	39	0.1	0.3	0.4	53	0.06	0.1	0.4	14	0.7
MAME1	ND 0.1	140	2.3	2.1	8.0	420	0.68	1.5	3.3	94	9.3
MAME2	ND 0.1	99	2.0	1.7	6.7	330	0.68	1.4	3.1	82	9.6
MAME3	ND 0.1	160	2.0	2.1	7.4	400	0.39	1.4	3.8	93	10.7
MAME4	ND 0.1	80	1.3	1.4	4.3	250	0.40	1.0	2.3	55	9.4
Mean	ND	**120**	**1.9**	**1.8**	**6.6**	**350**	**0.54**	**1.3**	**3.1**	**81**	**9.7**
SD		37	0.4	0.3	1.6	77	0.16	0.2	0.6	18	0.6
					NEW HAMPSHIRE						
NHHS1	0.10	190	1.3	1.4	7.6	300	0.44	1.2	1.5	110	14.5
NHHS2	ND 0.1	190	1.7	1.4	8.5	300	0.48	1.1	2.6	130	13.7
NHHS3	0.11	170	1.4	1.2	7.4	280	0.44	1.0	1.8	110	15.1
NHHS4	0.13	190	1.6	1.7	8.1	290	0.62	1.1	3.4	110	13.0
Mean	**0.11**	**185**	**1.5**	**1.4**	**7.9**	**293**	**0.50**	**1.1**	**2.3**	**115**	**14.1**
SD	0.02	10	0.2	0.2	0.5	10	0.09	0.1	0.9	10	0.9
					MAINE						
MECC1	ND 0.1	290	1.7	2.7	7.6	460	0.47	1.4	4.7	110	12.6
MECC2	0.10	330	2.0	3.1	7.8	560	0.79	1.4	5.0	110	12.4
MECC3	ND 0.1	400	1.6	3.2	8.7	580	0.98	1.6	5.8	110	11.2
MECC4	ND 0.1	320	1.6	2.5	8.8	470	1.20	1.3	4.9	120	12.1
Mean	**0.10**	**335**	**1.7**	**2.9**	**8.2**	**518**	**0.86**	**1.4**	**5.1**	**113**	**12.1**
SD		47	0.2	0.3	0.6	61	0.31	0.1	0.5	5	0.6

STATION	Ag	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn	%SOLID
		MAINE-continued									
MEBH1	0.38	290	1.8	1.5	7.2	350	0.30	1.6	2.0	120	12.6
MEBH2	0.18	290	1.5	1.4	6.1	350	0.46	1.3	1.6	100	12.6
MEBH3	0.26	300	1.9	1.6	6.3	380	0.47	1.6	1.9	100	12.6
MEBH4	0.36	280	1.6	1.5	6.9	330	0.46	1.4	2.0	120	12.1
Mean	**0.30**	**290**	**1.7**	**1.5**	**6.6**	**353**	**0.42**	**1.5**	**1.9**	**110**	**12.5**
SD	0.09	8	0.2	0.1	0.5	21	0.08	0.2	0.2	12	0.2
MERY1	ND 0.1	310	3.6	2.5	10.0	580	0.63	2.0	3.2	120	6.0
MERY2	ND 0.1	400	2.9	2.4	11.0	760	0.72	1.9	2.6	120	5.8
MERY3	ND 0.1	170	2.2	1.2	6.9	330	1.40	1.2	1.7	72	6.5
MERY4	ND 0.1	280	2.3	2.0	7.5	470	1.30	1.6	2.3	86	7.1
Mean	**ND**	**290**	**2.8**	**2.0**	**8.9**	**535**	**1.01**	**1.7**	**2.5**	**100**	**6.3**
SD		95	0.6	0.6	2.0	182	0.39	0.4	0.6	24	0.6
MEKN1	0.24	240	2.4	2.1	8.2	410	1.10	1.6	1.6	89	8.9
MEKN2	0.10	240	2.6	2.3	8.2	450	0.47	1.5	1.8	80	8.4
MEKN3	0.10	110	2.1	1.6	6.7	260	0.64	1.2	0.8	67	6.9
MEKN4	0.15	160	2.3	1.7	6.7	320	0.48	1.3	1.1	67	8.4
Mean	**0.15**	**188**	**2.4**	**1.9**	**7.5**	**360**	**0.67**	**1.4**	**1.3**	**76**	**8.2**
SD	0.07	64	0.2	0.3	0.9	86	0.30	0.2	0.5	11	0.9
MEFP1	ND 0.1	460	2.9	2.8	9.8	830	0.88	1.9	3.4	130	7.7
MEFP2	ND 0.1	240	2.4	2.3	6.3	500	1.22	1.2	2.2	76	8.6
MEFP3	0.20	360	3.2	2.9	8.6	750	0.79	1.7	3.1	120	8.6
MEFP4	0.10	310	2.6	2.4	7.9	650	0.73	1.7	2.5	85	7.7
Mean	**0.15**	**343**	**2.8**	**2.6**	**8.2**	**683**	**0.91**	**1.6**	**2.8**	**103**	**8.2**
SD	0.07	93	0.4	0.3	1.5	142	0.22	0.3	0.5	26	0.5
MEPI1	ND 0.1	200	1.7	1.2	6.1	270	0.40	0.8	1.0	95	11.6
MEPI2	0.12	210	1.5	1.3	5.7	300	0.40	1.1	0.9	79	10.2
MEPI3	ND 0.1	190	1.9	1.4	6.5	290	0.48	1.1	1.2	92	10.4
MEPI4	0.10	230	1.6	1.5	5.7	310	0.76	1.2	0.8	80	11.6
Mean	**0.11**	**208**	**1.7**	**1.4**	**6.0**	**293**	**0.51**	**1.1**	**1.0**	**87**	**11.0**
SD	0.01	17	0.2	0.1	0.4	17	0.17	0.2	0.2	8	0.8

STATION	Ag	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn	%SOLID
				NEW BRUNSWICK							
NBSC1	0.10	360	1.3	1.2	5.9	520	0.51	1.5	1.1	110	11.0
NBSC2	0.10	420	1.7	1.4	6.3	640	0.60	1.8	1.6	120	11.9
NBSC3	ND 0.1	410	1.4	1.4	5.4	590	0.44	1.6	1.4	93	10.5
NBSC4	ND 0.1	390	1.5	1.3	5.7	560	0.53	1.8	1.5	100	11.4
Mean	**0.10**	**395**	**1.5**	**1.3**	**5.8**	**578**	**0.52**	**1.7**	**1.4**	**106**	**11.2**
SD	0.00	26	0.2	0.1	0.4	51	0.07	0.2	0.2	12	0.6
NBCH1	ND 0.1	150	0.9	0.6	4.2	210	0.37	ND 0.8	0.8	62	15.7
NBCH2	ND 0.1	180	0.8	0.6	4.4	230	0.29	ND 0.8	0.7	73	14.9
NBCH3	0.10	170	1.1	0.6	4.6	230	0.41	ND 0.8	0.7	83	13.5
NBCH4	0.10	220	0.9	0.7	4.4	270	0.57	ND 0.8	0.8	63	15.3
Mean	**0.10**	**180**	**0.9**	**0.6**	**4.4**	**235**	**0.41**	**ND**	**0.8**	**70**	**14.9**
SD	0.00	29	0.1	0.1	0.2	25	0.12		0.1	10	1.0
NBLN1	ND 0.1	250	1.3	1.0	6.5	340	0.35	0.9	1.4	120	13.0
NBLN2	ND 0.1	260	1.4	1.0	7.0	350	0.33	0.9	1.4	91	13.2
NBLN3	ND 0.1	300	1.4	1.1	6.6	390	0.42	0.9	1.6	110	12.4
NBLN4	ND 0.1	340	1.4	1.1	6.5	450	0.49	1.1	1.6	100	12.5
Mean	**ND**	**288**	**1.4**	**1.1**	**6.7**	**383**	**0.40**	**1.0**	**1.5**	**105**	**12.8**
SD		41	0.0	0.1	0.2	50	0.07	0.1	0.1	13	0.4
				NOVA SCOTIA							
NSFI1	ND 0.1	690	2.2	1.7	5.7	840	0.38	1.7	1.1	54	15.0
NSFI2	ND 0.1	810	2.2	1.9	6.1	980	0.40	1.8	1.3	50	16.7
NSFI3	ND 0.1	640	2.4	1.6	5.8	770	0.37	1.7	1.0	51	16.8
NSFI4	ND 0.1	720	2.5	1.7	5.6	910	0.34	1.8	1.2	52	16.8
Mean	**ND**	**715**	**2.3**	**1.7**	**5.8**	**875**	**0.37**	**1.8**	**1.2**	**52**	**16.3**
SD		71	0.1	0.1	0.2	90	0.03	0.1	0.1	2	0.9
NSDI1	ND 0.1	340	1.3	1.4	7.3	450	0.65	1.2	2.8	86	15.3
NSDI2	ND 0.1	330	1.4	1.6	7.6	510	0.25	1.3	3.3	83	15.7
NSDI3	ND 0.1	260	1.5	1.5	5.8	380	0.27	1.1	3.1	86	14.6
NSDI4	ND 0.1	320	1.5	1.6	7.3	470	0.34	1.4	3.3	110	15.2
Mean	**ND**	**313**	**1.4**	**1.5**	**7.0**	**453**	**0.38**	**1.3**	**3.1**	**91**	**15.2**
SD		36	0.1	0.1	0.8	54	0.19	0.1	0.2	13	0.4
NSBC1	ND 0.1	230	2.5	1.9	6.0	410	0.23	1.8	3.0	82	15.3
NSBC2	ND 0.1	260	2.7	1.9	5.3	420	0.46	1.8	2.9	91	13.9
NSBC3	ND 0.1	260	2.7	2.0	5.8	420	0.29	1.9	2.6	110	14.2
NSBC4	ND 0.1	260	2.4	2.0	6.2	430	0.26	2.3	2.8	97	14.2
Mean	**ND**	**253**	**2.6**	**2.0**	**5.8**	**420**	**0.31**	**2.0**	**2.8**	**95**	**14.4**
SD		15	0.1	0.1	0.4	8	0.10	0.2	0.2	12	0.6

STATION	Ag	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn	%SOLID
		NOVA SCOTIA-continued									
NSAG1	ND 0.1	140	2.4	1.5	7.0	480	0.52	1.8	5.8	71	10.9
NSAG2	ND 0.1	170	1.9	1.7	6.6	460	0.67	1.3	4.2	77	11.6
NSAG3	ND 0.1	180	1.9	1.5	6.2	490	0.73	1.5	5.5	86	11.4
NSAG4	ND 0.1	150	2.1	1.6	6.5	470	0.62	1.5	5.2	78	12.1
Mean	**ND**	**160**	**2.1**	**1.6**	**6.6**	**475**	**0.64**	**1.5**	**5.2**	**78**	**11.5**
SD		18	0.2	0.1	0.3	13	0.09	0.2	0.7	6	0.5
NSYRI	0.36	270	1.9	1.8	8.4	550	0.63	2.1	4.3	100	11.0
NSYR2	0.18	230	2.0	1.6	8.1	480	0.66	1.8	4.9	130	11.8
NSYR3	0.19	230	1.9	1.7	7.2	490	0.68	1.7	3.5	130	10.7
NSYR4	0.20	140	2.2	1.4	7.1	450	0.64	1.5	3.7	130	11.4
Mean	**0.23**	**218**	**2.0**	**1.6**	**7.7**	**493**	**0.65**	**1.8**	**4.1**	**123**	**11.2**
SD	0.09	55	0.1	0.2	0.6	42	0.02	0.2	0.6	15	0.4

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	MAME1N	MAME2N	MAME3N	MAME4N	MAMH10	MAMH20	MAMH30	MAMH40
Naphthalene	<30	<30	<30	<30	<30	<30/<30	<30	<30
2-Me naphthalene	<30	<30	<30	<30	<30	<30/<30	<30	<30
1-Me naphthalene	<30	<30	<30	<30	<30	<30/<30	<30	<30
Biphenyl	<20	<20	<20	<20	<20	<20/<20	<20	<20
2,6-Dime naphthalene	<20	<20	<20	<20	<20	<20/<20	<20	<20
Acenaphthylene	<10	<10	<10	<10	<10	<10/<10	<10	<10
Acenaphthene	<10	<10	<10	<10	<10	<10/<10	<10	<10
2,3,5-Trime naphthalene	<20	<20	<10*	<20	<20	<20/<20	<20	<20
Fluorene	<10	<10	<10	<10	<10	<10/<10	<10	<10
Phenanthrene	32	31	31	46	14	13/13	18	13
Anthracene	<10	<10	<10	<10	<10	<10/<10	<10	<10
1-Me phenanthrene	<10	<10	13.4	11	<10	<10/<10	<10	<10
Fluoranthene	84	75	89	106	19	18/17	28	17
Pyrene	79	68	86	103	15	14/14	20	13
Benzo(a)Anthracene	24	18	29	28	<10	<10/<10	<10	<10
Chrysene	33	26	37	37	10	<10/<10	13	<10
Benzo(b+k)Fluoranthen	38	30	46	44	13	12/12	20	<10
Benzo(e)pyrene	24	19	27	29	10	<10/<10	13	<10
Benzo(a)pyrene	12	<10	13	14	<10	<10/<10	<10	<10
Perylene	<10	<10	<10	<10	<10	<10/<10	<10	<10
Indeno(123cd)pyrene	10	<10	10.6	13	<10	<10/<10	<10	<10
Dibenzo(ah)anthracene	<10	<10	<10	<10	<10	<10/<10	<10	<10
Benzo(ghi)perylene	14	<10	11.9	21	<10	<10/<10	<10	<10
Total	350	268	393	452	80	57/56	111	43
Surrogate Recovery								
Naphtalene-d8	41	33	50	34	51	51	80	56
Acenaphthene-d10	59	51	67	57	65	71	97	70
Phenanthrene-d10	72	64	73	77	83	82	115	78
Fluoranthene-d10	94	80	91	98	100	96	129	88
Chrysene-d12	91	71	83	82	101	95	129	88
Benzo[a]pyrene-d12	90	70	84	86	92	85	113	73
Benzo[ghi]perylene-d12	89	77	85	97	88	81	109	77

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	MASN1N	MASN2N	MASN3N	MASN4N	MEBH1N	MEBH2N	MEBH3N	MEBH4N
Naphthalene	<30	<30/<30	<30	<30	<30	<30	<30	<30
2-Me naphthalene	<30	<30/<30	<30	<30	<30	<30	<30	<30
1-Me naphthalene	<30	<30/<30	<30	<30	<30	<30	<30	<30
Biphenyl	<20	<20/<20	<20	<20	<20	<20	<20	<20
2,6-Dime naphthalene	<20	<20/<20	<20	<20	<20	<20	<20	<20
Acenaphthylene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Acenaphthene	<10	<10/<10	<10	<10	<10	<10	<10	<10
2,3,5-Trime naphthalene	<20	<20/<20	<20	<20	<20	<20	<20	<20
Fluorene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Phenanthrene	14	16/12	16	15	<10	<10	<10	<10
Anthracene	<10	<10/<10	<10	<10	<10	<10	<10	<10
1-Me phenanthrene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Fluoranthene	23	21/21	21	21	<10	<10	<10	<10
Pyrene	15	12 18	13	16	<10	<10	<10	<10
Benzo(a)Anthracene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Chrysene	11	<10/10	<10	<10	<10	<10	<10	<10
Benzo(b+k)Fluoranthene	<10	13 11	<10	<10	<10	<10	<10	<10
Benzo(e)pyrene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Benzo(a)pyrene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Perylene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Indeno(123cd)pyrene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Dibenzo(ah)anthracene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Benzo(ghi)perylene	<10	<10/<10	<10	<10	<10	<10	<10	<10
Total	63	62/72	50	52	ND	ND	ND	ND
Surrogate Recovery								
Naphtalene-d8	43	65/23	58	32	50	34	35	32
Acenaphthene-d10	58	74/30	70	43	69	44	49	50
Phenanthrene-d10	76	77/46	75	63	78	56	66	62
Fluoranthene-d10	93	93/87	95	91	95	82	86	84
Chrysene-d12	93	93/94	93	95	93	91	86	89
Benzo[a]pyrene-d12	75	91/96	87	97	83	72	79	80
Benzo[ghi]perylene-d12	59	76/76	69	76	86	60	79	83

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	MECC1N	MECC2N	MECC3N	MECC4N	MEFP1N	MEFP2N	MEFP3N	MEFP4N
Naphthalene	<30	<30	<30	<30/<30	<30	<30	<30	<30
2-Me naphthalene	<30	<30	<30	<30/<30	<30	<30	<30	<30
1-Me naphthalene	<30	<30	<30	<30/<30	<30	<30	<30	<30
Biphenyl	<20	<20	<20	<20/<20	<20	<20	<20	<20
2,6-Dime naphthalene	<20	<20	<20	<20/<20	<20	<20	<20	<20
Acenaphthylene	<10	<10	10	<10/<10	<10	<10	<10	<10
Acenaphthene	<10	<10	<10	<10/<10	17	15	13	11
2,3,5-Trime naphthalene	<20	<20	21	<20/<20	<20	<20	<20	<20
Fluorene	<10	<10	<10	<10/<10	16	14	12	12
Phenanthrene	13	12	13	14/14	76	63	40	68
Anthracene	<10	<10	<10	<10/<10	14	10	<10	12
1-Me phenanthrene	<10	<10	<10	<10/<10	10	<10	<10	13
Fluoranthene	35	35	41	36/40	191	169	111	172
Pyrene	32	33	39	32/35	146	112	85	154
Benzo(a)Anthracene	13	13	14	12/12	53	56	35	67
Chrysene	19	22	25	22/24	62	48	39	48
Benzo(b+k)Fluoranthen	34	37	39	32/35	78	72	50	93
Benzo(e)pyrene	20	22	23	20/22	40	32	27	63
Benzo(a)pyrene	<10	<10	<10	<10/<10	18	20	12	29
Perylene	<10	<10	<10	<10/<10	22	19	15	18
Indeno(123cd)pyrene	11	11	<10	10/11	15	15	11	25
Dibenzo(ah)anthracene	<10	<10	<10	<10/<10	<10	<10	<10	<10
Benzo(ghi)perylene	12	12	11	<10/13	14	12	10	47
Total	187	197	235	178/206	770	657	460	832
Surrogate Recovery								
Naphtalene-d8	46	46	50	47/51	55	30	28	40
Acenaphthene-d10	65	64	69	67/67	81	57	46	60
Phenanthrene-d10	73	75	77	79/75	88	65	50	82
Fluoranthene-d10	94	95	97	98/95	105	79	73	104
Chrysene-d12	82	93	93	94/91	113	73	84	104
Benzo[a]pyrene-d12	83	86	86	86/86	106	68	78	105
Benzo[ghi]perylene-d12	94	84	83	89/82	111	71	61	88

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	MEPI1N	MEPI2N	MEPI3N	MEPI4N	MEKN1N	MEKN2N	MEKN3N	MEKN4N
Naphthalene	<30/<30	<30	<30	<30	<30	<30	<30	<30
2-Me naphthalene	<30/<30	<30	<30	<30	<30	<30	<30	<30
1-Me naphthalene	<30/<30	<30	<30	<30	<30	<30	<30	<30
Biphenyl	<20/<20	<20	<20	<20	<20	<20	<20	<20
2,6-Dime naphthalene	<20/<20	<20	<20	<20	<20	<20	<20	<20
Acenaphthylene	<10/<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthene	<10/<10	<10	<10	<10	<10	<10	<10	<10
2,3,5-Trime naphthalene	<20/<20	<20	<20	<20	<20	<20	<20	<20
Fluorene	<10/<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	<10/<10	<10	<10	<10	<10	<10	10	<10
Anthracene	<10/<10	<10	<10	<10	<10	<10	<10	<10
1-Me phenanthrene	<10/<10	<10	<10	<10	<10	<10	<10	<10
Fluoranthene	<10/<10	<10	<10	<10	20	19	18	19
Pyrene	<10/<10	<10	<10	<10	24	22	20	24
Benzo(a)Anthracene	<10/<10	<10	<10	<10	22	<10	14	16
Chrysene	<10/<10	<10	<10	<10	20	14	12	10
Benzo(b+k)Fluoranthen	11/<10	10	<10	12	35	11	27	24
Benzo(e)pyrene	<10/<10	<10	<10	11	22	14	21	20
Benzo(a)pyrene	<10/<10	<10	<10	<10	16	<10	10	10
Perylene	<10/<10	<10	<10	<10	10	<10	<10	<10
Indeno(123cd)pyrene	10/10	10	<10	11	17	<10	15	16
Dibenzo(ah)anthracene	<10/<10	<10	<10	<10	11	<10	11	11
Benzo(ghi)perylene	<10/<10	<10	<10	10	11	<10	10	14
Total	21/10	20	ND	44	207	80	169	162
Surrogate Recovery								
Naphtalene-d8	28/27	56	63	41	20	61	42	39
Acenaphthene-d10	44/41	71	78	54	29	78	58	57
Phenanthrene-d10	73/68	77	85	70	54	85	81	70
Fluoranthene-d10	96/98	93	95	92	91	100	102	92
Chrysene-d12	101/102	98	94	98	102	99	108	93
Benzo[a]pyrene-d12	99/101	99	73	100	100	81	106	93
Benzo[ghi]perylene-d12	81/84	83	61	82	83	61	88	80

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	MERY1N	MERY2N	MERY3N	MERY4N	NHHS1N	NHHS2N	NHHS3N	NHHS4N
Naphthalene	<30	<30	<30	<30	<30	<30	<30	<30
2-Me naphthalene	<30	<30	<30	<30	<30	<30	<30	<30
1-Me naphthalene	<30	<30	<30	<30	<30	<30	<30	<30
Biphenyl	<20	<20	<20	<20	<20	<20	<20	<20
2,6-Dime naphthalene	<20	<20	<20	<20	<20	<20	<20	<20
Acenaphthylene	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthene	<10	<10	<10	<10	<10	<10	<10	<10
2,3,5-Trime naphthalene	<20	<20	<20	<20	<20	<20	<20	24
Fluorene	<10	<10	<10	<10	<10	<10	<10	13
Phenanthrene	<10	<10	<10	<10	11	14	11	29
Anthracene	<10	<10	<10	<10	<10	<10	<10	<10
1-Me phenanthrene	<10	<10	<10	<10	<10	<10	<10	<10
Fluoranthene	14	15	11	13	16	22	19	40
Pyrene	12	20	<10	11	13	31	16	29
Benzo(a)Anthracene	<10	12	<10	<10	<10	<10	<10	11
Chrysene	<10	<10	<10	<10	<10	13	<10	15
Benzo(b+k)Fluoranthene	<10	18	<10	10	11	11	12	13
Benzo(e)pyrene	<10	18	<10	<10	<10	19	<10	13
Benzo(a)pyrene	<10	<10	<10	<10	<10	<10	<10	<10
Perylene	11	<10	<10	11	<10	<10	<10	<10
Indeno(123cd)pyrene	<10	11	<10	<10	<10	<10	<10	<10
Dibenzo(ah)anthracene	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(ghi)perylene	<10	14	<10	<10	<10	22	<10	<10
Total	36	108	11	46	51	132	58	187
Surrogate Recovery								
Naphtalene-d8	37	44	33	42	37%	55%	51%	57
Acenaphthene-d10	40	60	31	46	49%	69%	65%	75
Phenanthrene-d10	68	74	52	62	67%	79%	81%	84
Fluoranthene-d10	83	93	78	80	89%	92%	97%	97
Chrysene-d12	78	93	76	78	90%	91%	101%	96
Benzo[a]pyrene-d12	69	94	60	63	79%	73%	88%	79
Benzo[ghi]perylene-d12	65	77	64	64	77%	78%	85%	61

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	NHDP1N	NHDP2N	NHDP3N	NHDP4N	NHFP1N	NHFP2N	NHFP3N	NHFP4N
	7/16/96	7/16/96	7/16/96	7/16/96				
Naphthalene	<30	<30	<30/<30	<30	<30	<30	<30	<30
2-Me naphthalene	<30	<30	<30/<30	<30	<30	<30	<30	<30
1-Me naphthalene	<30	<30	<30/<30	<30	<30	<30	<30	<30
Biphenyl	<20	<20	<20/<20	<20	<20	<20	<20	<20
2,6-Dime naphthalene	<20	<20	<20/<20	<20	25	25	35	81
Acenaphthylene	<10	<10	<10/<10	<10	<10	<10	<10	<10
Acenaphthene	<10	<10	<10/<10	<10	<10	11	<10	10
2,3,5-Trime naphthalene	22	23	26/35	21	50	54	80	121
Fluorene	<10	<10	<10/<10	<10	<10	15	13	18
Phenanthrene	19	20	24/27	21	46	97	81	125
Anthracene	<10	<10	<10/<10	<10	12	19	20	30
1-Me phenanthrene	25	32	36/37	34	109	139	169	243
Fluoranthene	64	71	86/92	70	64	112	92	102
Pyrene	85	95	112/119	96	134	178	181	229
Benzo(a)Anthracene	45	52	57/57	54	107	104	115	156
Chrysene	75	87	97/101	89	182	177	196	264
Benzo(b+k)Fluoranthene	103	112	121/129	110	126	133	141	166
Benzo(e)pyrene	54	59	69/72	58	80	84	89	110
Benzo(a)pyrene	23	24	27/28	24	46	35	41	59
Perylene	20	21	23/23	19	33	36	39	47
Indeno(123cd)pyrene	17	16	19/19	16	15	16	17	20
Dibenzo(ah)anthracene	<10	<10	<10/<10	<10	<10	<10	<10	<10
Benzo(ghi)perylene	16	15	18/19	15	17	16	17	21
Total	566	626	715/759	626	1045	1251	1324	1801
Surrogate Recovery								
Naphtalene-d8	29	32	32/41	16	37	27	31	43
Acenaphthene-d10	54	59	48/65	35	62	48	54	76
Phenanthrene-d10	76	84	75/91	76	90	91	87	97
Fluoranthene-d10	104	107	101/113	106	132	134	125	140
Chrysene-d12	102	106	101/107	106	111	114	112	117
Benzo[a]pyrene-d12	88	89	87/92	89	98	95	95	102
Benzo[ghi]perylene-d12	79	81	78/81	81	85	85	82	85

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)									
PAH	NHFP5N	NHDP1N	NHDP2N	NHDP3N	NHDP4N	NSBCN10	NSBCN20	NSBCN30	NSBCN40
		10/1/96	10/1/96	10/1/96	10/1/96				
Naphthalene	<30	<30	<30	<30	<30	<30	<30	<30 /<30	<30
2-Me naphthalene	<30	<30	<30	<30	<30	<30	<30	<30 /<30	<30
1-Me naphthalene	<30	<30	<30	<30	<30	<30	<30	<30 /<30	<30
Biphenyl	<20	<20	<20	<20	<20	<20	<20	<20 /<20	<20
2,6-Dime naphthalene	24	<20	<20	<20	<20	<20	<20	<20 /<20	<20
Acenaphthylene	<10	<10	<10	<10	<10	<10	<10	11/<10	11
Acenaphthene	<10	<10	<10	<10	<10	<10	12	<10 /<10	<10
2,3,5-Trime naphthalene	64	<20	<20	<20	<20	<20	<20	<20 /<20	<20
Fluorene	10	<10	<10	<10	<10	<10	11	<10 /<10	10
Phenanthrene	39	12	12	13	13	28	33	26/24	50
Anthracene	11	<10	<10	<10	<10	<10	<10	<10 /<10	10
1-Me phenanthrene	93	<10	<10	<10	<10	<10	10	<10 /<10	12
Fluoranthene	110	28	31	33	45	78	71	59/49	95
Pyrene	165	34	37	40	54	60	55	43/36	66
Benzo(a)Anthracene	202	19	18	21	29	27	25	28/24	27
Chrysene	107	27	28	30	43	22	23	22/19	23
Benzo(b+k)Fluoranthene	147	56	55	61	82	22	23	24/21	23
Benzo(e)pyrene	77	29	30	33	47	17	19	15/14	15
Benzo(a)pyrene	29	13	12	12	17	<10	<10	<10 /<10	<10
Perylene	24	14	14	15	22	<10	<10	<10 /<10	<10
Indeno(123cd)pyrene	19	12	13	12	17	<10	<10	<10 /<10	<10
Dibenzo(ah)anthracene	11	<10	<10	<10	<10	<10	<10	<10 /<10	<10
Benzo(ghi)perylene	15	14	14	14	19	10	13	<10 /<10	<10
Total	1145	257	264	285	387	263	296	228/197	342
Surrogate Recovery									
Naphtalene-d8	42	58%	44%	47%	61%	19	48	29/25	37
Acenaphthene-d10	64	71%	62%	61%	77%	33	75	52/46	66
Phenanthrene-d10	82	77%	75%	80%	101%	45	85	61/56	77
Fluoranthene-d10	126	92%	89%	94%	129%	82	103	88/74	92
Chrysene-d12	104	95%	87%	91%	136%	93	107	97/93	95
Benzo[a]pyrene-d12	99	82%	75%	79%	127%	80	98	89/78	74
Benzo[ghi]perylene-d12	84	79%	73%	77%	120%	74	98	77/74	76

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	NSFIN01	NSFIN02	NSFIN03	NSFIN04	NSYR1N0	NSYR2N0	NSYR3NO	NSYR4N0
Naphthalene	<30/<30	<30	<30	<30	<30	<30	<30	<30
2-Me naphthalene	<30/<30	<30	<30	<30	<30	<30	<30	<30
1-Me naphthalene	<30/<30	<30	<30	<30	<30	<30	<30	<30
Biphenyl	<20/<20	<20	<20	<20	<20	<20	<20	<20
2,6-Dime naphthalene	<20/<20	<20	<20	<20	<20	<20	<20	<20
Acenaphthylene	12/<10	<10	<10	<10	<10	11	<10	10
Acenaphthene	<10/<10	<10	<10	<10	<10	<10	<10	<10
2,3,5-Trime naphthalene	52/41*	20 *	<20	<20	<20	75	<20	36
Fluorene	<10/<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	10/<10	<10	<10	12	11	18	16	16
Anthracene	<10/<10	<10	<10	<10	<10	<10	<10	<10
1-Me phenanthrene	<10/<10	<10	<10	<10	<10	<10	<10	<10
Fluoranthene	12/11	<10	11	12	38	54	45	48
Pyrene	<10/<10	<10	<10	<10	<10	17	27	10
Benzo(a)Anthracene	<10/<10	<10	<10	<10	14	17	19	15
Chrysene	<10/<10	<10	<10	<10	16	19	15	17
Benzo(b+k)Fluoranthen	<10/<10	<10	<10	<10	12	14	28	26
Benzo(e)pyrene	<10/<10	<10	<10	14	11	13	14	12
Benzo(a)pyrene	<10/<10	<10	<10	<10	<10	<10	<10	<10
Perylene	<10/<10	<10	16	<10	<10	<10	<10	<10
Indeno(123cd)pyrene	<10/<10	<10	<10	10	<10	<10	11	<10
Dibenzo(ah)anthracene	<10/<10	<10	<10	<10	<10	<10	<10	<10
Benzo(ghi)perylene	<10/<10	<10	<10	<10*	<10	<10	<10	<10
Total	86/51	20	27	48	101	237	175	189
Surrogate Recovery								
Naphtalene-d8	27/24	27	17	47	13	22	40	28
Acenaphthene-d10	57/48	50	52	67	35	52	59	53
Phenanthrene-d10	70/63	66	70	74	49	74	78	71
Fluoranthene-d10	91/88	88	83	87	84	100	101	97
Chrysene-d12	95/92	90	84	93	97	101	102	102
Benzo[a]pyrene-d12	79/74	75	66	85	81	83	102	87
Benzo[ghi]perylene-d12	80/78	75	72	88	77	80	86	81

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	NSDIN10	NSDIN20	NSDIN30	NSDIN40	NSAG1N	NSAG2NO	NSAG3NO	NSAG4NO
		2.03g	2.09 g		(REPEAT)	1.77g		
Naphthalene	<30	<30	<30	<30	<30	<30	<30	<30
2-Me naphthalene	<30	<30	<30	<30	<30	<30	<30	<30
1-Me naphthalene	<30	<30	<30	<30	<30	<30	<30	<30
Biphenyl	<20	<20	<20	<20	<20	<20	<20	<20
2,6-Dime naphthalene	<20	<20	<20	<20	<20	<20	<20	<20
Acenaphthylene	<10	<10	<10	11	<10	<10	<10	<10
Acenaphthene	<10	<10	<10	<10	<10	<10	<10	<10
2,3,5-Trime naphthalene	<20	<20	<20	<20	<20	<20	<20	<20
Fluorene	<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	19	18	21	23	<10	11	11	10
Anthracene	<10	<10	<10	<10	<10	<10	<10	<10
1-Me phenanthrene	11	14	12	15	<10	<10	<10	<10
Fluoranthene	44	49	54	57	14	14	14	14
Pyrene	27	47	34	41	<10	<10	<10	<10
Benzo(a)Anthracene	18	14	16	16	<10	<10	<10	<10
Chrysene	13	19	18	18	<10	<10	<10	<10
Benzo(b+k)Fluoranthen	27	18	19	19	16	<10	<10	10
Benzo(e)pyrene	16	25	14	18	<10	<10	<10	<10
Benzo(a)pyrene	<10	10	<10	<10	<10	<10	<10	<10
Perylene	<10	<10	<10	<10	36	28	17	33
Indeno(123cd)pyrene	12	<10	<10	<10	12	<10	<10	<10
Dibenzo(ah)anthracene	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(ghi)perylene	<10	25	<10	13	<10	<10	<10	<10
Total	186	238	188	231	77	52	42	68
Surrogate Recovery								
Naphtalene-d8	35	30	30	26	43	36	23	28
Acenaphthene-d10	52	51	53	53	62	65	64	61
Phenanthrene-d10	74	62	70	75	74	79	84	74
Fluoranthene-d10	100	94	96	104	95	93	94	91
Chrysene-d12	99	101	97	100	98	94	96	97
Benzo[a]pyrene-d12	98	89	80	93	94	80	72	78
Benzo[ghi]perylene-d12	84	76	73	77	82	77	78	79

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	NBSC1N	NBSC2N	NBSC3N	NBSC4N	NBLN1N	NBLN2N	NBLN3N	NBLN4N
	<30	<30	<30	<30	<30	<30	<30	<30
Naphthalene	<30	<30	<30	<30	<30	<30	<30	<30
2-Me naphthalene	<30	<30	<30	<30	<30	<30	<30	<30
1-Me naphthalene	<20	<20	<20	<20	<20	<20	<20	<20
Biphenyl	<20	<20	<20	<20	<20	<20	<20	<20
2,6-Dime naphthalene	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthylene	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthene	<20	<20	<20	<20	<20	<20	<20	<20
2,3,5-Trime naphthalene	<10	<10	<10	<10	<10	<10	<10	<10
Fluorene	<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	<10	<10	<10	<10	<10	<10	<10	<10
Anthracene	<10	<10	<10	<10	<10	<10	<10	<10
1-Me phenanthrene	14	14	13	13	11	11	<10	<10
Fluoranthene	<10	12	11	<10	<10	<10	<10	<10
Pyrene	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)Anthracene	<10	<10	<10	<10	<10	<10	<10	<10
Chrysene	18	<10	<10	17	<10	<10	17	15
Benzo(b+k)Fluoranthene	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(e)pyrene	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)pyrene	<10	<10	<10	<10	<10	<10	<10	<10
Perylene	<10	<10	<10	<10	<10	<10	<10	<10
Indeno(123cd)pyrene	<10	<10	<10	<10	<10	<10	<10	<10
Dibenzo(ah)anthracene	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(ghi)perylene								
	32	26	24	30	11	11	17	15
Total								
Surrogate Recovery								
	27	26	27	20	14	40	22	29
Naphtalene-d8	39	49	51	29	32	54	35	43
Acenaphthene-d10	74	85	87	70	63	84	69	75
Phenanthrene-d10	93	107	109	90	94	109	87	91
Fluoranthene-d10	97	97	96	96	89	100	111	103
Chrysene-d12	94	78	77	92	70	72	111	102
Benzo[a]pyrene-d12	62	64	62	66	58	65	77	73
Benzo[ghi]perylene-d12								

Appendix B. Tissue Concentrations of Polyaromatic Hydrocarbons in Mytilus edulis (ng/g dry weight)								
PAH	NBCH1N	NBCH2N	NBCH3N	NBCH4N				
Naphthalene	<30	<30	<30	<30				
2-Me naphthalene	<30	<30	<30	<30				
1-Me naphthalene	<30	<30	<30	<30				
Biphenyl	<20	<20	<20	<20				
2,6-Dime naphthalene	<20	<20	<20	<20				
Acenaphthylene	<10	<10	<10	<10				
Acenaphthene	<10	<10	<10	<10				
2,3,5-Trime naphthalene	<20	<20	<20	<20				
Fluorene	<10	<10	<10	<10				
Phenanthrene	<10	<10	<10	<10				
Anthracene	<10	<10	<10	<10				
1-Me phenanthrene	<10	<10	<10	<10				
Fluoranthene	<10	<10	<10	<10				
Pyrene	<10	<10	<10	<10				
Benzo(a)Anthracene	<10	<10	<10	<10				
Chrysene	<10	<10	<10	<10				
Benzo(b+k)Fluoranthene	<10	13	15	<10				
Benzo(e)pyrene	<10	<10	<10	<10				
Benzo(a)pyrene	<10	<10	<10	<10				
Perylene	<10	<10	<10	<10				
Indeno(123cd)pyrene	<10	<10	<10	<10				
Dibenzo(ah)anthracene	<10	<10	<10	<10				
Benzo(ghi)perylene	<10	<10	<10	<10				
Total	ND	13	15	ND				
Surrogate Recovery								
Naphtalene-d8	18	20	9	28				
Acenaphthene-d10	26	32	26	36				
Phenanthrene-d10	49	67	69	52				
Fluoranthene-d10	94	89	90	64				
Chrysene-d12	95	105	104	60				
Benzo[a]pyrene-d12	70	107	104	47				
Benzo[ghi]perylene-d12	68	74	73	38				
Benzo[ghi]perylene-d12								

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).								
Sample I.D.	MAME1N	MAME2N	MAME3N	MAME4N	MAMH10	MAMH20	MAMH30	MAMH40
#8,5	<2	<2	<2	<2	<2	<2/<2	<2	<2
#18,15	<2	<2	<2	<2	<2	<2/<2	<2	<2
#29	<2	<2	<2	<2	<2	<2/<2	<2	<2
#28	<2	<2	<2	<2	<2	<2/<2	<2	<2
#50	<2	<2	<2	<2	<2	<2/<2	<2	<2
#52	2.2	3.3	3.8	4.2	<2	<2/<2	<2	<2
#44	<2	<2	<2	2.2	<2	<2/<2	<2	<2
#65,95	2.2	3.0	3.2	3.9	<2	<2/<2	<2	<2
#101,90	3.8	4.6	5.0	6.0	4.6	6/5	5.6	6.3
#87	<2	<2	<2	2.5	<2	<2/<2	<2	<2
#77	<2	<2	<2	<2	<2	<2/<2	<2	<2
#118	4.4	5.3	5.8	6.6	5.7	8/7	6.9	7.7
#153,132	9.5	9.7	10.9	11.4	12.0	14/13	13.0	14.7
#105	<2	<2	<2	2.4	<2	2.7/2.4	2.4	2.6
#138	5.5	5.9	7.0	7.4	7.9	11/9	9.2	10.0
#126	<2	<2	<2	<2	<2	<2/<2	<2	<2
#187	3.5	3.0	3.5	3.9	3.5	4/4	4.0	4.4
#128	<2	<2	<2	<2	<2	<2/<2	<2	<2
#180	<2	<2	<2	<2	<2	<2/<2	<2	<2
#169	<2	<2	<2	<2	<2	<2/<2	<2	<2
#170,190	<2	<2	<2	<2	<2	<2/<2	<2	<2
#195,208	<2	<2	<2	<2	<2	<2/<2	<2	<2
#206	<2	<2	<2	<2	<2	<2/<2	<2	<2
#209	<2	<2	<2	<2	<2	<2/<2	<2	<2
Total	31.1	34.5	39.2	50.6	33.6	46/42	41.1	45.7
Surrogate Recoveries %								
#103	97	86	96	111	108	105/95	104	113
#198	98	82	99	105	108	100/94	101	115

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).								
Sample I.D.	MASN1N	MASN2N	MASN3N	MASN4N	MEBH-1N	MEBH-2N	MEBH-3N	MEBH-4N
#8,5	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#18,15	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#29	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#28	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#50	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#52	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#44	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#66,95	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#101,90	4.0	2/3	3.2	3.7	<2	<2	<2	<2
#87	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#77	<2 ng/g	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#118	7.5	5/6	6.6	7.1	<2	<2	<2	<2
#153,132	15.7	11/12	15.1	16.1	<2	<2	<2	<2
#105	2.3	<2/<2	<2 ng/g	<2 ng/g	<2	<2	<2	<2
#138	8.6	6/7	7.7	8.5	<2	<2	<2	<2
#126	3.1	3/2	2.9	3.1	<2	<2	<2	<2
#187	4.7	3/3	4.5	5.0	<2	<2	<2	<2
#128	<2	<2/<2	<2	<2	<2	<2	<2	<2
#180	<2	<2/<2	<2	<2	<2	<2	<2	<2
#169	<2	<2/<2	<2	<2	<2	<2	<2	<2
#170,190	<2	<2/<2	<2	<2	<2	<2	<2	<2
#195,208	<2	<2/<2	<2	<2	<2	<2	<2	<2
#206	<2	<2/<2	<2	<2	<2	<2	<2	<2
#209	<2	<2/<2	<2	<2	<2	<2	<2	<2
Total	46	30/33	40	43	ND	ND	ND	ND
Surrogate Recoveries %								
#103	88	83/97	90	95	104	97	99	119
#198	94	92/103	97	104	107	101	105	127

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).								
Sample I.D.	MECC1N	MECC2N	MECC3N	MECC4N	MEFP1N	MEFP2N	MEFP3N	MEFP4N
#8,5	<2	<2	<2	<2/<2	<2	<2	<2	<2
#18,15	<2	<2	<2	<2/<2	<2	<2	<2	<2
#29	<2	<2	<2	<2/<2	<2	<2	<2	<2
#28	<2	<2	<2	<2/<2	<2	<2	<2	<2
#50	<2	<2	<2	<2/<2	<2	<2	<2	<2
#52	<2	<2	<2	<2/<2	<2	<2	<2	<2
#44	<2	<2	<2	<2/<2	<2	<2	<2	<2
#66,95	<2	<2	<2	<2/<2	<2	<2	<2	<2
#101,90	3.6	3.7	4.6	3/4	<2	<2	<2	<2
#87	<2	<2	<2	<2/<2	<2	<2	<2	<2
#77	<2	<2	<2	<2/<2	<2	<2	<2	<2
#118	5.3	5.2	5.6	5/5	2.0	<2	<2	2.4
#153,132	15.3	15.0	15.2	13/15	6.9	5.6	5.3	8.2
#105	<2	<2	<2	<2/<2	<2	<2	<2	<2
#138	8.8	8.5	9.0	8/9	4.0	3.2	3.2	4.5
#126	<2	<2	<2	<2/<2	2.0	<2	<2	<2
#187	5.2	5.0	5.2	4/5	2.5	<2	<2	3.0
#128	<2	<2	<2	<2/<2	<2	<2	<2	<2
#180	<2	<2	<2	<2/<2	<2	<2	<2	<2
#169	<2	<2	<2	<2/<2	<2	<2	<2	<2
#170,190	<2	<2	<2	<2/<2	<2	<2	<2	<2
#195,208	<2	<2	<2	<2/<2	<2	<2	<2	<2
#206	<2	<2	<2	<2/<2	<2	<2	<2	<2
#209	<2	<2	<2	<2/<2	<2	<2	<2	<2
Total	38	37	40	33/38	17	8.8	8.5	18
Surrogate Recoveries %								
#103	100	99	97	104/103	81	68	69	92
#198	104	109	101	105/108	89	74	80	106

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).								
Sample I.D.	MEPI1N	MEPI2N	MEPI3N	MEPI4N	MEKN1N	MEKN2N	MEKN3N	MEKN4N
#8,5	<2/<2	<2	<2	<2	<2	<2	<2	<2
#18,15	<2/<2	<2	<2	<2	<2	<2	<2	<2
#29	<2/<2	<2	<2	<2	<2	<2	<2	<2
#28	<2/<2	<2	<2	<2	<2	<2	<2	<2
#50	<2/<2	<2	<2	<2	<2	<2	<2	<2
#52	<2/<2	<2	<2	<2	2.2	3.4	2.2	2.7
#104	<2/<2	<2	<2	<2	<2	<2	<2	<2
#44	<2/<2	<2	<2	<2	<2	<2	<2	<2
#65,95	<2/<2	<2	<2	<2	<2	<2	<2	<2
#101,90	<2/<2	<2	<2	<2	3.1	3.7	2.8	3.2
#87	<2/<2	<2	<2	<2	<2	<2	<2	<2
#77	<2/<2	<2	<2	<2	<2	<2	<2	<2
#154	<2/<2	<2	<2	<2	<2	<2	<2	<2
#118	<2/<2	<2	<2	<2	2.5	3.0	2.3	2.6
#153,132	<2/<2	<2	<2	<2	11	13	9.8	13
#105	<2/<2	<2	<2	<2	<2	<2	<2	<2
#138	<2/<2	<2	<2	<2	5.3	6.0	4.7	5.6
#126	<2/<2	<2	<2	<2	<2	<2	<2	<2
#187	<2/<2	<2	<2	<2	4.1	4.7	3.2	4.6
#128	<2/<2	<2	<2	<2	<2	<2	<2	<2
#180	<2/<2	<2	<2	<2	<2	<2	<2	<2
#169	<2/<2	<2	<2	<2	<2	<2	<2	<2
#170,190	<2/<2	<2	<2	<2	<2	<2	<2	<2
#195,208	<2/<2	<2	<2	<2	<2	<2	<2	<2
#206	<2/<2	<2	<2	<2	<2	<2	<2	<2
#209	<2/<2	<2	<2	<2	<2	<2	<2	<2
Total	ND	ND	ND	ND	29	34	25	31
Surrogate Recovery								
#103	120/118	122	119	115	115	120	115	115
#198	112/109	115	116	111	117	117	112	112

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).								
Sample I.D.	MERY1N	MERY2N	MERY3N	MERY4N	NHHS1N	NHHS2N	NHHS3N	NHHS4N
#8,5	<2	<2	<2	<2	<2	<2	<2	<2
#18,15	<2	<2	4.8	11	<2	<2	<2	<2
#29	<2	<2	<2	<2	<2	<2	<2	<2
#28	2.5	3.4	3.8	7.6	<2	<2	<2	<2
#50	<2	<2	<2	<2	<2	<2	<2	<2
#52	2.8	7.1	7.2	15	<2	<2	<2	<2
#104	<2	<2	<2	<2	<2	<2	<2	<2
#44	2.2	5.7	7.5	16	<2	<2	<2	<2
#66,95	2.9	5.3	5.5	12	<2	<2	<2	<2
#101,90	2.3	3.9	3.5	7.5	2.1	2.6	2.3	5.8
#154	<2	<2	<2	3.8	<2	<2	<2	<2
#87	<2	<2	<2	<2	<2	<2	<2	<2
#77	<2	<2	<2	<2	<2	<2	<2	<2
#118	<2	3.0	3.1	6.2	2.8	3.2	3.0	7.2
#153,132	4.0	3.8	2.9	4.9	6.7	7.3	6.5	15
#105	<2	<2	<2	4.1	<2	<2	<2	<2
#138	3.0	2.6	<2	3.5	4.2	4.3	4.1	9.4
#126	<2	<2	<2	<2	<2	<2	<2	<2
#187	<2	<2	<2	<2	<2	<2	<2	5
#128	<2	<2	<2	<2	<2	<2	<2	<2
#180	<2	<2	<2	<2	<2	<2	<2	<2
#169	<2	<2	<2	<2	<2	<2	<2	<2
#170,190	<2	<2	<2	<2	<2	<2	<2	<2
#195,208	<2	<2	<2	<2	<2	<2	<2	<2
#206	<2	<2	<2	<2	<2	<2	<2	<2
#209	<2	<2	<2	<2	<2	<2	<2	<2
Total	20	35	38	92	16	17	16	42
Surrogate Recoveries %								
#103	128	119	98	102	127	118	126	125
#198	127	103	83	89	123	119	119	126

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).									
Sample I.D.	NHDP1N	NHDP2N	NHDP3N	NHDP4N	NHFP1N	NHFP2N	NHFP3N	NHFP4N	NHFP5N
	10/1/96	10/1/96	10/1/96	10/1/96					
#8,5	<2	<2	<2	<2	<2	<2	<2	<2	<2
#18,15	<2	<2	<2	<2	<2	<2	<2	<2	<2
#29	<2	<2	<2	<2	<2	<2	<2	<2	<2
#28	<2	<2	<2	<2	<2	<2	<2	<2	<2
#50	<2	<2	<2	<2	<2	<2	<2	<2	<2
#52	<2	<2	<2	<2	<2	2.1	2.3	<2	5.6
#104	<2	<2	<2	<2	<2	<2	<2	<2	<2
#44	<2	<2	<2	<2	<2	<2	<2	<2	<2
#66,95	<2	<2	<2	<2	<2	2.9	3.0	2.4	4.3
#101,90	4.5	5.8	6.9	6.2	9.1	13	12	10	16
#87	<2	<2	<2	<2	<2	2.6	2.9	2.5	3.5
#154	<2	<2	<2	<2	<2	<2	<2	<2	<2
#77	<2	<2	<2	<2	<2	<2	<2	<2	<2
#118	5.9	7.7	8.8	7.9	10	13	13	11	19
#153,132	13	15	19	15	19	24	23	20	32
#105	<2	2.6	2.8	2.6	2.3	3.8	3.9	3.3	<2
#138	8.5	10	12	10	13	17	18	15	15
#126	<2	<2	<2	<2	<2	2.5	2.4	<2	4.5
#187	4.0	4.6	5.7	4.6	6.1	8.0	7.6	6.4	13
#128	<2	<2	<2	<2	<2	2.0	<2	<2	2.8
#180	<2	<2	<2	<2	<2	<2	2.1	<2	<2
#169	<2	<2	<2	<2	<2	<2	<2	<2	<2
#170,190	<2	<2	<2	<2	<2	<2	<2	<2	<2
#195,208	<2	<2	<2	<2	<2	<2	<2	<2	<2
#206	<2	<2	<2	<2	<2	<2	<2	<2	<2
#209	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total	36	46	55	47	59	92	91	71	116
Surrogate Recoveries %									
#103	116	119	118	125	131	130	126	125	123
#198	118	118	116	121	119	119	115	117	125

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).								
Sample I.D.	NHDP1N	NHDP2N	NHDP3N	NHDP4N	NSBCN10	NSBCN20	NSBCN30	NSBCN40
	7/16/96	7/16/96	7/16/96	7/16/96				
#8,5	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#18,15	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#29	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#28	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#50	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#52	<2	2.3	3/<2	3.7	<2	<2	<2/<2	<2
#104	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#44	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#66,95	<2	2.6	3/2	3.0	<2	<2	<2/<2	<2
#101,90	8.3	9.0	11/11	10	<2	<2	<2/<2	<2
#154	<2	2.4	3/<2	2.7	<2	<2	<2/<2	<2
#87	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#77	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#118	8.9	9.3	11/11	9.4	<2	<2	<2/<2	<2
#153,132	18	17	20/22	18	<2	<2	<2/<2	<2
#105	<2	2.4	3/<2	2.4	<2	<2	<2/<2	<2
#138	11	12	15/14	12	<2	<2	<2/<2	<2
#126	<2	<2	2/2	<2	<2	<2	<2/<2	<2
#187	5.8	5.8	7/7	5.9	<2	<2	<2/<2	<2
#128	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#180	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#169	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#170,190	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#195,208	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#206	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
#209	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
Total	52	63	78/70	67	ND	ND	ND	ND
Surrogate Recoveries %								
#103	123	125	110/117	128	95	91	91/92	107
#198	116	114	104/111	115	101	100	102/97	114

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).								
Sample I.D.	96NSFIN01	96NSFIN02	NSFIN03	96NSFIN04	NSYR1NO	NSYR2NO	NSYR3NO	NSYR4NO
#8,5	<2/<2	<2	<2	<2	<2	<2	<2	<2
#18,15	<2/<2	<2	<2	<2	<2	<2	<2	<2
#29	<2/<2	<2	<2	<2	<2	<2	<2	<2
#50	<2/<2	<2	<2	<2	<2	<2	<2	<2
#28	<2/<2	<2	<2	<2	<2	<2	<2	<2
#52	<2/<2	<2	<2	<2	<2	<2	<2	<2
#44	<2/<2	<2	<2	<2	<2	<2	<2	<2
#65,95	<2/<2	<2	<2	<2	<2	<2	<2	<2
#101,90	<2/<2	<2	<2	<2	<2	<2	<2	<2
#87	<2/<2	<2	<2	<2	<2	<2	<2	<2
#77	<2/<2	<2	<2	<2	<2	<2	<2	<2
#118	<2/<2	<2	<2	<2	<2	<2	<2	<2
#153,132	<2/<2	<2	<2	<2	<2	<2	<2	<2
#105	<2/<2	<2	<2	<2	<2	<2	<2	<2
#138	<2/<2	<2	<2	<2	<2	<2	<2	<2
#126	<2/<2	<2	<2	<2	<2	<2	<2	<2
#187	<2/<2	<2	<2	<2	<2	<2	<2	<2
#128	<2/<2	<2	<2	<2	<2	<2	<2	<2
#180	<2/<2	<2	<2	<2	<2	<2	<2	<2
#169	<2/<2	<2	<2	<2	<2	<2	<2	<2
#170,190	<2/<2	<2	<2	<2	<2	<2	<2	<2
#195,208	<2/<2	<2	<2	<2	<2	<2	<2	<2
#206	<2/<2	<2	<2	<2	<2	<2	<2	<2
#209	<2/<2	<2	<2	<2	<2	<2	<2	<2
Total	ND	ND	ND	ND	ND	ND	ND	ND
Surrogate Recoveries								
#103	87/90	87	86	82	90	89	120	96
#198	85/87	83	96	85	91	91	117	97

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).								
Sample I.D.	NSDIN10	NSDIN20	NSDIN30	NSDIN40	NSAG1NO	NSAG2NO	NSAG3NO	NSAG4NO
#8,5	<2	<2	<2	<2	<2	<2	<2	<2
#18,15	<2	<2	<2	<2	<2	<2	<2	<2
#29	<2	<2	<2	<2	<2	<2	<2	<2
#50	<2	<2	<2	<2	<2	<2	<2	<2
#28	<2	<2	<2	<2	<2	<2	<2	<2
#52	<2	<2	<2	<2	<2	<2	<2	<2
#44	<2	<2	<2	<2	<2	<2	<2	<2
#65,95	<2	<2	<2	<2	<2	<2	<2	<2
#101,90	<2	<2	<2	<2	<2	<2	<2	<2
#87	<2	<2	<2	<2	<2	<2	<2	<2
#77	<2	<2	<2	<2	<2	<2	<2	<2
#118	<2	<2	<2	2	<2	<2	<2	<2
#153,132	2.8	3.3	3.1	3.6	<2	<2	<2	<2
#105	<2	2.1	2.0	2.2	<2	<2	<2	<2
#138	2.3	2.7	2.3	2.7	<2	<2	<2	<2
#126	<2	<2	<2	<2	<2	<2	<2	<2
#187	<2	<2	<2	<2	<2	<2	<2	<2
#128	<2	<2	<2	<2	<2	<2	<2	<2
#180	<2	<2	<2	<2	<2	<2	<2	<2
#169	<2	<2	<2	<2	<2	<2	<2	<2
#170,190	<2	<2	<2	<2	<2	<2	<2	<2
#195,208	<2	<2	<2	<2	<2	<2	<2	<2
#206	<2	<2	<2	<2	<2	<2	<2	<2
#209	<2	<2	<2	<2	<2	<2	<2	<2
Total	5.1	8.0	7.4	10	ND	ND	ND	ND
Surrogate Recoveries								
#103	104	102	105	99	94	91	94	99
#198	114	115	113	108	100	101	102	107

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).

Sample I.D.	NBSC1N	NBSC2N	NBSC3N	NBSC4N	NBLN1N	NBLN2N	NBLN3N	NBLN4N
#8,5	<2	<2	<2/<2	<2	<2	<2	<2	<2
#18,15	<2	<2	<2/<2	<2	<2	<2	<2	<2
#29	<2	<2	<2/<2	<2	<2	<2	<2	<2
#28	<2	<2	<2/<2	<2	<2	<2	<2	<2
#50	<2	<2	<2/<2	<2	<2	<2	<2	<2
#52	<2	<2	<2/<2	<2	<2	<2	<2	<2
#104	<2	<2	<2/<2	<2	<2	<2	<2	<2
#44	<2	<2	<2/<2	<2	<2	<2	<2	<2
#65,95	<2	<2	<2/<2	<2	<2	<2	<2	<2
#101,90	2.3	3	2.4/2.2	2.9	<2	<2	2.4	2.3
#87	<2	<2	<2/<2	<2	<2	<2	<2	<2
#77	<2	<2	<2/<2	<2	<2	<2	<2	<2
#154	<2	<2	<2/<2	<2	<2	<2	<2	<2
#118	<2	<2	<2/<2	<2	<2	<2	2.7	2.4
#153,132	10	12	10/10	12	6.4	4.3	8.0	6.9
#105	<2	<2	<2/<2	<2	<2	<2	<2	<2
#138	5.1	6.3	4.7/4.9	6.4	2.8	<2	4.1	3.5
#126	<2	<2	<2/<2	<2	<2	<2	<2	<2
#187	3.9	4.5	3.7/3.7	4.5	<2	<2	2.2	<2
#128	<2	<2	<2/<2	<2	<2	<2	<2	<2
#180	2.8	3.0	2.4/2.3	3.8	<2	<2	<2	<2
#169-COP	<2	<2	<2/<2	<2	<2	<2	<2	<2
#170,190	<2	<2	<2/<2	<2	<2	<2	<2	<2
#195,208	<2	<2	<2/<2	<2	<2	<2	<2	<2
#206	<2	<2	<2/<2	<2	<2	<2	<2	<2
#209	<2	<2	<2/<2	<2	<2	<2	<2	<2
Total	24	29	23/23	30	9.2	4.3	19	15
Surr 103	124	124	122/123	134	112	73	118	120
Surr 198	115	115	119/117	127	116	72	118	113

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in Mytilus edulis (ng/g dry weight).						
Sample I.D.	NBCH1N	NBCH2N	NBCH3N	NBCH4N		
#8,5	<2	<2	<2	<2		
#18,15	<2	<2	<2	<2		
#29	<2	<2	<2	<2		
#28	<2	<2	<2	<2		
#50	<2	<2	<2	<2		
#52	<2	<2	<2	<2		
#104	<2	<2	<2	<2		
#44	<2	<2	<2	<2		
#65,95	<2	<2	<2	<2		
#101,90	<2	<2	<2	<2		
#87	<2	<2	<2	<2		
#77	<2	<2	<2	<2		
#154	<2	<2	<2	<2		
#118	<2	<2	<2	<2		
#153,132	2.7	<2	2.7	<2		
#105	<2	<2	<2	<2		
#138	<2	<2	<2	<2		
#126	<2	<2	<2	<2		
#187	<2	<2	<2	<2		
#128	<2	<2	<2	<2		
#180	<2	<2	<2	<2		
#169-COP	<2	<2	<2	<2		
#170,190	<2	<2	<2	<2		
#195,208	<2	<2	<2	<2		
#206	<2	<2	<2	<2		
#209	<2	<2	<2	<2		
Total	2.7	ND	2.7	ND		
Surr 103	122	127	128	116		
Surr 198	117	123	119	112		

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	MAME1N	MAME2N	MAME3N	MAME4N	MAMH10	MAMH20	MAMH30	MAMH40
HCB	<2	<2	<2	<2	<2	<2/<2	<2	<2
r-HCH	<2	<2	<2	<2	<2	<2/<2	<2	<2
Heptachlor	<2	<2	<2	<2	<2	<2/<2	<2	<2
Aldrin	<2	<2	<2	<2	<2	<2/<2	<2	<2
Hepta Epoxide	<2	<2	<2	<2	<2	<2/<2	<2	<2
o,p'-DDE	<2	<2	<2	<2	<2	<2/<2	<2	<2
a-Endosulfan	<2	<2	<2	<2	<2	<2/<2	<2	<2
cis-Chlordane	<2	<2	<2	<2	<2	<2/<2	2.1	<2
trans-Nonachlor	<2	<2	2.0	2.0	<2	<2/<2	<2	<2
p,p'-DDE	4.5	5.1	5.8	6.1	5.3	5.8/6.0	6.3	6.3
Dieldrin	<2	<2	<2	<2	<2	<2/<2	<2	<2
o,p'-DDD	<2	<2	<2	<2	<2	<2/2.0	2.1	2.5
b-Endosulfan	<2	<2	<2	<2	<2	<2/<2	<2	<2
p,p'-DDD	2.6	3.1	3.8	4.3	3.1	3.5/4.0	4.2	<2
o,p'-DDT	<2	<2	<2	<2	<2	<2/<2	<2	<2
p,p'-DDT	<2	<2	<2	<2	<2	<2/<2	<2	<2
Mirex	<2	<2	<2	<2	<2	<2/<2	<2	<2
Total	7.1	8.2	12	12	8.4	9.3/12	15	8.8
Surrogate %								
g-chlordene	102	84	110	109	108	86/98	114	105
Water Content (%)	91%	90%	91%	89%	88%	87%	88%	87%
Lipid Content (mg/g)	25	31	35	36	39	49	53	43

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	MASN1N	MASN2N	MASN3N	MASN4N	MEBH1N	MEBH2N	MEBH3N	MEBH4N
HCB	<2	<2/<2	<2	<2	<2	<2	<2	<2
r-HCH	<2	<2/<2	<2	<2	<2	<2	<2	<2
Heptachlor	<2	<2/<2	<2	<2	<2	<2	<2	<2
Aldrin	<2	<2/<2	<2	<2	<2	<2	<2	<2
Hepta Epoxide	<2	<2/<2	<2	<2	<2	<2	<2	<2
o,p'-DDE	<2	<2/<2	<2	<2	<2	<2	<2	<2
a-Endosulfan	<2	<2/<2	<2	<2	<2	<2	<2	<2
cis-Chlordane	2.2	<2/<2	<2	<2	<2	<2	<2	<2
trans-Nonachlor	2.9	2.1/<2	2.4	2.5	<2	<2	<2	<2
p,p'-DDE	13	9.6/9.1	11	10	<2	<2	<2	2.3
Dieldrin	2.2	<2/<2	<2	<2	<2	<2	<2	<2
o,p'-DDD	2.5	<2/<2	2.1	<2	<2	<2	<2	<2
b-Endosulfan	<2	<2/<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	8.6	6.2/5.5	7.2	6.4	<2	<2	<2	<2
o,p'-DDT	2.3	<2/<2	<2	<2	<2	<2	<2	<2
p,p'-DDT	<2	<2/<2	<2	<2	<2	<2	<2	<2
Mirex	<2	<2/<2	<2	<2	<2	<2	<2	<2
Total	34	18/15	23	19	ND	ND	ND	2.3
Surrogate %								
g-chlordene	102	110/87	118	113	123	113	112	114
Water Content (%)	86%	86%	86%	85%	87%	87%	86%	87%
Lipid content(mg/g)	68	51	67	67	46	44	48	53

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	MECC1N	MECC2N	MECC3N	MECC4N	MEFP1N	MEFP2N	MEFP3N	MEFP4N
HCB	<2	<2	<2	<2/<2	<2	<2	<2	<2
r-HCH	<2	<2	<2	<2/<2	<2	<2	<2	<2
Heptachlor	<2	<2	<2	<2/<2	<2	<2	<2	<2
Aldrin	<2	<2	<2	<2/<2	<2	<2	<2	<2
Hepta Epoxide	<2	<2	<2	<2/<2	<2	<2	<2	<2
o,p'-DDE	<2	<2	<2	<2/<2	<2	<2	<2	<2
a-Endosulfan	<2	<2	<2	<2/<2	<2	<2	<2	<2
cis-Chlordane	<2	<2	<2	<2/<2	<2	<2	<2	<2
trans-Nonachlor	<2	<2	<2	<2/<2	<2	<2	<2	<2
p,p'-DDE	5.7	5.5	5.9	5/5	4.4	3.3	3.8	4.5
Dieldrin	<2	<2	<2	<2/<2	<2	<2	<2	<2
o,p'-DDD	<2	<2	<2	<2/<2	<2	<2	<2	<2
b-Endosulfan	<2	<2	<2	<2/<2	<2	<2	<2	<2
p,p'-DDD	2.0	2.7	2.1	<2/<2	3.1	<2	2.6	3.5
o,p'-DDT	<2	<2	<2	<2/<2	<2	<2	<2	<2
p,p'-DDT	<2	<2	<2	<2/<2	<2	<2	<2	<2
Mirex	<2	<2	<2	<2/<2	<2	<2	<2	<2
Total	7.8	8.2	8.0	5/5	7.5	3.3	6.3	7.9
Surrogate %								
g-chlordene	103	116	108	109/115	85	60	76	95
Water Content (%)	88%	87%	87%	87%	93%	92%	93%	92%
Lipid Content (mg/g)	43	38	47	34	50	42	39	48

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	MEPI1N	MEPI2N	MEPI3N	MEPI4N	MEKN1N	MEKN2N	MEKN3N	MEKN4N
HCB	<2/<2	<2	<2	<2	<2	<2	<2	<2
r-HCH	<2/<2	<2	<2	<2	<2	<2	<2	<2
Heptachlor	<2/<2	<2	<2	<2	<2	<2	<2	<2
Aldrin	<2/<2	<2	<2	<2	<2	<2	<2	<2
Hepta Epoxide	<2/<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDE	<2/<2	<2	<2	<2	<2	<2	<2	<2
a-Endosulfan	<2/<2	<2	<2	<2	<2	<2	<2	<2
cis-Chlordane	<2/<2	<2	<2	<2	<2	<2	<2	<2
trans-Nonachlor	<2/<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDE	2/2	2.1	2.4	2.6	4.0	4.4	3.6	2.4
Dieldrin	<2/<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDD	<2/<2	<2	<2	<2	<2	<2	<2	<2
b-Endosulfan	<2/<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	<2/<2	<2	<2	<2	2.0	2.7	<2	2.3
o,p'-DDT	<2/<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDT	<2/<2	<2	<2	<2	<2	<2	<2	<2
Mirex	<2/<2	<2	<2	<2	<2	<2	<2	<2
Total	2/2	2.1	2.4	2.6	6.1	7.0	3.6	4.8
Surrogate %								
g-chlordene	104/97	86	101	97	93	96	98	92
Water Content (%)	87%	86%	88%	87%	90%	91%	91%	91%
Lipid Content (mg/g)	47	41	50	42	52	51	52	50

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	MERY1N	MERY2N	MERY3N	MERY4N	NHHS1N	NHHS2N	NHHS3N	NHHS4N
HCB	<2	<2	<2	<2	<2	<2	<2	<2
r-HCH	<2	<2	<2	<2	<2	<2	<2	<2
Heptachlor	<2	<2	<2	<2	<2	<2	<2	<2
Aldrin	<2	<2	<2	<2	<2	<2	<2	<2
Hepta Epoxide	<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDE	<2	<2	<2	<2	<2	<2	<2	<2
a-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
cis-Chlordane	<2	<2	<2	<2	<2	<2	<2	<2
trans-Nonachlor	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDE	<2	<2	<2	<2	5.0	4.7	5.0	2.1
Dieldrin	<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDD	<2	<2	<2	<2	<2	<2	<2	<2
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	<2	<2	<2	<2	2.6	<2	2.4	<2
o,p'-DDT	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDT	<2	<2	<2	<2	<2	<2	<2	<2
Mirex	<2	<2	<2	<2	<2	<2	<2	<2
Total	ND	ND	ND	ND	7.6	4.7	7.4	2.1
Surrogate %								
g-chlordene	115	109	107	113	128	85	116	113
Water Content (%)	92%	93%	92%	92%	87%	86%	86%	90%
Lipid content(mg/g)	34	35	25	31	53	55	58	43

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)									
Sample I.D.	NHDP1N	NHDP2N	NHDP3N	NHDP4N	NHFP1N	NHFP2N	NHFP3N	NHFP4N	NHFP5N
	10/1/96	10/1/96	10/1/96	10/1/96					
HCB	<2	<2	<2	<2	<2	<2	<2	<2	<2
r-HCH	<2	<2	<2	<2	<2	<2	<2	<2	<2
Heptachlor	<2	<2	<2	<2	<2	<2	<2	<2	<2
Aldrin	<2	<2	<2	<2	<2	<2	<2	<2	<2
Hepta Epoxide	<2	<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDE	<2	<2	<2	<2	<2	<2	<2	<2	<2
a-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2	<2
cis-Chlordane	<2	<2	<2	<2	<2	2.1	<2	<2	3.4
trans-Nonachlor	<2	<2	<2	<2	<2	2.0	<2	<2	2.9
p,p'-DDE	<2	2.2	2.0	<2	<2	<2	2.5	2.3	24.0
Dieldrin	<2	<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDD	<2	2.3	<2	<2	<2	2.1	2.0	<2	2.5
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	2.8	2.2	2.1	<2	<2	4.0	3.5	2.6	6.7
o,p'-DDT	<2	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDT	<2	<2	<2	<2	<2	<2	<2	<2	<2
Mirex	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total	2.8	6.8	4.1	ND	ND	10	8.0	4.8	39
Surrogate %									
g-chlordene	170	102	100	103	102	114	105	107	87
Water Content (%)	90	90	89	90	86	86	86	86	86
Lipid Content (mg/g)	36	44	44	45	46	64	67	51	88

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	NHDP1N	NHDP2N	NHDP3N	NHDP4N	NSBCN10	NSBCN20F1	NSBCN30	NSBCN40
	7/17/96	7/17/96	7/17/96	7/17/96				
HCB	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
r-HCH	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
Heptachlor	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
Aldrin	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
Hepta Epoxide	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
o,p'-DDE	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
a-Endosulfan	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
cis-Chlordane	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
trans-Nonachlor	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
p,p'-DDE	<2	<2	<2/<2	<2	2.0	2.5	<2/<2	<2
Dieldrin	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
o,p'-DDD	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
b-Endosulfan	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
p,p'-DDD	2.0	2.0	<2/3	2.0	<2	<2	<2/<2	<2
o,p'-DDT	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
p,p'-DDT	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
Mirex	<2	<2	<2/<2	<2	<2	<2	<2/<2	<2
Total	2.0	2.0	<2/3	2.0	2.0	2.5	ND/ND	ND
Surrogate %								
g-chlordene	122	117	63/118	113	90	96	98/101	106
Water Content (%)	88	88	91	91	88	87	88	87
Lipid content(mg/g)	45	49	60	47	58	53	55	60

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	96NSFIN01	96NSFIN02	NSFIN03	NSFIN04	NSYR11NO	NSYR2NO	NSYR3NO	NSYR4NO
HCB	<2/<2	<2	<2	<2	<2	<2	<2	<2
r-HCH	<2/<2	<2	<2	<2	<2	<2	<2	<2
Heptachlor	<2/<2	<2	<2	<2	<2	<2	<2	<2
Aldrin	<2/<2	<2	<2	<2	<2	<2	<2	<2
Hepta Epoxide	<2/<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDE	<2/<2	<2	<2	<2	<2	<2	<2	<2
a-Endosulfan	<2/<2	<2	<2	<2	<2	<2	<2	<2
cis-Chlordane	<2/<2	<2	<2	<2	<2	<2	<2	<2
trans-Nonachlor	<2/<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDE	2/2	2.5	3.6	4.6	<2	<2	<2	<2
Dieldrin	<2/<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDD	<2/<2	<2	<2	<2	<2	<2	<2	<2
b-Endosulfan	<2/<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	<2/<2	2.3	<2	<2	<2	<2	<2	<2
o,p'-DDT	<2/<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDT	3/<2	2.7	<2	<2	<2	<2	<2	2.1
Mirex	<2/<2	<2	<2	<2	<2	<2	<2	<2
Total	5/2	7.5	3.6	4.6	ND	ND	ND	2.1
Surrogate %								
g-chlordene	93/98	94	96	108	91	91	77	95
Water Content (%)	88	86	85	87	85	86	87	87
Lipid content(mg/g)	46	56	62	55	32	43	36	40

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	NSDIN10	NSDIN20	NSDIN30	NSDIN40	NSAG1NO	NSAG2NO	NSAG3NO	NSAG4NO
HCB	<2	<2	<2	<2	<2	<2	<2	<2
r-HCH	<2	<2	<2	<2	<2	<2	<2	<2
Heptachlor	<2	<2	<2	<2	<2	<2	<2	<2
Aldrin	<2	<2	<2	<2	<2	<2	<2	<2
Hepta Epoxide	<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDE	<2	<2	<2	<2	<2	<2	<2	<2
a-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
cis-Chlordane	<2	<2	<2	<2	<2	<2	<2	<2
trans-Nonachlor	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDE	3.0	3.6	3.6	4.0	<2	<2	2.1	2.3
Dieldrin	<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDD	<2	<2	<2	<2	<2	<2	<2	<2
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	<2	<2	<2	<2	<2	<2	<2	<2
o,p'-DDT	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDT	<2	<2	<2	<2	<2	<2	<2	<2
Mirex	<2	<2	<2	<2	<2	<2	<2	<2
Total	3.0	3.6	3.6	4.0	ND	ND	2.1	2.3
Surrogate %								
g-chlordene	117	97	89	100	99	98	97	99
Water Content (%)	86	86	86	87	88	88	88	87
Lipid content(mg/g)	80	71	71	87	51	46	50	61

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)								
Sample I.D.	NBSC1N	NBSC2N	NBSC3N	NBSC4N	NBLN1N	NBLN2N	NBLN3N	NBLN4N
	<2	<2	<2/<2	<2	<2	<2	<2	<2
HCB	<2	<2	<2/<2	<2	<2	<2	<2	<2
r-HCH	<2	<2	<2/<2	<2	<2	<2	<2	<2
Heptachlor	<2	<2	<2/<2	<2	<2	<2	<2	<2
Aldrin	<2	<2	<2/<2	<2	<2	<2	<2	<2
Hepta Epoxide	<2	<2	<2/<2	<2	<2	<2	<2	<2
o,p'-DDE	<2	<2	<2/<2	<2	<2	<2	<2	<2
a-Endosulfan	<2	<2	<2/<2	<2	<2	<2	<2	<2
cis-Chlordane	<2	<2	<2/<2	<2	<2	<2	<2	<2
trans-Nonachlor	3.1	3.3	2.7/2.5	3	5.2	4.9	7.1	5.7
p,p'-DDE	<2	<2	<2/<2	<2	<2	<2	<2	<2
Dieldrin	2.7	<2	<2/<2	<2	<2	<2	<2	<2
o,p'-DDD	<2	<2	<2/<2	<2	<2	<2	<2	<2
b-Endosulfan	<2	<2	<2/<2	<2	<2	<2	<2	<2
p,p'-DDD	<2	<2	<2/<2	<2	<2	<2	<2	<2
o,p'-DDT	<2	<2	<2/<2	<2	<2	<2	<2	<2
p,p'-DDT	<2	<2	<2/<2	<2	<2	<2	<2	<2
Mirex								
	5.8	3.3	2.7/2.5	3	5.2	4.9	7.1	5.7
Total								
	82	84	84/86	77	89	98	97	87
Water Content (%)	88	88	87	88	87	86	86	86
Lipid Content (mg/g)	56	70	66	60	62	74	87	70

Appendix D. Tissue Concentrations of Chlorinated Pesticides in Mytilus edulis (ng/g dry weight)						
Sample I.D.	NBCH1N	NBCH2N	NBCH3N	NBCH4N		
HCB	<2	<2	<2	<2		
r-HCH	<2	<2	<2	<2		
Heptachlor	<2	<2	<2	<2		
Aldrin	<2	<2	<2	<2		
Hepta Epoxide	<2	<2	<2	<2		
o,p'-DDE	<2	<2	<2	<2		
a-Endosulfan	<2	<2	<2	<2		
cis-Chlordane	<2	<2	<2	<2		
trans-Nonachlor	<2	<2	<2	<2		
p,p'-DDE	3.7	3.1	3.4	3.2		
Dieldrin	<2	<2	<2	<2		
o,p'-DDD	<2	<2	<2	<2		
b-Endosulfan	<2	<2	<2	<2		
p,p'-DDD	<2	<2	<2	<2		
o,p'-DDT	<2	<2	<2	<2		
p,p'-DDT	<2	<2	<2	<2		
Mirex	<2	<2	<2	<2		
Total	3.7	3.1	3.4	3.2		
Surrogate %						
g-chlordene	107	102	105	103		
Water Content (%)	84	84	84	83		
Lipid Content (mg/g)	90	76	79	76		

		Appendix E.					
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS						
CLIENT SAMPLE I.D.: MAME 3N			AXYS FILE: 9727-01 R				
CLIENT: Environment Canada, Dartmouth			DATE: 17/Oct/97				
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2				
SAMPLE SIZE: 11.2 g wet			INSTRUMENT: GC-HRMS				
% MOISTURE: 92			CONCENTRATION IN: pg/g				
% LIPID: 0.22							
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)		
T4CDD - Total	0.5	0.2	T4CDF - Total	1.7	0.2		
2,3,7,8	ND	0.2	2,3,7,8	0.5	0.2		
P5CDD - Total	ND	0.2	P5CDF - Total	0.6	0.2		
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2		
			2,3,4,7,8	ND	0.2		
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4		
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4		
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4		
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4		
			1,2,3,7,8,9	ND	0.4		
H7CDD - Total	2.7	0.6	H7CDF - Total	ND	0.6		
1,2,3,4,6,7,8	1.2	0.6	1,2,3,4,6,7,8	ND	0.6		
			1,2,3,4,7,8,9	ND	0.6		
O8CDD - Total	6.6	0.8	O8CDF - Total	ND	0.8		
Surrogate Standards		% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
			2,3,7,8 - TCDF	0.4	pg/g		
13C-T4CDF		75					
13C-T4CDD		76	2,3,7,8 - TCDD	0.1	pg/g		
13C-P5CDF		71					
13C-P5CDD		70					
13C-H6CDF		76					
13C-H6CDD		65	1. SDL = Sample Detection Limit				
13C-H7CDF		59	2. ND = Not detected				
13C-H7CDD		59	3. NDR = Peak detected but did not meet				
13C-O8CDD		47	quantification criteria				
			4. Concentrations are recovery corrected.				

Appendix E.

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.: MAMH 40			AXYS FILE: 9727-02 R			
CLIENT: Environment Canada, Dartmouth			DATE: 17/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 11.4 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 86			CONCENTRATION IN: pg/g			
% LIPID: 0.38						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	1.8	0.2	T4CDF - Total	3.0	0.2	
2,3,7,8	ND	0.2	2,3,7,8	0.8	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	0.5	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	0.8	0.4	H6CDF - Total	0.4	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	4.8	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	1.9	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	8.8	0.8	O8CDF - Total	ND	0.8	

Surrogate Star	% Recovery
13C-T4CDF	89
13C-T4CDD	86
13C-P5CDF	82
13C-P5CDD	87
13C-H6CDF	81
13C-H6CDD	78
13C-H7CDF	71
13C-H7CDD	73
13C-O8CDD	64

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.5 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.1 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

		Appendix E.				
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS					
CLIENT SAMPLE I.D.: MASN 1N			AXYS FILE: 9727-03 R			
CLIENT: Environment Canada, Dartmouth			DATE: 17/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 2.95 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 86			CONCENTRATION IN: pg/g			
% LIPID: 0.62						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	0.3	0.2	T4CDF - Total	4.4	0.2	
2,3,7,8	ND	0.2	2,3,7,8	1.5	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	0.7	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	1.7	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	3.5	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	1.6	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	9.0	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.5	pg/g	
13C-T4CDF	81					
13C-T4CDD	83	2,3,7,8 - TCDD TEQs (ND=0) =		0.2	pg/g	
13C-P5CDF	79					
13C-P5CDD	77	1. SDL = Sample Detection Limit				
13C-H6CDF	82	2. ND = Not detected				
13C-H6CDD	76	3. NDR = Peak detected but did not meet				
13C-H7CDF	76	quantification criteria				
13C-H7CDD	83	4. Concentrations are recovery corrected.				
13C-O8CDD	72					

		Appendix E.				
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS					
CLIENT SAMPLE I.D.: MEBH 2N			AXYS FILE: 9727-04 R			
CLIENT: Environment Canada, Dartmouth			DATE: 17/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 11.0 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 88			CONCENTRATION IN: pg/g			
% LIPID: 0.39						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	0.4	0.2	
2,3,7,8	ND	0.2	2,3,7,8	0.2	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	0.3	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	0.8	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	ND	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	2.6	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.4	pg/g	
13C-T4CDF	93					
13C-T4CDD	97	2,3,7,8 - TCDD TEQs (ND=0) =		0.0	pg/g	
13C-P5CDF	88					
13C-P5CDD	90	1. SDL = Sample Detection Limit				
13C-H6CDF	94	2. ND = Not detected				
13C-H6CDD	83	3. NDR = Peak detected but did not meet				
13C-H7CDF	84	quantification criteria				
13C-H7CDD	87	4. Concentrations are recovery corrected.				
13C-O8CDD	76					

		Appendix E.				
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS					
CLIENT SAMPLE I.D.: MERY 3N			AXYS FILE: 9727-07 R			
CLIENT: Environment Canada, Dartmouth			DATE: 17/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 10.3 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 94			CONCENTRATION IN: pg/g			
% LIPID: 0.02						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	ND	0.2	
2,3,7,8	ND	0.2	2,3,7,8	ND	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	ND	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	ND	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	1.8	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.4	pg/g	
13C-T4CDF	78					
13C-T4CDD	78	2,3,7,8 - TCDD TEQs (ND=0) =		0.0	pg/g	
13C-P5CDF	73					
13C-P5CDD	74	1. SDL = Sample Detection Limit				
13C-H6CDF	87	2. ND = Not detected				
13C-H6CDD	73	3. NDR = Peak detected but did not meet				
13C-H7CDF	77	quantification criteria				
13C-H7CDD	82	4. Concentrations are recovery corrected.				
13C-O8CDD	73					

Appendix E.

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.: NHHS 3N		AXYS FILE: 9727-08 RA			
CLIENT: Environment Canada, Dartmouth		DATE: 17/Oct/97			
SAMPLE TYPE: Tissue		METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 3.96 g wet		INSTRUMENT: GC-HRMS			
% MOISTURE: 87		CONCENTRATION IN: pg/g			
% LIPID: 1.15					
Dioxins	Concentration (SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	0.6 0.2	T4CDF - Total	1.4	0.2	
2,3,7,8	ND 0.2	2,3,7,8	0.4	0.2	
P5CDD - Total	ND 0.2	P5CDF - Total	0.3	0.2	
1,2,3,7,8	ND 0.2	1,2,3,7,8	ND	0.2	
		2,3,4,7,8	ND	0.2	
H6CDD - Total	0.6 0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND 0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND 0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND 0.4	2,3,4,6,7,8	ND	0.4	
		1,2,3,7,8,9	ND	0.4	
H7CDD - Total	1.7 0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	NDR(0.8) 0.6	1,2,3,4,6,7,8	ND	0.6	
		1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	5.1 0.8	O8CDF - Total	ND	0.8	

Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)		
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)	0.4	pg/g
13C-T4CDF	84			
13C-T4CDD	84	2,3,7,8 - TCDD TEQs (ND=0) =	0.0	pg/g
13C-P5CDF	80			
13C-P5CDD	82	1. SDL = Sample Detection Limit		
13C-H6CDF	81	2. ND = Not detected		
13C-H6CDD	75	3. NDR = Peak detected but did not meet		
13C-H7CDF	71	quantification criteria		
13C-H7CDD	76	4. Concentrations are recovery corrected.		
13C-O8CDD	60			

Appendix E.

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.: NHHS 3N		AXYS FILE: 9727-08 RB			
CLIENT: Environment Canada, Dartmouth		DATE: 17/Oct/97			
SAMPLE TYPE: Tissue		METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 4.47 g wet		INSTRUMENT: GC-HRMS			
% MOISTURE: 87		CONCENTRATION IN: pg/g			
% LIPID: 1.2					
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	0.4	0.2	T4CDF - Total	0.6	0.2
2,3,7,8	ND	0.2	2,3,7,8	0.3	0.2
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	0.4	0.4	H6CDF - Total	ND	0.4
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4
			1,2,3,7,8,9	ND	0.4
H7CDD - Total	0.9	0.6	H7CDF - Total	ND	0.6
1,2,3,4,6,7,8	0.9	0.6	1,2,3,4,6,7,8	ND	0.6
			1,2,3,4,7,8,9	ND	0.6
O8CDD - Total	4.2	0.8	O8CDF - Total	ND	0.8

Surrogate Star	% Recovery
13C-T4CDF	87
13C-T4CDD	87
13C-P5CDF	82
13C-P5CDD	84
13C-H6CDF	93
13C-H6CDD	82
13C-H7CDF	77
13C-H7CDD	80
13C-O8CDD	65

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) =	0.4	pg/g
2,3,7,8 - TCDD TEQs (ND=0) =	0.0	pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Appendix E.

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.: NSAG 1NO			AXYS FILE: 9727-09 R			
CLIENT: Environment Canada, Dartmouth			DATE: 17/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 7.53 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 88			CONCENTRATION IN: pg/g			
% LIPID: 0.47						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	0.9	0.2	
2,3,7,8	ND	0.2	2,3,7,8	0.2	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	ND	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	ND	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	1.5	0.8	O8CDF - Total	ND	0.8	

Surrogate Star	% Recovery
13C-T4CDF	90
13C-T4CDD	89
13C-P5CDF	84
13C-P5CDD	90
13C-H6CDF	90
13C-H6CDD	82
13C-H7CDF	79
13C-H7CDD	85
13C-O8CDD	71

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

		Appendix E.				
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS					
CLIENT SAMPLE I.D.: NSBCN 10			AXYS FILE: 9727-10RB			
CLIENT: Environment Canada, Dartmouth			DATE: 19/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 5.09 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 87			CONCENTRATION IN: pg/g			
% LIPID: 0.60						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	ND	0.2	
2,3,7,8	ND	0.2	2,3,7,8	ND	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	ND	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	ND	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	1.3	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.4	pg/g	
13C-T4CDF	61					
13C-T4CDD	50	2,3,7,8 - TCDD TEQs (ND=0) =		0.0	pg/g	
13C-P5CDF	63					
13C-P5CDD	67					
13C-H6CDF	75					
13C-H6CDD	64	1. SDL = Sample Detection Limit				
13C-H7CDF	60	2. ND = Not detected				
13C-H7CDD	53	3. NDR = Peak detected but did not meet				
13C-O8CDD	42	quantification criteria				
		4. Concentrations are recovery corrected.				

		Appendix E.				
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS					
CLIENT SAMPLE I.D.: NSDIN 40			AXYS FILE: 9727-11R			
CLIENT: Environment Canada, Dartmouth			DATE: 19/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 9.27 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 86			CONCENTRATION IN: pg/g			
% LIPID: 0.76						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	1.5	0.2	
2,3,7,8	ND	0.2	2,3,7,8	0.3	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	0.9	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	ND	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	2.2	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.4	pg/g	
13C-T4CDF	94					
13C-T4CDD	99	2,3,7,8 - TCDD TEQs (ND=0) =		0.0	pg/g	
13C-P5CDF	93					
13C-P5CDD	99					
13C-H6CDF	98					
13C-H6CDD	91					
13C-H7CDF	86	1. SDL = Sample Detection Limit				
13C-H7CDD	83	2. ND = Not detected				
13C-O8CDD	84	3. NDR = Peak detected but did not meet				
		quantification criteria				
		4. Concentrations are recovery corrected.				

		Appendix E.				
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS					
CLIENT SAMPLE I.D.: NSFIN 40			AXYS FILE: 9727-12R			
CLIENT: Environment Canada, Dartmouth			DATE: 19/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 10.4 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 87			CONCENTRATION IN: pg/g			
% LIPID: 0.67						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	0.4	0.2	
2,3,7,8	ND	0.2	2,3,7,8	0.2	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	ND	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	ND	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	1.5	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.4	pg/g	
13C-T4CDF	78					
13C-T4CDD	67	2,3,7,8 - TCDD TEQs (ND=0) =		0.0	pg/g	
13C-P5CDF	76					
13C-P5CDD	81					
13C-H6CDF	88					
13C-H6CDD	86	1. SDL = Sample Detection Limit				
13C-H7CDF	82	2. ND = Not detected				
13C-H7CDD	77	3. NDR = Peak detected but did not meet				
13C-O8CDD	73	quantification criteria				
		4. Concentrations are recovery corrected.				

Appendix E.

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.: NSYR2NQ			AXYS FILE: 9727-13R		
CLIENT: Environment Canada, Dartmouth			DATE: 19/Oct/97		
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2		
SAMPLE SIZE: 10.0 g wet			INSTRUMENT: GC-HRMS		
% MOISTURE: 86			CONCENTRATION IN: pg/g		
% LIPID: 0.53					
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)
T4CDD - Total	2.9	0.2	T4CDF - Total	1.2	0.2
2,3,7,8	ND	0.2	2,3,7,8	0.3	0.2
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2
			2,3,4,7,8	ND	0.2
H6CDD - Total	1.4	0.4	H6CDF - Total	ND	0.4
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4
			1,2,3,7,8,9	ND	0.4
H7CDD - Total	9.9	0.6	H7CDF - Total	ND	0.6
1,2,3,4,6,7,8	1.3	0.6	1,2,3,4,6,7,8	ND	0.6
			1,2,3,4,7,8,9	ND	0.6
O8CDD - Total	7.1	0.8	O8CDF - Total	ND	0.8

Surrogate Star	% Recovery
13C-T4CDF	75
13C-T4CDD	62
13C-P5CDF	80
13C-P5CDD	92
13C-H6CDF	90
13C-H6CDD	82
13C-H7CDF	78
13C-H7CDD	73
13C-O8CDD	65

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.1 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

		Appendix E.				
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS					
CLIENT SAMPLE I.D.: MEPI			AXYS FILE: 9727-14R			
CLIENT: Environment Canada, Dartmouth			DATE: 19/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 10.94 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 88			CONCENTRATION IN: pg/g			
% LIPID: 0.60						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	0.2	0.2	
2,3,7,8	ND	0.2	2,3,7,8	0.2	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	2.4	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	1.0	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	NDR (3.8)	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.4	pg/g	
13C-T4CDF	84					
13C-T4CDD	85	2,3,7,8 - TCDD TEQs (ND=0) =		0.0	pg/g	
13C-P5CDF	78					
13C-P5CDD	80					
13C-H6CDF	79					
13C-H6CDD	74	1. SDL = Sample Detection Limit				
13C-H7CDF	69	2. ND = Not detected				
13C-H7CDD	68	3. NDR = Peak detected but did not meet				
13C-O8CDD	59	quantification criteria				
		4. Concentrations are recovery corrected.				

		Appendix E.				
	POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS					
CLIENT SAMPLE I.D.: MEKN			AXYS FILE: 9727-15R			
CLIENT: Environment Canada, Dartmouth			DATE: 19/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 5.88 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 86			CONCENTRATION IN: pg/g			
% LIPID: 0.27						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	1.4	0.2	
2,3,7,8	ND	0.2	2,3,7,8	0.7	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	ND	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	ND	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	2.6	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.4	pg/g	
13C-T4CDF	81					
13C-T4CDD	79	2,3,7,8 - TCDD TEQs (ND=0) =		0.1	pg/g	
13C-P5CDF	75					
13C-P5CDD	81					
13C-H6CDF	79					
13C-H6CDD	73	1. SDL = Sample Detection Limit				
13C-H7CDF	64	2. ND = Not detected				
13C-H7CDD	64	3. NDR = Peak detected but did not meet				
13C-O8CDD	60	quantification criteria				
		4. Concentrations are recovery corrected.				

Appendix E.

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.: NBLN			AXYS FILE: 9727-16R			
CLIENT: Environment Canada, Dartmouth			DATE: 19/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 9.15 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 85			CONCENTRATION IN: pg/g			
% LIPID: 1.04						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	0.2	0.2	T4CDF - Total	0.7	0.2	
2,3,7,8	ND	0.2	2,3,7,8	0.3	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	ND	0.4	H6CDF - Total	ND	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	ND	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	ND	0.6	1,2,3,4,6,7,8	ND	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	1.4	0.8	O8CDF - Total	ND	0.8	
Surrogate Star	% Recovery	2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)				
		2,3,7,8 - TCDD TEQs (ND=1/2 DL)		0.4	pg/g	
13C-T4CDF	82					
13C-T4CDD	85	2,3,7,8 - TCDD TEQs (ND=0) =		0.0	pg/g	
13C-P5CDF	84					
13C-P5CDD	100					
13C-H6CDF	81					
13C-H6CDD	77	1. SDL = Sample Detection Limit				
13C-H7CDF	72	2. ND = Not detected				
13C-H7CDD	73	3. NDR = Peak detected but did not meet				
13C-O8CDD	64	quantification criteria				
		4. Concentrations are recovery corrected.				

Appendix E.

POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

CLIENT SAMPLE I.D.: NBSC			AXYS FILE: 9727-17R			
CLIENT: Environment Canada, Dartmouth			DATE: 19/Oct/97			
SAMPLE TYPE: Tissue			METHOD NO.: DX-T-03/Ver.2			
SAMPLE SIZE: 4.31 g wet			INSTRUMENT: GC-HRMS			
% MOISTURE: 87			CONCENTRATION IN: pg/g			
% LIPID: 0.84						
Dioxins	Concentration	(SDL)	Furans	Concentration	(SDL)	
T4CDD - Total	ND	0.2	T4CDF - Total	2.4	0.2	
2,3,7,8	ND	0.2	2,3,7,8	1.5	0.2	
P5CDD - Total	ND	0.2	P5CDF - Total	ND	0.2	
1,2,3,7,8	ND	0.2	1,2,3,7,8	ND	0.2	
			2,3,4,7,8	ND	0.2	
H6CDD - Total	0.5	0.4	H6CDF - Total	0.6	0.4	
1,2,3,4,7,8	ND	0.4	1,2,3,4,7,8	ND	0.4	
1,2,3,6,7,8	ND	0.4	1,2,3,6,7,8	ND	0.4	
1,2,3,7,8,9	ND	0.4	2,3,4,6,7,8	ND	0.4	
			1,2,3,7,8,9	ND	0.4	
H7CDD - Total	2.6	0.6	H7CDF - Total	ND	0.6	
1,2,3,4,6,7,8	0.7	0.6	1,2,3,4,6,7,8	NDR (0.8)	0.6	
			1,2,3,4,7,8,9	ND	0.6	
O8CDD - Total	3.8	0.8	O8CDF - Total	ND	0.8	

Surrogate Star	% Recovery
13C-T4CDF	90
13C-T4CDD	92
13C-P5CDF	82
13C-P5CDD	96
13C-H6CDF	82
13C-H6CDD	81
13C-H7CDF	73
13C-H7CDD	76
13C-O8CDD	77

2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.5 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.2 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.