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SIXTH YEAR OF THE GULF OF MAINE ENVIRONMENTAL MONITORING PLAN

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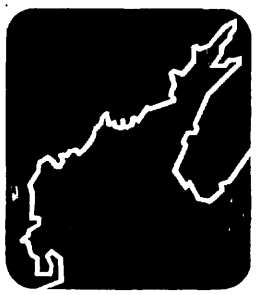

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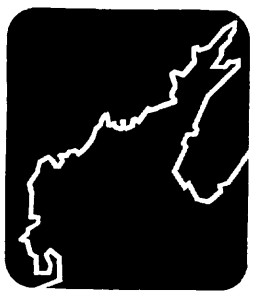

Gulf of Maine Council on the Marine Environment

EVALUATION OF GULFWATCH 1997:

SEVENTH YEAR OF THE GULF OF MAINE ENVIRONMENTAL MONITORING PLAN

Gulf of Maine Council on the Marine Environment
October, 1998

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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 are its principal income generating enterprises, although tourism is very important source of income to many small coastal communities and the aquaculture industry is rapidly expanding. As coastal populations around the Gulf and its watersheds have increased, forests and 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 (Crawford and Sowles, 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 (Crawford and Sowles, 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.

In order 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 Gulfs' 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 to meet the desired goals a project named Gulfwatch was established to measure Gulfwide chemical contamination.

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 like *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; Cantillo, 1998) 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; Cantillo, 1998). 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 of the Gulf Program 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 (Crawford and Sowles, 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 (Chase et al., 1996b; Sowles et al, 1996). Sampling of native mussels provided an assessment of long-term exposure to bioavailable contaminants (on the order of months to a year). The 1997 sampling year followed the protocol for 1993 and 1994, sampling indigenous mussels from three to seven sites in each jurisdiction.

In addition to documenting the level of contaminants in mussel tissue, biological variables, including shell growth and condition index, have been 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 a contaminant's effect 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. However, growth measurements are dependent on protocols that are only used when transplanting of mussels occurs, thus growth was not measured in 1997.

Condition Index (CI) has been 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. CI is measured on all mussel samples every year, including 1997.

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 the following 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 program 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. Native mussels were sampled in as many as seven 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 allows the program investigators to assess both short-term and long-term contaminant exposures. The 1997 samples are the second sampling of sites previously sampled in 1994, and which will be resampled in 2000.

METHODS

The 1997 Gulfwatch sample collection and analysis is the fifth year of the program's nine year sampling design (see Sowles et al., 1997). The 1997 sampling represents the second year of the second 3-year cycle. As such, stations that were sampled in 1997 were the same stations sampled in 1994. Therefore, in addition to spatial analysis, temporal analysis can be performed on the contaminant concentrations for all sites.

1997 Sampling Locations

The stations sampled in 1997 are shown in Figure 1 and Table 1. There were 5 sites in Massachusetts, 3 in New Hampshire, 7 in Maine, 3 in New Brunswick, and 4 in Nova Scotia, including the following benchmark sites from previous years to enable trend analysis: Sandwich, MA, Clarke Cove, ME/NH, Kennebec River, ME, Chamcook, NB, and Digby, NS. Until 1996, Hospital Island (NBHI) was the benchmark site for New Brunswick. However in 1996 no mussels were found at this site. As a result, Chamcook, NB (NBCH), a site located approximately 1.5 km from Hospital Island, is now sampled as the benchmark station for New Brunswick (see Chase et al., 1997).

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 *Mytilus edulis*. However, a similar species of *Mytilus*, *Mytilus trossulus* was identified in some 1993 Bay of Fundy samples (Sowles et al., 1996). 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; Jones et al., 1998).

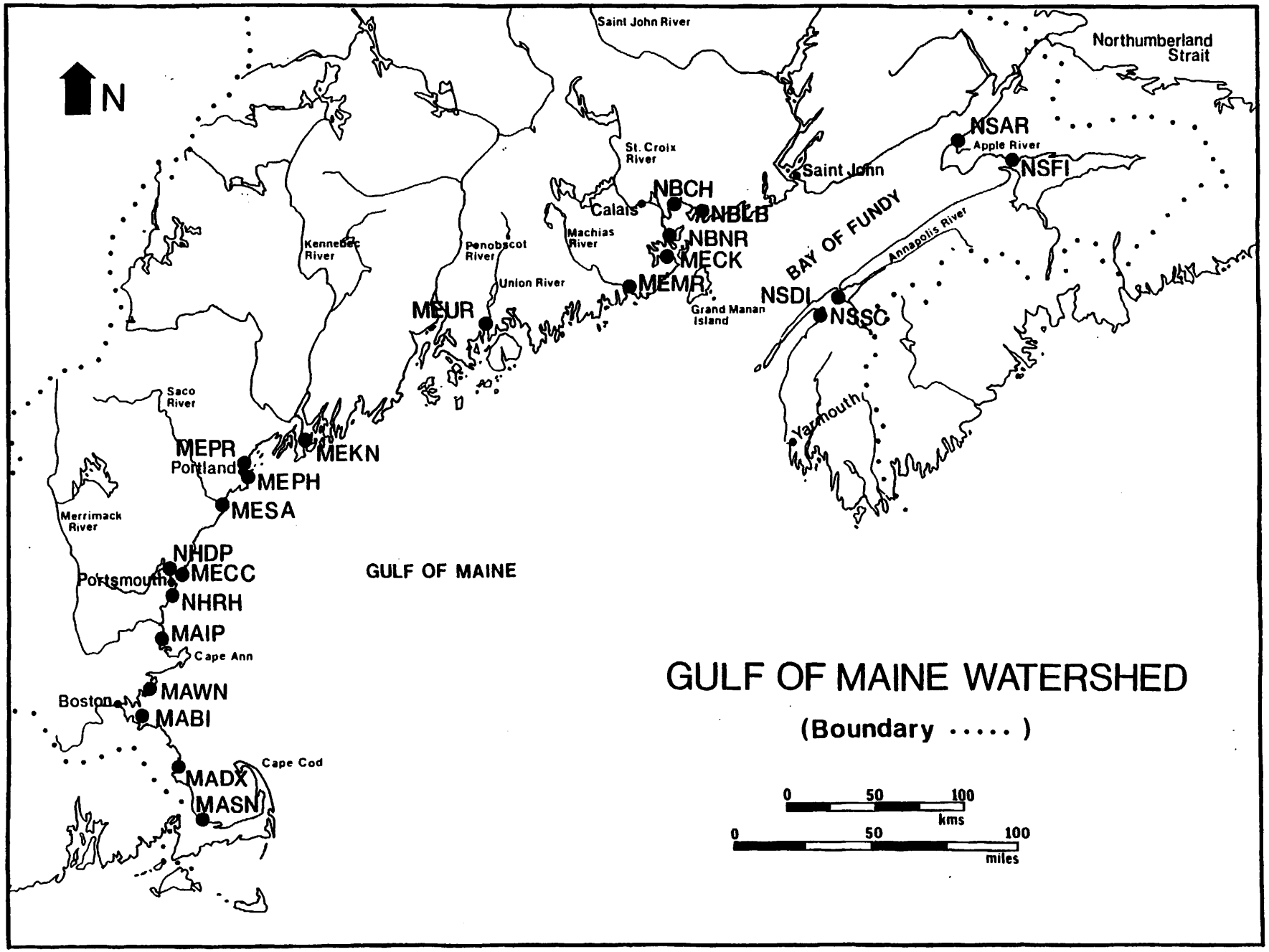

Figure 1. Location of Gulfwatch, 1997 stations in the Gulf of Maine

Table 1. Gulf of Maine, Gulfwatch study site locations sampled in 1997.

CODE	SITE LOCATION	LATITUDE	LONGITUDE
MASN	Sandwich, MA	41° 45.73' N	70° 28.38' W
MADX	Duxbury, MA	42° 02.01' N	70° 40.3' W
MABI	Brewster Island, MA	42° 20.55' N	70° 52.68' W
MAWN	Winthrop, MA	42° 21.89' N	70° 57.85' W
MAIP	Ipswich, MA	42° 42.04' N	70° 47.44' W
NHRH	Rye Harbor, NH	43° 00.00' N	70° 14.42' W
NHDP	Dover Point, NH	43° 07.09' N	70° 49.39' W
MECC	Clarke Cove, ME/NH	43° 45.95' N	70° 10.75' W
MESA	Saco River, ME	43° 26.52' N	70° 21.08' W
MEPH	Portland Harbor, ME	43° 38.75' N	70° 15.50' W
MEPR	Presumpscot River, ME	43° 41.60' N	70° 15.00' W
MEKN	Kennebec River, ME	43° 47.50' N	69° 47.60' W
MEUR	Union River, ME	44° 15.60' N	68° 43.80' W
MEMR	Machias River, NB	44° 41.20' N	67° 23.50' W
MECK	Cobscook Bay, ME	44° 54.28' N	67° 03.25' W
NBNR	Niger Reef, NB	45° 60.30' N	69° 23.50' W
NBCH	Chamcook, NB	45° 07.40' N	67° 03.20' W
NBLB	Limekiln Bay, NB	45° 51.35' N	69° 35.41' W
NSAR	Apple River, NS	45° 27.60' N	64° 51.80' W
NSFI	Five Islands, NS	45° 39.50' N	64° 06.7' W
NSDI	Digby, NS	44° 38.10' N	65° 44.7' W
NSSC	Specchts Cove, NS	44° 32.30' N	65° 52.20' W

All field sampling was conducted in the fall of 1997. Sampling was carried out 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 could result in enhanced uptake and accumulation of sediment in the mussel gut. The presence of sediment in the mussels was suspected to be the cause of the elevated concentrations of some metals (iron, aluminum and associated metals) (Lobel et al., 1991; Robinson et al., 1993) in previous reports (Sowles et al., 1994, 1996; Chase et al., 1996a, b, 1997).

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 -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 on a minimum of 30 mussels.

Analytical Procedures

Analytical procedures used followed those reported for the previous years (Sowles et al., 1994, 1996; Chase et al., 1996a, b, 1997). Table 2 contains a summary of trace metal and organic compounds measured.

TABLE 2. Inorganic and organic contaminants analyzed in mussel tissues from the Gulf of Maine in 1997.

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-hexachlorocyclohexane (HCH)
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

Metals

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

Organic contaminants in mussel samples were analyzed at the Environment Canada, ECB Laboratory in Moncton, NB. The analyte detection limits ranged from 3.6 to 12 ng/g for aromatic hydrocarbons, from < 0.7 to 2.8 ng/g for PCB congeners, and from <0.7 to 1.8 ng/g for chlorinated pesticides. 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), and more comprehensively in Jones et al. (1998).

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/Mass spectrometry(HRGC/MS).

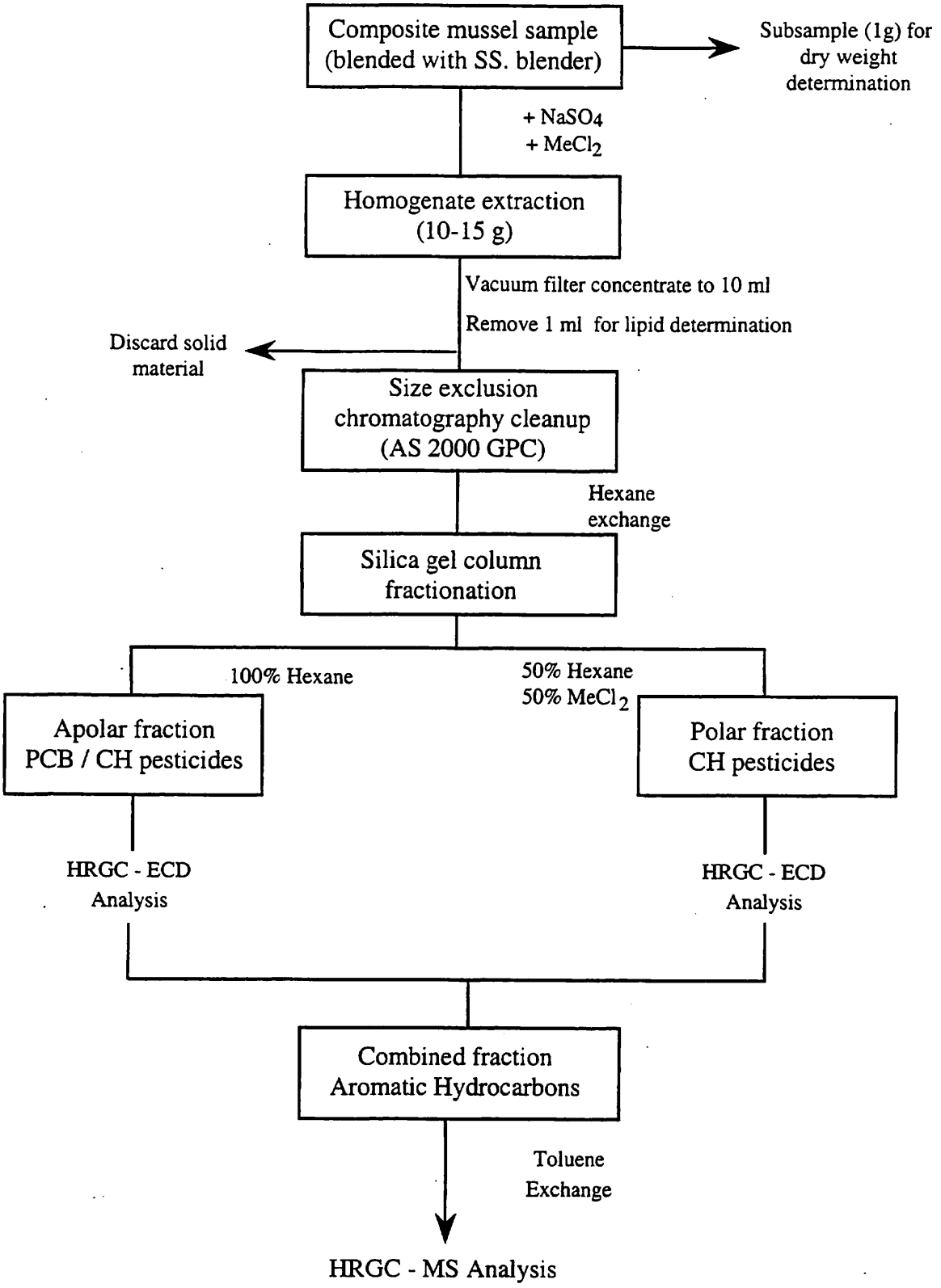

Figure 2. Analytical flow chart for organic analyte determination at the Environment Canada Laboratory in 1997. HRGC-MS, high resolution gas chromatography /massspectrometry; HRGC-ECD, high resolution dual column gas chromatography/electron capture detection; GPC, Gel permeation chromatography; SS., 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. Internal quality control and method performance specifications are described in the Environment Canada Shellfish Surveillance Protocol (Sowles et al., 1997; Jones et al., 1998). 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:

$$s_g = \text{antilog}\,(s_l) = 10^{s_l} \qquad (1)$$

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 pesticides ($\Sigma TPEST_{17}$) 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 deviation around the geometric means were calculated as described (Eq. 1).

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 most comparable to other sites in New Hampshire.

Temporal Analysis

Temporal analysis was performed on the benchmark sites (n=5 sites, n=5 years) and the 1997 sampling sites (n=18 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 - 1997 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, tissue concentrations from NBCH were used in the temporal analysis in place of NBHI. In a previous report (see Chase et al., 1997) a 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 the tissue concentrations of two metals (Cr and Ni) and ΣPAH_{24} in mussels from NBCH were significantly lower in 1996 (Chase et al., 1997). 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 1997 sampling sites were compared to concentrations from samples at these sites taken in 1994. Concentrations in 1994 and 1997 were compared at each site using a student t-test. 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 Nova Scotia. The Nova Scotia station at Barrington Passage (NSBP) was not sampled in 1997 as there were no mussels discovered at this site.

Metal Contaminants

Table 3 contains the metal concentrations (arithmetic mean ± SD, μg/g dry weight) for mussels from all sites sampled in 1997. 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 for Ag, Cd, Cr, Hg, and Ni were greater in Gulfwatch samples than in NOAA, NS&T samples. Moreover, the levels of Ag 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 (Sowles et al., 1994, 1996; Chase et al., 1996a, b, 1997). This is not surprising given that half of the Gulfwatch stations were chosen as potentially contaminated areas, whereas many of the NS&T stations were essentially reference stations that were chosen to avoid acute human activity or known sources of contamination.

Spatial Variation in Metal Concentrations

Figures 3 to 6 show the concentrations of the metals measured in the tissue of *M. edulis* at the 1997 sampling stations presented from south to north. In addition, the mean tissue metal concentrations at each of the Gulfwatch sites are compared to two "benchmark" values for each metal previously reported by Sowles (1993) from 23 Maine reference sites (Table 5): (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 as the "anomalous value"). These Maine reference stations are located in areas where anthropogenic contamination should be low. Maine Reference concentrations should therefore be

Table 3. Tissue metal concentrations (μg.g^{-1} dry weight, mean ± SD) for Gulfwatch mussels in 1997. 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	1.01±0.03^{B}	1.09±0.15^{AB}	1.00±0.09^{A}	7.2±0.4^{A}	3.10±0.36^{A}	0.29±0.07^{A}	0.98±0.05^{A}	78±6^{A}	105±13^{A}	265±31^{A}
MADX	0.21±0.14^{A}	1.01±0.13^{A}	1.11±0.13^{A}	6.9±0.7^{A}	3.19±0.45^{AB}	0.48±0.04^{B}	0.66±0.03^{A}	79±14^{A}	90±14^{A}	206±53^{A}
MABI	0.29±0.05^{A}	1.50±0.00^{BC}	1.60±0.28^{B}	7.1±0.6^{A}	3.60±1.41^{AB}	0.56±0.04^{B}	1.30±0.57^{BC}	140±0^{B}	189±143^{AB}	300±170^{A}
MAWN	0.22±0.06^{A}	1.68±0.28^{C}	2.58±0.44^{C}	7.4±1.1^{A}	4.73±0.87^{B}	0.55±0.05^{B}	1.63±0.26^{C}	114±19^{B}	310±56^{B}	498±92^{B}
MAIP	0.14±0.01^{A}	1.49±0.15^{C}	1.57±0.10^{B}	6.2±0.2^{A}	2.18±0.22^{A}	0.48±0.01^{B}	0.79±0.10^{AB}	84±7^{A}	129±16^{A}	292±22^{A}
NHRH	0.08±0.03	1.52±0.42^{A}	2.05±1.25^{A}	7.0±2.5^{A}	2.33±0.80^{A}	0.64±0.16^{A}	1.74±0.71^{A}	117±38^{A}	180±60^{A}	313±99^{A}
NHDP	ND	1.79±0.10^{A}	2.49±0.34^{A}	6.7±0.4^{A}	1.71±0.31^{A}	0.70±0.07^{A}	1.38±0.10^{A}	109±14^{A}	233±36^{A}	326±32^{A}
MECC	ND	1.55±0.31^{A}	3.01±0.33^{A}	7.0±1.2^{A}	5.06±1.07^{B}	0.66±0.06^{A}	1.87±0.26^{A}	76±11^{A}	428±57^{B}	611±112^{B}
MESA	ND	1.63±0.17^{A}	2.00±0.14^{B}	6.3±0.3^{A}	3.13±0.25^{BC}	0.52±0.05^{A}	1.15±0.13^{A}	101±6^{B}	173±26^{AB}	358±30^{AB}
MEPH	ND	1.47±0.33^{A}	1.63±0.50^{AB}	5.9±2.0^{A}	6.36±1.84^{C}	0.55±0.05^{A}	1.24±0.38^{A}	116±24^{B}	305±86^{BC}	438±129^{B}
MEPR	0.08±0.03^{A}	1.23±0.28^{A}	1.95±0.33^{B}	5.8±1.3^{A}	4.20±0.70^{C}	0.41±0.20^{A}	1.33±0.15^{A}	69±10^{AB}	415±59^{C}	513±111^{B}
MEKN	ND	1.33±0.13^{A}	1.03±0.32^{A}	5.0±1.2^{A}	0.98±0.31^{A}	0.33±0.14^{A}	ND	46±10^{A}	122±59^{A}	190±95^{A}
MEUR	0.17±0.09^{B}	1.51±0.57^{A}	1.13±0.46^{AB}	4.8±1.7^{A}	1.15±0.78^{A}	0.35±0.06^{A}	0.98±0.40^{A}	47±21^{A}	110±61^{A}	299±162^{AB}
MEMR	ND	1.26±0.50^{A}	1.20±0.54^{AB}	4.1±2.1^{A}	1.30±0.61^{A}	0.35±0.17^{A}	1.38±0.70^{A}	42±23^{A}	317±216^{BC}	455±282^{B}
MECK	ND	2.03±0.21^{A}	1.33±0.21^{AB}	6.0±0.9^{A}	1.95±0.37^{AB}	0.45±0.07^{A}	1.38±0.17^{A}	124±32^{B}	300±63^{BC}	388±81^{AB}
NBNR	ND	0.72±0.08^{A}	1.02±0.06^{B}	7.0±5.4^{A}	0.91±0.14^{B}	0.22±0.04^{A}	0.95±0.17^{B}	66±9^{A}	403±41^{C}	458±62^{B}
NBCH	0.08±0.03	1.16± .05^{B}	0.68±0.10^{A}	5.3±0.3^{A}	0.47±0.13^{A}	0.16±0.05^{A}	0.52±0.14^{A}	58±4^{A}	180±38^{A}	226±47^{A}
NBLB	ND	1.12±0.11^{B}	1.09±0.04^{B}	7.3±0.6^{A}	1.31±0.09^{B}	0.17±0.10^{A}	0.88±0.04^{B}	69±6^{A}	274±5^{B}	360±14^{B}
NSAR	ND	2.70±0.32^{C}	1.88±0.50^{A}	6.6±0.7^{A}	1.48±0.38^{A}	0.48±0.08^{B}	2.23±0.22^{B}	74±11^{BC}	615±176^{AB}	720±206^{AB}
NSFI	ND	1.70±0.12^{B}	2.25±0.58^{A}	6.0±0.4^{AB}	1.24±0.34^{A}	0.25±0.05^{A}	2.15±0.48^{B}	55±4^{A}	975±294^{B}	1085±350^{B}
NSDI	ND	1.54±0.58^{B}	1.81±0.52^{A}	6.6±0.6^{B}	2.79±0.60^{B}	0.32±0.05^{A}	1.44±0.04^{A}	89±15^{C}	392±45^{A}	513±27^{A}
NSSC	ND	0.93±0.09^{A}	1.38±0.40^{A}	5.2±0.6^{A}	1.48±0.40^{A}	0.31±0.04^{A}	1.28±0.15^{A}	58±5^{B}	390±211^{A}	693±290$^{A\ B}$
Geometric (±SD)	0.61±2.39	1.39±1.38	1.49±1.54	6.01±1.31	1.97±2.00	0.38±1.62	1.19±1.51	77±1	243±2	384± 2

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

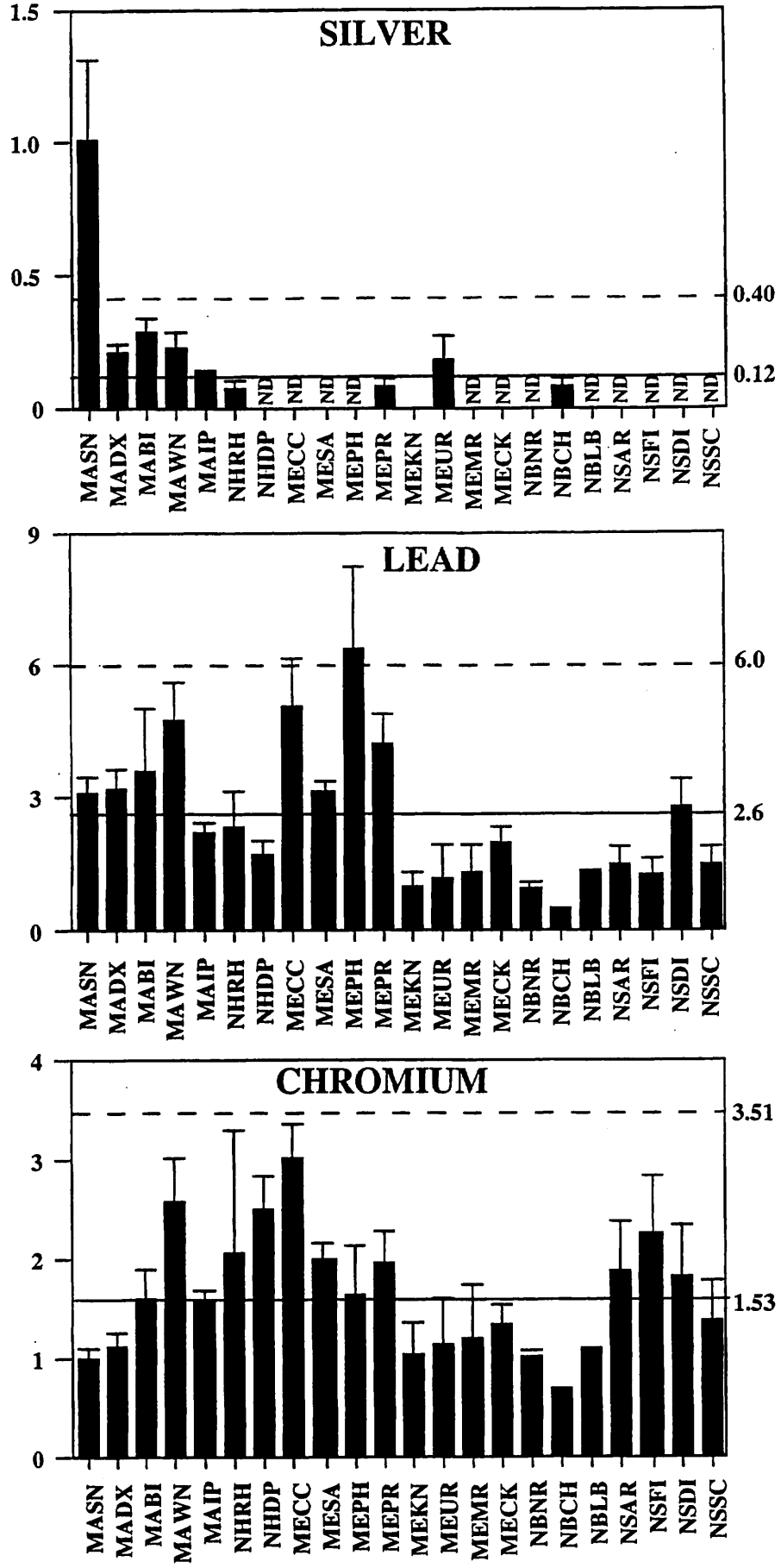

Figure 3. Distribution of silver, lead and chromium tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine Stations in 1997. The reference mean, ME-RM (straight line) and the high value, ME-HV (dashed line) from the Maine reference data (Sowles, 1993) are shown for comparison. ND=not detectable.

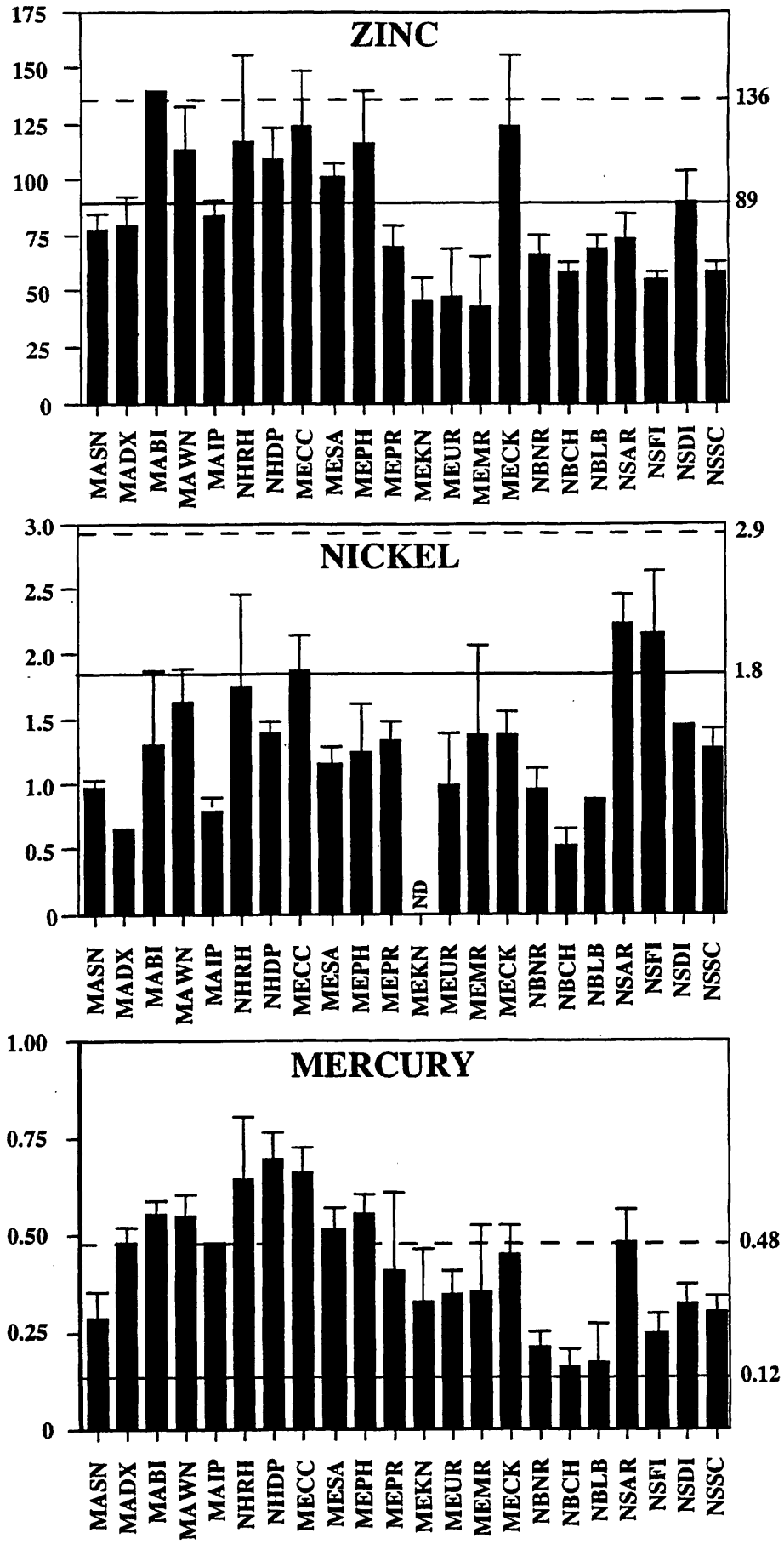

Figure 4. Distribution of zinc, nickel, and mercury tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine Stations in 1997. The reference mean, ME-RM (straight line) and the high value, ME-HV (dashed line) from the Maine reference data (Sowles, 1993) are shown for comparison. ND=not detectable.

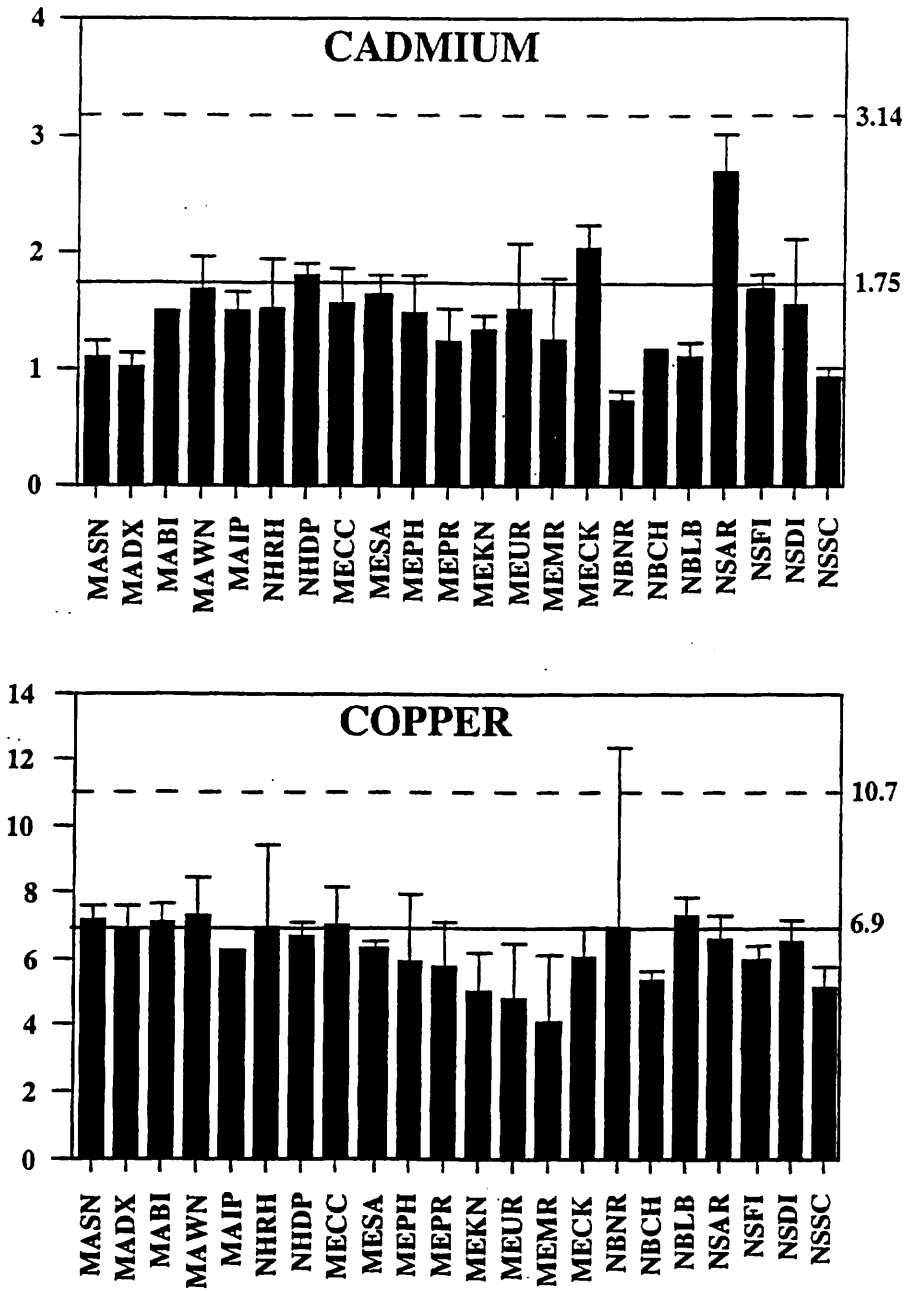

Figure 5. Distribution of cadmium and copper tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine Stations in 1997. The reference mean, ME-RM(straight line) and the high value, ME-HV (dashed line) from the Maine reference data (Sowles, 1993) are shown for comparison.

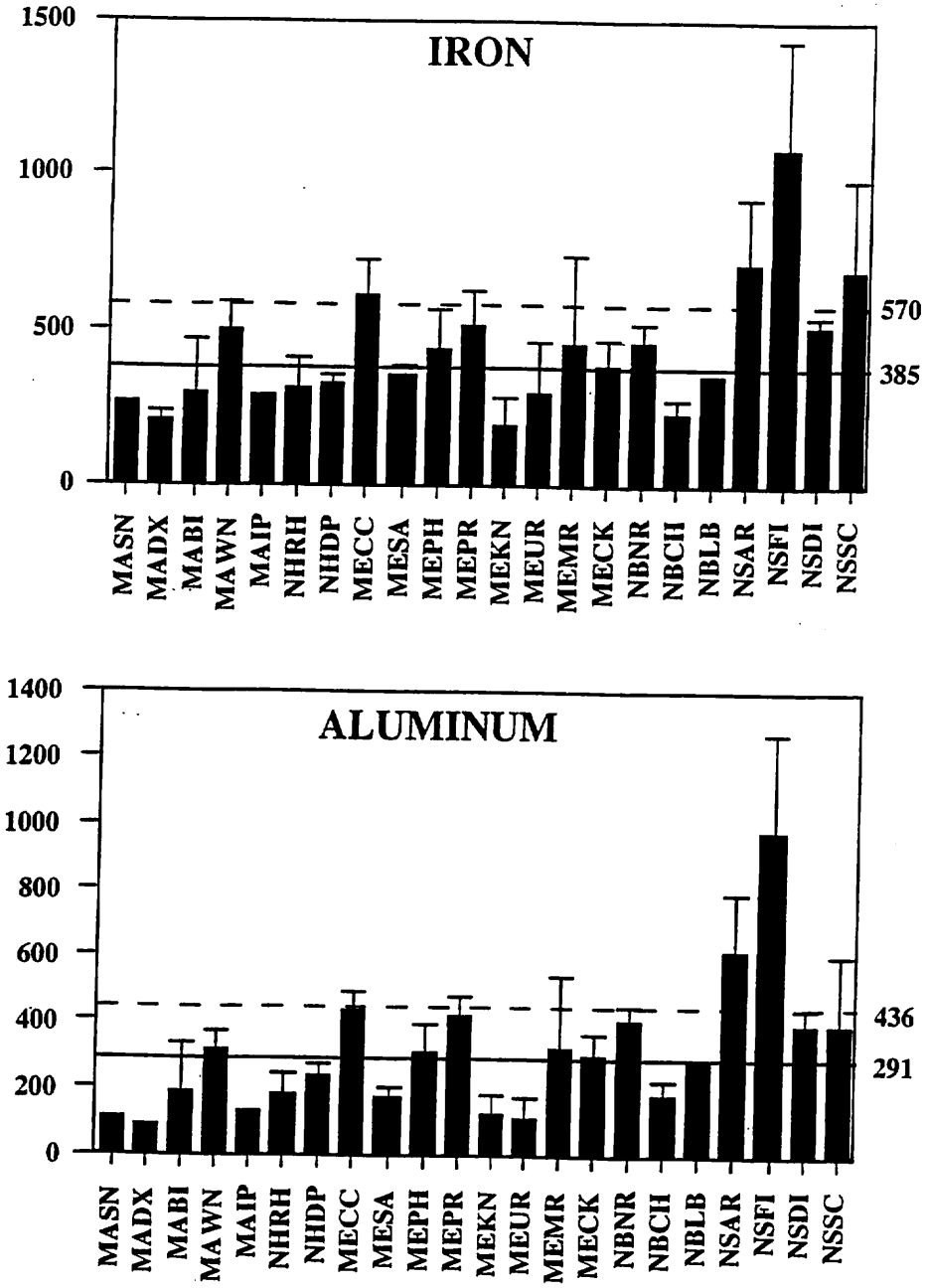

Figure 6. Distribution of iron and aluminum tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine Stations in 1997. The mean (straight line) and the high value (dashed line) from the NS&T data (O'Connor, 1992) are shown for comparison.

lower than that observed at several of the Gulfwatch stations.

In Table 3, sites were grouped by jurisdiction and ANOVA and Tukey Kramer tests were employed to examine differences among sites within a jurisdiction in 1997. Differences among all sites (22 stations throughout 5 jurisdictions) were not statistically examined.

Silver (Ag)

Elevated silver exposure concentrations have been shown to coincide with regions receiving municipal sewage (Sanudo-Wlhelmy and Flegal, 1992; Buchholz ten Brink et al., 1996). Mussel tissue concentrations of Ag ranged from non-detected (ND) at 13 sites (NHDP, MECC, MESA, MEPH, MEKN, MEMR, MECK, NBNR, NBLB, NSAR, NSFI, NSDI, NSSC) to 1.01 ± 0.03 µg/g dry weight at MASN (Table 3). As in previous reports (see Sowles et al., 1994, 1996; Chase et al., 1996a, b, 1997) the concentration of Ag in mussel tissue is significantly higher in the southern Gulf of Maine stations (Figure 3). Ag concentrations at MASN were significantly higher than all other sites in 1997 and exceed the Maine high value (ME-HV) of 0.40 µg/g dry weight for the Maine reference stations. Exceptionally high silver concentrations at MASN were also observed in the Gulfwatch 1993 to 1996 samples, but not in the 1992 samples (Sowles et al., 1994). These high Ag concentrations are unusual since there are no POTW outfalls or industrial effluent in the area. Most sites examined in 1997 were below the Maine reference mean of 0.12 µg/g dry weight with the exception of MADX, MABI, MAWN, MAIP and MEUR.

Lead (Pb)

The concentration of lead ranged from a value of 0.47 ± 0.13 µg/g dry weight (NBCH) to 6.36±1.84 µg/g dry weight (MEPH) (Table 3, Figure 3). Mean concentrations of Pb in mussels from coastal regions can range from 1 to 16 µg/g dry weight (Fowler, 1990). Nine of the twenty-two sites sampled in 1997 exceed the Maine reference concentrations (ME-RM) of 2.6 ± 1.1 µg/g dry weight, only MEPH 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 (5.1 ± 1.1 µg/g dry weight) in mussels at MECC. The Jamaica landfill and defense reutilization and Marketing Office on Seavey Island are sites of known sources of lead contamination to Portsmouth Harbor where waste plating sludge and lead batteries, respectively were disposed and stored (NCCOSC, 1994).

Analysis of the concentrations of Pb in mussel tissue within each jurisdiction (Table 3) showed that there were significant differences between sites within all jurisdictions. 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 (0.68 ± 0.10 µg/g dry weight) and the highest at MECC (3.01 ± 0.33 µg/g dry weight) (Table 3, Figure 3). Elevated concentrations at MECC probably reflect historical tanning industry discharges (Capuzzo and Anderson, 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. Higher concentrations of Cr have been found along the coast of Nova Scotia and 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 among sites in all jurisdictions with the exception of New Hampshire and Nova Scotia.

Zinc (Zn)

Zinc concentrations generally reflect human activity associated with tire wear, galvanized materials and industrial discharges. Eight sites had concentrations greater than the ME-RM (89 ± 16 µg/g dry weight). Only MABI had concentrations greater than the ME-HV (136 µg/g dry weight) (Table 3, Figure 4). The lowest concentration of Zn measured was at MEMR (42±23 µg/g dry weight) and the highest was at MECK (124±32 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 there were significant differences among sites in each jurisdiction with the exception of New Hampshire and New Brunswick (Table 3).

Nickel (Ni)

The concentration of nickel ranged from ND at MEKN to 2.23 ± 0.22 µg/g dry weight at NSAR (Table 3, Figure 4). The tissue concentration of Ni at NSFI and NSAR exceeded the ME-RM of 1.8 ± 0.4 µg/g dry weight. Such high concentrations in Nova Scotia stations may reflect the degree of exposed bedrock along the coast of Nova Scotia (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 New Hampshire, was the level of Ni consistent among sites.

Mercury (Hg)

The concentration of mercury in mussel tissue ranged from a value of 0.16 ± 0.05 µg/g dry weight at NBCH to 0.70 ± 0.39 µg/g dry weight at NHDP (Table 3, Figure 4). Mercury exceeded the ME-RM of 0.12 ± 0.12 µg/g dry weight at all sites except NBCH and NBLB. MADX, MABI, MAWN, MAIP, NHRH, NHDP, MECC, MESA, MEPH, and NSAR exceed the ME-HV of 0.48 µg/g dry weight. NHDP and MECC lie downstream from known historical mercury sources, including some that are suspected to be related to the Portsmouth Naval Shipyard (NCCOSC, 1994). In a recent review of the first five years of the Gulfwatch program tissue concentrations of Hg were discussed as being unusually high and a possible concern (Jones et al., 1998). 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, 1996). Over half of the Gulfwatch sites sampled in 1997 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, 1996). Analysis of the mussel tissue concentrations of Hg from sites within each jurisdiction (Table 3) showed that the level of Hg varied in Massachusetts and Nova Scotia, however, values were consistent in New Hampshire, Maine and New Brunswick.

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). About 47% of mercury deposition in the region originates from sources within the region, 30% from U.S. sources outside the region, and 23% from the global atmospheric reservoir (NESCAUM, 1998). On June 8, 1998, the New England governors and eastern Canadian premiers agreed to cut regional mercury emissions from power plants, incinerators, and other sources in half by the year 2003 (Boston Globe -6/9/98). However, until recently few coastal systems have been known to be affected by Hg pollution. In Maine's Penobscot Bay watershed, the origin of contaminants is likely to be from a combination of point and nonpoint sources, with over 750 pounds from the HoltraChem Manufacturing chlor-alkali plant in Orrington, ME. A series of recent chemical spills have focused concern on this facility, as these accidents have resulted in some of the highest sediment mercury levels (>100 ppm) in the U.S. Other areas in the Gulf of Maine also have elevated (5-20 ppm) sediment mercury concentrations (Buchholtz ten Brink et al, 1997). Thus, data on mussel tissue mercury levels are important to help assess current contamination problems and the effects of discharge reduction efforts in the future.

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 0.72 ± 0.08 μg/g dry weight at NBNR to 2.70 ± 0.32 μg/g dry weight at NSAR (Table 3, Figure 5). 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 NHDP, MECK, and NSAR. No values exceeded the ME-HV (3.14 μg/g dry weight). Within the jurisdictions, the concentration of Cd varied with significant differences among sites in Massachusetts, New Brunswick, and Nova Scotia.

Copper (Cu)

The level of copper in mussel tissue ranged from 4.1 ± 2.1 μg/g dry weight at MEMR to 7.4 ± 1.1 μg/g dry weight at MAWN (Table 3, Figure 5). Eight 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 all jurisdictions with the exception of Nova Scotia.

Iron (Fe) and Aluminum (Al)

The concentration of iron in mussel tissue ranged from 190 ± 95 μg/g dry weight at MEKN to 1085 ± 350 μg/g dry weight at NSFI (Table 3, Figure 6). There were no reference values for Fe from Maine stations with which to compare our data, but comparisons could be made to NS&T values. Analysis of the mussel tissue concentrations of Fe within jurisdictions (Table 3) showed that there were significant differences among sites within all jurisdictions.

The concentration of aluminum in mussel tissue ranged from 90 ± 13 μg/g dry weight at MADX to 975 ± 294 μg/g dry weight at NSFI (Table 3, Figure 6). 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 appears to be characteristic of NSFI, as similar results were observed in 1993 and 1994. 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 (Sowles et al., 1996). 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 (NBCH), and NSDI] showed that 'year' was significant only for Hg and Zn (Table 6). 'Site' was significant for the following metals: Cr, Pb, Zn, Al, and Fe. The concentration of Cr, Pb, and Zn was highest at MECC, and the concentration of Fe and Al was highest at NSDI. The year effect observed in both Hg and Zn is the result of the decrease in Hg and Zn concentration at all sites since 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 improved analytical ability.

As a result of the small sample size used in the test (n=5 sites; n=5 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 H_0 (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.

Annual sites (1994 vs 1997)

Figure 7 to 11 show the concentrations of all metals at the eighteen non-benchmark Gulfwatch sites sampled in 1994 and 1997. Asterisks show sites in which a significant difference in concentration was detected. Significant differences between years were observed for all contaminants. The direction of the change varied depending on the contaminant and the site examined. No change in metal tissue contaminant concentrations was observed at NHRH and MEMR. Decreased metal tissue concentrations were observed in the following sites: MADX (Cr, Cu, Fe, Hg, Ni, and Al), MAWN (Fe and PB), NHDP (Ag, Cd, Cr, Fe, Hg, Pb, and Zn), MEPH (Hg), MEUR (Hg), and NBLB (Cd, Cu, Hg, Ni, Pb, and ZN) whereas the following sites had increased metal tissue concentrations: MEPR (Al), MECK (Cd, Cr, Hg, Ni, Pb, and Zn), NSAR

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 Harbor, NS (NSDI) for 1993 to 1997. 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)
mean'97	1.01 (0.03)	1.09 (0.15)	1.00 (0.09)	7.2 (0.4)	3.10 (0.36)	0.29 (0.07)	0.98 (0.05)	78 (6)	105 (13)	265 (31)
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)
mean'97	ND	1.55 (0.31)	3.01 (0.33)	7.0 (1.2)	5.06 (1.07)	0.66 (0.06)	1.87 (0.26)	76 (11)	428 (57)	611 (112)
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)
mean'97	ND	1.33 (0.13)	1.03 (0.32)	5.0 (1.2)	0.98 (0.31)	0.33 (0.14)	ND	46 (10)	122 (59)	190 (95)
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)
mean'97	0.08 (0.03)	1.16 (0.05)	0.68 (0.10)	5.3 (0.3)	0.47 (0.13)	0.16 (0.05)	0.52 (0.14)	58 (4)	180 (38)	226 (47)
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)
mean'97	ND	1.54 (0.58)	1.81 (0.52)	6.6 (0.6)	2.79 (0.60)	0.32 (0.05)	1.44 (0.04)	89 (15)	392 (45)	513 (27)
p(site)	p>0.05	p>0.05	p<0.001*	p>0.50	p<0.001*	p>0.50	p>0.50	p<0.001*	p<0.001*	p<0.001*
p(year)	p>0.50	p<0.10	p>0.10	p>0.50	p>0.20	p>0.02*	p>0.50	p>0.005*	p>0.20	p>0.50

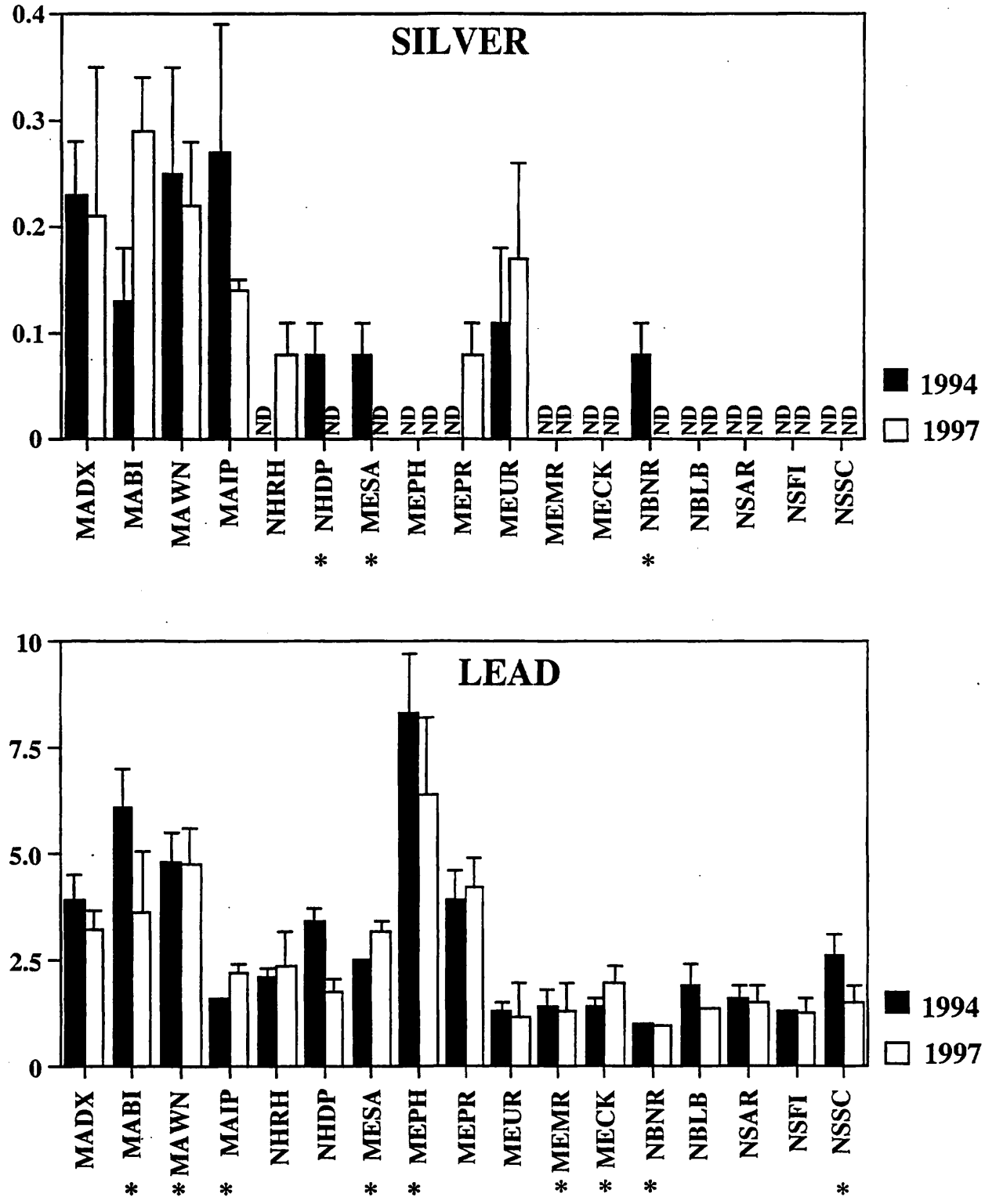

Figure 7. Distribution of silver and lead concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulf of Maine stations in 1994 and 1997. *, indicates a significant difference between years ($p<0.05$).

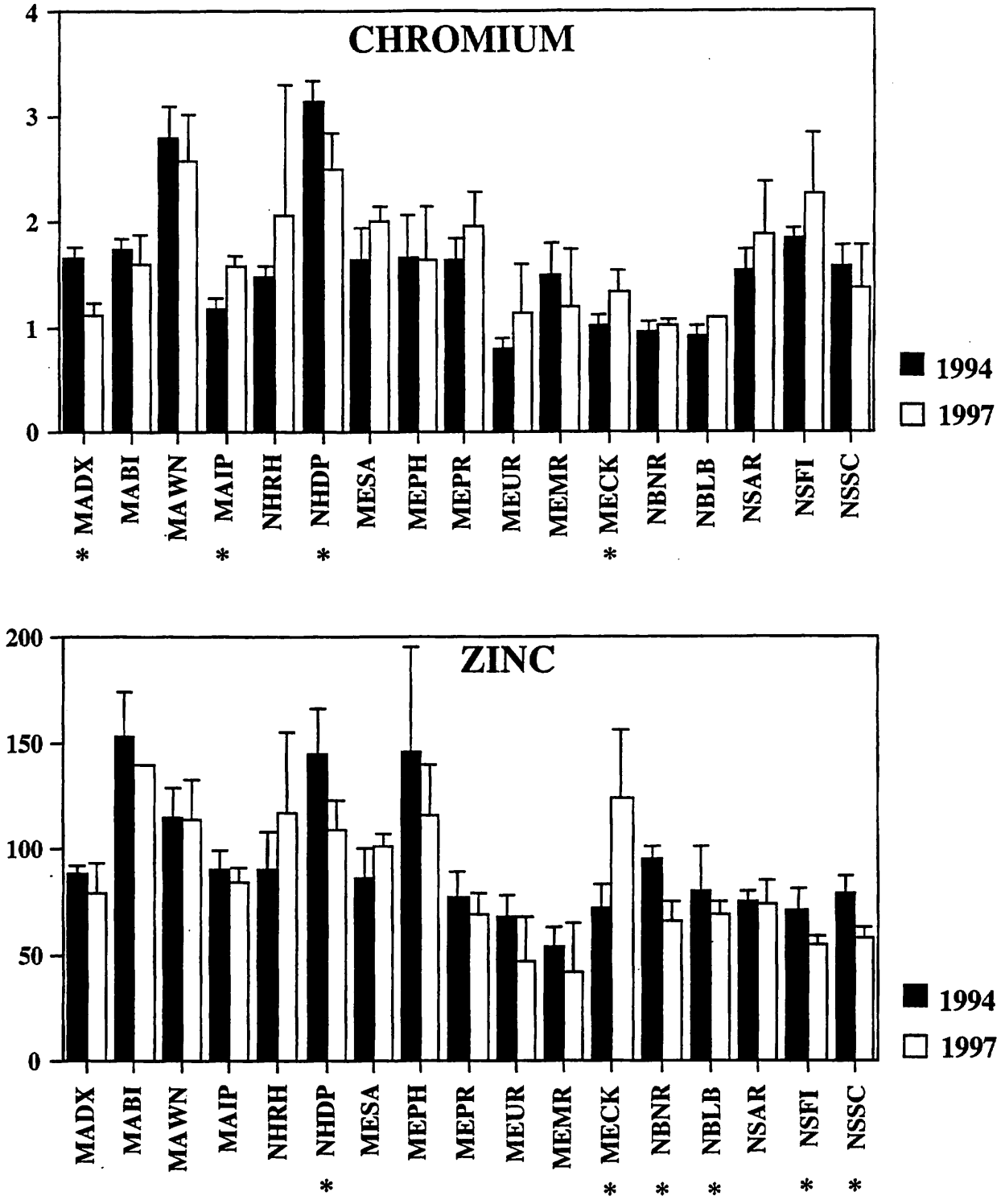

Figure 8. Distribution of chromium and zinc concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulf of Maine stations in 1994 and 1997. *, indicates a significant difference between years ($p<0.05$).

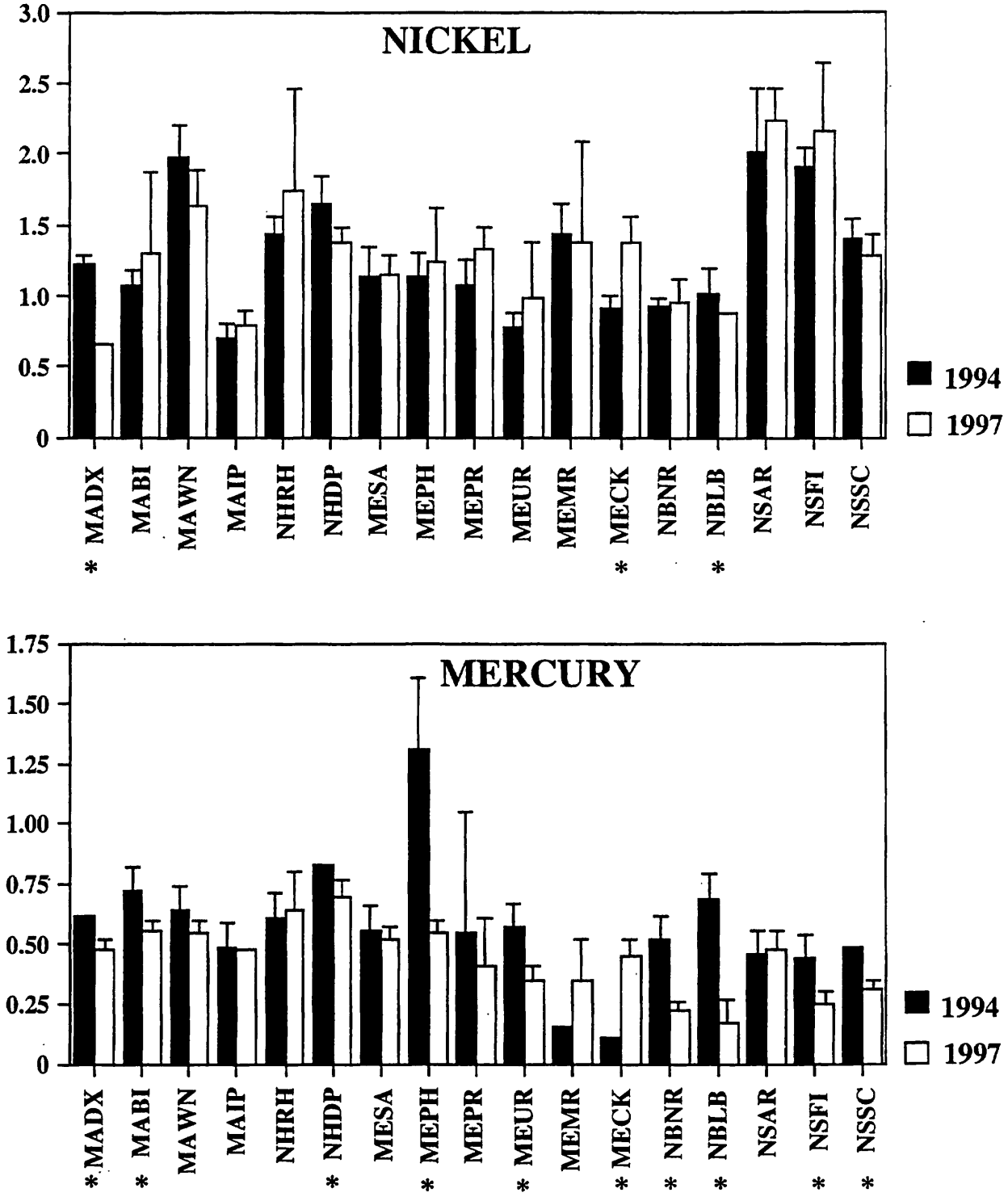

Figure 9. Distribution of nickel and mercury concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulf of Maine stations in 1994 and 1997. *, indicates a significant difference between years ($p<0.05$).

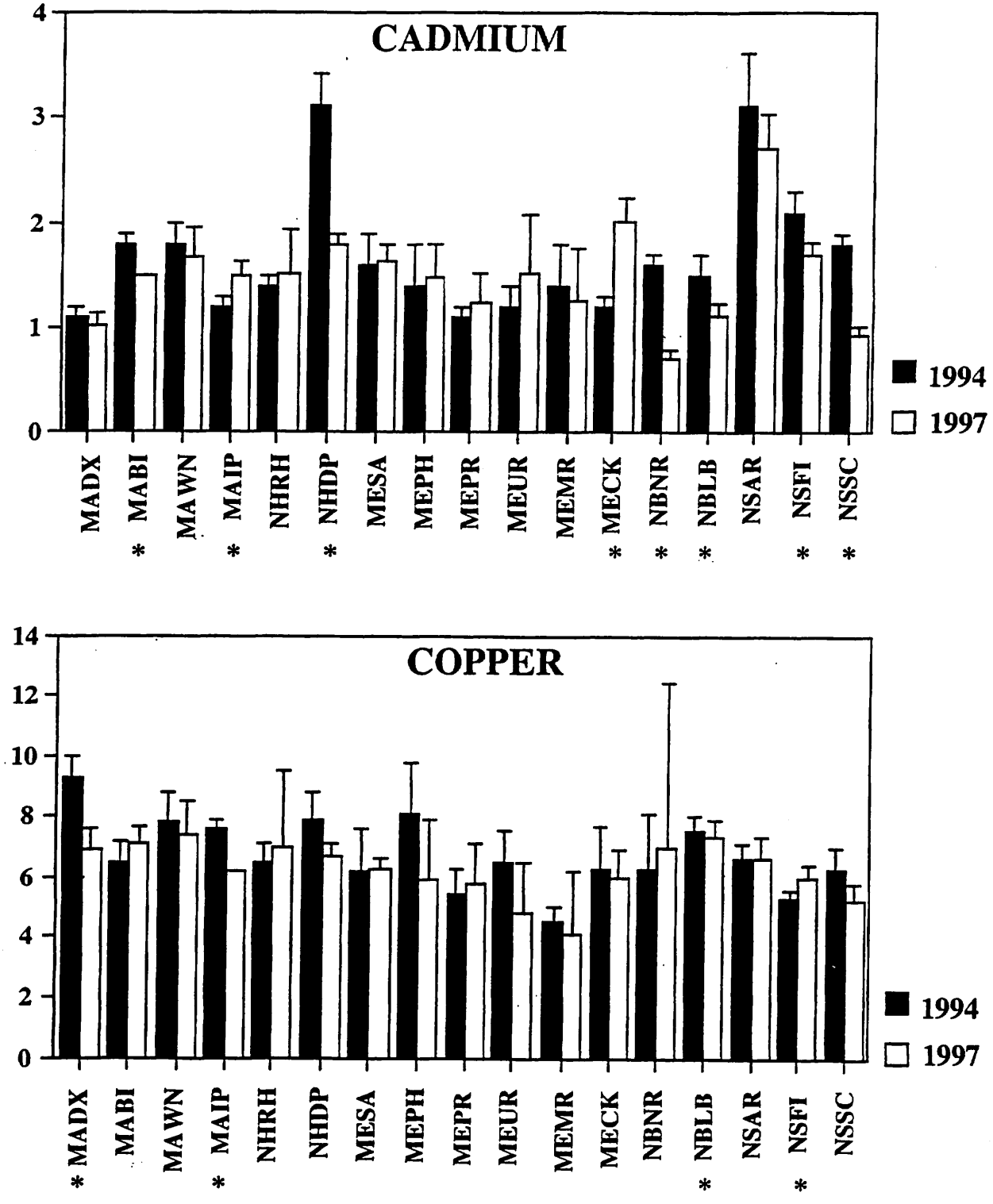

Figure 10. Distribution of cadmium and copper concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at Gulf of Maine stations in 1994 and 1997. *, indicates a significant difference between years ($p<0.05$).

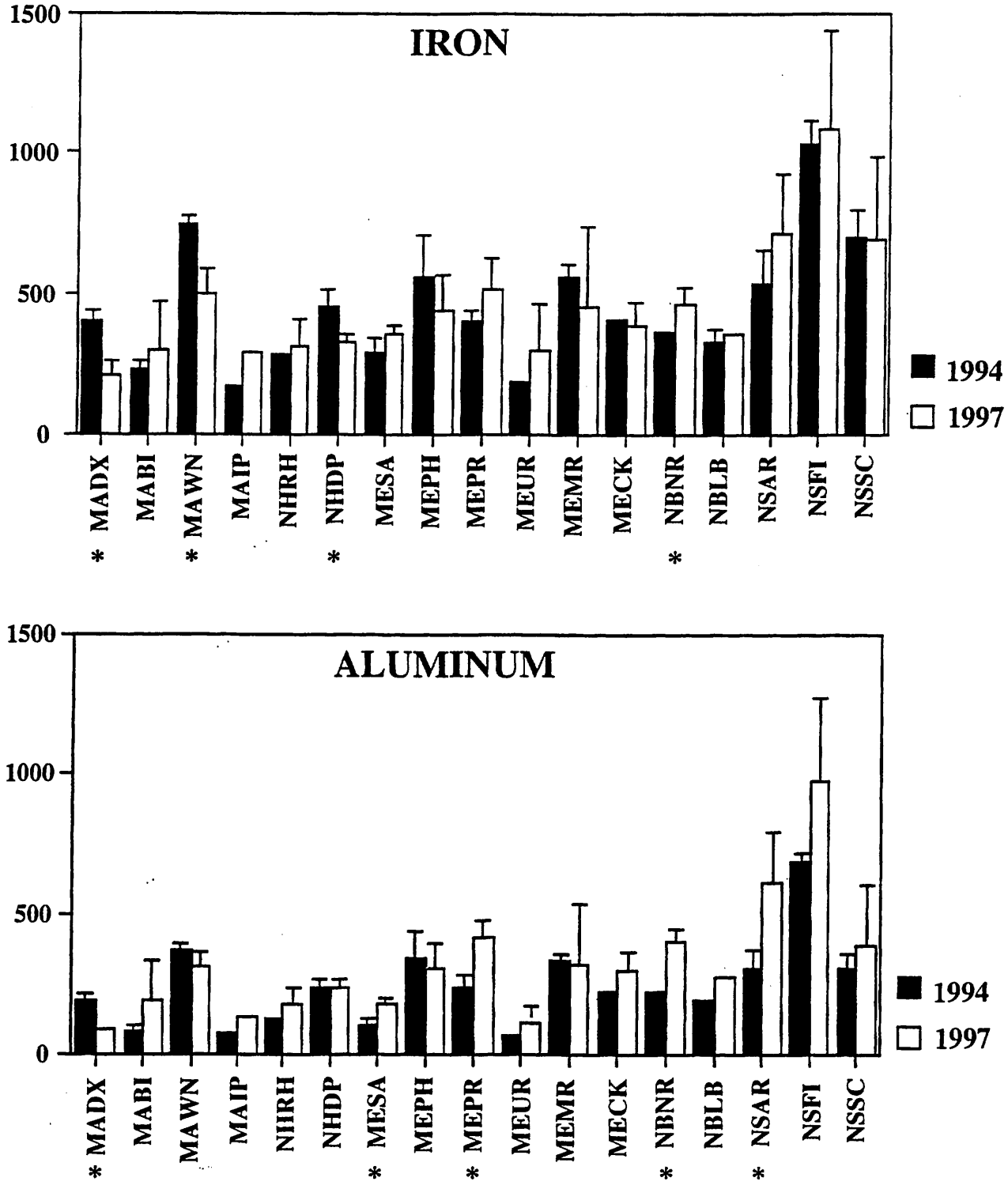

Figure 11. Distribution of iron and aluminum concentrations (arithmetic mean +/- SD, μg/g dry weight) in mussels at Gulf of Maine stations in 1994 and 1997. *, indicates a significant difference between years ($p<0.05$).

(Cu). At MABI, MAIP, MESA, NBNR and NSFI, the direction of change varied depending on the metal examined.

Organic Contaminants

The total concentration of polynuclear aromatic hydrocarbons (ΣPAH_{24}), polychlorinated biphenyls (ΣPCB_{24}) and organochlorine pesticides ($\Sigma TPEST_{17}$) measured in mussel tissue samples of indigenous mussels 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 12 and 13 show the concentration of ΣPAH_{24} (Figure 12), ΣPCB_{24} (Figure 12), and $\Sigma TPEST_{17}$ (Figure 13) measured in tissue of *M. edulis* in the 1997 sampling stations, presented from south to north. Concentrations of contaminants were plotted on a log scale and the geometric mean ± 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 139 ng/g dry weight in New Hampshire. At least one site in all jurisdictions exceed the geometric mean + 1 SD, with the exception of New Brunswick (Figure 12). The geometric mean of ΣPCB_{24} ranges from 1.1 in Nova Scotia to 84.1 ng/g dry weight in Massachusetts. MASN, MADX, MABI, MAWN, MAIP, NHDP, MECC, MESA, MEPH, MEPR, and MEKN all exceed the geometric mean + 1 SD (Figure 12). The geometric mean of $\Sigma TPEST_{17}$ ranged from 3.1 ng/g dry weight in Nova Scotia to 31.3 ng/g dry weight in Massachusetts. MASN, MADX, MABI, MAWN, MAIP, NHDP, MECC, MEPH, MEPR, MEKN, MEUR, and MECK all exceed the geometric mean + 1 SD (Figure 13). Nine sites examined in 1997 (MADX, MABI, MAWN, MAIP, NHDP, MECC, MEPH, MEPR, and MEKN) exceed the geometric mean + 1 SD in each of ΣPAH_{24}, ΣPCB_{24} and $\Sigma TPEST_{17}$.

In 1997 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

Table 7. Tissue organic contaminant concentrations (arithmetic mean ± SD, ng/g dry weight) from mussels collected throughout the Gulf of Maine in 1997 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	28 ± 1 A	42 ± 7 A	24 ± 2 A	5.7 ± 0.5 A	19 ± 1.6 A
MADX	123 ± 17 B	80 ± 4 B	41 ± 1 B	5.8 ± 0.6 A	35 ± 1 C
MABI	260 ± 11 C	188 ± 1 D	39 ± 2 B	11 ± 1.0 B	29 ± 1.2 C
MAWN	211 ± 20 C	124 ± 15 C	26 ± 4 A	6.9 ± 1.8 A	20 ± 2.5 AB
MAIP	110 ± 11 B	71 ± 5 B	29 ± 2 A	5.9 ± 0.2 A	23 ± 2 B
NHRH	69 ± 9 B	12 ± 1 A	12 ± 2 A	4.1 ± 0.25 A	7.9 ± 2.1 A
NHDP	27 ± 41 A	55 ± 12 B	20 ± 4 A	4.4 ± 0.52 A	16 ± 4 B
MECC	147 ± 19 C	37 ± 8 B	15 ± 5 AB	4.6 ± 2.0 A	11 ± 3 AB
MESA	60 ± 28 B	17 ± 8 CD	11 ± 2 A	4.1 ± 1.5 B	6.1 ± 0.90 A
MEPH	1375 ± 324 D	85 ± 21 E	40 ± 6 C	7.6 ± 0.77 C	33 ± 5 D
MEPR	191 ± 33 C	21 ± 3 D	19 ± 3 B	3.6 ± 1.1 AB	15 ± 2 C
MEKN	49 ± 10 B	25 ± 1 D	12 ± 1 A	3.2 ± 0.18 A	9 ± 0.51 B
MEUR	135 ± 25 C	0.98 ± 2.0 A	14 ± 1 A	7.8 ± 0.59 C	5.9 ± 1.4 A
MEMR	61 ± 19 B	4.1 ± 0.6 B	11 ± 1 A	4.9 ± 0.43 B	5.7 ± 0.53 A
MECK	ND A	6.7 ± 0.81 BC	19 ± 2 B	7.1 ± 0.70 C	11 ± 0.85 BC
NBNR	ND A	2.0 ± 0.38 B	4.4 ± 0.88 A	1.1 ± 0.70 A	3.3 ± 0.26 A
NBCH	ND A	ND A	4.8 ± 0.19 A	1.4 ± 0 A	3.3 ± 0.17 A
NBLB	ND A	9.1 ± 1.9 C	8.6 ± 1.7 B	2.4 ± 0.8 A	6.2 ± 1.0 B
NSAR	ND A	ND A	1.3 ± 0.13 A	ND A	1.3 ± 0.13 A
NSFI	ND A	ND A	4.2 ± 0.42 C	ND A	4.2 ± 0.42 C
NSDI	198 ± 50 B	0.48 ± 0.95 B	1.7 ± 0.46 AB	ND B	1.7 ± 0.46AB
NSSC	ND A	ND A	1.9 ± 0.12 B	ND B	1.9 ± 0.12 B

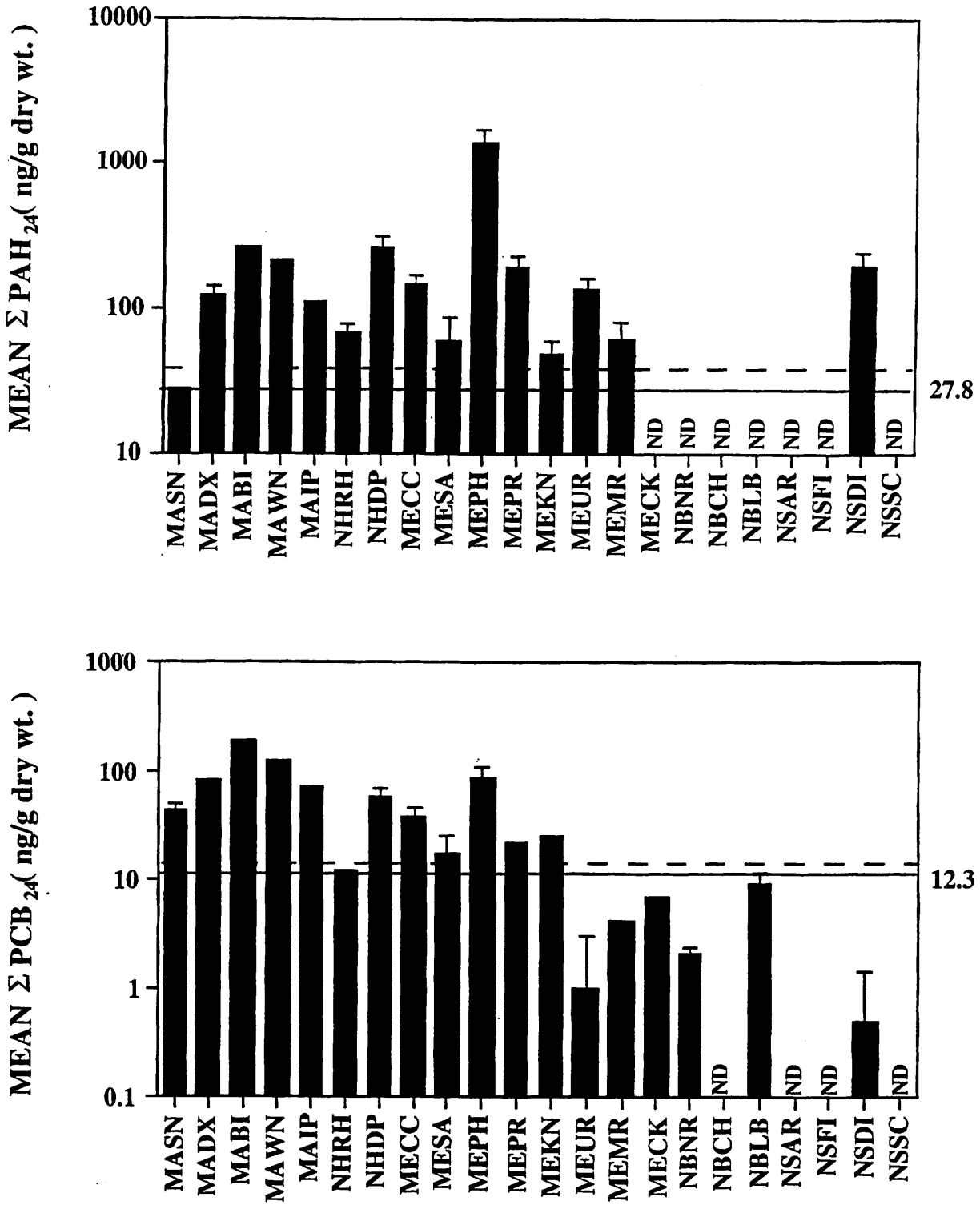

Figure 12. Log distribution of Σ PAH_{24} and Σ PCB 24 tissue concentrations (arithmetic mean: ng/g dry weight) in mussels at Gulf of Maine stations, 1997.
Geometric mean (straight line) one standard deviation (das hed line) of all Gulf of Maine Stations in 1997. ND= not detectable.

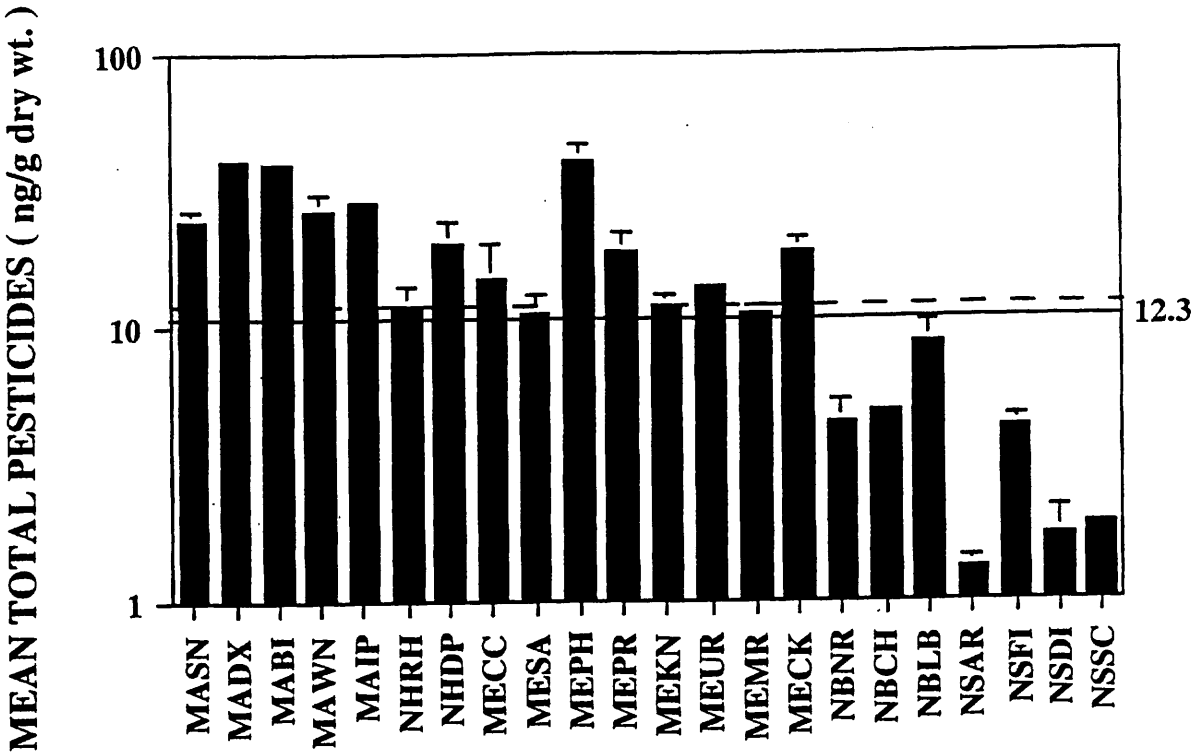

Figure 13. Log distribution of total pesticide ($\Sigma PEST_{17}$) tissue concentrations (arithmetic mean: ng/g dry weight) in mussels at Gulf of Maine stations, 1997.
Geometric mean (straight line) one standard deviation (das hed line) of all Gulf of Maine Stations in 1997. ND= not detectable.

Table 8. Geometric mean (±SD) of tissue organic contaminants for mussels within each jurisdiction and for all the Gulf of Maine, 1997 stations. ND, not detected.

Jurisdiction	ΣPAH_{24}	ΣPCB_{24}	$\Sigma TPEST_{17}$	$\Sigma OPEST_{11}$	ΣDDT_6
Massachusetts	106 ± 2.2	84.1 ± 1.58	31.3 ± 1.25	7.41 ± 1.22	24.8 ± 1.29
New Hampshire	139 ± 1.8	30.2 ± 1.93	16.2 ± 1.35	5.26 ± 1.24	11.8 ± 1.41
Maine	92 ± 5.8	12.5 ± 3.56	17.1 ± 1.53	6.31 ± 1.36	11.1 ± 1.8
New Brunswick	ND	3.08 ± 2.69	6.64 ± 1.35	2.45 ± 1.42	5.13 ± 1.30
Nova Scotia	3.7 ± 10.6	1.07 ± 1.31	3.09 ± 1.40	ND	3.09 ± 1.40
Gulf of Maine	27.8 ± 11.3	12.33± 5.46	12.27± 2.38	3.96 ± 2.18	9.38 ± 2.24

ΣPCB_{24} and $\Sigma TPEST_{17}$ (ΣDDT_6) data sets (Figure 12 and 13), which probably reflects the 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 seven stations to 1375 ± 324 ng/g dry weight at MEPH (Table 7, Figure 12).

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 (1400-16,000 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 MEPH (1375 ± 324 ng/g dry weight), located in Portland Harbor. This value is high in comparison to other sites in the 1997 Gulfwatch program. In 1996, there was a significant oil spill near this station. Despite high tissue concentration of ΣPAH_{24} at MEPH, the concentration is still lower than reported elsewhere 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 MABI (260 ± 11 ng/g dry weight).

There were significant differences in ΣPAH_{24} within all jurisdictions with the exception of New Brunswick (Table 7). Massachusetts (MABI and MAWN), New Hampshire (MECC), Maine (MEPH), and Nova Scotia (NSDI) all contained sites that were significantly higher than all other sites.

Polychlorinated Biphenyls

Mean ΣPCB_{24} concentrations in indigenous mussels ranged from ND to 188 ± 1 ng/g dry weight at MABI (Table 7, Figure 12). Analysis of variance revealed that there were significant differences in ΣPCB_{24} within all jurisdictions.

Pesticides

The concentration of $\Sigma TPEST_{17}$ in indigenous mussels ranged from 1.3 ± 0.13 at NSAR to

41 ± 1 ng/g dry weight at MADX (Table 7, Figure 13). In 1997 as in previous reports (Sowles et al., 1994, 1996; Chase et al., 1996a, b, 1997), ΣDDT_6 and its degenerative metabolites were the main contributors to total detectable pesticides. ΣDDT_6 was the only contributor to $\Sigma TPEST_{17}$ in Nova Scotia (Table 7).

Analysis of each jurisdiction (Table 7) showed that there were significant differences in $\Sigma TPEST_{17}$ among sites in all jurisdictions.

Chlorobiphenyls and Polychlorinated Dibenzo Dioxins and Dibenzo Furans

Several non-ortho, mono-ortho and di-ortho PCB congeners, planar chlorobiphenyls (CBs), are known to be biologically active and have structural and toxic properties similar to highly toxic 2,3,7,8-terachlorodibenzodioxin (2,3,7,8-TCDD). Mussel from several Gulfwatch sites were analyzed for planar chlorobiphenyls (CBs) in 1997. Planar CB concentrations typically are found in the environment at lower levels than other co-occurring PCB congeners. CBs concentrations in mussels, therefore, were measured by GC-high resolution mass spectrometry. The analytical results obtained are generally lower than the method detection limits established for the standard list of Gulfwatch PCB congeners shown in Appendix C using typical mussel watch methods of clean-up/fractionation and analysis by GC-ECD.

Table 9 contains chlorobiphenyl (CB) concentrations of single composite mussels samples collected from 12 Gulfwatch sites in 1997. The samples are a subset of the 1997 Gulfwatch sampling sites and are representative of several major riverine outflow locations in the Gulf of Maine. Concentrations of summed non-ortho, mono-ortho and di-ortho CBs in indigenous mussels ranged from 4703 to 175 pg/g wet weight. The highest concentration was measured in mussels at the Brewster Island site, MABI, (4703 pg/g wet wt) in Massachusetts which was considered a reference site for that jurisdiction earlier in the Gulfwatch program. The lowest concentrations were measured in mussels from two reference sites in Nova Scotia, NSAR and NSSC. Overall, Gulf-wide CB concentrations display a similar pattern of southerly increasing contamination that has been observed for other Gulfwatch organic contaminants in this and in past years.

In addition to planar CBs, polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were also measured in 1997 Gulf of Maine mussels. The results of these analyses are given in Appendix E. PCDD and PCDF concentrations in mussels were low or and in many cases below the limits of detection. In only one sample, MEPH (Portland Harbor ME), was a detectable concentration (0.89 pg/g wet wt) of the highly toxic 2,3,7,8-TCDD measured. No other samples had concentrations about detection limits for any other dioxin congener chlorinated

Table 9. Non-, mono- and di-ortho chlorobiphenyl concentrations (pg/g wet wt) in mussels at1997 Gulf of Maine sites.

Congener	MADX	MAWN	MAIP	MABI	NHDP	NHRH	MEPH	MEPR	MESA
Non-ortho									
PCB-77	81	100	120	140	52	14	28	ND	12
PCB-126	11	13	ND	15	15	6	6	ND	ND
PCB-169	ND	ND	ND	ND	5	ND	ND	ND	ND
Mono-ortho									
PCB-105	530	740	520	1100	370	90	220	94	92
PCB-114	17	31	28	44	8	ND	14	ND	ND
PCB-118	1600	1900	1200	2900	1100	220	540	220	220
PCB-156	130	170	98	220	97	28	55	ND	ND
PCB-189	ND	16	9	14	8	ND	ND	ND	ND
Di-ortho									
PCB-170	74	59	ND	ND	32	15	16	12	ND
PCB-180	350	360	230	270	16		95	69	56
Total pg/g wet wt	**2793**	**3376**	**2205**	**4703**	**1703**	**373**	**974**	**395**	**380**

Congener	NBNR	NBLB	NSAR	NSSC
Non-ortho				
PCB-77	18	15	ND	9
PCB-126	ND	ND	ND	ND
PCB-169	ND	ND	ND	ND
Mono-ortho				
PCB-105	67	110	ND	35
PCB-114	ND	ND	ND	ND
PCB-118	170	280	58	100
PCB-156	17	ND	7	ND
PCB-189	ND	ND	ND	ND
Di-ortho				
PCB-170	18	ND	15	7
PCB-180	77	180	44	24
Total pg/g wet wt	**367**	**585**	**124**	**175**

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. 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 (Hutzinger et al 1974).

Since planar CBs, dioxins and furans share a similar mode of action, and their relative toxicities can be standardized through the use of toxic equivalency factors (TEF), toxic equivalency concentration (TEQs) can be calculated for CBs and for PCDDs/PCDFs in Gulfwatch samples. TEQs for the CB concentrations given in Table 9 are shown in Table 10. TEQs were calculated using CB concentrations (Table 9) and the WHO interim toxic equivalency factors compiled by Alborg (Alborg at al. 1994). CB-derived TEQs in mussels from the 1997 sites ranged from a high of 2.11 pg/g at Brewster Island, Massachusetts to a low of 0.01 pg/g at Argyle, Nova Scotia. A graphical representation of the CB-derived TEQ distribution in samples collected from GOM sites in 1997 is shown in Figure 14. The spatial distribution of 1997 Gulfwatch mussel PCDD/PCDF derived TEQs is also presented in Figure 14. PCDD/PCDF derived TEQs were calculated using PCDD/PCDF concentrations (Appendix E) and established international toxic equivalency factors (NATO 1988). PCDD/PCDF derived TEQs range from a high of 1.04 pg/g at Portland Harbor, Maine to a low of 0.019 pg/g at Spechts Cove, Nova Scotia.

Total TEQs for both CBs and PCDD/PCDF are also shown in Figure 14. The range of total TEQs is 2.45 pg/g at Brewster Island MA to 0.04 pg/g at Spechts Cove NS. Interestingly, the greater contribution to total TEQs in most Massachusetts and New Hampshire sites is due to planar CBs in mussels, while the greater contribution to total TEQs in samples from Maine and New Brunswick is due to PCDDs/PCDFs.

From a human health perspective, total toxic equivalency concentrations for 1997 Gulfwatch samples are well below the 20 pg/g 2,3,7,8-TCDD Canadian tolerance level for the consumption of seafood that is considered protective of human health (Health Canada, 1993). The highest total TEQ measured in 1997 mussel was 2.45 pg/g, Brewster Island, MA. A tissue reference concentration of 0.32 pg TEQ/g diet that is considered protective of sensitive mammalian and avian species is currently under development (Environment Canada April 1988) . In 1997, Gulf of Maine mussels at MABI, MABI, MAWN, NHDP, NHRH, MEPH, MEPR, NBNR, and NBLB exceed this reference concentration.

Table 10. Non-, mono- and di-ortho chlorobiphenyl TEQs in mussels at 1997 Gulf of Maine sites.

Congener	TEF*	MADX	MAWN	MAIP	MABI	NHDP	NHRH	MEPH	MEPR
Non-ortho									
PCB-77	0.0005	0.041	0.050	0.060	0.070	0.026	0.007	0.014	
PCB-126	0.1	1.100	1.300		1.500	1.500	0.600	0.600	
PCB-169	0.01					0.050			
Mono-ortho									
PCB-105	0.0001	0.053	0.074	0.052	0.110	0.037	0.009	0.022	0.009
PCB-114	0.0005	0.009	0.016	0.014	0.022	0.004		0.007	
PCB-118	0.0001	0.160	0.190	0.120	0.290	0.110	0.022	0.054	0.022
PCB-156	0.0005	0.065	0.085	0.049	0.110	0.049	0.014	0.028	
PCB-189	0.0001		0.002	0.001	0.001	0.001			
Di-ortho									
PCB-170	0.0001	0.007	0.006			0.003	0.002	0.002	0.001
PCB-180	0.00001	0.004	0.004	0.002	0.003			0.001	0.001
Total (pg/g wet wt)		**1.44**	**1.73**	**0.30**	**2.11**	**1.78**	**0.65**	**0.73**	**0.03**

Congener	TEF*	MESA	NBNR	NBLB	NSAR	NSSC
Non-ortho						
PCB-77	0.0005	0.006	0.009	0.008		0.005
PCB-126	0.1					
PCB-169	0.01					
Mono-ortho						
PCB-105	0.0001	0.009	0.007	0.011		0.004
PCB-114	0.0005					
PCB-118	0.0001	0.022	0.017	0.028	0.006	0.010
PCB-156	0.0005		0.009		0.004	
PCB-189	0.0001					
Di-ortho						
PCB-170	0.0001		0.002		0.002	0.001
PCB-180	0.00001	0.001	0.001	0.002	0.000	0.000
Total (pg/g wet wt)		**0.04**	**0.04**	**0.05**	**0.01**	**0.02**

* Toxic Equivalency Factors (Ahlorg et al 1994)

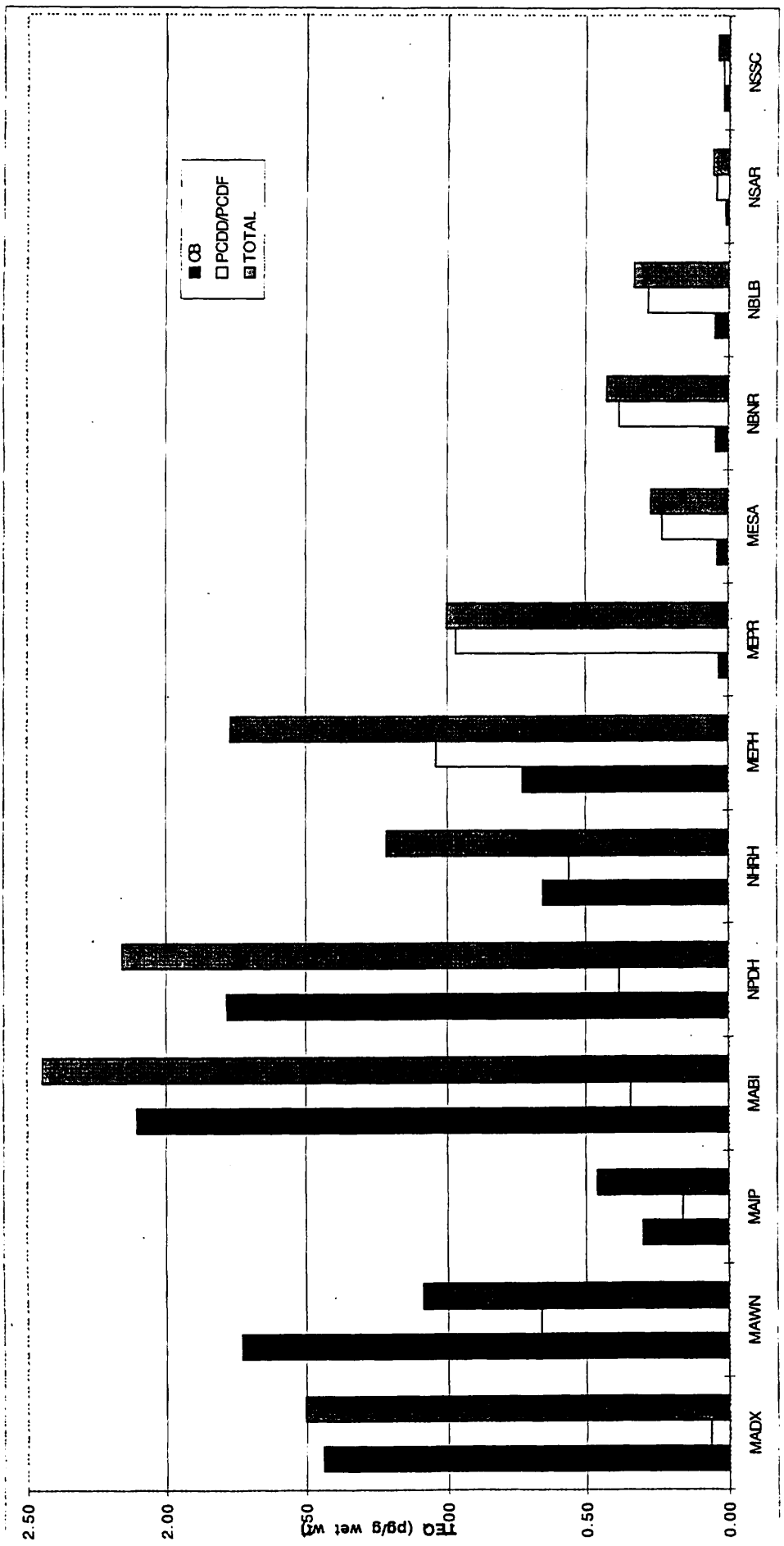

Figure 14. Distribution of CB and PCDD/PCDF Toxic Equivalency Concentrations (TEQs) in Mussels at 1997 Gulf of Maine Sites

Temporal Variation in Organic Concentrations

Benchmark sites

The repeated measures ANOVA comparing organic contaminant concentrations at each of the 5 benchmark sites [MASN, MECC, MEKN, NBHI (NBCH), and NSDI] showed that 'year' was significant only for ΣPAH_{24} (Table 11). The year effect for ΣPAH_{24} appears to be the result of increased concentrations of ΣPAH_{24} at all sites. '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=5 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 H_0 (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 II error occurred. The only exception was ΣPAH_{24}, where the chance that a Type II error occurred was only 22%. Concentrations of ΣPAH_{24} appear to be showing a pattern of increased concentrations since 1993.

Annual sites (1994 vs 1997)

Figure 15 to 17 show the concentrations of all organic contaminants at the eighteen non-benchmark Gulfwatch sites sampled in 1994 and 1997. Asterisks show sites in which a significant difference in concentration was detected. Significant differences between years were observed for all contaminants. The majority of differences reveal significantly higher concentrations than observed in 1993. With the exception of NSAR, all sites had at least one organic contaminant tissue concentration that was significantly higher in 1997 that in 1994.

Temporal comparison of MEPH and NHDP are of particular interest and relevance. Since the sampling in 1994, oil spills have occurred near both Gulfwatch stations. Temporal analysis of total organic contaminant concentrations at NHDP revealed that the concentrations of ΣPAH_{24} were significantly higher in 1997. The oil spill into the Piscataqua River near NHDP happened on July 1, 1996, and elevated levels of ΣPAH_{24} may be a reflection of this event. Analysis of the effects of the oil spill that occurred into the Piscataqua River near NHDP has been examined in

Table 11. 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) from 1993 to 1997. Results of repeated measure ANOVA are shown below. *, indicates significance at $p \leq 0.05$.

SITE	Σ PAH_{24}	Σ PCB_{24}	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)
mean'97	27.6 (1.2)	42.2 (6.7)	18.8 (1.56)	5.65 (0.48)	24.4 (2.03)
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)
mean'97	147 (19.1)	37.4 (8.4)	10.8 (3.03)	4.58 (1.97)	15.3 (4.97)
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)
mean'97	48.9 (9.86)	25.1 (1.14)	9.26 (0.51)	3.19 (0.18)	12.5 (0.69)
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)
mean'97	ND	ND	3.35 (0.17)	2.38 (0.78)	4.78 (0.19)
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)
mean'97	198 (50.1)	0.48 (0.95)	1.90 (0.12)	ND	1.90 (0.12)
p (site)	p<0.001*	p>0.001*	p>0.001*	p<0.002*	p<0.001*
p (year)	p>0.02*	p>0.50	p>0.10	p>0.05	p>0.05

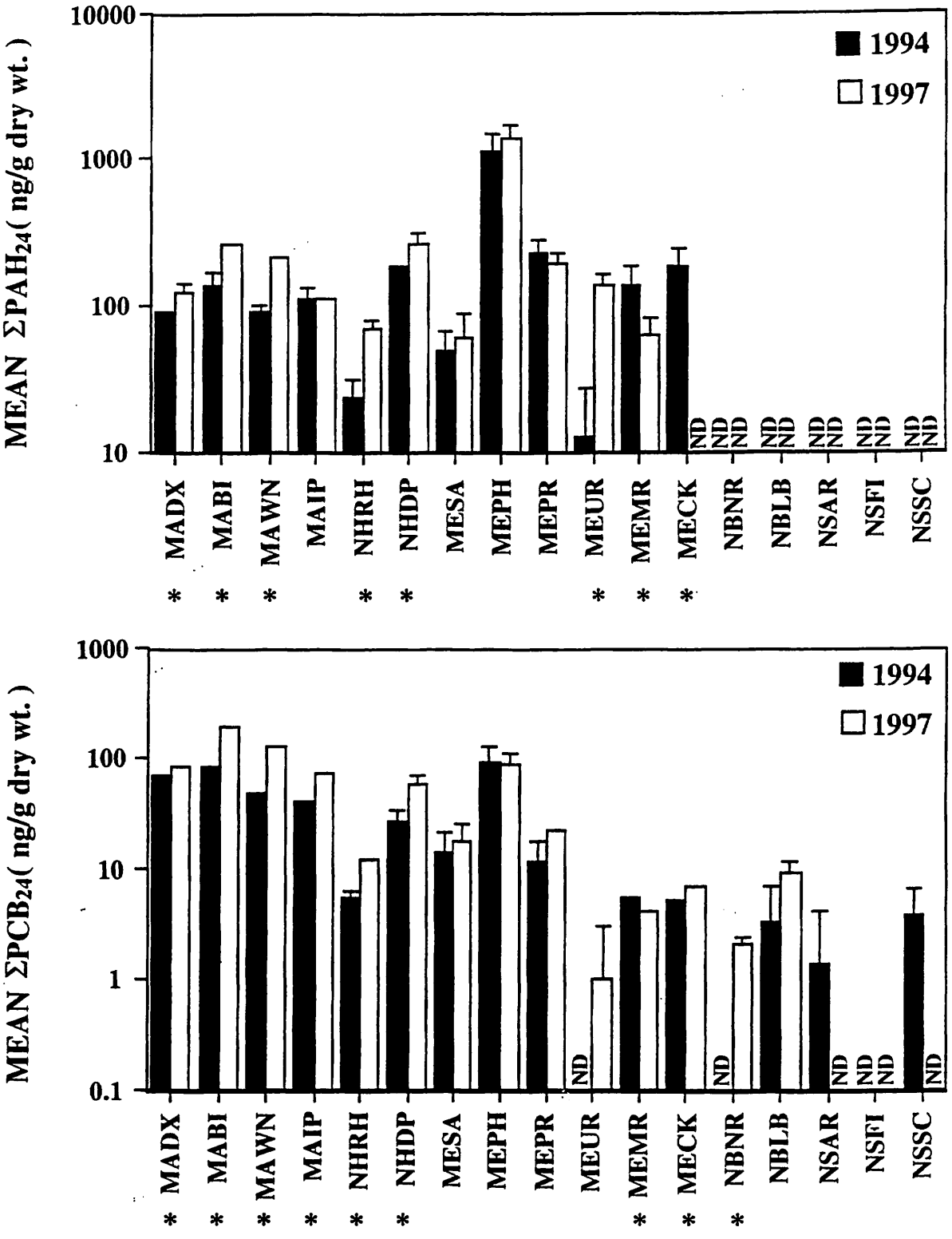

Figure 15. Log distribution of ΣPAH_{24} and ΣPCB_{24} tissue concentrations (arithmetic mean: ng/g dry weight) in mussels at Gulf of Maine stations in 1994 and 1997. * indicates a significant difference between years ($P<0.05$).

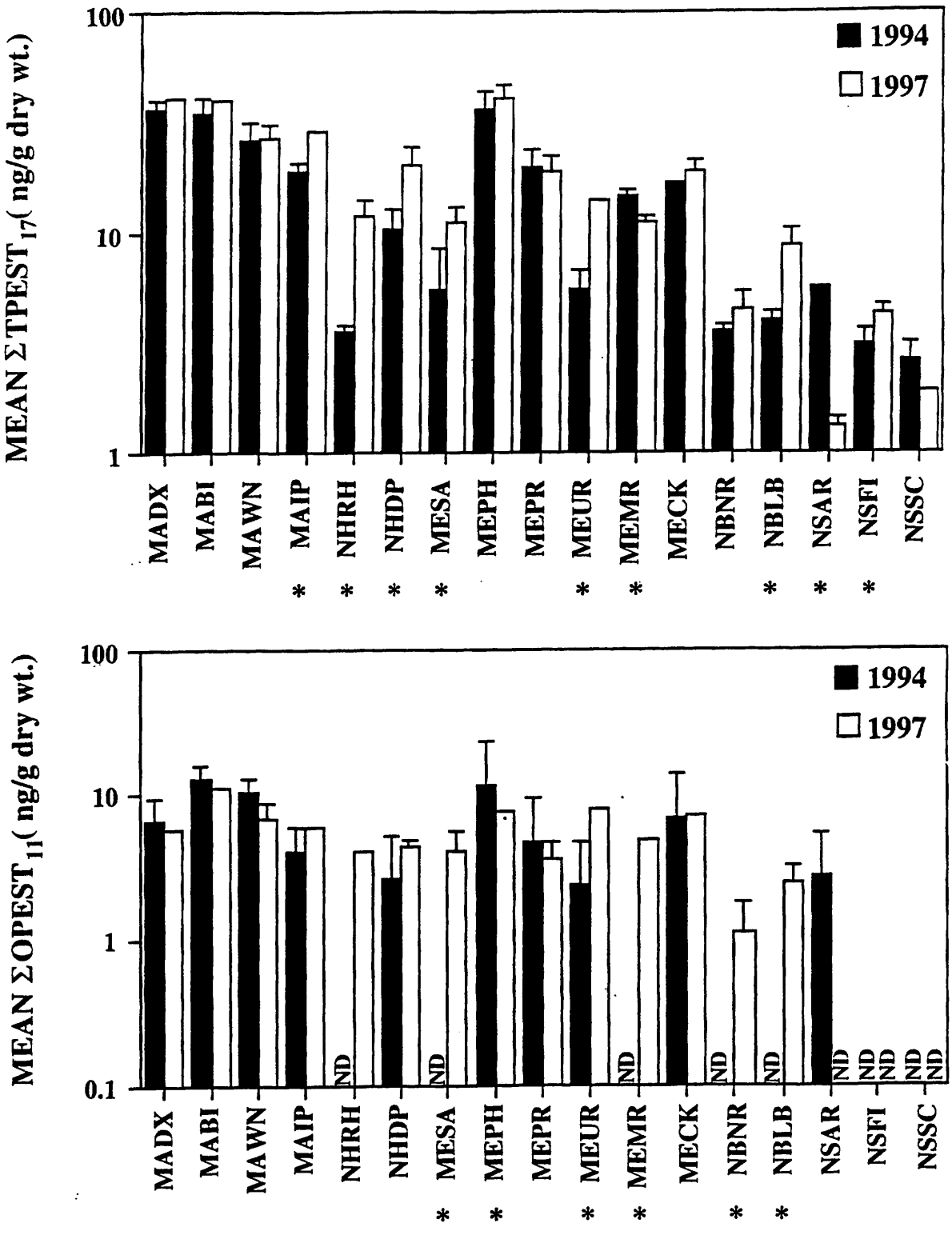

Figure 16. Log distribution of $\Sigma TPEST_{17}$ and $\Sigma OPEST_{11}$ tissue concentrations (arithmetic mean: ng/g dry weight) in mussels at Gulf of Maine stations in 1994 and 1997. * indicates a significant difference between years ($P<0.05$).

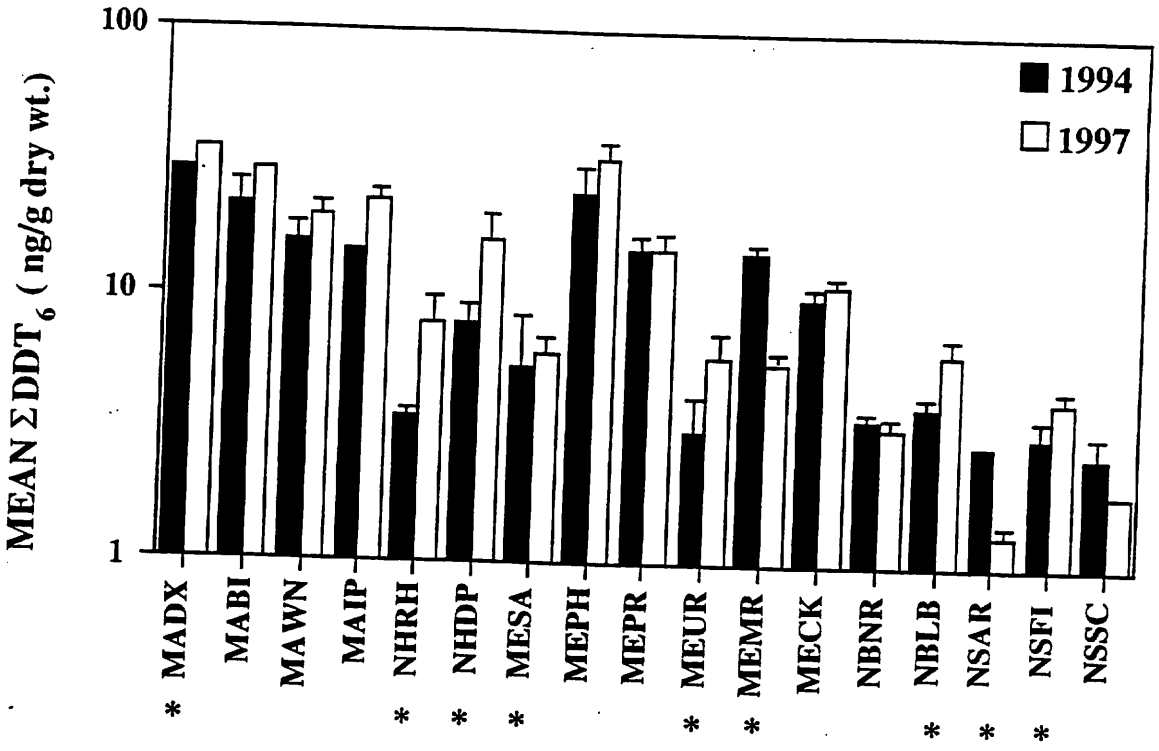

Figure 17. Log distribution of ΣDDT_6 tissue concentrations (arithmetic mean: ng/g dry weight) in mussels at Gulf of Maine stations in 1994 and 1997. * indicates a significant difference between years ($P<0.05$).

more detail in a previous report (Chase et al., 1997) and in the following section "Effects of an Oil Spill in the Great Bay Estuary" in this report. Temporal analysis of total organic/ΣPAH_{24} contaminant concentrations at MEPH, however, revealed no significant difference between 1994 and 1997 samples.

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 also 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 and 1997 mussel tissue samples to the oil spill contaminants.

The PAH found in mussel tissue samples collected in 1994, on July 16 (16d) and October 1 (3 mo.) of 1996, and in 1997 are illustrated in Figure 18 and summarized in Table 12.

The PAH found in mussel tissue samples collected in 1994, on July 16 (16d) and October 1 (3 mo.) of 1996 and in 1997 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. And 1997 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. and 1997 samples were not detected in the 1994 samples. However, the four higher MW PAHs found in 16d and 3 mo. Samples were still detected in 1997. 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 all of

Figure 18. PAH concentrations in mussel tissue from Dover Point, NH, before (1994) and 16 days, 3 months and 15 months after an oil spill in July, 1996.

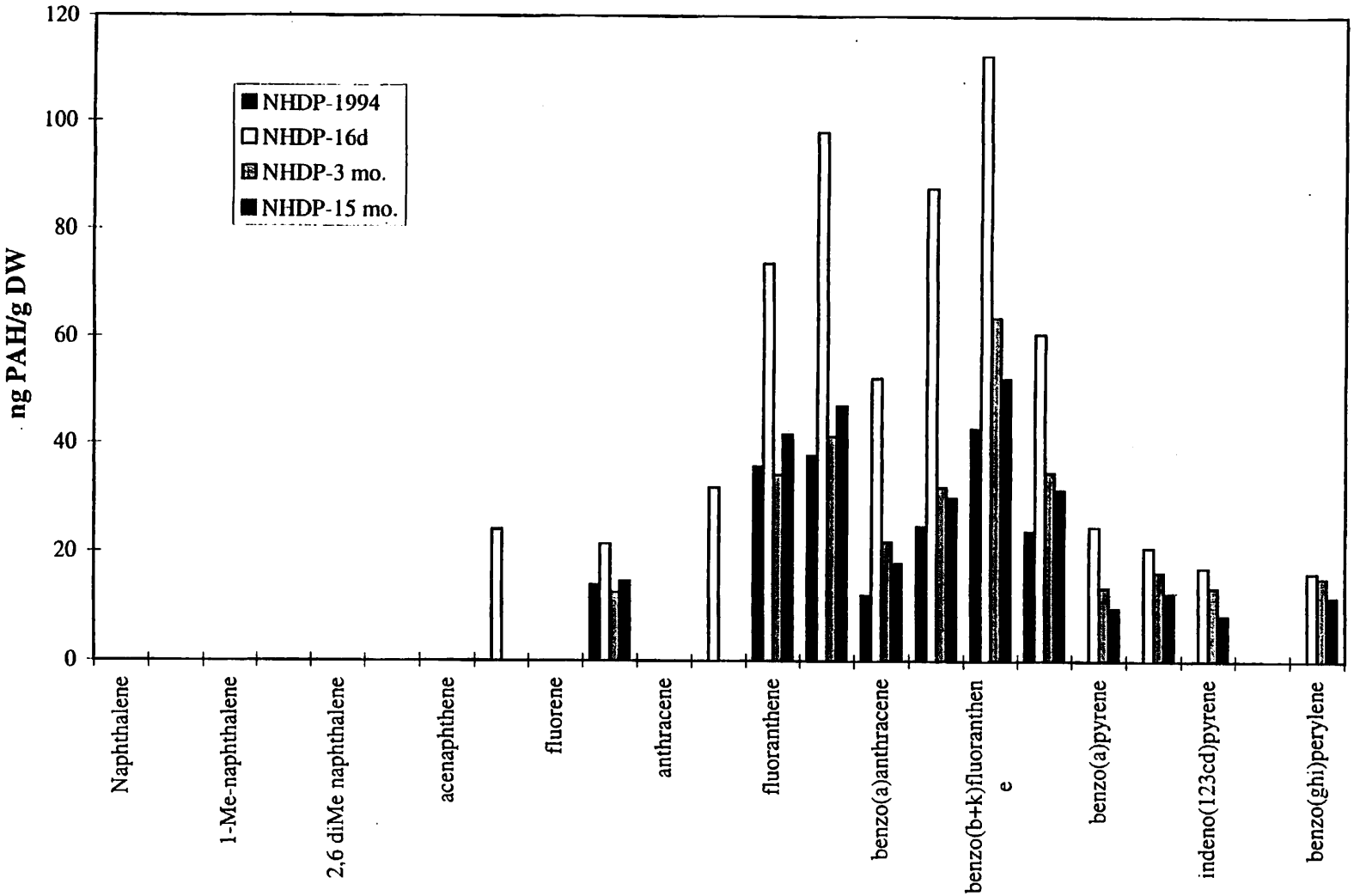

Table 12. Tissue concentrations (ng/g DW) of polyaromatic hydrocarbons in *Mytilus edulis* at sites in the Great Bay Estuary of Maine and New Hampshire in 1994 (NHDP-1994) and 16 days (NHDP-16d), 3 months (NHDP-3 mo.) and 15 months (NHDP-15mo.) after an oil spill.

PAH	NHDP-1994	NHDP-16d	NHDP-3 mo.	NHDP-15 mo.
Naphthalene	<30	<30	<30	<8.2
2-Me naphthalene	<30	<30	<30	<9
1-Me-naphthalene	<30	<30	<30	<8.9
Biphenyl	<20	<20	<20	<6.1
2,6 diMe naphthalene	<20	<20	<20	<8.8
acenaphthylene	<10	<10	<10	<5.9
acenaphthene	<10	<10	<10	<6.4
2,3,5-trime naphthalene	<20	24	<20	<9.8
fluorene	<10	<10	<10	<5.1
phenanthrene	14	21	13	15
anthracene	<10	<10	<10	<5.1
1-me phenanthrene	<10	32	<10	<8
fluoranthene	36	74	34	42
pyrene	38	98	41	47
benzo(a)anthracene	12	52	22	18
chrysene	25	88	32	30
benzo(b+k)fluoranthene	43	113	64	52
benzo(e)pyrene	24	60	35	32
benzo(a)pyrene	<10	25	14	10
perylene	<10	21	16	12
indeno(123cd)pyrene	<10	17	14	8
dibenzo(ah)anthracene	<10	<10	<10	<3.6
benzo(ghi)perylene	<10	16	15	12
TOTAL	**187**	**639**	**298**	**266**

the other samples, while only phenanthrene and fluoranthene concentrations in the 1994 samples were greater than in the 3 mo. Samples, but were less than in the 1997 samples. Concentrations of phenanthrene, fluoranthene and pyrene were slightly higher in 1997 compared to 1996-3 mo. Samples, while concentrations of all eight of the higher MW PAHs detected in the two samples were present at lower concentrations in the 1997 tissue. The average ΣPAH_{24} concentrations were 639, 298, 266 and 187 ng/g DW for the 16d, 3 mo., 1997 and 1994 samples, respectively. Thus, the total PAH concentration has decreased slightly from 1996 to 1997, but the same number of PAHs are still detectable, including the four higher MW PAHs that were not present before the oil spill. However, even those are present at relatively low concentrations close to detection limits.

Acceptable Levels and Standards of Mussel Contamination

Limited information is available on observed human health effects of consumption of chemically-contaminated shellfish. While there may be limited epidemiological documented effects, laboratory assays and isolated occurrences of acute human poisonings are responsible for the focus of attention on human health impacts from eating chemically contaminated marine fish and 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). MABI had the highest concentrations of PCBs in mussels, 0.19 ± 0.01 ppm dry weight, during the 1997 survey. The action level for the pesticides dieldrin, aldrin, chlordane, heptachlor, and heptachlor epoxide is 2.0 ppm dry weight, or 0.3 ppm wet weight (USFDA, 1990). All of these pesticides were below detection concentrations in the 1997 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). Duxbury, MA had the highest level, 0.04 ± 0.01 ppm dry weight, in 1997. 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 1997 Gulfwatch Project was 0.70 ± 0.07 ppm dry weight, at Dover Point, New Hampshire, which is well below both federal action concentrations.

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 1997 Gulfwatch Project. No metal approaches the guideline values.

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 1997 Gulfwatch value (dry weight)	Location
Cadmium	3.7 µg/g	25 µg/g	2.7 µg/g	Apple River, NS
Chromium	13 µg/g	87 µg/g	3.0 µg/g	Clark Cove, ME/NH
Lead	1.7 µg/g	11.5 µg/g	6.4 µg/g	Portland Harbor, ME
Nickel	80 µg/g	533 µg/g	2.2 µg/g	Apple River, 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 1×10^{-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 1997 Gulfwatch stations are well below the EPA Screening Values (EPA, 1993). The Screening Value for the $\sum PCB_{24}$ is notably low (0.01 μg/g wet weight or approximately 0.07 μg/g dry weight; EPA, 1993). Mean $\sum PCB_{24}$ concentrations at five Gulfwatch sites (MADX, MABI, MAWN, MAIP, and MEPH) exceed this value. These stations should therefore be examined in much more detail to adequately assess potential human health risk to PCBs and determine potential sources of contaminants. In the past there has generally been two or fewer Gulfwatch sites that have exceeded this screening 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 shell length (±SD) at the 22 sites was 54.1 ± 3.4 mm (Table 14, Figure 19). 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. In this report, as in previous reports (Sowles et al., 1996; Chase et al., 1996a, b, 1997) the shell length has been significantly lower at the New Brunswick stations.

Condition Index and Weight

Condition indices (CI) of mussels collected in 1997 are shown in Table 14 and Figure 20. The average CI (±SD) for all sites throughout the Gulf of Maine was 0.204 ± 0.066. ANOVA on the mean CI of all mussels was significant ($p<0.05$). The CI ranged from a value of 0.109 ± 0.035 at NSAR, to 0.304 ± 0.059 at NBCH. The CIs of all sites in Nova Scotia and New Hampshire were below the Gulf-wide mean. The CI varied in all jurisdictions except New Hampshire.

The average wet weight (g) of mussels collected in 1997 are shown in Table 14 and Figure 21. Comparison of the distribution of CI (Figure 20) and wet weight (Figure 21) reveals a similar pattern of variation. As such an 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 Maine, length, width, and height were all significant covariates. Length and width were the only significant covariates in Maine. 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 21 and Table 14 show the adjusted mean weights for stations sampled in 1996. There was a significant relationship between adjusted wet weight and the CI at a given site ($p<0.001$).

Table 14. Morphometric characteristics (mean SD) of mussels collected at the Gulf of Maine, 1997 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	56.5 ± 2.0C	24.0 ± 1.5B	30.5 ± 1.8D	7.66 ± 1.64B	6.68 ± 1.34B	0.185 ± 0.034BC
MADX	30	54.1 ± 2.9AB	28.2 ± 0.4C	23.2 ± 2.2A	7.09 ± 2.33B	7.47 ± 0.74B	0.201 ± 0.071C
MABI	30	52.9 ± 2.2A	24.3 ± 2.6B	24.1 ± 3.3A	4.51 ± 0.78A	5.18 ± 0.98A	0.147 ± 0.015AB
MAWN	30	55.5 ± 2.2BC	22.5 ± 1.3A	28.1 ± 1.8B	4.77 ± 0.76A	4.69 ± 0.74A	0.137 ± 0.021A
MAIP	30	55.4 ± 2.4BC	27.9 ± 2.1C	23.2 ± 1.8A	5.12 ± 1.01A	5.19 ± 1.04A	0.142 ± 0.018A
NHRH	30	53.6 ± 2.5B	28.5 ± 1.5B	21.3 ± 2.6B	5.51 ± 1.14B	5.06 ± 1.14A	0.170 ± 0.026A
NHDP	30	51.1 ± 3.1A	26.4 ± 1.6A	19.8 ± 1.5A	4.84 ± 1.04A	5.84 ± 1.41A	0.180 ± 0.024A
MECC	30	56.6 ± 1.9C	31.3 ± 2.4C	21.5 ± 1.8B	6.60 ± 1.07C	5.50 ± 0.80A	0.174 ± 0.018A
MESA	30	57.6 ± 2.5B	29.8 ± 2.0C	21.9 ± 1.7A	7.16 ± 1.33A	7.06 ± 1.31A	0.189 ± 0.018A
MEPH	30	55.1 ± 2.6A	29.2 ± 1.3BC	22.1 ± 2.7ABC	9.46 ± 1.91BC	10.50 ± 2.00C	0.276 ± 0.042C
MEPR	30	55.0 ± 2.4A	28.3 ± 1.5B	21.6 ± 1.9AB	8.73 ± 2.16B	10.10 ± 2.09C	0.263 ± 0.048C
MEKN	30	56.2 ± 2.4AB	28.2 ± 1.8B	22.4 ± 1.8AB	9.77 ± 1.96BC	9.85 ± 1.98C	0.274 ± 0.033C
MEUR	30	55.4 ± 2.6A	29.4 ± 1.7BC	24.5 ± 2.5C	11.58 ± 2.51C	10.84 ± 2.29C	0.288 ± 0.038C
MEMR	30	56.3 ± 2.0AB	28.4 ± 1.7B	21.8 ± 1.5AB	8.12 ± 2.29A	8.44 ± 2.42AB	0.231 ± 0.048B
MECK	30	54.5 ± 2.6A	26.6 ± 3.0A	24.5 ± 3.2C	9.75 ± 2.58B	9.38 ± 2.44BC	0.275 ± 0.054C
NBNR	30	43.9 ± 4.2A	19.8 ± 2.1A	17.9 ± 2.0A	4.76 ± 1.40A	6.76 ± 2.41A	0.303 ± 0.065B
NBCH	30	46.0 ± 5.6A	23.1 ± 2.9B	20.4 ± 2.9B	6.64 ± 2.23B	6.87 ± 2.35A	0.304 ± 0.059B
NBLB	30	52.5 ± 6.6B	28.2 ± 4.5C	23.5 ± 3.8C	9.45 ± 4.34C	6.38 ± 2.44A	0.261 ± 0.050A
NSAR	40	53.8 ± 3.2A	26.7 ± 1.8A	20.5 ± 2.0A	3.22 ± 1.10A	3.67 ± 1.39A	0.109 ± 0.035A
NSFI	40	57.2 ± 3.2C	29.8 ± 1.9C	24.1 ± 2.4C	4.66 ± 1.33B	4.18 ± 1.10B	0.113 ± 0.027A
NSDI	40	55.3 ± 2.5B	29.8 ± 1.8C	22.0 ± 2.0B	4.97 ± 1.16B	4.88 ± 1.12C	0.137 ± 0.028B
NSSC	40	56.1 ± 2.2BC	28.4 ± 3.7B	21.2 ± 1.5B	4.59 ± 0.91B	4.61 ± 0.91BC	0.137 ± 0.028B
MEAN(SD)		54.1 ± 3.4	27.2 ± 2.8	22.7 ± 2.7	6.77 ± 2.72		0.204 ± 0.066

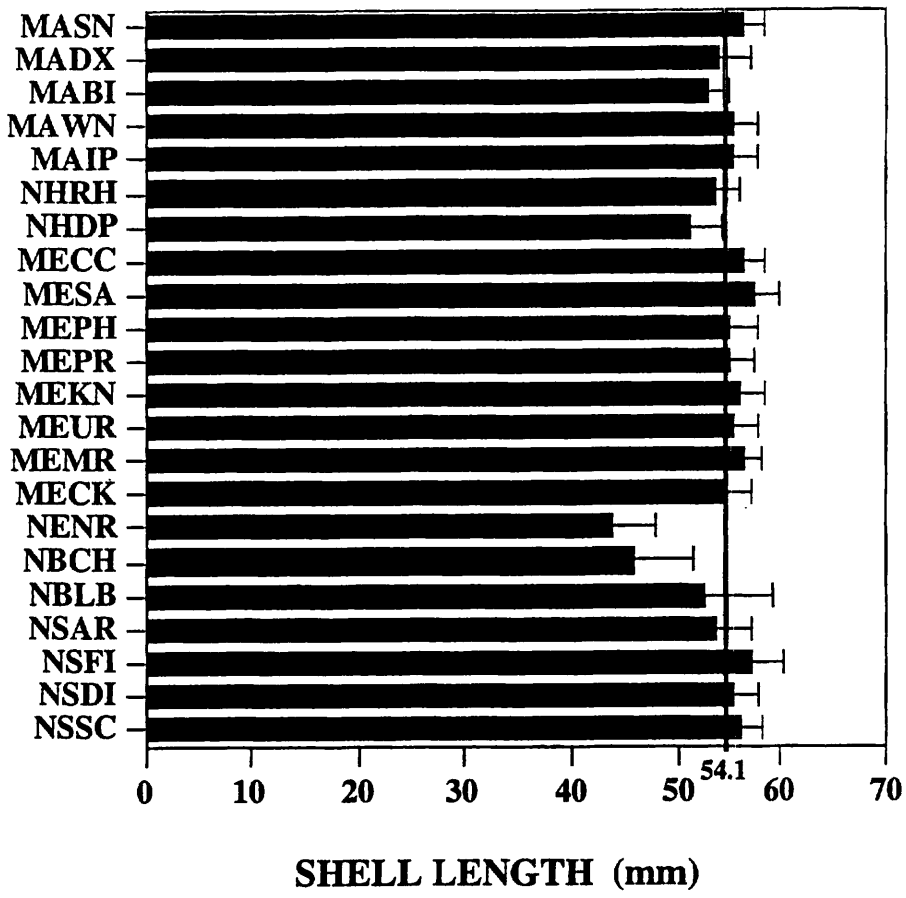

Figure 19. Mean length (+/- SD) of mussels collected at the Gulf of Maine stations in 1997. Stations are organized clockwise from south to north. Mean length of mussels is indicated by the straight line.

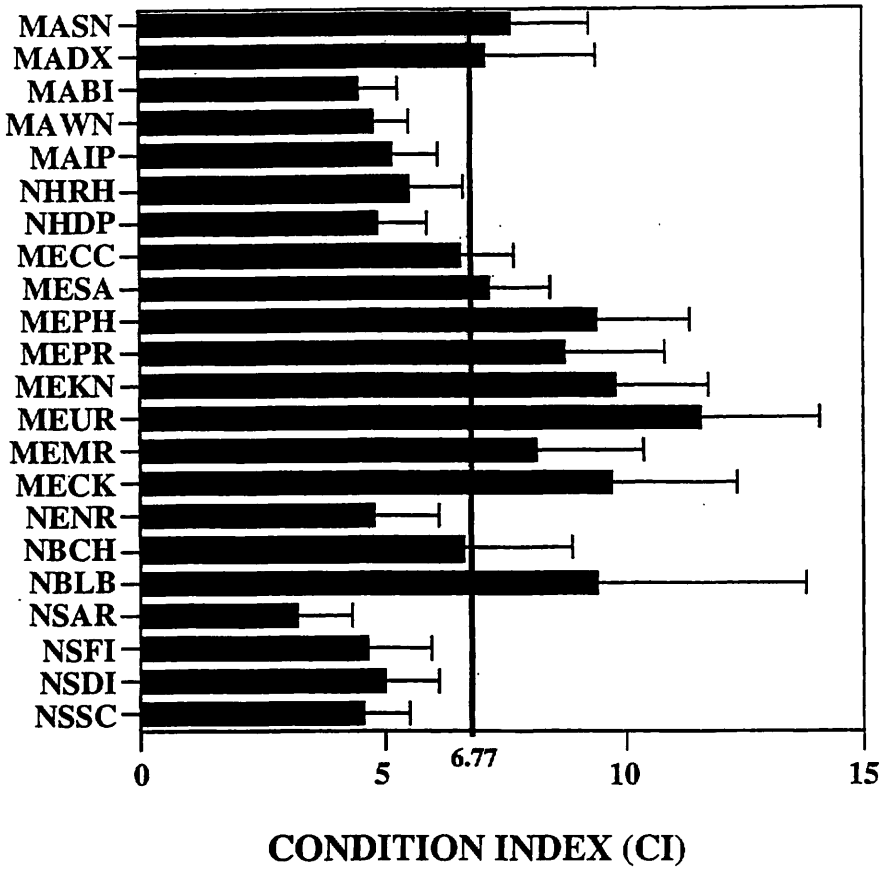

Figure 20. Mean condition indicies (+/- SD) of mussels collected at the Gulf of Maine stations in 1997. Stations are organized clockwise from south to north. Mean condition index of mussels is indicated by the straight line.

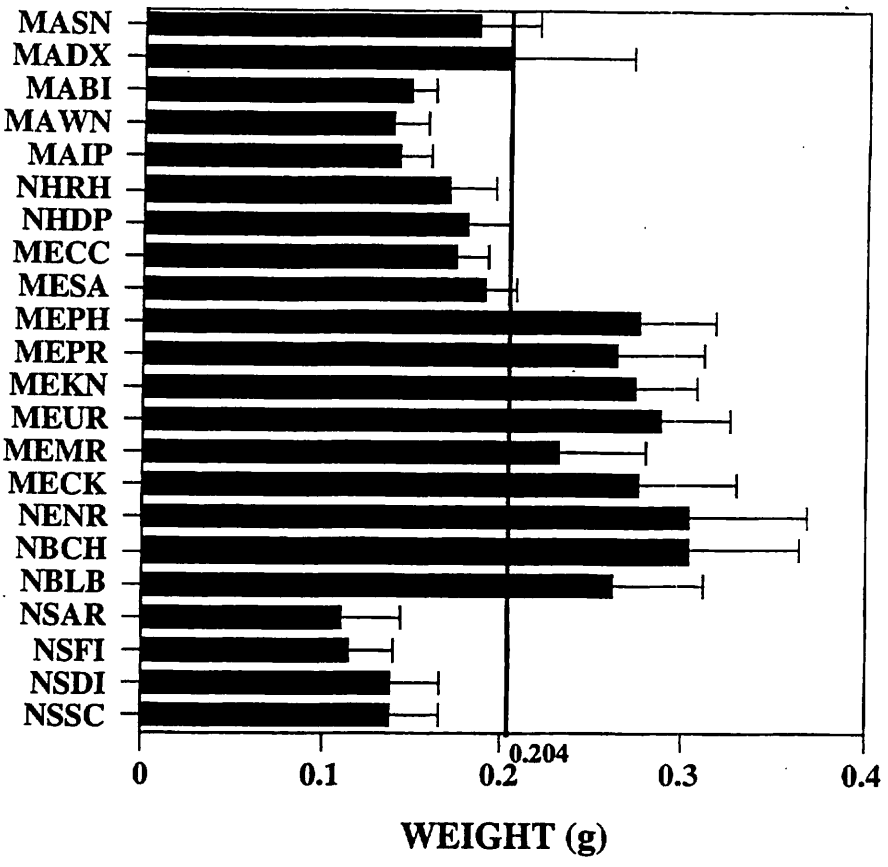

Figure 21. Mean weight (+/- SD) of mussels collected at the Gulf of Maine stations in 1997. Stations are organized clockwise from south to north. Mean weight of mussels is indicated by the straight line.

CONCLUSIONS

The field season of 1997 represented the seventh Gulfwatch field season overall and the second 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 benchmark sites that are sampled every year. Samples were obtained from all sites, with the exception of Barrington Passage, Nova Scotia. No mussels were found at that site in 1997.

Some trends in contaminant concentrations are beginning to emerge, especially for the benchmark sites. With five years of data, our ability to predict 'year' effects is increasing. However, it is still low. Examination of metal contaminants revealed two 'year' effects, for mercury and zinc. Analysis suggests that the concentrations of both metals have decreased in the benchmark stations. 'Year' was not significant for the remainder of the metals examined. This may be a reflection of the power to detect year differences. It appears, however, that the metals (except mercury and zinc) vary depending on the year examined. It is likely that what is being observed is natural variation in the baseline concentrations of these contaminants. Documentation of baseline concentration is very important and this will strengthen the importance of the Gulfwatch database. Knowledge of baseline contaminant concentrations will enable researchers and managers to provide more accurate information in environmental assessment procedures.

The concentrations of organic contaminants appear to be increasing. Although a 'year' effect was only observed for ΣPAH_{24}, examination of the other benchmark sites seems to indicate that organic contaminants may be higher in 1996 and 1997, in comparison to 1993-1995. Comparison of the tissue contaminant concentrations of all sites in 1997 in comparison to samples taken in 1994 revealed increased levels in the majority of cases where differences between the years was observed. Perhaps this should be cause for concern. In the past 2 years at least two known oil spills have occurred in the Gulf of Maine near Gulfwatch sites. It would be worthwhile to examine other possible sources of organic contaminants at other sites.

The use of the Gulfwatch program to provide information in response to an oil spill was also a new activity for the program during the last two years. 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 that specific case of spilled oil. Having strategically located sampling sites in so many areas Gulfwide provides a baseline data base for comparison of 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. In addition, the Hew Hampshire Department of Environmental Services has recently adopted and expanded Gulfwatch for use around the whole coast of the State. Their focus is to establish a strong baseline database for use with future oil spills and to help identify existing sources of chronic oil spills and other contaminants.

Coastal monitoring programs like Gulfwatch provide a valuable measure of the current state of the coastal environment that is useful 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. It is anticipated that 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 heavy metals in *Mytilus edulis* in the Gulf of Maine, 1997.											
	(ug/g dry wt: mean and standard deviation (SD))										
STATION	Pb	Zn	Ag	Cd	Cr	Cu	Fe	Hg	Ni	Al	% SOLID
		MASSACHUSSETTS									
MASN1	2.8	70	0.65	1.0	1.0	6.6	250	0.23	0.9	110	15.2
MASN2	2.8	75	0.88	1.0	0.9	7.2	250	0.27	1.0	91	16.5
MASN3	3.5	82	1.20	1.3	1.1	7.5	280	0.38	1.0	100	15.3
MASN4	3.3	84	1.30	1.1	1.0	7.4	280	0.27	1.0	120	16.7
Mean	3.1	78	1.01	1.1	1.0	7.2	265	0.29	1.0	105	15.9
SD	0.4	6	0.30	0.2	0.1	0.4	17	0.06	0.1	13	0.8
MADX1	3.2	88	0.20	1.0	1.1	6.4	180	0.44	0.7	86	17.6
MADX2	2.6	59	0.16	1.0	1.0	6.2	190	0.52	0.6	75	17.0
MADX3	3.7	85	0.22	1.2	1.3	7.5	250	0.50	0.7	110	16.9
MADX4	3.2	85	0.24	0.9	1.1	7.5	204	0.46	0.7	90	18.5
Mean	3.2	79	0.21	1.0	1.1	6.9	206	0.48	0.7	90	17.5
SD	0.5	14	0.03	0.1	0.1	0.7	31	0.04	0.0	15	0.7
MABI1	4.6	140	0.25	1.5	1.8	7.5	420	0.58	1.7	290	16.2
MABI2	2.6	140	0.32	1.5	1.4	6.7	180	0.53	0.9	88	14.9
Mean	3.6	140	0.29	1.5	1.6	7.1	300	0.56	1.3	189	15.6
SD	1.4	0	0.05	0.0	0.3	0.6	170	0.04	0.6	143	0.9
MAWN1	4.1	110	0.18	1.5	2.2	6.6	410	0.51	1.4	280	13.4
MAWN2	5.2	110	0.17	1.8	2.9	7.5	550	0.59	1.9	320	12.0
MAWN3	3.9	94	0.23	1.4	2.2	6.5	430	0.50	1.4	280	14.0
MAWN4	5.7	140	0.30	2.0	3.0	8.8	600	0.60	1.8	320	15.1
Mean	4.7	114	0.22	1.7	2.6	7.4	498	0.55	1.6	300	13.6
SD	0.9	19	0.06	0.3	0.4	1.1	92	0.05	0.3	23	1.3
MAIP1	2.3	82	0.13	1.7	1.7	6.3	300	0.48	0.9	130	13.5
MAIP2	2.4	88	0.14	1.5	1.6	6.4	320	0.48	0.8	150	14.9
MAIP3	2.1	90	0.16	1.4	1.5	6.2	270	0.47	0.7	110	15.0
MAIP4	1.9	74	0.14	1.4	1.5	6.0	279	0.47	0.8	127	15.0
Mean	2.2	84	0.14	1.5	1.6	6.2	292	0.48	0.8	129	14.6
SD	0.2	7	0.01	0.1	0.1	0.2	22	0.01	0.1	16	0.7

APPENDIX A. Tissue concentrations of heavy metals in *Mytilus edulis* in the Gulf of Maine, 1997.

(ug/g dry wt: mean and standard deviation (SD))

STATION	Pb	Zn	Ag	Cd	Cr	Cu	Fe	Hg	Ni	Al	% SOLID
		NEW HAMPSHIRE									
NHRH1	3.1	140	0.00	1.9	1.9	7.7	400	0.71	1.9	200	10.0
NHRH2	2.1	110	0.10	1.4	1.6	6.5	330	0.75	1.6	210	11.7
NHRH3	1.3	66	0.00	1.0	0.9	3.8	170	0.40	0.9	91	18.8
NHRH4	2.8	150	0.10	1.8	3.8	9.8	350	0.71	2.6	220	10.4
Mean	2.3	117	0.08	1.5	2.0	7.0	313	0.64	1.7	180	12.7
SD	0.8	38	0.03	0.4	1.3	2.5	99	0.16	0.7	60	4.1
NHDP1	1.8	100	0.00	1.9	2.4	7.2	330	0.71	1.5	240	12.3
NHDP2	1.7	130	0.00	1.7	3.0	6.2	280	0.66	1.3	180	12.0
NHDP3	1.3	100	0.00	1.7	2.3	6.6	340	0.78	1.3	260	12.7
NHDP4	2.0	106	0.09	1.8	2.3	6.8	353	0.63	1.4	251	12.3
Mean	1.7	109	0.00	1.8	2.5	6.7	326	0.70	1.4	233	12.3
SD	0.3	14	0.00	0.1	0.3	0.4	32	0.07	0.1	36	0.3
MECC1	3.8	90	0.00	1.1	2.6	5.6	500	0.61	1.5	380	13.1
MECC2	6.2	140	0.00	1.8	3.2	7.7	660	0.65	2.0	460	12.0
MECC3	4.6	140	0.00	1.6	2.9	6.5	540	0.63	1.9	380	12.5
MECC4	5.7	127	0.09	1.7	3.3	8.2	744	0.75	2.1	493	11.8
Mean	5.1	124	0.00	1.5	3.0	7.0	611	0.66	1.9	428	12.4
SD	1.1	24	0.00	0.3	0.3	1.2	112	0.06	0.3	57	0.6
			MAINE								
MESA1	2.8	96	ND	1.4	1.8	6.6	330	0.44	1.0	150	11.9
MESA2	3.2	99	ND	1.7	2.0	6.0	350	0.53	1.1	170	11.1
MESA3	3.4	110	ND	1.8	2.1	6.3	350	0.52	1.3	160	9.8
MESA4	3.1	100	ND	1.6	2.1	6.4	400	0.57	1.2	210	11.1
Mean	3.1	101	ND	1.6	2.0	6.3	350	0.52	1.1	173	11.0
SD	0.3	60		0.2	0.1	0.3	30	0.05	0.1	26	0.9
MEPH1	8.1	130	0.13	1.7	2.1	7.4	550	0.62	1.4	340	7.1
MEPH2	7.8	140	ND	1.8	2.0	7.8	550	0.50	1.7	410	8.3
MEPH3	4.9	89	ND	1.2	1.1	3.7	330	0.56	0.9	230	9.3
MEPH4	4.7	103	ND	1.2	1.3	4.8	323	0.53	1.0	240	8.2
Mean	6.4	116	ND	1.5	1.6	5.9	438	0.55	1.2	305	8.2
SD	1.8	24		0.3	0.5	2.0	129	0.05	0.4	86	0.9

APPENDIX A. Tissue concentrations of heavy metals in *Mytilus edulis* in the Gulf of Maine, 1997.

(ug/g dry wt: mean and standard deviation (SD))

STATION	Pb	Zn	Ag	Cd	Cr	Cu	Fe	Hg	Ni	Al	% SOLID
			MAINE								
MEPR2	4.5	67	0.10	1.5	2.0	5.7	510	0.27	1.5	410	9.1
MEPR3	3.9	75	ND	1.1	1.7	5.3	440	0.43	1.2	370	9.6
MEPR4	3.4	56	ND	0.9	1.7	4.5	430	0.25	1.2	380	9.5
Mean	4.2	69	0.08	1.2	2.0	5.8	513	0.41	1.3	415	9.1
SD	0.7	10	0.03	0.3	0.3	1.3	111	0.20	0.2	59	0.7
MEKN1	1.4	56	0.10	1.5	1.5	6.6	330	0.52	1.1	210	10.7
MEKN2	0.7	49	ND	1.2	0.9	4.7	160	0.23	ND	100	12.6
MEKN3	1.0	44	ND	1.3	0.9	4.9	150	0.24	ND	96	11.7
MEKN4	0.8	33	ND	1.3	0.8	3.7	120	0.32	ND	82	10.6
Mean	1.0	46	ND	1.3	1.0	5.0	190	0.33	ND	122	11.4
SD	0.3	10		0.1	0.3	1.2	95	0.14		59	0.9
MEUR1	0.6	32	0.10	1.0	0.8	3.1	200	0.26	0.6	67	10.8
MEUR2	2.3	78	0.29	2.3	1.8	7.1	540	0.36	1.5	200	6.8
MEUR3	0.9	44	0.20	1.5	1.0	4.6	250	0.40	1.1	100	8.5
MEUR4	0.8	34	0.11	1.3	1.0	4.4	206	0.37	0.7	75	8.3
Mean	1.2	47	0.17	1.5	1.1	4.8	299	0.35	1.0	110	8.6
SD	0.8	21	0.09	0.6	0.5	1.7	162	0.06	0.4	61	1.7
MEMR1	0.9	38	ND	1.0	1.0	3.5	360	0.36	1.0	230	10.7
MEMR2	1.0	24	ND	0.9	0.8	2.6	240	ND	0.9	180	8.5
MEMR3	2.2	75	ND	2.0	2.0	7.1	870	0.52	2.4	640	9.7
MEMR4	1.1	33	ND	1.1	1.0	3.0	350	0.41	1.2	218	9.6
Mean	1.3	42	ND	1.3	1.2	4.1	455	0.35	1.4	317	9.6
SD	0.6	23		0.5	0.5	2.1	282	0.17	0.7	216	0.9
MECK1	1.6	95	0.11	1.8	1.6	6.3	430	0.44	1.3	320	7.6
MECK2	2.1	140	ND	2.2	1.3	6.3	480	0.54	1.6	380	6.8
MECK3	2.4	160	ND	2.2	1.1	6.8	330	0.36	1.4	260	8.7
MECK4	1.7	99	ND	1.9	1.3	4.7	310	0.46	1.2	240	8.1
Mean	2.0	124	ND	2.0	1.3	6.0	388	0.45	1.4	300	7.8
SD	0.4	32		0.2	0.2	0.9	81	0.07	0.2	63	0.8

APPENDIX A. Tissue concentrations of heavy metals in *Mytilus edulis* in the Gulf of Maine, 1997.											
	(ug/g dry wt: mean and standard deviation (SD))										
STATION	Pb	Zn	Ag	Cd	Cr	Cu	Fe	Hg	Ni	Al	% SOLID
		NEW BRUNSWICK									
NBNR1	0.8	79	ND	0.8	1.1	15.0	530	0.22	1.1	450	11.8
NBNR2	1.1	60	ND	0.7	1.0	4.1	380	0.21	0.8	350	13.2
NBNR3	0.8	61	ND	0.7	1.0	4.7	350	0.17	0.8	410	13.1
NBNR4	0.9	65	0.10	0.7	1.0	4.1	470	0.26	1.1	400	12.3
Mean	0.9	66	ND	0.7	1.0	7.0	458	0.22	1.0	403	12.6
SD	0.1	9		0.1	0.1	5.4	62	0.04	0.2	41	0.7
NBCH1	0.5	64	0.10	1.1	0.6	5.7	170	0.20	0.7	130	18.1
NBCH2	0.3	58	ND	1.2	0.7	5.5	205	0.11	0.6	170	18.4
NBCH3	0.6	58	0.11	1.2	0.7	5.2	270	0.20	0.4	210	17.2
NBCH4	0.5	54	ND	1.2	0.7	5.0	260	0.14	0.4	210	18.6
Mean	0.5	58	0.08	1.2	0.7	5.3	226	0.16	0.5	180	18.1
SD	0.1	42	0.03	0.0	0.1	0.3	47	0.05	0.1	38	0.6
NBLB1	1.2	77	ND	1.0	1.1	6.6	360	0.16	0.8	270	13.3
NBLB2	1.3	68	ND	1.0	1.0	7.4	350	ND	0.9	280	11.9
NBLB3	1.4	69	ND	1.2	1.1	8.0	350	0.14	0.9	270	12.9
NBLB4	1.4	63	ND	1.2	1.1	7.2	380	0.32	0.9	275	13.1
Mean	1.3	69	ND	1.1	1.1	7.3	360	0.17	0.9	274	12.8
SD	0.1	6		0.1	0.0	0.6	14	0.10	0.0	5	0.6
		NOVA SCOTIA									
NSAR1	1.8	84	ND	2.8	2.2	6.7	850	0.60	2.3	700	15.5
NSAR2	1.8	82	ND	3.1	2.4	7.6	940	0.41	2.5	820	13.8
NSAR3	1.2	66	ND	2.5	1.5	6.2	570	0.44	2.0	500	14.8
NSAR4	1.1	62	ND	2.4	1.4	6.0	520	0.46	2.1	400	13.8
Mean	1.5	74	ND	2.7	1.9	6.6	720	0.48	2.2	615	14.5
SD	0.4	11		0.3	0.5	0.7	206	0.08	0.2	176	0.8
NSFI1	1.7	57	0.10	1.8	2.8	6.4	1600	0.27	2.8	1400	16.0
NSFI2	1.3	58	ND	1.8	2.7	5.7	970	0.31	2.2	890	17.2
NSFI3	1.0	50	ND	1.6	1.8	5.6	950	0.22	1.9	890	17.5
NSFI4	1.0	54	ND	1.6	1.7	6.3	820	0.20	1.7	720	16.8
Mean	1.2	55	ND	1.7	2.3	6.0	1085	0.25	2.2	975	16.9
SD	0.3	4		0.1	0.6	0.4	350	0.05	0.5	294	0.7

APPENDIX A. Tissue concentrations of heavy metals in *Mytilus edulis* in the Gulf of Maine, 1997.											
	(ug/g dry wt: mean and standard deviation (SD))										
STATION	Pb	Zn	Ag	Cd	Cr	Cu	Fe	Hg	Ni	Al	% SOLID
			NOVA SCOTIA								
NSDI1	3.6	76	ND	2.4	1.9	6.2	480	0.30	1.5	350	13.2
NSDI2	2.4	79	ND	1.2	2.5	6.4	520	0.39	1.4	400	14.0
NSDI3	2.9	108	ND	1.4	1.4	7.5	507	0.33	1.5	366	14.8
NSDI4	2.3	95	ND	1.2	1.4	6.2	546	0.27	1.4	451	14.8
Mean	2.8	89	ND	1.5	1.8	6.6	513	0.32	1.4	392	14.2
SD	0.6	15		0.6	0.5	0.6	27	0.05	0.0	45	0.8
NSSC1	0.9	65	ND	0.8	0.9	4.5	470	0.26	1.1	170	19.8
NSSC2	1.5	56	ND	0.9	1.2	5.7	500	0.30	1.2	280	18.7
NSSC3	1.8	57	ND	1.0	1.6	5.6	700	0.35	1.4	460	16.7
NSSC4	1.7	55	ND	1.0	1.8	4.8	1100	0.31	1.4	650	17.2
Mean	1.5	58	ND	0.9	1.4	5.2	693	0.31	1.3	390	18.1
SD	0.4	5		0.1	0.4	0.6	290	0.04	0.2	211	1.4

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	NSSC1	NSSC2	NSSC3	NSSC4	NSDI1	NSDI2	NSDI2	NSDI3	NSDI4
Naphthalene	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
2-Methylnaphthalene	<9	<9	<9	<9	<9	<9	<9	<9	<9
1-Methylnaphthalene	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	15.8	34.6	33.5	41.9	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	18.2	31.4	20.6	33.5	13.8
Fluorene	<5.1	<5.1	<5.1	<5.1	8.8	12.2	10.4	12.8	8.6
Phenanthrene	<8	<8	<8	<8	37.4	45.7	43.2	52.6	36.6
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	<8	<8	<8	<8	34.4	41.3	41.1	50.9	40.2
Fluoranthrene	<8.5	<8.5	<8.5	<8.5	19.2	20.5	22.1	28.3	22
Pyrene	<12	<12	<12	<12	13.9	14.6	15.9	20.5	17.6
Benzo(a)anthracene	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7
Chrysene	<8	<8	<8	<8	8.4	8.5	9.2	10.5	11.2
Benzo(b)fluoranthene	<12	<12	<12	<12	<12	<12	12.5	13.6	12.8
Benzo(k)fluoranthene	<12	<12	<12	<12	<12	<12	<12	<12	<12
Benzo(e)pyrene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Benzo(a)pyrene	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6
Perylene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Indeno(123)pyrene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Dibenzo(ah)anthracene	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
Benzo(g,h,i)perylene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Total	0	0	0	0	156.1	208.8	208.5	264.6	162.8
Surrogate Recoveries(%)									
Napthalene_d8	83	68	71	72	17	18	23	19	21
Acenaphthene_d10	92	78	85	85	50	52	49	54	52
Phenanthrene_d10	90	87	89	94	73	80	76	83	79
Fluoranthene_d10	98	98	95	97	78	85	83	91	71
Chrysene_d12	92	94	91	92	83	86	83	87	122
Benzo(a)pyrene-d12	88	89	85	88	69	72	76	79	62
Benzo(g,h,i)perylene_d12	76	80	78	78	82	84	85	90	80

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	NSFI1	NSFI2	NSFI3	NSFI4	NSAR1	NSAR2	NSAR3	NSAR4	NBLB1
Naphthalene	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
2-Methylnaphthalene	<9	<9	<9	<9	<9	<9	<9	<9	<9
1-Methylnaphthalene	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
Phenanthrene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Fluoranthrene	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5
Pyrene	<12	<12	<12	<12	<12	<12	<12	<12	<12
Benzo(a)anthracene	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7
Chrysene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Benzo(b)fluoranthene	<12	<12	<12	<12	<12	<12	<12	<12	<12
Benzo(k)fluoranthene	<12	<12	<12	<12	<12	<12	<12	<12	<12
Benzo(e)pyrene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Benzo(a)pyrene	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6
Perylene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Indeno(123)pyrene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Dibenzo(ah)anthracene	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
Benzo(g,h,i)perylene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Total	0	0	0	0	0	0	0	0	0
Surrogate Recoveries(%)									
Napthalene_d8	14	14	11	14	25	27	18	24	74
Acenaphthene_d10	33	35	33	41	65	72	53	71	87
Phenanthrene_d10	58	74	68	72	80	89	68	85	93
Fluoranthene_d10	66	85	83	80	95	93	75	88	96
Chrysene_d12	70	92	93	89	106	100	90	89	94
Benzo(a)pyrene-d12	66	77	80	71	90	87	65	81	87
Benzo(g,h,i)perylene_d12	71	92	87	85	97	99	79	92	75

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	NBLB2	NBLB3	NBLB4	NBCH1	NBCH2	NBCH3	NBCH4	NBNR1	NBNR2
Naphthalene	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
2-Methylnaphthalene	<9	<9	<9	<9	<9	<9	<9	<9	<9
1-Methylnaphthalene	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
Phenanthrene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Fluoranthrene	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5	<8.5
Pyrene	<12	<12	<12	<12	<12	<12	<12	<12	<12
Benzo(a)anthracene	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7
Chrysene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Benzo(b)fluoranthene	<12	<12	<12	<12	<12	<12	<12	<12	<12
Benzo(k)fluoranthene	<12	<12	<12	<12	<12	<12	<12	<12	<12
Benzo(e)pyrene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Benzo(a)pyrene	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6
Perylene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Indeno(123)pyrene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Dibenzo(ah)anthracene	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
Benzo(g,h,i)perylene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Total	0	0	0	0	0	0	0	0	0
Surrogate Recoveries(%)									
Napthalene_d8	74	53	70	85	81	77	74	46	70
Acenaphthene_d10	88	62	84	92	92	88	83	65	82
Phenanthrene_d10	96	67	89	95	95	93	88	84	87
Fluoranthene_d10	100	79	95	99	101	99	98	92	90
Chrysene_d12	97	85	92	94	94	93	94	91	89
Benzo(a)pyrene-d12	90	81	88	94	89	90	91	85	91
Benzo(g,h,i)perylene_d12	80	72	76	79	76	77	78	74	74

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	NBNR3	NBNR4	MECK1	MECK1	MECK2	MECK3	MECK4	MEMR1	MEMR
Naphthalene	<8.2	<8.2	11.7	9.3	<8.2	<8.2	<8.2	8.8	<8.2
2-Methylnaphthalene	<9	<9	<9	<9	<9	<9	<9	<9	<9
1-Methylnaphthalene	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
Phenanthrene	<8	<8	<8	<8	<8	<8	<8	<8	8.2
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Fluoranthrene	<8.5	<8.5	<8.5	9.9	<8.5	<8.5	<8.5	12.9	17.1
Pyrene	<12	<12	<12	<12	<12	<12	<12	<12	13.9
Benzo(a)anthracene	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7
Chrysene	<8	<8	<8	<8	<8	<8	<8	<8	8.3
Benzo(b)fluoranthene	<12	<12	<12	<12	<12	<12	<12	<12	12.1
Benzo(k)fluoranthene	<12	<12	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Benzo(e)pyrene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Benzo(a)pyrene	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6
Perylene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	20.4	20
Indeno(123)pyrene	<7.3	<7.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3
Dibenzo(ah)anthracene	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
Benzo(g,h,i)perylene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Total	0	0	11.7	19.2	0	0	0	42.1	79.6
Surrogate Recoveries(%)									
Napthalene_d8	79	66	47	66	30	45	45	60	55
Acenaphthene_d10	90	78	78	78	62	76	73	83	73
Phenanthrene_d10	97	88	91	86	81	87	89	91	90
Fluoranthene_d10	103	96	91	91	88	88	94	96	98
Chrysene_d12	99	93	96	94	89	89	97	97	98
Benzo(a)pyrene-d12	102	92	66	69	67	66	69	78	77
Benzo(g,h,i)perylene_d12	85	77	75	76	71	71	78	80	85

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	MEMR3	MEMR4	MEUR1	MEUR2	MEUR3	MEUR4	MEKN1	MEKN2	MEKN3
Naphthalene	8.3	7.3	11.5	11.4	<8.2	0	<8.2	<8.2	<8.2
2-Methylnaphthalene	<9	<9	<9	<9	<9	<9	<9	<9	<9
1-Methylnaphthalene	<8.9	<8.9	5.7	5.7	5.7	5.7	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
Phenanthrene	<8	<8	7.5	9	9.1	<8	3.6	<8	<8
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Fluoranthrene	14.2	12.6	30.5	33.1	38	25.8	16.9	13.5	13.8
Pyrene	12.5	10.5	31.3	31.7	39.3	25.9	21.8	18	18.6
Benzo(a)anthracene	<9.7	<9.7	<9.7	<9.7	10.7	<9.7	<9.7	<9.7	<9.7
Chrysene	8	<8	13.3	13.8	16.2	12.9	10.6	8.3	8.7
Benzo(b)fluoranthene	13.2	<12	16.9	16.2	18.8	15.2	<12	<12	<12
Benzo(k)fluoranthene	<5.9	<5.9	<5.9	<5.9	6.7	7.9	<5.9	<5.9	<5.9
Benzo(e)pyrene	<11	<11	15.2	12	14.8	13.6	<11	<11	<11
Benzo(a)pyrene	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6
Perylene	19.7	17.1	<7.3	<7.3	7.6	<7.3	7.5	<7.3	<7.3
Indeno(123)pyrene	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3
Dibenzo(ah)anthracene	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
Benzo(g,h,i)perylene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Total	75.9	47.5	131.9	132.9	166.9	107	60.4	39.8	41.1
Surrogate Recoveries(%)									
Napthalene_d8	53	68	65	60	59	65	75	57	79
Acenaphthene_d10	70	76	79	83	69	78	84	68	84
Phenanthrene_d10	87	89	93	97	71	92	94	77	91
Fluoranthene_d10	96	101	97	102	82	96	96	84	94
Chrysene_d12	94	102	99	104	89	97	94	84	94
Benzo(a)pyrene-d12	74	86	78	82	74	77	78	64	82
Benzo(g,h,i)perylene_d12	79	83	81	86	74	78	87	73	82

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	MEKN3	MEKN4	MEPR1	MEPR2	MEPR3	MEPR4	MEPH1	MEPH2	MEPH3
Naphthalene	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	23.8	17.4	9.3
2-Methylnaphthalene	<9	<9	<9	<9	<9	<9	18.5	15.6	9.6
1-Methylnaphthalene	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	11.3	8.9	5.7
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	10.1	7.1	6.7
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	9.6	8.6	6.9
Phenanthrene	<8	<8	13.6	10.9	10.9	11.8	53.1	46.9	28.1
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	10.1	9.2	<5.1
1-Methylphenanthrene	<8	<8	8.6	7.9	<8	<8	26.3	24.4	13.7
Fluoranthrene	14.5	14.6	54.8	54.5	44.2	48.6	334.6	319.3	189.6
Pyrene	19.2	18.3	41.8	41.8	33.5	37.9	300.1	269.8	170.7
Benzo(a)anthracene	<9.7	<9.7	10.6	11.6	<9.7	<9.7	96.5	83	53.1
Chrysene	8.7	9.1	25.9	26.3	20.7	21.9	223.1	199.2	131.4
Benzo(b)fluoranthene	<12	<12	22.9	20.7	16.6	16.6	198.7	168.3	111
Benzo(k)fluoranthene	<5.9	<5.9	7.1	6.9	7.7	5.8	66.6	56.6	40
Benzo(e)pyrene	<11	<11	16.8	17.3	14	16	158.3	145.1	96
Benzo(a)pyrene	<6.6	<6.6	<6.6	6.9	<6.6	<6.6	48.6	39.7	28.3
Perylene	<7.3	<7.3	<7.3	7.8	<7.3	7.6	23	22.2	15.1
Indeno(123)pyrene	<5.3	<5.3	6.9	7.1	<5.3	5.8	48.8	38.9	26.3
Dibenzo(ah)anthracene	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	8.7	7.9	4.5
Benzo(g,h,i)perylene	<11	<11	<11	<11	<11	<11	53.3	44.9	31.7
Total	42.4	42	209	219.7	147.6	172	1723.1	1533	977.7
Surrogate Recoveries(%)									
Napthalene_d8	72	29	65	58	71	53	53	32	47
Acenaphthene_d10	79	59	78	66	80	67	65	76	59
Phenanthrene_d10	89	79	92	78	89	81	84	93	70
Fluoranthene_d10	89	86	96	91	92	89	97	105	76
Chrysene_d12	88	86	96	95	93	88	97	107	77
Benzo(a)pyrene-d12	76	62	78	75	74	67	82	85	64
Benzo(g,h,i)perylene_d12	79	79	83	84	82	79	76	89	61

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	MEPH4	MESA1	MESA2	MESA3	MESA4	MECC1	MECC2	MECC3	MECC4
Naphthalene	20	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
2-Methylnaphthalene	13.9	<9	<9	<9	<9	<9	<9	<9	<9
1-Methylnaphthalene	5.7	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	8.9	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	7.3	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
Phenanthrene	42.6	<8	9.9	<8	8.5	11.2	10.0	8.9	9.1
Anthracene	7.5	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	15.9	<8	<8	<8	<8	<8	<8	<8	<8
Fluoranthrene	238.6	12.7	22.4	15.6	16.3	38.1	35.4	34.9	28.6
Pyrene	205.7	10.8	21.8	13.1	15.4	33.6	31.8	33.0	25.3
Benzo(a)anthracene	71.5	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7
Chrysene	155.4	6.1	11.2	7.6	7.9	18.3	16.8	16.5	13.8
Benzo(b)fluoranthene	150.5	7.2	13.4	8.5	9.5	19.4	18.9	18.1	15.0
Benzo(k)fluoranthene	54.6	<5.9	7.4	<5.9	<5.9	6.8	6.4	8.3	7.6
Benzo(e)pyrene	116	<11	12.9	<11	<11	19.5	20.2	18.0	13.9
Benzo(a)pyrene	38.6	<6.6	<6.6	<6.6	<6.6	7.9	6.7	7.5	<6.6
Perylene	21	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Indeno(123)pyrene	41.7	<5.3	<5.3	<5.3	<5.3	8.0	7.1	6.9	5.8
Dibenzo(ah)anthracene	7	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
Benzo(g,h,i)perylene	43.6	<11	<11	<11	<11	<11	<11	<11	<11
Total	1266	36.7951	98.9103	44.8692	57.5851	162.849	153.432	152.034	119.29
Surrogate Recoveries(%)									
Napthalene_d8	65	70	66	70	57	80	72	65	59
Acenaphthene_d10	79	85	79	85	79	91	83	79	71
Phenanthrene_d10	90	98	90	95	96	101	95	92	84
Fluoranthene_d10	99	102	100	97	100	103	101	97	88
Chrysene_d12	99	106	103	101	104	106	106	104	93
Benzo(a)pyrene-d12	79	84	76	77	78	88	90	81	70
Benzo(g,h,i)perylene_d12	81	83	80	79	81	85	83	79	73

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight) ·								
Sample I.D.	NHDP1	NHDP1	NHDP2	NHDP3	NHDP4	NHRH1	NHRH2	NHRH3	NHRH4
Naphthalene	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
2-Methylnaphthalene	<9	<9	<9	<9	<9	<9	<9	<9	<9
1-Methylnaphthalene	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
Phenanthrene	<8	<8	14.5	<8	<8	<8	<8	<8	<8
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	<8	<8	<8	<8	<8	<8	<8	<8	<8
Fluoranthrene	43.6	45.2	50.8	38.8	32.3	22.1	21.7	19.7	20.0
Pyrene	50.0	53.2	55.0	44.2	37.0	18.6	18.7	16.8	21.7
Benzo(a)anthracene	18.9	19.9	20.7	16.3	15.0	<9.7	<9.7	<9.7	<9.7
Chrysene	31.3	34.9	33.3	29.5	24.6	13.4	14.1	11.7	13.3
Benzo(b)fluoranthene	39.3	45.2	41.2	38.5	29.0	11.9	15.2	11.8	12.9
Benzo(k)fluoranthene	13.4	16.2	14.3	16.3	10.6	<5.9	<5.9	<5.9	<5.9
Benzo(e)pyrene	32.9	38.8	33.9	31.6	24.7	<11	<11	<11	12.4
Benzo(a)pyrene	8.7	10.3	9.1	11.0	9.4	<6.6	<6.6	<6.6	<6.6
Perylene	13.9	14.0	13.0	12.9	9.6	<7.3	<7.3	<7.3	<7.3
Indeno(123)pyrene	8.7	7.3	8.8	7.9	8.6	<5.3	<5.3	<5.3	<5.3
Dibenzo(ah)anthracene	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
Benzo(g,h,i)perylene	12.2	11.6	12.2	11.1	11.9	<11	<11	<11	<11
Total	272.9	296.698	306.8	258.087	212.7	66.055	69.7866	60.1149	80.3
Surrogate Recoveries(%)									
Napthalene_d8	93	66	84	63	76	71	68	74	66
Acenaphthene_d10	98	81	90	76	85	82	80	86	73
Phenanthrene_d10	105	93	95	89	92	90	94	94	84
Fluoranthene_d10	106	106	97	95	98	101	101	101	94
Chrysene_d12	103	117	95	96	98	108	108	110	97
Benzo(a)pyrene-d12	90	90	84	81	85	81	87	91	84
Benzo(g,h,i)perylene_d12	91	90	85	77	86	81	84	88	86

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	MAIP1	MAIP2	MAIP3	MAIP4	MAIP4	MAWN1	MAWN2	MAWN3	MAWN4
Naphthalene	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
2-Methylnaphthalene	<9	<9	<9	<9	<9	<9	<9	<9	<9
1-Methylnaphthalene	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	8.2
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
Phenanthrene	11.1	11.5	10.4	11.8	11.3	14	18	15.4	17.2
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	<8	<8	<8	<8	<8	4.3	5.5	4.4	5.1
Fluoranthrene	26.7	29.6	29	28.1	26.1	38.5	48.5	42.8	46.1
Pyrene	22.4	24.5	23.9	24.6	21.9	43.5	53.7	45.9	50.7
Benzo(a)anthracene	<9.7	<9.7	<9.7	<9.7	<9.7	11.3	12.7	11.5	11.2
Chrysene	13.3	15.5	16.1	15.3	13.3	20.3	24.4	20.7	20.2
Benzo(b)fluoranthene	13.2	13.8	15.1	14	12.8	17.4	22.9	16.8	18.8
Benzo(k)fluoranthene	<5.9	<5.9	5.9	5.9	<5.9	8.2	7	8.1	8.4
Benzo(e)pyrene	12.2	13.5	14.1	14.4	11.9	18.2	21.8	19	20.7
Benzo(a)pyrene	<6.6	<6.6	6.5	<6.6	<6.6	7.5	8.1	7.2	6.7
Perylene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Indeno(123)pyrene	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	5.9	5	5
Dibenzo(ah)anthracene	<3.6	<3.6	4.2	<3.6	<3.6	4.8	4.8	4.5	4.5
Benzo(g,h,i)perylene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Total	98.9	108.4	125.2	114.1	97.3	188	233.3	201.3	222.8
Surrogate Recoveries(%)									
Napthalene_d8	71	69	60	83	80	68	78	71	75
Acenaphthene_d10	86	81	74	95	90	77	86	83	86
Phenanthrene_d10	96	87	91	108	100	83	98	97	94
Fluoranthene_d10	100	95	104	109	101	90	102	105	101
Chrysene_d12	99	100	104	110	100	87	103	105	100
Benzo(a)pyrene-d12	73	77	81	76	73	77	84	84	80
Benzo(g,h,i)perylene_d12	85	87	91	92	85	78	88	89	85

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	MABI1	MABI2	MADX1	MADX2	MADX3	MADX4	MASN1	MASN2	MASN3
Naphthalene	11.6	17.1	10.7	10.8	9.3	<8.2	<8.2	<8.2	<8.2
2-Methylnaphthalene	<9	<9	14.4	15.1	14.2	11.6	<9	<9	<9
1-Methylnaphthalene	<8.9	<8.9	8.9	9.1	<8.9	<8.9	<8.9	<8.9	<8.9
Biphenyl	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1
2,6-Dimethylnaphthalene	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8	<8.8
Acenaphthylene	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Acenaphthene	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4	<6.4
2,3,5-Trimethylnaphthalene	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
Fluorene	<5.1	<5.1	7.4	7.6	7.1	5.7	<5.1	<5.1	<5.1
Phenanthrene	26.6	24.9	35.7	34.5	32.7	28.8	13	11.4	11.7
Anthracene	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1
1-Methylphenanthrene	11.4	10.2	<8	<8	<8	<8	<8	<8	<8
Fluoranthrene	59.2	53.1	33.8	32.9	29.8	31.5	14.6	14.9	15.5
Pyrene	51.6	46.2	18.9	17.5	16	20.7	<12	<12	<12
Benzo(a)anthracene	14	12.8	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7	<9.7
Chrysene	37.8	35.8	8.8	8.8	<8	10.4	<8	<8	<8
Benzo(b)fluoranthene	21.8	20.2	<12	<12	<12	<12	<12	<12	<12
Benzo(k)fluoranthene	7.6	7.2	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Benzo(e)pyrene	26.2	24.6	<11	<11	<11	<11	<11	<11	<11
Benzo(a)pyrene	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6
Perylene	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3	<7.3
Indeno(123)pyrene	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3
Dibenzo(ah)anthracene	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6	<3.6
Benzo(g,h,i)perylene	<11	<11	<11	<11	<11	<11	<11	<11	<11
Total	267.8	252.1	138.6	136.3	109.1	108.7	27.6	26.3	27.2
Surrogate Recoveries(%)									
Napthalene_d8	88	87	78	79	73	60	69	67	72
Acenaphthene_d10	91	92	88	89	87	71	85	74	81
Phenanthrene_d10	99	98	100	100	97	80	95	88	89
Fluoranthene_d10	104	104	104	101	102	92	98	96	96
Chrysene_d12	102	100	104	104	100	100	95	103	99
Benzo(a)pyrene-d12	87	84	94	91	87	88	73	85	85
Benzo(g,h,i)perylene_d12	93	92	91	90	89	90	82	87	86

APPENDIX B. Tissue concentrations of polyaromatic hydrocarbons in *Mytilus edulis* .									
	(ng/g dry weight)								
Sample I.D.	MASN4								
Naphthalene	<8.2								
2-Methylnaphthalene	<9								
1-Methylnaphthalene	<8.9								
Biphenyl	<6.1								
2,6-Dimethylnaphthalene	<8.8								
Acenaphthylene	<5.9								
Acenaphthene	<6.4								
2,3,5-Trimethylnaphthalene	<9.8								
Fluorene	<5.1								
Phenanthrene	11.4								
Anthracene	<5.1								
1-Methylphenanthrene	<8								
Fluoranthrene	14.9								
Pyrene	<12								
Benzo(a)anthracene	<9.7								
Chrysene	<8								
Benzo(b)fluoranthene	2.8								
Benzo(k)fluoranthene	<5.9								
Benzo(e)pyrene	<11								
Benzo(a)pyrene	<6.6								
Perylene	<7.3								
Indeno(123)pyrene	<5.3								
Dibenzo(ah)anthracene	<3.6								
Benzo(g,h,i)perylene	<11								
Total	29.1								
Surrogate Recoveries(%)									
Napthalene_d8	76								
Acenaphthene_d10	83								
Phenanthrene_d10	93								
Fluoranthene_d10	96								
Chrysene_d12	97								
Benzo(a)pyrene-d12	71								
Benzo(g,h,i)perylene_d12	84								

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in *Mytilus edulis*														
	(ng/g dry weight)													
Sample I.D.	NSDI1N	NSDI2	NSDI2	NSDI3N	NSDI4	NSFI1	NSFI2	NSFI3	NSFI4	NSAR1	NSAR2	NSAR3	NSAR4	NSSC1
#8,5	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
#18,15	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
#29	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#28	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
#50	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
#52	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
#44	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
#66,95	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
#101,90	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
#87	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.5
#77	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2
#154	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2
#118	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#105	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
#153,132	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#138	<1.4	<1.4	<1.4	1.9	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.5
#126	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#187	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
#128	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
#180	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
#169	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#170,190	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#195,208	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#206	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surrogate Recoveries (%)														
#103	110	121	125	118	109	94	113	107	94	95	114	92	106	109
#198	107	122	126	123	112	88	106	99	86	94	108	88	99	104

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in *Mytilus edulis*														
	(ng/g dry weight)													
Sample I.D.	NSSC2	NSSC3	NSSC4	NBNR1	NBNR2	NBNR3	NBNR4	NBCH1	NBCH2	NBCH3	NBCH4	NBLB1	NBLB2	NBLB3
#8,5	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
#18,15	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
#29	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#28	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
#50	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
#52	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
#44	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
#66,95	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
#101,90	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	1.6	<1.6
#87	<1.5	<1.5	<1.5	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.5	<1.5
#77	<2	<2	<2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2	<2
#154	<2	<2	<2	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2	<2
#118	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	1.7	1.9	1.6
#105	<1.1	<1.1	<1.1	1.7	2.5	1.7	1.9	<1.1	<1.1	<1.1	<1.1	4.5	4.7	4.3
#153,132	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#138	<1.5	<1.5	<1.5	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	3.2	3.4	3.0
#126	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#187	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
#128	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
#180	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
#169	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#170,190	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#195,208	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#206	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	0.0	0.0	0.0	1.7	2.5	1.7	1.9	0.0	0.0	0.0	0.0	9.5	11.6	8.9
Surrogate Recoveries (%)														
#103	101	87	117	104	110	106	115	112	106	109	106	118	107	106
#198	106	98	106	94	105	103	103	101	100	101	107	111	103	104

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in *Mytilus edulis*														
	(ng/g dry weight)													
Sample I.D.	NBLB3	NBLB4	MECK1	MECK1	MECK2	MECK3	MECK4	MEMR1	MEMR2	MEMR3	MEMR4	MEUR1	MEUR2	MEUR3
#8,5	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
#18,15	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
#29	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#28	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
#50	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
#52	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
#44	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
#66,95	<2.3	<2.3	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
#101,90	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
#87	<1.5	<1.5	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7
#77	<2	<2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
#154	<2	<2	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
#118	1.3	1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#105	3.7	3.4	4.1	4.0	3.2	4.3	3.7	2.7	2.4	1.7	1.9	<1.1	<1.1	2.0
#153,132	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#138	2.4	2.5	3.2	3.0	2.4	3.1	2.8	2.0	2.3	1.7	1.9	<1.5	<1.5	1.9
#126	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#187	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
#128	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
#180	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
#169	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#170,190	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#195,208	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#206	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	7.3	7.2	7.3	7.1	5.6	7.4	6.5	4.6	4.7	3.4	3.8	0.0	0.0	3.9
Surrogate Recoveries (%)														
#103	87	104	83	88	81	88	85	64	75	70	72	89	81	92
#198	95	100	82	81	79	83	82	61	73	68	72	89	77	87

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in *Mytilus edulis*														
	(ng/g dry weight)													
Sample I.D.	MEUR4	MEKN1	MEKN2	MEKN3	MEKN3	MEKN3	MEKN4	MEPR1	MEPR2	MEPR3	MEPR4	MEPH1	MEPH2	MEPH3
#8,5	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
#18,15	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
#29	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#28	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
#50	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
#52	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	3.0	2.9	<1.9
#44	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
#66,95	<2	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	8.0	8.0	5.2
#101,90	<1.6	3.2	2.9	3.3	3.2	3.3	3.0	4.0	3.8	3.1	3.5	13.4	13.2	8.6
#87	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	4.5	4.3	2.7
#77	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2	<2	<2
#154	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2	2.0	<2
#118	<1.3	2.6	2.8	2.3	2.3	2.3	2.1	3.4	3.3	2.6	3.0	13.9	13.4	9.2
#105	<1.1	8.6	7.8	8.6	8.6	8.6	8.2	7.0	6.9	5.8	6.2	21.3	20.5	14.5
#153,132	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	1.2	1.1	<1.4	<1.4	6.8	6.6	5.0
#138	<1.4	6.2	5.8	6.2	6.4	6.2	5.8	6.2	6.1	5.1	5.6	19.8	19.2	13.5
#126	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#187	<1.2	3.5	3.1	3.6	3.5	3.6	3.3	1.9	2.1	1.6	1.9	6.2	6.3	4.1
#128	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	4.5	4.4	3.3
#180	<1.1	1.9	1.7	2.1	2.0	2.1	1.8	<1.1	<1.1	<1.1	<1.1	1.9	2.2	1.4
#169	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#170,190	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#195,208	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#206	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	0.0	25.9	24.0	26.2	26.1	26.2	24.2	23.7	23.2	18.3	20.1	103.2	103.0	67.6
Surrogate Recoveries (%)														
#103	78	92	78	88	93	88	83	93	81	90	82	71	75	73
#198	85	95	84	88	93	88	83	100	99	100	92	80	80	77

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in *Mytilus edulis*														
	(ng/g dry weight)													
Sample I.D.	MEPH4	MESA1	MESA2	MESA3	MESA4	MECC1	MECC2	MECC3	MECC4	NHRH1	NHRH2	NHRH3	NHRH4	NHDP1
#8,5	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
#18,15	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
#29	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#28	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
#50	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
#52	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
#44	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
#66,95	5.0	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
#101,90	8.6	<1.6	2.7	<1.5	2.2	5.0	5.0	4.8	3.0	<1.6	<1.6	<1.6	<1.6	7.9
#87	2.5	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	1.8
#77	<2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	2.3
#154	<2	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
#118	9.0	1.8	3.2	2.3	3.0	6.2	6.4	6.0	3.9	2.3	1.8	2.1	1.9	9.6
#105	13.9	4.1	8.1	4.7	6.8	12.7	12.6	11.5	8.1	5.7	4.7	5.0	4.5	17.0
#153,132	4.6	<1.4	<1.4	1.0	1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	2.4
#138	13.3	3.7	7.1	4.2	5.9	11.0	11.2	10.0	7.2	4.6	3.7	4.0	3.7	14.5
#126	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#187	4.0	<1.2	2.4	<1	1.6	4.8	4.9	4.2	2.9	1.6	1.2	1.3	1.1	5.7
#128	3.4	<0.7	<0.7	<0.7	<0.7	1.1	1.2	1.0	<0.7	<0.7	<0.7	<0.7	<0.7	2.0
#180	1.4	<1.1	2.3	<1.1	<1.1	1.4	1.7	1.6	<1.1	<1.1	<1.1	<1.1	<1.1	1.1
#169	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#170,190	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#195,208	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#206	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	65.6	9.6	25.8	12.1	20.9	42.3	43.0	39.0	25.1	14.2	11.4	12.4	11.1	64.2
Surrogate Recoveries (%)														
#103	56	85	81	83	84	95	91	86	77	87	84	84	72	97
#198	61	88	89	93	92	103	102	97	89	101	101	102	87	98

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in *Mytilus edulis*														
	(ng/g dry weight)													
Sample I.D.	NHDP2	NHDP3	NHDP4	NHDP4	MAIP1	MAIP2	MAIP3	MAIP4	MAIP4	MAWN1	MAWN2	MAWN3	MAWN4	MABI1
#8,5	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
#18,15	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
#29	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#28	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
#50	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
#52	<1.9	<1.9	<1.9	<1.9	4.0	4.0	3.8	4.5	4.5	2.3	2.7	2.5	3.1	4.4
#44	<2.0	<2.0	<2.0	<2.0	2.4	2.5	2.1	2.7	2.6	<2.0	<2.0	<2.0	<2.0	2.2
#66,95	<2.3	<2.3	<2.3	1.6	5.5	5.6	5.2	6.4	7.1	4.0	5.0	4.4	5.9	7.0
#101,90	8.1	5.8	5.0	4.1	7.7	7.7	7.4	8.4	8.6	10.6	11.9	11.2	13.8	20.6
#87	2.0	<1.7	<1.7	<1.7	2.7	2.8	2.6	3.0	3.1	3.4	3.7	3.6	4.5	6.5
#77	2.4	2.2	<2.2	<2.2	5.2	5.2	4.9	5.7	6.2	6.0	7.2	6.4	8.3	10.8
#154	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
#118	9.8	8.1	6.3	6.4	8.4	8.7	8.4	9.4	9.8	14.7	16.4	15.7	19.3	26.3
#105	17.6	14.8	12.2	11.9	11.8	11.9	11.1	12.3	12.8	23.7	27.4	26.1	31.7	41.2
#153,132	2.6	3.0	1.6	2.1	2.7	2.9	2.7	3.2	3.4	5.2	6.1	5.6	7.0	8.4
#138	14.2	12.6	10.0	9.7	10.7	11.1	10.3	11.5	11.8	22.0	25.5	23.6	28.5	38.4
#126	<1.4	<1.4	<1.4	<1.4	1.6	1.7	1.6	1.8	1.9	3.2	3.6	3.2	4.0	<1.4
#187	5.5	4.4	4.0	3.8	4.1	4.1	3.8	4.3	4.3	7.5	8.8	8.2	9.7	12.6
#128	2.0	1.1	1.3	<0.7	1.6	1.8	1.6	1.9	1.9	3.5	4.3	4.0	4.3	6.9
#180	1.1	<1.1	<1.1	<1.1	1.1	1.4	1.4	1.5	1.5	2.9	2.9	2.9	3.5	2.8
#169	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#170,190	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
#195,208	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#206	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
#209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	65.3	52.0	40.3	39.7	69.435	71.259	66.962	76.778	79.372	109.122	125.84	117.327	143.529	188.1
Surrogate Recoveries (%)														
#103	95	83	99	66	111	105	118	117	118	103	109	114	115	105
#198	95	99	99	95	117	123	129	125	127	115	128	142	133	108

APPENDIX C. Tissue concentrations of polychlorinated biphenyls in *Mytilus edulis*														
	(ng/g dry weight).													
Sample I.D.	MABI2	MADX1	MADX2	MADX3	MADX4	MASN1	MASN2	MASN3	MASN4					
#8,5	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8					
#18,15	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2					
#29	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3					
#28	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1					
#50	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4					
#52	3.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9					
#44	2.1	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0					
#66,95	6.9	2.7	2.7	2.6	2.4	2.0	<2	<2	<2					
#101,90	19.5	7.6	7.2	7.5	7.5	5.1	3.8	4.4	3.8					
#87	6.4	2.0	1.9	1.9	2.0	<1.7	<1.7	<1.7	<1.7					
#77	10.7	4.6	4.3	4.2	4.3	3.2	2.5	2.6	2.5					
#154	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3					
#118	24.6	11.3	10.8	11.3	11.7	8.1	6.5	7.2	6.5					
#153,132	38.8	18.0	17.3	18.9	19.9	13.7	11.1	12.7	11.3					
#105	7.9	3.4	3.0	2.9	3.3	1.9	1.6	1.6	1.7					
#138	35.8	16.3	15.6	16.7	18.2	11.6	9.7	10.6	9.6					
#126	<1.4	2.5	2.3	2.7	3.0	1.9	<1.5	1.5	<1.5					
#187	11.7	6.0	5.8	6.4	6.8	4.2	3.3	3.7	3.3					
#128	6.3	2.7	2.4	2.5	3.0	1.7	1.5	1.6	1.6					
#180	13.6	2.6	2.3	2.2	2.3	1.1	<1.1	<1.1	<1.1					
#169	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3					
#170,190	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3					
#195,208	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4					
#206	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4					
#209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5					
Total	188.3	79.676	75.651	79.796	84.503	54.536	40.03	45.952	40.391					
Surrogate Recoveries (%)														
#103	103	117	113	112	94	129	99	111	105					
# 198	105	135	134	129	134	148	128	130	119					

APPENDIX D. Tissue concentrations of chlorinated pesticides in *Mytilus edulis*

(ng/g dry weight)

Sample I.D.	NSDI1	NSDI2	NSDI2	NSDI3	NSDI4	NSFI1	NSFI2	NSFI3	NSFI4	NSAR1	NSAR2	NSAR3	NSAR4
HCB	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
g-HCH	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Heptachlor	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Aldrin	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Hepta Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p'-DDE	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
trans-Nonachlor	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
p,p'-DDE	1.7	1.8	1.8	2.2	1.1	2.6	2.8	3.0	2.4	1.1	1.3	1.3	1.4
Dieldrin	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
o,p'-DDD	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
o,p'-DDT	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
p,p'-DDT	<0.7	<0.7	<0.7	<0.7	<0.7	1.4	1.6	1.7	1.4	<0.7	<0.7	<0.7	<0.7
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	1.7	1.8	1.8	2.2	1.1	3.9	4.4	4.7	3.8	1.1	1.3	1.3	1.4
Surrogate Recovery (%)													
g-Chlordene	88%	95%	98%	97%	76%	85%	104%	102%	98%	82%	99%	81%	91%

APPENDIX D. Tissue concentrations of chlorinated pesticides in *Mytilus edulis*													
	(ng/g dry weight)												
Sample I.D.	NSSC1	NSSC2	NSSC3	NSSC4	NBNR1	NBNR2	NBNR3	NBNR4	NBCH1	NBCH2	NBCH3	NBCH4	
HCB	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	
g-HCH	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	
Heptachlor	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	
Aldrin	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	
Hepta Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	
o,p'-DDE	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	
cis-Chlordane	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	
trans-Nonachlor	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
p,p'-DDE	1.8	2.0	1.8	2.0	3.5	3.6	3.1	3.1	3.4	3.1	3.5	3.4	
Dieldrin	<1.3	<1.3	<1.3	<1.3	1.4	1.4	<1.3	1.4	1.4	1.4	1.4	1.4	
o,p'-DDD	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	
p,p'-DDD	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	
o,p'-DDT	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	
p,p'-DDT	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	
Total	1.8	2.0	1.8	2.0	4.9	5.0	3.1	4.5	4.8	4.5	4.9	4.8	
Surrogate Recovery (%)													
g-Chlordene	84	86	76	93	70	83	84	92	92	87	86	94	

APPENDIX D. Tissue concentrations of chlorinated pesticides in *Mytilus edulis*													
	(ng/g dry weight)												
Sample I.D.	NBLB1	NBLB2	NBLB3	NBLB3	NBLB4	MECK1	MECK1	MECK2	MECK3	MECK4	MEMR1	MEMR2	MEMR3
HCB	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
g-HCH	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Heptachlor	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Aldrin	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Hepta Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p'-DDE	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	1.2	1.2	1.1	<0.9	<0.9	2.8	2.7	2.2	2.6	2.6	2.0	1.9	1.8
trans-Nonachlor	<1	<1	<1	<1	<1	2.0	2.0	1.7	2.0	1.9	1.5	1.4	1.3
p,p'-DDE	6.1	6.2	5.7	5.0	5.0	7.5	7.5	6.4	7.7	7.0	3.6	3.5	3.1
Dieldrin	1.8	1.8	1.5	1.5	1.4	2.9	2.7	2.4	3.2	2.4	1.9	1.8	1.7
o,p'-DDD	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	<1.6	<1.6	<1.6	<1.6	<1.6	2.6	2.5	2.2	2.5	2.4	2.4	2.5	2.2
o,p'-DDT	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
p,p'-DDT	<0.7	1.2	1.0	1.0	<1	2.0	1.9	1.7	1.9	1.8	<0.7	<0.7	<0.7
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	9.0	10.5	9.3	7.5	6.5	19.9	19.3	16.5	19.8	18.1	11.4	11.2	10.2
Surrogate Recovery (%)													
g-Chlordene	87	83	80	65	77	90	94	90	92	90	66	76	75

APPENDIX D. Tissue concentrations of chlorinated pesticides in *Mytilus edulis*													
	(ng/g dry weight)												
Sample I.D.	MEMR4	MEUR1	MEUR2	MEUR3	MEUR4	MEKN1	MEKN2	MEKN3	MEKN3	MEKN4	MEPR1	MEPR2	MEPR3
HCB	<1.2	1.7	1.5	1.5	1.3	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
g-HCH	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Heptachlor	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Aldrin	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Hepta Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p'-DDE	<1.1	<1.1	<1.1	<1.1	<1.1	2.3	2.0	2.2	2.1	2.0	<1.1	1.2	<1.1
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	1.6	2.6	2.5	2.4	2.2	1.6	1.5	1.6	1.6	1.4	1.6	1.8	1.4
trans-Nonachlor	1.2	1.9	1.9	1.9	1.6	<1	<1	<1	<1	<1	1.5	1.6	1.2
p,p'-DDE	3.1	3.9	3.8	4.1	3.5	5.3	4.7	5.0	4.9	4.8	7.3	7.5	6.2
Dieldrin	1.4	2.3	2.2	2.1	2.0	1.9	1.6	1.7	1.7	1.6	1.3	1.4	<1.3
o,p'-DDD	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	2.1	2.3	1.7
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	2.0	<1.5	2.9	2.8	2.6	2.3	2.2	2.3	2.3	2.1	6.4	7.0	4.9
o,p'-DDT	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
p,p'-DDT	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	9.4	12.3	14.7	14.8	13.1	13.3	12.0	12.8	12.6	11.8	20.2	22.7	15.4
Surrogate Recovery (%)													
g-Chlordene	72	98	86	92	80	100	86	96	95	84	89	79	88

APPENDIX D. Tissue concentrations of chlorinated pesticides in *Mytilus edulis*													
	(ng/g dry weight)												
Sample I.D.	MEPR4	MEPH1	MEPH2	MEPH3	MEPH4	MESA1	MESA2	MESA3	MESA4	MECC1	MECC2	MECC3	MECC4
HCB	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
g-HCH	<1.2	<1.2	<1.2	<1.2	<1.2	1.4	1.6	1.7	1.6	1.5	1.3	1.2	1.1
Heptachlor	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Aldrin	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Hepta Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p'-DDE	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	1.5	3.3	3.0	2.7	2.7	1.2	1.5	1.6	1.6	2.4	1.7	1.6	*
trans-Nonachlor	1.4	2.7	2.4	2.2	2.1	<1	1.0	<1	1.0	1.6	1.0	<1	<1
p,p'-DDE	6.7	12.9	12.5	10.0	10.0	3.2	4.3	3.9	4.5	5.9	5.5	5.5	3.9
Dieldrin	<1.3	2.6	2.4	2.1	2.2	1.1	1.4	1.3	1.4	1.3	1.2	1.3	1.0
o,p'-DDD	2.0	4.6	4.3	3.4	3.3	<0.9	<0.9	<0.9	<0.9	1.3	1.2	1.2	1.0
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
p,p'-DDD	5.7	12.6	11.6	8.9	9.1	1.6	2.4	2.1	2.2	4.0	3.0	2.8	2.1
o,p'-DDT	<1.3	2.5	2.3	1.9	1.9	<1.3	<1.3	<1.3	<1.3	1.7	<1.3	<1.3	<1.3
p,p'-DDT	<0.7	5.0	4.4	3.8	4.3	<0.7	<0.7	<0.7	<0.7	1.7	1.1	1.0	<0.7
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	17.2	46.2	43.0	35.0	35.7	8.6	12.3	10.6	12.2	21.3	16.1	14.7	9.2
Surrogate Recovery (%)													
g-Chlordene	81	67	64	72	52	86	78	84	83	89	84	79	77

APPENDIX D. Tissue concentrations of chlorinated pesticides in *Mytilus edulis*													
	(ng/g dry weight)												
Sample I.D.	NHRH1	NHRH2	NHRH3	NHRH4	NHDP1	NHDP2	NHDP3	NHDP4	MAIP1	MAIP2	MAWN1	MAWN2	MAWN3
HCB	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
g-HCH	1.6	1.7	1.6	1.5	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Heptachlor	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Aldrin	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	1.1	<1.4
Hepta Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p'-DDE	<1.1	<1.1	<1.1	<1.1	1.5	1.6	<1.1	1.2	1.7	1.7	2.1	2.5	2.3
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	1.5	1.5	1.5	2.3	2.3
cis-Chlordane	1.4	1.2	1.4	1.2	1.8	1.9	1.6	1.4	<0.9	<0.9	<0.9	<0.9	<0.9
trans-Nonachlor	<1	<1	<1	<1	1.5	1.6	1.3	1.1	3.0	2.5	2.0	2.2	2.0
p,p'-DDE	4.6	4.0	4.4	4.1	9.7	9.9	7.4	7.1	9.3	9.7	6.9	8.4	7.9
Dieldrin	1.1	1.5	1.1	1.0	1.5	1.5	1.4	1.3	1.4	1.6	<1.3	1.4	1.4
o,p'-DDD	<0.9	1.1	<0.9	<1	1.8	1.9	1.4	1.4	2.3	2.4	2.0	2.4	2.2
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2	<2.0	<2.0	1.6	2.0	<2.0
p,p'-DDD	6.3	2.2	2.5	2.4	4.1	4.4	4.0	2.9	8.1	9.1	5.8	6.9	6.3
o,p'-DDT	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
p,p'-DDT	<0.7	<0.7	<0.7	<0.7	1.4	1.4	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	15.0	11.7	11.0	10.2	23.4	24.1	17.1	16.4	27.4	28.6	21.8	29.1	24.4
Surrogate Recovery (%)													
g-Chlordene	84	93	93	87	104	98	75	102	107	102	97	102	108

APPENDIX D. Tissue concentrations of chlorinated pesticides in *Mytilus edulis*													
	(ng/g dry weight)												
Sample I.D.	MAWN4	MABI1	MABI2	MADX1	MADX2	MADX3	MADX4	MASN1	MASN2	MASN3	MASN4		
HCB	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		
g-HCH	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		
Heptachlor	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9		
Aldrin	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4		
Hepta Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		
o,p'-DDE	2.7	5.0	5.0	2.0	2.0	2.2	2.0	2.2	2.1	2.0	1.9		
a-Endosulfan	1.8	<1.2	<1.2	1.7	2.0	1.5	1.4	1.8	1.3	2.0	1.3		
cis-Chlordane	<0.9	4.3	4.0	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9		
trans-Nonachlor	2.5	4.6	4.1	2.0	2.0	2.0	1.3	<1.0	<1.0	<1.0	<1.0		
p,p'-DDE	9.3	13.1	12.9	18.9	18.3	18.7	19.5	11.0	9.1	9.7	7.8		
Dieldrin	1.5	2.2	1.7	2.4	2.3	2.5	2.2	2.1	2.1	2.0	1.8		
o,p'-DDD	2.6	2.6	2.5	3.2	2.9	3.1	2.9	2.1	1.9	2.0	1.5		
b-Endosulfan	2.2	<2	<2	<2.0	<2.0	<2.0	<2.0	2.2	2.2	2.1	2.0		
p,p'-DDD	8.0	6.8	6.0	11.4	10.6	11.0	10.9	5.9	5.8	5.9	5.2		
o,p'-DDT	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3		
p,p'-DDT	<0.7	2.4	1.8	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7		
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		
Total	30.5	41.0	37.9	41.5	40.1	40.9	40.1	27.2	24.5	25.7	21.5		
Surrogate Recovery (%)													
g-Chlordene	102	90	101	110	107	103	90	111	103	105	100		

Appendix E. Polychlorinated dibenzodioxins and polychlorinated dibenzofurans (pg/g wet weight).

Component	MAWN2	NHRH4	NHDP2	MEPH3	MEPR1	MESA3	NBNR2	NBLB3
Total Tetrachlorodibenzofurans	2.8	<0.83	3.0	0.86	1.7	0.72	1.1	1.5
Total Pentachlorodibenzofurans	2.5	<0.40	<2.1	0.56	2.7	1.6	0.88	1.3
Total Hexachlorodibenzofurans	2.1	0.36	<1.0	0.90	5.3	2.1	0.74	1.0
Total Heptachlorodibenzofurans	0.74	0.54	2.0	<0.60	3.0	2.3	2.2	2.7
Octachlorodibenzofuran	0.77	0.53	<1.9	0.73	1.6	1.2	1.1	<1.2
Total Tetrachlorodibenzo-p-dioxins	3.8	1.5	10	0.89	<0.36	<0.41	<0.43	<0.73
Total Pentachlorodibenzo-p-dioxins	<0.52	<0.41	<1.5	<0.35	<0.38	<0.36	<0.58	<0.71
Total Hexachlorodibenzo-p-dioxins	2.5	1.1	2.4	1.1	2.8	1.6	0.64	<0.65
Total Heptachlorodibenzo-p-dioxins	6.7	3.2	12	4.2	6.4	5.6	4.5	3.5
Octachlorodibenzo-p-dioxin	13	4.6	24	6.7	9.4	6.7	8.1	3.8
2,3,7,8-Cl4-Dibenzofuran	1.9	<0.83	3.0	0.86	1.7	0.72	1.1	1.5
2,3,7,8-Cl4-Dibenzo-p-dioxin	<0.56	<0.61	<1.6	0.89	<0.36	<0.41	<0.43	<0.73
1,2,3,7,8-Cl5-Dibenzofuran	<0.28	<0.40	<1.4	<0.35	<0.31	<0.32	<0.41	<0.77
2,3,4,7,8-Cl5-Dibenzofuran	0.61	<0.40	<1.4	<0.36	0.66	<0.33	0.45	<0.78
1,2,3,7,8-Cl5-Dibenzo-p-dioxin	<0.43	<0.41	<1.0	<0.35	<0.38	<0.36	<0.58	<0.71
1,2,3,4,7,8-Cl6-Dibenzofuran	0.46	<0.31	<0.92	<0.32	1.3	<0.69	<0.47	<0.75
1,2,3,6,7,8-Cl6-Dibenzofuran	0.33	0.31	<0.95	0.33	0.71	0.63	<0.41	0.88
2,3,4,6,7,8-Cl6-Dibenzofuran	0.38	<0.35	<1.0	<0.36	1.3	0.65	<0.53	<0.84
1,2,3,7,8,9-Cl6-Dibenzofuran	<0.35	<0.38	<1.1	<0.38	<0.41	<0.49	<0.57	<0.91
1,2,3,4,7,8-Cl6-Dibenzo-p-dioxin	<0.45	<0.39	<1.8	<0.35	<0.47	<0.42	<0.50	<0.70
1,2,3,6,7,8-Cl6-Dibenzo-p-dioxin	<0.39	<0.34	<1.6	<0.30	<0.41	<0.36	<0.43	<0.61
1,2,3,7,8,9-Cl6-Dibenzo-p-dioxin	<0.41	<0.36	<1.6	<0.32	0.83	<0.38	<0.46	<0.64
1,2,3,4,6,7,8-Cl7-Dibenzofuran	<0.81	0.50	<1.3	<0.56	1.9	1.5	1.3	1.7
1,2,3,4,7,8,9-Cl7-Dibenzofuran	<0.59	<0.40	<1.1	<0.48	<0.63	<0.59	<0.59	<0.78
1,2,3,4,6,7,8-Cl7-Dibenzo-p-dioxin	3.2	1.5	5.6	1.8	3.1	2.7	2.3	2.1
1,2,3,4,6,7,8,9-Cl8-Dibenzofuran	0.77	0.53	<1.9	0.73	1.6	1.2	1.1	<1.2
1,2,3,4,6,7,8,9-Cl8-Dibenzo-p-dioxin	13	4.6	24	6.7	9.4	6.7	8.1	3.8
Surrogate Recoveries %								
2,3,7,8-T4CDF-13C12	31	20	23	22	32	33	25	32
2,3,7,8-T4CDD-13C12	30	20	23	22	32	33	26	32
1,2,3,7,8-P5CDF-13C12	38	30	31	32	38	40	34	39
1,2,3,7,8-P5CDD-13C12	54	45	43	51	45	56	47	55
1,2,3,6,7,8-H6CDF-13C12	56	50	48	48	57	57	53	51
1,2,3,6,7,8-H6CDD-13C12	62	60	55	65	63	71	62	73
1,2,3,4,6,7,8-H7CDF-13C12	66	63	59	59	69	68	64	59
1,2,3,4,6,7,8-H7CDD-13C12	72	69	65	62	74	72	72	62
OCDD-13C12	67	66	61	60	74	70	69	60

Appendix E. Polychlorinated dibenzodioxins and polychlorinated dibenzofurans (pg/g wet weight).

Component	NBLB3	MADX	MAIP	MABI	NSAR	NSSC
Total Tetrachlorodibenzofurans	<2.0	<3.4	1.1	3.3	<0.76	<8.9
Total Pentachlorodibenzofurans	<0.72	0.91	<0.78	1.8	0.52	<0.43
Total Hexachlorodibenzofurans	0.74	0.50	0.54	<0.57	0.47	<0.44
Total Heptachlorodibenzofurans	1.8	1.8	1.5	<3.2	<0.88	<0.51
Octachlorodibenzofuran	0.95	1.9	1.0	<0.81	<2.7	<0.56
Total Tetrachlorodibenzo-p-dioxins	<0.85	0.99	<0.55	10.0	<0.67	<16
Total Pentachlorodibenzo-p-dioxins	<0.68	<0.52	<1.1	<1.3	<0.54	<0.48
Total Hexachlorodibenzo-p-dioxins	<0.79	2.3	1.8	<1.1	<0.74	<0.89
Total Heptachlorodibenzo-p-dioxins	6.9	8.9	7.4	<4.7	1.1	2.3
Octachlorodibenzo-p-dioxin	13	17	13	4.4	3.2	4.2
2,3,7,8-Cl4-Dibenzofuran	<1.1	<1.2	1.1	3.3	<0.76	<1.3
2,3,7,8-Cl4-Dibenzo-p-dioxin	<0.85	<0.84	<0.55	<4.3	<0.67	<1.9
1,2,3,7,8-Cl5-Dibenzofuran	<0.72	<0.51	<0.52	<0.89	<0.46	<0.44
2,3,4,7,8-Cl5-Dibenzofuran	<0.73	<0.50	<0.50	<0.87	<0.44	<0.42
1,2,3,7,8-Cl5-Dibenzo-p-dioxin	<0.68	<0.52	<1.1	<1.3	<0.54	<0.48
1,2,3,4,7,8-Cl6-Dibenzofuran	<0.67	<0.41	<0.45	<0.55	<0.41	<0.42
1,2,3,6,7,8-Cl6-Dibenzofuran	0.62	<0.37	<0.40	<0.49	0.40	<0.38
2,3,4,6,7,8-Cl6-Dibenzofuran	<0.76	<0.46	<0.50	<0.60	<0.45	<0.47
1,2,3,7,8,9-Cl6-Dibenzofuran	<0.82	<0.50	<0.54	<0.66	<0.49	<0.51
1,2,3,4,7,8-Cl6-Dibenzo-p-dioxin	<0.85	<0.88	<0.72	<1.2	<0.77	<0.86
1,2,3,6,7,8-Cl6-Dibenzo-p-dioxin	<0.74	<0.80	<0.65	<1.1	<0.70	<0.84
1,2,3,7,8,9-Cl6-Dibenzo-p-dioxin	<0.78	<0.86	<0.70	<1.2	<0.76	<0.84
1,2,3,4,6,7,8-Cl7-Dibenzofuran	0.97	0.75	0.68	<3.0	<0.82	<0.48
1,2,3,4,7,8,9-Cl7-Dibenzofuran	<0.74	<0.66	<0.44	<3.4	<0.94	<0.55
1,2,3,4,6,7,8-Cl7-Dibenzo-p-dioxin	2.7	3.8	3.3	<4.7	<0.99	1.5
1,2,3,4,6,7,8,9-Cl8-Dibenzofuran	0.95	1.9	1.0	<0.81	<2.7	<0.56
1,2,3,4,6,7,8,9-Cl8-Dibenzo-p-dioxin	13	17	13	4.4	3.2	4.2
Surrogate Recoveries %						
2,3,7,8-T4CDF-13C12	22	30	41	43	62	44
2,3,7,8-T4CDD-13C12	22	31	40	42	62	44
1,2,3,7,8-P5CDF-13C12	30	46	55	49	61	55
1,2,3,7,8-P5CDD-13C12	42	54	62	54	59	62
1,2,3,6,7,8-H6CDF-13C12	46	66	71	57	66	66
1,2,3,6,7,8-H6CDD-13C12	52	73	80	62	71	72
1,2,3,4,6,7,8-H7CDF-13C12	56	76	77	61	67	69
1,2,3,4,6,7,8-H7CDD-13C12	61	79	83	65	70	86
OCDD-13C12	60	79	79	61	67	68

QA for 1997 Metals Analysis

Standards as samples											
(ppm)		silver	aluminum	cadmium	chromium	copper	iron	lead	nickel	zinc	
GROUP 1											
expected		0.1	1	1	1	1	1	1	1	1	
recovered a		0.101	0.98	1	0.99	0.99	1	0.99	1	1	
recovered b		0.1	1	1.01	1	1	1.01	1.01	1.01	1.01	
recovered c		0.103	0.99	1.02	0.99	1	0.98	1	1.03	1.02	
GROUP 2											
expected		0.1	1	1	1	1	1	1	1	1	
recovered a		0.102	1	0.99	0.99	0.99	0.98	0.99	0.99	0.99	
recovered b		0.099	0.97	0.98	0.98	0.97	0.99	0.98	0.97	0.98	
recovered c		0.1	0.98	0.96	0.96	0.96	0.96	0.96	0.96	0.96	
GROUP 3											
expected		0.1	1	1	1	1	1	1	1	1	
recovered a		0.1	1	1	1	0.99	1.01	1.01	0.99	1	
recovered b		0.099	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	
recovered c		0.098	0.98	0.99	0.98	0.99	0.99	1.01	0.99	0.99	
GROUP 4											
expected		0.1	1	1	1	1	1	1	1	1	
recovered a		0.1	1.02	1.01	1	1	1	1	1.01	1.01	
recovered b		0.1	1.01	1.02	1.02	1.01	1.01	1.01	1.01	1.02	
recovered c		0.1	0.97	1	0.99	0.99	0.99	0.99	1	1	

QA for 1997 Metals Analysis

Standards as samples		**MERCURY**								
(ug)										
DATE RUN		4-Jun	12-Jun	13-Jun	18-Jun	26-Jun	27-Jun	1-Jul		
expected		0.2	0.2	0.2	0.2	0.2	0.2	0.2		
recovered a		0.22	0.19	0.19	0.19	0.19	0.19	0.19		
% recov		110	95	95	95	95	95	95		
LFB's (ug)										
exp.		0.2	0.2	0.2	0.2	0.2	0.2	0.2		
recov		0.2	0.199	0.19	0.19	0.21	0.21	0.21		
% recov		100	99.5	95	95	105	105	105		
blanks		ND.01	ND.01	ND.01	ND.01	ND.01	ND.01	ND.01		
(ug/gm)										
DUPS (ug/gm)										
#		4353	4349	4355	4348	4345	4365	4367		
A		0.51	0.23	0.44	0.64	0.63	0.63	1.41		
B		0.48	0.22	0.57	0.69	0.62	0.63	1.42		
mean		0.495	0.225	0.505	0.665	0.625	0.63	1.415		
rel. diff.		6.06	4.444	25.743	7.519	1.60	0	0.7067138		
#		4353	4349	4355	4348	4345	4365	4367		
spike value (ug)		0.1	0.2	0.2	0.2	0.2	0.2	0.2		
expected		0.199	0.397	0.398	0.394	0.398	0.395	0.396		
obtained		0.204	0.424	0.409	0.392	0.438	0.411	0.41		
% recovery		102.5	106.8	102.8	99.49	110.1	104.1	103.5		
dorm-1 (ug/gm wet)		OYSTER								
expected		0.0642	4.64	4.64	4.64	4.64	4.64	4.64		
obtained		0.04	4.98	4.93	3.69	4.93	4.86	4.71		
% recovery		62.31	107.33	106.25	79.53	106.25	104.74	101.51		
dorm-1 (ug/gm wet)										
expected					4.64					
obtained					5.02					
% recovery					108.19					
era1000 (ug)										
expected		0.2	0.2	0.2	0.2	0.2	0.2	0.2		
obtained		0.218	0.212	0.191	0.22	0.214	0.209	0.203		
% recovery		109	106	95.5	110	107	104.5	101.5		
1974a + era1000	(ug)									
expected			0.2	0.2	0.2	0.2	0.2	0.2		
obtained			0.199	0.205	0.23	0.22	0.21	0.21		
% recovery			99.5	102.5	115.0	110	105	105		

Reagent Blanks											
(ppm)											
GROUP 1		silver	aluminum	cadmium	chromium	copper	iron	lead	nickel	zinc	
recovered a		ND.0005	ND.02	ND.0005	ND.001	ND.002	ND.02	ND.004	ND.001	ND.0025	
recovered b		ND.0005	ND.02	ND.0005	ND.001	ND.002	ND.02	ND.004	ND.001	ND.0025	
GROUP 2											
recovered a		ND.0005	ND.02	ND.0005	ND.001	ND.002	ND.02	ND.004	ND.001	0.006	
recovered b		ND.0005	ND.02	ND.0005	ND.001	0.012	ND.02	ND.004	ND.001	ND.0025	
GROUP 3											
recovered a		ND.0005	ND.02	ND.0005	ND.001	ND.002	ND.02	ND.004	ND.001	ND.0025	
recovered b		ND.0005	ND.02	ND.0005	ND.001	ND.002	ND.02	ND.004	ND.001	ND.0025	
GROUP 4											
recovered a		0.0005	ND.02	ND.0005	ND.001	ND.002	ND.02	ND.004	ND.001	0.007	
recovered b		ND.0005	ND.02	ND.0005	ND.001	ND.002	ND.02	ND.004	ND.001	ND.0025	

Laboratory Fortified Blanks											
(ppm)											
GROUP 1		silver	aluminum	cadmium	chromium	copper	iron	lead	nickel	zinc	
true value		0.01	2	0.01	0.03	0.05	2	0.01	0.01	1	
rec. value		0.0107	1.94	0.01	0.0315	0.0495	1.87	0.0105	0.0102	0.96	
% recovery		107	97	100	105	99	93.5	105	102	96	
rec. value		0.0107	1.98	0.0101	0.0321	0.0493	1.9	0.0097	0.0105	1	
% recovery		107	99	101	107	98.6	95	97	105	100	
GROUP 2											
true value		0.01	2	0.01	0.03	0.05	2	0.01	0.01	1	
rec. value		0.0103	1.88	0.0093	0.0283	0.0462	1.72	0.0096	0.01	0.91	
% recovery		103	94	93	94.33	92.4	86	96	100	91	
rec. value		0.0104	1.91	0.0094	0.0286	0.0485	1.8	0.0109	0.01	0.92	
% recovery		104	95.5	94	95.333333	97	90	109	100	92	
GROUP 3											
true value		0.01	2	0.01	0.03	0.05	2	0.01	0.01	1	
rec. value		0.0111	1.99	0.0098	0.0301	0.0501	1.85	0.0094	0.0103	0.97	
% recovery		111	99.5	98	100.33	100.2	92.5	94	103	97	
rec. value		0.0103	1.93	0.0095	0.0293	0.0484	1.8	0.0093	0.0095	0.94	
% recovery		103	96.5	95	97.67	96.8	90	93	95	94	
GROUP 4											
true value		0.01	2	0.01	0.03	0.05	2	0.01	0.01	1	
rec. value		0.0099	1.91	0.0099	0.0295	0.0505	1.8	0.0112	0.0098	0.95	
% recovery		99	95.5	99	98.333333	101	90	112	98	95	
rec. value		0.0095	1.98	0.0098	0.029	0.0488	1.8	0.0073	0.0098	0.97	
% recovery		95	99	98	96.7	97.6	90	73	98	97	

						QA for 1997 metals analysis				
Knowns										
GROUP 1		silver	aluminum	cadmium	chromium	copper	iron	lead	nickel	zinc
(ppm)	ERA 2 & ERA 3									
true value		0.1	1	0.1	0.1	0.1	1	0.1	0.1	0.1
rec. value		0.104	0.99	0.1	0.1	0.095	0.93	0.096	0.101	0.099
% recovery		104.0	99.00	100.00	100.00	95.00	93	96	101.00	99.00
rec. value		0.101	0.99	0.098	0.1	0.096	0.93	0.097	0.1	0.098
% recovery		101.00	99.00	98	100.00	96.00	93.00	97.00	100.00	98.00
rec. value		0.104	0.97	0.099	0.098	0.093	0.91	0.095	0.102	0.099
% recovery		104.0	97.0	99.0	98.0	93.0	91	95.0	102.0	99
	1566a oyster									
(mg/kg dry wt)										
tv		1.68	202.5	4.15	1.43	66.3	539	0.371	2.25	830
rec. value		1.76	108	4.25	1.26	67	468	0.313	2.37	797
% recovery		105	53	102	88	101	87	84	105	96
	1974a mussel									
(mg/kg wet wt)										
tv		0.068	51		0.24		57			11.9
rec val		0.0777	23		0.24		40			11.9
% recovery		114	45		100		70			100
GROUP 2										
(ppm)	ERA 2 & ERA 3									
true value		0.1	1	0.1	0.1	0.1	1	0.1	0.1	0.1
rec. value		0.103	0.98	0.097	0.098	0.094	0.9	0.095	0.098	0.097
% recovery		103	98.00	97.00	98.00	94.00	90.00	95.00	98.00	97.00
rec. value		0.103	1	0.1	0.101	0.098	0.95	0.097	0.101	0.099
% recovery		103	100.00	100	101.00	98.00	95.00	97.00	101.00	99.00
rec. value		0.101	1	0.098	0.099	0.096	0.92	0.096	0.099	0.097
% recovery		101	100	98	99	96	92	96	99	97
	1566a oyster									
(mg/kg dry wt)										
tv		1.68	202.5	4.15	1.43	66.3	539	0.371	2.25	830
rec. value		1.79	78	4	0.84	63	438	0.44	3	763
% recovery		107	39	96	59	95	81	119	133	92
	1974a mussel									
(mg/kg wet wt)										
tv		0.068	51		0.24		57			11.9
rec val		0.075	17		0.2		37			11
% recovery		110	33		83		65			92
GROUP 3										
(ppm)	ERA 2 & ERA 3									
true value		0.1	1	0.1	0.1	0.1	1	0.1	0.1	0.1
rec. value		0.102	0.99	0.098	0.1	0.096	0.92	0.094	0.099	0.096
% recovery		102.0	99	98.00	100.00	96.00	92.00	94	99.00	96.00
rec. value		0.1	0.99	0.098	0.099	0.096	0.91	0.094	0.098	0.096
% recovery		100.0	99	98.00	99.00	96.00	91.00	94.00	98.00	96.00
rec. value		0.099	0.99	0.098	0.099	0.096	0.91	0.095	0.099	0.096
% recovery		99.0	99.00	98.00	99.00	96.00	91.00	95.00	99.00	96.00
	1566a oyster									
(mg/kg dry wt)										
tv		1.68	202.5	4.15	1.43	66.3	539	0.371	2.25	830
rec. value		1.67	83	4.22	0.89	65.5	472	0.31	2.22	822
% recovery		99	41	102	62	99	88	84	99	99
	1974a mussel									
(mg/kg wet wt)										
tv		0.068	51		0.24		57			11.9
rec val		0.076	17		0.21		39.2			10.7
% recovery		112	33		88		69			90
GROUP 4										
(ppm)	ERA 2 & ERA 3									
true value		0.1	1	0.1	0.1	0.1	1	0.1	0.1	0.1
rec. value		0.98	1	0.098	0.098	0.096	0.91	0.094	0.098	0.097
% recovery		980.0	100	98.00	98.00	96	91.0	94.0	98.0	97
rec. value		0.098	1.02	0.1	0.1	0.097	0.93	0.096	0.101	0.099
% recovery		98.0	102.00	100.00	100.00	97.00	93	96.00	101.00	99.00
rec. value		0.099	1	0.099	0.098	0.096	0.91	0.096	0.099	0.098
% recovery		99.0	100.00	99.00	98.00	96.00	91.0	96.00	99.00	98.00
	1566a oyster									
(mg/kg dry wt)										
tv		1.68	202.5	4.15	1.43	66.3	539	0.371	2.25	830
rec. value		1.71	94	4.3	0.95	67.9	475	0.31	2.15	852
% recovery		102	46	104	66	102	88	84	96	103
	1974a mussel									
(mg/kg wet wt)										
tv		0.068	51		0.24		57			11.9
rec val		0.043	26.6		0.21		48.2			13
% recovery		63	52		88		85			109

DUPLICATES		(mg/kg dry wt)							
GROUP 1	#4345								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
REP 1	0.33	277	1.91	1.8	8.1	555	4.30	2.1	101
REP 2	0.38	259	1.92	1.78	8.6	539	4.30	2.1	101
MEAN	0.355	268	1.915	1.79	8.35	547	4.30	2.1	101
REL % DIFF	14.08	6.72	0.522	1.12	5.99	2.93	0.00	0	0.00
GROUP 1	#4359								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
REP 1	ND 0.1	268	1.66	1.55	6.3	406	3.36	1.24	93
REP 2	ND 0.1	250	1.37	1.34	5.2	354	2.74	1.04	79
MEAN	***	259	1.515	1.445	5.75	380	3.05	1.14	86
REL % DIFF	***	6.95	19.142	14.53	19.13	13.68	20.33	17.54	16.28
GROUP 2	#4370								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
REP 1	ND 0.1	189	0.85	0.63	4.5	239	0.80	ND 0.8	74
REP 2	ND 0.1	175	0.81	0.63	4.2	227	0.60	ND 0.8	72
MEAN	**	182	0.83	0.63	4.35	233	0.70	**	73
REL % DIFF	**	7.69	4.82	0.00	6.90	5.15	28.57	**	2.74
GROUP 2	#4398								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
REP 1	ND 0.1	820	2.2	1.9	6.2	990	1.20	1.8	51
REP 2	ND 0.1	790	2.1	1.9	6	962	1.30	1.8	49
MEAN	**	805	2.15	1.9	6.1	976	1.25	1.80	50
REL % DIFF	**	3.73	4.65	0.00	3.28	2.87	8.00	0.00	4.00
GROUP 3	#4348								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
REP 1	0.27	137	2.2	1.44	6.99	450	3.69	1.55	129
REP 2	0.16	136	2.2	1.41	7.22	452	3.70	1.52	132
MEAN	0.215	136.5	2.2	1.425	7.105	451	3.70	1.535	130.5
REL % DIFF	51.16	0.73	0	2.11	3.24	0.44	0.27	1.95	2.3
GROUP 3	#4388								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
REP 1	0.13	199	1.57	1.65	8.18	298	3.42	1.05	106
REP 2	0.12	183	1.6	1.64	7.99	272	3.44	1.07	107
MEAN	0.125	191	1.585	1.645	8.085	285	3.43	1.06	106.5
REL % DIFF	8.00	8.38	1.89	0.61	2.35	9.12	0.58	1.89	0.9
GROUP 4	#4365	*DIFFICULT TO GRIND(LARGE CHUNKS)							
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
REP 1	ND 0.1	360	4	2.7	11.6	672	3.60	2.2	139
REP 2	ND 01.	250	3.1	2.2	8.8	483	2.70	1.7	104
MEAN	***	305	3.55	2.45	10.2	577.5	3.15	1.95	121.5
REL % DIFF	***	36.07	25.4	20.41	27.45	32.73	28.57	25.64	28.81
GROUP 4	#4415								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
REP 1	ND 0.1	318	2.7	2.5	7.9	654	2.50	1.7	86
REP 2	0.12	302	2.5	2.3	7.8	639	2.50	1.6	83
MEAN	***	310	2.6	2.4	7.85	646.5	2.50	1.65	84.5
REL % DIFF	***	5.16	7.7	8.33	1.27	2.32	0.00	6.06	3.55

QA for 1997 Metals Analysis

Spiked Samples	(mg/kg dry wt)								
GROUP 1	#4345 SPIKED								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
SAMPLE RES.	0.355	268	1.92	1.79	8.35	547	4.3	2.1	101
SPIKE ADDED	1.75	350	1.75	5.25	8.75	350	1.75	1.75	175
SPIKE RECOVERED	1.93	339	1.56	4.77	8.52	263	1.62	1.63	157
% RECOVERY	110	97	89	91	97	75	93	93	90
GROUP 1	#4359 SPIKED								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
SAMPLE RES.	ND 0.1	259	1.52	1.45	5.75	380	3.1	1.14	86
SPIKE ADDED	1.38	290	1.45	4.35	7.25	290	1.45	1.45	145
SPIKE RECOVERED	1.48	311	1.48	3.95	7.75	275	1.7	1.44	137
% RECOVERY	107	107	102	91	107	95	117	99	94
GROUP 2	#4370 SPIKED								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
SAMPLE RES.	ND0.1	182	0.83	0.63	4.35	233	0.7	ND 0.8	73
SPIKE ADDED	1.29	258	1.29	3.87	6.45	258	1.29	1.29	129
SPIKE RECOVERED	1.34	262	1.07	3.27	6.15	196	1.04	1.6	111
% RECOVERY	104	102	83	84	95	76	81	124	86
GROUP2	#4398 SPIKED								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
SAMPLE RES.	ND.02	805	2.15	1.9	6.1	976	1.3	1.8	50
SPIKE ADDED	1.09	218	1.09	3.27	5.45	218	1.09	1.09	109
SPIKE RECOVERED	1.01	181	0.85	2.8	4.8	104	0.82	0.8	93
% RECOVERY	93	83	78	86	88	48	75	73	85
GROUP 3	# 4348 SPIKED								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
SAMPLE RES.	0.2	136.5	2.2	1.425	7.11	451	3.695	1.535	130.5
SPIKE ADDED	1.82	364	1.82	5.46	9.1	364	1.82	1.82	182
SPIKE RECOVERED	1.8	391	1.68	5.095	8.59	318	1.655	1.655	173
% RECOVERY	99	107	92	93	94	87	91	91	95
GROUP 3	# 4388 SPIKED								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
SAMPLE RES.	0.1	191	1.59	1.65	8.09	285	3.4	1.06	106.5
SPIKE ADDED	1.56	312	1.56	4.68	7.8	312	1.56	1.56	156
SPIKE RECOVERED	1.41	305	1.45	4.22	7.51	255	1.37	1.37	148
% RECOVERY	90	98	93	90	96	82	88	88	95
GROUP 4	#4365 SPIKED								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
SAMPLE RES.	ND 0.1	305	3.55	2.45	10.2	577.5	3.15	1.95	121.5
SPIKE ADDED	3.28	656	3.28	9.84	16.4	656	3.28	3.28	328
SPIKE RECOVERED	3.28	620	2.52	8.75	14.4	425.5	1.87	2.74	308
% RECOVERY	101	95	77	89	88	65	57	84	94
GROUP 4	#4415 SPIKED								
	SILVER	ALUMINUM	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	NICKEL	ZINC
SAMPLE RES.	0.12	310	2.6	2.4	7.85	646.5	2.5	1.65	84.5
SPIKE ADDED	2.27	454	2.27	6.81	11.35	454	2.27	2.27	227
SPIKE RECOVERED	2.3	528	2.53	6.95	12.35	530	2.38	2.37	239
% RECOVERY	1	116	111	102	109	117	105	104	105

QA for 1997 Metals Analysis

Percent Solids								
sample #	4352	4345	4351	4361	4393	4398	4533	4369
VALUE 1	14.22	11.04	14.17	12.55	10.91	16.66	10.46	15.72
VALUE2	14.17	11.27	14.12	12.56	10.98	16.75	10.43	15.66
MEAN	14.195	11.155	14.145	12.555	10.945	16.705	10.445	15.69
sample #	4386	4378	4367	4365				
VALUE 1	13.74	10.2	6.46	5.98				
VALUE 2	13.72	10.08	6.61	5.84				
MEAN	13.73	10.14	6.535	5.91				