EVALUATION OF GULFWATCH 1999:

NINETH YEAR OF THE GULF OF MAINE ENVIRONMENTAL MONITORING PLAN

May 2002

Prepared by:

The Gulf of Maine Council on the Marine Environment

Gulf of Maine Council on the Marine Environment

EVALUATION OF GULFWATCH 1999:

NINETH YEAR OF THE GULF OF MAINE ENVIRONMENTAL MONITORING PLAN

Prepared for
Gulf of Maine Council on the Marine Environment
May 2002

By: Margo Chase[1], Stephen Jones[1], Peter Hennigar[2], John Sowles[3], Gareth Harding[4], Peter Vass[4], Christian Krafhforst[5], Natalie Landry[6], Peter Wells[2], Jack Schwartz[7], Guy Brun[2], Darrell Taylor[8], Bruce Thorpe[9], Marc Bernier[2], Mireille Savoie[2] and Bob Crawford[4]

[1]University of New Hampshire

[2]Environment Canada

[3]Maine Department of Environmental Protection

[4]Department of Fisheries and Oceans

[5]Massachusetts Coastal Zone Management

[6]New Hampshire Department of Environmental Services

[7]Massachusetts Division of Marine Fisheries

[8]Nova Scotia Department of the Environment and Labour

[9]New Brunswick Department of Fisheries and Aquaculture

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 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 productivity of seaweed, salt marsh grasses, and phytoplankton make it one of the world's most productive ecosystems that supports a vast array of animal species, including some of great commercial importance. Commercial fisheries are its principal income generating enterprises. Tourism is also a significant source of income to coastal communities and marine aquaculture is rapidly expanding. Increases in coastal populations and industrial and residential development have contributed to the deteriorating quality of sections of the Gulf's coastal environment (Crawford and Sowles 1992, Dow and Braasch 1996). One important factor is the steady input of toxic chemicals, either mobilized or synthesized by man, into the estuarine and coastal environments, despite efforts to improve pollution treatment. Many human-made 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 on productivity, reproduction and survival of marine organisms and humans (Kawaguchi et al. 1999, Wells and Rolston 1991).

To protect water quality and commercial uses in the Gulf of Maine, the *Agreement on the Conservation of the Marine Environment of the Gulf of Maine* was signed in December 1989 by the premiers of Nova Scotia and New Brunswick and the governors of Maine, New Hampshire and Massachusetts establishing the Gulf of Maine Council on the Marine Environment. The overarching mission of this council is to maintain and enhance the Gulf's marine ecosystem, its natural resources and environmental quality. To help meet the council's mission statement, The Gulf of Maine Environmental Monitoring Committee was formed and charged with the development of the Gulf of Maine Environmental Monitoring Plan. The monitoring plan is based on a mission statement provided by the council:

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

Three monitoring goals were established to meet the mission statement:

(1) To provide information on the status, trends, and sources of risk to the marine environment in the Gulf of Maine;

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

In support of the mission and as a first step towards meeting the desired goals, a project named Gulfwatch was established to measure chemical contamination Gulfwide (Barchard and Johnson-Hayden, 1990; Barchard, 1991)

1.2 Gulfwatch Objectives

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

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

Throughout the history of the program, Gulfwatch has taken different approaches to using mussels as bioindicators of anthropogenic contamination. During the first two years of the program (1991 & 1992), both transplanted and native mussels sampled from areas adjacent to the transplant sites were analyzed for organic and inorganic contaminants (GOMC, 1992). Transplanted mussels were initially collected from relatively pristine sites in each jurisdiction, moved to sites selected for monitoring and held there for approximately 60 days. Because of the logistics and the analytical costs, however, only two sites per jurisdiction could be monitored each year using this transplant technique. Transplant provided an assessment of the short-term exposure (on the order of weeks to months) to bioavailable contaminants throughout the region whereas sampling of native mussels provided an assessment of long-term exposure to bioavailable contaminants (on the order of months to a year). It was therefore decided to design a sampling program, which included transplant experiments to assess short-term exposure. However, in order to assess the degree and extent of contamination in the Gulf of Maine many sites need to be monitored throughout the Gulf of Maine. As such a sampling scheme involving a three-year rotation of sites (see below) was implemented in 1993 and continued until 1998. In 1996, a five-year review of the program assessed the feasibility of continuing transplant studies (Jones et al., 1998). Considering the cost of performing transplant experiments, the low rate of return, missing data, and the complications with the interpretation of the data it was decided that (at least for the present) transplant studies would be abandoned. As such for 1998 additional (previously unsampled) sites were added to the program to increase the coverage in certain areas of concern. New sample sites were established in New Hampshire and New Brunswick. Sampling of the New Hampshire sites was in conjunction with the New Hampshire Gulfwatch program. The New Brunswick sites were located in the Saint John Harbour, a region of concern for environmental contaminants. Additional sampling of New Hampshire site continued for the 1999 sampling season. Associations with such programs are advantageous to the Gulfwatch program and serve to highlight the usefulness of such an endeavor.

In addition to documenting the level of contaminants in mussel tissue, biological variables, including shell growth and condition index, were measured as a means to determine the response of organisms to stress under different concentrations of contaminant burden. Growth is often one of the most sensitive measures of the effect of a contaminant on an organism (Sheehan, 1984; Sheehan et al., 1984; Howells et al., 1990). Shell growth has often been used as a measure of environmental quality and pollution effects as the rate of growth is a fundamental measure of physiological fitness/performance (Widdows and Donkin, 1992; Salazar and Salazar, 1995) and therefore is a direct, integrative measure of the impairment of the organisms physiology. Condition index (CI) was used as an indicator of the physiological status of the mussels. It relates the tissue wet weight to shell volume and is a measure traditionally used by shellfishery biologists (Widdows, 1985). Because gonadal weight is a significant contributor to total body weight just prior to spawning, CI also reflects differences in the reproductive state of 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). Granby and Spliid (1995) found a significant negative correlation between PAHs and CI but no correlation between PCB or DDE concentration and CI. Regardless, the relationship between CI and contaminant concentrations must be carefully considered.

The objective of the first two years (1991 and 1992) of the Gulfwatch program was to evaluate the feasibility of the project and the level of co-operation required through collecting comparative data from different locations in the Gulf of Maine. The sites that were selected fell into two categories; test sites that were suspected or known to be contaminated and reference sites that were free of any known contaminant source. After the success of the pilot studies in 1991 and 1992, it was recognised that there should be a broader or Gulf-wide orientation of the mussel watch monitoring in addition to known contaminated and reference sites within each jurisdiction. As such, a three-year sampling cycle was initiated in 1993. In the first two years of the three-year cycle, only indigenous mussels were sampled. In 1993 and 1994 as many as 7 additional locations within each jurisdiction (state or province) where feasible, were sampled to increase the geographic coverage. However, one location in each jurisdiction was chosen as a benchmark station to be resampled every year. This broader geographic coverage increased the chance of locating unforeseen environmental contamination. In the third year of the three-year cycle transplant experiments are conducted at two sites in each jurisdiction. 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, was to be repeated for the remaining years of the Gulfwatch Program to allow for the assessment of both short-term and long-term contaminant exposure. However, as mentioned above the discontinuation of the transplant study in 1998 has allowed for expansion of study sites within select regions of concern in two jurisdictions in 1998 and 1999.

2.0 METHODS

2.1 1999 Sampling Locations

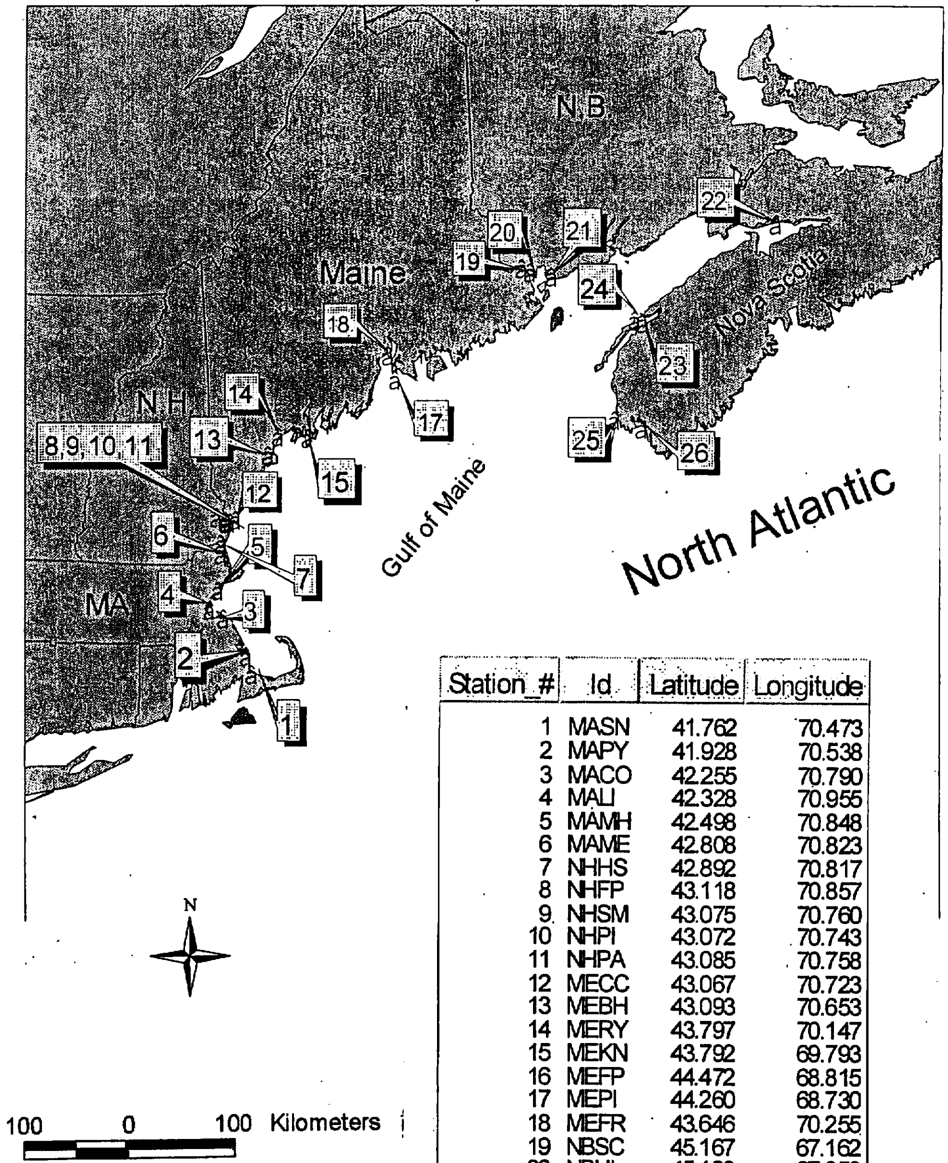
The 1999 Gulf of Maine mussel survey is the seventh year of the nine year sampling design (see Sowles et al., 1997). The 1999 sampling represents the first year of the third 3-year cycle. As such, some stations that were sampled in 1999 were the same stations sampled in 1993 and 1996. Therefore, in addition to spatial analysis, temporal analysis can be performed on the contaminant concentrations for comparable sites. In addition to repeating the sites sampled in 1993 and 1996, four sites were sampled in New Hampshire: Fox Point (NHFP), South Mill Pond (NHSM), Pierce Island (NHPI), New Hampshire Port Authority (NHPA) and one in Maine: Fore River, Portland Harbour (MEFR). The New Hampshire sites are sampled as part of the New Hampshire Gulfwatch Program and were included to provide a more comprehensive assessment of toxic contaminant exposure, especially oil, to biota in New Hampshire estuarine waters. The stations sampled in 1999 are presented in Table 1 with reference to site numbers in Fig. 1.

TABLE 1.

Gulf of Maine Gulfwatch study site locations sampled in 1999. Number refers to site location in Figure 1.

CODE	LOCATION	LATITUDE	LONGITUDE
1 - MASN	Sandwich, MA	41°45.7'N	70°28.38'W
2 - MAPY	Manomet Point, Plymouth, MA	41°55.7'N	70°32.3'W
3 - MACO	Cohasset, MA	42°15.3'N	70°47.4'W
4 - MALI	Long Island, MA	42°19.7'N	70°57.3'W
5 - MAMH	Marblehead, MA	42°29.9'N	70°50.9'W
6 - MAME	Merrimack River, MA	42°48.5'N	70°49.4'W
7 - NHHS	Hampton / Seabrook Estuary, NH	42°53.5'N	70°49.0'W
8 - NHFP	Fox Point, NH	43°07.1'N	70°51.4'W
9 - NHSM	South Mill Pond, NH	43°04.5'N	70°45.6'W
10 - NHPI	Pierce Island, NH	43°04.3'N	70°44.6'W
11 - NHPA	NH Port Authority	43°05.1'N	70°45.5'W
12 - MECC	Clarks Cove, ME	43°04.0'N	70°43.4'W
13 - MEBH	Brave Boat Harbor, ME	43°05.6'N	70°39.2'W
14 - MERY	Royal River, ME	43°47.8'N	70°08.8'W
14 - MEKN	Kennebec River, ME	43°47.5'N	69°47.6'W
16 - MEFP	Fort Point, Penobscot River ME	44°28.3'N	68°48.9'W
17 - MEPI	Pickering Island, ME	44°15.6'N	68°43.8'W
18 - MEFR	Fore River, ME	43°38.8'N	70°15.3'W
19 - NBSC	St. Croix River, NB	45°10.0'N	67°09.7'W
20 - NBHI	Hospital Island, NB	45°07.4'N	67°03.2'W
21 - NBLN	Letang Estuary, NB	45°04.6'N	66°48.0'W
22 - NSFI	Five Islands, NS	45°23.7'N	64°04.02'W
23 - NSDI	Digby, NS	44°38.1'N	65°44.7'W
24 - NSBC	Broad Cove, NS	44°40.1'N	65°49.8'W
25 - NSAG	Argyle, NS	43°44.3'N	66°08.6'W
26 - NSYR	Yarmouth, NS	43°49.1'N	65°50.6'W

Figure 1. Gulfwatch site locations sampled in 1999.



Station_#	Id	Latitude	Longitude
1	MASN	41.762	70.473
2	MAPY	41.928	70.538
3	MACO	42.255	70.790
4	MALI	42.328	70.955
5	MAMH	42.498	70.848
6	MAME	42.808	70.823
7	NHHS	42.892	70.817
8	NHFP	43.118	70.857
9	NHSM	43.075	70.760
10	NHPI	43.072	70.743
11	NHPA	43.085	70.758
12	MECC	43.067	70.723
13	MEBH	43.093	70.653
14	MERY	43.797	70.147
15	MEKN	43.792	69.793
16	MEFP	44.472	68.815
17	MEPI	44.260	68.730
18	MEFR	43.646	70.255
19	NBSC	45.167	67.162
20	NBHI	45.123	67.053
21	NBLN	45.077	66.800
22	NSFI	45.395	64.067
23	NSDI	44.635	65.745
24	NSBC	44.668	65.830
25	NSYR	43.818	66.143
26	NSAG	43.739	65.844

2.2 Field and Laboratory Procedures

Details regarding the mussel collection, measurement, and sample preparation are published in Sowles et al. (1997). Gulfwatch attempts to control confounding variables by collecting organisms within a specific size range, at the same site, at similar tidal levels and in early fall, after major spawning has occurred. Details regarding the field procedures, including mussel collection, measurement and sample preparation, for the Gulfwatch program are published in Sowles et al. (1997) and summarised below.

The mussels collected were intended to be *Mytilus edulis*. However, a related species, *Mytilus trossulus*, was identified in some Bay of Fundy samples (Mucklow, 1996). Gulfwatch results could be confounded by inadvertent selection, by field personnel, of the wrong species. To alleviate this problem, a description of *M. edulis* was developed for the Gulfwatch program using shell criteria such as length:height ratio, internal color, weight, and location and size of the adductor scars (Jones et al., 1998).

Field sampling occurred between mid-September and mid-November. Mussels were collected from four discrete areas within a segment of the shoreline that is representative of local water quality. Using a polycarbonate gauge or a ruler, four replicates of 45-50 mussels of 50-60 mm shell length were collected at each location. The mussels were placed in containers, then transported to the lab in coolers with ice packs. They were not depurated prior to processing.

From each replicate, 20 mussels were analysed for trace metals and 20 for organic contaminants. Mussels were washed in the laboratory to remove any external growth, sediment and debris and excess seawater was drained from their mantles. The mussels were then measured for length (anterior umbo to posterior growing lip), height (distance dorsal-ventral) and maximum width to the nearest 0.1mm. A subset of mussels (10) used for metal analysis were shucked and weighed altogether wet (±0.1g) for reporting contaminant concentrations and for calculation of a condition index. Condition index was calculated using the following formula (after Seed, 1968):

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

All samples for trace metal and organic contaminant analysis were placed in pre-cleaned or quality assured bottles (Sowles et al., 1997). These composite samples (20 mussels/composite; 4 composites/station) were capped, labelled and stored at -15°C for 3-6 months prior to analysis.

2.3 Analytical Procedures

Analytical procedures used followed those reported for the previous years (Jones et al. 1998). Table 2 contains a summary of trace metal and organic compounds measured.

2.3.1 Metals

Inorganic contaminants were analyzed at the State of Maine Department of Health and Environmental Testing Laboratory (Orono, ME). Analyses for mercury were conducted on a sub-sample 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 analyzed 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.

2.3.2 Organics

Organic contaminants in mussel samples were analyzed at the Environment Canada Environmental Quality Laboratory in Moncton, New Brunswick. The analyte detection limits ranged from 3.6-12.6 ng/g for aromatic hydrocarbons, from 0.7-2.8 ng/g for PCB congeners, and from 0.9- 2.0 ng/g for chlorinated pesticides (Jones et al., 1998). 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 in the U.S.A. Other organic compounds selected for analysis are also consistent, for the most part, with NOAA National Status and Trends mussel monitoring (NOAA, 1989).

A description of the full analytical protocol and accompanying performance based QA/QC procedures are found in Sowles et al. (1997), and more comprehensively in Jones et al. (1998). Tissue samples were extracted by homogenization with an organic solvent and a drying agent. Solvent extracts were obtained by vacuum filtration, and biomatrix interference was separated from target analytes in extracts 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).

Table 2.
Inorganic and organic compounds analyzed in mussel tissue from the Gulf of Maine in 1999.

INORGANIC CONTAMINANTS

Metals

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

ORGANIC CONTAMINANTS

Aromatic Hydrocarbons

Naphthalene
1-Methylnaphthalene
2-Methylnaphthalene
Biphenyl
2,6-Dimethylnaphthalene
Acenaphthylene
Acenaphthalene
2,3,5-Trimethylnaphthalene
Fluorene
Phenanthrene
Anthracene
1-Methylphenanthrene
Fluoranthene
Pyrene
Benzo [a] anthracene
Chrysene
Benzo [b] fluoranthene
Benzo [k] fluoranthene
Benzo [e] pyrene
Benzo [a] pyrene
Perylene
Indo [1,2,3-cd] pyrene
Dibenze [a,h] anthracene
Benzo [g,h,I] perylene

Chlorinated Pesticides

Hexachlorobenzene (HCB)
gamma-Benzenehexachloride (BHC)
Heptachlor
Heptachlor epoxide
Aldrin
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

2.4 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 laboratory quality control followed by the Moncton laboratory for the analysis of organic contaminants in mussel samples are in the Environment Canada Shellfish Surveillance Protocol (Dumouchel & Hennigar, 1995). The guidelines specify mandatory QC measures that are incorporated with each analytical sample batch including method blanks, spike matrix samples, duplicate samples, sample surrogate addition, and the analysis of certified reference materials (SRM 1974A). The guidelines also specify performance criteria related to method accuracy and precision, detection limits and data reporting for the analysis of organic contaminants in shellfish samples. The Moncton laboratory's QC sample results for the analyses of the 1999 Gulfwatch samples can be obtained upon request from the authors Peter Hennigar and/or Guy Brun. The laboratory also participates annually in the NIST/NOAA NS&T EMAP Intercomparison Exercise Program for Organic Contaminants in the Marine Environment.

2.5 Statistical Methods

2.5.1 Data Analysis

Total PAH (ΣPAH_{24}), total PCB (ΣPCB_{24}) and total pesticides ($\Sigma TPEST_{17}$) values were calculated 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 2,4-DDT and 4,4-DDT and homologues (2,4-DDE, 4,4-DDE, 2,4-DDD and 4,4-DDD). Several tissue samples for metals and organics were below the detection level. Variables in which all replicate measurements were below the detection limit were treated as zero and recorded as not-detected (ND). However, if at least one of the replicates was greater than the detection limit, then the other replicates were recorded as 1/2 the detection limit.

For statistical analysis, all metal data, with the exception of Ag and Ni, were $\log_{10}$ transformed to correct for heterogeneity of variances whereas all organic contaminant data, Ag and Ni were $\log_{10}(x+1)$ transformed.

2.5.2 Spatial Analysis

At each site, arithmetic means and standard deviations (SD) were calculated for all metal and organic contaminants. Arithmetic means were calculated since, with a few exceptions, metals and organics at each station were normally distributed as demonstrated by applying Kolmogorov-Smorov test using p=0.05 (SAS, 1990). Medians (MD) and MD + PC85 (defined as the 85^{th} percentile) were calculated for both Gulfwide comparisons and National NS&T intercomparisons of mussel contaminants. Electronic files of the NS&T contaminant data for 1991 to 1996 were downloaded from the following Internet address: http://ccmaserver.nos.noaa.gov/. Although medians were calculated for each year, only 1991 values were used as the basis of comparison to the Gulfwatch results as it was the most recent year with a large number of stations reported (n=190). Graphs of the mean concentrations (±SD) are presented for all stations sampled. Differences in metal and organic contaminant concentrations among Gulfwatch sites within each jurisdiction were analysed by 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 interpretive purposes, Clark Cove, Maine (MECC) is grouped with the New Hampshire sites because it is located in the Great Bay / Piscataqua River watershed, and therefore more comparable to other sites in New Hampshire.

2.5.3 Temporal Analysis

The following "benchmark" sites (Sandwich, MA (MASN), Clarks Cove, ME (MECC), Kennebec River, ME (MEKN), Hospital Island, N.B. (NBHI), Digby, N.S. (NSDI)) were sampled in consecutive years (1993-1999). Tissue contamination concentrations at these sites were analyzed for temporal trends using a Generalised Linear Model (GLM) with the variables being site, year and their interaction term. In addition to looking for whether the pattern in contaminant (metal and organic) concentration was the same among sites, within-site models were performed to assess whether there were significant relationships between contaminant concentration and time (SAS, 1990).

The 1999 tissue contamination values of twenty-one other Gulfwatch sites were compared to the values analyzed at these sites in 1993 and 1996 (GOMC, 1996; GOMC, 1997). These comparisons between years at each site were done with a Generalised Linear Model (GLM). Stations with data available for only 2 years were compared using a one-way Analysis of Variance (ANOVA). This includes all analysis of mercury concentrations. In 1993 there were problems with variable mercury results and the accuracy of the measurements were questioned (GOMC, 1996). As such, the concentrations from 1993 were not used in the analysis. For all statistical tests, a probability of < 0.05 was chosen as the level of significance.

3.0 RESULTS AND DISCUSSION

3.1 Field Operations and Logistics

Field collections proceeded as planned to revisit the stations sampled in 1993 and 1996, with four additional sites sampled in New Hampshire and one in Maine.

3.2 Spatial Variation in Contaminant Concentration

Table 3 contains the metal concentrations (arithmetic mean ± SD, μg/g dry weight) for mussels from all site composite (n=4) samples in 1999. Metal concentrations for each of the composite samples are provided in Appendix A. Overall metal concentrations for indigenous mussels are given as medians (MD) and MD + PC85 (Table 3) to allow for both a Gulfwide comparison and a comparison with NOAA National Status and Trends concentrations (Table 4). Table 4 compares our overall 1999 Gulfwatch values for MD and MD + PC85 with the 1991 to 1996 NS&T Mussel Watch data (O'Connor, 1998; http://ccmaserver.nos.noaa.gov/). Although the NS&T data was summarized for years 1991 to 1996, only data from 1991 was used for comparison to Gulfwatch results. Trace metals were detected at all Gulfwatch sites except for Ag, which was below the detection limit (0.1 μg/g dry weight) at 10 of the 26 sites. Using the NS&T MD + PC85 value as a measure of elevated concentrations, 2 sites exceeded the Ag value, 3 sites exceeded the Cr value, 24 sites exceeded the Hg value, 5 sites exceeded the Pb value, 1 site exceeded the Al value and 1 site exceeded the Fe value. Trace metals for which a few sites exceeded the NS&T MD + PC85 value suggests localized sources of these contaminants at those sites. Thus localized sources of Ag, Cr, Pb, Al and Fe are indicated in the Gulf of Maine, with a more widespread prevalence of Hg contamination suggesting a more regional source.

TABLE 3.

Tissue metal concentrations (arithmetic mean ± SD,]g.g^{-1} dry weight) from mussels collected throughout the Gulf of Maine in 1999 and ANOVA of concentrations by jurisdiction. Same letter indicates no significant difference among sites within each jurisdiction. ND = not detected. MD (PC85) = Median (85 percentile)

Station	Ag	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Al	Fe
MASN	1.01 ± 0.76^{A}	1.5 ± 0.30^{BC}	0.80 ± 0.10^{C}	6.3 ± 1.0^{AB}	2.0 ± 0.7^{C}	0.26 ± 0.02^{B}	0.60 ± 0.10^{C}	70 ± 10^{C}	66 ± 13^{D}	143 ± 22^{D}
MAPY	0.35 ± 0.13^{A}	1.2 ± 0.10^{C}	1.0 ± 0.10^{C}	5.8 ± 0.10^{B}	1.8 ± 0.3^{C}	0.36 ± 0.05^{AB}	0.90 ± 0.10^{AB}	83 ± 6^{BC}	88 ± 9^{CD}	208 ± 15^{C}
MACO	0.43 ± 0.26^{A}	1.2 ± 0.10^{C}	1.4 ± 0.20^{B}	6.6 ± 0.9^{AB}	3.3 ± 0.7^{B}	0.47 ± 0.12^{A}	0.80 ± 0.20^{BC}	116 ± 30^{AB}	125 ± 25^{BC}	263 ± 45^{BC}
MALI	0.23 ± 0.05^{B}	1.7 ± 0.1^{B}	1.9 ± 0.2^{A}	7.6 ± 0.8^{AB}	5.9 ± 0.5^{A}	0.40 ± 0.09^{AB}	1.0 ± 0.2^{AB}	163 ± 26^{A}	153 ± 24^{AB}	293 ± 66^{BC}
MAMH	0.13 ± 0.05^{B}	1.7 ± 0.20^{B}	1.9 ± 0.2^{A}	6.8 ± 1.0^{AB}	2.5 ± 0.4^{BC}	0.47 ± 0.05^{A}	1.2 ± 0.2^{A}	120 ± 19^{AB}	215 ± 31^{A}	430 ± 49^{A}
MAME	0.1 ± 0.0^{B}	2.6 ± 0.6^{A}	1.8 ± 0.15^{AB}	7.8 ± 0.7^{A}	2.9 ± 0.3^{BC}	0.46 ± 0.09^{A}	1.0 ± 0.1^{AB}	85 ± 8^{BC}	107 ± 6^{B}	313 ± 6^{AB}
NHHS	ND^{B}	2.0 ± 0.3^{A}	1.3 ± 0.1^{D}	7.6 ± 0.3^{AB}	2.6 ± 0.7^{D}	0.38 ± 0.03^{B}	1.2 ± 0.2^{A}	113 ± 20^{AB}	170 ± 14^{C}	258 ± 13^{C}
NHFP	0.1 ± 0.1^{A}	2.3 ± 0.3^{A}	2.6 ± 0.2^{AB}	7.3 ± 0.2^{AB}	2.8 ± 0.6^{DC}	0.70 ± 0.02^{A}	1.5 ± 0.10^{A}	128 ± 25^{AB}	285 ± 17^{A}	430 ± 26^{A}
NHSM	ND^{B}	1.0 ± 0.1^{C}	2.8 ± 0.3^{A}	6.9 ± 0.3^{C}	4.5 ± 0.4^{AB}	0.77 ± 0.11^{A}	1.8 ± 1.1^{A}	61 ± 4^{C}	238 ± 25^{AB}	430 ± 42^{A}
NHPI	ND^{B}	2.4 ± 0.3^{A}	3.1 ± 0.5^{A}	8.2 ± 0.7^{A}	4.9 ± 0.9^{A}	0.67 ± 0.15^{A}	1.4 ± 0.1^{A}	150 ± 22^{A}	200 ± 51^{BC}	383 ± 86^{AB}
NHPA	ND^{B}	1.9 ± 0.2^{A}	2.1 ± 0.1^{BC}	7.8 ± 0.4^{AB}	3.0 ± 0.6^{BCD}	0.71 ± 0.11^{A}	1.6 ± 0.2^{A}	125 ± 6^{AB}	210 ± 18^{ABC}	310 ± 16^{BC}
MECC	ND^{B}	1.4 ± 0.1^{B}	1.9 ± 0.1^{C}	7.0 ± 0.5^{BC}	4.1 ± 0.5^{ABC}	0.56 ± 0.07^{A}	1.3 ± 0.1^{A}	107 ± 14^{B}	198 ± 30^{BC}	325 ± 33^{BC}
MEBH	0.2 ± 0.0^{A}	1.5 ± 0.1^{BC}	1.2 ± 0.3^{A}	5.7 ± 0.1^{B}	1.5 ± 0.3^{B}	0.39 ± 0.05^{C}	1.3 ± 0.5^{A}	$80\pm\cap3^{B}$	141 ± 61^{BC}	210 ± 37^{CD}
MERY	ND^{C}	1.3 ± 0.1^{C}	1.2 ± 0.2^{A}	7.7 ± 1.1^{AB}	1.3 ± 0.1^{B}	0.54 ± 0.05^{B}	1.1 ± 0.3^{A}	83 ± 9^{B}	228 ± 46^{AB}	385 ± 62^{AB}
MEKN	0.1 ± 0.0^{B}	2.3 ± 0.2^{A}	$3:1\pm2.7^{A}$	9.0 ± 1.6^{A}	1.2 ± 0.1^{B}	0.53 ± 0.02^{BC}	0.9 ± 0.1^{A}	63 ± 3^{B}	96 ± 19^{C}	185 ± 56^{CD}
MEFP	0.06 ± 0.03^{B}	1.4 ± 0.3^{C}	1.2 ± 0.3^{A}	6.4 ± 1.0^{B}	1.1 ± 0.2^{B}	0.57 ± 0.12^{B}	0.9 ± 0.3^{A}	69 ± 10^{B}	118 ± 26^{BC}	278 ± 63^{BC}
MEPI	0.08 ± 0.03^{B}	1.7 ± 0.2^{ABC}	1.1 ± 0.2^{A}	5.7 ± 0.3^{B}	0.6 ± 0.1^{C}	0.56 ± 0.13^{B}	0.8 ± 0.1^{A}	71 ± 8^{B}	75 ± 15^{C}	135 ± 17^{D}
MEFR	0.08 ± 0.03^{B}	1.9 ± 0.3^{AB}	1.6 ± 0.4^{A}	7.4 ± 1.4^{AB}	5.8 ± 1.7^{A}	0.98 ± 0.13^{A}	1.4 ± 0.3^{A}	139 ± 39^{A}	323 ± 132^{A}	548 ± 196^{A}

TABLE 3.

Tissue metal concentrations (arithmetic mean ± SD, μg.g^{-1} dry weight) from mussels collected throughout the Gulf of Maine in 1999 and ANOVA of concentrations by jurisdiction. Same letter indicates no significant difference among sites within each jurisdiction. ND = not detected. MD (PC85) = Median (85 percentile)

Station	Ag	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Al	Fe
NBSC	0.06 ± 0.03^{A}	1.2 ± 0.1^{A}	1.0 ± 0.1^{A}	4.6 ± 0.2^{B}	2.4 ± 0.5^{A}	0.27 ± 0.02^{A}	0.8 ± 0.1^{A}	62 ± 2^{AB}	238 ± 21^{A}	328 ± 15^{A}
NBHI	ND^{B}	0.7 ± 0.1^{B}	0.5 ± 0.0^{C}	4.1 ± 0.3^{B}	0.5 ± 0.1^{C}	0.17 ± 0.01^{C}	0.7 ± 0.1^{B}	55 ± 5^{B}	88 ± 9^{C}	115 ± 6^{C}
NBLN	ND^{B}	1.0 ± 0.1^{A}	0.8 ± 0.1^{B}	5.8 ± 0.5^{A}	1.0 ± 0.2^{B}	0.23 ± 0.02^{B}	0.6 ± 0.1^{B}	63 ± 3^{A}	175 ± 31^{B}	253 ± 13^{B}
NSFI	ND^{B}	2.5 ± 0.3^{A}	1.8 ± 0.4^{A}	5.3 ± 0.6^{AB}	1.1 ± 0.3^{B}	0.41 ± 0.07^{AB}	2.0 ± 0.4^{A}	69 ± 11^{A}	690 ± 180^{A}	878 ± 216^{A}
NSDI	ND^{B}	1.1 ± 0.2^{C}	0.9 ± 0.1^{C}	6.7 ± 0.4^{A}	1.9 ± 0.4^{BA}	0.30 ± 0.05^{C}	0.9 ± 0.1^{B}	72 ± 7^{A}	198 ± 19^{B}	290 ± 29^{B}
NSBC	0.10 ± 0.0^{B}	2.5 ± 0.4^{A}	1.9 ± 0.1^{A}	5.7 ± 0.2^{AB}	2.0 ± 1.1^{BA}	0.40 ± 0.06^{B}	1.4 ± 0.7^{AB}	74 ± 22^{A}	243 ± 108^{B}	365 ± 182^{B}
NSYR	0.58 ± 0.15^{A}	1.5 ± 0.1^{B}	1.6 ± 0.3^{AB}	6.4 ± 0.7^{AB}	2.4 ± 0.2^{AB}	0.40 ± 0.02^{B}	1.5 ± 0.2^{AB}	87 ± 10^{A}	280 ± 104^{B}	478 ± 95^{AB}
NSAG	0.09 ± 0.03^{B}	1.5 ± 0.1^{B}	1.3 ± 0.1^{B}	4.9 ± 1.1^{B}	3.4 ± 0.5^{A}	0.54 ± 0.08^{A}	1.4 ± 0.2^{AB}	86 ± 6^{A}	140 ± 22^{B}	310 ± 34^{B}
MD	**0.05**	**1.50**	**1.50**	**6.50**	**2.30**	**0.45**	**1.00**	**82**	**170**	**310**
PC85	**0.2**	**2.2**	**2.2**	**7.8**	**4.3**	**0.70**	**1.6**	**130**	**270**	**460**

TABLE 4

Comparison of contaminant concentrations (median (MD) and MD + 1SD) of Gulfwatch and NOAA, National Status and Trends (NS&T) Mussel Watch data (O'Connor, 1998; http://ccmaserver.nos.noaa.gov/). Concentrations of metal contaminants are $\mu g.g^{-1}$ dry weight, concentrations of organic contaminants are $ng.g^{-1}$ dry weight.

	GULFWATCH		NS&T											
	1999 (n=26)		1991 (n=190)		1992 (n=131)		1993 (n=169)		1994 (n=135)		1995 (n=148)		1996 (n=118)	
Contaminant	**MD**	**+1SD**	**MD**	**+1SD**	**MD**	**+1SD**	**MD**	**+1SD**	**MD**	**+1SD**	**MD**	**+1SD**	**MD**	**+1SD**
Ag	0.05	0.20	0.08+	0.48+	0.09+	0.55+	0.05+	0.85+	0.12+	0.56+	0.05+	0.76+	NA	NA
Al	170	270	280	653	210	510	120	280	350	1100	480	1577	340	1020
Cd	1.50	2.20	2.33	5.43	2.08	4.46	2.47	4.67	1.97	4.29	2.40	4.39	1.88	4.23
Cr	1.50	2.20	1.43	2.73	1.41	3.50	1.21	2.71	1.16	2.21	1.80	5.18	11.1	3.1
Cu	6.50	7.8	8.83+	11.67+	8.64+	10.11+	8.35+	10.5+	8.69+	10.54+	8.41+	12.62+	7.3+	9.9+
Fe	310	460	400	790	338	690	340	673	350	774	607	1615	424	985
Hg	0.45	0.70	0.11	0.24	0.10	0.23	0.11	0.20	0.10	0.21	0.11	0.23	0.11	0.20
Ni	1.00	1.60	2.07	3.60	2.09	3.85	1.64	2.66	1.46	2.78	1.98	3.46	1.6	3.3
Pb	2.30	4.30	0.77	3.57	0.70	2.30	0.78	2.90	0.99	2.73	0.70	2.36	0.75	2.4
Zn	82	130	130+	200+	120+	170+	120+	200+	120+	170+	115+	169+	102+	148+
ΣPAH	79	342	227	937	233	959	253	1201	210	1291	190	913	274	851
ΣPEST	5.1	23	30	116	37	132	37	131	38	127	31	127	40	126
ΣPCB	46*	128*	26	145	31	186	30	157	39	152	28	207	58	180

*, ΣPCB_{24} calculated as tpcb = tpcbcon x 1.945 + 3.35 (O'Connor, 1998)

+, Median concentrations for Ag, Cu and Zn were calculated for mussels only (O'Connor, 1998)

3.2.1 Metals

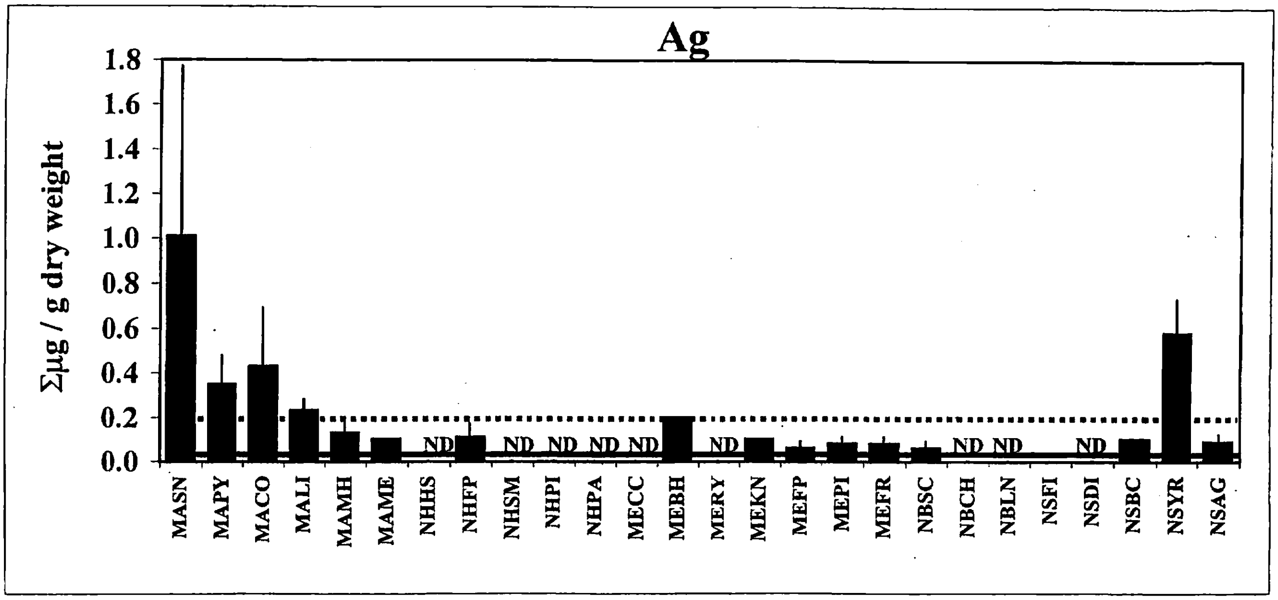
Figures 2 to 6 show the concentration of the metals measured in the tissue of *M. edulis* at the 1999 sampling stations arranged clockwise from south to north. The concentrations of most metals were relatively evenly distributed around the Gulf of Maine (Table 3), with no apparent spatial trends and an occasional hot spot of elevated concentrations.

3.2.1.1 Silver (Ag)

Silver concentrations ranged from below the detection limit (0.1 μg/g dry weight) at ten sites to 1.01 ± 0.76 μg/g DW at Sandwich, MA (MASN) with elevated concentrations in other Massachusetts sites, Brave Boat Harbour, ME (MEBH), and Yarmouth, N.S. (NSYR) (Table 3; Figure 2). The highest concentrations were observed in Massachusetts from Boston Harbor south to Sandwich, and in Nova Scotia around Yarmouth Harbour. Concentrations at these sites exceeded the MD + PC85 of both the Gulfwatch and the NOAA NS&T programs. Elevated concentrations in Nova Scotia may reflect the degree of exposed bedrock along the coast (Wells et al., 1997). In addition to geological sources, elevated silver exposure concentrations have been shown to coincide with regions receiving municipal sewage (Sanudo-Wlhelmy and Flegal, 1992; Buchholz ten Brink et al., 1997). Because of silver's use in the photographic and jewellery industries, the coastal waters of Massachusetts are up to 1000 times more concentrated in Ag than in Gulf of Maine waters (Krahforst and Wallace 1996). The high levels observed at Sandwich, MA (MASN), which is not near any significant source of municipal waste, may be a function of transport and deposition of sewage-derived particles (Bothner et al. 1993) that are sequestered in Cape Cod Bay and taken up by mussels. In contrast, despite the presence of numerous municipal sewage sources in the Great Bay Estuary, Ag was detected in mussels from only the Fox Point site in New Hampshire (NHFP). Ag was detected at elevated levels at MEBH relative to nearby New Hampshire sites in 1993 and 1996 (GOMC 1996 & 1997). The source of Ag is a puzzle because MEBH is a pristine site with no known history of industry and presently it is relatively undeveloped.

3.2.1.7 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 0.70 μg/g dry weight at Hospital Island, N.B. (NBHI) to 2.60 μg/g dry weight at Merrimack River, MA (MAME) (Table 3; Figure 2). Cadmium concentrations were elevated in New Hampshire and some sites in Massachusetts, New Brunswick and Nova Scotia. Six sites exceeded the Gulfwatch MD + PC85 (Merrimack River, MA (MAME), Fox Point, NH (NHFP), Pierce Island, NH (NHPI), Kennebec River, ME (MEKN), Five Islands, N.S. (NSFI), Broad Cove, N.S. (NSBC)), however, none exceeded the NS&T MD + PC85. Mean concentrations of cadmium in mussels (*Mytilus* spp.) from several coastal regions world wide range from approximately 1 to 5 μg/g dry weight (Fowler, 1990).



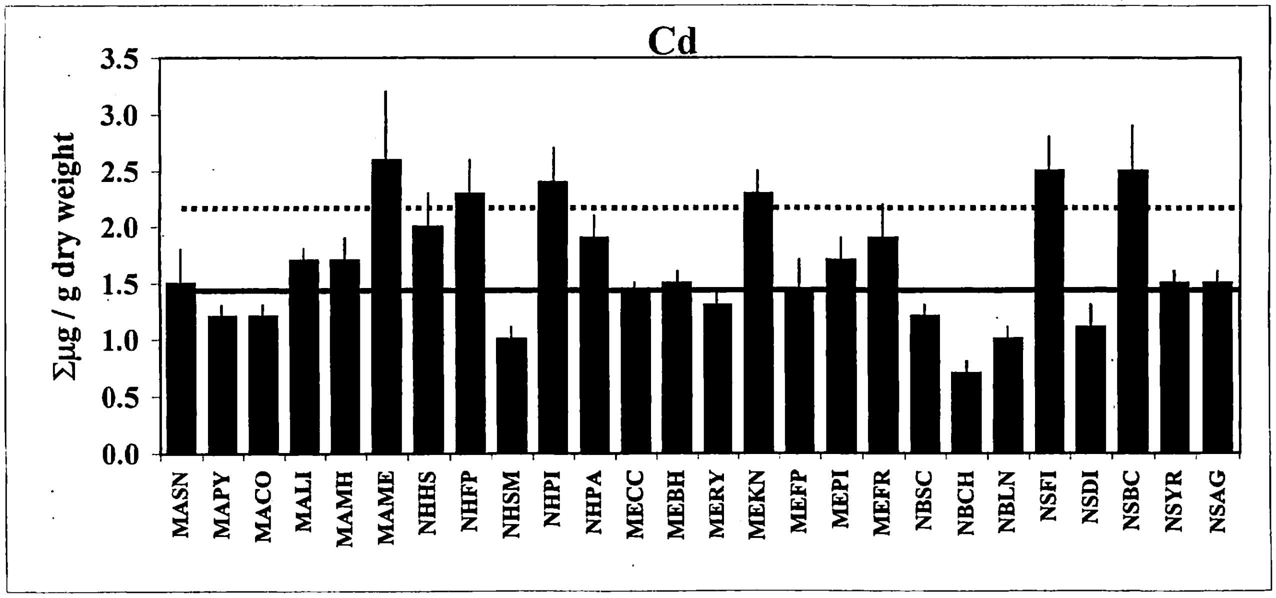


Figure 2. Distribution of silver and cadmium tissue concentrations (arithmetic mean +/- SD, μg/g dry weight) in mussels at the Gulf of Maine Stations in 1999. The median (solid line) and median + PC85 (dotted line) are shown for comparison. ND=Not Detected.

3.2.1.3 Chromium (Cr)

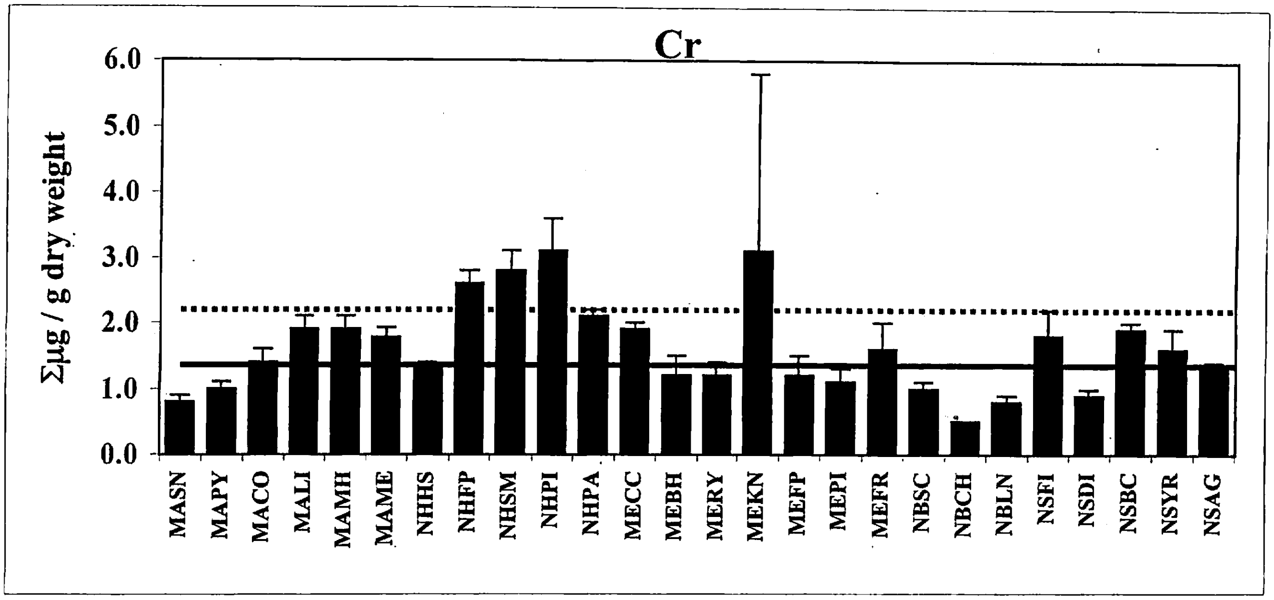
Chromium concentrations at Fox Point, NH (NHFP) exceeded the Gulfwatch MD + PC85 (Table 3; Figure 3). However, 3 sites exceeded both the Gulfwatch MD + PC85 and the NS&T MD + PC85 (South Mill Pond, NH (NHSM), Pierce Island, NH (NHPI), Kennebec River, ME (MEKN)). The lowest concentration was at Hospital Island, N.B. (NBHI) (0.50 µg/g dry weight) and the highest at Pierce Island, NH (NHPI) and Kennebec River, ME (MEKN) (3.1 µg/g dry weight). Chromium is the primary agent used in the tanning process and was discharged with untreated tannery wastes throughout much of this century. Chromium persists in the environment as shown by elevated concentrations in the sediments near such sources (Capuzzo, 1974; NCCOSC, 1997). During the 19^{th} and 20^{th} centuries, coastal New Hampshire was one of the hide tanning centres of the United States. Other tannery centres were located in Salem, MA and on the Saco River, ME (Capuzzo, 1996). High Cr was also observed in the sediments of the Gulf of Maine by other studies (Mayer and Fink, 1990).

3.2.1.8 Copper (Cu)

The concentration of copper in mussel tissue ranged from 4.1 µg/g dry weight at Hospital Island, N.B. (NBHI) to 9.0 µg/g dry weight at Kennebec River, ME (MEKN) (Table 3; Figure 3). Four sites exceeded the Gulfwatch MD + PC85 (Merrimack River, MA (MAME), Fox Point, NH (NHFP), Pierce Island, NH (NHPI), Kennebec River, ME (MEKN)), however, none exceeded the NS&T MD + PC85.

3.2.1.6 Mercury (Hg)

The concentration of mercury in mussel tissue ranged from a value of 0.17 µg/g dry weight at Hospital Island, N.B. (NBHI) to 0.98 ± 0.13 µg/g at Fore River, ME MEFR (Table 3; Figure 4). Only four sites exceeded the Gulfwatch MD + PC85 (Fox Point, NH (NHFP), South Mill Pond, NH (NHSM), NH Port Authority (NHPA), Fore River, ME (MEFR)), however, mercury values exceeded the NS&T MD + PC85 of 0.24 µg/g dry weight at 24 of the 26 sites. In general, the mussel mercury level at New Hampshire sites, followed by Maine, are higher than sites in other jurisdictions. There are several known historical mercury sources in the New Hampshire Seacoast, including some that are suspected to be related to the Portsmouth Naval Shipyard (NCCOSC, 1997). Analysis of the mussel tissue concentrations of Hg revealed that there was a significant difference in Hg concentrations between Hampton / Seabrook Estuary, NH (NHHS) and all other New Hampshire sites. This site has typically had lower levels of contaminants compared to other Great Bay areas (GOMC, 1997). Mean values of Hg in *Mytilus* spp. from coastal regions world-wide range from 0.1 to



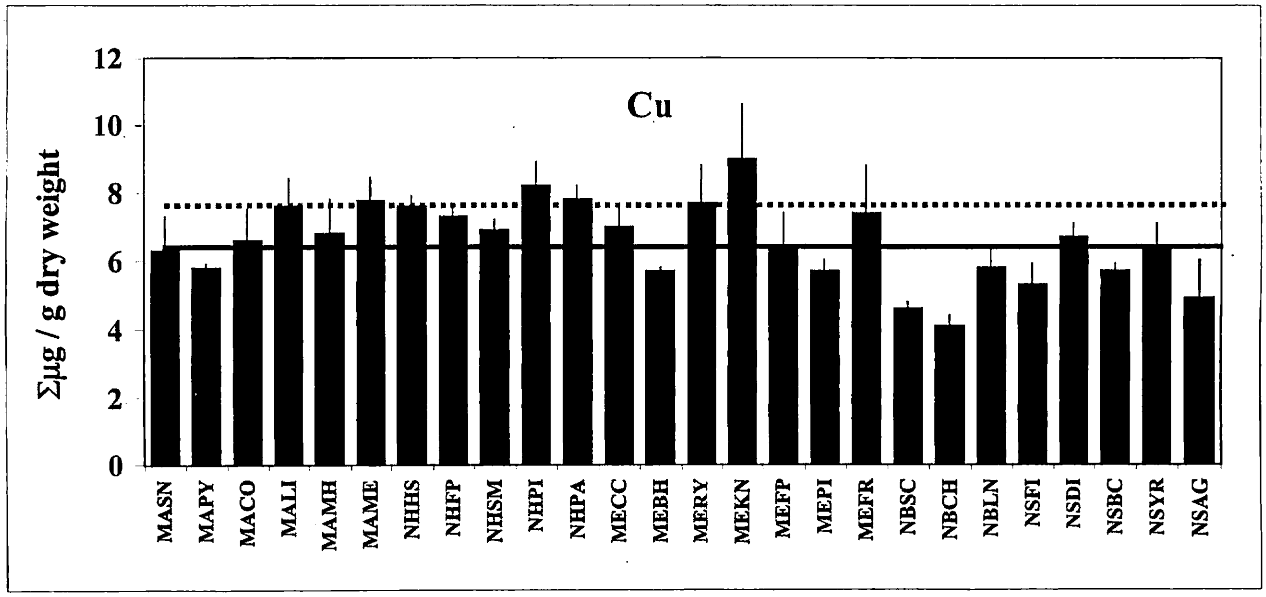
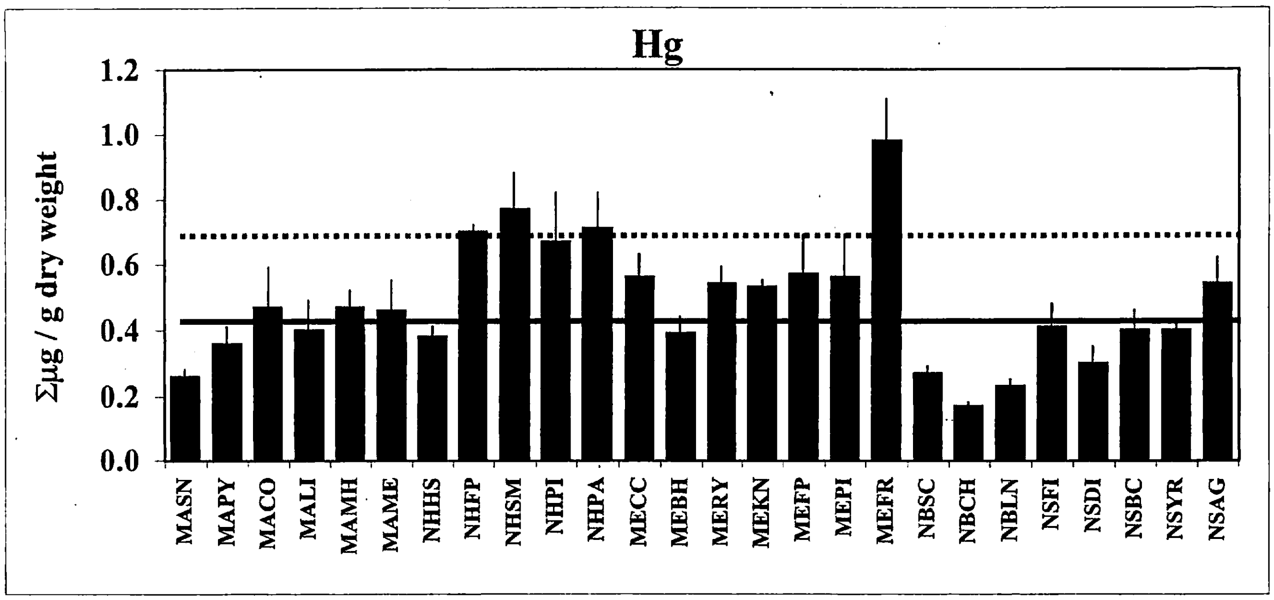


Figure 3. Distribution of chromium and copper tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine Stations in 1999. The median (solid line) and median + PC85 (dotted line) are shown for comparison.



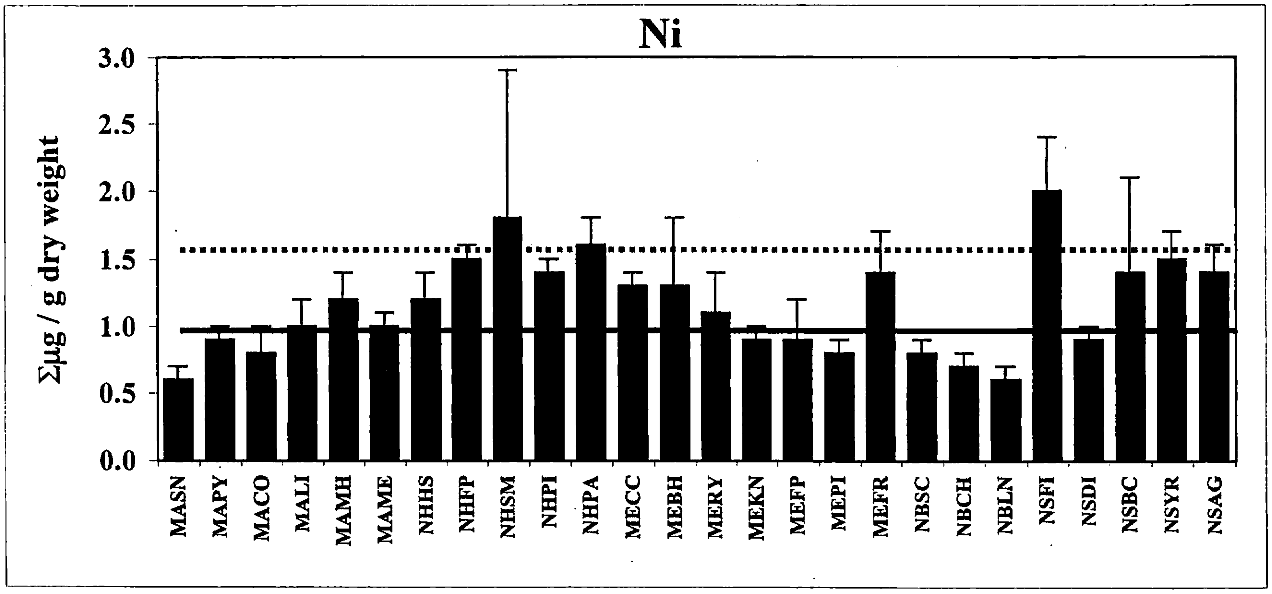


Figure 4. Distribution of mercury and nickle tissue concentrations (arithmetic mean +/- SD, µg/g dry weight) in mussels at the Gulf of Maine Stations in 1999. The median (solid line) and median + PC85 (dotted line) are shown for comparison.

0.4 μg/g dry weight (Kennish, 1997), but can be much higher in areas like the south-west Pacific, where sites average as much as 2.7 μg Hg/g dry weight (Fowler, 1990). In a review of the first five years of the Gulfwatch program tissue concentrations of Hg were discussed as being unusually high and a possible concern for human consumption (Jones et al. 1998).

Recent studies have shown that a mercury problem exists in freshwater systems of the Northeast U.S. and the maritime provinces of Canada (Welch, 1994, DiFranco et al., 1995, Evers et al., 1996). About 47% of mercury deposition in the region originates from sources within the region, 30% from continental 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. Atmospheric mercury deposition measurements made at New Castle, NH, at the mouth of Portsmouth Harbor, showed ~ 8 ng/m^2 total mercury was deposited during 1998 (http://nadp.sws.uiuc.edu/nadpdata/mdnsites.asp). The New Castle site, along with two other Maine coastal sites in Casco Bay and Acadia National Park, showed somewhat elevated total mercury atmospheric deposition compared to nearby, upstream inland sites. Other areas in the Gulf of Maine have elevated (5-20 ppm) sediment mercury concentrations (Buchholtz ten Brink et al., 1997), including the Penobscot River near Orrington, where permitted and accidental discharges from the Holtra-Chem facility have resulted in sediments having much higher (>100 ppm) Hg concentrations (MEDEP, unpublished). Thus, data on mercury levels in mussels are important to help assess current contamination problems and the effects of discharge reduction efforts in the future.

3.2.1.5 Nickel (Ni)

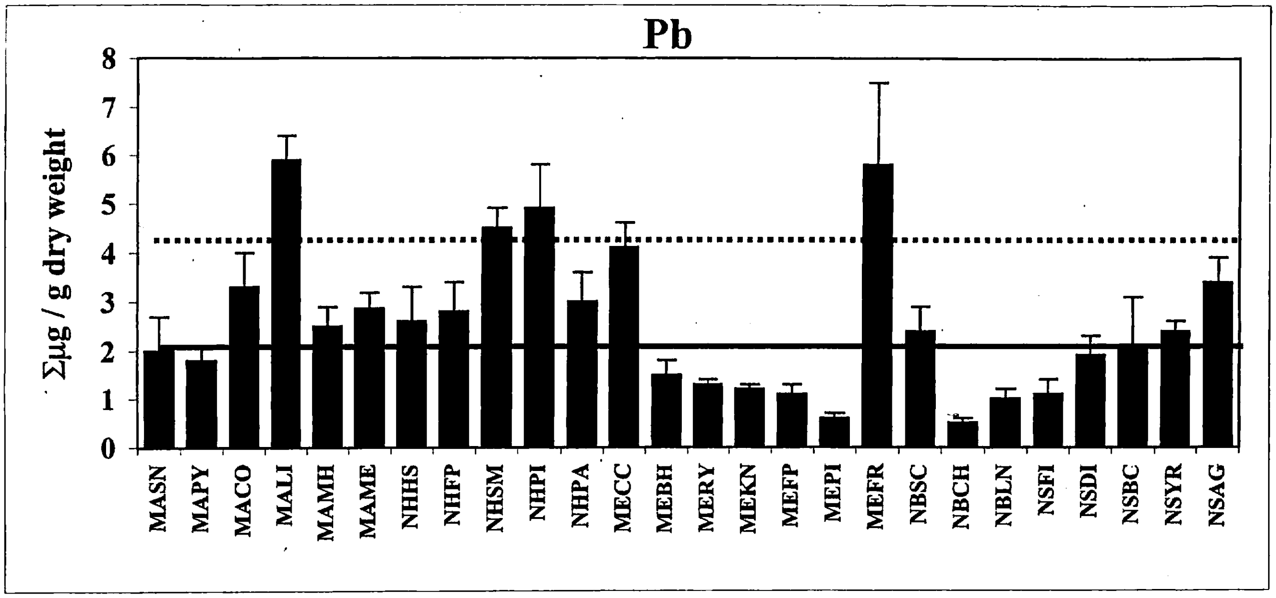
The concentration of nickel ranged from 0.6 μg/g dry weight at sandwich, MA (MASN) and Letang Estuary, N.B. (NBLN) to 2.00 μg/g dry weight at Five Islands, N.S. (NSFI) (Table 3; Figure 4). Three sites exceeded the Gulfwatch or the NS&Ts MD + PC85 (South Mill Pond, NH (NHSM), NH Port Authority (NHPA), Five Islands, N.S. (NSFI)), however, no site exceeded the NS&T MD + PC85. High concentrations were observed in New Hampshire and Nova Scotia. High concentrations in Nova Scotia may reflect leaching from exposed bedrock along the coast (Wells et al., 1997).

3.2.1.2 Lead (Pb)

The concentration of lead ranged from a value of 0.50 ± 0.10 μg/g dry weight at Chamcook, N.B., to 5.9 ± 0.5 μg/g dry weight at Long Island, MA (MALI) (Table 3, Figure 5). Lead levels at Long Island, MA (MALI), South Mill Pond, NH (NHSM), Pierce Island, NH (NHPI) and Fore River, ME (MEFR) exceed NS&T MD + PC85, however, not the Gulfwatch MD + PC85. Clarks Cove, ME (MECC) exceeded the NS&T PC85 only. Lead concentrations were generally higher in the southern (Massachusetts and New Hampshire) and northern (Nova Scotia) jurisdictions (Figure 5). Mean concentrations of Pb in mussels from coastal regions generally range from 1 to 16 µg/g dry weight (Fowler, 1990). Long Island, MA (MALI) is in an area surrounded by heavy industry, marine transport activities and municipal waste discharges. It has been suggested that sediment particles containing Pb may be transported to Boothbay Harbor from the Kennebec-Androscoggin watershed (Larson and Gaudette 1995). However, recent work has shown that local unidentified sources are largely responsible for the heavy metal concentrations in Boothbay sediments. (Getchell, 2001). Elevated lead in the New Hampshire sites may be related to the close proximity of the sites to the Portsmouth Naval Shipyard where waste plating sludge and lead batteries, respectively were disposed of and stored (NCCOSC, 1997). The potential for the Shipyard to be a source of lead to estuarine biota was demonstrated in July, 1999, when significant amounts of contaminated soil containing as much as 14.2 mg Pb/g soil dry weight was discovered to be eroding into the Piscataqua River (Cohen, 2000).

3.2.1.4 Zinc (Zn)

Zinc concentrations generally reflect human activity associated with tire wear, galvanized materials and industrial discharges. Three sites exceeded the Gulfwatch MD + PC85 (Long Island, MA (MALI), Pierce Island, NH (NHPI) and Fore River, ME (MEFR)). However, no sites exceeded the NS&T MD + PC85 for zinc concentration. The lowest concentration was at Hospital Island, N.B. (NBHI) (55 µg/g dry weight) and the highest at Long Island, MA (MALI) (163 µg/g dry weight) (Table 3; Figure 5). 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).



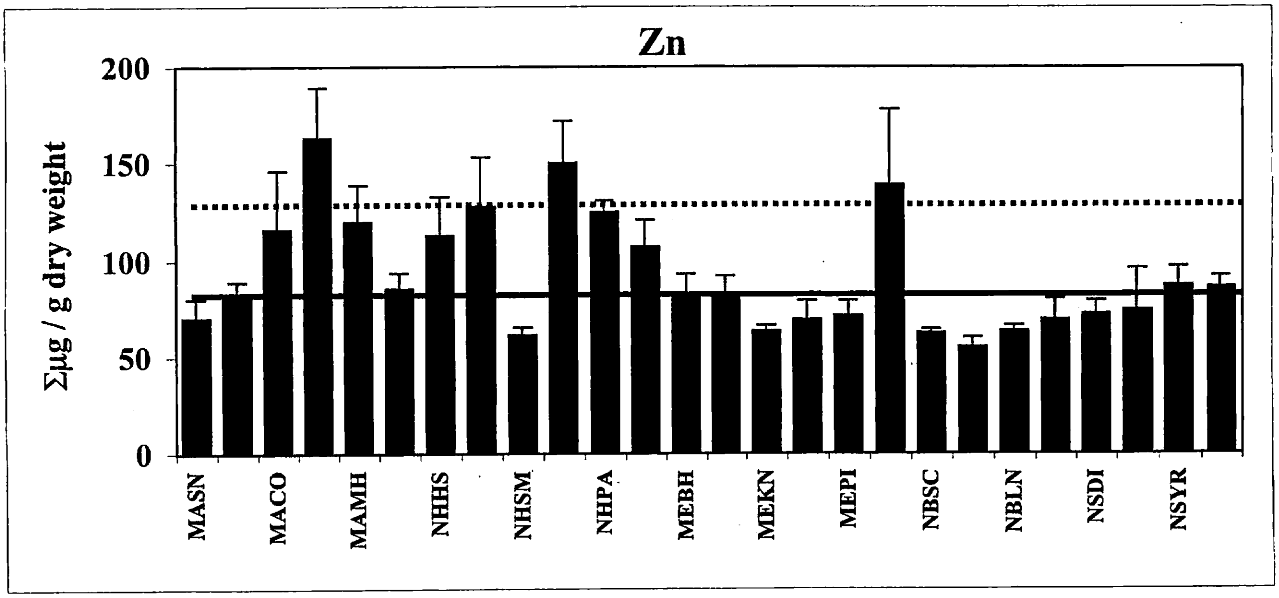
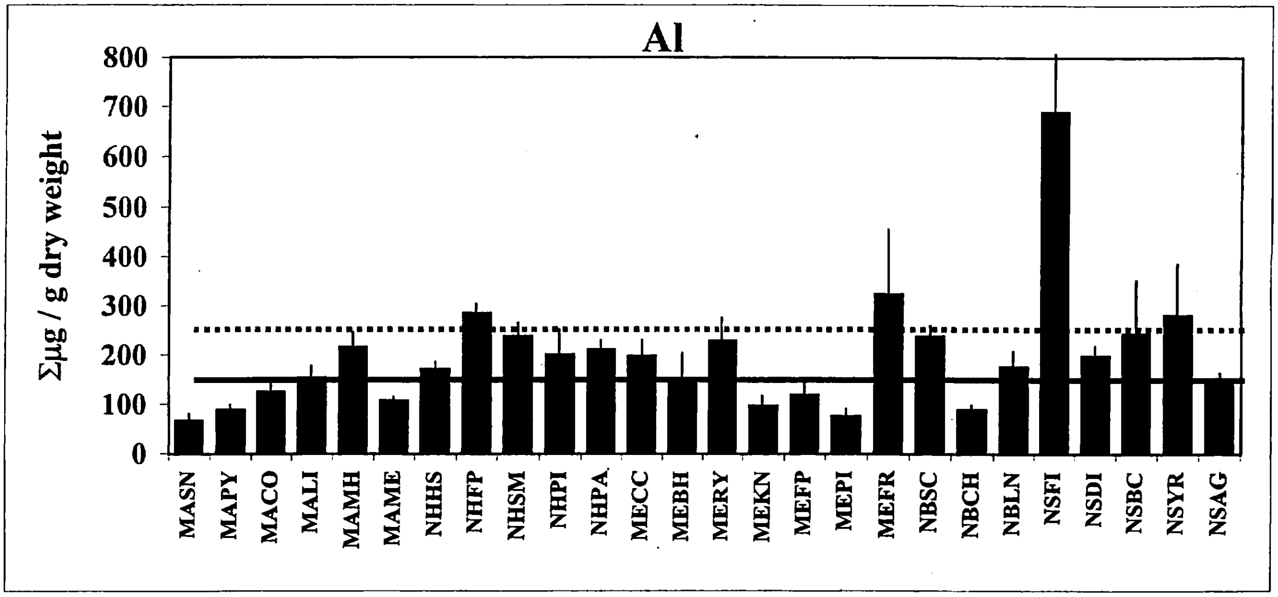


Figure 5. Distribution of lead and zinc tissue concentrations (arithmetic mean +/- SD, μg/g dry weight) in mussels at the Gulf of Maine Stations in 1999. The median (solid line) and median + PC85 (dotted line) are shown for comparison.

3.2.1.9 Iron and Aluminium (Fe & Al)

In general, concentrations of Fe and Al increased in a south to north direction around the Gulf of Maine (Table 3; Fig. 6). The concentration of Fe ranged from 115 μg/g dry weight at Hospital Island, N.B. (NBHI) to 878 μg/g dry weight at Five Islands, N.S. (NSFI). The concentration of Al ranged from 66 μg/g dry weight at Sandwich, MA (MASN) to 690 μg/g dry weight at Five Islands, N.S. (NSFI). The tissue analysis for Al and Fe is included to serve as an indication of the degree of sediment contamination in mussel tissue. Sites in New Brunswick and Nova Scotia typically have relatively high concentrations of Al and Fe, suggesting that the mussel tissue contained elevated levels of inorganic sediments. The concern within the Gulfwatch program is that the observed elevated levels of some trace metals are a function of sediment associated metals or are associated with contaminated sediments (Robinson et al., 1993). Sites in the Bay of Fundy are dominated by extensive intertidal mudflats that can lead to considerable resuspension during windy storm events.

To test the hypothesis regarding an association between high sediment load and higher metal contaminant concentrations a study at Five Islands, N.S. was carried out. Five Islands was chosen as an area with large tides and high sediment resuspension during wind events. In the past, the Five Islands site has had extremely high percentage of solids in the tissues analyzed (mean ± SD for 1993 and 1996 respectively: 10.6±2.3 and 16.3±0.9). In 1999, however, the mean % solids at the Five Islands site was below the Gulfwatch median (13.7%, Figure 7). In addition, there was a significant negative correlation between most contaminants and % solids in the mussel tissue. It is unknown whether or not this pattern is typical for Gulfwatch sites or whether 1999 is an unusual year. Results of the depuration study revealed significant differences in contaminant tissue concentrations were observed between depurated and non-depurated mussels for only 3 contaminants: Al, Fe and Cr (Figure 8). This small study suggests that for most metals the percentage of solids in the mussel tissue does not affect the overall measurement of metal contaminant concentrations. In addition, the lack of significant differences of other metals between depurated and non-depurated mussels lends confidence to other contaminant levels measured at the other Gulfwatch sites.



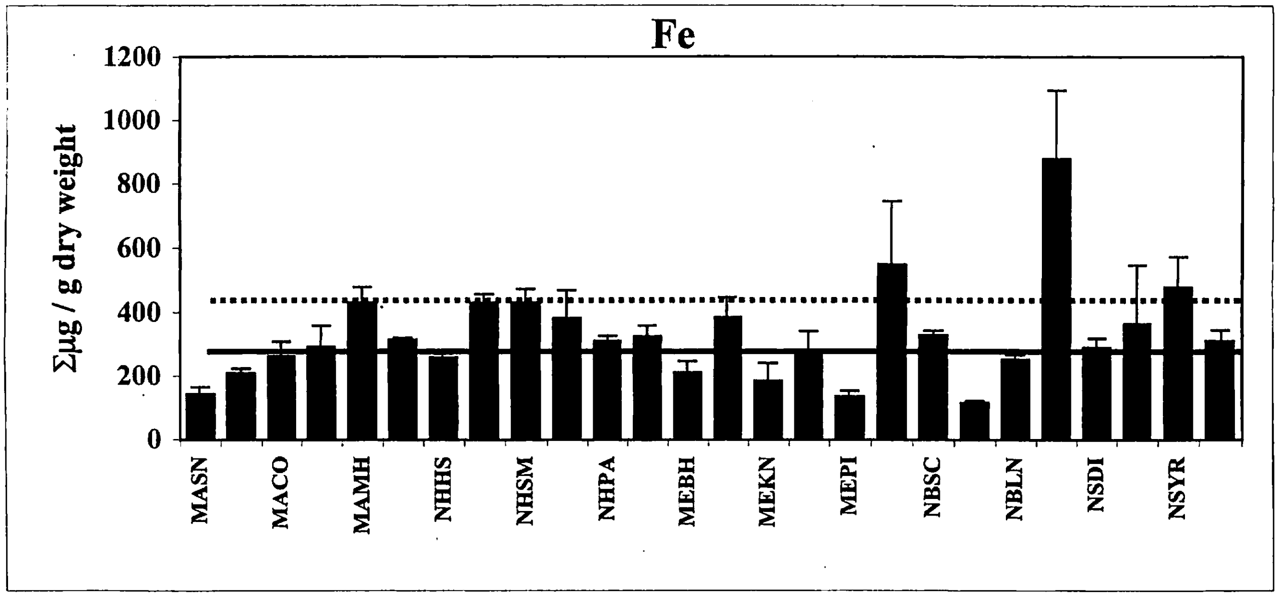


Figure 6. Distribution of aluminum and lead tissue concentrations (arithmetic mean +/- SD, μg/g dry weight) in mussels at the Gulf of Maine Stations in 1999. The median (solid line) and median + PC85 (dotted line) are shown for comparison.

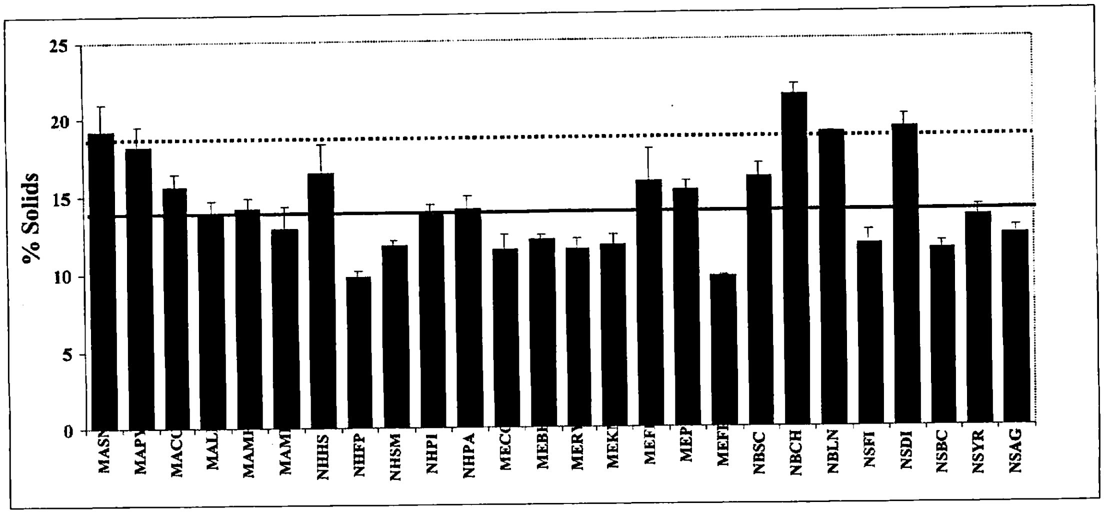
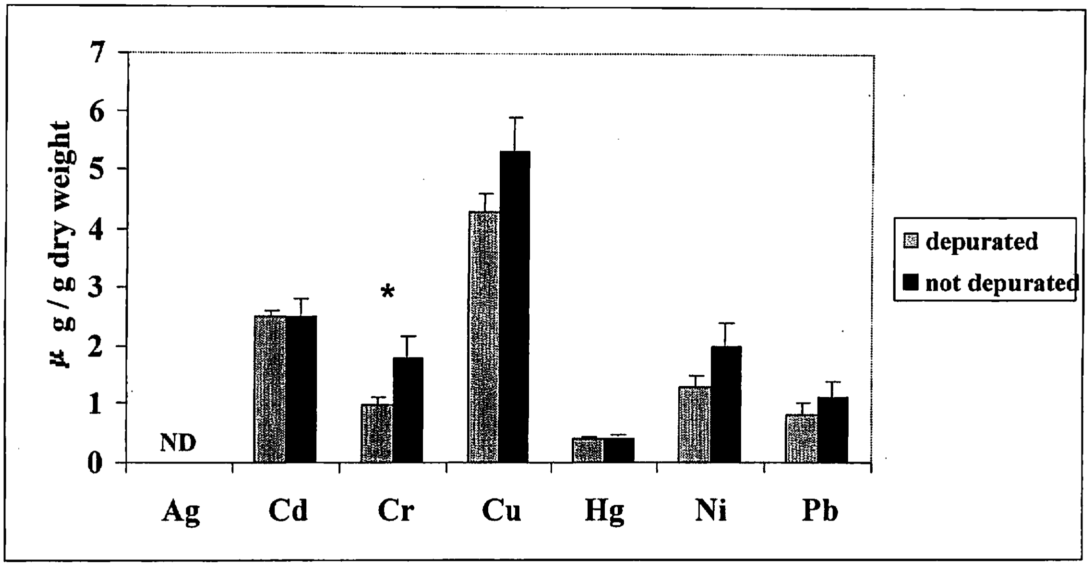


Figure 7. % solids in mussels collected at the 1999 Gulfwatch sites. Solid line, Gulfwatch median. Dotted line, Gulfwatch PC85.



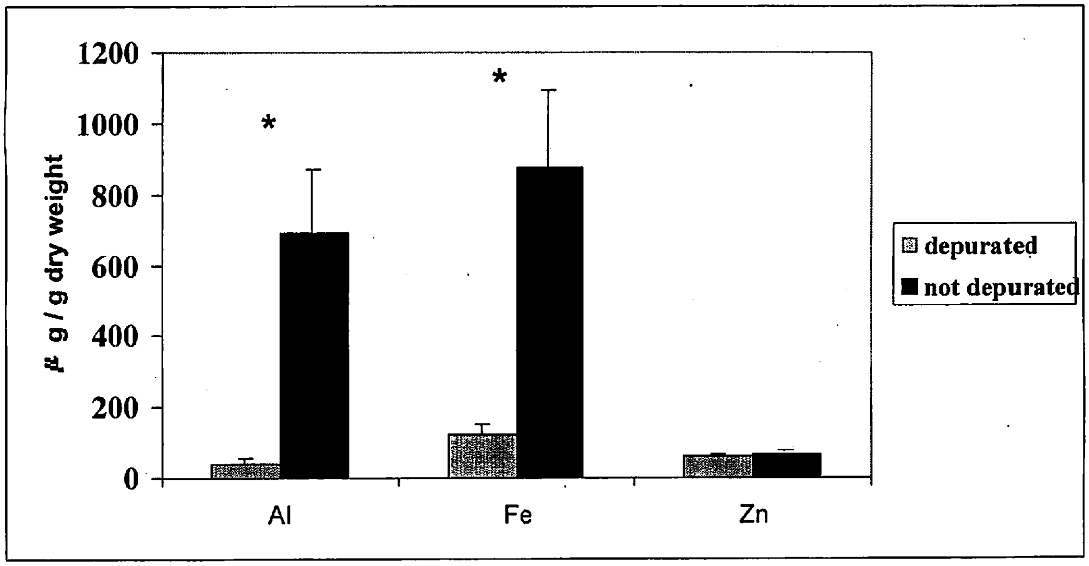


Figure 8. Experiment at Five Islands, Nova Scotia to determine the effect of depuration on the content of metal in mussels collected at the site. ND, not detected. *, result significant at $p<0.05$.

3.2.2 Organics

The total concentration (arithmetic mean ± SD, ng/g dry weight) of detectable 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 5 and Figures 9-10. Individual analyte concentrations of each compound class are provided in Appendices B, C and D, respectively. Overall organic contaminant concentrations for indigenous mussels are given as medians (MD) and MD + PC85 (Table 6) to allow for both a Gulfwide comparison and a comparison with NOAA National Status and Trends concentrations (Table 4). Table 4 includes values for MD and MD + PC85 from the 1991 NS&T Mussel Watch data (O'Connor, 1998; http://ccmaserver.nos.noaa.gov/).

Analytes within each category of organic contaminant were detected at most sites, except for ΣPCB_{24} at Brave Boat Harbor, ME (MEBH), Pickering Island, ME (MEPI), Hospital Island, N.B. (NBHI), Five Islands, N.S. (NSFI), and Broad Cove, N.S. (NSBC) and) ΣPCB_{24} and $\Sigma TPEST_{17}$ at Argyle, N.S. (NSAG). There were much wider ranges in concentrations of organic compared to trace metal contaminants. There is a pattern of higher ΣPCB_{24} and $\Sigma TPEST_{17}$ concentrations in the south-western Gulf compared to the north-eastern Gulf (Table 5). This pattern can be seen in Figures 9 and 10, which show the chemicals measured in the tissue of *M. edulis* from the 1999 sites, presented from south to north. However, the concentration of ΣPAH_{24} was higher in New Hampshire and Maine than in Massachusetts (Table 6, Figure 9), although the lowest concentrations of ΣPAH_{24} were in the northern Gulf.

TABLE 5.

Tissue organic contaminant concentrations (arithmetic mean ±SD, ng/g dry weight) from mussels collected throughout the Gulf of Maine in 1999 and ANOVA of concentrations by jurisdiction. Same letter indicates no significant difference among sites within each jurisdiction. ND = not detected.

Station	ΣPAH_{24}	ΣPCB_{24}	$\Sigma TPEST_{17}$	$\Sigma OPEST_{11}$	ΣDDT_6
MASN	49.3 ± 6.60^{CD}	47.5 ± 3.32^{C}	32.5 ± 2.55^{A}	2.30 ± 0.38^{B}	30.2 ± 2.17^{A}
MAPY	30.8 ± 8.62^{D}	37.8 ± 2.87^{C}	7.93 ± 0.88^{C}	2.30 ± 0.14^{B}	5.63 ± 0.85^{C}
MACO	56.0 ± 12.0^{C}	69.8 ± 8.34^{B}	25.5 ± 2.29^{B}	4.50 ± 0.59^{A}	21.0 ± 1.84^{B}
MALI	405.4 ± 51.5^{A}	167.4 ± 5.94^{A}	24.3 ± 1.63^{B}	2.25 ± 0.17^{B}	22.1 ± 1.63^{B}
MAMH	31.5 ± 4.12^{D}	17.0 ± 1.41^{D}	4.65 ± 0.27^{D}	ND^{C}	4.65 ± 0.27^{C}
MAME	242.5 ± 101.8^{B}	79.8 ± 17.9^{B}	21.6 ± 2.01^{B}	2.63 ± 0.71^{B}	19.0 ± 1.32^{B}
NHHS	56.0 ± 4.24^{E}	11.9 ± 0.63^{C}	8.41 ± 0.37^{C}	1.41 ± 0.06^{B}	7.00 ± 0.41^{C}
NHFP	361.0 ± 26.6^{B}	57.8 ± 5.5^{A}	16.4 ± 2.51^{B}	2.58 ± 1.55^{AB}	13.8 ± 1.37^{B}
NHSM	438.3 ± 17.5^{A}	36.5 ± 5.26^{B}	29.4 ± 4.79^{A}	4.08 ± 0.43^{A}	25.3 ± 4.82^{A}
NHPI	285.5 ± 12.1^{C}	41.3 ± 6.65^{B}	14.6 ± 1.37^{B}	2.40 ± 0.89^{AB}	12.2 ± 1.44^{B}
NHPA	282 ± 25.5^{C}	45.88 ± 7.69^{AB}	16.7 ± 2.61^{B}	4.40 ± 0.97^{A}	12.3 ± 1.69^{B}
MECC	190.7 ± 21.5^{D}	41.3 ± 2.99^{B}	4.80 ± 0.32^{D}	ND^{C}	4.80 ± 0.32^{D}
MEBH	7.75 ± 0.96^{C}	ND^{D}	1.15 ± 0.06^{C}	ND^{A}	1.15 ± 0.06^{C}
MERY	87.8 ± 15.1^{B}	18.3 ± 3.59^{C}	5.71 ± 1.92^{B}	ND^{A}	5.71 ± 1.92^{B}
MEKN	83.9 ± 15.9^{B}	33.1 ± 2.78^{B}	4.29 ± 0.35^{B}	ND^{A}	4.29 ± 0.35^{B}
MEFP	93.3 ± 15.2^{B}	20.0 ± 1.41^{C}	4.98 ± 0.51^{B}	ND^{A}	4.98 ± 0.51^{B}
MEPI	4.75 ± 1.26^{D}	ND^{D}	1.33 ± 0.10^{C}	ND^{A}	1.33 ± 0.10^{C}
MEFR	1515 ± 103^{A}	192.0 ± 9.20^{A}	17.8 ± 1.79^{A}	ND^{A}	17.8 ± 1.79^{A}
NBSC	93.0 ± 31.1^{A}	24.75 ± 1.71^{A}	3.73 ± 0.25^{B}	ND^{B}	3.73 ± 0.25^{B}
NBHI	16.8 ± 7.32^{B}	ND^{C}	3.58 ± 0.25^{B}	1.50 ± 0.22^{A}	2.08 ± 0.10^{C}
NBLN	27.5 ± 6.56^{B}	7.25 ± 0.50^{B}	4.40 ± 0.27^{A}	ND^{B}	4.40 ± 0.27^{A}
NSFI	22.5 ± 4.12^{E}	ND^{C}	4.05 ± 0.24^{A}	1.18 ± 0.10^{B}	2.88 ± 0.25^{A}
NSDI	76.5 ± 12.7^{C}	0.63 ± 0.25^{B}	4.70 ± 0.83^{A}	2.15 ± 0.70^{AB}	2.55 ± 0.17^{A}
NSBC	242.5 ± 70.8^{A}	ND^{C}	4.23 ± 1.06^{A}	2.35 ± 1.05^{A}	1.88 ± 0.10^{B}
NSYR	136.9 ± 14.6^{B}	2.00 ± 0.00^{A}	1.53 ± 0.19^{B}	ND^{C}	1.53 ± 0.19^{C}
NSAG	43.0 ± 5.48^{D}	ND^{C}	ND^{C}	ND^{C}	ND^{D}

TABLE 6.

Median (±PC85) of tissue organic contaminants for mussels within each jurisdiction and for all the Gulf of Maine, 1999 stations. ND, not detected.

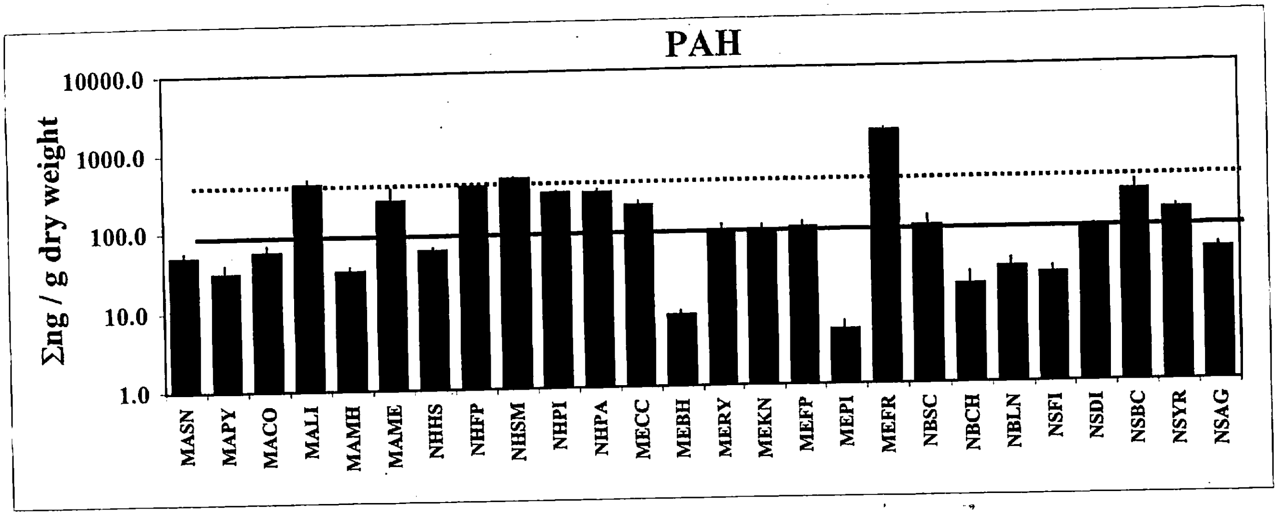
JURISDICTION	ΣPAH_{24}	ΣPCB_{24}	$\Sigma TPEST_{17}$	$\Sigma OPEST_{11}$	ΣDDT_{6}
Massachusetts (n=24)	49 ± 391	55 ± 161	23 ± 29	2.3 ± 3.9	20 ± 27
New Hampshire (n=24)	288 ± 425	41 ± 53	14 ± 25	2.2 ± 4.6	12 ± 21
Maine (n=24)	82 ± 1410	20 ± 180	4.4 ± 15	0 ± 0	4.4 ± 15
New Brunswick (n=12)	28 ± 105	7.0 ± 25	3.8 ± 4.3	0 ± 1.6	3.8 ± 4.3
Nova Scotia (n=20)	77 ± 193	0 ± 2.0	3.9 ± 4.8	1.2 ± 2.7	1.9 ± 2.8
Gulf of Maine (n=104)	79 ± 342	22 ± 64	5.0 ± 23	1.2 ± 3.4	4.8 ± 21

3.2.2.1 Polynuclear Aromatic Hydrocarbons (PAH) and Polychlorinated Biphenyls (PCB)

The ΣPAH_{24} concentrations ranged from 7.75 ± 0.96 ng/g dry weight at Brave Boat Harbor, ME (MEBH) to 1515 ± 103 ng/g dry weight at Fore River, ME (MEFR). Concentrations of ΣPAH_{24} in all jurisdictions except New Brunswick sites 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). However, only Fore River, ME (MEFR) was as high as in industrialized areas affected by coking operations in Sydney Harbour, NS (1400-16,000 ng/g, in Environment Canada 1986).

Table 6 shows the MD and MD + PC85 of all Gulfwatch stations in 1999. The concentrations that exceeded the Gulfwatch MD + PC85 were in the southern regions of the Gulf The ΣPAH_{24} MD and MD + PC85 was exceeded at Long Island, MA (MALI), Fox Point, NH (NHFP), South Mill Pond, NH (NHSM), and the Fore River, ME (MEFR). The ΣPCB_{24}: MD and MD + PC85 was exceeded at Cohasset, MA (MACO), Long Island, MA (MALI) and at the Fore River, ME (MEFR). The $\Sigma TPEST_{17}$: MD and MD + PC85 was exceeded at Sandwich, MA (MASN), Cohasset, MA (MACO), Long Island, MA (MALI) and at South Mill Pond, NH (NHSM). Comparisons were also made with the NOAA NS&T program (Table 4). For comparison wofith PCB, concentrations, a correction factor had to be applied to the Gulfwatch data (O'Connor, 1998). Only one site, Fore River, ME (MEFR) exceeded the NS&T MD + PC85 for PAH (937 ng/g dry weight) (Figure 9). Only 2 other sites (Long Island, MA (MALI), South Mill Pond, NH (NHSM)) are at concentrations close to half of this value. Regions in Massachusetts and New Hampshire have been subject to high levels of all types of contamination, including oil spills like the recent (June, 2000) spill in Chelsea, MA.

The concentrations of ΣPCB_{24} ranged from None Detected at Brave Boat Harbor, ME (MEBH), Pickering Island, ME (MEPI), Hospital Island, N.B. (NBHI), Five Islands, N.S. (NSFI), Broad Cove, N.S. (NSBC) and Argyle, N.S. (NSAG) to 192 ± 9 ng/g DW at Fore River, ME (MEFR) (Table 5). Figure 9 shows the MD of ΣPCB_{24} concentrations for all 1999 Gulfwatch sites. The same pattern of elevated concentrations in the southwest compared to the northeast sites can be seen. A Maine site, Fore River, ME (MEFR), had the highest concentrations of ΣPCB_{24} (192 ng/g DW). The corrected concentrations (O'Connor, 1998) of ΣPCB_{24} at Long Island, MA (MALI), Merrimack River, MA (MAME) and Fore River, ME (MEFR) exceeded the NS&T MD + 1 SD of 145 ng/g DW (Data not presented).



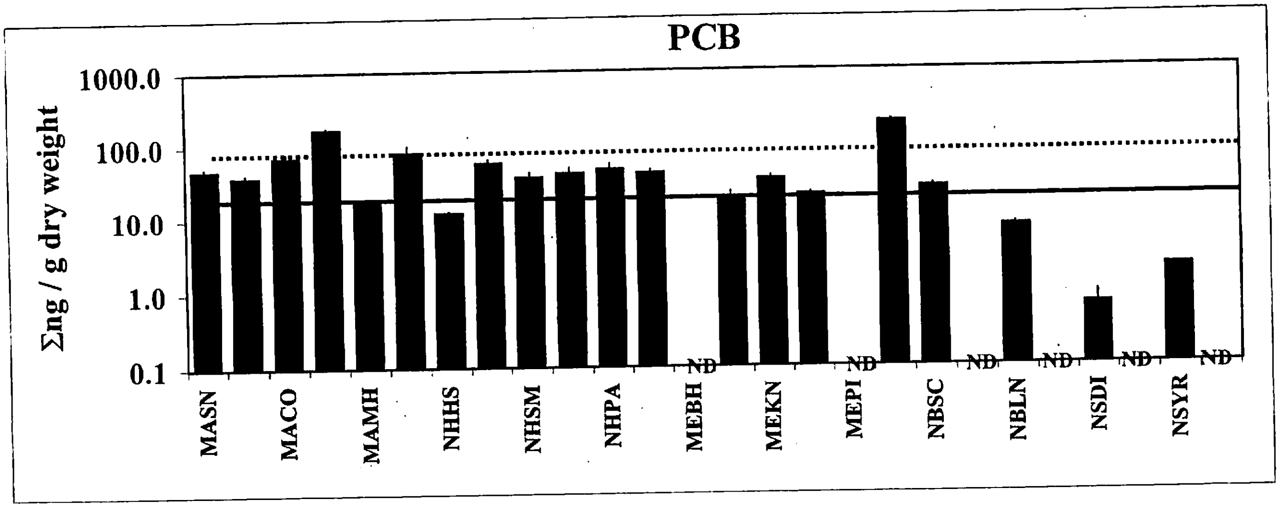


Figure 9. Log distribution of ΣPAH_{24} and ΣPCB_{24} tissue concentrations (arithmetic mean +/- SD ng/g dry weight) in mussels at the Gulf of Maine Stations in 1999. Median (solid line) and Median + PC85 (dashed line) are shown for comparison. ND=Not Detected.

3.2.2.2 Chlorinated Pesticides

The concentration of $\Sigma TPEST_{17}$ ranged from ND at Argyle, NS (NSAG) to 30.2±2.2 ng/g dry weight at Sandwich, MA (MASN) (Table 5; Figure 10). In 1999 as in previous reports, ΣDDT_6 and its degenerative metabolites were the main contributors to total detectable pesticides. ΣDDT_6 is the only contributor to $\Sigma TPEST_{17}$ in all Maine sites and 1-2 sites within Massachusetts, New Hampshire, New Brunswick and Nova Scotia (Figure 11). Analysis of each jurisdiction (Table 5) showed that there were significant differences in $\Sigma TPEST_{17}$ among sites in all jurisdictions. There are also significant among-year differences in mussel pesticide concentrations. Perhaps those of most interest are St. Croix River, N.B. (NBSC), Five Islands, N.S. (NSFI), Digby, N.S. (NSDI), Broad Cove, N.S. (NSBC) and Yarmouth, N.S. (NSYR). The concentration of $\Sigma TPEST_{17}$ at these sites was not detectable (ND) in 1993. Although the concentrations in 1999 were still below the Gulfwatch mean they have increased considerably. This region may warrant further observations.

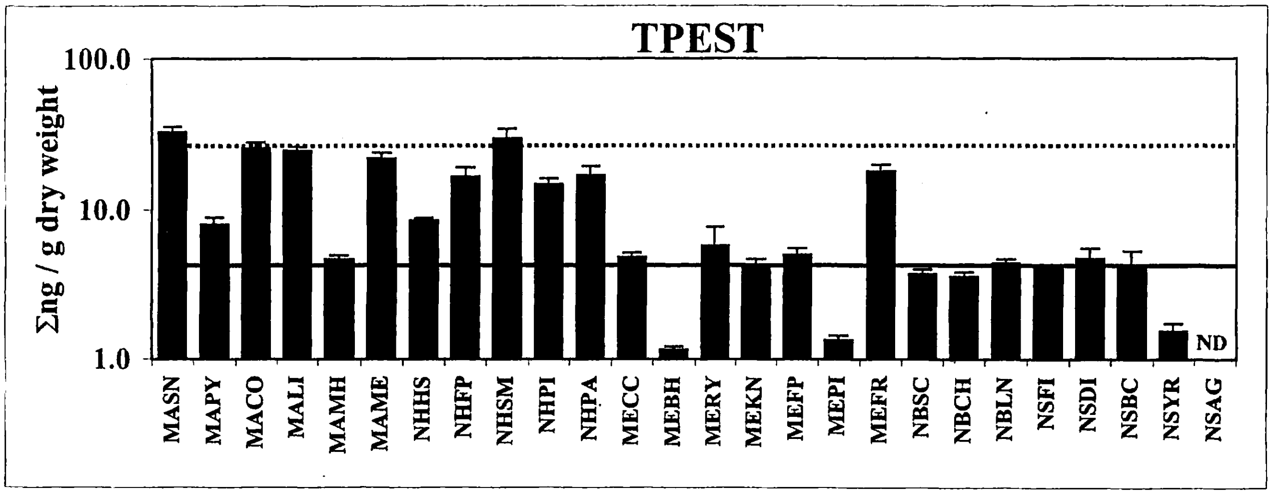
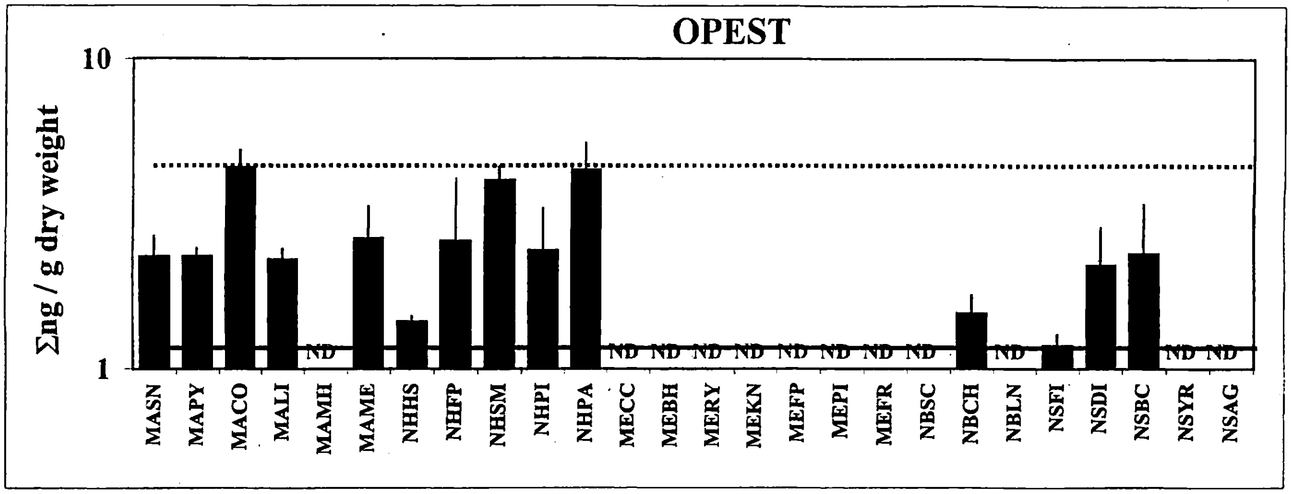


Figure 10. Log distribution of $\Sigma TPEST_{17}$ tissue concentrations (arithmetic mean +/- SD ng/g dry weight) in mussels at the Gulf of Maine Stations in 1999. Median (solid line) and Median + PC85 (dashed line) are shown for comparison. ND=Not Detected.



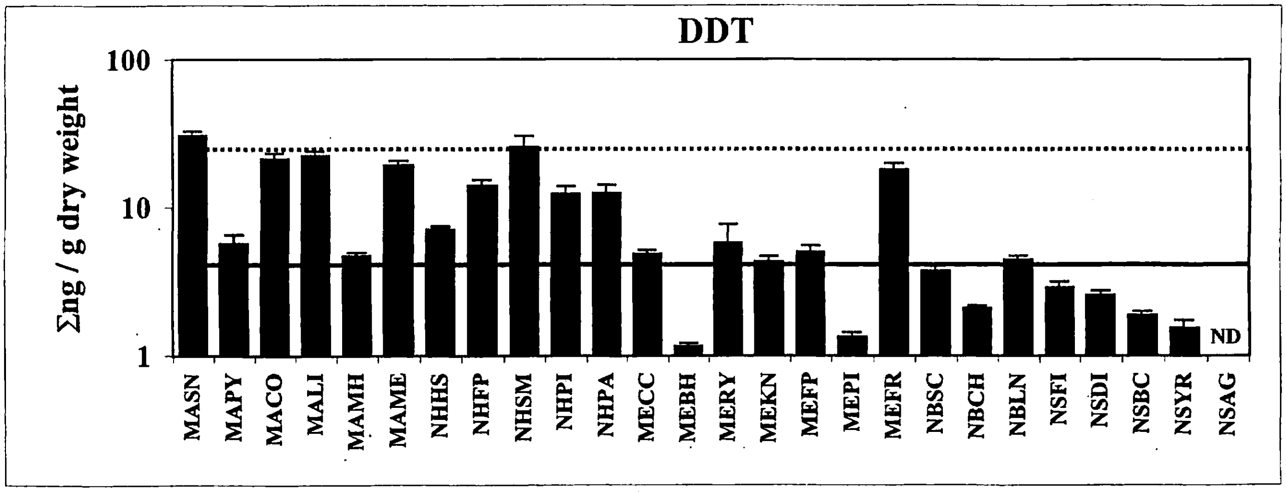


Figure 11. Log distribution of $\Sigma OPEST_{11}$ and ΣDDT_6 tissue concentrations (arithmetic mean +/- SD ng/g dry weight) in mussels at the Gulf of Maine Stations in 1999. Median (solid line) and Median + PC85 (dashed line) are shown for comparison. ND=Not Detected.

3.3 Temporal Variation in Contaminant Concentrations

3.3.1 Benchmark Sites

Table 7 (metals) and Table 8 (organics) show the tissue concentrations measured at the 5 benchmark stations from 1993 to 1999. The results of the GLM comparing metal and organic contaminant concentrations at each of the 5 sites (Sandwich, MA (MASN), Clark Cove, ME (MECC), Kennebec River, ME (MEKN), Hospital Island, N.B. (NBHI), Digby, N.S. (NSDI)) showed that for all contaminants except Ag the temporal pattern was not the same (year*site, $p<0.05$). This result may be expected given that the sites represent diverse circumstances with different sources and contaminant levels. Each site was therefore examined separately to determine whether temporal trends existed, i.e., whether there was a significant increase or decrease in contaminant concentration over time (Table 9). This was done by GLM ANOVA on each site. Only the first-degree model was tested as it is only of interest whether there was a linear increase or decrease in contaminant concentration over this time period. This is equivalent to examining the relationship between the slope of each contaminant and year to determine if they differ significantly from zero (Table 9). Of the 60 comparisons (5 sites, 12 contaminants) the ratio (in percent) of increases : decreases : no change was: 6.6% : 46.7% : 46.7%. Decreases were observed for all contaminants with the exception of ΣPAH_{24}. At least one organic contaminant group increased in at least 1 site: ΣPAH_{24}, ΣPCB_{24}, and $\Sigma PEST_{17}$. No significant increases were observed with the metal contaminants. The site with the greatest number of decreases (2 of 4) was Sandwich, MA (MASN). Sandwich is a site with generally low mussel contaminant values, except for Ag, ΣPCB_{24}, and $\Sigma PEST_{17}$. Therefore slight deviations, even as a result of yearly protocol, may influence the data and result in significant contaminant*year relationships.

TABLE 7.
Tissue metal concentrations (arithmetic mean ±SD, µg/g dry weight) for Gulfwatch stations at Sandwich, MA (MASN), Clark Cove, ME (MECC), Kennebec River, ME (MEKN), Hospital Island, NB (NBHI), and Digby, NS (NSDI) for 1993 to 1999.

Site | Year	Ag	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn
MASN 1993	1.64 (0.36)	61 (4)	1.68 (0.25)	1.64 (0.46)	6.1 (0.4)	354 (20)	0.77 (0.73)	2.24 (0.55)	3.78 (0.12)	101 (11)
MASN 1994	1.05 (0.29)	84 (18)	1.60 (0.20)	1.10 (0.10)	7.5 (0.5)	265 (31)	0.51 (0.10)	1.05 (0.06)	2.90 (0.40)	103 (9)
MASN 1995	1.04 (0.40)	110 (14)	1.08 (0.10)	1.75 (0.31)	6.9 (0.7)	245 (6)	0.30 (0.03)	0.88 (0.13)	2.65 (0.34)	98 (6)
MASN 1996	0.98 (0.30)	145 (24)	1.33 (0.22)	1.18 (0.19)	9.3 (2.0)	323 (43)	0.35 (0.04)	1.10 (0.08)	3.38 (0.66)	91 (6)
MASN 1997	1.01 (0.30)	105 (12.5)	1.09 (0.15)	1.00 (0.09)	7.2 (0.40)	265 (17.3)	0.29 (0.06)	0.98 (0.05)	3.10 (0.36)	91 (6)
MASN 1998	0.83 (0.04)	72 (17)	1.90 (0.41)	1.13 (0.19)	6.2 (1.3)	218 (39)	0.37 (0.06)	ND	3.15 (0.64)	101 (63)
MASN 1999	1.01 (0.76)	66 (13)	1.5 (0.3)	0.8 (0.1)	6.3 (1.0)	143 (22)	0.26 (0.02)	0.60 (0.10)	2.00 (0.70)	70 (10)
MECC 1993	0.10 (0.05)	187 (80)	2.39 (0.36)	3.31 (1.28)	7.5 (0.9)	535 (138)	0.74 (0.06)	2.60 (0.20)	5.35 (2.18)	126 (17)
MECC 1994	0.05 (0.00)	157 (15)	1.50 (0.30)	1.90 (0.10)	7.5 (1.3)	367 (67)	0.58 (0.10)	1.30 (0.35)	4.60 (0.60)	95 (7)
MECC 1995	0.12 (0.05)	345 (26)	1.80 (0.08)	3.33 (0.82)	9.9 (1.4)	535 (39)	0.56 (0.13)	1.65 (0.17)	6.05 (0.68)	135 (10)
MECC 1996	0.08 (0.03)	335 (47)	1.73 (0.19)	2.88 (0.33)	8.2 (0.6)	518 (61)	0.86 (0.31)	1.43 (0.13)	5.10 (0.48)	113 (5)
MECC 1997	ND	428 (57)	1.55 (0.31)	3.01 (0.33)	7.0 (1.2)	611 (112)	0.66 (0.06)	1.87 (0.26)	5.06 (1.07)	124 (24)
MECC 1998	ND	298 (65)	2.08 (0.13)	3.18 (0.70)	7.2 (0.7)	528 (80)	0.82 (0.11)	2.33 (1.08)	5.75 (0.70)	135 (24)
MECC 1999	ND	198 (30)	1.40 (0.10)	1.90 (0.10)	7.0 (0.5)	325 (33)	0.56 (0.07)	1.30 (0.10)	4.10 (0.50)	107 (14)
MEKN 1993	0.06 (0.01)	136 (27)	2.16 (0.36)	1.78 (0.58)	7.9 (0.3)	360 (51)	0.61 (0.27)	1.40 (0.11)	1.60 (0.35)	79 (18)
MEKN 1994	0.05 (0.00)	84 (13)	1.40 (0.40)	1.13 (0.20)	6.6 (1.3)	230 (47)	0.80 (0.10)	0.68 (0.13)	1.40 (0.30)	60 (11)
MEKN 1995	0.07 (0.04)	103 (10)	1.90 (0.28)	1.53 (0.34)	7.4 (1.3)	225 (31)	0.53 (0.11)	1.08 (0.15)	1.55 (0.40)	79 (13)
MEKN 1996	0.15 (0.07)	188 (64)	2.35 (0.21)	1.93 (0.33)	7.5 (0.9)	360 (86)	0.67 (0.30)	1.40 (0.18)	1.33 (0.46)	76 (11)
MEKN 1997	ND	122 (59.2)	1.33 (0.13)	1.03 (0.32)	5.0 (1.2)	190 (98.9)	0.33 (0.14)	ND	0.98 (0.31)	45.5 (9.7)
MEKN 1998	0.12 (0.05)	117 (26)	2.08 (0.43)	1.27 (0.23)	5.3 (0.6)	225 (42)	0.41 (0.09)	0.71 (0.36)	1.58 (0.40)	53 (10)
MEKN 1999	0.10 (0.00)	96 (19)	2.30 (0.20)	3.10 (2.70)	9.0 (1.6)	185 (56)	0.53 (0.02)	0.90 (0.10)	1.20 (0.10)	63 (3)

Tissue metal concentrations (arithmetic mean ±SD, 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 Harbour, NS (NSDI) for 1993 to 1999.

Site | Year	Ag	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn
NBHI 1993	0.11 (0.06)	75 (12)	1.68 (0.09)	1.12 (0.12)	5.0 (0.9)	240 (41)	2.11 (0.49)	1.18 (0.19)	0.94 (0.15)	78 (9)
NBHI 1994	0.20 (0.00)	213 (22)	1.90 (0.40)	1.33 (0.30)	7.0 (0.6)	400 (56)	0.48 (0.49)	1.18 (0.13)	1.50 (0.40)	99 (21)
NBHI 1995	0.13 (0.04)	410 (74)	1.09 (0.11)	1.48 (0.40)	6.6 (0.7)	240 (27)	0.27 (0.04)	0.92 (0.09)	1.15 (0.13)	71 (12)
NBHI 1996	0.08 (0.03)	180 (29)	0.93 (0.13)	0.63 (0.16)	4.4 (0.2)	235 (25)	0.41 (0.12)	ND	0.75 (0.06)	70 (10)
NBHI 1997	0.08 (0.03)	180 (38)	1.16 (0.05)	0.68 (0.05)	5.3 (0.3)	226 (47)	0.16 (0.05)	0.47 (0.13)	0.47 (0.13)	58.4 (4.15)
NBHI 1998	1.82 (0.20)	793 (179)	2.00 (0.30)	4.00 (1.00)	29.0 (10.0)	696 (160)	0.29 (0.20)	1.90 (0.40)	2.30 (0.30)	139 (140)
NBHI 1999	ND	88 (9)	0.70 (0.10)	0.50 (0.00)	4.1 (0.3)	115 (6)	0.17 (0.01)	0.70 (0.10)	0.50 (0.10)	55 (5)
NSDI 1993	0.26 (0.20)	413 (65)	1.77 (0.35)	1.91 (0.29)	7.1 (0.3)	678 (80)	1.82 (1.22)	1.86 (0.22)	3.94 (0.43)	112 (4)
NSDI 1994	ND	325 (84)	1.50 (0.10)	1.43 (0.20)	7.1 (0.3)	573 (145)	0.44 (0.01)	1.33 (0.13)	3.30 (0.30)	83 (7)
NSDI 1995	0.06 (0.03)	303 (75)	1.53 (0.15)	1.60 (1.41)	7.1 (0.3)	480 (84)	0.47(0.05)	1.48 (0.05)	3.25 (0.34)	96 (9)
NSDI 1996	ND	313 (36)	1.43 (0.10)	1.53 (0.10)	7.0 (0.8)	453 (54)	0.38 (0.19)	1.25 (0.13)	3.13 (0.24)	91 (13)
NSDI 1997	ND	392 (44.5)	1.54 (0.60)	1.81 (0.52)	6.6 (0.6)	513 (27.3)	0.32 (0.05)	1.44 (0.04)	2.79 (0.60)	89.3 (14.7)
NSDI 1998	0.08 (0.05)	338 (31)	1.60 (0.18)	1.43 (0.22)	5.3 (1.4)	485 (37)	0.46 (0.06)	1.63 (0.15)	2.70 (0.22)	94 (16)
NSDI 1999	ND	198 (19)	1.10 (0.20)	0.90 (0.10)	6.7 (0.4)	290 (29)	0.30 (0.05)	0.90 (0.10)	1.90 (0.40)	72 (7)

TABLE 8

Tissue organic contaminant concentrations (arithmetic mean ± SD, ng/g dry weight) for Gulfwatch stations at Sandwich, MA (MASN), Clark Cove, ME (MECC), Kennebec River, ME (MEKN), Hospital Island, NB (NBHI), and Digby, NS (NSDI) from 1993-1999.

Site | Year	ΣPAH_{24}	ΣPCB_{24}	$\Sigma TPEST_{17}$
MASN 1993	19.0 (7.0)	28.8 (7.20)	16.3 (5.10)
MASN 1994	42.4 (9.8)	28.6 (6.92)	20.3 (5.06)
MASN 1995	17.5 (11.7)	36.8 (7.63)	26.8 (6.55)
MASN 1996	58.0 (8.3)	40.1 (6.3)	23.3 (7.24)
MASN 1997	29.1 (1.2)	45.2 (6.77)	24.7 (2.42)
MASN 1998	13.0 (2.0)	28.0 (7.0)	29 (3)
MASN 1999	49.3 (6.6)	47.5 (3.3)	32.5 (2.55)
MECC 1993	154 (47)	70.3 (10.7)	11.1 (5.30)
MECC 1994	137 (9.54)	66.8 (4.79)	12.5 (1.29)
MECC 1995	158 (38.8)	35.4 (10.20)	13.8 (0.96)
MECC 1996	203 (21.9)	37.6 (1.9)	7.3 (1.5)
MECC 1997	147 (19.0)	37.3 (8.35)	15.3 (4.97)
MECC 1998	200 (26)	43 (8)	15 (2)
MECC 1999	191 (22)	41.3 (2.99)	4.80 (0.32)
MEKN 1993	94.0 (31.0)	27.3 (3.70)	3.50 (2.00)
MEKN 1994	103 (15.2)	42.5 (11.7)	18.3 (4.43)
MEKN 1995	64.0 (25.6)	24.5 (7.19)	17.5 (1.00)
MEKN 1996	155 (53.5)	29.8 (3.8)	5.4 (1.50)
MEKN 1997	46.0 (9.66)	25.3 (0.98)	12.5 (0.69)
MEKN 1998	59 (20)	17 (4)	5 (0.5)
MEKN 1999	84 (16)	33.1 (2.78)	4.29 (0.35)
NBHI 1993	ND	3.70 (1.20)	3.00 (1.00)
NBHI 1994	ND	ND	3.43 (0.10)
NBHI 1995	ND	ND	3.86 (0.59)
NBHI 1996	7.0 (8.1)	1.4 (1.6)	3.40 (0.30)
NBHI 1997	ND	ND	4.75 (0.17)
NBHI 1998	22 (11)	ND	7 (2)
NBHI 1999	17 (7)	ND	3.58 (0.25)
NSDI 1993	108 (26)	ND	ND
NSDI 1994	70.5 (8.7)	1.2 (1.4)	1.7 (1.1)
NSDI 1995	129 (38.2)	3.0 (0.0)	1.8 (1.2)
NSDI 1996	211 (28)	7.6 (2.0)	3.6 (0.4)
NSDI 1997	198 (50.2)	0.47 (0.94)	1.7 (0.46)
NSDI 1998	106 (14)	4.0 (0.6)	6 (1)
NSDI 1999	77 (13)	0.63 (0.25)	4.70 (0.83

TABLE 9.

Results of Repeated Measures Anova on Gulfwatch benchmark sites: Sandwich, MA (MASN), Clark Cove, ME (MECC), Kennebec River, ME (MEKN), Hospital Island, NB (NBHI), and Digby, NS (NSDI). nc, no change; I, increase; D, decrease.

BENCHMARK SITES

Contaminant	**MASN**	**MECC**	**MEKN**	**NBHI**	**NSDI**
Ag*	nc	nc	nc	nc	nc
Al	nc	nc	nc	nc	D
Cd	nc	nc	nc	D	D
Cr	D	nc	nc	D	D
Cu	nc	nc	nc	D	D
Fe	D	nc	D	D	D
Hg	D	nc	D	D	D
Ni	D	nc	nc	D	nc
Pb	D	nc	nc	D	D
Zn	D	nc	D	D	D
ΣPAH_{24}	nc	I	nc	I	nc
ΣPCB_{24}	I	D	nc	D	nc
$\Sigma PEST_{17}$	I	nc	nc	D	nc

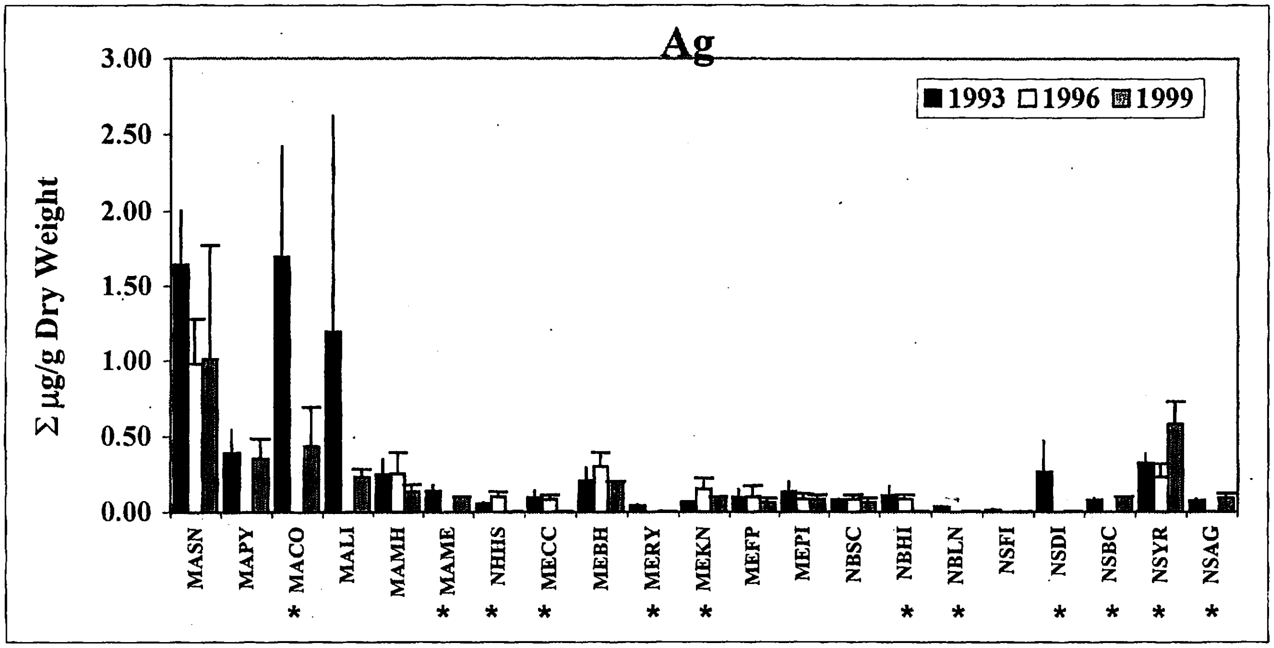
*, the pattern of contaminant concentration was the same for all sites (siteyear $p>0.05$) therefore individual sites were not tested. Site, $p<0.001$; year, $p=0.0718$.

3.3.2 Annual Sites (1993 vs. 1996 vs. 1999)

Figures 12-16 show the concentrations of all metals at the 7 regular Gulfwatch sites sampled in 1993, 1996 and 1999. Asterisks below the abscissa show sites in which a significant difference in concentration was detected. Significant differences between years were observed for all contaminants. For all contaminants except Al the percentage of contaminants that significantly decreased was greater than the percentage that increased. Significant differences in contaminant concentrations of Hg were found at 8 sites, all of which were decreases in comparison to previous years. The mean concentration of mercury decreased at all sites except Five Islands, N.S. (NSFI) and Broad Cove, N.S. (NSBC), although the increases at those sites were not significant. Given the concern regarding the level of Hg in the Gulf of Maine these results may seem encouraging. These results are based on comparison of only 2 of the 3 years of data (1996 and 1999). As mentioned earlier, in 1993 there were problems with variable Hg results and the accuracy of the measurements were questioned (GOMC, 1996). The metal with the most among-year significant differences was Pb (18/21 sites). Concentrations of Pb decreased at significantly at 17/21 sites over the 3 years. The only site where the concentration of Pb increased was St. Croix River, N.B. (NBSC). Concentrations at NBSC were significantly higher in 1999. Observed significant differences in the concentration of Ag were generally decreases, with the exception of Nova Scotia sites. As mentioned earlier the concentration of Ag at Yarmouth, N.S. (NSYR) was higher than the Gulfwatch and NOAA NS&T MD + PC85.

Figure 17 and 18 show the concentrations of all _PAH24, _PCB24 (Figure 17) and _TPEST17 (Figure 18) contaminants at the 13 regular Gulfwatch sites sampled in 1993, 1996 and 1999. Asterisks below the abscissa show sites in which a significant difference in contaminant concentration was detected. Significant differences between years were observed for all contaminants. In the majority of sites where significant changes were found, contaminant concentrations were significantly higher than observed in previous years. This is mainly attributed to the decrease in the number of not detectable (ND) results from 1993 to 1999. In 1993 there were 7 sites with ND results for _PAH24 and _TPEST17 concentrations as opposed to 0 and 1 respectively in 1999. Concentrations of both _PAH24 and _TPEST17 increased from ND between 1993 and 1999 at 4 sites: Brave Boat Harbor, ME (MEBH), St. Croix River, N.B. (NBSC), Five Islands, N.S. (NSFI) and Argyle, N.S. (NSAG).

It must be noted that this analysis is based on concentrations from three years. As such it will be sensitive to sampling fluctuations and may not be indicative of true differences. However, the results support those observed for the benchmark sites i.e. metal contaminants tended to decrease while the organic contaminants tended to increase.



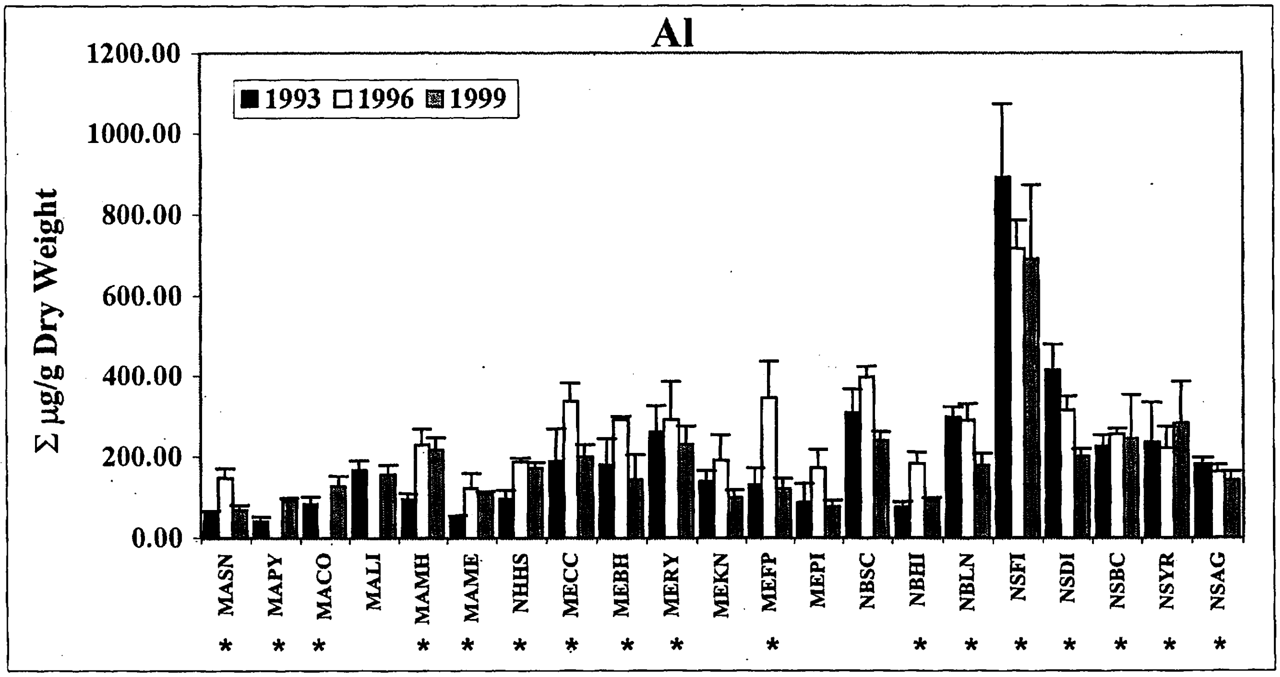
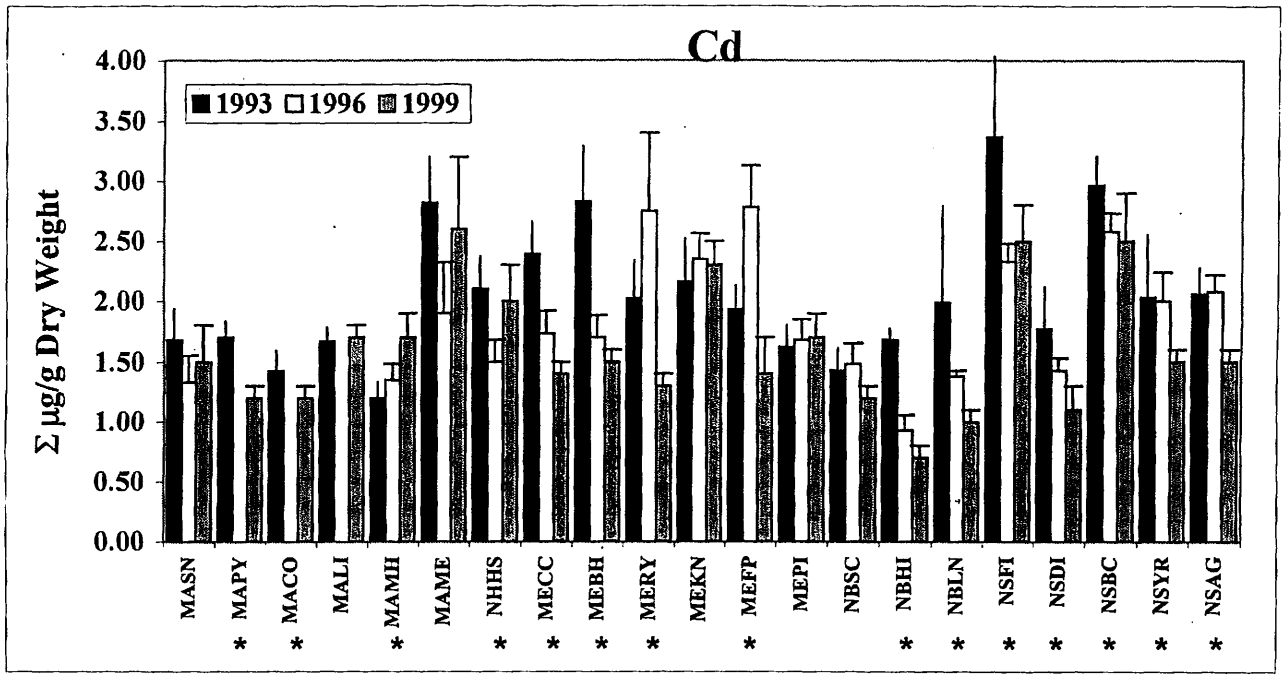


Figure 12. Distribution of silver and aluminum tissue concentrations (arithmetic mean +/ SD µg/g dry weight) in mussels at the Gulf of Maine Stations in 1993 (black), 1996 (white) and 1999 (gray). *, indicates a significant difference between years ($p<0.05$).



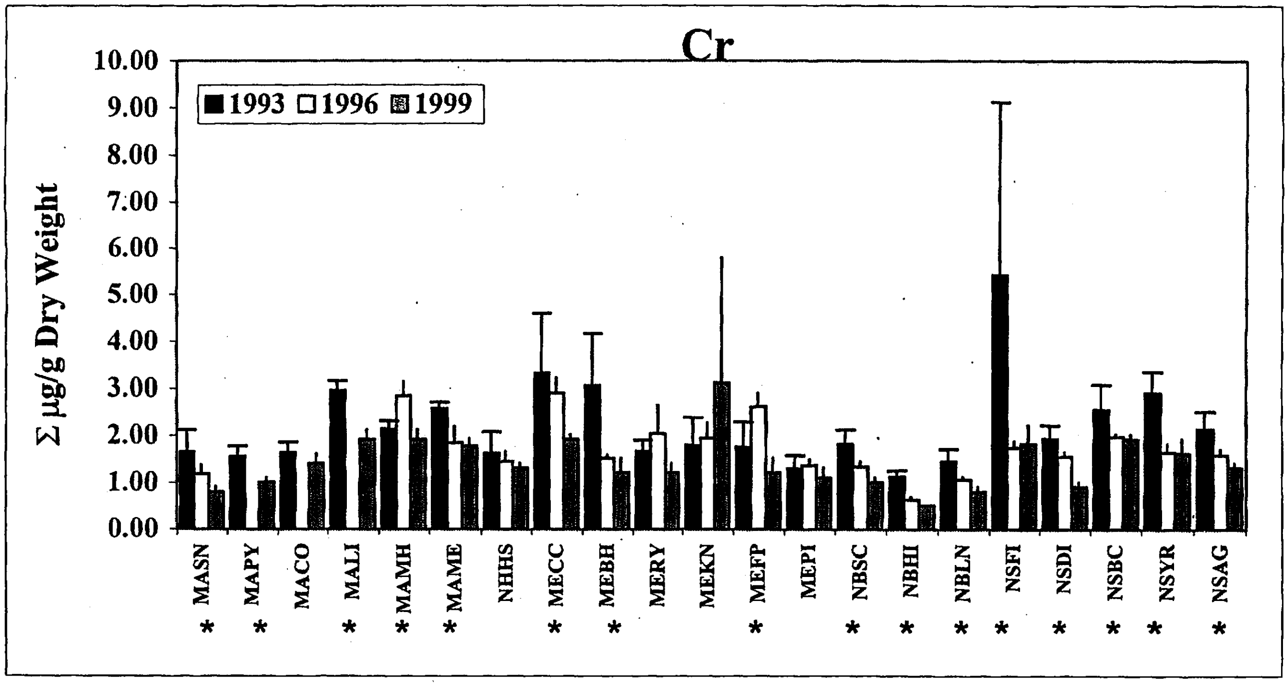
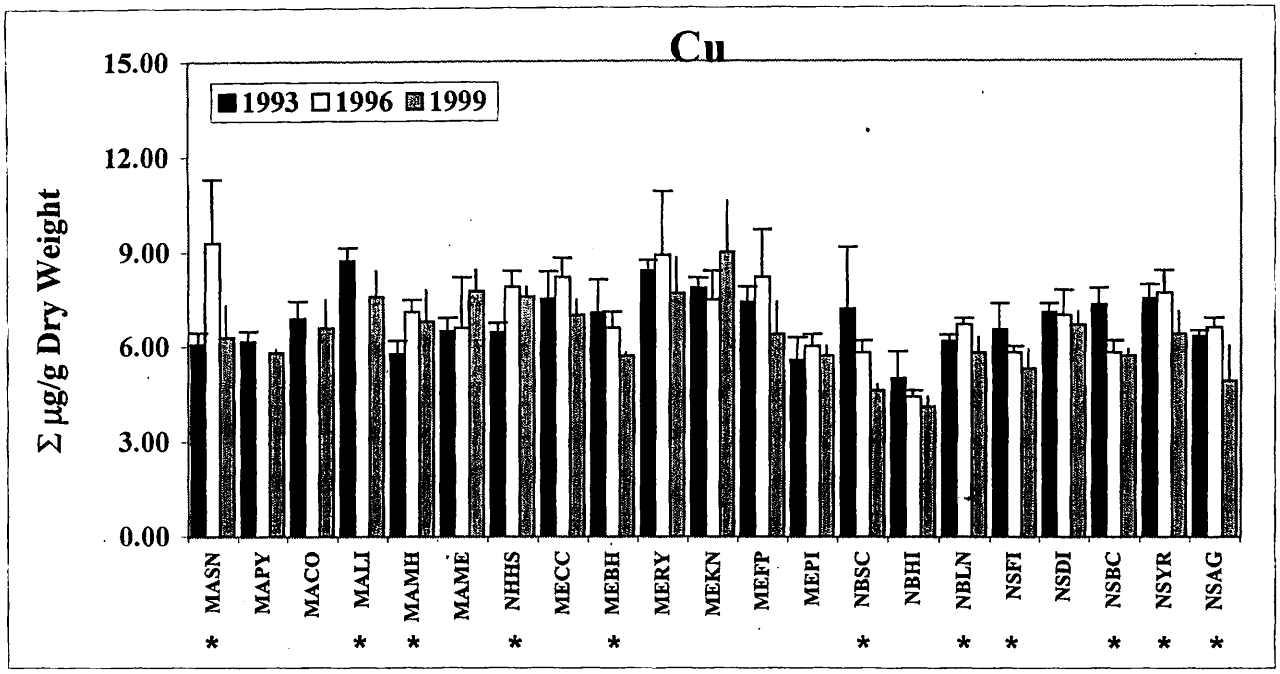


Figure 13. Distribution of cadmium and chromium tissue concentrations (arithmetic mean +/- SD µg/g dry weight) in mussels at the Gulf of Maine Stations in 1993 (black), 1996 (white) and 1999 (gray). *, indicates a significant difference between years ($p<0.05$).



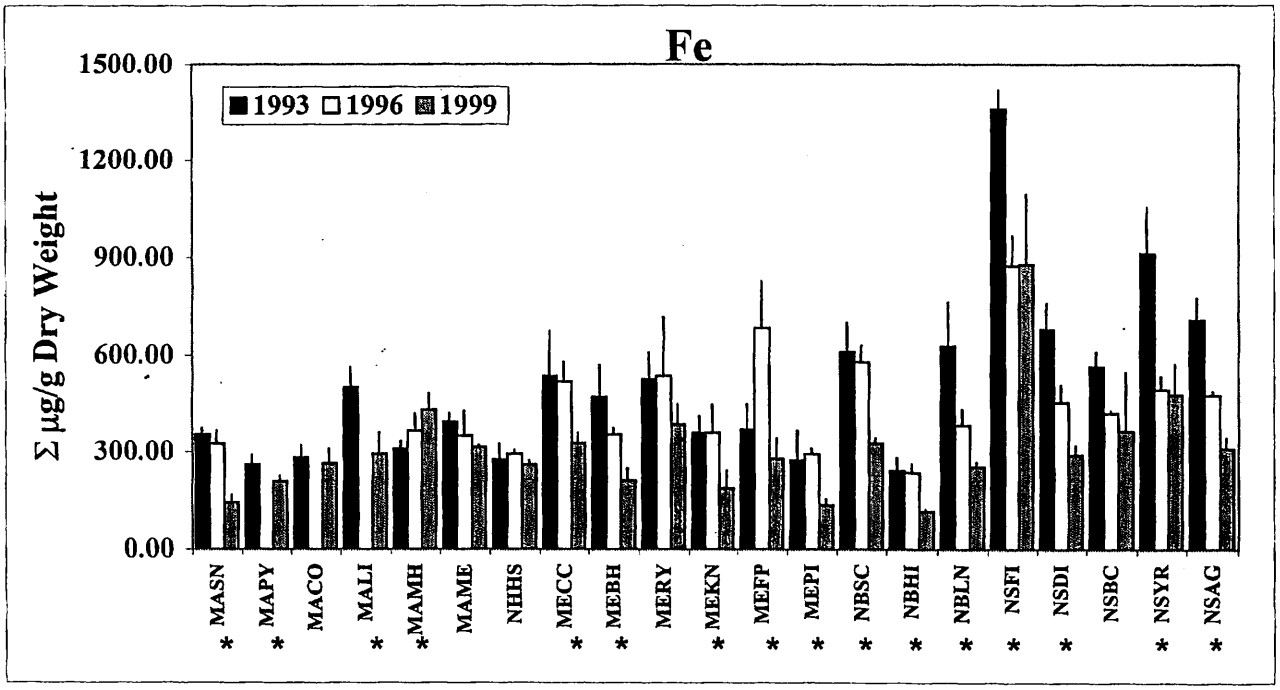
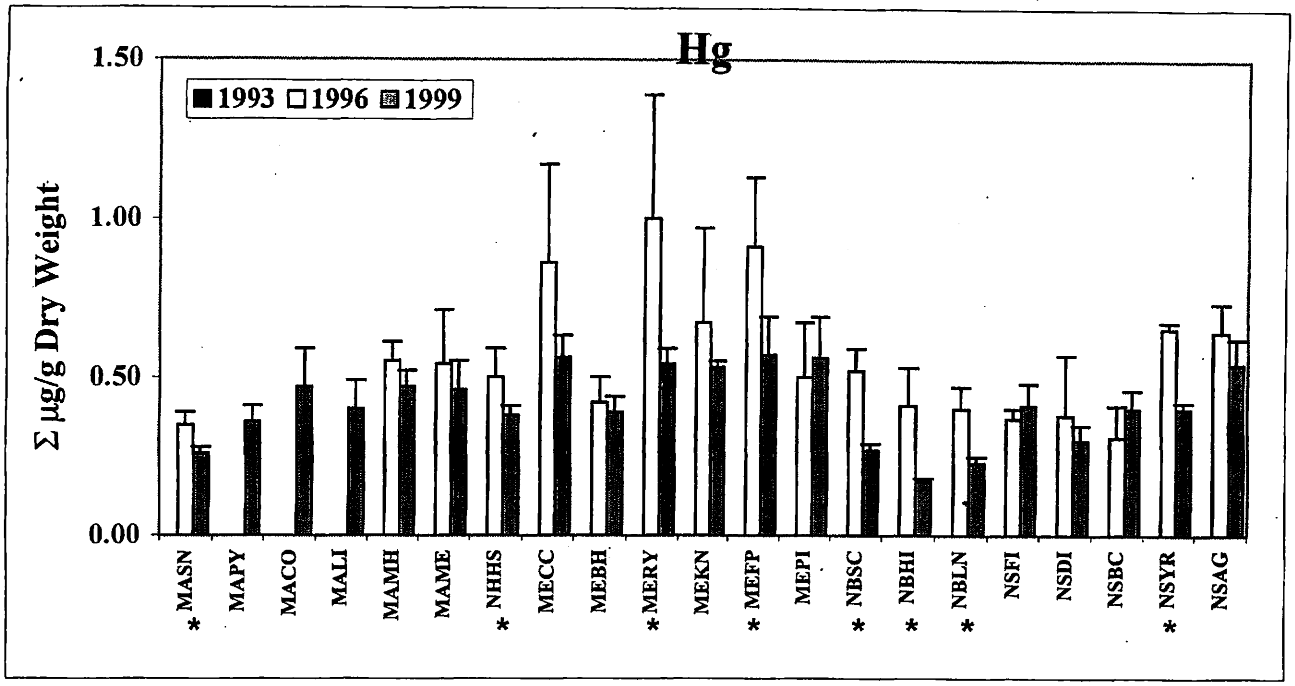


Figure 14. Distribution of copper and iron tissue concentrations (arithmetic mean +/- SD µg/g dry weight) in mussels at the Gulf of Maine Stations in 1993 (black), 1996 (white) and 1999 (gray). *, indicates a significant difference between years ($p<0.05$).



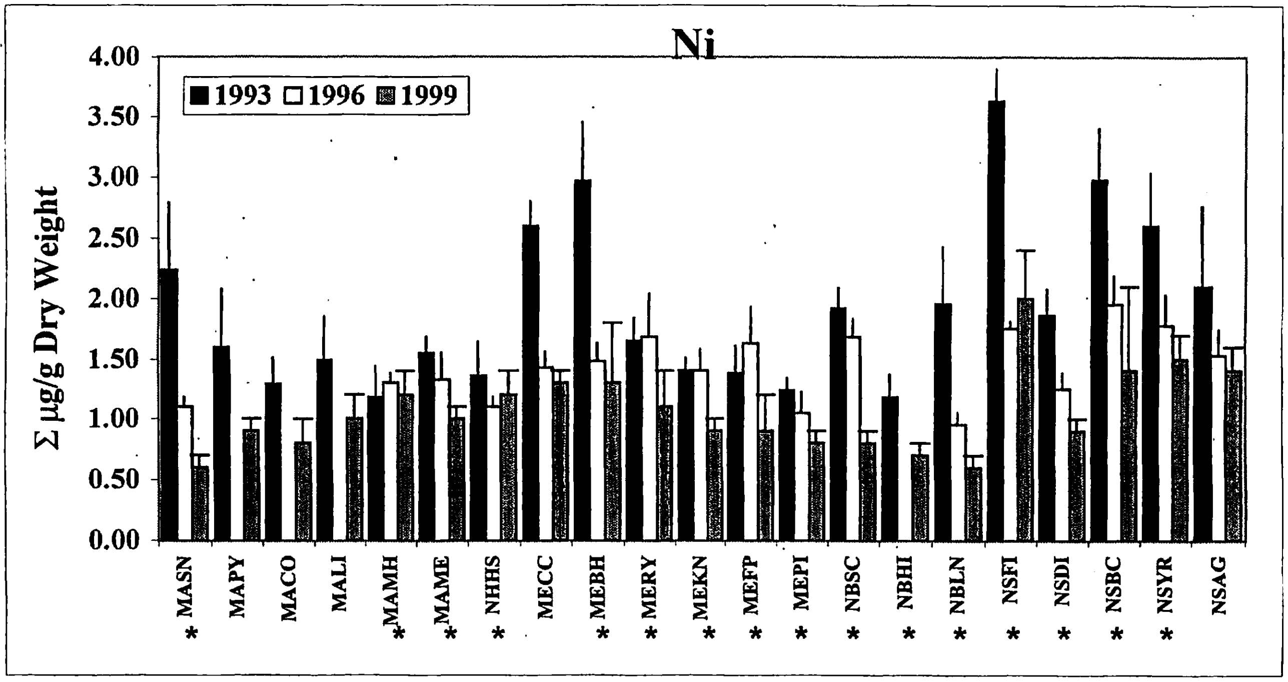
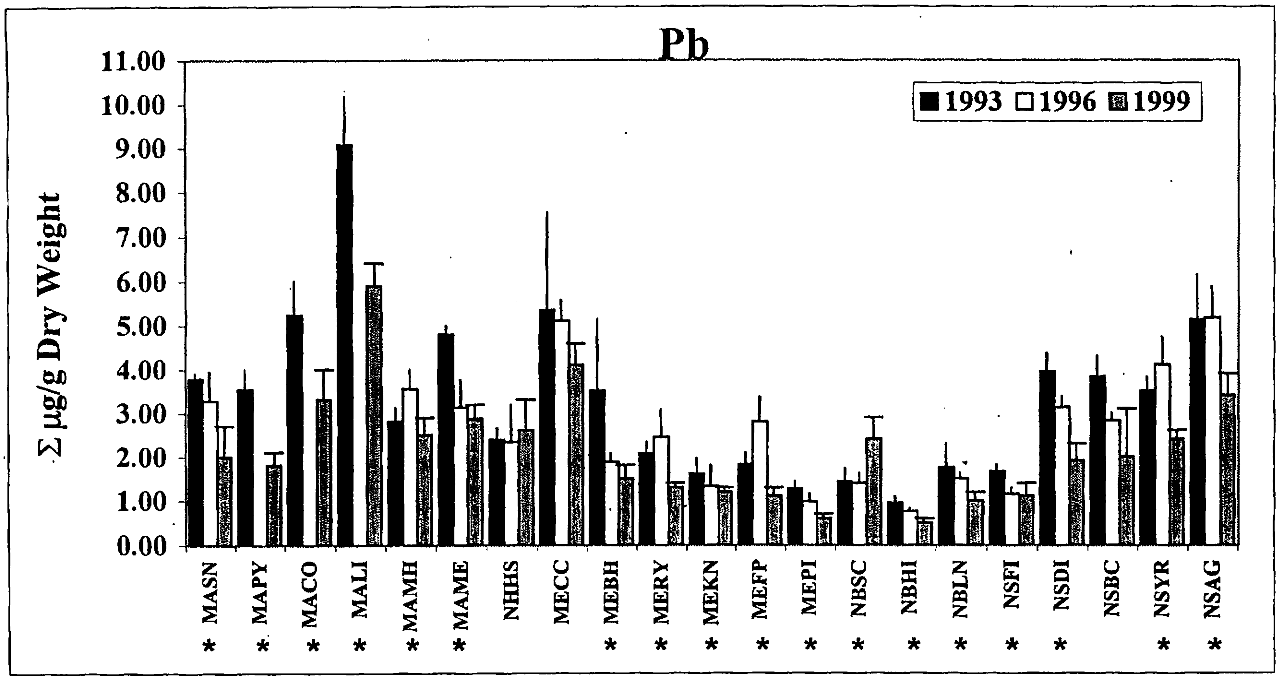


Figure 15. Distribution of mercury and nickle tissue concentrations (arithmetic mean +/- SD µg/g dry weight) in mussels at the Gulf of Maine Stations in 1993 (black), 1996 (white) and 1999 (gray). *, indicates a significant difference between years ($p<0.05$).



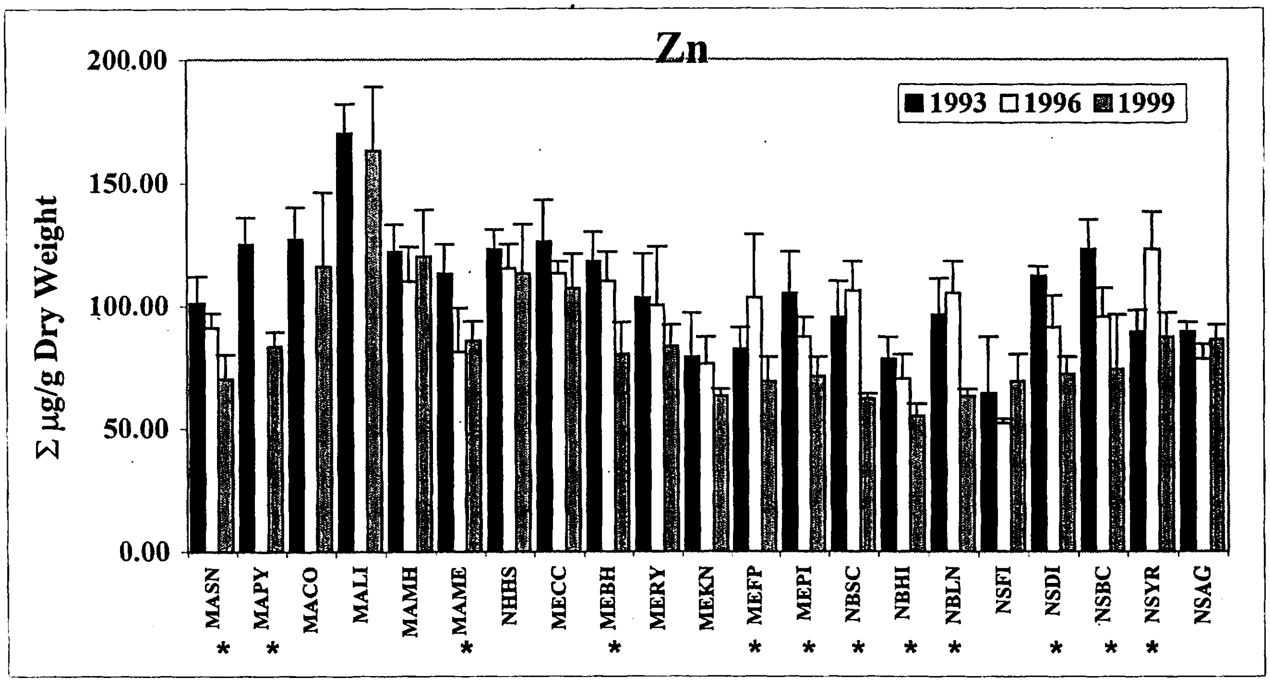


Figure 16. Distribution of lead and zinc tissue concentrations (arithmetic mean +/- SD µg/g dry weight) in mussels at the Gulf of Maine Stations in 1993 (black), 1996 (white) and 1999 (gray). *, indicates a significant difference between years ($p<0.05$).

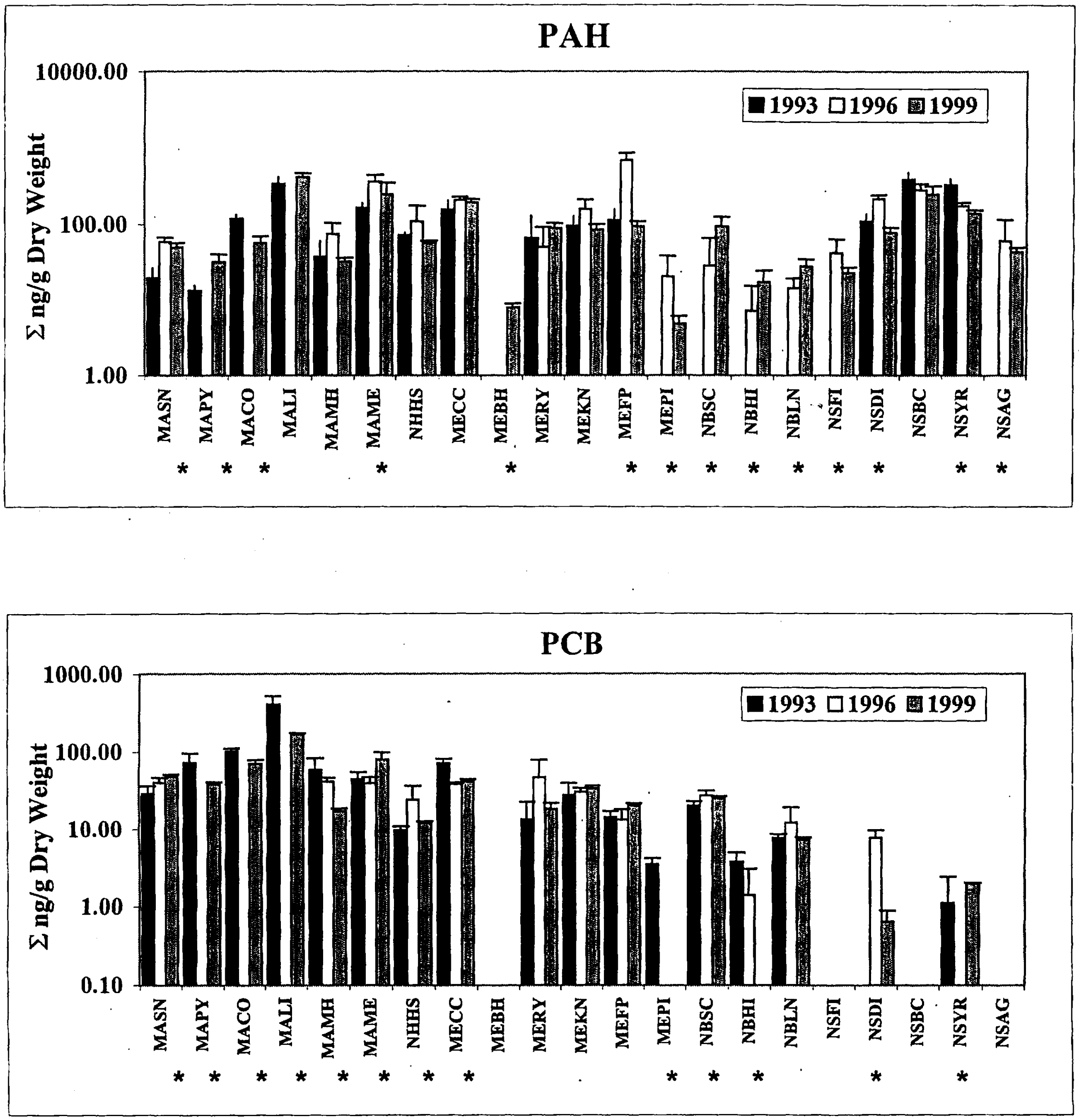


Figure 17. Distribution of ΣPAH_{24} and ΣPCB_{24} tissue concentrations (arithmetic mean +/- SD ng/g dry weight) in mussels at the Gulf of Maine Stations in 1993 (black), 1996 (white) and 1999 (gray). *, indicates a significant difference between years ($p<0.05$).

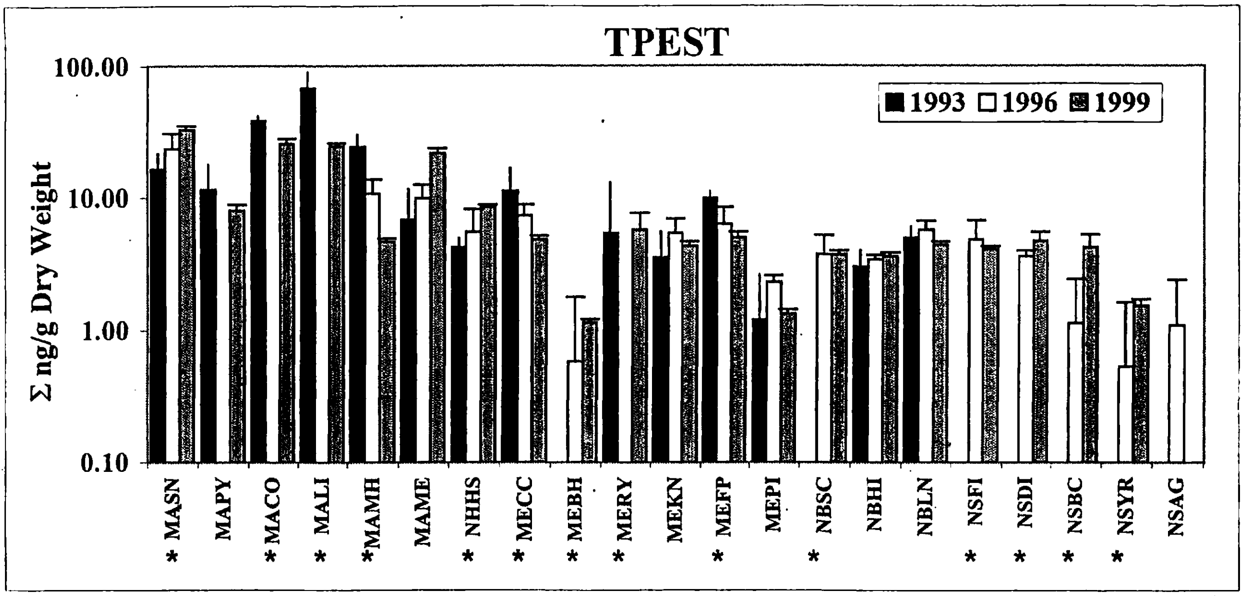


Figure 18. Distribution of $\Sigma TPEST_{17}$ tissue concentrations (arithmetic mean +/- SD ng/g dry weight) in mussels at the Gulf of Maine Stations in 1993 (black), 1996 (white) and 1999 (gray). *, indicates a significant difference between years ($p<0.05$).

3.5 Acceptable Levels and Standards of Mussel Contamination

Despite the wealth of information on the effects of toxic contaminants on a variety of species, 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. For example in New Hampshire, there are currently human consumption advisories for Hg and PCBs (NHDES, 1998; NHEP, 2000). The advisory for Hg is based on a recent national FDA advisory. For marine waters, there is a consumption advisory for lobsters and bluefish based on elevated levels of PCBs.

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 assumed to derive dry weight equivalents from the wet weight based health values (Table 10). All reported organic concentrations are within acceptable concentrations for those compounds that have established USFDA Action Limits in fish and shellfish. PCB concentrations found in Gulfwatch mussels (Table 10A) are less than the action level of 13 µg/g dry weight (USFDA, 1990; CSSP, 1992), with Fore River, ME (MEFR) having the highest concentrations of PCBs in mussels, 0.19 µg/g dry weight, during the 1999 survey. The action level for the pesticides dieldrin, aldrin, chlordane, heptachlor and heptachlor epoxide is 2.0 µg/g dry weight (USFDA, 1990). Only dieldrin and chlordane were detected in the 1999 mussel survey, but at concentrations barely above detection limits which are orders of magnitude below the action levels. The total DDT concentrations found are several orders-of-magnitude below the action level of 33 µg/g dry weight (USFDA, 1990; CSSP, 1992). Site MASN had the highest level of $\Sigma PEST_{17}$, 0.033 µg/g dry weight, in 1998. Canadian limits for agricultural chemicals exclusive of DDT are 0.67 µg/g dry weight.

As presented in Table 10A, admissible levels of methyl mercury, expressed as mercury, are less than 6.7 µg/g dry weight, or 1 µg/g wet weight in the United States (USFDA, 1990), and less than 3.3 µg/g dry weight, or 0.5 µg/g wet weight in Canada (CSSP, 1992). The highest concentration of mercury found in the 1999 Gulfwatch study was 1.14 µg/g dry weight, in one replicate sample from Fore River, ME (MEFR) which is high but still well below both federal action concentrations.

A series of FDA "Guidance Documents" (USFDA, 1993) for cadmium, chromium, lead and nickel was 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

TABLE 10

Comparison of Gulfwatch tissue contaminant concentrations with (A) Health Canada (1992) standards; (B) relative levels of concern based on USFDA (1993) provisional intake levels; and (C) USEPA (1993) screening values.

A.

Contaminant	Action level (ww)	Action level (dw)	Highest observed value (dw)	Location
ΣPCB	2 µg / g	13.3 µg / g	0.19 µg / g	Fore River, ME (MEFR)
ΣDDT	5 µg / g	33.3 µg / g	0.030 µg / g	Sandwich, MA (MASN)
Other pesticides	>0.1 µg / g	0.7 µg / g	0.045 µg / g	Cohasset, MA (MACO)
Hg (Canada)	0.5 µg / g	3.3 µg / g	1.14 µg / g	Fore River, ME (MEFR)
Hg (USA)	1.0 µg / g	6.7 µg / g	1.14 µg / g	Fore River, ME (MEFR)

B.

Contaminant	Guideline (ww)	Guideline (dw)	Highest observed value (dw)	Location
Cd*	3.7 µg / g	25 µg / g	2.60 µg / g	Merrimack River, MA (MAME)
Cr*	13 µg / g	87 µg / g	3.10 µg / g	Pierce Island, NH (NHPI)
				Kennebec River, ME (MEKN)
Pb*	1.7 µg / g	11.5 µg / g	5.9 µg / g	Long Island, MA (MALI)
Ni*	80 µg / g	533 µg / g	1.80 µg / g	South Mill Pond, NH (NHSM)

C.

Contaminant	Guideline (ww)	Guideline (dw)	Values exceeding (dw)	Location
ΣPCB	0.01 µg / g	0.07 µg / g	0.167 µg / g	Long Island, MA (MALI)
			0.798 µg / g	Merrimack River, MA (MAME)
			0.192 µg / g	Fore River, ME (MEFR)

. In Table 10B, 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 1999 Gulfwatch samples. All nickel, chromium, cadmium and lead concentrations in 1999 Gulfwatch mussels were well below the guidance values. The highest observed concentrations from the 1999 Gulfwatch data for other trace metals for which there is no guidance or action limit are included in Table 10. This highlights hot spots of localized elevated contamination as well as sites where elevated levels may also be associated with excessive sediment in tissue samples, such as suspected for the New Brunswick sites.

The U.S. EPA has promulgated a series of "screening values" (EPA, 1993) which were derived using human health risk assessment procedures. The promulgated values for specific carcinogenic compounds 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 plus an acceptable lifetime cancer risk of 1×10^{-5}. Exceedances of any of the screening values by the Gulfwatch data provide yet another index of possible human health concern. The screening value for ΣPCB_{24} is exceedingly low (Table 10C). Despite this, no Gulfwatch site exceeded this value in 1999.

3.6 Morphometric Comparison

Table 11 contains a summary of the morphological measurements [length (mm), height (mm), width (mm), wet weight (g) and condition index (CI)] for mussels collected at each site.

3.6.1 Shell Morphology

The field protocol recommended the collection of mussels within the length range of 50-60 mm. This was attained at all sites with the exception of St. Croix River, N.B. (NBSC) and Hospital Island, N.B. (NBHI). The Gulfwide mean length (±SD) at the 26 sites where data was available was 55.0±3.3 mm (Table 11; Figure 19). ANOVA on 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.

3.6.2 Condition Index

Condition Indexes (CI) of the mussels collected in 1999 are shown in Table 11 and Figure 20. The CI ranged from a value of 0.14±0.03 at NHPA to 0.24±0.02-0.05 at St. Croix River, N.B. (NBSC) and Digby, N.S. (NSDI). The average CI (±SD) for all sites where data was available was 0.19±0.04. ANOVA on the mean CI of all mussels was significant ($p<0.05$). The mean CI of at least one site in all jurisdictions except New Brunswick was below the Gulfwatch mean. The lower CI at these sites is likely a reflection of the low weight. There is generally significant relationship between CI and wet weight.

TABLE 11.

Morphometric characteristics (mean SD) of mussels collected at the Gulf of Maine, 1999 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.

Station	N	Length (mm)	Height (mm)	Width (mm)	Wet Weight (g)	Condition index (CI)
MASN	29	54.9(3.1)^{B}	30.8(1.8)^{D}	26.7(1.9)^{C}	8.99(1.5)^{B}	0.197(0.02)^{B}
MAPY	30	53.2(2.7)^{A}	30.4(1.8)^{CD}	23.2(1.6)^{AB}	6.28(1.2)^{A}	0.164(0.02)^{A}
MACO	30	55.6(3.4)^{B}	28.4(1.7)^{B}	23.4(2.0)^{A}	6.25(1.4)^{A}	0.170(0.02)^{A}
MALI	30	55.1(2.4)^{B}	28.2(1.8)^{B}	22.3(1.6)^{AB}	5.71(0.98)^{A}	0.164(0.02)^{A}
MAMH	30	56.1(2.6)^{B}	29.1(1.7)^{BC}	23.8(1.6)^{B}	6.08(0.93)^{A}	0.156(0.02)^{A}
MAME	30	56.2(3.3)^{B}	26.9(1.6)^{A}	22.6(1.5)^{AB}	5.75(1.0)^{A}	0.171(0.03)^{A}
NHHS	40	54.6(2.5)^{A}	28.4(2.1)^{A}	24.6(2.3)^{D}	6.30(1.3)^{BC}	0.168(0.04)^{BC}
NHFP	40	55.3(2.6)^{ABC}	28.7(2.0)^{A}	22.7(2.1)^{C}	7.11(1.5)^{CD}	0.196(0.04)^{DE}
NHSM	40	56.0(2.4)^{CB}	29.4(1.9)^{A}	23.3(2.2)^{BCD}	6.86(1.5)^{C}	0.181(0.03)^{CD}
NHPI	40	55.6(2.8)^{B}	30.4(1.8)^{BC}	23.1(2.5)^{BC}	5.79(1.2)^{B}	0.149(0.02)^{AB}
NHPA	40	54.9(2.5)^{AB}	29.0(1.7)^{A}	20.6(1.8)^{A}	4.76(1.2)^{A}	0.145(0.03)^{A}
MECC	40	56.5(2.1)^{C}	30.8(1.9)^{C}	22.3(2.8)^{B}	8.04(1.6)^{D}	0.208(0.04)^{E}
MEBH	-	no data	no data	no data	no data	no data
MERY	30	56.2(2.6)^{B}	29.9(1.6)^{A}	21.6(1.8)^{A}	6.70(1.4)^{B}	0.182(0.03)^{B}
MEKN	30	56.2(2.5)^{B}	29.2(1.6)^{A}	22.1(2.1)^{A}	8.33(1.6)^{C}	0.229(0.03)^{C}
MEFP	30	55.2(2.7)^{A}	29.6(1.9)^{A}	21.4(1.9)^{A}	5.37(1.2)^{A}	0.158(0.04)^{A}
MEPI	20	55.8(2.7)^{AB}	29.6(2.4)^{A}	23.8(2.1)^{B}	6.64(1.4)^{B}	0.181(0.02)^{AB}
MEFR	-	no data	no data	no data	no data	no data
NBSC	29	49.6(5.0)^{A}	24.5(3.2)^{AB}	22.0(2.3)^{B}	5.42(2.1)^{A}	0.191(0.04)^{A}
NBHI	30	49.8(4.0)^{AB}	23.1(2.2)^{A}	17.3(2.3)^{A}	4.78(1.5)^{A}	0.236(0.05)^{B}
NBLN	30	51.4(4.1)^{B}	26.4(4.7)^{B}	22.4(3.1)^{B}	6.62(1.8)^{B}	0.214(0.03)^{AB}
NSFI	120	54.3(2.6)^{A}	29.1(1.9)^{AB}	22.9(2.0)^{BC}	7.71(1.4)^{C}	0.212(0.02)^{D}
NSDI	80	56.5(2.3)^{B}	30.2(1.7)^{C}	22.2(1.4)^{B}	8.99(1.5)^{D}	0.236(0.02)^{E}
NSBC	80	55.6(2.7)^{B}	29.8(2.2)^{BC}	23.4(2.0)^{C}	6.82(1.3)^{AB}	0.176(0.03)^{A}
NSYR	80	55.8(2.7)^{B}	30.3(1.8)^{C}	22.5(2.0)^{B}	7.13(1.3)^{B}	0.187(0.03)^{BC}
NSAG	80	55.6(2.4)^{B}	28.6(1.6)^{A}	21.4(1.2)^{A}	6.49(1.3)^{A}	0.190(0.03)^{C}
MEAN		55.0 (3.3)	29.0 (2.6)	22.6 (2.4)	6.84 (1.8)	0.189 (0.04)

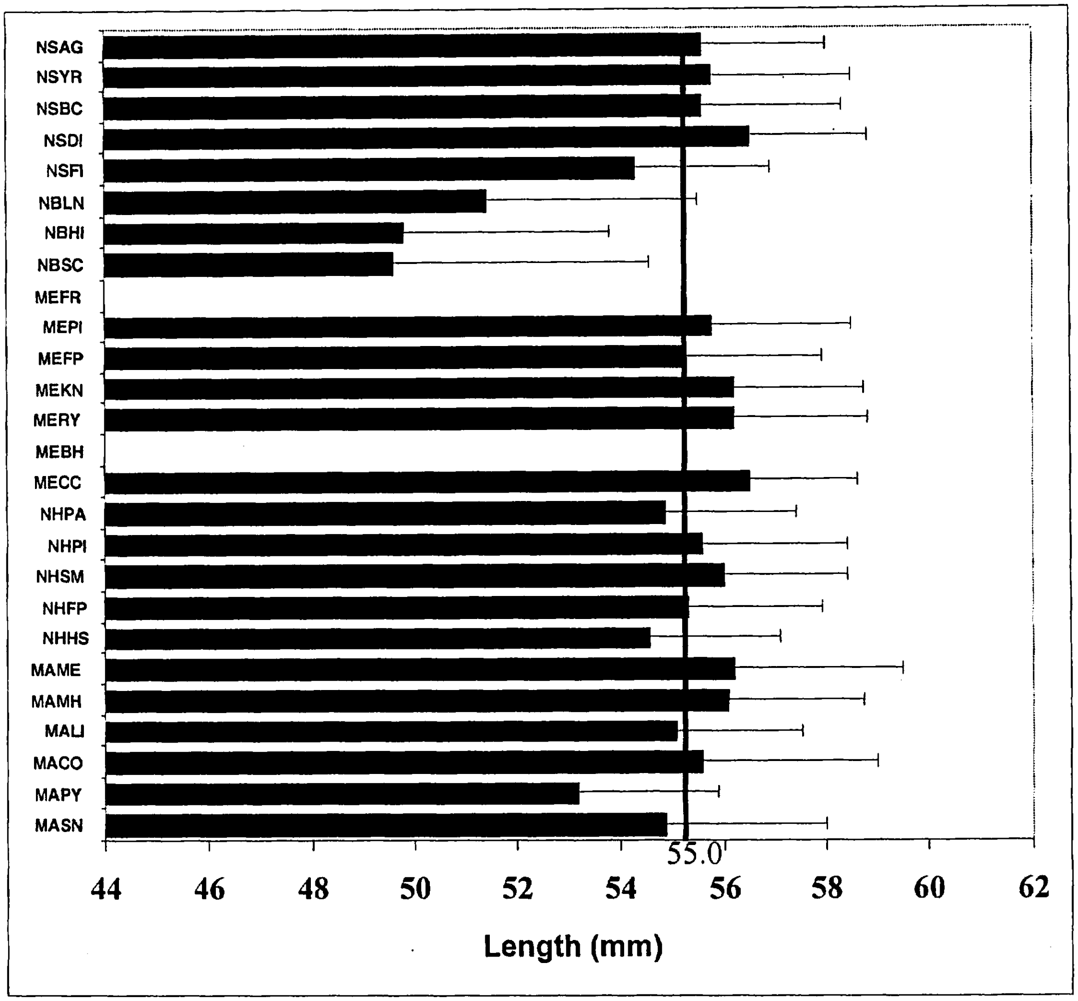


Figure 12. Mean length (+/- SD) of mussels collected at the Gulf of Maine stations, 1999 organised from south to north. Mean length of mussels from all sites is indicated by the straight line.

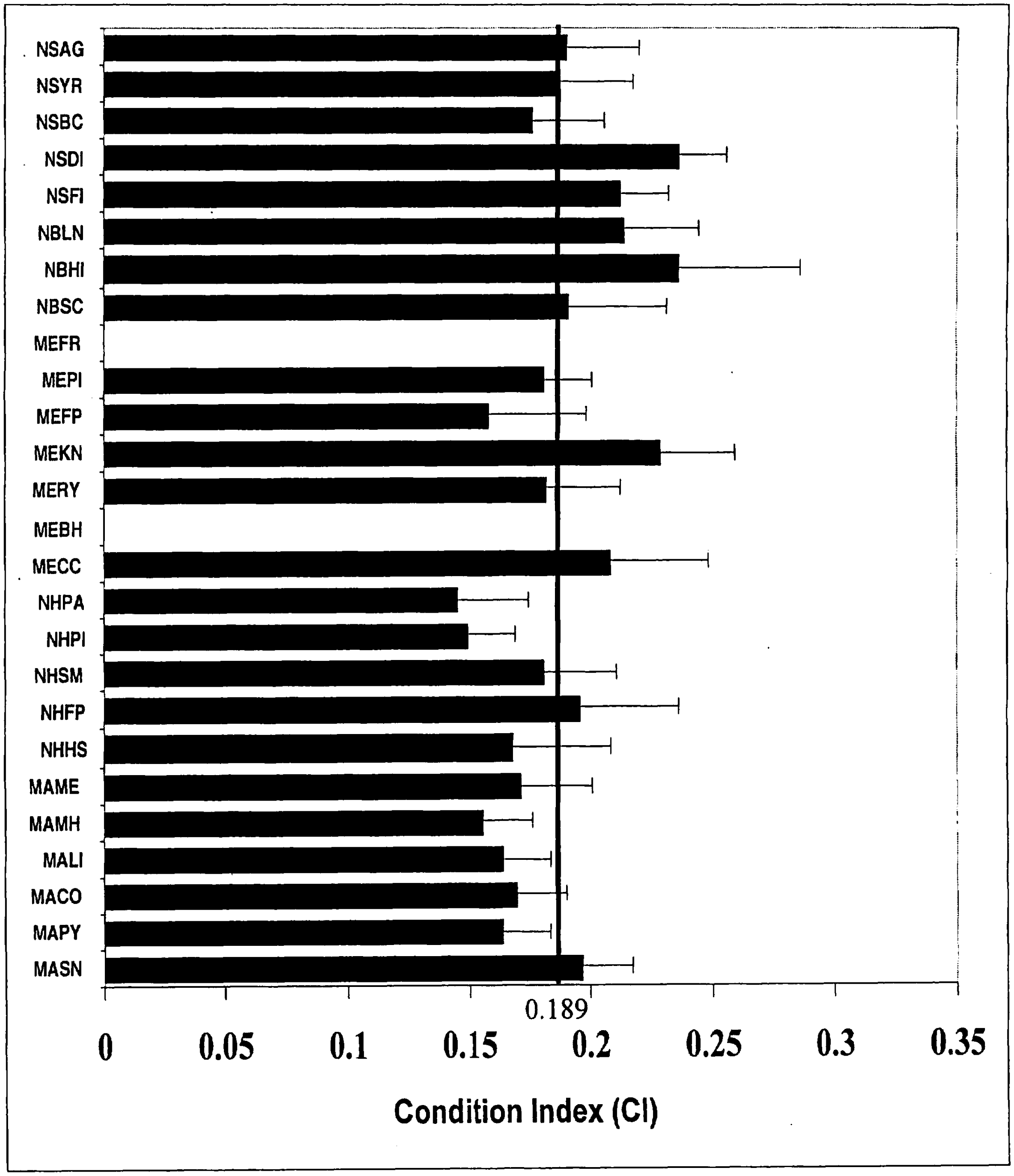


Figure 13. Mean Condition Indicies (CI) (+/- SD) of mussels collected at the Gulf of Maine stations, 1999 organised from south to north. Mean CI of mussels from all sites is indicated by the straight line.

4.0 CONCLUSIONS

The field season of 1999 represented the ninth Gulfwatch season overall and the first year of the third three-year rotation sampling plan.. This year's sampling revealed few sites exceeding the NS&T MD + 1 SD concentration for the metal or organic contaminants. The concentrations of mercury throughout the Gulf continue to be a source of concern. Twenty-one of the 26 Gulwatch sites sampled in 1999 exceeded the NS&T MD + 1 SD for Hg. Currently the best explanation for the source of the contamination is atmospheric deposition. Although the concentrations of mercury were high they did not exceed the federal action concentration.

The spatial pattern of contaminant concentrations was similar to that observed in previous years. The concentration of metals was relatively uniform with the occasional elevated hot spot. Whereas, the concentration of organic contaminants, especially ΣPCB and ΣPEST tended to be higher in the south-western Gulf.

There are now seven years of data from the benchmark sites. Analysis revealed decreases in all contaminants except Al, ΣPAH and ΣPEST. Concentrations of all organic contaminants (ΣPAH, ΣPCB and ΣPEST) increased in at least one site. In addition to looking for temporal patterns in the benchmark sites the sampling design of Gulfwatch allows for repeated sampling of annual sites every 3 years. Most of the stations sampled in 1999 were the same ones sampled in 1993 and 1996. For both metal and organic contaminants significant differences were observed between years for all contaminants. When differences were observed, the majority of metals appeared to decrease, however, most organic contaminant concentrations increased. The temporal pattern of the benchmark sites and annual sites are similar. This is an encouraging result for the final Gulfwatch temporal analysis.

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

5.0 ACKNOWLEDGEMENTS

The authors are grateful to the following individuals: Don Walter, Andy Bagnell, Noel Carlson, Andrea Riley, Joanne McLaughlin, Andrea Bowman, Amber Currier, Paul Currier, Rob Livingston, Eric Williams, Deb Lamson, Charles Elvin, Tina Nims, Bob Gaudet, Ronald MacDonald and Irma Simon for their assistance in field collection, sample preparation and laboratory analyses. This study was possible through the diligent field work of teams in Massachusetts, New Hampshire, Maine, New Brunswick and Nova Scotia. The study team gratefully acknowledges financial support from the U.S. Environmental Protection Agency through the U.S. Gulf of Maine Association and Environment Canada. Association and laboratory determinations of organic pollutants by Environment Canada and mussel depuration studies by Fisheries and Oceans Canada.

6.0 REFERENCES

Barchard, W. W. & A. Johnson-Hayden. (1990) *Gulf Watch, The Gulf of Maine Marine Environmental Quality Monitoring Program.* Presented at the 14th Annual Aquatic Toxicity Workshop, Vancouver, B.C.

Barchard, W. W. (1991) *The Gulf of Maine Marine Environmental Quality Monitoring Program.* Presented at the Scientific Workshop on the Gulf of Maine. Maine Biology Laboratory. Woods Hole, Mass.

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

Bryan, G.W. & W.J. Langston (1992) Bioavailability, accumulation, and the effects of heavy metals in sediments with special reference to United Kingdom Estuaries: a review. Environ. Pollut. 76:89.

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

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

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

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

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

Cohen, D.J. (2000) *Interim offshore monitoring program Round 1 data package for Portsmouth Naval Shipyard, Kittery, Maine.* Northern Division, Naval Facilities Engineering Command, Lester, PA.

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

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

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

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

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

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

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

Getchell, S. 2002. The spatial and temporal distribution of Cu, Pb, Zn and Cd in marine sediments from Boothbay, Maine. MS Thesis. Department of Earth Sciences University of New Hampshire, Durham.

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

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

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

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

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

Jones, S.H., M. Chase, J. Sowles, P. Hennigar, P. Wells, W. Robinson, G. Harding, R. Crawford, D. Taylor, K. Freeman, J. Pederson, L. Mucklow and K. Coombs. 1998. The first five years of Gulfwatch, 1991-1995: A review of the program and results. The Gulf of Maine Council on the Marine Environment. 152 p.

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

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

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

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

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

Larsen, R.P. & H.E. Gaudette (1995) Spatial and temporal aspects of sedimentary trace metal concentrations in mid-coast Maine. *Mar. Pollut. Bull.* **30(7)**: 437-444.

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

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

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

NCCOSC, Naval Command, Control and Ocean Surveillance Center (1997) *Estuarine ecological risk assessment in Portsmouth Naval Shipyard, Kittery, ME*, Vol. 1: Technical report. Revised draft final. Northern Division, Naval Facilities Engineering Command, Lester, PA.

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

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

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

New Hampshire Estuaries Project (NHEP). (2001) A technical characterization of estuarine and coastal New Hampshire. Jones, S.H. (Ed.). New Hampshire Estuaries Project, Portsmouth, NH.

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

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

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

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

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

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

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

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

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

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

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

Sowles, J., R. Crawford, P. Hennigar, G. Harding, S. Jones, M.E. Chase, W. Robinson, J. Pederson, K. Coombs, D. Taylor and K. Freeman. 1997. Gulfwatch project standard procedures: field and laboratory. Gulfwatch implementation period 1993-2001. Gulf of Maine Council on the Marine Environment, State Planning Office, Augusta, ME.

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

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

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

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

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

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

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

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

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

APPENDIX A: TISSUE CONCENTRATION OF HEAVY METALS

MASSACHUSETTS SAMPLES

Station/Sample#	AG	AL	CD	CR	CU	FE	HG	NI	PB	ZN	% Solids
MASN1N	0.05	54	1.5	0.7	5.7	120	0.25	0.5	2.1	75	21.3
MASN2N	1.4	56	1.4	0.7	6.5	130	0.25	0.5	2.6	68	19.5
MASN3N	1.8	74	1.9	0.9	7.6	170	0.26	0.7	2.3	80	16.9
MASN4N	0.8	81	1.3	0.7	5.3	150	0.29	0.6	1.1	57	19.1
Mean	**1.01**	**66.25**	**1.53**	**0.75**	**6.28**	**142.50**	**0.26**	**0.58**	**2.03**	**70.00**	**19.20**
St. Dev.	**0.76**	**13.33**	**0.26**	**0.10**	**1.01**	**22.17**	**0.02**	**0.10**	**0.65**	**9.97**	**1.81**
MASN1N	0.2	250	1.8	2	7.9	470	0.44	1.3	3	140	14
MASN2N	0.1	230	1.7	1.9	7.1	470	0.48	1.3	2.5	110	15.1
MASN3N	0.1	180	1.4	1.6	5.6	370	0.42	1	2	99	13.7
MASN4N	0.1	200	1.7	2	6.4	410	0.53	1.3	2.4	130	13.8
Mean	**0.13**	**215.00**	**1.65**	**1.88**	**6.75**	**430.00**	**0.47**	**1.23**	**2.48**	**119.75**	**14.15**
St. Dev.	**0.05**	**31.09**	**0.17**	**0.19**	**0.98**	**48.99**	**0.05**	**0.15**	**0.41**	**18.63**	**0.65**
MAME1N	0.1	100	3.2	1.9	8	310	0.4	1	3	90	14.5
MAME2N	0.1	110	2.6	1.8	8.3	320	0.42	1.1	3.1	90	11.8
MAME3N	0.1	110	2	1.6	7	310	0.57	0.9	2.5	76	12.5
Mean	**0.10**	**106.67**	**2.60**	**1.77**	**7.77**	**313.33**	**0.46**	**1.00**	**2.87**	**85.33**	**12.93**
St. Dev.	**0.00**	**5.77**	**0.60**	**0.15**	**0.68**	**5.77**	**0.09**	**0.10**	**0.32**	**8.08**	**1.40**
MAPY1N	0.2	100	1.1	1.1	5.6	230	0.34	1	2	90	16.9
MAPY2N	0.3	80	1.3	1	5.8	200	0.42	0.9	2	82	17.2
MAPY3N	0.4	85	1.2	0.9	5.7	200	0.31	0.8	1.7	84	19.1
MAPY4N	0.5	85	1	0.8	5.9	200	0.35	0.8	1.3	76	19.5
Mean	**0.35**	**87.50**	**1.15**	**0.95**	**5.75**	**207.50**	**0.36**	**0.88**	**1.75**	**83.00**	**18.18**
St. Dev.	**0.13**	**8.66**	**0.13**	**0.13**	**0.13**	**15.00**	**0.05**	**0.10**	**0.33**	**5.77**	**1.31**
MACO1N	0.2	90	1	1.2	5.5	260	0.35	0.6	2.5	82	15.4
MACO2N	0.3	130	1.3	1.6	7	320	0.57	0.9	3.9	130	14.7
MACO3N	0.4	130	1.2	1.3	6.2	210	0.57	0.6	2.9	100	15.6
MACO4N	0.8	150	1.1	1.5	7.6	260	0.39	0.9	3.9	150	16.6
Mean	**0.43**	**125.00**	**1.15**	**1.40**	**6.58**	**262.50**	**0.47**	**0.75**	**3.30**	**115.50**	**15.58**
St. Dev.	**0.26**	**25.17**	**0.13**	**0.18**	**0.92**	**45.00**	**0.12**	**0.17**	**0.71**	**30.35**	**0.78**
MALI1N	0.2	150	1.6	1.9	7.1	280	0.48	0.9	6.1	140	12.7
MALI2N	0.3	170	1.8	2.2	8.6	380	0.27	1.2	6.4	160	13.2
MALI3N	0.2	170	1.7	1.9	7.7	290	0.44	0.9	5.8	200	14
MALI4N	0.2	120	1.5	1.6	6.8	220	0.41	0.8	5.3	150	14.9
Mean	**0.23**	**152.50**	**1.65**	**1.90**	**7.55**	**292.50**	**0.40**	**0.95**	**5.90**	**162.50**	**13.70**
St. Dev.	**0.05**	**23.63**	**0.13**	**0.24**	**0.79**	**66.02**	**0.09**	**0.17**	**0.47**	**26.30**	**0.96**

NEW HAMPSHIRE SAMPLES

Station/Sample#	AG	AL	CD	CR	CU	FE	HG	NI	PB	ZN	% Solids
NHPA1N	ND 0.1	220	1.8	2.3	7.4	310	0.79	1.9	2.6	120	13.2
NHPA2N	ND 0.1	190	1.8	2	8.1	290	0.55	1.6	2.7	120	14.5
NHPA3N	ND 0.1	230	1.8	2	7.5	310	0.76	1.6	2.8	130	13.8
NHPA4N	ND 0.1	200	2.2	2.2	8	330	0.75	1.4	3.9	130	14.9
Mean	**0.00**	**210.00**	**1.90**	**2.13**	**7.75**	**310.00**	**0.71**	**1.63**	**3.00**	**125.00**	**14.10**
St. Dev.	**0.00**	**18.26**	**0.20**	**0.15**	**0.35**	**16.33**	**0.11**	**0.21**	**0.61**	**5.77**	**0.75**
NHHS1N	ND 0.1	180	1.6	1.3	7.5	260	0.4	1.3	2.5	94	14.9
NHHS2N	ND 0.1	170	2.1	1.5	7.8	270	0.39	1.2	3.5	130	15
NHHS3N	ND 0.1	150	2.1	1.2	7.2	240	0.37	1.4	2.5	130	18.2
NHHS4N	ND 0.1	180	2.2	1.2	7.7	260	0.34	0.9	1.8	98	17.8
Mean	**0.00**	**170.00**	**2.00**	**1.30**	**7.55**	**257.50**	**0.38**	**1.20**	**2.58**	**113.00**	**16.48**
St. Dev.	**0.00**	**14.14**	**0.27**	**0.14**	**0.26**	**12.58**	**0.03**	**0.22**	**0.70**	**19.70**	**1.77**
NHSM1N	ND 0.1	210	1.1	3	6.6	430	0.81	1.1	4.4	66	11.9
NHSM2N	ND 0.1	270	1	2.8	6.7	490	0.87	1.2	5.1	57	12
NHSM3N	ND 0.1	240	1	3.1	7.3	400	0.62	3.4	4.5	60	12
NHSM4N	ND 0.1	230	1	2.4	6.8	400	0.78	1.3	4.1	62	11.4
Mean	**0.00**	**237.50**	**1.03**	**2.83**	**6.85**	**430.00**	**0.77**	**1.75**	**4.53**	**61.25**	**11.83**
St. Dev.	**0.00**	**25.00**	**0.05**	**0.31**	**0.31**	**42.43**	**0.11**	**1.10**	**0.42**	**3.77**	**0.29**
NHPI1N	ND 0.1	150	2.1	2.8	8	330	0.67	1.4	4.3	140	14.6
NHPI2N	ND 0.1	200	2.3	3.8	7.9	360	0.67	1.3	4.7	150	13.3
NHPI3N	ND 0.1	180	2.4	2.6	7.6	330	0.49	1.4	4.3	130	13.6
NHPI4N	ND 0.1	270	2.7	3.1	9.1	510	0.85	1.5	6.2	180	13.1
Mean	**0.00**	**200.00**	**2.38**	**3.08**	**8.15**	**382.50**	**0.67**	**1.40**	**4.88**	**150.00**	**13.65**
St. Dev.	**0.00**	**50.99**	**0.25**	**0.53**	**0.66**	**86.17**	**0.15**	**0.08**	**0.90**	**21.60**	**0.67**
NHFP1N	0.1	300	2.4	2.8	7.3	440	0.71	1.4	2.9	130	9.3
NHFP2N	0.1	270	2.2	2.5	7.4	420	0.72	1.6	2.9	120	9.8
NHFP3N	0.2	270	1.9	2.4	7	400	0.68	1.5	2	100	10.3
NHFP4N	0.05	300	2.5	2.7	7.5	460	0.7	1.6	3.4	160	9.6
Mean	**0.11**	**285.00**	**2.25**	**2.60**	**7.30**	**430.00**	**0.70**	**1.53**	**2.80**	**127.50**	**9.75**
St. Dev.	**0.06**	**17.32**	**0.26**	**0.18**	**0.22**	**25.82**	**0.02**	**0.10**	**0.58**	**25.00**	**0.42**

MAINE SAMPLES

Station/Sample#	AG	AL	CD	CR	CU	FE	HG	NI	PB	ZN	% Solids
MEKN1N	0.1	70	2.1	1.4	7.2	130	0.5	0.7	1.1	58	11
MEKN2N	0.1	110	2.5	7.1	8.9	260	0.54	1	1.3	64	11.3
MEKN3N	0.1	110	2.3	2.2	9	190	0.52	1	1.1	64	12.4
MEKN4N	0.1	92	2.1	1.5	11	160	0.55	0.9	1.2	65	12.2
Mean	**0.10**	**95.50**	**2.25**	**3.05**	**9.03**	**185.00**	**0.53**	**0.90**	**1.18**	**62.75**	**11.73**
St. Dev.	**0.00**	**19.00**	**0.19**	**2.72**	**1.55**	**55.68**	**0.02**	**0.14**	**0.10**	**3.20**	**0.68**
MEPI1N	0.05	94	1.6	1.2	5.5	150	0.75	0.8	0.6	71	15.7
MEPI2N	0.05	75	1.8	1	5.7	140	0.51	0.8	0.6	79	15.1
MEPI3N	0.1	71	2	1.4	6.2	140	0.47	1	0.6	73	14.3
MEPI4N	0.1	58	1.5	0.9	5.5	110	0.51	0.7	0.4	59	15.5
Mean	**0.08**	**74.50**	**1.73**	**1.13**	**5.73**	**135.00**	**0.56**	**0.83**	**0.55**	**70.50**	**15.15**
St. Dev.	**0.03**	**14.89**	**0.22**	**0.22**	**0.33**	**17.32**	**0.13**	**0.13**	**0.10**	**8.39**	**0.62**
MEFP1N	0.05	80	1.1	0.9	5.1	200	0.5	0.6	0.8	58	18
MEFP2N	0.05	140	1.7	1.5	7.3	350	0.74	0.8	1.3	77	13.2
MEFP3N	0.05	130	1.3	1.1	6	300	0.48	0.8	1.2	77	17
MEFP4N	0.1	120	1.4	1.2	7.2	260	0.56	1.3	1.2	62	15
Mean	**0.06**	**117.50**	**1.38**	**1.18**	**6.40**	**277.50**	**0.57**	**0.88**	**1.13**	**68.50**	**15.80**
St. Dev.	**0.03**	**26.30**	**0.25**	**0.25**	**1.05**	**63.44**	**0.12**	**0.30**	**0.22**	**9.95**	**2.14**
MERY1N	ND 0.1	220	1.4	1.4	7.6	400	0.6	1.5	1.3	78	10.7
MERY2N	ND 0.1	170	1.2	1	9.2	310	0.5	0.8	1.4	83	12.4
MERY3N	ND 0.1	280	1.4	1.4	7.6	460	0.56	1	1.3	96	11.4
MERY4N	ND 0.1	240	1.2	1.1	6.5	370	0.5	0.9	1.2	75	11.6
Mean	**0.00**	**227.50**	**1.30**	**1.23**	**7.73**	**385.00**	**0.54**	**1.05**	**1.30**	**83.00**	**11.53**
St. Dev.	**0.00**	**45.73**	**0.12**	**0.21**	**1.11**	**62.45**	**0.05**	**0.31**	**0.08**	**9.27**	**0.70**
MEFR1N	0.05	440	2.2	1.9	8.4	760	1.14	1.8	7.2	190	9.7
MEFR2N	0.1	420	2	1.8	8.5	640	0.98	1.5	6.9	140	9.5
MEFR3N	0.1	270	1.8	1.4	7	480	0.95	1.2	5.6	130	9.7
MEFR4N	0.05	160	1.5	1.1	5.5	310	0.83	1.1	3.4	96	9.7
Mean	**0.08**	**322.50**	**1.88**	**1.55**	**7.35**	**547.50**	**0.98**	**1.40**	**5.78**	**139.00**	**9.65**
St. Dev.	**0.03**	**132.26**	**0.30**	**0.37**	**1.41**	**195.51**	**0.13**	**0.32**	**1.73**	**38.87**	**0.10**
MEBH1N	0.2	230	1.3	1.7	5.7	260	0.32	2	1.1	84	12.5
MEBH2N	0.2	94	1.6	1.1	5.7	170	0.39	1.1	1.7	95	11.9
MEBH3N	0.2	120	1.5	1	5.8	200	0.44	0.9	1.5	66	11.8
MEBH4N	0.2	120	1.4	1	5.7	210	0.39	1	1.6	73	12
Mean	**0.20**	**141.00**	**1.45**	**1.20**	**5.73**	**210.00**	**0.39**	**1.25**	**1.48**	**79.50**	**12.05**
St. Dev.	**0.00**	**60.59**	**0.13**	**0.34**	**0.05**	**37.42**	**0.05**	**0.51**	**0.26**	**12.71**	**0.31**
MECC1N	ND 0.1	160	1.5	1.8	6.5	280	0.63	1.1	3.6	120	11.7
MECC2N	ND 0.1	190	1.3	1.9	7.4	320	0.47	1.2	3.7	110	12.3
MECC3N	ND 0.1	210	1.5	2	7.4	350	0.6	1.4	4.3	110	11.8
MECC4N	ND 0.1	230	1.4	1.8	6.7	350	0.53	1.3	4.6	87	10.1
Mean	**0.00**	**197.50**	**1.43**	**1.88**	**7.00**	**325.00**	**0.56**	**1.25**	**4.05**	**106.75**	**11.48**
St. Dev.	**0.00**	**29.86**	**0.10**	**0.10**	**0.47**	**33.17**	**0.07**	**0.13**	**0.48**	**13.99**	**0.95**

NEW BRUNSWICK SAMPLES

Station/Sample#	AG	AL	CD	CR	CU	FE	HG	NI	PB	ZN	% Solids
NBLN1N	ND 0.1	170	1	0.8	6.2	250	0.23	0.6	1	58	18.9
NBLN2N	ND 0.1	220	1.1	0.9	6.2	270	0.2	0.6	1	63	19
NBLN3N	ND 0.1	150	1.1	0.8	5.3	240	0.23	0.5	1.1	66	18.7
NBLN4N	ND 0.1	160	0.9	0.8	5.4	250	0.25	0.6	0.7	64	19
Mean	**0.00**	**175.00**	**1.03**	**0.83**	**5.78**	**252.50**	**0.23**	**0.58**	**0.95**	**62.75**	**18.90**
St. Dev.	**0.00**	**31.09**	**0.10**	**0.05**	**0.49**	**12.58**	**0.02**	**0.05**	**0.17**	**3.40**	**0.14**
NBSC1N	0.05	260	1.2	1	4.5	340	0.29	0.9	2.7	64	15.2
NBSC2N	0.1	210	1.1	0.9	4.9	310	0.28	0.7	3	62	15.2
NBSC3N	0.05	240	1.2	1	4.5	320	0.27	0.8	1.9	59	17
NBSC4N	0.05	240	1.1	1	4.5	340	0.24	0.9	2.1	64	16.5
Mean	**0.06**	**237.50**	**1.15**	**0.98**	**4.60**	**327.50**	**0.27**	**0.83**	**2.43**	**62.25**	**15.98**
St. Dev.	**0.03**	**20.62**	**0.06**	**0.05**	**0.20**	**15.00**	**0.02**	**0.10**	**0.51**	**2.36**	**0.92**
NBHI1N	ND 0.1	100	0.7	0.5	4.3	120	0.17	0.6	0.4	48	20.7
NBHI2N	ND 0.1	79	0.6	0.5	4.4	110	0.18	0.6	0.5	55	21.4
NBHI3N	ND 0.1	83	0.7	0.5	4.1	110	0.16	0.7	K 0.4	58	21.3
NBHI4N	ND 0.1	90	0.6	0.6	3.7	120	0.18	0.7	0.5	59	22.2
Mean	**0.00**	**88.00**	**0.65**	**0.53**	**4.13**	**115.00**	**0.17**	**0.65**	**0.47**	**55.00**	**21.40**
St. Dev.	**0.00**	**9.20**	**0.06**	**0.05**	**0.31**	**5.77**	**0.01**	**0.06**	**0.06**	**4.97**	**0.62**

NOVA SCOTIA SAMPLES

Station/Sample#	AG	AL	CD	CR	CU	FE	HG	NI	PB	ZN	% Solids
NSBC1N	0.1	240	2.5	1.9	5.9	340	0.41	0.9	2.1	64	12
NSBC2N	0.1	100	2.1	1.9	5.8	120	0.32	0.6	0.4	48	11.5
NSBC3N	0.1	270	2.3	1.7	5.6	470	0.41	1.7	2.2	97	11.3
NSBC4N	0.1	360	3	2	5.5	530	0.45	2.2	3.1	88	10.7
Mean	**0.10**	**242.50**	**2.48**	**1.88**	**5.70**	**365.00**	**0.40**	**1.35**	**1.95**	**74.25**	**11.38**
St. Dev.	**0.00**	**107.82**	**0.39**	**0.13**	**0.18**	**181.57**	**0.06**	**0.73**	**1.13**	**22.37**	**0.54**
NSYR1N	0.7	280	1.5	1.6	6.3	460	0.42	1.7	2.3	79	12.8
NSYR2N	0.7	420	1.5	1.9	7.3	600	0.37	1.7	2.1	99	12.9
NSYR3N	0.5	250	1.4	1.5	6.3	480	0.39	1.4	2.6	90	14.2
NSYR4N	0.4	170	1.4	1.2	5.6	370	0.42	1.3	2.5	78	14
Mean	**0.58**	**280.00**	**1.45**	**1.55**	**6.38**	**477.50**	**0.40**	**1.53**	**2.38**	**86.50**	**13.48**
St. Dev.	**0.15**	**104.24**	**0.06**	**0.29**	**0.70**	**94.65**	**0.02**	**0.21**	**0.22**	**9.95**	**0.73**
NSAG1N	0.05	110	1.4	1.2	5.3	260	0.46	1.2	2.9	81	12.3
NSAG2N	0.1	160	1.5	1.4	5.8	330	0.49	1.6	3	82	12
NSAG3N	0.1	150	1.4	1.3	5.2	320	0.59	1.5	3.6	95	13.1
NSAG4N	0.1	140	1.7	1.3	3.4	330	0.62	1.3	3.9	86	11.9
Mean	**0.09**	**140.00**	**1.50**	**1.30**	**4.93**	**310.00**	**0.54**	**1.40**	**3.35**	**86.00**	**12.33**
St. Dev.	**0.03**	**21.60**	**0.14**	**0.08**	**1.05**	**33.67**	**0.08**	**0.18**	**0.48**	**6.38**	**0.54**
NSDI1N	K 0.1	210	1.1	0.9	6.8	300	0.27	0.9	1.9	81	19
NSDI2N	ND 0.1	200	1	0.9	7.1	290	0.26	0.8	1.6	72	20.1
NSDI3N	ND 0.1	210	1.3	0.9	6.6	320	0.36	1	2.4	72	18.3
NSDI4N	ND 0.1	170	0.9	0.8	6.2	250	0.29	0.8	1.5	63	19.5
Mean	**0.00**	**197.50**	**1.08**	**0.88**	**6.68**	**290.00**	**0.30**	**0.88**	**1.85**	**72.00**	**19.23**
St. Dev.	**0.00**	**18.93**	**0.17**	**0.05**	**0.38**	**29.44**	**0.05**	**0.10**	**0.40**	**7.35**	**0.76**
NSFI1N-dep	0.05	24	2.4	0.9	4.3	110	0.39	1.2	0.7	61	13
NSFI2N-dep	0.01	32	2.5	0.9	4	100	0.43	1.5	0.6	58	12.2
NSFI3N-dep	0.05	39	2.5	0.9	4.3	130	0.43	1.1	0.8	62	12.2
NSFI4N-dep	0.1	65	2.6	1.2	4.7	160	0.41	1.4	1.1	68	12.6
Mean	**0.05**	**40.00**	**2.50**	**0.98**	**4.33**	**125.00**	**0.42**	**1.30**	**0.80**	**62.25**	**12.50**
St. Dev.	**0.04**	**17.76**	**0.08**	**0.15**	**0.29**	**26.46**	**0.02**	**0.18**	**0.22**	**4.19**	**0.38**
NSFI1N	ND 0.1	610	2.1	1.6	5.3	780	0.35	1.7	0.8	66	12.7
NSFI2N	ND 0.1	960	2.8	2.3	6.2	1200	0.38	2.5	1.5	84	11.6
NSFI3N	ND 0.1	590	2.5	1.5	4.9	740	0.4	1.8	0.9	58	12
NSFI4N	ND 0.1	600	2.4	1.8	4.8	790	0.5	2.1	1	68	10.6
Mean	**0.00**	**690.00**	**2.45**	**1.80**	**5.30**	**877.50**	**0.41**	**2.03**	**1.05**	**69.00**	**11.73**
St. Dev.	**0.00**	**180.19**	**0.29**	**0.36**	**0.64**	**216.08**	**0.07**	**0.36**	**0.31**	**10.89**	**0.88**

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	MASN 01	MASN 02	MASN 03	MASN 04	MACO 01	MACO 02	MACO 03
Naphthalene	<4	<4	<4	<4	<4	<4	4.3
1-Methylnaphthalene	<3	<3	4.3	<3	<3	<3	<3
2-Methylnaphthalene	4.9	4.2	6.9	4.2	<3	<3	3.0
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	4.1	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	7.6	8.4	9.0	8.4	6.4	6.8	8.6
Anthracene	<2	<2	<2	<2	<2	<2	<2
1-Methylphenanthracene	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	14.3	17.4	17.6	16.3	15	15	20
Pyrene	8.7	8.9	8.0	9.3	10	9.5	13
Benzo(a)Anthracene	4.0	4.9	<2	<2	<2	<2	2.5
Chrysene	3.4	4.7	3.9	<2	5.2	5.1	6.6
Benzo(b)Fluoranthene	<8	<8	<8	<8	<8	<8	<8
Benzo(k)Fluoranthene	<2	<2	<2	<2	2.5	2.6	3.5
Benzo(e)Pyrene	3.2	3.7	3.4	4.1	4.7	4.6	6.5
Benzo(a)Pyrene	<3	<3	<3	<3	<3	<3	<3
Perylene	<3	<3	<3	<3	<3	<3	<3
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	<2	<2	<2	<2	2.2	2.3	3.0
Total	46	52	57	42	46	46	70
Surrogate Recovery							
Naphthalene-d8	71%	68%	68%	62%	67%	58%	70%
Acenaphthene-d10	86%	86%	88%	81%	81%	80%	82%
Phenanthrene-d10	94%	96%	92%	92%	91%	91%	92%
Fluoranthene-d10	102%	101%	101%	98%	99%	97%	100%
Chrysene-d12	97%	101%	94%	93%	97%	96%	100%
Benzo(a)pyrene-d12	89%	93%	88%	91%	81%	80%	82%
Benzo(g,h,i)perylene-d12	91%	95%	87%	93%	90%	90%	90%
% dry wt	18%	18%	18%	18%	17%	17%	17%
% water	82%	82%	82%	82%	83%	83%	83%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	MACO 04	MAMH 01	MAMH 02	MAMH 03	MAMH 04	MAPY 01	MAPY 02	MAPY 03
Naphthalene	<4	<4	<4	<4	<4	<4	<4	<4
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	9.0	5.1	5.9	5.9	4.8	6.9	4.7	5.4
Anthracene	<2	<2	<2	<2	<2	<2	<2	<2
1-Methylphenanthracene	<4	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	19	12	12	12	9.2	12.8	9.0	10.5
Pyrene	13	7.4	7.9	7.9	6.5	9.4	6.2	7.4
Benzo(a)Anthracene	<2	<2	<2	<2	<2	<2	<2	<2
Chrysene	7.2	4.8	4.6	4.5	4.3	5.7	3.7	4.2
Benzo(b)Fluoranthene	<8	<8	<8	<8	<8	<8	<8	<8
Benzo(k)Fluoranthene	3.9	<2	2.0	2.0	2.0	2.9	<2	2.1
Benzo(e)Pyrene	6.2	<3	3.0	3.0	<3	4.1	<3	3.4
Benzo(a)Pyrene	<3	<3	<3	<3	<3	<3	<3	<3
Perylene	<3	<3	<3	<3	<3	<3	<3	<3
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	3.4	<2	<2	<2	<2	<2	<2	<2
Total	62	29	35	35	27	42	24	33
Surrogate Recovery								
Naphthalene-d8	68%	64%	62%	63%	67%	62%	66%	69%
Acenaphthene-d10	84%	76%	76%	78%	83%	86%	86%	88%
Phenanthrene-d10	94%	85%	94%	92%	96%	95%	88%	95%
Fluoranthene-d10	97%	92%	101%	98%	99%	98%	92%	98%
Chrysene-d12	97%	90%	101%	93%	98%	97%	90%	94%
Benzo(a)pyrene-d12	78%	75%	85%	75%	80%	90%	80%	84%
Benzo(g,h,i)perylene-d12	91%	88%	93%	92%	94%	93%	85%	92%
% dry wt	18%	19%	19%	19%	19%	21%	17%	19%
% water	82%	81%	81%	81%	81%	79%	83%	81%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	MAPY 04	MALI 01	MALI 02	MALI 03	MALI 04	MALI 04	MAME 04
						dup	
Naphthalene	<4	5.6	6.5	7.1	4.5	6.9	<4
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	3.9	3.6	4.6	3.2	4.2	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	4.8	35.2	20.1	18.6	12.5	12.8	10.4
Anthracene	<2	7.1	4.4	4.7	3.8	3.7	3.0
1-Methylphenanthracene	<4	7.9	6.5	6.9	5.3	5.2	<4
Fluoranthene	9.7	134.6	100.9	102.9	84.5	82.4	37.5
Pyrene	6.4	118.7	94.6	96.9	81.6	79.7	40.7
Benzo(a)Anthracene	<2	24.0	21.4	20.0	20.1	19.9	12.1
Chrysene	3.4	48.5	43.6	49.8	44.5	43.9	28.0
Benzo(b)Fluoranthene	<8	16.7	17.3	17.6	18.9	18.5	15.5
Benzo(k)Fluoranthene	<2	15.3	15.3	14.9	15.3	15.4	14.9
Benzo(e)Pyrene	<3	33.8	32.9	35.8	32.2	31.9	29.3
Benzo(a)Pyrene	<3	7.1	7.0	7.3	7.3	7.5	7.4
Perylene	<3	<3	<3	<3	<3	<3	7.1
Indeno(1,2,3,4-cd)Pyrene	<4	6.2	6.5	6.2	6.5	6.8	5.7
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	<2	10.0	10.8	10.9	10.6	10.7	10.3
Total	24	475	391	404	351	350	222
Surrogate Recovery							
Naphthalene-d8	72%	64%	77%	73%	59%	59%	66%
Acenaphthene-d10	92%	85%	91%	91%	78%	77%	82%
Phenanthrene-d10	106%	93%	94%	95%	94%	91%	90%
Fluoranthene-d10	108%	98%	97%	100%	99%	94%	94%
Chrysene-d12	108%	100%	99%	101%	100%	95%	92%
Benzo(a)pyrene-d12	96%	93%	93%	96%	92%	89%	82%
Benzo(g,h,i)perylene-d12	100%	94%	96%	95%	92%	91%	86%
% dry wt	18%	13%	14%	15%	15%	15%	13%
% water	82%	87%	86%	85%	85%	85%	87%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	MAME 03	MAME 02	MAME 01	NHHS 1N	NHHS 2N	NHHS 3N	NHHS 4N
Naphthalene	<4	<4	9.9	<4	<4	<4	<4
1-Methylnaphthalene	<3	<3	3.7	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	6.1	<3	<3	<3	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	3.0	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	7.3	7.8	16.0	4.9	5.1	7.3	8.1
Anthracene	2.0	2.0	3.8	<2	<2	<2	<2
1-Methylphenanthracene	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	28.2	29.8	56.4	16	16	17	19
Pyrene	30.3	31.8	65.8	14	13	13	14
Benzo(a)Anthracene	9.4	9.4	20.4	2.8	2.3	<2	<2
Chrysene	24.9	24.4	50.5	7	6.7	6.6	7.4
Benzo(b)Fluoranthene	13.9	13.2	30.5	<8	<8	<8	<8
Benzo(k)Fluoranthene	12.8	12.0	27.3	3.1	2.5	2.7	3.3
Benzo(e)Pyrene	23.4	24.8	50.2	5.9	5.3	6.4	7.0
Benzo(a)Pyrene	5.9	5.6	13.8	<3	<3	<3	<3
Perylene	5.7	4.9	10.4	<3	<3	<3	<3
Indeno(1,2,3,4-cd)Pyrene	5.7	4.5	10.4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	8.8	8.2	17.2	<2	<2	2.7	2.8
Total	178	178	392	54	51	59	61
Surrogate Recovery							
Naphthalene-d8	64%	69%	70%	70%	61%	54%	47%
Acenaphthene-d10	81%	83%	82%	87%	80%	60%	60%
Phenanthrene-d10	90%	93%	90%	94%	92%	90%	90%
Fluoranthene-d10	94%	97%	98%	103%	105%	107%	106%
Chrysene-d12	91%	95%	90%	99%	98%	96%	97%
Benzo(a)pyrene-d12	82%	87%	80%	79%	87%	83%	84%
Benzo(g,h,i)perylene-d12	83%	87%	83%	94%	97%	95%	94%
% dry wt	12%	13%	7%	18%	17%	18%	18%
% water	88%	87%	93%	82%	83%	82%	82%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	NHHS 4N	NHFP 1N	NHFP 2N	NHFP 3N	NHFP 4N	NHSM 1N	NHSM 2N
	dup						
Naphthalene	<4	<4	<4	4.4	<4	5.6	4.7
1-Methylnaphthalene	<3	<3	<3	4.9	<3	<3	<3
2-Methylnaphthalene	3.9	<3	3.2	11.1	<3	<3	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	3.1	<3	<3	<3	<3	<3	<3
Fluorene	<4	4.1	<4	<4	<4	<4	<4
Phenanthrene	6.7	7.6	10	10	8.1	9.8	11
Anthracene	<2	2.2	2.7	2.3	2.3	2.2	2.7
1-Methylphenanthracene	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	16	39	38	39	40	52	46
Pyrene	12	66	69	68	71	74	69
Benzo(a)Anthracene	<2	19	19	20	26	23	23
Chrysene	6.5	37	35	35	41	58	47
Benzo(b)Fluoranthene	<8	36	35	38	44	60	50
Benzo(k)Fluoranthene	2.6	30	27	30	37	48	45
Benzo(e)Pyrene	5.8	40	41	40	47	56	52
Benzo(a)Pyrene	<3	13	12	13	17	16	18
Perylene	<3	17	19	19	23	11	13
Indeno(1,2,3,4-cd)Pyrene	<4	13	16	17	19	27	27
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	2.4	14	15	16	17	22	23
Total	59	337	342	371	394	464	431
Surrogate Recovery							
Naphthalene-d8	52%	63%	62%	59%	61%	69%	62%
Acenaphthene-d10	75%	77%	79%	81%	79%	81%	78%
Phenanthrene-d10	89%	87%	85%	92%	94%	87%	87%
Fluoranthene-d10	112%	95%	91%	99%	104%	95%	94%
Chrysene-d12	98%	94%	86%	93%	101%	90%	92%
Benzo(a)pyrene-d12	80%	90%	82%	92%	100%	88%	91%
Benzo(g,h,i)perylene-d12	97%	98%	94%	110%	108%	100%	99%
% dry wt	18%	11%	13%	11%	12%	12%	13%
% water	82%	89%	87%	89%	88%	88%	87%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	NHSM 3N	NHSM 4N	NHPI 1N	NHPI 2N	NHPI 3N	NHPI 4N	NHPA 1N
Naphthalene	<4	9.6	4.3	5.1	7.2	5.2	4.8
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	5.8	3.8	<3	4.2	4.0	4.4
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	13	10	11	12	10	11	9
Anthracene	2.7	2.0	3.1	2.9	3.1	3.0	2.6
1-Methylphenanthracene	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	57	46	38	39	36	36	36
Pyrene	78	66	63	57	58	54	48
Benzo(a)Anthracene	21	22	18	17	17	16	14
Chrysene	54	46	33	29	27	30	27
Benzo(b)Fluoranthene	48	55	26	28	30	26	17
Benzo(k)Fluoranthene	40	42	21	20	23	19	18
Benzo(e)Pyrene	52	53	35	30	34	28	30
Benzo(a)Pyrene	16	15	9.9	9.6	10	8.6	8.0
Perylene	10	11	11	9.8	12	9.1	8.4
Indeno(1,2,3,4-cd)Pyrene	21	23	9.6	11	11	9.9	8.2
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	20	20	11	12	12	10	9
Total	433	425	297	282	293	270	246
Surrogate Recovery							
Naphthalene-d8	60%	60%	59%	65%	64%	63%	46%
Acenaphthene-d10	74%	81%	74%	81%	75%	78%	67%
Phenanthrene-d10	83%	89%	87%	93%	88%	88%	82%
Fluoranthene-d10	92%	96%	102%	105%	106%	100%	94%
Chrysene-d12	86%	95%	96%	94%	96%	86%	91%
Benzo(a)pyrene-d12	84%	95%	99%	92%	98%	81%	83%
Benzo(g,h,i)perylene-d12	101%	106%	108%	105%	112%	97%	89%
% dry wt	12%	11%	14%	13%	15%	15%	12%
% water	88%	89%	86%	87%	85%	85%	88%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	NHPA 2N	NHPA 3N	NHPA 4N	NHPA 4N	MECC 1N	MECC 2N	MECC 3N
				dup			
Naphthalene	<4	8.5	5.4	5.8	<4	4.5	<4
1-Methylnaphthalene	<3	3.1	<3	<3	<3	<3	<3
2-Methylnaphthalene	3.3	6.9	4.8	5.1	<3	<3	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	21	14	11	12	7.0	5.8	8.3
Anthracene	2.6	3.0	2.2	2.3	2.2	<2	3.1
1-Methylphenanthracene	<4	<4	4.1	4.5	<4	int	int
Fluoranthene	22	40	29	32	28.4	27.3	32.4
Pyrene	59	57	46	47	32.7	32.3	37.0
Benzo(a)Anthracene	20	16	16	16	9.6	9.0	13.3
Chrysene	20	28	26	26	17.5	16.5	26.7
Benzo(b)Fluoranthene	32	28	29	32	15.6	14.0	19.1
Benzo(k)Fluoranthene	23	20	21	23	13.0	15.3	16.1
Benzo(e)Pyrene	40	34	34	34	19.2	18.7	23.4
Benzo(a)Pyrene	16	9	9.9	11	6.0	6.7	11.0
Perylene	11	10	11	11	11.2	8.6	9.0
Indeno(1,2,3,4-cd)Pyrene	16	11	12	13	6.9	6.8	10.5
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	15	11	12	13	7.9	8.7	10.9
Total	301	299	275	289	177	174	221
Surrogate Recovery							
Naphthalene-d8	50%	69%	71%	70%	68%	65%	66%
Acenaphthene-d10	72%	83%	85%	83%	82%	80%	80%
Phenanthrene-d10	88%	91%	90%	92%	91%	86%	86%
Fluoranthene-d10	88%	99%	100%	104%	94%	95%	92%
Chrysene-d12	96%	93%	99%	96%	91%	89%	91%
Benzo(a)pyrene-d12	104%	93%	103%	101%	81%	85%	85%
Benzo(g,h,i)perylene-d12	99%	104%	110%	108%	87%	87%	85%
% dry wt	11%	16%	16%	16%	9%	12%	12%
% water	89%	84%	84%	84%	91%	88%	88%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	MECC 4N	MEFR 1N	MEFR 2N	MEFR 3N	MEFR 4N	MEBH 1N	MEBH 2N
Naphthalene	<4	<4	<4	<4	<4	<4	<4
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	6.3	7.6	7.4	7.1	<4	<4
Phenanthrene	7.9	23.3	25.8	25.6	27.4	<2	<2
Anthracene	2.0	8.4	10.6	10.5	10.5	<2	<2
1-Methylphenanthracene	<4	9.1	10.4	10.3	10.8	<4	<4
Fluoranthene	33.6	201.1	230.0	219.0	225.2	3.9	4.9
Pyrene	35.8	228.0	248.0	251.2	253.3	2.8	3.3
Benzo(a)Anthracene	10.7	89.9	84.9	103.4	95.7	<2	<2
Chrysene	20.4	192.9	196.4	220.6	211.2	<2	<2
Benzo(b)Fluoranthene	15.7	157.6	156.9	199.2	180.4	<8	<8
Benzo(k)Fluoranthene	13.0	152.9	131.4	173.2	151.1	<2	<2
Benzo(e)Pyrene	19.8	155.0	166.4	186.7	177.7	<3	<3
Benzo(a)Pyrene	7.5	51.8	46.9	58.3	60.6	<3	<3
Perylene	8.3	40.4	42.7	49.3	46.0	<3	<3
Indeno(1,2,3,4-cd)Pyrene	8.0	39.2	39.4	50.5	48.6	<4	<4
Dibenz(a,h)Anthracene	<4	8.4	6.8	11.8	11.5	<4	<4
Benzo(ghi)Perylene	8.8	46.0	45.5	54.0	51.2	<2	<2
Total	191	1410	1450	1631	1568	7	8
Surrogate Recovery							
Naphthalene-d8	59%	54%	60%	59%	61%	62%	62%
Acenaphthene-d10	78%	78%	81%	82%	79%	81%	79%
Phenanthrene-d10	91%	86%	88%	87%	86%	89%	89%
Fluoranthene-d10	94%	89%	92%	92%	90%	93%	93%
Chrysene-d12	93%	92%	95%	97%	91%	91%	91%
Benzo(a)pyrene-d12	86%	79%	84%	86%	86%	77%	80%
Benzo(g,h,i)perylene-d12	84%	81%	87%	86%	87%	79%	83%
% dry wt	9%	11%	12%	11%	12%	14%	14%
% water	91%	89%	88%	89%	88%	86%	86%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	MEBH 3N	MEBH 4N	MERY 1	MERY 2	MERY 3	MERY 4	MERY 4
							dup
Naphthalene	<4	<4	12.4	12.8	11.2	6.3	8.2
1-Methylnaphthalene	<3	<3	4.9	6.0	3.9	<3	3.9
2-Methylnaphthalene	<3	<3	8.8	9.7	7.0	3.3	7.0
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	<2	<2	2.7	<2	2.4	2.4	2.2
Anthracene	<2	<2	<2	<2	<2	<2	<2
1-Methylphenanthracene	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	5.2	4.4	19.0	9.5	17.0	19.4	16.7
Pyrene	3.3	2.9	17.6	9.3	15.1	16.5	14.5
Benzo(a)Anthracene	<2	<2	4.1	2.3	3.9	3.3	3.0
Chrysene	<2	<2	9.9	4.6	8.1	7.6	6.6
Benzo(b)Fluoranthene	<8	<8	<8	<8	<8	<8	<8
Benzo(k)Fluoranthene	<2	<2	<2	2.5	3.6	<2	2.8
Benzo(e)Pyrene	<3	<3	7.9	3.7	5.7	6.6	5.6
Benzo(a)Pyrene	<3	<3	<3	<3	<3	<3	<3
Perylene	<3	<3	14.5	7.7	12.6	12.3	11.1
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	<2	<2	3.6	2.3	3.1	2.9	2.5
Total	9	7	105	70	94	80	84
Surrogate Recovery							
Naphthalene-d8	61%	65%	66%	54%	56%	60%	51%
Acenaphthene-d10	83%	84%	82%	78%	75%	78%	77%
Phenanthrene-d10	93%	92%	125%	94%	88%	93%	90%
Fluoranthene-d10	99%	98%	96%	93%	86%	91%	92%
Chrysene-d12	92%	95%	180%	103%	93%	104%	97%
Benzo(a)pyrene-d12	81%	84%	78%	75%	65%	80%	78%
Benzo(g,h,i)perylene-d12	86%	83%	88%	88%	80%	84%	83%
% dry wt	14%	14%	8%	11%	9%	10%	10%
% water	86%	86%	92%	89%	91%	90%	90%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	MEPI 1	MEPI 2	MEPI 3	MEPI 4	MEFP 1	MEFP 2	MEFP 3
Naphthalene	<4	<4	<4	<4	<4	<4	8.8
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	<3	<3	<3	<3	6.1
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	<2	<2	<2	<2	4.6	4.9	7.2
Anthracene	<2	<2	<2	<2	<2	<2	<2
1-Methylphenanthracene	<4	<4	<4	<4	int	<4	<4
Fluoranthene	3.1	3.1	2.8	2.7	22.0	21.4	23.6
Pyrene	2.4	2.1	<2	2.0	20.8	21.1	25.0
Benzo(a)Anthracene	<2	<2	<2	<2	3.9	4.6	4.8
Chrysene	<2	<2	<2	<2	8.2	8.1	8.9
Benzo(b)Fluoranthene	<8	<8	<8	<8	<8	<8	<8
Benzo(k)Fluoranthene	<2	<2	<2	<2	4.3	4.6	5.1
Benzo(e)Pyrene	<3	<3	<3	<3	9.2	9.3	9.1
Benzo(a)Pyrene	<3	<3	<3	<3	<3	5.0	3.7
Perylene	<3	<3	<3	<3	8.4	8.2	9.3
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	<2	<2	<2	<2	3.7	<2	4.8
Total	6	5	3	5	85	87	116
Surrogate Recovery							
Naphthalene-d8	60%	50%	58%	53%	57%	62%	58%
Acenaphthene-d10	81%	75%	82%	77%	82%	83%	83%
Phenanthrene-d10	91%	108%	107%	88%	93%	95%	93%
Fluoranthene-d10	95%	94%	99%	98%	95%	101%	98%
Chrysene-d12	94%	140%	139%	94%	102%	104%	95%
Benzo(a)pyrene-d12	83%	78%	0%	0%	92%	95%	87%
Benzo(g,h,i)perylene-d12	115%	88%	0%	0%	104%	0%	111%
% dry wt	11%	12%	12%	12%	10%	11%	11%
% water	89%	88%	88%	88%	90%	89%	89%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	MEFP 4	MEKN 1	MEKN 2	MEKN 3	MEKN 4	MEKN 4	NBSC 1N
						dup	
Naphthalene	<4	<4	<4	5.9	<4	<4	<4
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	3.0	5.8	3.5	4.0	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	4.8	<2	<2	2.5	2.0	<2	7.8
Anthracene	<2	<2	<2	<2	<2	<2	<2
1-Methylphenanthracene	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	21.4	15.3	11.6	18.3	14.2	12.7	14.5
Pyrene	20.2	24.8	20.9	28.1	21.9	20.7	13.3
Benzo(a)Anthracene	4.0	4.4	3.8	4.7	3.4	3.4	3.6
Chrysene	8.1	9.5	9.5	11.7	8.7	8.3	8.3
Benzo(b)Fluoranthene	<8	<8	<8	<8	<8	<8	<8
Benzo(k)Fluoranthene	3.9	3.9	3.5	4.4	3.6	3.2	7.0
Benzo(e)Pyrene	8.3	9.4	8.9	10.7	8.3	8.5	6.0
Benzo(a)Pyrene	3.3	<3	<3	<3	<3	<3	<3
Perylene	7.4	10.0	7.9	10.7	9.4	8.6	<3
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	3.5	3.7	3.0	4.2	3.4	3.2	5.4
Total	85	81	72	107	78	73	66
Surrogate Recovery							
Naphthalene-d8	54%	56%	49%	64%	53%	55%	53%
Acenaphthene-d10	76%	80%	77%	80%	79%	79%	82%
Phenanthrene-d10	87%	95%	93%	90%	92%	95%	95%
Fluoranthene-d10	91%	95%	96%	94%	95%	96%	98%
Chrysene-d12	88%	100%	102%	94%	94%	103%	97%
Benzo(a)pyrene-d12	78%	85%	82%	82%	80%	81%	77%
Benzo(g,h,i)perylene-d12	127%	95%	92%	90%	89%	87%	90%
% dry wt	11%	9%	11%	8%	10%	10%	17%
% water	89%	91%	89%	92%	90%	90%	83%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	NBSC 1N	NBSC 2N	NBSC 3N	NBSC 4N	NBLN 1N	NBLN 2N	NBLN 3N
	dup						
Naphthalene	<4	<4	<4	<4	<4	<4	<4
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	6.6	8.6	8.4	10.9	3.7	3.3	3.4
Anthracene	<2	2.6	<2	3.0	<2	<2	<2
1-Methylphenanthracene	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	12.5	12.3	16.6	16.2	5.4	5.6	5.8
Pyrene	11.7	17.5	13.6	18.4	5.0	4.8	4.4
Benzo(a)Anthracene	3.2	3.9	4.3	5.0	4.7	4.6	4.5
Chrysene	6.9	8.2	9.4	11.4	3.7	3.6	<2
Benzo(b)Fluoranthene	<8	10.8	<8	11.4	<8	<8	<8
Benzo(k)Fluoranthene	6.3	9.5	8.8	11.4	3.4	2.4	2.6
Benzo(e)Pyrene	5.3	9.7	7.1	11.6	3.1	<3	<3
Benzo(a)Pyrene	<3	3.8	<3	5.5	<3	<3	<3
Perylene	<3	4.5	<3	5.7	<3	<3	<3
Indeno(1,2,3,4-cd)Pyrene	<4	4.7	<4	6.6	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	5.2	9.0	5.7	13.8	<2	<2	<2
Total	58	105	74	131	29	24	21
Surrogate Recovery							
Naphthalene-d8	45%	57%	58%	59%	54%	59%	57%
Acenaphthene-d10	73%	71%	80%	78%	78%	71%	70%
Phenanthrene-d10	86%	83%	92%	89%	91%	83%	85%
Fluoranthene-d10	90%	89%	96%	103%	96%	92%	94%
Chrysene-d12	90%	109%	95%	112%	116%	108%	112%
Benzo(a)pyrene-d12	71%	110%	74%	115%	121%	111%	111%
Benzo(g,h,i)perylene-d12	81%	63%	88%	64%	113%	115%	106%
% dry wt	17%	17%	17%	18%	19%	18%	19%
% water	83%	83%	83%	82%	81%	82%	81%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	NBLN 4N	NBHI 1N	NBHI 2N	NBHI 3N	NBHI 4N	NSAG 1N	NSAG 2N
Naphthalene	<4	<4	<4	<4	<4	5.2	4.3
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	4.0	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	3.6	4.4	3.6	3.9	8.6	3.6	3.3
Anthracene	<2	<2	<2	<2	<2	<2	<2
1-Methylphenanthracene	13.2	<4	<4	<4	<4	<4	<4
Fluoranthene	6.3	5.9	4.8	5.5	5.3	9.1	8.1
Pyrene	5.3	2.6	2.1	2.8	4.5	5.7	5.4
Benzo(a)Anthracene	4.7	<2	<2	<2	<2	<2	<2
Chrysene	<2	2.0	<2	<2	2.7	3.0	2.9
Benzo(b)Fluoranthene	<8	<8	<8	<8	<8	<8	<8
Benzo(k)Fluoranthene	2.7	<2	<2	<2	2.2	2.3	<2
Benzo(e)Pyrene	<3	<3	<3	<3	<3	<3	<3
Benzo(a)Pyrene	<3	<3	<3	<3	<3	<3	<3
Perylene	<3	<3	<3	<3	<3	20.6	20.7
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	<2	2.1	<2	<2	<2	<2	<2
Total	36	17	11	12	27	49	45
Surrogate Recovery							
Naphthalene-d8	63%	70%	67%	59%	57%	53%	61%
Acenaphthene-d10	73%	83%	81%	77%	76%	79%	74%
Phenanthrene-d10	84%	92%	89%	86%	90%	97%	85%
Fluoranthene-d10	101%	107%	95%	95%	100%	105%	95%
Chrysene-d12	107%	96%	94%	91%	99%	119%	108%
Benzo(a)pyrene-d12	113%	88%	92%	86%	96%	97%	88%
Benzo(g,h,i)perylene-d12	115%	110%	98%	93%	103%	94%	84%
% dry wt	19%	21%	21%	21%	22%	12%	13%
% water	81%	79%	79%	79%	78%	88%	87%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	NSAG 3N	NSAG 4N	NSYR 1N	NSYR 2N	NSYR 3N	NSYR 4N	NSYR 4N
							dup
Naphthalene	<4	<4	<4	14.4	<4	9.7	<4
1-Methylnaphthalene	<3	<3	<3	3.6	<3	<3	<3
2-Methylnaphthalene	<3	<3	<3	6.6	<3	4.4	<3
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	3.8	1.8	10.8	13.9	12.6	12.2	11.6
Anthracene	<2	<2	<2	<2	<2	<2	<2
1-Methylphenanthracene	<4	<4	4.7	4.7	4.6	4.8	4.6
Fluoranthene	8.3	6.6	37.0	44.8	42.9	45.0	41.5
Pyrene	5.4	4.6	26.9	28.2	27.9	26.9	26.1
Benzo(a)Anthracene	<2	<2	7.0	6.0	6.3	6.6	6.2
Chrysene	2.8	2.4	12.5	12.2	12.4	13.0	12.6
Benzo(b)Fluoranthene	<8	<8	<8	<8	<8	<8	8.3
Benzo(k)Fluoranthene	2.0	<2	7.0	5.4	5.9	6.4	6.1
Benzo(e)Pyrene	<3	<3	9.0	9.1	9.6	9.7	9.9
Benzo(a)Pyrene	<3	<3	<3	<3	<3	<3	<3
Perylene	19.6	20.4	5.3	5.2	5.4	4.7	4.7
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	<2	<2	2.2	2.0	2.3	2.1	2.0
Total	42	36	122	156	130	146	133
Surrogate Recovery							
Naphthalene-d8	65%	38%	56%	57%	59%	58%	3%
Acenaphthene-d10	83%	77%	70%	76%	75%	77%	54%
Phenanthrene-d10	96%	95%	82%	86%	88%	86%	84%
Fluoranthene-d10	98%	99%	91%	93%	97%	94%	96%
Chrysene-d12	107%	100%	103%	102%	107%	108%	111%
Benzo(a)pyrene-d12	93%	81%	90%	90%	99%	96%	109%
Benzo(g,h,i)perylene-d12	85%	87%	87%	89%	89%	91%	97%
% dry wt	13%	12%	13%	14%	13%	13%	13%
% water	87%	88%	87%	86%	87%	87%	87%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	NSDI 1N	NSDI 2N	NSDI 3N	NSDI 4N	NSBC 1N	NSBC 2N	NSBC 3N
Naphthalene	<4	<4	<4	<4	8.1	5.9	8.8
1-Methylnaphthalene	<3	<3	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	<3	<3	3.7	3.2	5.4
Biphenyl	<3	<3	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4	<4	4.2
Acenaphthylene	<4	<4	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4	<4	4.6
2,3,5-Trimethylnaphthalene	<3	<3	3.6	3.3	<3	<3	<3
Fluorene	4.2	<4	<4	<4	6.1	<4	8.6
Phenanthrene	20	11	13	16	43	35	68
Anthracene	2.5	<2	2.0	2.1	7.3	7.3	10
1-Methylphenanthracene	<4	<4	<4	<4	4.8	4.3	7.2
Fluoranthene	31	26	28	26	56	51	74
Pyrene	19	13	15	17	47	43	64
Benzo(a)Anthracene	2.8	2.1	2.1	2.2	14	15	16
Chrysene	5.5	4.8	5.0	5.3	19	18	20
Benzo(b)Fluoranthene	<8	<8	<8	<8	10	9.2	11
Benzo(k)Fluoranthene	2.4	<2	2	<2	8.3	8.1	9.8
Benzo(e)Pyrene	5.2	4.1	5.1	5.4	13	11	12
Benzo(a)Pyrene	<3	<3	<3	<3	6.4	5.9	7.7
Perylene	<3	<3	<3	<3	<3	<3	<3
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	<2	<2	<2	<2	3.6	3.5	3.5
Total	92	61	76	77	250	219	335
Surrogate Recovery							
Naphthalene-d8	65%	52%	66%	60%	62%	52%	55%
Acenaphthene-d10	77%	61%	77%	72%	76%	75%	75%
Phenanthrene-d10	90%	78%	88%	85%	89%	92%	89%
Fluoranthene-d10	98%	88%	94%	93%	96%	97%	96%
Chrysene-d12	94%	87%	92%	92%	93%	95%	95%
Benzo(a)pyrene-d12	87%	82%	86%	91%	87%	89%	93%
Benzo(g,h,i)perylene-d12	112%	99%	106%	107%	103%	100%	101%
% dry wt	19%	19%	19%	19%	12%	12%	11%
% water	81%	81%	81%	81%	88%	88%	89%

APPENDIX B: TISSUE CONCENTRATION OF POLYAROMATIC HYDROCARBONS

Sample ID	NSBC 4N	NSFI 1N	NSFI 2N	NSFI 3N	NSFI 4N
Naphthalene	<4	6.2	<4	4.4	5.4
1-Methylnaphthalene	<3	<3	<3	<3	<3
2-Methylnaphthalene	<3	<3	<3	<3	<3
Biphenyl	<3	<3	<3	<3	<3
2,6-Dimethylnaphthalene	<4	<4	<4	<4	<4
Acenaphthylene	<4	<4	<4	<4	<4
Acenaphthene	<4	<4	<4	<4	<4
2,3,5-Trimethylnaphthalene	<3	<3	<3	<3	<3
Fluorene	<4	<4	<4	<4	<4
Phenanthrene	26	4.6	4.9	4.9	4.3
Anthracene	4.3	<2	<2	<2	<2
1-Methylphenanthracene	<4	<4	<4	6.6	<4
Fluoranthene	40	5.2	6.4	4.4	4.8
Pyrene	34	3.9	4.5	3.9	3.9
Benzo(a)Anthracene	11	<2	<2	<2	<2
Chrysene	15	2.0	2.0	<2	<2
Benzo(b)Fluoranthene	8.7	<8	<8	<8	<8
Benzo(k)Fluoranthene	7.2	<2	<2	<2	<2
Benzo(e)Pyrene	10	<3	<3	<3	<3
Benzo(a)Pyrene	5.8	<3	<3	4.2	3.7
Perylene	<3	<3	<3	<3	<3
Indeno(1,2,3,4-cd)Pyrene	<4	<4	<4	<4	<4
Dibenz(a,h)Anthracene	<4	<4	<4	<4	<4
Benzo(ghi)Perylene	3.2	<2	<2	<2	<2
Total	166	22	18	28	22
Surrogate Recovery					
Naphthalene-d8	41%	58%	59%	58%	57%
Acenaphthene-d10	63%	77%	72%	76%	66%
Phenanthrene-d10	75%	91%	87%	91%	79%
Fluoranthene-d10	83%	99%	100%	96%	85%
Chrysene-d12	82%	96%	97%	95%	81%
Benzo(a)pyrene-d12	75%	87%	90%	93%	77%
Benzo(g,h,i)perylene-d12	90%	108%	104%	103%	94%
% dry wt	11%	12%	14%	13%	12%
% water	89%	88%	86%	87%	88%

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	MASN 01	MASN 02	MASN 03	MASN 04	MALI 01	MALI 02	MALI 03
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	5.7	5.6	6.1	6.5	22.9	22.2	22.4
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	8.1	7.8	8.8	9.4	28.7	28.1	28.4
153;132	12.4	13.1	12.0	14.0	45.0	46.6	53.1
105	2.2	2.2	2.4	2.6	10.8	10.4	10.7
138	10.7	10.5	11.5	12.0	38.6	38.6	38.5
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	4.0	4.1	4.5	5.4	12.4	12.9	13.8
128	2.1	2.0	2.2	2.6	8.4	8.4	8.7
180	<1	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	na	na	na	na	na	na	na
Total	45	45	48	52	167	167	175
Surrogate Recovery							
103	105%	105%	112%	109%	109%	112%	102%
198	105%	110%	107%	113%	100%	103%	108%
% Lipid	7%	8%	8%	10%	5%	4%	6%
mg/g lipid	74	79	82	99	49	43	57
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	MALI 04	MALI 04 dup	MACO 01	MACO 02	MACO 03	MACO 04	MAMH 01
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	3.9	3.1	3.3	3.5	<2
101;90	23.8	22.9	8.0	8.7	9.3	7.2	2.1
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	29.8	28.1	10.7	11.3	12.0	8.4	3.1
153;132	44.7	42.0	19.8	20.0	21.0	16.3	6.2
105	11.2	10.7	3.0	3.4	3.5	2.7	<1
138	41.1	24.7	15.1	16.9	17.1	12.6	4.5
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	13.6	13.6	5.4	6.6	6.6	4.1	<1
128	8.9	5.8	2.5	2.6	2.9	1.7	<1
180	<1	<1	1.1	1.4	1.8	1.1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	na	na	<1.5	<1.5	<1.5	<1.5	<1.5
Total	173	148	70	74	77	58	16
Surrogate Recovery							
103	113%	78%	113%	119%	104%	98%	99%
198	102%	87%	103%	105%	98%	86%	98%
% Lipid	5%	5%	5%	5%	7%	5%	4%
mg/g lipid	48	48	53	51	68	54	39
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	MAMH 02	MAMH 03	MAMH 04	MAPY 04	MAPY 03	MAPY 02	MAPY 01
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	2.4	2.9	2.1	4.4	4.3	3.8	4.6
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	3.3	3.9	3.1	5.5	6.6	6.1	7.4
153;132	6.4	6.8	6.5	9.9	10.0	11.6	11.6
105	<1	<1	<1	1.4	1.8	1.6	2.0
138	4.5	5.7	4.8	10.2	8.9	8.4	10.1
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	<1	<1	<1	3.2	3.8	3.3	4.4
128	<1	<1	<1	1.3	1.8	1.5	2.1
180	<1	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	<1.5	<1.5	<1.5	na	na	na	na
Total	17	19	16	36	37	36	42
Surrogate Recovery							
103	95%	110%	103%	87%	117%	99%	118%
198	94%	107%	103%	116%	107%	100%	109%
% Lipid	3%	4%	3%	4%	5%	4%	5%
mg/g lipid	35	45	29	43	52	43	47
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	MAME 04	MAME 03	MAME 02	MAME 01	NHHS 1N	NHHS 2N	NHHS 3N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	12.6	11.3	11.6	16.4	1.6	2.0	1.8
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	13.6	11.4	12.1	18.8	2.3	2.2	2.6
153;132	20.4	15.0	19.6	28.6	3.6	3.6	4.0
105	5.3	5.6	4.7	7.8	<1	<1	<1
138	19.9	16.8	19.1	26.4	3.3	3.8	3.4
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	3.2	2.1	2.8	4.1	<1	<1	<1
128	2.6	1.4	2.3	3.2	<1	<1	<1
180	<1	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	na	na	na	na	<1.5	<1.5	<1.5
Total	78	64	72	105	11	12	12
Surrogate Recovery							
103	110%	100%	117%	109%	107%	107%	109%
198	103%	100%	106%	103%	107%	105%	106%
% Lipid	8%	6%	6%	11%	5%	5%	7%
mg/g lipid	76	61	62	108	52	53	66
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	NHHS 4N	NHHS 4N	NHFP 1N	NHFP 2N	NHFP 3N	NHFP 4N	NHSM 1N
		dup					
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	2.2	2.1	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	2.1	1.9	8.3	8.6	6.6	6.6	5.9
87	<1.5	<1.5	<1.5	1.9	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	2.8	2.8	8.3	9.1	8.0	7.4	6.0
153;132	4.1	3.7	17	18	17	16	12
105	<1	<1	1.8	2.3	1.7	1.7	1.4
138	4.0	3.6	13	14	13	13	10
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	<1	<1	5.7	5.7	5.4	5.5	4.3
128	<1	<1	1.2	1.5	1.3	1.1	1.4
180	<1	<1	1.5	1.7	1.7	1.7	1.5
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	13	12	59	65	54	53	42
Surrogate Recovery							
103	110%	105%	100%	96%	96%	101%	100%
198	109%	104%	104%	97%	103%	100%	103%
% Lipid	7%	7%	6%	5%	5%	5%	5%
mg/g lipid	65	65	55.8	53.6	46.8	46.7	54.5
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	NHSM 2N	NHSM 3N	NHSM 4N	NHPI 1N	NHPI 2N	NHPI 3N	NHPI 4N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	4.7	6.1	4.6	7.2	5.9	6.6	4.7
87	<1.5	<1.5	<1.5	1.7	<1.5	1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	4.8	6.3	4.8	7.2	6.7	6.5	5.2
153;132	9.9	12	9.6	12	12	12	10
105	1.1	1.5	1.1	1.9	1.7	1.8	1
138	8.4	9.8	8.2	11	10	10	8.1
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	3.5	3.9	3.3	3.6	3.6	3.9	3.0
128	<1	<1	<1	1.3	<1	1.1	<1
180	<1	1.3	<1	1.2	1.1	1.2	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	32	40	32	47	41	45	32
Surrogate Recovery							
103	92%	91%	87%	88%	95%	98%	87%
198	97%	99%	95%	94%	101%	94%	83%
% Lipid	6%	5%	5%	6%	4%	5%	5%
mg/g lipid	59.1	45.2	45.1	55.7	37.6	47.1	45.5
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	NHPA 1N	NHPA 2N	NHPA 3N	NHPA 4N	NHPA 4N dup	MECC 1N	MECC 2N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	8.3	6.1	8.3	6	6.6	5.9	6.1
87	2	<1.5	2	<1.5	1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	7.8	6.5	7.8	5.7	6.0	5.3	6.4
153;132	13	11	14	11	11	12.9	14.1
105	1.8	1.6	2.1	1.3	1.3	<1	<1
138	12	9.6	12	9.1	9.4	12.0	12.9
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	4.2	3.5	4.4	3.4	3.7	1.9	2.6
128	1.3	<1	1.4	<1	<1	<1	<1
180	1.4	1.1	1.3	<1	1.0	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	<1.5	<1.5	<1.5	<1.5	<1.5	na	na
Total	52	40	53	36	41	38	42
Surrogate Recovery							
103	88%	90%	92%	92%	94%	105%	101%
198	88%	97%	92%	89%	90%	106%	105%
% Lipid	5%	5%	6%	5%	5%	5%	5%
mg/g lipid	54.0	48.3	62.0	51.6	51.6	45	46
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	MECC 3N	MECC 4N	MEPI 1	MEPI 2	MEPI 3	MEPI 4	MEFP 1
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	6.7	5.5	<1.5	<1.5	<1.5	<1.5	2.5
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	6.7	5.7	<1	<1	<1	<1	2.6
153;132	15.1	13.9	<1.5	<1.5	<1.5	<1.5	7.8
105	<1	<1	<1	<1	<1	<1	<1
138	14.1	12.5	<1.5	<1.5	<1.5	<1.5	4.8
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	2.7	2.1	<1	<1	<1	<1	2.1
128	<1	<1	<1	<1	<1	<1	<1
180	<1	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	na	na	na	na	na	na	na
Total	45	40	ND	ND	ND	ND	20
Surrogate Recovery							
103	101%	107%	77%	119%	123%	128%	74%
198	102%	106%	120%	int	int	int	int
% Lipid	5%	5%	7%	8%	5%	7%	6%
mg/g lipid	49	52	70	77	46	68	58
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	MEFP 2	MEFP 3	MEFP 4	MEFR 1N	MEFR 2N	MEFR 3N	MEFR 4N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	2.2	2.9	2.6	28.8	31.9	30.1	31.8
87	<1.5	<1.5	<1.5	11.8	13.3	12.1	13.0
77	<2	<2	<2	<2	<2	<2	<2
118	2.6	2.5	3.3	32.0	34.7	33.7	36.1
153;132	6.2	8.0	6.2	38.6	40.6	41.2	42.8
105	<1	<1	<1	13.0	14.5	13.5	14.9
138	4.2	5.3	5.5	47.9	51.7	52.6	53.6
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	2.8	2.6	2.3	<1	<1	<1	<1
128	<1	<1	<1	7.9	8.0	8.0	9.9
180	<1	<1	1.0	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	na	na	na	na	na	na	na
Total	18	21	21	180	195	191	202
Surrogate Recovery							
103	67%	115%	115%	109%	114%	114%	117%
198	int	int	int	116%	124%	113%	118%
% Lipid	6%	7%	7%	5%	5%	6%	6%
mg/g lipid	56	70	65	52	51	60	55
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	MEKN 1	MEKN 2	MEKN 3	MEKN 4	MEKN dup	MERY 1	MERY 2
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	4.4	4.5	5.1	4.1	3.9	2.8	1.2
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	3.9	3.1	4.4	3.7	3.4	2.8	2.1
153;132	9.9	11.3	12.0	8.9	8.6	7.1	5.2
105	<1	<1	<1	<1	<1	<1	<1
138	8.2	6.8	7.4	7.5	7.4	5.4	3.6
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	4.4	4.1	5.2	4.5	4.4	2.6	1.2
128	<1	<1	<1	<1	<1	<1	<1
180	1.8	2.2	2.6	2.4	2.1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	na	na	na	na	na	na	na
Total	33	32	37	31	30	21	13
Surrogate Recovery							
103	116%	119%	108%	112%	113%	118%	124%
198	int	int	int	int	int	int	int
% Lipid	8%	6%	9%	5%	5%	7%	5%
mg/g lipid	80	60	87	54	54	71	50
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	MERY 3	MERY 4	MERY dup	MEBH 1N	MEBH 2N	MEBH 3N	MEBH 4N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	2.2	2.6	2.1	<1.5	<1.5	<1.5	<1.5
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	3.2	3.2	2.8	<1	<1	<1	<1
153;132	6.5	6.5	6.6	<1.5	<1.5	<1.5	<1.5
105	<1	<1	<1	<1	<1	<1	<1
138	5.5	5.5	4.8	<1.5	<1.5	<1.5	<1.5
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	2.6	2.5	1.9	<1	<1	<1	<1
128	<1	<1	<1	<1	<1	<1	<1
180	<1	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	na	na	na	na	na	na	na
Total	20	20	18	ND	ND	ND	ND
Surrogate Recovery							
103	112%	126%	114%	110%	98%	111%	120%
198	int	int	int	110%	103%	114%	118%
% Lipid	8%	6%	6%	6%	7%	6%	5%
mg/g lipid	83	62	62	56	69	57	48
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	NBSC 1N	NBSC 1N dup	NBSC 2N	NBSC 3N	NBSC 4N	NBLN 1N	NBLN 2N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	3.8	3.7	2.5	3.9	3.1	<1.5	<1.5
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	2.4	2.4	1.9	2.6	2.3	1.3	1.2
153;132	8.9	9.0	8.3	9.3	9.5	3.0	3.0
105	<1	<1	<1	<1	<1	<1	<1
138	3.5	3.6	5.6	3.8	6.4	2.5	2.4
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	3.0	3.0	1.9	3.2	2.7	<1	<1
128	<1	<1	<1	<1	<1	<1	<1
180	2.5	2.6	2.6	2.6	2.7	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	na	na	<1.5	na	<1.5	<1.5	<1.5
Total	24	24	23	25	27	7	7
Surrogate Recovery							
103	82%	83%	101%	79%	104%	105%	102%
198	99%	98%	98%	97%	102%	107%	106%
% Lipid	9%	9%	9%	8%	10%	10%	10%
mg/g lipid	86	86	90	82	99	103	98
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	NBLN 3N	NBLN 4N	NBHI 1N	NBHI 2N	NBHI 3N	NBHI 4N	NSAG 1N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	1.3	1.5	<1	<1	<1	<1	<1
153;132	3.2	3.7	<1.5	<1.5	<1.5	<1.5	<1.5
105	<1	<1	<1	<1	<1	<1	<1
138	2.5	3.0	<1.5	<1.5	<1.5	<1.5	<1.5
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	<1	<1	<1	<1	<1	<1	<1
128	<1	<1	<1	<1	<1	<1	<1
180	<1	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	7	8	ND	ND	ND	ND	ND
Surrogate Recovery							
103	108%	120%	107%	105%	95%	101%	108%
198	108%	120%	107%	107%	103%	107%	109%
% Lipid	10%	10%	11%	12%	11%	11%	4%
mg/g lipid	100	103	108	115	106	110	44
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	NSAG 2N	NSAG 3N	NSAG 4N	NSYR 1N	NSYR 2N	NSYR 3N	NSYR 4N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	<1	<1	<1	<1	<1	<1	<1
153;132	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
105	<1	<1	<1	<1	<1	<1	<1
138	<1.5	<1.5	<1.5	1.6	1.7	1.7	1.7
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	<1	<1	<1	<1	<1	<1	<1
128	<1	<1	<1	<1	<1	<1	<1
180	<1	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	ND	ND	ND	2	2	2	2
Surrogate Recovery							
103	106%	106%	97%	98%	99%	101%	103%
198	113%	109%	105%	105%	105%	108%	106%
% Lipid	5%	5%	5%	5%	6%	6%	6%
mg/g lipid	45	47	48	54	64	55	65
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	NSYR 4N dup	NSDI 1N	NSDI 2N	NSDI 3N	NSDI 4N	NSBC 1N	NSBC 2N
8;5	<2	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2	<2
101;90	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2	<2
118	<1	1.0	<1	<1	<1	<1	<1
153;132	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
105	<1	<1	<1	<1	<1	<1	<1
138	1.6	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	<1	<1	<1	<1	<1	<1	<1
128	<1	<1	<1	<1	<1	<1	<1
180	<1	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	2	1	ND	ND	ND	ND	ND
Surrogate Recovery							
103	100%	104%	98%	99%	105%	107%	107%
198	108%	109%	111%	109%	111%	109%	110%
% Lipid	6%	7%	7%	7%	8%	5%	6%
mg/g lipid	65	74	75	70	82	46	62
ND: not detected							
na: not analyzed							
int: matrix interference							

APPENDIX C: TISSUE CONCENTRATION OF POLYCHLORINATED BIPHENYLS

Sample ID	NSBC 3N	NSBC 4N	NSFI 1N	NSFI 2N	NSFI 3N	NSFI 4N
8;5	<2	<2	<2	<2	<2	<2
18;15	<2	<2	<2	<2	<2	<2
29	<1	<1	<1	<1	<1	<1
28	<2	<2	<2	<2	<2	<2
50	<2	<2	<2	<2	<2	<2
52	<2	<2	<2	<2	<2	<2
44	<2	<2	<2	<2	<2	<2
66;95	<2	<2	<2	<2	<2	<2
101;90	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
87	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
77	<2	<2	<2	<2	<2	<2
118	<1	<1	<1	<1	<1	<1
153;132	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
105	<1	<1	<1	<1	<1	<1
138	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
126	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
187	<1	<1	<1	<1	<1	<1
128	<1	<1	<1	<1	<1	<1
180	<1	<1	<1	<1	<1	<1
169	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
170;190	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
195;208	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
206	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
209	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	ND	ND	ND	ND	ND	ND
Surrogate Recovery						
103	103%	87%	104%	101%	106%	100%
198	109%	94%	104%	107%	107%	105%
% Lipid	5%	7%	6%	8%	7%	8%
mg/g lipid	47	72	60	79	69	77
ND: not detected						
na: not analyzed						
int: matrix interference						

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	MASN 01	MASN 02	MASN 03	MASN 04	MALI 01	MALI 02	MALI 03	MALI 04
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	<1	<1	<1	<1
Transnonachlor	<1	<1	<1	<1	<1	<1	<1	<1
p,p-DDE	24.3	26.6	28.0	27.8	15.3	14.9	17.6	15.5
Dieldrin	1.8	2.2	2.5	2.5	2.4	2.3	2.3	2.0
o,p-DDD	2.8	3.7	3.8	3.8	1.3	1.8	1.9	2.3
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	4.4	4.2	4.9	4.1
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	28.9	32.5	34.4	34.2	23.4	23.2	26.7	23.9
Surrogate Recovery								
g-Chlordene	119%	115%	117%	113%	114%	116%	108%	116%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	MAMH 01	MAMH 02	MAMH 03	MAMH 04	MAME 04	MAME 03	MAME 02	MAME 01
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	<1	<1	<1	<1
Transnonachlor	<1	<1	<1	<1	2.2	2.0	2.6	3.6
p,p-DDE	2.8	2.8	3.2	2.6	9.0	9.4	10.8	10.7
Dieldrin	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	2.2	2.1	2.0	1.8
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	2.1	1.8	1.6	1.7	7.3	5.9	6.6	8.0
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	4.9	4.6	4.8	4.3	20.7	19.4	22.1	24.1
Surrogate Recovery								
g-Chlordene	92%	105%	103%	108%	118%	113%	125%	119%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	MAPY 04	MAPY 03	MAPY 02	MAPY 01	MACO 01	MACO 02	MACO 03	MACO 04
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	1.5	2.1	2.4	2.0
Transnonachlor	<1	<1	<1	<1	2.3	3.1	2.6	2.0
p,p-DDE	4.8	5.9	5.1	6.7	8.1	8.7	7.7	6.9
Dieldrin	2.3	2.4	2.3	2.3	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	1.6	2.0	2.0	1.5
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	9.7	10.4	9.6	9.0
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	1.6	2.0	1.8	1.2
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	7.0	8.4	7.4	8.9	24.9	28.2	26.0	22.7
Surrogate Recovery								
g-Chlordene	114%	116%	110%	117%	97%	103%	97%	87%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	NHHS 1N	NHHS 2N	NHHS 3N	NHHS 4N	NHHS 4N dup	NHFP 1N	NHFP 2N	NHFP 3N
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	<1	1.8	1.6	1.5
Transnonachlor	<1	<1	<1	<1	<1	1.2	<1	<1
p,p-DDE	4.2	4.8	4.2	4.7	4.5	8.4	8.3	7.2
Dieldrin	1.5	1.5	1.4	1.4	1.4	1.8	<1.2	1.2
o,p-DDD	<1	<1	<1	<1	<1	2.1	2.3	2.3
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	2.3	2.7	2.8	2.4	2.4	4.1	4.5	4.0
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	8.0	8.9	8.4	8.4	8.3	19.3	16.8	16.2
Surrogate Recovery								
g-Chlordene	107%	98%	105%	101%	105%	112%	105%	106%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	NHFP 4N	NHSM 1N	NHSM 2N	NHSM 3N	NHSM 4N	NHPI 1N	NHPI 2N	NHPI 3N
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	1.3	1.9	1.7	2.2	1.9	<1	1.5	1.6
Transnonachlor	<1	1.6	1.0	<1	<1	<1	<1	<1
p,p-DDE	6.6	12	9.5	12	9.8	7.4	6.3	5.5
Dieldrin	<1.2	1.7	1.5	1.5	1.9	1.5	1.9	<1.2
o,p-DDD	1.9	2.8	2.0	3.1	2.0	1.8	1.3	1.8
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	3.5	12	8.7	14	9.4	4.7	3.6	4.4
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	1.5	1.0	1.4	<1	<1	1.4	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	13.2	32.9	25.4	34.1	25.1	15.5	16.0	13.4
Surrogate Recovery								
g-Chlordene	113%	135%	127%	127%	138%	133%	142%	130%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	NHPI 4N	NHPA 1N	NHPA 2N	NHPA 3N	NHPA 4N	NHPA 4N	MECC 1N	MECC 2N
						dup		
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	1.6	2.2	2.0	2.2	1.6	1.6	<1	<1
Transnonachlor	<1	1.1	<1	1.3	<1	<1	<1	<1
p,p-DDE	4.9	6.3	5.1	7.1	5.0	6.0	4.7	5.0
Dieldrin	1.3	2.2	1.9	1.5	1.6	2.0	<1.2	<1.2
o,p-DDD	1.7	1.8	1.5	1.6	1.5	1.4	<1	<1
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	3.9	5.8	3.8	4.8	4.3	4.4	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	13.4	19.4	14.2	18.4	14.0	15.4	4.7	5.0
Surrogate Recovery								
g-Chlordene	126%	106%	106%	108%	126%	141%	118%	121%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	MECC 3N	MECC 4N	MEKN 1	MEKN 2	MEKN 3	MEKN 4	MEKN dup	MERY 1
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	<1	<1	<1	<1
Transnonachlor	<1	<1	<1	<1	<1	<1	<1	<1
p,p-DDE	4.4	5.1	4.0	4.0	4.7	4.5	4.4	7.8
Dieldrin	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	<1	<1	<1	<1
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	4.4	5.1	4.0	4.0	4.7	4.5	4.4	7.8
Surrogate Recovery								
g-Chlordene	113%	117%	96%	113%	96%	105%	101%	105%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	MERY 2	MERY 3	MERY 4	MERY 4 dup	MEPI 1	MEPI 2	MEPI 3	MEPI 4
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	<1	<1	<1	<1
Transnonachlor	<1	<1	<1	<1	<1	<1	<1	<1
p,p-DDE	3.8	6.1	7.6	6.1	1.4	1.3	1.4	1.2
Dieldrin	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	<1	<1	<1	<1
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	3.8	6.1	7.6	6.1	1.4	1.3	1.4	1.2
Surrogate Recovery								
g-Chlordene	104%	100%	116%	114%	109%	115%	119%	122%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	MEFP 1	MEFP 2	MEFP 3	MEFP 4	MEFR 1N	MEFR 2N	MEFR 3N	MEFR 4N
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	<1	<1	<1	<1
Transnonachlor	<1	<1	<1	<1	<1	<1	<1	<1
p,p-DDE	5.1	4.4	5.6	4.8	13.2	12.7	13.7	10.2
Dieldrin	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	5.8	5.6	5.1	4.8
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	5.1	4.4	5.6	4.8	18.9	18.2	18.8	15.1
Surrogate Recovery								
g-Chlordene	112%	115%	120%	95%	105%	106%	112%	113%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	MEBH 1N	MEBH 2N	MEBH 3N	MEBH 4N	NBSC 1N	NBSC 1N dup	NBSC 2N	NBSC 3N
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	<1	<1	<1	<1
Transnonachlor	<1	<1	<1	<1	<1	<1	<1	<1
p,p-DDE	1.1	1.2	1.2	1.1	3.7	3.7	3.4	3.8
Dieldrin	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	<1	<1	<1	<1
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	1.1	1.2	1.2	1.1	3.7	3.7	3.4	3.8
Surrogate Recovery								
g-Chlordene	116%	115%	120%	118%	99%	96%	90%	92%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	NBSC 4N	NBLN 1N	NBLN 2N	NBLN 3N	NBLN 4N	NBHI 1N	NBHI 2N	NBHI 3N
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	<1	<1	<1	1.5	1.7	1.6
Transnonachlor	<1	<1	<1	<1	<1	<1	<1	<1
p,p-DDE	4.0	4.3	4.2	4.3	4.8	2.2	2.0	2.1
Dieldrin	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	<1	<1	<1	<1
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	4.0	4.3	4.2	4.3	4.8	3.7	3.7	3.7
Surrogate Recovery								
g-Chlordene	94%	95%	90%	101%	99%	108%	98%	95%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	NBHI 4N	NSAG 1N	NSAG 2N	NSAG 3N	NSAG 4N	NSYR 1N	NSYR 2N	NSYR 3N
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	1.2	<1	<1	<1	<1	<1	<1	<1
Transnonachlor	<1	<1	<1	<1	<1	<1	<1	<1
p,p-DDE	2.0	<1.2	<1.2	<1.2	<1.2	1.4	1.8	1.5
Dieldrin	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	<1	<1	<1	<1
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	3.2	ND	ND	ND	ND	1.4	1.8	1.5
Surrogate Recovery								
g-Chlordene	93%	85%	84%	90%	81%	83%	88%	89%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	NSYR 4N	NSYR 4N dup	NSDI 1N	NSDI 2N	NSDI 3N	NSDI 4N	NSBC 1N	NSBC 2N
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	<1	<1	1.4	1.6	1.5	1.5	1.3	1.7
Transnonachlor	<1	<1	<1	<1	<1	<1	<1	<1
p,p-DDE	1.4	<1.2	2.5	2.5	2.4	2.8	1.8	2.0
Dieldrin	<1.2	<1.2	1.3	<1.2	<1.2	1.3	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	<1	<1	<1	<1
b-Endosulfan	<2	<2	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	1.4	ND	5.2	4.1	3.9	5.6	3.1	3.8
Surrogate Recovery								
g-Chlordene	85%	83%	93%	90%	95%	89%	103%	92%

APPENDIX D: TISSUE CONCENTRATION OF CHLORINATED PESTICIDES

Sample ID	NSBC 3N	NSBC 4N	NSFI 1N	NSFI 2N	NSFI 3N	NSFI 4N
HCB	<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
Heptachlor	<1	<1	<1	<1	<1	<1
Aldrin	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Heptachlor Epoxide	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
o,p-DDE	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
a-Endosulfan	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
cis-Chlordane	1.3	1.8	1.3	1.2	1.1	1.1
Transnonachlor	<1	<1	<1	<1	<1	<1
p,p-DDE	1.8	1.9	2.6	3.2	2.9	2.8
Dieldrin	1.3	1.9	<1.2	<1.2	<1.2	<1.2
o,p-DDD	<1	<1	<1	<1	<1	<1
b-Endosulfan	<2	<2	<2	<2	<2	<2
p,p-DDD	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
o,p-DDT	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
p,p-DDT	<1	<1	<1	<1	<1	<1
Mirex	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Total	4.4	5.6	3.9	4.4	4.0	3.9
Surrogate Recovery						
g-Chlordene	102%	91%	98%	90%	95%	88%

APPENDIX E: **Quality Control results for 1999 Metal Contaminants**

DATE	29/12/99			30/12/99				
ELEMENT	BLK	BLK-12908	BLK-12909	BLK	BLK-12910	BLK-12911	BLK-12912	BLK-12913
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	1.3	3.7	0.7	0.7	0.4	ND 0.2	ND 0.2
Cu	ND 0.4	ND 0.4	ND 0.4	ND 0.4	ND 0.4	ND 0.4	ND 0.4	ND 0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	8.7	24	8.8	8.5	4	ND 4.0	ND 4.0
Zn	1	ND 1.0	ND 1.0	2.6	2.7	1.6	ND 1.0	ND 1.0
Al	9	44	78	42	40	65	69	37
ELEMENT	BLK-12914	BLK-12915	BLK-12916	BLK-12917	BLK-12918	BLK-12919	BLK-12920	BLK-12921
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	0.3	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.2
Cu	ND 0.4	ND 0.4	ND 0.4	1.3	ND 0.4	0.5	ND 0.4	ND 0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0
Zn	ND 1.0	ND 1.0	ND 1.0	ND 1.0	1.2	ND 1.0	1.3	ND 1.0
Al	59	52	12	92	55	29	110	100
ELEMENT	BLK-12922	BLK-12923	BLK-12924	BLK-12925	BLK-12926	BLK-12927	BLK-BEFOR	BLK-12928
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	0.8	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2
Cu	0.6	0.6	ND 0.4	ND 0.4	0.5	ND 0.4	ND 0.4	ND 0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	12.2	ND 4.0	ND 4.0	9.8	ND 4.0	ND 4.0	ND 4.0
Zn	ND 1.0	3.2	ND 1.0	ND 1.0	ND 1.0	ND 1.0	1.2	ND 1.0
Al	140	100	44	67	140	64	54	52

APPENDIX E: Quality Control results for 1999 Metal Contaminants

ELEMENT	BLK-12929	BLK-12930	BLK-12931	BLK-12932	BLK-12933	BLK-12934	BLK-12935	BLK-12936
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	ND 0.2	0.2	0.3	ND 0.2	0.2	ND 0.2	ND 0.2
Cu	ND 0.4	ND 0.4	ND 0.4	ND 0.4	0.4	ND 0.4	ND 0.4	ND 0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	9.6	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0
Zn	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0
Al	30	32	30	63	50	43	42	75
ELEMENT	BLK-12937	BLK-12938	BLK-BEFOR	BLK-12939	BLK-12940	BLK-12941	BLK-12942	BLK-12943
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	0.2	0.3
Cu	ND 0.4	ND 0.4	ND 0.4	ND 0.4	1500	ND 0.4	8	ND 0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0
Zn	ND 1.0	ND 1.0	ND 1.0	ND 1.0	1.3	1.5	ND 1.0	ND 1.0
Al	85	70	47	42	33	39	64	87
ELEMENT	BLK-12944	BLK-12945	BLK-12946	BLK-12947	BLK-12948	BLK-12949	BLK-12950	BLK-12951
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2
Cu	ND 0.4	ND 0.4	0.7	ND 0.4	4.2	0.6	ND 0.4	ND 0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0
Zn	ND 1.0	ND 1.0	1.7	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0
Al	67	51	33	76	44	82	38	50

APPENDIX E: **Quality Control results for 1999 Metal Contaminants**

					05/01/00			
ELEMENT	BLK-12952	BLK-12953	BLK-12954	BLK-12955	BLK	BLK-12956	BLK-12957	BLK-12958
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	0.3	ND 0.2	0.2	ND 0.2	ND 0.2	0.9	0.3
Cu	ND 0.4	ND 0.4	3.7	ND 0.4	ND 0.4	1.1	ND 0.4	0.5
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	5	5
Zn	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0
Al	60	110	48	64	86	110	110	51
ELEMENT	BLK-12959	BLK-12960	BLK-12961	BLK-12962	BLK-12963	BLK-12964	BLK-12965	BLK-12966
Ag	0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	0.3	ND 0.2	0.2	ND 0.2	0.2	ND 0.2	ND 0.2
Cu	ND 0.4	0.6	0.6	ND 0.4	ND 0.4	ND 0.4	0.5	0.9
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	5
Zn	ND 1.0	1.4	ND 1.0	ND 1.0	ND 1.0	ND 1.0	1.6	ND 1.0
Al	73	75	130	47	77	110	97	71
ELEMENT	BLK-12967	BLK-12968	BLK-12969	BLK-12970	BLK-12971	BLK-12972	BLK-12973	BLK-12974
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	ND 0.2	0.2	0.3	ND 0.2	ND 0.2	0.3	ND 0.2
Cu	ND 0.4	0.8	0.6	0.4	ND 0.4	5	0.5	ND 0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	4	ND 4.0	ND 4.0
Zn	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	1.8	1.2
Al	81	31	140	86	27	92	130	120

APPENDIX E: Quality Control results for 1999 Metal Contaminants

ELEMENT	06/01/00							
Ag	BLK-12975	BLK	BLK-12976	BLK-12977	BLK-12978	BLK-12979	BLK-12980	BLK-12981
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cu	0.8	ND 0.2	ND 0.2	0.3	0.2	ND 0.2	ND 0.2	ND 0.2
Ni	0.6	ND 0.4	ND 0.4	ND 0.4	3.6	0.7	0.4	0.8
Pb	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Fe	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Zn	6	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0
Al	1.1	ND 1.0	2.3	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0
	99	42	94	36	84	140	46	56
ELEMENT	BLK-12982	BLK-12983	BLK-12984	BLK-12985	BLK-12986	BLK-12987	BLK-12988	BLK-12989
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2
Cu	ND 0.4	0.6	ND 0.4	0.5	0.6	ND 0.4	0.4	0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	4	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0
Zn	ND 1.0	4	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0
Al	95	73	97	57	110	27	50	62
		07/01/00						
ELEMENT	BLK-12990	BLK	BLK-12991	BLK-12992	BLK-12993	BLK-12994	BLK-12995	BLK-12996
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	ND 0.2	ND 0.2	0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2
Cu	ND 0.4	ND 0.4	ND 0.4	ND0.4	ND 0.4	0.4	ND 0.4	0.4
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	ND 4.0	6	4	ND 4.0	ND 4.0	ND 4.0	ND 4.0
Zn	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	3.5
Al	68	4	93	85	57	87	40	41

APPENDIX E: Quality Control results for 1999 Metal Contaminants

							10/01/00	
ELEMENT	BLK-12997	BLK-12998	BLK-12999	BLK-13000	BLK-13001	BLK-13002	BLK-BEFOR	BLK-13003
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	ND 0.2	0.3	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2
Cu	0.4	0.5	ND 0.4	0.4	0.6	0.6	0.5	0.5
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	6	ND 4.0
Zn	ND 1.0	1.3	ND 1.0	ND 1.0	ND 1.0	ND 1.0	ND 1.0	1.1
Al	28	53	54	66	54	110	120	126
							11/01/00	
ELEMENT	BLK-13004	BLK-13005	BLK-13006	BLK-13007	BLK-13008	BLK-13009	BLK-BEFOR	BLK-13010
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Cr	ND 0.2	0.3	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2	ND 0.2
Cu	0.6	0.7	0.4	0.5	0.7	0.4	0.5	0.5
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8	ND 0.8
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6	ND 0.6
Fe	ND 4.0	5	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0	ND 4.0
Zn	ND 1.0	1	ND 1.0	ND 1.0	ND 1.0	ND 1.0	2.2	ND 1.0
Al	160	53	160	140	180	100	92	140
ELEMENT	BLK-13011	BLK-13012	BLK-13013	BLK-13014				
Ag	ND 0.1	ND 0.1	ND 0.1	ND 0.1				
Cd	ND 0.1	ND 0.1	ND 0.1	ND 0.1				
Cr	0.5	0.4	ND 0.2	ND 0.2				
Cu	7.3	1	1.1	0.6				
Ni	ND 0.8	ND 0.8	ND 0.8	ND 0.8				
Pb	ND 0.6	ND 0.6	ND 0.6	ND 0.6				
Fe	ND 4.0	5.7	5	ND 4.0				
Zn	23	1.9	ND 1.0	ND 1.0				
Al	140	120	120	200				