2009
Fish and Shellfish Report

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FISH AND SHELLFISH REPORT

submitted to

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EXECUTIVE SUMMARY

The objective of the MWRA Fish and Shellfish monitoring program is to define the post-discharge condition of three indicator species: winter flounder (*Pseudopleuronectes americanus*), lobster (*Homarus americanus*), and blue mussel (*Mytilus edulis*). Flounder and lobster specimens were collected from three core sites in Boston Harbor and the Bays: Deer Island Flats (DIF), the Outfall Site (OS), and East Cape Cod Bay (ECCB). Flounder were also collected at one ancillary site off Nantasket Beach (NB), to provide information on flounder in the general area of the former Deer Island outfall. Caged mussels, collected from Stover's Point, ME, were deployed at sites in Boston Harbor and the bays to evaluate bioaccumulation potential.

The 2009 Fish and Shellfish Report details chemical contaminant results from flounder edible meat and liver, lobster edible meat and hepatopancreas, and mussel edible meat. Flounder liver histological results are also discussed. The monitored parameters were examined for spatial distribution among stations in 2009 and inter-annual variations from previous monitoring data. In addition, body burdens of certain pesticides, PCBs, PAHs, lead, and mercury were compared to FDA Action Limits and Contingency Plan (MWRA 2001a) threshold values to evaluate potential risk.

Flounder

Winter flounder were collected at the four monitoring locations (DIF, NB, OS, and ECCB). Fish at all stations were of approximately the same average age but fish collected off of Deer Island were longer and heavier than those from other stations. Only one fish from Deer Island (DIF) and two from Nantasket Beach (NB) had ventral lesions. These ulcers were first observed in marked numbers in 2003 but have become infrequent since 2005. The fish at all stations were predominantly females.

In 2009 no liver neoplasia were reported and the relatively low prevalence of hydropic vacuolation suggests a steady system-wide reduction in the contaminant–associated pathology over the past two decades. Centrotubular hydropic vacuolation (CHV) remains highest in fish collected off Deer Island and remains low in the vicinity of the Massachusetts Bay Outfall Site (OS).

Fifteen winter flounder were collected at each locations and edible meat and live were analyzed for chemical contaminants. In general mean concentrations of organic compounds in fillets were highest off Deer Island and lowest at Eastern Cape Cod Bay (ECCB), a pattern observed throughout this program. Chlordane and DDT show region wide long term decreases throughout the region. Metal tissue burdens were less predictable. While mercury in flounder meat, and lead and silver in flounder liver remain highest at the Outfall Site, copper was numerically highest in flounder from Cape Cod Bay. There has been no evident trend in the body burdens of metals. All flounder edible tissue contaminant levels remain well below the federal action limits and the MWRA Threshold Levels and indicate no risk for human consumption.

Lobster

Twenty one lobsters were collected at each of the three core monitoring stations in 2009 (DIF, OS, and ECCB). The size, sex, and external appearance (*i.e*., black gill disease, shell erosion, external tumors, etc.) were determined for the collected lobsters. Little difference in length and weight were noted among stations. The percentage of females varied considerably from 13% off Deer Island (DIF) to 74% at the Outfall Site (OS). One lobster collected from OS and two from Cape Cod Bay (ECCB) had indications of shell erosion. No other deleterious external conditions were noted.

Similar to the 2009 flounder results and historical lobster results organic contaminants tended to be highest in lobster collected in Boston Harbor and lowest in those from Cape Cod Bay. Chlordane and DDTs continue to show downward trends throughout the region. One replicate from both DIF and OS had very high PCB tissue concentrations; the other two replicates had lower, more typical concentrations. Metal concentrations were less predictable. While mercury was highest in OS meat samples there appears to be a long term decrease in mercury in the sampling area. Copper and zinc were measured at the highest concentrations yet observed in harbor lobster hepatopancreas. Cadmium and nickel were at the highest level yet observed at OS. Lobster edible tissue were well below and MWRA Caution and Warning Thresholds and FDA Action Limits for human consumption.

Mussels

Mussels were collected at Stover's Point, Maine and deployed in arrays at Deer Island (DIL), Boston Inner Harbor (IH), Outfall Site (OSM), and "B" Buoy (LNB). A full set of arrays was successfully retrieved at fifty six days from all locations. Mussel survival at 56 days ranged from around 80% in the harbor stations to over 90% in Massachusetts Bay.

The 2009 data were similar to previous years with the highest contaminant levels generally observed in mussels deployed in Boston's Inner Harbor with lower concentrations in Massachusetts Bay. As expected the mussels from Maine had the lowest concentrations. A review of the pre- and post-wastewater diversion results suggests that chlordane and low molecular weight PAHs have decreased at Deer Island as a result of the diversion but only High Molecular weight PAHs have increased at the Outfall site. There were no exceedances of any MWRA Caution Threshold or FDA Action Limit.

1.0 INTRODUCTION

The Massachusetts Water Resources Authority (MWRA) has implemented a long-term Harbor and Outfall Monitoring (HOM) Program for Massachusetts and Cape Cod Bays. The objectives of the HOM Program are to access whether the environmental impacts of the MWRA discharge are consistent with SEIS projections and whether the impacts exceed any Contingency Plan thresholds (MWRA 2001a). A detailed description of the monitoring and its rationale is provided in the Effluent Outfall Monitoring Plan developed for the baseline period and the post-discharge monitoring plan (MWRA 1997, 2004).

One aspect of the MWRA HOM program is a long-term monitoring program for fish and shellfish (MWRA 1991). The goal of the fish and shellfish monitoring is to provide data to assess environmental impact of effluent discharge into Massachusetts Bay. These data are used to ensure that discharge from the new outfall does not result in adverse impacts to fish and shellfish by comparing values with established thresholds (MWRA 2001a and b).

The objective of the fish and shellfish monitoring is to define the condition of three indicator species: winter flounder (*Pseudopleuronectes americanus),* lobster (*Homarus americanus),* and blue mussel *(Mytilus edulis*). Measured parameters include length, weight, the presence of external or internal disease, and inorganic and organic contaminant tissue concentrations. This characterization of the health of winter flounder, lobster, and mussel in Boston Harbor, Massachusetts Bay, and Cape Cod Bay (hereafter: Boston Harbor and the Bays) forms the basis for assessing changes resulting from the relocation of the outfall discharge (Figure 1-1).

The scope of the 2009 Fish and Shellfish Report is focused primarily on assessing changes, if any, as a result of relocation of the MWRA wastewater discharge. The report first provides a summary of the survey and laboratory methods (Section 2). Section 3 presents the results of monitoring data from surveys conducted during 2009, as well as selected data from previous studies. References can be found in Section 4. All historical data are reported in Appendices A - E.

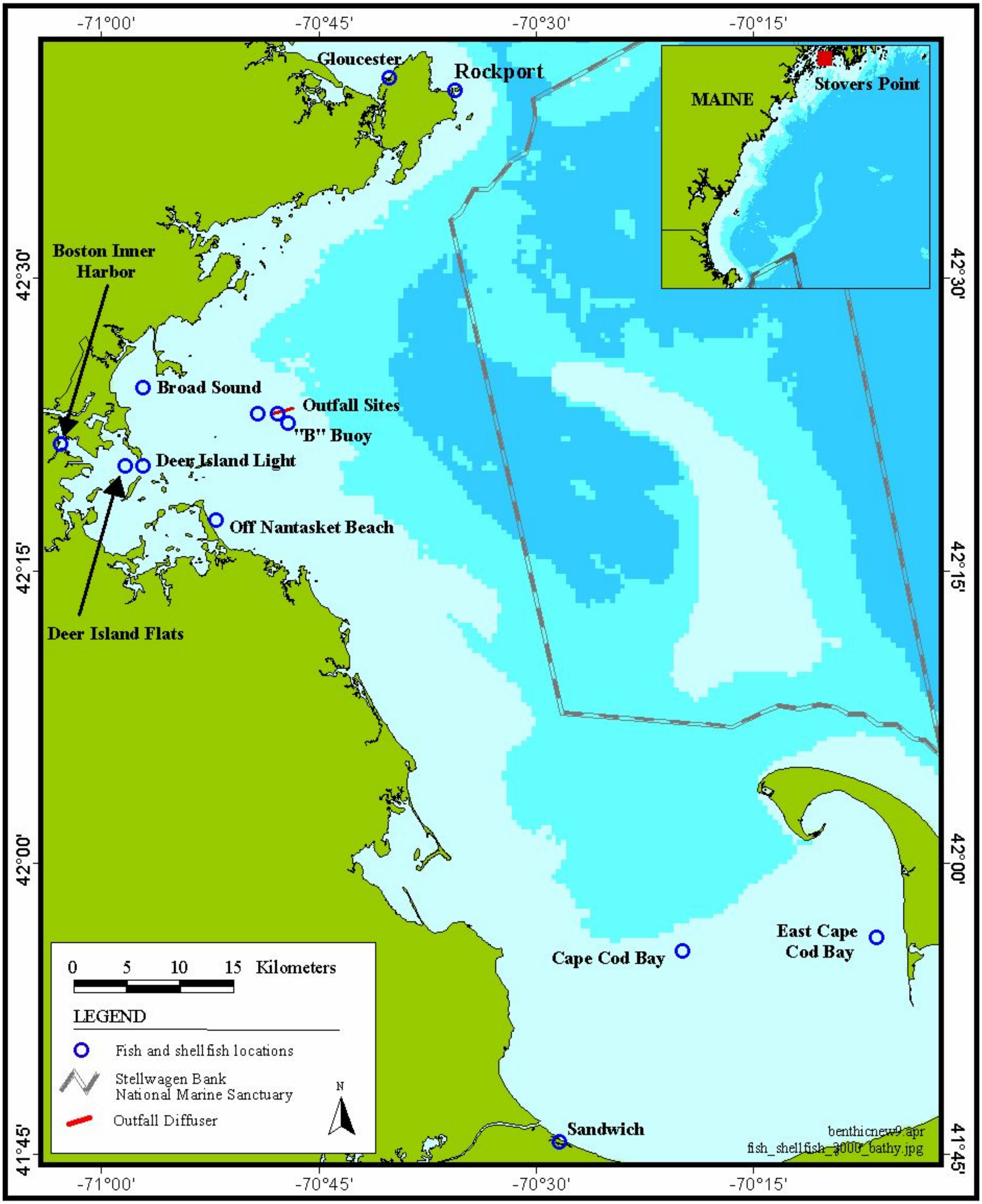

Figure 1-1. Boston Harbor and the Bays with Outfall Site.

2.0 METHODS

The methods and protocols used in the 2009 surveys conducted to collect biological specimens are similar to and consistent with previously used methods. More detailed descriptions of the methods are contained in *Combined Work/Quality Assurance Project Plan (CW/QAPP) for Fish and Shellfish Monitoring: 2008-09. (Maciolek et al. 2008)* and *Quality assurance project plan (QAPP) for fish and shellfish Monitoring.* (Lao *et al*. 2009).

2.1 Winter Flounder Monitoring

Winter flounder *(Pseudopleuronectes americanus)* were collected from four locations in Boston Harbor and the Bays to obtain specimens for age, weight, and length determination, gross examination of health, histology of livers, and chemical analyses of tissues to determine contaminant exposure. Chemical data were used to determine whether contaminant tissue burdens have changed since the startup of the Massachusetts Bay outfall and whether these concentrations approach human health consumption limits.

2.1.1 Stations and Sampling

The 2009 flounder survey was conducted between April 20 and May 5, 2009. Four sites were sampled to collect winter flounder for histological and chemical analyses:

- Deer Island Flats (DIF)
- Off Nantasket Beach (NB)
- Massachusetts Bay Outfall Site (OS)
- East Cape Cod Bay (ECCB)

Table 2-1 provides the planned and actual sampling sites and locations for the 2009 flounder sampling. Adjustments in location and time were made to maximize collection efforts in an attempt to collect the required 50 flounder per site. Figure 2-1 shows the actual monitoring locations.

At each of the four designated sampling sites, otter-trawl tows were conducted from the F/V *Harvest Moon* (captained by Mr. Mark Carroll) to collect 50 sexually mature (4-5 years old, total length ≥30 cm) winter flounder. Thirty-five fish at each station were assigned unique identification numbers to indicate date, time, and site of collection. These fish were killed at sea by cervical section and used for histological processing. They were examined externally and their external condition was noted prior to histological processing. The gonads of each flounder were examined to determine sexual maturity. All specimens were weighed, and total and standard lengths were determined. Scales were then taken from each specimen for age determination.

Of the 50 flounder collected from each station, 15 were designated for tissue chemical analysis. Because contaminant-free conditions were not available on board the vessel, the fish used for chemical analysis were returned to the laboratory for organ dissection. These fish were maintained alive on-board (on ice) and transported to Battelle (Duxbury) for histological and chemical analyses. These fish were also examined for external condition in the laboratory. Fifteen additional unique sample identification numbers were generated at sea at the time of fish collection; however, actual assignment of IDs to individual fish did not occur until the fish were sacrificed at the laboratory.

2.1.2 Age Determination

Scales from each specimen were collected for age determination. Scales were removed after first removing any mucus, debris, and epidermis from the dorsum of the caudal peduncle by wiping in the direction of the tail with a blunt-edged table knife. Scales were then collected from the cleaned area by applying quick, firm, scraping motions in the direction of the head. The loosened scales were placed in the labeled age-sample envelope by inserting the knife between the liner of the sample envelope and scraping off the scales. The age of each flounder was determined by scientists at the National Marine Fisheries Services (NMFS) in Woods Hole, Massachusetts through analysis of growth rings (annuli).

2.1.3 Dissection of Fish

The flounder tissues were removed in the laboratory under contaminant-free conditions. Tissue processing was conducted in a Class-100 clean room. The fillets (muscle) were removed from the flounder and the skin was removed from the fillet, using a pre-cleaned (*i.e*., rinsed with 10% HCL, Milli-Q (18 meg-ohm) water, acetone, DCM, and hexane) stainless steel knife.

From each site, three composites were prepared; each composed of approximately equal masses of top and bottom tissue from five randomly chosen fish. Homogenization was performed using a stainless steel TEKMAR® tissuemizer. Each composite was placed in a sample container clearly identified with the unique sample identifier.

Livers from the 15 fish selected for chemical analyses were removed using a titanium knife and processed for chemical analysis, after sectioning for histopathology analysis. (Livers from the fish not used for chemical analyses were removed shipboard and processed for histology as described below). Following the removal of three individual slices of liver for histology analysis, the remaining liver tissue from each fish was homogenized by finely chopping with the titanium knife and three separate composites per station were formed to correspond to the composites made for the fillets (*i.e.*, the livers of the same five specimens used for each edible tissue composite were combined). This was done to ensure comparability between fillet and liver chemical analyses. Each composite was placed in a sample container clearly identified with the unique sample identifier. This resulted in 24 pooled samples for analysis in 2009 (12 pooled fillets and 12 pooled livers). The homogenized tissue and liver samples were frozen and stored. Any remaining tissue from each specimen was archived frozen in case additional analysis was required.

At least one homogenization blank was carried out for each batch of 20 fish to monitor for sample contamination during the homogenization process. For the blank sample, a known quantity (about 100 ml) of Milli-Q water was transferred to a clear glass jar and "tissuemized" for two minutes. The blank was held for analysis of both PCB/Pesticides and Hg (fillet measurements only).

2.1.4 Histological Processing

After the fish were completely examined and scales removed, the livers were removed (either on-board the ship or in the lab, as described above) and examined for visible gross abnormalities ("Gross Liver Lesion"). The livers were then preserved in 10% neutral buffered formalin for histological analysis. Liver samples from each fish were placed in a separate clearly labeled sample container.

2.1.5 Histological Analysis

Livers of 50 flounder from each site were prepared for histological analysis by Experimental Pathology Laboratories in Herndon, VA. Transverse sections of flounder livers fixed as part of tissue sample processing were removed from the buffered formalin after at least 24 hours, rinsed in running tap water, dehydrated through a series of ethanols, cleared in xylene, and embedded in paraffin. Paraffin-embedded material was sectioned on a rotary microtome at a thickness of 5 μm. Each block contained three liver slices, resulting in one slide with three slices per slide per fish, for a total of 200 slides (50 fish X 4 sites). The sections were stained in hematoxylin and eosin.

Each slide was examined under bright-field illumination at 25x, 100x, and 200x magnification to quantify the presence and extent of:

- Three types of vacuolation (centrotubular, tubular, and focal)
- Macrophage aggregation
- Biliary duct proliferation
- Neoplasia

The severity of each lesion was rated on a scale of 0 to 4, where: 0 = absent; 1 = minor; 2 = moderate; 3 = severe; and 4 = extreme. For each lesion and each fish, a histopathological index was then calculated as a mean of scores from three slices on one slide.

2.1.6 Tissue Processing and Chemical Analyses

Chemical analyses were performed on composite samples of flounder from all stations. Two tissue types (fillet and liver) were analyzed. Flounder fillet and livers were analyzed for PCBs/Pesticides, lipids, and mercury. In addition, flounder livers were analyzed for PAHs, lead, silver, cadmium, chromium, copper, nickel, and zinc. The individual steps involved in the tissue processing and chemical analyses of these samples are detailed in Section 2.4.

2.1.7 Data Reduction and Statistical Analyses

Data reduction was conducted as described in the Fish and Shellfish Monitoring CW/QAPP (Maciolek *et al.* 2008) and in Section 2.5 of this report. Histopathological indices and prevalence of lesions were compared among groups of flounder by station. Chemical constituents were presented graphically and compared among stations and over time.

In addition to reporting the prevalence and lesion index of hydropic vacuolation, historical data has included several other lesions, including macrophage aggregates, biliary proliferation, neoplasia, and a lesion unreported before 1993, referred to as "balloon hepatocytes" (Hillman & Peven 1995).

2.2 Lobster Monitoring

Lobsters *(Homarus americanus)* were collected from three sampling sites for gross examination (to determine specimen health) and chemical analyses (to determine tissue burden of contaminants).

2.2.1 Stations and Sampling

Lobster surveys were conducted on June 26-30, 2009 (DIF), August 10-14, 2009 (ECCB), and September 7-10, 2009 (OS). Lobsters were captured in traps deployed at each location from the sampling platform F/V *Shanna Rose* captained by Mr. Josh Goodwin.

Table 2-2 provides the planned and actual sampling sites and locations for the lobster surveys. Figure 2-2 illustrates the actual sampling locations in Boston Harbor and the Bays. Adjustments in location and time were made to maximize collection efforts.

Individual lobsters retained for analyses were assigned a unique identification number to indicate date, time, and site of collection. Lobsters were measured for carapace length and weight, and the gender was determined. Lobster specimens were visually examined and the condition noted. Processing of the hepatopancreas and edible tissue samples was conducted in the laboratory.

2.2.2 Size and Sex Determination

Carapace length was determined with calipers by measuring the distance from the posterior of the eye socket to the midpoint of the posterior of the carapace. Measurements were recorded to the nearest millimeter. Specimen weight was recorded to the nearest gram. Specimens were visually examined for the presence and severity of gross external abnormalities, such as black gill disease, shell erosion, and parasites. Data for each specimen were recorded on a lobster sample collection log.

2.2.3 Dissection of Lobster

The hepatopancreas was removed and frozen for chemical analysis. The tail and claw meat (edible tissue) was stored frozen in the shells until processed in the laboratory. Samples were placed in sample containers that were clearly identified with a conventional label containing the pertinent sample information.

The lobsters collected at each site were randomly divided into three groups of seven lobsters each. Within each of the three groups, edible meat (tail and claw) and hepatopancreas from the same seven lobsters were pooled by tissue type. Homogenization of lobster meat was performed using a stainless steel TEKMAR® tissuemizer. Hepatopancreas samples were homogenized using a titanium knife to avoid metals contamination. Each composite was placed in a sample container clearly identified with the unique sample identifier. This resulted in 18 pooled samples for analysis in 2009 (nine edible meat samples and nine hepatopancreas samples).

2.2.4 Tissue Processing and Chemical Analyses

Chemical analyses were performed on the composite samples of lobster (edible meat and hepatopancreas). Edible lobster meat and hepatopancreas were analyzed for PCBs/Pesticides, lipids, and mercury. In addition, hepatopancreas samples were analyzed for PAHs, lead, silver, cadmium, chromium, copper, nickel, and zinc. The individual steps involved in the tissue processing and chemical analyses of these samples are detailed in Section 2.4.

2.2.5 Data Reduction and Statistical Analyses

Data reduction was conducted as described in the Fish and Shellfish Monitoring CW/QAPP (Maciolek *et al.* 2008) and Section 2.5 of this report. Chemical constituents were presented graphically and compared among stations and over time.

2.3 Mussel Bioaccumulation Monitoring

Blue mussels *(Mytilus edulis)* were collected from Stover’s Point, ME and deployed in suspended cages at four sites in Boston Harbor and the bays. Mussels were recovered for determination of short-term accumulation of anthropogenic contaminants in soft tissues.

2.3.1 Stations and Reference Area

2009 pre-deployment mussels were collected from a reference site in Stover’s Point, ME and were deployed at four sites:

- Deer Island Light (DIL)
- Outfall Site (OSM)
- Outfall Site “B” Buoy – 1 km south of the outfall risers (LNB)
- Boston Inner Harbor (IH)

Table 2-3 provides the planned and actual sampling sites and locations. Figure 2-3 illustrates the sampling locations in Boston Harbor and Massachusetts Bay.

2.3.2 Mussel Collection

On June 25, 2009, approximately 1350 mussels were collected from Stover's Point, ME (SP) for deployment and organic and inorganic chemical analyses. Mussels between 55 and 65 mm in length were harvested during low tide with 100 mussels individually checked for length. A sub-sample of 100 mussels was randomly selected and set aside for pre-deployment biological and chemical analyses.

2.3.3 Mussel Deployment

After collection, the mussels were randomly distributed to plastic cages for deployment as an array (i.e., set of cages) in sufficient number to provide the necessary biological material. At least 10% additional mussels were included to account for potential mortality. Mussels were deployed on June 26 in replicate arrays at the four sites (Figures 2-3 and 2-4). Table 2-4 lists the minimum numbers of mussels and the number of cages and corresponding arrays that were deployed at each location. Each array was deployed on a separate mooring and each with enough mussels to provide sufficient tissue to complete the study. The locations of the arrays were recorded using Differential Global Positioning System (DGPS).

At OSM, five arrays (OS-M1, OS-M3, OS-M5, OS-M6 and OS-M8) were deployed at various locations just south of the diffuser heads and one approximately 1 km away at the "B" buoy (LNB) (Figure 2-4). This deployment scheme was used to better understand the spatial variability of contaminant concentrations along the length of the outfall.

2.3.4 Mussel Retrieval

Mussel retrieval was planned for two occasions with a collection of up to one half of the mussels per station at 45-days to provide tissue in the event of failure to recover cages at the planned 60-day retrievals. The 45-day retrievals occurred on August 11 at which time the array from OS-M1 was recovered and it was discovered that all arrays at OS-M5 and OS-M8 had been lost. The 56-day retrieval occurred on August 21. This was four days earlier than planned due to the pending arrival of Tropical Storm Bill on August 22. Actual mussel recovery is discussed in Section 3.3. The amount of bio-fouling of the arrays was also assessed at 45 days.

2.3.5 Tissue Processing and Chemical Analyses

Individual mussels were pooled into a single composite for organic and inorganic analyses. A total of four replicate samples were created with mussels deployed and collected at DIL, IH, and LNB. At OS, eight pooled samples of 25 mussels each were created; five composites were created from the OS-M3 deployment, and three composites from the OS-M6 deployment. Four pooled replicates of Stover's Point pre-deployment mussels were also analyzed for organic and inorganic parameters.

Mussel composites were prepared from individual mussels by removing attached material and byssal threads. All soft tissue, including fluids, was placed directly into a clean glass jar. Mussel composite samples were prepared for both organic and inorganic chemical analyses by homogenization of the 25 mussels using a Titanium Tekmar "tissumizer" rinsed with methanol and de-ionized water prior to use. The homogenate was separated into aliquots using a titanium or Teflon utensil and placed in a pre-cleaned 4 ounce plastic jar. All composite splits were stored frozen prior to analysis.

The mussel tissue composites were analyzed for PCBs/Pesticides, PAHs, lipids, mercury, and lead. The individual steps involved in the tissue processing and chemical analyses of these samples are detailed in Section 2.4.

2.3.6 Data Reduction and Statistical Analyses

The extent of bioaccumulation of contaminants in the mussels was evaluated using the data reduction methods described in the Fish and Shellfish Monitoring CW/QAPP (Maciolek *et al.* 2008) and in Section 2.5 of this report. Chemical concentrations by constituent were presented graphically and compared among stations and over time.

2.4 Chemical Analyses of Tissue Samples

Table 2-5 summarizes the analyses performed on each type of tissue sample. The methods, references and specific analytes are listed in Table 2-7 and 2-7.. The same analytical methods were used for all tissues.

2.4.1 Organic Tissue Extraction

The MWRA Central Laboratory performed all organic fish and shellfish tissue chemistry analyses. Tissue samples are extracted for PAH, chlorinated pesticides, and PCB congeners following MWRA Central Lab SOP #1189.0 (MWRA, 2004a). This extraction method utilizes sonication, and is based on EPA Method 3550B. Between 2 and 5 g of homogenized tissue is mixed with sodium sulfate and is serially extracted with methylene chloride (DCM) using sonication techniques. The sample is weighed in an extraction vessel, mixed with the appropriate amount of sodium sulfate to achieve a free-flowing consistency, and spiked with the surrogate compounds. Methylene chloride is added and the sample is sonicated using the ultrasonic disruptor. The extract is decanted in an Erlenmeyer flask through a powder funnel containing glass wool and sodium sulfate to remove any water and solid particles. After each extraction (total of three solvent additions) the filtered solvent is combined in the flask. If a percent lipids determination is to be performed, 10 mL of the total extract is removed and transferred to an aluminum weighing dish. The solvent is allowed to evaporate overnight and the pan is weighed for the percent lipids determination. The remaining extract is measured in a graduated cylinder and then concentrated to 1 mL using the TurboVap automatic concentrator technique. This concentrated extract is then processed through a silica gel cartridge and concentrated to 2 mL using the TurboVap automatic concentrator technique. The post-cleanup extracts are then split 50:50 for analysis by the PAH and pesticide/congener methods.

2.4.2 Metals Tissue Digestion and Analyses

The MWRA Central Laboratory performed metals digestions and analyses for Ag, Cd, Cr, Cu, Hg, Ni, Pb, and Zn. Tissue samples are prepared by weighing, freeze drying, and then weighing again to determine the dry weight. Then tissue samples are digested using a nitric acid digestion according to MWRA Central Lab SOP #1195.0 (MWRA, 2004b). A 500 to 1000 mg aliquot of each homogeneous lyophilized sample is combined with 5 mL HNO_3 and 5 mL water in a Teflon microwave vessel. Samples are cold-digested in this acid mixture overnight. Samples are then microwave digested for approximately 30 minutes. After heating and cooling, samples are filtered through Whatman #541 filters and rinsed with Milli-Q water (final volume is 50 mL).

Samples for mercury analysis are digested according to MWRA Central Lab SOP #1236.0 (MWRA, 2006). A 200 mg lyophilized aliquot is cold-digested with 15 mL dilute HNO_3 and H_2SO_4 overnight. Samples are then heated in a 58^{o}C waterbath for 1 hour, then heated again at 80^{o}C for an additional 30 minutes. Cooled samples are further oxidized with $KMnO_4$ and $K_2S_2O_8$ overnight. Deionized water is added to bring the final sample volume to 50 mL. Analysis of metals by ICP - Digestates are analyzed by ICP according to MWRA Central Lab SOP #1008.3 (MWRA, 2008a). Elements that are undetected by ICP may be analyzed by GFA for lower reporting limits according to MWRA Central Lab SOP #1150.3 (MWRA, 2008b). Results are reported as μg/g dry-weight.

Analysis of Hg - The digested sample is mixed with a reducing agent in-line to release elemental Hg vapor. Hg is quantified by atomic absorption at 254 nm. Results are reported as µg/g dry-weight. Samples are analyzed according to MWRA Central Lab SOP #1049.3 (MWRA, 2008c).

2.4.3 Organic Analyses

PAH Analysis - Sample extracts are analyzed for PAH compounds by gas chromatography/mass spectrometry (GC/MS) operating in the selected-ion-monitoring (SIM) mode, using a 30m Rtx-5 column (or equivalent) and an Agilent 5973 detector (or equivalent) according to MWRA Central Lab SOP #1030.3 (MWRA, 2004c). The PAH compounds are quantified using the internal standard method. Concentrations of the substituted PAH homologues are determined by summing the total area of each homologue and using the response factor of the parent PAH compound.

PCB/Pesticide Analysis – Pesticides and PCB congeners are analyzed by gas chromatography/mass spectrometry (GC/MS) operating in the selected-ion-monitoring (SIM) mode, using a 60m Rtx-5 column (or equivalent) and an Agilent 5973 detector (or equivalent) according to MWRA Central Lab SOP #1173.3 (MWRA, 2004d). Two separate analyses are performed, one to determine the pesticide compounds and one for the PCB congeners. Concentrations for all target analytes are determined using the internal standard method.

All PAH, PCB congener, and pesticide results are reported in micrograms per kilogram (µg/kg) on a dry weight basis, which is determined during metals analysis.

2.5 General Data Treatment and Reduction

This section describes the data reduction performed on 2009 Fish and Shellfish data, as well as historical data, as part of the MWRA Harbor and Outfall Monitoring Project.

Specifics of data handling are as follows:

- All 2009 chemical data were generated by MWRA's Department of Laboratory Services and loaded directly into the HOM database.
- Mussel data for all OS 60-day deployment locations (e.g. OS-M1, OS-M3, OS-M6) were averaged for both 2009 and time-series plots.
- All fish and shellfish data (2009 and historical) were extracted directly from the HOM database and exported into Excel files, where graphical presentations and statistical analyses were preformed.
- All laboratory duplicates for pre-1998 data were averaged for reporting and calculating. No laboratory duplicate data were entered for post-1998 data.
- Error bars in all graphical presentations represent standard errors. Means and n by station and year are reported in the Appendices.
- 1992 flounder collection consisted of three individual fish and a composite of seven fish. Results were calculated by treating the composite as seven individual fish and averaging those values with the values of the other three individual fish (i.e., [(7*val1 +val2 + val3 + val4)/10]). MWRA decided that the appropriate standard error and *n* values for this composite are null. This manipulation was done in the script used to query the data from the database and is not reflected in the EM&MS database.

- 1993 lobster selection consisted of two animals collected in June and one in August. Results were calculated by taking the average of these three animals (*n* = 3). The difference in sample collection times was footnoted.
- Total PCB was calculated as the sum of twenty PCB congeners (Table 2-7).
- Total DDT was calculated as the sum of six DDT-related compounds: 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT (Table 2-7).
- Total chlordane was calculated as the sum of four compounds: heptachlor, heptachlorepoxide, cis-chlordane, and trans-nonachlor (Table 2-7).
- Sums of PAHs were calculated using several groupings. The "Total PAH List" and the "Historical NOAA List" are presented in Table 2-8.
- In 1995, the individual five alkylated PAHs on the "Historical NOAA List" were not measured in mussels. Instead, the C1-, C2-, and C3-alkylated napthalene homologue groups were quantified. To make 1995 results more comparable to the "Historical NOAA List", values for the individual alkylated naphthalene compounds were estimated using ratios of the individuals to their respective homologue groups from 1996 and 1997 data sets.
- All organic data (i.e., PAHs, PCBs, and pesticides) are surrogate recovery corrected.
- The "s" qualifier was used to indicate suspect data. Unless otherwise noted, only "s"-flagged data were excluded in calculations, tables, or graphs presented in this report.
- All non-detects used in calculations and trend analyses in this report were treated as zero.
- All data entered into the database are in dry weight units.
- Wet weight tissue concentrations were calculated from the wet/dry ratio and used in comparison to MWRA Contingency Plan Thresholds.
- Years in which composite samples were made up of only one animal were excluded from temporal plots.

Table 2-1. Planned and actual sampling locations for flounder survey

Station ID	Sampling Site	Number of Tows	Planned Locations		Actual Locations[1]	
			N Latitude	W Longitude	N Latitude	W Longitude
DIF	Deer Island Flats	3	42º20.4'	70º58.4'	42º20.9'	70º58.1'
NB	Off Nantasket Beach	4	42º17.6'	70º52.2'	42º17.4'	70º51.9'
OS	Outfall Site	2	42º23.1'	70º49.3'	42º23.2'	70º48.8'
ECCB	East Cape Cod Bay	1	41º56.2'	70º06.6'	41º56.1'	70º07.6'

[1]Based on an average of the Latitude and Longitude of several tows

Table 2-2. Planned and actual sampling locations for lobster survey

Station ID	Sampling Site	Planned Location		Actual Location	
		N Latitude	W Longitude	N Latitude	W Longitude
DIF	Deer Island Flats	42º20.4'	70º58.4'	42º20.89'	70º58.47'
OS	Outfall Site	42º23.1'	70º49.3'	42º23.02'	70º48.93'
ECCB	East Cape Cod Bay	41º56.2'	70º06.6'	41º56.15'	70º06.31'

Table 2-3. Planned and actual sampling locations for mussels survey

Station ID	Sampling Site	Planned Location		Actual Location	
		N Latitude	W Longitude	N Latitude	W Longitude
DIL	Deer Island Light	42º20.4'	70º57.2'	42º20.39'	71º57.23'
OS-M3	Outfall Site - Mussel Array 3	42º23.15'	70º47.92'	42º23.17'	70°47.45'
OS-M6	Outfall Site - Mussel Array 6	42º23.15'	70º47.92'	42º23.26'	70°46.98'
LNB	Boston "B" Buoy	42º22.67'	70º47.25'	42º22.71'	70º47.19'
IH	Boston Inner Harbor	42º21.5'	71º02.9'	42º21.53'	71°02.91'
SP	Stover's Point, ME	43º45.1'	69º59.9'	43º45.11'	69º59.87'

Table 2-4. Summary of mussel deployment scheme

Site	Description/ Location	Water Depth[a]	Cage Height Above Bottom	# Arrays	# Cages/Array	# Mussels/ Cage
DIL	Deer Island Light	2-5 m	<1-1.5m	3	2	55
OS	Outfall Site	33m	12m	5	1-2	55
LNB	"B" Buoy	33m	12 m	2	2	55
IH	Boston Inner Harbor	8-11m	1.5-4.5m[b]	2	2	55

[a] Arrays rise and fall with tide, so that they are at a constant depth below the water surface.
[b] Based on historical data.

Table 2-5. Summary of chemical analyses performed

Sample Type	Number of Samples	Metals (1) (other than Hg and Pb)	Hg	Pb	PCBs	PAHs	Pesticides	Lipids
Flounder Meat	12	NR	*	NR	*	NR	*	*
Flounder Liver	12	*	*	*	*	*	*	*
Lobster Meat	9	NR	*	NR	*	NR	*	*
Lobster Hepatopancreas	9	*	*	*	*	*	*	*
Mussel Tissue	24	NR	*	*	*	*	*	*

*Targeted for Analysis; NR = Not Required
(1) Additional metals: Ag, Cd, Cr, Cu, Ni, and Zn

Table 2-6. Summary of analytical methods.

Parameter	Unit of Measurement	Method	Reference
Organic Analyses			
Organic Extraction	NA	Tissuemize/Methylene Chloride	MWRA (2004a), SOP 1189.0
Polycyclic Aromatic Hydrocarbons (PAH)	ng/g dry wt.	GC/MS-SIM	MWRA (2004c), SOP 1030.3
Polychlorinated Biphenyls (PCB)/Pesticides	ng/g dry wt.	GC/MS-SIM	MWRA (2004d), SOP 1173.3
Metals Analyses			
Digestion: Ag, Cd, Cr, Cu, Ni, Pb, Zn	NA	Microwave digestion Nitric acid	MWRA (2004b), SOP 1195.0
Digestion: Hg	NA	Nitric acid, sulfuric acid	MWRA (2006), SOP 1236.0
Analysis: Ag, Cd, Cr, Cu, Ni, Pb, Zn	µg/g dry wt	ICP AES, GFA as needed	MWRA (2008a, b), SOP 1008.3, 1150.3
Analysis: Hg	µg/g dry wt	CVA	MWRA (2008c), SOP 1049.3
Ancillary Parameters			
Lipids	% by dry weight	Gravimetric	MWRA (2004a), SOP 1189.0
Dry Weight	% by dry weight	Freeze drying	MWRA (2004b), SOP 1195.0

Table 2-7. Specific chemical analytes

Chemical Analytes
Trace Metals[a]
Ag Silver
Cd Cadmium
Cr Chromium
Cu Copper
Hg Mercury[b,d]
Ni Nickel
Pb Lead[d]
Zn Zinc
Polychlorinated biphenyls (PCBs)[c,d]
2,4’-Cl_2(8)
2,2’,5-Cl_3(18)
2,4,4’-Cl_3(28)
2,2’,3,5’-Cl_4(44)
2,2’,5,5’-Cl_4(52)
2,3’,4,4’-Cl_4(66)
3,3’,4,4’-Cl_4(77)
2,2’4,5,5’-Cl_5(101)
2,3,3’,4,4’-Cl_5(105)
2,3’,4,4’5-Cl_5(118)
3,3’,4,4’,5-Cl_5(126)
2,2’,3,3’,4,4’-Cl_6(128)
2,2’,3,4,4’,5’-Cl_6(138)
2,2’4,4’,5,5’-Cl_6(153)
2,2’3,3’,4,4’,5-Cl_7(170)
2,2’,3,4,4’,5,5’-Cl_7(180)
2,2’,3,4’,5,5’,6-Cl_7(187)
2,2’,3,3’,4,4’,5,6-Cl_8(195)
2,2’,3,3’4,4’,5,5’,6-Cl_9(206)
Decachlorobiphenyl-Cl_{10}(209)
Polynuclear Aromatic Hydrocarbons (PAHs)[a,d]
Naphthalene
C_1-naphthalenes
C_2-naphthalenes
C_3-naphthalenes
C_4-naphthalenes
1-methylnaphthalenes[e]
2-methylnaphthalenes[e]
2,6-methylnaphthalenes[e]
2,3,5-methylnaphthalenes[e]
Acenaphthylene
Acenaphthene
Fluorene
C_1-fluorenes
C_2-fluorenes
C_3-fluorenes
Phenanthrene
1-methylphenanthrene[e]
Anthracene
Polynuclear Aromatic Hydrocarbons (PAHs) (continued)
C_1-Phenanthrenes/anthracene
C_2-Phenanthrenes/anthracene
C_3-Phenanthrenes/anthracene
C_4-Phenanthrenes/anthracene
Dibenzothiophene
C_1-dibenzothiophenes
C_2-dibenzothiophenes
C_3-dibenzothiophenes
Fluoranthene
Pyrene
C_1-fluoranthenes/pyrene
C_2-fluoranthenes/pyrene
C_3-fluoranthenes/pyrene
Benzo[*a*]anthracene
Chrysene
C_1-chrysene
C_2-chrysene
C_3-chrysene
C_4-chrysene
Benzo[*b*]fluoranthene
Benzo[*k*]fluoranthene
Benzo[*a*]pyrene
Dibenzo[*a,h*]anthracene
Benzo[g,h,i]perylene
Indeno[1,2,3-*c,d*]pyrene
Perylene
Biphenyl
Benzo[*e*]pyrene
Dibenzofuran
Benzothiazole
Pesticides[c,d]
Hexachlorobenzene
Lindane
Endrin
Aldrin
Dieldrin
Mirex
Heptachlor
Heptachlorepoxide
cis-chlordane
trans-nonachlor
2,4’-DDD
4,4’-DDD
2,4’-DDE
4,4’-DDE
2,4’-DDT
4,4’-DDT
DDMU
Lipids[c,d]

[a] Flounder liver; lobster hepatopancreas
[b] Flounder and lobster edible tissue
[c] Flounder edible tissue and liver; lobster edible tissue and hepatopancreas
[d] Mussel soft tissue
[e] Measured in mussel tissue in 1992–1994 and 1996–2009

Table 2-8. Summary of PAH lists of analytes

Total PAH List	"Historical" NOAA PAH List
Low Molecular Weight PAHs	**Low Molecular Weight PAHs**
1-methylnaphthalene*	1-methylnaphthalene
1-methylphenanthrene*	1-methylphenanthrene
2,3,5-trimethylnaphthalene*	2,3,5-trimethylnaphthalene
2,6-dimethylnaphthalene*	2,6-dimethylnaphthalene
2-methylnaphthalene*	2-methylnaphthalene
Acenaphthene	Acenaphthene
Acenaphthylene	Acenapthylene
Anthracene	Anthracene
Benzothiozole*	
Biphenyl	Biphenyl
C1-dibenzothiophenes	
C1-fluorenes	
C1-naphthalenes	
C1-phenanthrenes/anthracenes	
C2-dibenzothiophenes	
C2-fluorenes	
C2-naphthalenes	
C2-phenanthrenes/anthracenes	
C3-dibenzothiophenes	
C3-fluorenes	
C3-naphthalenes	
C3-phenanthrenes/anthracenes	
C4-naphthalenes	
C4-phenanthrenes/anthracenes	
Dibenzofuran	
Dbenzothiophene	
Fluorene	Fluorene
Naphthalene	Naphthalene
Phenanthrene	Phenanthrene
High Molecular Weight PAHs	**High Molecular Weight PAHs**
Benzo(a)anthracene	Benzo(a)anthracene
Benzo(a)pyrene	Benzo(a)pyrene
Benzo(b)fluoranthene	Benzo(b)fluoranthene
Benzo(e)pyrene	Benzo(e)pyrene
Benzo(g,h,i)perylene	Benzo(g,h,i)perylene
Benzo(k)fluoranthene	Benzo(k)fluoranthene
C1-chrysenes	
C1-fluoranthenes/pyrenes	
C2-chrysenes	
C2-fluoranthenes/pyrenes	
C3-chrysenes	
C3-fluoranthenes/pyrenes	
C4-chrysenes	
Chrysene	Chrysene
Dibenzo(a,h)anthracene	**D**ibenzo(a,h)anthracene
Fluoranthene	Fluoranthene
Indeno(1,2,3-c,d)pyrene	Indeno(1,2,3-c,d)pyrene
Perylene	Perylene
Pyrene	Pyrene

*** Not Included in Total PAH**

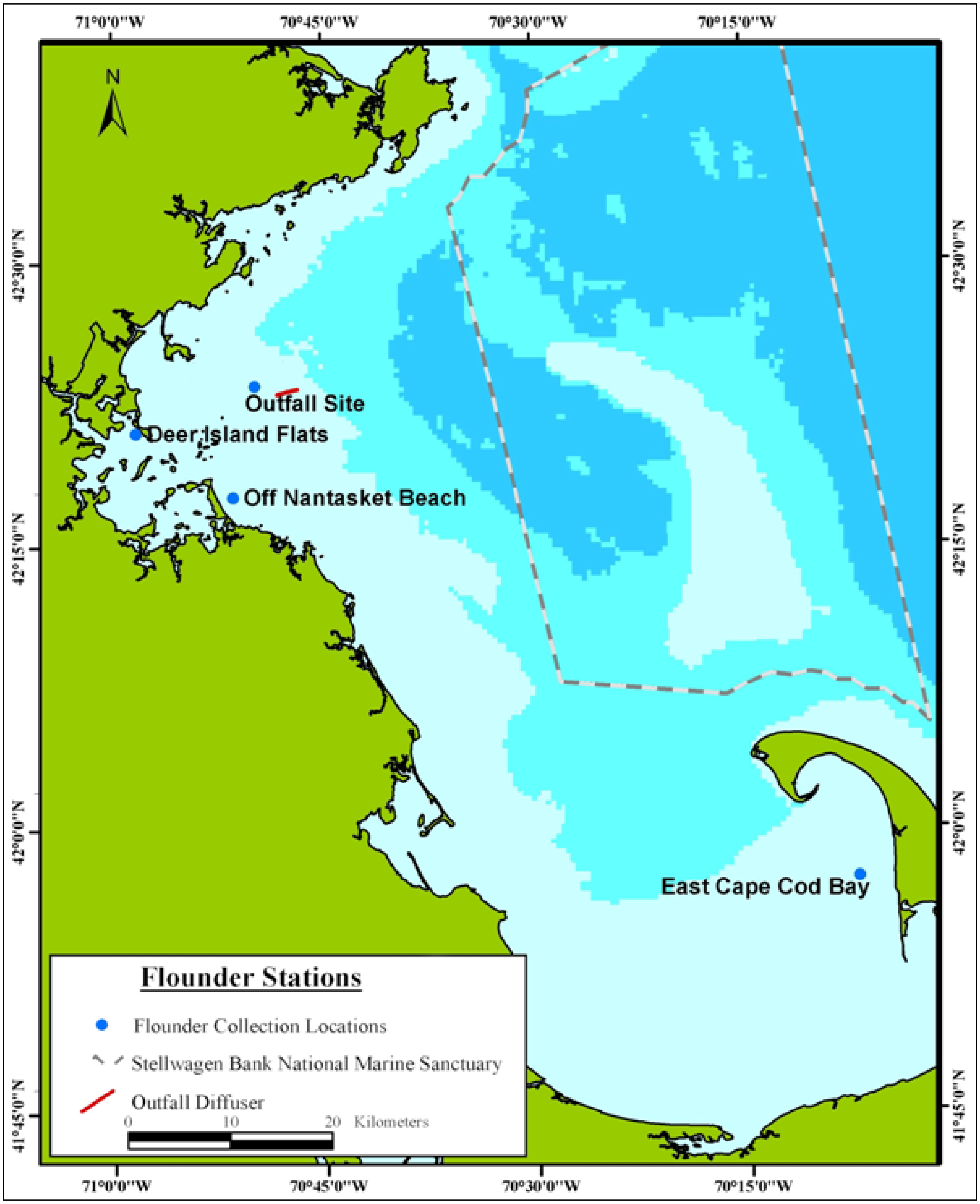

Figure 2-1. 2009 Flounder Monitoring Locations.

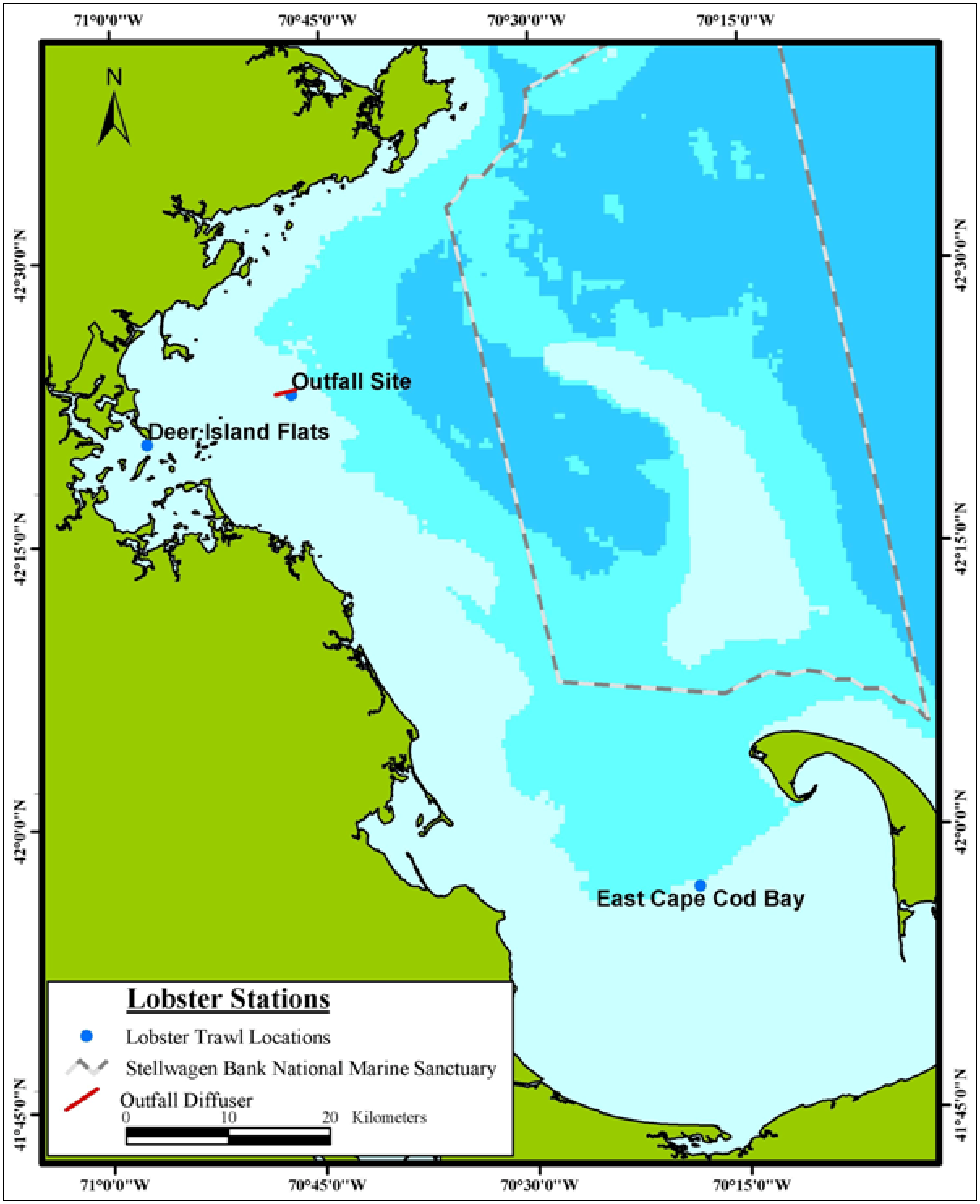

Figure 2-2. 2009 Lobster Monitoring Locations.

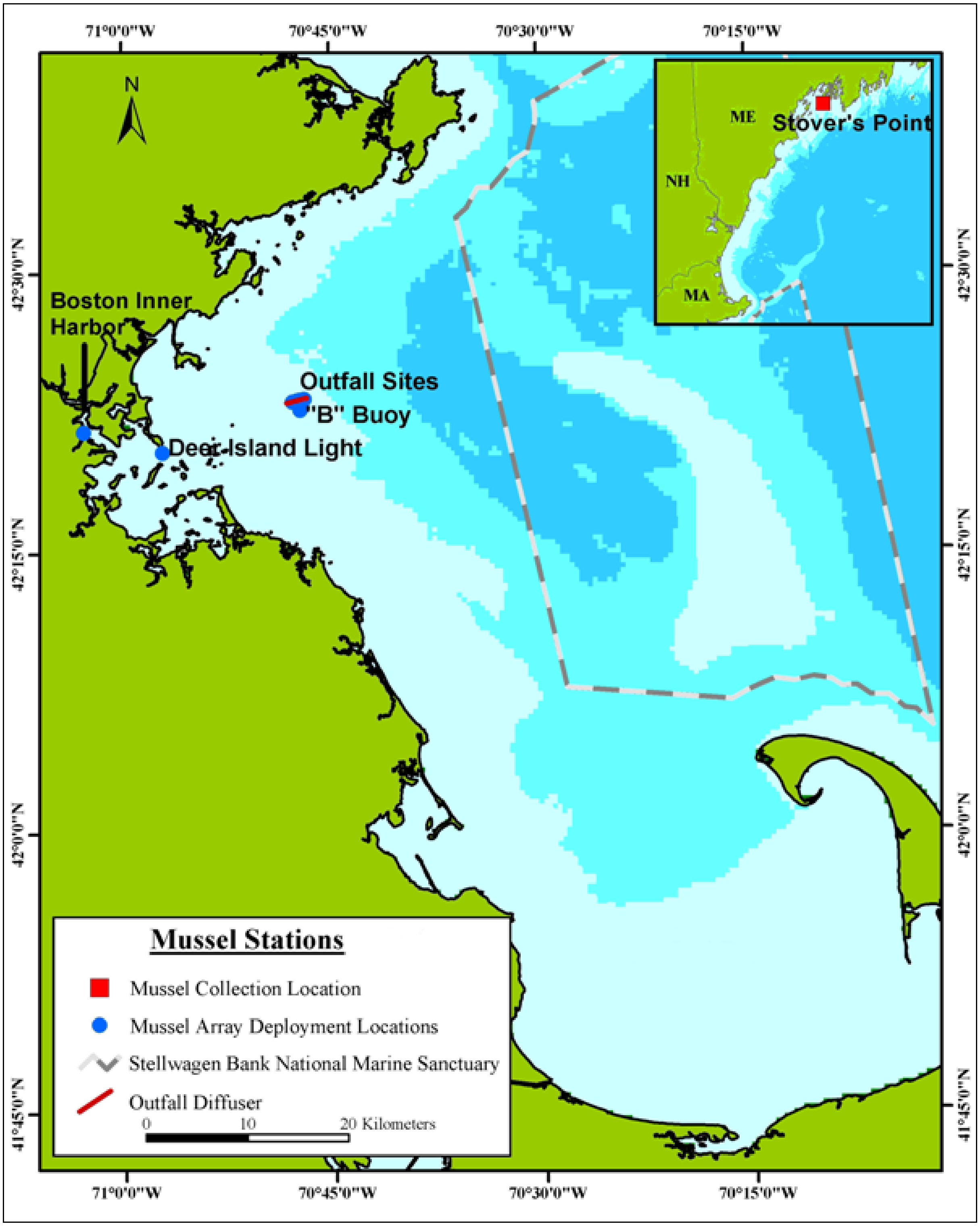

Figure 2-3. 2009 Mussel Collection and Deployment Locations.

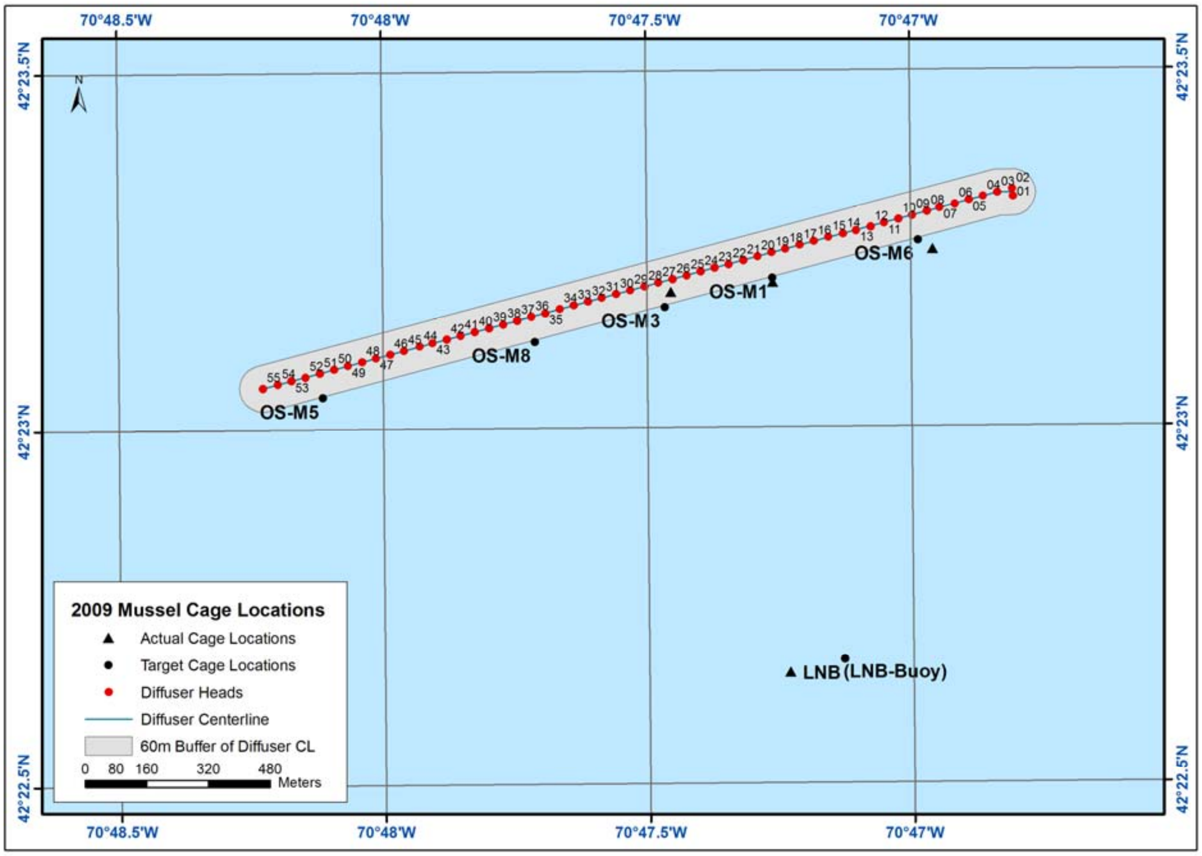

Figure 2-4. Mussel Deployment Locations at OS in 2009.

3.0 RESULTS

3.1 Winter Flounder

3.1.1 Fish Collected

Winter flounder, each a minimum 30 cm in length, were collected between April 20 and May 5, 2009 at four stations in the study area (Figure 2-1). The catch per unit effort (CPUE), defined as the number of fish obtained per minute of bottom trawling time, is reported in Figure 3-1. In 2009, the maximum CPUE was in Cape Cod Bay (ECCB). This was the highest at that station in 19 years of MWRA monitoring. At the Outfall Site (OS) the CPUE was the highest since 2004 but well below those observed from 2000-2004. CPUE continue to be relatively low off Deer Island (DIF) and Nantasket Beach (NB). Current levels represent a decrease from the early monitoring period at NB (Figure 3-1) and from the late 1980's off Deer Island when a CPUE of 10 fish per minute was reported (pers. comm.– M. Moore).

While the reported CPUE are specific to the Boston Harbor to Cape Cod region in late April, the long term trends shown in Figure 3-1 loosely parallel estimates of the Gulf of Maine Spawning Stock Biomass for Winter Flounder reported by Vonderweidt *et al.* 2009. Biomass decreased steadily from 12 million pounds in 1982 to less than 2 million pounds in 1995. From 1997 to 2003 it modestly increased, peaking in 2001 at approximately 3 million pounds before decreasing again.

3.1.2 Physical Characteristics

Mean age, total length, and weight of the winter flounder collected at the four stations are provided in Table 3-1. While fish collected at NB were numerically slightly older than those from the other stations, fish collected from DIF had the highest mean lengths and weights. Fish from the OS location were the youngest and smallest.

Figure 3-2 displays the mean age of fish collected at each site since 1991. Somewhat similar to the trends noted for CPUE the mean age at most stations stayed level or decreased during the 1990's but trended higher during the 2000 to 2007 period. The average fish age has dropped again over the past two field seasons.

As in past years 2009 mean weights followed a similar pattern as the age data (Figure 3-3). It was one of many years when fish collected at DIF were heavier than at other locations even though they were on average no older. Another factor besides age that may have contributed to the increase in mean weights since 2000 is the increase in the proportion of female fish collected (Figure 3-4). Since females reach a larger adult size than males (Pereira *et al*. 1999) increases in the proportion of females would be expected to be reflected as modestly higher mean weights.

3.1.3 External Condition

The prevalence of external abnormalities (*i.e*., bent fin ray, fin erosion, blind side ulcers, lymphocystis) at each station are presented in Table 2. Fish collected off Deer Island were more likely to be affected by bent fin ray and fin erosion that those collected from other stations. Fin erosion is a useful parameter in detecting sub-optimal water quality conditions (Bosakowski and Wagner 1994) and its prevalence has often been higher at DIF than at other stations (Figure 3-5). The Outfall site had the highest prevalence of lymphocysits, a viral caused swelling of epithelial cells.

The prevalence of blind side ulcers, first observed in 2003 (see Moore *et al.* 2004, 2010), remained low for the third consecutive year at all stations.

3.1.4 Liver Histopathology

Winter flounder have historically been used as a sentinel of chemical contamination impact on the marine environment. Chang *et al*. (1998) and Myers *et al.* (1998) discuss the positive relationships observed in the NOAA National Benthic Surveillance Program between the prevalence of liver neoplasm and pre-neoplasm and concentrations of toxic contaminants. The high prevalence of liver neoplasm in Boston Harbor winter flounder reported by Murchelano and Wolke (1985) was one of several important findings which resulted in the Boston Harbor "clean-up" project.

In 2009 neoplasm were again not observed at any of the stations sampled. Neoplasm have always been rare or absent from all sites other than DIF with none ever detected at OS, the Outfall Site (Figure 3-6).

Table 3-3 displays the prevalence of other liver abnormalities enumerated in 2009. Hydropic vacuolation (HV), lesions also positively associated with chemical contaminants, have been one of the principal abnormalities monitored throughout this program. HVs range from the least severe centrotubular hydropic vacuolation (CHV) to the most severe focal HV. As in past years the prevalence of CHV and the moderately severe tubular HV was highest in fish collected from the harbor (Figure 3-7). However, the long term trend at DIF, as well as at NB and OS is a decrease in the prevalence of CHV. Fish collected from Cape Cod have shown a consistently low prevalence since the inception of this program.

Because the onset of neoplasm and HV are age sensitive, being preferentially observed in older fish (Moore *et al* 1997, 2010) it is reasonable to normalize the prevalence of CHV to age (Figure 3-8). The age-normalized data suggest steeper declines in CHV prevalence than observed without normalization.

Focal HV were absent at all stations in 2009 (Table 3-3). Biliary proliferation was highest in fish from Cape Cod Bay and lowest from fish from Boston Harbor, and macrophage aggregation was highest at OS and lowest at ECCB. Neither abnormality has shown meaningful long-term trends. See Moore *et al*. (2010) for more discussion of the 2009 liver histopathology results.

3.1.5 Tissue Contaminant Levels

In this section the body burdens of selected contaminants measured in 2009 are presented and discussed within the context of historical trends. The trend plots begin in the year 1995 when the number of organisms per replicate increased from one to five. All winter flounder body burden data collected during this program are presented in Appendices A and B.

Edible fillet - The 2009 results for organic contaminants in edible tissue continue the pattern observed in previous years, a long term decrease at all stations for total chlordane (the sum of alpha chlordane, trans-nonachlor, heptachlor, and heptachlor epoxide), 4-4 DDE (the predominant DDT breakdown isomer), and total PCB (Figures 3.9 to 3-11). The observed decreases appear not to be related to the diversion of the MWRA's effluent into Massachusetts Bay in September 2000. A Before/After Control Impact (BACI) study concluded that changes observed in the harbor and Massachusetts Bay are not statistically different from those at the control station, Cape Cod Bay (Kane-Driscoll *et al*. 2008).

This region wide decrease is anticipated given that these compounds have been banned in the United States - DDTs since 1972, PCBs since 1979, and chlordane since 1988. The similarity of the station trends may also reflect subtle differences in analytical techniques and reporting limits employed by the several laboratories used in this program. For example the PCB and pesticide analyses conducted in 2009 used a technique, MS-SIM, which eliminates interferences that may have been quantified in past years. Also, there is evidence from the National Marine Fisheries Service that flounder in the Gulf of Maine have been wintering in deeper, offshore waters (Nye *et al*. 2009). This suggests the possibility that the fish collected in this program may be spending more time in less contaminated environments which would result in a decrease in exposure to bio-accumulating contaminants.

As in past years fish fillets collected off of Deer Island had the highest concentrations of organic contaminants and those from Cape Cod Bay the lowest. However, in 2009 concentrations in fillets from DIF were only slightly greater for 4-4 DDE and chlordane than fish from the Outfall Site or Nanatasket.

Mercury shows no clear temporal pattern although the more intermittent measurement in fish from NB suggests that at that location there has been a decrease since the early years of this program (Figure 3-12). In contrast to the spatial patterns observed for organics, body burdens of mercury have tended to be highest at the Outfall Site.

Liver - The patterns of organic contaminants in flounder liver are similar to those for fillets. PCB concentrations are plotted in Figure 3-13 and are representative of many other organic compounds (see Appendix B).

Unlike for organics, the body burdens of metals have ambiguous temporal trends and the spatial pattern is less predictable. For example, body burdens of silver, copper, and lead (Figures 3-14 to 3-16) have often been highest at OS (or occasionally at ECCB), and lowest at DIF. These counter intuitive results probably reflect less on the total concentrations of metals in the respective environments and more on their bio-availability. Solids and organic matter will bind up metals in non-bioavailable forms decreasing their actual bioaccumulation potential. Inshore environments, like Boston Harbor have higher levels of these binding compounds than the environment near the Outfall or Cape Cod Bay (see Hunt *et al.* 2006).

Myers *et al.* (1998) and Chang *et al.* 1998) suggest that organics, especially pesticides and PAHs, show the strongest positive association with neoplasms and cellular vacuolations. The similarity in trend line of CHVs and organic contaminants in our study is also suggestive that organics rather than metals are more closely associated with the liver vacuolations.

3.2 Lobster

3.2.1 Size, Sex, and External Conditions

Weight, carapace length, and sex were determined for 23 lobsters from each of the three sites (Table 3-4). The average carapace length was identical at all locations, and average weight marginally highest at OS. Outfall lobsters were predominantly female (74%) while DIF and ECCB lobsters were mainly males (13 and 30% females, respectively). Visual inspection of the lobsters indicated one animal from OS and two from Cape Cod Bay had signs of shell erosion. No other deleterious external conditions were reported.

3.2.2 Tissue Contaminant Levels

In this section the body burdens of selected contaminants measured in 2009 are presented and discussed within the context of historical trends. The trend plots presents data beginning in 1994 when the number of organisms per replicate increased from one to five. All lobster body burden data collected during this program can be found in Appendices C and D.

Edible Meat - Since the inception of this program organics in lobster meat have tended to be highest in animals collected from Boston Harbor and lowest in those from Cape Cod Bay. This pattern was repeated in 2009 for total chlordane, DDT, and PCB (Figures 3-17 to 3-19). For both total chlordane and total DDT we observed a decrease in concentration at all three stations from the mid-1990s to 2000. Since that time concentrations at all stations have leveled off. The BACI analysis reported in Kane-Driscoll *et al.* (2008) concluded that the changes were not due to relocation of the outfall since decreases in the harbor and Massachusetts Bay were statistically no different than changes at the control station in Cape Cod Bay.

Historically, PCBs in lobster meat have shown no clear trend at any of the three stations (Figure 3-19). Through 2002 PCBs at all stations appeared to be decreasing but since 2003 body burdens in lobsters from the Outfall area and off from of Deer Island have returned to levels observed in the mid-1990's. In 2009 PCBs in DIF lobster meat had the highest average yet observed in this program. Only one of the three replicates was high, a phenomenon similar to that observed at OS in 2003. At that time analysis of tissue from each individual lobster demonstrated that the high level of PCBs in the replicate came from only one of the five lobsters in the composited replicate (Wisneski *et al.* 2004). Given that adult lobster can be highly migratory, moving inshore in the early summer and offshore in the fall, it is always difficult to assess with certainty where a given lobster has been exposed to anthropogenic contaminants (see Mitchell *et al.* 1998 and Lavallli and Kropp, 1999 for further discussion of lobster biology and migration).

Mercury in lobster meat at DIF was the lowest yet observed at that location, even as levels at OS and ECCB edged up from the very low values observed in 2006 (Figure 3-20).

Hepatopancreas - In 2009 concentrations of total chlordane, DDTs, and PAHs were among the lowest reported during this program at all three stations (Appendix D). This continues the long term trend of apparent regional decreases of organic contaminants in lobster hepatopancreas. While, the relatively high levels of PCBs in 2003 and 2009 at OS and DIF hint at increasing trends at the two stations (Figure 3-21), the fact that one highly contaminated lobster can cause a marked increase in an annual average (Wisneski *et al.* 2004) suggests that such an interpretation may be too simplistic.

Like metals in flounder liver, the spatial and temporal pattern of metals in lobster hepatopancreas has been less predictable than for organic contaminants. Cadmium has tended to be highest around the Outfall and lowest in Boston Harbor (Figure 3-22), copper highest at either OS or DIF and lowest at Cape Cod Bay (Figure 3-23), nickel highest at OS or ECCB and lowest in the harbor (Figure 3-24), and zinc has shown no consistent spatial pattern (Figure 3-25). 2009 results continue a pattern of recent elevations in metals with lobster from OS having numerically the highest average cadmium and nickel, and lobster from Deer Island the highest copper ,yet reported at any station during this program. Zinc in lobsters from the harbor was the highest at that station since 1994. In addition the four highest nickel levels in Deer Island lobsters have occurred during the last four collection years (2002, 2003, 2006, and 2009). Since metals data for this program have been generated by five different laboratories we cannot rule out that the possible increases in some metals may be due to subtle differences in analytical approach. If any of these increases are real it seems likely that they are due to changes in metal bioavailability rather than due to actual increases in metal loadings to the environment (see Hunt *et al.*2006).
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3.3 Blue Mussel

3.3.1 Mussel Survival

Samples were successfully collected at all stations on August 11 (45-day retrieval) and August 21 (56-day retrieval). As has been observed in the past survival was highest at the offshore sites (OS and LNB) and lowest in Boston Harbor (DIL and IH) (Table 3-5).

3.3.2 Tissue Contaminant Levels

2009 Spatial Comparison – Blue mussels passively filter ambient waters and readily bioacccumulate contaminants in those waters, making them an excellent and commonly employed tool for assessing spatial patterns in water quality (O'Connor and Lauenstein 2006). For this reason the MWRA has used caged mussels as a "controlled experiment", deploying mussels from a clean environment at various locations, collecting them after a set period of time, and determining the extent of contaminant bioaccumulation.

The 2009 results were largely consistent with past years. Mercury showed a clear indication of bioaccumulation over baseline conditions (SP) at all sites except LNB (Figure 3-26), while lead increased only in the two harbor stations of Deer Island (DIL) and Inner Harbor (IH) (Figure 3-27).

The general pattern for PCBs, chlordane, and DDT was for bioaccumulation at all deployed stations with the largest increases in the harbor, especially at IH (Figures 3-28 to 3-30). NOAA Low and High Molecular Weight PAH (Table 2-7) show a slight deviation from this pattern. While mussels deployed at OS and LNB are elevated compared to baseline (SP), they tend to show little differentiation from mussels from DIL (Figures 3-31 and 3-32). PAH in mussels from the Inner Harbor were substantially higher than at any of the other stations.

In general the mussel results indicate decreasing water quality as we move from coastal Maine to Massachusetts Bay to Outer Boston Harbor to Boston's Inner Harbor.

Inter-annual comparison – This study is intended to assess whether there have been changes in water quality either at the new (OS) or old (DIL) discharge locations as a result of the diversion of wastewater discharge in September of 2000. A BACI analysis based on data through 2006 suggested that after controlling for data from a control station in Cape Cod Bay (CCB) there had been an increase of lead, PCBs, chlordane, DDE, and HMW PAHs in mussels deployed at the Outfall Site. At Deer Island only chlordane had shown a significant decrease (Kane-Driscoll *et al.* 2008).

Figure 3-33 displays the trends in total PCB bioaccumulation in mussels from DIL, OS, and LNB. The reported increase in PCBs at OS by the BACI analysis was based upon only three pre-diversion years (1998-2000) when "control" data was available from Cape Cod Bay. The longer data set suggests no post-diversion change in PCBs at any station. These results are consistent with PCB concentrations of ambient mussels from Deer Island collected and analyzed by the NOAA Status and Trends Program (O'Connor and Lauenstein 2006) and Hunt and Stone - in press.

In 2009 total DDT was at its lowest levels at all three sites (Figure 3-34). This continues an apparent decrease at DIL which predates the diversion and which was also observed by NOAA. The low values at the two Outfall stations (OS and LNB) in 2009 are not consistent with the BACI determination of an increase as a result of wastewater diversion.

Total chlordane continued its decades-long decrease at DIL (Figure 3-35). Since the five lowest values all occur post-diversion, the results of the BACI analysis (i.e. a significant decrease as a result of the wastewater diversion) are strengthened. These results are also consistent with NOAA results. While there were clear increases in chlordane at the Outfall in 2001-2003 as a result of diversion, the "cleaner" effluent since 2005 - the average effluent Total Suspended Solids during mussel deployments decreased from an average of 15.5 tons per day from 2001-2003 to 7.3 tons per day in 2006 and 2009 – has resulted in total chlordane in mussels within the pre-diversion range.

Similar to chlordane low molecular weight PAH (e.g. un-combusted hydrocarbons) show a long-term decrease at DIL and consistently low concentrations post-diversion (Figure 3-37). This is consistent with the NOAA results. At OS and LNB the LMW PAH concentrations in mussels have been consistently low. The modest increase in 2000 was partially or totally due to laboratory issues.

High molecular weight PAH (combusted hydrocarbons) show a long term downwards trend at DIL (Figure 3-38) but a trend that is not observed through 2006 by NOAA (Hunt and Stone - in press). Post-diversion HMW PAH have been consistently low at DIL. Similar to chlordane HMW PAH increased at OS and LNB as a result of the diversion. Subsequently, as a result of lower levels of effluent contaminants, HMW PAH have decreased in mussels but remain slightly elevated in comparison to pre-diversion conditions (Figure 3-38).

3.4 Comparison to Thresholds

The U.S. Food and Drug Administration (FDA) has set action limits for the maximum tissue concentrations of specific contaminants in the edible portions of fish and fishery products. For the MWRA monitoring program, Caution and Warning thresholds have been set for tissue contaminant concentrations (organic and inorganic) and liver disease incidence (MWRA 2001a, MWRA 2001b). These thresholds are derived from either the FDA Action Limits, when available, or from the baseline mean of contaminant concentrations at OS. These two levels provide reference benchmarks for detecting adverse changes (and their potential human health risks) of the outfall discharge.

All thresholds for flounder fillet (Table 3-6) and lobster meat (Table 3-7) were met. While there were mussel threshold exceedances for total chlordane in 2001 and PAH in 2001, 2002, and 2003 there were no exceedances in 2009 (Table 3-8). The only 2009 result which was greater than 33% of its Caution Threshold was that for PAHs in mussel.

Table 3-1. Summary of physical characteristics of flounder collected in 2009

Station Name		DIF	NB	OS	ECCB
Sample size		50	50	50	50
Age (years)	Mean	4.3	4.5	4.2	4.2
	Std. Dev.	1.2	1.1	0.9	1.0
Total Length (mm)	Mean	370.8[a]	356.2	339.7	348.1
	Std. Dev.	42.7	34.2	22.2	27.2
Weight (g)	Mean	614.1	532.0	440.2	502.4
	Std. Dev.	182.7	155.1	95.3	109.6

Std. Dev. = Standard Deviation
[a] N=49

Table 3-2. Prevalence (%) of external flounder conditions

Station	Bent Fin Ray	Fin Erosion	Blind Side Ulcers	Lymphocystis
DIF	34	44	2	16
NB	10	20	4	24
OS	2	8	0	54
ECCB	14	26	0	10

Sample size – 50 fish at each station

Table 3-3. Prevalence (%) of liver abnormalities

Station		DIF	NB	OS	ECCB
N		49	48	48	50
Abnormality	Neoplasm	0	0	0	0
	Focal HV	0	0	0	0
	Tubular HV	27	10	15	2
	Centrotubular HV	29	10	15	2
	Macrophage Aggregation	43	52	60	42
	Biliary Proliferation	10	17	15	30

Table 3-4. Mean length and weight, and % females of lobsters collected in 2009

Parameter	DIF			OS			ECCB		
	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N
Carapace Length (mm)	88	3	23	88	3	23	88	3	23
Weight (g)	488.7	73.4	23	494.7	69	23	481.8	63.8	23
Percent female (%)	13	NA	23	74	NA	23	30	NA	23

S.D. = Standard Deviation

Table 3-5. 2009 caged mussels survival data

Collection	Site	Total Mussels	Dead Mussels	Survival Rate
45-day	IH	110	14	87%
	DIL	110	9	92%
	OS	110	1	99%
	LNB	110	6	95%
56-day	IH	110	23	79%
	DIL	220	42	81%
	OS	155	4	97%
	LNB	110	14	87%

Table 3-6. Comparison of 2009 flounder fillet results to MWRA Caution and Warning Levels

Station	Liver Disease Incidence (%)			Total PCB (ng/g wet wt.)			Total DDT (ng/g lipid)			Total Chlordane (ng/g lipid)			Dieldrin (ng/g lipid)			Mercury (µg/g wet wt.)		
	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n
Outfall Site (OS)	15	0	50	28	8	3	255	61	3	74	21	3	0	0	3	0.09	0.01	3
MWRA Caution Level	44.94			1000			1552			484			127			0.5		
MWRA Warning Level	NA			1600			NA			NA			NA			0.8		
FDA Limit	NA			2000			5000			300			300			1		

Table 3-7. Comparison of 2009 lobster meat results to MWRA Caution and Warning Levels

Station	Total PCB (ng/g wet wt.)			Total DDT (ng/g lipid)			Total Chlordane (ng/g lipid)			Dieldrin (ng/g lipid)			Mercury (µg/g wet wt.)		
	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n
Outfall Site (OS)	22	12	3	63	4	3	12	1	3	13	3	3	0.09	0.0	3
MWRA Caution Level	1000			683			150			322			0.5		
MWRA Warning Level	1600			NA			NA			NA			0.8		
FDA Limit	2000			5000			300			300			1		

Table 3-8. Comparison of 2009 mussel results to MWRA Caution and Warning Levels

Station	Total PCB (ng/g wet wt.)			Total DDT (ng/g lipid)			Total Chlordane (ng/g lipid)			Dieldrin (ng/g lipid)			Total PAH[1] (ng/g lipid)			Mercury (µg/g wet wt.)			Lead (µg/g wet wt.)		
	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n	mean	se	n
Outfall Site (OS)	3	0.1	8	87	5	8	62	3	8	0	0	8	1820	58	8	0.01	0.0	8	0.11	0.0	8
MWRA Caution Level	1000			483			205			50			2160			0.5			2		
MWRA Warning Level	1600			NA			NA			NA			NA			0.8			3		
FDA Limit	2000			5000			300			300			NA			1.000			3.75		

[1]Based on NOAA PAHs only

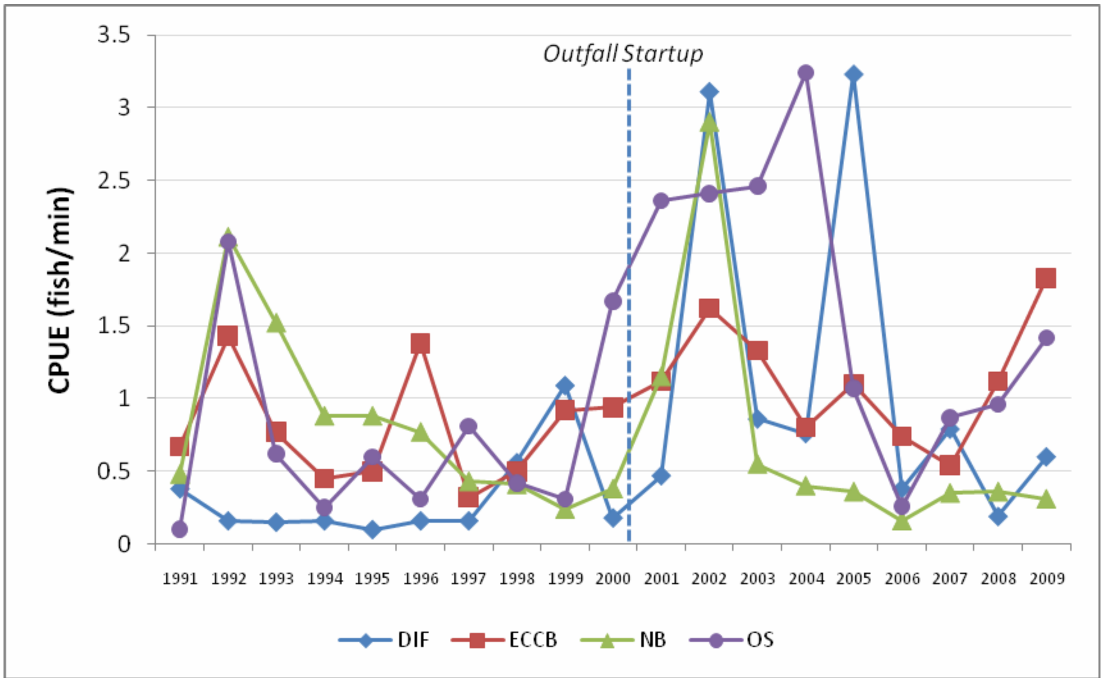

Figure 3-1. Flounder Catch Per Unit Effort (CPUE) 1991–2009.

Effort was constant up until and including 2007 with the FV Odessa (70' sweep rope). For 2008, the FV Harvest Moon (74' sweep rope) was used for DI, NB, and OS, with a net that was 1.04 x wider and for ECCB the FV Explorer 2 (84' sweep rope) was used with a net that was 1.2 x wider. In 2009, FV Harvest Moon was used for all stations.

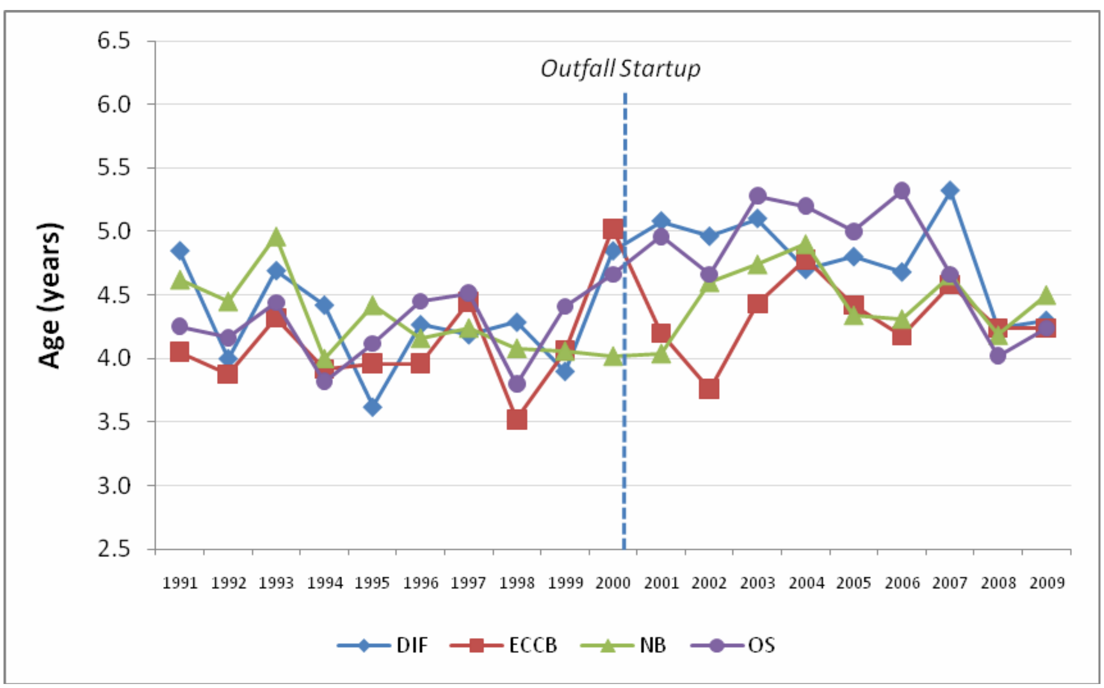

Figure 3-2. Average flounder age 1991-2009.

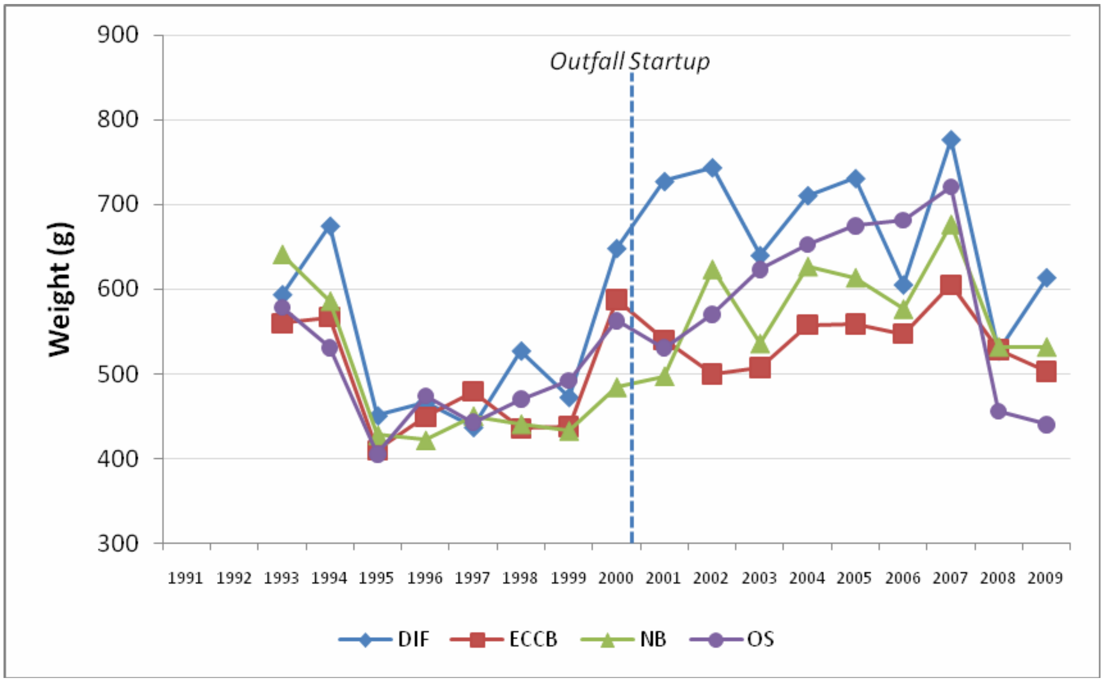

Figure 3-3. Average flounder weight 1991-2009

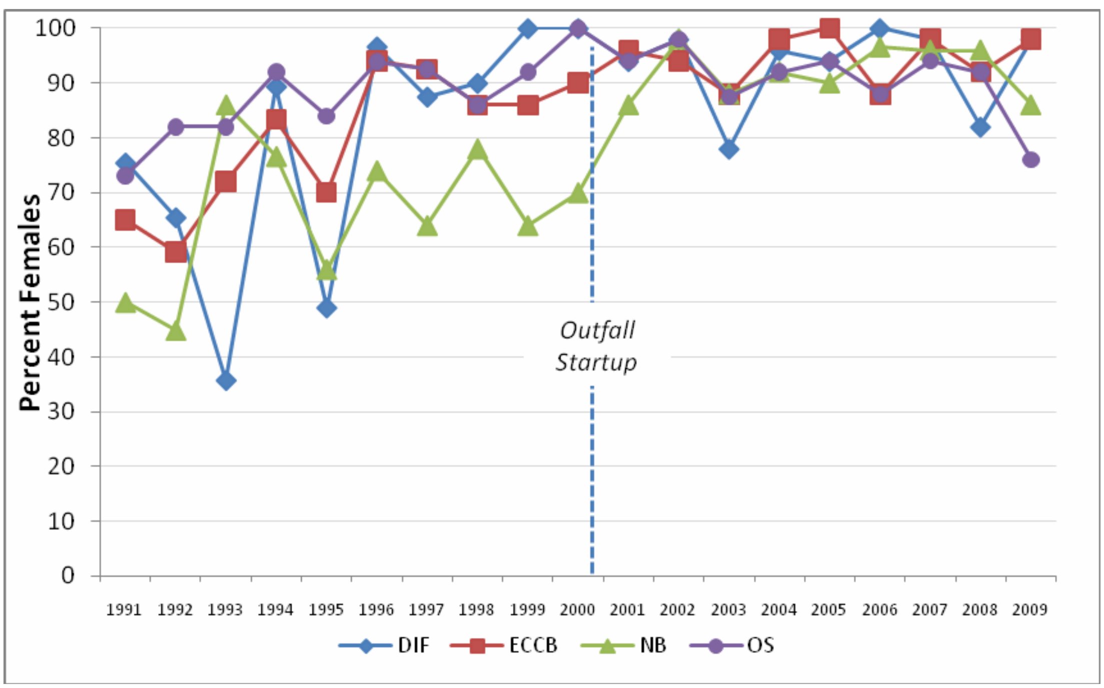

Figure 3-4. Percentage of female flounder

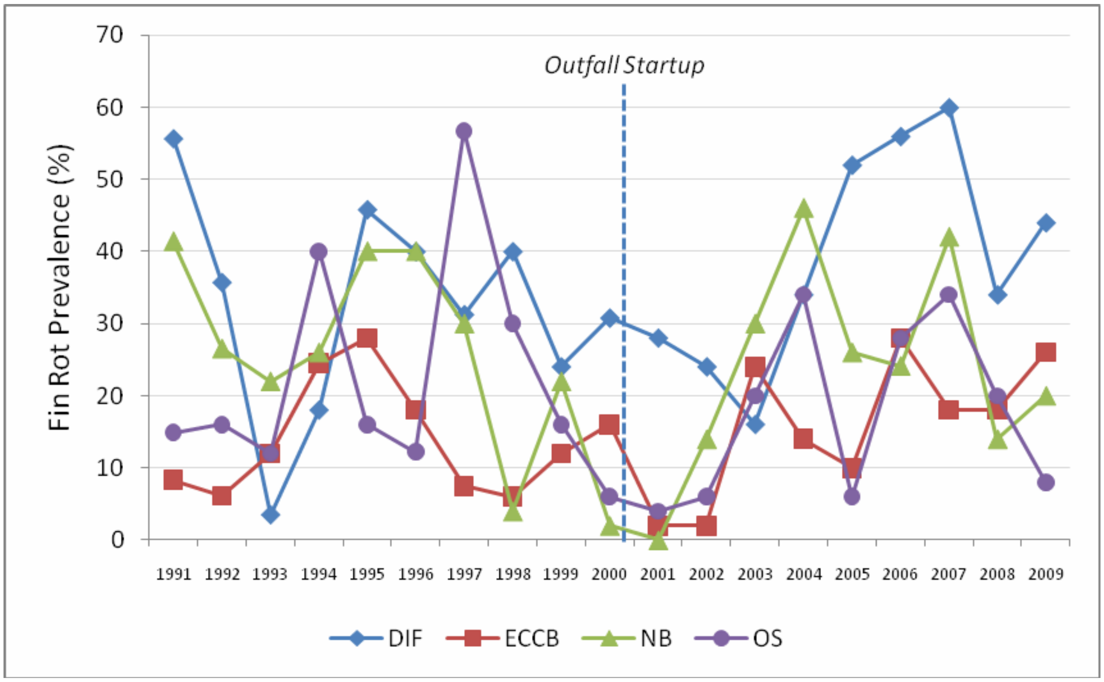

Figure 3-5. Prevalence (%) of flounder fin erosion 1991-2009

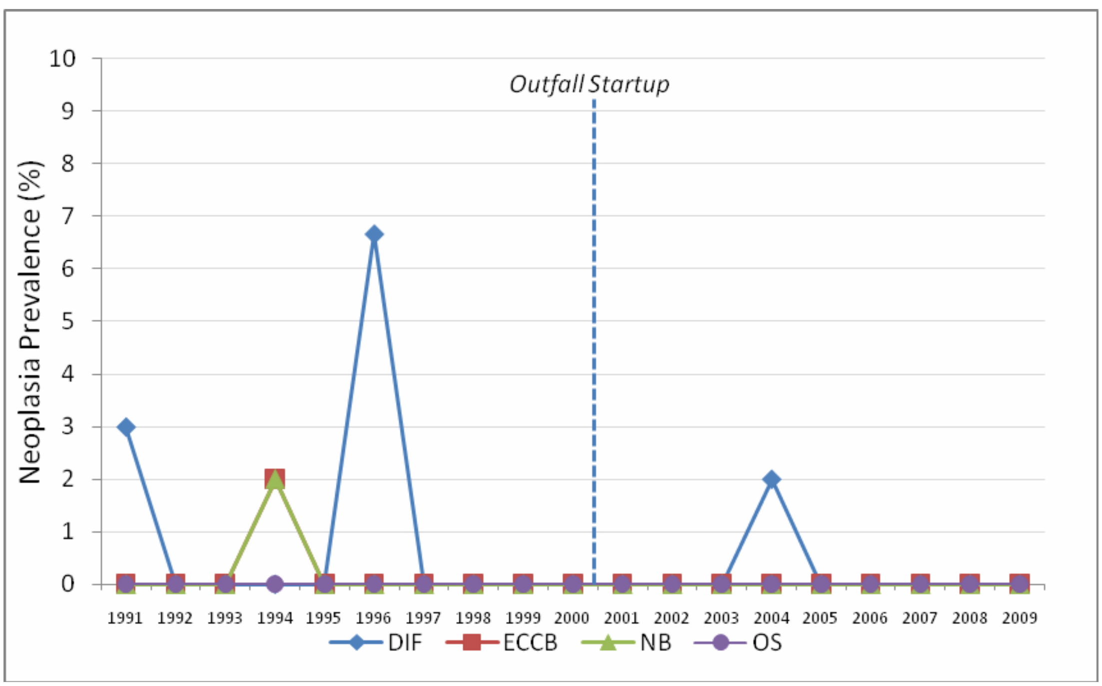

Figure 3-6. Prevalence (%) of flounder neoplasia 1991-2009

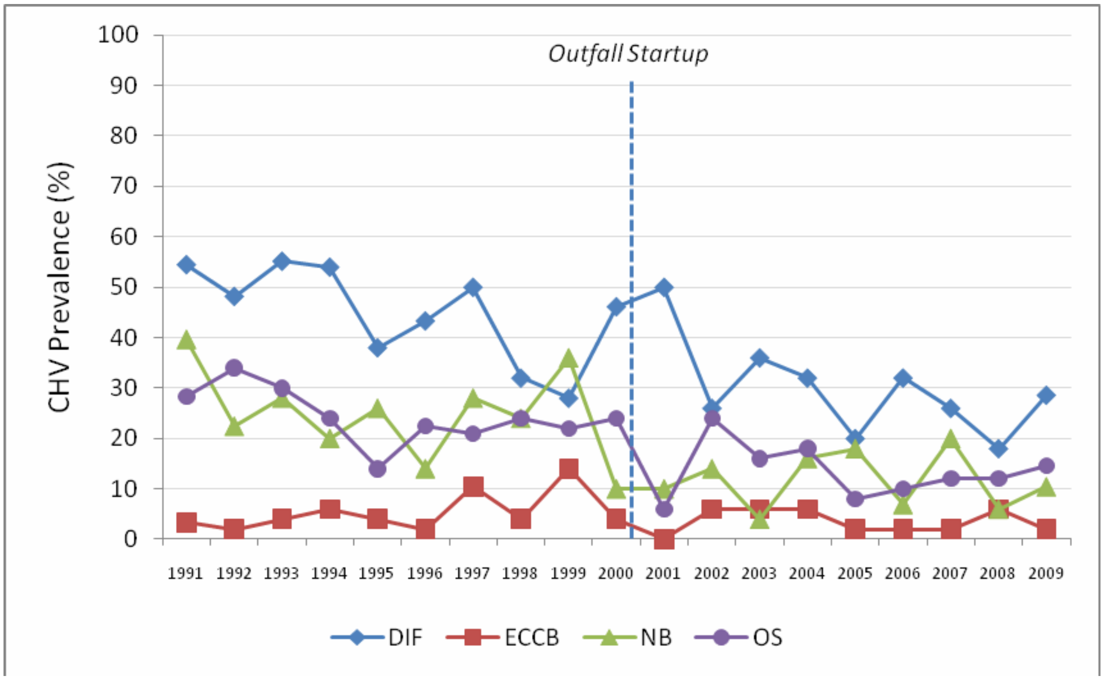

Figure 3-7. Prevalence of flounder CHV 1991-2009

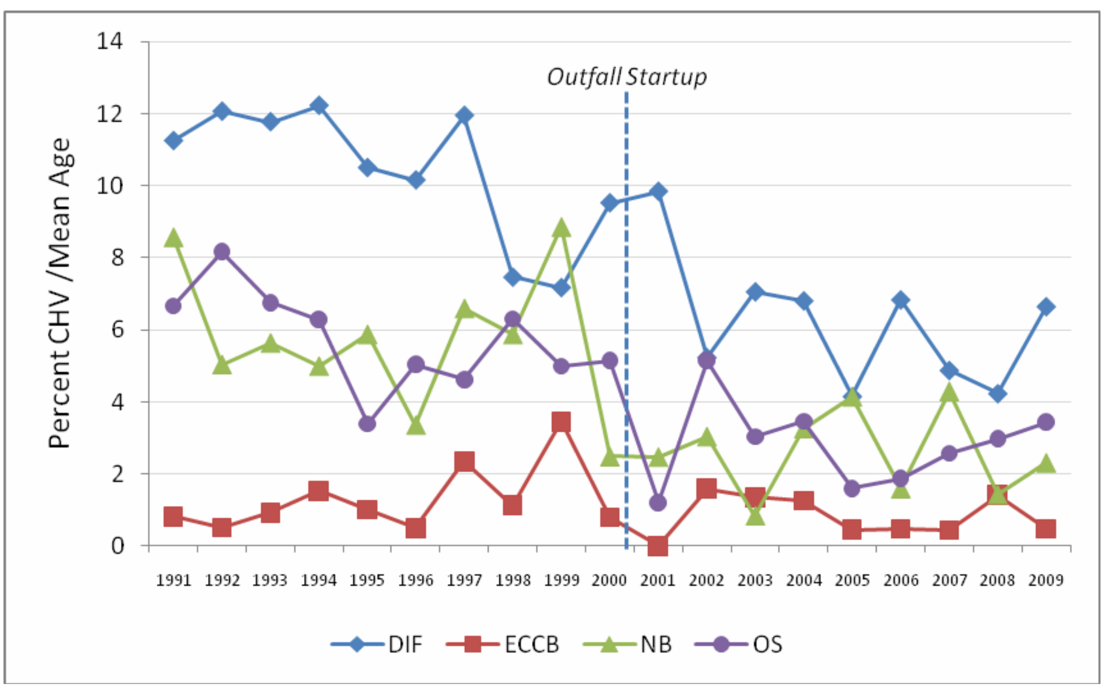

Figure 3-8. Hydropic vacuolation index (CHV%/Age) 1991-2009

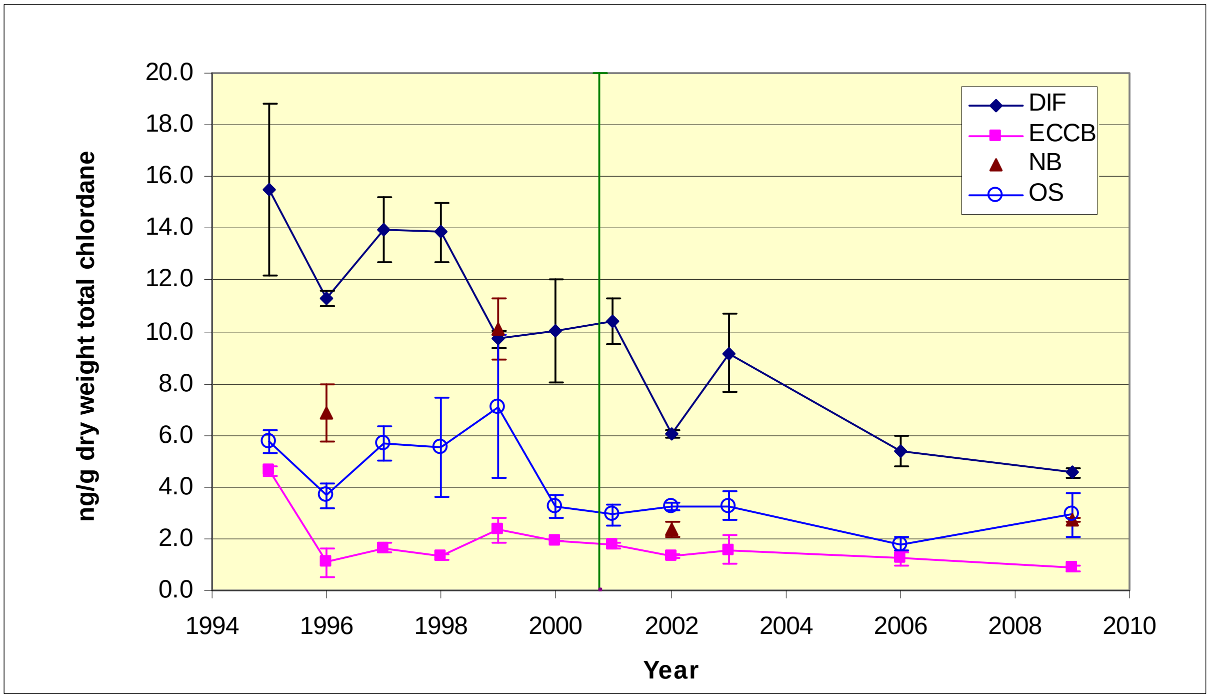

Figure 3-9. Total chlordane in flounder fillet 1995-2009.

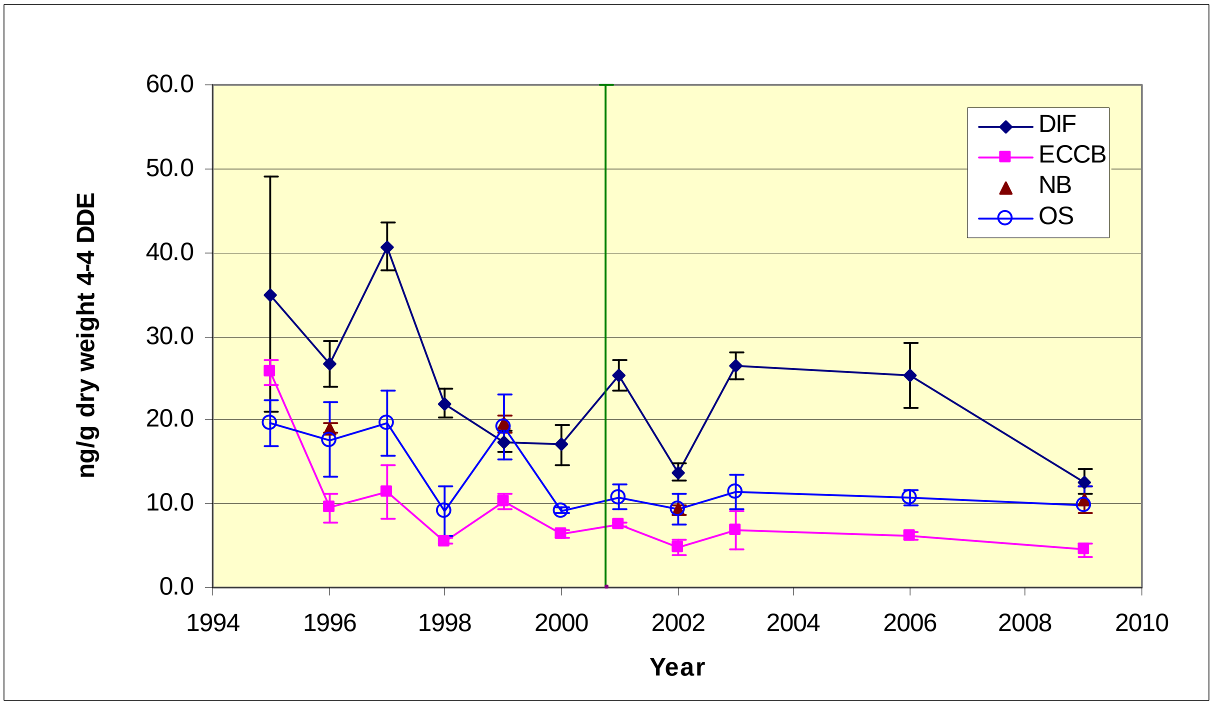

Figure 3-10. 4-4 DDE in flounder fillet 1995-2009.

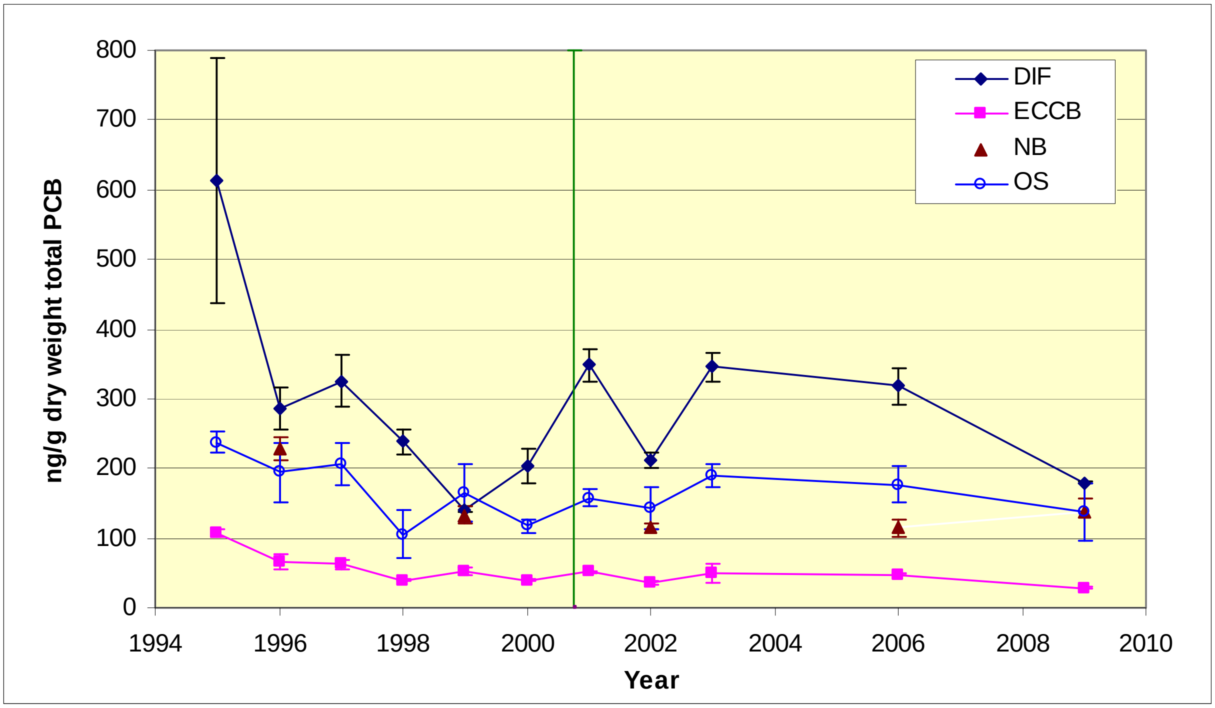

Figure 3-11. Total PCB in flounder fillet 1995-2009

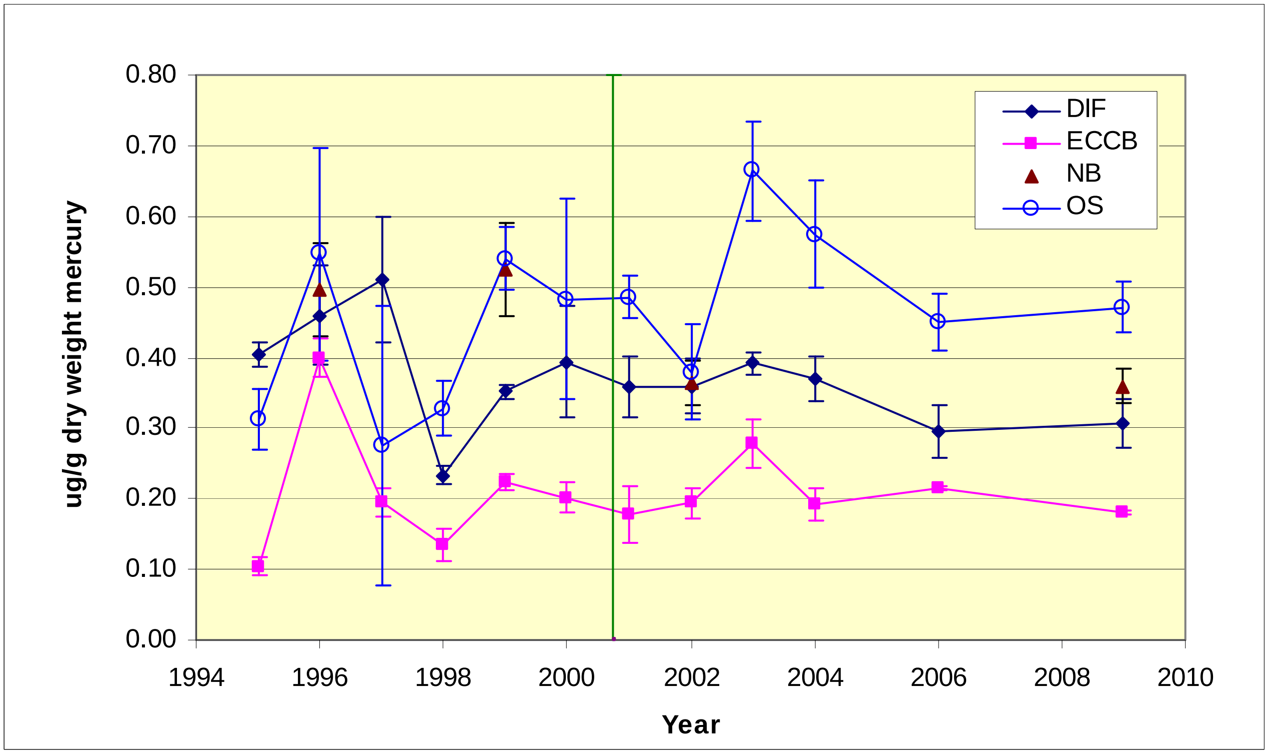

Figure 3-12. Mercury in flounder fillet 1995-2009

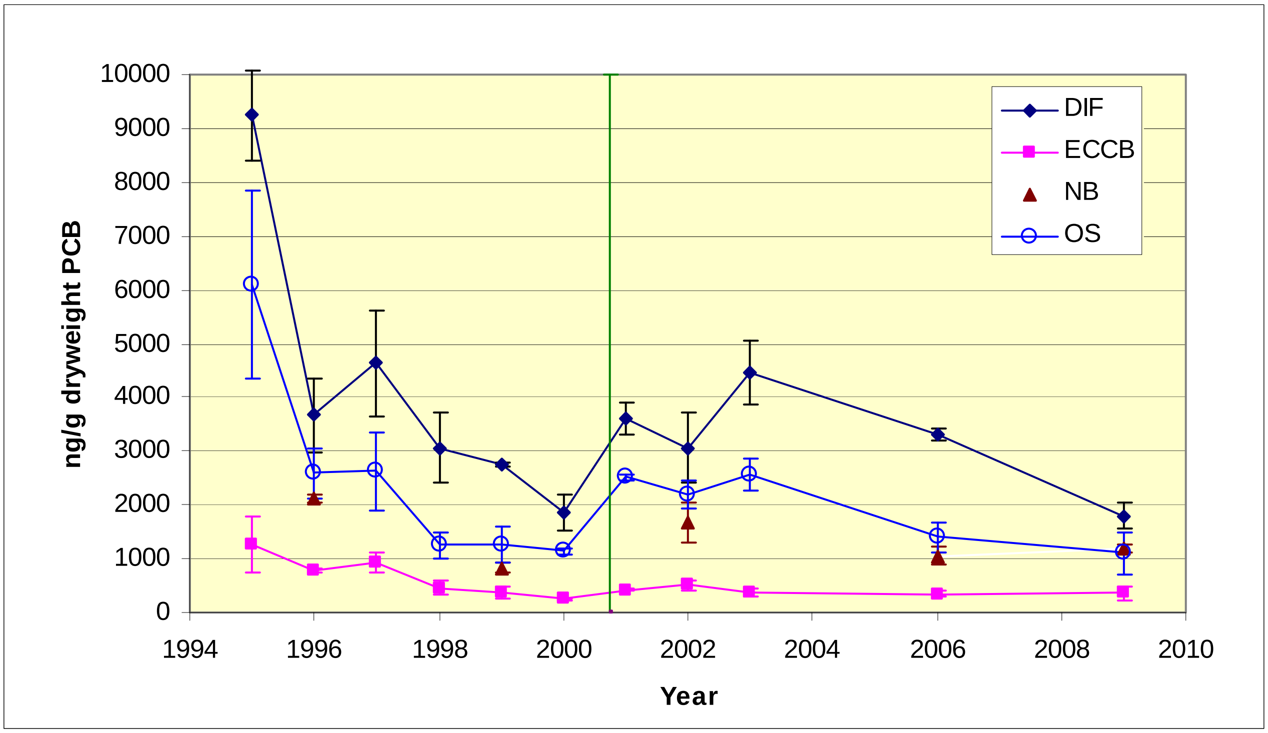

Figure 3-13. Total PCBs in flounder liver 1995-2009

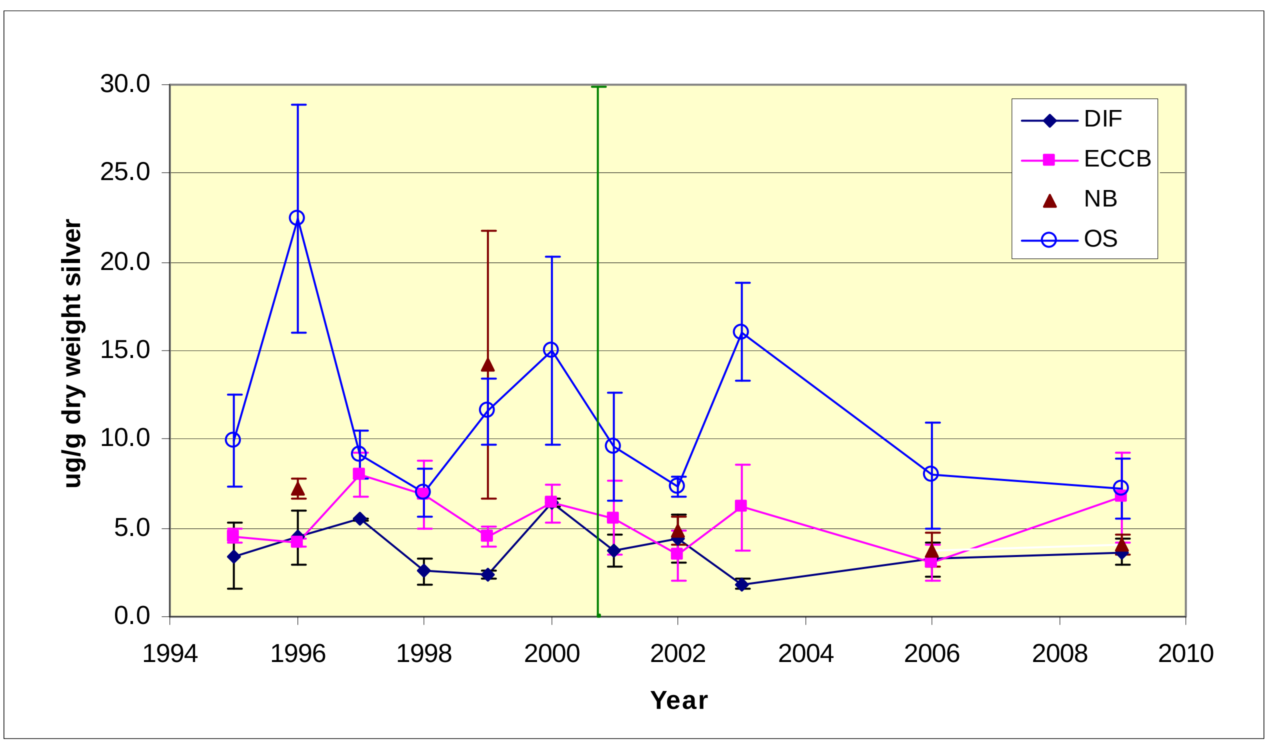

Figure 3-14. Silver in flounder liver 1995-2009

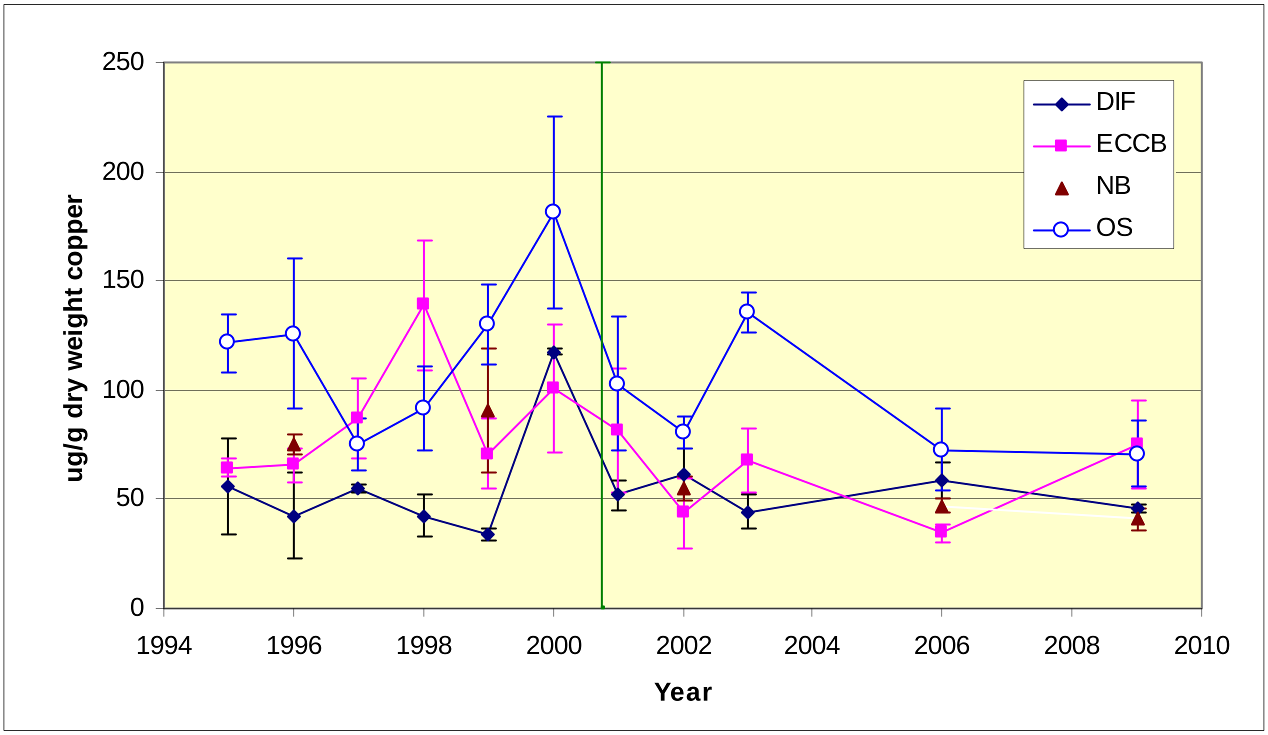

Figure 3-15. Copper in flounder liver 1995-2009

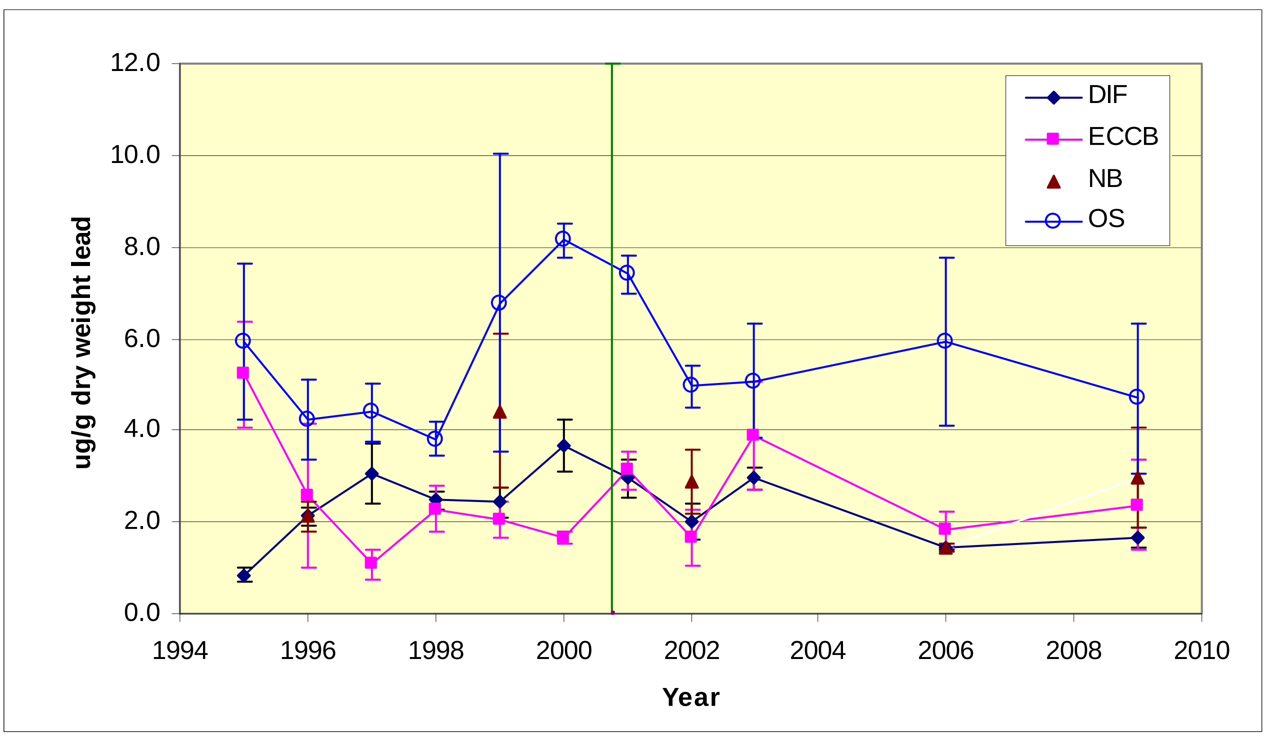

Figure 3-16. Lead in flounder liver 1995-2009

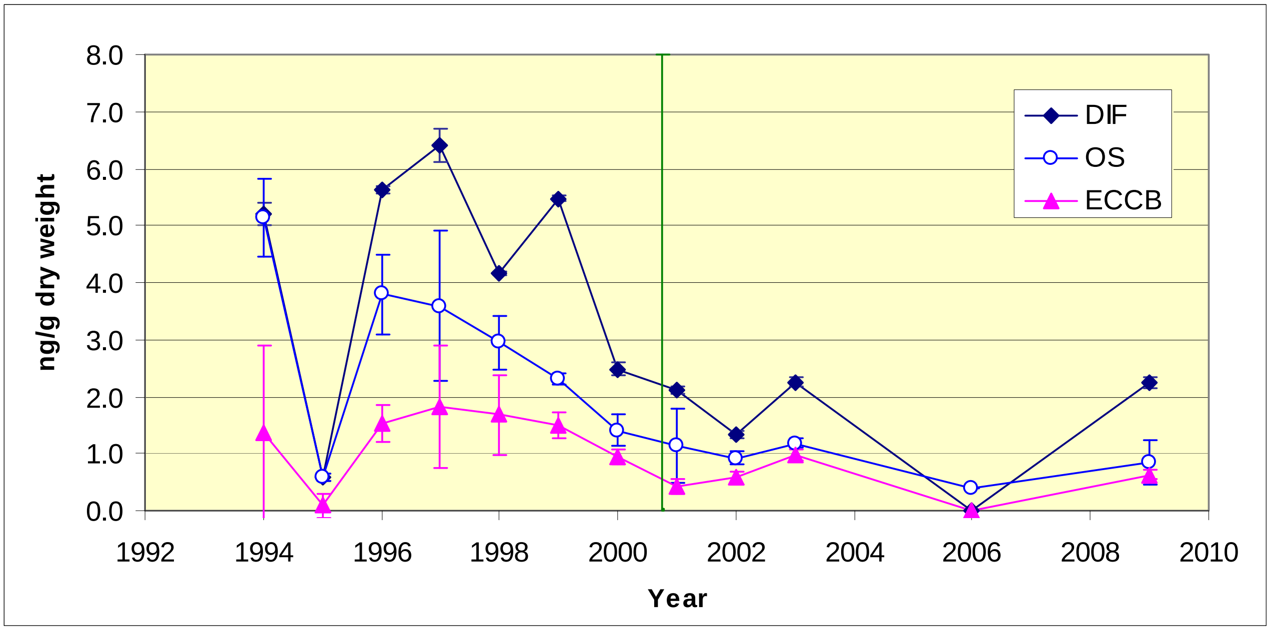

Figure 3-17. Total chlordane in lobster meat 1994-2009

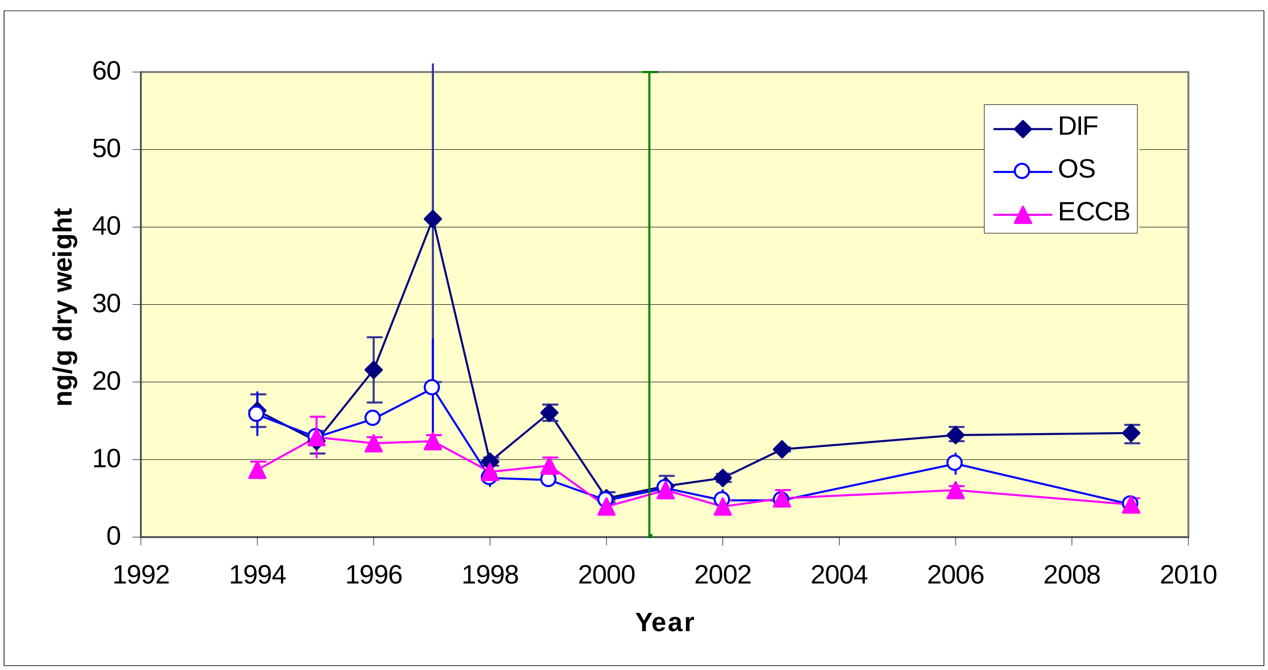

Figure 3-18. Total DDT in lobster meat 1994-2009

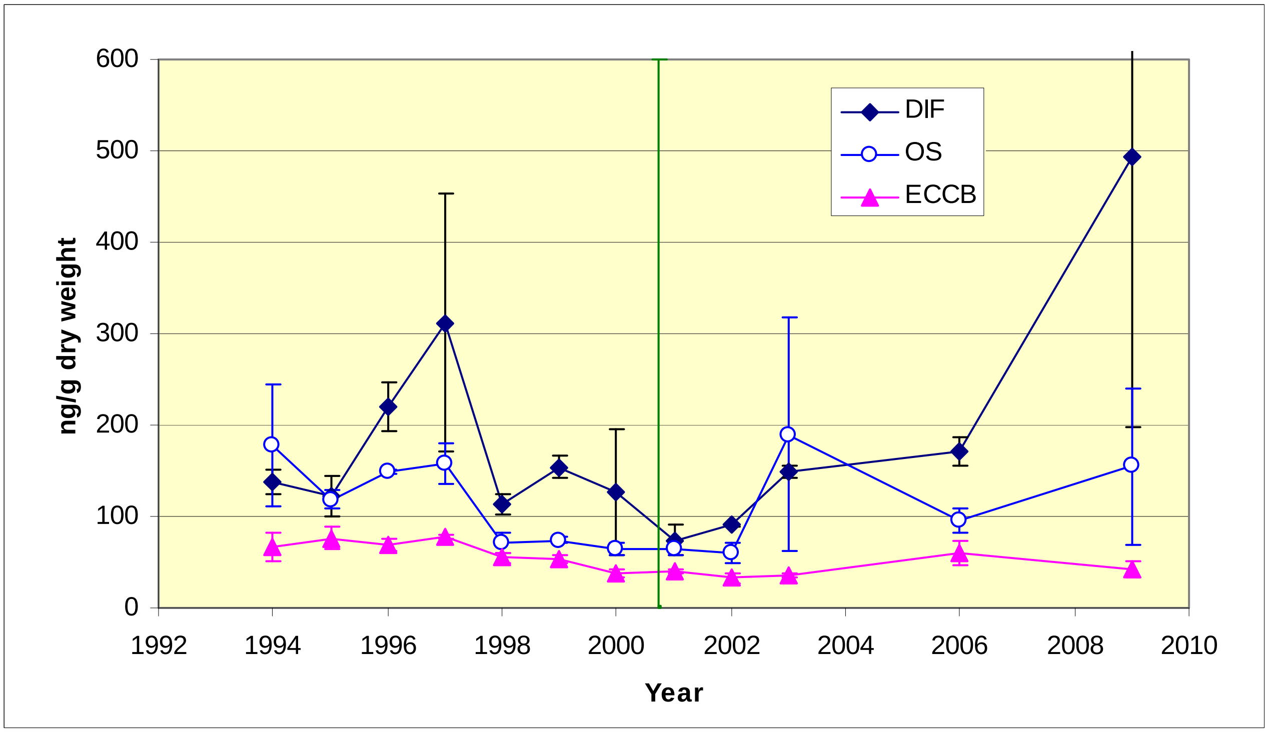

Figure 3-19. Total PCB in lobster meat 1994-2009

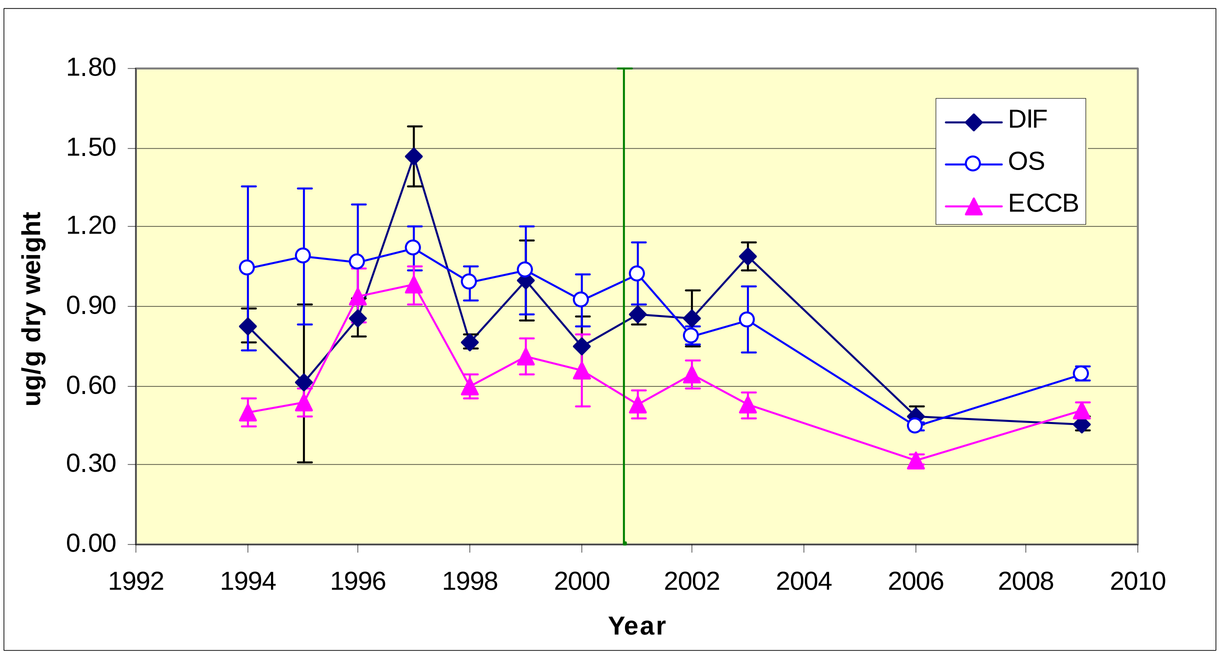

Figure 3-20. Mercury in lobster meat 1994-2009

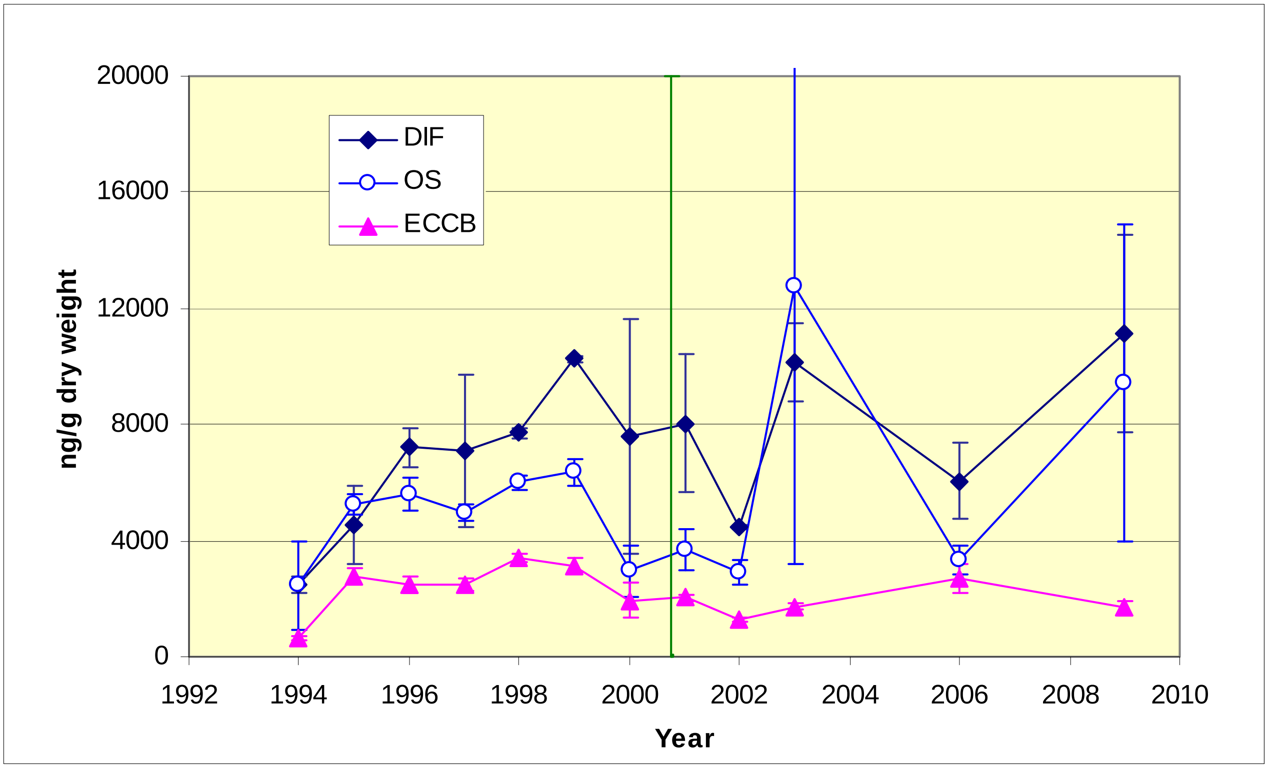

Figure 3-21. Total PCB in lobster hepatopancreas 1994-2009

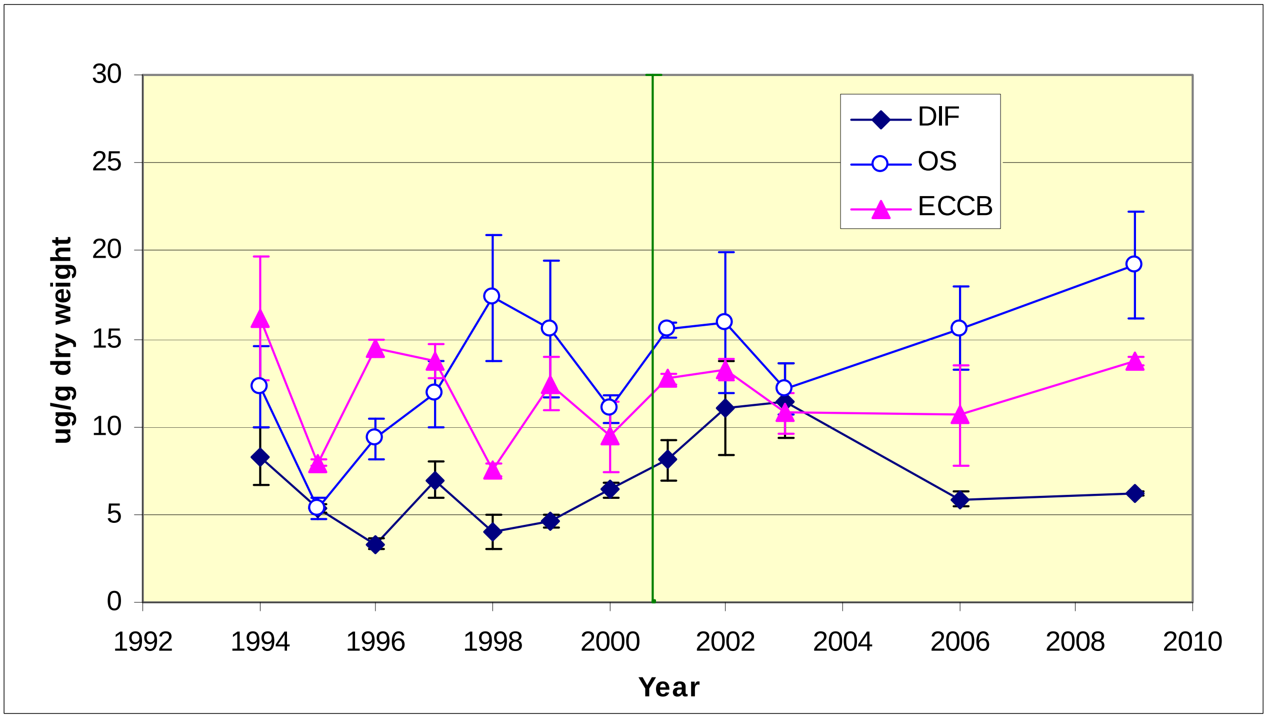

Figure 3-22. Cadmium in lobster hepatopancreas 1994-2009

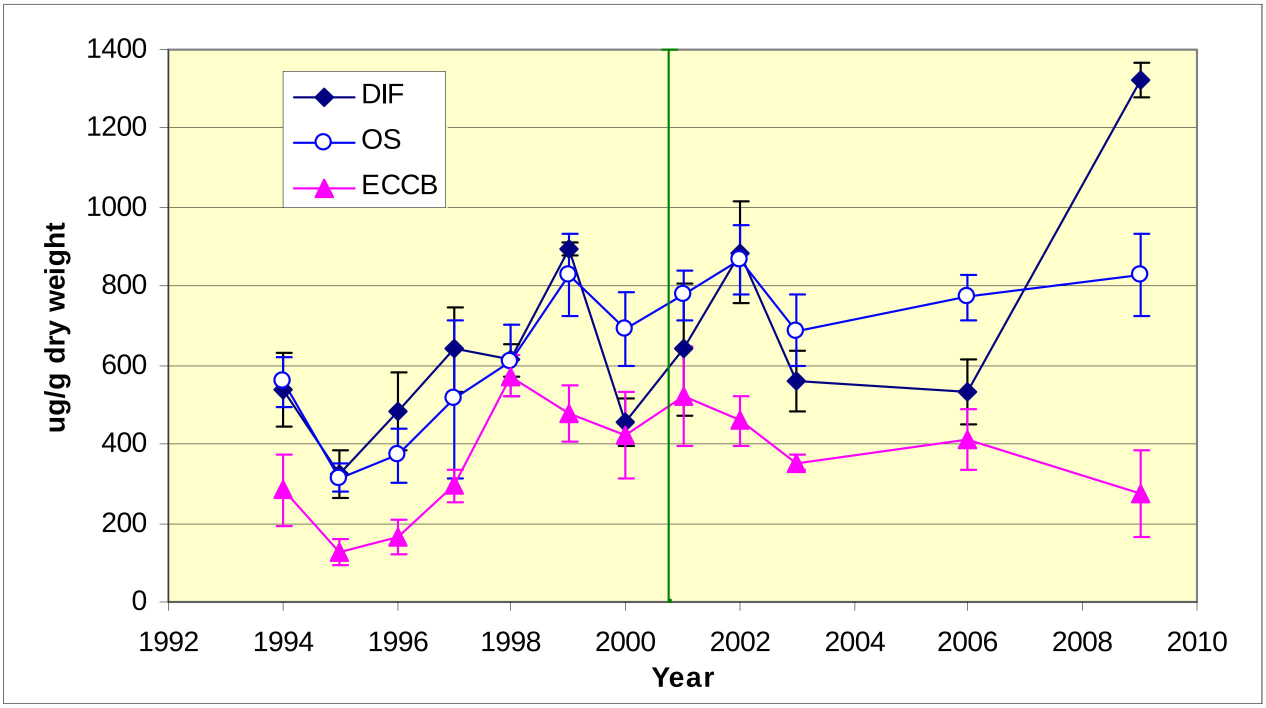

Figure 3-23. Copper in lobster hepatopancreas 1994-2009

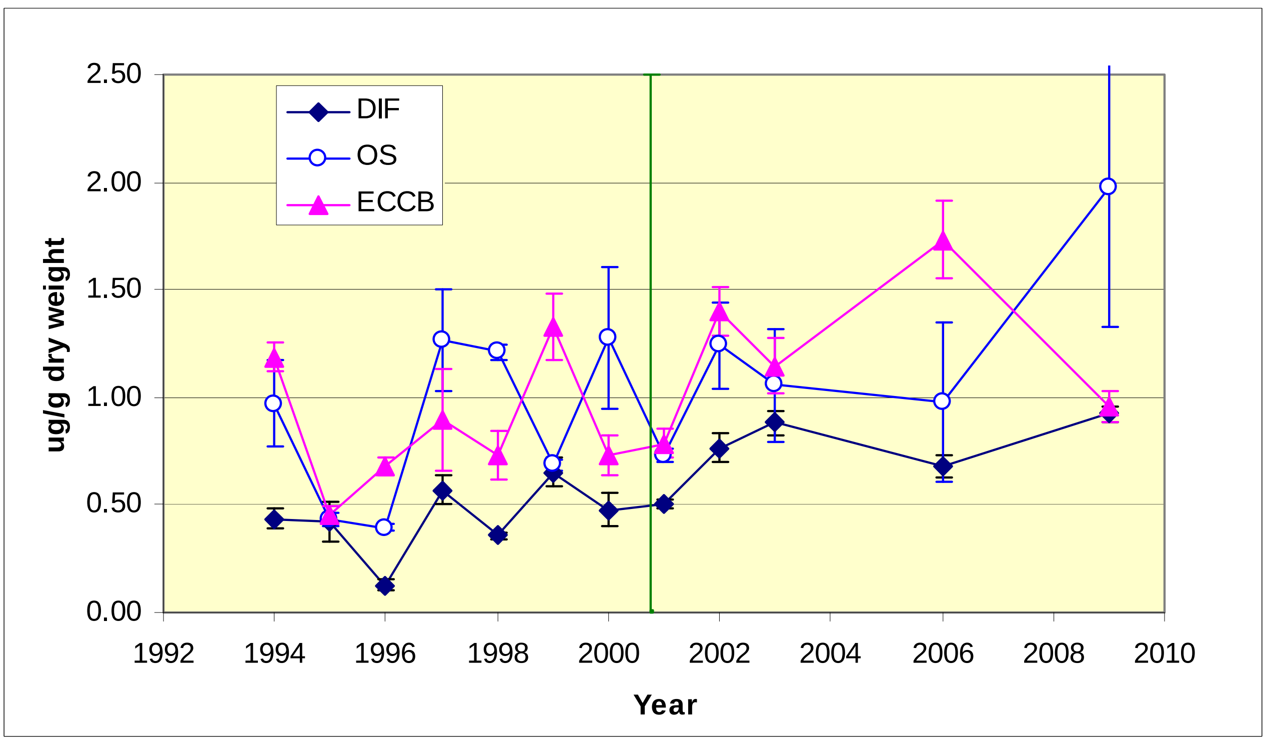

Figure 3-24. Nickel in lobster hepatopancreas 1994-2009

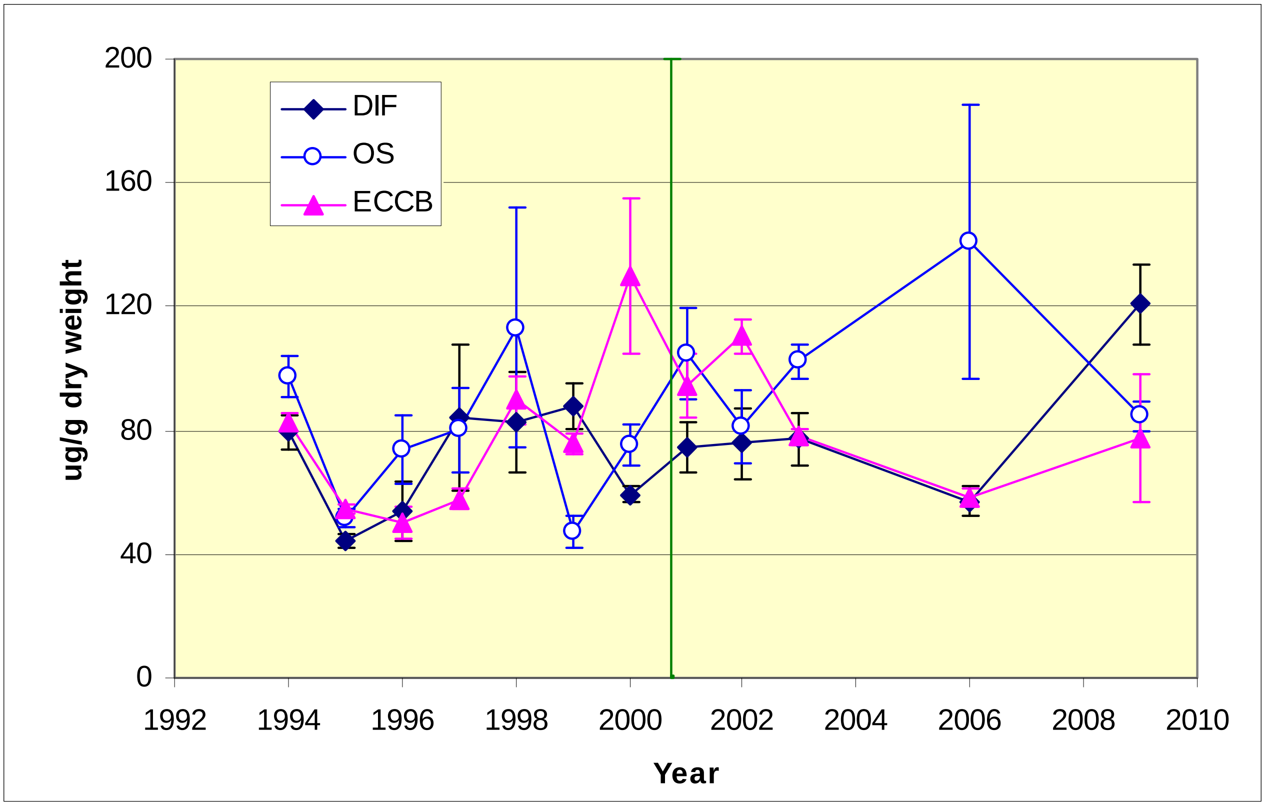

Figure 3-25. Zinc in lobster hepatopancreas 1994-2009

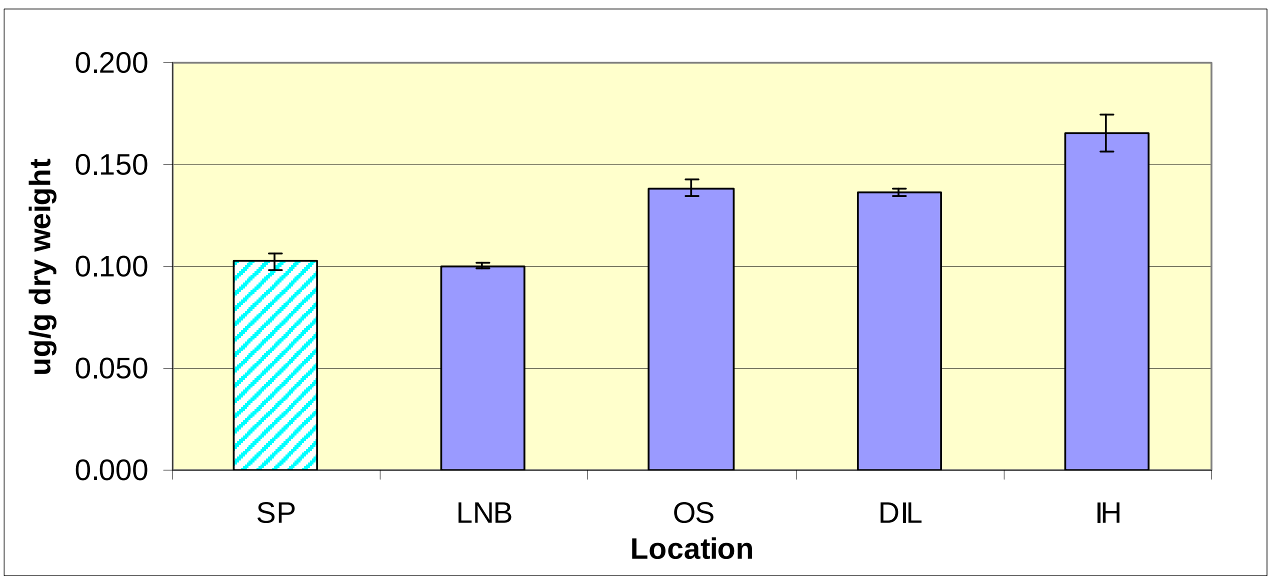

Figure 3-26. Mercury bioaccumulation in mussels -2009

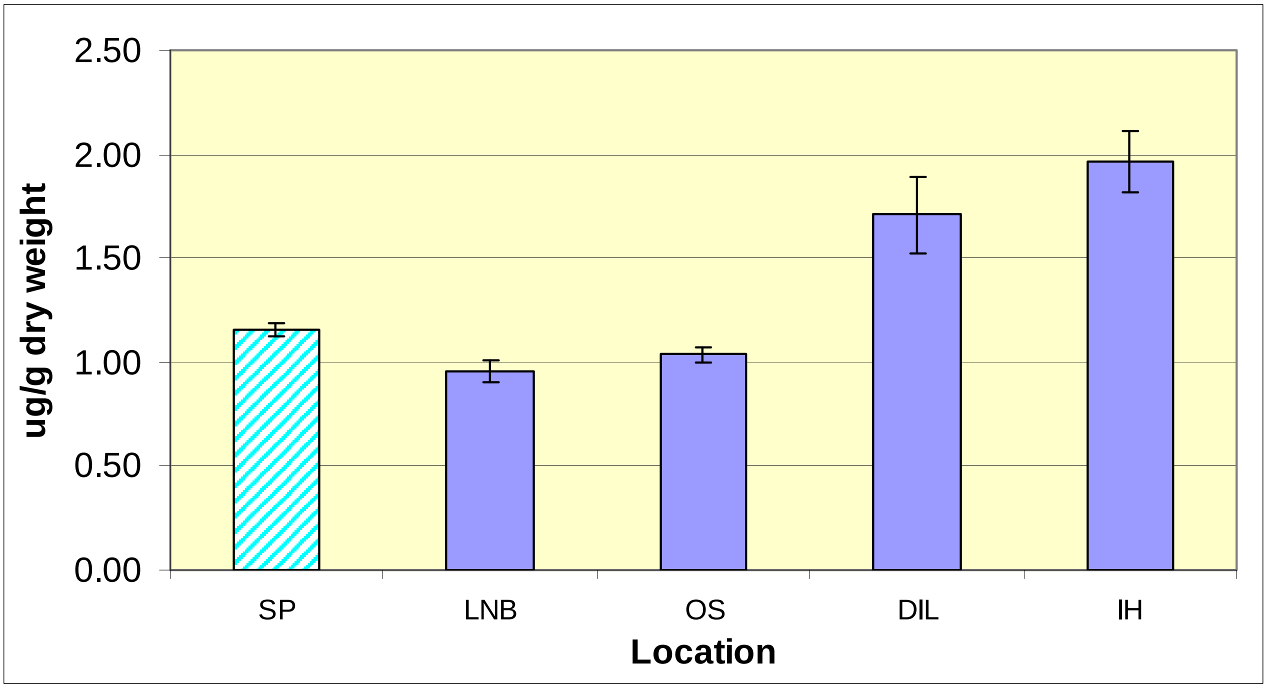

Figure 3-27. Lead bioaccumulation in mussels -2009

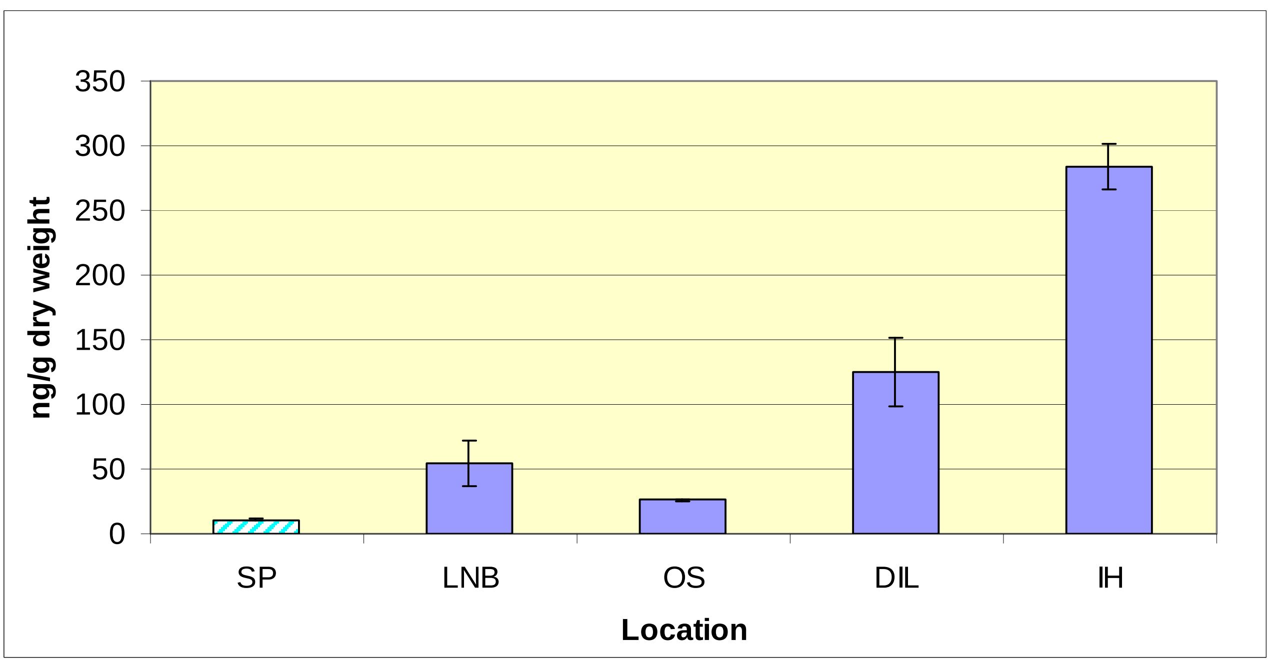

Figure 3-28. Total PCB bioaccumulation in mussels -2009

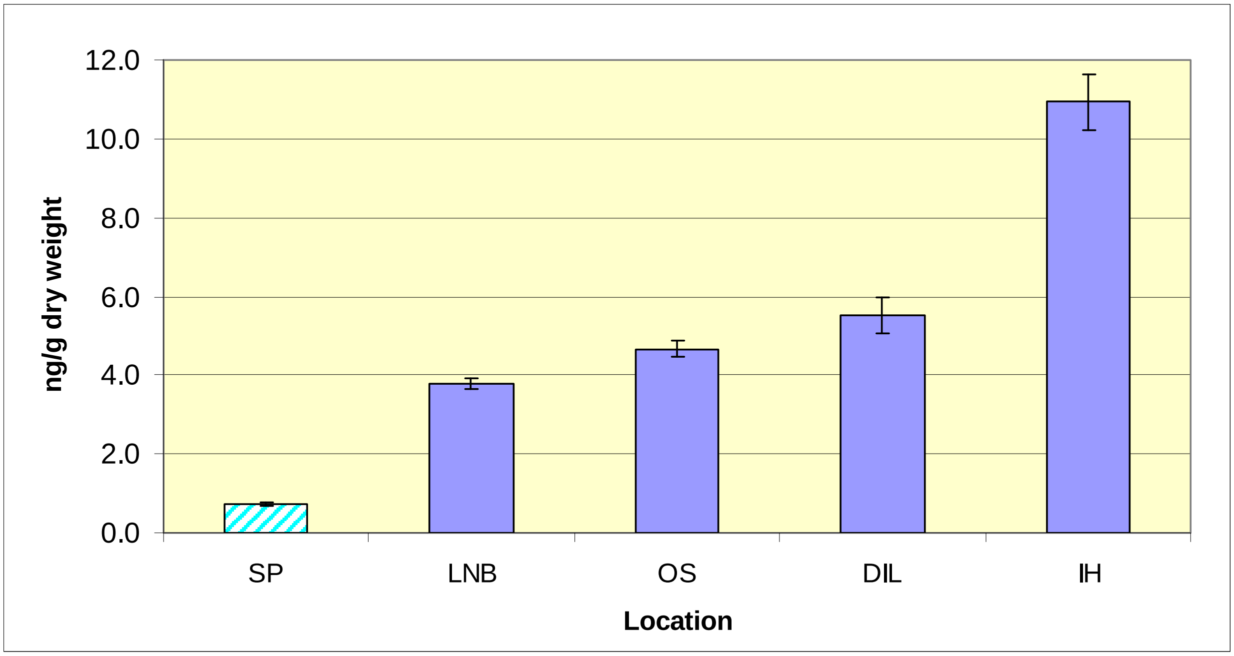

Figure 3-29. Total Chlordane bioaccumulation in mussels -2009

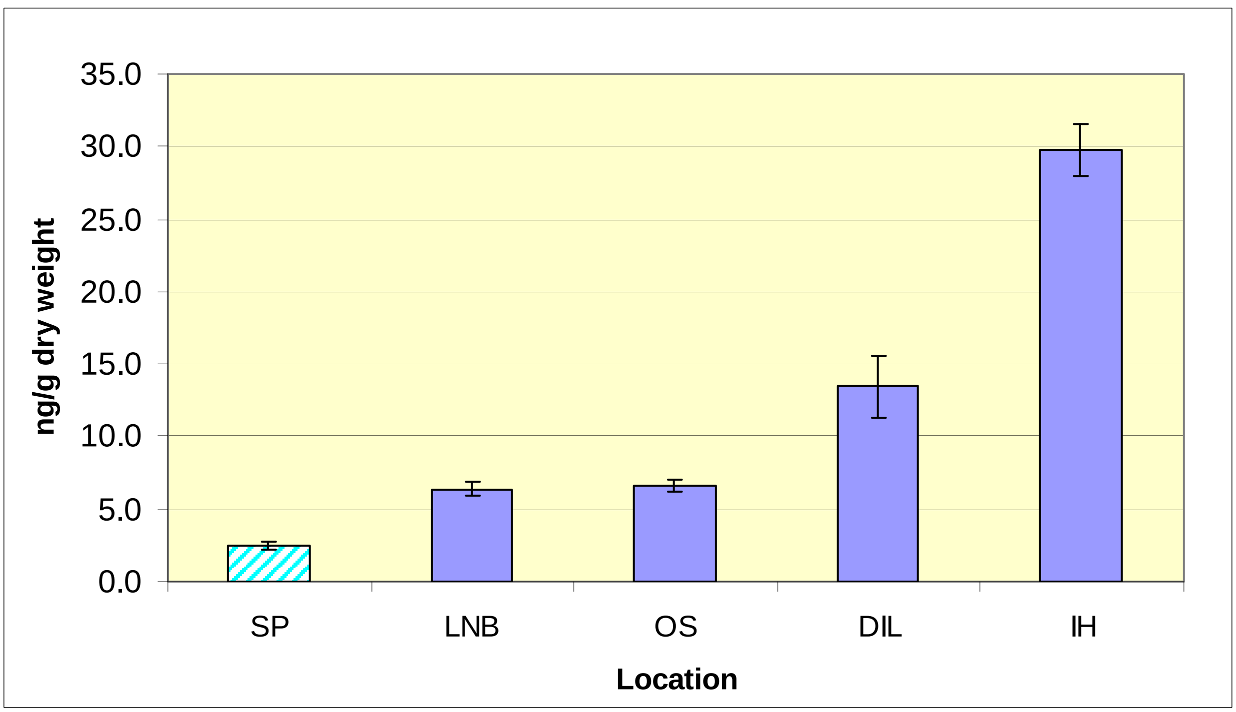

Figure 3-30. Total DDT bioaccumulation in mussels -2009

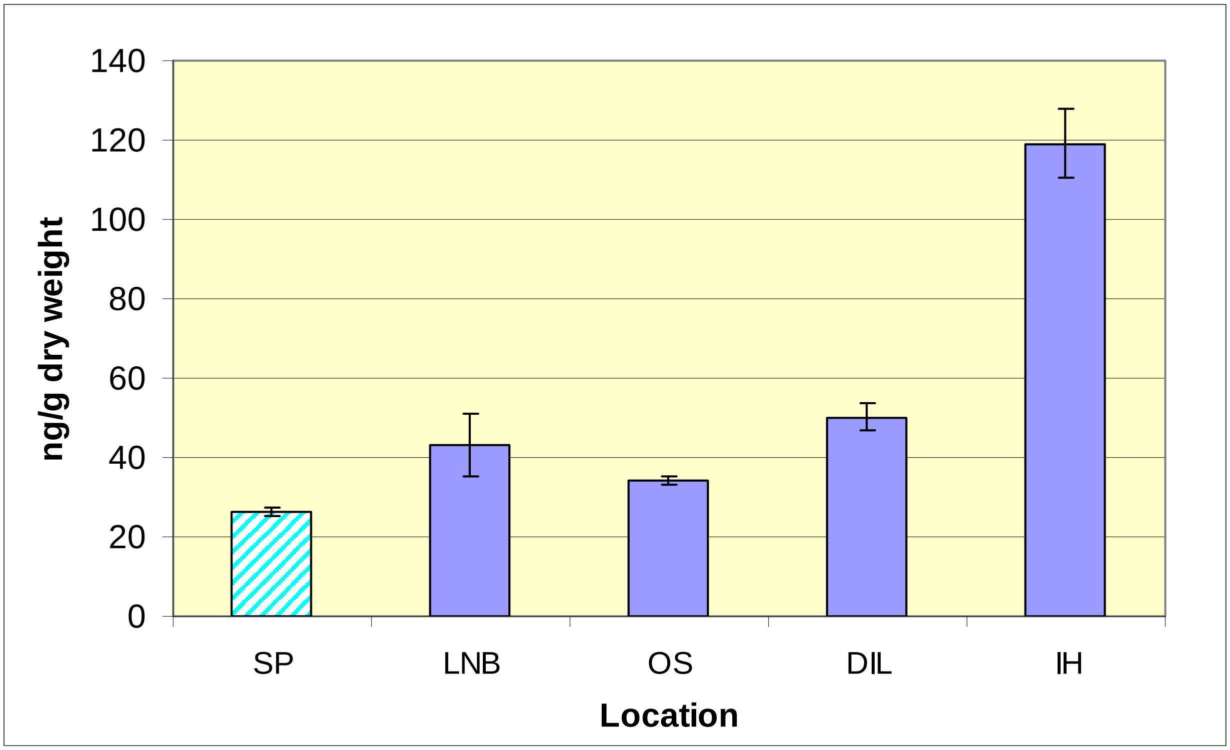

Figure 3-31. NOAA Low Molecular Weight PAH bioaccumulation in mussels -2009

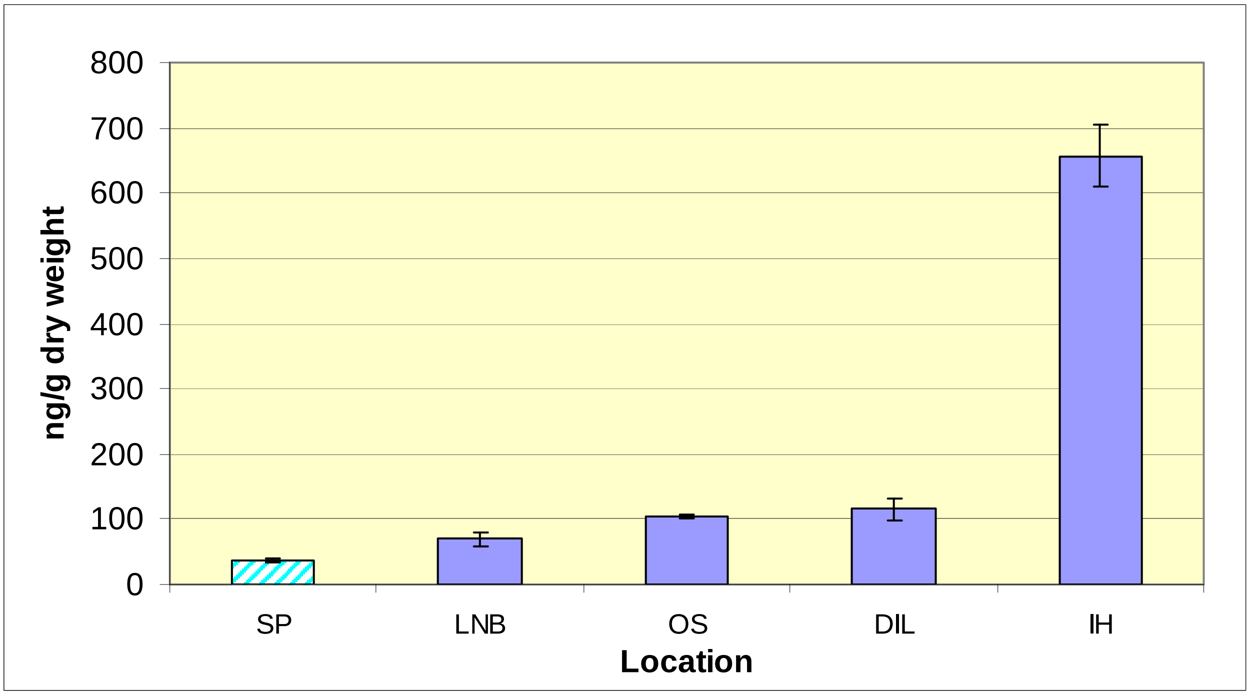

Figure 3-32. NOAA High Molecular Weight PAH bioaccumulation in mussels -2009

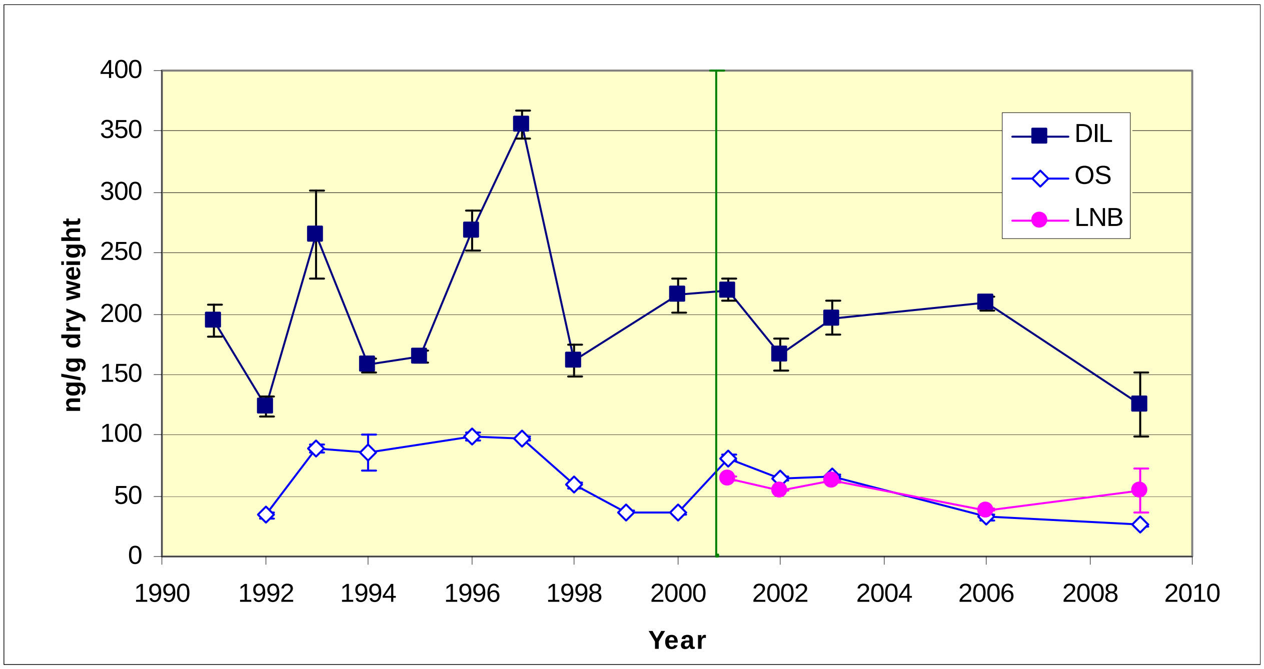

Figure 3-33. **PCB bioaccumulation in mussels- 1991-2009**

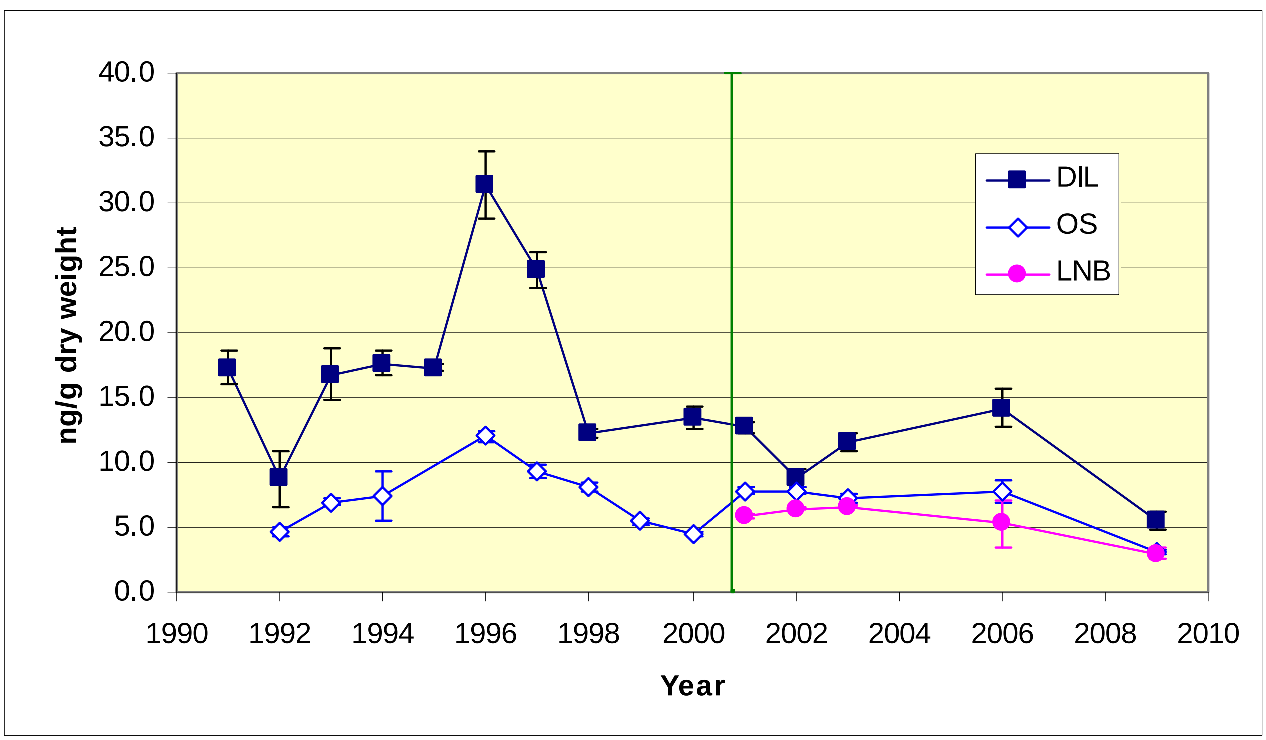

Figure 3-34. **DDT bioaccumulation in mussels- 1991-2009**

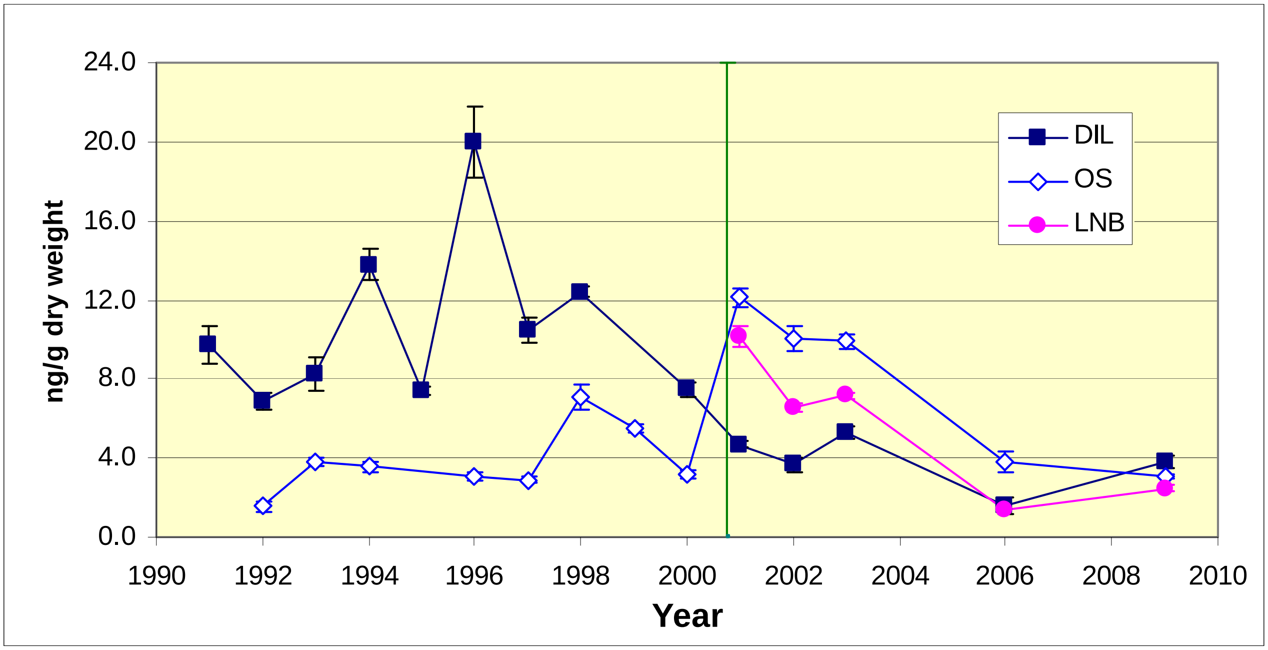

Figure 3-35. Total Chlordane bioaccumulation in mussels- 1991-2009

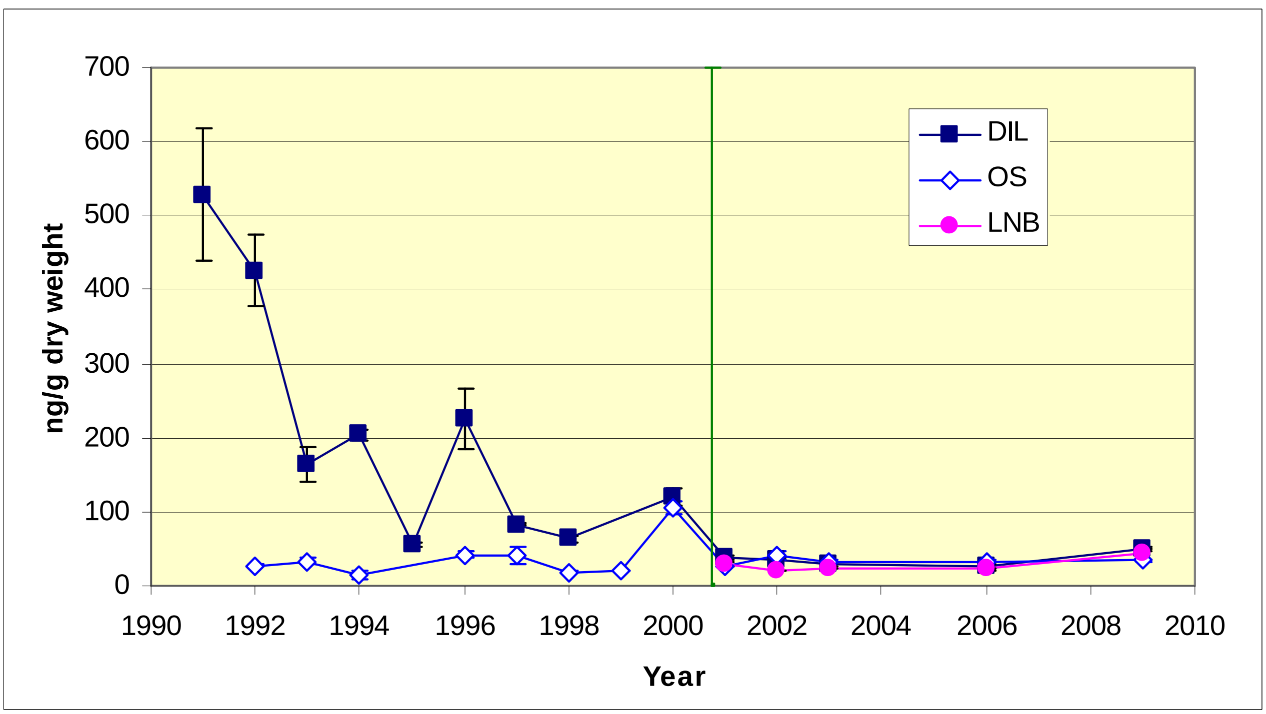

Figure 3-36. LMW PAH bioaccumulation in mussels- 1991-2009

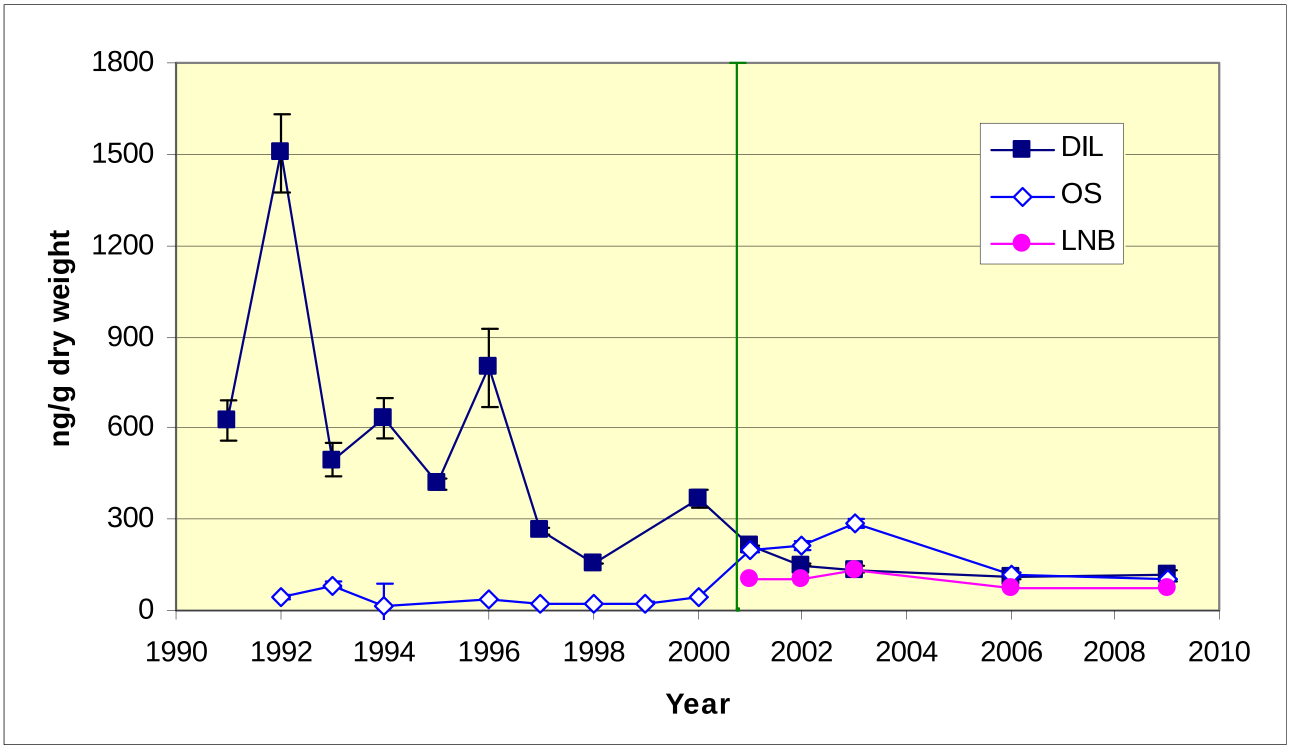

Figure 3-37. HMW PAH bioaccumulation in mussels- 1991-2009

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Fraction code: FILLET

						Mean					N				
					station	BS	DIF	ECCB	NB	OS	BS	DIF	ECCB	NB	OS
Group Id	Abbrev	Descr	Unit code	Year											
CHLOR	N.A.	Total chlordanes	ng/g	1992		25.545	35.478	2.666	12.237	8.476	4	4	4	4	4
				1993		N.A.	15.400	4.800	N.A.	16.198	N.A.	10	10	N.A.	9
				1994		7.613	18.783	2.930	5.570	7.550	3	3	3	3	3
				1995		N.A.	15.467	4.633	N.A.	5.767	N.A.	3	3	N.A.	3
				1996		5.400	11.300	1.077	6.867	3.667	3	3	3	3	3
				1997		N.A.	13.933	1.657	N.A.	5.663	N.A.	3	3	N.A.	3
				1998		N.A.	13.857	1.293	N.A.	5.544	N.A.	3	3	N.A.	3
				1999		8.842	9.734	2.342	10.101	7.114	3	3	3	3	3
				2000		N.A.	10.032	1.915	N.A.	3.246	N.A.	3	3	N.A.	3
				2001		N.A.	10.380	1.740	N.A.	2.917	N.A.	3	3	N.A.	3
				2002		4.760	6.031	1.305	2.380	3.265	3	3	3	3	3
				2003		N.A.	9.178	1.574	N.A.	3.279	N.A.	6	6	N.A.	6
				2006		N.A.	5.393	1.221	N.A.	1.801	N.A.	3	3	0	3
				2009		N.A.	4.559	0.853	2.725	2.927	N.A.	3	3	3	3
DDT	N.A.	Total DDTs	ng/g	1992		43.095	45.865	10.070	27.288	21.758	4	4	4	4	4
				1993		N.A.	31.574	12.396	N.A.	27.081	N.A.	10	10	N.A.	9
				1994		24.767	43.827	13.817	18.593	22.660	3	3	3	3	3
				1995		N.A.	43.233	27.467	N.A.	23.133	N.A.	3	3	N.A.	3
				1996		17.387	32.067	9.813	19.900	19.280	3	3	3	3	3
				1997		N.A.	46.267	13.413	N.A.	22.467	N.A.	3	3	N.A.	3
				1998		N.A.	30.060	6.371	N.A.	12.304	N.A.	3	3	N.A.	3
				1999		17.073	21.407	11.741	23.293	22.307	3	3	3	3	3
				2000		N.A.	18.293	6.737	N.A.	9.941	N.A.	3	3	N.A.	3
				2001		N.A.	28.090	8.200	N.A.	12.050	N.A.	3	3	N.A.	3
				2002		13.160	17.240	5.422	10.323	10.980	3	3	3	3	3
				2003		N.A.	30.307	7.877	N.A.	13.417	N.A.	6	6	N.A.	6
				2006		N.A.	32.633	7.427	N.A.	14.183	N.A.	3	3	0	3
				2009		N.A.	14.077	4.839	10.859	10.223	N.A.	3	3	3	3
LIPID/DRYWT	N.A.	Lipids	PCTDRYWT	1992		9.425	6.125	3.625	4.975	10.775	4	4	4	4	4
				1993		N.A.	3.200	2.950	N.A.	2.744	N.A.	10	10	N.A.	9
				1994		5.033	4.867	5.433	4.967	5.467	3	3	3	3	3
				1995		N.A.	1.900	2.500	N.A.	2.200	N.A.	3	3	N.A.	3
				1996		1.900	2.133	2.267	2.300	1.900	3	3	3	3	3
				1997		N.A.	1.400	1.533	N.A.	1.633	N.A.	3	3	N.A.	3
				1998		N.A.	7.667	6.667	N.A.	5.333	N.A.	3	3	N.A.	3
				1999		5.233	4.167	3.100	4.533	4.767	3	3	3	3	3
				2000		N.A.	2.501	2.772	N.A.	2.926	N.A.	3	3	N.A.	3
				2001		N.A.	2.180	1.988	N.A.	2.012	N.A.	3	3	N.A.	3
				2002		3.867	4.867	3.567	3.600	4.467	3	3	3	3	3
				2003		N.A.	2.100	2.000	N.A.	2.400	N.A.	6	6	N.A.	6
				2006		N.A.	2.483	2.860	2.433	2.583	N.A.	6	6	3	6
				2009		N.A.	6.850	5.537	3.867	4.293	N.A.	3	3	3	3
		Percent weight of the sample which is dry	PCT	1992		20.253	19.605	20.168	19.525	19.393	4	4	4	4	4
				1993		N.A.	18.153	17.766	N.A.	17.952	N.A.	10	10	N.A.	9
				1994		17.697	17.283	18.123	17.597	17.813	3	3	3	3	3
				1995		N.A.	17.033	17.833	N.A.	17.400	N.A.	3	3	N.A.	3
				1996		18.267	18.267	18.267	17.967	19.167	3	3	3	3	3
				1997		N.A.	17.733	17.733	N.A.	17.633	N.A.	3	3	N.A.	3
				1998		N.A.	18.590	21.947	N.A.	20.910	N.A.	3	3	N.A.	3
				1999		18.243	17.580	16.710	17.483	15.783	3	3	3	3	3
				2000		N.A.	17.193	16.710	N.A.	16.797	N.A.	3	3	N.A.	3
				2001		N.A.	16.990	17.793	N.A.	16.850	N.A.	3	3	N.A.	3
				2002		17.333	17.667	18.000	17.000	17.333	3	3	3	3	3
				2003		N.A.	17.230	16.820	N.A.	15.770	N.A.	6	6	N.A.	6
				2004		N.A.	18.210	19.160	N.A.	18.623	N.A.	3	3	N.A.	3
				2006		N.A.	17.092	17.355	18.600	17.395	N.A.	6	6	3	6
				2009		N.A.	18.533	18.500	18.767	19.933	N.A.	3	3	3	3

						Mean					N				
					station	BS	DIF	ECCB	NB	OS	BS	DIF	ECCB	NB	OS
Group Id	Abbrev	Descr	Unit code	Year											
METAL	Hg	Mercury	ug/g	1992		0.566	0.443	0.062	0.511	0.607	4	4	4	4	4
				1993		N.A.	0.460	0.186	N.A.	0.413	N.A.	10	10	N.A.	9
				1994		0.477	0.283	0.120	0.378	0.434	3	3	3	3	3
				1995		N.A.	0.404	0.104	N.A.	0.312	N.A.	3	3	N.A.	3
				1996		0.378	0.460	0.400	0.497	0.547	3	3	3	3	3
				1997		N.A.	0.511	0.195	N.A.	0.276	N.A.	3	3	N.A.	3
				1998		N.A.	0.234	0.136	N.A.	0.328	N.A.	3	3	N.A.	3
				1999		0.417	0.352	0.224	0.525	0.540	3	3	3	3	3
				2000		N.A.	0.394	0.202	N.A.	0.482	N.A.	3	3	N.A.	3
				2001		N.A.	0.358	0.179	N.A.	0.486	N.A.	3	3	N.A.	3
				2002		0.347	0.359	0.194	0.363	0.379	3	3	3	3	3
				2003		N.A.	0.392	0.278	N.A.	0.664	N.A.	6	6	N.A.	6
				2004		N.A.	0.369	0.193	N.A.	0.574	N.A.	3	3	N.A.	3
				2006		N.A.	0.325	0.222	0.193	0.451	N.A.	3	3	3	3
				2009		N.A.	0.307	0.180	0.359	0.472	N.A.	3	3	3	3
PCB	N.A.	Total PCBs	ng/g	1992		380.650	458.525	51.138	261.968	220.400	4	4	4	4	4
				1993		N.A.	197.110	55.430	N.A.	211.566	N.A.	10	10	N.A.	9
				1994		194.167	520.033	60.233	150.567	249.900	3	3	3	3	3
				1995		N.A.	613.900	107.607	N.A.	237.167	N.A.	3	3	N.A.	3
				1996		141.767	285.767	65.690	227.833	194.700	3	3	3	3	3
				1997		N.A.	325.100	62.777	N.A.	206.667	N.A.	3	3	N.A.	3
				1998		N.A.	238.433	39.413	N.A.	105.600	N.A.	3	3	N.A.	3
				1999		111.423	141.533	51.700	133.233	166.200	3	3	3	3	3
				2000		N.A.	203.300	39.460	N.A.	117.567	N.A.	3	3	N.A.	3
				2001		N.A.	348.600	51.333	N.A.	157.733	N.A.	3	3	N.A.	3
				2002		146.800	211.367	36.123	116.800	143.067	3	3	3	3	3
				2003		N.A.	345.467	49.687	N.A.	189.600	N.A.	6	6	N.A.	6
				2006		N.A.	317.533	47.790	114.470	176.700	N.A.	3	3	3	3
				2009		N.A.	180.033	28.737	138.500	138.450	N.A.	3	3	3	3
PEST	N.A.	Dieldrin	ng/g	1992		1.709	2.667	1.044	2.918	1.034	4	4	4	4	4
				1993		N.A.	3.301	2.016	N.A.	2.960	N.A.	10	10	N.A.	9
				1994		1.252	3.560	1.331	1.152	1.374	3	3	3	3	3
				1995		N.A.	3.000	0.000	N.A.	1.100	N.A.	3	3	N.A.	3
				1996		0.590	2.000	1.027	1.233	1.067	3	3	3	3	3
				1997		N.A.	2.967	1.080	N.A.	1.733	N.A.	3	3	N.A.	3
				1998		N.A.	2.490	0.680	N.A.	1.164	N.A.	3	3	N.A.	3
				1999		2.668	3.721	0.743	2.971	4.787	3	3	3	3	3
				2000		N.A.	1.541	0.431	N.A.	0.589	N.A.	3	3	N.A.	3
				2001		N.A.	2.843	1.080	N.A.	1.375	N.A.	3	3	N.A.	3
				2002		0.500	0.745	0.405	0.363	0.461	3	3	3	3	3
				2003		N.A.	1.352	1.126	N.A.	0.685	N.A.	6	6	N.A.	6
				2006		N.A.	1.030	0.764	N.A.	0.561	N.A.	3	3	0	3
				2009		N.A.	0.000	0.000	0.000	0.000	N.A.	3	3	3	3
PEST_NO_DIE	N.A.	Total pesticides (without Dieldrin)	ng/g	1992		1.094	1.465	0.431	0.851	0.915	4	4	4	4	4
				1993		N.A.	1.610	0.886	N.A.	1.199	N.A.	10	10	N.A.	9
				1994		1.176	1.668	0.776	0.981	1.041	3	3	3	3	3
				1995		N.A.	1.077	0.710	N.A.	0.797	N.A.	3	3	N.A.	3
				1996		1.010	0.867	0.760	0.723	0.847	3	3	3	3	3
				1997		N.A.	0.677	0.547	N.A.	0.740	N.A.	3	3	N.A.	3
				1998		N.A.	1.478	0.461	N.A.	0.840	N.A.	3	3	N.A.	3
				1999		0.549	0.488	0.526	0.468	0.601	3	3	3	3	3
				2000		N.A.	0.940	0.558	N.A.	0.772	N.A.	3	3	N.A.	3
				2001		N.A.	0.930	1.076	N.A.	0.776	N.A.	3	3	N.A.	3
				2002		0.505	0.498	0.477	0.405	0.521	3	3	3	3	3
				2003		N.A.	0.633	0.453	N.A.	0.556	N.A.	6	6	N.A.	6
				2006		N.A.	1.017	0.390	N.A.	0.640	N.A.	3	3	0	3
				2009		N.A.	0.227	0.000	0.089	0.132	N.A.	3	3	3	3

Notes: - NA is used if no data were collected that year or if all results are suspect or under investigation. - Organic contaminants are surrogate-corrected. - Zero is used for nondetects. - Individual component results are rounded to four significant figures.

Appendix B - Flounder Liver

Fraction code: LIVER

						Mean					N				
					station	BS	DIF	ECCB	NB	OS	BS	DIF	ECCB	NB	OS
Group Id	Abbrev	Descr	Unit code	Year											
CHLOR	N.A.	Total chlordanes	ng/g	1992		262.943	206.975	15.345	89.110	105.010	4	4	4	4	4
				1993		N.A.	122.700	26.330	N.A.	92.200	N.A.	1	1	N.A.	1
				1994		122.630	207.933	19.390	58.943	113.007	3	3	3	3	3
				1995		N.A.	283.000	39.733	N.A.	96.000	N.A.	3	3	N.A.	3
				1996		59.900	169.867	20.233	69.333	86.333	3	3	3	3	3
				1997		N.A.	243.667	32.700	N.A.	78.667	N.A.	3	3	N.A.	3
				1998		N.A.	176.133	11.866	N.A.	51.327	N.A.	3	3	N.A.	3
				1999		68.370	225.833	15.419	41.680	47.800	3	3	3	3	3
				2000		N.A.	95.713	12.387	N.A.	30.350	N.A.	3	3	N.A.	3
				2001		N.A.	91.877	13.513	N.A.	41.353	N.A.	3	3	N.A.	3
				2002		34.990	77.173	15.427	34.707	34.483	3	3	3	3	3
				2003		N.A.	84.813	10.433	N.A.	29.677	N.A.	6	6	N.A.	6
				2006		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	N.A.	0
				2009		N.A.	31.867	13.418	22.460	24.696	N.A.	3	3	3	3
DDT	N.A.	Total DDTs	ng/g	1992		436.325	214.450	48.763	166.138	207.100	4	4	4	4	4
				1993		N.A.	257.900	69.410	N.A.	247.300	N.A.	1	1	N.A.	1
				1994		297.600	407.300	73.537	168.667	264.100	3	3	3	3	3
				1995		N.A.	866.333	160.300	N.A.	455.233	N.A.	3	3	N.A.	3
				1996		176.233	420.000	104.000	192.667	274.333	3	3	3	3	3
				1997		N.A.	635.200	237.367	N.A.	342.400	N.A.	3	3	N.A.	3
				1998		N.A.	381.800	64.660	N.A.	132.433	N.A.	3	3	N.A.	3
				1999		186.967	484.467	80.557	116.343	181.033	3	3	3	3	3
				2000		N.A.	145.937	42.437	N.A.	94.110	N.A.	3	3	N.A.	3
				2001		N.A.	232.300	62.437	N.A.	175.267	N.A.	3	3	N.A.	3
				2002		122.533	237.433	82.463	135.017	142.700	3	3	3	3	3
				2003		N.A.	309.267	59.477	N.A.	160.033	N.A.	6	6	N.A.	6
				2006		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	0	0
				2009		N.A.	117.030	43.367	79.487	68.207	N.A.	3	3	3	3
LIPID/DRY	N.A.	Lipids	PCTDRYW	1992		32.825	32.700	21.600	30.275	30.138	4	4	4	4	4
				1993		N.A.	34.000	20.000	N.A.	22.600	N.A.	1	1	N.A.	1
				1994		64.033	85.967	32.967	38.300	34.800	3	3	3	3	3
				1995		N.A.	33.033	14.267	N.A.	23.200	N.A.	3	3	N.A.	3
				1996		21.567	23.700	25.133	19.600	24.233	3	3	3	3	3
				1997		N.A.	13.167	18.767	N.A.	14.800	N.A.	3	3	N.A.	3
				1998		N.A.	54.000	29.000	N.A.	45.333	N.A.	3	3	N.A.	3
				1999		36.650	44.153	49.853	27.213	27.673	3	3	3	3	3
				2000		N.A.	44.193	33.383	N.A.	46.337	N.A.	3	3	N.A.	3
				2001		N.A.	18.713	17.727	N.A.	22.717	N.A.	3	3	N.A.	3
				2002		34.000	31.933	39.133	40.633	45.400	3	3	3	3	3
				2003		N.A.	32.167	27.667	N.A.	28.300	N.A.	6	6	N.A.	6
				2006		N.A.	22.400	17.767	18.933	20.933	N.A.	3	3	3	3
				2009		N.A.	60.800	44.133	41.733	52.733	N.A.	3	3	3	3
		Percent	PCT	1992		23.808	22.393	22.953	21.675	24.158	4	4	4	4	4
				1993		N.A.	20.220	20.340	N.A.	20.530	N.A.	1	1	N.A.	1
				1994		17.397	20.767	20.137	22.443	21.697	3	3	3	3	3
				1995		N.A.	19.467	19.500	N.A.	20.333	N.A.	3	3	N.A.	3
				1996		21.567	21.600	21.033	20.700	20.100	3	3	3	3	3
				1997		N.A.	22.000	24.333	N.A.	21.667	N.A.	3	3	N.A.	3
				1998		N.A.	20.537	34.317	N.A.	25.810	N.A.	3	3	N.A.	3
				1999		20.883	28.320	18.997	22.117	22.003	3	3	3	3	3
				2000		N.A.	23.753	23.673	N.A.	22.833	N.A.	3	3	N.A.	3
				2001		N.A.	22.057	21.730	N.A.	22.733	N.A.	3	3	N.A.	3
				2002		22.667	24.667	26.000	23.000	24.667	3	3	3	3	3
				2003		N.A.	22.457	22.100	N.A.	22.210	N.A.	6	6	N.A.	6
				2004		N.A.	22.717	24.373	N.A.	23.847	N.A.	3	3	N.A.	3
				2006		N.A.	24.900	23.167	23.833	23.667	N.A.	3	3	3	3
				2009		N.A.	23.267	22.633	22.467	25.100	N.A.	3	3	3	3

Appendix B - Flounder Liver

Fraction code: LIVER

						Mean					N				
					station	BS	DIF	ECCB	NB	OS	BS	DIF	ECCB	NB	OS
Group Id	Abbrev	Descr	Unit code	Year											
METAL	Ag	Silver	ug/g	1992		3.339	2.656	4.465	2.908	4.768	4	4	4	4	4
				1993		N.A.	5.460	1.410	N.A.	4.780	N.A.	1	1	N.A.	1
				1994		7.767	3.757	6.110	5.670	10.113	3	3	3	3	3
				1995		N.A.	3.417	4.549	N.A.	9.891	N.A.	3	3	N.A.	3
				1996		6.278	4.472	4.160	7.212	22.403	3	3	3	3	3
				1997		N.A.	5.470	8.015	N.A.	9.170	N.A.	3	3	N.A.	3
				1998		N.A.	2.547	6.901	N.A.	7.023	N.A.	3	3	N.A.	3
				1999		5.713	2.370	4.533	14.177	11.567	3	3	3	3	3
				2000		N.A.	6.437	6.393	N.A.	14.993	N.A.	3	3	N.A.	3
				2001		N.A.	3.670	5.570	N.A.	9.597	N.A.	3	3	N.A.	3
				2002		5.223	4.393	3.487	4.843	7.343	3	3	3	3	3
				2003		N.A.	1.857	6.163	N.A.	16.067	N.A.	6	6	N.A.	6
				2006		N.A.	3.263	3.047	3.750	7.970	N.A.	3	3	3	3
				2009		N.A.	3.643	6.737	4.083	7.220	N.A.	3	3	3	3
	Cd	Cadmium	ug/g	1992		2.172	2.284	0.509	1.321	1.823	4	4	4	4	4
				1993		N.A.	0.911	0.423	N.A.	0.848	N.A.	1	1	N.A.	1
				1994		1.093	0.980	0.970	0.830	2.163	3	3	3	3	3
				1995		N.A.	0.438	0.662	N.A.	1.420	N.A.	3	3	N.A.	3
				1996		1.155	0.901	1.088	1.653	3.335	3	3	3	3	3
				1997		N.A.	2.248	1.827	N.A.	1.039	N.A.	3	3	N.A.	3
				1998		N.A.	0.655	1.652	N.A.	1.216	N.A.	3	3	N.A.	3
				1999		1.473	0.590	1.643	2.207	3.177	3	3	3	3	3
				2000		N.A.	1.648	1.247	N.A.	2.677	N.A.	3	3	N.A.	3
				2001		N.A.	1.534	1.571	N.A.	3.807	N.A.	3	3	N.A.	3
				2002		1.576	1.990	1.707	1.250	2.207	3	3	3	3	3
				2003		N.A.	1.433	5.253	N.A.	2.723	N.A.	6	6	N.A.	6
				2006		N.A.	1.325	1.673	1.416	2.113	N.A.	3	3	3	3
				2009		N.A.	0.626	1.822	0.942	2.080	N.A.	3	3	3	3
	Cr	Chromium	ug/g	1992		0.144	0.235	0.043	0.025	0.055	4	4	4	4	4
				1993		N.A.	0.735	0.000	N.A.	0.917	N.A.	1	1	N.A.	1
				1994		0.166	0.191	0.099	0.100	0.142	3	3	3	3	3
				1995		N.A.	0.137	0.087	N.A.	0.089	N.A.	3	3	N.A.	3
				1996		0.046	0.077	0.039	0.157	0.116	3	3	3	3	3
				1997		N.A.	0.422	0.327	N.A.	0.304	N.A.	3	3	N.A.	3
				1998		N.A.	0.356	0.075	N.A.	0.186	N.A.	3	3	N.A.	3
				1999		0.565	0.260	0.136	0.542	0.165	3	3	3	3	3
				2000		N.A.	0.125	0.116	N.A.	0.129	N.A.	3	3	N.A.	3
				2001		N.A.	0.215	0.132	N.A.	0.244	N.A.	3	3	N.A.	3
				2002		0.342	0.342	0.421	0.364	0.351	3	3	3	3	3
				2003		N.A.	0.155	0.239	N.A.	0.135	N.A.	6	6	N.A.	6
				2006		N.A.	0.000	0.000	0.133	0.000	N.A.	3	3	3	3
				2009		N.A.	0.238	0.255	0.262	0.279	N.A.	3	3	3	3
	Cu	Copper	ug/g	1992		37.250	66.275	72.625	60.025	91.725	4	4	4	4	4
				1993		N.A.	82.700	26.400	N.A.	50.600	N.A.	1	1	N.A.	1
				1994		103.033	51.813	121.300	80.467	112.200	3	3	3	3	3
				1995		N.A.	55.863	64.517	N.A.	121.400	N.A.	3	3	N.A.	3
				1996		68.310	42.280	65.553	74.783	125.483	3	3	3	3	3
				1997		N.A.	54.923	87.007	N.A.	75.067	N.A.	3	3	N.A.	3
				1998		N.A.	42.547	138.837	N.A.	91.590	N.A.	3	3	N.A.	3
				1999		67.980	33.513	70.887	90.587	129.960	3	3	3	3	3
				2000		N.A.	117.667	100.500	N.A.	181.000	N.A.	3	3	N.A.	3
				2001		N.A.	51.800	81.533	N.A.	102.800	N.A.	3	3	N.A.	3
				2002		74.900	61.100	43.633	55.100	80.700	3	3	3	3	3
				2003		N.A.	44.400	67.733	N.A.	135.667	N.A.	6	6	N.A.	6
				2006		N.A.	59.000	34.633	47.133	72.733	N.A.	3	3	3	3
				2009		N.A.	45.733	74.967	40.767	70.767	N.A.	3	3	3	3
	Hg	Mercury	ug/g	1992		1.054	1.000	0.278	0.736	0.560	4	4	4	4	4
				1993		N.A.	0.694	0.232	N.A.	0.420	N.A.	1	1	N.A.	1
				1994		0.453	0.277	0.226	0.309	0.545	3	3	3	3	3
				1995		N.A.	0.250	0.301	N.A.	0.386	N.A.	3	3	N.A.	3
				1996		0.730	0.530	0.436	0.751	0.552	3	3	3	3	3
				1997		N.A.	0.343	0.202	N.A.	0.343	N.A.	3	3	N.A.	3
				1998		N.A.	0.271	0.266	N.A.	0.386	N.A.	3	3	N.A.	3
				1999		0.494	0.223	0.308	0.743	0.645	3	3	3	3	3
				2000		N.A.	0.426	0.321	N.A.	0.631	N.A.	3	3	N.A.	3
				2001		N.A.	0.353	0.175	N.A.	0.475	N.A.	3	3	N.A.	3
				2002		0.364	0.297	0.216	0.330	0.398	3	3	3	3	3
				2003		N.A.	0.427	0.331	N.A.	0.648	N.A.	6	6	N.A.	6
				2004		N.A.	0.301	0.209	N.A.	0.493	N.A.	3	3	N.A.	3
				2006		N.A.	0.155	0.149	0.219	0.324	N.A.	3	3	3	3
				2009		N.A.	0.258	0.181	0.366	0.435	N.A.	3	3	3	3

Appendix B - Flounder Liver

Fraction code: LIVER

						Mean					N				
					station	BS	DIF	ECCB	NB	OS	BS	DIF	ECCB	NB	OS
Group Id	Abbrev	Descr	Unit code	Year											
	Ni	Nickel	ug/g	1992		1.214	0.840	0.362	0.464	0.799	4	4	4	4	4
				1993		N.A.	0.620	0.397	N.A.	0.648	N.A.	1	1	N.A.	1
				1994		0.610	0.237	0.367	0.269	0.597	3	3	3	3	3
				1995		N.A.	0.138	0.461	N.A.	0.437	N.A.	3	3	N.A.	3
				1996		0.000	0.000	0.000	0.113	0.171	3	3	3	3	3
				1997		N.A.	0.405	0.422	N.A.	0.384	N.A.	3	3	N.A.	3
				1998		N.A.	0.583	0.660	N.A.	0.637	N.A.	3	3	N.A.	3
				1999		0.988	0.173	0.383	0.785	0.579	3	3	3	3	3
				2000		N.A.	0.615	0.489	N.A.	0.631	N.A.	3	3	N.A.	3
				2001		N.A.	0.505	0.319	N.A.	0.767	N.A.	3	3	N.A.	3
				2002		0.430	0.430	0.688	0.417	1.000	3	3	3	3	3
				2003		N.A.	0.820	0.747	N.A.	0.665	N.A.	6	6	N.A.	6
				2006		N.A.	0.830	0.863	0.523	0.697	N.A.	3	3	3	3
				2009		N.A.	0.589	0.792	0.735	0.928	N.A.	3	3	3	3
	Pb	Lead	ug/g	1992		5.552	2.753	6.255	3.393	3.287	4	4	4	4	4
				1993		N.A.	2.020	1.140	N.A.	2.320	N.A.	1	1	N.A.	1
				1994		6.517	1.417	4.150	1.650	6.220	3	3	3	3	3
				1995		N.A.	0.840	5.219	N.A.	5.938	N.A.	3	3	N.A.	3
				1996		3.845	2.120	2.581	2.120	4.241	3	3	3	3	3
				1997		N.A.	3.059	1.071	N.A.	4.387	N.A.	3	3	N.A.	3
				1998		N.A.	2.474	2.283	N.A.	3.818	N.A.	3	3	N.A.	3
				1999		4.954	2.424	2.044	4.427	6.768	3	3	3	3	3
				2000		N.A.	3.653	1.650	N.A.	8.140	N.A.	3	3	N.A.	3
				2001		N.A.	2.950	3.130	N.A.	7.410	N.A.	3	3	N.A.	3
				2002		2.787	1.997	1.653	2.890	4.963	3	3	3	3	3
				2003		N.A.	2.950	3.890	N.A.	5.077	N.A.	6	6	N.A.	6
				2006		N.A.	1.453	1.820	1.453	5.933	N.A.	3	3	3	3
				2009		N.A.	1.660	2.378	2.969	4.703	N.A.	3	3	3	3
	Zn	Zinc	ug/g	1992		141.875	117.750	158.250	131.000	163.250	4	4	4	4	4
				1993		N.A.	86.700	82.300	N.A.	85.300	N.A.	1	1	N.A.	1
				1994		138.000	112.267	176.667	143.333	154.000	3	3	3	3	3
				1995		N.A.	105.700	138.100	N.A.	151.633	N.A.	3	3	N.A.	3
				1996		124.267	87.080	126.300	120.167	121.000	3	3	3	3	3
				1997		N.A.	127.467	137.233	N.A.	141.267	N.A.	3	3	N.A.	3
				1998		N.A.	106.267	147.733	N.A.	113.633	N.A.	3	3	N.A.	3
				1999		106.870	101.537	112.200	122.867	108.537	3	3	3	3	3
				2000		N.A.	127.667	136.667	N.A.	139.333	N.A.	3	3	N.A.	3
				2001		N.A.	104.000	128.667	N.A.	120.667	N.A.	3	3	N.A.	3
				2002		111.000	103.300	131.667	116.000	109.333	3	3	3	3	3
				2003		N.A.	98.067	120.667	N.A.	116.667	N.A.	6	6	N.A.	6
				2006		N.A.	111.000	119.333	125.667	130.333	N.A.	3	3	3	3
				2009		N.A.	97.000	128.333	111.000	119.333	N.A.	3	3	3	3
PAH	N.A.	Total PAH	ng/g	1992		N.A.	N.A.	N.A.	N.A.	N.A.	0	0	0	0	0
				1993		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	N.A.	0
				1994		198.043	217.700	148.190	232.347	243.840	3	3	3	3	3
				1995		N.A.	240.233	60.300	N.A.	61.533	N.A.	3	3	N.A.	3
				1996		304.733	268.633	284.700	334.967	339.233	3	3	3	3	3
				1997		N.A.	233.033	103.907	N.A.	140.800	N.A.	3	3	N.A.	3
				1998		N.A.	76.327	34.290	N.A.	49.423	N.A.	3	3	N.A.	3
				1999		85.177	104.637	126.727	97.530	88.587	3	3	3	3	3
				2000		N.A.	104.687	69.337	N.A.	131.980	N.A.	3	3	N.A.	3
				2001		N.A.	141.167	60.837	N.A.	99.360	N.A.	3	3	N.A.	3
				2002		51.217	58.167	99.760	49.367	40.960	3	3	3	3	3
				2003		N.A.	55.718	34.423	N.A.	26.328	N.A.	5	6	N.A.	4
				2006		N.A.	19.504	2.197	41.460	37.613	N.A.	3	3	3	3
				2009		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	0	0
PCB	N.A.	Total PCBs	ng/g	1992		3771.750	2609.250	372.725	1844.200	2415.000	4	4	4	4	4
				1993		N.A.	1797.000	336.500	N.A.	1733.000	N.A.	1	1	N.A.	1
				1994		2167.667	3615.000	343.700	1115.833	2381.667	3	3	3	3	3
				1995		N.A.	9243.000	1249.233	N.A.	6090.667	N.A.	3	3	N.A.	3
				1996		1689.900	3672.000	778.100	2123.000	2600.667	3	3	3	3	3
				1997		N.A.	4638.000	938.367	N.A.	2629.333	N.A.	3	3	N.A.	3
				1998		N.A.	3060.667	448.367	N.A.	1255.967	N.A.	3	3	N.A.	3
				1999		1213.667	2761.000	360.300	825.200	1271.133	3	3	3	3	3
				2000		N.A.	1856.333	249.867	N.A.	1140.667	N.A.	3	3	N.A.	3
				2001		N.A.	3611.333	424.333	N.A.	2513.000	N.A.	3	3	N.A.	3
				2002		1558.667	3059.000	515.900	1661.333	2186.667	3	3	3	3	3
				2003		N.A.	4462.333	371.900	N.A.	2558.667	N.A.	6	6	N.A.	6
				2006		N.A.	3309.333	351.500	1046.400	1411.000	N.A.	3	3	3	3
				2009		N.A.	1789.333	356.967	1191.333	1101.200	N.A.	3	3	3	3

Fraction code: LIVER

						Mean					N				
					station	BS	DIF	ECCB	NB	OS	BS	DIF	ECCB	NB	OS
Group Id	Abbrev	Descr	Unit code	Year											
PEST	N.A.	Dieldrin	ng/g	1992		17.755	18.070	7.306	15.191	12.332	4	4	4	4	4
				1993		N.A.	23.370	11.200	N.A.	20.250	N.A.	1	1	N.A.	1
				1994		13.462	30.273	5.636	9.260	13.820	3	3	3	3	3
				1995		N.A.	52.667	7.000	N.A.	0.000	N.A.	3	3	N.A.	3
				1996		0.000	30.000	9.800	9.000	8.333	3	3	3	3	3
				1997		N.A.	36.667	14.333	N.A.	18.333	N.A.	3	3	N.A.	3
				1998		N.A.	24.123	4.886	N.A.	9.918	N.A.	3	3	N.A.	3
				1999		25.357	38.867	6.756	10.707	18.493	3	3	3	3	3
				2000		N.A.	12.816	3.986	N.A.	4.365	N.A.	3	3	N.A.	3
				2001		N.A.	19.957	6.446	N.A.	14.977	N.A.	3	3	N.A.	3
				2002		4.147	7.944	5.444	3.689	4.237	3	3	3	3	3
				2003		N.A.	11.585	6.430	N.A.	5.591	N.A.	6	6	N.A.	6
				2006		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	0	0
				2009		N.A.	0.000	0.000	0.000	0.000	N.A.	3	3	3	3
PEST_NO	N.A.	Total pesticides (without Dieldrin)	ng/g	1992		14.543	7.240	3.446	9.974	8.852	4	4	4	4	4
				1993		N.A.	9.580	6.250	N.A.	8.950	N.A.	1	1	N.A.	1
				1994		32.903	23.130	18.277	19.707	22.667	3	3	3	3	3
				1995		N.A.	13.000	3.652	N.A.	8.400	N.A.	3	3	N.A.	3
				1996		0.000	9.000	0.000	0.000	3.133	3	3	3	3	3
				1997		N.A.	19.233	8.600	N.A.	13.033	N.A.	3	3	N.A.	3
				1998		N.A.	16.200	4.319	N.A.	9.314	N.A.	3	3	N.A.	3
				1999		4.427	6.533	3.491	2.970	3.839	3	3	3	3	3
				2000		N.A.	7.343	3.563	N.A.	5.826	N.A.	3	3	N.A.	3
				2001		N.A.	9.126	4.982	N.A.	9.321	N.A.	3	3	N.A.	3
				2002		4.023	4.185	3.320	3.595	4.446	3	3	3	3	3
				2003		N.A.	4.677	2.457	N.A.	4.073	N.A.	6	6	N.A.	6
				2006		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0	0	0	0
				2009		N.A.	1.391	0.297	0.755	1.189	N.A.	3	3	3	3

Fraction code:MEAT

						Mean			N		
					station	DIF	ECCB	OS	DIF	ECCB	OS
Group Id	Abbrev	Descr	Unit code	Year							
CHLOR	N.A.	Total chlordanes	ng/g	1992		3.726	1.570	1.493	3	3	3
				1993		6.070	1.816	1.540	3	10	2
				1994		5.194	1.358	5.132	3	3	2
				1995		0.390	0.058	0.587	3	3	3
				1996		5.630	1.517	3.800	3	3	3
				1997		6.410	1.830	3.586	3	3	3
				1998		4.162	1.677	2.947	3	3	3
				1999		5.473	1.490	2.298	3	3	3
				2000		2.479	0.945	1.412	6	6	6
				2001		2.125	0.428	1.135	3	3	3
				2002		1.334	0.569	0.925	3	3	3
				2003		2.257	0.983	1.177	3	3	3
				2006		0.000	0.000	0.130	3	3	3
				2009		2.237	0.632	0.853	3	3	3
DDT	N.A.	Total DDTs	ng/g	1992		13.997	17.833	8.978	3	3	3
				1993		27.290	9.574	8.670	3	10	2
				1994		23.827	10.300	21.935	3	3	2
				1995		13.617	13.223	14.337	3	3	3
				1996		25.980	13.010	18.533	3	3	3
				1997		46.343	14.607	20.897	3	3	3
				1998		11.377	9.686	8.915	3	3	3
				1999		15.977	9.315	7.358	3	3	3
				2000		5.077	3.993	4.795	6	6	6
				2001		7.562	6.400	6.942	3	3	3
				2002		8.632	4.511	5.502	3	3	3
				2003		12.850	5.733	5.620	3	3	3
				2006		15.003	7.700	9.520	3	3	3
				2009		15.090	4.667	4.469	3	3	3
LIPID/ DRYWT	N.A.	Lipids	PCTDRYW	1992		19.200	16.267	13.533	3	3	3
				1993		2.500	4.180	3.650	3	10	2
				1994		8.933	4.900	11.400	3	3	2
				1995		4.933	4.667	4.267	3	3	3
				1996		3.800	3.167	3.333	3	3	3
				1997		3.400	3.300	3.367	3	3	3
				1998		4.333	3.667	4.000	3	3	3
				1999		1.894	2.047	1.527	3	3	3
				2000		1.855	2.060	1.689	6	6	6
				2001		2.633	3.100	2.300	3	3	3
				2002		1.867	2.067	2.000	3	3	3
				2003		4.400	4.153	4.337	3	3	3
				2006		4.585	4.534	3.984	3	3	6
				2009		6.040	4.110	7.993	3	3	3
		Percent weight of the sample	PCT	1992		21.737	18.380	18.410	3	3	3
				1993		13.430	15.437	15.915	3	10	2
				1994		11.567	16.217	15.105	3	3	2
				1995		12.067	14.533	12.533	3	3	3
				1996		15.300	19.400	15.033	3	3	3
				1997		13.633	15.833	13.833	3	3	3
				1998		14.787	14.407	13.590	3	3	3
				1999		15.523	12.983	13.577	3	3	3
				2000		13.067	14.267	13.667	6	6	6
				2001		14.613	14.800	14.910	3	3	3
				2002		13.600	15.783	14.297	3	3	3
				2003		15.577	12.360	13.057	3	3	3
				2006		16.700	16.567	14.747	3	3	6
				2009		14.233	16.800	14.667	3	3	3

Fraction code:MEAT

						Mean			N		
					station	DIF	ECCB	OS	DIF	ECCB	OS
Group Id	Abbrev	Descr	Unit code	Year							
METAL	Hg	Mercury	ug/g	1992		1.228	0.921	0.854	3	3	3
				1993		0.842	0.659	1.013	3	10	2
				1994		0.827	0.498	1.043	3	3	2
				1995		0.610	0.535	1.089	3	3	3
				1996		0.858	0.940	1.067	3	3	3
				1997		1.467	0.983	1.120	3	3	3
				1998		0.767	0.598	0.990	3	3	3
				1999		0.999	0.712	1.038	3	3	3
				2000		0.746	0.659	0.922	6	6	6
				2001		0.873	0.530	1.024	3	3	3
				2002		0.853	0.642	0.790	3	3	3
				2003		1.089	0.528	0.848	3	3	3
				2006		0.487	0.320	0.447	3	3	3
				2009		0.454	0.506	0.644	3	3	3
PCB	N.A.	Total PCBs	ng/g	1992		99.607	87.250	60.603	3	3	3
				1993		150.567	62.668	62.355	3	10	2
				1994		137.167	66.797	177.950	3	3	2
				1995		122.320	76.083	118.733	3	3	3
				1996		220.433	68.880	148.100	3	3	3
				1997		311.833	77.553	157.633	3	3	3
				1998		112.943	54.900	71.830	3	3	3
				1999		154.233	52.913	73.730	3	3	3
				2000		127.427	37.973	64.003	6	6	6
				2001		74.257	39.897	65.513	3	3	3
				2002		90.550	32.807	59.920	3	3	3
				2003		148.667	35.800	189.547	3	3	3
				2006		171.633	59.447	96.100	3	3	2
				2009		494.400	41.920	154.490	3	3	3
PEST	N.A.	Dieldrin	ng/g	1992		5.506	3.516	3.946	3	3	3
				1993		9.017	3.515	4.660	3	10	2
				1994		11.524	3.726	6.430	3	3	2
				1995		6.500	3.933	5.767	3	3	3
				1996		8.533	3.767	9.500	3	3	3
				1997		6.800	4.233	6.267	3	3	3
				1998		3.745	2.379	3.811	3	3	3
				1999		6.794	4.264	5.151	3	3	3
				2000		3.187	2.266	2.948	6	6	6
				2001		3.674	2.831	3.924	3	3	3
				2002		2.687	1.740	2.566	3	3	3
				2003		3.520	2.647	3.337	3	3	3
				2006		3.985	0.000	2.607	3	3	3
				2009		2.837	0.000	1.174	3	3	3
PEST_NO_DIELDRIN	N.A.	Total pesticides (without Dieldrin)	ng/g	1992		1.432	0.642	0.613	3	3	3
				1993		5.817	5.524	5.585	3	10	2
				1994		1.699	1.426	1.318	3	3	2
				1995		0.000	0.247	0.213	3	3	3
				1996		2.857	0.747	2.090	3	3	3
				1997		0.743	2.050	1.033	3	3	3
				1998		0.421	1.528	1.710	3	3	3
				1999		1.029	0.557	0.764	3	3	3
				2000		5.426	1.141	0.513	6	6	6
				2001		0.444	0.343	0.443	3	3	3
				2002		0.377	0.345	0.365	3	3	3
				2003		4.080	3.647	4.300	3	3	3
				2006		0.000	0.000	2.537	3	3	3
				2009		0.293	0.086	0.066	3	3	3

Notes: - NA is used if no data were collected that year or if all results are suspect or under investigation. Organic contaminants are surrogate-corrected. - Zero is used for nondetects. - Individual component results are rounded to four significant figures.

Fraction code:HEPATOPANC

						Mean			N		
					station	DIF	ECCB	OS	DIF	ECCB	OS
Group Id	Abbrev	Descr	Unit code	Year							
CHLOR	N.A.	Total chlordanes	ng/g	1992		196.683	18.637	50.743	3	3	3
				1993		192.000	73.862	46.515	3	10	2
				1994		116.353	13.212	21.415	3	3	2
				1995		38.667	65.000	73.667	3	3	3
				1996		199.000	81.200	156.667	3	3	3
				1997		137.633	41.593	57.867	3	3	3
				1998		233.800	42.020	93.853	3	3	3
				1999		138.067	31.853	57.937	3	3	3
				2000		89.263	33.240	37.760	6	6	6
				2001		97.113	22.287	37.143	3	3	3
				2002		55.900	18.610	40.537	3	3	3
				2003		70.640	22.103	34.173	3	3	3
				2006		123.257	82.177	56.180	3	3	3
				2009		53.733	21.810	25.287	3	3	3
DDT	N.A.	Total DDTs	ng/g	1992		609.833	207.867	475.367	3	3	3
				1993		639.700	285.420	288.250	3	10	2
				1994		404.867	165.567	308.750	3	3	2
				1995		670.500	745.933	929.900	3	3	3
				1996		1251.000	702.167	1025.667	3	3	3
				1997		1093.033	789.033	1088.700	3	3	3
				1998		1105.667	761.300	1033.433	3	3	3
				1999		1298.000	559.133	745.867	3	3	3
				2000		445.333	378.700	312.767	6	6	6
				2001		813.533	401.200	431.733	3	3	3
				2002		449.633	203.200	304.100	3	3	3
				2003		1024.267	337.567	399.100	3	3	3
				2006		1452.667	835.900	750.900	3	3	3
				2009		463.067	203.467	210.867	3	3	3
LIPID/DRYWT	N.A.	Lipids	PCTDRYW	1992		68.600	43.800	61.100	3	3	3
				1993		41.767	51.040	50.750	3	10	2
				1994		70.467	69.333	57.850	3	3	2
				1995		63.667	67.333	64.367	3	3	3
				1996		56.333	61.600	51.300	3	3	3
				1997		49.100	59.100	57.233	3	3	3
				1998		79.333	59.333	66.000	3	3	3
				1999		31.360	38.627	43.227	3	3	3
				2000		56.293	55.727	50.813	6	6	6
				2001		53.367	49.933	51.633	3	3	3
				2002		55.500	55.333	65.633	3	3	3
				2003		43.013	54.497	56.100	3	3	3
				2006		60.447	61.293	51.750	3	3	3
				2009		45.300	59.800	58.367	3	3	3
		Percent weight of the sample	PCT	1992		43.273	32.057	39.737	3	3	3
				1993		20.817	25.831	25.075	3	10	2
				1994		27.583	28.187	28.975	3	3	2
				1995		35.533	33.467	31.667	3	3	3
				1996		34.567	41.500	33.567	3	3	3
				1997		29.467	34.467	30.967	3	3	3
				1998		34.620	29.770	32.390	3	3	3
				1999		38.260	25.390	29.630	3	3	3
				2000		32.400	28.300	31.667	6	6	6
				2001		31.133	28.613	33.483	3	3	3
				2002		27.990	27.973	28.973	3	3	3
				2003		30.693	28.347	32.423	3	3	3
				2006		30.567	31.100	32.333	3	3	3
				2009		24.300	30.933	32.267	3	3	3
METAL	Ag	Silver	ug/g	1992		5.070	3.527	3.517	3	3	3
				1993		6.530	6.345	2.430	3	10	2
				1994		10.737	14.633	7.465	3	3	2
				1995		27.553	8.098	21.987	3	3	3
				1996		32.887	15.252	21.283	3	3	3
				1997		6.523	9.419	13.236	3	3	3
				1998		30.383	29.747	29.903	3	3	3
				1999		47.030	32.237	47.840	3	3	3
				2000		18.733	20.013	34.367	6	6	6
				2001		29.233	24.167	39.567	3	3	3
				2002		41.700	21.700	40.000	3	3	3
				2003		27.330	16.027	26.283	3	3	3
				2006		7.960	11.290	6.880	3	3	3
				2009		3.267	5.583	3.217	3	3	3

						Mean			N		
					station	DIF	ECCB	OS	DIF	ECCB	OS
Group Id	Abbrev	Descr	Unit code	Year							
	Cd	Cadmium	ug/g	1992		6.147	27.123	12.970	3	3	3
				1993		3.333	10.918	13.260	3	10	2
				1994		8.307	16.143	12.295	3	3	2
				1995		5.292	7.942	5.322	3	3	3
				1996		3.321	14.447	9.299	3	3	3
				1997		6.982	13.707	11.889	3	3	3
				1998		3.977	7.558	17.323	3	3	3
				1999		4.581	12.423	15.528	3	3	3
				2000		6.413	9.440	11.000	6	6	6
				2001		8.103	12.700	15.500	3	3	3
				2002		11.023	13.267	15.917	3	3	3
				2003		11.437	10.767	12.144	3	3	3
				2006		5.890	10.653	15.567	3	3	3
				2009		6.187	13.700	19.200	3	3	3
	Cr	Chromium	ug/g	1992		2.910	2.090	3.358	3	3	3
				1993		1.457	1.089	1.270	3	10	2
				1994		0.246	0.191	0.491	3	3	2
				1995		0.237	0.095	0.181	3	3	3
				1996		0.151	0.081	0.120	3	3	3
				1997		0.256	0.098	0.303	3	3	3
				1998		0.089	0.153	0.230	3	3	3
				1999		0.190	0.219	0.175	3	3	3
				2000		0.196	0.142	0.295	6	6	6
				2001		0.314	0.255	0.276	3	3	3
				2002		0.271	0.163	0.254	3	3	3
				2003		0.321	0.344	0.327	3	3	3
				2006		0.000	0.000	0.000	3	3	3
				2009		0.808	0.304	0.674	3	3	3
	Cu	Copper	ug/g	1992		261.367	1014.400	440.767	3	3	3
				1993		642.000	463.510	309.000	3	10	2
				1994		537.000	283.667	557.500	3	3	2
				1995		324.733	125.237	314.367	3	3	3
				1996		485.100	166.587	371.033	3	3	3
				1997		641.200	294.467	513.500	3	3	3
				1998		612.433	572.667	610.800	3	3	3
				1999		895.200	477.967	830.467	3	3	3
				2000		454.667	422.000	693.000	6	6	6
				2001		639.667	521.333	778.000	3	3	3
				2002		886.667	459.667	867.167	3	3	3
				2003		559.600	353.533	688.500	3	3	3
				2006		532.667	410.333	773.000	3	3	3
				2009		1323.333	275.667	829.667	3	3	3
	Hg	Mercury	ug/g	1992		0.240	0.423	0.537	3	3	3
				1993		0.296	0.192	0.236	3	10	2
				1994		0.269	0.236	0.399	3	3	2
				1995		0.350	0.271	0.335	3	3	3
				1996		0.202	0.243	0.260	3	3	3
				1997		0.432	0.400	0.437	3	3	3
				1998		0.262	0.243	0.365	3	3	3
				1999		0.302	0.317	0.528	3	3	3
				2000		0.266	0.234	0.465	6	6	6
				2001		0.252	0.241	0.314	3	3	3
				2002		0.378	0.234	0.364	3	3	3
				2003		0.373	0.205	0.337	3	3	3
				2006		0.153	0.150	0.263	3	3	3
				2009		0.233	0.231	0.320	3	3	3
	Ni	Nickel	ug/g	1992		0.795	0.952	1.601	3	3	3
				1993		0.652	1.308	0.467	3	10	2
				1994		0.437	1.187	0.970	3	3	2
				1995		0.421	0.453	0.432	3	3	3
				1996		0.126	0.676	0.393	3	3	3
				1997		0.570	0.893	1.264	3	3	3
				1998		0.359	0.729	1.210	3	3	3
				1999		0.650	1.327	0.685	3	3	3
				2000		0.478	0.730	1.274	6	6	6
				2001		0.505	0.787	0.728	3	3	3
				2002		0.765	1.400	1.243	3	3	3
				2003		0.880	1.146	1.055	3	3	3
				2006		0.677	1.733	0.977	3	3	3
				2009		0.921	0.954	1.979	3	3	3

						Mean			N		
					station	DIF	ECCB	OS	DIF	ECCB	OS
Group Id	Abbrev	Descr	Unit code	Year							
	Pb	Lead	ug/g	1992		0.375	4.492	0.275	3	3	3
				1993		0.333	0.104	0.380	3	10	2
				1994		0.427	0.089	0.544	3	3	2
				1995		0.255	0.042	0.301	3	3	3
				1996		0.350	0.068	0.411	3	3	3
				1997		0.391	0.039	0.299	3	3	3
				1998		0.230	0.305	0.629	3	3	3
				1999		0.525	0.247	0.418	3	3	3
				2000		0.298	0.363	0.317	6	6	6
				2001		0.390	0.371	0.418	3	3	3
				2002		0.377	0.418	0.326	3	3	3
				2003		0.295	0.210	0.372	3	3	3
				2006		0.315	0.080	0.431	3	3	3
				2009		0.739	0.000	0.857	3	3	3
	Zn	Zinc	ug/g	1992		76.600	100.633	110.767	3	3	3
				1993		74.800	49.730	83.550	3	10	2
				1994		79.667	82.700	97.450	3	3	2
				1995		43.937	54.443	51.593	3	3	3
				1996		53.820	50.327	73.863	3	3	3
				1997		84.097	57.920	80.320	3	3	3
				1998		82.943	89.767	112.990	3	3	3
				1999		88.067	75.733	47.367	3	3	3
				2000		59.333	129.733	75.467	6	6	6
				2001		74.633	94.667	104.833	3	3	3
				2002		75.700	110.333	81.083	3	3	3
				2003		77.213	78.123	102.343	3	3	3
				2006		56.867	58.267	141.000	3	3	3
				2009		120.733	77.400	84.533	3	3	3
PAH	N.A.	Total PAH	ng/g	1992		29710.000	4055.000	4060.333	3	3	3
				1993		11608.700	3082.950	5782.500	3	10	2
				1994		16576.667	786.933	4602.500	3	3	2
				1995		5386.333	4321.333	6576.333	3	3	3
				1996		12814.667	2372.333	6243.667	3	3	3
				1997		8423.000	N.A.	3059.333	3	0	3
				1998		7413.000	1478.333	2429.333	3	3	3
				1999		7597.333	1309.667	1563.000	3	3	3
				2000		13049.000	1364.333	2726.667	6	6	6
				2001		10732.333	1410.667	2196.333	3	3	3
				2002		7101.000	1292.000	4074.333	3	3	3
				2003		3375.000	788.567	2726.000	3	3	3
				2006		7693.667	602.067	1194.000	3	3	3
				2009		6788.667	407.133	1199.600	3	3	3
PCB	N.A.	Total PCBs	ng/g	1992		3253.667	1206.000	2046.333	3	3	3
				1993		2846.333	2140.810	2254.500	3	10	2
				1994		2482.333	657.067	2452.550	3	3	2
				1995		4525.000	2779.333	5234.000	3	3	3
				1996		7225.333	2465.333	5582.667	3	3	3
				1997		7111.333	2477.667	4935.333	3	3	3
				1998		7722.667	3409.667	6003.333	3	3	3
				1999		10253.333	3132.333	6353.667	3	3	3
				2000		7578.667	1920.667	2965.000	6	6	6
				2001		8018.000	2029.667	3696.333	3	3	3
				2002		4465.000	1268.333	2897.333	3	3	3
				2003		10135.667	1731.667	12781.333	3	3	3
				2006		6045.333	2714.333	3314.000	3	3	3
				2009		11136.333	1691.000	9423.667	3	3	3

						Mean			N		
					station	DIF	ECCB	OS	DIF	ECCB	OS
Group Id	Abbrev	Descr	Unit code	Year							
PEST	N.A.	Dieldrin	ng/g	1992		65.727	13.410	27.008	3	3	3
				1993		124.700	39.791	56.600	3	10	2
				1994		40.747	9.405	17.083	3	3	2
				1995		52.667	30.000	106.667	3	3	3
				1996		126.667	50.333	143.333	3	3	3
				1997		46.000	32.667	50.667	3	3	3
				1998		44.560	25.853	45.110	3	3	3
				1999		59.633	28.130	51.657	3	3	3
				2000		61.940	25.493	35.540	6	6	6
				2001		48.103	20.553	27.087	3	3	3
				2002		17.397	9.678	15.333	3	3	3
				2003		45.840	20.680	28.260	3	3	3
				2006		53.610	36.430	31.863	3	3	3
				2009		10.680	0.000	0.000	3	3	3
PEST_NO_DIELDRIN	N.A.	Total pesticides (without Dieldrin)	ng/g	1992		23.805	55.087	14.950	3	3	3
				1993		22.160	25.093	19.725	3	10	2
				1994		7.033	33.046	5.459	3	3	2
				1995		22.683	17.567	28.167	3	3	3
				1996		37.533	22.700	36.200	3	3	3
				1997		21.900	19.133	25.967	3	3	3
				1998		11.834	10.583	12.780	3	3	3
				1999		18.403	16.483	20.367	3	3	3
				2000		16.903	15.383	14.917	6	6	6
				2001		17.910	15.990	15.510	3	3	3
				2002		13.130	10.296	13.453	3	3	3
				2003		8.110	7.133	6.900	3	3	3
				2006		15.260	12.260	11.713	3	3	3
				2009		7.866	1.665	2.474	3	3	3

Notes: - NA is used if no data were collected that year or if all results are suspect or under investigation.
Organic contaminants are surrogate-corrected. Zero is used for nondetects.
Individual component results are rounded to four significant figures.

Fraction code:SOFT TISSUE

						Mean											N										
					station	CCB	DIL	GL	IH	LNB	OSM	OSR	QBM	RP	SA	SP	CCB	DIL	GL	IH	LNB	OSM	OSR	QBM	RP	SA	SP
Group Id	Abbrev	Descr	Unit code	Year																							
CHLOR	N.A.	Total chlordanes	ng/g	1991		N.A.	18.244	2.705	20.860	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	17.971	2.850	45.530	N.A.	4.923	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	19.380	N.A.	22.225	N.A.	7.850	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	0	4	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	26.687	9.817	25.233	N.A.	8.221	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	11.700	3.180	20.780	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	40.960	9.767	31.220	N.A.	7.252	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	3	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1997		N.A.	20.428	8.800	29.042	N.A.	6.176	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1998		8.300	24.968	6.795	25.766	N.A.	10.468	N.A.	22.880	N.A.	14.152	N.A.	8	5	5	5	N.A.	8	N.A.	5	N.A.	5	N.A.
				1999		7.522	N.A.	7.632	22.496	N.A.	7.723	N.A.	N.A.	N.A.	N.A.	N.A.	8	N.A.	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				2000		N.A.	13.796	N.A.	28.354	N.A.	4.956	N.A.	N.A.	2.610	N.A.	N.A.	N.A.	5	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		4.808	8.688	N.A.	12.250	13.921	18.551	18.860	N.A.	2.867	N.A.	N.A.	8	5	N.A.	5	8	8	8	N.A.	5	N.A.	N.A.
				2002		4.048	7.364	N.A.	12.600	11.408	16.646	N.A.	N.A.	N.A.	N.A.	2.060	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5
				2003		4.174	9.992	N.A.	26.558	12.563	16.614	N.A.	N.A.	N.A.	N.A.	1.615	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		0.318	4.461	N.A.	6.766	1.828	5.828	N.A.	N.A.	N.A.	N.A.	0.539	4	5	N.A.	5	4	4	N.A.	N.A.	N.A.	N.A.	7
				2009		N.A.	5.522	N.A.	10.940	3.790	4.666	N.A.	N.A.	N.A.	N.A.	0.718	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
DDT	N.A.	Total DDTs	ng/g	1991		N.A.	45.638	25.080	89.180	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	21.727	17.626	99.488	N.A.	8.910	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	57.500	N.A.	127.975	N.A.	25.575	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	0	4	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	49.173	24.313	77.723	N.A.	16.783	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	44.800	28.562	91.480	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	84.400	56.767	118.500	N.A.	29.020	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	3	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1997		N.A.	60.040	51.760	134.860	N.A.	22.416	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1998		15.820	38.040	34.080	81.954	N.A.	19.914	N.A.	50.812	N.A.	55.812	N.A.	8	5	4	5	N.A.	8	N.A.	5	N.A.	5	N.A.
				1999		17.723	N.A.	34.342	85.904	N.A.	12.188	N.A.	N.A.	N.A.	N.A.	N.A.	8	N.A.	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				2000		N.A.	32.682	N.A.	99.968	N.A.	7.875	N.A.	N.A.	3.308	N.A.	N.A.	N.A.	5	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		15.111	25.326	N.A.	47.670	10.607	15.228	14.793	N.A.	6.713	N.A.	N.A.	8	5	N.A.	5	8	8	8	N.A.	5	N.A.	N.A.
				2002		9.625	19.980	N.A.	47.708	14.228	17.657	N.A.	N.A.	N.A.	N.A.	6.781	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5
				2003		11.895	26.334	N.A.	115.120	13.730	15.626	N.A.	N.A.	N.A.	N.A.	6.870	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		14.258	23.592	N.A.	40.554	8.881	10.437	N.A.	N.A.	N.A.	N.A.	7.794	4	5	N.A.	5	4	7	N.A.	N.A.	N.A.	N.A.	7
				2009		N.A.	13.442	N.A.	29.760	6.408	6.571	N.A.	N.A.	N.A.	N.A.	2.540	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
HMW-PAH	N.A.	Total NOAA HMW PAH	ng/g	1991		N.A.	624.875	99.650	2112.000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	4	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	1504.550	132.420	3343.400	N.A.	45.100	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	5	5	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	495.167	105.000	1210.333	N.A.	83.625	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	6	6	6	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	632.667	132.333	2175.667	N.A.	18.286	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	415.300	93.080	1238.200	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	799.360	195.133	2232.800	N.A.	37.130	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	3	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1997		N.A.	260.980	88.470	1345.400	N.A.	23.674	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1998		20.564	154.320	138.560	1865.000	N.A.	19.746	N.A.	143.780	N.A.	58.100	N.A.	8	5	5	5	N.A.	8	N.A.	5	N.A.	4	N.A.
				1999		17.848	N.A.	481.220	2506.200	N.A.	25.128	N.A.	N.A.	N.A.	N.A.	N.A.	8	N.A.	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				2000		N.A.	365.525	N.A.	2182.800	N.A.	43.175	N.A.	N.A.	28.832	N.A.	N.A.	N.A.	4	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		60.763	209.740	N.A.	1281.800	100.765	197.850	200.400	N.A.	38.050	N.A.	N.A.	8	5	N.A.	5	8	8	8	N.A.	5	N.A.	N.A.
				2002		13.331	149.920	N.A.	837.460	103.025	223.236	N.A.	N.A.	N.A.	N.A.	49.528	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	4
				2003		30.523	135.880	N.A.	1747.600	133.975	288.075	N.A.	N.A.	N.A.	N.A.	38.934	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		40.000	110.360	N.A.	1143.000	70.470	119.225	N.A.	N.A.	N.A.	N.A.	39.215	2	2	N.A.	2	2	4	N.A.	N.A.	N.A.	N.A.	2
				2009		N.A.	115.403	N.A.	656.375	70.110	102.903	N.A.	N.A.	N.A.	N.A.	36.815	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
LIPID/DRY	N.A.	Lipids	PCTDRY	1991		N.A.	3.263	4.420	5.760	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	5.133	4.800	5.082	N.A.	4.229	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	6.500	8.000	5.300	N.A.	7.100	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	4	N.A.	11	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	4.978	4.215	5.493	N.A.	5.555	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4	4	3	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	11.218	8.738	9.854	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	13.774	8.223	10.026	N.A.	10.558	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	3	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1997		N.A.	8.892	8.526	7.836	N.A.	8.542	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1998		8.250	7.000	5.800	6.400	N.A.	7.375	N.A.	7.200	N.A.	8.600	N.A.	8	5	5	5	N.A.	8	N.A.	5	N.A.	5	N.A.
				1999		11.897	N.A.	6.588	6.133	N.A.	8.151	N.A.	N.A.	N.A.	N.A.	N.A.	8	N.A.	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				2000		N.A.	7.416	N.A.	8.245	N.A.	7.144	N.A.	N.A.	5.106	N.A.	N.A.	N.A.	5	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		9.337	7.143	N.A.	5.316	6.922	7.528	8.654	N.A.	5.468	N.A.	N.A.	8	5	N.A.	5	8	8	8	N.A.	5	N.A.	N.A.
				2002		7.400	6.940	N.A.	7.900	7.900	8.036	N.A.	N.A.	N.A.	N.A.	6.700	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5

Fraction code:SOFT TISSUE

						Mean											N										
					station	CCB	DIL	GL	IH	LNB	OSM	OSR	QBM	RP	SA	SP	CCB	DIL	GL	IH	LNB	OSM	OSR	QBM	RP	SA	SP
Group Id	Abbrev	Descr	Unit code	Year																							
				2003		10.328	7.519	N.A.	6.643	10.110	8.767	N.A.	N.A.	N.A.	N.A.	9.433	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		8.502	7.904	N.A.	6.096	9.245	8.040	N.A.	N.A.	N.A.	N.A.	8.703	6	7	N.A.	7	6	12	N.A.	N.A.	N.A.	N.A.	7
				2009		N.A.	6.938	N.A.	8.225	8.473	7.643	N.A.	N.A.	N.A.	N.A.	6.805	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
		Percent weight of the sample which is dry	PCT	1991		N.A.	12.950	11.000	11.160	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	12.175	14.260	9.380	N.A.	15.763	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	14.360	11.860	10.725	N.A.	18.309	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	4	N.A.	11	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	12.975	13.775	13.600	N.A.	16.725	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4	4	3	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	11.900	11.580	13.100	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.
				1996		N.A.	13.058	12.503	14.984	N.A.	17.785	N.A.	N.A.	N.A.	17.830	N.A.	N.A.	10	3	8	N.A.	10	N.A.	N.A.	N.A.	5	N.A.
				1997		N.A.	14.390	17.120	15.515	N.A.	17.680	N.A.	N.A.	N.A.	22.130	N.A.	N.A.	10	5	10	N.A.	10	N.A.	N.A.	N.A.	5	N.A.
				1998		19.355	15.615	11.146	13.081	N.A.	16.342	N.A.	15.608	N.A.	14.476	N.A.	16	10	5	10	N.A.	16	N.A.	10	N.A.	10	N.A.
				1999		21.659	N.A.	12.842	15.418	N.A.	19.614	N.A.	N.A.	N.A.	19.860	N.A.	16	N.A.	5	10	N.A.	16	N.A.	N.A.	N.A.	5	N.A.
				2000		N.A.	12.354	N.A.	9.997	N.A.	13.303	N.A.	N.A.	9.390	N.A.	N.A.	N.A.	10	N.A.	10	N.A.	16	N.A.	N.A.	10	N.A.	N.A.
				2001		18.571	13.824	N.A.	9.626	11.984	12.448	14.498	N.A.	8.989	N.A.	N.A.	8	5	N.A.	5	8	16	8	N.A.	5	N.A.	N.A.
				2002		13.533	9.706	N.A.	8.066	12.803	12.877	N.A.	N.A.	N.A.	N.A.	10.612	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5
				2003		17.725	11.750	N.A.	7.990	16.995	13.104	N.A.	N.A.	N.A.	N.A.	13.404	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		15.260	13.334	N.A.	9.816	15.658	13.879	N.A.	N.A.	N.A.	N.A.	10.970	6	7	N.A.	7	6	12	N.A.	N.A.	N.A.	N.A.	7
				2009		N.A.	10.335	N.A.	9.330	13.825	10.183	N.A.	N.A.	N.A.	N.A.	13.675	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
LMW-PAH	N.A.	Total NOAA LMW PAH	ng/g	1991		N.A.	528.250	60.200	209.000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	4	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	426.013	70.140	194.780	N.A.	27.329	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	5	5	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	163.667	16.167	92.000	N.A.	33.250	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	6	6	6	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	203.667	71.667	53.333	N.A.	14.714	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	55.450	26.100	125.300	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	226.680	138.700	189.620	N.A.	41.480	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	3	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1997		N.A.	83.460	65.700	147.500	N.A.	40.748	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1998		19.001	63.402	104.286	181.760	N.A.	18.753	N.A.	47.598	N.A.	65.760	N.A.	8	5	5	5	N.A.	8	N.A.	5	N.A.	5	N.A.
				1999		33.659	N.A.	184.800	175.680	N.A.	21.464	N.A.	N.A.	N.A.	N.A.	N.A.	8	N.A.	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				2000		N.A.	119.465	N.A.	277.200	N.A.	106.416	N.A.	N.A.	105.900	N.A.	N.A.	N.A.	4	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		23.805	38.258	N.A.	114.318	28.868	25.793	31.688	N.A.	23.782	N.A.	N.A.	8	5	N.A.	5	8	8	8	N.A.	5	N.A.	N.A.
				2002		4.537	36.298	N.A.	80.288	20.783	33.344	N.A.	N.A.	N.A.	N.A.	24.748	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	4
				2003		13.535	29.326	N.A.	172.680	23.133	32.848	N.A.	N.A.	N.A.	N.A.	25.646	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		15.725	26.320	N.A.	67.270	22.515	33.615	N.A.	N.A.	N.A.	N.A.	21.180	2	2	N.A.	2	2	4	N.A.	N.A.	N.A.	N.A.	2
				2009		N.A.	50.200	N.A.	119.050	43.035	34.225	N.A.	N.A.	N.A.	N.A.	26.515	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
METAL	Cu	Copper	ug/g	1991		N.A.	9.250	8.100	12.740	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Hg	Mercury	ug/g	1993		N.A.	0.183	0.386	N.A.	N.A.	0.099	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	N.A.	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	0.208	0.185	0.163	N.A.	0.131	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4	3	3	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	0.061	N.A.	0.079	N.A.	N.A.	N.A.	N.A.	N.A.	0.065	N.A.	N.A.	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.	5	N.A.
				1996		N.A.	0.154	N.A.	0.126	N.A.	0.146	N.A.	N.A.	N.A.	0.131	N.A.	N.A.	5	N.A.	3	N.A.	5	N.A.	N.A.	N.A.	5	N.A.
				1997		N.A.	0.063	N.A.	0.320	N.A.	0.104	N.A.	N.A.	N.A.	0.173	N.A.	N.A.	5	N.A.	5	N.A.	5	N.A.	N.A.	N.A.	5	N.A.
				1998		0.070	0.098	N.A.	0.110	N.A.	0.089	N.A.	0.104	N.A.	0.098	N.A.	8	5	N.A.	5	N.A.	8	N.A.	5	N.A.	5	N.A.
				1999		0.053	N.A.	N.A.	0.099	N.A.	0.063	N.A.	N.A.	N.A.	0.075	N.A.	8	N.A.	N.A.	5	N.A.	8	N.A.	N.A.	N.A.	5	N.A.
				2000		N.A.	0.162	N.A.	0.178	N.A.	0.114	N.A.	N.A.	0.120	N.A.	N.A.	N.A.	5	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		0.099	0.127	N.A.	0.203	N.A.	0.141	0.136	N.A.	0.150	N.A.	N.A.	8	5	N.A.	5	N.A.	8	8	N.A.	5	N.A.	N.A.
				2002		0.120	0.183	N.A.	0.195	0.138	0.175	N.A.	N.A.	N.A.	N.A.	0.157	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5
				2003		0.115	0.130	N.A.	0.152	0.112	0.132	N.A.	N.A.	N.A.	N.A.	0.118	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		0.088	0.084	N.A.	0.106	0.073	0.080	N.A.	N.A.	N.A.	N.A.	0.084	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2009		N.A.	0.137	N.A.	0.165	0.100	0.139	N.A.	N.A.	N.A.	N.A.	0.102	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
	Pb	Lead	ug/g	1991		N.A.	5.850	5.770	6.400	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	5.880	5.190	N.A.	N.A.	3.713	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	N.A.	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	9.125	9.350	6.667	N.A.	4.800	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4	3	3	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	8.402	6.048	8.536	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	6.272	N.A.	9.359	N.A.	1.567	N.A.	N.A.	N.A.	2.857	N.A.	N.A.	5	N.A.	3	N.A.	5	N.A.	N.A.	N.A.	5	N.A.
				1997		N.A.	7.831	N.A.	9.893	N.A.	2.093	N.A.	N.A.	N.A.	2.436	N.A.	N.A.	5	N.A.	5	N.A.	5	N.A.	N.A.	N.A.	5	N.A.
				1998		1.948	3.470	N.A.	4.092	N.A.	2.135	N.A.	3.288	N.A.	2.852	N.A.	8	5	N.A.	5	N.A.	8	N.A.	5	N.A.	5	N.A.

Fraction code:SOFT TISSUE

						Mean											N										
					station	CCB	DIL	GL	IH	LNB	OSM	OSR	QBM	RP	SA	SP	CCB	DIL	GL	IH	LNB	OSM	OSR	QBM	RP	SA	SP
Group Id	Abbrev	Descr	Unit code	Year																							
				1999		1.261	N.A.	N.A.	4.694	N.A.	1.089	N.A.	N.A.	N.A.	1.560	N.A.	8	N.A.	N.A.	5	N.A.	8	N.A.	N.A.	N.A.	5	N.A.
				2000		N.A.	6.929	N.A.	13.204	N.A.	0.943	N.A.	N.A.	1.515	N.A.	N.A.	N.A.	5	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		1.751	3.502	N.A.	10.056	N.A.	1.864	1.929	N.A.	1.906	N.A.	N.A.	8	5	N.A.	5	N.A.	8	8	N.A.	5	N.A.	N.A.
				2002		1.540	5.156	N.A.	8.036	1.690	2.598	N.A.	N.A.	N.A.	N.A.	2.376	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5
				2003		1.450	2.586	N.A.	9.112	1.463	1.726	N.A.	N.A.	N.A.	N.A.	1.660	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		1.740	3.026	N.A.	3.624	1.655	1.879	N.A.	N.A.	N.A.	N.A.	2.176	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2009		N.A.	1.708	N.A.	1.965	0.958	1.036	N.A.	N.A.	N.A.	N.A.	1.155	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
	Zn	Zinc	ug/g	1991		N.A.	142.875	160.800	219.800	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
PCB	N.A.	Total PCBs	ng/g	1991		N.A.	194.863	61.245	462.040	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	123.769	46.722	639.440	N.A.	34.295	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	264.340	N.A.	480.000	N.A.	89.050	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	0	4	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	157.500	104.050	484.367	N.A.	85.144	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	164.760	88.654	436.020	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	268.680	156.567	532.560	N.A.	98.788	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	3	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1997		N.A.	355.580	131.100	752.660	N.A.	97.346	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1998		48.901	161.340	63.162	460.020	N.A.	58.806	N.A.	271.920	N.A.	79.108	N.A.	8	5	5	5	N.A.	8	N.A.	5	N.A.	5	N.A.
				1999		47.665	N.A.	53.726	491.800	N.A.	36.873	N.A.	N.A.	N.A.	N.A.	N.A.	8	N.A.	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				2000		N.A.	215.260	N.A.	592.320	N.A.	35.490	N.A.	N.A.	9.132	N.A.	N.A.	N.A.	5	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		70.538	219.400	N.A.	398.100	64.305	81.011	93.466	N.A.	18.750	N.A.	N.A.	8	5	N.A.	5	8	8	8	N.A.	5	N.A.	N.A.
				2002		40.558	165.800	N.A.	297.540	54.498	62.735	N.A.	N.A.	N.A.	N.A.	20.472	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5
				2003		41.010	196.520	N.A.	484.300	61.935	65.186	N.A.	N.A.	N.A.	N.A.	15.218	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		47.633	208.720	N.A.	289.560	38.520	32.276	N.A.	N.A.	N.A.	N.A.	17.905	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	7
				2009		N.A.	124.795	N.A.	284.300	54.365	26.231	N.A.	N.A.	N.A.	N.A.	10.952	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
PEST	N.A.	Dieldrin	ng/g	1991		N.A.	2.919	0.785	9.000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	2.664	0.154	6.730	N.A.	1.088	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	3.160	N.A.	4.525	N.A.	2.238	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	0	4	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	10.353	0.727	14.567	N.A.	1.966	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	3.150	1.540	6.940	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	5.600	0.000	9.280	N.A.	1.360	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	3	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1997		N.A.	3.400	2.280	7.140	N.A.	2.020	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1998		2.824	4.096	2.829	7.610	N.A.	2.246	N.A.	5.568	N.A.	5.665	N.A.	8	5	5	5	N.A.	8	N.A.	5	N.A.	5	N.A.
				1999		1.572	N.A.	1.436	9.057	N.A.	1.472	N.A.	N.A.	N.A.	N.A.	N.A.	8	N.A.	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				2000		N.A.	3.548	N.A.	9.013	N.A.	1.739	N.A.	N.A.	0.000	N.A.	N.A.	N.A.	5	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		1.186	1.581	N.A.	2.944	1.566	1.863	3.255	N.A.	0.591	N.A.	N.A.	8	5	N.A.	5	8	8	8	N.A.	5	N.A.	N.A.
				2002		1.642	2.327	N.A.	4.467	1.750	2.065	N.A.	N.A.	N.A.	N.A.	1.385	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5
				2003		1.344	2.452	N.A.	6.941	1.696	1.895	N.A.	N.A.	N.A.	N.A.	1.126	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		0.000	0.000	N.A.	0.000	0.000	0.828	N.A.	N.A.	N.A.	N.A.	0.291	4	5	N.A.	5	4	4	N.A.	N.A.	N.A.	N.A.	7
				2009		N.A.	0.000	N.A.	0.000	0.000	0.000	N.A.	N.A.	N.A.	N.A.	0.000	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4
PEST_NO	N.A.	Total pesticides (without Dieldrin)	ng/g	1991		N.A.	0.000	0.840	0.000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	8	10	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1992		N.A.	0.160	0.000	0.000	N.A.	0.000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	7	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1993		N.A.	4.880	N.A.	16.525	N.A.	0.413	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	0	4	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				1994		N.A.	1.560	4.530	0.000	N.A.	0.479	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	3	3	3	N.A.	7	N.A.	N.A.	N.A.	N.A.	N.A.
				1995		N.A.	1.701	0.896	1.832	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
				1996		N.A.	1.362	1.767	1.740	N.A.	1.702	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	3	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1997		N.A.	0.942	0.598	0.920	N.A.	0.490	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	5	5	5	N.A.	5	N.A.	N.A.	N.A.	N.A.	N.A.
				1998		0.173	0.755	0.419	0.706	N.A.	0.458	N.A.	0.712	N.A.	0.748	N.A.	8	5	5	5	N.A.	8	N.A.	5	N.A.	5	N.A.
				1999		1.069	N.A.	0.823	1.139	N.A.	0.638	N.A.	N.A.	N.A.	N.A.	N.A.	8	N.A.	5	5	N.A.	8	N.A.	N.A.	N.A.	N.A.	N.A.
				2000		N.A.	0.385	N.A.	1.036	N.A.	0.699	N.A.	N.A.	0.000	N.A.	N.A.	N.A.	5	N.A.	5	N.A.	8	N.A.	N.A.	5	N.A.	N.A.
				2001		0.747	0.727	N.A.	0.830	0.630	0.671	1.119	N.A.	0.613	N.A.	N.A.	8	5	N.A.	5	8	8	8	N.A.	5	N.A.	N.A.
				2002		0.696	0.747	N.A.	0.847	0.911	1.121	N.A.	N.A.	N.A.	N.A.	0.822	4	5	N.A.	5	4	11	N.A.	N.A.	N.A.	N.A.	5
				2003		0.785	0.458	N.A.	0.948	0.870	0.741	N.A.	N.A.	N.A.	N.A.	1.058	4	5	N.A.	5	4	8	N.A.	N.A.	N.A.	N.A.	5
				2006		0.000	0.000	N.A.	0.000	0.000	0.668	N.A.	N.A.	N.A.	N.A.	0.199	4	5	N.A.	5	4	4	N.A.	N.A.	N.A.	N.A.	7
				2009		N.A.	0.000	N.A.	0.000	0.000	0.000	N.A.	N.A.	N.A.	N.A.	0.000	N.A.	4	N.A.	4	4	8	N.A.	N.A.	N.A.	N.A.	4

Notes: - NA is used if no data were collected that year or if all results are suspect or under investigation. - Organic contaminants are surrogate-corrected.
- Zero is used for nondetects. - Individual component results are rounded to four significant figures.

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