1993 annual fish and shellfish report

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FINAL REPORT

1993 ANNUAL FISH AND SHELLFISH REPORT

for

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Executive Summary

The Massachusetts Water Resources Authority (MWRA) is implementing Phase I of a long-term monitoring plan for the effluent outfall to be located in Massachusetts Bay. The goal of Phase I monitoring is to provide baseline data that may be used to assess potential environmental impacts of the effluent discharge into Massachusetts Bay and to evaluate compliance with the discharge permit. The overall objective of the fish and shellfish monitoring is to define the baseline of winter flounder and lobster health in terms of the presence of disease, and organic and metal contaminant concentrations in tissues of flounder and lobster.

To achieve the objectives of the fish and shellfish monitoring tasks, winter flounder (*Pleuronectes americanus*) were collected from five sites in Boston Harbor and the Bays: Deer Island Flats, Broad Sound, Nantucket Beach, the Future Outfall Site, and a reference site in Eastern Cape Cod Bay. The Deer Island, Future Outfall, and Eastern Cape Cod Bay sites are core sites for the monitoring study, while Broad Sound and Nantasket Beach are ancillary sites providing information on fish in the general area of the existing Deer Island outfall. Lobsters (*Homarus americanus*) were collected only at the Deer Island, Future Outfall, and Eastern Cape Cod Bay sites. Edible muscle and livers of winter flounder from the three core sites, and the hepatopancreas and tail muscle of lobster were analyzed for contaminants. Histopathological observations of the livers of winter flounder from all five sites were carried out, and some comparisons of the 1993 results with those of previous years were made. Possible relationships between observed lesions and contaminant body burdens were investigated. The issue of migration of the flounder populations in the Harbor and Bays as an aid to interpreting the pathology data is investigated through the use of a stable isotope study. Finally, a statistical power analysis was conducted to determine the level of change in certain measured parameters that can be detected under the present sampling and analysis program.

The mean age and length of the fish collected in 1993 were slightly greater than the mean age and length of the fish collected in 1992. The oldest fish, averaging slightly over five years of age, were collected at Broad Sound, although there was no statistical difference in mean age between the Broad Sound and Nantasket Beach populations. The youngest fish, just over four years of age, were collected at the Future Outfall and Eastern Cape Cod Bay sites. Broad Sound produced the largest fish, but they were not significantly larger than the Nantasket Beach fish. The smallest fish came from the Future Outfall Site, but they were not significantly smaller than those from all other sites except Broad Sound.

There was a decrease from 1992 to 1993 in the severity of fin erosion at all sites except the Eastern Cape Cod Bay site, where the severity of fin erosion increased considerably. The decrease in fin erosion index was particularly large at the Deer Island and Broad Sound sites. Centrotubular hydropic vacuolation, the least severe of the three categories of hydropic vacuolation, occurred in about one half of the flounder from Deer Island and Broad Sound, and in slightly less than one third of the flounder from Nantasket Beach and the Future Outfall Site. Only two of fifty fish collected at the Eastern Cape Cod Bay reference site showed the lesion. Deer Island and Broad Sound flounder also had the highest prevalence of tubular hydropic vacuolation, and were the only fish to have any incidence of focal hydropic vacuolation. This prevalence pattern is generally comparable to what was observed in 1992.

The prevalence of macrophage aggregates and biliary proliferation increased at all sites over what was observed in 1992. Neoplasia was generally absent except for one observation in the liver of a seven-year-old female from Broad Sound. In the context of the available data on winter flounder from Deer Island, the levels of histological change have remained largely unchanged since 1989, persisting at a somewhat lower level than what was observed in 1984, 1987 and 1988.

The results of stable isotope studies indicated that a significant portion of the diet of winter flounder from Deer Island is sewage sludge-derived compared to the other sites, with a recent trend toward a diminishing of the difference. This result can be expected given the cessation of sludge dumping from Deer Island beginning in December 1991. The data also indicate that there was relatively little movement of flounder populations in the area, and that hydropic vacuolation in fish from the sites, other than Deer Island, was not associated with exposure to sewage sludge.

Organic and metal contaminant concentrations were measured in flounder fillet and liver from populations collected at Deer Island, the Future Outfall Site, and in Eastern Cape Cod Bay and in lobster tail muscle and hepatopancreas. The results of flounder fillet tissue analyses showed a significant increase in mercury and dieldrin at Deer Island. Total PCB declined slightly at Deer Island. The most substantial differences between 1992 and 1993 results were the relatively large increases in dieldrin, total chlordane, total DDT, and total PCB at the Future Outfall Site. Slight increases in mercury, dieldrin, and total chlordane concentrations were observed at the Eastern Cape Cod Bay sites(s).

Concentrations of dieldrin, mercury, and total PAH in flounder livers from Deer Island changed little between 1992 and 1993, whereas total chlordane and total PCB declined. Total DDT at Deer Island and the Future Outfall Site rose sharply from concentrations observed in 1992, and dieldrin increased by twofold at the Future Outfall Site. Contaminant concentrations in livers from Eastern Cape Cod Bay fish remained relatively unchanged from 1992 to 1993, except for mercury and total PAH which declined considerably.

Dieldrin, total DDT, total PCB, and total chlordane concentrations increased in lobster tail meat at Deer Island in 1993, whereas mercury decreased. There was little change at the Future Outfall and Eastern Cape Cod Bay sites, except for a moderate decline in total DDT concentrations.

The concentration of dieldrin in lobster hepatopancreas increased at Deer Island, Future Outfall and Eastern Cape Cod Bay sites in 1993, and total chlordane and total PCB increased at Eastern Cape Cod Bay. Total chlordane and total PCB remained at about the 1992 levels at Deer Island and the Future Outfall Site. The largest decrease was observed for total PAH at Deer Island. Mercury concentrations in lobster hepatopancreas at the Future Outfall and Eastern Cape Cod Bay sites were lower in 1993 than in 1992. Copper increased threefold in hepatopancreas tissue from Deer Island lobster, in contrast to cadmium which decreased tenfold. Chromium also decreased at the three sampling sites, and lead decreased at Eastern Cape Cod Bay.

The ability to detect changes in the contaminant concentrations in important commercial fish and shellfish species is a key issue in the monitoring program. Chemical analysis of individual fish or shellfish samples collected in 1993 for demonstrated that the variability (as the coefficient of variation) in Massachusetts Bay was approximately $\pm$ 30 to 120% of the site mean. This variability is consistent with previously published results for such measurements in marine organisms. Statistical power analysis demonstrated that the change in contaminant concentrations that can be detected in this system ranges from $\approx$50 to $\approx$100% when 10 individual organisms are included in the analysis. The

detectable change also depends on the specific tissue type and contaminant being measured. The concentrations of contaminants in flounder and lobster were substantially below applicable FDA Action Limits. Only mercury in flounder fillets, and total PCB in flounder fillets and lobster hepatopancreas were greater than 10% of the FDA Action Limits. For total PCB in lobster hepatopancreas, the mean site values were within 20 to 30% of the FDA Action Limits and can reach this limit in individual organisms. Generally, analysis of 10 individual organisms provided the ability to detect change well before the tissue concentrations approach 50% of the FDA Action Limits. Thus, the need to detect small changes ($< 10\%$) in contaminant concentrations is not scientifically warranted. Furthermore, sample compositing can provide a more robust ability to detect change at lower cost than analysis of individuals. Thus, compositing of tissue samples is recommended for the MWRA Harbor and Outfall Monitoring Program.

1.0 INTRODUCTION

The Massachusetts Water Resources Authority (MWRA) is implementing Phase I of a long-term monitoring plan (MWRA, 1991) for the MWRA effluent outfall that will be located in Massachusetts Bay. The goal of Phase I monitoring is to provide baseline data that may be used to assess potential environmental impacts of effluent discharge into Massachusetts Bay and to evaluate compliance with the discharge permit. The overall objective of the fish and shellfish monitoring is to define the baseline of winter flounder and lobster health in terms of the presence of disease (external and internal), and organic and inorganic (metal) contaminant concentrations in the liver (winter flounder), hepatopancreas (lobster), and edible tissue (winter flounder and lobster). With a sound baseline characterization of the health of winter flounder and lobster in Boston Harbor and the Bays, it should be possible to observe potential changes resulting from the relocation of the outfall discharge.

To achieve the objectives of the fish and shellfish monitoring tasks, winter flounder (*Pleuronectes americanus*) were collected from five sites in Boston Harbor and the Bays: Deer Island Flats, Broad Sound, Nantasket Beach, the Future Outfall Site, and a reference site in Eastern Cape Cod Bay. The Deer Island, Future Outfall, and Eastern Cape Cod Bay sites are core sites for the monitoring study, while Broad Sound and Nantasket Beach are ancillary sites providing information on fish in the general area of the existing Deer Island outfall. Lobsters (*Homarus americanus*) were collected only at the Deer Island, Future Outfall, and Eastern Cape Cod Bay sites. Edible muscle and livers of winter flounder from the core sites, and the hepatopancreas and tail muscle of lobster were analyzed for contaminants. Histopathological observations of the livers of the winter flounder from all sites were carried out, and some comparisons of the 1993 results with those of previous years were made. Possible relationships between observed lesions and contaminant body burdens were investigated. The issue of migration of the flounder populations in the Harbor and Bays areas, as an aid to interpreting the pathology data, is discussed in the report through the use of a stable isotope study. Finally, a statistical power analysis was conducted to determine the level of change in certain measured parameters that can be detected under the present program.

The incidence of toxic chemical-associated liver lesions in winter flounder from Deer Island Flats was noted by Murchelano and Wolke in 1984 (Murchelano and Wolke, 1985). Annual monitoring of the lesions in the Harbor has been ongoing since 1987 (Moore, 1991; Moore *et al.*, 1992; Moore and Stegeman, 1993). Four additional locations in Massachusetts and Cape Cod Bays were added in 1991 (Moore *et al.*, 1992). The reason for pursuing these studies further is to build an internally consistent baseline data set on winter flounder liver pathology for the Deer Island and Future Outfall sites, in addition to other sites in the region. This is necessary because of the current biological effects of the existing outfall at Deer Island, and the need to understand and document the change in biological impact on this ecosystem of recent and projected changes in sewage management by MWRA. These changes include cessation of sludge dumping at the beginning of 1992, planned initiation of primary and potentially secondary treatment, and the relocation of the outfall to the future site scheduled to occur in 1995.

The rationale and necessary background information on the biology and toxicology of winter flounder have been reported previously (Moore *et al.*, 1992; Moore and Stegeman, 1993). In these previous

studies, hydropic vacuolation in the liver of winter flounder was shown to be detectable at all stations sampled, but substantially more prevalent at the contaminated near-urban sites. In contrast, liver neoplasia was a rare lesion and absent from all but the most contaminated sites. Moore (1991) has shown a close association between hydropic vacuolation and liver neoplasms in winter flounder, and Johnson *et al.* (1992) have demonstrated that hydropic vacuolation was closely correlated with a suite of chemical contaminants, particularly chlorinated hydrocarbons. Hydropic vacuolation can be regarded as a harbinger of neoplastic risk, given adequate duration and level of exposure to carcinogens. Because, at this latitude, winter flounder apparently do not migrate substantially (Howe and Coates, 1975), observations of hydropic vacuolation prevalence, given age-specific analysis, and between-year consistency in histopathological interpretation, are an appropriate long-term monitor for the effects of benthic chemical contaminants on winter flounder in the Boston Harbor area. Thus, hydropic vacuolation is emphasized in this report.

As indicated above, the prevalence of hydropic vacuolation is closely correlated with hepatic concentrations of chlorinated hydrocarbons. Hydropic vacuolation decreased with increasing distance from major municipal sewage outfalls (Johnson *et al.*, 1992). However, there was a surprisingly high prevalence of hydropic vacuolation at the Future Outfall Site, sampled at 6.5 miles east northeast of Deer Island (Moore *et al.*, 1992; Moore and Stegeman, 1993). This prevalence was higher than it would have been predicted on the basis of known concentrations of sediment contaminants shown by Boehm (1984) in that area. Possible explanations for this include prior migration of the fish sampled at the Future Outfall Site into contaminated urban areas for part of preceding years, or exposure to offshore contaminants from other known or unknown more highly contaminated areas. Known offshore areas of increased contamination include the Massachusetts Bay Disposal Site (Shea, *et al.*, 1991; Shea and Kelly, 1992). Unknown areas would be any "hotspot" not detected by published survey data, that may have resulted from shortdumping or other poorly documented activities. A stable isotope study was designed to establish the extent to which winter flounder from each station surveyed had been feeding on sewage-derived organic matter. This would enable an evaluation of the possibility that winter flounder caught at the Future Outfall Site have been exposed to sewage sludge discharged at other sites along the Massachusetts Bay coast. This would aid our interpretation of past, current, or future monitoring data on the biological effects of chemical contaminants in relation to ongoing management changes in sewage disposal.

One of the objectives of the Harbor and Outfall Monitoring Study is to determine the level of change in chemical concentrations that can be detected in fish and shellfish. Preliminary information on the level of change that can be detected was derived from the chemical concentrations measured in flounder and lobster sampled in 1992 (Hunt and Baptiste, 1994). Tissue samples from three individual organisms per sampling site (four types of tissue in total) were analyzed. Estimates of the change in chemical concentrations that could be detected using these data were made using the concept of reverse power analysis (Peterman, 1989). This concept is relevant to environmental management, particularly if the maximum probability of a Type II error that can be (will be) tolerated can be stated. Peterman (1989) suggests that 0.80 is the minimum power that should be achieved for credible results. This level is consistent with guidance provided in EPA (1987) for the 301(h) monitoring program. To further address the detectability question, a similar power analysis was applied to chemical data obtained from the 1993 fish and shellfish sampling.

2.0 METHODS

2.1 Stations and Sampling

The sampling sites for the flounder and lobster collections are shown in Figure 1. Five sites were sampled for flounder: Deer Island Flats (Boston Harbor), off Nantasket Beach, Broad Sound, the Future Outfall Site, and Eastern Cape Cod Bay. Table 1 provides the trawl data (stations, positions, etc.) for the flounder collections. Lobster traps were set on Deer Island Flats, at the Future Outfall Site, and in Eastern Cape Cod Bay in the same general locations as the flounder collection sites.

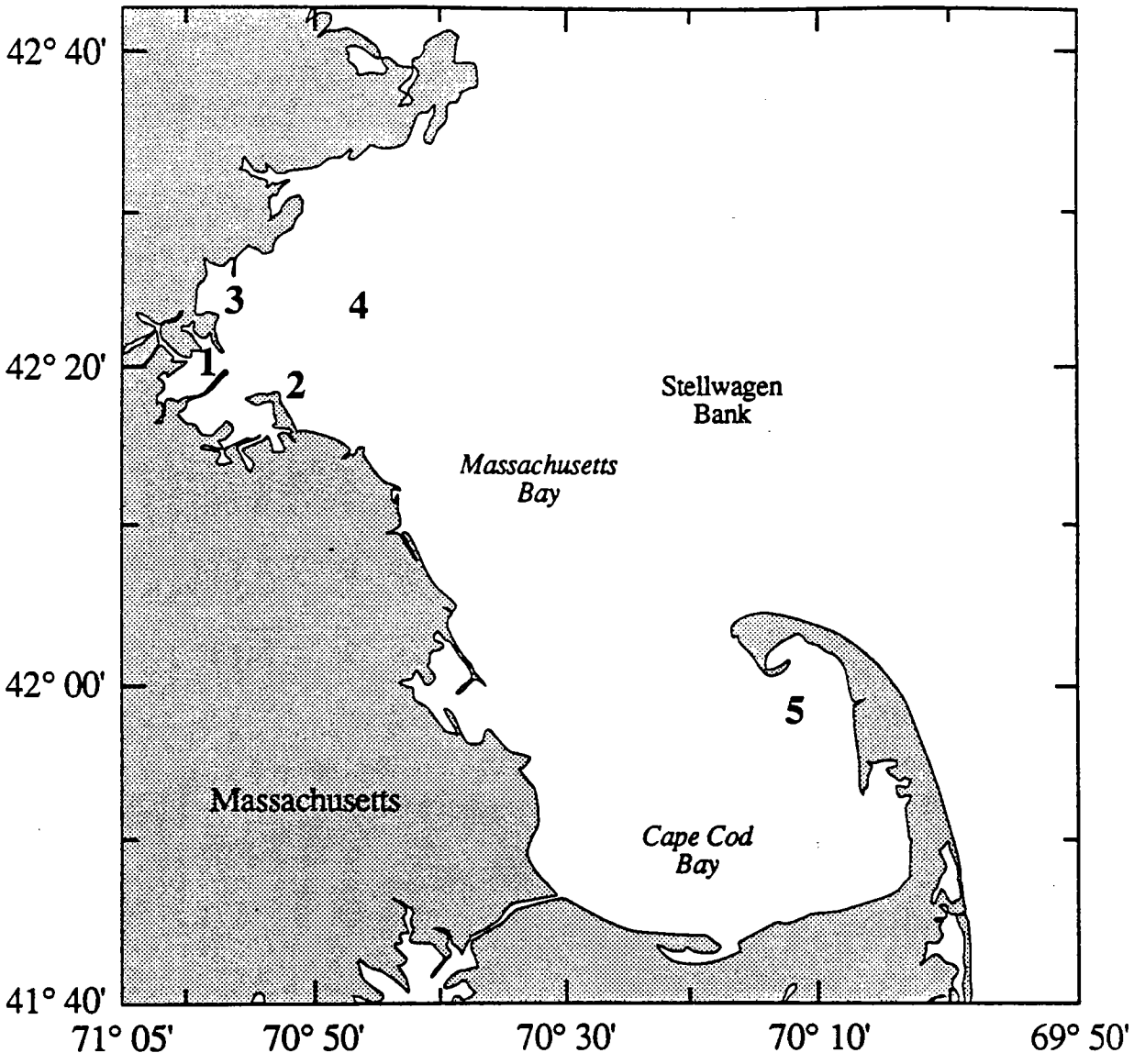
2.2 Fish Collections

Sampling for winter flounder was conducted from April 13 through April 15, 1993 (West and Hillman, 1993). An additional attempt at collection was made on June 23 at the Deer Island site. At each of the five designated sampling sites, otter-trawl tows were conducted in an attempt to collect 50 sexually mature (4-5 years old) winter flounder. The F/V *Odessa*, owned and operated by William Crossen, served as the platform for the collections. Fishing gear comprised a Western Atlantic trawl, with a 4-seam chain sweep, 53-foot head rope, 83-foot rope, 10-fathom legs, 10-fathom ground cables, 400-pound Bison steel doors, and 25-fathom of main wire for shallow stations, with more for the deep stations. Trawling speed was approximately 2 knots. Fish were placed in a livebox prior to measurement and dissection for pathology and chemistry.

Five male and five female specimens were collected at each site for histopathological and chemical analysis, except for the site of the future outfall where three females and seven males were collected. In addition to these 10 fish from each site, and additional 40 flounder were collected from each site for histopathological analysis. At Deer Island, only 19 additional flounder were collected. The additional collection at Deer Island on June 23 was not accomplished because of weather and excess lobster gear in the area. All specimens between 30 and 50 cm in length were retained. The rest were returned alive to the environment. No fish >50 cm were caught.

Fish to be used for chemical analysis as well as histopathology were placed in seawater in coolers labeled with the date and the site at which the fish were collected. Fish used only for histopathology were processed on board the collecting vessel.

Fish processed on board the vessel were each assigned a sample identification number (pathology accession number) that was unique to the site and date. Each fish was examined grossly for external lesions, and the general external conditions were noted. All specimens were weighed on a Chatillon fish scale and the standard and fork length were determined. A sample of scales for age analysis was taken from the dorsum of the caudal peduncle of each specimen kept. The scales were placed in scale envelopes, labeled with the appropriate sample information, and subsequently delivered to Jay Burnett, National Marine Fisheries Service, Woods Hole, Massachusetts, for age determination.



Key:
1 — Deer Island Flats
2 — Off Nantasket Beach
3 — Broad Sound
4 — The site of the future effluent outfall
5 — Eastern Cape Cod Bay

Figure 1. Sampling Stations for Winter Flounder and Lobster During the 1993 Fish and Shellfish Collection Period

Table 1. **Summary of Trawl Data for Winter Flounder Collections made in April 1993.**

Station	Trawl Date	Start Time (EST)	Latitude	Longitude	End Time (EST)	Latitude	Longitude	Bottom Time (Minutes)
FI1	4/13/93	07:57	42 20' 54'' W	70 58' 16'' N	08:22	42 20' 58'' W	70 58' 31'' N	25
FI1	4/13/93	08:34	42 20' 98'' W	70 58' 41'' N	09:35	42 20' 54'' W	70 58' 35'' N	61
FI1	4/13/93	09:50	42 21' 00'' W	70 58' 36'' N	11:00	42 21' 00'' W	70 58' 36'' N	70
FI1	4/13/93	11:13	42 21' 01'' W	70 58' 36'' N	11:54	42 20' 57'' W	70 58' 39'' N	41
FI2	4/14/93	12:32	42 17' 25'' W	70 51' 24'' N	12:54	42 17' 36'' W	70 51' 08'' N	22
FI2	4/14/93	13:03	42 17' 36'' W	70 51' 15'' N	13:14	42 17' 33'' W	70 51' 49'' N	11
FI3	4/13/93	13:06	42 24' 43'' W	70 57' 38'' N	13:25	42 24' 04'' W	70 57' 38'' N	19
FI3	4/13/93	13:35	42 23' 58'' W	70 57' 29'' N	14:34	42 24' 24'' W	70 57' 12'' N	59
FI3	4/13/93	14:51	42 22' 56'' W	70 56' 22'' N	15:15	42 24' 13'' W	70 57' 24'' N	24
FI4	4/14/93	08:33	42 23' 16'' W	70 49' 47'' N	08:53	42 23' 19'' W	70 49' 36'' N	20
FI4	4/14/93	09:22	42 23' 04'' W	70 49' 48'' N	09:55	42 22' 58'' W	70 49' 57'' N	33
FI4	4/14/93	10:18	42 23' 04'' W	70 49' 45'' N	10:46	42 23' 23'' W	70 49' 52'' N	28
FI5	4/15/93	10:22	41 56' 23'' W	70 07' 18'' N	10:50	41 57' 31'' W	70 07' 04'' N	28
FI5	4/15/93	11:01	41 57' 33'' W	70 06' 52'' N	11:19	41 57' 05'' W	70 06' 55'' N	18
FI5	4/15/93	11:34	41 56' 53'' W	70 07' 13'' N	11:53	41 57' 43'' W	70 07' 16'' N	19

Some of the scales were also used for stable isotope determination. The heads of fish greater than 35 cm were frozen for future removal of the otoliths, if age determination from the scales needed verification.

Fish used for chemical analysis were returned alive to the Battelle Ocean Sciences laboratory in Duxbury, Massachusetts in the labeled coolers and immediately processed for analysis. Each fish was assigned an identification number in the same manner as those fish processed on board the collecting vessel, and processed similarly. The accession number was then used for all parts of the fish that were to undergo chemical and histopathological analysis.

2.3 Lobster Collections

A string of five lobster traps (collectively referred to as a lobster trawl) was set at the Deer Island, Future Outfall, and Eastern Cape Cod Bay sites in April 1993 (Figure 1) in an attempt to collect 10 commercially harvestable lobsters (carapace length >3.25 inches) from each site. The traps, set over a two- to four-day period, proved relatively unsuccessful and provided only one lobster (from the Deer Island site) in April.

Lobster collections were attempted again in August 1993. Five traps were deployed at each of the trace sites. Two legal-sized lobsters were captured in the traps at Deer Island and the Future Outfall site. Because no lobsters were taken at the Eastern Cape Cod Bay site, arrangements were made to accompany a commercial lobsterman in the Eastern Cape Cod Bay area and to purchase 10 lobsters. This arrangement produced 10 lobsters from near the established sampling region in September 1993.

The total number of lobsters collected for chemical analysis in 1993 included three from Deer Island, two from the Future Outfall Site, and ten from Eastern Cape Cod Bay. All lobsters were grossly inspected for lesions or other aberrations, and returned alive to the laboratory in Duxbury where they were frozen until processed for chemical analysis.

2.4 Dissection of the Fish

Fish to be used only for histopathology were processed on board the collecting vessel. They were killed by cervical section. An oval incision was made in the ventral body wall overlying the liver and anterior ventral gonad. The gonads were examined and their color and sex recorded. Gonads were either white and triangular in males, pink and elongated caudally in females, or small and blue-gray in immature fish. Livers were removed by severance of the peritoneal attachments, and examined grossly for color and abnormalities. Each liver was completely submerged in a 10% neutral-buffered formalin solution in a 140-ml plastic container. The formalized livers were returned to the laboratory in Duxbury and processed for histological sectioning. The tissues remained in the formalin until processed, a period of not more than two weeks. At the time of dissection of the livers, stomachs were also removed and frozen for subsequent diet analysis and stable isotope determination.

Because it was unlikely that contaminant-free conditions would be found on board the collecting vessel, the fish collected for chemical analysis were returned to the Battelle chemistry laboratory for organ dissection. Tissue processing was conducted in a Class-100 clean room. Livers to be used jointly for histopathology and chemistry were dissected using a precleaned [*i.e.*, rinsed sequentially with 10% HCl, Milli-Q (18 megohm) water, acetone, DCM, and hexane] scalpel. Sections of the liver, approximately 4 to 6 mm thick, were cut transversely from three equidistant areas (A, B, and C) of the liver and placed in cassettes numbered to correspond with the sampling information. These sections were processed for histopathology. The remaining liver tissue was pooled for subsequent chemical analyses. Edible muscle tissue was also removed from each fish. A precleaned titanium knife was used to remove the fillets (muscle) from the flounder and the skin from the fillets. A composite sample of the edible muscle of each fish was prepared using approximately equal masses of top and bottom tissue. For analysis of contaminants in the flounders' edible tissues, individual fish were analyzed, rather than the pooled samples as indicated in the Combined Work/Quality Assurance Project Plan (Hillman *et al.*, 1993). Flounder liver tissue was pooled for each site.

The tissues were placed in a precleaned vessel (cleaned for organic and inorganic analyses) and homogenized with a titanium tissuemiser; subsequently, the sample was split for trace metals and organic contaminant analyses. Edible tissues from each fish were placed in a sample container clearly identified with a unique sample identifier (pathology laboratory accession number for the flounder liver) that allowed the sample to be traced from collection through analysis to reporting.

At the time of dissection of the livers, stomachs were also removed and frozen for subsequent diet analysis and stable isotope determination.

2.5 Dissection of Lobster

Lobsters for chemical analysis were thawed, and ventral incisions were made in the carapace and tail. The hepatopancreas and a piece of tail muscle were removed for analysis and treated as described above for the flounder. The hepatopancreas and tail meat of individual lobsters were analyzed for chemical contaminants.

2.6 Histological Processing

Livers that were fixed on the collecting vessel were removed from the fixative after about 24 hours, and rinsed overnight in running tap water. Sections, approximately 4 to 6 mm thick, were cut transversely from three equidistant areas (A, B, and C) of the liver and placed in cassettes numbered to correspond with the sampling information. The tissues were embedded in paraffin, and two 5-μm-thick sections (1 and 2), from each of the three transversely cut portions, were cut and stained with hematoxylin and eosin by standard methods (see Hillman *et al.*, 1993). Hillman read slides A1, B1, and C1 and Moore read slides A2, B2, and C2.

2.7 Histological Analysis

After an initial examination of the material, the prevalence and severity of the following lesions, which have been described and illustrated in detail elsewhere (Moore, 1991), were recorded:

1. Hydropic vacuolation, seen in three forms:

    a. Centrotubular vacuolation—isolated groups of 1-2 vacuolated cells in the center of the hepatic tubule.

    b. Tubular vacuolation—linear arrays of vacuolated cells, filling the hepatic tubule, often extending into biliary duct structures.

    c. Focal vacuolation—foci of thirty to several hundred contiguous vacuolated cells.

2. Macrophage aggregation—circular golden-brown cellular masses, often associated with fibrotic tracts, bile ducts, and blood vessels.

3. Biliary duct proliferation—branching ducts, often ensheathed by fibrosis.

4. Neoplasms—focal, often grossly visible areas of cells fulfilling established criteria for neoplasia in this species (Moore, 1991).

5. Balloon hepatocytes—an idiopathic lesion in which the hepatocytes become swollen by a large vacuole that displaces the nucleus. The vacuole often contains a small round body with basophilic components. The presence of these cells in the liver is often accompanied by a variety of pathological conditions including necrotic foci, loss of distinction of hepatocellular boundaries, cytomegaly, foci of basophilic hepatocytes, and foci of cellular alteration. The lesion is possibly a manifestation of apoptosis (M. Myers, J. Fournie, personal communication).

The severity of each lesion was scored as follows: histological slides were examined under bright field illumination at 25 x, 100 x, and 200 x using a Zeiss Photomicroscope (REH) or a Zeiss Axioskop (MJM). For each slide, each lesion was scored by examining the whole section at 25 x, and at least five views at 100 x and 200 x. Each lesion was scored from 0 - 4, 0 = absent, 1 = minor, 2 = moderate, 3 = severe, and 4 = extreme. Lesion indices were calculated as the mean scores for a particular lesion at a given site. The result of a statistical analysis (Appendix A) indicated no difference in scoring between the two individuals involved in reading the slides.

To allow comparison of 1993 data with those from previous years, the prevalence of each lesion was also calculated from each site. These data were derived from the histopathological indices by assigning each fish with a lesion score of 1 or more as having the lesion present. This approach was used previously (Moore and Stegeman, 1993).

2.8 Stable Isotope Determination

The use of stable isotopes in ecosystem studies was reviewed by Peterson and Fry (1987) and, in particular, the use of stable isotopes as indicators of sewage uptake by marine organisms has been described both in coastal (Raucy *et al.*, 1989) and deep-sea (Van Dover *et al.*, 1992; Hunt *et al.*, 1994) systems. The stable isotope approach is based on the observation that organic matter derived from marine phytoplankton has a significantly heavier ratio of isotopes, such as ^{13}C:^{12}C, ^{15}N:^{14}N, and ^{35}S:^{34}S, than organic matter derived from terrestrial plants. By convention, the ∂ notation to report these ratios is as follows:

$$\partial X = \{(R_{sample}/R_{standard})-1\} \cdot 10^3 \text{ ‰}$$

where $X = {}^{13}C$, ^{15}N, or ^{35}S

$R = {}^{13}C$:^{12}C, ^{15}N:^{14}N, or ^{35}S:^{34}S.

International reference standards are available for each element of interest. The isotope ratios are affected by both food source, and cycling within organisms and sediment. Nitrogen values are known to increase by 3‰ with each level in a food chain (Peterson and Fry, 1987). However, within a given ecosystem, it is often possible to demonstrate significant differences attributable to major effects of concern, such as the impact of sewage sludge as a food source.

Scale samples, from winter flounder archived for age analysis, were selected for analysis of sulfur (S), carbon (C), and nitrogen (N) stable isotope ratios. Samples were selected to maximize the coverage of stations and sampling times. Station locations and sampling dates have been previously reported for 1988-1992 samples (Moore, 1991; Moore *et al.*, 1992; Moore and Stegeman, 1993). Samples from those previous studies were selected from sample archives maintained in the laboratory of John Stegeman at Woods Hole Oceanographic Institution (WHOI). All animals analyzed were three- and four-year-old females, with the exception of the 1991 Broad Sound archived sample, which lacked enough animals of that age; in this case, five- and 6-year-old samples were also included.

Samples for sulfur analysis were taken as pools of four to six scales per animal from all available three- and 4-year-old samples per station per time point. This resulted in each pool representing between 25 and 40 fish. Pooling was necessary to generate sufficient sample mass for the sulfur technique.

Samples for carbon and nitrogen included eight to ten scales from each of three individual animals from each station and each time point analyzed using three- and four-year-old females.

Diet samples collected in 1993 were frozen in the field, returned to the WHOI laboratory, where they were thawed, sorted into broad taxa, including crustacea, polychaetes, polychaete tubes, nematodes, coelenterates, bivalves, and plant material, and dried at 60°C overnight. Pooled crustacean, polychaete, and coelenterate subsamples from two fish from each of four stations were analyzed for C, N, and S isotope ratios. A single sample archived from 1988 was also analyzed.

Samples for sulfur analysis were rinsed in deionized water ten times before drying at 60°C overnight. Sulfur analyses were conducted by the Ecosystems Center, Marine Biological Laboratory, Woods Hole. Samples were combusted with KNO_3 using a sealed tube technique, digested with 0.1 N HCl, and precipitated as $BaSO_4$ with $BaCl_2$. $BaSO_4$ was decomposed to SO_2 with V_2O_5 and the SO_2 was

analyzed on the MAT 251 gas isotope ratio mass spectrometer. Carbon and nitrogen analyses were conducted by the Stable Isotope Laboratory, Department of Biology, Boston University, using a Finnigan Delta-S isotope ratio mass spectrometer with a Heraeus carbon-nitrogen analyzer and a Finnigan CR box for cryogenic separation of gases. Each sample was combusted at 1000°C, combustion products were then separated from the helium stream, and CO_2 and N_2 were analyzed by the mass spectrometer. Data were compared to known international standards. Daily method standards and sample replicates were run to ensure data quality. Typically, precision was within 0.1‰.

2.9 Chemical Analysis

Fish and lobster tissue collected in 1993 from Deer Island Flats, Future Outfall Site, and Eastern Cape Cod Bay were analyzed for chemical contaminants. Contaminants in flounder from Broad Sound and Nantasket Beach were not determined because of budget limitations. Contaminant concentrations were measured in 29 individual flounder muscle tissue samples (the tissues of one fish were apparently lost after the liver was removed), 15 individual lobster muscle tissue samples, 15 lobster hepatopancreas samples, and in 3 composited flounder liver samples. Liver samples were analyzed for organic contaminants listed in Table 2 and for mercury. Muscle tissue was analyzed for the organic contaminants except PAHs. The lobster hepatopancreas samples were also analyzed for seven additional metals: silver, cadmium, chromium, copper, nickel, lead, and zinc. Tissues to be analyzed were divided between the organics and metals laboratories, although the division was not equal because the organic analyses require more material.

2.9.1 Organic Analyses

Tissue samples were serially extracted for PAH, chlorinated pesticides, and PCB following methods developed by Battelle in support of the NOAA Status & Trends Mussel Watch Project (Peven and Uhler, 1993). Briefly, an aliquot of homogenized tissue was serially extracted with dichloromethane (DCM) and sodium sulfate using a Teckmar tissuemizer. An aliquot of the original sample was removed for dry weight determination. The sample was weighed in a Teflon extraction jar and spiked with the appropriate surrogate internal standards. Sodium sulfate and solvent were added, and the sample was macerated for 2 min and centrifuged. The solvent extract was decanted into an Erlenmeyer flask. After each extraction (total of two homogenizations and a third shake by hand), the centrifuge solvent was combined in the flask. A 10-mL aliquot of the combined extracts was removed for lipid weight determination (Peven, 1993), and sodium sulfate was added to the extract in the flask. After approximately 30 min, the contents of the Erlenmeyer flask were

Table 2. Analytes Included in Tissue Chemistry Analyses.

Trace Metals[a]
- Ag Silver
- Cd Cadmium
- Cr Chromium
- Cu Copper
- Hg Mercury[b]
- Ni Nickel
- Pb Lead
- Zn Zinc

Polychlorinated biphenyls (PCBs)[c]
- 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]
- naphthalene
- C_1-naphthalenes
- C_2-naphthalenes
- C_3-naphthalenes
- C_4-naphthalenes
- acenaphthylene
- acenaphthene
- fluorene
- C_1-fluorenes
- C_2-fluorenes
- C_3-fluorenes

Polynuclear Aromatic Hydrocarbons (PAHs) (continued)
- anthracene
- phenanthrene
- 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
- 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
- benzo[*g,h,i*]perylene
- dibenz[*a,h*]anthracene
- indeno[1,2,3-*c,d*]pyrene
- perylene
- biphenyl
- benzo[*e*]pyrene
- dibenzofuran

Pesticides[c]
- hexachlorobenzene
- lindane
- heptachlor
- aldrin
- endrin
- heptachlorepoxide
- alpha-chlordane
- trans-Nonachlor
- dieldrin
- mirex
- 2,4′-DDD
- 4,4′-DDD
- 2,4′-DDE
- 4,4′-DDE
- 2,4′-DDT
- 4,4′-DDT

Lipids[c]

[a] Flounder liver; lobster hepatopancreas
[b] Flounder and lobster edible tissue
[c] Flounder edible tissue and liver; lobster edible tissue and hepatopancreas

processed through an alumina column. The eluate from the alumina column was concentrated to 900 μL using a Kuderna-Danish apparatus and nitrogen evaporation techniques. The concentrated extract was further cleaned using a high-performance liquid chromatographic (HPLC) gel-permeation technique. This procedure removed common contaminants, including lipids, that interfere with instrumental analysis. The post-HPLC extract was concentrated to approximately 500 μL under nitrogen gas and the recovery internal standards were added to quantify extraction efficiency. The tissue final extract was split for analysis, one half remaining in DCM for PAH analysis, and the other half solvent-exchanged with isooctane for PCB and pesticide analysis.

Sample extracts were analyzed for PAH compounds in the selected-ion-monitoring (SIM) mode by gas chromatography/mass spectrometry (GC/MS).Pesticides and PCB congeners were analyzed and quantified using gas chromatography/electron capture detection (GC/ECD).

2.9.2 Metal Analyses

Metals analyzed in the tissues are shown in Table 2. The tissue samples were homogenized with an OMNI Tissue Homogenizer fitted with a titanium cutting probe. After homogenization, samples were freezedried and digested with hot acids for dissolution. Silver and mercury were analyzed by atomic absorption spectrophotometry (AAS) and, cadmium, chromium, copper, nickel, lead, and zinc were analyzed by inductively coupled plasma-mass spectrometry (ICP-MS).

A 0.5-g subsample of the dry tissue was heated by microwave in a Teflon digestion vessel containing 6 mL HNO_3 and 0.5 mL $HClO_4$. The digestion solution was then diluted to $\approx$ 30 mL and transferred to pre-cleaned polyethylene storage containers for final analysis. Silver (Ag), cadmium (Cd), chromium (Cr), nickel (Ni), copper (Cu), lead (Pb), and zinc (Zn) concentrations were measured using ICP-MS instrumentation. Mercury (Hg) was measured in the digestion solution by cold-vapor atomic absorption spectrophotometry (CVAAS) using an LDC mercury monitor.

2.10 Data Reduction and Analysis

Data reduction and analysis was carried out as described in the Combined Work/Quality Assurance Project Plan (CW/QAPP) for Fish and Shellfish Monitoring: 1993-1994, dated May 6, 1993 (Hillman *et al.*, 1993). Histopathological indices and prevalence of lesions were compared between classes of fish defined by differences in station, age, sex, and length. Because many lesions were found together, they were not statistically independent. Centrotubular vacuolation has been considered the most sensitive histological indicator of exposure to chemical contaminants (e.g., Moore and Stegeman, 1993), and was thus tested by analysis of variance for significant differences between groups of fish.

2.11 Detectable Change in Contaminants in Fish and Shellfish

Contaminant concentrations in individual fish and lobster tissue that were collected in 1993 from Deer Island Flats, the Future Outfall Site, and Eastern Cape Cod Bay were subjected to reverse power

analysis (power set to 0.8) (Peterman, 1989). For compound classes with multiple congeners or numerous individual compounds (PCB and PAH), the total concentration of the compound class was calculated and used for the statistical analysis. For example, the PCB concentration is the sum of the individual PCB congeners, while the PAH value represents the sum of the measured compounds in this class of organic contaminants. Similarly, chlordane and DDT represent the sum of all chlordane- and DDT-related compounds, respectively. The concentrations of other pesticides and eight trace metals were treated as individual compounds.

The goal of the reverse power analysis was to evaluate the changes (effect size) that can be measured under the sampling and analytical design used in 1993 (n = 10) versus 1992 (n = 3). As in 1992, sample stations were kept separate. The analysis was run as a two-tailed test with α = 0.05 and 1-β (power) equal to 0.8. The analysis was performed on untransformed data using the standard deviation of the individual tissue samples, thus assuming the variance was independent of the mean. Note that the individual organisms analyzed in 1992 were not randomly selected samples; rather, the individuals that were analyzed were selected on the basis of the relative liver histopathology (e.g., the low, medium, and high indices within each sample site). To directly compare the 1993 and 1992 data, a similar non-random selection procedure was followed for the flounder samples from each site.

3.0 RESULTS AND DISCUSSION

3.1 Winter Flounder Histopathology

The sex, age, length, weight, gross pathological observations, and the results of microscopic examination of the livers of each fish are presented in Appendix A. Those data are summarized below and some comparisons are made with data from previous years. Most comparisons have been made with data from 1992 (Moore and Stegeman, 1993). Lesion prevalence data from 1984 and 1987 through 1992 are summarized in Moore and Stegeman (1993).

3.1.1 Age/Length Parameters

The mean age of the winter flounder collected in the April 1993 samples is shown in Table 3. The oldest fish, averaging slightly over five years of age, were collected at Broad Sound. The youngest fish, averaging just over four years of age, were collected at the Future Outfall Site and Eastern Cape Cod Bay. Statistically, however, there was no difference in age between the Broad Sound and Nantasket Beach populations. The mean age of the fish collected in 1993 was somewhat higher than in 1992 (Figure 2), and closer to the mean age in 1991, although there was little difference in the mean ages of the Future Outfall Site samples between the three years. The average age of the Deer Island flounder remains less than five years, the youngest age at which liver neoplasms have been found at that site (Moore, 1991; Moore and Stegeman, 1993).

As with age, the fish collected in 1993 tended to be larger than those collected in 1992, and closer to the size of fish collected in 1991 (Figure 3). In addition to having the highest mean age of fish collected in the 1993 survey, the Broad Sound flounder were the largest (Table 4), but not statistically different in mean length from the Nantasket Beach population. The smallest fish were collected at the Future Outfall Site, although there was no significant difference in mean length among all sites except Broad Sound. At the Eastern Cape Cod Bay site, the mean length of fish collected in 1993 was greater than those collected in 1991 and 1992.

3.1.2 Fin Erosion Indices

The mean fin erosion index for each of the five winter flounder populations is shown in Table 5. The highest mean fin erosion index was calculated for the Nantasket Beach population. There was, however, no statistical difference between it and the indices calculated for Eastern Cape Cod Bay and the Future Outfall Site, nor was there any difference among the four sites other than the Nantasket Beach population.

Comparison of 1992 and 1993 fin erosion indices is shown in Figure 4. There was a marked decrease in fin erosion at the Deer Island and Broad Sound sites from 1992 to 1993; fin erosion was

Table 3. **Mean Age of Winter Flounder Collected at Boston Harbor and Massachusetts and Cape Cod Bay Sites during April 1993.**

Station	Station ID Number	Date of Collection	Sample Size	Age in Years (Mean ± S.D.)
Deer Island	1	4/13/93	29	4.68 ± 1.07
Broad Sound	3	4/13/93	50	5.26 ± 1.34
Nantasket Beach	2	4/14/93	50	4.96 ± 1.00
Future Outfall Site	4	4/14/93	50	4.32 ± 0.89
Eastern Cape Cod Bay	5	4/15/93	50	4.32 ± 0.84

Station

3 2 1 4 5

Stations connected by bars are not significantly different.
(Student - Neuman - Kuels Ranking Test)

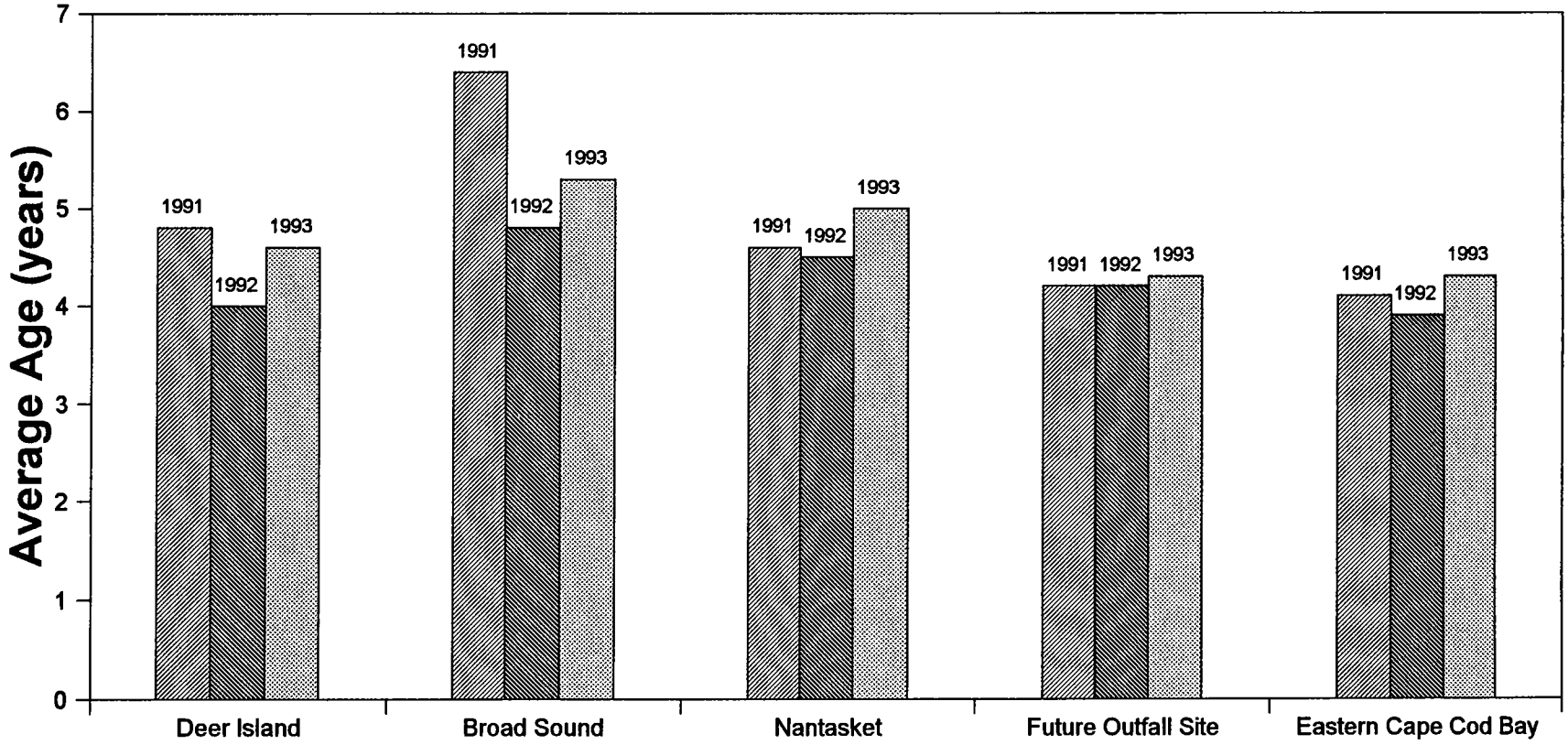


Figure 2. **Average age of winter flounder by site in 1991, 1992, 1993.**

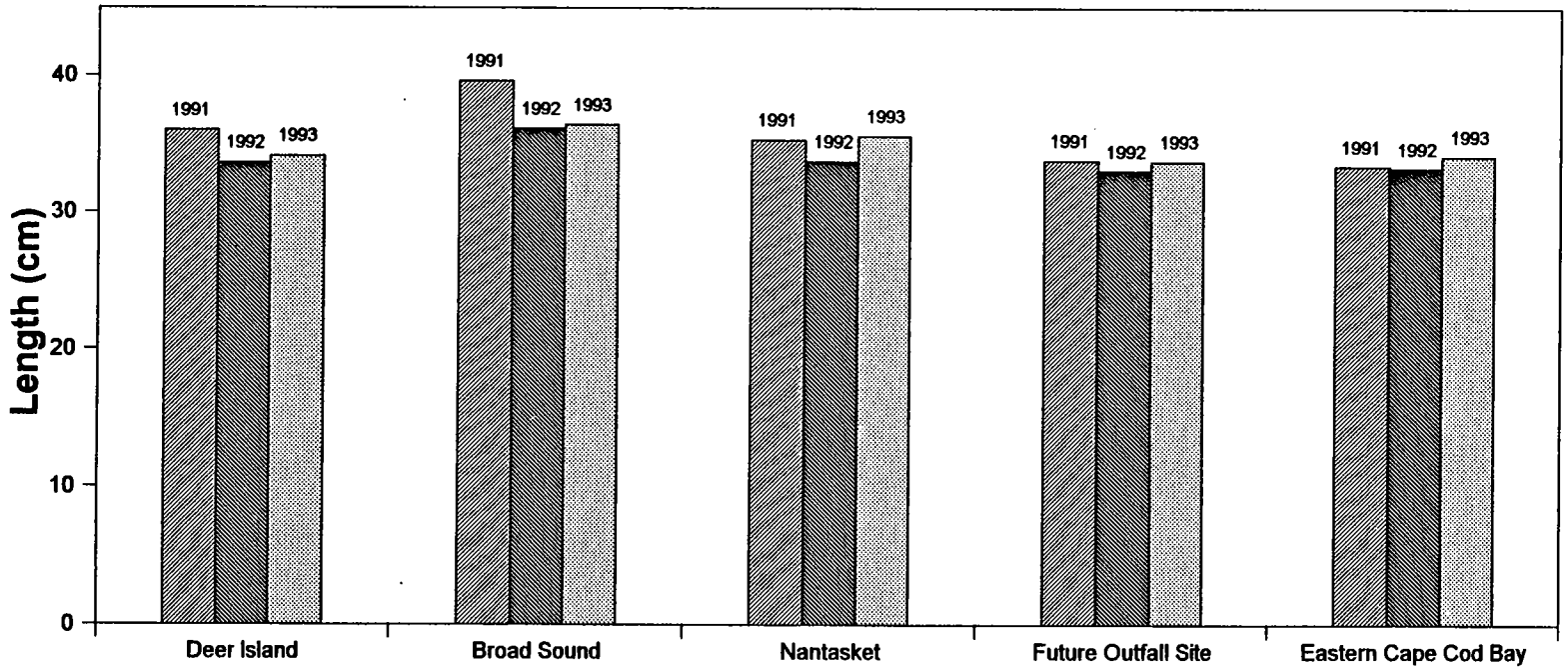


Figure 3. Average length of winter flounder by site in 1991, 1992, 1993.

Table 4. **Mean Length of Winter Flounder Collected at Boston Harbor and Massachusetts and Cape Cod Bay Sites during April 1993.**

Station	Station ID Number	Date of Collection	Station Sample Size	Total Length (cm) (Mean ± S.D.)
Deer Island	1	4/13/93	29	34.1 ± 3.2
Broad Sound	3	4/13/93	50	36.4 ± 4.5
Nantasket Beach	2	4/14/93	50	35.6 ± 3.6
Future Outfall Site	4	4/14/93	50	33.7 ± 3.1
Eastern Cape Cod Bay	5	4/15/93	50	34.1 ± 2.8

3 2 5 1 4

Stations connected by bars are not significantly different.
(Student - Neuman - Kuels Ranking Test)

Table 5. **Fin Erosion Index for Winter Flounder Collected at Boston Harbor and Massachusetts and Cape Cod Bay Sites during April 1993.**

Station	Station ID Number	Date of Collection	Sample Size	Fin Erosion Index (Mean Score ± S.D.)
Deer Island	1	4/13/93	29	0.03 ± 0.19
Broad Sound	3	4/13/93	50	0.04 ± 0.20
Nantasket Beach	2	4/14/93	50	0.24 ± 0.48
Future Outfall Site	4	4/14/93	50	0.12 ± 0.33
Eastern Cape Cod Bay	5	4/15/93	50	0.14 ± 0.40

Station

2 5 4 3 1

Stations connected by bars are not significantly different.
(Student - Neuman - Kuels Ranking Test)

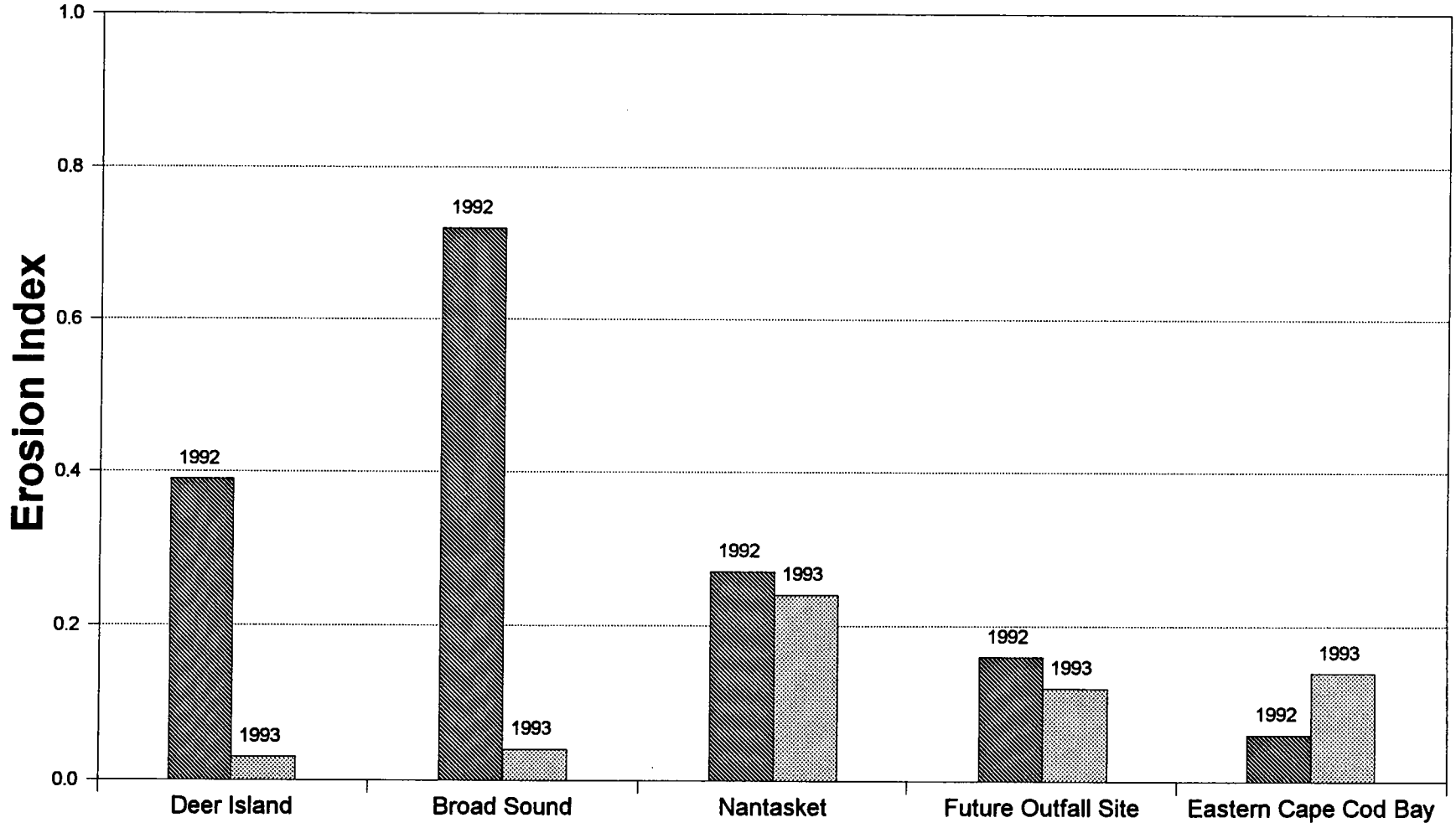


Figure 4. **Fin erosion index by site in 1992 and 1993.**

almost non-existent in 1993. There were slight, but probably not significant, decreases in fin erosion at Nantasket Beach and the Future Outfall Site, but a relatively large increase at the Eastern Cape Cod Bay reference site.

3.1.3 Lesion Prevalence and Severity

The prevalences of histopathological lesions observed in sections of winter flounder liver tissues from fish collected at the five sampling sites are shown in Table 6. Fish from Deer Island and Broad Sound continued to show higher prevalences of hydropic vacuolation than fish from the other three sites. Centrotubular hydropic vacuolation, the least severe of the three categories of hydropic vacuolation, occurred in about one half of the flounder from Deer Island and Broad Sound, and in slightly less than one third of the flounder from Nantasket Beach and the Future Outfall Site. The lesion prevalence was near zero at the Eastern Cape Cod Bay reference site. Deer Island and Broad Sound flounder also had the highest prevalences of tubular hydropic vacuolation, and were the only populations from which any incidence of focal hydropic vacuolation was recorded. These patterns are consistent with data reported for flounder collected in 1992 (Moore and Stegeman, 1993) (Table 7).

Whereas prevalence is an indication of the percentage of flounder in which a particular lesion was observed, the lesion index is an indication of the severity of the lesion. Table 8 shows the lesion indices for the five flounder populations studied in 1993.

While there were individual instances of one or more lesion types rated as severe (a rating of "3") or extreme (a rating of "4"), only macrophage aggregates registered a lesion index of 1.00 or higher. The highest lesion index, 1.13, was calculated for the Broad Sound sample. An index of 1.00 was calculated for the Nantasket Beach sample. These were the only indices to equal or exceed 1.00, although the macrophage aggregate index of Deer Island sample was 0.96. In general, the Deer Island and Broad Sound samples received the highest lesion indices. Severity of the lesions decreased with increasing distance from the Deer Island and Lynn outfalls.

Figures 5 through 9 compare the 1992 lesion prevalences and indices with the 1993 prevalences and indices at each site. Figure 10 shows the prevalence and index of a newly reported lesion that is being called "balloon" hepatocytes. It is possibly a condition known as apoptosis, and might have been present previously but in such low incidence that it was overlooked. Hydropic vacuolation patterns for prevalence and index at all sites are generally similar from year to year, with the exception of a sizeable decrease in prevalence and severity at Broad Sound. Centrotubular hydropic vacuolation was the most prevalent and most severe of the hydropic vacuolation lesions (Figure 5), a pattern consistent with previous years' observations (Moore and Stegeman, 1993).

Figure 8 shows the prevalence and lesion indices for macrophage aggregates in 1992 and 1993. The prevalence of macrophage aggregates increased at all sites except Eastern Cape Cod Bay from 1992 to 1993. The increase in prevalence was probably not significant in samples from Broad Sound, but was considerable at Deer Island, Nantasket Beach, and the Future Outfall Site. Between 1992 and 1993, the severity of the lesions increased sharply at all sites except at Broad Sound.

Table 6. **Histopathological Lesion Prevalences (%) for Winter Flounder Livers Collected from Boston Harbor and Massachusetts and Cape Cod Bay Sites in April 1993. Numbers in parentheses represent sample size.**

Lesion	Deer Island (29)	Broad Sound (50)	Nantasket Beach (50)	Future Outfall Site (50)	Eastern Cape Cod Bay (50)
Centrotubular Hydropic Vacuolation	55[4]	50[4]	28[2]	30[4]	4
Tubular Hydropic Vacuolation	28	36	14	22	2
Focal Hydropic Vacuolation	7	2	0	0	0
Neoplasia	0	2	0	0	0
Macrophage Aggregates	90	86	98	94	7
Biliary Proliferation	83	84	68	72	52
Balloon Hepatocytes	59	62	50	52	23

Significance of difference of centrotubular hydropic vacuolation prevalence was compared between each station and the reference station, Eastern Cape Cod Bay.

[1] $p \leq 0.05$; [2] $p \leq 0.01$; [3] $p \leq 0.001$; [4] $p \leq 0.0001$

Table 7. **Prevalence of Histological Lesions (%) in Winter Flounder Livers from Boston Harbor and Massachusetts and Cape Cod Bays. Numbers in parentheses represent sample size. 1992 data are from Moore and Stegeman (1993).**

Lesion	Deer Island		Broad Sound		Nantasket Beach		Future Outfall Site		Eastern Cape Cod Bay	
	1992 (56)	1993 (29)	1992 (50)	1993 (50)	1992 (49)	1993 (50)	1992 (50)	1993 (50)	1992 (50)	1993 (50)
Centrotubular Hydropic Vacuolation	48[4]	55[4]	74[4]	50[4]	20[2]	28[2]	34[3]	30[4]	2	4
Tubular Hydropic Vacuolation	25	28	44	36	8	14	18	22	0	2
Focal Hydropic Vacuolation	4	7	2	2	0	0	0	0	0	0
Neoplasia	0	0	0	2	0	0	0	0	0	0
Macrophage Aggregates	46	90	82	86	55	98	30	94	14	7
Biliary Proliferation	11	83	20	84	4	68	8	72	0	52
Balloon Hepatocytes	-	59	-	62	-	50	-	52	-	23

Significance of difference of centrotubular hydropic vacuolation prevalence was compared between each station and the reference station, Eastern Cape Cod Bay.

[1] $p \leq 0.05$; [2] $p \leq 0.01$; [3] $p \leq 0.001$; [4] $p \leq 0.0001$

Table 8. **Histopathological Lesion Indices for Winter Flounder Livers Collected from Boston Harbor and Massachusetts and Cape Cod Bays in April 1993. Each histological condition was scored on a scale of 0 to 4 for severity, with 0=absent to 4=severe. Individual indices for each fish were averaged for each station.**

Lesion	Deer Island (29)	Broad Sound (50)	Nantasket Beach (50)	Future Outfall Site (50)	Eastern Cape Cod Bay (50)
Centrotubular Hydropic Vacuolation	0.90	0.87	0.44	0.61	0.08
Tubular Hydropic Vacuolation	0.45	0.43	0.22	0.36	0.01
Focal Hydropic Vacuolation	0.02	0.01	0	0	0
Neoplasia	0	0.06	0	0	0
Macrophage Aggregates	0.96	1.13	1.00	0.81	0.54
Biliary Proliferation	0.69	0.76	0.55	0.44	0.32
Balloon Hepatocytes	0.90	0.81	0.60	0.62	0.64

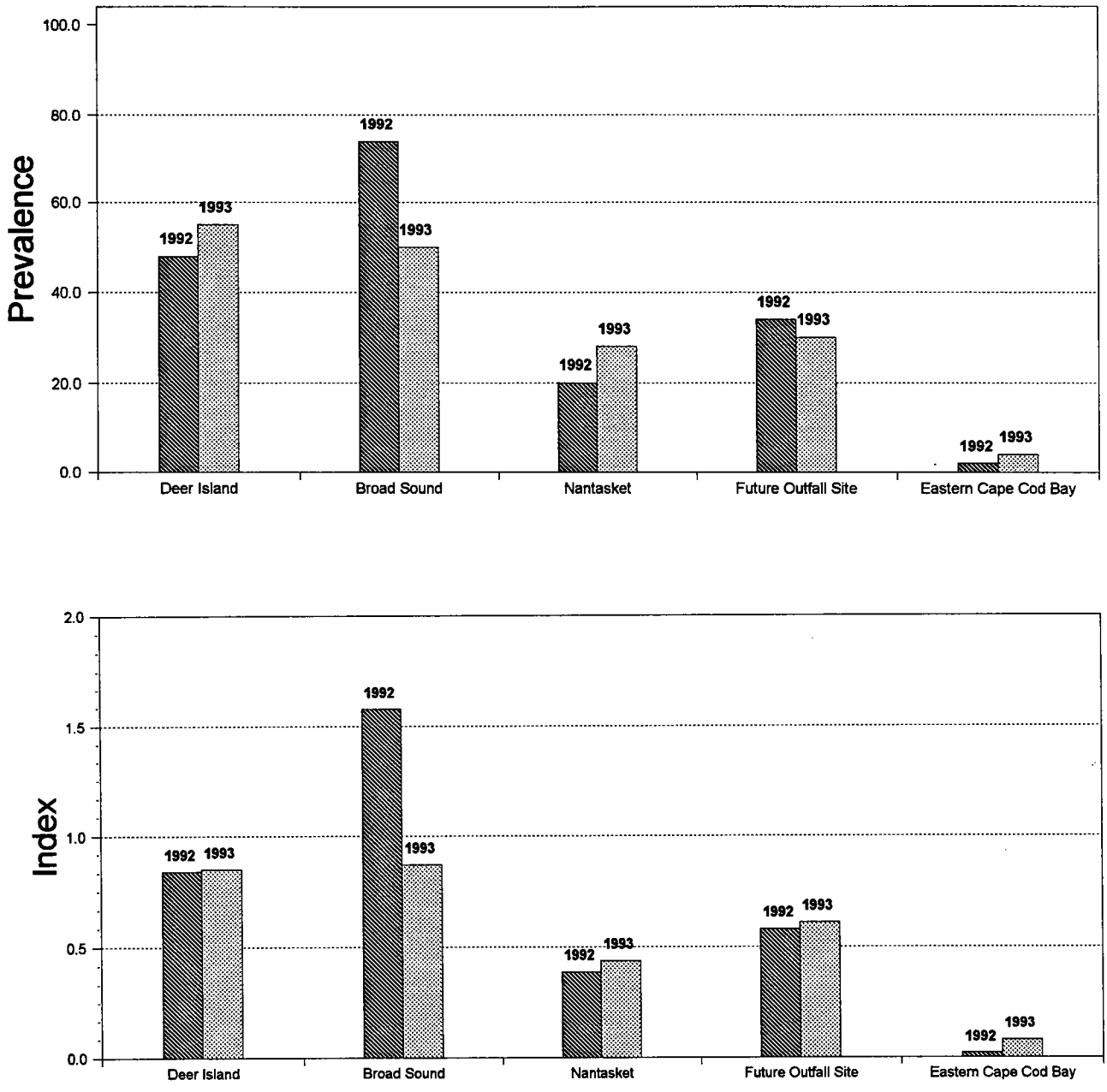


Figure 5. **Comparison of prevalence and index of centrotubular hydropic vacuolation in livers of fish collected at sites in Boston Harbor and Massachusetts and Cape Cod Bays in 1992 and 1993.**

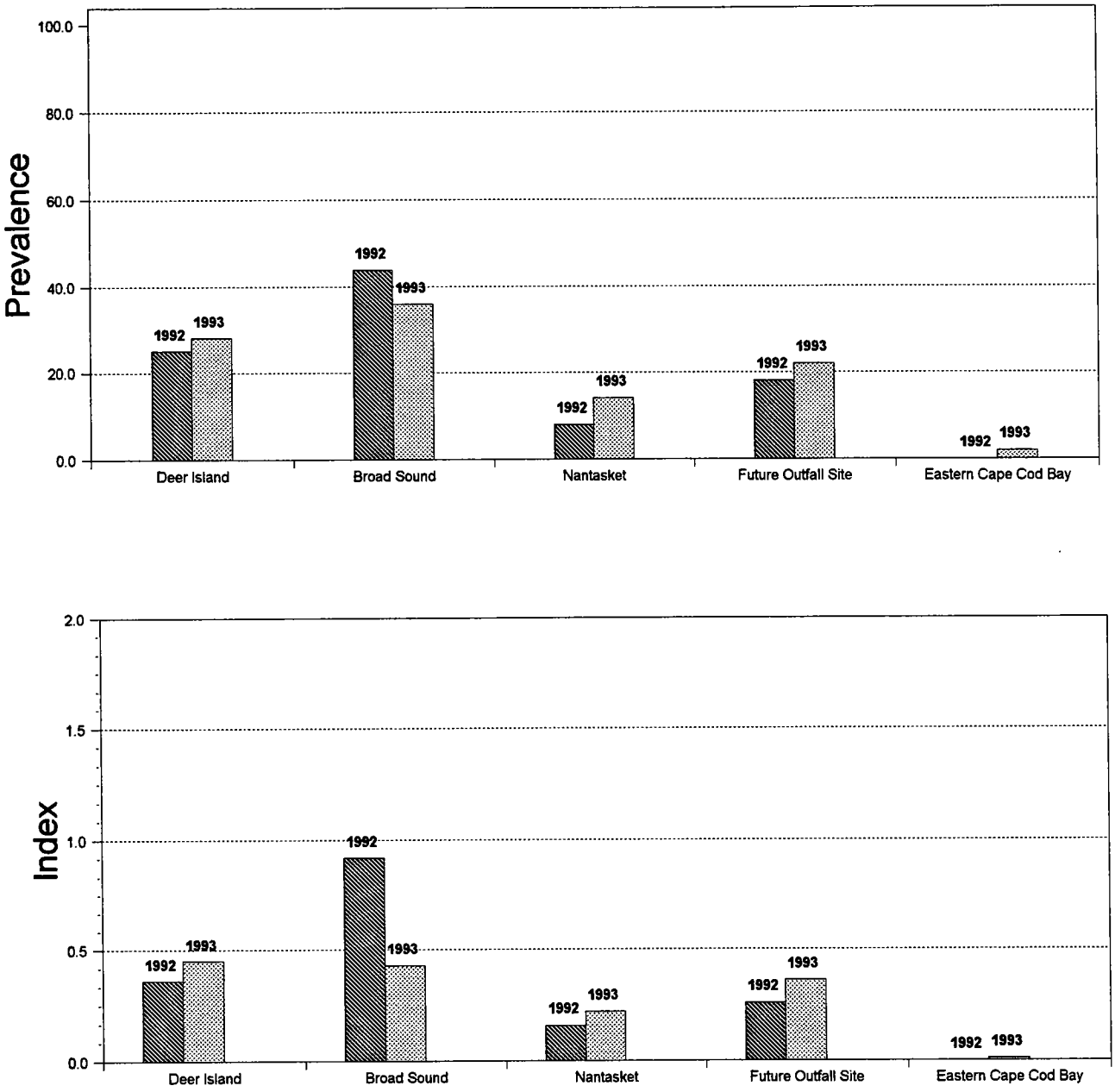


Figure 6. **Comparison of prevalence and index of tubular hydropic vacuolation in livers of fish collected at sites in Boston Harbor and Massachusetts and Cape Cod Bays in 1992 and 1993.**

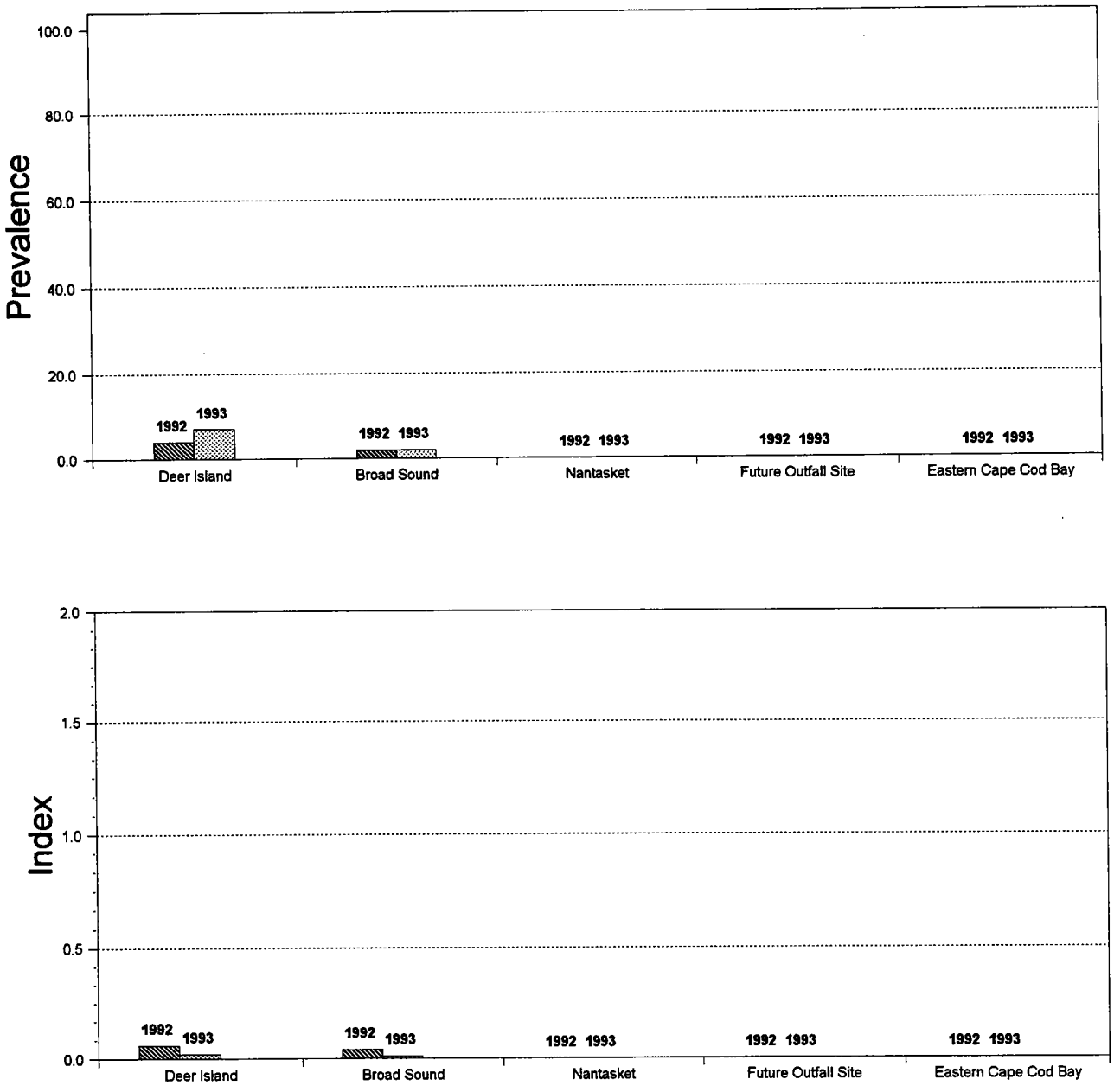


Figure 7. **Comparison of prevalence and index of focal hydropic vacuolation in livers of fish collected at sites in Boston Harbor and Massachusetts and Cape Cod Bays in 1992 and 1993.**

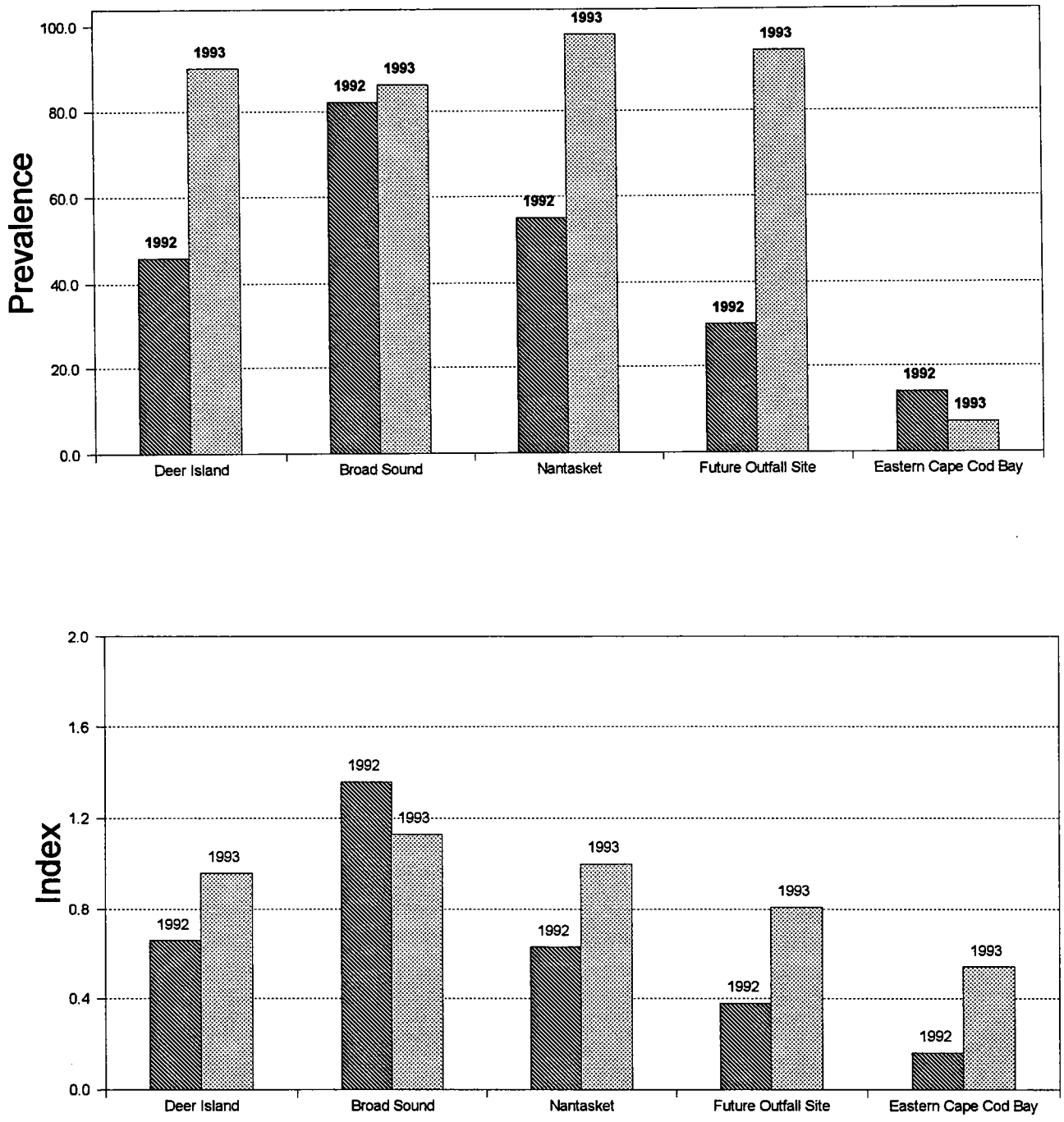


Figure 8. **Comparison of prevalence and index of macrophage aggregates in livers of fish collected in Boston Harbor and Massachusetts and Cape Cod Bays in 1992 and 1993.**

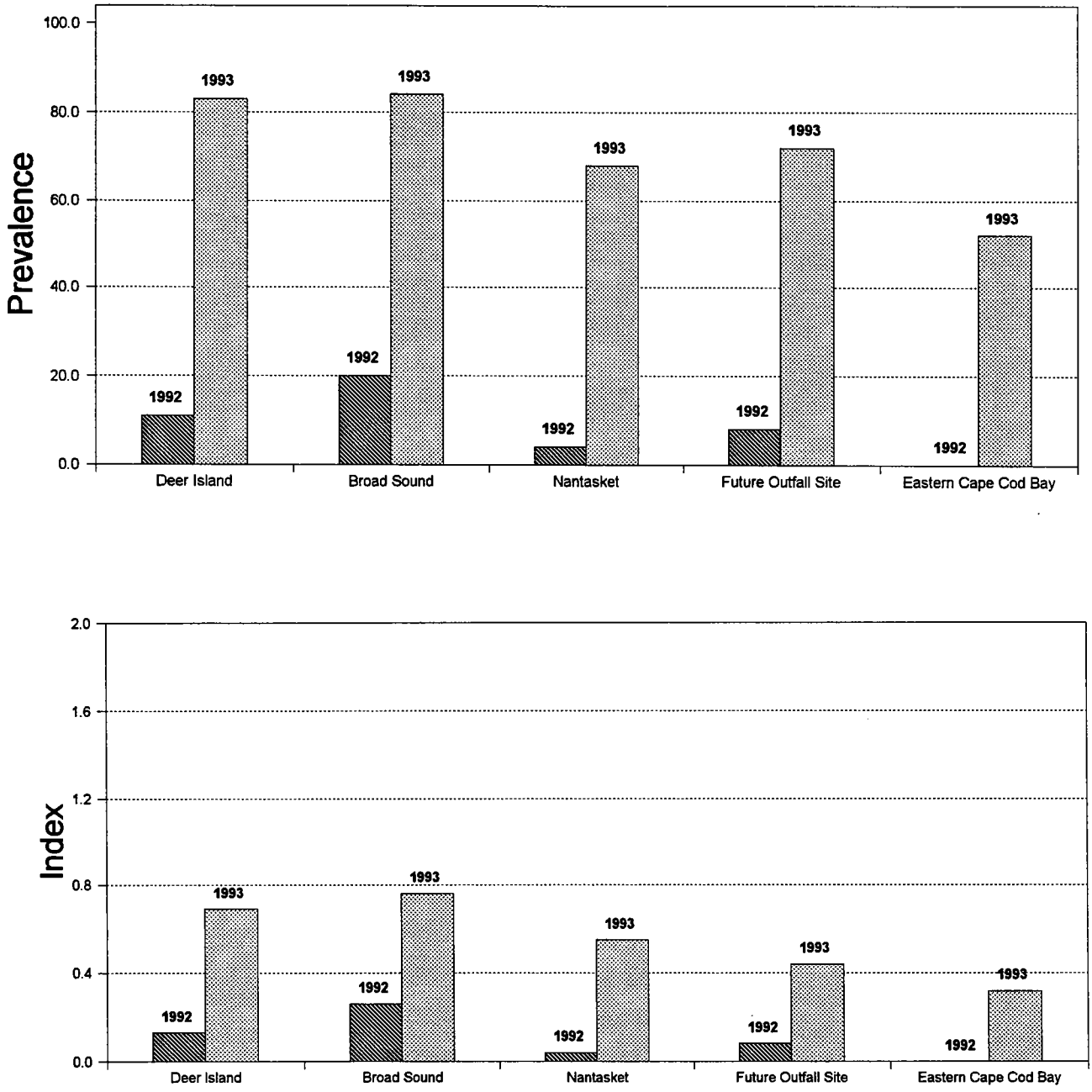


Figure 9. **Comparisons of prevalence and index of biliary proliferation in livers of fish collected in Boston Harbor and Massachusetts and Cape Cod Bays in 1992 and 1993.**

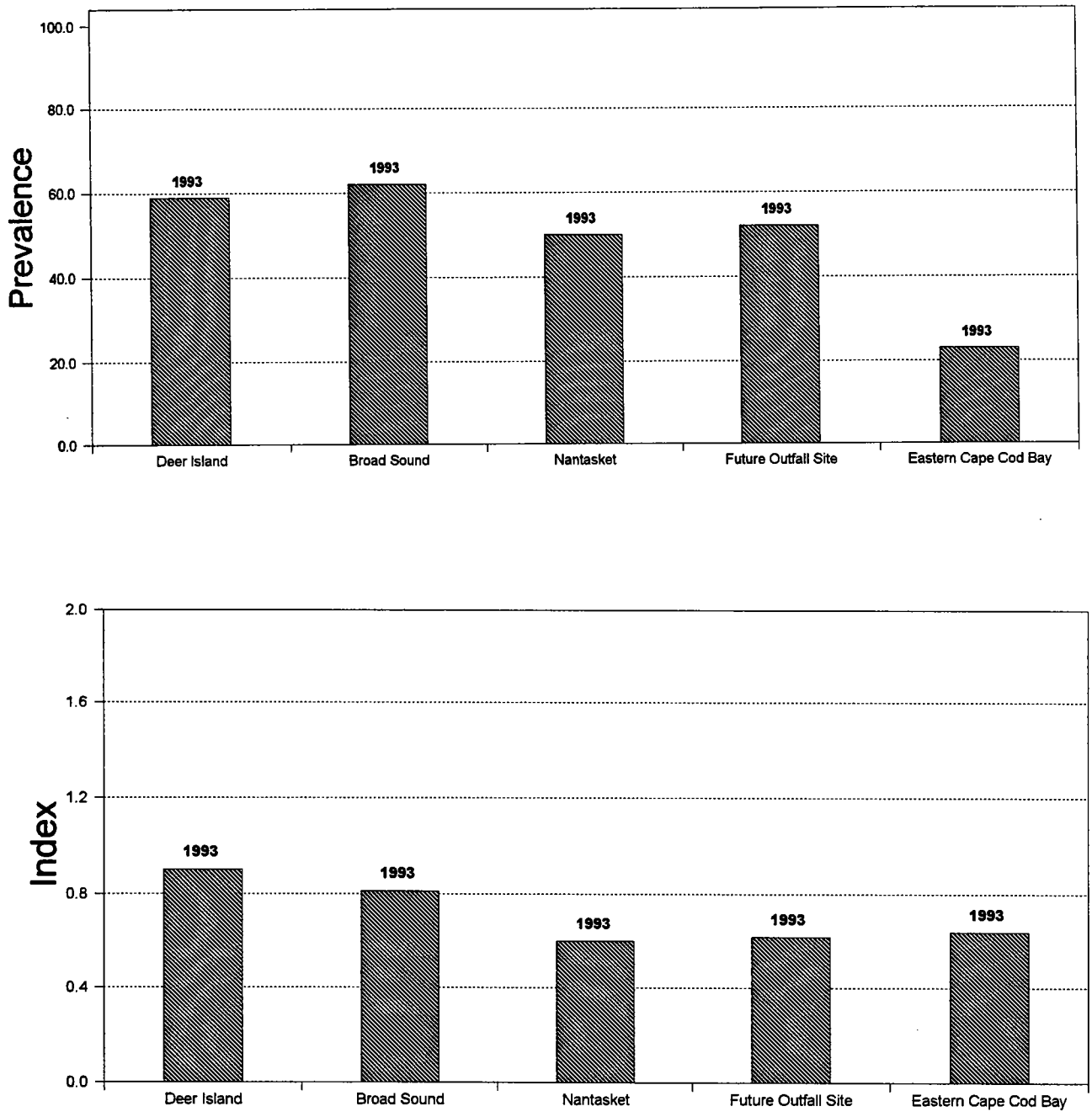


Figure 10. **Prevalence and index of "balloon" hepatocytes in livers of fish collected in Boston Harbor and Massachusetts and Cape Cod Bays in 1993.**

The most significant increase in prevalence and severity of a lesion was in biliary proliferation, which increased two- to three-fold at all sites from 1992 to 1993 (Figure 9). Neoplasia were generally absent except for a neoplasm in the liver of a seven-year-old female collected at Broad Sound.

It should be pointed out that the increases in lesion prevalence in 1993 over what was previously reported (e.g., Moore and Stegeman, 1993) might not necessarily be as large as they appear. Calculations of the lesion prevalences in this report are based on the reading of six slides per liver, whereas the prevalences reported by Moore and Stegeman (1993) were based on the reading of only one slide per liver, possibly resulting in a more focused lesion being missed, and leading to prevalences in a given sample a few percentage points lower than if the lesion had been observed. Nevertheless, it is reasonable to infer that there were real increases, particularly in macrophage aggregates and biliary proliferation. In the context of the available data on winter flounder from Deer Island, the levels of histological parameters have remained largely unchanged since 1989, persisting at a somewhat lower level than was observed in 1984 (Murchelans and Wolke, 1985, 1987 and 1988), (Moore and Stegeman, 1993).

The widespread incidence of apparent apoptosis is of considerable interest. The significance of apoptosis as a natural mechanism of cell death has been described in detail by Wyllie *et al.* (1980) and Kerr and Harmon (1991). It is the mechanism by which larval organs and phylogenetic vestiges are eliminated during metamorphosis, and by which healthy adult tissue size is regulated. In addition, it has been shown to occur spontaneously in growing neoplasms, and can be increased by ionizing radiation and certain cancer-chemotherapeutic agents.

Normally, apoptosis involves only scattered single cells, rapid disappearance of the early stages, and rapid dispersal, phagocytosis, and digestion of the apoptotic bodies (which are usually very small) in tissues without any inflammatory response. The rapid appearance and disappearance of the apoptotic cells has led to underrecognition of the condition in the past (Wyllie *et al.*, 1980). In the fish from Boston Harbor and Cape Cod Bay, however, large areas of the liver were affected, and what appeared to be a variety of stages in the process were evident. Further, although only the key lesions discussed in prior reports to MWRA are discussed here, the apoptotic condition was also often accompanied by focal necrosis, foci of cell alteration, cytomegaly, basophilia or eosinophilia of groups of hepatocytes, and a variety of other anomalies.

A similar syndrome has recently been reported by Köhler *et al.* (1992) in the livers of dab (*Limanda limanda*) from the North Sea. In that study, the syndrome was attributed to toxic injury from contaminants in the area. There is no indication from the results of the chemical analyses carried out by us that there has been any major change in contaminant concentrations in the area since 1992 that would account for the appearance of the apoptosis and associated pathology. Further, although most aspects of the lesion resemble apoptosis, it has not been definitely established that it is apoptosis, or what affect it has on the fish.

3.1.4 Gender Differences in Centrotubular Vacuolation Prevalence

The prevalence of centrotubular vacuolation in female fish versus male fish from the 1993 collections is shown in Table 9, along with comparisons of 1992 data from Moore and Stegeman (1993). As in

Table 9. **Prevalence (%) of Centrotubular Vacuolation Compared Between Genders of Fish from Each Station in 1992 and 1993.**

Station	Sample Size		Percent Female		Prevalence of Centrotubular Hydropic Vacuolation (%)			
					Female		Male	
	1992	1993	1992	1993	1992	1993	1992	1993
Deer Island	56	29	59	34	53	80	37	44
Broad Sound	50	50	24	62	67	48	76	53
Nantasket Beach	49	50	45	86	32	28	11	29
Future Outfall Site	50	50	82	82	29	29	56	33
Eastern Cape Cod Bay	49	50	59	72	3	3	0	11

previous years, there is no consistent evidence favoring an increased prevalence of the lesion in females as opposed to males.

At Broad Sound, Nantasket Beach, and Eastern Cape Cod Bay, there was an increase in the percentage of females collected in 1993 over what was collected in 1992. At Deer Island, the percentage of females collected in 1993 was considerably lower than in 1992, and at the Future Outfall Site, percentages in the two years were approximately equal. The lesion prevalence in females, however, increased at Deer Island in 1993, was reduced at Broad Sound and Nantasket Beach and, at the Future Outfall Site and Eastern Cape Cod Bay, was about equal to the 1992 prevalence. In males, the prevalence of the lesion in 1993 was reduced at Broad Sound and the Future Outfall Site, and increased at Nantasket Beach and Eastern Cape Cod Bay. At Deer Island, it was about equal to the 1992 prevalence.

3.1.5 Age Effects on Prevalence of Centrotubular Vacuolation

Previous studies by Moore (1991) and Moore and Stegeman (1993) showed that hydropic vacuolation in winter flounder increased with both length and age, underscoring the importance of attempting to standardize the collections to fish of similar age distributions. This pattern continued to be reflected in the 1993 samples from Deer Island (Table 10). The number of fish in each age group decreased with increasing age from four years through eight years, but the prevalence increased from 24% of the fifteen four-year-old fish to 50% of the eight five-year-old fish to 100% of the three six-year-old fish. Only one flounder was collected in each of the seven- and eight-year-old categories, but each one showed some degree of the lesion.

3.2 Stable Isotopes

Carbon and nitrogen stable isotope ratios in scales of winter flounder collected from sites in Boston Harbor and Massachusetts Bay between 1989 and 1993 are shown in Table 11, and those ratios in the diets of the fish are shown in Table 12. Figure 11 compares the nitrogen ratios among sites and years. Tables 13 and 14 show the ratios of sulfur in scales and diets, respectively, of the same fish, and Figure 12 shows the comparison of sulfur ratios among sites and years.

Previous studies showed that the stable isotope values of 3.3 for ^{15}N and 7.5 for ^{34}S were determined for MWRA sewage sludge (Ann Giblin, pers. comm.). It should be noted that, although the Broad Sound site is adjacent to an outfall emanating from the City of Lynn, no sludge is discharged at that site. It seems very possible that, compared to the other stations, the reduced values of $\partial^{15}N$ and $\partial^{34}S$ for the winter flounder from Deer Island Flats suggest that a significant portion of the flounder diet is derived from sewage sludge. Furthermore, there is perhaps a diminishing of the use of sewage sludge as food by the flounder throughout the area. This is not unexpected given the cessation of sludge discharge from Deer Island in December 1991. Giblin *et al.* (Ann Giblin, pers. comm.) have shown a steady rise in surface sediment $\partial^{15}N$ through the summer of 1992 near the Nut Island sludge discharge site. One would expect a significant lag in the winter flounder isotope values in tissues, such as scales, that are not shed. In contrast, one might expect a more rapid change in high-

Table 10. **Age-Class Analysis of Prevalence of Centrotubular Vacuolation in Winter Flounder from Deer Island Flats, Boston Harbor, Collected in 1989, 1990, 1991, 1992, and 1993.**

	All Fish	3 year olds	4 year olds	5 year olds	6 year olds	7 year olds	8 year olds	9 year olds
1989	51 (25)	0 (2)	29 (7)	33 (9)	100 (4)	100 (2)	0 (1)	
1990	39 (99)	0 (4)	38 (29)	48(31)	35 (23)	50 (4)	50 (4)	0 (1)
1991	47 (167)	33 (12)	32 (69)	55 (40)	67 (24)	60 (10)	75 (4)	67 (3)
1992	48 (56)	45 (20)	55 (20)	50 (12)	25 (4)			
1993	55 (29)	0 (1)	47 (15)	50 (8)	100 (3)	100 (1)	100 (1)	

Prevalence given as a % of sample affected, with sample size in parentheses.
1989-1992 data are from Moore and Stegeman (1993).

Table 11. **Carbon and Nitrogen Stable Isotope Ratios in Scales of Winter Flounder Collected in Boston Harbor, Massachusetts and Cape Cod Bays from 1989 through 1993.**

	Carbon					Nitrogen				
	1989	1990	1991	1992	1993	1989	1990	1991	1992	1993
Deer Island	15.2	14.8	15.4	16.7	14.7	10.7	9.5	9.1	9.8	13.3
	14.4	15.2	15.0	14.3	14.6	10.7	11.5	7.8*	12.6	10.5
	15.8	15.4	15.0*	14.9	14.2	10.3	9.7	9.3*	9.4	11.6
Broad Sound	-	-	14.3*	-	14.8	-	-	13.5*	-	12.7
	-	-	13.1	-	14.0	-	-	13.0	-	13.1
	-	-	15.2*	-	14.7	-	-	10.7	-	13.4*
Nantasket Beach	-	-	15.3	-	14.8	-	-	12.6	-	13.1
	-	-	13.6	-	14.8	-	-	12.2	-	12.3
	-	-	14.7	-	13.9	-	-	12.7	-	13.5
Future Outfall Site	-	-	14.6	14.6	15.2	-	-	13.1	12.3	11.9
	-	-	15.0	15.1	15.3	-	-	12.5	12.1	11.1
	-	-	14.8	14.8	15.3	-	-	11.5	13.3	12.7
Eastern Cape Cod Bay	-	-	15.6	15.1	14.6	-	-	12.5	13.1	13.9
	-	-	15.0*	14.8	15.2	-	-	12.3	13.3*	12.7
	-	-	14.2	15.5	15.0	-	-	12.5	12.6	14.0

* Mean of two replicates

Table 12. Carbon and Nitrogen Stable Isotope Ratios in the Diet of Winter Flounder Collected in Boston Harbor, Massachusetts and Cape Cod Bays.

	Carbon		Nitrogen	
	1988	1993	1988	1993
Deer Island	18	18.8	8	7.2
Broad Sound	-	18.6	-	9.8
Future Outfall Site	-	20	-	10.4*
Eastern Cape Cod Bay	-	20.1	-	10.3

* Mean of two replicates

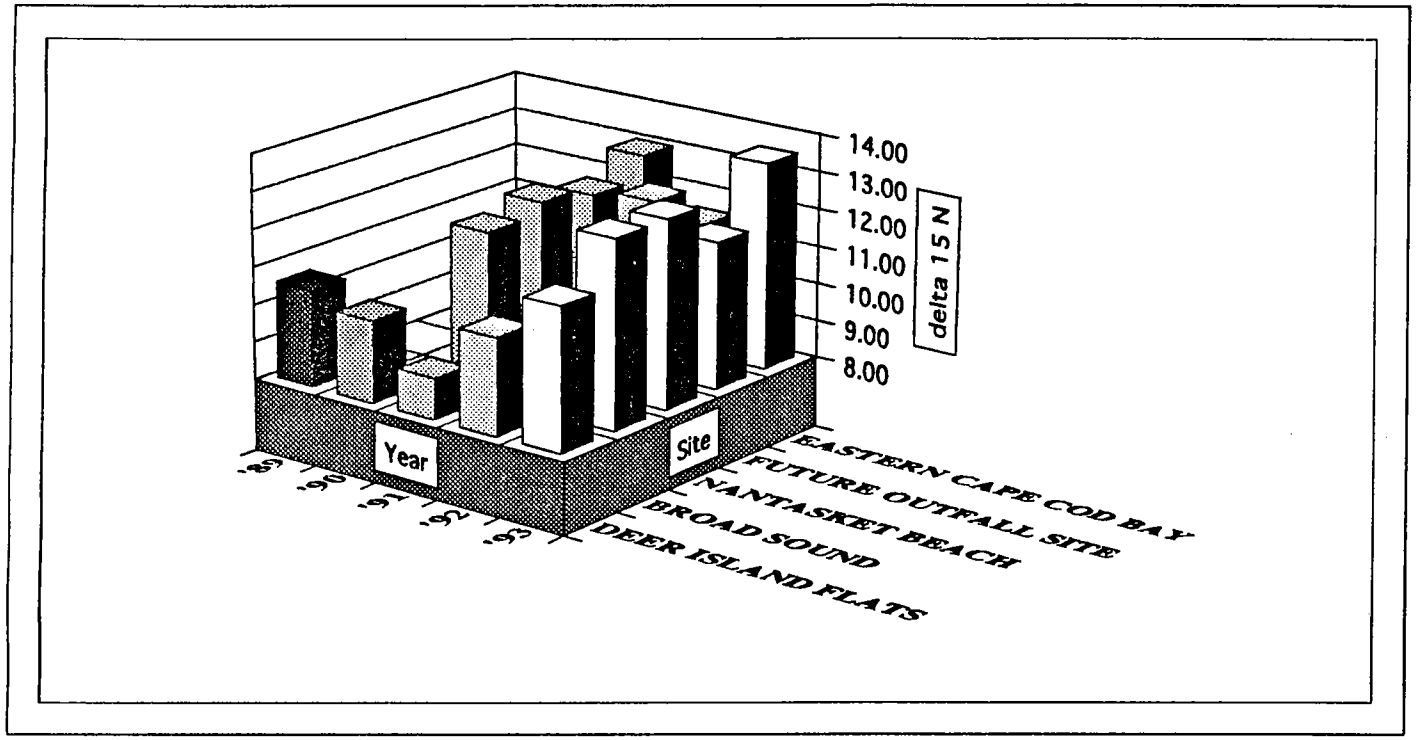


Figure 11. **Ratios of ^{15}N in scales of fish collected at sites in Boston Harbor, Massachusetts Bay and Cape Cod Bay from 1989 through 1993. There are no data from Broad Sound and Nantasket Beach for 1992, and from all sites except Deer Island in 1989 and 1990. Each data point is a mean from three 3- or 4-year-old female fish.**

Table 13. **Sulfur Stable Isotope Ratios in Scales of Winter Flounder Collected from Boston Harbor, Massachusetts and Cape Cod Bays from 1989 through 1993.**

	1989	1990	1991	1992	1993
Deer Island	9.9	9.2	9.8	9.8	10.5
Broad Sound	-	-	11.6	-	12.5
Nantasket Beach	-	-	12.9	-	13.0
Future Outfall Site	-	-	13.3	12.7	12.2
Eastern Cape Cod Bay	-	-	13.0	12.2	11.6

Table 14. Sulfur Stable Isotope Ratios in the Diet of Winter Flounder Collected in Boston Harbor, Massachusetts Bay and Cape Cod Bay.

	1988	1993
Deer Island	5.1	1.3
Future Outfall Site	-	9.4
Eastern Cape Cod Bay	-	15.9

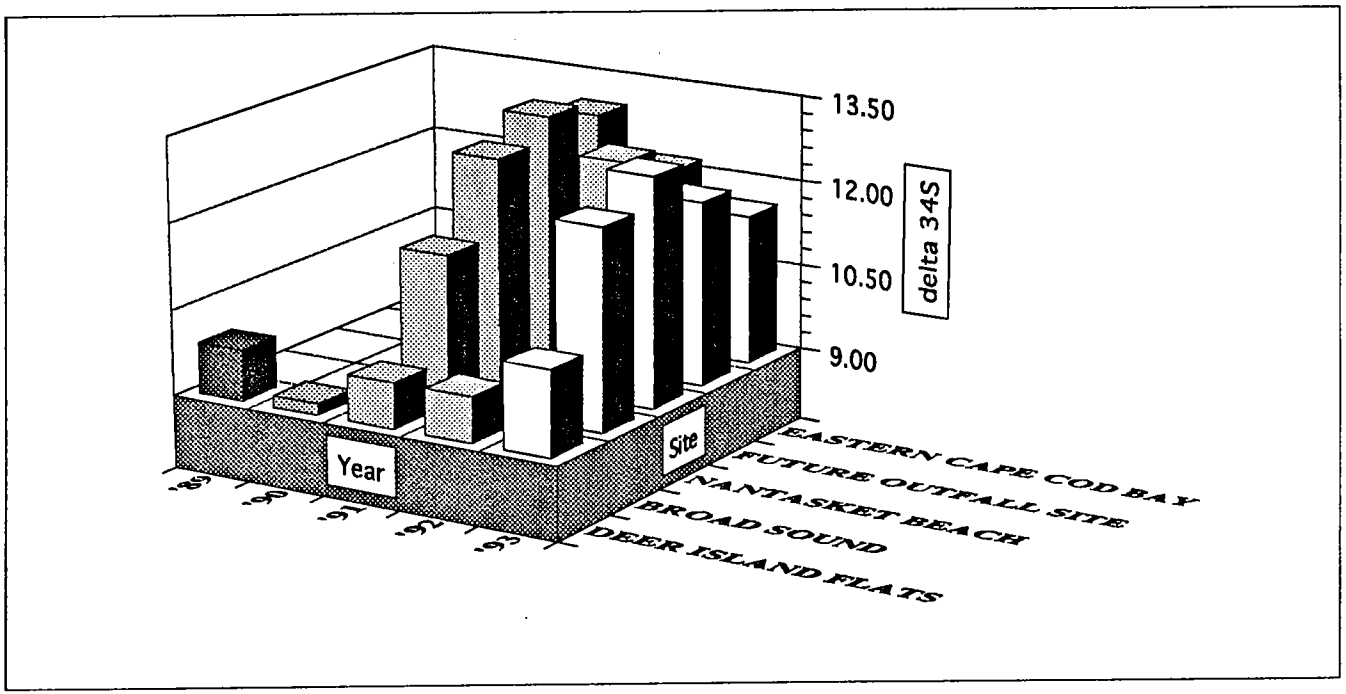


Figure 12. **Ratios of ^{34}S in the scales of fish collected at sites in Boston Harbor and Massachusetts and Cape Cod Bays from 1989 through 1993. No data for Broad Sound and Nantasket Beach in 1992, and all sites except Deer Island in 1989 and 1990. Each data point is a pool of 25 to 40 three- to four-year-old fish.**

turnover epithelia, such as the intestines and gills. Another conclusion suggested by these data is that movement of winter flounder along the shore is relatively minor. Otherwise, one would expect to detect the Deer Island sludge signal in fish from both Broad Sound and Nantasket Beach. This suggests that winter flounder movements at this latitude are slight, as originally suggested by previous tagging studies (Howe and Coates, 1975), and if they occur are primarily perpendicular to the shore. Figure 13 shows sulfur data plotted against the prevalence of centrotubular vacuolation for fish from each 1991 station. This figure suggests that the chemical exposure resulting in the elevated hydropic vacuolation in fish from Broad Sound, Nantasket Beach, and the Future Outfall Site may not be associated with exposure to sewage sludge-derived contaminants. Analysis of diet samples presented in Tables 12 and 14 suggests that the degree of horizontal transport of sewage sludge is slight.

3.3 Chemistry

Contaminant concentrations were measured in 29 individual flounder samples, 15 individual lobster tissue samples, 15 lobster hepatopancreas samples, and in composited flounder liver samples collected from Deer Island, the Future Outfall Site, and Eastern Cape Cod Bay. All tissue samples and the composited liver sample were analyzed for organic substances listed in Table 2 and for mercury. The lobster hepatopancreas samples were also analyzed for seven additional metals: silver, cadmium, chromium, copper, nickel, lead, and zinc. The results of all analyses are provided in Appendix B. For illustration and discussion purposes, individual congeners were grouped into total DDT, total PCB, total PAH, and total chlordane (the sum of cis-chlordane, trans-nonochlor, heptachlor, and heptachlor epoxide). No year-to-year comparisons were possible for Broad Sound and Nantasket Beach because no flounder or lobster were analyzed at either of those sites in 1993. Because of the differences in the way samples were analyzed from year to year (e.g., some samples were composited and no mean value calculated, while others were analyzed individually) and/or small sample sizes (e.g., when only two individual lobsters from a single site were analyzed) no valid statistical analysis comparing values from one year to the next could be carried out. Therefore, graphs showing year to year comparisons do not contain error bars.

3.3.1 Individual Flounder Tissue Analyses

The results of the individual flounder tissue analysis in 1993 and the composited flounder tissue sample from 1992 (Shea, 1993) are plotted in Figures 14 through 18. Data for the 1992 composited tissue samples rather than the individual tissue averages are plotted because only three individuals were used in deriving the averages and these individuals were selected to encompass the range of histopathological lesions observed and were not randomly selected as in 1993. The 1992 flounder tissue composite consisted of seven individuals. The 1993 flounder tissue averages represented either nine or ten individuals. The results of the chemical analysis showed an increase in the concentrations of mercury (Figure 18) and dieldrin (Figure 16) at Deer Island in 1993. This trend was not observed for total chlordane (Figure 17) and total PCB (Figure 14) which showed a slight decline at Deer Island. The most substantial difference in tissue chemical concentrations between 1992 and 1993 was observed at the Future Outfall Site where the concentrations of dieldrin, total chlordane, total DDT, and total PCB increased from the previous year; total chlordane concentrations were three times higher in 1993. Slight increases in mercury, dieldrin, and total chlordane concentrations were observed at Eastern Cape Cod Bay.

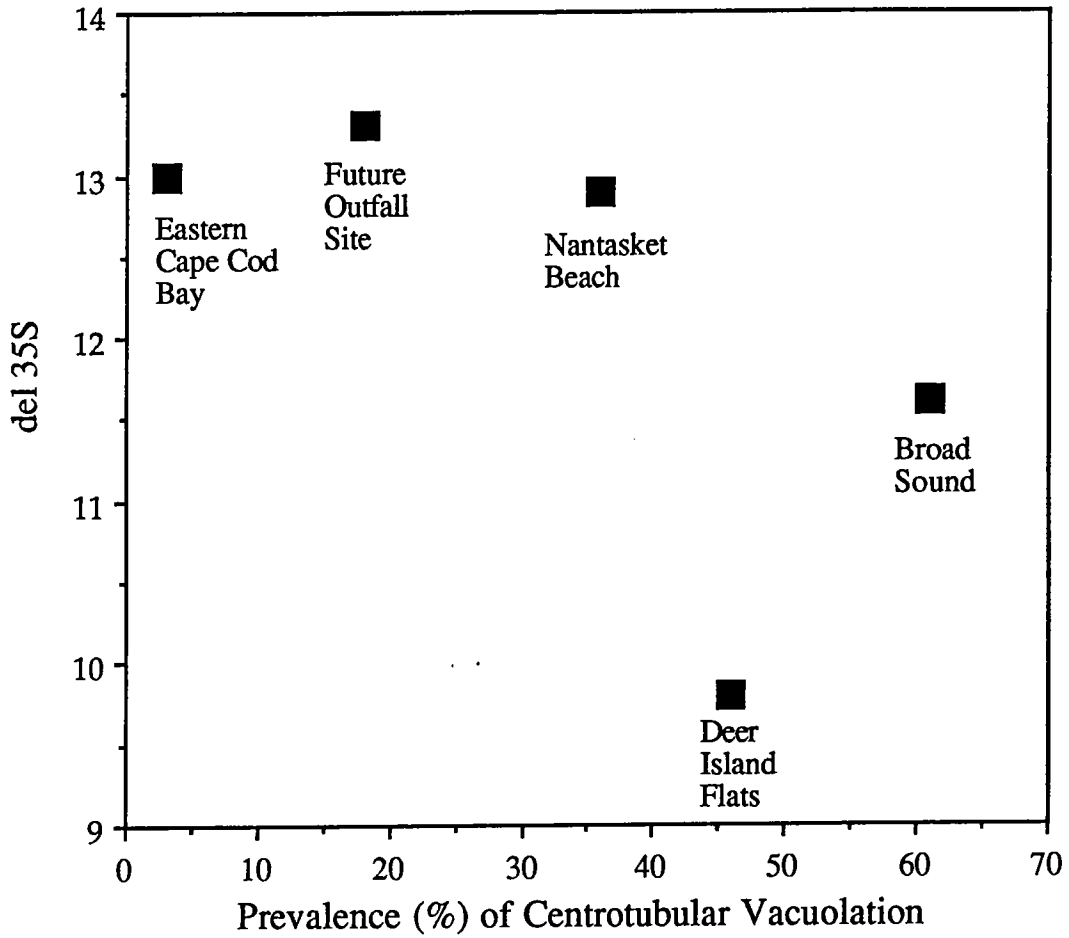


Figure 13. **Comparison of hepatic hydropic vacuolation prevalence with $\partial^{35}S$ values from pooled winter flounder scales collected from each site in 1991. Prevalence data are from Moore *et al.* (1992.)**

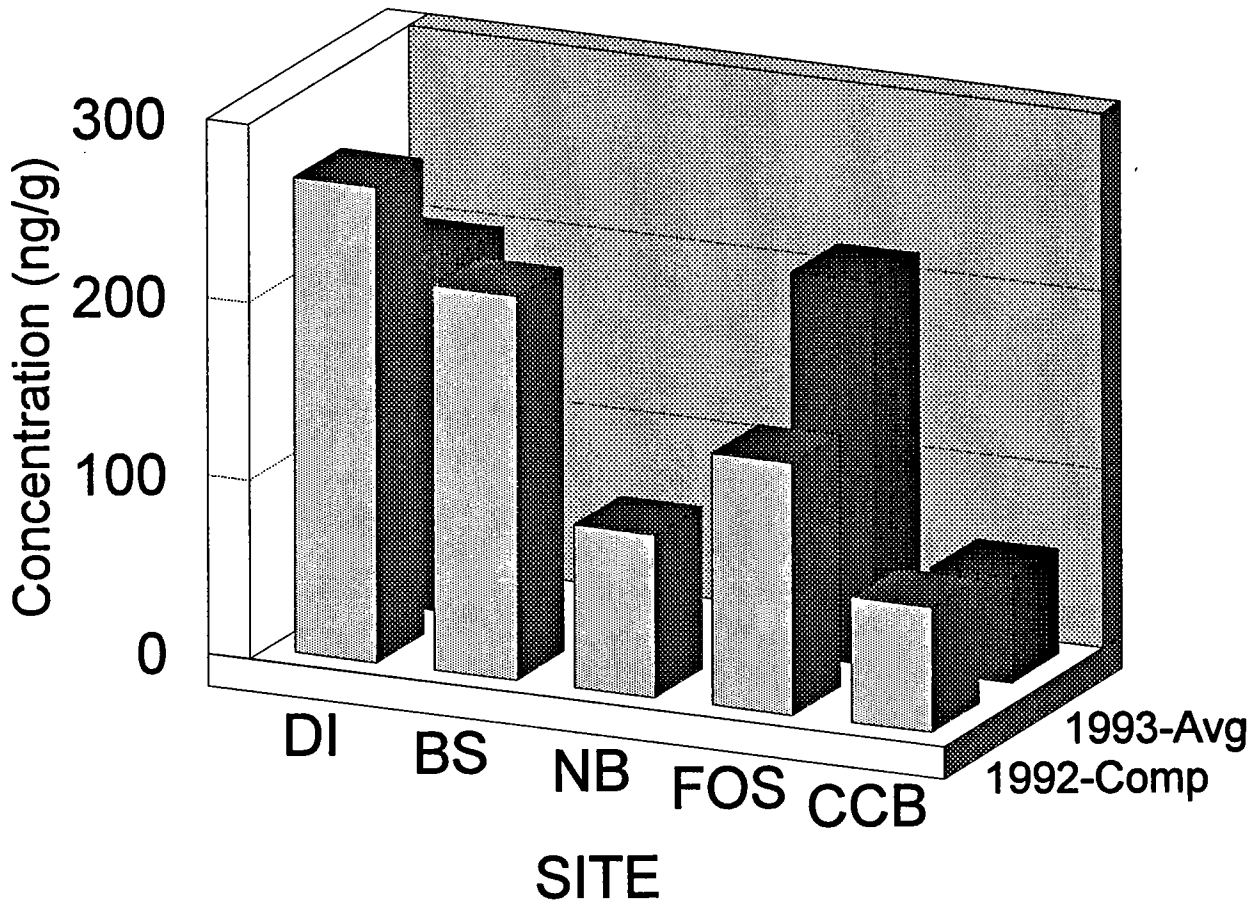


Figure 14. **Comparison of 1992 and 1993 total PCB concentrations in flounder tissue (dry wt).**

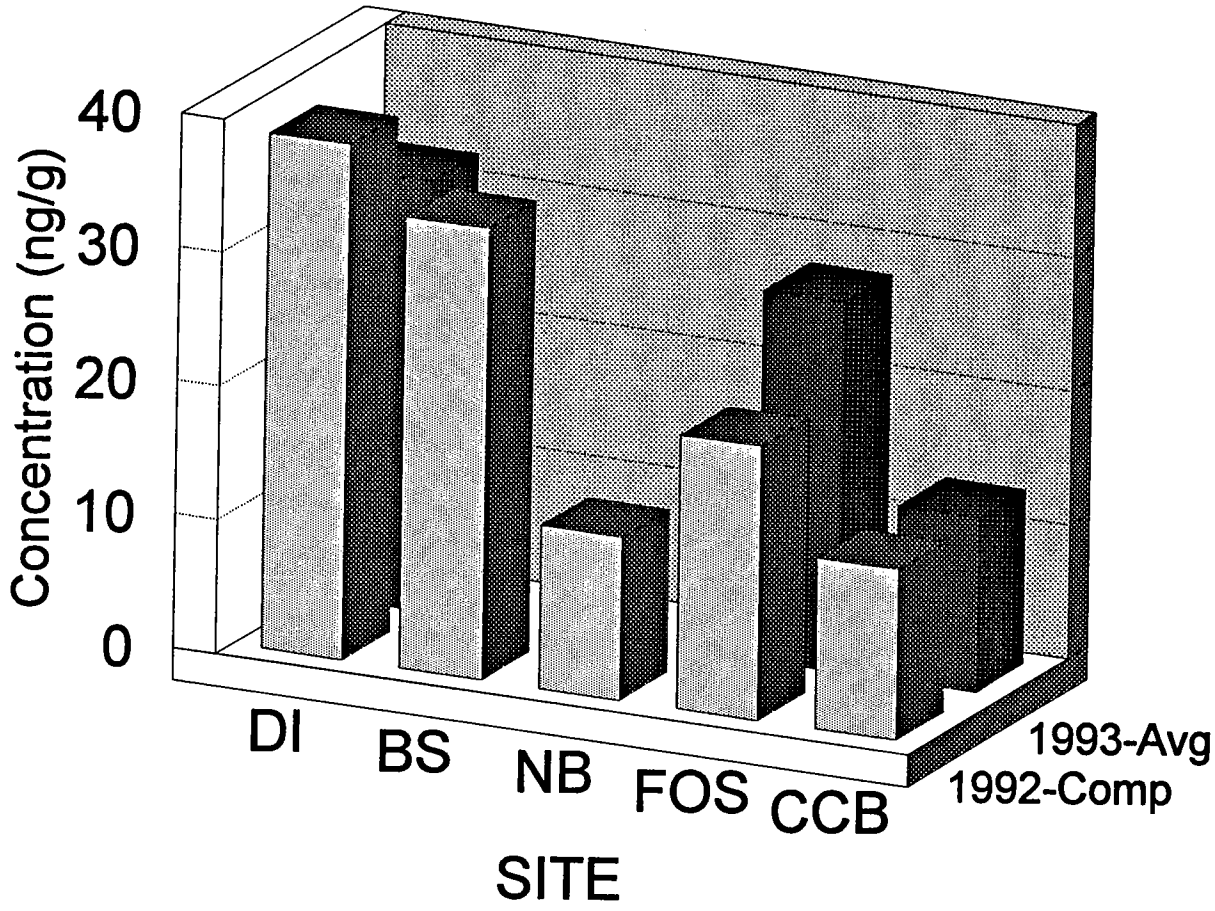


Figure 15. **Comparison of 1992 and 1993 total DDT concentration in flounder tissue (dry wt).**

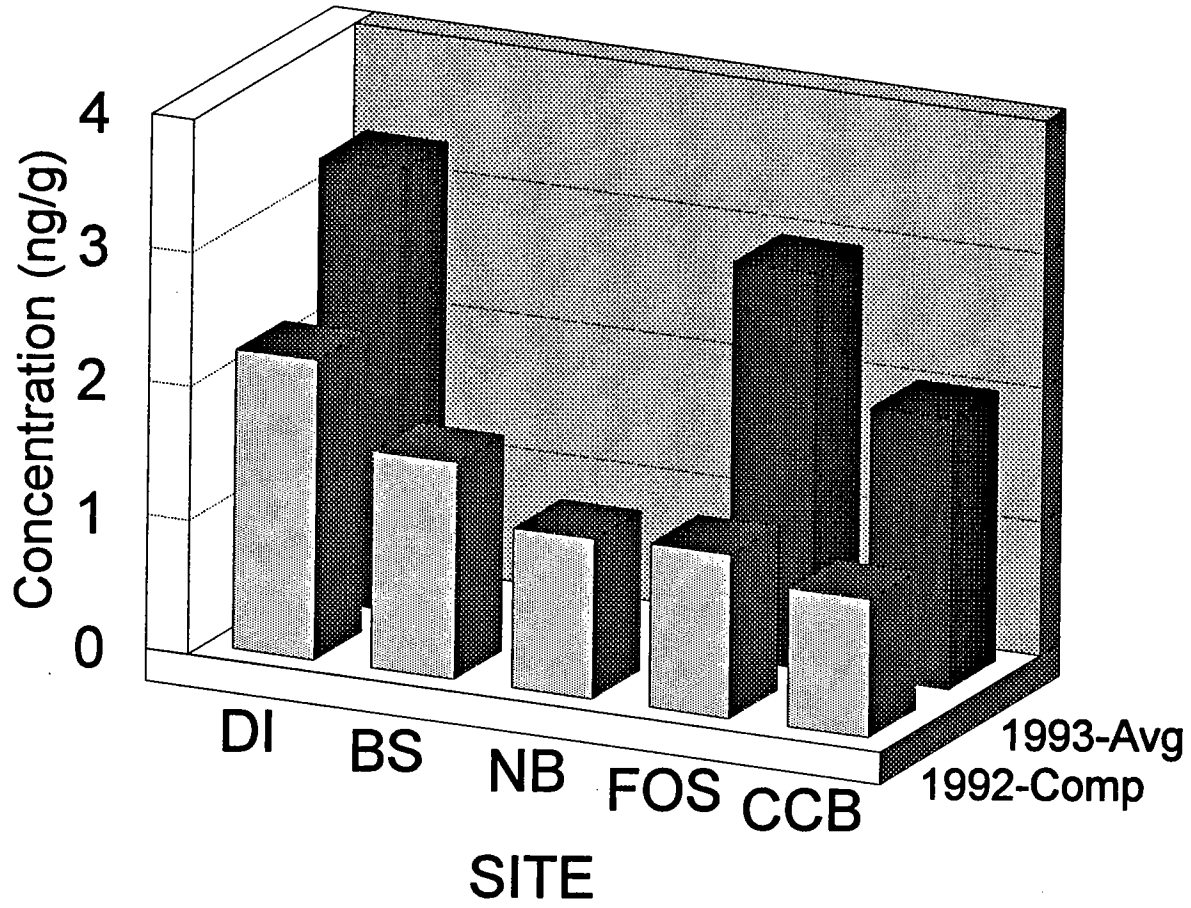


Figure 16. **Comparison of 1992 and 1993 dieldrin concentrations in flounder tissue (dry wt).**

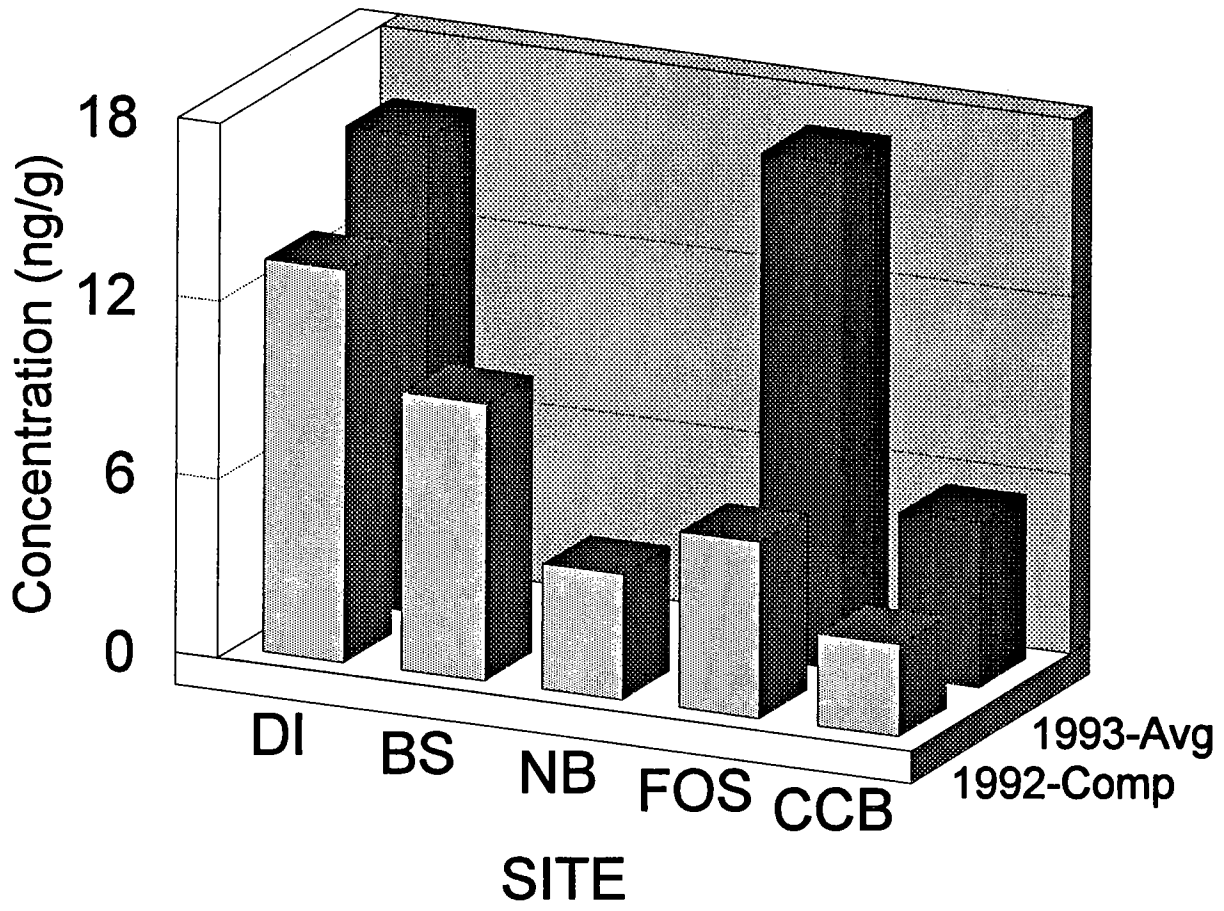


Figure 17. **Comparison of 1992 and 1993 chlordane concentrations in flounder tissue (dry wt).**

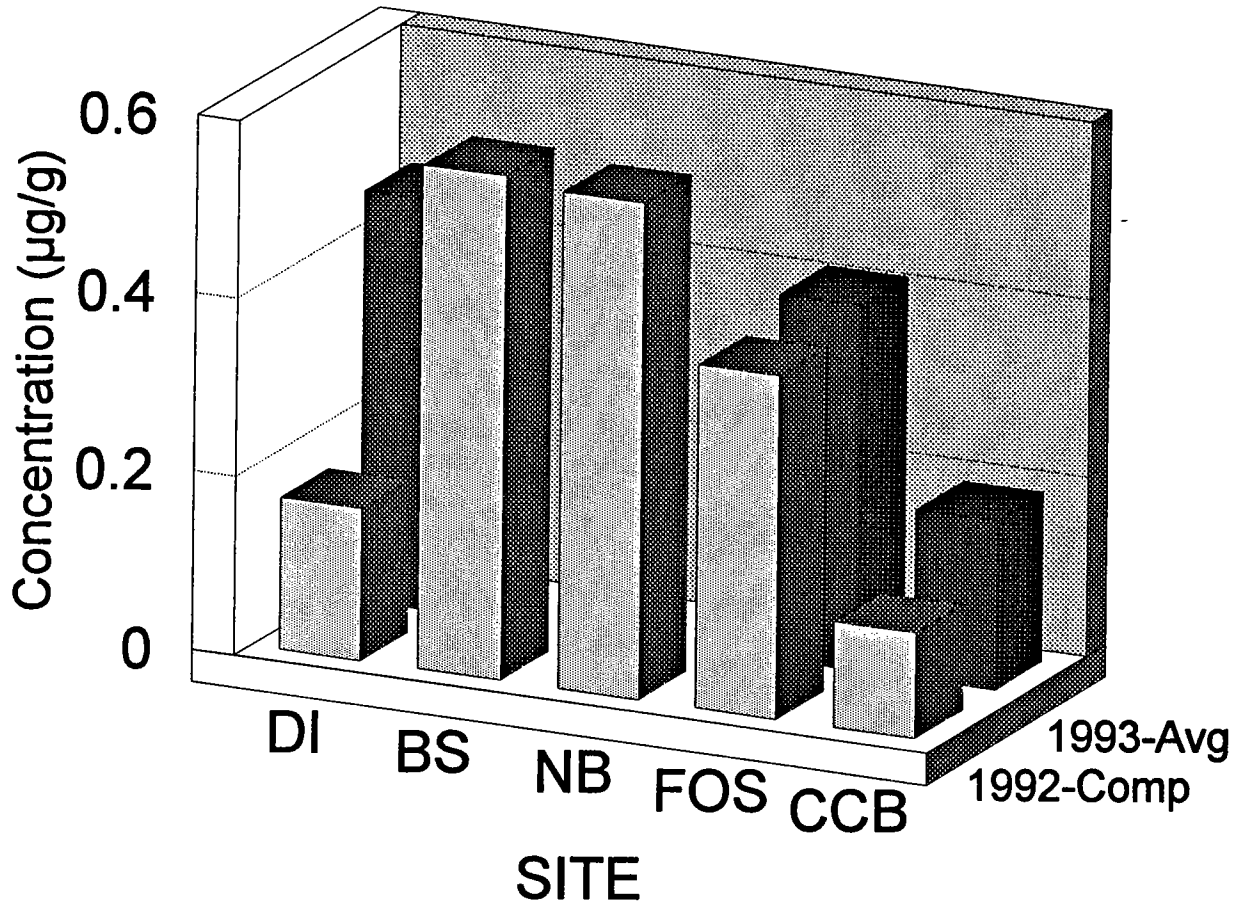


Figure 18. **Comparison of 1992 and 1993 mercury concentrations in flounder tissue (dry wt).**

3.3.2 Composite Flounder Liver Analyses

Direct comparisons between the 1992 and 1993 results were made for composite flounder livers and are illustrated in Figures 19 through 24. A comparison of contaminant concentrations between flounder tissue and flounder livers from year to year and site to site did not show any specific relationship except for total PCB (Figures 14 and 20). In this one case, total PCB concentrations in muscle and liver tissues either increased or decreased in a similar manner from year to year depending on site. The 1992 composited liver sample consisted of seven individuals and the 1993 composite was made up of ten individuals. The concentrations of dieldrin (Figure 22), mercury (Figure 24), and total PAH (Figure 19) in the composite flounder livers showed little change at Deer Island, whereas the concentrations of total chlordane (Figure 23) and total PCB declined. The concentration of total DDT (Figure 21) at Deer Island and at the Future Outfall Site rose significantly from the previous year. A twofold increase in the concentration of dieldrin was observed at the Future Outfall Site. Concentrations of contaminants in the composite liver samples at Eastern Cape Cod Bay remained relatively unchanged from 1992 to 1993, with the exception of mercury and total PAH which fell sharply by a factor of three in 1993.

3.3.3 Lobster Tissue Analyses

A total of 15 lobsters was collected at Deer Island, Future Outfall Site, and Eastern Cape Cod Bay. The results from the analysis of individual lobsters are available for tissue and hepatopancreas samples for both 1992 and 1993. The average contaminant concentrations in the lobster tissue are plotted in Figures 25 through 29. The concentrations of dieldrin (Figure 27), total DDT (Figure 26), total PCB (Figure 25), and total chlordane (Figure 28) all showed a substantial rise at Deer Island in 1993, whereas the concentration of mercury (Figure 29) in lobster tissue decreased. The Future Outfall Site and the Eastern Cape Cod Bay site showed little change from year to year, except for total DDT which declined moderately in 1993. It should be pointed out that year to year changes in lobster tissue contaminant levels could appear to vary considerably because of the low sample sizes available for most tissue/site combinations.

3.3.4 Lobster Hepatopancreas Analyses

The trends of contaminant concentrations noted in the edible tissue were not observed in the lobster hepatopancreas (Figures 30 through 35). The concentration of dieldrin in the lobster hepatopancreas (Figure 33) showed a significant increase at Deer Island, Future Outfall Site, and Eastern Cape Cod Bay in 1993. Total chlordane (Figure 34) and total PCB (Figure 31) concentrations also increased at Eastern Cape Cod Bay in 1993, although these concentrations remained relatively consistent at Deer Island and the Future Outfall Site. The largest decrease was observed for total PAH (Figure 30) at Deer Island, which dropped from 30 μg/g in 1992 to 12 μg/g in 1993. Mercury concentrations in lobster hepatopancreas (Figure 35) from the Future Outfall Site and Eastern Cape Cod Bay were noticeably lower in 1993 than in 1992. One hepatopancreas contained <0.003 μg/g of mercury. This level was not used in the calculation of mean contaminant levels. Total DDT concentrations (Figure 32) showed no major differences from the previous year.

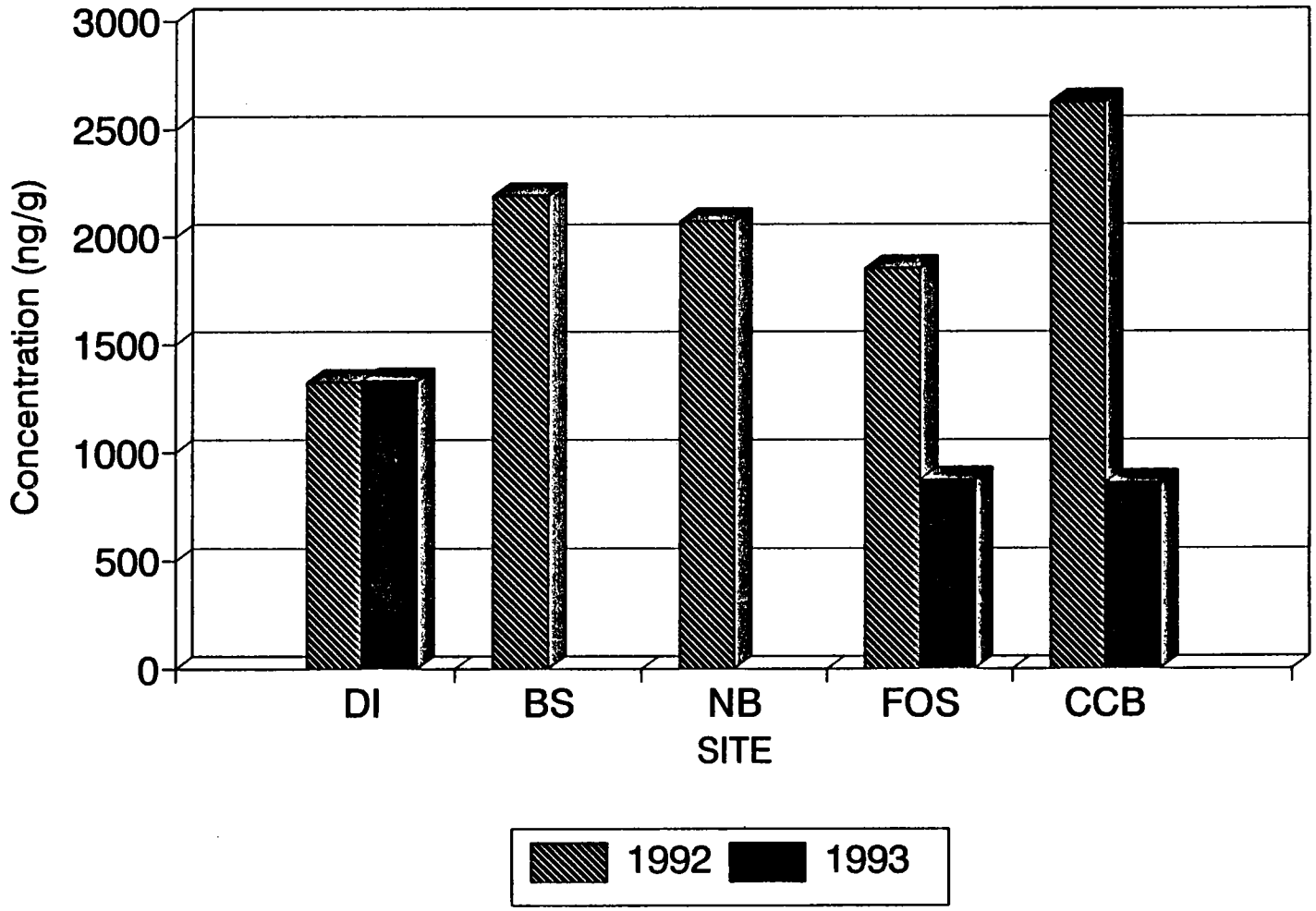


Figure 19. **Comparison of 1992 and 1993 total PAH concentrations in composite flounder livers (dry wt).**

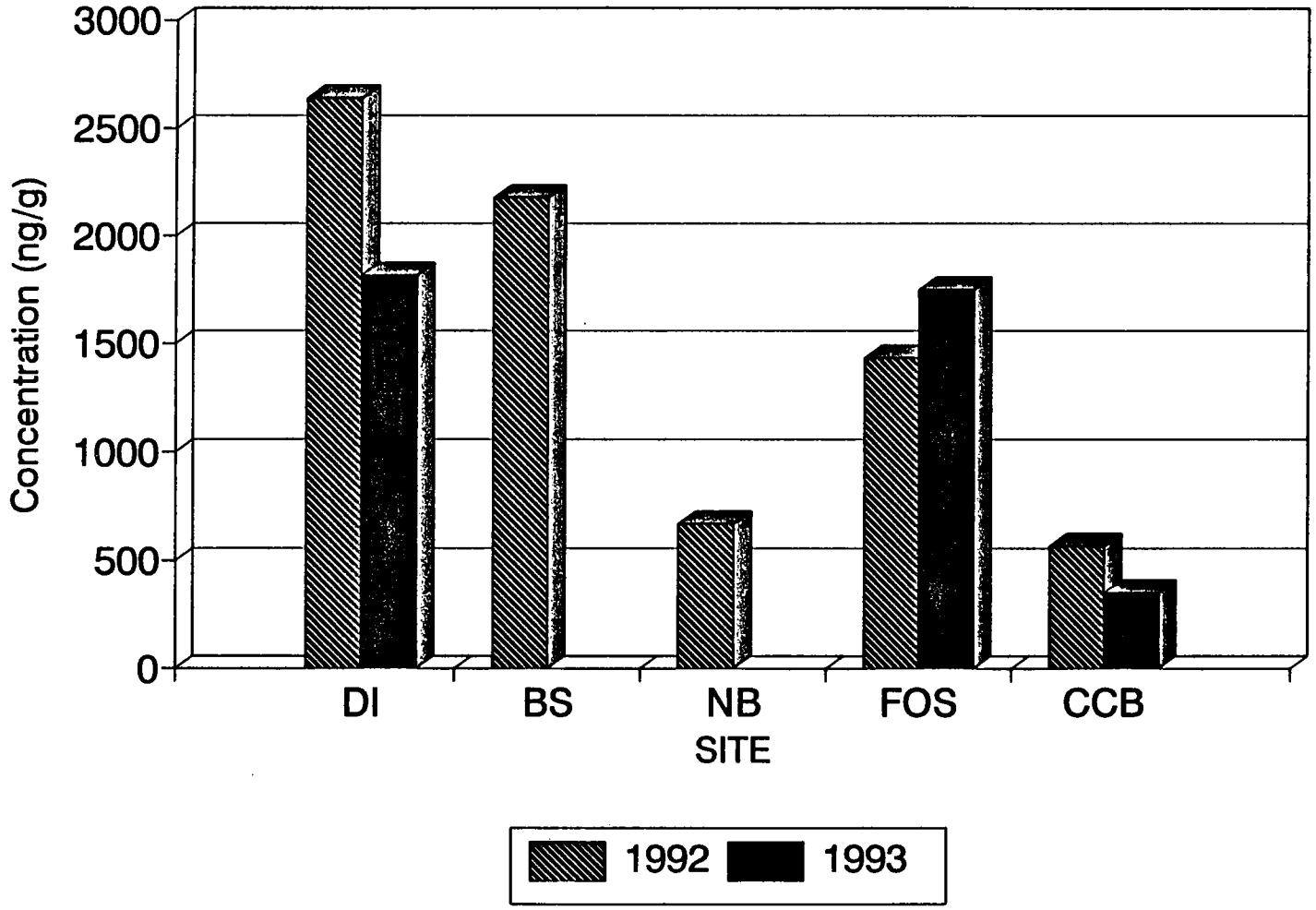


Figure 20. **Comparison of 1992 and 1993 total PCB concentrations in composite flounder livers (dry wt).**

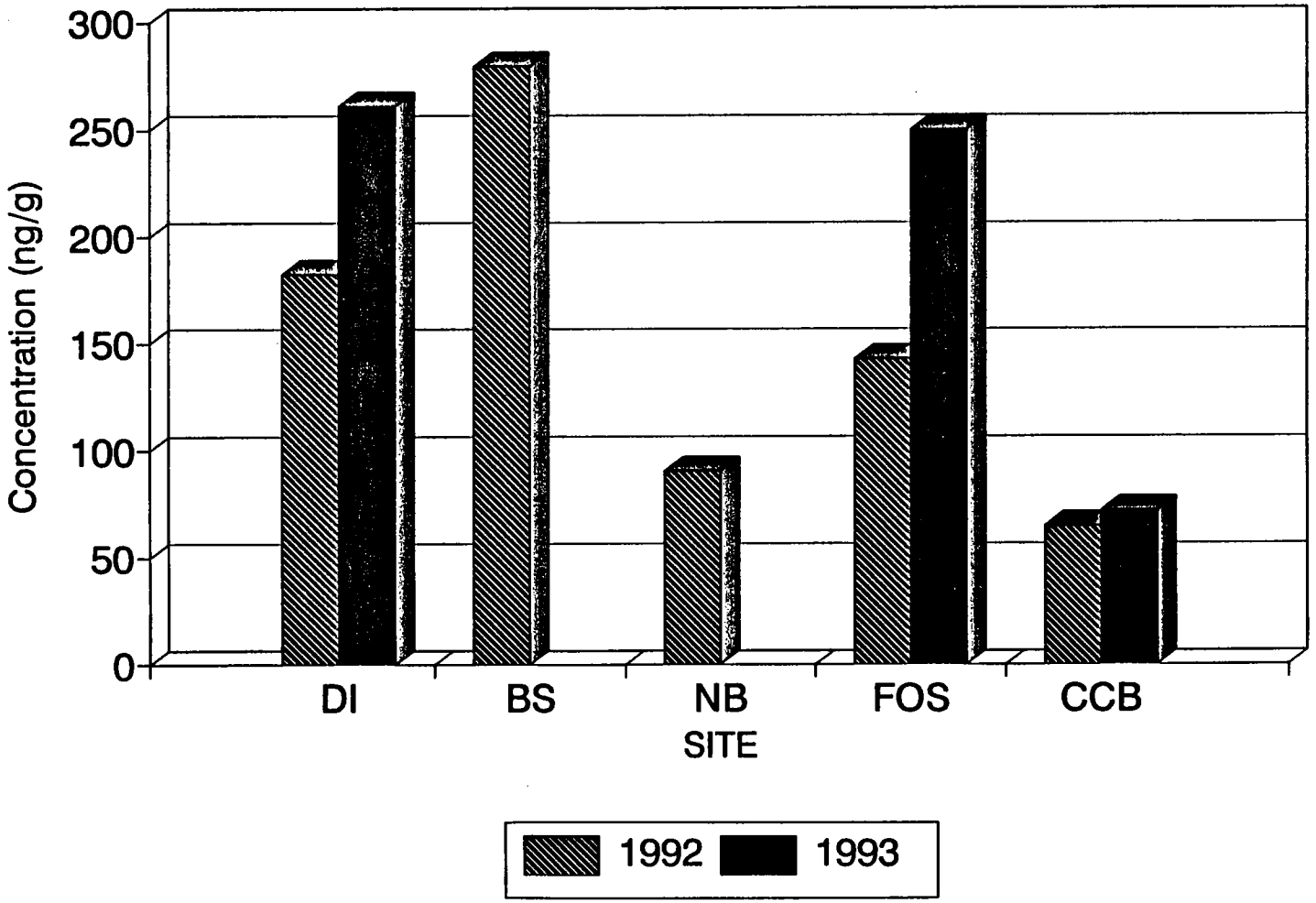


Figure 21. **Comparison of 1992 and 1993 total DDT concentrations in composite flounder livers (dry wt).**

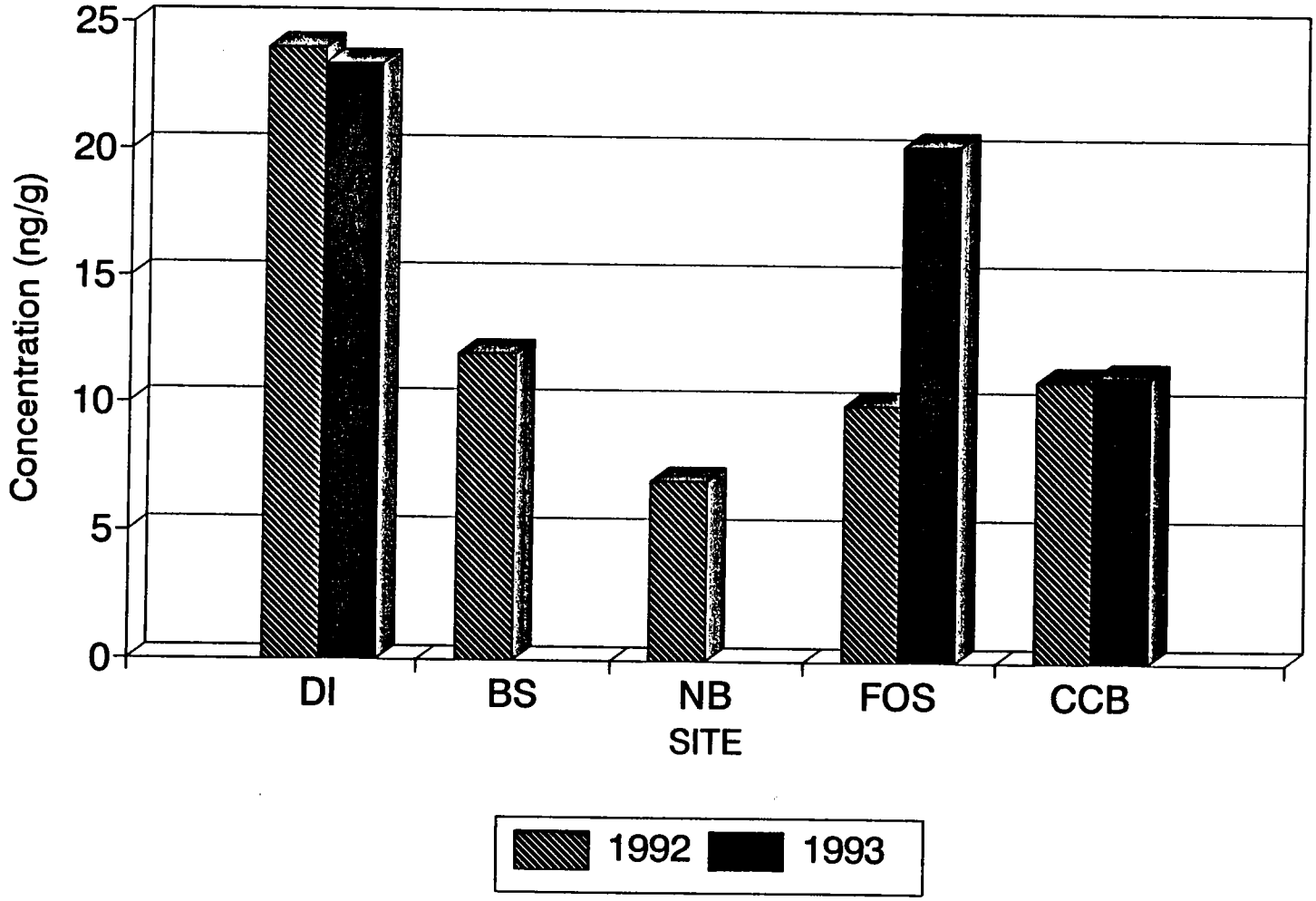


Figure 22. **Comparison of 1992 and 1993 dieldrin concentrations in composite flounder livers (dry wt.)**

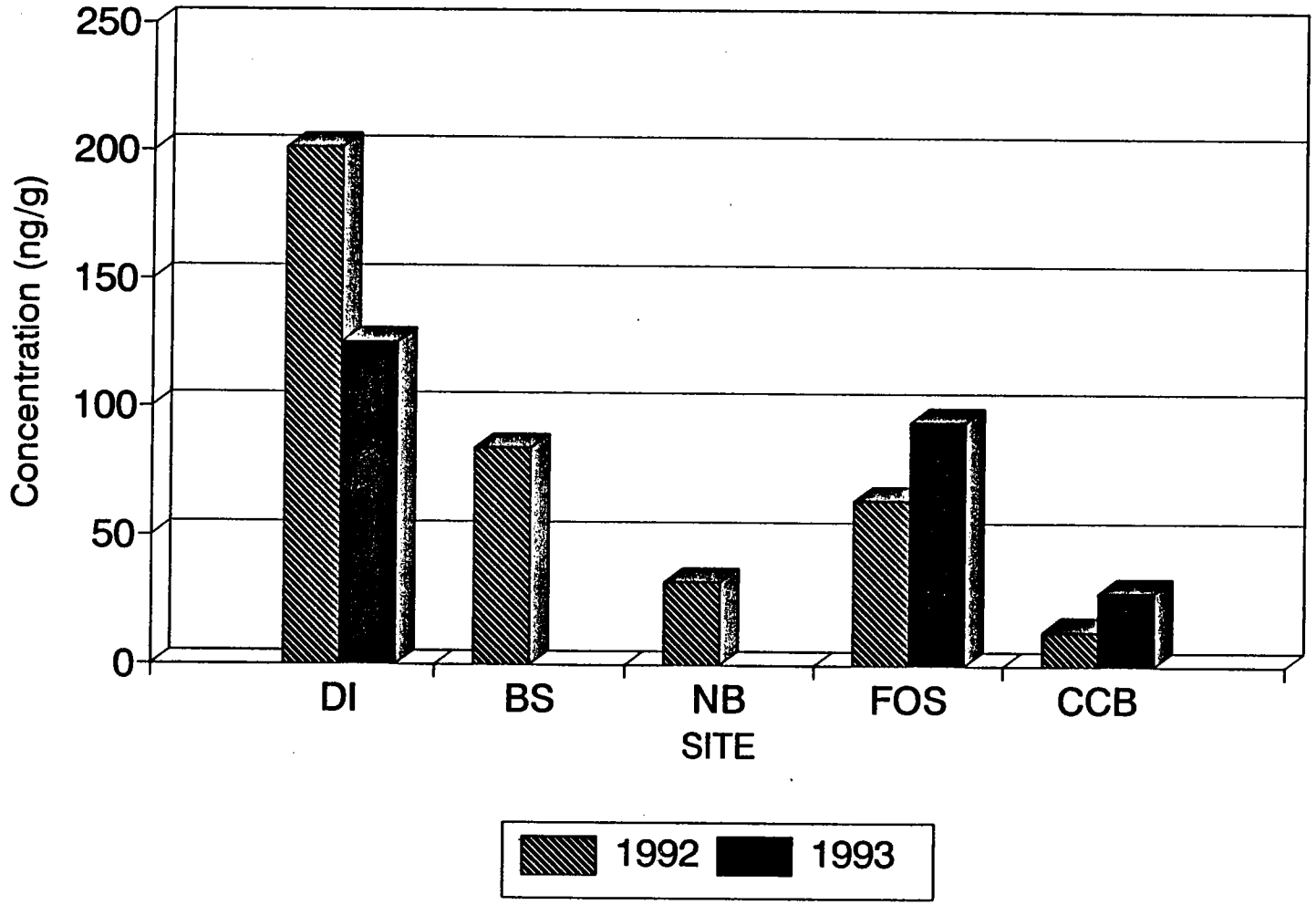


Figure 23. **Comparison of 1992 and 1993 chlordane concentrations in composite flounder livers (dry wt).**

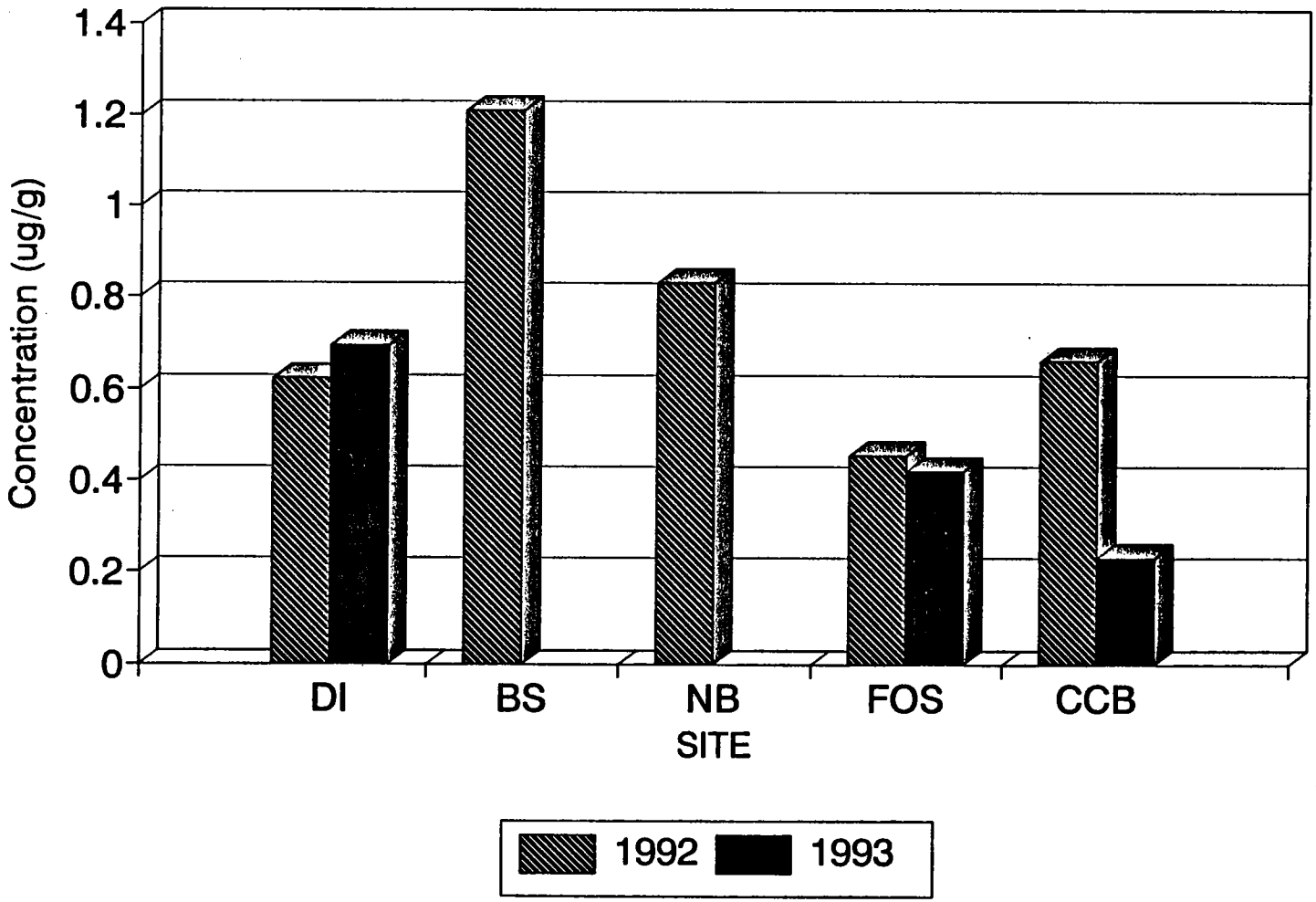


Figure 24. **Comparison of 1992 and 1993 mercury concentrations in composite flounder livers (dry wt).**

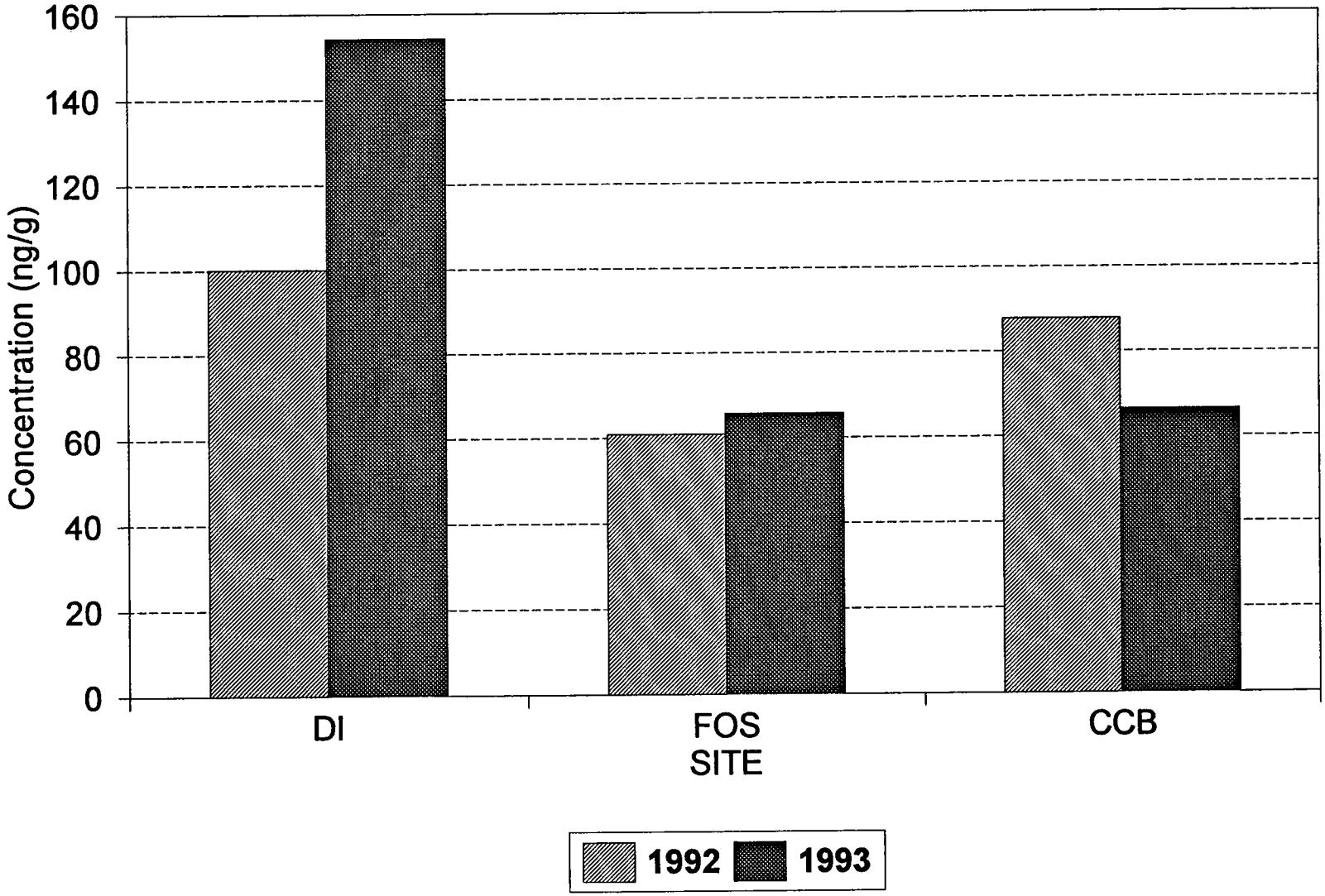


Figure 25. **Comparison of 1992 and 1993 total PCB concentrations in lobster tissue (dry wt).**

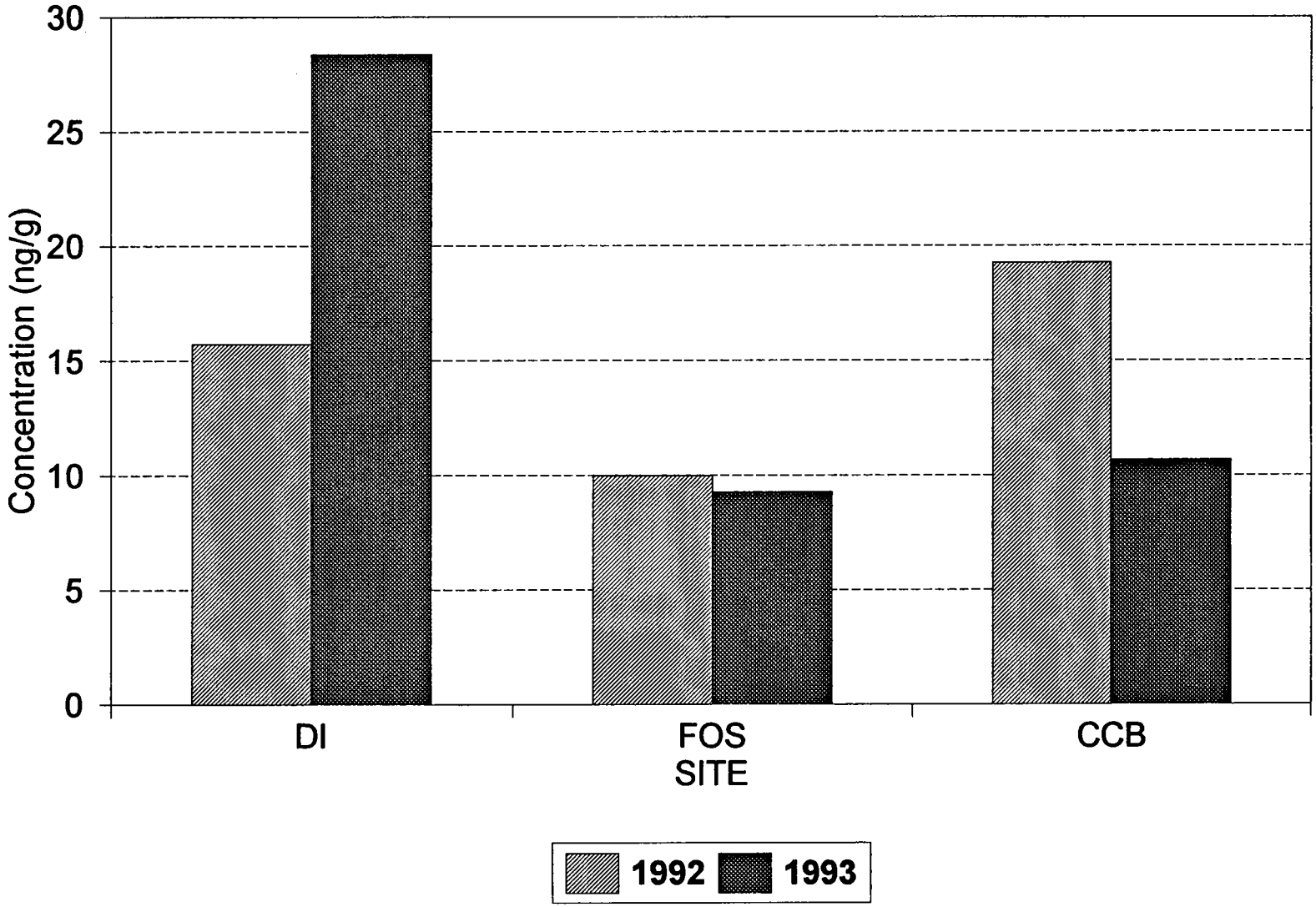


Figure 26. **Comparison of 1992 and 1993 total DDT concentrations in lobster tissue (dry wt).**

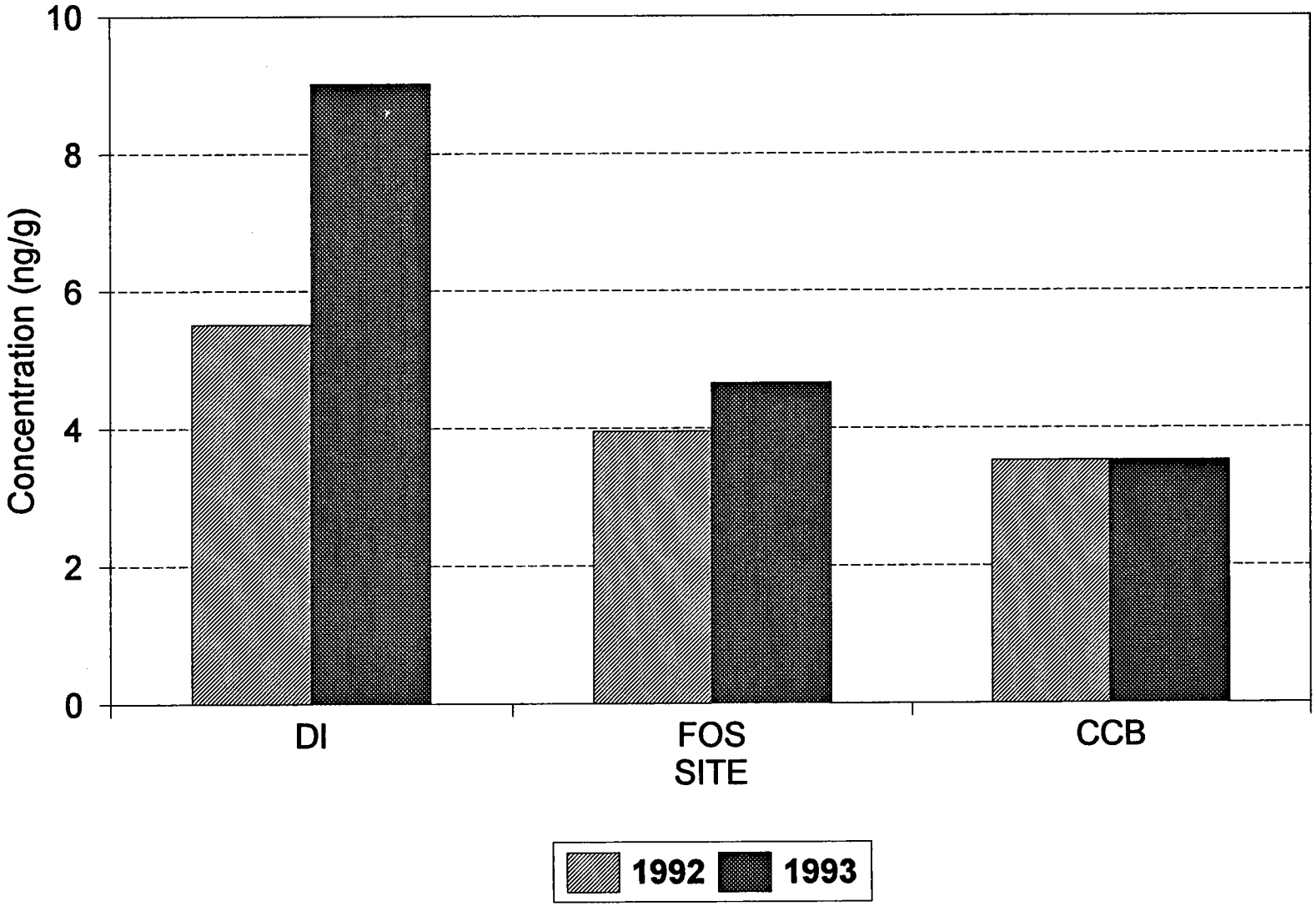


Figure 27. Comparison of 1992 and 1993 dieldrin concentrations in lobster tissue (dry wt).

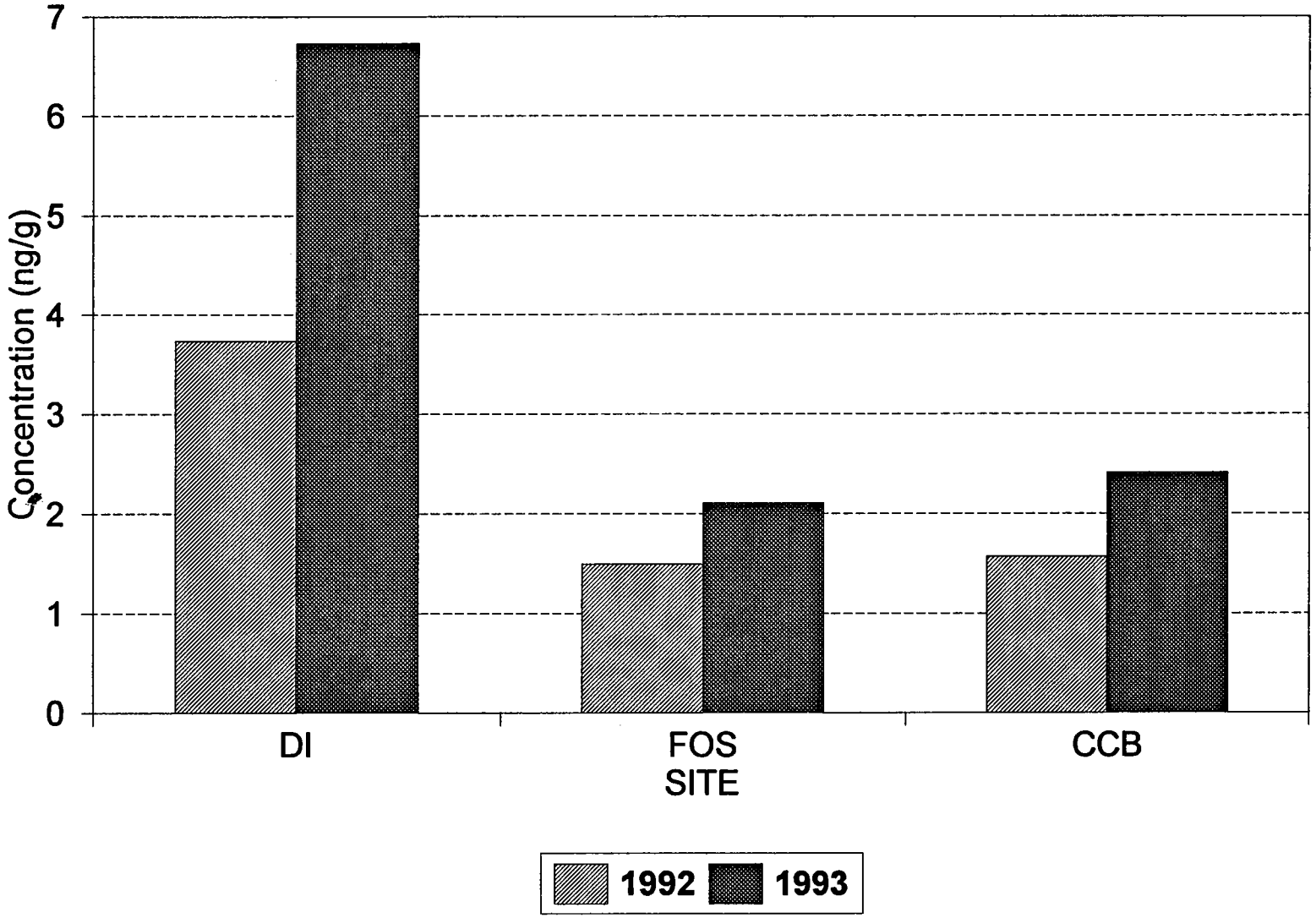


Figure 28. Comparison of 1992 and 1993 chlordane concentrations in lobster tissue (dry wt).

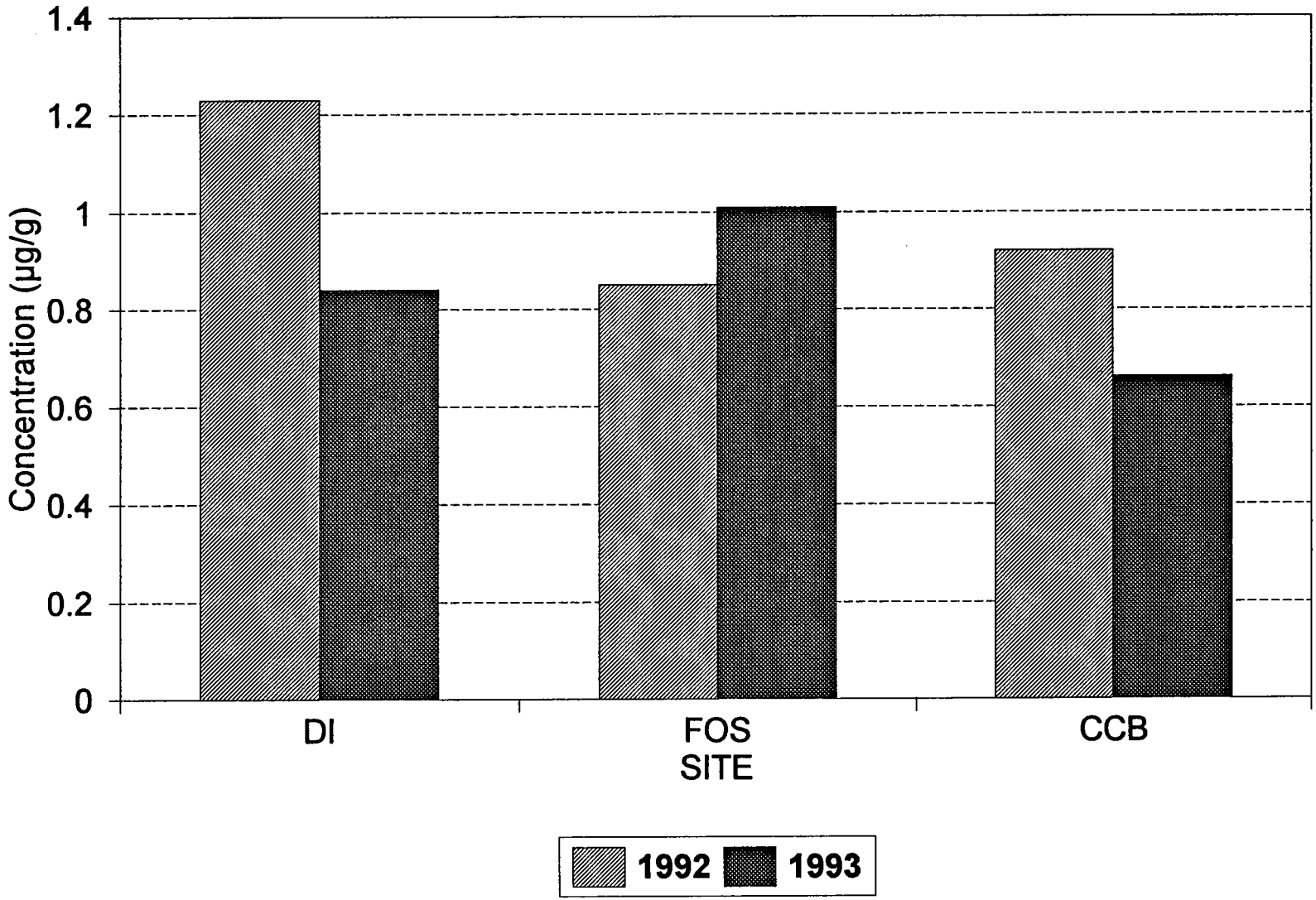


Figure 29. **Comparison of 1992 and 1993 mercury concentrations in lobster tissue (dry wt).**

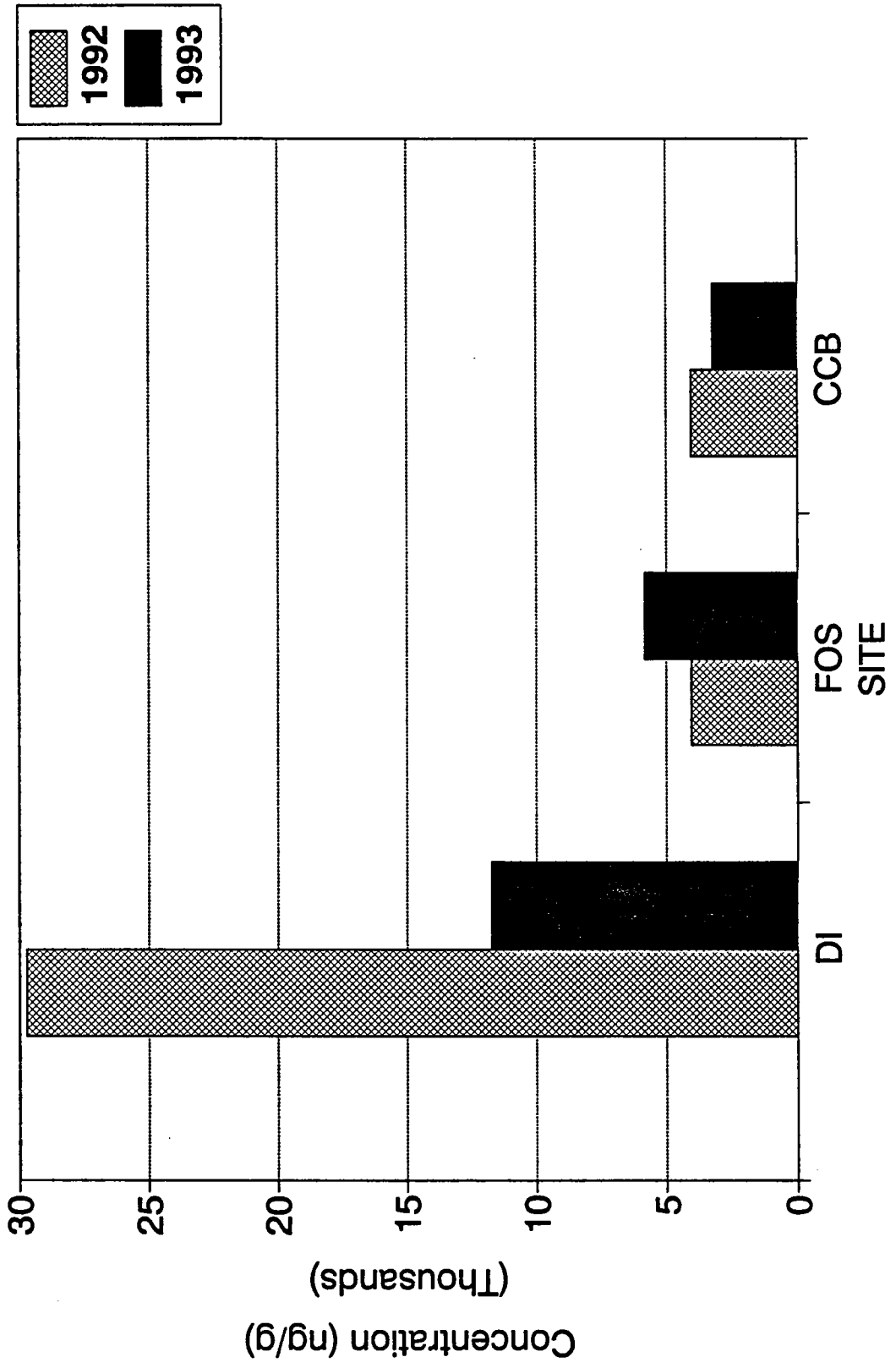


Figure 30. Comparison of 1992 and 1993 total PAH concentrations in lobster hepatopancreas (dry wt).

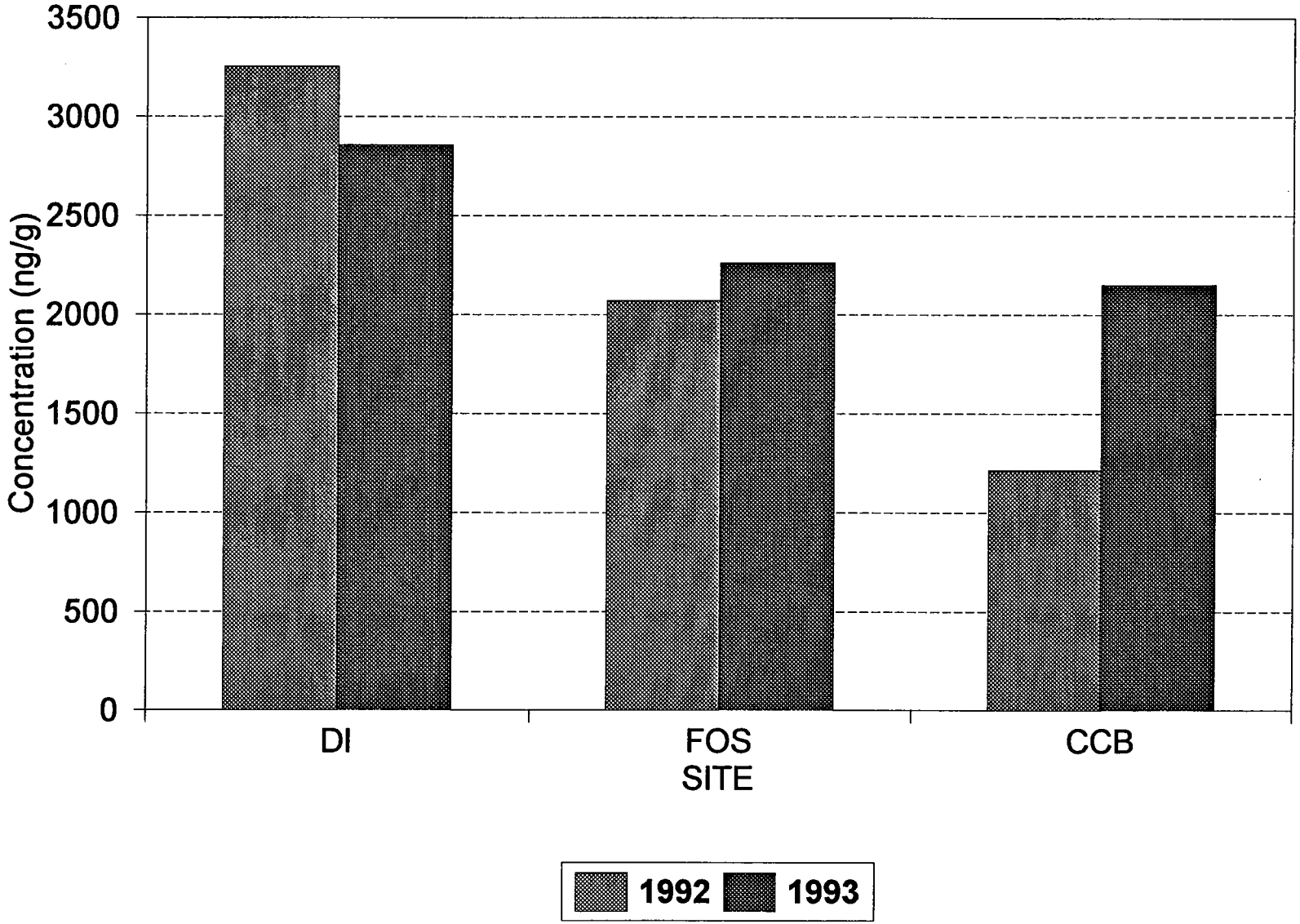


Figure 31. **Comparison of 1992 and 1993 total PCB concentrations in lobster hepatopancreas (dry wt).**

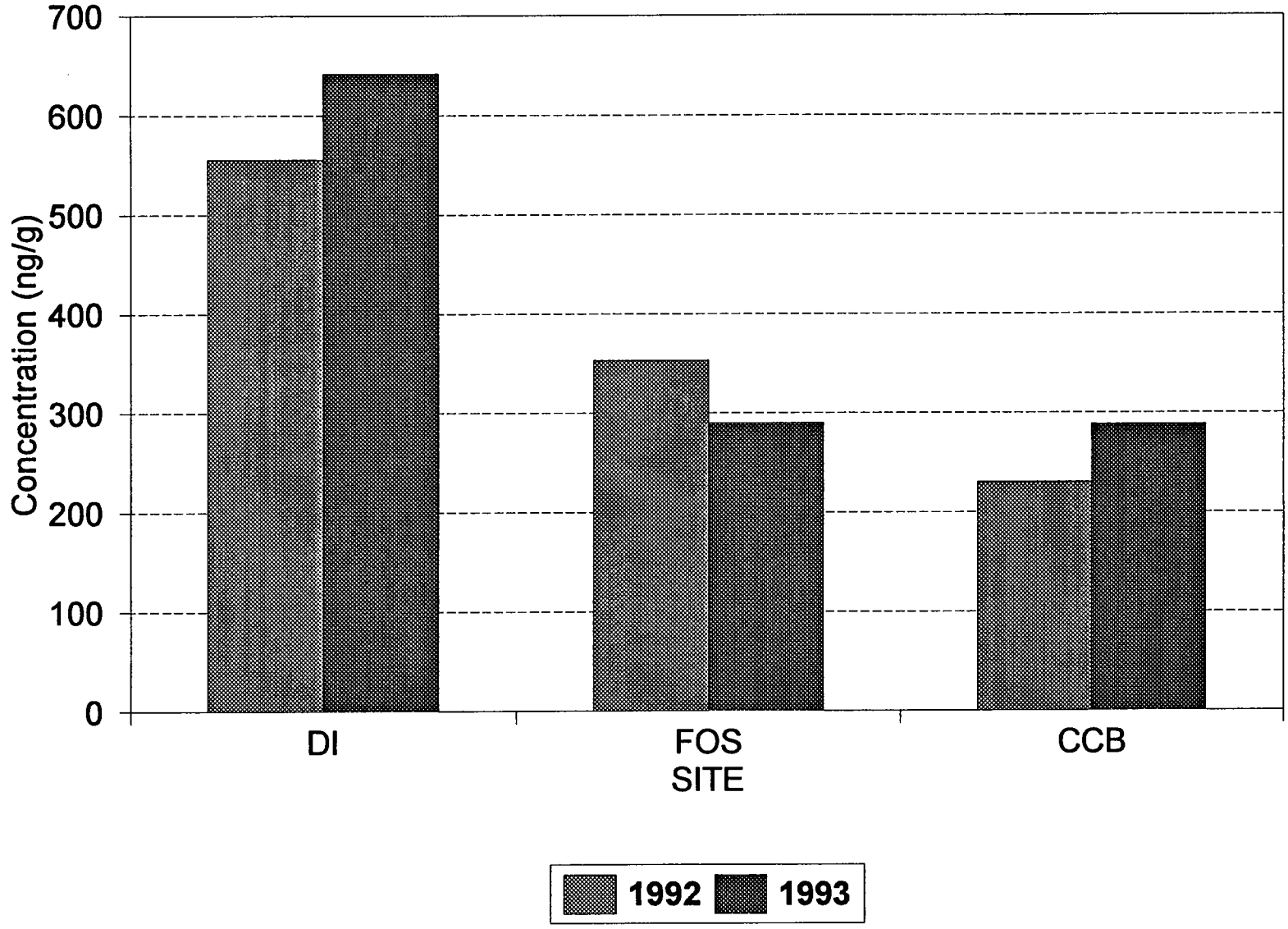


Figure 32. **Comparison of 1992 and 1993 DDT concentrations in lobster hepatopancreas (dry wt).**

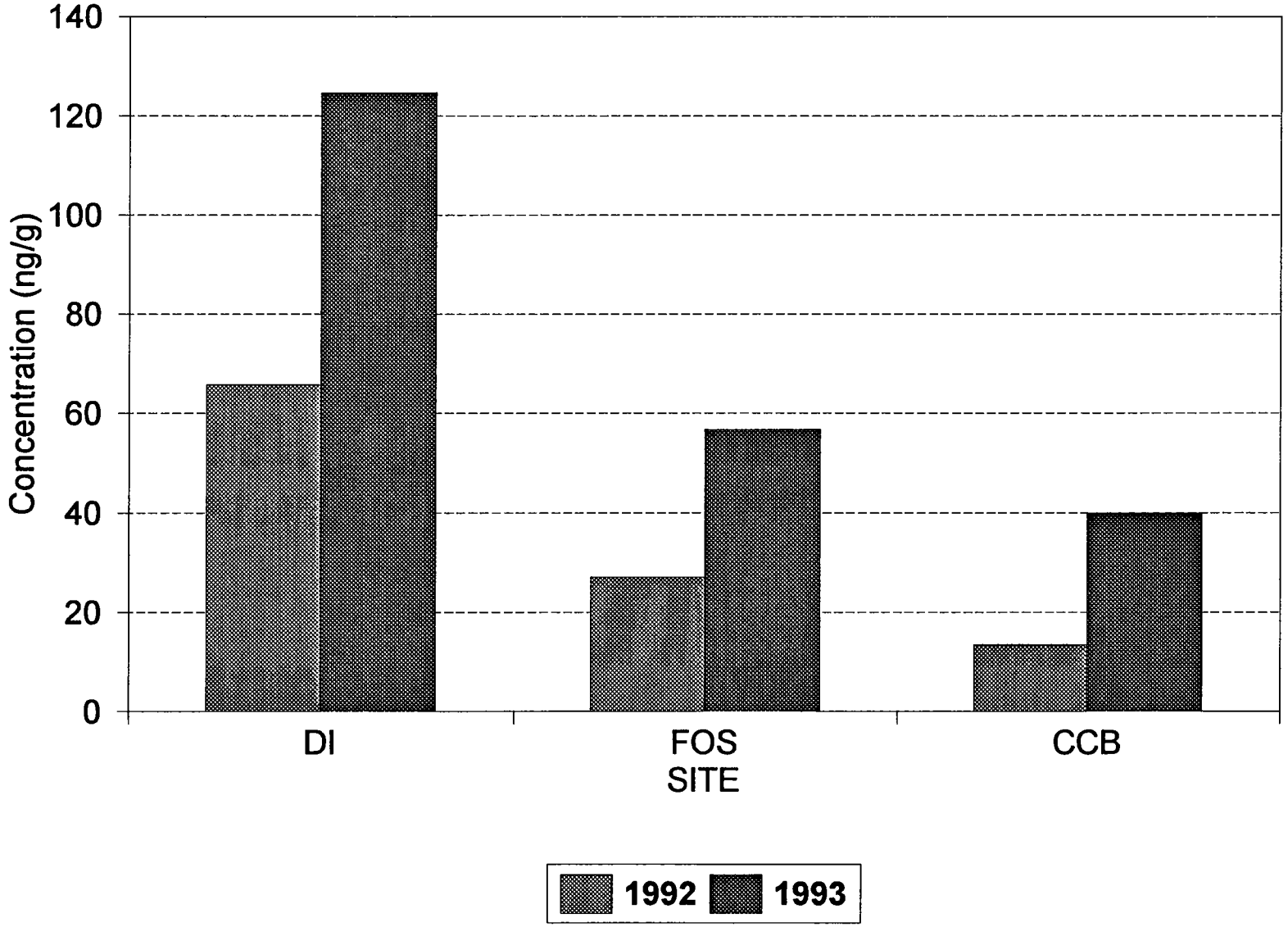


Figure 33. **Comparison of 1992 and 1993 dieldrin concentrations in lobster hepatopancreas (dry wt).**

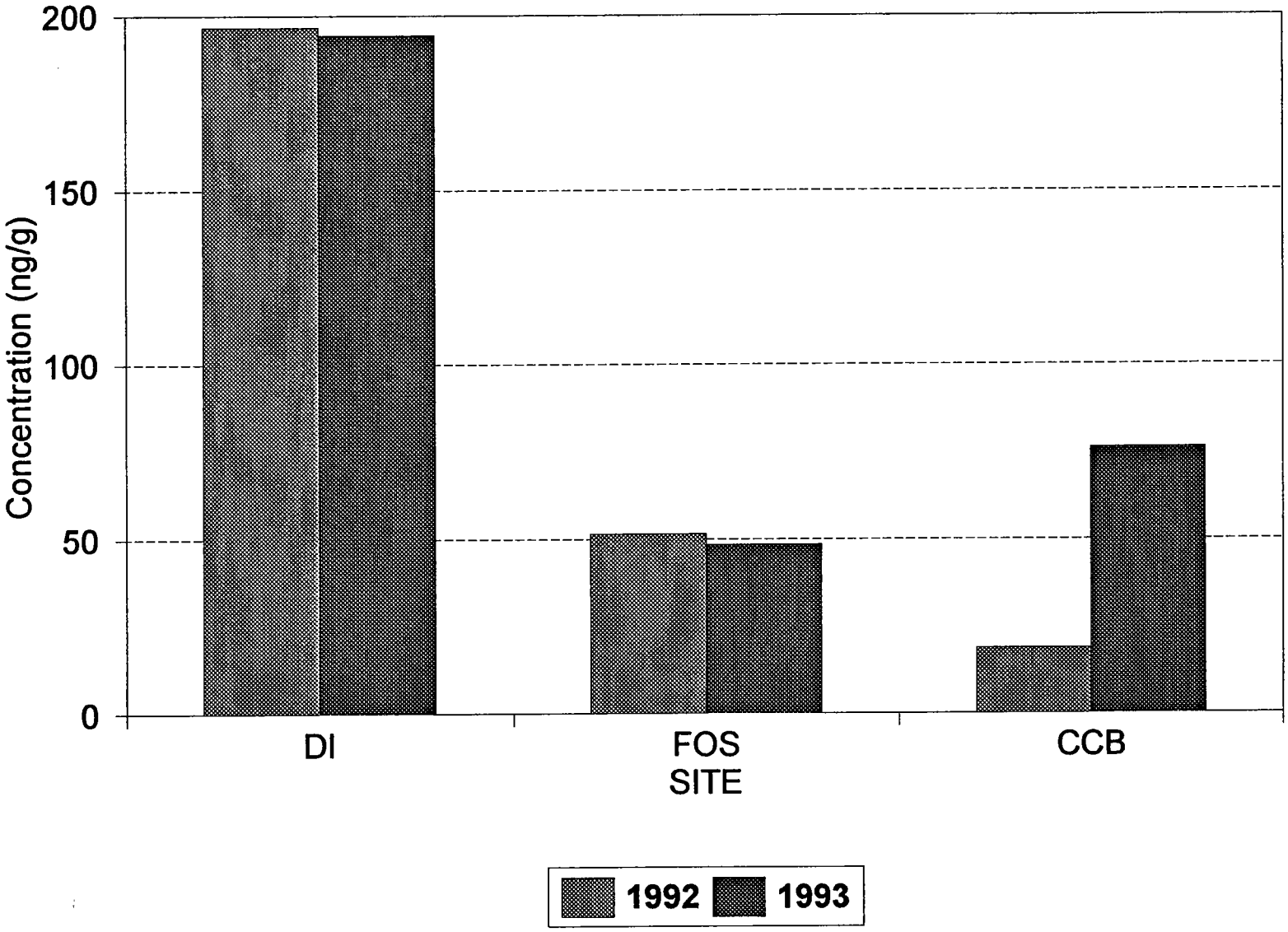


Figure 34. **Comparison of 1992 and 1993 chlordane concentrations in lobster hepatopancreas (dry wt).**

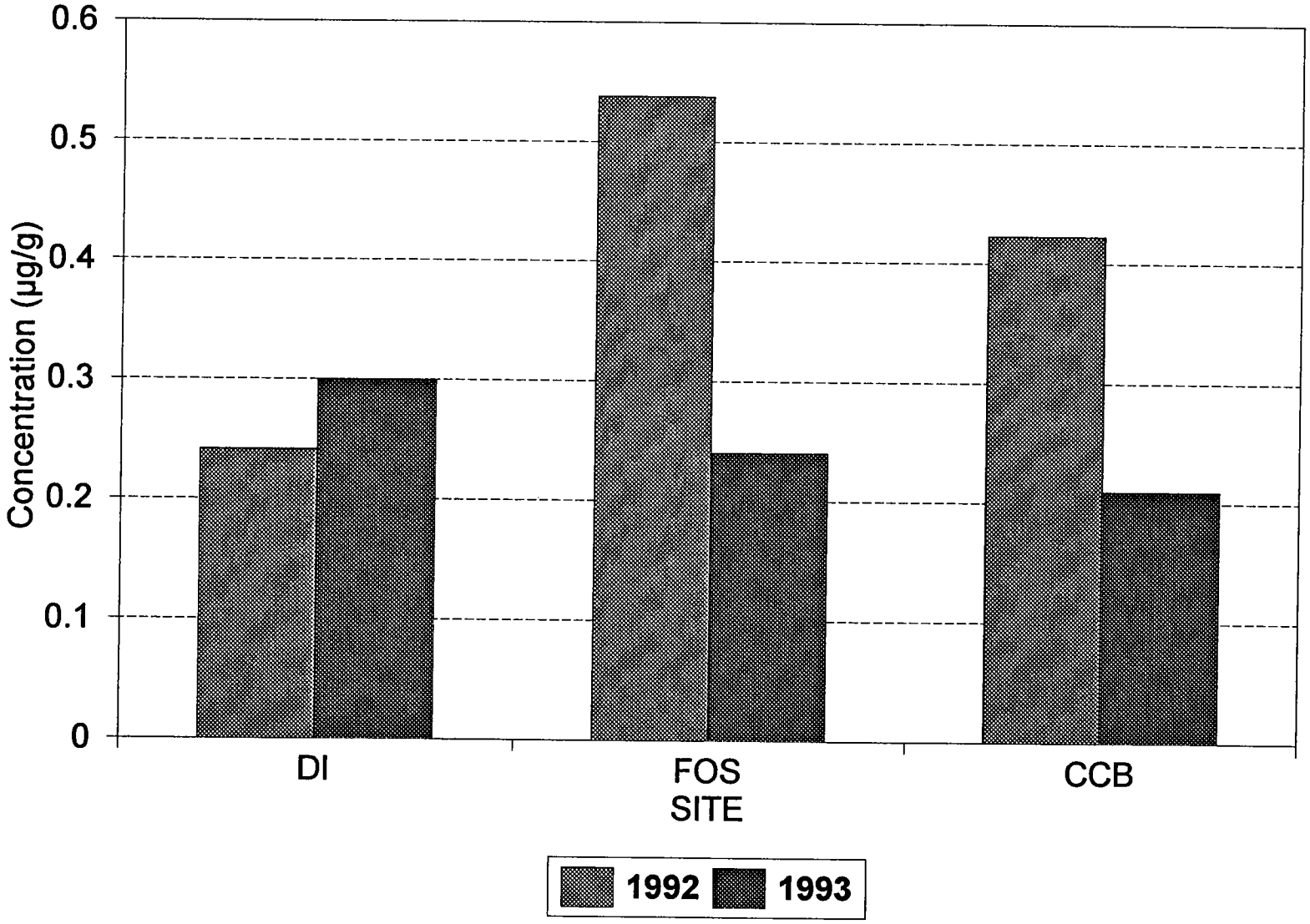


Figure 35. **Comparison of 1992 and 1993 mercury concentrations in lobster hepatopancreas (dry wt).**

The lobster hepatopancreas samples from Deer Island, the Future Outfall Site, and Eastern Cape Cod Bay were also analyzed for Ag, Cd, Cr, Cu, Pb, Ni, and Zn (Figures 36 through 42). The most dramatic change in 1993 was apparent at Deer Island where the concentration of Cu (Figure 39) increased threefold, in contrast to Cd (Figure 37) which decreased tenfold. The concentrations of Cr (Figure 38) also decreased consistently in 1993 at the three sampling sites. The concentration of Pb (Figure 41) dropped sharply at Eastern Cape Cod Bay in 1993, although the data for 1992 may be suspect because they were not consistent with data from any of the other sites. Some of the minor fluctuations observed at the Future Outfall Site were insignificant due to the limited number of individuals analyzed and the large deviation around the average. The exceptions to this are the decreases measured for Cr at all three sites and the decreases observed for Cd, Cu, and Zn (Figure 42) at Eastern Cape Cod Bay.

3.3.5 Relationship of Contaminants to Pathology

The decision to chemically analyze tissues from only the three core sites in 1993 limited the ability to monitor the contaminant concentrations spatially, especially for the flounder tissue and composited liver samples, which were analyzed at all five sites in 1992. Additional data from Broad Sound and Nantasket Beach would be most useful when comparing the flounder composited liver results with the histology scores for the flounder livers available from all five sites. Figures 43 and 44 illustrate the relationship between prevalences of four histopathological lesions observed in flounder livers and the concentrations of selected analytes in the composited flounder livers. The histological prevalence and indices are available for all individual flounder livers collected in 1993. We chose not to use these data for comparison with the chemistry data and, instead, used only the pathology data for the 10 flounder livers used in the composite sample.

We do not suggest that a direct relationship exists between the contaminant body burdens and the prevalences of histopathological lesions. Figures 43 and 44 are only intended to show trends between the sites, and between the chemistry and the histopathology data. It is possible to infer an association between total PAH and the prevalence of "balloon" hepatocytes in flounder livers because they exhibit a similar trend, neither showing a decrease at Eastern Cape Cod Bay, unlike other contaminants and prevalence values. Additional chemistry data from all five sites would help to provide a better understanding of the relationship between contaminant body burdens and the prevalence of histopathological lesions.

3.4 Detectable Change in Contaminants in Fish and Shellfish

The results of the reverse power analysis carried out to address the level of detectable change in measured chemical and histopathological parameters are discussed below.

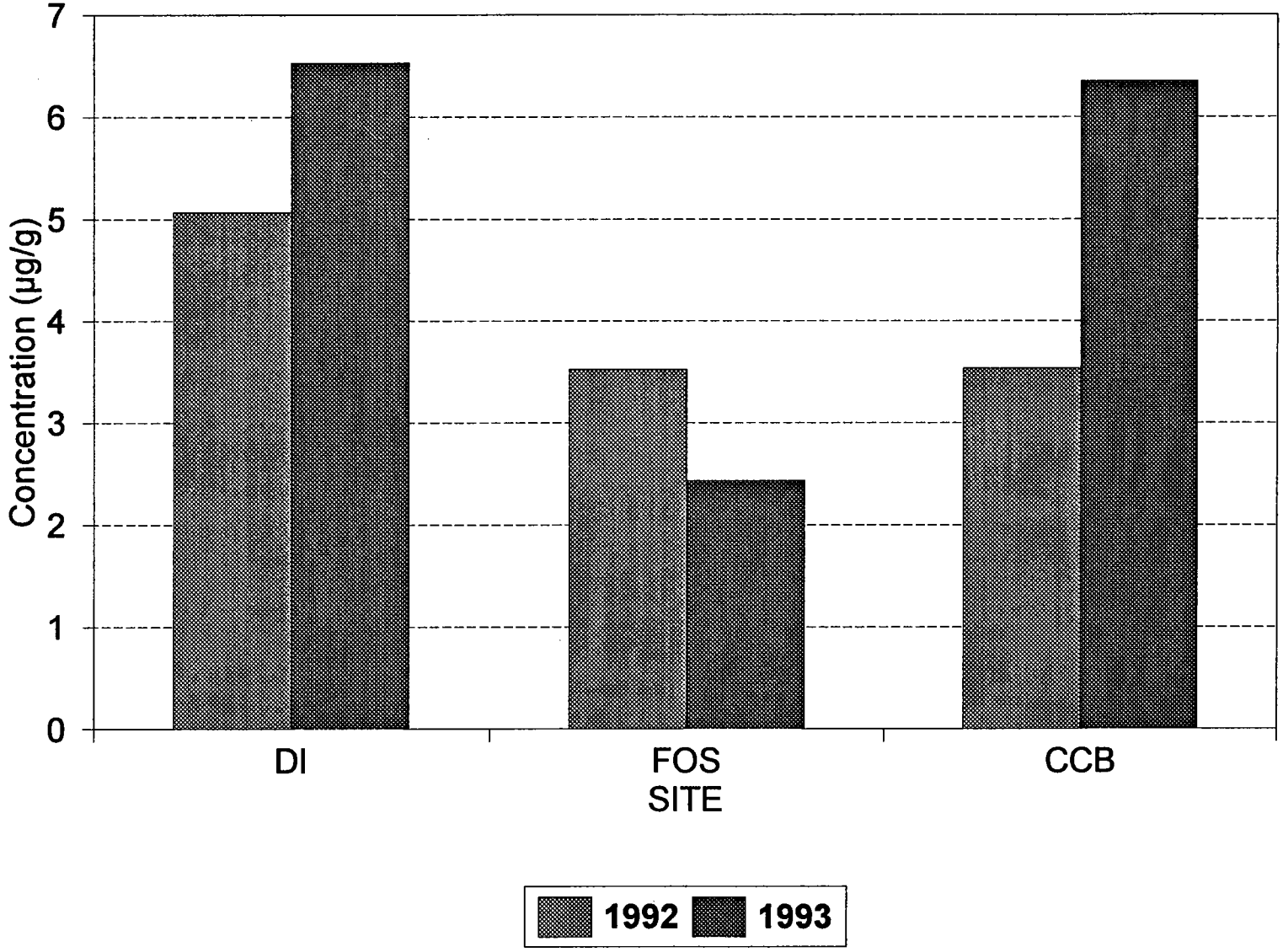


Figure 36. **Comparison of 1992 and 1993 silver concentrations in lobster hepatopancreas (dry wt).**

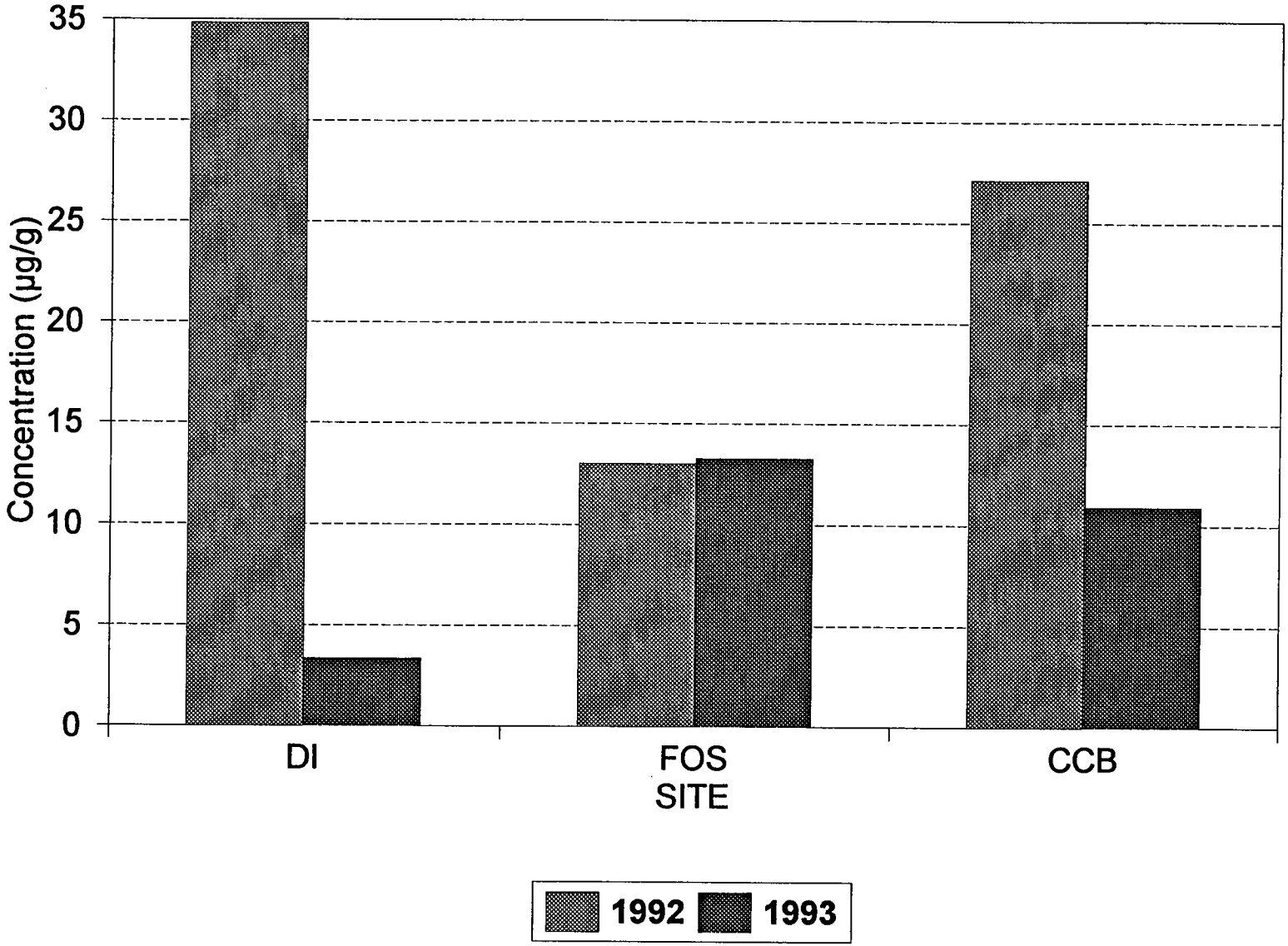


Figure 37. **Comparison of 1992 and 1993 cadmium concentrations in lobster hepatopancreas (dry wt).**

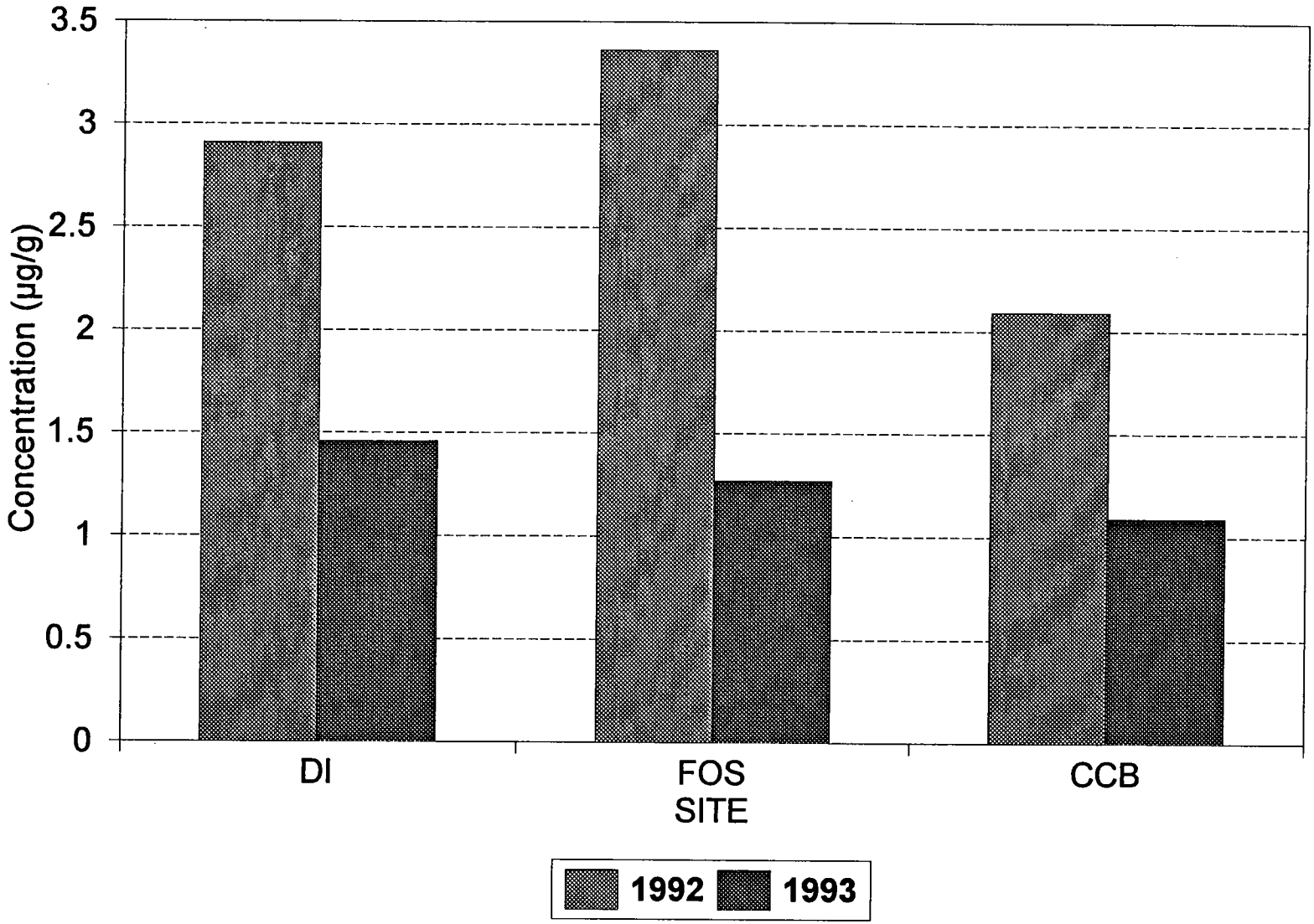


Figure 38. **Comparison of 1992 and 1993 chromium concentrations in lobster hepatopancreas (dry wt).**

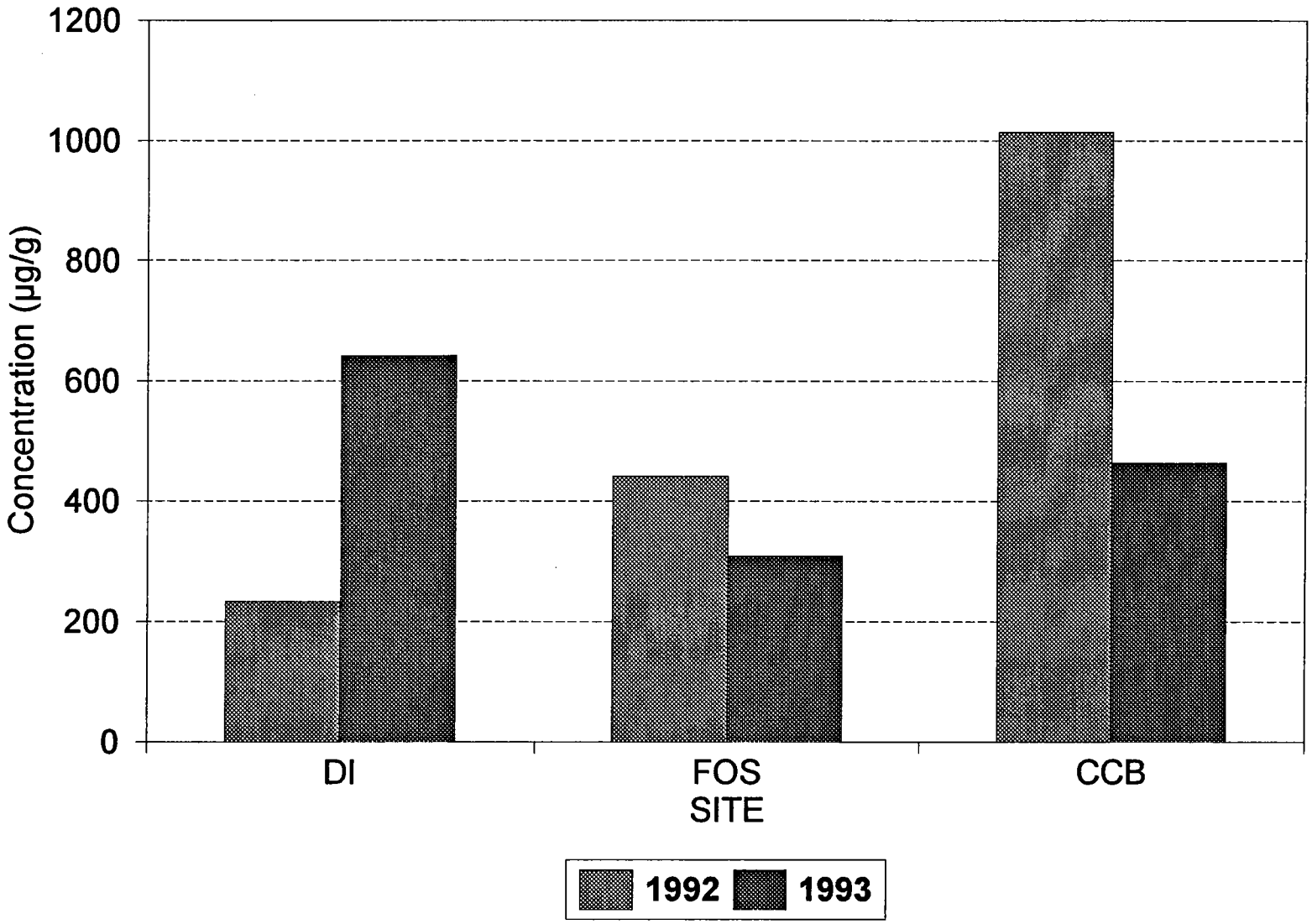


Figure 39. **Comparison of 1992 and 1993 copper concentrations in lobster hepatopancreas (dry wt).**

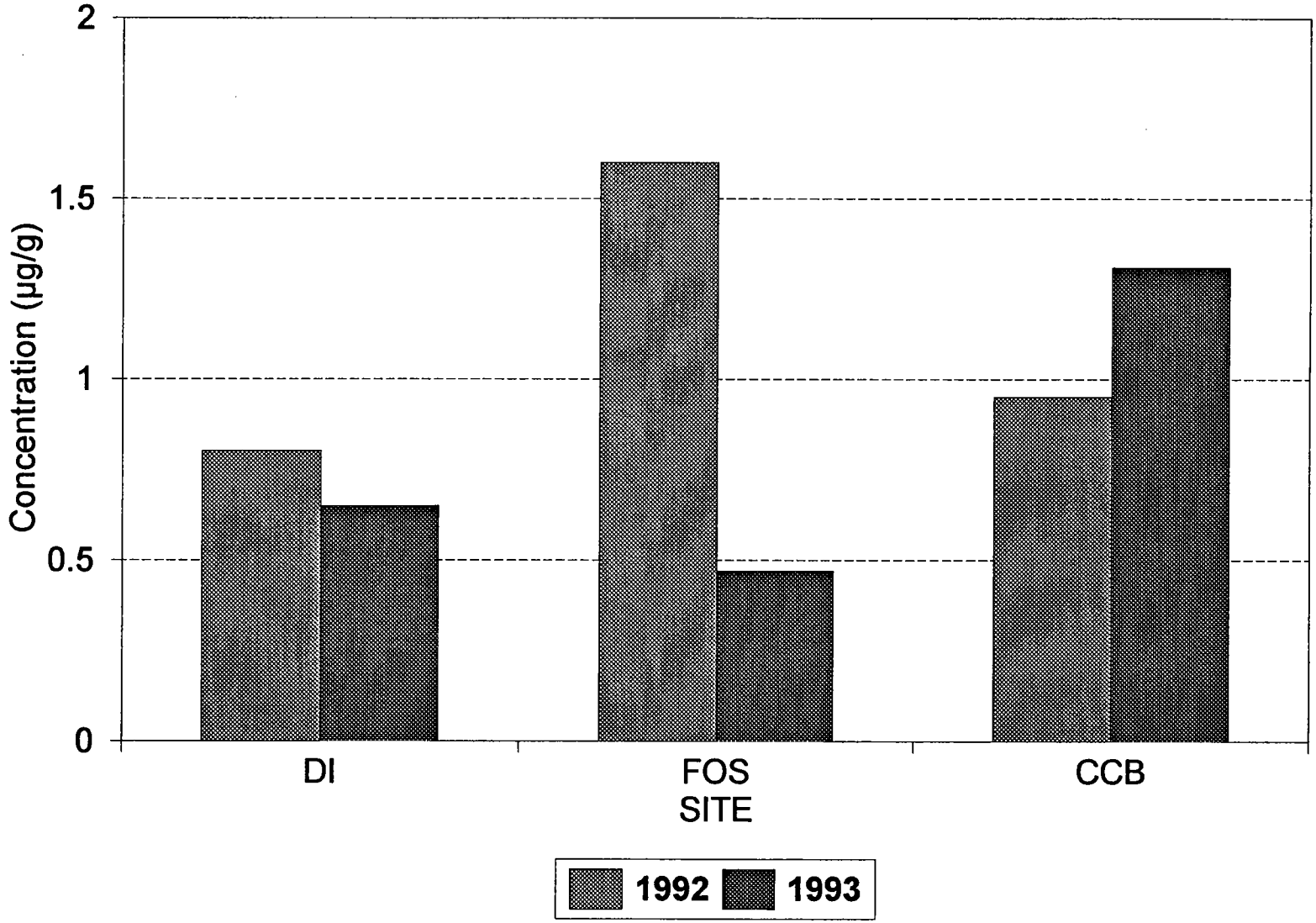


Figure 40. **Comparison of 1992 and 1993 nickel concentrations in lobster hepatopancreas (dry wt).**

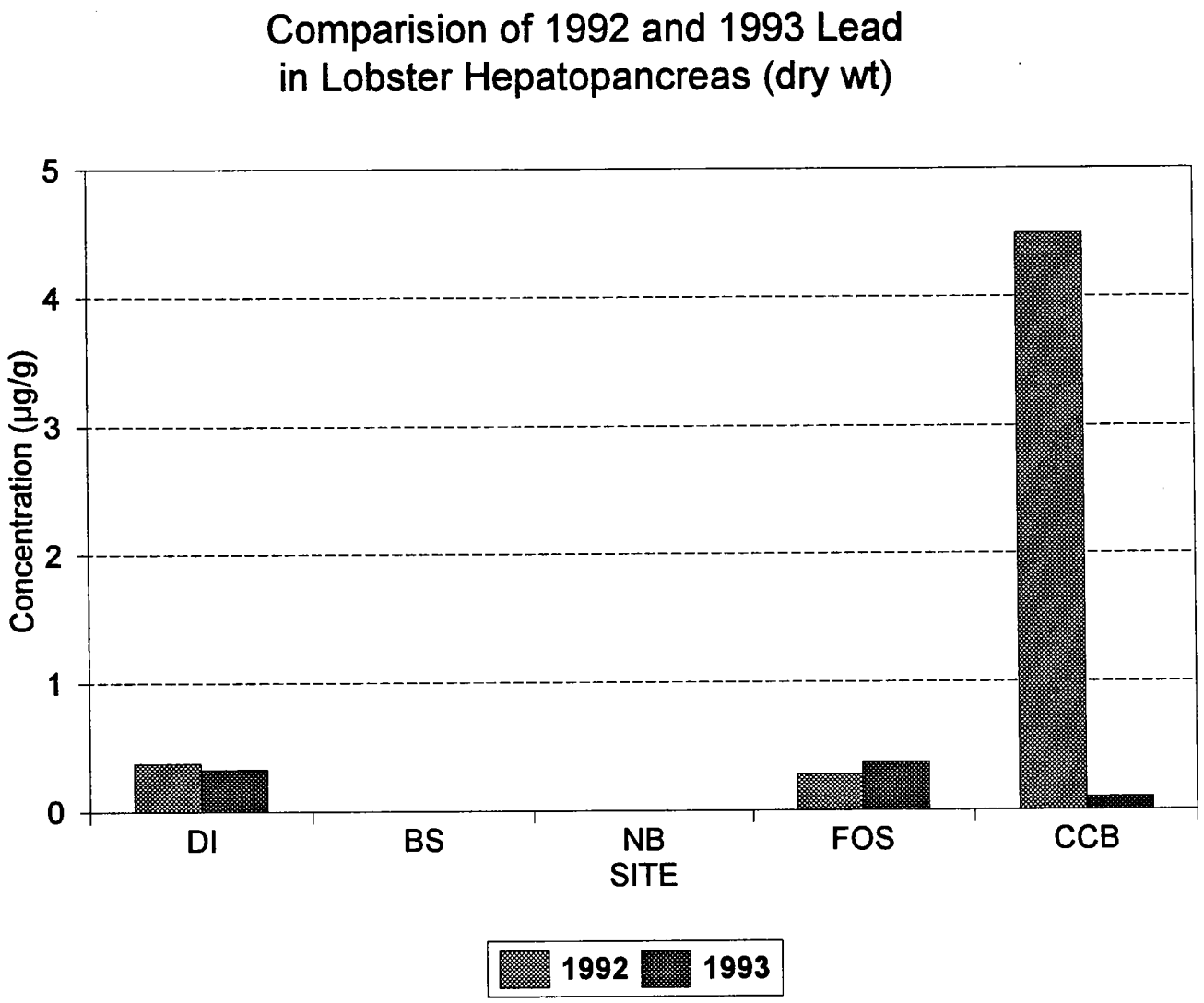


Figure 41. **Comparison of 1992 and 1993 lead concentrations in lobster hepatopancreas (dry wt).**

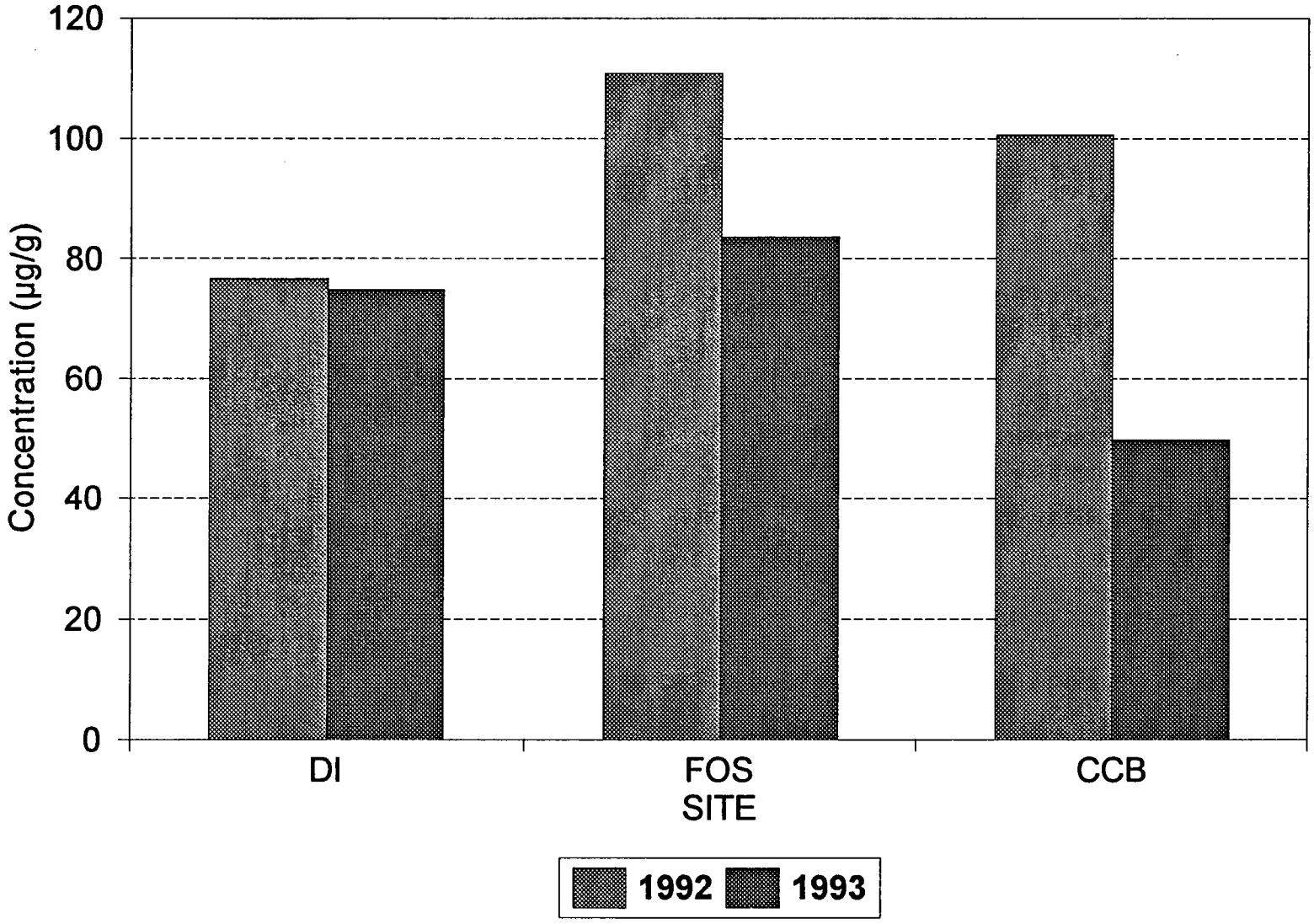


Figure 42. **Comparison of 1992 and 1993 zinc concentrations in lobster hepatopancreas (dry wt).**

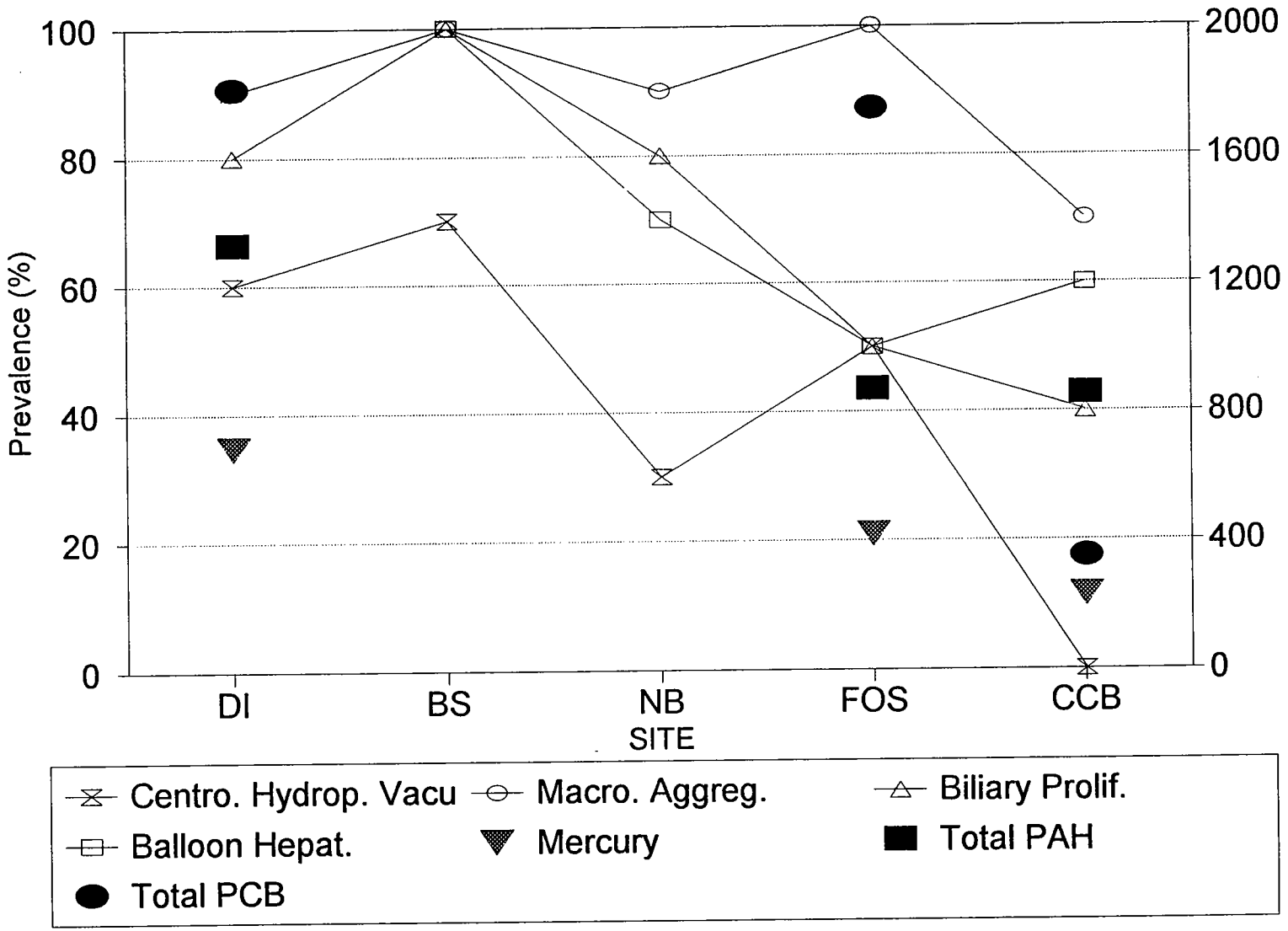


Figure 43. **Comparison of histopathology prevalences with total PAH, total PCB, and mercury concentrations in 1993 flounder livers.**

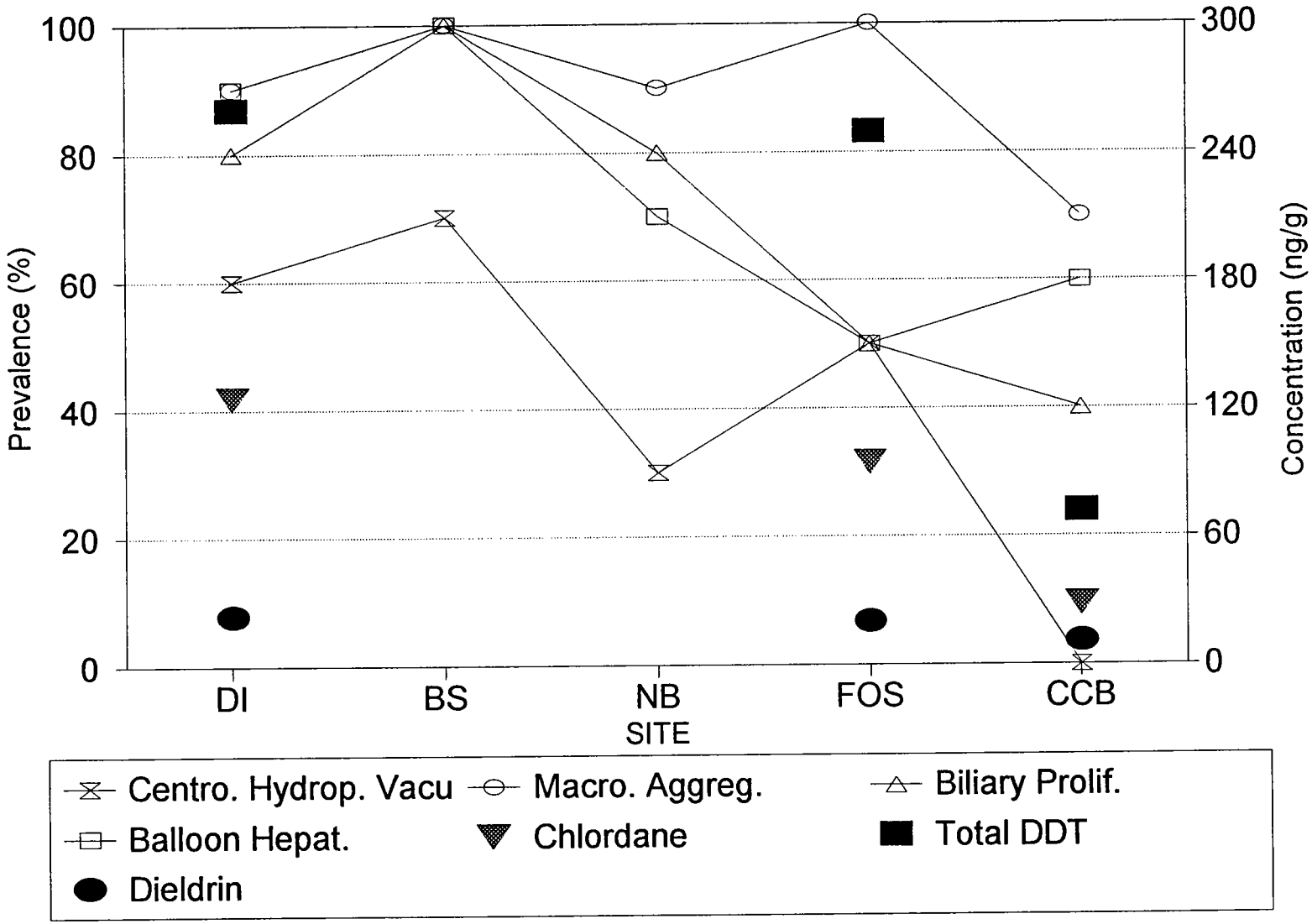


Figure 44. **Comparison of histopathology prevalences with chlordane, total DDT, and dieldrin concentrations in 1993 flounder livers.**

3.4.1 Variability

Representative distributions of contaminant concentrations in the individual organisms from specific sites are shown in Figures 45 through 48. These distributions were selected because they represent the range of variability observed at the various sites in 1993 and the chemicals that most closely approach FDA Action Limits in edible tissue. Results for the remaining tissues and compounds can be found in Appendix B. Generally, the range between the lowest and highest concentration across all tissues and contaminants was within a factor of 2 to 8. The specific patterns among the sites generally fell into three categories. One pattern was of fairly consistent concentrations all within a factor of 2 (Figure 46a). The second pattern was one of relatively similar concentrations in all individuals except one; the contaminant concentration in this individual was much greater (3 or 4 times) the concentration in the other individuals (Figure 48a). These two patterns were relatively rare within the data set. The most prevalent pattern was represented by Hg in flounder meat at FOS and CCB (Figure 45) and by lobster meat at CCB (Figure 46a). In this pattern, the contaminant concentrations were relatively evenly distributed around the mean concentration for the site. One additional observation is that the specific pattern among contaminants within a given tissue set was not the same (i.e., the individual with the highest concentration for one contaminant was not the same for other contaminants).

The variability in the contaminant concentrations is better represented by comparing the standard deviation (Appendix C) of the site concentrations to the mean concentrations calculated for chemicals at each site. This comparison is summarized in Table 15 where the coefficient of variation ranged from 19% (DDT in lobster meat) to 106% (Ag in lobster hepatopancreas). Overall, the coefficient of variation in the population was generally around 50% and was analyte specific. In addition, close examination of the data in Table 15 shows that, overall, the variability in the chemical data for the lobster hepatopancreas is slightly greater than for the lobster and flounder meat. The observed range in the coefficient of variation is consistent with other data sets for contaminants in fish and shellfish, and suggests, as summarized in EPA (1987), that the variability in contaminant concentrations in organisms will generally be in the vicinity of 50%. Thus, unless the number of individuals per site increases significantly, the ability to detect change will not substantially improve. The issue of whether detection of very small changes (i.e., factors of 100 or 200%) is required for the program is considered below.

3.4.2 Detectable Change

The specific data used for the reverse power analysis, and the detectable change achieved from the analysis of the individual tissues, are tabulated in Appendix C for each of the three tissue types and element or compound class. Table 16 summarizes the detectable change that can be observed at sites where more than nine individual tissue samples were available for analysis. Generally, the change (effect size) that can be detected at a power of 0.80 using 10 individuals falls within the range of 30 to 100% of the site mean, which is in the range suggested in the draft outfall monitoring plan (MWRA, 1991).

These data suggest that, a rule of thumb, the detectable change in contaminant concentration that can be measured in this region is a doubling. Note also that the detectable change is similar, although

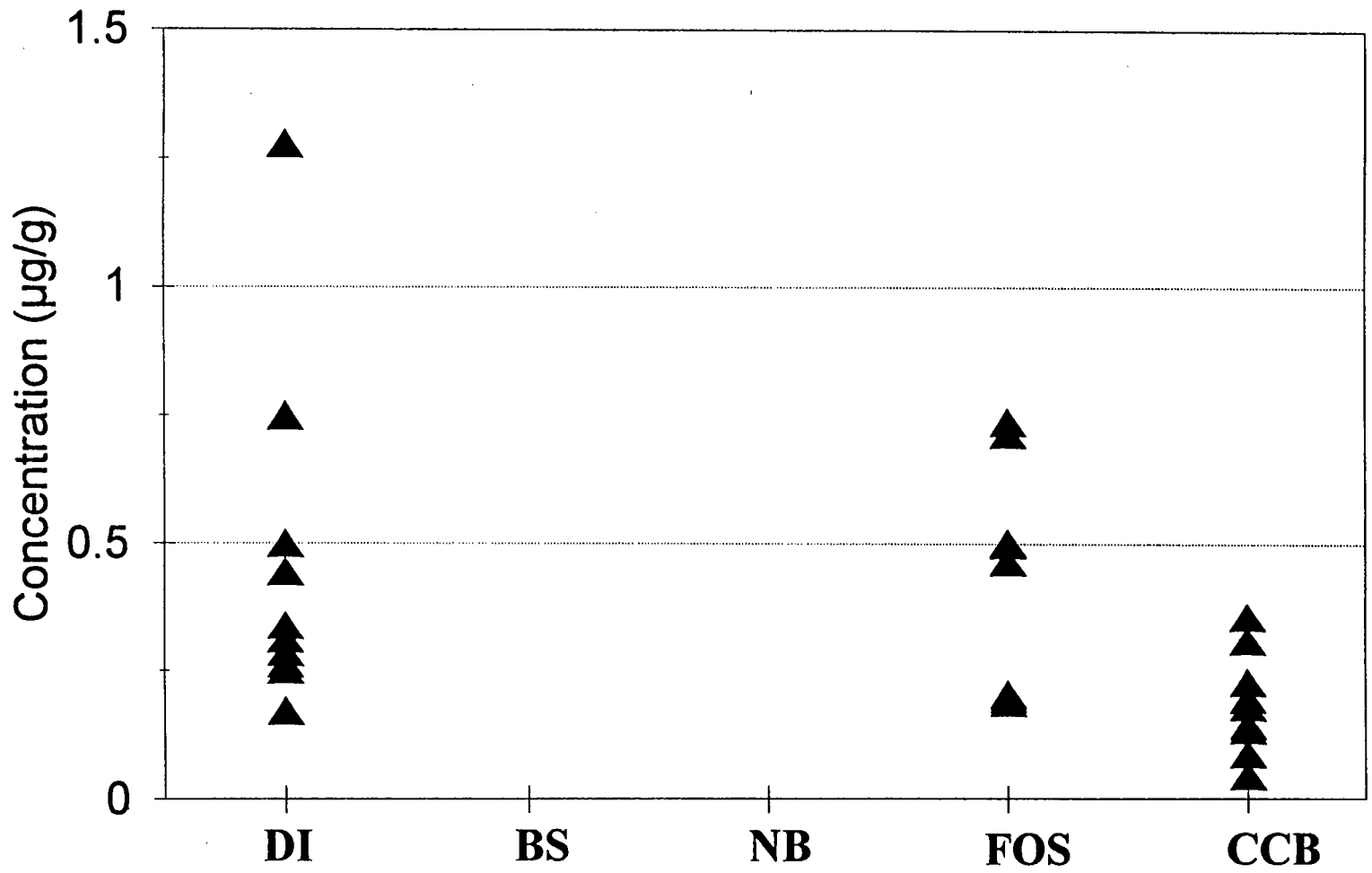


Figure 45. **Comparison of total mercury concentrations in filets of individual flounder collected at Deer Island (DI), the Future Outfall Site (FOS), and eastern Cape Cod Bay (CCB) in 1993. Samples from (Broad Sound) BS and (Nantasket Beach) NB were collected but not measured during 1993.**

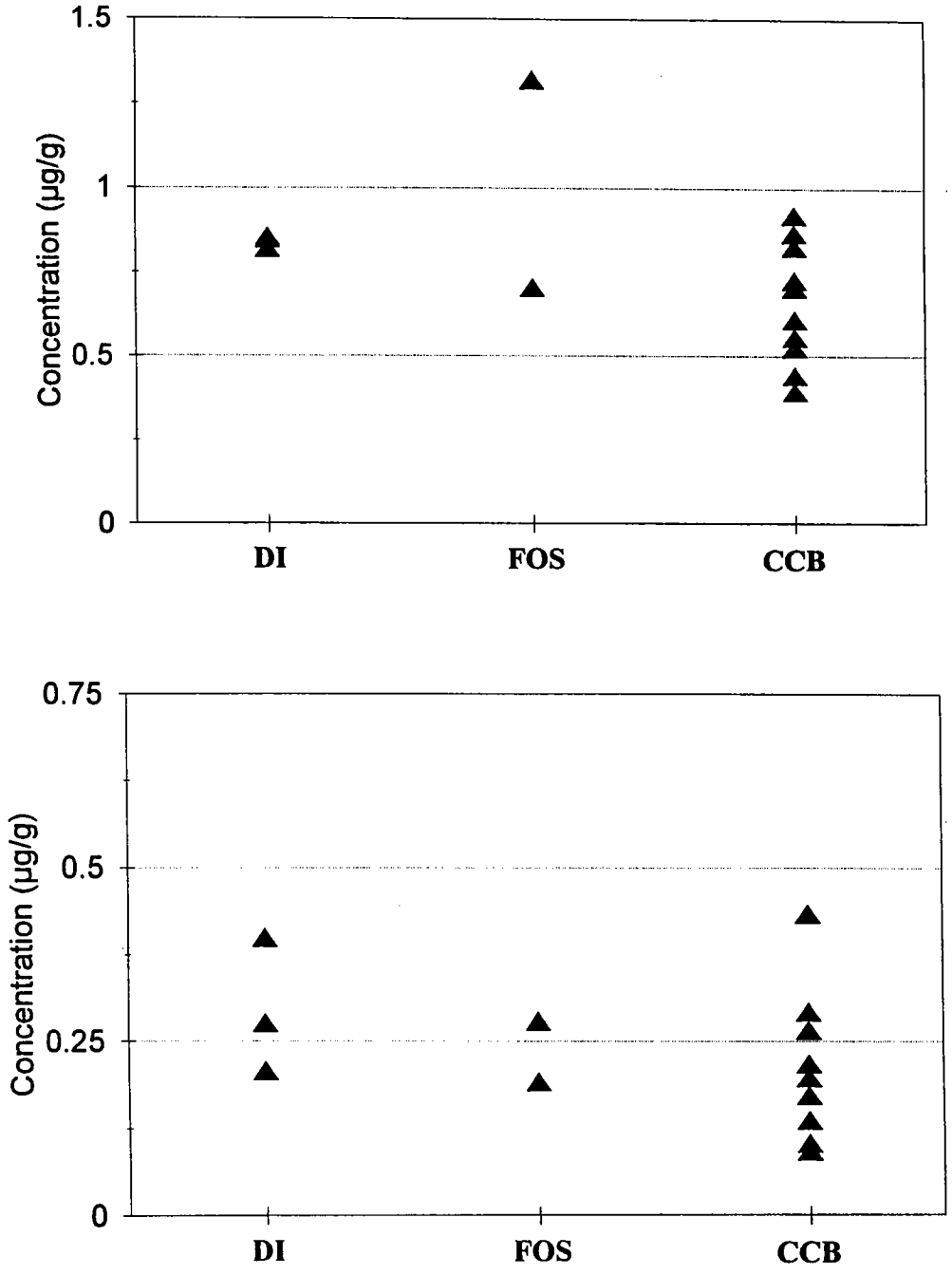


Figure 46. **Comparison of total mercury concentrations in individual lobster meat (2a) and hepatopancreas (2b) collected at Deer Island (DI), the Future Outfall Site (FOS), and eastern Cape Cod Bay (CCB) in 1993.**

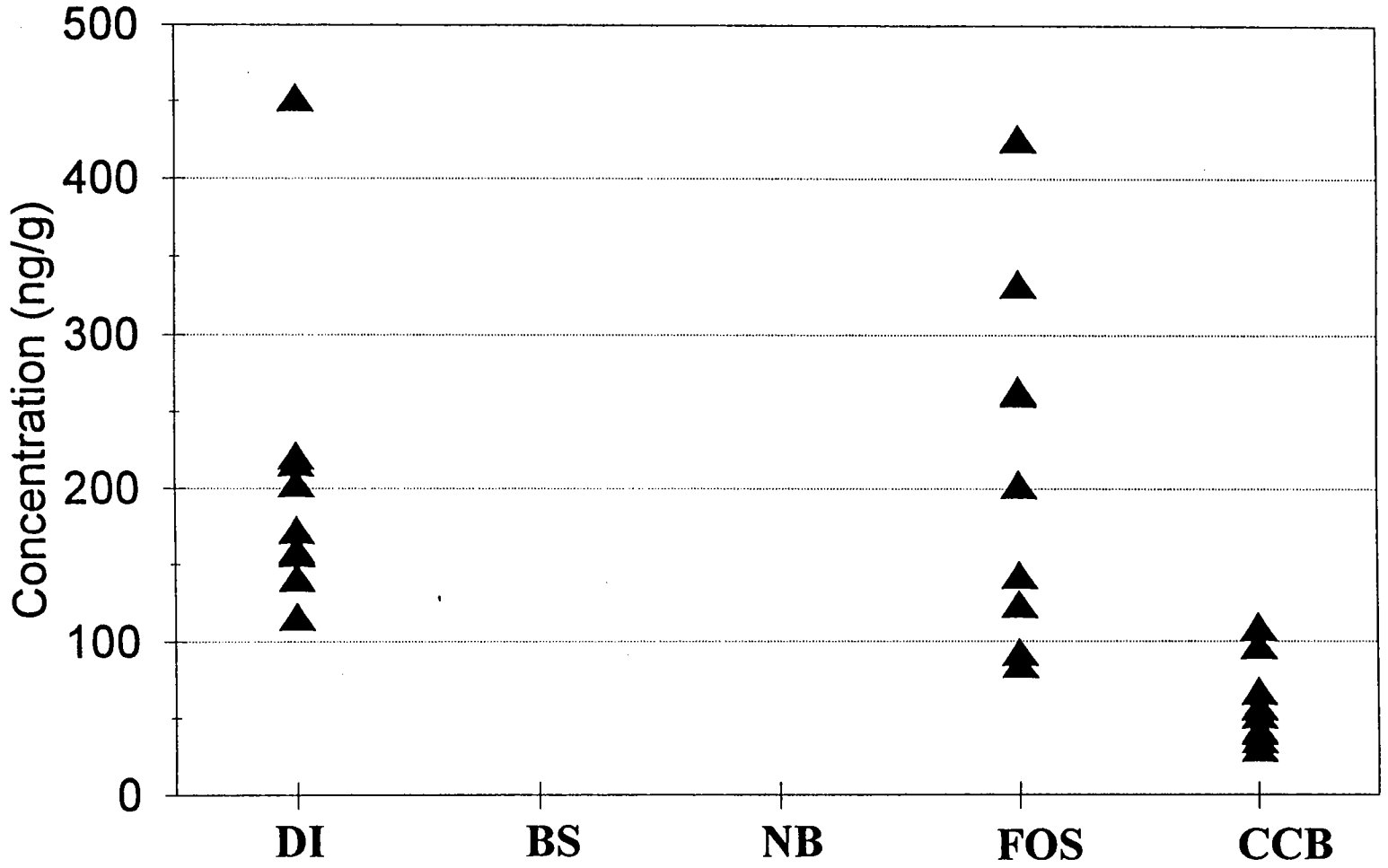


Figure 47. **Comparison of total PCB concentrations in filets of individual flounder collected at Deer Island (DI), the Future Outfall Site (FOS), and eastern Cape Cod Bay (CCB) in 1993.**

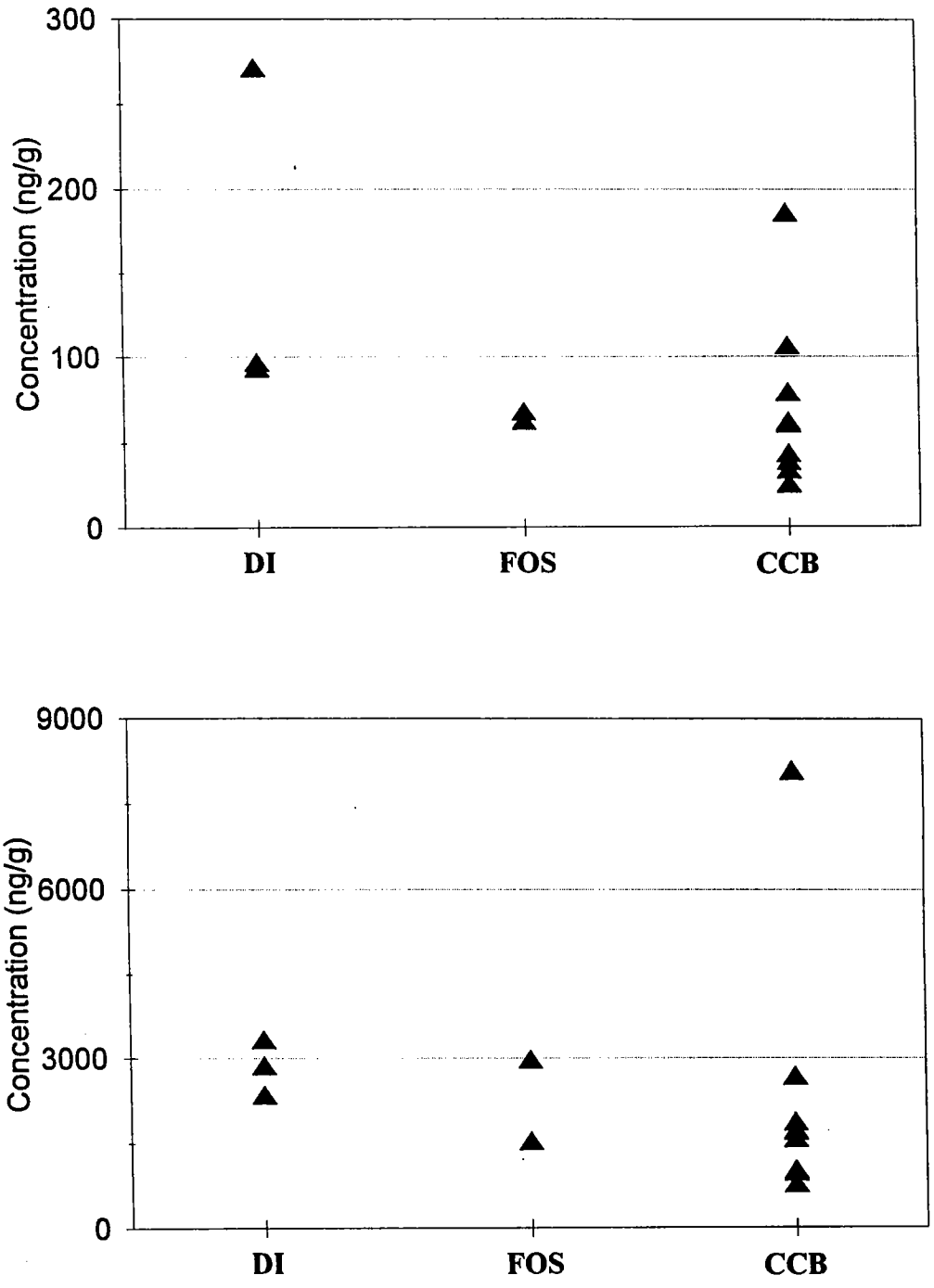


Figure 48. **Comparison of total PCB concentrations in individual lobster meat (2a) and hepatopancreas (2b) collected at Deer Island (DI), the Future Outfall Site (FOS), and eastern Cape Cod Bay (CCB) in 1993.**

Table 15. **Comparison of Variability as the Percent Coefficient of Variation from Chemical Analysis of Ten Individual Tissue Samples from Boston Harbor's Deer Island Area (DI), the Future Outfall Site (FOS), and Cape Cod Bay (CCB). The coefficient of variation is based on results from ten individuals at each site.**

Analyte	FLOUNDER (Meat)			LOBSTER (CCB)	
	DI	FOS[1]	DI	MEAT	HEPATOPANCREAS
PCB	47	54	44	74	100
Dieldrin	32	65	26	19	43
DDT	57	45	39	37	37
Chlordane	51	69	50	81	106
Hg	72	54	51	28	51
PAH					96
Cu					86
Cd					47
Cr					32
Ag					100
Ni					51
Pb					87
Zn					44

[1] $n = 9$ for organic analytes

Table 16. **Comparison of Detectable Change (%) for Chemical Analytes in Tissues from Boston Harbor's Deer Island Area (DI), the Future Outfall Site (FOS), and Cape Cod Bay (CCB). The detectable change analysis was based on sample size of $n = 10$, $\alpha = 0.05$ (two-tailed test), and power $(1-\beta) = 0.8$.**

Analyte	FLOUNDER (Meat)			LOBSTER (CCB)	
	DI	FOS[1]	DI	MEAT	HEPATOPANCREAS
PCB	63	76	58	98	133
Dieldrin	43	91	35	25	57
DDT	75	63	52	50	49
Chlordane	67	97	66	107	141
Hg	95	77	67	37	67
PAH					127
Cu					114
Cd					62
Cr					43
Ag					132
Ni					68
Pb					107
Zn					58

[1] $n = 9$ for organic analytes

slightly greater than the coefficient of variation shown in Table 15. The information in these two tables is consistent with the linear relationship between minimum detectable change and the coefficient of variation described in EPA (1987). Thus, at the most basic level, knowledge of the coefficient of variation provides a first order estimate of the level of change that can be detected.

Given that analysis of many more individual organisms will be required to substantially improve the ability to detect change and that the resources for conducting such analyses are limited, the question becomes: what is the most effective approach to achieve the goals of the current monitoring program? Two strategies can be implemented: analysis of a large number of individuals or compositing of samples. EPA (1993) recommends that compositing of organisms be conducted for determining human health effects from eating fish and shellfish. Compositing has two advantages and one drawback. The advantages are lower monitoring costs (fewer analyses) and greater power to detect change (EPA, 1987, 1993). The disadvantage is the loss of information on the underlying variability in the organism population, and thus the ability to determine whether or not there are individuals with extremely high levels of contamination in the population.

3.4.3 Sample Compositing

To help resolve the issue of whether or not to composite, data from the 1993 fish and shellfish samples were examined from several perspectives. First, to determine if the present tissue concentrations approach any level of concern, the measured concentrations at each site were compared to the potential endpoints (FDA Action Limits) that could result in some type of regulatory/management action. The detectable change that could be observed based on the 1993 data was also compared to the FDA Action Limits. Second, a series of power analyses was run to compare the detectable change as a percentage of the site mean. These analyses included comparison of the non-random data from 1992 to a set of similarly derived data from 1993, several subsets of three individuals randomly selected from the 1993 site data, and a replicated set of randomly selected pooled samples (to represent compositing).

Comparison of the contaminant concentrations (wet weight basis) to FDA Action Limit of Hg, total PCB, dieldrin, and DDT, showed that concentrations in the lobster and flounder tissues were consistently less than 10% of the FDA Action Limit. The wet-weight concentrations were less than 35% of the FDA Action Limit for Hg in lobster meat (Figure 49), and PCBs in flounder fillets (Figure 50) and lobster hepatopancreas (Figure 51).

As shown in Figure 49, the Hg concentrations in the lobster meat were relatively constant among the three sites, although the data from Deer Island and FOS are not robust enough to provide a definitive comparison. On the average, the Hg concentrations were less than 20% of the FDA Action Limit. Also, shown are the results for the individual organism that had the highest concentration (for those cases where $n > 9$) at each site. For Hg, the concentration in this individual was only slightly higher than the mean concentration for the site and was less than 20% of the Hg FDA Action Limit. Also included on Figure 50 is the mean concentration that constitutes a detectable change at each site. This concentration is only slightly higher than the mean concentration for the site. For Hg at the FOS, the detectable change approaches within 50% of the FDA Action Limit, but the result is based on only two samples, and therefore the data are not a reliable indicator of levels or detectable change at that site. Regardless of site, the increase in contaminant concentrations that can be detected is small

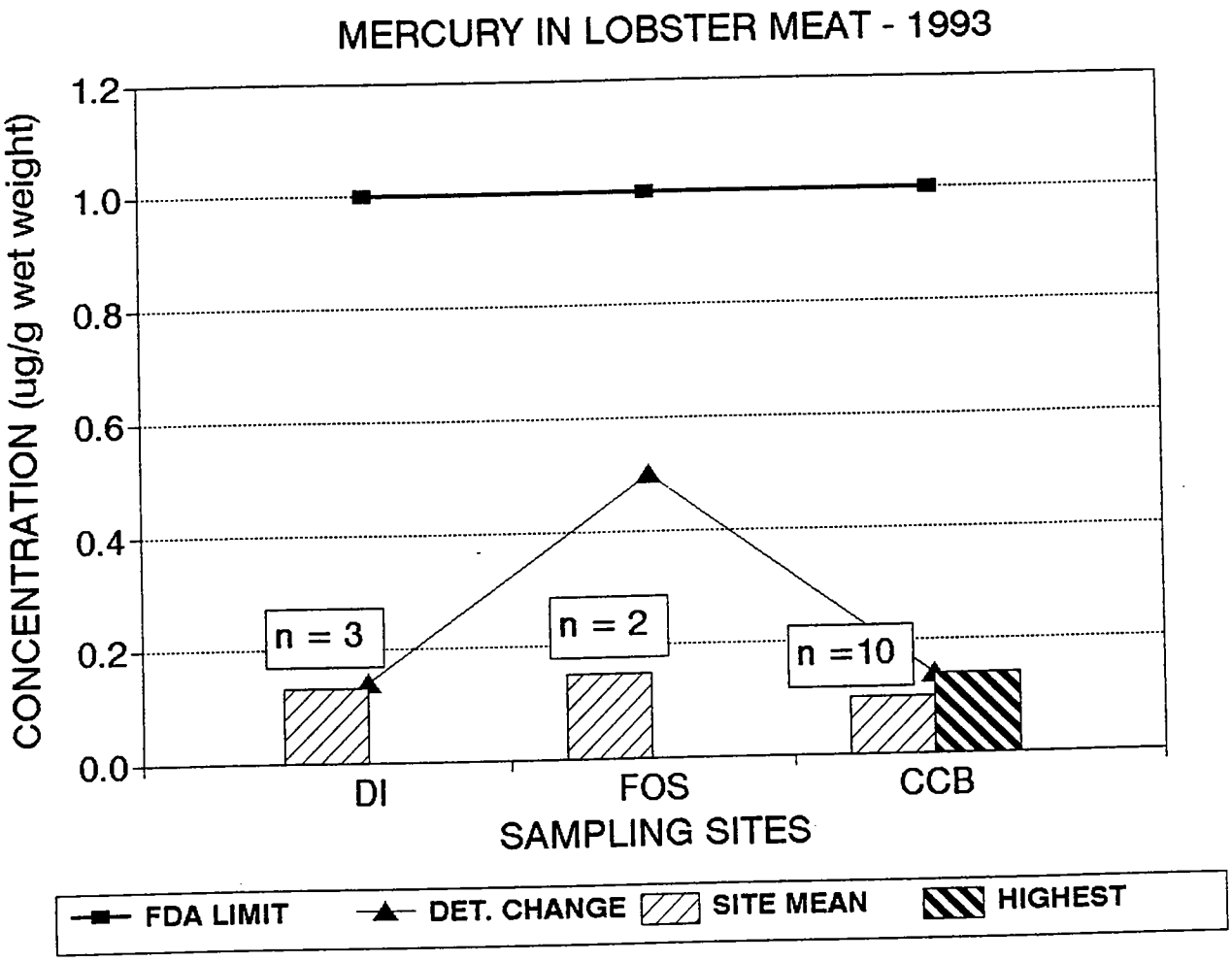


Figure 49. **Comparison of the FDA Action Limit for total mercury to the measured concentration in lobster meat (site mean and animal with the highest concentration) and the detectable concentration. Samples are from Deer Island (DI), the Future Outfall Site (FOS), and eastern Cape Cod Bay (CCB).**

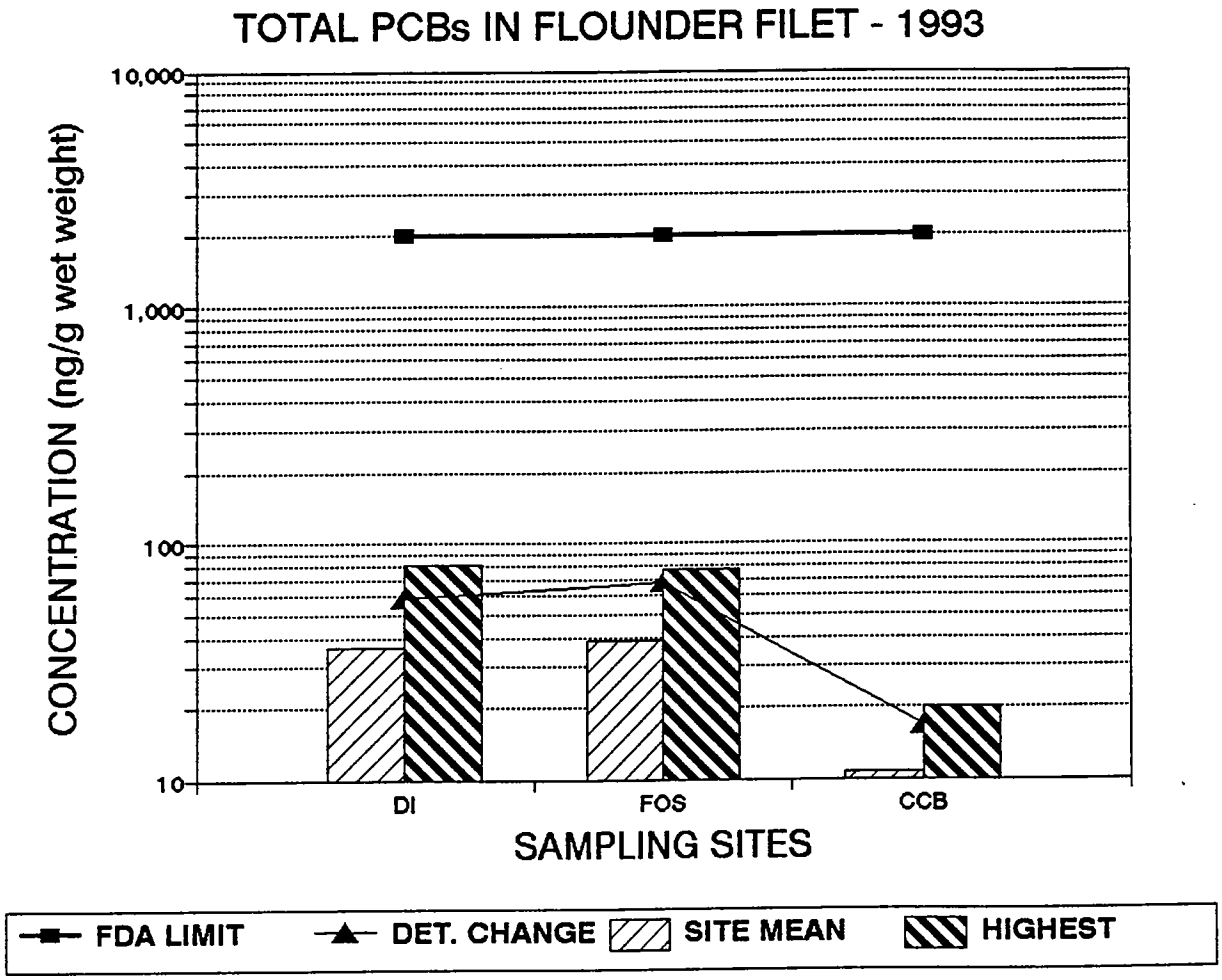


Figure 50. **Comparison of the FDA Action Limit for total PCB to the measured concentration in flounder filet (site mean and animal with the highest concentration) and the detectable concentration. Samples are from Deer Island (DI), the Future Outfall Site (FOS), and eastern Cape Cod Bay (CCB).**

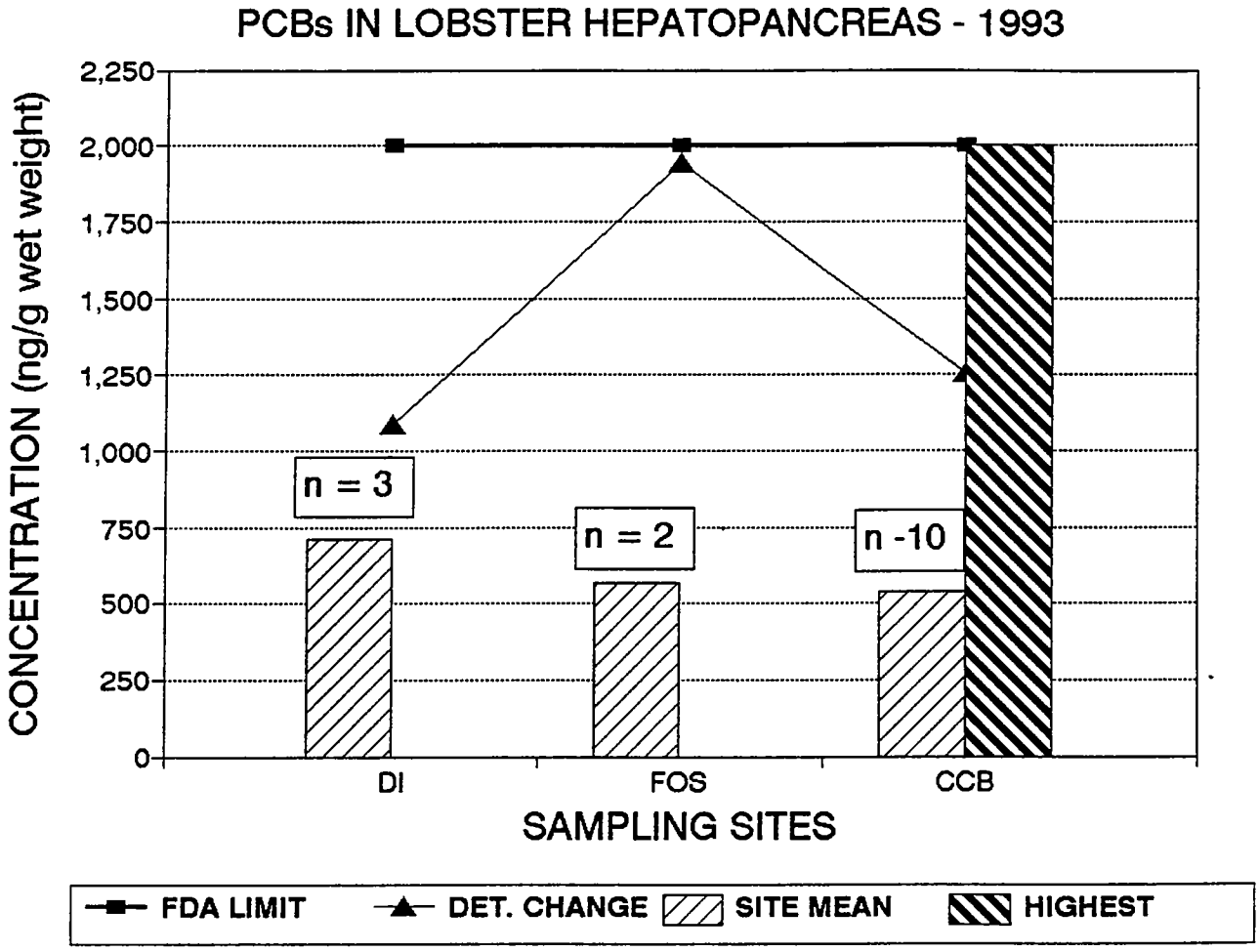


Figure 51. **Comparison of the FDA Action Limit for total PCB to the measured concentration in lobster hepatopancreas (site mean and animal with the highest concentration) and the detectable concentration. Samples are from Deer Island (DI), the Future Outfall Site (FOS), and eastern Cape Cod Bay (CCB).**

relative to present concentrations and, more importantly, the FDA Action Limits. Therefore, the ability to detect change at a power level of 0.8 is more than adequate to determine if concentrations are unacceptably increasing towards this endpoint, thus providing adequate capability to respond should any trends be detected during monitoring. Note that measurement of more individual organisms or composite samples could increase the statistical power or level of detectable change; however, this level of statistical strength is probably not needed to ensure that public and ecological health are protected.

A similar evaluation was completed for PCB in the flounder fillet and lobster hepatopancreas. The flounder analysis (Figure 50) was the most robust because at least nine individuals from each of three sites were included. The results were very similar to those discussed for Hg in lobster meat. Clear differences in the mean PCB concentration of flounder from CCB were evident; concentrations at Deer Island and the FOS were similar. For DI and FOS, the PCB concentration in the individual with the highest PCB concentration was about twice the site mean. At the CCB site, the concentration in the individual was about 10 times higher than the site mean. Note that the highest concentration of PCBs in any individual was still about 40 times less than the FDA Action Limit for PCBs. The level of detectable change was about 50% higher than the 1993 site mean and $\approx$ 20 times than the FDA Action Limit.

In contrast, the PCB concentrations in the lobster hepatopancreas (Figure 51) more closely approached the FDA Action Limit. Mean site concentrations were 20 to 30% of the FDA Action Limit and PCB concentrations in the hepatopancreas of one individual lobster at the CCB site was equal to the FDA Action Limit. However, as in the other cases, the ability to detect change (based on the 10 organisms) was at about 50% of the FDA Action Limit and considered adequate to ensure that any changes in concentration towards the FDA Action Limit endpoint are detected.

To address the second issue, selected contaminants and sites were evaluated to determine the percent detectable change that would occur from selection of various random and non-random sets of three animals drawn from the 1993 site data. In addition, data for sets of three randomly pooled samples were developed to portray the strength of sample compositing. The results are illustrated for PCBs in lobster hepatopancreas (Figure 52), Hg in flounder filet from Deer Island (Figure 53), and Hg in flounder filet from the FOS (Figure 54).

For PCBs in lobster hepatopancreas, the percent detectable change based on the three individuals collected in 1992 is shown in Figure 52 as bar No. 1. Bar No. 2 is reserved for the 1993 non-random flounder analysis. Bar No. 3 shows the detectable change for the 10 individuals collected in 1993. Bar No. 10 represents the detectable change that results from the mean and standard deviation of three randomly selected pools of five animals each. The main feature of this graph is the range (85 to 170%) in detectable change that results from random selection of three sets of individual animals. This range encompasses the detectable change observed for the 1992 samples and this range is expected for any set of three animals collected each year of the monitoring plan. The detectable change, based on all 10 individuals measured from 1993, was 120% and falls within the range based on the three individuals. Thus, selection of 10 organisms did not greatly improve the ability to determine the level of change relative to the random sets of three individuals. Comparison of the detectable change derived from the three randomly pooled samples shows a substantially lower detectable change ($\approx$ 15%), and thus shows substantial improvement in the change level that can be detected relative to the individual samples as demonstrated theoretically in EPA (1987).

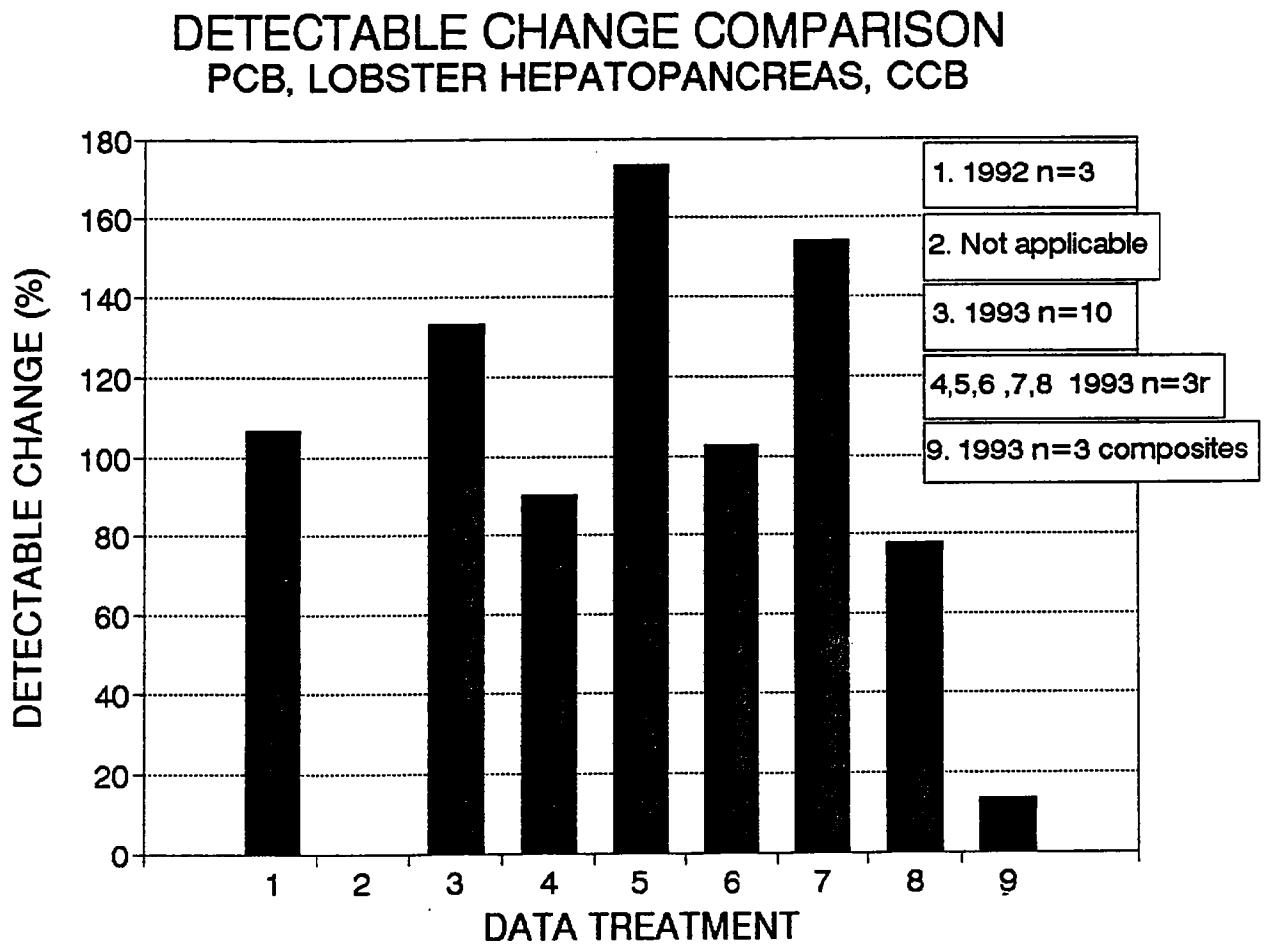


Figure 52. **Comparison of detectable change (as percent of site mean) for PCB in lobster hepatopancreas from Cape Cod Bay. Results were derived from 1992 samples (Treatment 1), 10 individuals from 1993 (Treatment 3), sets of three randomly selected individuals (Treatments 4 through 8), and triplicate pooled samples (Treatment 9).**

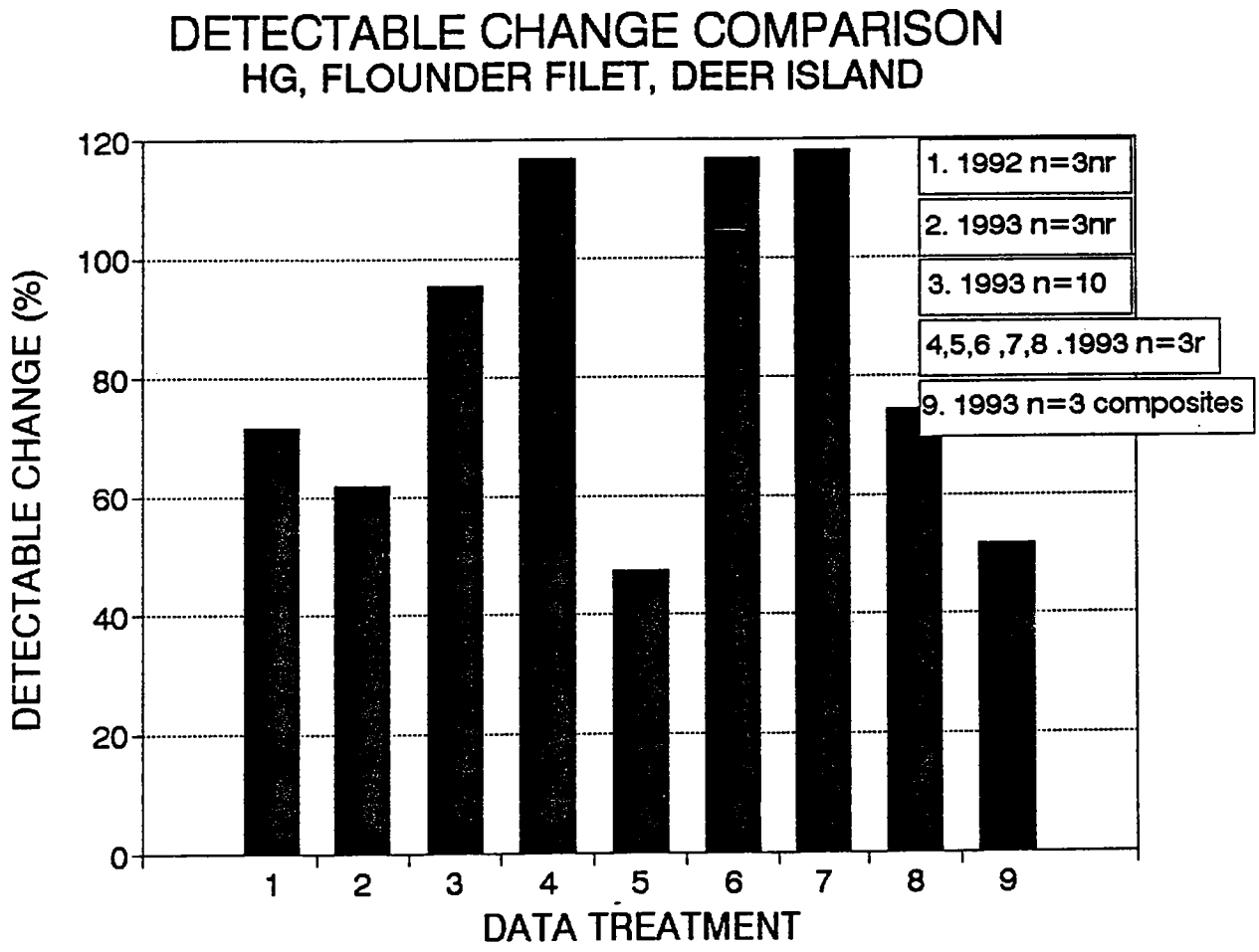


Figure 53. **Comparison of detectable change (as percent of site mean) for mercury in flounder filet from Deer Island. Results were derived from 1992 samples (Treatment 1), selected samples from 1993 (Treatment 2), 10 individuals from 1993 (Treatment 3), sets of three randomly selected individuals (Treatment 4 through 8), and triplicate pooled samples (Treatment 9).**

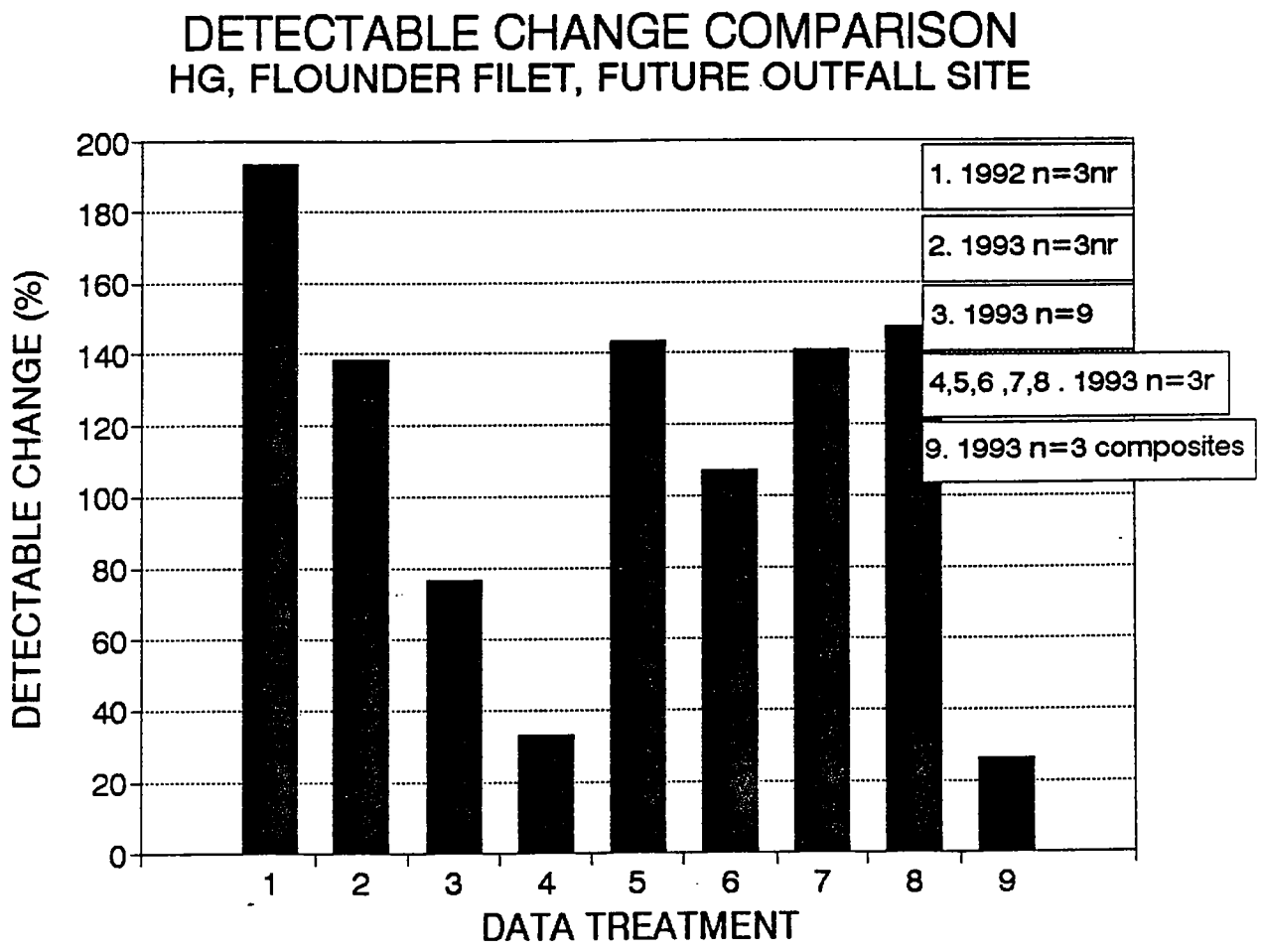


Figure 54. **Comparison of detectable change (as percent of site mean) for mercury in flounder filet from the Future Outfall Site. Results were derived from 1992 samples (Treatment 1), selected samples from 1993 (Treatment 2), 10 individuals from 1993 (Treatment 3), sets of three randomly selected individuals (Treatments 4 through 8), and triplicate pooled samples (Treatment 9).**

Figures 53 and 54 show a similar comparison for Hg in flounder from two different sites. The bars represent the same analysis scheme as discussed above with the exceptions noted below. The detectable changes represented by bars No. 1 and No. 2 were developed from non-randomly selected samples. For this comparison, animals with high, mid, and low liver histopathology indices were selected. Thus, the data for 1992 (bar No. 1) and 1993 (bar No. 2) are directly comparable and show similar levels of detectable change at both sites. Bars No. 4 through 8 each represent three randomly selected animals and show a wide range in the percent change that can be detected. Comparison of the detectable change based on the 10 organisms (bar No. 3) shows that the ability to detect change using the 10 individuals falls within the range observed for the sets of three randomly selected individuals, and that any given set of three individuals could result in widely disparate ability to detect change with confidence. The data do not demonstrate a clear advantage for analysis of 10 versus 3 individual tissue samples, primarily because the standard deviation of the analysis does not improve greatly with only 10 individuals. As indicated previously, the advantage gained from the analysis of 10 individual samples results primarily from the knowledge that there are a greater number of individuals contributing to the site mean. Finally, note that the pooled samples generally provide a level of detectable change that is much lower than the series of three individuals, but not for all cases. Also, the improvement observed in the pooled series depends on the specific variability at a site (e.g., the coefficient of variation at DI is larger than at FOS: (72 versus 54, respectively)), which also shows as larger detectable change at DI relative to FOS.

In summary, this analysis shows that detectable change does not improve substantially or consistently across the sites and tissues when 10 individuals versus 3 were included in the mean. Use of composite samples will improve the ability to detect change relative to analysis of individual samples, and is consistent with statistical theory related to sample compositing (EPA, 1987).

4.0 RECOMMENDATIONS

Based on the results of the 1993 Fish and Shellfish task, several recommendations for future efforts are suggested.

- A retrospective analysis of the 1987 to 1982 WHOI flounder archive should be carried out to establish whether the so-called balloon hepatocyte lesion is a new event, or had been previously present, but unrecorded.

- Because of the prevalence and severity of balloon hepatocytes an effort should be made to determine the exact nature of the lesion.

- An annual nitrogen and sulfur stable isotope study should be part of the program, using scales from fish collected at Deer Island, The Future Outfall Site, and Eastern Cape Cod Bay.

- A small research project should be established to identify more labile tissues, such as gut or gill for stable isotope studies

- Flounder liver from all five sites should be analyzed chemically to help determine any relationship between observed pathology and contaminant levels.

- Measurements of contaminants in composite tissue samples should include

  - Three replicates (minimum) of five randomly selected tissue samples per site

  - Samples in the present targeted size range for flounder (30 to 50 cm)

  - Samples of lobster with lengths within 10% of the mean length for the site

  - Separate analysis of large individuals (lobster >2 lbs; flounder >50 cm)

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APPENDIX A

WINTER FLOUNDER HISTOPATHOLOGY SCORES FOR FISH COLLECTED IN APRIL 1993

STATID=FI1

TABLE OF CENTROHV BY READER

CENTROHV	READER		
Frequency / Percent / Row Pct / Col Pct	1	2	Total
N	46	54	100
	26.44	31.03	57.47
	46.00	54.00	
	52.87	62.07	
Y	41	33	74
	23.56	18.97	42.53
	55.41	44.59	
	47.13	37.93	
Total	87	87	174
	50.00	50.00	100.00

STATISTICS FOR TABLE OF CENTROHV BY READER

Statistic	DF	Value	Prob
Chi-Square	1	1.505	0.220
Likelihood Ratio Chi-Square	1	1.507	0.220
Continuity Adj. Chi-Square	1	1.152	0.283
Mantel-Haenszel Chi-Square	1	1.496	0.221
Fisher's Exact Test (Left)			0.142
(Right)			0.916
(2-Tail)			0.283
Phi Coefficient		-0.093	
Contingency Coefficient		0.093	
Cramer's V		-0.093	

Sample Size = 174

STATID=FI2

TABLE OF CENTROHV BY READER

CENTROHV	READER		
Frequency / Percent / Row Pct / Col Pct	1	2	Total
N	122	111	233
	40.67	37.00	77.67
	52.36	47.64	
	81.33	74.00	
Y	28	39	67
	9.33	13.00	22.33
	41.79	58.21	
	18.67	26.00	
Total	150	150	300
	50.00	50.00	100.00

STATISTICS FOR TABLE OF CENTROHV BY READER

Statistic	DF	Value	Prob
Chi-Square	1	2.325	0.127
Likelihood Ratio Chi-Square	1	2.334	0.127
Continuity Adj. Chi-Square	1	1.922	0.166
Mantel-Haenszel Chi-Square	1	2.318	0.128
Fisher's Exact Test (Left)			0.952
(Right)			0.083
(2-Tail)			0.165
Phi Coefficient		0.088	
Contingency Coefficient		0.088	
Cramer's V		0.088	

Sample Size = 300

---------- STATID=FI3 ----------

TABLE OF CENTROHV BY READER

CENTROHV	READER		
Frequency Percent Row Pct Col Pct	1	2	Total
N	82 27.33 47.40 54.67	91 30.33 52.60 60.67	173 57.67
Y	68 22.67 53.54 45.33	59 19.67 46.46 39.33	127 42.33
Total	150 50.00	150 50.00	300 100.00

STATISTICS FOR TABLE OF CENTROHV BY READER

Statistic	DF	Value	Prob
Chi-Square	1	1.106	0.293
Likelihood Ratio Chi-Square	1	1.107	0.293
Continuity Adj. Chi-Square	1	0.874	0.350
Mantel-Haenszel Chi-Square	1	1.102	0.294
Fisher's Exact Test (Left)			0.175
(Right)			0.879
(2-Tail)			0.350
Phi Coefficient		-0.061	
Contingency Coefficient		0.061	

Cramer's V -0.061

Sample Size = 300

STATID=FI4

TABLE OF CENTROHV BY READER

CENTROHV	READER		
Frequency / Percent / Row Pct / Col Pct	1	2	Total
N	109	108	217
	36.33	36.00	72.33
	50.23	49.77	
	72.67	72.00	
Y	41	42	83
	13.67	14.00	27.67
	49.40	50.60	
	27.33	28.00	
Total	150	150	300
	50.00	50.00	100.00

STATISTICS FOR TABLE OF CENTROHV BY READER

Statistic	DF	Value	Prob
Chi-Square	1	0.017	0.897
Likelihood Ratio Chi-Square	1	0.017	0.897
Continuity Adj. Chi-Square	1	0.000	1.000
Mantel-Haenszel Chi-Square	1	0.017	0.897
Fisher's Exact Test (Left)			0.602
(Right)			0.500
(2-Tail)			1.000

Phi Coefficient	0.007
Contingency Coefficient	0.007
Cramer's V	0.007

Sample Size = 300

STATID=FI5

TABLE OF CENTROHV BY READER

CENTROHV	READER		
Frequency / Percent / Row Pct / Col Pct	1	2	Total
N	145	144	289
	48.33	48.00	96.33
	50.17	49.83	
	96.67	96.00	
Y	5	6	11
	1.67	2.00	3.67
	45.45	54.55	
	3.33	4.00	
Total	150	150	300
	50.00	50.00	100.00

STATISTICS FOR TABLE OF CENTROHV BY READER

Statistic	DF	Value	Prob
Chi-Square	1	0.094	0.759
Likelihood Ratio Chi-Square	1	0.094	0.759
Continuity Adj. Chi-Square	1	0.000	1.000
Mantel-Haenszel Chi-Square	1	0.094	0.759
Fisher's Exact Test (Left)			0.729

	(Right)	0.500
	(2-Tail)	1.000
Phi Coefficient	0.018	
Contingency Coefficient	0.018	
Cramer's V	0.018	

Sample Size = 300

											CENTROTUBULAR HV						TUBULAR HV						FOCAL HV					
											A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	SEX	YR	TL	SL	WT	FIN	GR	GS	LC	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI1	406	M	5	35.5		650	0	0	0	B	2	3	2	3	2	2	2	2	2	2	1	1	0	0	0	0	0	0
FI1	407	M	5	35.5		650	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	408	M	6	38		675	0	0	0	B	2	2	2	2	1	1	2	3	2	3	1	2	0	0	0	0	0	0
FI1	409	M	4	32.5		450	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	410	M	4	30		450	0	0	0	B	1	1	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	411	M	5	34.5		550	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	412	M	4	30		425	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	413	M	5	34.5		500	0	0	0	B	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0
FI1	414	F	6	36		550	0	0	0	B	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
FI1	415	F	5	35		550	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	416	M	4	33		525	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	417	F	6	39		950	0	0	0	B	2	2	2	3	2	2	3	3	3	3	3	3	1	0	1	0	0	0
FI1	418	F	4	33		425	0	0	0	B	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	419	M	4	31.5		400	0	0	0	B	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	420	M	4	33		550	0	0	0	B	2	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	421	F	4	34.5		600	0	0	0	YB	3	3	3	2	2	2	2	1	2	1	1	1	0	0	0	0	0	0
FI1	422	M	4	34		550	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	423	M	4	31		400	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	424		4	31		450	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	465	M	3	31.5		450	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	466	M	4	33		525	0	0	0	B	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	467	F	5	34.5		575	0	0	0	B	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	468	F	4	37		600	0	0	0	B	2	3	2	3	2	3	3	3	3	3	3	2	0	0	0	0	0	0
FI1	469	M	4	31.5		450	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	470	M	5	30.5		850	0	0	0	YB	2	3	2	3	2	2	2	2	2	2	2	1	1	0	0	0	0	0
FI1	471	F	8	45		1450	1	0	1-	YB	1	0	2	1	2	1	0	0	1	0	1	0	0	0	0	0	0	0
FI1	472	F	7	38.5		950	0	0	0	YB	2	2	2	3	2	2	0	0	1	0	0	0	0	0	0	0	0	0
FI1	473	F	5	32		525	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	474	M	4	33.5		550	0	0	0	DB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	525	F	4	31.5	25.5	375	0	1+	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	526	F	5	35.5	28.5	600	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	527	F	4	34.5	28.0	650	0	1	1	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	528	F	4	34	27.5	500	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	529	F	6	40.5	33.0	1000	0	2	2	YB	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	530	F	5	32.5	26.0	400	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	531	F	7	37.5	29.0	825	0	0	0	YB/B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	532	F	4	31.5	25.0	450	0	1-	0	B	2	2	3	2	3	2	0	1	1	1	1	1	0	0	0	0	0	0
FI2	533	F	5	36.5	29.0	750	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	534	F	4	31	25.5	525	1	1	2	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	535	F	4	31.5	25.5	375	0	1+	1	DB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	536	M	5	35	28.0	475	0	1+	1+	DB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	537	F	6	41.5	33.0	1075	0	0	0	YB/B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	538	F	4	31	25.0	450	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

											CENTROTUBULAR HV						TUBULAR HV						FOCAL HV					
											A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	SEX	YR	TL	SL	WT	FIN	GR	GS	LC	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI2	539	F	4	34.5	27.0	500	0	0	0	Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	540	F	5	39	31.0	825	2	1+	3+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	541	M	4	33	26.5	550	0	1+	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	542	F	7	41	33.0	775	0	1-	1-	B	3	3	3	3	3	3	3	1	3	2	2	2	0	0	0	0	0	0
FI2	543	F	4	32	25.0	425	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	544	F	4	33	27.0	475	1	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	545	F	6	39	31.0	900	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	546	F	5	31	27.0	550	1-	1	1+	B	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	547	F	4	32.5	26.5	475	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	548	F	4	31	25.5	375	NO			B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	549	F	5	37	30.5	700	0	1-	1-	Pale g	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	550	F	4	31	25.0	450	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	551	F	4	34	27.5	500	0	1-	1-	B/YB	3	3	3	2	3	2	0	0	0	0	0	0	0	0	0	0	0	0
FI2	552	F	4	32	25.5	425	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	553	F	8	41	33.0	975	1	0	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	554	F	5	37	30.0	625	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	555	F	4	35	28.0	525	1-	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	556	F	5	34.5	27.5	600	0	1-	1-	YB	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	557	F	5	34.5	28.0	650	0	1+	1	B	3	2	2	2	1	2	3	2	2	1	1	1	0	0	0	0	0	0
FI2	558	F	6	40	32.0	800	0	2	2	YB	1	1	2	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	559	F	6	38	30.5	925	1	0	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	560	F	6	37	30.0	775	1-	2	1-	YB	3	2	3	2	2	2	3	2	3	2	2	2	0	0	0	0	0	0
FI2	561	F	5	38.5	31.0	800	0	0	0	YB	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	562	F	5	43.5	34.5	1100	0	1	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	563	F	6	40	34.0	650	1	1-	1+	DB	3	1	2	1	2	1	0	1	0	1	1	1	0	0	0	0	0	0
FI2	564	F	6	43	32.0	1175	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	575	M	6	34	27.5	575	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	576	F	4	30.5	24.0	425	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	577	F	5	38	31.5	850	0	1+	1+	Y/YB	1	2	1	2	1	1	1	1	1	2	1	1	0	0	0	0	0	0
FI2	578	M	5	38	31.5	725	0	1	1	DB	3	3	3	3	3	3	2	2	2	2	2	2	0	0	0	0	0	0
FI2	579	M	5	36	29.0	625	1-	1+	1+	B/DB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	580	F	4	34.5	28.0	450	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	581	M	5	39	32.0	775	0	1-	1-	B	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	582	F	5	34	27.5	600	1-	0	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	583	M	7	38	30.5	675	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	584	F	4	30	24.5	375	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	425	F	5	34.5		850	0	0	0	YB	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	426	M	6	38.5		700	0	0	0	B	3	3	2	3	2	3	0	0	1	0	0	0	0	0	0	0	0	0
FI3	427	F	5	31		450	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	428	M	4	30.5		425	0	0	0	B	3	2	2	3	2	3	2	2	2	1	1	1	0	0	0	0	0	0
FI3	429	F	8	44		875	0	0	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	430	F	5	38.5		650	0	0	0	YB	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	431	F	7	42		850	0	0	0	B	3	3	3	3	2	3	1	0	0	0	0	0	0	0	0	0	0	0

											CENTROTUBULAR HV						TUBULAR HV						FOCAL HV					
											A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	SEX	YR	TL	SL	WT	FIN	GR	GS	LC	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI3	432	F	4	31		425	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	433	F	6	42.5		1200	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	434	F	5	34.5		525	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	435	F	6	41.5		825	0	0	0	B	3	3	3	3	2	3	1	2	2	2	1	2	0	0	0	0	0	0
FI3	436	M	5	37.5		750	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	437	M	6	38		750	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	438	M	4	33		500	0	0	0	B	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	439	M	3	33.5		575	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	440	F	4	32		450	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	441	M	4	30		400	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	442	F	6	41		800	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	443	F	4	30		375	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	444	M	5	45.5		550	0	0	0	B	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	445	F	6	39.5		700	0	0	0	B	2	3	2	2	2	3	3	0	2	0	2	0	0	0	0	0	0	0
FI3	446	F	5	30		650	0	0	0	YB/B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	447	F	4	31.5		375	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	448	F	5	35		575	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	449	F	4	30.5		450	0	0	0	B	2	2	2	2	3	2	1	1	1	1	2	1	0	0	0	0	0	0
FI3	450	M	3	32		475	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	451	F	4	35.5		525	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	452	M	5	34.5		650	0	0	0	B	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	453	F	5	36		650					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	454	F	4	34		525	0	0	0	B	3	3	2	2	2	2	0	1	0	0	0	0	0	0	0	0	0	0
FI3	455	F	6	42		775	0	0	0	B	3	3	3	3	2	3	2	3	2	2	2	2	0	0	0	0	0	0
FI3	456	M	5	38		650	0	0	0	B	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0
FI3	457	M	4	30		450	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	458	M	4	32		450	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	459	F	4	33.5		575	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	460	F	6	37		850	0	0	0	B	2	2	2	2	2	2	0	1	1	1	1	1	0	0	0	0	0	0
FI3	461	F	6	38.5		650	0	0	0	B	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	462	F	7	40.5		925	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	463	F	7	41		750	0	0	1-	B	2	1	3	2	3	1	1	1	0	1	0	0	0	0	0	0	0	0
FI3	464	M	5	34		575	0	0	0	B	2	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	475	F	6	40.5		800	0	1+	1	Y	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0
FI3	476	M	6	39		700	0	0	0	DB	2	2	3	2	2	2	3	3	3	3	2	3	0	0	0	0	0	0
FI3	477	M	5	36.5		575	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	478	F	5	37		775	0	1	1	Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	479	F	10	43		975	0	1	1	G	3	3	3	3	2	3	2	2	2	2	2	2	0	0	0	0	0	0
FI3	480	M	5	31		775	1-	0	1-	DB	2	2	3	3	3	3	3	3	3	3	3	3	0	0	0	0	1	1
FI3	481	F	7	43.5		925	0	0	0	B	3	3	3	3	3	3	3	3	3	3	2	3	0	0	0	0	0	0
FI3	482	M	5	35.5		575	0	0	0	Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	483	F	8	45		1000	1	0	1		1	2	1	1	2	1	0	0	1	0	1	0	0	0	0	0	0	0
FI3	484	M	5	37.5		775	0	0	0	B	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0

											CENTROTUBULAR HV						TUBULAR HV						FOCAL HV					
											A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	SEX	YR	TL	SL	WT	FIN	GR	GS	LC	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI4	485	F	3	31	25.0	425	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	486	F	3	30	24.0	450	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	487	M	4	30	23.5	400	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	488	F	4	30	24.5	400	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	489	F	4	33	27.0	475	0	0	0	YB/B	3	2	3	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0
FI4	490	F	5	34	27.5	525	0	0	0	YB/B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	491	F	4	31	25.0	450	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	492	F	4	32.5	26.5	550	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	493	F	5	36	28.5	600	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	494	F	4	30	24.5	400	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	495	F	6	34.5	27.5	525	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	496	F	4	34	27.0	600	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	497	F	5	31	24.5	500	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	498	F	6	38.5	31.0	650	0	1-	1-	YB	3	2	3	2	2	2	1	1	0	1	0	1	0	0	0	0	0	0
FI4	499	F	4	32	26.5	475	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	500	F	5	36.5	30.0	700	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	501	F	4	30	24.5	425	1-	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	502	F	4	31	25.0	425	1-	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	503	F	4	32	26.5	525	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	504	F	5	35	28.0	725	0	0	0	YB/B	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
FI4	505	F	4	32	26.0	475	0	0	0	YB/B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	506	F	4	30	24.0	400	0	0	0	B	0	1	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	507	F	4	35	29.0	650	0	1	1	B	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	508	F	4	30.5	25.0	475	0	0	0	Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	509	F	5	33	26.5	500	0	0	0	B	3	3	3	3	3	3	2	2	3	2	2	2	0	0	0	0	0	0
FI4	510	F	5	39	32.0	850	0	1	2+	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	511	F	4	38.5	31.0	900	1	0	1	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	512	F	4	30.5	24.5	450	0	0	0	YB	2	2	3	2	3	2	2	2	2	2	1	1	0	0	0	0	0	0
FI4	513	F	6	40	32.5	950	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	514	F	4	33.5	27.0	500	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	515	F	4	36	29.5	550	1-	1-	1-	B	2	1	3	1	2	1	0	0	1	0	0	0	0	0	0	0	0	0
FI4	516	F	5	35	28.0	575	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	517	F	5	37	30.5	775	0	1	1	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	518	F	3	33	27.0	550	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	519	F	4	31	25.0	475	0	0	0	Y/YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	520	F	4	33	26.5	550	0	0	0	Y	2	1	3	1	3	0	0	0	1	0	1	0	0	0	0	0	0	0
FI4	521	F	4	33	26.5	600	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	522	F	7	41	34.0	1025	0	2	2	Y/YB	3	1	3	2	3	2	2	1	3	2	2	1	0	0	0	0	0	0
FI4	523	M	5	32.5	26.0	450	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	524	F	5	32.5	26.0	525	1+	1+	1+	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	565	M	3	30	26.0	500	0	0	0	YB	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	566	F	5	38	30.5	775	0	0	1+	YB	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0
FI4	567	M	4	30.5	25.0	450	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

											CENTROTUBULAR HV						TUBULAR HV						FOCAL HV					
											A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	SEX	YR	TL	SL	WT	FIN	GR	GS	LC	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI4	568	M	5	32	26.0	475	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	569	M	4	35	29.5	675	0	1-	1-	YB/B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	570	M	4	35.5	29.0	600	0	1-	1-	YB/B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	571	F	5	36.5	36.0	750	0	1	1	YB	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0
FI4	572	M	4	32	26.0	450	0	1-	1-	YB	3	3	2	3	3	3	3	3	2	2	2	3	0	0	0	0	0	0
FI4	573	F	6	41	34.0	1225	0	1+	0	Y/YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	574	M	5	34.5	28.5	575	1	2	3	YB	3	3	3	3	3	2	3	3	3	3	3	2	0	0	0	0	0	0
FI5	585	M	4	32.5	26.0	475	0	0	0	B	3	3	4	3	3	3	0	1	0	1	0	0	0	0	0	0	0	0
FI5	586	M	4	33	27.5	550	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	587	F	4	33	27.0	550	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	588	F	4	31.5	26.0	400	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	589	F	5	33	27.5	600	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	590	F	5	37.5	31.5	625	0	1+	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	591	F	5	35.5	28.5	625	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	592	F	4	31	26.0	475	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	593	M	4	31.5	25.5	375	0	1-	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	594	F	4	31	25.0	475	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	595	F	4	30	24.5	425	0	1-	1-	YB/B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	596	F	4	32.5	26.5	500	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	597	M	4	31	25.0	400	0	1+	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	598	F	3	31.5	25.5	400	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	599	M	3	30	25.0	375	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	600	F	4	34	27.5	475	1	1-	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	601	M	3	30.5	24.5	400	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	602	F	6	38	30.5	775	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	603	F	4	35.5	29.0	650	0	1	1	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	604	F	4	34.5	28.0	600	0	1+	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	605	M	4	34	27.5	550	0	1+	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	606	F	4	32	25.5	475	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	607	F	4	33.5	27.0		1	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	608	F	6	40	32.0		0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	609	F	3	32	26.0	425	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	610	F	4	32	26.0	400	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	611	F	3	31	25.0	400	0	1	1	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	612	F	5	34	27.5	575	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	613	F	6	31	24.0	425	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	614	F	4	33.5	27.0	450	1	0	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	615	F	5	38	31.0	625	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	616	F	5	38.5	31.5	825	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	617	F	5	37.5	29.5	800	2+	0	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	618	F	5	36.5	29.5	750	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	619	M	4	35.5	28.5	600	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	620	F	5	38.5	31.5	725	0	1-	1-	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

											CENTROTUBULAR HV						TUBULAR HV						FOCAL HV					
											A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	SEX	YR	TL	SL	WT	FIN	GR	GS	LC	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI5	621	F	7	41	33.0	975	0	0	0	B	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	622	M	3	31	25.0	475	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	623	F	4	32.5	26.5	525	0	2	2	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	624	F	4	39	30.0	800	0	1-	1-	B/YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	625	F	5	34.5	28.0	600	0	0	0	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	626	F	5	36	29.0	700	0	0	0	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	627	M	4	33	27.0	500	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	628	M	4	33	27.5	475	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	629	F	4	33.5	27.5	650	0	1+	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	630	F	4	34	27.5	625	0	1+	1+	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	631	M	4	35	29.0	500	0	1	1	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	632	M	5	38.5	31.0	700	1+	1	2+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	633	F	5	37.5	30.0	675	1	1-	1+	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	634	M	4	32.5	27.0	500	0	1-	1-	YB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		MACROPHAGE						BILIARY PROLIFERATION						NEOPLASM						BALLOON HEPATOCYT					
		A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI1	406	2	1	3	2	2	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	407	1	1	1	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	408	3	2	3	3	3	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	409	1	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	410	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	411	1	1	1	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	412	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
FI1	413	2	2	2	2	2	2	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	414	2	3	2	2	1	1	2	2	2	1	2	1	0	0	0	0	0	0	0	0	0	0	1	0
FI1	415	1	2	1	1	0	0	0	1	1	2	0	2	0	0	0	0	0	0	3	3	3	3	3	3
FI1	416	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	417	1	3	1	2	1	2	2	2	2	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0
FI1	418	1	1	1	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	1	0	2	0	1	0
FI1	419	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	420	0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	3	0	1	0
FI1	421	1	1	1	0	1	1	2	1	2	1	1	1	0	0	0	0	0	0	1	1	1	1	2	1
FI1	422	1	2	1	1	0	0	1	2	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0
FI1	423	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI1	424	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0
FI1	465	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4
FI1	466	0	1	0	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	2	1	1	1	2	1
FI1	467	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	3	2	3	2	3	2
FI1	468	2	2	1	2	1	2	0	0	1	0	1	0	0	0	0	0	0	0	2	2	3	2	3	3
FI1	469	0	0	1	0	1	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI1	470	1	0	1	0	1	0	1	1	1	1	2	1	0	0	0	0	0	0	1	0	1	0	1	0
FI1	471	3	2	3	2	3	3	1	1	2	1	2	0	0	0	0	0	0	0	3	2	3	3	3	3
FI1	472	3	3	3	3	3	2	2	1	2	1	2	1	0	0	0	0	0	0	1	0	1	0	1	0
FI1	473	1	1	2	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	2	3	2
FI1	474	1	1	1	0	1	1	2	1	2	1	1	1	0	0	0	0	0	0	3	3	3	3	3	2
FI2	525	2	0	2	0	2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	526	1	1	2	1	2	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1	0
FI2	527	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
FI2	528	2	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	529	2	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	1
FI2	530	2	1	2	1	3	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1	0
FI2	531	2	1	2	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	4	1	4	1	4	1
FI2	532	1	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	533	2	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	534	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	1	2	1
FI2	535	1	0	1	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
FI2	536	4	3	4	3	4	3	2	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	537	2	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	538	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		MACROPHAGE						BILIARY PROLIFERATION						NEOPLASM						BALLOON HEPATOCYT					
		A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI2	539	0	0	1	0	1	0	1	1	2	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	540	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	541	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	542	1	1	2	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1
FI2	543	1	0	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	544	2	1	0	1	0	1	0	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
FI2	545	1	0	2	0	2	0	0	1	1	1	1	1	0	0	0	0	0	0	0	2	0	2	0	2
FI2	546	1	1	1	0	2	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1
FI2	547	2	1	2	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	548	1	0	1	0	1	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	549	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	550	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2	2	2	2
FI2	551	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	552	1	1	0	1	0	1	1	2	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	553	2	1	2	1	2	1	2	1	2	1	2	1	0	0	0	0	0	0	2	2	2	2	2	2
FI2	554	3	1	3	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	2	1	2
FI2	555	2	2	2	1	2	1	0	1	1	1	1	1	0	0	0	0	0	0	1	1	1	2	1	2
FI2	556	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
FI2	557	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	558	2	1	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	559	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1
FI2	560	2	1	2	1	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	561	2	2	2	1	2	0	1	1	2	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	562	2	1	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	563	2	1	2	1	2	1	2	1	2	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	564	2	1	2	0	1	1	2	1	2	1	2	1	0	0	0	0	0	0	1	1	1	1	1	1
FI2	575	0	0	1	0	1	1	0	0	1	0	1	1	0	0	0	0	0	0	2	1	1	1	2	1
FI2	576	0	0	0	0	0	0	1	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	577	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	1	1
FI2	578	3	3	3	3	3	3	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0
FI2	579	2	2	3	2	3	2	1	1	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
FI2	580	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3
FI2	581	3	4	3	2	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI2	582	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	3	3	2	2	2	2
FI2	583	1	0	2	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
FI2	584	1	0	0	0	1	0	1	1	1	0	1	1	0	0	0	0	0	0	2	3	2	3	2	3
FI3	425	2	2	1	1	1	1	2	1	1	1	0	0	0	0	0	0	0	0	2	0	2	0	2	1
FI3	426	2	2	2	2	1	2	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	427	1	2	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	2	0	2	1	1	0
FI3	428	2	2	1	2	1	2	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	429	3	2	3	2	2	2	2	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	2
FI3	430	1	1	1	1	0	1	2	1	2	1	2	0	0	0	0	0	0	0	1	2	1	1	1	1
FI3	431	2	2	2	2	2	2	2	3	3	3	2	3	3	3	3	3	3	3	1	3	2	1	1	2

		MACROPHAGE						BILIARY PROLIFERATION						NEOPLASM						BALLOON HEPATOCYT					
		A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI3	432	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	3	3	2	3	2	3
FI3	433	2	1	1	2	1	1	1	2	1	1	1	2	0	0	0	0	0	0	2	3	1	3	1	3
FI3	434	0	2	0	1	0	1	1	1	1	1	0	1	0	0	0	0	0	0	1	0	1	0	1	0
FI3	435	1	2	0	2	0	1	1	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	436	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	437	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	438	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	439	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	440	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	2	3	2	3	2	3
FI3	441	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0
FI3	442	2	1	1	1	2	1	2	2	1	1	1	0	0	0	0	0	0	0	1	1	1	1	2	1
FI3	443	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	2	0	2	0	2	0
FI3	444	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0
FI3	445	1	2	1	1	1	1	0	2	0	2	0	2	0	0	0	0	0	0	1	0	1	0	1	0
FI3	446	1	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	2	0
FI3	447	1	2	1	2	1	2	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	2	0
FI3	448	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	4	2	4	2
FI3	449	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	1	0	2	0
FI3	450	1	0	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0
FI3	451	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	452	2	1	2	1	2	1	1	2	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	453	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	454	2	1	2	1	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	455	3	2	2	2	2	2	2	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	456	2	2	2	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	457	1	1	1	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	458	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	459	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	1	2	1
FI3	460	1	1	1	1	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	461	2	2	2	2	3	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	462	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	2	3	2	3	4
FI3	463	1	1	2	1	2	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI3	464	2	1	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI3	475	1	0	2	2	1	1	2	1	2	1	1	1	0	0	0	0	0	0	3	3	3	3	3	2
FI3	476	2	2	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	2	3	2	2	1	1
FI3	477	2	3	2	3	2	3	1	1	1	1	1	1	0	0	0	0	0	0	1	1	3	3	2	1
FI3	478	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0
FI3	479	3	3	3	3	3	2	1	1	1	1	1	1	0	0	0	0	0	0	2	1	3	2	3	1
FI3	480	3	3	3	3	3	3	2	2	2	2	2	2	0	0	0	0	0	0	1	3	1	1	1	0
FI3	481	3	3	3	2	3	2	2	2	2	1	2	1	0	0	0	0	0	0	0	0	0	1	0	0
FI3	482	2	2	1	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	2	1	1	2
FI3	483	2	2	2	2	2	2	2	2	0	0	1	0	0	0	0	0	0	0	1	2	1	0	1	2
FI3	484	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	2	0	1

		MACROPHAGE						BILIARY PROLIFERATION						NEOPLASM						BALLOON HEPATOCYT					
		A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI4	485	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	486	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	487	3	2	3	2	3	2	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	488	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	489	2	1	2	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	490	1	1	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	491	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	492	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
FI4	493	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
FI4	494	1	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	495	0	1	1	0	1	0	0	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	496	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
FI4	497	1	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	3	0	3	0
FI4	498	3	2	2	2	2	2	0	1	0	1	1	1	0	0	0	0	0	0	1	0	1	0	0	0
FI4	499	1	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	500	1	0	1	0	1	0	2	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	2	1
FI4	501	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	502	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	503	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	1
FI4	504	1	1	1	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	2	1	2
FI4	505	1	0	1	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	506	1	1	1	1	1	1	1	1	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	507	0	1	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	508	2	1	3	1	3	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	3	0	2	0
FI4	509	2	2	2	1	2	2	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	510	2	1	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	2	0	2	0	2	0
FI4	511	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	2	0	2	0
FI4	512	1	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	513	3	1	3	1	3	1	0	0	1	0	2	0	0	0	0	0	0	0	2	1	3	1	3	1
FI4	514	1	0	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0
FI4	515	2	1	1	1	0	1	0	2	1	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0
FI4	516	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	2	0
FI4	517	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1	2	1
FI4	518	1	0	1	0	1	0	0	1	0	1	1	1	0	0	0	0	0	0	1	0	1	0	0	0
FI4	519	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
FI4	520	1	0	2	0	2	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	2	0	1
FI4	521	1	0	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	1	0	1	0	2	1
FI4	522	2	2	3	2	3	1	1	1	1	1	0	0	0	0	0	0	0	0	1	2	2	3	2	3
FI4	523	2	0	2	0	2	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	524	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	1	2	2
FI4	565	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	566	1	2	2	2	1	2	1	1	1	1	1	1	0	0	0	0	0	0	1	2	2	0	2	0
FI4	567	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3

		MACROPHAGE						BILIARY PROLIFERATION						NEOPLASM						BALLOON HEPATOCYT					
		A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI4	568	1	2	2	2	2	0	2	2	1	1	1	0	0	0	0	0	0	0	3	3	2	3	3	3
FI4	569	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	570	1	1	2	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	571	1	1	0	0	1	0	1	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FI4	572	1	0	1	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI4	573	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	2	2	3
FI4	574	2	3	2	2	2	2	1	1	1	2	2	1	0	0	0	0	0	0	3	3	3	3	3	3
FI5	585	2	2	2	2	2	2	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	586	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	587	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	2	1	2
FI5	588	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0
FI5	589	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	590	2	2	2	2	2	2	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	591	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1	2	1
FI5	592	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	1	2	1
FI5	593	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	594	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2	2	1	2
FI5	595	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	2	2	2	2	3	2
FI5	596	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	1	0	1
FI5	597	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	598	1	0	1	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	599	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	600	2	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0	1	1	1	1	0	1
FI5	601	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	602	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2	1	2	1	2	1
FI5	603	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	604	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	605	2	1	2	1	2	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	606	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	607	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	608	2	1	2	1	2	1	2	2	2	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	609	1	0	1	0	0	0	0	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	610	1	1	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	611	0	0	0	0	0	0	0	1	2	1	0	1	0	0	0	0	0	0	0	1	1	1	1	1
FI5	612	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	613	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	614	1	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	615	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	616	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
FI5	617	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2	3	3	3	2	3
FI5	618	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
FI5	619	2	1	2	1	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	620	0	0	0	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	1	1	1	1	1	1

		MACROPHAGE						BILIARY PROLIFERATION						NEOPLASM						BALLOON HEPATOCYT					
		A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C	A	A	B	B	C	C
ST	ID	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
FI5	621	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
FI5	622	0	0	1	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
FI5	623	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2
FI5	624	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
FI5	625	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0
FI5	626	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	2	2	1	1
FI5	627	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	628	2	1	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	629	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	4	4	4	4
FI5	630	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	3	3	3
FI5	631	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	632	1	1	1	1	1	0	2	1	1	1	1	1	0	0	0	0	0	0	2	2	2	2	2	2
FI5	633	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI5	634	2	1	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	2	2

APPENDIX B

RESULTS OF CHEMISTRY ANALYSES ON FISH AND SHELLFISH COLLECTED DURING 1993

PAH/LAB Spreadsheet		PCB/Pesticide Spreadsheet	
Column	Full Analyte Name	Column	Full Analyte Name
naphthalene	naphthalene	CL2(08)	CL2(08)
C1-naphthal	C1-naphthalenes	HEXACHLOROB	HEXACHLOROBENZENE
C2-naphthal	C2-naphthalenes	LINDANE	LINDANE
C3-naphthal	C3-naphthalenes	CL3(18)	CL3(18)
C4-naphthal	C4-naphthalenes	CL3(28)	CL3(28)
biphenyl	biphenyl	HEPTACHLOR	HEPTACHLOR
acenaphthyl	acenaphthylene	CL4(52)	CL4(52)
acenaphthen	acenaphthene	ALDRIN	ALDRIN
dibenzofura	dibenzofuran	CL4(44)	CL4(44)
fluorene	fluorene	HEPTACHLORE	HEPTACHLOREPOXIDE
C1-fluorene	C1-fluorenes	CL4(66)	CL4(66)
C2-fluorene	C2-fluorenes	2,4-DDE	2,4-DDE
C3-fluorene	C3-fluorenes	CL5(101)	CL5(101)
anthracene	anthracene	CIS-CHLORDA	CIS-CHLORDANE
C1-phenanth	C1-phenanthrenes/anthracenes	TRANS-NONAC	TRANS-NONACHLOR
C2-phenanth	C2-phenanthrenes/anthracenes	DIELDRIN	DIELDRIN
C3-phenanth	C3-phenanthrenes/anthracenes	4,4-DDE	4,4-DDE
C4-phenanth	C4-phenanthrenes/anthracenes	CL4(77)	CL4(77)
dibenzothio	dibenzothiophene	2,4-DDD	2,4-DDD
C1-dibenzot	C1-dibenzothiophenes	ENDRIN	ENDRIN
C2-dibenzot	C2-dibenzothiophenes	CL5(118)	CL5(118)
C3-dibenzot	C3-dibenzothiophenes	4,4-DDD	4,4-DDD
fluoranthen	fluoranthene	2,4-DDT	2,4-DDT
pyrene	pyrene	CL6(153)	CL6(153)
C1-fluorant	C1-fluoranthenes/pyrenes	CL5(105)	CL5(105)
benz[a]anth	benz[a]anthracene	4,4-DDT	4,4-DDT
chrysene	chrysene	CL6(138)	CL6(138)
C1-chrysene	C1-chrysenes	CL5(126)	CL5(126)
C2-chrysene	C2-chrysenes	CL7(187)	CL7(187)
C3-chrysene	C3-chrysenes	CL6(128)	CL6(128)
C4-chrysene	C4-chrysenes	CL7(180)	CL7(180)
benzo[b]flu	benzo[b]fluoranthene	MIREX	MIREX
benzo[k]flu	benzo[k]fluoranthene	CL7(170)	CL7(170)
benzo[e]pyr	benzo[e]pyrene	CL8(195)	CL8(195)
benzo[a]pyr	benzo[a]pyrene	CL9(206)	CL9(206)
perylene	perylene	CL10(209)	CL10(209)
indeno[1,2,	indeno[1,2,3-c,d]pyrene	DBOFB	DBOFB
dibenz[a,h]	dibenz[a,h]anthracene	CL5(112)	CL5(112)
benzo[g,h,i	benzo[g,h,i]perylene		
phenyl deca	phenyl decanes		
phenyl unde	phenyl undecanes		
phenyl dode	phenyl dodecanes		
phenyl trid	phenyl tridecanes		
phenyl tetr	phenyl tetradecanes		
naphthalene	naphthalene-d8		
acenaphthen	acenaphthene-d10		
benzo[a]pyr	benzo[a]pyrene-d12		
phenyl nona	phenyl nonane		

Massachusetts Water Resources Authority

Trace Metals Data Reported in ug/g dry weight

1993 Tissue Chemistry - Task 17

Product Number
KP93TMET.WK1

Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	Ag	Cd	Cr	Cu	Hg	Ni	Pb	Zn
FI1	42.3485	70.9712	13-APR-93	F93010017	467	FISH					0.446			
FI1	42.3485	70.9712	13-APR-93	F93010017	468	FISH					0.286			
FI1	42.3497	70.9735	13-APR-93	F93010023	465	FISH					0.263			
FI1	42.3497	70.9735	13-APR-93	F93010023	466	FISH					0.171			
FI1	42.3497	70.9735	13-APR-93	F93010023	470	FISH					0.313			
FI1	42.3500	70.9766	13-APR-93	F93010030	KG34	HEPATOPANC	7.41	2.07	1.35	638	0.4	1.03	0.506	143
FI1	42.3500	70.9766	13-APR-93	F93010030	KG34	LOBSTER					0.849			
FI1	42.3500	70.9768	13-APR-93	F93010029	471	FISH					0.749			
FI1	42.3500	70.9768	13-APR-93	F93010029	472	FISH					1.278			
FI1	42.3500	70.9768	13-APR-93	F93010029	473	FISH					0.501			
FI1	42.3500	70.9768	13-APR-93	F93010029	474	FISH					0.251			
FI1	42.3503	70.9768	13-APR-93	F93010035	469	FISH					0.34			
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	HEPATOPANC	6.36	4.41	1.5	363	0.209	0.447	0.175	31.2
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	LOBSTER					0.857			
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	HEPATOPANC	5.82	3.52	1.52	925	0.278	0.478	0.317	50.2
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	LOBSTER					0.821			
FI4	42.3845	70.8300	14-APR-93	F93010063	573	FISH					0.203			
FI4	42.3845	70.8300	14-APR-93	F93010063	574	FISH					0.467			
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	HEPATOPANC	3.18	9.02	1.33	487	0.28	0.434	0.503	117
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	LOBSTER					1.32			
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	HEPATOPANC	1.68	17.5	1.21	131	0.192	0.499	0.256	50.1
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	LOBSTER					0.705			
FI4	42.3880	70.8298	14-APR-93	F93010059	565	FISH					0.202			
FI4	42.3880	70.8298	14-APR-93	F93010059	566	FISH					0.716			
FI4	42.3880	70.8298	14-APR-93	F93010059	567	FISH					0.188			
FI4	42.3880	70.8298	14-APR-93	F93010059	569	FISH					0.196			
FI4	42.3880	70.8298	14-APR-93	F93010059	570	FISH					0.739			
FI4	42.3880	70.8298	14-APR-93	F93010059	571	FISH					0.503			
FI4	42.3880	70.8298	14-APR-93	F93010059	572	FISH					0.5			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KH99	HEPATOPANC	3.28	7.97	1.36	356	0.172	0.797	0.207	31
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KH99	LOBSTER					0.868			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI01	HEPATOPANC	3.32	6.91	1.07	63.8	0.198	0.959	0.04	40.3
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI01	LOBSTER					0.706			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI02	HEPATOPANC	6.09	6.9	0.868	207	0.136	0.845	0.059	37.9
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI02	LOBSTER					0.612			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI03	HEPATOPANC	23.4	15.4	0.778	1264	0.003 <	1.4	0.085	63.5
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI03	LOBSTER					0.394			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI04	HEPATOPANC	8.49	4.62	1.64	34.2	0.103	0.622	0.02	21.3

Massachusetts Water Resources Authority

Trace Metals Data Reported in ug/g dry weight

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Product Number
KP93TMET.WK1

Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	Ag	Cd	Cr	Cu	Hg	Ni	Pb	Zn
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI04	LOBSTER					0.525			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI05	HEPATOPANC	1.86	18.9	0.648	599	0.294	2.81	0.048	56.8
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI05	LOBSTER					0.923			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI21	HEPATOPANC	2.85	10.7	0.886	912	0.218	1.83	0.151	53.7
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI21	LOBSTER					0.559			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI22	HEPATOPANC	5.56	18.6	0.772	619	0.435	1.77	0.083	98.9
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI22	LOBSTER					0.442			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI23	HEPATOPANC	6.15	7.48	1.37	96.1	0.092	1.18	0.063	36.6
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI23	LOBSTER					0.729			
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI24	HEPATOPANC	2.45	11.7	1.5	484	0.267	0.866	0.283	57.3
FI5	41.7500	70.1833	04-SEP-93	LOB-FI5	KI24	LOBSTER					0.828			
FI5	41.9398	70.1218	15-APR-93	F93010097	625	FISH					0.18			
FI5	41.9398	70.1218	15-APR-93	F93010097	626	FISH					0.357			
FI5	41.9398	70.1218	15-APR-93	F93010097	627	FISH					0.135			
FI5	41.9398	70.1218	15-APR-93	F93010097	628	FISH					0.309			
FI5	41.9398	70.1218	15-APR-93	F93010097	629	FISH					0.089			
FI5	41.9398	70.1218	15-APR-93	F93010097	630	FISH					0.18			
FI5	41.9398	70.1218	15-APR-93	F93010097	631	FISH					0.227			
FI5	41.9398	70.1218	15-APR-93	F93010097	632	FISH					0.144			
FI5	41.9398	70.1218	15-APR-93	F93010097	633	FISH					0.195			
FI5	41.9398	70.1218	15-APR-93	F93010097	634	FISH					0.046			

Description of Qualifiers:

f = reported value below method detection limit

< = reported value is the method detection limit

x = matrix interference

Massachusetts Water Resources Authority
1993 Tissue Chemistry - Task 17
Product Number TKP93PST.WK1
PCB/Pesticide Data Reported in ng/g dry weight

Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	CL2(08)	HEXACHLOROB	LINDANE	CL3(18)	CL3(28)	HEPTACHLOR	CL4(52)
FI1	42.3485	70.9711667	13-APR-93	F93010017	467	FISH	1.53	0.59	0.2 f	0.41 f	1.39	0.58 <	1.07
FI1	42.3485	70.9711667	13-APR-93	F93010017	468	FISH	1.23 <	0.84	0.45 <	0.71 <	3.42	0.48 <	1.15
FI1	42.3496667	70.9735	13-APR-93	F93010023	465	FISH	1.16 <	0.86	0.43 <	0.67 <	3.25	0.46 <	1.42
FI1	42.3496667	70.9735	13-APR-93	F93010023	466	FISH	1.59 <	0.72	0.59 <	0.92 <	2.94	0.63 <	2.1
FI1	42.3496667	70.9735	13-APR-93	F93010023	470	FISH	1.68 <	0.45	0.62 <	0.97 <	1.87	0.66 <	1.32
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	HEPATOPANC	7.52 <	5.73	6.68	15.05	128.77	2.97 <	23.86
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	LOBSTER	1.59 <	0.55	4.25	0.91 <	5.03	0.63 <	1.22
FI1	42.35	70.9768333	13-APR-93	F93010029	471	FISH	1.69 <	2.23	0.73	1.05	6.9	0.67 <	4.28
FI1	42.35	70.9768333	13-APR-93	F93010029	472	FISH	1.44 <	0.83	0.53 <	0.83 <	1.57	0.57 <	3.29
FI1	42.35	70.9768333	13-APR-93	F93010029	473	FISH	1.91 <	1.62	0.7 <	1.1 <	0.56 <	0.75 <	0.87 f
FI1	42.35	70.9768333	13-APR-93	F93010029	474	FISH	1.62 <	1.03	0.6 <	0.93 <	5.84	0.64 <	1.7
FI1	42.3503333	70.9768333	13-APR-93	F93010035	469	FISH	1.25 <	0.59	0.46 <	0.72 <	2.04	0.49 <	1.56
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	HEPATOPANC	4.86 <	10.98	6.13	14.11	122.73	6.89	38.41
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	LOBSTER	1.75 <	0.44	4.43	1.01 <	2.68	0.69 <	0.81 f
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	HEPATOPANC	6.66 <	10.38	7.77	13.74	78.42	2.63 <	64.54
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	LOBSTER	1.69 <	0.42	6.18	1.65	2.61	0.67 <	1.06
FI4	42.3845	70.83	14-APR-93	F93010063	573	FISH	1.92 <	1.02	0.71 <	1.1 <	9.43	0.76 <	2.61
FI4	42.3845	70.83	14-APR-93	F93010063	574	FISH	1.15 <	0.7	0.43 <	0.66 <	1.53	0.46 <	0.62
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	HEPATOPANC	5.99 <	9.64	2.22 <	21.12	44.26	2.36 <	7.65
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	LOBSTER	1.8 <	0.49	4.63	1.04 <	0.66	0.71 <	0.39 f
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	HEPATOPANC	4.38 <	6.87	7.68	6.91	32.18	1.73 <	2.39
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	LOBSTER	1.09 <	0.29	5.23	0.63 <	0.69	0.43 <	0.56
FI4	42.388	70.8298333	14-APR-93	F93010059	565	FISH	1.16 <	0.71	0.43 <	0.67 <	2.77	0.46 <	0.8
FI4	42.388	70.8298333	14-APR-93	F93010059	566	FISH	1.3 <	0.58	0.48 <	0.75 <	0.85	0.51 <	0.27 f
FI4	42.388	70.8298333	14-APR-93	F93010059	567	FISH	1.5 <	0.74	0.56 <	0.87 <	1.2	0.59 <	1.48
FI4	42.388	70.8298333	14-APR-93	F93010059	569	FISH	1.1 <	0.46	0.41 <	0.57 f	2.75	0.44 <	4.02
FI4	42.388	70.8298333	14-APR-93	F93010059	570	FISH	1.16 <	0.82	0.43 <	0.67 <	3.69	0.46 <	4.82
FI4	42.388	70.8298333	14-APR-93	F93010059	571	FISH	2.08 <	0.76	0.77 <	1.2 <	0.74	0.82 <	1.17
FI4	42.388	70.8298333	14-APR-93	F93010059	572	FISH	1.39 <	0.63	0.51 <	0.8 <	0.41 <	0.55 <	0.72 <
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	HEPATOPANC	4.72 <	22.96	11.13	21.74	36.04	1.86 <	21.68
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	LOBSTER	1.78 <	0.45	3.85	1.03 <	0.52 <	0.7 <	1.6
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	HEPATOPANC	3.65 <	8.12	5.81	8.47	20.69	1.44 <	17.05
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	LOBSTER	1.54 <	0.3 f	4.2	0.89 <	0.45 <	0.61 <	0.39 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	HEPATOPANC	4.24 <	9.23	1.57 <	2.44 <	18.25	1.67 <	15.63
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	LOBSTER	1.25 <	0.26	3.93	0.72 <	0.37 <	0.49 <	0.4 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	HEPATOPANC	10.19 <	6.62	18.79	10.84	36.77	4.02 <	26.84
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	LOBSTER	1.77 <	0.23 f	3.53	1.02 <	0.77	0.7 <	0.72 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	HEPATOPANC	3.03 <	9.46	6.16	9.11	20.77	1.2 <	12.35
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	LOBSTER	1.09 <	0.38	3.62	0.76	0.55	0.43 <	0.52 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	HEPATOPANC	5.8 <	5.98	11.82	8.99	25.29	2.29 <	1.67 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	LOBSTER	1.56 <	0.34	5.2	1.54	0.48	0.62 <	0.54 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	HEPATOPANC	8.67 <	5.91	18.41	6.39	16.74	3.42 <	5.84
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	LOBSTER	1.86 <	0.35 f	12.96	1.07 <	0.55 <	0.73 <	0.43 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	HEPATOPANC	6.83 <	4.09	11.12	7.13	11.3	2.69 <	3.57
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	LOBSTER	1.64 <	0.32 f	4.71	0.94 <	0.48 <	0.65 <	0.34 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	HEPATOPANC	3.55 <	6.84	4.35	6.4	15.52	1.4 <	13.89

Massachusetts Water Resources Authority
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Product Number TKP93PST.WK1
PCB/Pesticide Data Reported in ng/g dry weight

Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	CL2(08)	HEXACHLOROB	LINDANE	CL3(18)	CL3(28)	HEPTACHLOR	CL4(52)
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	LOBSTER	0.99 <	0.17 f	1.37	0.57 <	0.29 <	0.39 <	0.21 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	HEPATOPANC	6.51 <	9.13	14.05	16.47	26.29	2.57 <	18.51
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	LOBSTER	1.63 <	0.34	3.58	0.94 <	0.37 f	0.64 <	0.36 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	625	FISH	1.59 <	0.46	0.59 <	0.91 <	0.47 <	0.63 <	0.33 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	626	FISH	2.41	0.75	0.49 <	0.77 <	0.68	0.53 <	0.61 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	627	FISH	1.76 <	0.89	0.65 <	1.01 <	1.74	0.69 <	0.57 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	628	FISH	1.79 <	0.61	0.66 <	1.03 <	1.06	0.71 <	0.89 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	629	FISH	1.91 <	0.61	0.71 <	1.1 <	0.44 f	0.75 <	0.57 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	630	FISH	1.89 <	0.44	0.7 <	1.09 <	0.6	0.74 <	0.38 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	631	FISH	1.73 <	0.39	0.64 <	1 <	0.52	0.68 <	0.27 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	632	FISH	1.68 <	1.36	0.62 <	0.97 <	0.84	0.66 <	0.47 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	633	FISH	1.31 <	0.76	0.48 <	0.75 <	0.68	0.52 <	0.43 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	634	FISH	1.46 <	0.2 f	0.54 <	0.84 <	0.44	0.58 <	0.45 f

Massachusetts Water Resources Authority
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PCB/Pesticide Data Reported in ng/g dry weight

Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	ALDRIN	CL4(44)	HEPTACHLOR-EPOXIDE	CL4(66)	2,4-DDE	CL5(101)	CIS-CHLORDA
FI1	42.3485	70.9711667	13-APR-93	F93010017	467	FISH	0.35 <	0.64	0.51 <	4.11	0.58 <	5.24	2.3
FI1	42.3485	70.9711667	13-APR-93	F93010017	468	FISH	0.29 <	0.76	0.56	7.81	0.48 <	7.06	5.67
FI1	42.3496667	70.9735	13-APR-93	F93010023	465	FISH	0.28 <	0.99	0.45	7.56	0.46 <	8.04	7.15
FI1	42.3496667	70.9735	13-APR-93	F93010023	466	FISH	0.38 <	0.8	0.48 f	6.72	0.63 <	12.6	6.64
FI1	42.3496667	70.9735	13-APR-93	F93010023	470	FISH	0.4 <	0.71	0.26 f	3.51	0.66 <	7.35	4.21
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	HEPATOPANC	1.8 <	7.05	9.37	293.94	2.97 <	150.39	28.23
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	LOBSTER	0.38 <	0.44 f	0.95	11.02	0.63 <	6.46	1.77
FI1	42.35	70.9768333	13-APR-93	F93010029	471	FISH	0.4 <	1.75	1.27	16.39	0.67 <	25.68	11
FI1	42.35	70.9768333	13-APR-93	F93010029	472	FISH	0.34 <	1.26	0.58	3.26	0.57 <	11.65	3.88
FI1	42.35	70.9768333	13-APR-93	F93010029	473	FISH	0.46 <	0.65 f	0.5 f	1.72	0.75 <	4.95	1.69
FI1	42.35	70.9768333	13-APR-93	F93010029	474	FISH	0.39 <	1.2	0.86	9.01	0.64 <	11.07	9.6
FI1	42.3503333	70.9768333	13-APR-93	F93010035	469	FISH	0.3 <	0.84	0.4 f	4.43	0.49 <	5.95	5.35
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	HEPATOPANC	1.17 <	7.02	1.69 <	105.88	1.92 <	195.16	48.68
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	LOBSTER	0.42 <	0.53 f	0.53 f	4.17	0.69 <	3.88	1.85
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	HEPATOPANC	1.6 <	11.21	10.78	213.13	2.63 <	110.75	82.98
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	LOBSTER	0.41 <	0.53 f	0.36 f	4.85	0.67 <	3.37	1.46
FI4	42.3845	70.83	14-APR-93	F93010063	573	FISH	0.46 <	1.57	0.54 f	17.74	0.76 <	16.31	9.31
FI4	42.3845	70.83	14-APR-93	F93010063	574	FISH	0.28 <	0.55	0.4 <	4.48	0.46 <	4.95	2.59
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	HEPATOPANC	1.44 <	2.08 f	7.38	182.12	2.36 <	62.25	14.4
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	LOBSTER	0.43 <	0.24 f	0.32 f	2.25	0.71 <	1.12	0.47 f
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	HEPATOPANC	1.05 <	1.19 f	5.41	81.02	1.73 <	29.79	6.45
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	LOBSTER	0.26 <	0.23 f	0.37 f	2.13	0.43 <	1	0.38 f
FI4	42.388	70.8298333	14-APR-93	F93010059	565	FISH	0.28 <	0.51	0.29 f	6.66	0.46 <	7.08	7.98
FI4	42.388	70.8298333	14-APR-93	F93010059	566	FISH	0.31 <	0.43 f	0.45 <	3.3	0.51 <	1.35	2.51
FI4	42.388	70.8298333	14-APR-93	F93010059	567	FISH	0.36 <	0.53 f	0.52 <	3.73	0.59 <	8.41	2.85
FI4	42.388	70.8298333	14-APR-93	F93010059	569	FISH	0.26 <	1.19	0.38 <	5.68	0.44 <	12.67	5.95
FI4	42.388	70.8298333	14-APR-93	F93010059	570	FISH	0.28 <	1.57	0.62	10.04	0.46 <	21.85	11.11
FI4	42.388	70.8298333	14-APR-93	F93010059	571	FISH	0.5 <	0.84 f	0.4 f	3.07	0.82 <	7.04	1.89
FI4	42.388	70.8298333	14-APR-93	F93010059	572	FISH	0.33 <	0.58 <	0.48 <	4.34	0.55 <	3.8	2.42
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	HEPATOPANC	1.13 <	6.25	11.36	128.56	1.86 <	222.83	206.02
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	LOBSTER	2.36	0.31 f	0.31 f	1.18	0.7 <	2.09	5.87
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	HEPATOPANC	0.87 <	4.46	3.92	44.36	1.44 <	65.2	17.1
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	LOBSTER	0.37 <	0.26 f	0.25 f	0.72	0.61 <	0.63 f	0.31 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	HEPATOPANC	1.02 <	6.43	9.23	39.85	1.67 <	33.47	17.18
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	LOBSTER	0.3 <	0.21 f	0.18 f	0.82	0.49 <	1.15	0.53
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	HEPATOPANC	2.44 <	3.68 f	8.45	175	4.02 <	133.79	26.31
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	LOBSTER	0.42 <	0.23 f	0.17 f	2.21	0.7 <	2.29	0.58 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	HEPATOPANC	0.73 <	3.47	5.64	51.44	1.2 <	37.56	19.78
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	LOBSTER	0.26 <	0.23 f	0.3 f	1.17	0.16 f	1.39	0.69
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	HEPATOPANC	1.39 <	1.7 f	9.17	115.54	2.29 <	11.57	2.02 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	LOBSTER	0.38 <	0.27 f	0.3 f	2.14	0.62 <	0.8 f	0.22 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	HEPATOPANC	2.08 <	1.84 f	5.76	79.4	3.42 <	26.09	5.66
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	LOBSTER	0.45 <	0.25 f	0.27 f	1.64	0.73 <	0.97 f	0.31 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	HEPATOPANC	1.64 <	1.48 f	5.67	57.77	2.69 <	24.26	6.29
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	LOBSTER	0.39 <	0.23 f	0.19 f	1.86	0.65 <	1.12	0.3 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	HEPATOPANC	0.85 <	4.04	3.71	47.28	1.4 <	68.53	18.39

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Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	ALDRIN	CL4(44)	HEPTACHLOR-EPOXIDE	CL4(66)	2,4-DDE	CL5(101)	CIS-CHLORDA
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	LOBSTER	0.24 <	0.17 f	0.15 f	0.93	0.39 <	1.06	0.27 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	HEPATOPANC	1.56 <	7.22	5.28	98.84	2.57 <	53.54	18.41
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	LOBSTER	0.39 <	0.28 f	0.17 f	1.26	0.64 <	1.05	0.42 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	625	FISH	0.38 <	0.61 f	0.28 f	1.07	0.63 <	1.49	0.73
FI5	41.9398333	70.1218333	15-APR-93	F93010097	626	FISH	0.32 <	0.39 f	0.47 <	2.76	0.53 <	4.53	1.71
FI5	41.9398333	70.1218333	15-APR-93	F93010097	627	FISH	0.42 <	0.37 f	0.76	1.76	0.69 <	2.58	2.61
FI5	41.9398333	70.1218333	15-APR-93	F93010097	628	FISH	0.43 <	0.71 f	0.36 f	2.91	0.71 <	5.47	2.6
FI5	41.9398333	70.1218333	15-APR-93	F93010097	629	FISH	0.46 <	0.73 f	0.23 f	1	0.75 <	1.6	0.71 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	630	FISH	0.45 <	1.7	0.31 f	1.01	0.74 <	1.67	0.82
FI5	41.9398333	70.1218333	15-APR-93	F93010097	631	FISH	0.42 <	0.5 f	0.24 f	1.13	0.68 <	1.6	1.57
FI5	41.9398333	70.1218333	15-APR-93	F93010097	632	FISH	0.4 <	0.83	0.51 f	2.63	0.66 <	2.65	2.07
FI5	41.9398333	70.1218333	15-APR-93	F93010097	633	FISH	0.31 <	0.7	0.46 <	1.81	0.52 <	2.97	1.53
FI5	41.9398333	70.1218333	15-APR-93	F93010097	634	FISH	0.35 <	0.39 f	0.13 f	1.23	0.58 <	1.49	0.78

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Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	TRANS-NONAC	DIELDRIN	4,4-DDE	CL4(77)	2,4-DDD	ENDRIN	CL5(118)
FI1	42.3485	70.9711667	13-APR-93	F93010017	467	FISH	3.05	2.3	13.75	0.64 <	1.4	0.38 f	20.33
FI1	42.3485	70.9711667	13-APR-93	F93010017	468	FISH	10.11	3.93	15.07	0.54 <	1.62	0.37 <	27.08
FI1	42.3496667	70.9735	13-APR-93	F93010023	465	FISH	12.17	3.33	12.77	0.51 <	1.38	0.35 <	18.62
FI1	42.3496667	70.9735	13-APR-93	F93010023	466	FISH	9.94	2.99	19.25	0.7 <	1.81	0.48 <	25.28
FI1	42.3496667	70.9735	13-APR-93	F93010023	470	FISH	4.7	2.5	14.11	0.74 <	1.47	0.51 <	16.46
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	HEPATOPANC	159.16	87.7	424.3	3.3 <	23.58	2.29 <	386.11
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	LOBSTER	5.52	11.1	38.69	0.7 <	1.74	0.48 <	50.36
FI1	42.35	70.9768333	13-APR-93	F93010029	471	FISH	19.02	5.87	40.56	0.74 <	4.81	0.51 <	55.05
FI1	42.35	70.9768333	13-APR-93	F93010029	472	FISH	6.25	3.23	17.07	0.63 <	5.7	0.44 <	17.33
FI1	42.35	70.9768333	13-APR-93	F93010029	473	FISH	2.99	2.81	14.64	0.84 <	1.37	0.58 <	12.3
FI1	42.35	70.9768333	13-APR-93	F93010029	474	FISH	13.34	3.78	15.97	0.71 <	1.85	0.49 <	22.07
FI1	42.3503333	70.9768333	13-APR-93	F93010035	469	FISH	9.58	2.27	11.71	0.55 <	1.23	0.38 <	15.53
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	HEPATOPANC	142.15	113.21	353.78	2.13 <	21.66	1.48 <	330.24
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	LOBSTER	3.25	8.45	14.28	0.77 <	0.92	0.53 <	16.82
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	HEPATOPANC	87.74	173.2	353.25	2.92 <	25.85	2.03 <	463.2
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	LOBSTER	2.52	7.5	10.37	0.74 <	0.51	0.52 <	20.07
FI4	42.3845	70.83	14-APR-93	F93010063	573	FISH	18.01	7.42	29.99	0.84 <	2.83	0.58 <	57.13
FI4	42.3845	70.83	14-APR-93	F93010063	574	FISH	4.19	1.67	11.95	0.51 <	1.35	0.35 <	16.62
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	HEPATOPANC	29.35	67.19	265.04	21.95	7.03	1.82 <	412.2
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	LOBSTER	0.68	4.22	5.57	0.79 <	0.22 f	0.55 <	13.79
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	HEPATOPANC	30.04	46.01	160.69	1.92 <	2.4	1.33 <	216.51
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	LOBSTER	0.86	5.1	8.4	0.48 <	0.3	0.33 <	18.09
FI4	42.388	70.8298333	14-APR-93	F93010059	565	FISH	18.9	3.25	20.77	0.51 <	2.23	0.35 <	30.01
FI4	42.388	70.8298333	14-APR-93	F93010059	566	FISH	3.51	2.28	19.26	0.57 <	2.28	0.4 <	35.54
FI4	42.388	70.8298333	14-APR-93	F93010059	567	FISH	5.11	1.13	6.57	0.66 <	0.81	0.46 <	8.57
FI4	42.388	70.8298333	14-APR-93	F93010059	569	FISH	18.12	4	12.06	0.48 <	1.88	0.34 <	20.69
FI4	42.388	70.8298333	14-APR-93	F93010059	570	FISH	22.78	3.35	25.16	0.51 <	2.67	0.35 <	35.06
FI4	42.388	70.8298333	14-APR-93	F93010059	571	FISH	2.17	1.73	15.1	0.91 <	1.08	0.63 <	10.62
FI4	42.388	70.8298333	14-APR-93	F93010059	572	FISH	4.53	1.81	10.87	0.61 <	1.28	0.42 <	13.59
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	HEPATOPANC	79.96	81.51	295.85	2.07 <	20.17	1.43 <	313.03
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	LOBSTER	0.93	5.2	8.69	0.78 <	0.22 f	0.54 <	9.42
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	HEPATOPANC	36.87	31.74	127.85	1.6 <	12.16	1.11 <	124.72
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	LOBSTER	0.26 f	3.73	3.32	0.68 <	0.1 f	0.47 <	4.35
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	HEPATOPANC	16.64	32.66	108.88	1.86 <	3.87	1.29 <	127.15
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	LOBSTER	0.66	3.08	4.35	0.55 <	0.3	0.38 <	5.09
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	HEPATOPANC	54.67	55	251.82	4.47 <	22.34	3.1 <	413.23
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	LOBSTER	0.91	3.31	12.19	0.78 <	0.75	0.54 <	31.26
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	HEPATOPANC	36.89	35.53	129.16	1.33 <	6.8	0.92 <	277.22
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	LOBSTER	1.11	2.83	9.1	0.48 <	0.29	0.33 <	7.28
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	HEPATOPANC	11.18	40.07	223.54	2.54 <	1.41	1.76 <	225.34
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	LOBSTER	0.44 f	3.71	8.58	0.69 <	0.09 f	0.48 <	13.12
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	HEPATOPANC	16.2	29.33	191.25	3.8 <	3.87	2.64 <	376.57
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	LOBSTER	0.49 f	3.59	9.29	0.81 <	0.18 f	0.56 <	14.04
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	HEPATOPANC	22.5	22.75	279.91	2.99 <	5.09	2.08 <	275.39
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	LOBSTER	0.74	3.39	10.4	0.72 <	0.28 f	0.5 <	18.13
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	HEPATOPANC	27.28	28.45	113.91	1.56 <	7.86	1.08 <	200.62

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Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	TRANS-NONAC	DIELDRIN	4,4-DDE	CL4(77)	2,4-DDD	ENDRIN	CL5(118)
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	LOBSTER	0.29 f	3.09	3.1	0.44 <	0.21 <	0.3 <	4.14
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	HEPATOPANC	31.12	40.87	233.13	2.86 <	15.29	1.98 <	341.88
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	LOBSTER	0.54 f	3.22	6.91	0.71 <	0.29 f	0.49 <	6.93
FI5	41.9398333	70.1218333	15-APR-93	F93010097	625	FISH	1.18	1.24	5.15	0.7 <	0.56	0.48 <	3.57
FI5	41.9398333	70.1218333	15-APR-93	F93010097	626	FISH	2.39	1.33	8.26	0.59 <	0.98	0.41 <	11.05
FI5	41.9398333	70.1218333	15-APR-93	F93010097	627	FISH	5.57	2.31	7.88	0.77 <	0.39	0.54 <	5.38
FI5	41.9398333	70.1218333	15-APR-93	F93010097	628	FISH	6.8	2.9	20.74	0.79 <	1.51	0.55 <	15.46
FI5	41.9398333	70.1218333	15-APR-93	F93010097	629	FISH	1.79	2.36	6.45	0.84 <	0.52	0.58 <	4.61
FI5	41.9398333	70.1218333	15-APR-93	F93010097	630	FISH	1.42	1.8	7.29	0.83 <	0.6	0.57 <	5
FI5	41.9398333	70.1218333	15-APR-93	F93010097	631	FISH	3.6	2.21	11.8	0.76 <	0.69	0.53 <	8.59
FI5	41.9398333	70.1218333	15-APR-93	F93010097	632	FISH	3.66	2.26	9.86	0.74 <	0.43	0.51 <	6.77
FI5	41.9398333	70.1218333	15-APR-93	F93010097	633	FISH	2.46	2.22	10.39	0.57 <	0.8	0.4 <	8.08
FI5	41.9398333	70.1218333	15-APR-93	F93010097	634	FISH	1.18	1.53	6.2	0.64 <	0.56	0.44 <	4.1

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Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	4,4-DDD	2,4-DDT	CL6(153)	CL5(105)	4,4-DDT	CL6(138)	CL5(126)	CL7(187)
FI1	42.3485	70.9711667	13-APR-93	F93010017	467	FISH	2.26	1.19	30.52	4.63	1.09 f	33.13	0.52 <	8.78
FI1	42.3485	70.9711667	13-APR-93	F93010017	468	FISH	4.24	1.21	43.27	9.27	2.7	47.12	0.44 <	8.69
FI1	42.3496667	70.9735	13-APR-93	F93010023	465	FISH	3.9	1.09	25.46	7.99	3.41	30.32	0.41 <	6.63
FI1	42.3496667	70.9735	13-APR-93	F93010023	466	FISH	3.07	1.92	40.12	9.66	2.13	46.26	0.57 <	12.58
FI1	42.3496667	70.9735	13-APR-93	F93010023	470	FISH	3.66	1.23	22.36	5.78	2.37	28.45	0.6 <	7.76
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	HEPATOPANC	122.04	51.78	427.18	163.97	26.51	526.14	2.67 <	420.39
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	LOBSTER	4.58	2.83	61.14	15.21	1.21 <	59.57	0.56 <	16.38
FI1	42.35	70.9768333	13-APR-93	F93010029	471	FISH	11.31	4.22	85.22	13.69	15.61	81.68	0.6 <	20.83
FI1	42.35	70.9768333	13-APR-93	F93010029	472	FISH	17.57	3.38	32.33	5.65	7.41	32.05	0.51 <	12.48
FI1	42.35	70.9768333	13-APR-93	F93010029	473	FISH	1.98	0.93	23.29	4.84	1.35 f	24	0.68 <	8.8
FI1	42.35	70.9768333	13-APR-93	F93010029	474	FISH	5.18	1.57	32.33	9.55	3.4	37.7	0.58 <	9.73
FI1	42.3503333	70.9768333	13-APR-93	F93010035	469	FISH	2.98	1.19	27.79	5.78	4.65	29.99	0.44 <	7.8
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	HEPATOPANC	120.07	49.07	358.15	122.85	44.05	451	1.73 <	141.35
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	LOBSTER	2.08	1.51	14.46	7.54	0.71 f	21.13	0.62 <	5.76
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	HEPATOPANC	221.47	57.3	451.16	195.04	24.41	571.09	2.37 <	175.04
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	LOBSTER	2.09	1.06	15.09	6.84	0.5 f	20.75	0.6 <	5.3
FI4	42.3845	70.83	14-APR-93	F93010063	573	FISH	9.97	2.4	83.29	23.67	2.52	95.38	0.68 <	19.9
FI4	42.3845	70.83	14-APR-93	F93010063	574	FISH	2.11	0.92	26.8	4.42	3.25	26.73	0.41 <	8.77
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	HEPATOPANC	38.82	30.7	512.73	159.34	17.2	516.3	2.13 <	358.36
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	LOBSTER	0.59 f	0.48 f	11.43	3.47	0.18 f	12.33	0.64 <	3.95
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	HEPATOPANC	22.08	24.83	233.56	81.61	7.7	239.33	1.55 <	231.77
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	LOBSTER	0.81	0.69	11.37	4.02	0.1 f	12.08	0.39 <	4.95
FI4	42.388	70.8298333	14-APR-93	F93010059	565	FISH	3.37	1.72	51.6	11.96	2.94	55.86	0.41 <	12.78
FI4	42.388	70.8298333	14-APR-93	F93010059	566	FISH	3.1	0.71	57.5	9.93	5.84	57.14	0.46 <	7.5
FI4	42.388	70.8298333	14-APR-93	F93010059	567	FISH	0.8	0.68	14.72	2.36	0.87 f	16.51	0.53 <	2.29
FI4	42.388	70.8298333	14-APR-93	F93010059	569	FISH	5.75	1.71	37.93	10.17	2.8	44.64	0.39 <	11.03
FI4	42.388	70.8298333	14-APR-93	F93010059	570	FISH	4.3	3.14	58.67	12.83	7.18	63.89	0.41 <	20.09
FI4	42.388	70.8298333	14-APR-93	F93010059	571	FISH	1.79	1.34	18.35	2.9	2.23	18.14	0.74 <	6.47
FI4	42.388	70.8298333	14-APR-93	F93010059	572	FISH	1.35	1.05	23.84	4.63	1.75	27.65	0.49 <	8.29
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	HEPATOPANC	53.99	79.3	1168.8	238.07	34.14	1120.32	1.68 <	1179.23
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	LOBSTER	0.88	1.02	23.9	7.77	1.36 <	30.4	0.63 <	27.77
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	HEPATOPANC	35.62	19.99	159.05	49.53	8.98	194.09	1.3 <	72.84
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	LOBSTER	0.53 f	0.33 f	4.19	1.28	1.18 <	4.83	0.55 <	1.71
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	HEPATOPANC	21.25	10.61	168.16	33.87	9.32	166.5	1.5 <	74.23
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	LOBSTER	0.6	0.5	5.48	2.09	0.17 f	7.71	0.44 <	2.79
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	HEPATOPANC	80.56	46.59	378.8	144.31	19.98	418.53	3.62 <	309.19
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	LOBSTER	2.06	1.39	17.91	8.49	0.25 f	21.4	0.63 <	5.45
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	HEPATOPANC	35.2	15.84	121.91	30	18.68	131.88	1.08 <	122.7
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	LOBSTER	1	0.83	8.31	2.34	0.52 f	9.57	0.39 <	3.33
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	HEPATOPANC	16.33	26.23	274.77	86.54	7.81	252.02	2.06 <	238.32
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	LOBSTER	0.54 f	0.72	11.49	4.06	1.19 <	11.3	0.56 <	4.72
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	HEPATOPANC	20.97	25.75	227.23	40.39	15.8	466.41	3.08 <	257.5
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	LOBSTER	0.68	0.78	11.12	3.33	0.23 f	11.7	0.66 <	4.89
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	HEPATOPANC	13.34	17.77	411.24	79.65	5.29	378.26	2.43 <	176.67
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	LOBSTER	0.75	0.93	16.31	4.28	1.25 <	17.18	0.58 <	6.12
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	HEPATOPANC	36.02	14.72	126.36	35.25	28.79	140.03	1.26 <	119.33

Massachusetts Water Resources Authority
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PCB/Pesticide Data Reported in ng/g dry weight

Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	4,4-DDD	2,4-DDT	CL6(153)	CL6(105)	4,4-DDT	CL6(138)	CL5(126)	CL7(187)
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	LOBSTER	0.51	0.3 f	4.67	0.97	0.21 f	5.32	0.35 <	1.8
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	HEPATOPANC	42.13	25.77	223.4	62.27	13.32	259.57	2.31 <	230.4
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	LOBSTER	0.62	0.52 f	6.5	2.24	0.28 f	8.59	0.58 <	3.05
FI5	41.9398333	70.1218333	15-APR-93	F93010097	625	FISH	1.43	0.42 f	6.18	0.91	0.5 f	6.48	0.56 <	2.27
FI5	41.9398333	70.1218333	15-APR-93	F93010097	626	FISH	0.79	0.72	18.94	2.88	0.56 f	21.25	0.47 <	7.74
FI5	41.9398333	70.1218333	15-APR-93	F93010097	627	FISH	0.75	0.39 f	9.26	2.12	0.34 f	10.58	0.63 <	3.47
FI5	41.9398333	70.1218333	15-APR-93	F93010097	628	FISH	1.1	1.36	23.86	4.43	0.47 f	26.33	0.64 <	8.26
FI5	41.9398333	70.1218333	15-APR-93	F93010097	629	FISH	0.72	0.4 f	8.98	1.73	0.27 f	8.95	0.68 <	2.85
FI5	41.9398333	70.1218333	15-APR-93	F93010097	630	FISH	0.91	0.43 f	7.36	1.79	0.64 f	8.55	0.67 <	2.86
FI5	41.9398333	70.1218333	15-APR-93	F93010097	631	FISH	1.09	0.79	14.52	2.73	0.47 f	16.32	0.62 <	4.44
FI5	41.9398333	70.1218333	15-APR-93	F93010097	632	FISH	1.38	0.91	10.23	2.14	1.54	12.03	0.6 <	3.39
FI5	41.9398333	70.1218333	15-APR-93	F93010097	633	FISH	1.08	0.67	13.26	1.58	0.6 f	12.98	0.47 <	3.59
FI5	41.9398333	70.1218333	15-APR-93	F93010097	634	FISH	1.16	0.5	6.32	1.5	0.51 f	8.02	0.52 <	2.91

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PCB/Pesticide Data Reported in ng/g dry weight

Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	CL6(128)	CL7(180)	MIREX	CL7(170)	CL8(195)	CL9(206)	CL10(209)
FI1	42.3485	70.9711667	13-APR-93	F93010017	467	FISH	1.94	33.92	0.36	5.86	1.33	1.4	0.72
FI1	42.3485	70.9711667	13-APR-93	F93010017	468	FISH	4.04	42.1	0.53	10.02	1.33	1.08	0.52
FI1	42.3496667	70.9735	13-APR-93	F93010023	465	FISH	4.96	31.8	0.26	8.65	0.76	0.62	0.35
FI1	42.3496667	70.9735	13-APR-93	F93010023	466	FISH	6.94	40.29	0.51	8.98	1.15	0.95	0.48
FI1	42.3496667	70.9735	13-APR-93	F93010023	470	FISH	3.68	27.67	0.29 f	9.76	0.57	0.41 f	0.25 f
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	HEPATOPANC	165.07	307.39	6.18	180.11	52.94	67.73	9.72
FI1	42.35	70.9766	13-APR-93	F93010030	KG34	LOBSTER	6.57	21.26	0.51	8.03	2.06	2.3	0.63
FI1	42.35	70.9768333	13-APR-93	F93010029	471	FISH	5.04	104.38	1.06	20.66	2.89	2.72	1.18
FI1	42.35	70.9768333	13-APR-93	F93010029	472	FISH	3.09	32.22	0.71	9.5	1.82	1.62	0.83
FI1	42.35	70.9768333	13-APR-93	F93010029	473	FISH	2.43	16.11	0.57	6.64	1.74	2.06	1.25
FI1	42.35	70.9768333	13-APR-93	F93010029	474	FISH	5.76	40.67	0.46	10.73	1.22	0.98	0.54
FI1	42.3503333	70.9768333	13-APR-93	F93010035	469	FISH	4.59	38.64	0.28	7.99	1.02	0.7	0.35
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	HEPATOPANC	128.22	219.37	6.63	57.55	22.26	27.37	10.37
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	LOBSTER	2.62	5.73	0.33 f	2.68	0.41	0.31 f	0.23 f
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	HEPATOPANC	105.43	248.56	6	86.4	32.29	32.59	8.88
FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	LOBSTER	2.72	5.51	0.34	3.14	0.37	0.22 f	0.16 f
FI4	42.3845	70.83	14-APR-93	F93010063	573	FISH	7.44	62.43	1.12	18.55	2.49	2.59	1.26
FI4	42.3845	70.83	14-APR-93	F93010063	574	FISH	2.34	32.5	0.3	5.99	1.63	2.43	0.58
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	HEPATOPANC	148.27	260.77	9.75	153.24	45.39	53.4	20
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	LOBSTER	1.83	3.65	0.22 f	2.64	0.47	0.37 f	0.29 f
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	HEPATOPANC	90.36	113.06	5.51	93.75	27.46	34.93	11.98
FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	LOBSTER	1.96	4.88	0.31	2.33	0.56	0.5	0.48
FI4	42.388	70.8298333	14-APR-93	F93010059	565	FISH	8.3	53.32	0.61	13.4	2.06	2.02	0.82
FI4	42.388	70.8298333	14-APR-93	F93010059	566	FISH	4.19	62.61	0.5	14.4	2.43	2.6	1
FI4	42.388	70.8298333	14-APR-93	F93010059	567	FISH	2.91	9.3	0.3 <	3.33	0.73	0.87	0.41
FI4	42.388	70.8298333	14-APR-93	F93010059	569	FISH	6.53	30.94	0.44	9.06	1.21	1.32	0.7
FI4	42.388	70.8298333	14-APR-93	F93010059	570	FISH	9.87	67.21	0.58	13.26	2.78	3.35	1.26
FI4	42.388	70.8298333	14-APR-93	F93010059	571	FISH	1.33	12.52	0.38 f	2.94	0.65	0.67	0.59
FI4	42.388	70.8298333	14-APR-93	F93010059	572	FISH	4.53	18.23	0.44	6.04	1.62	2.08	1.09
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	HEPATOPANC	158.95	2219.76	15.9	740.34	265.51	215.79	25.86
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	LOBSTER	2.33	47.6	0.35 <	16.84	5.73	4.34	0.57
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	HEPATOPANC	64.16	59.95	4.98	61.83	13.73	17.02	6.79
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	LOBSTER	0.65 f	0.93	0.13 f	0.84	0.28 <	0.38 <	0.39 <
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	HEPATOPANC	28.26	40.99	2.63	19.4	3.88	3.89	2.26
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	LOBSTER	0.97	1.56	0.25	1.59	0.29	0.19 f	0.19 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	HEPATOPANC	166.84	261.11	7.39	125.16	27.28	31.16	11.52
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	LOBSTER	3.55	4.24	0.47	3.14	0.53	0.44	0.33 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	HEPATOPANC	47.97	95.8	3.37	42.2	9.04	10.52	4.19
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	LOBSTER	1.33	2.53	0.25	1.72	0.24	0.17 f	0.14 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	HEPATOPANC	88.72	111.45	6.19	85.37	17.48	20.31	6.55
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	LOBSTER	1.81	4.15	0.41	2.28	0.41	0.31 f	0.21 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	HEPATOPANC	84.27	154.39	6.21	71.35	14.97	20.81	8.9
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	LOBSTER	1.93	2.76	0.36 f	2.03	0.36	0.28 f	0.27 f
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	HEPATOPANC	69.01	129.07	4.59	64.5	11.62	13.41	4.41
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	LOBSTER	2.57	2.87	0.56	2.64	0.57	0.41	0.43
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	HEPATOPANC	47.35	104.95	4.3	45.32	12.17	16.33	7.81

Massachusetts Water Resources Authority
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PCB/Pesticide Data Reported in ng/g dry weight

Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	CL6(128)	CL7(180)	MIREX	CL7(170)	CL8(195)	CL9(206)	CL10(209)
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	LOBSTER	0.77	1.44	0.12 f	0.69	0.26	0.24 f	0.25
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	HEPATOPANC	78.91	162.02	5.39	69.64	17.28	21.42	8.78
FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	LOBSTER	1.17	1.66	0.24 f	1.12	0.3	0.21 f	0.19 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	625	FISH	0.47 f	1.69	0.32 <	1.07	0.17 f	0.11 f	0.08 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	626	FISH	1.83	11.85	0.28	4.56	1.37	1.51	1.08
FI5	41.9398333	70.1218333	15-APR-93	F93010097	627	FISH	1.44	3.8	0.18 f	3.98	0.25 f	0.21 f	0.15 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	628	FISH	4.61	7.18	0.51	2.96	0.57	0.46	0.29 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	629	FISH	0.68 f	3.28	0.26 f	1.4	0.19 f	0.13 f	0.08 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	630	FISH	0.62 f	3.09	0.37 <	2.86	0.29 f	0.27 f	0.19 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	631	FISH	3.03	5.27	0.45	3.12	0.49	0.47	0.35 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	632	FISH	2.03	5.85	0.24 f	2.6	0.45	0.48	0.37 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	633	FISH	0.7	4.96	0.21 f	1.76	0.28	0.2 f	0.12 f
FI5	41.9398333	70.1218333	15-APR-93	F93010097	634	FISH	1.33	1.98	0.26 f	1.7	0.24 f	0.23 f	0.2 f

Description of Qualifiers:
f = reported value below method detection limit
< = reported value is the method detection limit
x = matrix interference

Massachusetts Water Resources Authority — Composite Liver Tissue Data

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Product Number LIVER.WK1

Analyte		Station FI1-04		FI4-05		FI5-06	
Ag	ug/g	5.46		4.78		1.41	
Cd	ug/g	0.911		0.848		0.423	
Cu	ug/g	82.7		50.6		26.4	
Cr	ug/g	0.735		0.917		0.019	<
Pb	ug/g	2.02		2.32		1.14	
Zn	ug/g	86.7		85.3		82.3	
Ni	ug/g	0.62		0.648		0.397	
Hg	ug/g	0.694		0.42		0.232	
C1-dibenzothiophenes	ng/g	15.14	<	13.3	<	14.08	<
C1-fluoranthenes/pyrenes	ng/g	16.1	<	14.14	<	14.97	<
C1-fluorenes	ng/g	36.66		21.18		20.8	
C1-naphthalenes	ng/g	128.19		72.15		64.21	
C2-fluorenes	ng/g	15.14	<	13.3	<	14.08	<
C3-dibenzothiophenes	ng/g	15.14	<	13.3	<	14.08	<
C4-chrysenes	ng/g	23.38	<	20.54	<	21.74	<
C2-phenanthrenes/anthracenes	ng/g	16.82	<	14.77	<	15.64	<
acenaphthene	ng/g	9	<	10.29		8.37	<
C2-dibenzothiophenes	ng/g	15.14	<	13.3	<	14.08	<
dibenzofuran	ng/g	32.41		17.61		16.69	
dibenz[a,h]anthracene	ng/g	16.96	<	14.9	<	15.77	<
chrysene	ng/g	5.03	f	20.54	<	21.74	<
biphenyl	ng/g	29.08		17.95	f	15	f
benzo[k]fluoranthene	ng/g	10.8	<	9.49	<	10.04	<
benzo[e]pyrene	ng/g	10.11	<	8.88	<	9.4	<
benzo[b]fluoranthene	ng/g	23.09	<	20.29	<	21.47	<
benzo[a]pyrene	ng/g	8.6	<	7.55	<	7.99	<
C4-naphthalenes	ng/g	25.7	<	22.58	<	23.9	<
C3-naphthalenes	ng/g	181.94		68.05		82.52	
C3-fluorenes	ng/g	15.14	<	13.3	<	14.08	<
C3-chrysenes	ng/g	23.38	<	20.54	<	21.74	<
C2-naphthalenes	ng/g	175.02		73.95		83.85	
pyrene	ng/g	12.72	f	7.18	f	4.61	f
indeno[1,2,3-c,d]pyrene	ng/g	18.81	<	16.52	<	17.49	<
dibenzothiophene	ng/g	9.34	f	13.3	<	4.53	f
benzo[g,h,i]perylene	ng/g	15.83	<	13.9	<	14.72	<
C4-phenanthrenes/anthracenes	ng/g	16.82	<	14.77	<	15.64	<
C3-phenanthrenes/anthracenes	ng/g	16.82	<	14.77	<	15.64	<
C2-chrysenes	ng/g	23.38	<	20.54	<	21.74	<
C1-phenanthrenes/anthracenes	ng/g	42.86		16.87		18.7	
C1-chrysenes	ng/g	23.38	<	20.54	<	21.74	<
phenanthrene	ng/g	56.6		25.55		25.69	
perylene	ng/g	12.18	<	10.7	<	11.32	<
naphthalene	ng/g	137.2		105.6		77.44	
fluorene	ng/g	26.5		15.87		15.65	
fluoranthene	ng/g	30.61		12.2	f	7	f

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Analyte		Station FI1-04		FI4-05		FI5-06	
anthracene	ng/g	5.17	f	11.34	<	12.01	<
acenaphthylene	ng/g	12.18	f	11.73	f	5.7	f
benz[a]anthracene	ng/g	20.44	<	17.95	<	19.01	<
2,4-DDD	ng/g	15.67		15.52		4.01	
4,4-DDD	ng/g	37.28		30.95		5.89	
CIS-CHLORDANE	ng/g	45.79		30.7		9.23	
CL3(18)	ng/g	3.76	<	3.31	<	3.5	<
CL4(66)	ng/g	65.95		49.69		11.96	
CL6(128)	ng/g	31.34		36.31		7.94	
CL7(180)	ng/g	371.19		309.58		32.92	
CL5(101)	ng/g	105.84		53.61		18.37	
CL4(77)	ng/g	2.87	<	2.52	<	2.66	<
CL4(52)	ng/g	17.44		7.51		3.21	
CL4(44)	ng/g	5.78		2.84		2.67	
CL3(28)	ng/g	37.34		23.84		6.11	
CL2(08)	ng/g	6.53	<	5.74	<	6.07	<
CL10(209)	ng/g	4.62		6.23		1.34	f
ALDRIN	ng/g	1.57	<	1.38	<	1.46	<
TRANS-NONACHLOR	ng/g	73.69		59.15		14.61	
LINDANE	ng/g	2.42	<	2.12	<	2.25	<
HEXACHLOROBENZENE	ng/g	6.6		4.7		4.78	
HEPTACHLOR	ng/g	2.58	<	2.27	<	2.4	<
ENDRIN	ng/g	1.99	<	1.74	<	1.85	<
CL9(206)	ng/g	12.63		21.45		2.19	
CL8(195)	ng/g	12.03		15.72		2.53	
CL7(187)	ng/g	100.19		97.9		26.59	
CL7(170)	ng/g	70.79		83.01		13.44	
CL6(153)	ng/g	329.85		337.49		71.92	
CL6(138)	ng/g	349.28		367.16		77.62	
CL5(126)	ng/g	2.32	<	2.04	<	2.16	<
CL5(118)	ng/g	219.73		235.59		45.61	
CL5(105)	ng/g	62.95		84.98		12.04	
4,4-DDT	ng/g	33.07		25.97		2.9	f
4,4-DDE	ng/g	157.04		161.32		52.67	
2,4-DDT	ng/g	14.85		13.54		3.94	
2,4-DDE	ng/g	2.58	<	2.27	<	2.4	<
DIELDRIN	ng/g	23.37		20.25		11.2	
HEPTACHLOREPOXIDE	ng/g	3.2		2.35		2.49	
MIREX	ng/g	2.98		4.25		1.47	

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Massachusetts Water Resources Authority
1993 Tissue Chemistry - Task 17
Product Number KP93TPAH.wk1
PAH Data Reported in ng/g dry weight

Station	Station	Latitude	Longitude	Station Date	Sample ID	Organism ID	Organism Fraction	naphthalene
FI1	FI1	42.35	70.9766	13-APR-93	F93010030	KG34	HEPATOPANC	1307.09
FI1	FI1	42.3528	70.9705	19-AUG-93	S93030417	KI06	HEPATOPANC	902.85
FI1	FI1	42.3528	70.9705	19-AUG-93	S93030417	KI07	HEPATOPANC	420.69
FI4	FI4	42.3857	70.8215	19-AUG-93	S93030409	KH97	HEPATOPANC	694.96
FI4	FI4	42.3857	70.8215	19-AUG-93	S93030409	KH98	HEPATOPANC	916.38
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KH99	HEPATOPANC	458.36
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI01	HEPATOPANC	241.5
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI02	HEPATOPANC	1016.37
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI03	HEPATOPANC	774.35
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI04	HEPATOPANC	253.28
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI05	HEPATOPANC	1079.3
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI21	HEPATOPANC	825.72
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI22	HEPATOPANC	522.01
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI23	HEPATOPANC	556.7
FI5	FI5	41.75	70.1833	04-SEP-93	LOB-FI5	KI24	HEPATOPANC	493.25

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Massachusetts Water Resources Authority
1993 Tissue Chemistry - Task 17
Product Number KP93TPAH.wk1
PAH Data Reported in ng/g dry weight

Station	C1-naphthal	C2-naphthal	C3-naphthal		C4-naphthal		biphenyl	acenaphthyl		acenaphthen	
FI1	331.16	659.75	1124.98		941.23		219.27	71.92		66.86	
FI1	168.95	381.99	813.54		852.65		141.23	14.01	f	48.55	
FI1	57.27	60.29	22.29	<	22.29	<	84.37	20.59	<	7.8	<
FI4	85.48	115.83	116.66		23.56	<	135.63	11.43	f	60.97	
FI4	115.66	146.69	140.16		17.22	<	140.26	10.9	f	13.84	
FI5	59	70.64	89.65		18.56	<	91.09	6.17	f	6.5	<
FI5	51.8	54.72	52.58		14.34	<	49.7	7.18	f	7.66	
FI5	156.91	154.6	16.66	<	16.66	<	170.02	15.39	<	5.83	<
FI5	113.31	135.29	40.1	<	40.1	<	158	13.64	f	14.04	<
FI5	45.85	49.2	11.92	<	11.92	<	51.93	4.38	f	5.2	
FI5	143.42	157.98	134.61		22.82	<	158.72	11.9	f	12.31	
FI5	95.2	100.09	81.7		34.11	<	173.95	8.49	f	11.94	<
FI5	121.58	293.74	561.79		732.63		105.88	8.76	f	35.92	
FI5	95.07	109.7	108.2		13.96	<	89.41	9.57	f	9.2	
FI5	73.79	82.1	25.63	<	25.63	<	100.09	6.54	f	8.97	<

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Station	dibenzofura	fluorene	C1-fluorene	C2-fluorene	C3-fluorene	phenanthren	C1-phenanth
FI1	117.33	124.01	304.7	804.1	955.08	728.2	1122.01 .
FI1	66.86	38.12	206.45	679.1	751.31	183.48	550.29 .
FI1	28.81	9.15 f	13.13 <	13.13 <	13.13 <	56.88	32.57 .
FI4	59.84	59.05	77.17	133.5	13.88 <	720.54	365.02 .
FI4	54.06	14.13	52.35	107.74	10.14 <	117.17	95.85 .
FI5	35.48	14.11	43.91	10.93 <	10.93 <	76.57	103.88 .
FI5	25.05	15.59	32.53	56.86	8.45 <	47.18	36.24 .
FI5	46.71	9.81 <	9.81 <	9.81 <	9.81 <	89.25	63.66 .
FI5	58.48	19.06 f	37.73	23.62 <	23.62 <	115.74	74.43 .
FI5	25.34	12.17	28.63	68.27	7.02 <	51.98	44.71 .
FI5	45.83	8.48 f	13.44 <	13.44 <	13.44 <	94.88	59.7 .
FI5	57.2	9.71 f	42.65	20.09 <	20.09 <	106.83	54.61 .
FI5	66.11	34.14	180.93	638.91	816.12	142.01	315.66 .
FI5	36.47	13.72	37.34	8.22 <	8.22 <	70.33	48.76 .
FI5	41.46	13.58 f	15.1 <	15.1 <	15.1 <	77.73	59.98 .

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Station	C2-phenanth		C3-phenanth		C4-phenanth		dibenzothio		anthracene		C1-dibenzot	
FI1	1822.11	.	1305.56	.	698.24	.	73.1	.	53.13		324.98	
FI1	1161.08	.	848.62	.	469.77	.	29.13	.	35.53		187.74	
FI1	14.59	<	14.59	<	14.59	<	7.2	f	4.21	f	13.13	<
FI4	275.22	.	211.84	.	15.42	<	35.95	.	101.15		66.5	
FI4	211.61	.	159.89	.	11.27	<	12.03	.	10.61		39.16	
FI5	203.07	.	280.43	.	136.24	.	7.77	f	6.5	f	31.87	
FI5	37.59	.	10.9	<	10.9	<	4.01	f	5.93	f	8.45	<
FI5	10.9	<	9.39	<	9.39	<	9.81	<	8.37	<	9.81	<
FI5	88.24	.	26.24	<	26.24	<	14.38	f	11.18	f	23.62	<
FI5	59.45	.	67.84	.	7.8	<	5.23	f	4.37	f	14	
FI5	65.09	.	14.94	<	14.94	<	8.35	f	4.11	f	18.81	
FI5	66.17	.	76.67	.	22.32	<	11.08	f	5.44	f	19.76	f
FI5	878.13	.	878.03	.	369.99	.	25.28	.	31.66		127.97	
FI5	54.64	.	9.13	<	9.13	<	7.54	f	7.92		20.25	
FI5	85.99	.	83.78	.	16.77	<	8.37	f	6.47	f	19.07	

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Station	C2-dibenzot		C3-dibenzot		fluoranthen	pyrene	C1-fluorant		benz[a]anth		chrysene	
FI1	851.77		637.62		1373.19	1065.24	836.81		192.71		602.99	
FI1	580.68		443.97		1273.4	759.96	641.21		99.45		445.23	
FI1	13.13	<	13.13	<	26.53	14.64	21.48		5.89	f	19.44	f
FI4	88.79		90.54		700.77	748.77	558.02		182.16		432.02	
FI4	80.31		70.86		249.71	201.77	185.64		24.14		99.09	
FI5	65.9		76.35		418.7	339.85	306.74		84.39		338.15	
FI5	8.45	<	8.45	<	57.22	22.72	19.54		7.62	f	34.57	
FI5	9.81	<	9.81	<	70.59	37.7	10.44	<	8.4	f	31.75	
FI5	23.62	<	23.62	<	93.49	65.47	64.96		28.69	f	86.39	
FI5	30.33		7.02	<	93.89	42.56	36.24		7.98	f	42.87	
FI5	13.44	<	13.44	<	76.87	36.01	35.53		8.98	f	39.56	
FI5	21.02		20.09	<	93.62	61.36	52.11		18.3	f	62.36	
FI5	403.13		391.04		1153.15	667.65	514.61		70.06		548.15	
FI5	24.25		23.58		88.48	58.7	42.89		12.87		53.09	
FI5	15.1	<	15.1	<	120.6	66.76	48.79		11.52	f	79.72	

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Station	C1-chrysene	C2-chrysene	C3-chrysene	C4-chrysene	benzo[b]flu	benzo[k]flu	benzo[e]pyr
FI1	227.42	248.54	26.9 <	26.9 <	210.77	107.58	208.02
FI1	192.51	195.89	80.42	17.4 <	131.9	65.64	138.16
FI1	20.28 <	20.28 <	20.28 <	20.28 <	11.39 f	7.66 f	11.7
FI4	203.77	215.95	117.75	21.44 <	224.46	179.04	301.71
FI4	59.86	15.66 <	15.66 <	15.66 <	65.04	31.15	49.9
FI5	152.08	160.01	80.51	16.88 <	136.39	104.3	268.83
FI5	13.05 <	13.05 <	13.05 <	13.05 <	12.59 f	11.96	14.09
FI5	15.16 <	15.16 <	15.16 <	15.16 <	20.13	12.54	10.17
FI5	35.43 f	36.48 <	36.48 <	36.48 <	58.73	38.45	43.93
FI5	12.95	10.84 <	10.84 <	10.84 <	29.43	13.04	14.74
FI5	17.19 f	20.76 <	20.76 <	20.76 <	29.6	14.59	19.74
FI5	23.38 f	31.03 <	31.03 <	31.03 <	46.46	25.78	38.81
FI5	180.1	212.54	24.43 <	24.43 <	99.53	62.14	181
FI5	21.29	12.7 <	12.7 <	12.7 <	47.85	21.38	39.91
FI5	19.39 f	23.31 <	23.31 <	23.31 <	39.75	15.81	27.78

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Massachusetts Water Resources Authority
1993 Tissue Chemistry - Task 17
Product Number KP93TPAH.wk1
PAH Data Reported in ng/g dry weight

Station	benzo[a]pyr	perylene	indeno[1,2,	dibenz[a,h]	benzo[g,h,i
FI1	106.45	54.69	85.78	14.96 f	103.74
FI1	67	22.54	70.68	11.69 f	72.95
FI1	5.02 f	3.85 f	12.38 f	3.62 f	21.06
FI4	176.23	51.25	180.03	26.08	177.9
FI4	31.31	7.01 f	31.07	5.86 f	31.6
FI5	90.42	69.42	126.99	18.7	210.66
FI5	6.33	18.76	12.04	5 f	17.95
FI5	11.05	7.89 <	15.89	11 <	20.9
FI5	32.22	23.38	46.68	11.4 f	55.63
FI5	7.62	3.32 f	12.78	2.2 f	7.99
FI5	13.39	5.26 f	25.38	3.32 f	26.13
FI5	17.71	14.65 f	39.07	7.83 f	45.17
FI5	39.57	22.53	61.09	14.63 f	89.95
FI5	17.69	7.05	30.07	3.99 f	30.98
FI5	10.62	7.15 f	24.66	5.03 f	27.02

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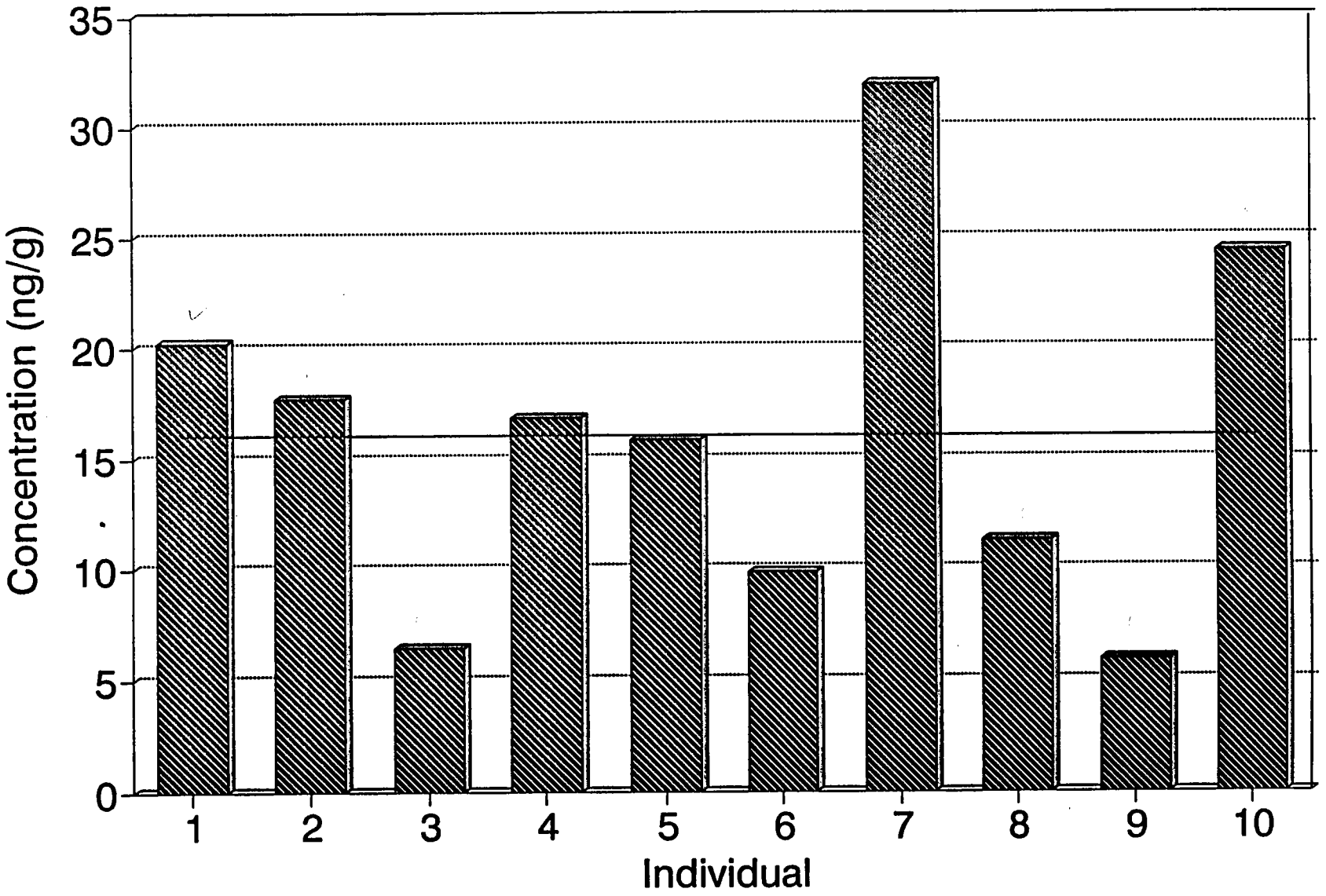
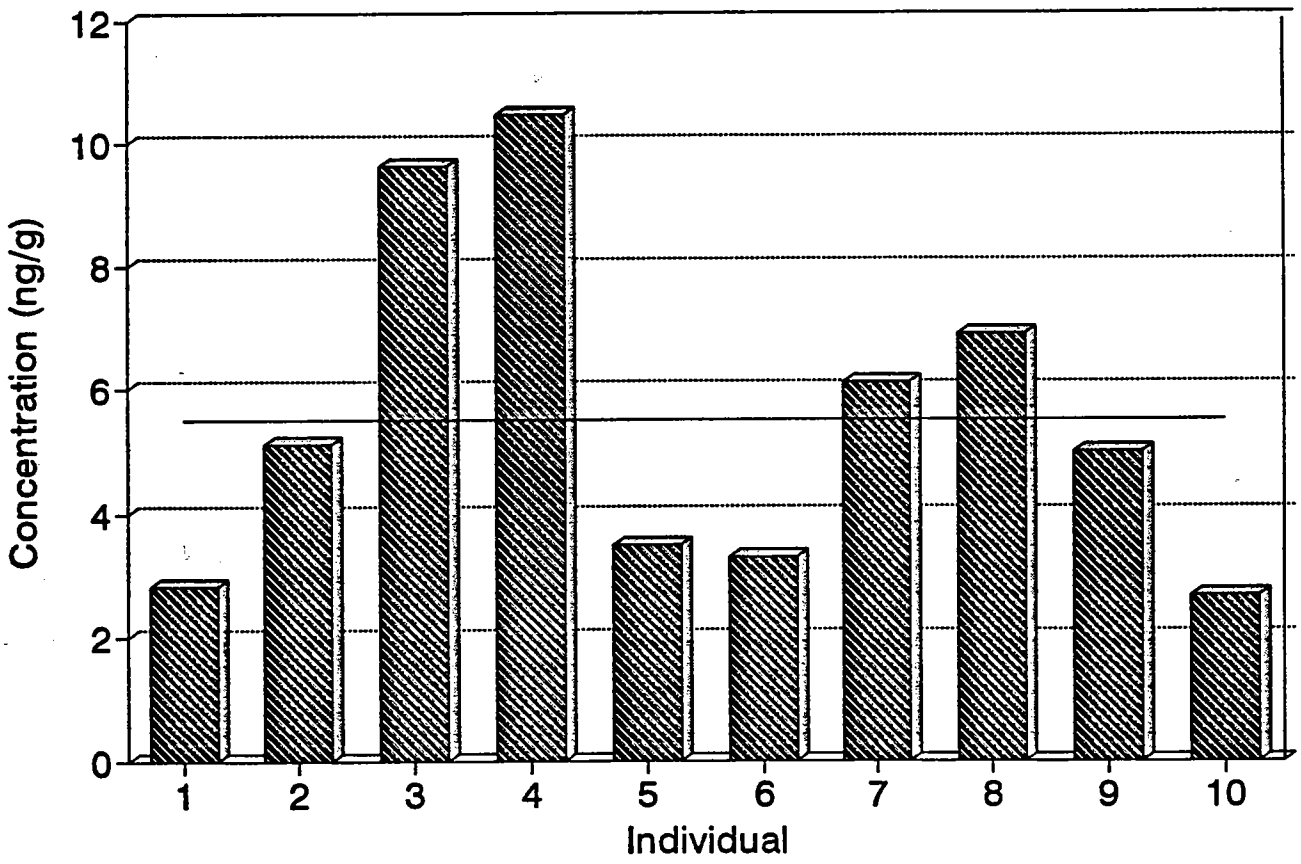
APPENDIX C

DISTRIBUTION OF CONTAMINANTS IN INDIVIDUAL TISSUE SAMPLES COLLECTED IN 1993

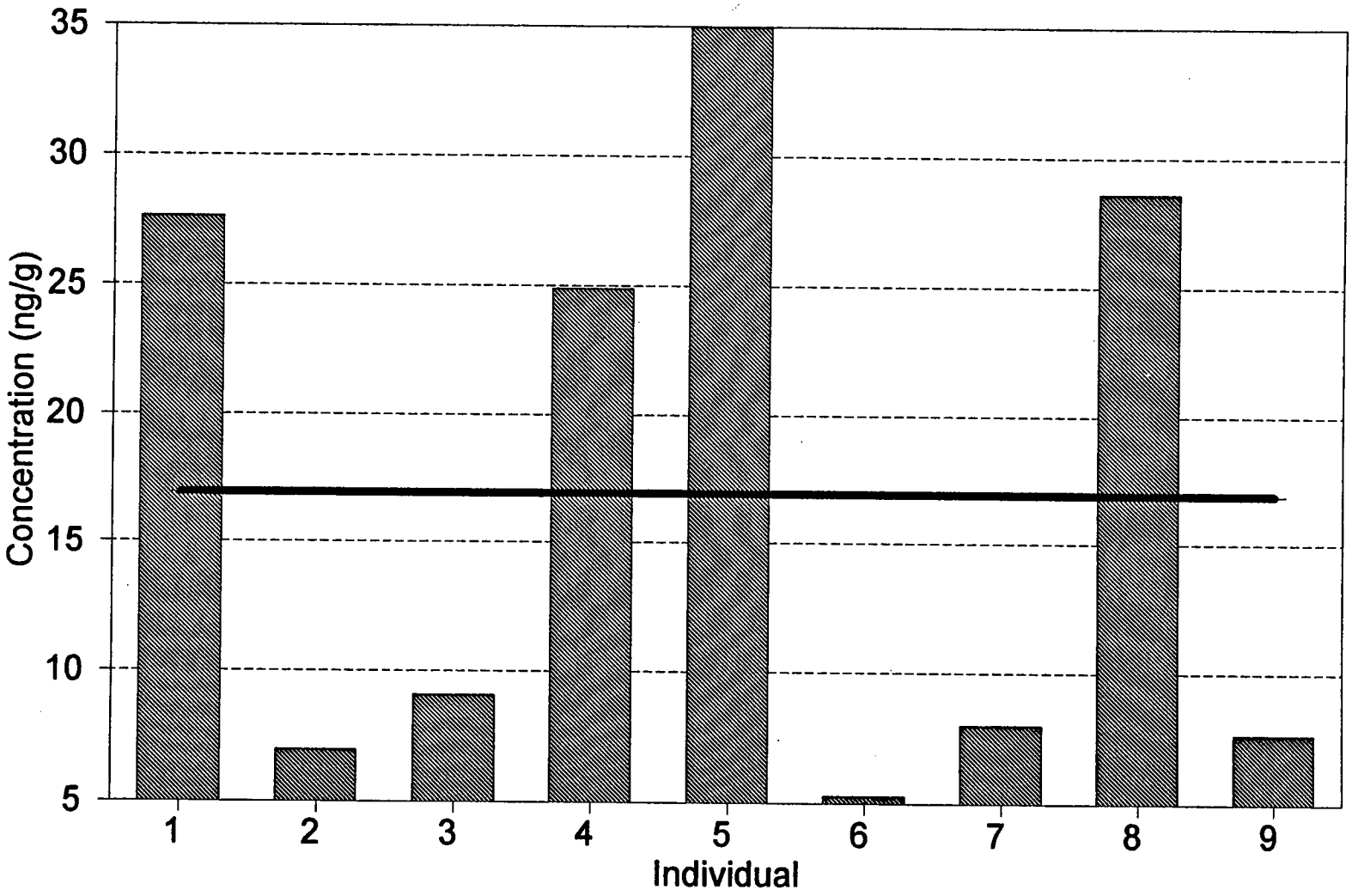
1993 Flounder Tissue Total Chlordane Levels (dry weight) at Deer Island



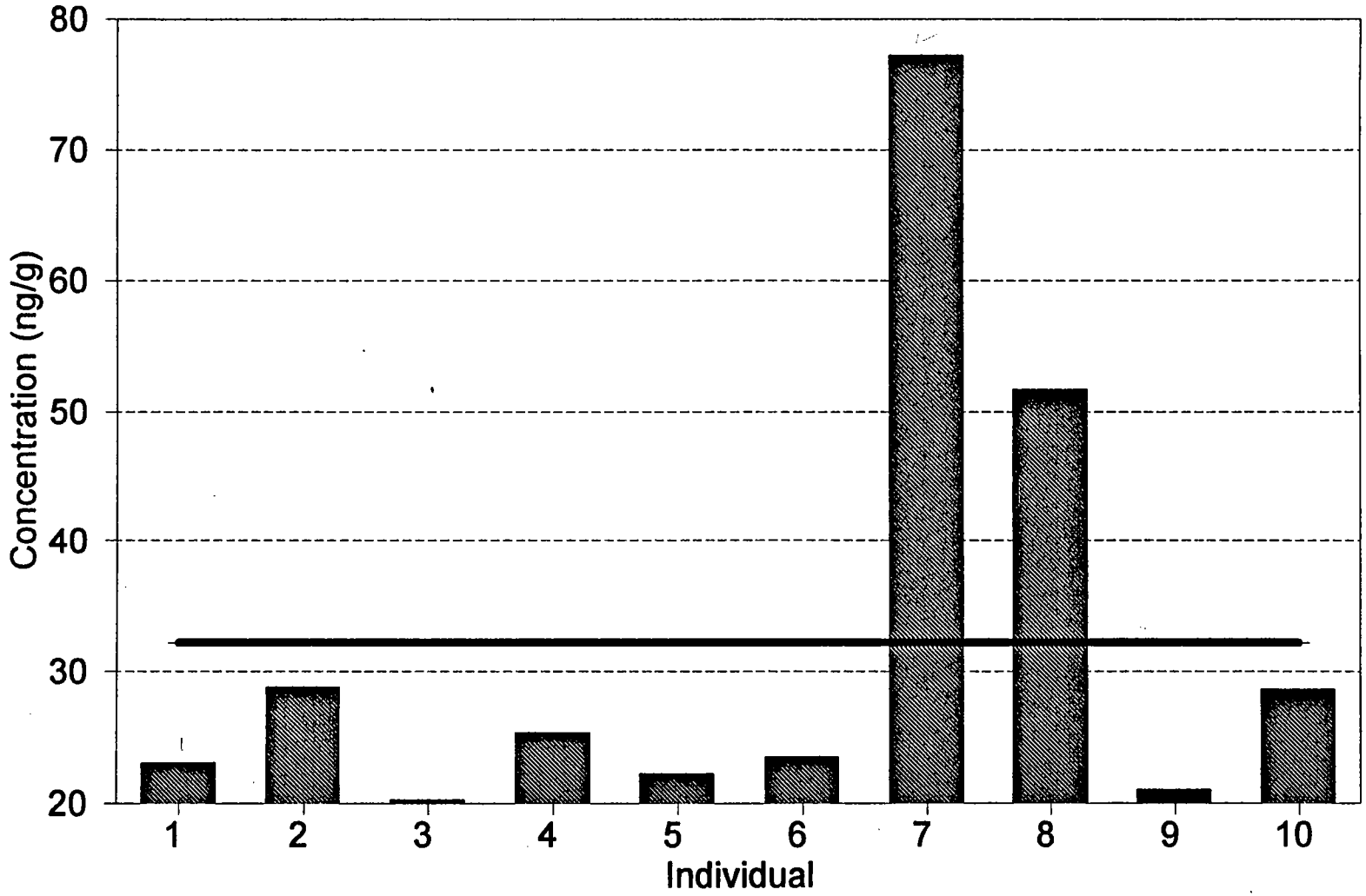
1993 Flounder Tissue Total Chlordane Levels (dry weight) for Cape Cod Bay



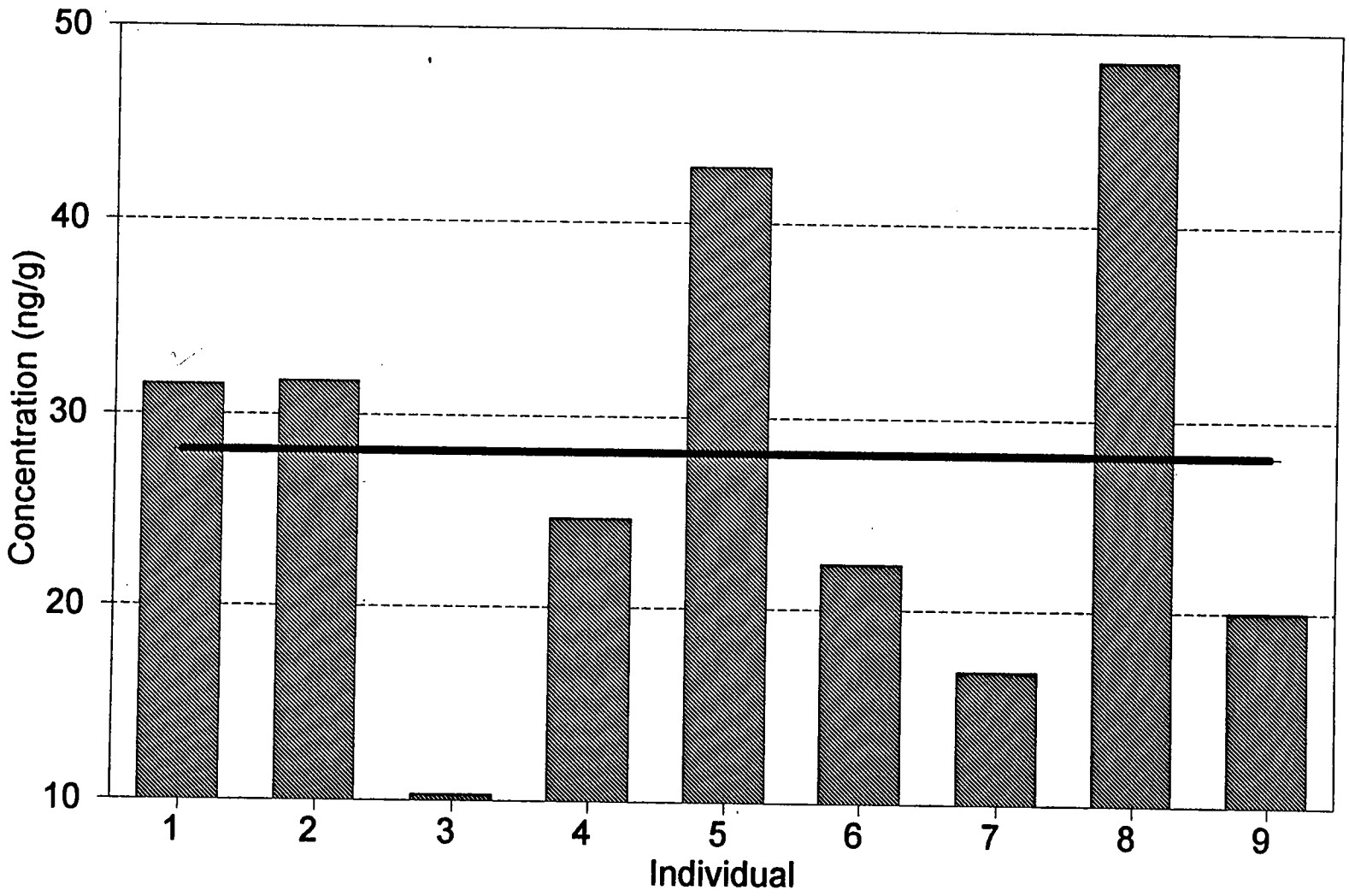
1993 Flounder Tissue Total Chlordane Levels (dry wt) at Future Outfall Site



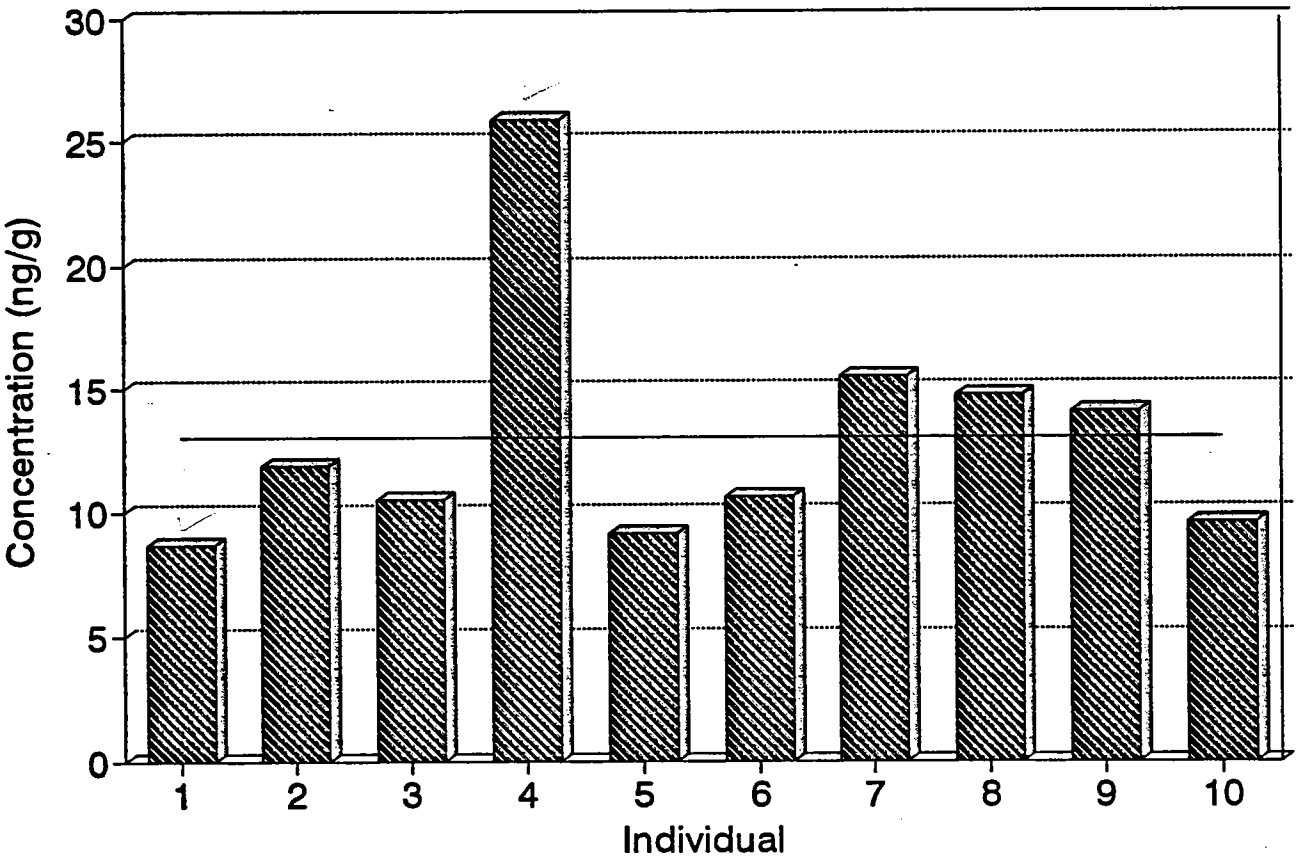
1993 Flounder Tissue Total DDT Levels (dry weight) at Deer Island



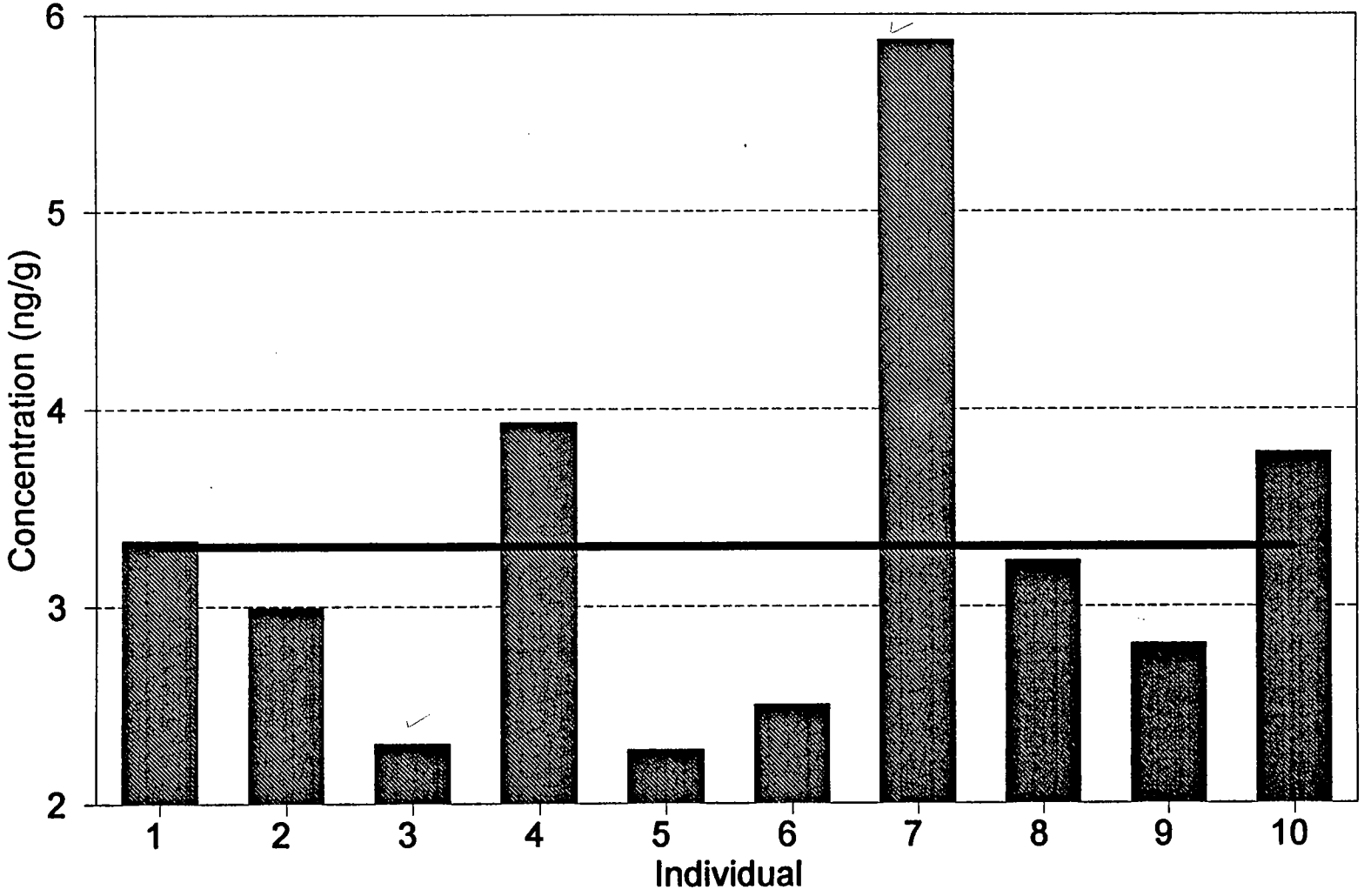
1993 Flounder Tissue Total DDT Levels (dry wt) at Future Outfall Site



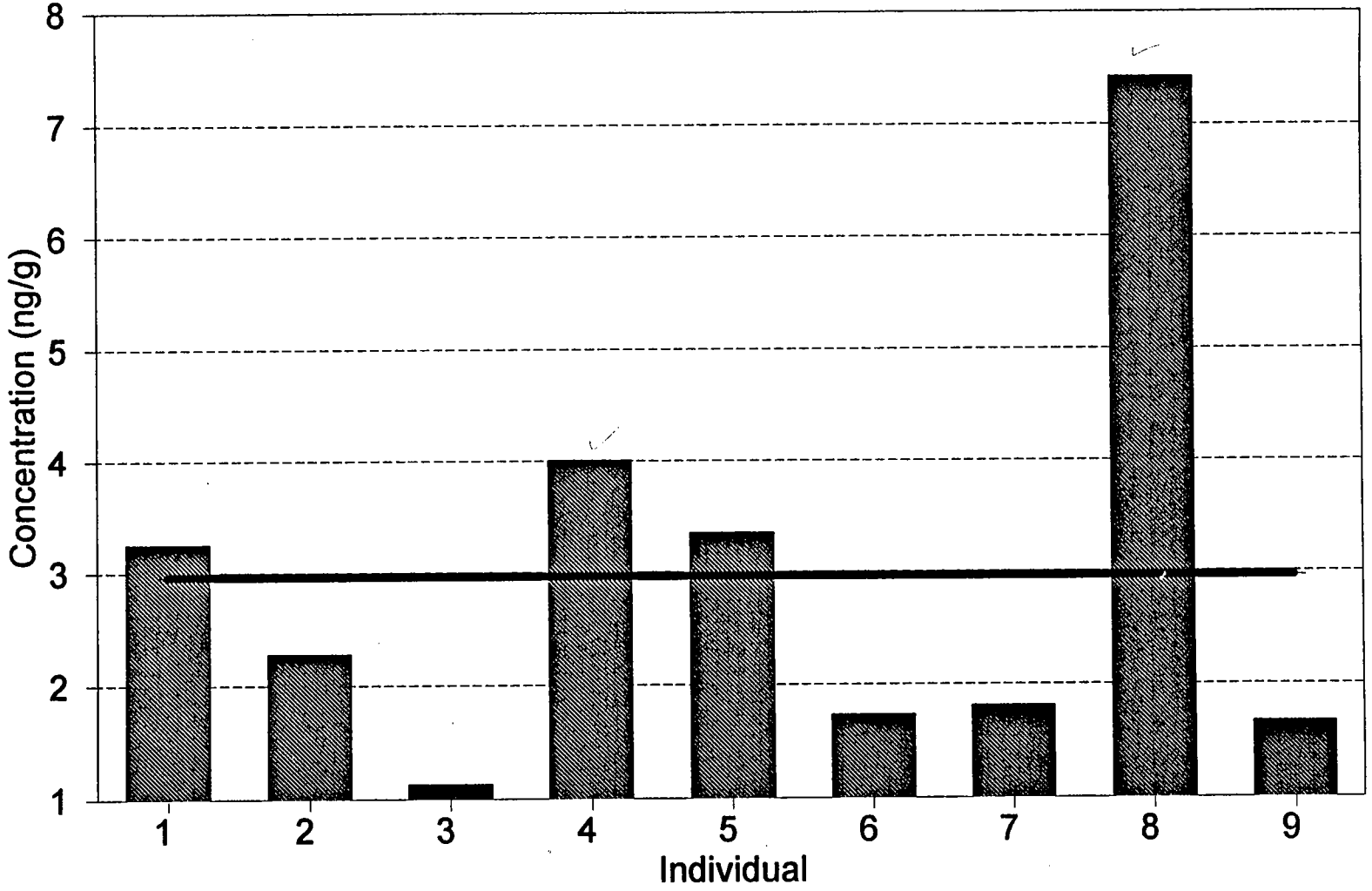
1993 Flounder Tissue Total DDT Levels (dry weight) for Cape Cod Bay



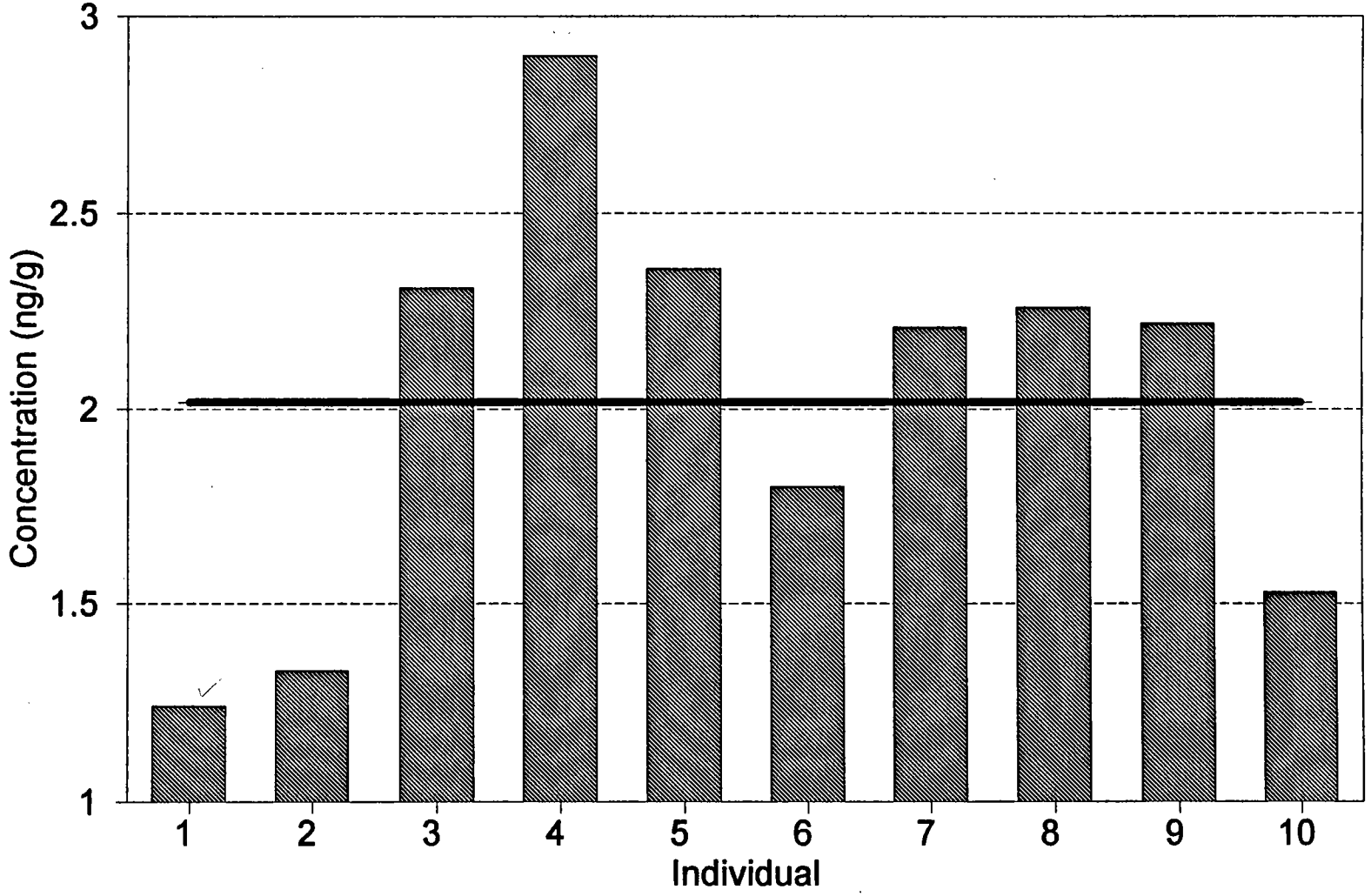
1993 Flounder Tissue Dieldrin Levels (dry weight) for Deer Island



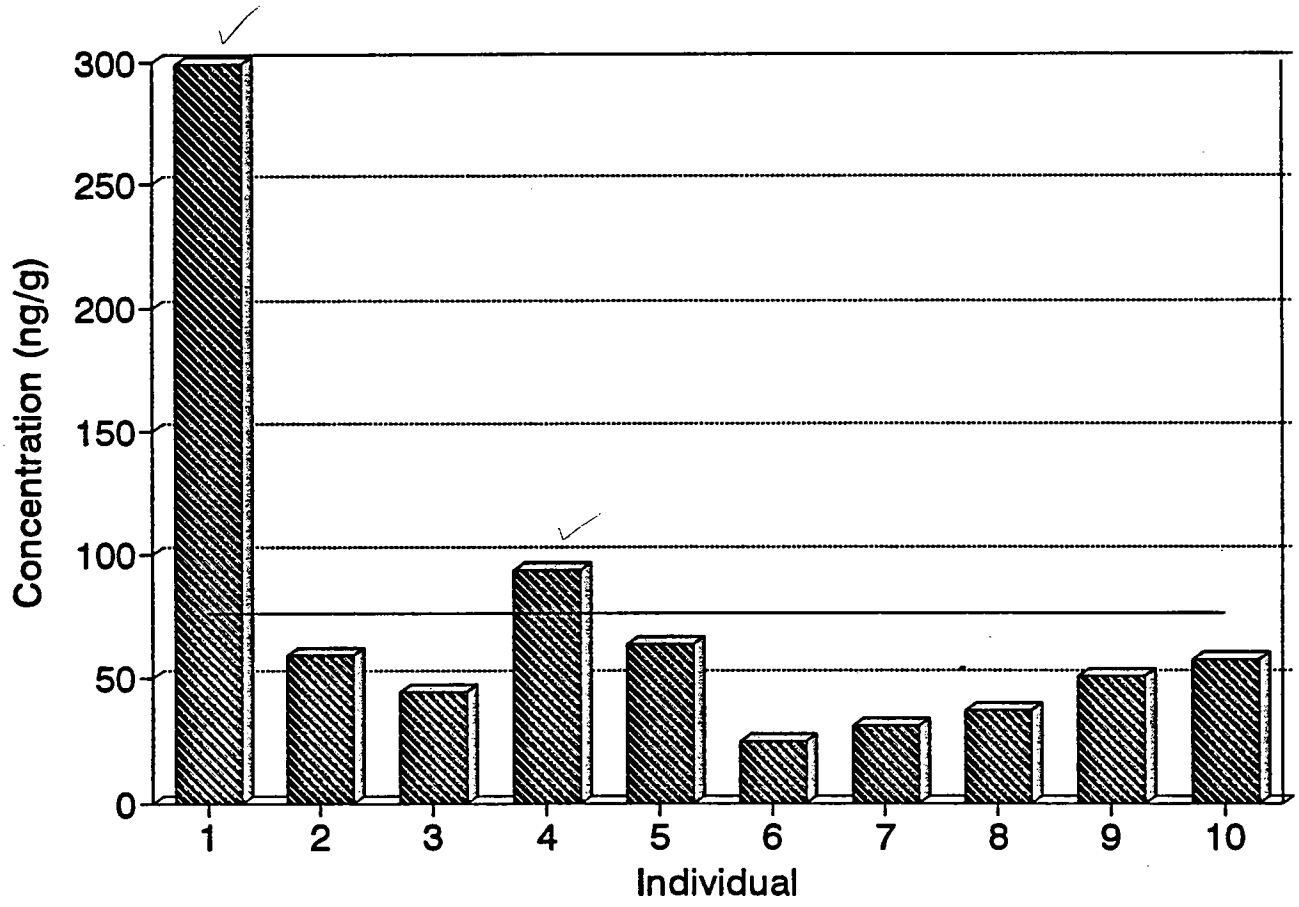
1993 Flounder Tissue Total Dieldrin Levels (dry wt) at Future Outfall Site



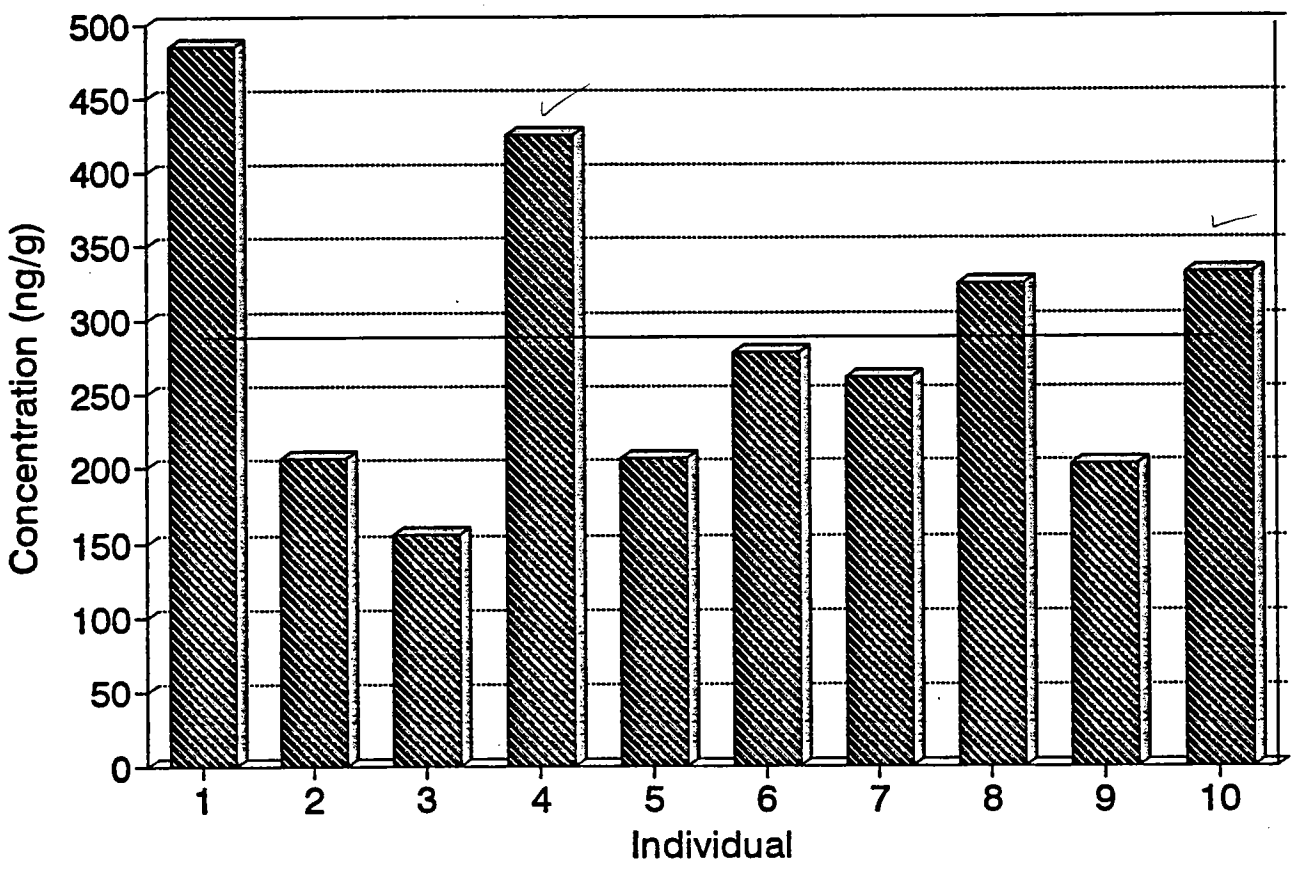
1993 Flounder Tissue Total Dieldrin Levels (dry wt) for Cape Cod Bay



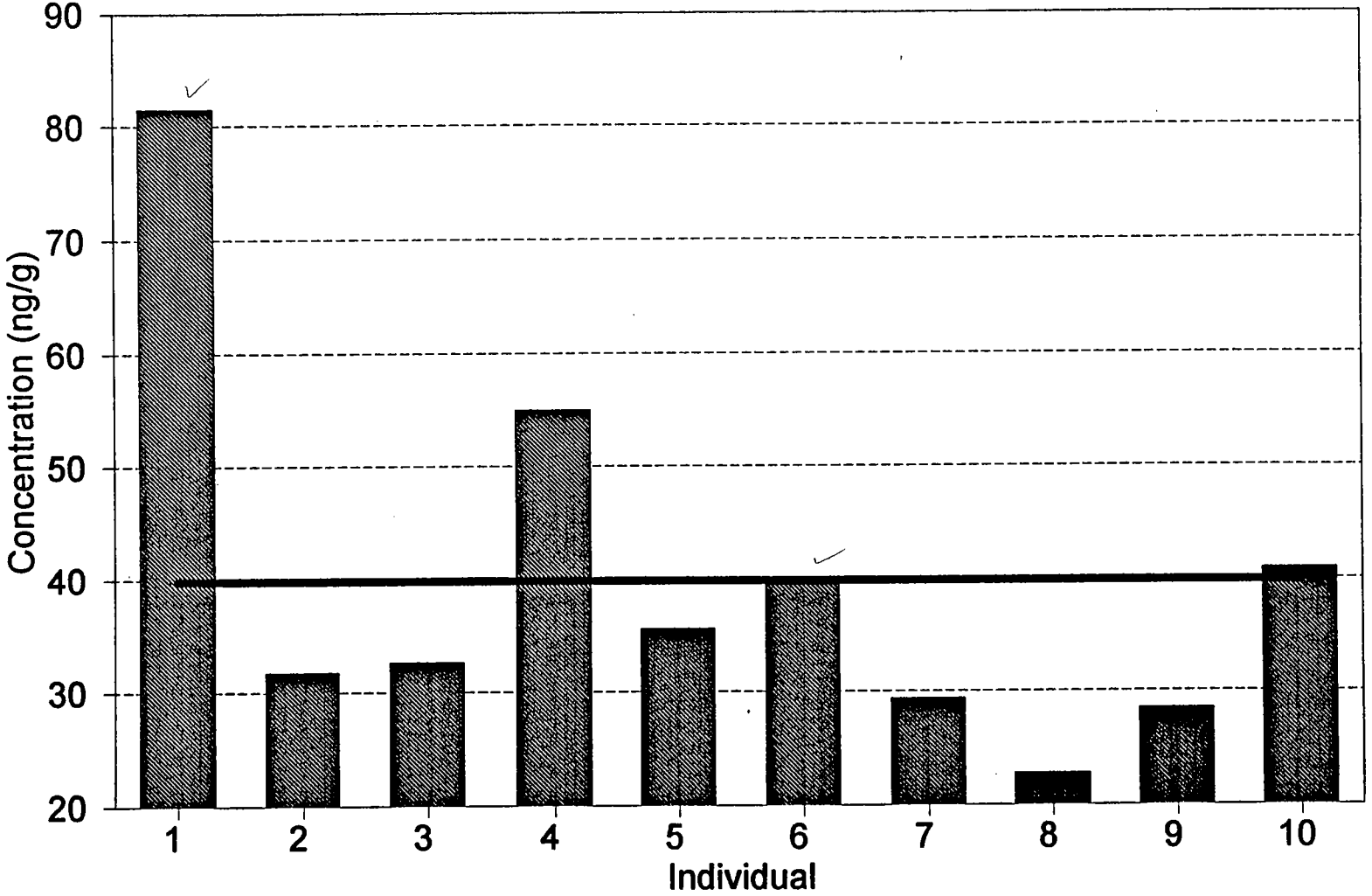
1993 Lobster Hepatopancreas Chlordane Levels (dry weight) for Cape Cod Bay



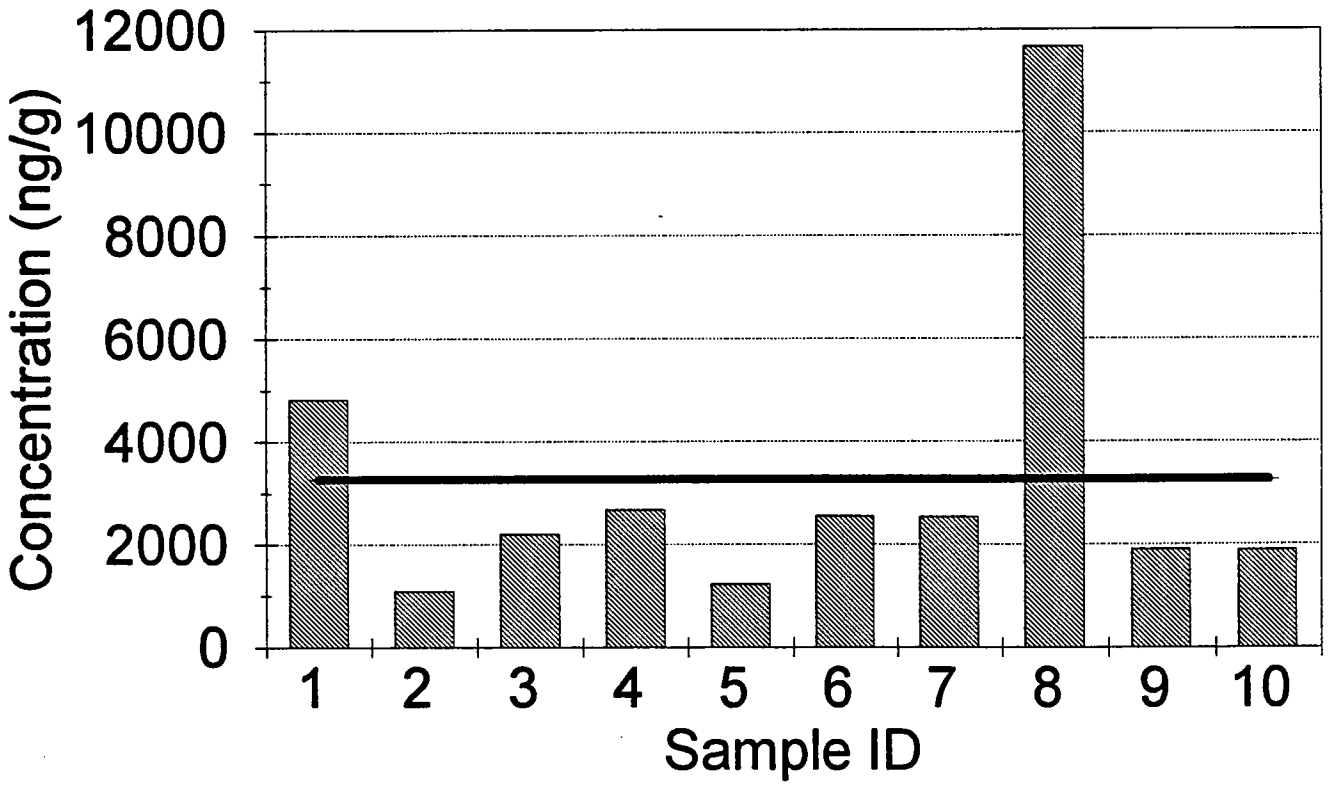
1993 Lobster Hepatopancreas DDT Levels (dry weight) for Cape Cod Bay



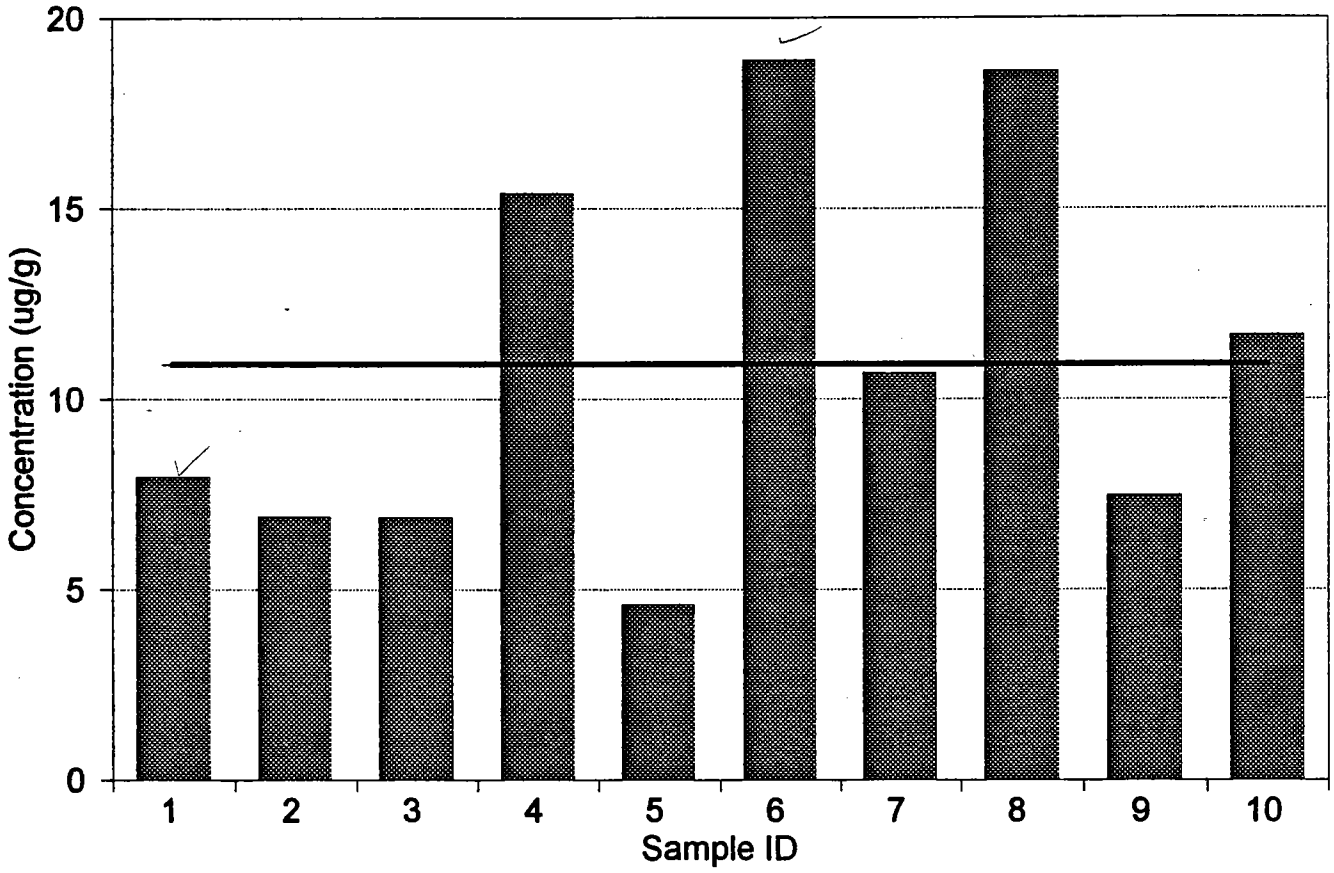
1993 Lobster Hepatopancreas Dieldrin Levels (dry weight) for Cape Cod Bay



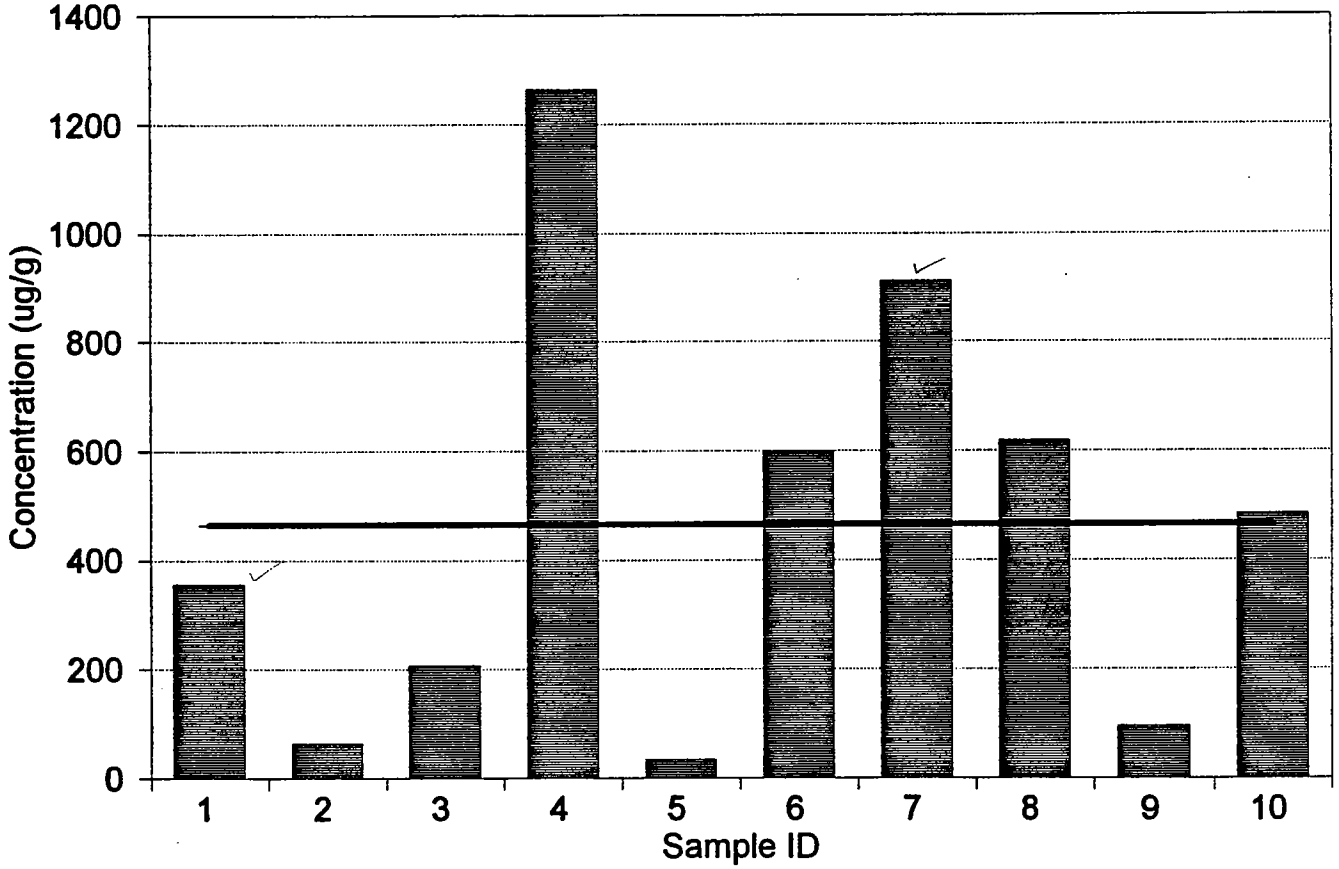
1993 Lobster Hepatopancreas Total PAH Levels (dry wt) for Cape Cod Bay



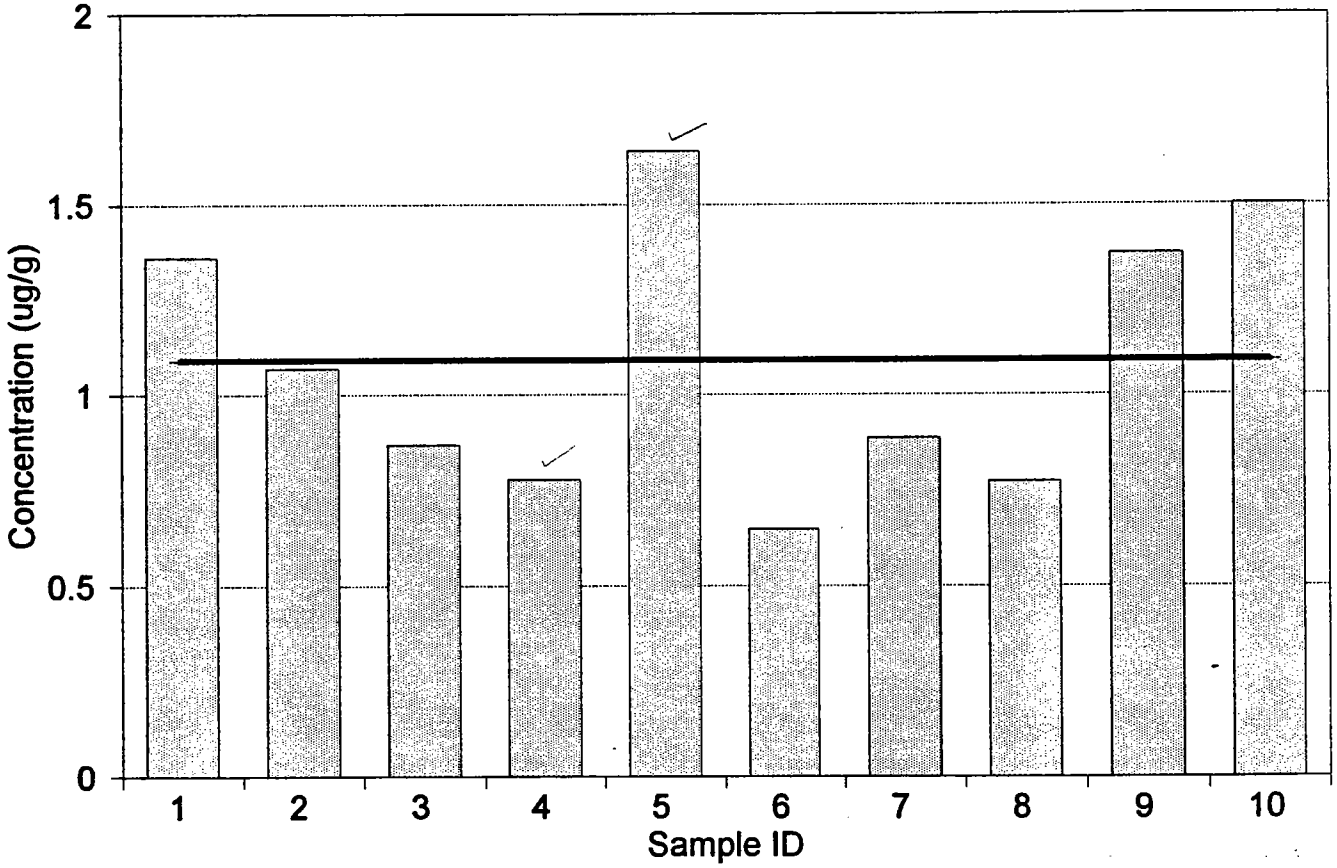
1993 Lobster Hepatopancreas Cadmium Levels (dry weight) for Cape Cod Bay



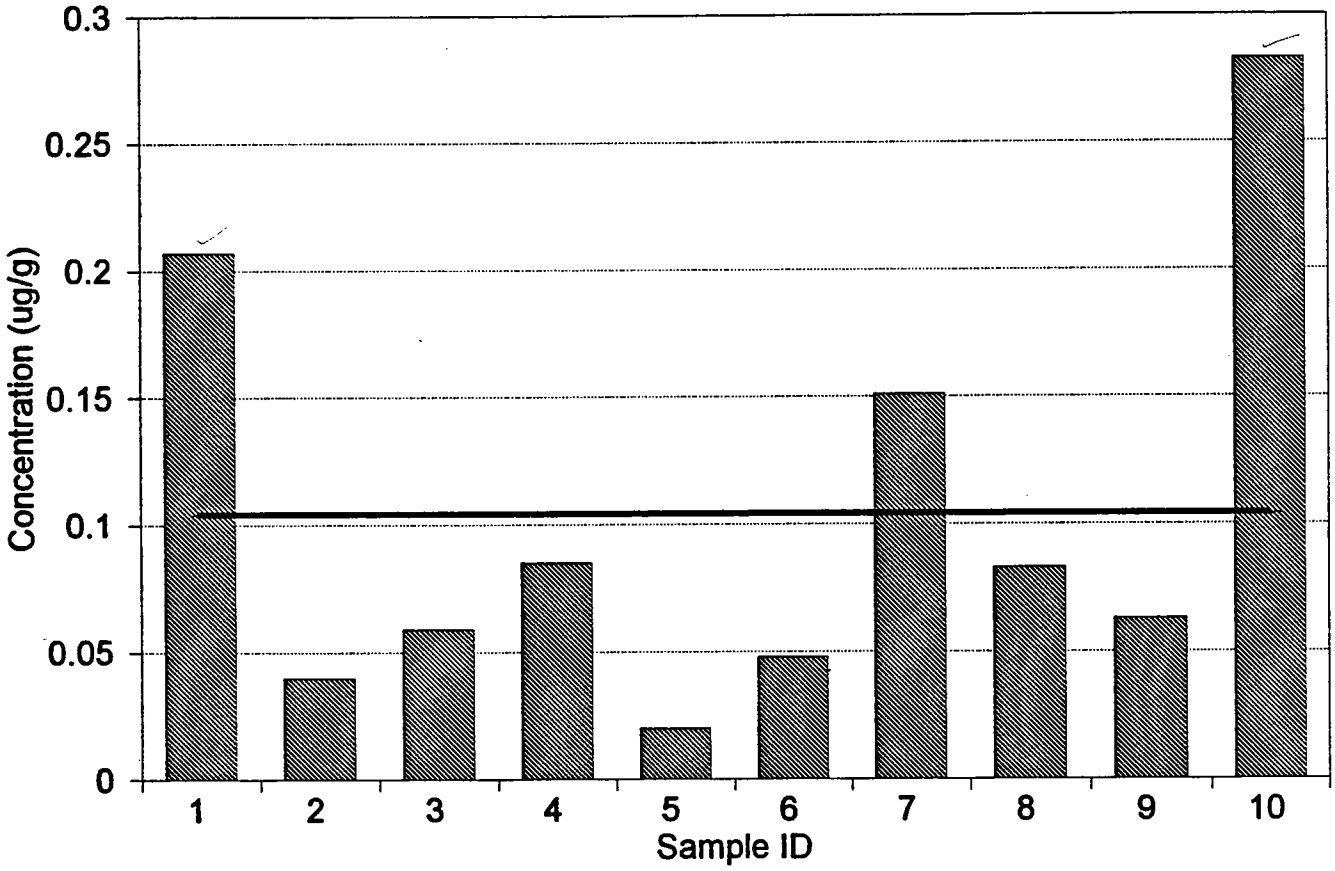
1993 Lobster Hepatopancreas Copper Levels (dry weight) for Cape Cod Bay



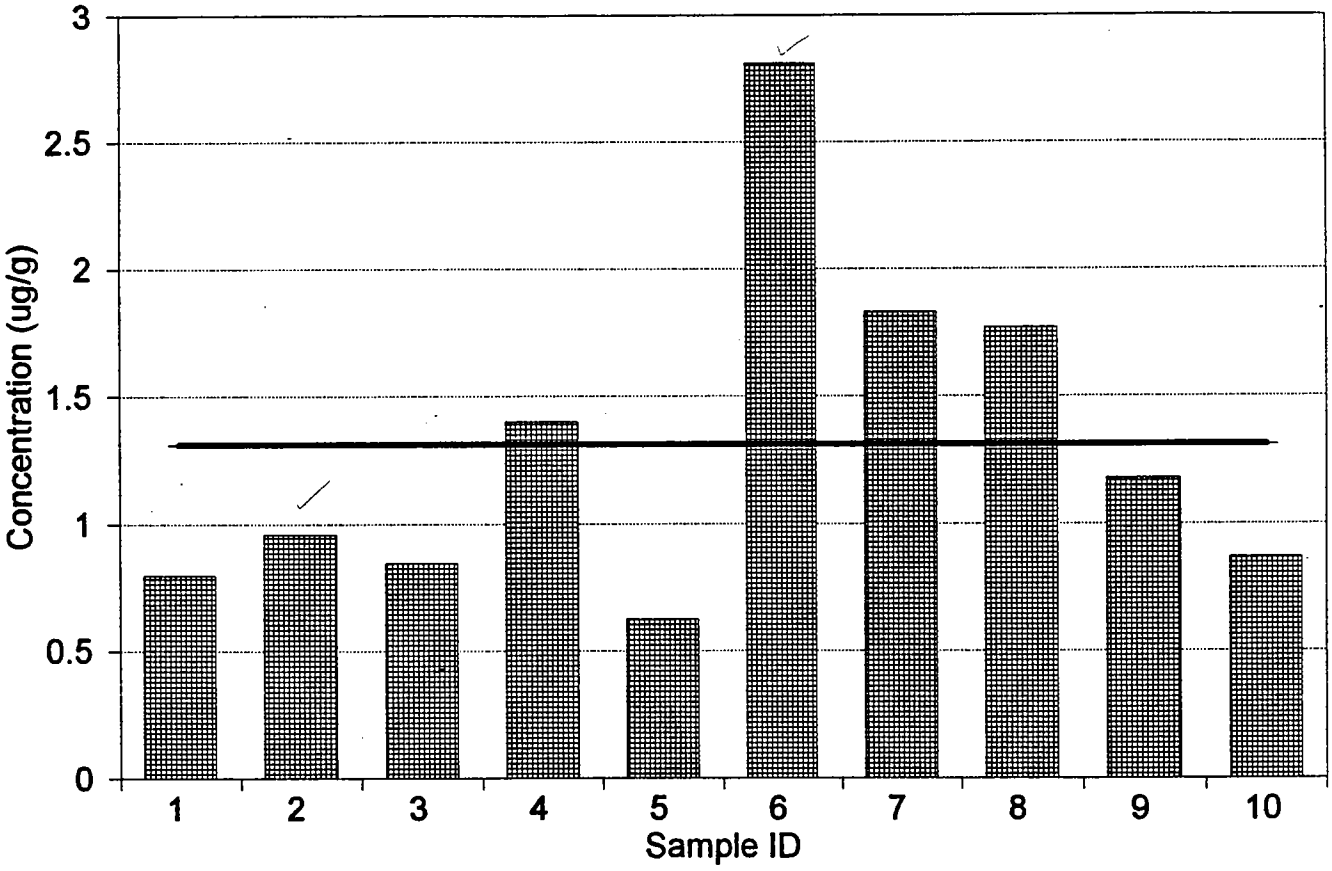
1993 Lobster Hepatopancreas Chromium Levels (dry weight) for Cape Cod Bay



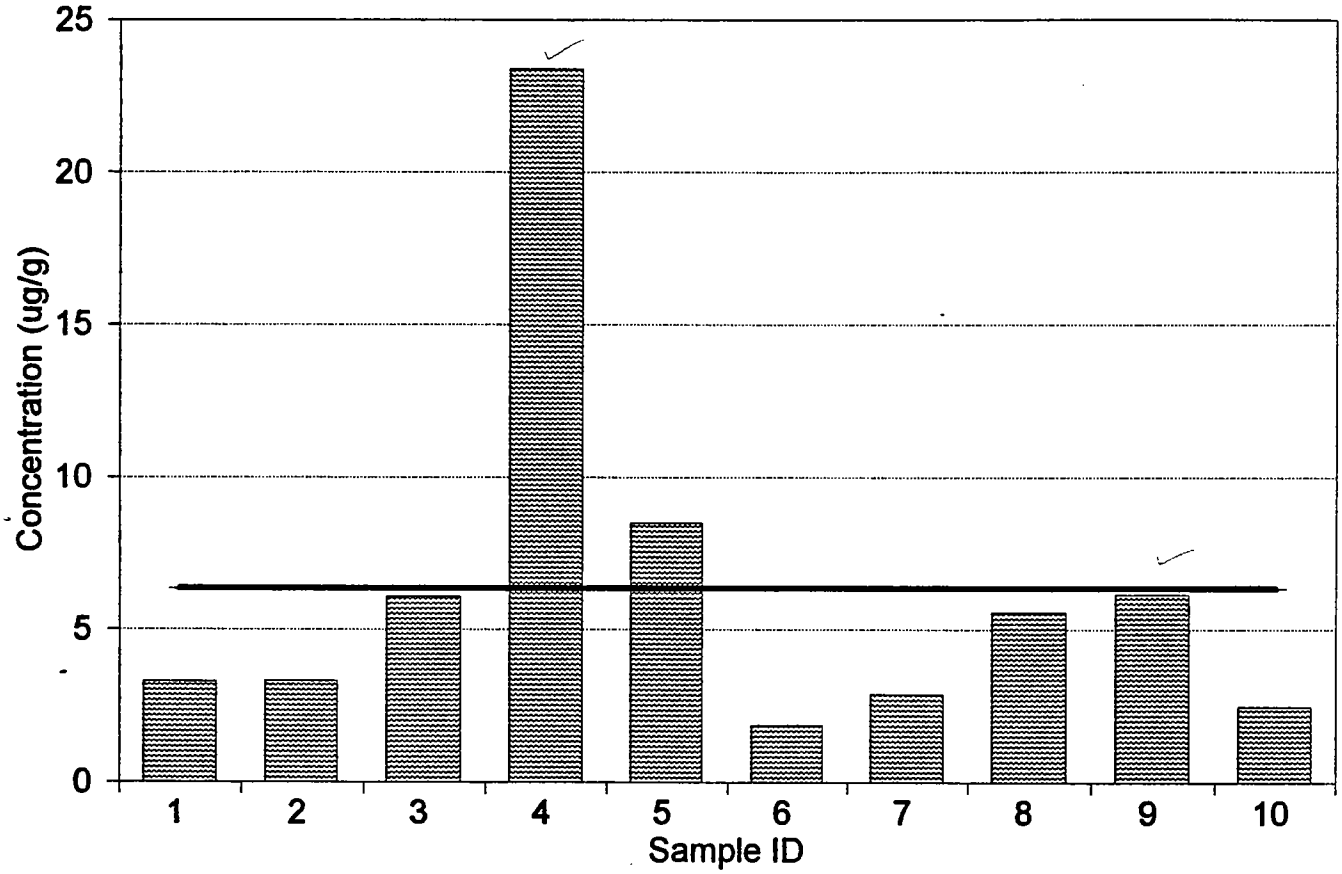
1993 Lobster Hepatopancreas Lead Levels (dry weight) for Cape Cod Bay



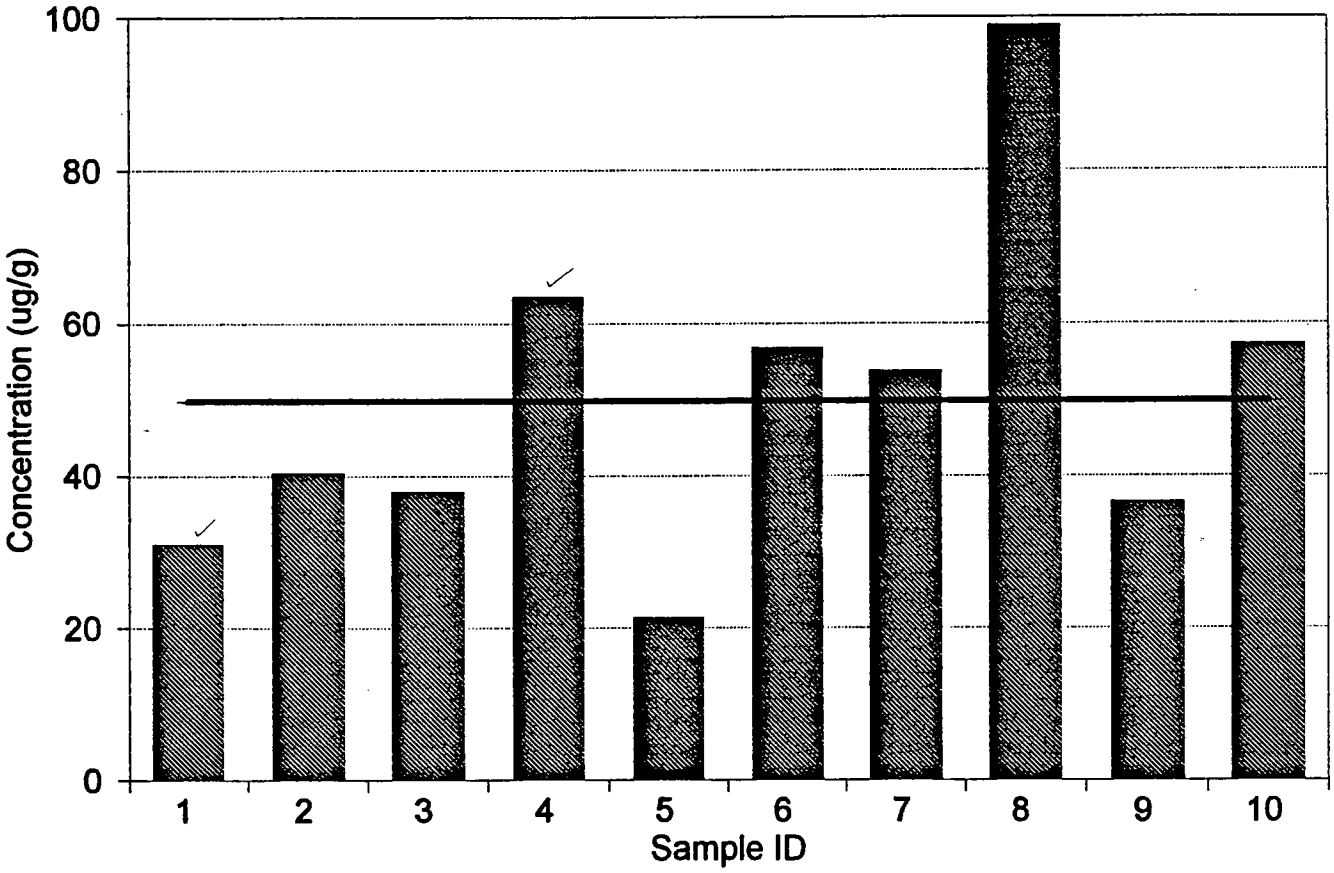
1993 Lobster Hepatopancreas Nickel Levels (dry weight) for Cape Cod Bay



1993 Lobster Hepatopancreas Silver Levels (dry weight) for Cape Cod Bay



1993 Lobster Hepatopancreas Zinc Levels (dry weight) for Cape Cod Bay



APPENDIX B

SUMMARY OF THE POWER ANALYSIS TO DETERMINE THE LEVEL . . OF DETECTABLE CHANGE BASED ON ANALYSIS OF INDIVIDUAL TISSUE SAMPLES

Appendix B

TABLE . Summary of statistics used to determine detectable change of chemical contaminants in fish and shellfish collected in the vicinity of Deer Island (DI) in Boston Harbor, the Future Outfall Site (FOS) in Massachusetts Bay, and Cape Cod Bay (CCB) in 1993.

						P80 Detectable Change	
Station	Tissue Type	Compound	n	Average ng/g dry	STD ng/g dry	ng/g dry	%
DI	Winter Flounder	Chlordane	10	16.04	8.17	10.82	67.47
FOS	Winter Flounder	Chlordane	9	17.01	11.74	16.52	97.13
CCB	Winter Flounder	Chlordane	10	5.54	2.76	3.66	66.03
DI	Winter Flounder	Dieldrin	10	3.30	1.07	1.42	42.89
FOS	Winter Flounder	Dieldrin	9	2.96	1.92	2.70	91.31
CCB	Winter Flounder	Dieldrin	10	2.02	0.53	0.70	34.51
DI	Winter Flounder	Hg (ug/g)	10	0.46	0.33	0.44	95.43
FOS	Winter Flounder	Hg (ug/g)	9	0.41	0.22	0.32	76.52
CCB	Winter Flounder	Hg (ug/g)	10	0.19	0.09	0.12	66.92
DI	Winter Flounder	PCB	10	200.39	94.65	125.43	62.59
FOS	Winter Flounder	PCB	9	215.05	116.44	163.82	76.18
CCB	Winter Flounder	PCB	10	59.24	25.93	34.37	58.01
DI	Winter Flounder	DDT	10	32.17	18.26	24.20	75.23
FOS	Winter Flounder	DDT	9	27.64	12.30	17.30	62.58
CCB	Winter Flounder	DDT	10	13.05	5.12	6.79	52.05
DI	Lobster Meat	Chlordane	3	6.73	1.96	5.96	88.48
FOS	Lobster Meat	Chlordane	2	2.11	0.10	0.53	25.16
CCB	Lobster Meat	Chlordane	10	2.41	1.94	2.57	106.63
DI	Lobster Meat	Dieldrin	3	9.02	1.87	5.66	62.80
FOS	Lobster Meat	Dieldrin	2	4.66	0.62	3.34	71.62
CCB	Lobster Meat	Dieldrin	10	3.52	0.66	0.87	24.86
DI	Lobster Meat	Hg (ug/g)	3	0.84	0.02	0.06	6.81
FOS	Lobster Meat	Hg (ug/g)	2	1.01	0.43	2.33	230.36
CCB	Lobster Meat	Hg (ug/g)	10	0.66	0.18	0.24	36.52
DI	Lobster Meat	PCB	3	154.21	101.54	308.20	199.86
FOS	Lobster Meat	PCB	2	65.79	3.73	19.99	30.38
CCB	Lobster Meat	PCB	10	66.46	49.39	65.44	98.47
DI	Lobster Meat	DDT	3	28.36	18.63	56.56	199.46
FOS	Lobster Meat	DDT	2	9.24	2.11	11.30	122.31
CCB	Lobster Meat	DDT	10	10.65	3.99	5.28	49.62

TABLE . Summary of statistics used to determine detectable change of chemical contaminants in fish and shellfish collected in the vicinity of Deer Island (DI) in Boston Harbor, the Future Outfall Site (FOS) in Massachusetts Bay, and Cape Cod Bay (CCB) in 1993.

Station	Tissue Type	Compound	n	Average ng/g dry	STD ng/g dry	P80 Detectable Change ng/g dry	P80 Detectable Change %
DI	Hepatopancreas	Chlordane	3	194.42	8.92	27.06	13.92
FOS	Hepatopancreas	Chlordane	2	48.56	6.97	37.39	77.00
CCB	Hepatopancreas	Chlordane	10	76.12	80.75	107.00	140.56
DI	Hepatopancreas	Dieldrin	3	124.70	43.89	133.23	106.84
FOS	Hepatopancreas	Dieldrin	2	56.60	14.98	80.32	141.91
CCB	Hepatopancreas	Dieldrin	10	39.79	17.11	22.67	56.98
DI	Hepatopancreas	Pb (ug/g)	3	0.33	0.17	0.50	151.51
FOS	Hepatopancreas	Pb (ug/g)	2	0.38	0.17	0.94	246.83
CCB	Hepatopancreas	Pb (ug/g)	10	0.10	0.08	0.11	107.26
DI	Hepatopancreas	Hg (ug/g)	3	0.30	0.10	0.29	99.29
FOS	Hepatopancreas	Hg (ug/g)	2	0.24	0.06	0.33	141.41
CCB	Hepatopancreas	Hg (ug/g)	10	0.21	0.11	0.14	67.28
DI	Hepatopancreas	Ni (ug/g)	3	0.65	0.33	1.00	152.78
FOS	Hepatopancreas	Ni (ug/g)	2	0.47	0.05	2.47	528.42
CCB	Hepatopancreas	Ni (ug/g)	10	1.31	0.67	0.89	67.80
DI	Hepatopancreas	Ag (ug/g)	3	6.53	0.81	2.45	37.58
FOS	Hepatopancreas	Ag (ug/g)	2	2.43	1.06	5.69	234.10
CCB	Hepatopancreas	Ag (ug/g)	10	6.35	6.34	8.41	132.49
DI	Hepatopancreas	Cd (ug/g)	3	3.33	1.18	3.59	107.55
FOS	Hepatopancreas	Cd (ug/g)	2	13.26	6.00	32.16	242.53
CCB	Hepatopancreas	Cd (ug/g)	10	10.92	5.12	6.78	62.13
DI	Hepatopancreas	Cr (ug/g)	3	1.46	0.09	0.28	19.36
FOS	Hepatopancreas	Cr (ug/g)	2	1.27	0.08	0.46	35.83
CCB	Hepatopancreas	Cr (ug/g)	10	1.09	0.35	0.46	42.67
DI	Hepatopancreas	Cu (ug/g)	3	642.00	281.02	852.97	132.86
FOS	Hepatopancreas	Cu (ug/g)	2	309.00	251.73	1350.11	436.93
CCB	Hepatopancreas	Cu (ug/g)	10	463.51	400.18	530.27	114.40
DI	Hepatopancreas	Zn (ug/g)	3	74.80	59.82	181.58	242.75
FOS	Hepatopancreas	Zn (ug/g)	2	83.55	47.31	253.71	303.67
CCB	Hepatopancreas	Zn (ug/g)	10	49.73	21.83	28.93	58.18
DI	Hepatopancreas	PCB	3	2857.83	489.46	1485.62	51.98

TABLE . Summary of statistics used to determine detectable change of chemical contaminants in fish and shellfish collected in the vicinity of Deer Island (DI) in Boston Harbor, the Future Outfall Site (FOS) in Massachusetts Bay, and Cape Cod Bay (CCB) in 1993.

						P80 Detectable Change	
Station	Tissue Type	Compound	n	Average ng/g dry	STD ng/g dry	ng/g dry	%
FOS	Hepatopancreas	PCB	2	2262.60	1028.06	5513.81	243.69
CCB	Hepatopancreas	PCB	10	2151.32	2162.26	2865.20	133.18
DI	Hepatopancreas	PAH	3	11727.20	9642.59	29267.70	249.57
FOS	Hepatopancreas	PAH	2	5862.35	3102.69	16640.70	283.86
CCB	Hepatopancreas	PAH	10	3248.79	3126.43	4142.80	127.52
DI	Hepatopancreas	DDT	3	642.21	47.81	145.13	22.60
FOS	Hepatopancreas	DDT	2	290.29	100.21	537.46	185.15
CCB	Hepatopancreas	DDT	10	287.68	105.40	139.66	48.55

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