

Technical Memorandum NMFS-NWFSC-3



**Intraorgan Distribution
of Chemical Contaminants
in Tissues of Harbor Porpoises
(*Phocoena phocoena*)
from the Northwest Atlantic**

December 1992

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**Marine Mammal Health
and**



Stranding Response Program

**The current study was conducted for the
Marine Mammal Tissue Bank and
Quality Assurance Component**

Technical Memorandum NMFS-NWFSC-3



Intraorgan Distribution of Chemical Contaminants in Tissues of Harbor Porpoises (*Phocoena phocoena*) from the Northwest Atlantic

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ABSTRACT

The National Marine Fisheries Service through its National Marine Mammal Tissue Bank and Stranding Network Program is developing baseline data on the concentrations of chemical contaminants in marine mammals that are endangered or that could be used as sentinel species in monitoring studies. The Program is also archiving marine mammal tissues to be used for retrospective analyses of chemical contaminants as improved analytical methodologies are developed.

The possible heterogeneous partitioning of chemical contaminants within tissues of marine mammals, however, is a factor affecting whether a tissue sample is representative of the entire organ. This potential partitioning is of particular concern in marine mammals where the analytical sample is quite often a very small proportion of the whole organ. Accordingly, blubber and liver samples were taken from different anatomical locations in these organs of three apparently healthy harbor porpoises (*Phocoena phocoena*) caught in a gill-net fishery in the northwest Atlantic. Concentrations of chlorinated hydrocarbons (CHs), such as polychlorinated biphenyls (PCBs), DDTs, and chlordanes, were measured in the blubber (n = 7) and liver (n = 5) samples, and selected toxic elements (e.g., mercury, lead, cadmium) were also measured in the liver. Additionally, individual samples were taken from brain, lung, kidney, and gonad to assess the disposition of toxic chemicals within harbor porpoise.

Based on the analysis of a total of 21 blubber and 15 liver samples, the mean concentrations of PCBs ranged from 13,000 to 33,000 and 390 to 1,200, ng/g (ppb) wet weight tissue, respectively. Further, the concentrations of DDE in blubber and mercury in liver ranged from 3,900 to 5,600 and 610 to 2,500 ng/g, respectively. The PCB concentrations in blubber were comparable to concentrations in harbor porpoise from the west coast of the United States, whereas the concentrations of DDE in blubber and mercury in liver were considerably lower in the present study than the DDE concentrations in harbor porpoise from the west coast of the United States or of mercury in porpoise from the British Isles.

Statistical analyses of the results showed that the anatomical location of the blubber or liver sample had no statistically significant effect on concentrations of either CHs in blubber and liver or of toxic elements in liver. However, the concentrations of CHs and level of total lipids in blubber from a lateral site slightly anterior to the peduncle were consistently less than those in most of the other subsamples. Thus, these results show that sampling blubber and liver from different anatomical locations contributes little to the variation in tissue concentrations of CHs and toxic elements among individual harbor porpoise. Nevertheless, the designation of a specific site for sampling tissues of marine mammals for archival in a tissue bank is recommended, because of potential differences among species in the distribution of contaminants and the potential of analyses, in the future, for compounds for which there may be substantial differences in distribution within an organ.

In addition to determining if tissue concentrations of CHs and toxic elements were dependent on the anatomical location of the sample, the analyses of CHs in the brain, gonad, kidney, and lung of one porpoise provided an initial assessment of the distribution of CHs among harbor porpoise tissues. The results showed that the CH concentrations, based on wet weight, were considerably higher in the blubber than in the other tissues; however, the concentrations of CHs in the different tissues were comparable when values were based on total lipid weight. An exception was the brain where lipid normalized concentrations were lower than in all other tissues. The low relative accumulation of lipophilic contaminants in the brain tissue may be due to a lower proportion of neutral lipids in brain. Previous studies suggest that the level of total lipid, and specifically neutral lipid, in a tissue is an important factor influencing the uptake of lipophilic CHs, such as PCBs. Accordingly, in addition to measuring the total content of lipids in a tissue, the composition of lipids should be determined to provide proper assessment of the distribution of lipophilic contaminants among tissues.

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PREFACE

The recent strandings of marine mammals and the decline in populations of some species has heightened the concern that environmental pollution may have a role in these events and has pointed to the need for high quality samples from marine mammals for assessing the role, if any, of environmental contaminants. In response to this need, the National Marine Fisheries Service (NMFS), in 1989, initiated the development of the National Marine Mammal Tissue Bank (NMMTB) at the National Biomonitoring Specimen Bank located in the National Institute of Standards and Technology (NIST). The NMMTB archives selected marine mammal tissues that have been collected and processed using rigorous well-documented protocols. These tissue samples are stored under the best conditions currently available (-150° C) for maintaining sample integrity. As part of the NMMTB, the NIST and the Environmental Conservation (EC) Division are cooperating in the development and application of quality assurance procedures and materials for chemical analysis of marine mammal samples. Additionally in 1989, enhanced support for the Marine Mammal Stranding Network (MMSN) began. The stranding network has a primary role in the collection of tissues for anthropogenic contaminant analyses and for the NMMTB, but it was also recognized that additional biological data should be collected to enhance the monitoring of the health of marine mammal populations and their relationships to chemical contaminant exposure.

In 1991, the NMFS combined the NMMTB and the MMSN into a single broader program, now known as the National Marine Mammal Tissue Bank and Stranding Network Program (NMMTB&SN Program), which includes a contaminant monitoring component presently conducted by the EC Division of the Northwest Fisheries Science Center, NMFS. The monitoring component includes real-time analyses to determine concentrations (based on current methods) of environmental contaminants and biotoxins in marine mammals, as well as research on ways to enhance methods and procedures used by the program.

This report presents the results of a study to assist in developing a protocol for the NMMTB&SN for sampling marine mammal tissues for the measurement of chemical contaminant

concentrations. Specifically, the present study determined if there is heterogeneity in the distribution of persistent chemical contaminants, such as chlorinated hydrocarbons (e.g., polychlorinated biphenyls) and certain toxic elements (e.g., mercury), in tissues of harbor porpoise (*Phocoena phocoena*). Any significant heterogeneity in the distribution of chemicals is of particular concern in marine mammals where the tissue sample for chemical analysis is often a very small proportion of the entire organ.

INTRODUCTION

To address the public and scientific concern that chemical contaminants may be affecting the health of marine mammals, the National Marine Fisheries Service (NMFS), through its National Marine Mammal Tissue Bank and Stranding Network (NMMTB&SN) Program, is developing baseline data (primarily by the NMFS laboratory in Seattle) on the concentrations of chemical contaminants in marine mammals that are endangered or that could be used as sentinel species in monitoring studies. Additionally, the NMMTB&SN is archiving (conducted by the National Institute of Standards and Technology) marine mammal tissues to be used for retrospective analyses of chemical contaminants as improved analytical methodologies are developed. The availability of baseline data and high quality archived samples will greatly aid in documenting and refining information on long-term trends in chemical contaminants presently of concern and those that may emerge as potential toxicopathic agents.

The possible heterogeneous partitioning of chemical contaminants within tissues of marine mammals, however, is a factor that could affect whether a tissue sample that is collected is representative of the entire organ. This is of particular concern for marine mammals where the sample of tissue for detailed chemical analysis quite often represents a very small proportion of the mass of the whole organ. Thus, information on the distribution of chemical contaminants within tissues sampled as part of marine mammal monitoring programs is needed in designing sampling protocols for the NMMTB&SN Program.

Currently, there are limited data available on the anatomical distribution of chemical contaminants, such as chlorinated hydrocarbons (CHs), within tissues of marine mammals. Aguilar (1985) in his review of sampling procedures for surveys of concentrations of CHs in cetaceans discussed the distribution of CHs among different types of tissues as well as potential limitations of using blubber as a representative tissue in assessing CH exposure in cetaceans. Aguilar (1985) suggested that because of differences in compositions of lipids in blubber and mobilization of lipids in starved animals, blubber may not be a homogeneous tissue, and therefore,

there may be significant differences in contaminant concentrations in areas of the blubber, both with respect to location on the body where it is sampled and whether the entire thickness of blubber is sampled. In contrast to the data reported by Aguilar, Calambokidis (1986) reported that the concentrations of CHs in blubber (all strata) sampled from different anatomical locations on two harbor porpoises (*Phocoena phocoena*) from the west coast of the United States were very similar. Further, there are very limited data available for other tissues that are commonly sampled, such as liver, or for tissue concentrations of elements (e.g. mercury) of toxicological concern.

Accordingly, in the present study the profiles and concentrations of CHs (Table 1) in both blubber and liver, and of selected toxic elements in liver from three apparently healthy harbor porpoises incidentally caught in gill nets were determined to improve our understanding of potential intratissue differences in accumulation of these chemicals by marine mammals. Such information will aid in refining sampling procedures for the NMMTB&SN Program. Additionally, the concentrations of CHs and toxic elements were determined in kidney, brain, lung, and testis of one porpoise to make a preliminary assessment of the distribution of toxic chemical contaminants among harbor porpoise tissues. The availability of information on the distribution of contaminants in various tissues of apparently healthy animals will aid in interpreting data from stranded animals.

METHODS

Field Sampling

Multiple samples of blubber (all strata of blubber, from skin to muscle) (Fig. 1) and liver (Figs. 2 and 3) were taken from a harbor porpoise (MH-91-424) that was caught in a gill net off Boston Harbor, Massachusetts, and from two harbor porpoises (MH-91-504, MH-91-506) that were caught in gill nets off Boothbay Harbor, Maine. The Boston Harbor animal was a yearling female (MH 91-424; length, 120.0 cm) and the Boothbay Harbor porpoises were both males; one yearling (MH-91-504; length, 120.0 cm) and one approximately 4 years old (MH-91-506; length, 136.5 cm). Additionally, kidney, gonad, lung, and one-half of the brain were collected from all

three animals. A biologist from Northwest Fisheries Science Center's Environmental Conservation (EC) Division and personnel from the National Institute of Standards and Technology and the New England Aquarium conducted the necropsies of the animals. The frozen samples were shipped on dry ice to our laboratories in Seattle, Washington. Samples of blubber and liver from each animal were also archived for the NMMTB at the National Institute of Standards and Technology.

Analytical Procedures

The subsamples of blubber from the three harbor porpoises were analyzed for CHs (Table 1), percent lipid, and percent dry weight, and the subsamples of liver were analyzed for CHs, percent lipid, percent dry weight, and selected toxic elements (arsenic, cadmium, copper, lead, selenium, mercury). Additionally, samples of kidney, brain, gonad, and lung from animal MH-91-506 were analyzed for CHs, percent lipid, percent dry weight, and toxic elements.

Toxic Element Determinations

The concentrations of toxic elements were determined using analytical methodologies and quality control procedures used in the National Benthic Surveillance Project of NOAA's National Status and Trends Program. Briefly, thawed tissue (1.0 to 1.8 g) was digested with 10 mL of concentrated ultrapure nitric acid for 2 hours at room temperature in a sealed Teflon bomb. The bomb was then heated in a microwave oven at 650 watts for 6 minutes. The digestate was further treated to destroy organic matter by digestion with 4 mL hydrogen peroxide and again heated in the microwave oven. The digestates were diluted with deionized water to a final volume of 25 mL. Concentrations of elements were determined by atomic absorption spectrophotometry using the following techniques: 1) cold vapor hydride generation was used for determining mercury; 2) graphite furnace was used for copper; and 3) Zeeman-corrected graphite furnace was used for arsenic, selenium, cadmium, and lead.

Chlorinated Hydrocarbon Determinations

The concentrations of CHs (Table 1) were determined by modifying the National Benthic Surveillance Project method to account for the lipid-rich blubber tissue of marine mammals. Briefly, samples of thawed tissue were extracted using modified procedures of Krahn et al. (1988). Tissue (1 g) was macerated with sodium sulfate and methylene chloride. The methylene chloride extract was filtered through a column of silica gel and alumina, and the extract concentrated for further cleanup. Size exclusion chromatography with high performance liquid chromatography (HPLC) (flow rate of 5 mL/min vs. 7 mL/min in the original method) was used and a fraction containing the CHs was collected. The HPLC fraction was exchanged into hexane and the extracts were analyzed for CHs by capillary column gas chromatography (GC) equipped with an electron capture detector. Identification of individual CHs was confirmed using GC-mass spectrophotometry (MS).

Lipid Determinations

To determine extractable lipids, an aliquot of the initial methylene chloride extract of tissue was filtered through filter paper with diatomaceous earth as a filtering aid and the solvent was removed from each sample using a rotary evaporator. After the solvent was evaporated, the flask was weighed and the weight of lipid determined. The percent lipid was determined by dividing the weight of lipid by the original sample wet weight and multiplying by 100. Evaluation of this method using sea lion blubber ($n = 5$) and liver ($n = 5$) samples showed that this procedure gave results for total lipids comparable to those obtained using the method of Hanson and Olley (1963), a modification of the Bligh and Dyer method. The percent total lipids in blubber determined by our method and the Hanson and Olley method were $84 \pm 0.7\%$ and $80 \pm 2.2\%$, respectively, and for liver were $2.7 \pm 0.1\%$ and $2.2 \pm 0.2\%$, respectively.

Quality Assurance

Quality control procedures included the use of standard reference materials (SRMs) and certified reference materials (CRMs). The reference material SRM 1974 (mussel (*Mytilus edulis*) tissue), analyzed for CHs, and CRM 1566a (oyster tissue), used for toxic elements, were from the

National Institute of Standards and Technology. The reference materials for toxic elements also included the National Research Council of Canada's DOLT-1 (dogfish liver), DORM-1 (dogfish muscle), LUTS-1 (nondefatted lobster hepatopancreas), and TORT-1 (lobster hepatopancreas).

The quality control procedures for CHs and toxic elements also included analyses of method blanks, solvent blanks, certified calibration standards, and replicate samples. Replicate analyses ($n = 2$) for CHs in samples of porpoise liver and blubber agreed within $\pm 15\%$ (Tables 2 and 3) and the analyses of replicates for toxic elements agreed within $\pm 16\%$. Further, as an indication of the accuracy of the analytical method, the grand mean recovery ($110 \pm 2\%$) of selected CH analytes in SRM 1974 was calculated from the mean recoveries for selected CH analytes by calculating the ratio of the concentrations of analytes from this series ($n = 4$) to those of previous analyses ($n = 19$). The mean recovery of the toxic elements in the CRMs was $99 \pm 25\%$.

Statistical Methods

Samples of blubber were taken from seven different anatomical locations on the body (Fig. 1) and from five different sites in the liver (Fig. 3) of the three harbor porpoises to assess the effect of anatomical location of the sample on the distribution of chemical contaminants. The data on chemical concentrations (based on wet weight and lipid weight) were analyzed by two-way analysis of variance (ANOVA), with tissue sampling location within the animal and the animal itself as the factors. This approach has the advantage of taking into account variability among animals in the concentration of chemicals in a tissue, but at the same time allows determination of whether there are intraorgan differences in the concentrations. Further, the data were log transformed ($\log(x + 1)$) to reduce deviations from normality. The results of the statistical analyses were very similar whether concentrations were expressed on a wet weight or dry weight basis, thus only the results for the analyses using concentrations based on wet weight are discussed. The significance level was set at $P \leq 0.05$.

RESULTS AND DISCUSSION

The data on concentrations (ng/g wet weight) of CHs (Σ PCBs, Σ DDTs, Σ DDEs and Σ DDDd which are metabolites of DDTs, and Σ other CHs), percent lipid and percent dry weight in samples of blubber and liver from each of the three porpoises are presented in Tables 2 and 3. The concentrations (ng/g wet weight) of arsenic, cadmium, copper, lead, selenium, and mercury in liver samples are presented in Table 4. Detailed results on concentrations of individual DDTs, DDEs, DDDs, other CHs, selected polychlorinated biphenyls (PCB) congeners, and PCBs by homolog class (tri- to nonachlorobiphenyls) are given in Appendix A (Tables A1-A14). The detailed quality control results for analyses of CHs and of toxic elements are presented in Appendix B (Tables B1-B4 and B5, respectively).

Concentrations of Chlorinated Hydrocarbons and Toxic Elements Comparison Among the Individual Porpoises and to Previous Studies

The results of the statistical analyses (Tables 5-7) showed that the concentrations of the selected CHs in blubber and liver were significantly different among the three porpoises ($P < 0.001$). For example, concentrations (mean \pm standard error (SE)) of Σ PCBs in subsamples ($n = 7$) of blubber of each of the animals were $33,000 \pm 1,100$, $22,000 \pm 1,600$, and $13,000 \pm 770$ ng/g wet weight (Table 2), and in liver were $1,200 \pm 68$, 620 ± 4 , and 390 ± 14 ng/g wet weight (Table 3). Additionally, the concentrations of toxic elements in subsamples of liver were significantly different among the three porpoises ($P < 0.004$), except for the concentrations of lead (Table 4), which were not significantly different ($P = 0.06$). The lack of significant differences for lead would appear to be related to the low (< 5 ng/g) concentrations measured and thus greater variation in concentrations among the subsamples of liver from each porpoise.

The comparison of concentrations of CHs and toxic elements in tissues of harbor porpoise in the present study to results from other studies must be made with caution because of differences

in methodology and lack of availability of quality control data in some studies. With this in mind, the concentrations of Σ PCB and hexachlorobenzene (HCB) ($23,000 \pm 5,900$ and 520 ± 180 ng/g wet weight, respectively) in blubber of the three porpoises in the present study appear to be comparable to the concentrations ($14,000 \pm 1,900$ and 510 ± 60 ng/g wet weight, respectively) reported for harbor porpoises from the west coast of the United States (Calambokidis and Barlow 1991). However, the concentrations ($31,000 \pm 4,500$ ng/g wet weight) of Σ DDE in harbor porpoise from the west coast were six times greater than the concentrations ($4,800 \pm 500$ ng/g wet weight) in porpoises from the northwest Atlantic. For the toxic elements, the concentrations of cadmium and copper in livers of harbor porpoise from the British Isles were 200 ± 60 and $24,000 \pm 8,900$ ng/g wet weight, respectively (Law et al. 1991) and were comparable to concentrations (150 ± 80 and $11,000 \pm 3,600$ ng/g wet weight, respectively) for these elements in porpoises in the present study, whereas the concentrations ($14,000 \pm 7,400$ ng/g wet weight) of mercury in porpoise from the British Isles were 10 times as great as the concentrations ($1,400 \pm 570$ ng/g wet weight) reported here. The data on the toxic elements can be compared with greater confidence because the same CRMs were used in both studies and the results of analysis of the CRMs confirmed the accuracy of the methods used.

Effect of Sampling Blubber and Liver from Different Anatomical Locations

Chlorinated Hydrocarbon Concentrations

Sampling blubber from different locations on the body of the porpoises had no statistically significant ($P > 0.05$) effect on concentrations (wet weight) of the CHs measured (Table 5). However, even though there were no statistically significant differences in the mean concentrations of the CHs in subsamples of harbor porpoise blubber, the concentrations of CHs in the subsamples (Fig. 4) from site 5 (a lateral site slightly anterior to the peduncle) were consistently lower than the mean concentrations in most of the other subsamples. This finding is similar to previous results (Calambokidis 1986) showing agreement in PCB and DDE concentrations among most subsamples of blubber taken from various locations on the bodies of harbor porpoises from

the west coast of the United States, except that a dorsal site near the peduncle also had the lowest concentrations.

Similar to blubber, the mean concentrations (wet weight) of selected CHs in subsamples of liver from each of the three harbor porpoises also showed no significant differences ($P > 0.05$) among subsamples with the exception of the concentrations of Σ DDD_s ($P = 0.02$) (Table 6). Even though there were statistically significant differences among concentrations of this CH among subsamples, the difference between the subsamples with the highest and lowest concentrations (Fig. 5) was only 17%. Overall, the statistical results also illustrated that the major source of variation in both liver and blubber concentrations of CHs was due to differences among porpoises and that only a small proportion of the variation was due to sampling from different anatomical locations.

An important factor in the accumulation of lipophilic CHs by marine mammals is the lipid content of the tissue (Aguilar 1985). The results of the analysis of the replicate samples of blubber and liver showed no significant differences ($P > 0.05$) in percent lipid among different anatomical locations (Tables 5 and 6). Further, statistical analyses of concentrations of CHs in blubber when based on total lipid (Table 5) showed that the probability of significant differences with respect to anatomical location was not affected in a consistent manner when compared to the results of the analyses done using concentrations of CHs based on wet weight tissue. This result is consistent with the finding that the lipid content of the subsamples of tissues was not markedly different (Table 3). However, lipid normalization of the concentrations of CHs did result in the concentrations of CHs in blubber from site 5 being generally comparable to the other subsamples, rather than being less than the other sites when the concentrations are expressed on a wet weight tissue basis (Fig. 6). This result reflects the lower percent total lipid for site 5 ($74 \pm 1.0\%$, $n = 3$) compared to the other sites ($83 \pm 1.0\%$, $n = 18$). Calambokidis (1986) also found that the percent total lipid for blubber from the dorsal peduncle area was less than that for blubber from other anatomical locations in harbor porpoise from the west coast. Thus, overall these results suggest that although there were no statistically significant differences in the lipid content of blubber from

different anatomical locations, variation in lipid content among the subsamples does appear to account for some of the variation in the concentrations of CHs. This supports the accurate measurement and reporting of the lipid content of tissues from stranded animals when concentrations of CHs are determined.

Normalizing the concentrations of CHs in liver to total lipid also had no consistent effect on the probability of significant differences among sampling locations (Table 6) because, as with blubber, there were no consistent differences in percent lipid among the subsamples (Table 3). However, the results shown in Figure 7 indicate that the variation among subsamples was increased, with site 5 generally exhibiting higher lipid-based concentrations of CHs than in the other subsamples. The increased variability in lipid-based concentrations of CHs among liver subsamples was a consequence of relatively low percent lipid (~ 1.5%) in liver and the magnification of differences among subsamples when the values were converted to concentrations based on total lipid.

Toxic Element Concentrations

The concentrations of the selected toxic elements in liver taken from different anatomical locations also showed no significant differences ($P > 0.05$) among subsamples (Table 7). However, the concentrations of lead in the subsamples were more variable than the concentrations of the other toxic elements (Fig. 8). The greater variability in lead concentrations is expected at the low concentrations found (not detected to 57 ng/g wet weight). There are apparently no published data on the distribution of toxic elements within liver for other marine mammals for comparison.

Overall, the results for CHs and toxic elements showed that the anatomical location of the sample had minimal effects on concentrations of CHs in blubber and liver or toxic elements in liver, regardless of the basis used for expressing the concentrations (CHs: wet or dry weight tissue or total lipids; toxic elements: wet or dry weight tissue). However, the findings of somewhat lower concentrations of CHs based on wet weight tissue in blubber near site 5 suggest that this area should be avoided when sampling blubber. The finding of lower concentrations of CHs in blubber from site 5 was due, in part, to the lower percent lipid in this site compared to other sites.

Differences in composition of lipid in blubber strata in going from the skin to the muscle may also introduce a heterogeneous distribution of CHs in blubber. Because the present study did not address the issue of vertical stratification of CHs in blubber, additional study is needed to provide information for interpreting data from studies analyzing biopsy samples or samples from the large marine mammals where the entire thickness of blubber may not be routinely sampled or analyzed.

Distribution of Chemical Contaminants Among Tissues

Samples of kidney, gonad, brain, and lung were also analyzed from one porpoise (MH-91-506) as an initial assessment of the distribution among tissues of CHs (Table 8) and toxic elements (Table 9). Consistent with previous data (Aguilar 1985) the present results indicate that the concentrations (wet weight) of CHs were considerably higher in the blubber than in the other tissues analyzed. However, when the concentrations are expressed on total lipid weight, the concentrations of CHs in the different tissues are comparable (Table 8), with the exception of brain, in which the concentrations were lower than in all the other tissues. These findings are also similar to the results from previous studies (reviewed in Aguilar 1985) with several marine mammal species showing that the concentrations in blubber of Σ PCBs and Σ DDTs on a total lipid basis were on average approximately equal to the concentrations in liver, muscle, or kidney; whereas for brain the concentrations of these CHs on a total lipid basis were considerably lower than the concentrations in blubber. Similarly in the present study, the blubber-to-brain concentration (total lipid basis) ratios were 4.3, 13, and 7.9 for Σ PCBs, Σ DDTs, and Σ other CHs, respectively.

Analysis by Aguilar (1985) of the data of Fukushima and Kawai (1981) on CHs in tissues of the striped dolphin (*Stenella coeruleoalba*) shows that the high blubber-to-brain concentration ratios are in large part due to low proportions of neutral lipids (triglycerides and nonesterified fatty acids) comprising total lipids in brain. For example, concentrations based on total lipids of Σ DDTs and Σ PCBs in 14 tissues were highly correlated (Σ DDTs, $r = 0.86$, $P = 0.001$;

Σ PCBs, $r = 0.75$, $P = 0.005$) with the proportion of the neutral lipids in the tissues (Aguilar 1985). These results demonstrate that measurement of neutral lipids should also be considered when determining concentrations of lipophilic contaminants such as CHs. Currently, we are evaluating methodologies for determination of triglycerides as markers of neutral lipids in tissues of aquatic species.

The distribution of toxic elements (Table 9) among different organs of porpoise MH-91-506 (liver, kidney, gonad, brain) appeared to be more variable relative to the distribution of CHs. The concentrations of mercury in liver were 4 to 17 times greater than that found in other organs and the concentrations of cadmium were highest in the kidney and not detected in the brain. The concentrations of copper were similar in liver, kidney, and brain. The present results for mercury, cadmium and copper are similar to those for harbor porpoise from the east coast of Scotland, reported by Falconer et al. (1983). In the present study, the concentrations of selenium were highest in the kidney (tenfold higher than in liver), while the concentrations of arsenic appeared to be similar in all tissues analyzed. The concentrations of lead were low in liver (11 ± 3 ng/g wet weight) and in the other tissues examined.

SUMMARY

In conclusion, the present study shows that there were no marked differences in the concentrations of either CHs or selected toxic elements among subsamples of blubber or liver of harbor porpoise in which the concentrations of PCBs in blubber, for example, ranged from 12,000 to 33,000 ng/g wet weight. It is recommended, however, that blubber should not be sampled from near the dorsal peduncle because the concentrations, based on wet weight tissue, were consistently lower compared to samples from most of the other anatomical locations. These differences in concentrations were, in part, due to lower levels of total lipid in blubber from this location.

An additional factor in the similarity of concentrations of CHs among subsamples of blubber from different anatomical locations in the present study may also be that all strata of

blubber were sampled and analyzed. Vertical differences (skin to muscle) in the composition of lipids in blubber, however, would be expected to affect the accumulation of CHs. Thus, additional studies are needed to determine the vertical distribution in blubber of both CHs and the composition of lipids in large marine mammals in particular. Such information is important for interpreting results from studies using samples from biopsies or from studies with large marine mammals where the full thickness of blubber may not be routinely sampled or analyzed.

The preliminary results on the distribution of CHs among tissues also support previous results showing that the lipid content of a tissue may be an important factor controlling accumulation of lipophilic CHs in tissues. However, in the present study, the lack of correlation of total lipid normalized concentrations of CHs in brain to those in other tissues supports the hypothesis (Aguilar 1985) that the proportion of neutral lipids rather than content of total lipids is an important factor affecting the accumulation of lipophilic CHs in tissues of marine mammals. The high quality of the samples of tissue from the harbor porpoises in the present study warrants analysis of the remaining tissue samples (e.g., brain, kidney, lung) to substantiate this finding and to expand the database on distribution of toxic chemicals in apparently healthy harbor porpoise. The results on the distribution of toxic chemicals among tissues would provide a sound basis for interpreting results from stranded animals.

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TABLES

Table 1. Chlorinated hydrocarbon (CH) analytes measured in samples from harbor porpoise. The analytes within each group were summed for tabulation.

DDEs

o,p'-DDE
p,p'-DDE

DDDs

o,p'-DDD
p,p'-DDD

DDTs

o,p'-DDT
p,p'-DDT

PCBs

trichlorobiphenyls
tetrachlorobiphenyls
pentachlorobiphenyls
hexachlorobiphenyls
heptachlorobiphenyls
octachlorobiphenyls
nonachlorobiphenyls
decachlorobiphenyl

Other CHs

hexachlorobenzene
lindane
heptachlor
aldrin
heptachlor epoxide
alpha-chlordane
trans-nonachlor
dieldrin
mirex

Table 2. Concentrations, ng/g wet weight, of chlorinated analytes (Table 1), percent lipid, and percent dry weight in subsamples of harbor porpoise blubber. SE - standard error. RSD - relative standard deviation.

	Subsample number							Mean	SE	RSD
	1	2	3	4	5	6	7			
Σ DDEs										
MH-91-424	5,200	5,000	6,400	6,400 (5,200) *	5,400	6,600	4,600	5,600	280	13
MH-91-504	3,900	3,900	4,700	4,100	2,700	4,300	3,700	3,900	240	16
MH-91-506	5,300	5,400	5,000	4,900	4,500 (4,400)	4,200	4,300	4,800	180	10
Σ DDD _s										
MH-91-424	3,200	3,300	4,400	4,000 (3,400)	3,200	4,500	3,100	3,600	220	16
MH-91-504	2,000	2,000	2,400	2,100	1,400	2,200	1,900	2,000	120	15
MH-91-506	2,000	2,100	2,100	1,800	1,700 (1,600)	1,400	1,500	1,800	110	16
Σ DDT _s										
MH-91-424	2,100	2,500	3,200	2,700 (2,600)	2,300	3,400	2,400	2,700	180	18
MH-91-504	1,200	1,200	1,500	1,300	830	1,400	1,100	1,200	82	18
MH-91-506	1,900	1,900	1,800	1,700	1,500 (1,500)	1,400	1,400	1,700	84	13

Table 2 Continued.

	Subsample number							Mean	SE	RSD
	1	2	3	4	5	6	7			
Σother CHs										
MH-91-424	8,600	9,000	11,000	10,000 (8,900) *	8,100	12,000	8,300	9,500	600	15
MH-91-504	4,300	4,200	4,800	4,300	3,100	4,600	4,100	4,200	200	13
MH-91-506	5,500	5,400	5,200	5,100	4,700 (4,600)	4,100	4,400	4,900	200	11
ΣPCBs										
MH-91-424	31,000	33,000	33,000	40,000 (35,000)	33,000	37,000	29,000	33,000	1,100	9
MH-91-504	22,000	19,000	27,000	23,000	15,000	26,000	20,000	22,000	1,600	19
MH-91-506	15,000	15,000	13,000	13,000	12,000 (12,000)	9,400	11,000	13,000	770	16
Percent lipid										
MH-91-424	76	86	86	88 (71)	68	88	83	81	2.8	9
MH-91-504	82	87	81	84	73	88	85	83	1.9	6
MH-91-506	88	85	82	87	81 (82)	70	79	82	2.3	7
Percent dry weight										
MH-91-424	100	93	94	95	94	84	91	93	1.8	5
MH-91-504	94	96	96	92	86	93	100	94	1.8	4
MH-91-506	86	91	84	91	84	80	87	86	1.5	5

* Values in parentheses are concentrations of analytes in replicate homogenized tissue samples.

Table 3. Concentrations, ng/g wet weight, of chlorinated analytes (Table 1), percent lipid, and percent dry weight in subsamples of harbor porpoise liver. SE - standard error. RSD - relative standard deviation.

	Subsample number					Mean	SE	RSD
	1	2	3	4	5			
ΣDDEs								
MH-91-424	140	150	160	120	120	140	8	13
MH-91-504	64	60	62	58	58	60	2	4
MH-91-506	62	53	53	54	55	55	2	7
ΣDDD_s								
MH-91-424	60	65	63	53	53	59	2	9
MH-91-504	24	23	21	20	21	22	0.7	8
MH-91-506	20	18	15	15	16	17	1	13
ΣDDT_s								
MH-91-424	29	29	34	23	23	28	2	17
MH-91-504	6	6	4	7	6	6	0.5	19
MH-91-506	8	8	7	8	8	8	0.2	6

Table 3 Continued

	Subsample number					Mean	SE	RSD
	1	2	3	4	5			
Σother CHs								
MH-91-424	310	330	340	280	260	300	15	11
MH-91-504	98	96	94	92	92	94	1	3
MH-91-506	96	78	83	86	83	85	3	8
ΣPCBs								
MH-91-424	1,100	1,200	1,400	1,100	1,000	1,200	68	13
MH-91-504	620	610	610	630	620	620	4	1
MH-91-506	440	390	360	370	390	390	14	8
Percent lipid								
MH-91-424	1.5	1.6	1.8	1.1	0.8	1.4	0.2	29
MH-91-504	1.4	1.4	1.3	1.6	1.2	1.4	0.1	11
MH-91-506	3.6	1.9	1.1	1.4	1.3	1.9	0.5	53
Percent dry weight								
MH-91-424	26	27	26	26	26	26	0.2	2
MH-91-504	26	26	27	27	26	26	0.2	2
MH-91-506	24	23	24	24	24	24	0.2	2

Table 4. Individual concentrations, ng/g wet weight, of selected toxic elements, and percent dry weight in harbor porpoise livers. SE - standard error. RSD - relative standard deviation.

	Subsample number					Mean	SE	RSD
	1	2	3	4	5			
MH-91-424								
arsenic	530	430	480	580	540	510	26	11
cadmium	60	70	60	70	80	68	4	12
copper	14,000	18,000	7,500	21,000	26,000	17,000	3,100	41
lead	45	40	57	4	<2	37	10	62
selenium	1,100	1,100	1,100	910	950	1,000	42	9
mercury	660	660	500	580	660	610	32	12
MH-91-504								
arsenic	710	720	700	710	620	690	18	6
cadmium	70	80	80	90	70	78	4	11
copper	5,600	5,700	5,700	6,100	5,200	5,700	140	6
lead	7	2	<2	2	4	4	1	63
selenium	1,000	1,100	1,100	1,100	1,100	1,100	20	4
mercury	700	1,400	1,100	1,300	1,300	1,200	120	23
MH-91-506								
arsenic	500	530	560	590	550	550	15	6
cadmium	350	200	330	370	270	300	31	23
copper	10,000	6,400	9,900	9,600	8,200	8,800	680	17
lead	2	16	18	13	4	11	3	68
selenium	2,600	2,800	3,100	2,800	2,500	2,800	100	8
mercury	2,200	1,700	3,300	2,600	2,700	2,500	270	24
Percent dry weight								
MH-91-424	30	29	27	36	37	32	2	14
MH-91-504	33	36	35	37	34	35	1	5
MH-91-506	33	28	32	31	29	31	1	7

Table 5. Summary of results of two-way analysis of variance (ANOVA) of the effects of A) sampling blubber from different locations on the body and B) sampling from different animals, on the concentrations, based on wet weight and lipid weight, of selected CHs in blubber of three harbor porpoises. The values (P) are the levels of significance for each factor. Differences were considered significant at $P \leq 0.05$. *

Analyte	ANOVA significance (P) level			
	Based on wet weight concentrations		Based on lipid normalized concentrations	
	Blubber Sampling location	Animal	Blubber Sampling location	Animal
hexachlorobenzene	0.14	0.0001	0.19	0.0001
lindane (gamma-BHC)	0.50	0.0001	0.45	0.0001
heptachlorepoxyde	0.34	0.0001	0.23	0.0001
alpha-chlordane	0.17	0.0001	0.06	0.0001
trans-nonachlor	0.09	0.0001	0.11	0.0001
dieldrin	0.25	0.0001	0.06	0.0001
mirex	0.09	0.0001	0.06	0.0001
Σ DDEs	0.11	0.0005	0.25	0.0002
Σ DDD _s	0.12	0.0001	0.08	0.0001
Σ DDT _s	0.59	0.0001	0.27	0.0001
Σ PCBs	0.53	0.0001	0.68	0.0001
PCB # 153	0.12	0.0001	0.34	0.0001
	Significance level (P)			
	Tissue			
	<u>Sampling location</u>	<u>Animal</u>		
Percent lipid	0.45	0.86		

* Data were log-transformed ($\log(x+1)$) to reduce heteroscedasticity in the data.

Table 6. Summary of results of two-way analysis of variance (ANOVA) of the effects of A) sampling liver from different locations on the body and B) sampling from different animals, on the concentrations, based on wet weight and lipid weight, of selected CHs in liver of three harbor porpoises. The values (P) are the levels of significance for each factor. Differences were considered significant at $P \leq 0.05$. *

Analyte	Factors	ANOVA significance (P) level			
		Based on wet weight concentrations		Based on lipid normalized concentrations	
		Liver Sampling location	Animal	Liver Sampling location	Animal
HCB		0.77	0.0001	0.52	0.007
lindane (gamma-BHC)		0.38	0.005	0.99	0.08
heptachlorepoxide		0.80	0.02	0.80	0.02
alpha-chlordane		0.65	0.006	0.65	0.006
trans-nonachlor		0.85	0.04	0.85	0.04
dieldrin		0.16	0.0001	0.55	0.001
mirex		0.30	0.05	0.60	0.24
Σ DDEs		0.28	0.0001	0.54	0.03
Σ DDD _s		0.02	0.0001	0.65	0.005
Σ DDT _s		0.92	0.0001	0.47	0.001
Σ PCBs		0.82	0.0001	0.42	0.007
PCB # 153		0.73	0.0001	0.46	0.006
		Significance level (P)			
		Tissue			
		Sampling location	Animal		
percent lipid		0.44	0.56		

* Data were log-transformed ($\log(x+1)$) to reduce heteroscedasticity in the data.

Table 7. Summary of results of two-way analysis of variance (ANOVA) of the effects of A) sampling liver from different sites within the tissue and B) sampling from different animals, on the concentrations, based on wet weight, of selected toxic elements in liver of three harbor porpoises. The values (P) are the levels of significance for each factor. Differences were considered significant at $P \leq 0.05$. *

		ANOVA significance (P) level	
		Based on wet weight concentrations	
Analyte	Factors	Liver	Animal
		Sampling location	
arsenic		0.48	0.0007
cadmium		0.51	0.0001
selenium		0.18	0.0001
copper		0.68	0.003
mercury		0.69	0.0001
lead		0.39	0.06

* Data were log-transformed ($\log(x+1)$) to reduce heteroscedasticity in the data.

Table 8. Concentrations, ng/g wet weight and ng/g lipid, of chlorinated analytes (Table 1), percent lipid and percent dry weight in various tissues of a male (~4 years old) harbor porpoise (MH-91-506) caught in a gill net off Boothbay, Maine.

	Tissue and number of tissue subsamples analyzed					
	Blubber	Liver	Kidney	Testis	Brain	Lung
	7	5	1	1	1	1
Wet weight (ng/g wet weight)						
other CHs	4,900 ± 200 ^a	85 ± 3	39	26	52	26
ΣDDTs ^b	8,200 ± 370	80 ± 2	30	23	53	22
ΣPCBs	13,000 ± 770	390 ± 14	160	140	250	140
Lipid weight (ng/g lipid)						
other CHs	6,000 ± 120	5,400 ± 870	3,200	2,900	760	3,200
ΣDDTs ^b	10,000 ± 290	5,000 ± 760	2,500	2,600	780	2,800
ΣPCBs	16,000 ± 530	24,000 ± 3,700	13,000	16,000	3,700	18,000
Percent lipid	82 ± 2.3	1.9 ± 0.4	1.2	0.9	6.8	0.8
Percent dry weight	86 ± 1.5	24 ± 0.2	21	16	21	19

^a The mean ± standard error for the analyses of subsamples from harbor porpoise MH-91-506.

^b The sum of the concentrations of o,p'-DDE, p,p'-DDE, o,p'-DDD, p,p'-DDD, o,p'-DDT and p,p'-DDT.

Table 9. Concentrations, ng/g wet weight, of selected toxic elements and percent dry weight in various tissues of a male (~4 years old) harbor porpoise (MH-91-506) caught in a gill net off Boothbay, Maine.

	Tissue and number of tissue subsamples analyzed			
	Liver	Kidney	Testis	Brain
	5	1	1	1
arsenic	550 ± 20 *	580	360	320
cadmium	300 ± 30	1,900	9	< 3
copper	8,800 ± 670	5,600	1,600	11,000
lead	11 ± 3	4	2	13
selenium	2,800 ± 110	30,000	4,000	1,600
mercury	2,500 ± 1,200	610	150	260
Percent dry weight	31 ± 1	30	26	29

* The mean ± standard error for the analyses of subsamples from harbor porpoise MH-91-506.

FIGURES

MH-91-424
MH-91-504
MH-91-506

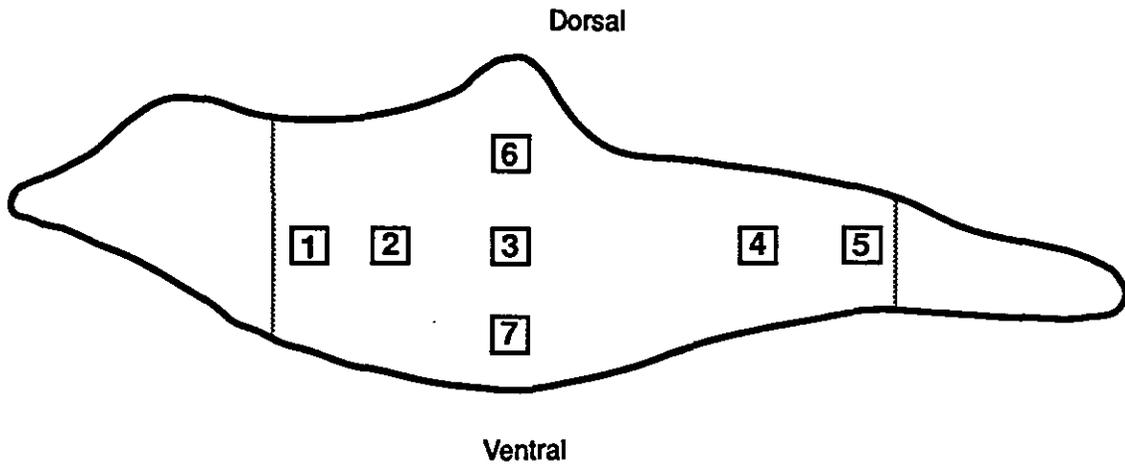


Figure 1. Locations of subsamples of blubber taken from three harbor porpoises from the northwest Atlantic.

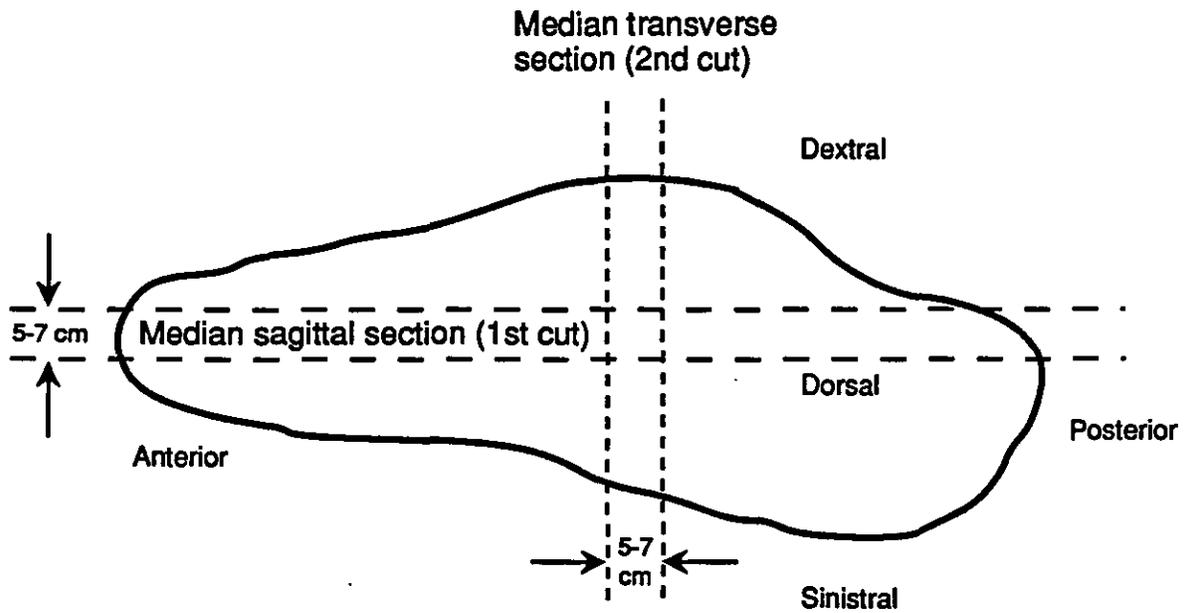
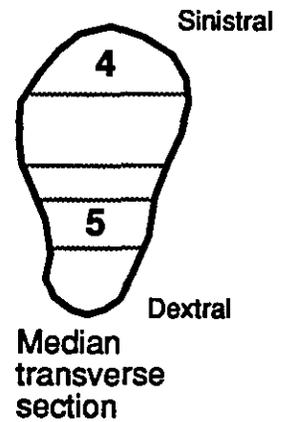
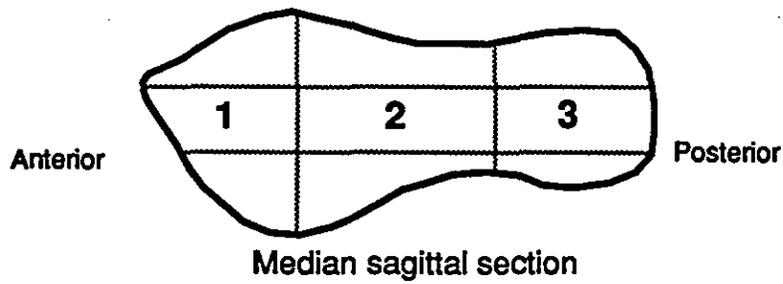
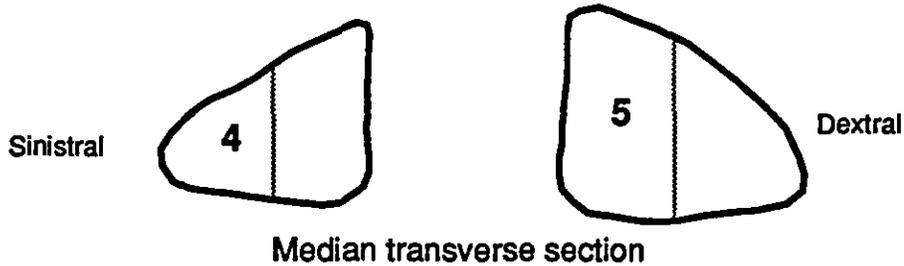
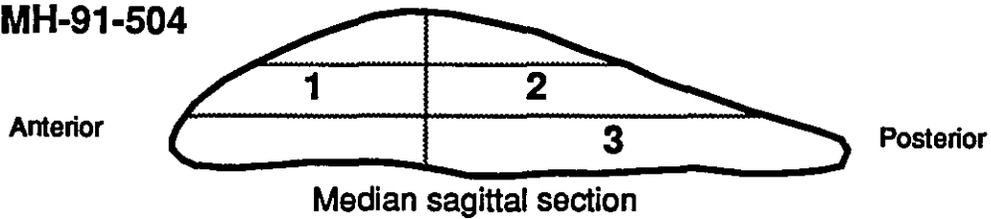


Figure 2. Diagrammatic top view of liver: 5-7 cm median sagittal and median transverse sections of the liver were removed. The sections were laid on their sides and further sectioned as shown in Figure 3.

MH-91-424



MH-91-504



MH-91-506

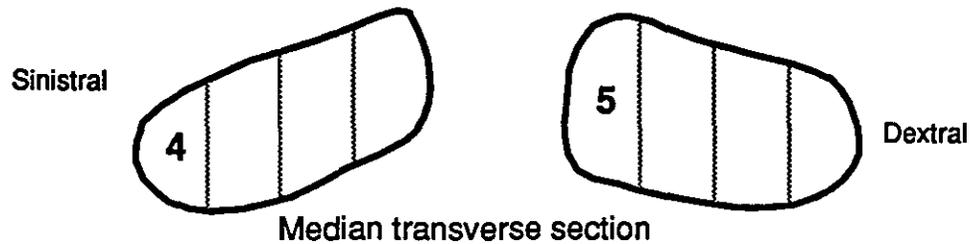
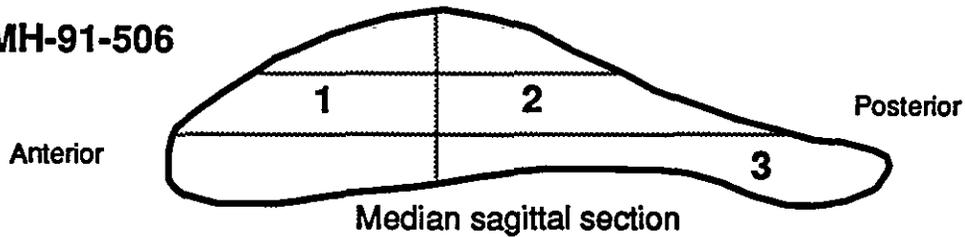


Figure 3. Locations of subsamples from liver sections (see Fig. 2) of three harbor porpoises from the northwest Atlantic.

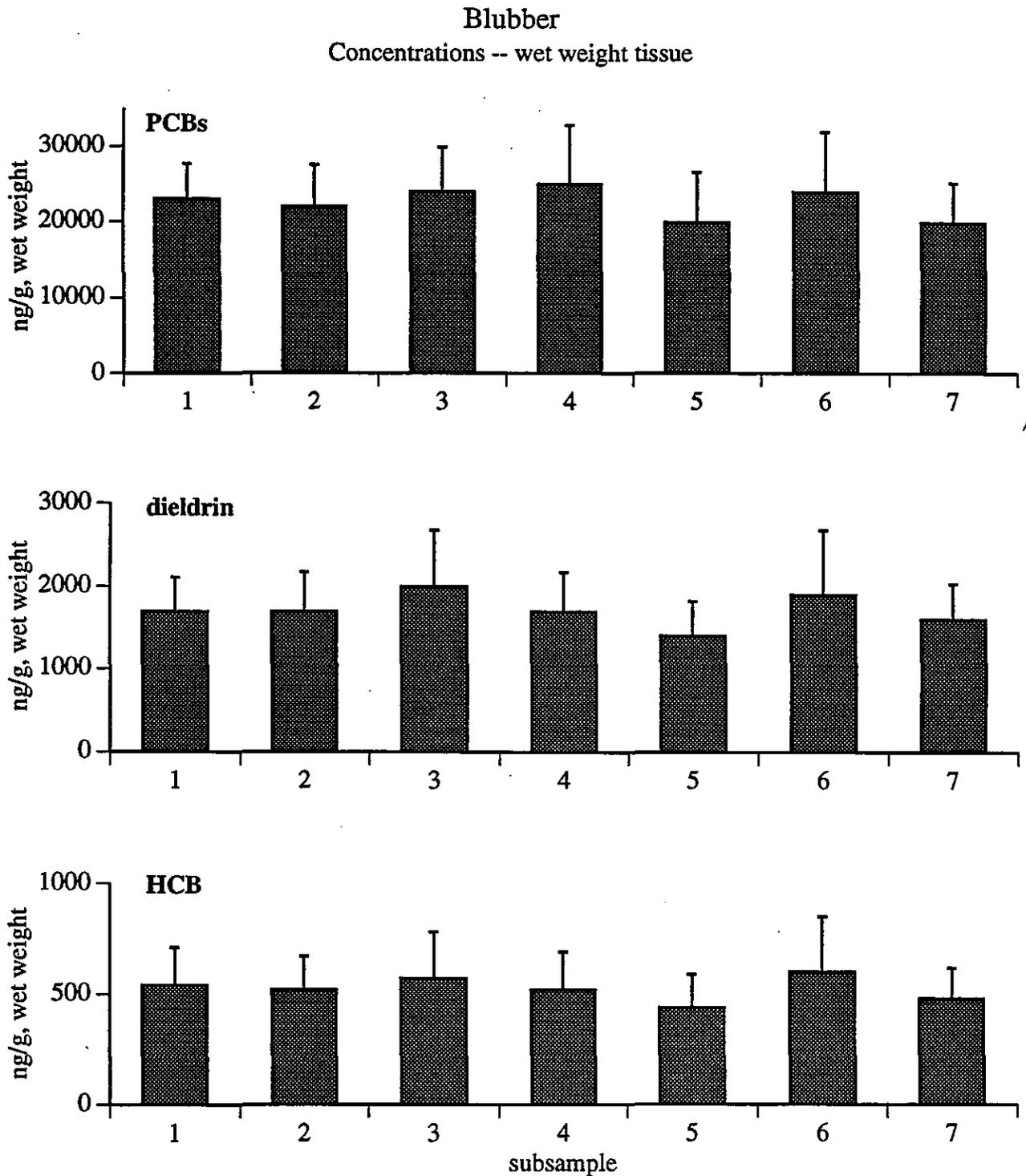


Figure 4a. Mean (\pm SE) concentrations, ng/g wet weight tissue, of polychlorinated biphenyls (PCBs), dieldrin and hexachlorobenzene (HCB) in harbor porpoise ($n=3$) blubber subsamples taken from different locations on the body (see Fig. 1).

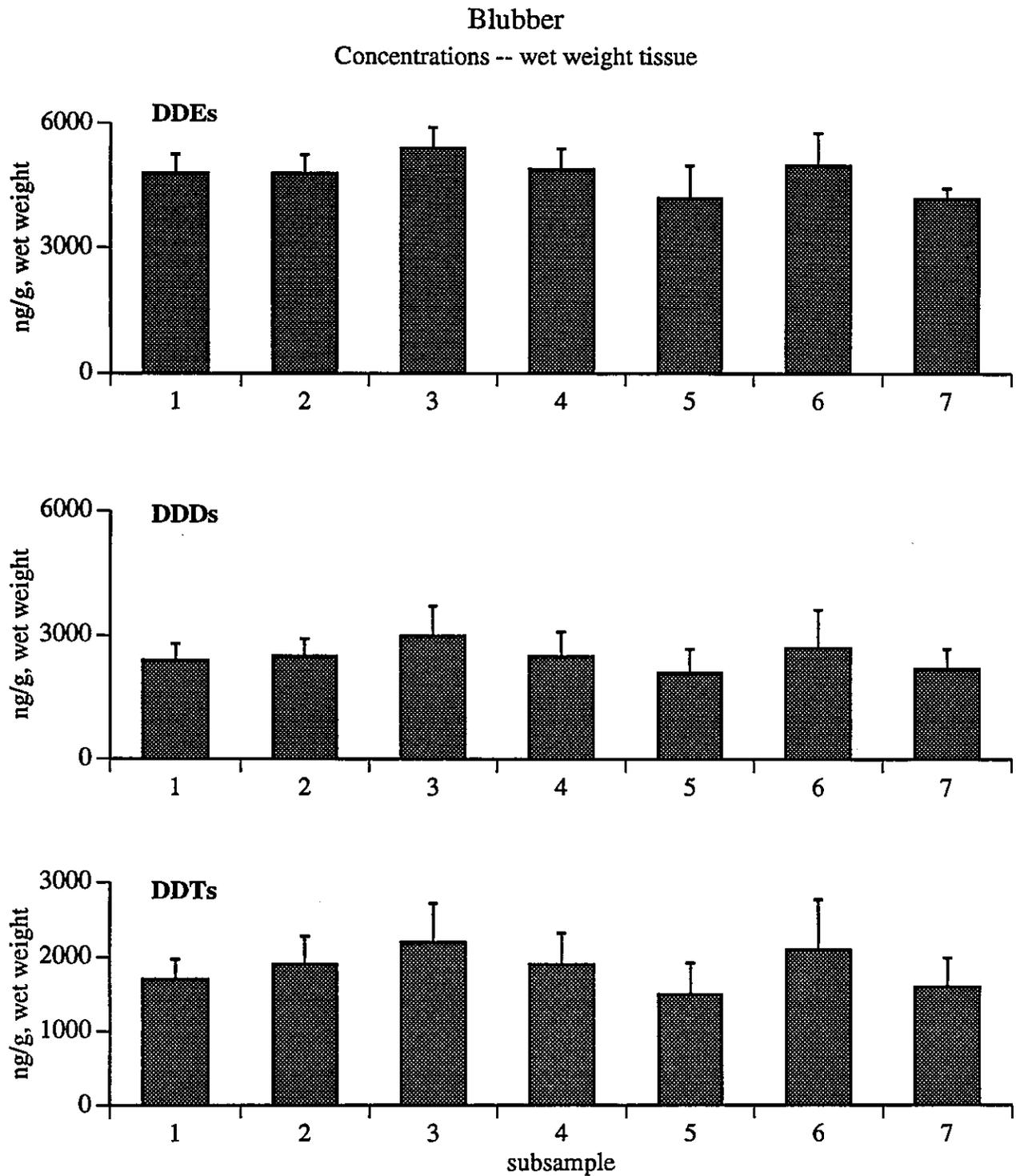


Figure 4b. Mean (\pm SE) concentrations, ng/g wet weight tissue, of DDEs, DDDs and DDTs in harbor porpoise ($n=3$) blubber subsamples taken from different locations on the body (see Fig. 1).

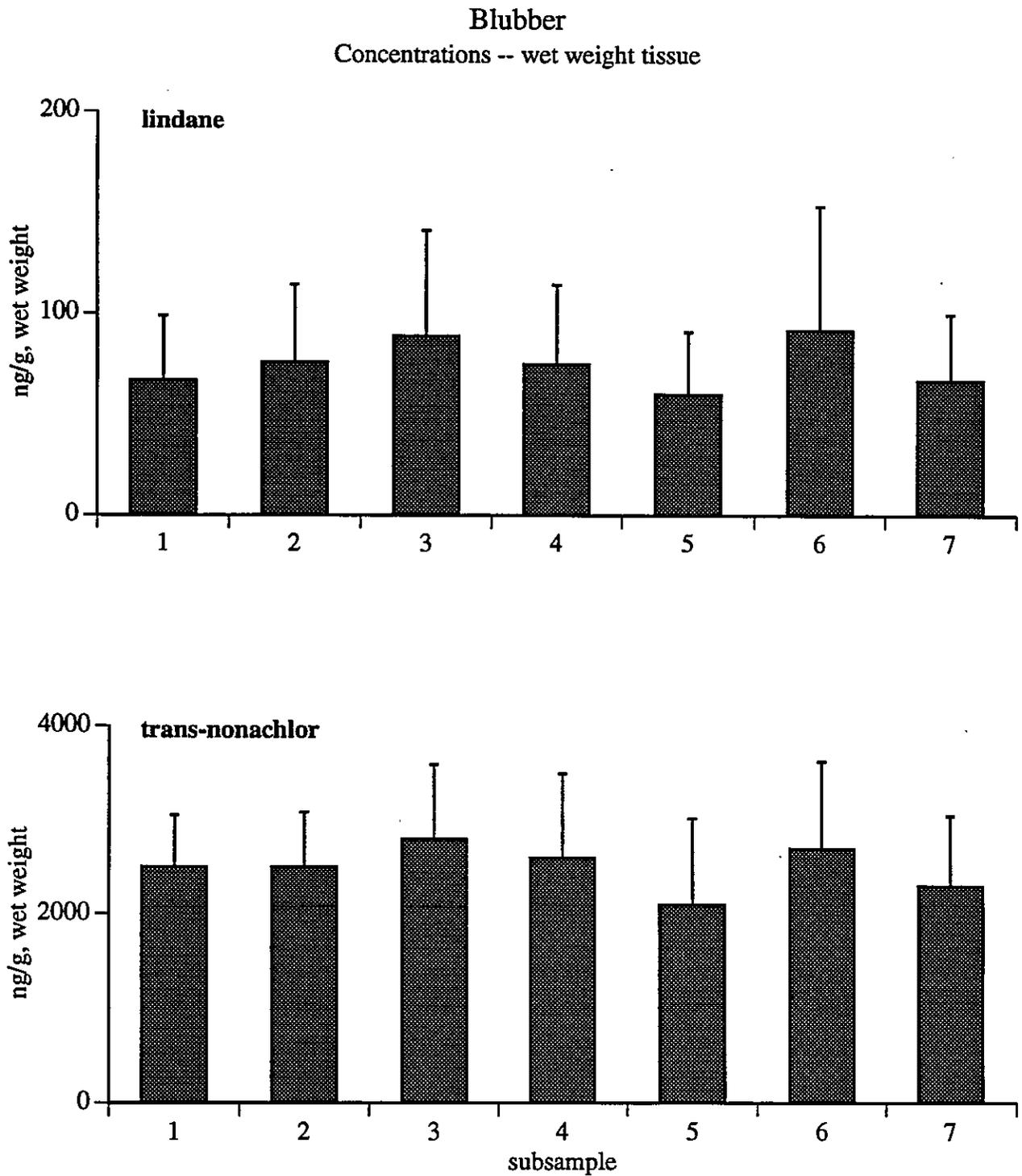


Figure 4c. Mean (\pm SE) concentrations, ng/g wet weight tissue, of lindane and trans-nonachlor in harbor porpoise ($n=3$) blubber subsamples taken from different locations on the body (see Fig. 1).

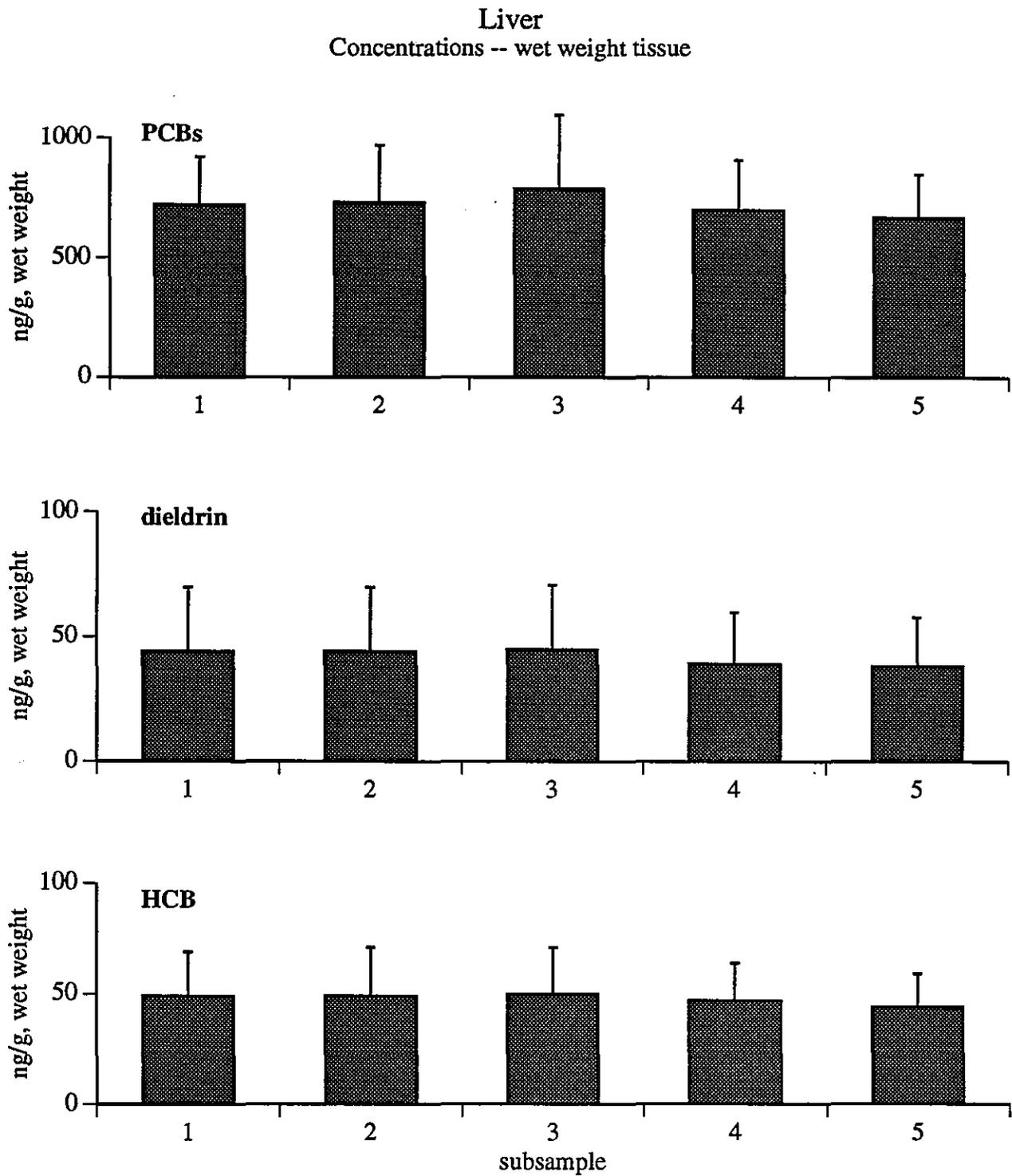


Figure 5a. Mean (\pm SE) concentrations, ng/g wet weight tissue, of polychlorinated biphenyls (PCBs), dieldrin and hexachlorobenzene (HCB) in harbor porpoise ($n=3$) liver subsamples taken from different locations within the tissue (see Fig. 3).

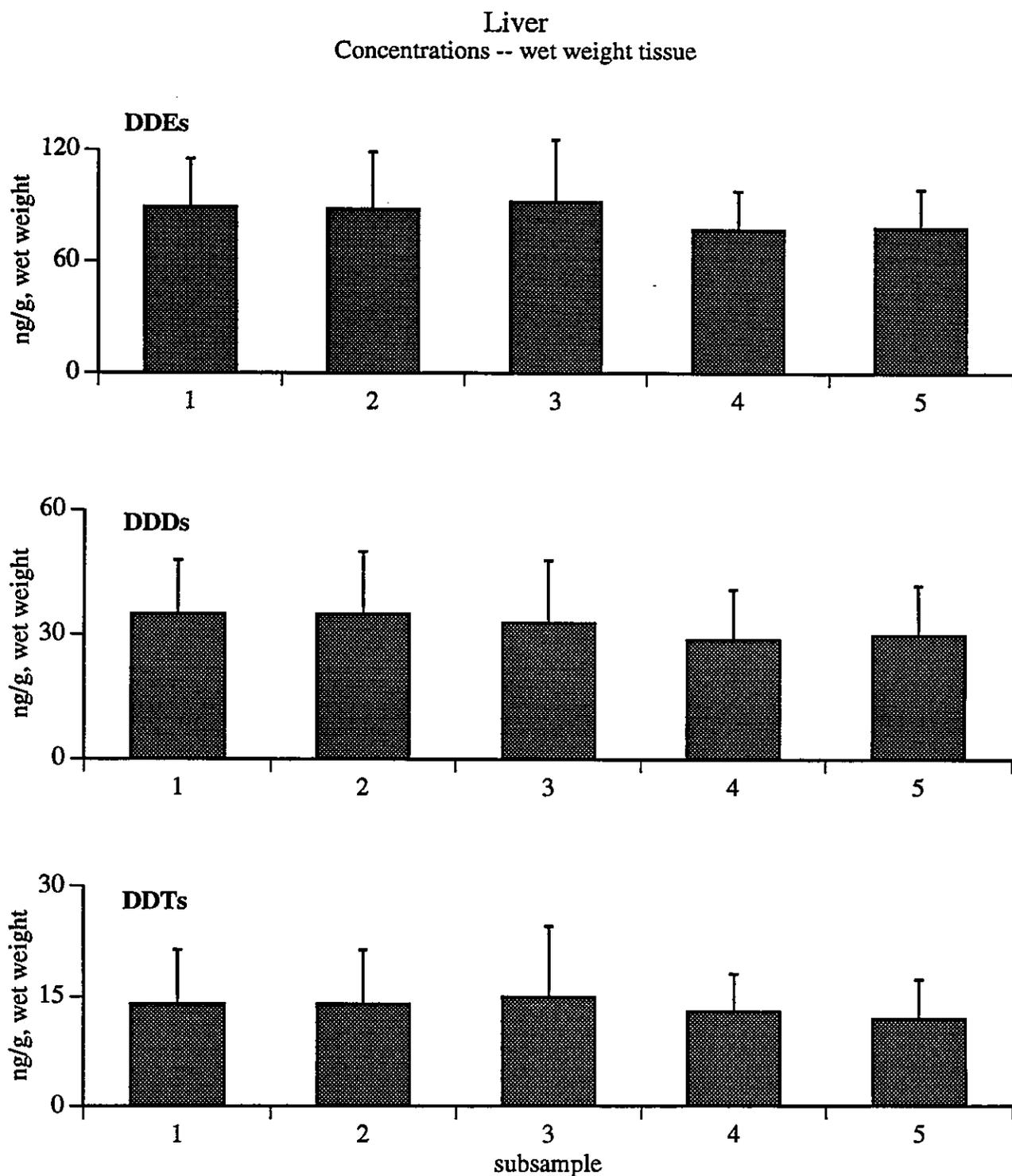


Figure 5b. Mean (\pm SE) concentrations, ng/g wet weight tissue, of DDEs, DDDs and DDTs in harbor porpoise ($n=3$) liver subsamples taken from different locations within the tissue (see Fig. 3).

Liver
Concentrations -- wet weight tissue

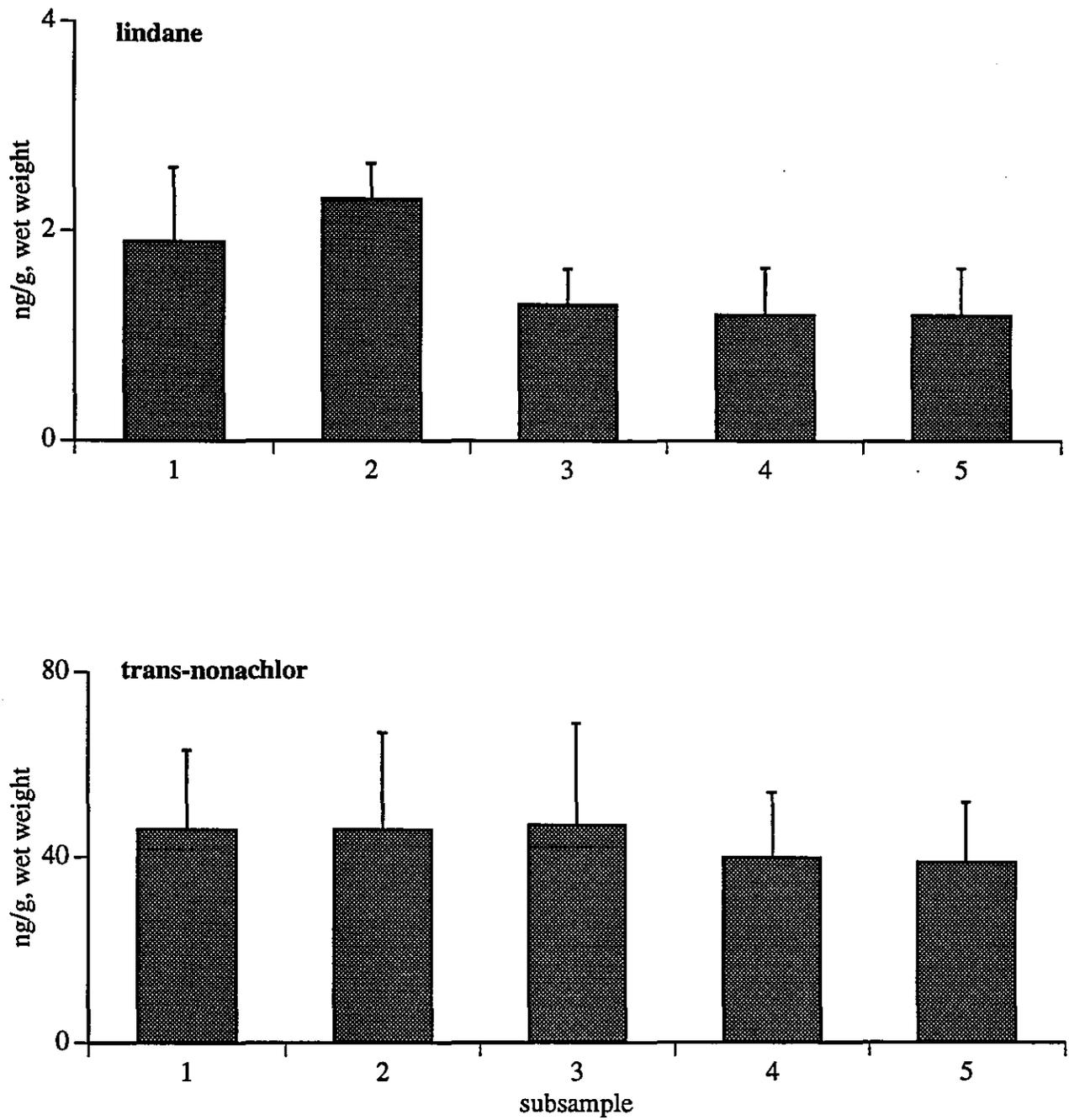


Figure 5c. Mean (\pm SE) concentrations, ng/g wet weight tissue, of lindane and trans-nonachlor in harbor porpoise ($n=3$) liver subsamples taken from different locations within the tissue (see Fig. 3).

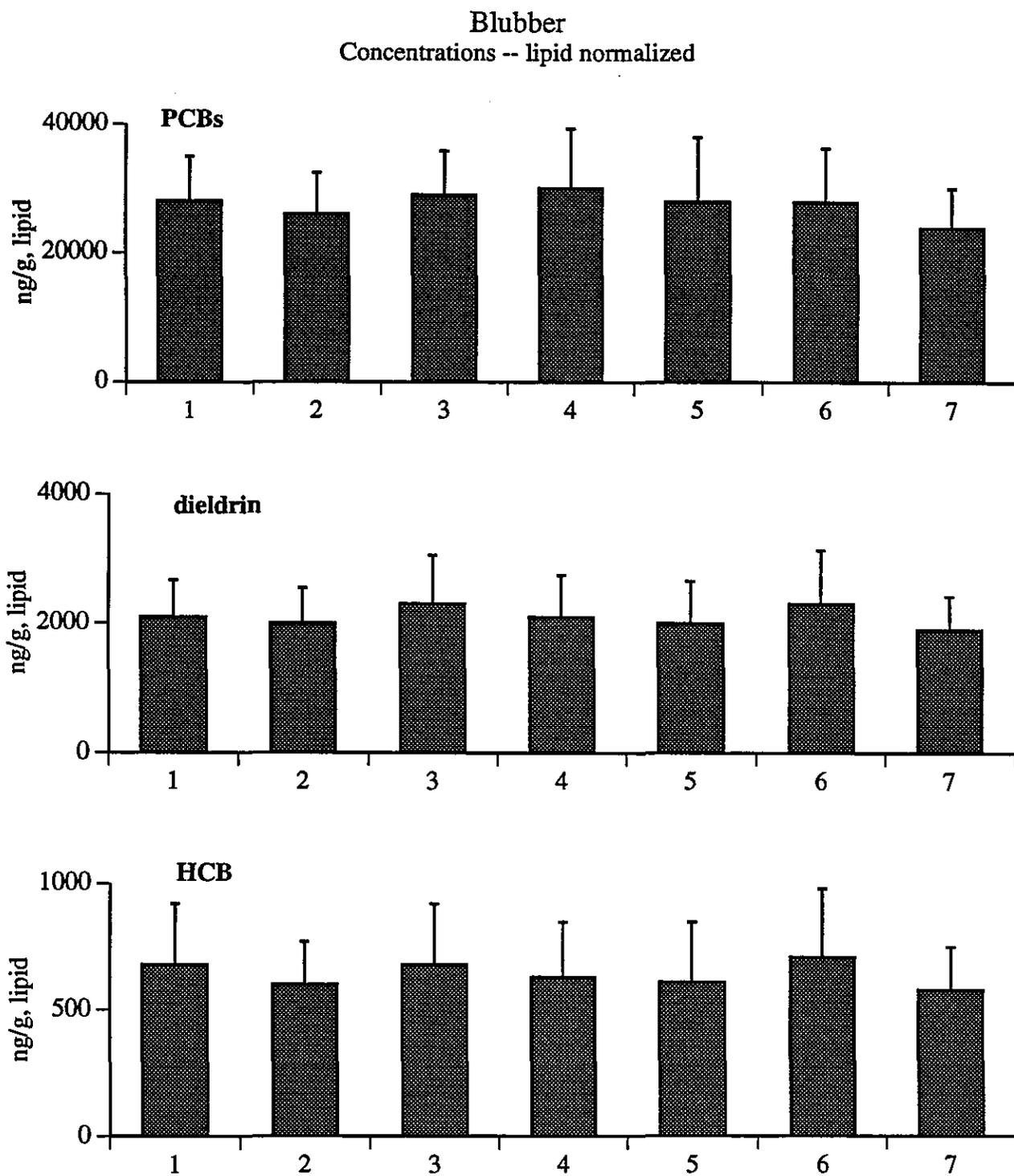


Figure 6a. Mean (\pm SE) concentrations, ng/g lipid, of polychlorinated biphenyls (PCBs), dieldrin and hexachlorobenzene (HCB) in harbor porpoise ($n=3$) blubber subsamples taken from different locations on the body (see Fig. 1).

Blubber
Concentrations -- lipid normalized

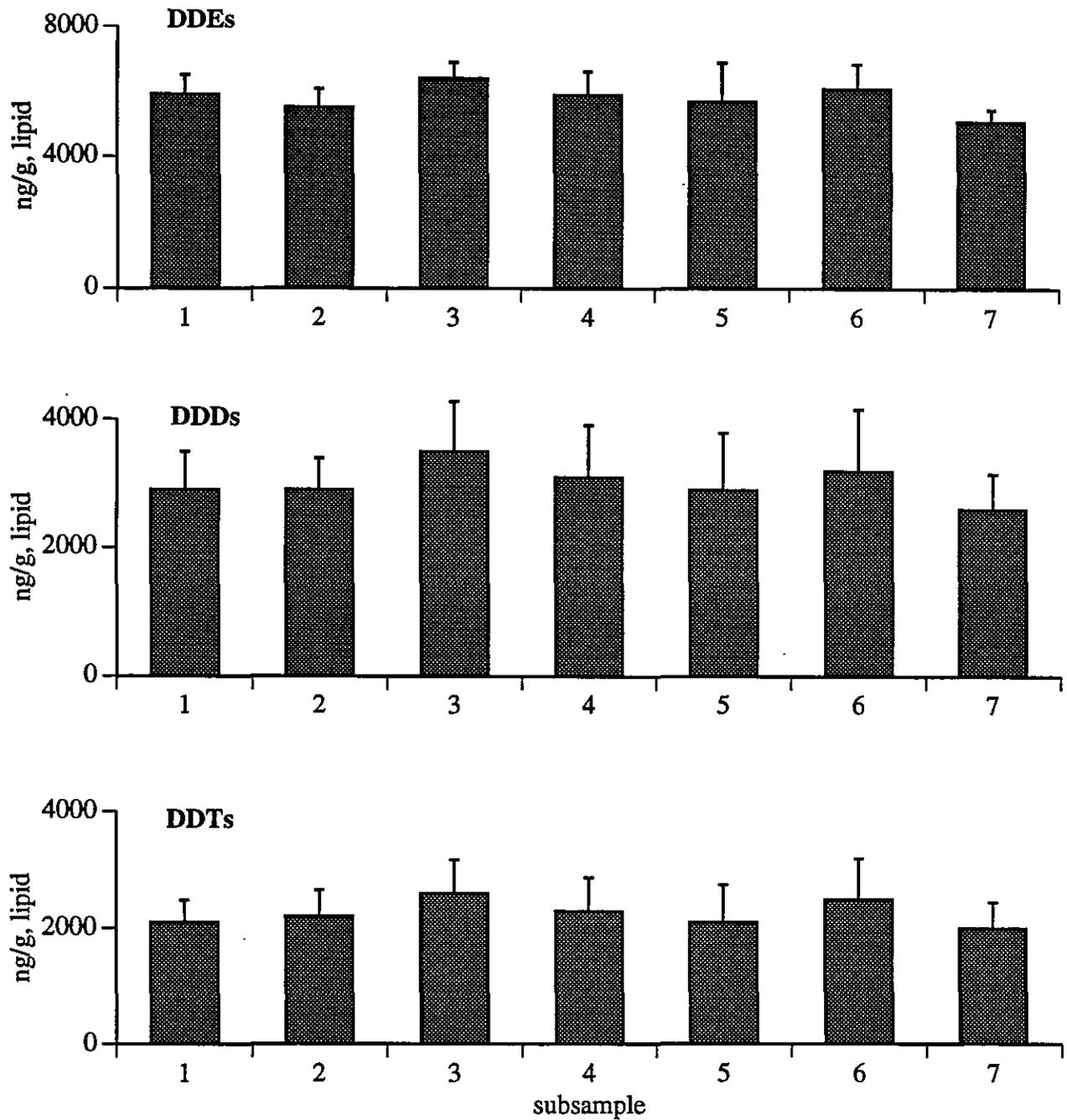


Figure 6b. Mean (\pm SE) concentrations, ng/g lipid, of DDEs, DDDs and DDTs in harbor porpoise ($n=3$) blubber subsamples taken from different locations on the body (see Fig. 1).

Blubber
Concentrations -- lipid normalized

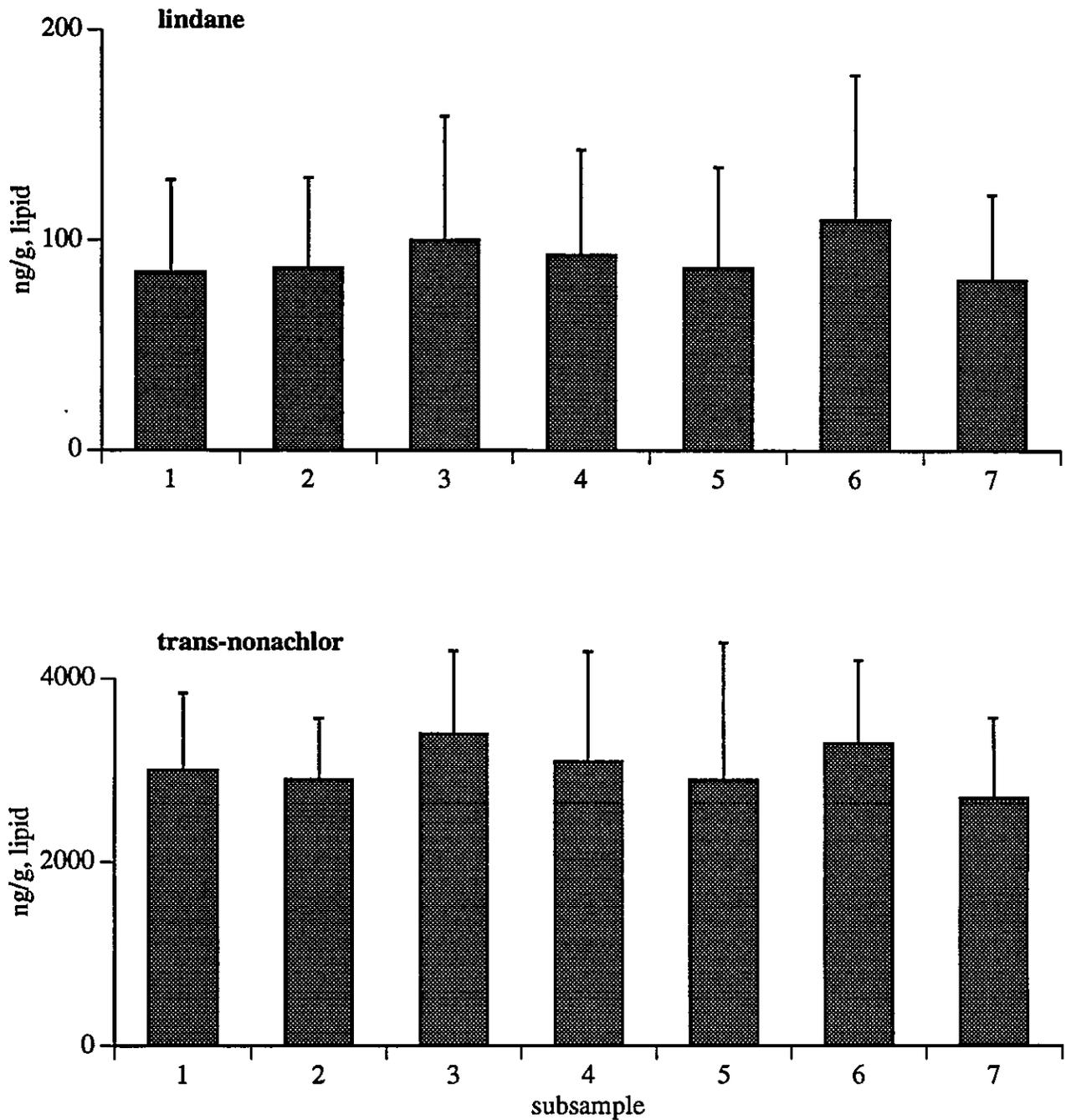


Figure 6c. Mean (\pm SE) concentrations, ng/g lipid, of lindane and trans-nonachlor in harbor porpoise ($n=3$) blubber subsamples taken from different locations on the body (see Fig. 1).

Liver
Concentrations -- lipid normalized

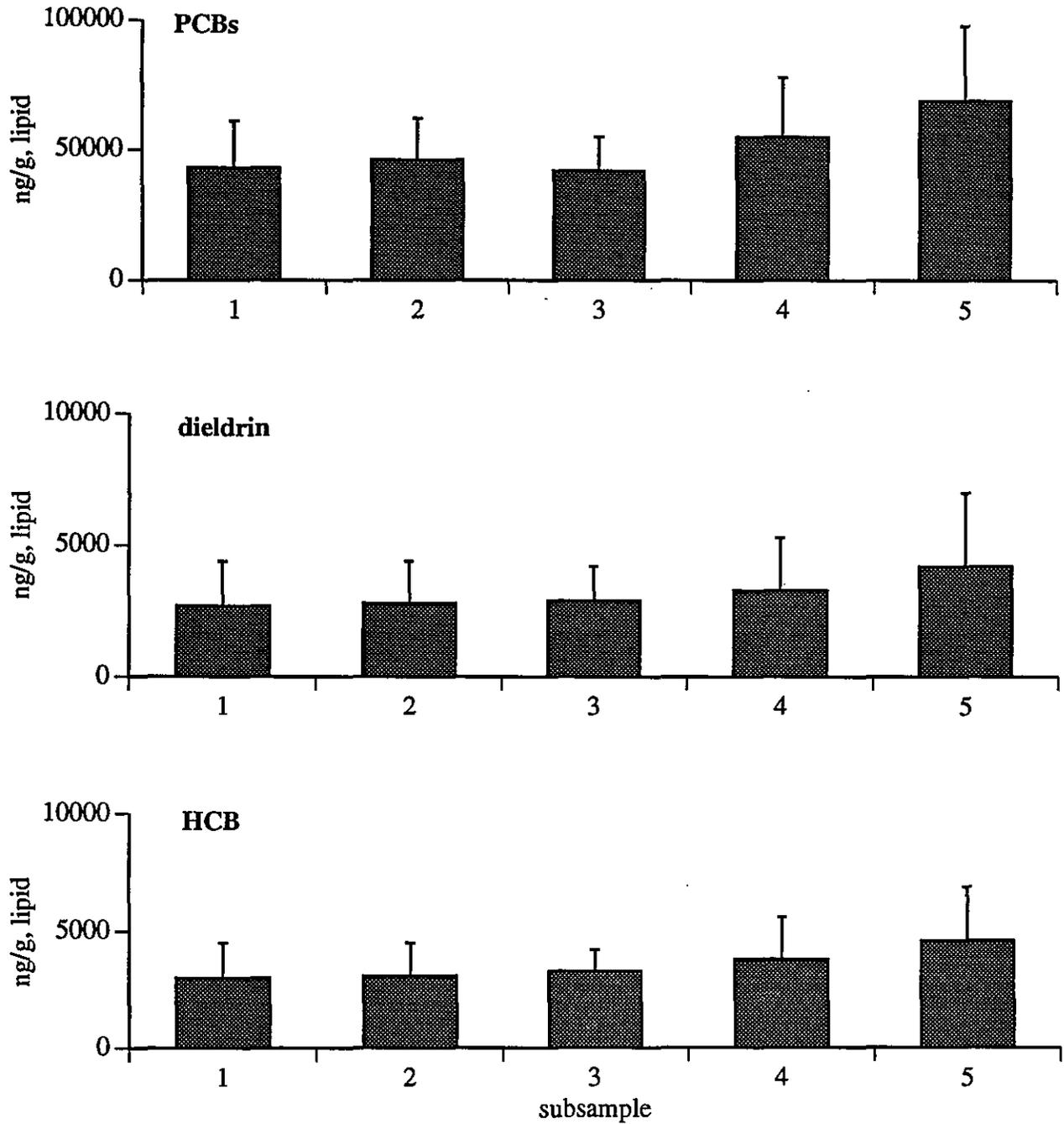


Figure 7a. Mean (\pm SE) concentrations, ng/g lipid, of polychlorinated biphenyls (PCBs), dieldrin and hexachlorobenzene (HCB) in harbor porpoise (n=3) liver subsamples taken from different locations within the tissue (see Fig. 3).

Liver
Concentrations -- lipid normalized

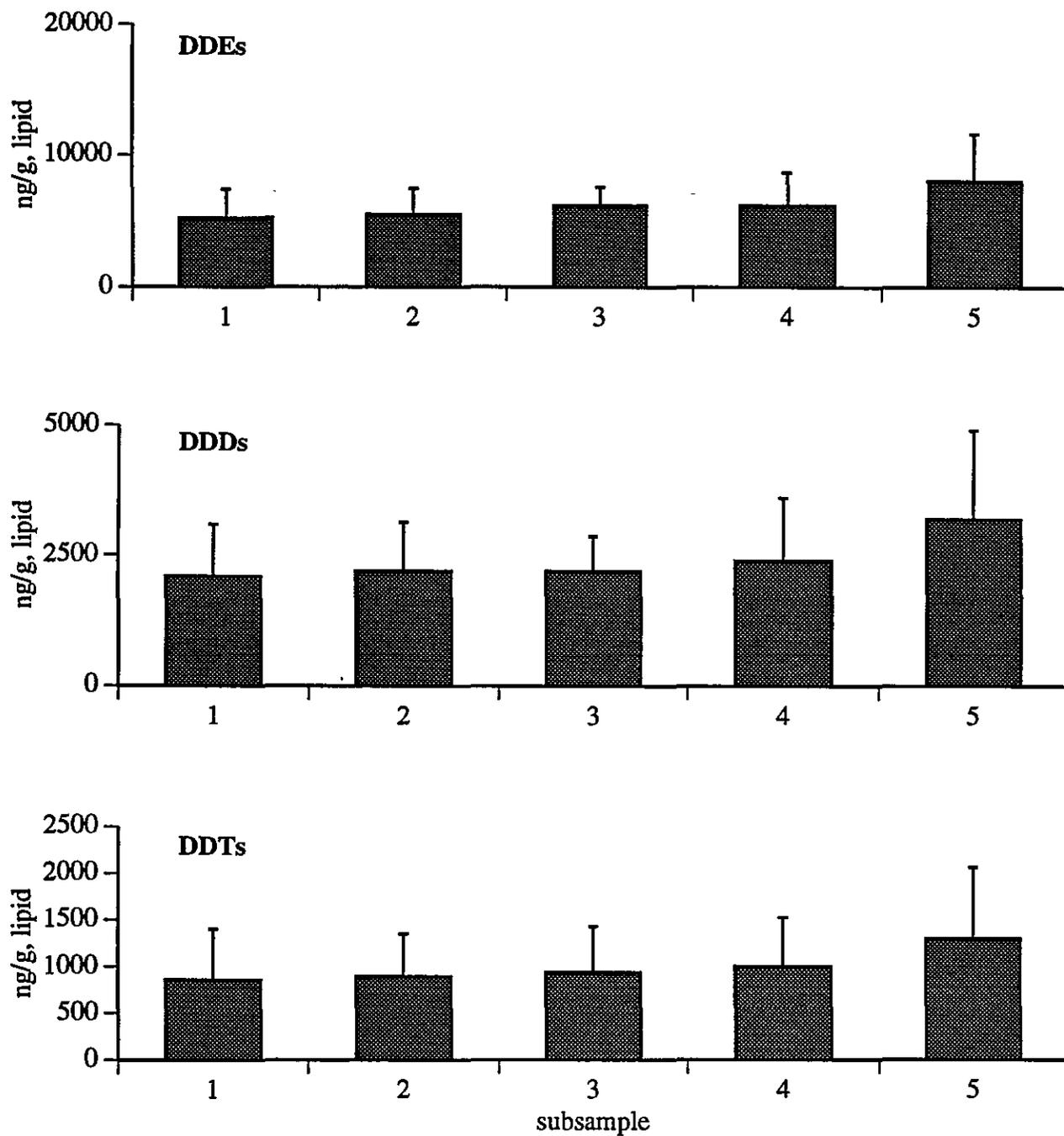


Figure 7b. Mean (\pm SE) concentrations, ng/g lipid, of DDEs, DDDs and DDTs in harbor porpoise ($n=3$) liver subsamples taken from different locations within the tissue (see Fig. 3).

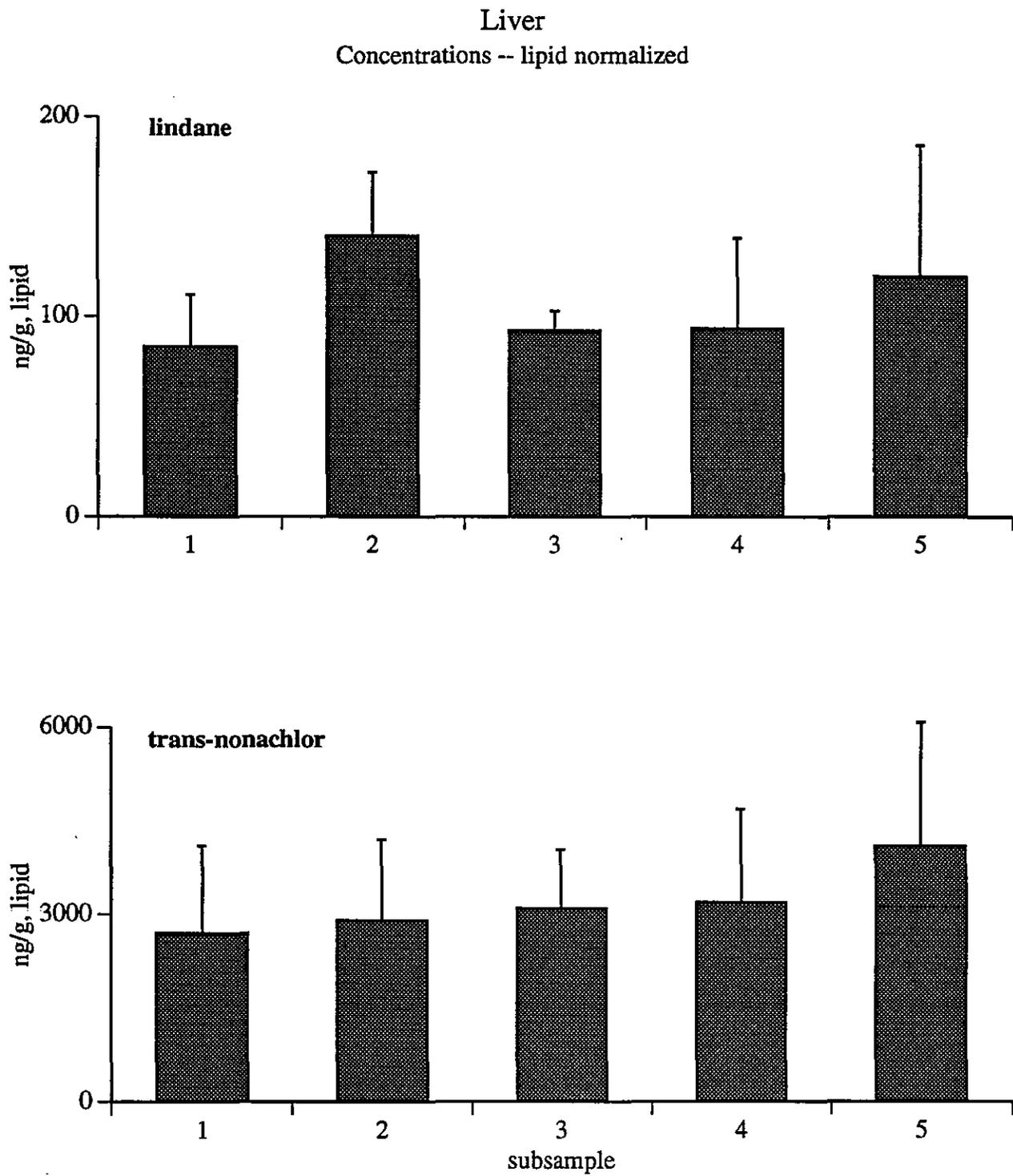


Figure 7c. Mean (\pm SE) concentrations, ng/g lipid, of lindane and trans-nonachlor in harbor porpoise ($n=3$) liver subsamples taken from different locations within the tissue (see Fig. 3).

Liver
Concentrations -- wet weight tissue

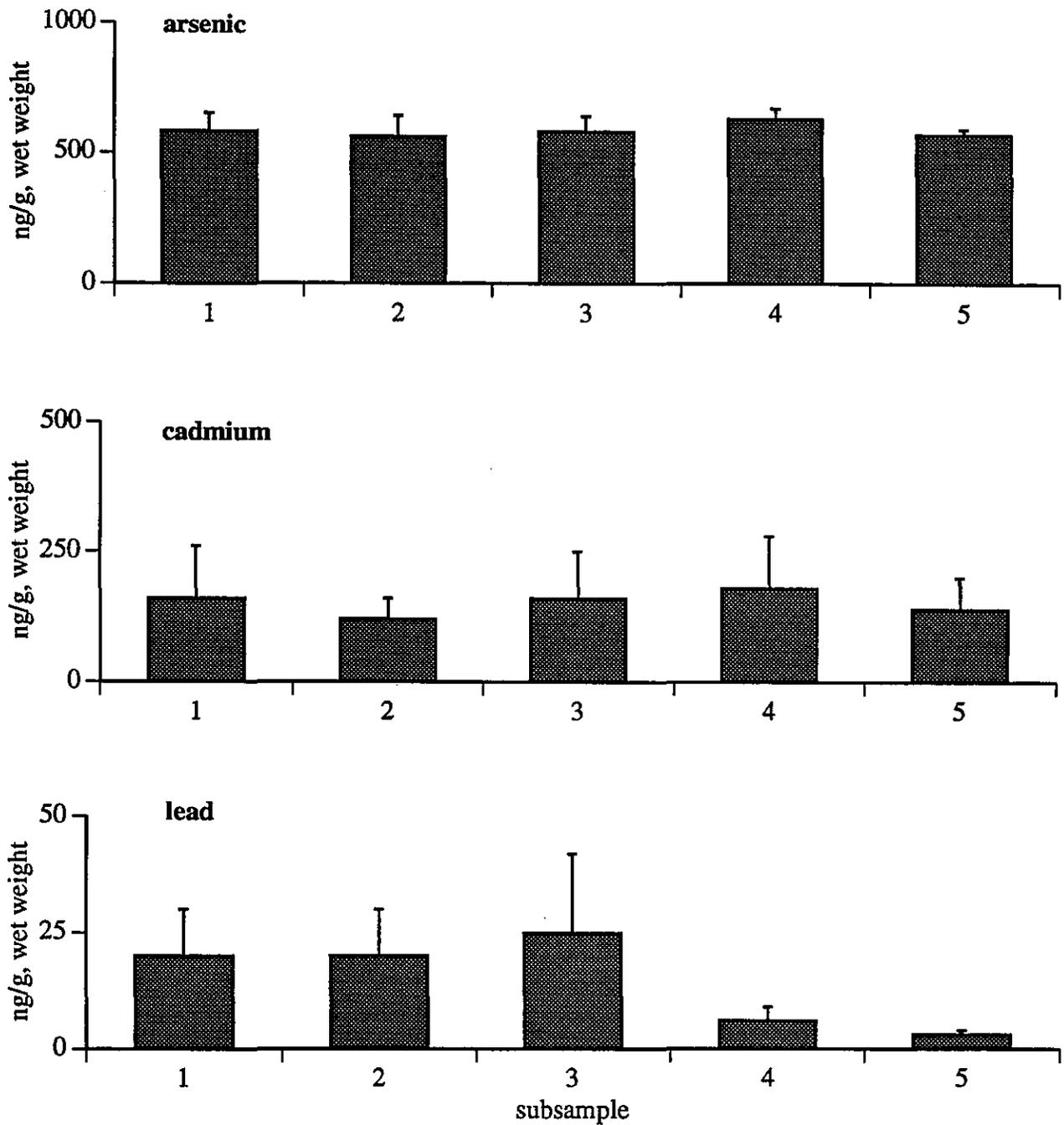


Figure 8a. Mean (\pm SE) concentrations, ng/g wet weight tissue, of arsenic, cadmium and lead in harbor porpoise ($n=3$) liver subsamples taken from different locations within the tissue (see Fig. 3).

Liver
Concentrations -- wet weight tissue

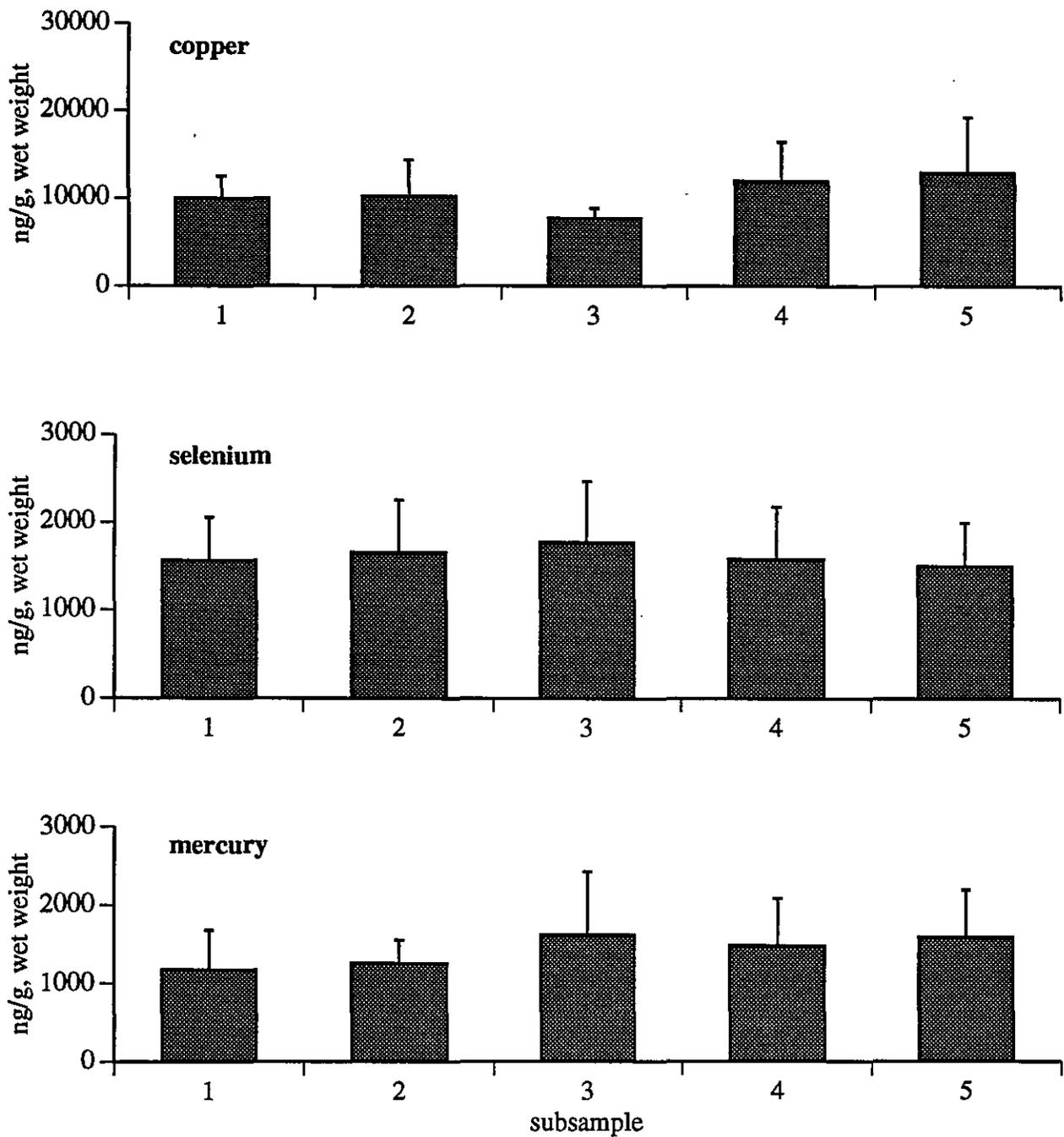


Figure 8b. Mean (\pm SE) concentrations, ng/g wet weight tissue, of copper, selenium and mercury in harbor porpoise ($n=3$) liver subsamples taken from different locations within the tissue (see Fig. 3).

APPENDIX A

CONCENTRATIONS OF
INDIVIDUAL CHLORINATED HYDROCARBONS
IN HARBOR PORPOISE SAMPLES

Chlorinated Hydrocarbon Analyses for
the Harbor Porpoise Contaminant Distribution Study
Explanatory Notes for Tables A1-A14

Abbreviations used:

nd - indicates that the analyte was not detected above the limit of detection which ranged from < 0.1 to < 2 ng/g (ppb) wet weight.

RSD - relative standard deviation - the standard deviation divided by the mean and expressed as a percent.

Results were determined by gas chromatography (GC)/electron capture detection (ECD).

4,4'-dibromooctofluorobiphenyl was the internal standard (surrogate standard) for all the analytes.

Percent recoveries for the internal standards (surrogate standards) analyzed with the subsamples and the quality control samples averaged 91%, RSD = 8%, n = 52.

Identification of analytes was confirmed for lab sample 59-370 by GC/mass spectrophotometry (MS); the identification applies to all other samples (blubber and liver).

Mean values given for samples are calculated using those samples in which the designated compounds were detected. The means of the concentrations of duplicate samples were calculated first and that value was used in the calculation of the mean and RSD.

Table A1. Blubber. Concentrations, ng/g wet weight, of chlorinated analytes in harbor porpoise MH-91-424 (sampled 1-29-91).

Chlorinated analytes	Subsample no.:	1	2	3	4	4	5	6	7	Mean	RSD
	Lab sample no.:	59-463	59-612	59-357	Duplicates *		59-464	59-356	59-613		
hexachlorobenzene		880	820	990	920	790	740	1,100	760	870	13
lindane (gamma-BHC)		130	150	190	160	140	120	210	130	150	20
heptachlor		2	6	4	4	6	3	5	6	5	31
aldrin		nd	nd	nd	nd	nd	nd	nd	nd	nd	-
heptachlorepoxyde		660	690	960	780	670	620	980	610	740	19
alpha-chlordane		1,400	1,400	1,700	1,700	1,400	1,300	1,800	1,300	1,500	13
trans-nonachlor		3,000	3,200	3,900	3,600	3,300	3,000	4,100	3,000	3,400	12
dieldrin		2,400	2,600	3,300	2,800	2,500	2,200	3,500	2,400	2,700	16
mirex		110	120	210	140	90	130	250	66	140	41
sum of other chlorinated hydrocarbons		8,600	9,000	11,000	10,000	8,900	8,100	12,000	8,300	9,500	16
o,p'-DDE		130	130	170	160	140	130	190	120	150	15
p,p'-DDE		5,100	4,900	6,200	6,200	5,100	5,300	6,400	4,500	5,500	12
o,p'-DDD		450	420	650	580	440	470	720	380	510	22
p,p'-DDD		2,700	2,900	3,700	3,400	3,000	2,700	3,800	2,700	3,100	14
o,p'-DDT		720	810	1,100	920	840	770	1,200	760	890	18
p,p'-DDT		1,400	1,700	2,100	1,800	1,800	1,500	2,200	1,600	1,800	14
sum of DDEs, DDDs and DDTs		10,000	11,000	14,000	13,000	11,000	11,000	15,000	10,000	12,000	16
trichlorobiphenyls		220	390	280	260	260	220	280	250	270	19
tetrachlorobiphenyls		4,000	4,200	4,600	4,900	4,100	3,900	4,900	3,900	4,300	9
pentachlorobiphenyls		7,800	8,800	8,600	10,000	9,100	8,100	9,300	8,000	8,800	9
hexachlorobiphenyls		13,000	14,000	14,000	17,000	15,000	14,000	16,000	12,000	15,000	11
heptachlorobiphenyls		4,900	4,900	4,900	6,600	5,400	5,700	5,600	4,100	5,300	14
octachlorobiphenyls		840	830	690	1,100	950	980	870	560	870	19
nonachlorobiphenyls		66	68	55	95	96	93	80	54	78	23
decachlorobiphenyl		26	13	15	18	25	21	24	11	19	28
sum of polychlorinated biphenyls		31,000	33,000	33,000	40,000	35,000	33,000	37,000	29,000	33,000	9
sample weight, grams		1.00	1.18	1.01	0.99	1.02	1.01	1.01	1.07	-	-
% lipid		76	86	86	88	71	68	88	83	81	9

* Duplicates refers to analyses of replicate subsamples of a unique sample.

Table A2. Blubber. Concentrations, ng/g wet weight, of individual polychlorinated biphenyl (PCB) isomers in harbor porpoise MH-91-424 (sampled 1-29-91).

Individual PCB isomers	Subsample no.:	1	2	3	4	4	5	6	7	Mean	RSD
	Lab sample no.:	59-463	59-612	59-357	Duplicates ^a 59-465 59-614		59-464	59-356	59-613		
2,2',5-trichlorobiphenyl (no. 18) ^b		130	130	160	150	120	120	150	120	140	11
2,4,4'-trichlorobiphenyl (no. 28)		64	90	73	75	83	62	71	80	75	12
2,2',3,5'-tetrachlorobiphenyl (no. 44)		180	200	180	230	190	170	190	190	190	9
2,2',5,5'-tetrachlorobiphenyl (no. 52)		1,400	1,400	1,600	1,700	1,400	1,400	1,700	1,300	1,500	10
2,3',4,4'-tetrachlorobiphenyl (no. 66)		66	64	71	76	64	64	75	59	68	8
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		1,100	1,100	1,200	1,300	1,100	1,100	1,300	980	1,200	9
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		150	150	170	190	170	160	180	140	170	10
2,3',4,4',5-pentachlorobiphenyl (no. 118)		960	980	1,100	1,200	1,100	1,000	1,200	890	1,100	10
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		510	550	590	680	570	550	650	490	580	11
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		3,600	3,800	3,800	4,500	4,100	3,800	4,200	3,400	3,900	9
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		4,100	4,300	4,500	5,100	4,800	4,400	4,900	3,900	4,600	9
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		500	470	440	620	460	550	530	300	490	18
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		1,400	1,600	1,300	2,000	1,800	1,700	1,500	1,300	1,600	16
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		1,200	1,200	1,400	1,600	1,400	1,300	1,600	1,100	1,400	13
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		55	68	53	73	89	65	74	51	68	19
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		58	58	33	84	82	82	51	46	64	30
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		26	13	15	18	25	21	24	6	19	35

^a Duplicates refers to analyses of replicate subsamples of a unique sample.

^b The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

Table A3. Blubber. Concentrations, ng/g wet weight, of chlorinated analytes in harbor porpoise MH-91-504 (sampled 5-9-91).

	Subsample no.:	1	2	3	4	5	6	7		
Chlorinated analytes	Lab sample no.:	59-457	59-458	59-459	59-460	59-461	59-456	59-462	Mean	RSD
hexachlorobenzene		400	390	420	380	290	410	390	380	11
lindane (gamma-BHC)		44	51	46	50	37	49	46	46	10
heptachlor		nd	1	2	4	0.9	1	1	2	74
aldrin		nd	-							
heptachlorepoxyde		250	260	280	260	200	270	250	250	10
alpha-chlordane		590	580	640	600	440	640	550	580	12
trans-nonachlor		1,900	1,800	2,200	1,900	1,300	2,000	1,800	1,800	15
dieldrin		1,000	1,000	1,100	1,000	740	1,100	970	990	12
mirex		76	69	110	80	45	97	58	76	29
sum of other chlorinated hydrocarbons		4,300	4,200	4,800	4,300	3,100	4,600	4,100	4,200	13
o,p'-DDE		47	51	56	53	34	54	48	49	15
p,p'-DDE		3,900	3,800	4,600	4,000	2,700	4,200	3,700	3,800	15
o,p'-DDD		190	200	260	240	140	240	200	210	19
p,p'-DDD		1,800	1,800	2,100	1,900	1,300	2,000	1,700	1,800	14
o,p'-DDT		260	260	310	290	180	320	240	270	18
p,p'-DDT		950	940	1,200	1,000	650	1,100	900	960	18
sum of DDEs, DDDs and DDTs		7,100	7,100	8,500	7,500	5,000	7,900	6,800	7,100	15
trichlorobiphenyls		160	130	140	140	110	140	120	130	12
tetrachlorobiphenyls		2,400	2,200	2,500	2,300	1,800	2,300	2,200	2,200	10
pentachlorobiphenyls		5,700	5,500	6,600	5,800	4,100	6,300	5,400	5,600	14
hexachlorobiphenyls		8,900	6,500	11,000	9,600	5,700	11,000	8,000	8,700	24
heptachlorobiphenyls		4,300	4,000	5,800	4,300	2,400	5,200	3,400	4,200	27
octachlorobiphenyls		610	550	1,100	750	360	940	540	690	37
nonachlorobiphenyls		77	60	130	84	34	97	53	76	41
decachlorobiphenyl		22	19	57	37	18	32	24	30	46
sum of polychlorinated biphenyls		22,000	19,000	27,000	23,000	15,000	26,000	20,000	22,000	19
sample weight, grams		1.02	1.03	1.03	1.02	1.02	0.99	0.99	-	-
% lipid		82	87	81	84	73	88	85	83	6

Table A4. Blubber. Concentrations, ng/g wet weight, of individual polychlorinated biphenyl (PCB) isomers in harbor porpoise MH-91-504 (sampled 5-9-91).

	Subsample no.:	1	2	3	4	5	6	7		
Individual PCB isomers	Lab sample no.:	59-457	59-458	59-459	59-460	59-461	59-456	59-462	Mean	RSD
2,2',5-trichlorobiphenyl (no. 18) *		73	71	73	72	56	73	70	70	9
2,4,4'-trichlorobiphenyl (no. 28)		42	38	38	40	29	42	33	37	13
2,2',3,5'-tetrachlorobiphenyl (no. 44)		92	78	74	77	65	72	72	76	11
2,2',5,5'-tetrachlorobiphenyl (no. 52)		860	810	910	810	600	870	790	810	12
2,3',4,4'-tetrachlorobiphenyl (no. 66)		44	42	49	43	32	46	42	43	12
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		720	710	820	710	510	760	680	700	14
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		110	100	150	120	68	130	97	110	24
2,3',4,4',5-pentachlorobiphenyl (no. 118)		930	890	1,100	940	620	1,100	800	910	18
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		400	370	450	410	270	470	340	390	18
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		2,500	2,300	3,100	2,600	1,600	2,900	2,200	2,500	20
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		3,000	2,800	3,900	3,100	1,800	3,500	2,600	3,000	23
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		360	330	580	400	210	510	310	390	32
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		1,600	1,500	2,100	1,700	920	1,900	1,200	1,600	26
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		880	780	1,200	970	550	1,100	780	890	24
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		47	38	83	68	26	85	40	55	42
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		67	53	120	77	29	83	45	68	44
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		22	19	57	37	18	32	24	30	46

* The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

Table A5. Blubber. Concentrations, ng/g wet weight, of chlorinated analytes in harbor porpoise MH-91-506 (sampled 5-9-91).

Chlorinated analytes	Subsample no.:	1	2	3	4	5	5 ^a	6	7	Mean	RSD
	Lab sample no.:	59-371	59-372	59-373	59-374	Duplicates ^a 59-375 59-379		59-370	59-376		
hexachlorobenzene		350	350	300	320	290	280	280	280	310	10
lindane (gamma-BHC)		27	27	30	26	24	24	17	24	25	16
heptachlor		nd	nd	nd	nd	nd	nd	nd	nd	nd	-
aldrin		nd	nd	nd	nd	nd	nd	nd	nd	nd	-
heptachlorepoxyde		370	350	360	330	320	330	260	330	330	11
alpha-chlordane		560	570	600	550	530	510	420	470	530	12
trans-nonachlor		2,500	2,500	2,400	2,300	2,100	2,000	1,900	2,000	2,200	11
dieldrin		1,600	1,500	1,500	1,500	1,400	1,400	1,200	1,300	1,400	10
mirex		70	78	58	58	46	42	54	39	57	25
sum of other chlorinated hydrocarbons		5,500	5,400	5,200	5,100	4,700	4,600	4,100	4,400	4,900	11
o,p'-DDE		100	110	100	100	100	98	180	97	110	28
p,p'-DDE		5,200	5,300	4,900	4,800	4,400	4,300	4,000	4,200	4,700	11
o,p'-DDD		200	210	210	190	180	190	110	170	180	19
p,p'-DDD		1,800	1,900	1,900	1,600	1,500	1,400	1,300	1,300	1,600	17
o,p'-DDT		270	300	270	270	240	220	180 ^b	210	250	17
p,p'-DDT		1,600	1,600	1,500	1,400	1,300	1,300	1,200	1,200	1,400	13
sum of DDEs, DDDs and DDTs		9,200	9,400	8,900	8,400	7,700	7,500	7,000	7,200	8,200	12
trichlorobiphenyls		57	64	63	59	58	52	48	57	58	9
tetrachlorobiphenyls		1,400	1,400	1,300	1,300	1,300	1,200	980	1,200	1,300	11
pentachlorobiphenyls		4,100	4,100	3,800	3,800	3,700	3,600	3,100	3,600	3,700	9
hexachlorobiphenyls		5,900	6,300	5,400	5,400	4,800	4,500	4,500	4,200	5,200	15
heptachlorobiphenyls		2,800	3,000	2,500	2,400	2,100	1,900	2,200	1,800	2,400	18
octachlorobiphenyls		490	550	380	390	290	260	400	250	390	27
nonachlorobiphenyls		47	51	33	38	26	20	38 ^b	17	35	35
decachlorobiphenyl		11	14	4	5	2	5	10 ^b	2	7	64
sum of polychlorinated biphenyls		15,000	15,000	13,000	13,000	12,000	12,000	9,400	11,000	13,000	16
sample weight, grams		1.01	1.00	1.03	1.04	1.04	1.01	1.04	1.03	-	-
% lipid		88	85	82	87	81	82	70	79	82	7

^a Duplicates refers to analyses of replicate subsamples of a unique sample.

^b Analyte not confirmed by gas chromatography/mass spectrophotometry.

Table A6. Blubber. Concentrations, ng/g wet weight, of individual polychlorinated biphenyl (PCB) isomers in harbor porpoise MH-91-506 (sampled 5-9-91).

Individual PCB isomers	Subsample no.:	1	2	3	4	5	5 ^a	6	7	Mean	RSD
	Lab sample no.:	59-371	59-372	59-373	59-374	Duplicates		59-370	59-376		
2,2',5-trichlorobiphenyl (no. 18) ^b		36	31	34	35	36	32	27	31	33	9
2,4,4'-trichlorobiphenyl (no. 28)		17	20	22	16	17	16	13	19	18	17
2,2',3,5'-tetrachlorobiphenyl (no. 44)		53	54	57	51	50	48	38 ^c	46	50	13
2,2',5,5'-tetrachlorobiphenyl (no. 52)		570	570	530	540	500	490	460	480	520	8
2,3',4,4'-tetrachlorobiphenyl (no. 66)		26	26	24	24	23	22	19	21	24	11
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		740	720	660	680	650	630	610	640	23	7
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		67	72	59	62	52	47	53	45	58	17
2,3',4,4',5-pentachlorobiphenyl (no. 118)		440	450	420	400	380	360	300	340	390	14
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		200	210	200	180	170	150	150	130	180	17
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		1,500	1,600	1,400	1,400	1,200	1,100	1,200	1,000	1,300	17
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		2,200	2,400	1,900	1,900	1,600	1,400	1,700	1,300	1,800	22
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		250	270	220	210	170	150	190	140	210	24
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		940	1,000	830	820	700	630	720	590	790	19
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		700	720	580	620	520	490	550	470	590	16
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		34	39	26	26	19	17	28	16	27	33
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		36	38	24	29	18	14	31	12	27	40
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		11	14	4	5	2	5	10 ^c	2	7	72

^a Duplicates refers to analyses of replicate subsamples of a unique sample.

^b The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

^c Analyte not confirmed by gas chromatography/mass spectrophotometry.

Table A7. Liver. Concentrations, ng/g wet weight, of chlorinated analytes in harbor porpoise MH-91-424 (sampled 1-29-91).

	Subsample no.:	1	2	3	4	5		
Chlorinated analytes	Lab sample no.:	59-353	59-354	59-355	59-505	59-506	Mean	RSD
hexachlorobenzene		89	91	92	81	74	85	9
lindane (gamma-BHC)		2	2	2	2	2	2	0
heptachlor		nd	nd	nd	nd	nd	nd	-
aldrin		nd	nd	nd	nd	nd	nd	-
heptachlorepoxyde		16	18	18	16	15	17	8
alpha-chlordane		31	33	34	27	26	30	12
trans-nonachlor		80	86	90	67	64	77	15
dieldrin		89	96	98	81	78	88	10
mirex		7	7	10	6	5	7	27
sum of other chlorinated hydrocarbons		310	330	340	280	260	300	11
o,p'-DDE		nd	2	2	2	2	2	0
p,p'-DDE		140	150	160	120	120	140	13
o,p'-DDD		13	12	12	10	10	11	12
p,p'-DDD		47	53	51	43	43	47	10
o,p'-DDT		15	15	17	10	12	14	20
p,p'-DDT		14	14	17	13	11	14	16
sum of DDEs, DDDs and DDTs		230	250	260	200	200	230	12
trichlorobiphenyls		17	17	19	11	11	15	25
tetrachlorobiphenyls		130	120	130	95	95	110	16
pentachlorobiphenyls		270	280	300	240	230	260	11
hexachlorobiphenyls		510	490	570	470	450	500	9
heptachlorobiphenyls		130	200	270	180	170	190	27
octachlorobiphenyls		54	53	74	51	49	56	18
nonachlorobiphenyls		8	9	14	8	8	9	28
decachlorobiphenyl		8	9	13	7	7	9	28
sum of polychlorinated biphenyls		1,100	1,200	1,400	1,100	1,000	1,200	13
sample weight, grams		1.00	1.00	1.00	1.00	1.00	-	-
% lipid		1.5	1.6	1.8	1.1	0.8	1.4	29

Table A8. Blubber. Concentrations, ng/g wet weight, of individual polychlorinated biphenyl (PCB) isomers in harbor porpoise MH-91-424 (sampled 1-29-91).

	Subsample no.:	1	2	3	4	5		
Individual PCB isomers	Lab sample no.:	59-353	59-354	59-355	59-505	59-506	Mean	RSD
2,2',5-trichlorobiphenyl (no. 18) *		7	7	8	3	3	6	43
2,4,4'-trichlorobiphenyl (no. 28)		4	4	4	3	3	4	15
2,2',3,5'-tetrachlorobiphenyl (no. 44)		7	7	7	5	6	6	14
2,2',5,5'-tetrachlorobiphenyl (no. 52)		52	53	56	42	40	49	15
2,3',4,4'-tetrachlorobiphenyl (no. 66)		2	2	2	2	2	2	0
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		29	30	33	27	25	29	11
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		7	7	9	6	6	7	17
2,3',4,4',5-pentachlorobiphenyl (no. 118)		41	42	47	37	35	40	12
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		16	16	19	14	14	16	13
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		160	160	180	140	140	160	11
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		210	210	240	190	180	210	11
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		21	22	31	21	20	23	20
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		63	65	83	59	57	65	16
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		68	69	81	56	54	66	17
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		5	5	8	5	5	6	24
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		7	8	12	7	7	8	26
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		8	9	13	7	7	9	28

* The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

Table A9. Liver. Concentrations, ng/g wet weight, of chlorinated analytes in harbor porpoise MH-91-504 (sampled 5-9-91).

	Subsample no.:	1	2	3	4	5		
Chlorinated analytes	Lab sample no.:	59-510	59-511	59-514	59-512	59-513	Mean	RSD
hexachlorobenzene		34	35	34	34	34	34	1
lindane (gamma-BHC)		0.6	3	1	0.5	0.5	1	96
heptachlor		nd	nd	nd	nd	nd	nd	-
aldrin		nd	nd	nd	nd	nd	nd	-
heptachlorepoxyde		5	4	4	4	5	4	12
alpha-chlordane		7	6	6	6	6	6	7
trans-nonachlor		28	26	27	26	26	27	3
dieldrin		20	18	19	18	18	19	5
mirex		3	4	3	3	3	3	14
sum of other chlorinated hydrocarbons		98	96	94	92	92	94	3
o,p'-DDE		0.5	0.5	0.5	0.5	0.5	0.5	0
p,p'-DDE		63	59	61	57	57	59	4
o,p'-DDD		4	5	4	4	4	4	11
p,p'-DDD		20	18	17	16	17	18	9
o,p'-DDT		3	3	nd	4	3	3	17
p,p'-DDT		3	3	4	3	3	3	14
sum of DDEs, DDDs and DDTs		94	88	87	84	84	87	5
trichlorobiphenyls		18	28	12	25	20	21	30
tetrachlorobiphenyls		59	52	60	70	74	63	14
pentachlorobiphenyls		130	120	130	130	130	130	3
hexachlorobiphenyls		240	240	240	240	230	240	2
heptachlorobiphenyls		110	110	110	110	110	110	0
octachlorobiphenyls		44	42	42	43	42	43	2
nonachlorobiphenyls		9	9	9	8	8	9	6
decachlorobiphenyl		6	6	7	6	6	6	7
sum of polychlorinated biphenyls		620	610	610	630	620	620	1
sample weight, grams		1.03	1.02	1.02	1.03	1.02	-	-
% lipid		1.4	1.4	1.3	1.6	1.2	1.4	11

Table A10. Blubber. Concentrations, ng/g wet weight, of individual polychlorinated biphenyl (PCB) isomers in harbor porpoise MH-91-504 (sampled 5-9-91).

	Subsample no.:	1	2	3	4	5		
Individual PCB isomers	Lab sample no.:	59-510	59-511	59-514	59-512	59-513	Mean	RSD
2,2',5-trichlorobiphenyl (no. 18) *		2	5	1	nd	nd	3	69
2,4,4'-trichlorobiphenyl (no. 28)		3	3	2	3	3	3	16
2,2',3,5'-tetrachlorobiphenyl (no. 44)		6	5	5	7	7	6	17
2,2',5,5'-tetrachlorobiphenyl (no. 52)		20	21	22	23	21	21	5
2,3',4,4'-tetrachlorobiphenyl (no. 66)		0.9	0.9	1	1	0.9	1	6
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		12	12	13	12	12	12	4
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		3	3	3	3	3	3	0
2,3',4,4',5-pentachlorobiphenyl (no. 118)		25	24	24	25	24	24	2
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		9	9	9	9	8	9	5
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		71	72	74	73	71	72	2
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		98	100	100	100	99	99	1
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		14	13	14	15	13	14	6
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		39	39	40	39	38	39	2
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		36	37	38	37	36	37	2
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		5	5	5	5	5	5	0
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		8	8	8	7	7	8	7
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		6	6	7	6	6	6	7

* The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

Table A11. Liver. Concentrations, ng/g wet weight, of chlorinated analytes in harbor porpoise MH-91-506 (sampled 5-9-91).

	Subsample no.:	1	2	3	4	5		
Chlorinated analytes	Lab sample no.:	59-377	59-378	59-509	59-507	59-508	Mean	RSD
hexachlorobenzene		25	20	24	26	24	24	10
lindane (gamma-BHC)		3	2	1	1	1	2	56
heptachlor		0.5	nd	0.6	nd	nd	0.6	12
aldrin		nd	nd	nd	nd	nd	nd	-
heptachlorepoxyde		7	5	5	5	5	5	17
alpha-chlordane		6	5	5	5	5	5	9
trans-nonachlor		29	25	25	27	27	27	6
dieldrin		22	19	19	19	19	20	7
mirex		3	2	3	3	2	3	21
sum of other chlorinated hydrocarbons		96	78	83	86	83	85	8
o,p'-DDE		1	1	0.7	0.7	0.7	1	20
p,p'-DDE		61	52	52	53	54	54	7
o,p'-DDD		3	3	4	4	4	4	15
p,p'-DDD		17	15	11	11	12	13	20
o,p'-DDT		4	4	3	4	4	4	12
p,p'-DDT		4	4	4	4	4	4	0
sum of DDEs, DDDs and DDTs		90	79	75	77	79	80	7
trichlorobiphenyls		38	25	22	13	20	24	39
tetrachlorobiphenyls		61	51	38	38	40	46	22
pentachlorobiphenyls		92	84	79	84	87	85	6
hexachlorobiphenyls		160	150	140	150	150	150	5
heptachlorobiphenyls		70	65	58	62	63	64	7
octachlorobiphenyls		12	12	19	20	20	17	25
nonachlorobiphenyls		3	3	4	3	4	3	16
decachlorobiphenyl		2	2	4	3	2	3	34
sum of polychlorinated biphenyls		440	390	360	370	390	390	8
sample weight, grams		1.01	1.06	1.03	1.01	0.98	-	-
% lipid		3.6	1.9	1.1	1.4	1.3	1.9	55

Table A12. Blubber. Concentrations, ng/g wet weight, of individual polychlorinated biphenyl (PCB) isomers in harbor porpoise MH-91-506 (sampled 5-9-91).

	Subsample no.:	1	2	3	4	5		
Individual PCB isomers	Lab sample no.:	59-377	59-378	59-509	59-507	59-508	Mean	RSD
2,2',5-trichlorobiphenyl (no. 18) *		5	3	3	nd	1	3	54
2,4,4'-trichlorobiphenyl (no. 28)		nd	nd	4	2	3	3	33
2,2',3,5'-tetrachlorobiphenyl (no. 44)		13	10	5	4	5	7	56
2,2',5,5'-tetrachlorobiphenyl (no. 52)		17	15	15	15	15	15	6
2,3',4,4'-tetrachlorobiphenyl (no. 66)		1	1	0.5	0.6	0.7	0.8	29
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		11	10	10	11	11	11	5
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		2	2	2	2	2	2	0
2,3',4,4',5-pentachlorobiphenyl (no. 118)		11	11	11	11	11	11	0
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		5	4	5	5	5	5	9
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		49	43	41	44	45	44	7
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		70	64	59	65	64	64	6
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		9	8	7	7	7	8	11
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		21	19	20	22	22	21	6
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		20	20	19	21	21	20	4
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		2	2	2	2	2	2	0
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		3	3	3	3	3	3	0
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		2	2	4	3	2	3	30

* The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

Table A13. Blubber, liver, kidney, gonad, brain, lung. Concentrations, ng/g wet weight, of chlorinated analytes in harbor porpoise MH-91-506.

Chlorinated analytes	Lab sample no.:	Blubber	Liver	Kidney	Gonad	Brain Duplicates *		Lung
		mean (n=7)	mean (n=5)	59-694	59-695	59-696	59-698	59-697
hexachlorobenzene		310	24	8	5	13	13	6
lindane (gamma-BHC)		25	2	nd	nd	0.5	0.4	0.3
heptachlor		nd	0.6	nd	nd	nd	nd	nd
aldrin		nd	nd	nd	nd	nd	nd	nd
heptachlorepoxyde		330	5	3	2	3	3	1
alpha-chlordane		530	5	2	2	4	4	2
trans-nonachlor		2,200	27	11	9	17	19	8
dieldrin		1,400	20	14	7	14	15	8
mirex		57	3	0.9	0.6	1	1	0.4
sum of other chlorinated hydrocarbons		4,900	85	39	26	52	55	26
o,p'-DDE		110	1	nd	nd	nd	nd	nd
p,p'-DDE		4,700	54	21	17	38	42	15
o,p'-DDD		180	4	nd	1	1	2	0.5
p,p'-DDD		1,600	13	4	5	5	5	3
o,p'-DDT		250	4	2	nd	4	4	1
p,p'-DDT		1,400	4	3	nd	5	5	2
sum of DDEs, DDDs and DDTs		8,200	80	30	23	53	58	22
trichlorobiphenyls		58	24	2	5	3	4	5
tetrachlorobiphenyls		1,300	46	19	18	25	31	23
pentachlorobiphenyls		3,700	85	39	35	59	62	34
hexachlorobiphenyls		5,200	150	68	53	110	110	51
heptachlorobiphenyls		2,400	64	27	22	40	42	20
octachlorobiphenyls		390	17	5	5	7	7	4
nonachlorobiphenyls		35	3	1	1	1	1	0.6
decachlorobiphenyl		7	3	2	0.9	1	0.8	1
sum of polychlorinated biphenyls		12,000	390	160	140	250	260	140
sample weight, grams		-	-	1.01	1.01	1.05	1.05	1.02
% lipid		82	1.9	1.2	0.9	6.8	6.6	0.8

* Duplicates refers to analyses of replicate subsamples of a unique sample.

Table A14. Blubber, liver, kidney, gonad, brain, lung. Concentrations, ng/g wet weight, of individual polychlorinated biphenyl (PCB) isomers in harbor porpoise MH-91-506.

Individual PCB isomers	Lab sample no.:	Blubber	Liver	Kidney	Gonad	Brain Duplicates ^a		Lung
		mean (n=7)	mean (n=5)	59-694	59-695	59-696	59-698	59-697
2,2',5-trichlorobiphenyl (no. 18) ^b		33	3	nd	2	nd	nd	2
2,4,4'-trichlorobiphenyl (no. 28)		18	3	1	2	2	2	2
2,2',3,5'-tetrachlorobiphenyl (no. 44)		50	7	6	6	5	7	7
2,2',5,5'-tetrachlorobiphenyl (no. 52)		520	15	8	6	11	12	6
2,3',4,4'-tetrachlorobiphenyl (no. 66)		4	0.8	nd	nd	nd	nd	nd
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		23	11	5	4	9	10	4
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		58	2	1	1	2	2	0.8
2,3',4,4',5-pentachlorobiphenyl (no. 118)		390	11	6	5	8	9	4
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		180	5	2	1	2	3	1
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		1,300	44	21	15	32	34	16
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		1,800	64	32	27	49	50	23
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		210	8	4	3	4	4	3
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		790	21	10	8	15	15	7
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		590	20	9	7	13	14	6
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		27	2	1	1	1	1	0.6
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		27	3	1	1	1	1	0.6
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		7	3	2	0.9	1	0.8	1

^a Duplicates refers to analyses of replicate subsamples of a unique sample.

^b The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

APPENDIX B

QUALITY CONTROL DATA FOR
CHLORINATED HYDROCARBONS
AND TOXIC ELEMENTS

Chlorinated Hydrocarbon Analyses for
the Harbor Porpoise Contaminant Distribution Study
Explanatory Notes for Tables B1-B4

Abbreviations used:

nd - indicates that the analyte was not detected above the limit of detection which ranged from < 0.1 to < 2 ng/g (ppb) wet weight.

RSD - relative standard deviation - the standard deviation divided by the mean and expressed as a percent.

Results were determined by gas chromatography (GC)/electron capture detection (ECD).

4,4'-dibromooctofluorobiphenyl was the internal standard (surrogate standard) for all the analytes.

Mean values given for samples are calculated using those samples in which the designated compounds were detected. The means of the concentrations of duplicate samples were calculated first and that value was used in the calculation of the mean and RSD.

Table B1. Method blanks. Concentrations, ng/g wet weight, of chlorinated analytes in method blank.

Chlorinated analytes	Lab sample no.:	59-467	59-516	59-381	59-616	59-705
hexachlorobenzene		nd	nd	nd	nd	nd
lindane (gamma-BHC)		nd	nd	nd	nd	nd
heptachlor		nd	nd	nd	nd	nd
aldrin		nd	nd	nd	nd	nd
heptachlorepoxyde		nd	nd	nd	nd	nd
alpha-chlordane		nd	nd	nd	nd	nd
trans-nonachlor		nd	nd	nd	nd	nd
dieldrin		nd	nd	nd	nd	nd
mirex		nd	nd	nd	nd	nd
sum of other chlorinated hydrocarbons		nd	nd	nd	nd	nd
o,p'-DDE		nd	nd	nd	nd	nd
p,p'-DDE		nd	nd	nd	nd	nd
o,p'-DDD		nd	nd	nd	nd	nd
p,p'-DDD		nd	nd	nd	nd	nd
o,p'-DDT		nd	nd	nd	nd	nd
p,p'-DDT		nd	nd	nd	nd	nd
sum of DDEs, DDDs and DDTs		nd	nd	nd	nd	nd
trichlorobiphenyls		3	2	nd	nd	nd
tetrachlorobiphenyls		13	7	nd	7	nd
pentachlorobiphenyls		5	6	nd	4	nd
hexachlorobiphenyls		5	5	nd	2	nd
heptachlorobiphenyls		0.8	0.3	nd	0.7	nd
octachlorobiphenyls		0.3	nd	nd	nd	nd
nonachlorobiphenyls		nd	nd	nd	nd	nd
decachlorobiphenyl		0.4	nd	nd	nd	nd
sum of polychlorinated biphenyls		28	20	nd	14	nd

Table B2. Method blanks. Concentrations, ng/g wet weight, of individual polychlorinated biphenyls (PCB) isomers in method blank.

Individual PCB isomers	Lab sample no.:	59-467	59-516	59-381	59-616	59-705
2,2',5-trichlorobiphenyl (no. 18) *		1	nd	nd	nd	nd
2,4,4'-trichlorobiphenyl (no. 28)		2	2	nd	nd	nd
2,2',3,5'-tetrachlorobiphenyl (no. 44)		5	3	nd	3	nd
2,2',5,5'-tetrachlorobiphenyl (no. 52)		0.9	nd	nd	nd	nd
2,3',4,4'-tetrachlorobiphenyl (no. 66)		2	1	nd	1	nd
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		0.6	1	nd	2	nd
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		0.3	0.3	nd	nd	nd
2,3',4,4',5-pentachlorobiphenyl (no. 118)		0.9	1	nd	nd	nd
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		nd	nd	nd	nd	nd
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		3	2	nd	4	nd
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		1	2	nd	2	nd
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		nd	nd	nd	2	nd
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		0.3	nd	nd	0.8	nd
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		nd	nd	nd	nd	nd
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		0.3	nd	nd	nd	nd
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		nd	nd	nd	nd	nd
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		0.4	nd	nd	nd	nd

* The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

Table B3. National Institute of Standards and Technology (NIST) reference tissue. Concentrations, ng/g wet weight, of chlorinated analytes in NIST control tissue Standard Reference Material SRM 1974.

Chlorinated analytes	Lab sample no.:	59-466	59-380	59-615	59-704	Prior analyses (n=19)	
						Mean	RSD
hexachlorobenzene		0.5	nd	0.3	nd	0.2	89
lindane (gamma-BHC)		0.2	nd	0.4	nd	0.2	60
heptachlor		0.2	2	nd	nd	0.4	160
aldrin		nd	nd	3	2	3	12
heptachlorepoxyde		0.5	0.5	nd	0.9	0.6	120
alpha-chlordane		4	2	3	3	3	24
trans-nonachlor		4	2	3	3	3	27
dieldrin		2	2	2	3	2	36
mirex		0.2	nd	nd	nd	0.3	180
sum of other chlorinated hydrocarbons		12	8	12	12	10	23
o,p'-DDE		2	1	2	2	2	61
p,p'-DDE		9	5	6	7	6	30
o,p'-DDD		2	2	2	2	2	55
p,p'-DDD		8	3	5	7	6	44
o,p'-DDT		2	1	0.9	1	0.9	37
p,p'-DDT		0.7	nd	0.4	0.5	0.5	49
sum of DDEs, DDDs and DDTs		24	12	16	20	16	26
trichlorobiphenyls		28	21	21	18	22	20
tetrachlorobiphenyls		200	160	200	180	180	14
pentachlorobiphenyls		150	110	130	140	120	19
hexachlorobiphenyls		64	52	85	65	55	15
heptachlorobiphenyls		14	6	11	12	11	24
octachlorobiphenyls		0.3	0.6	nd	nd	0.3	62
nonachlorobiphenyls		0.1	nd	nd	nd	0.2	97
decachlorobiphenyl		0.2	nd	nd	nd	0.1	36
sum of polychlorinated biphenyls		460	350	450	420	390	14

Table B4. National Institute of Standards and Technology (NIST) reference tissue. Concentrations, ng/g wet weight, of individual polychlorinated biphenyls (PCB) isomers in NIST control tissue Standard Reference Material SRM 1974.

Individual PCB isomers	Lab sample no.:	59-466	59-380	59-615	59-704	Prior analyses (n=19)	
						Mean	RSD
2,2',5-trichlorobiphenyl (no. 18) *		4	4	6	5	4	28
2,4,4'-trichlorobiphenyl (no. 28)		25	17	17	15	20	48
2,2',3,5'-tetrachlorobiphenyl (no. 44)		13	10	12	13	12	13
2,2',5,5'-tetrachlorobiphenyl (no. 52)		19	17	19	18	16	12
2,3',4,4'-tetrachlorobiphenyl (no. 66)		29	25	27	19	26	29
2,2',4,5,5'-pentachlorobiphenyl (no. 101)		21	18	23	21	18	20
2,3,3',4,4'-pentachlorobiphenyl (no. 105)		6	5	5	6	6	25
2,3',4,4',5-pentachlorobiphenyl (no. 118)		19	16	19	21	17	13
2,2',3,3',4,4'-hexachlorobiphenyl (no. 128)		3	2	3	3	4	150
2,2',3,4,4',5'-hexachlorobiphenyl (no. 138)		20	17	20	21	18	13
2,2',4,4',5,5'-hexachlorobiphenyl (no. 153)		26	23	22	29	23	18
2,2',3,3',4,4',5-heptachlorobiphenyl (no. 170)		nd	0.6	0.7	0.3	0.9	55
2,2',3,4,4',5,5'-heptachlorobiphenyl (no. 180)		3	2	2	3	2	29
2,2',3,4',5,5',6-heptachlorobiphenyl (no. 187)		6	4	5	6	5	21
2,2',3,3',4,4',5,6-octachlorobiphenyl (no. 195)		0.3	nd	nd	nd	0.3	53
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl (no. 206)		0.1	nd	nd	nd	0.2	97
2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl (no. 209)		0.2	nd	nd	nd	0.1	37

* The accepted numbering system for PCB isomers as developed by Ballschmiter and Zell (1980).

Table B5. Certified Reference Materials (CRMs). Concentrations, ng/g dry weight, of selected toxic elements in CRMs.^a

Analytes	DOLT		DORM		LUTS	
	Analyzed value	Certified value	Analyzed value	Certified value	Analyzed value	Certified value
arsenic	14,000 ± 1,900	10,000 ± 1,400	10,000 ± 2,000	18,000 ± 2,100	13,000 ± 2,300	19,000 ± 900
cadmium	5,200 ± 1,200	4,200 ± 280	60 ± 3	90 ± 12	13,000 ± 1,900	14,000 ± 1,000
copper	20,000 ± 2,900	21,000 ± 1,200	5,300 ± 600	5,200 ± 330	110,000 ± 15,000	110,000 ± 8,000
lead	1,300 ± 330	1,400 ± 290	480 ± 160	400 ± 120	53 ± 17	69 ± 11
selenium	5,400 ± 1,200	7,300 ± 420	2,300 ± 570	1,600 ± 120	2,800 ± 430	4,300 ± 360
mercury	270 ± 43	220 ± 37	600	800 ± 74	120 ± 24	110 ± 15

Analytes	TORT		1566a	
	Analyzed value	Certified value	Analyzed value	Certified value
arsenic	17,000 ± 1,600	25,000 ± 2,200	17,000 ± 2,700	14,000 ± 1,200
cadmium	32,000 ± 5,900	26,000 ± 2,100	4,000 ± 270	4,200 ± 380
copper	^b	440,000 ± 22,000	64,000 ± 7,500	66,000 ± 4,300
lead	10,000 ± 800	10,000 ± 2,000	320 ± 30	370 ± 14
selenium	11,000 ± 500	6,900 ± 470	1,900 ± 460	2,200 ± 240
mercury	310 ± 5	330 ± 60	65 ± 1	64 ± 7

^a CRMs analyzed included:
DOLT - 1 Dogfish liver.
DORM - 1 Dogfish muscle tissue.
LUTS - 1 Nondefatted lobster hepatopancreas.
TORT - 1 Lobster hepatopancreas.
1566a Oyster tissue.

^b Data not available.

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