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ALASKAN MARINE MAMMAL TISSUE ARCHIVAL PROJECT:

ACQUISITION AND CURATION OF ALASKAN MARINE MAMMAL TISSUES FOR DETERMINING LEVELS OF CONTAMINANTS ASSOCIATED WITH OFFSHORE OIL AND GAS DEVELOPMENT

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Contents

Tables

Figures

1.0 INTRODUCTION

The goal of the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Research Unit 692 *(Alaskan Marine Mammal Tissue Archival Project)* is to [illegible] representative collection of Alaskan marine mammal tissues for future co[illegible] analyses and documentation of long term trends in environmental quality.

The concept of archiving biological and environmental samples for retrospective analysis is recognized as a major component of systematic environmental monitoring (Wise, et al., 1988). The long-term storage of carefully selected, repre[illegible] samples in an environmental specimen bank is an important complement to [illegible] time monitoring of the environment. These archived samples permit:

1. the use of new and innovative analytical technology that [illegible] available at the time the samples were collected, for clear s[illegible] identification and quantification of analytes of interest, and

2. the identification and quantification of analytes that are of [illegible] the present but that were not of interest at the time the sam[illegible] collected.

The retrospective analysis of archived samples allows the comparison of p[illegible] past analytical techniques and values, thus providing continued credibil[illegible] analytical values, and allowing flexibility in environmental monitoring progr[illegible].

Marine mammals are long-lived and considered top predators in t[illegible] environment. Chemical analysis of their tissues can be particularly determining whether bioaccumulation of contaminants (and potential biologi[illegible] associated with human industrial activities, including offshore petroleum a[illegible] extraction, is occurring in marine food chains. The collection of marine mamm[illegible] over a period of several years will provide an archive of samples that can b[illegible] determine baseline contaminant levels against which future contaminant mea[illegible] be compared. The project has two objectives:

1. Collect Alaskan marine mammal tissues that are su[illegible] determining levels of organic and inorganic contaminants . . . . . with offshore mineral extraction.

2. Transport, catalog, and curate the tissues in a conditions suitable for long-term storage and eventual contaminant analyses.

The marine mammals of principal interest include ringed seals (*Phoca hispida*), spotted seals (*P. largha*), harbor seals (*P. vitulina*), bearded seals (*Erignath us barbatus*), Steller sea lions (*Eumatopias jubatus*), northern fur seals (*Callorhinus ursinus*), Pacific walrus (*Odobenus rosmarus divergens*), bowhead whales (*Balaena mysticetus*), belukha whales (*Delphinapterus leucas*), Dall's porpoise (*Phocoenoides dalli*), polar bears (*Ursus maritimus*), and sea otters (*Enhydra lutris*). These animals represent a range of sizes, habitat use, and subsistence values.

Archived tissues are being limited to those collected from freshly killed animals taken under controlled conditions, e.g., animals taken by researchers associated with ongoing programs or freshly killed animals taken in subsistence hunts. Tissue samples are collected according to the standard protocols designed for the project (Becker, et al., 1988a). These protocols are consistent with those employed by the National Biomonitoring Specimen Bank (NBSB), National Institute of Standards and Technology (NIST).

Cataloging and archiving of samples are being conducted by the NBSB, NIST, Gaithersburg, Maryland. Procedures are consistent with those employed by the NBSB in support of the National Status and Trends Program. Samples are stored at the NBSB under liquid nitrogen vapor at -150" C, which is the best condition available for minimizing sample degradation.

Samples will be selected in the future for contaminant analysis by OSCEAP/MMS. Emphasis will be on those metal and organic contaminants associated with offshore mineral extraction. Requests by other researchers and agencies for archived samples will be considered on a case by case basis.

2.0 REPORTING PERIOD ACTIVITIES

The project activities during the reporting period consisted of:

1. Archival support
2. Planning and coordination
3. Field collection of tissue samples
4. Survey of existing collections

FY 89 milestones for project activities are presented in Table 1.

2.1. Archival Support

The Alaskan Marine Mammal Tissue Archive is maintained by NIST in the National Biomonitoring Specimen Bank (NBSB), Gaithersburg, Maryland. The NBSB is the result of 10 years development involving cooperative efforts between NIST and EPA, and several years of comparative studies with specimen archiving programs of West Germany, Japan, Sweden, and Canada (Wise et al., 1988). Other Agencies using the NBSB include EPA, U.S. Department of Agriculture, Food and Drug Administration (FDA), the National Cancer Institute (NCI), and the National Status and Trends Program of NOAA.

In support of the *Archival Project,* NIST is providing the facilities and expertise required for the cataloging and storage of the marine mammal tissues and is providing the expertise and advice for the development and testing of collection protocols. More specifically, NIST is performing the following tasks:

a. Aid the Alaska Office, OAD, in the development and evaluation of protocols for the collection, transport, cataloging, and long-term storage of the tissue samples.

b. Provide facilities for the cryogenic storage of these samples. This includes the purchase, installation, and maintenance of a liquid nitrogen vapor freezer.

c. Provide the materials and implements required for the collection and shipment of samples to the specimen archive.

Table 1. Activity milestones for **RU** 692, ***Alaskan Marine Mammal Tissue Archival Project,*** FY 89.

1988:

October:

- FY 88 Research Unit Annual Report submitted to MMS

1989:

March:

- Presentation at the Alaska & Inuvialuit Beluga Whale Committee (AIBWC) meeting, Fairbanks; endorsement of the project received from the AIBWC

April:

- Presentation at the international Conference on Nuclear Analytical Methods in the Life Sciences
- Planning/Coordination Meeting with whaling captains, Point Hope
- Planning/Coordination Meeting with the Nome native agencies and the chairman of the Eskimo Walrus Commission, Nome

May:

- Ringed and bearded seal tissue collections, Nome

June:

- Belukha whale tissue collections, Point Hope

July:

- Bearded seal tissue collections, Barrow

September:

- Presentation at the Canadian Specimen Banking Seminars, Ottawa
- Presentation at the 12th US-German Seminar of State and Planning on Environmental Specimen Banking, Ottawa

d Collaborate with the Alaska Office, OAD, in the field during the sample collections in order to conduct on-site evaluation of the collection procedures.

e. Maintain an inventory of archived samples identified by type, date of collection, collection site, weight, identification numbers, and other information provided by the collector.

f. Evaluate specimen stability through regular monitoring of concentrations of selected contaminants in sample aliquots.

NIST. is an active participant in the OCSEAP's Quality Assurance Program for Trace Petroleum Component Analysis, which is coordinated with the Quality-Assurance Program of NOAA's National Status and Trends Program.

2.2 Planning and Coordination

As was the case last year, sampling in FY 89 required extensive coordination with numerous individuals and organizations including: National Marine Fisheries Service, Alaska Department of Fish and Game, the Alaska and Inuvialuit Beluga Whale Commitee, the North Slope Borough (Department of Wildlife Management, Point Hope whaling captains, and the Fish and Game Management Committee), and the Nome Native Agencies (Kawerak, Inc., Sitnasuak Native Corporation, Norton Sound Health Corporation, and Nome Eskimo Community).

2.2.1 National Marine Fisheries Service (NMFS)

Cooperation with the Environmental Conservation Division, Northwest Fisheries Science Center, NMFS, in collection of samples and analysis began last year and continued in 1989. With NMFS providing the sample containers, we collected bile and selected tissues for contaminant analyses. In turn, NMFS provided preliminary results from their analyses for FACS (fluorescent aromatic compounds) of ringed seal bile we collected at Barrow in 1988. FACS give some indication of exposure to petroleum-type hydrocarbons.

The Office of Protected Resources and Habitat Programs, NMFS, is developing a national program to establish and maintain a bank of selected marine mammal tissues for

retrospective analysis. The Alaskan Marine Mammal Tissue Archival Project is cooperating with this national program to establish collection protocols and to design a pilot program for testing these protocols.

2.2.2 Alaska Department of Fish and Game (ADF&G)

The *Archival Project* continued to coordinate with the ADF&G in its sampling. Some equipment and facility support was provided by the ADF&G office in Nome during our sampling of ringed and bearded seals in Norton Sound. We are providing biological information to the ADF&G Division of Wildlife Conservation during our ringed seal sampling. This information includes data on sex, standard length, girth, and blubber thickness. We are also providing the following samples to ADF&G: stomach with contents, female reproductive tracts, front flipper claws, and lower jaws for aging.

2.2.3 Alaska and Inuvialuit Beluga Whale Committee (AIBWC)

The *Archival Project* was presented to the AIBWC meeting held in Fairbanks in March, 1989. This organization consists of representatives from belukha whale hunting communities in Alaska and Canada, plus representatives from local, state, and federal agencies. The purposes of the AIBWC are to: develop a management plan for the belukha whale, improve hunting efficiency, promote research, compile harvest records, protect habitat, and serve as a contact organization for information exchange between the United States and Canada. This meeting provided us the opportunity to discuss with representatives of various native whaling villages the possibility of obtaining belukha whale samples from subsistence harvests. The AIBWC passed a resolution supporting in principle the *Archival Project.*

2.2.4 North Slope Borough (NSB)

Tissues of bearded seals were collected during 1989 through cooperation and coordination with the NSB Department of Wildlife Management. As was the case last year, the Department provided the support of their subsistence experts (Charlie Brewer and Billy Adams), plus some logistics support and the use of their facilities for sample processing.

Collection of tissues samples from belukha whales was accomplished through the cooperation and help of the residents of Point Hope and the NSB Department of Wildlife Management. The *Archival Project* was presented to the Point Hope whaling captains at

a meeting in Point Hope in April, 1989. The whaling captains formally approved the collection of tissues from belukha whales taken in the spring subsistence hunt. This sampling also required coordination and cooperation with the NSB Department of Wildlife Management's project for monitoring the subsistence harvest of belukha whales and collecting skin samples for mitochondrial DNA analysis. Rex Tuzroyluk of Point Hope provided valuable assistance in obtaining tissue samples during the spring hunt.

2.2.5 Nome Native Agencies

Tissues of ringed and bearded seals were collected during the study period through cooperation and coordination with the various native agencies of Nome (Kawerak, Inc., Sitnasuak Native Corporation, Norton Sound Health Corporation, and Nome Eskimo Community). Meetings with these different agencies were held in Nome in April 1989. Matthew Iya, with the support of Caleb Pungowiyi, President of Kawerak, Inc., arranged these meetings. Matthew Iya also provided valuable advice in arranging for living/work space during the sampling activities and provided some logistic support during the actual collections. Continuous contact was maintained between the Project Office in Anchorage and Mr. Iya in Nome in order to mobilize the sampling trip to correspond to the hunting period (determined by the nearshore ice movement in Norton Sound).

2.2.6 Canadian and US-German Environmental Specimen Banking Seminars

The *Archival Project* was presented at the Canadian Specimen Banking Seminars and the 12th US-German Seminar of State and Planning on Environmental Specimen Banking which were held consecutively in Ottawa, Canada, in September 1989. The Canadian Seminars featured lectures on Canadian specimen banking activities and specimen banking programs from other nations. The US-German Seminars involved roundtable discussions of coordination of activities associated with multi-national environmental specimen banking programs, exchange of information on policies and approaches used by different countries, strengthening communication between muti-national programs, and developing new communication links with countries and programs not represented at previous international specimen banking meetings.

2.3 Field Collections

2.3.1 Ringed and Bearded Seals, Nome

On May 25 - June 3, 1989, Paul Becker, Alaska Office, OAD, and Steve Wise and Barbara Koster, NBSB, NIST, collected tissues from ringed and bearded seals taken in local subsistence hunts in Norton Sound near Nome. Lab space for processing samples was established at the Nanuq Manor in Nome.

Although Ice and weather conditions made hunting difficult, we were able obtain tisssues from five ringed seals and one bearded seal. We accompanied two hunting crews during the sampling period. One crew consisted of Roy Ashenfelter and Aaron (Luke) Jackson. The other crew consisted of Matthew Iya, Timothy Gologergen, Sr., Julian Iya, and Clifford Iknokinok, Jr. Hunting took place with small boats (16-18 foot) launched from shore. Because of the shorefast ice, these boats had to be manually dragged over the ice to open water. Animals were taken by rifle shots to the head while the animals were either hauled out on an ice floe or swimming in the water. For several days the hunting crews could not go out due to bad weather.

Two subsamples (150 g, each) of three tissue-types (liver, kidney, and fat) were collected from five individual ringed seals and one bearded seal according to the protocols described in Becker, et al. (1988a) and as modified by Becker, et al. (1988b, pages 9-11). Unlike the ringed seal sampling last year in Barrow, all samples were taken from the animals while out on the ice. No animals were brought back to the lab for sample removal, This appeared to be the most efficient manner of obtaining samples under the cleanest conditions. However, such sampling does require clean, flat and stable ice floes. Members of each of the hunting crews provided excellent assistance in sample removal and data recording.

In addition to samples for archival, female reproductive organs (ovaries plus uterine horns), stomachs with contents, the left front flippers with claws, and the entire jawbones were collected from each ringed seal and the single bearded seal. These were labeled with the corresponding AMMTAP number, frozen, and transferred to Bob Nelson, ADF&G, Nome, for later shipment to Kathy Frost, ADF&G., Fairbanks. Results of stomach analysis, breeding condition, and age determinations for each animal will be provided to the *Archival Project.*

2.3.2 Belukha Whales, Point Hope

Belukha whales are hunted at Point Hope coincidentally with the bowhead whale harvest. Belukhas shot from the whaling boats are hauled up on the shorefast ice edge in the vicinity of the whaling camps. Here, on the ice, they are butchered. Sampling requires that the collector be on the ice during the hunt and that he (or she) be prepared to take samples during the butchering. The sampling of belukha whales was coordinated with the harvest surveys conducted by Rex Tuzroyluk, Point Hope, under the direction of Geoff Carroll, NSB Department of Wildlife Management.

Two sampling trips were made to Point Hope by Paul Becker, Alaska Office, OAD, to collect belukha whale tissues. The first trip (April 29 - May 4, 1989) was unsuccessful; no whales were taken and, because of unfavorable weather and ice conditions, most hunting camps had to be temporarily abandoned. The second trip took place on June 12-15. Samples of blubber, liver and kidney were taken by Rex Tuzroyluk from four belukha whales on the ice according to the protocols described in Becker, et al. (1988a). The samples were transported to the Whaler Inn, Point Hope, where they were processed and shipped to the NBSB, Gaithersburg.

The following information, which was gathered during the NSB Belukha Harvest Survey by Rex Tuzroyluk, was recorded on the *Archival Project* data forms. The definitions of these measures were provided by Geof Carroll, NSB Department of Wildlife Management.

Sex is initially determined by examining the genital slit. For males the genital canal within the genital slit extends toward the tail; for females, it extends toward the head. The initial sex determinations are confirmed when the animal is dissected for obtaining tissue samples.

Blubber thickness is measured in the middle of the chest by pushing a ruler in a slit until it touches the bone. Measurement was recorded as blubber and skin thickness (skin is approximately 1/2 cm thick).

Fluke width is measured from tip to tip while the animal is lying flat.

Total length is measured as a straight line distance from front tip of the lower jaw to the notch in the flukes with the animal lying dorsal side up. A rope with pole attached at each end is used to measure the straight line distance. After marking the spot where the the length lines up with the pole, the line is then

measured with a tape.

Color is recorded as:

W = white mature animal
G = light gray; adolescent animal
DG = dark gray; young animal
GW = mottled animal, part gray and part white

Age. The entire jawbone is taken for aging. The procedure involves skinning the bones from the outside with a knife, peeling the skin back, and then chopping the jawbones in half behind the last teeth. The tongue is then cut loose so that the bones are free (both jawbones and all teeth}.

W. The first and last name of the captain of the crew that harvested the whale.

The specimen number used by the NSB Harvest Survey to identifiy each individual whale was also recorded on the *Archival Project* data forms. In addition to the above information, the following samples were collected for the NSB Department of Wildlife Management: liver, kidney, blubber, and reproductive organs (ovaries plus uterine horns for the females; testes for the males) were frozen; skin samples in DMSO solution for mitochondrial DNA analysis. Stomach samples were taken from one individual animal (*Appendix A).*

The spring of 1989 was a very poor season for both bowhead and belukha whale hunting at Point Hope. No bowheads were landed and only five belukhas. Fortunately we were able to obtain samples from four of these animals.

2.3.3 Bearded Seals, Barrow

On July 16-22, 1989, Paul Becker, Alaska Office, OAD, and Rolf Zeisler, NBSB, NIST, collected tissues from bearded seals taken in local subsistence hunts at Barrow. Due to ice conditions, hunting was limited. The ice was located far offshore and the animals were scarce in the hunting area. However, due to the efforts of Billy Adams, North Slope Borough Department of Wildlife Management, we were able to obtain two subsamples (150 g, each) of three tissue-types (liver, kidney, and fat) from two individual bearded seals according to protocols described in Becker, et al. (1988a) and as modified by Becker, et al. (1988b, pages 9-11).

2.4 Survey of Existing Collections

Steps were initiated in FY 88 to document the locations and condition of tissue samples held by researchers and government agencies and to determine their suitability for future contaminant analysis. A total of 325 samples of ringed seal tissues collected in 1984 from Norton Sound and at Cape Lisburne were transferred from USFWS to OCSEAP in 1988 and their suitability for future analysis is being evaluated. Although the survey was to be completed in FY 89, additional collections continue to be located and this effort will extend through FY 90.

3.0 ARCHIVED TISSUES

The following are presently archived within the NBSB as part of OCSEAP RU 692:40 samples (liver, kidney, fat, and muscle) collected from northern fur seals in the Bering Sea; 60 samples (liver, kidney, and fat) collected from ringed seals, 10 samples (liver, kidney, and fat) collected from bearded seals, and 18 samples (liver, kidney, and fat) collected from belukha whales in the Chukchi Sea; 6 samples (liver, kidney, and fat) collected from bearded seals and 30 samples (liver, kidney, and fat) collected from ringed seals in Norton Sound. Besides these tissues, which are stored in liquid nitrogen vapor, teeth samples and histological samples of liver and kidney are also maintained by the archive or are held by the OCSEAP Office in Anchorage. An itemization of this tissue collection is presented in *Appendix A.*

Samples of ringed seal liver, kidney, blubber, muscle, and brain tissues collected by ADF&G in 1984 and transferred to the USFWS (100 samples from Norton Sound and 225 samples from Cape Lisburne), are presently in the OCSEAP freezer in Anchorage. Copies of the original forms containing measurement data on each of the individual animals are also located at the OCSEAP offices in Anchorage. An itemization of this tissue collection is presented in *Appendix B.*

4.0 QUALITY CONTROL ANALYSES

In order to evaluate the stability of the archived tissues, NIST monitors the concentrations of selected trace elements and organic contaminants in 20% of the tissue specimens. Aliquots of those specimens selected for monitoring are initially analyzed to establish the baseline levels. Repeated analyses of aliquots of these tissues on a regular basis (every one or two-years) provide measures of any change from the initial baseline concentrations. Besides providing a baseline to evaluate sample storage stability, these analyses also serve two other purposes:

1. They provide some real-time measure of contaminant concentrations for monitoring purposes.

2. They provide a baseline for comparing contaminant levels using present analytical techniques with those measured in the future by other laboratories using different methods.

Of the two subsamples (samples A and B) of each tissue which are archived, sample "A" is maintained in long-term storage in the liquid nitrogen freezer while sample "B" is used for the initial baseline analyses and storage stability evaluation. Samples to be analyzed are homogenized using a cryogenic homogenization procedure designed to reduce the likelihood of changes in sample composition due to thawing and refreezing (Zeisler, et al., 1983). The sample homogenate is then aliquoted into small Teflon jars (7-1 O g) for analysis and for storage as the homogenate.

The analytical approach for the baseline determinations of the trace elements focuses on the use of a multi-element analytical technique, neutron activation analysis (NAA), to provide data on a large number of trace elements using only a limited amount of sample. Additional analytical techniques (voltammetry and atomic absorption) are used to provide data on elements of high priority that are not routinely measured by NAA (e.g., Pb and Ni) and to provide quality control data for selected elements by comparing data from two different analytical techniques. High performance liquid chromatography with fluorescence detection are used to measure aromatic hydrocarbons and capillary gas chormatography with electron capture detection to measure selected chlorinated hydrocarbons.

As part of the sample stability monitoring, aliquots of tissue samples collected from northern fur seals in 1987 (Bering Sea) and ringed seals in 1988 (Chukchi Sea) were

analyzed during the reporting period. Four tissue types (liver, kidney, fat, and muscle) were analyzed from two northern fur seals from the St. Paul Island Northeast Rookery. Animal number 1 (692-FRSL-O04 in *Appendix A)* was a three year-old male; animal number 2 (692 -FRSL-O05 in *Appendix A)* was a two year-old male. Since muscle tissue was eliminated from collections in 1989 due to sample homogenization difficulties and low analyte levels, three tissue types (liver, kidney, and fat) were analyzed from two ringed seals. Both animals were two year-old males. Animal number 1 is 692-RGSL-004 and animal number 2 is 692-RGSL-008 in *Appendix A.*

4.1 Analytical Methods

4.1.1 Trace Elements

The determination of trace elements were performed on liver, kidney, and muscle from the two northern fur seals and liver and kidney from the two ringed seals using instrumental neutron activation analysis (INAA). The procedure followed the approach developed for analyzing human tissue from the NBSB (Zeisler, et al., 1988). The tissue homogenates were freeze-dried, pressed into 200 mg pellets, and irradiated. The fat tissue could not be transformed into a sample suitable for the INAA procedure and therefore was not analyzed for trace elements using this technique. The INAA procedure consisted of a 120 s irradiation at a fluence rate of 2x1017 $n \cdot m^{-2} \cdot s^{-1}$ followed by two counts on a high resolution gamma spectrometer and a second 16 hour irradiation followed by two counts after appropriate decay times. Element standards for quantitation by the comparator method and certified reference materials (NIST SRM 1577 Bovine Liver, NIST SRM 1572 Citrus Leaves, and IAEA MA-A-2/TM Fish Flesh) for quality assurance were included in the irradiation sets. A special high count rate gamma spectrometer, combined with loss-free counting techniques (Westphal, 1982) was used to lower the instrumental detection limit for vanadium.

4.1.1 Organic Compounds

The determination of concentrations of selected organic compounds were performed on fat, liver, kidney, and muscle from the two northern fur seals and fat, liver, and kidney from the two ringed seals. Analytical methods are described in detail in NIST Reports of Analysis 552-88-079 and 552-89-047 which are provided in *Appendix C, Quality Control Analytical Data: Organic Contaminants.*

4.2 Results

4.2.1 Trace Elements

The results of the INAAanalyses of the northern fur seal tissues are given in Table 2. Replicate samples from the various tissues did not deviate more than 5% relative if the analytical uncertainty due to counting statistics was sufficiently small. This result is in agreement with earlier findings on human liver tissue in the NBSB (Zeisler, et al., 1984). The analysis of the certified reference materials did not reveal any bias. The following elements were also included in the quantitative evaluation, but were below their detection limit in all investigated tissues: Sr, La, Ce, Sm, Eu, Tb, Hf, Ta, Au, and U.

It is difficult to interpret data sets from only two animals; however, comparing these data with previously published range values for this species does provide for some preliminary comparisons. Generally speaking, the trace element data for the northern fur seals are the same order of magnitude as has been previously reported for this species (Goldblatt and Anthony, 1983; Smith, 1986). Cd is quite interesting because its reported levels in liver and kidneys of northern fur seals are quite high (Goldblatt and Anthony, 1983; Smith, 1986; Table 2), even for marine mammals. It is also interesting to note that the concentrations (based on wet weight) we found in the liver (8.01 - 18.51 $mg \cdot kg^{-1}$), muscle (0.26 - 0.39 $mg \cdot kg^{-1}$), and kidney (29.02 - 66.6 $mg \cdot kg^{-1}$) are quite similar to the levels reported by Fujise, et al. (1988) in two Dall's porpoise (*Phocoenoides dalli*) taken at the end of the Aleutian chain in 1982 (liver, 3.86 - 20.6 $mg \cdot kg^{-1}$; muscle, 0.09 - 0.35 mg·kg -1; kidney, 20.1 - 34.0 $mg \cdot kg^{-1}$). Both species range over the same geographic area and have similar food habits, preying on squid and deep-water fish.

Although INAA analyses of the ringed seal tissues have been completed, the data are very preliminary and will not be reported here. The results of these analyses will be given in the first FY 90 Quarterly Report (January, 1990).

4.2.2 Organic Contaminants

The results of the organochlorine analyses of both the northern fur seal and ringed seal tissues are given in NIST Reports of Analysis 552-88-079 and 552-89-047 which are found in *Appendix C, Quality Control Analytical Data: Organic Contaminants.* Concentrations of PCB and pesticides were determined for all 20 PCB congeners and all 15 chlorinated pesticide analytes contained in the NOAA calibration solutions

Table 2. Trace element concentrations by INAA in northern fur seal (*Callorhinus ursinus*) tissues. Values are $mg \cdot kg^{-1}$, wet weight; errors (+or-) represent uncertainty of a single determination and are comprised of counting statistics and estimated uncertainty due to standards and irradiation and counting geometries.

	Liver		Kidney		Muscle	
	animal 1	animal 2	animal 1	animal 2	animal 1	animal 2
	MM1L013	MM1L017	MM1K014	MM1K018	MM1M015	MM1M019
Na	760.4 (6.0)	699.8 (5.5)	1305.4 (9.8)	1382.3 (10.2)	505.4 (3.7)	479.4 (3.6)
Mg	194 (4.5)	213 (4.4)	189 (5.4)	168.4 (4.2)	231 (3.9)	272 (4.5)
Al	0.533 (0.081)	0.522 (0.042)	1.599 (0.085)	0.780 (0.053)	0.313 (0.041)	0.712 (0.049)
cl	1016 (13)	891 (12)	1578 (18)	1697 (16)	538.9 (8.0)	470.0 (6.0)
K	3316 (50)	3155 (59)	2610 (49)	2464 (33)	3350 (33)	3615 (38)
Ca	38.3 (4.4)	30.6 (3.8)	38.1 (4.4)	53.1 (4.0)	31.5 (3.7)	22 .1 (2.5)
Sc	≤0.00012	≤0.00013	≤0.00011	≤0.00009	0.000143 (0.000007)	0.000087 (0.000006)
v	0.0843 (0.0062)	0.1088 (0.0044)	≤0.013	≤0.008	≤0.0073	≤0.0073
Cr	0.0251 (0.0044)	0.0551 (0.0050)	0.0390 (0.0036)	0.0106 (0.0032)	0.0612 (0.0030)	0.0386 (0.0030)
Mn	4.179 (0.045)	3.185 (0.036)	1.157 (0.022)	1.260 (0.015)	0.1630 (0.0058	0.1857 (0.0063)
Fe	171.8 (1.0)	118.8 (0.8)	74.00 (0.49)	51.70 (0.37)	75.12 (0.48)	70.58 (0.45)

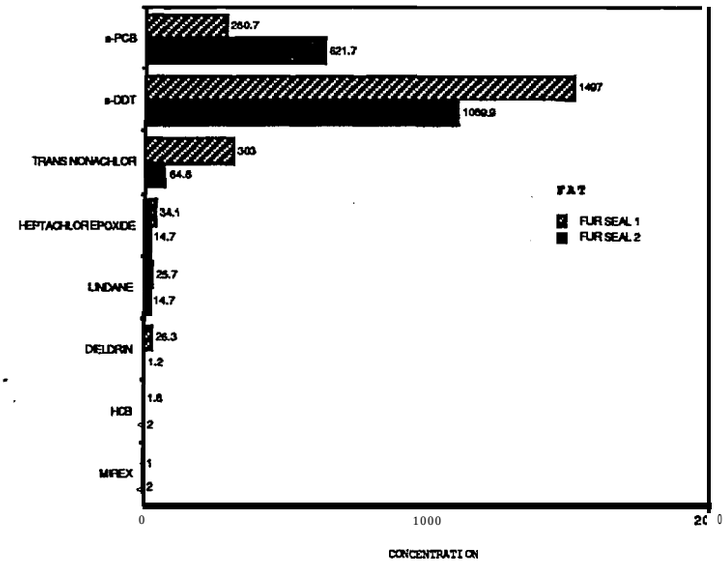
	Liver		Kidney		Muscle	
	animal 1	animal 2	animal 1	animal 2	animal 1	animal 2
	MM1L013	MM1L017	MM1K014	MM1K018	MM1Mo15	MM1M019
co	0.01884 (0.0001 6)	0.01624 (0.00016)	0.02501 (0.00017)	0.01733 (0.0001 4)	0.005094 (0.000068)	0.003641 (0.000057)
Cu	56.34 (0.82)	17.03 (0.49)	7.06 (0.52)	8.71 (0.35)	2.20 (0.45)	2.07 (0.30)
Zn	56.53 (0.42)	57.89 (0.43)	63.28 (0.47)	37.18 (0,28)	35.00 (0.26)	33.43 (0.25)
As	≤0.092	0,187 (0.20)	0.164 (0,021)	0.503 (0.023)	0,174 (0.012)	0.311 (0.014)
Se	6.289 (0.052)	5.450 (0.045)	3.856 (0.032)	3.066 (0.026)	3.109 (0.026)	2.147 (0.018)
Rb	1.874 (0.047)	1.759 (0.049)	1.368 (0.033)	1.038 (0.030)	1.518 (0.028)	1.408 (0.028)
Mo	0.38 (0.10)	0.65 (0.11)	≤0.40	≤0.29	≤0.25	≤0.28
Ag	0.1721 (0.0023)	0.3815 (0.0037)	≤0.0044	0,0129 (0.0011)	≤0.0030	≤0.0029
Cd	18.5.1 (0.29)	8.01 (0.19)	66.66 (0.79)	29.02 (0.39)	≤0.26	≤0.39
Sb	0.00105 (0.00027)	0.00375 (0.00033)	≤0.00069	≤0.00054	≤0.00048	0,00060 (0.00016)
I	0.447 (0.071)	1.74 (0.12)	≤0.32	≤0.16	≤0.20	≤0.21
Cs	0.1691 (0.00048	0.02880 (0.00053)	0.02474 (0.00050)	0.02312 (0.00044)	0.04045 (0,00046)	0.04321 (0.00045)

(SRMS 1492 and 1493). Results of the aromatic hydrocarbon analyses will be reported in the first FY 90 Quarterly Report (January, 1990). Preliminary indications are that aromatic hydrocarbon concentrations were below detection limits for all the tissue samples analyzed.

The Environmental Conservation Division, Northwest Fisheries Center, NMFS, measured fluorescent aromatic compounds in bile we collected from the ringed seals. The method for this analysis is presented in Krahn, et al. (1 984). Preliminary results suggest that all 10 animals had not been exposed to aromatic compounds (Varanasi, personal communication, 1989). An interim reference value for marine mammals not exposed to petroleum hydrocarbons has been established from these results and has been used to compare with bile collected from harbor seals and sea lions in Prince William Sound following the EXXON VALDEZ oil spill.

It is difficult to interpret data sets from only two animals, each; however, comparing the organochlorine data with previously published range values for these two species does raise some questions that might be addressed as more samples from these animals are analyzed. Comparing the relative concentrations of the organochlorines we measured in fat and liver of the two species (Figures 1 and 2), it is apparent that for both species and for both tissues the dominant organochlorines are sPCB (sum of 20 conveners), sDDT (DDE + DDD + DDT), and metabolic products of the chlordane group compounds (trans-nonachlor and heptachlor epoxide). The relative importance of the chlordane group is not surprising since Muir, et al. (1987; 1988) reported chlordane compounds at levels equal to that of both sDDT and sPCB in ringed seals from the Northwest Territories, Canada.

When the distribution patterns of the northern fur seals (Figure 1) are compared with those of the ringed seals (Figure 2), some differences are apparent. In the ringed seals, sPCB > sDDT, while in fur seals sDDT > sPCB. Also, the distribution of relative concentrations of organochlorines is consistent between animals and between fat and liver in the northern fur seal (sDDT > sPCB > trans-nonachlor > heptachlor epoxide > lindane > dieldrin > HCB > mirex. The distribution of relative concentrations appears to be different between fat and liver tissue in the ringed seals.



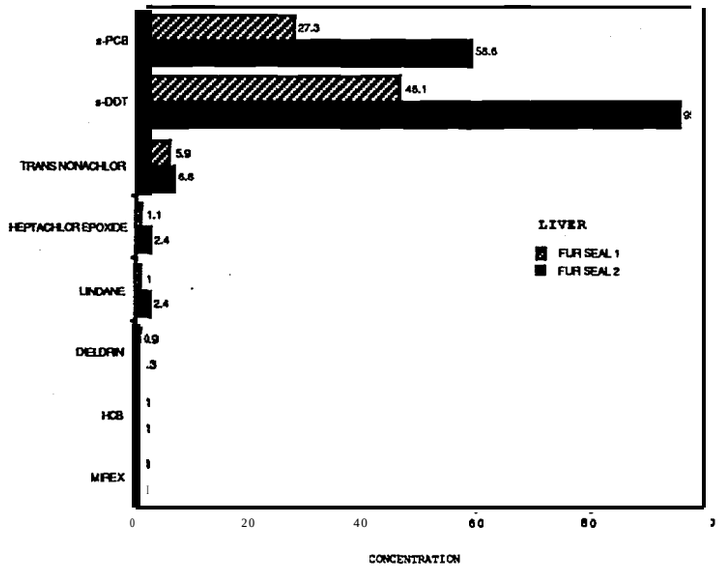
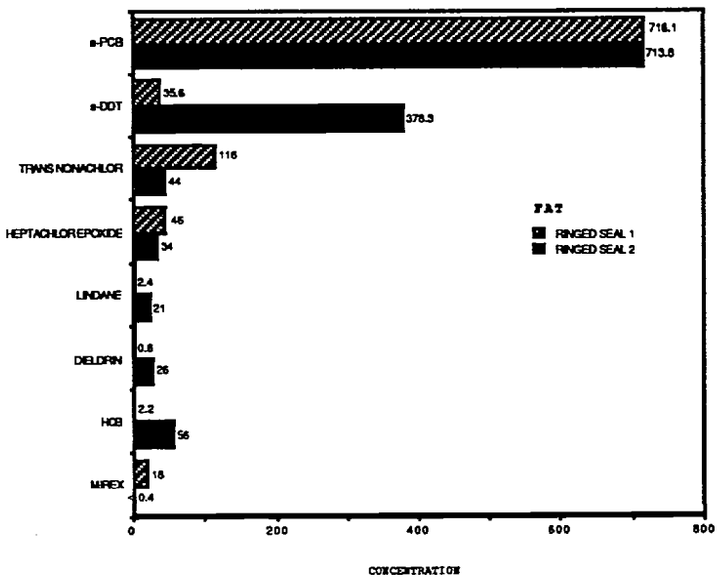


Figure 1. **Concen**ration **(ng·g-1,** wet we**ght)** of chlorinated hydrocarbons in northern fur seal (***Callorhinus ursinus***) fat and liver.



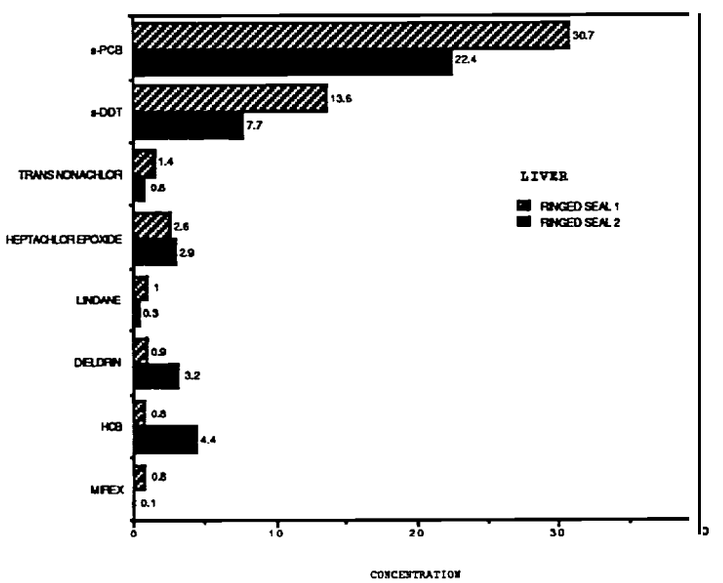


Figure 2. Concentration (rig-g-l, wet weight) of chlorinated hydrocarbons in ringed seal (***Phoca hispida***) fat and liver.

4.2.2.1 DDT

As is consistent with DDT data reported from other marine mammals world-wide, the great majority (at least 80 %) of sDDT in the northern fur seals (Figure 3) and ringed seals (Figure 4) is in the metabolized form, DDE. This is reflected in all tissue types analyzed, although the highest proportion of DDE to sDDT is found in the fat.

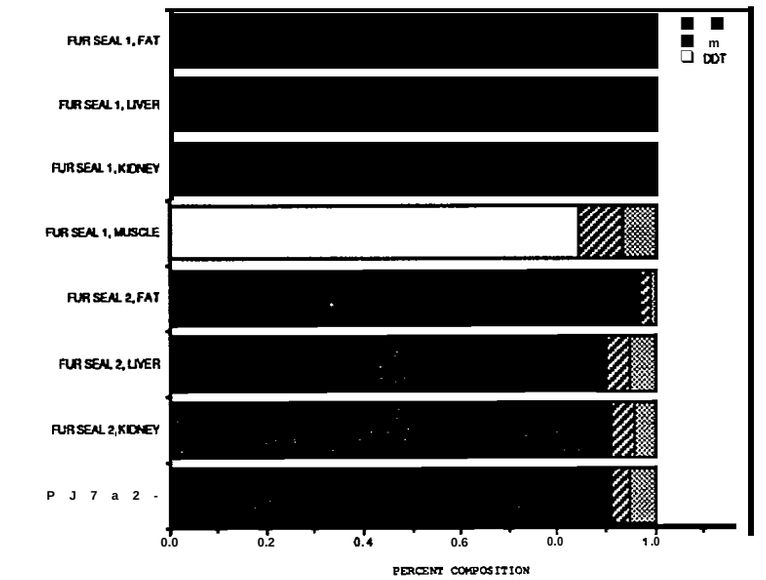
Phillips and Tanabe (1989) presented the distribution of DDE, DDD, and DDT in the fat of three trophic levels in the North Pacific leading to the striped dolphin (*Stenella coeruleoalba*) (Figure 3). Both the myctophid fish and the squid are also food items of the northern fur seal The pattern of increasing fraction of DDE from mixed zooplankton to the top predator (striped dolphin) shown by Phillips and Tanabe (1989) is probably consistent with what would be expected between the northern fur seal and the lower trophic levels in the Bering Sea.

The concentrations of sDDT in the two northern fur seals are somewhat lower than have been previously reported for the same age and sex of this species. Although sDDT appears somewhat lower in fat, it is almost an order of magnitude lower in the liver (Table 3). it also appears that the fraction of DDE to sDDT has remained fairly constant throughout the 1970's and the 1980's in both fat and liver.

4.2.2.2 PCB

The levels of sPCB (sum of 20 congeners) measured in the liver and fat of the two ringed seals are basically the same as that which we measured in the same tissues of the northern fur seals (Figure 5). These levels cannot really be compared with. that reported by Muir, et al. (1987; 1988) for ringed seals in the Northwest Territories, Canada (sum of 46 conveners). Nor can one really compare the sPCB we measured in northern fur seals (sum of 20 congeners) to previous concentrations reported for this species in the Pribilof Islands (primarily based on Aroclors) (Kurtz, n.d.; Kurtz and Kim, 1976; Calambokidis and Peard, 1985).

Comparisons can possibly be made with data from other sources if reported on a congener specific basis. Unfortunately, there are few such studies. Some examples are: Abarnou, et al. (1 986) who presented data for Commersons dolphins (*Cephalorhynchus commersonii*) in the southern Indian Ocean, Boon, et al. (1987) who presented data on harbor seals (*Phoca vitulina*) from the Dutch coast, and Masse, et al. (1986) who presented data on belukha whales (*Delphinapterus leucas*) from the St. Lawerence



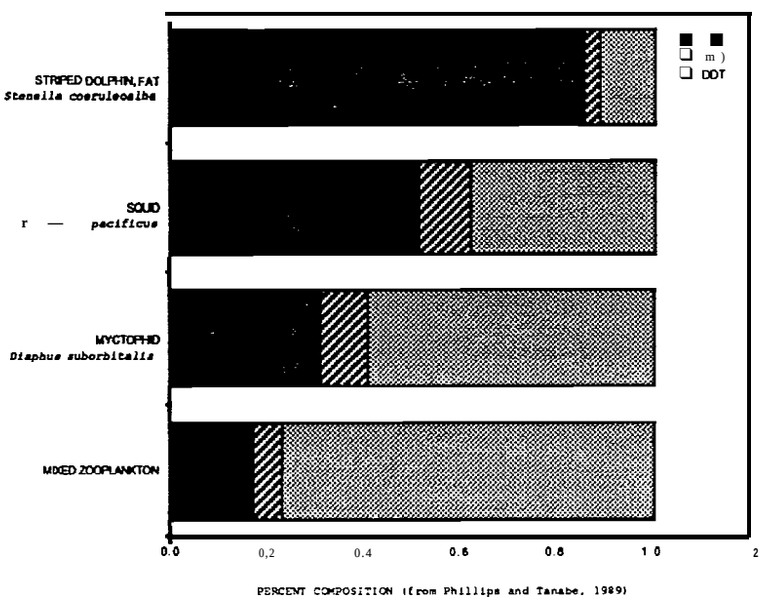


Figure 3. DDT and metabolizes, northern fur seal (***Callorhinus ursinus***)

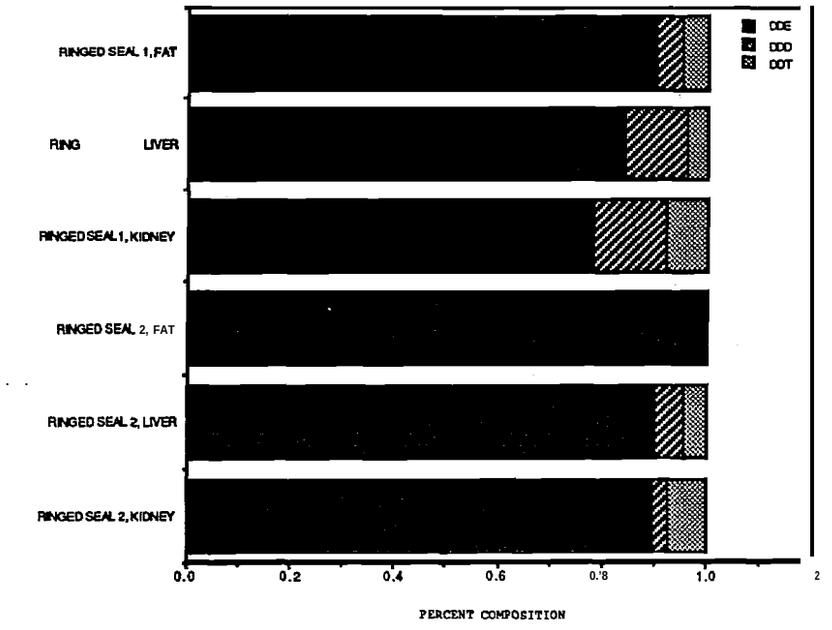


Figure 4. DDT and metabolizes, ringed seal (***Phoca hispida***).

estuary. Two investigations reporting congener specific data especially pertinent to our project are by Tanabe, et al. (1988) who presented data on ribbon seals (*Phoca fasciata*), Dall's porpoise (*Phocoenoides dalli*), and major food items from the Bering Sea , and by Muir, et al. (1987) who presented data on ringed seals and their principal food from the Northwest Territories, Canada.

The pattern of PCB congeners in the tissue samples is probably determined by the source of the PCB (technical PCB source), time of input, modification during transport and transfer through the food web, with periodic different sources superimposed (Zen, et al., 1978), and also as modified by selective metabolism of the animal (species, individual, and organ specific). PCBS 153 and 138 (hexachloroisomers) consistently dominate the congener distribution in all four tissue types analyzed in the northern fur seals. Other prominent congeners are PCBS 66, 118, and 180. Since in mammalian systems PCB 153 usually occurs at relatively high levels and is also resistant to metabolic action, fat and liver concentrations of PCB congeners are normalized to PCB 153 and presented in Figure 6. The relative distribution of the 20 PCB congeners is

Table 3. sDDT concentrations and DDE/s DDT in northern fur seal (*Callorhinus ursinus*) fat and liver. Values are expressed as $ng \cdot g^{-1}$, wet weight; errors (+or-).

Source	Fat		Liver	
	sDDT	DDE/sDDT	sDDT	DDE/sDDT
1969[1]	1600	0.81	110	0.80
c1 yr	**(1900)**	0.55 - 0.94	(80)	0.60-0.95
19752	5210	0.80	280	0.86
3-4 yr male	(1260)		(loo)	
1978[3]	7770	0.77	330	0.86
3-4 yr male	(5980)		(280)	
19803	7520	1.00	237	1.00
2-6 yr male	(4010)		(94)	
1981[2]	5470	0.77	230	0.75
3-4 yr male	(2210)		(110)	
1987[4]	1497	0.89	46.1	0.84
3 yr male				
1987[4]	1089.9	0.97	95.1	0.90
2 yr male				

[1] Anas and Wilson (1970)

[2] Kurtz n.d.

[3] Calambokidis and Peard (1 985)

[4] Collected by the AMMTAP in 1987

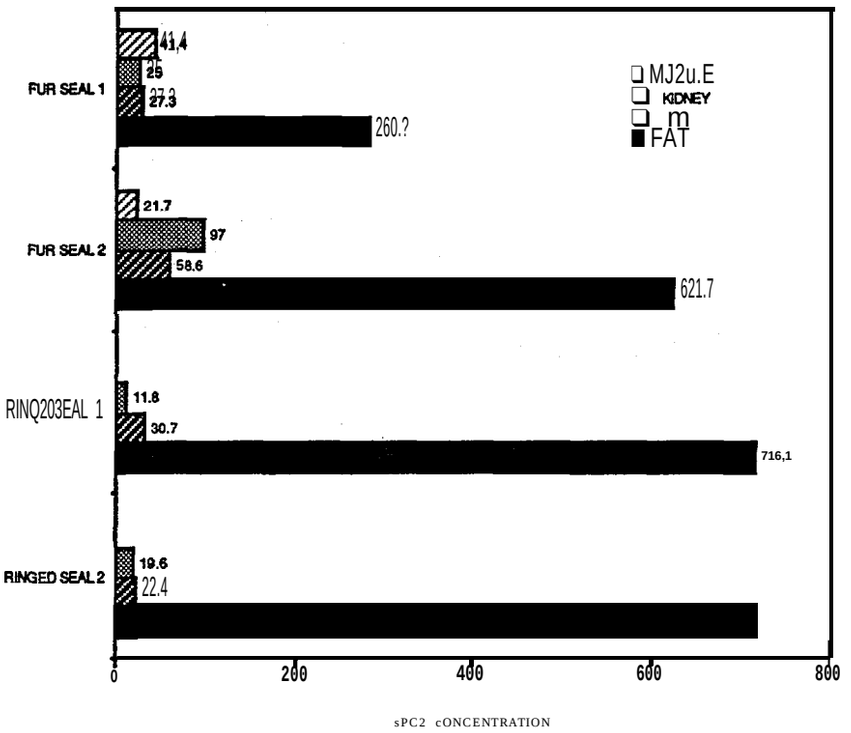


Figure 5. sPCB concentration **(ng·g-1,** wet weight) based on the sum of 20 **congeners** for tissues of northern fur seals **(*Callorhinus ursinus*)** and ringed seals **(*Phoca hispida*).**

similar between the two individual animals and between the tissue types. This pattern of distribution is also quite similar to that reported for Dall's porpoise and ribbon seal in the Bering Sea (Tanabe, et al., 1988).

The patterns of PCB congener distribution in the ringed seals (Figure 7) are quite different from those shown in the northern fur seal (Figure 6). Like the northern fur seal, **PCB's** 66, 118, 153, 138, and 180 are prominent in the tissues of the ringed seal. However, other **congeners** also become important in the distribution patterns, PCBS 8, 28, and particularly 101. The following congeners were also reported by Muir, et al.

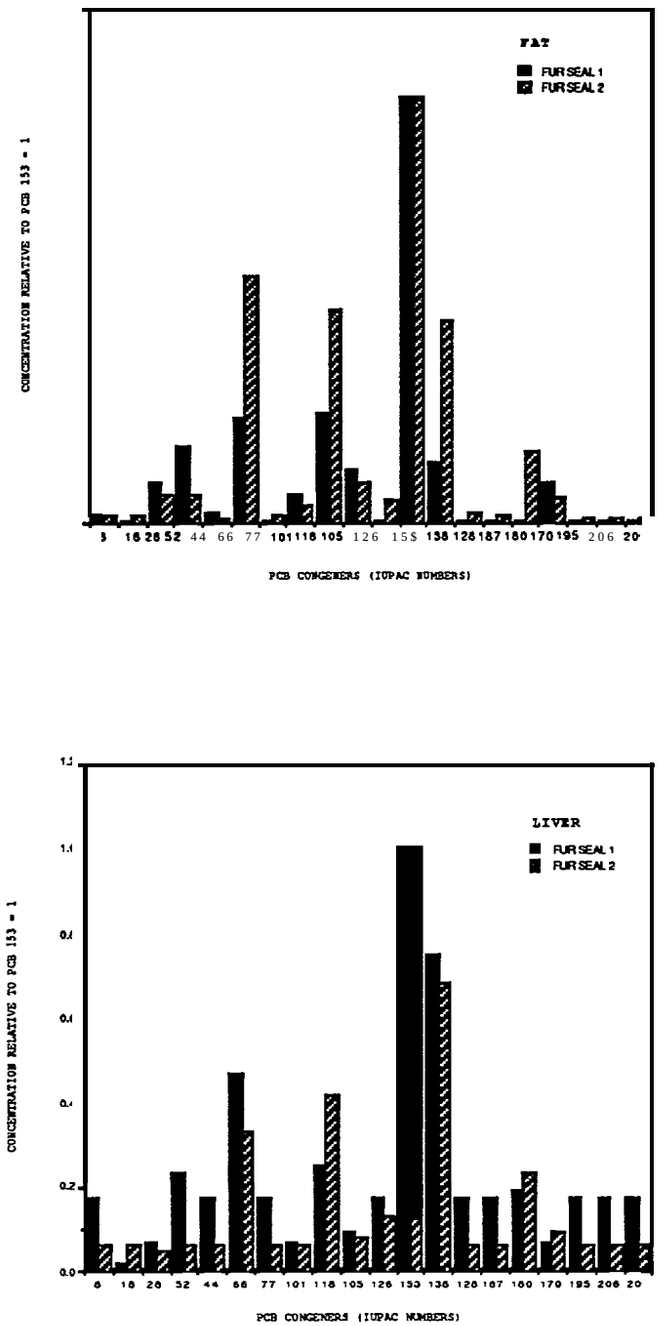


Figure 6. Distribution of PCB congeners relative to PCB 153 in northern fur **seal (*Callorhinus ursinus*)** fat and liver.

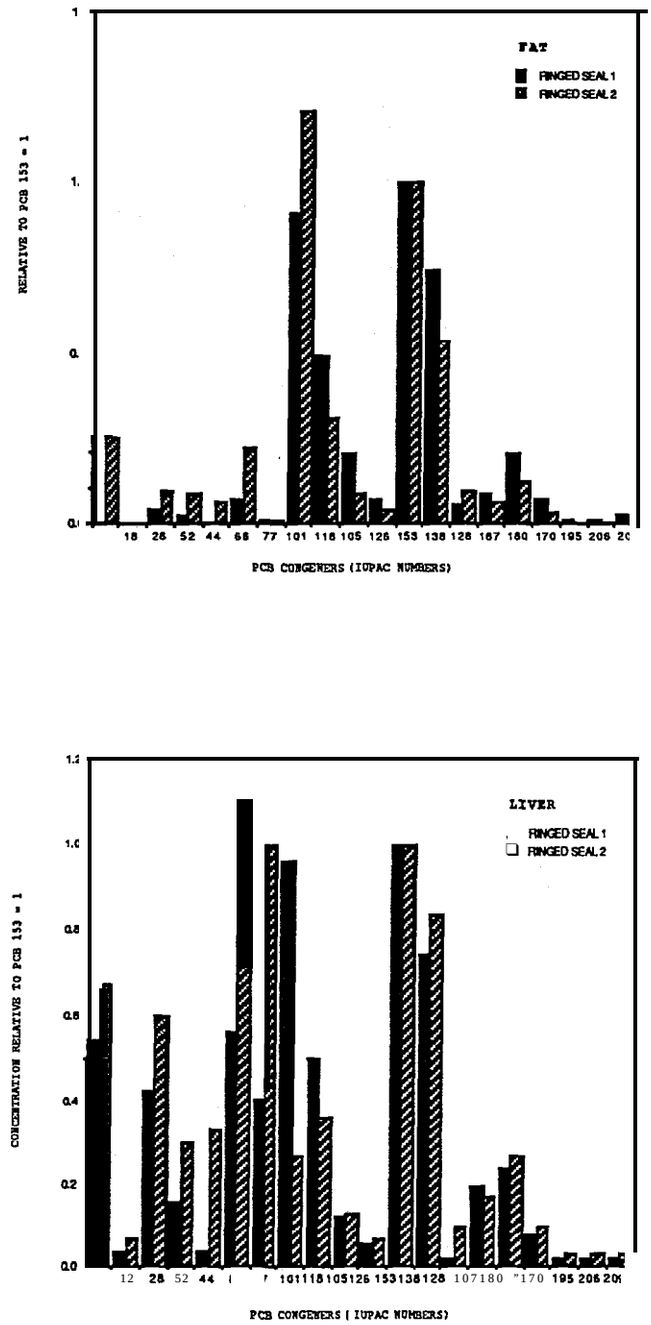


Figure 7. Distribution of PCB congeners relative to PCB 153 in ringed seal (***Phoca hispida***) fat and liver.

(1988) in the fat of ringed seals: 138, 149, 153, 180 (>5 %, each, of sPCB); 52, 66/95, 101, 99, 118, 187, and 170 (2 -5 %, each, of sPCB).

In several cases, the concentrations of other congeners exceed that of PCB 153 in the ringed seals (66 in the kidney of animal no 1; 28 in the kidney, 66 in the liver, and 101 in the fat of animal 2 *(Appendix C* and Figure 6). Also quite different from the northern fur seals, the congener distribution patterns are not consistent between tissue types. Figure 8 presents the percent composition of chloroisomers in the tissues of the individual northern fur seals and ringed seals. The patterns in fat, liver, kidney and muscle tissue of the northern fur seals are similar. Tetra- penta-, and hexachlorobiphenyls are most abundant, with the hexachlorobiphenyls dominating.

In the case of the ringed seals, patterns in the kidney and liver tissue are quite different from those in the fat (Figure 8). Penta- and hexachlorobiphenyls dominate the fat tissue. Concentrations of tetrachlorobiphenyls are relatively higher in the liver and kidney than in the fat, and there appears to be skewing of the distribution in the liver and kidney to the lower chlorinated biphenyls (di- and trichlorobipheny is). One might suggest that the distribution of chloroisomers between the different tissues of the northern fur seal reflect a condition of equilibrium between the tissues, while the distribution in the ringed seal tissues reflect a non-equilibrium state.

Several hypotheses might explain differences in chloroisomer distribution patterns between these two species. Although both the ringed seals and northern fur seals are of the same sex (males) and about the same age (2-3 years), the patterns for the fur seals appear to show a greater metabolized form of the PCB mixture than that for the ringed seals. This could be reflective of different technical sources of PCBS for the two species, different modifications of the PCB compounds during transport, species specific metabolic differences, and/or differences in the food webs supporting the two species.

Recent investigations of chloroisomer distribution in different trophic levels have indicated a pattern of increasing dominance of higher chlorinated biphenyls from lower to higher trophic levels (Muir, et al., 1987; Tanabe, et al., 1988). The more highly chlorinated biphenyls are more resistant to metabolic breakdown and tend to bioconcentrate in the lipid reservoir at the higher trophic levels. The lesser chlorinated isomers tend to be metabolized more readily and are not bioconcentrated at the higher trophic levels. The distribution of chloroisomers in the liver and kidney of the ringed seals may reflect a somewhat lower trophic level than that of the northern fur seal.

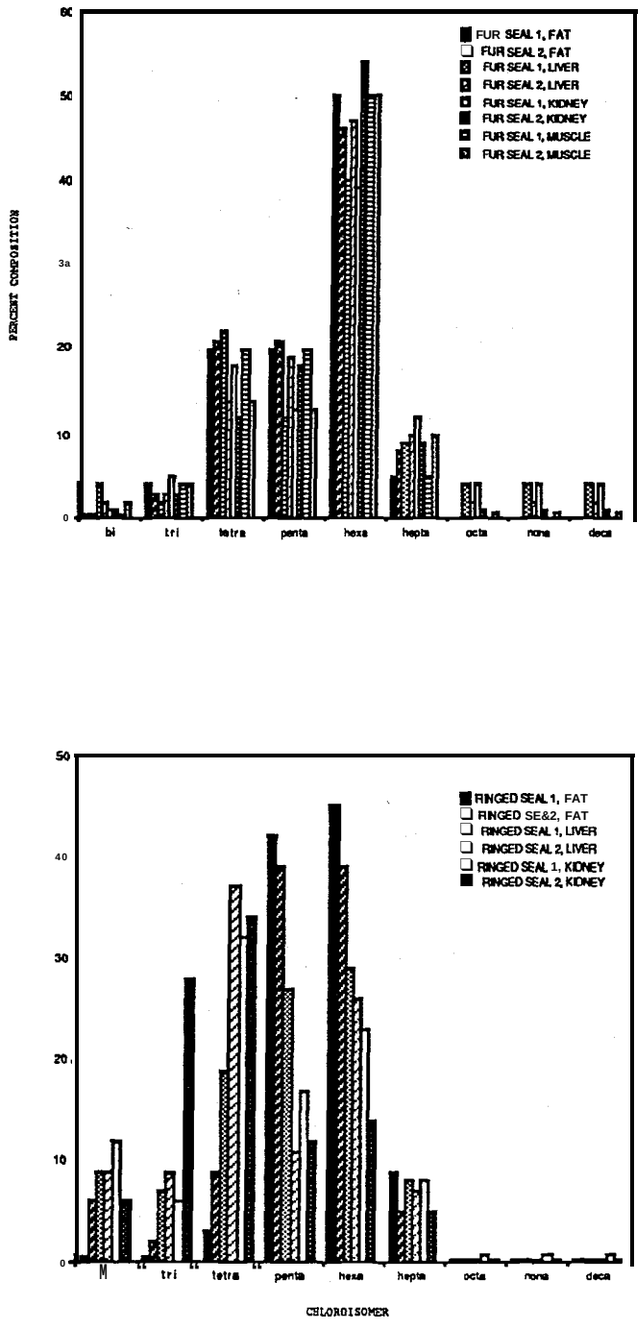
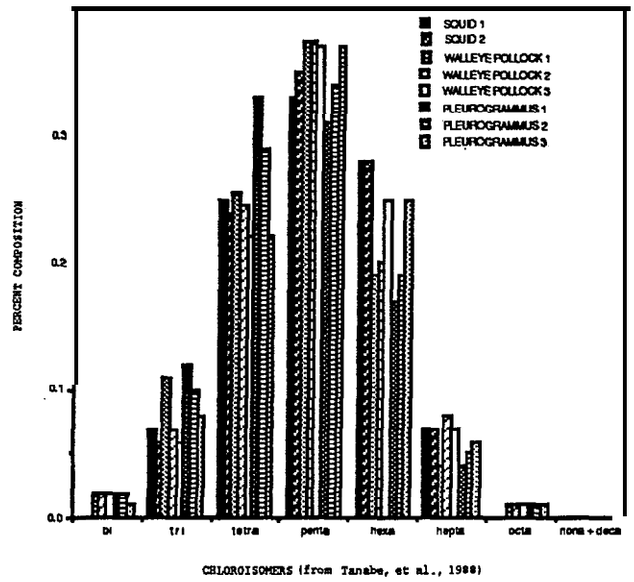


Figure 8. Chloroisomer distribution in northern fur seal (***Callorhinus ursinus***) and ringed seal (***Phoca hispida***) tissues.

The chloroisomer distribution in the fat of both seal species and prey items of each are shown in Figures 9 and 10. The potential food organisms shown in Figure 9 were collected in the Bering Sea and analyzed by Tanabe, et al. (1988). Both finfish (*Pleurogrammus monopterygius* and walleye pollock, *Theragra chalcogramma*) and squid are principal prey of the northern fur seal. Chloroisomer distribution in these three species are similar and resemble that of arctic cod, an important prey of adult ringed seals (Figure 10); however, tetrachlorobiphenyls appear to be more enhanced in the three Bering Sea species. Hexachlorobiphenyls appear to be enhanced in the northern fur seal tissues at the expense of the di-, tri-, tetra-, and pentachlorobiphenyls (Figure 9). This pattern in the northern fur seal is reflective of its relatively high trophic position.

Although such an enhancement of hexachlorobiphenyl was shown by Muir, et al., (1988) in comparing ringed seal to attic cod (Figure 10) and although such an enhancement might be the case for the fat of ringed seals we sampled at Barrow, this is not supported by the chloroisomer distribution in the liver or the kidney of this species (Figure 8). Both the ringed seals we sampled at Barrow had invertebrates (amphipods, euphausiids and mysids) in their stomachs. The chloroisomer distribution patterns in the liver and kidney of these animals might be more reflective of food originating from a lower trophic level than that represented by arctic cod.

Isomer specific analysis of PCBS promises to produce new understanding in the ecotoxicology of PCBS (Tanabe, et al., 1987; Tanabe, 1989). The toxicity of PCBS appears to be related to levels of a few specific congeners having four or more chlorine atoms at both para and meta positions in the biphenyl rings, but no chorine atoms in the ortho positions. Such congeners are coplanar; mono- and di-ortho analogues of these coplanar PCBS also appear to be toxic due to their ability to induce MC-type hepatic microsomal enzymes (Tanabe, 1989). Five of the congeners measured in the ringed seals and northern fur seals are coplanar (PCBs 66, 77, 118, 105, and 126). Two of these have been identified as highly toxic, PCB 77 (3,3',4,4'-tetrachlorobiphenyl) and PCB 126 (3,3',4,4',5-pentachlorobiphenyl, and one, PCB 105 (2,3,3',4,4'-pentachlorobipheny l), has been implicated in reproductive problems in snapping turtles. The most toxic PCB, 169 (3,3 ',4,4',5,5'-hexachlorobiphenyl), was not reported in our samples.



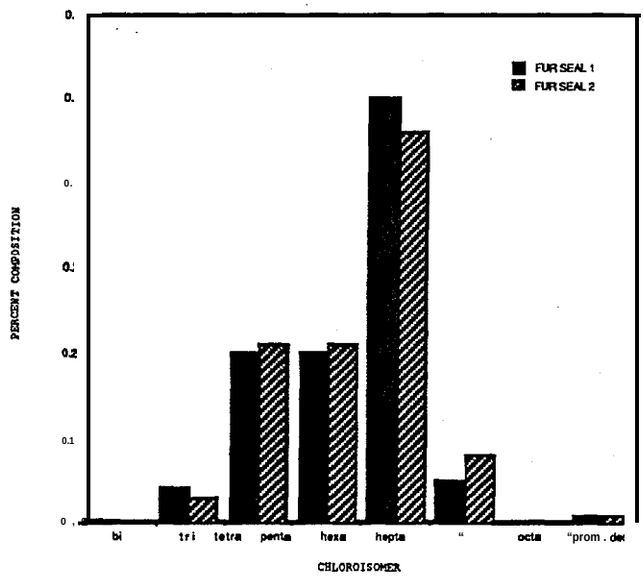


Figure 9. **Chloroisomer** distribution in fat of northern fur seal (***Callorhinus ursinus***) and potential food organisms.

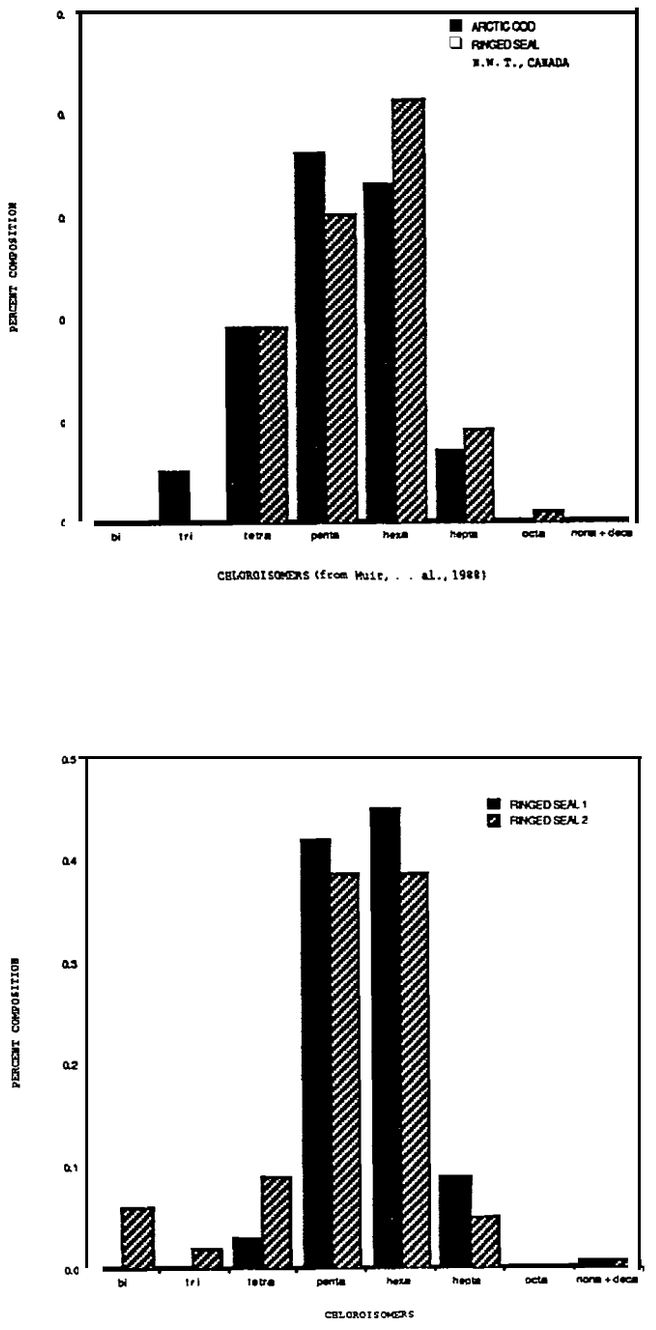


Figure 10. **Chloroisomer** distribution in fat of ringed seal (***Phoca hispida***) and potential food organisms.

The relative distributions of the coplanar PCBs are shown in Figure 11. The most toxic coplanars, PCBs 77 and 126, occur at the lowest coplanar concentrations in both species. The values of PCB 126 (based on wet weight) in the fat of the ringed seals appear to be relatively high (12.3 and 6.5 $ng \cdot g^{-1}$) when compared with values reported for other marine mammals. Tanabe, et al. (1987) reported wet weight PCB 126 values for the fat of Dali's porpoise as 0.083 - 0.250 $ng \cdot g^{-1}$, Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) as 3.2 -4.4 rig-g-l Baird's beaked whale (*Berardius bairdii*) as 0.39-0.57 rig-g-l, finless porpoise (*Neophocoena phocoenoides*) as 0.89 $ng \cdot g^{-1}$, and killer whale (*Orcinus orca*) as 4.0 $ng \cdot g^{-1}$. Terrestrial mammals had much lower concentrations (0.1 2 - 0.73 $ng \cdot g^{-1}$ for humans, 0.064- 0.13 $ng \cdot g^{-1}$ for cats, as did striped mullet, *Mugil cephalus* (0.032 - 0.23 rig-g-l). Muir, et al. (1987) did not report either PCBS 77 or 126 in ringed seals he sampled from the Northwest Territories, Canada. Nor were these two congeners reported by Arbanou, et al., (1986) in Commersons dolphins from the Indian Ocean, Boon, et al., (1987) in harbor seals from the Dutch coast, and Masse, et al. (1986) in belukha whales from the St. Lawerence estuary. Norstrom, personal communication (1989) suggests the possibility of the presence of toxaphene (which we did not measure) producing elevated measures of PCB 126 in our ringed seal samples. This is being evaluated. The significance of coplanar PCBS in the ringed seals of the Alaskan Arctic will only become apparent as more seals are sampled and congener specific data is reported on a more routine basis, world-wide.

4.3.2.3 Other Organochlorines

The levels of dieldrin in the tissues of ringed seals and northern fur seals are similar. In the case of the fur seals, the concentration of dieldrin in fat (1.2 -26.3 $ng \cdot g^{-1}$, wet weight) is somewhat lower than what has been previously reported for this species at the Pribilof Islands (Arias and Wilson, 1970; Calambokidis and Peard, 1985). The levels of dieldrin found in the fat of the ringed seals (0.6 -26.0 $ng \cdot g^{-1}$, wet wt.) is also lower than that reported by Muir, et al. (1987; 1988) for the same species in Northwest Territories, Canada.

One compound of possible interest is mirex. This pesticide was found in low wet weight concentrations ($<1 ng \cdot g^{-1}$) in tissues of both species of seals. Although at low concentrations for most ringed seal tissues ($<1 ng \cdot g^{-1}$), one animal was found to have 18 $ng \cdot g^{-1}$ in its fat.

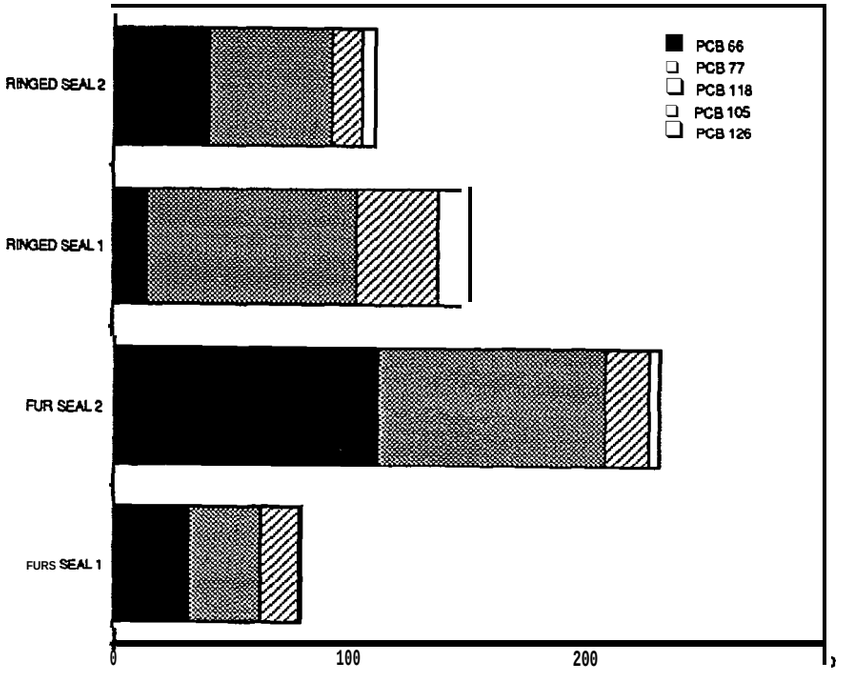


Figure 11. Concentration ($ng \cdot g^{-1}$, wet weight) of coplanar PCBS in northern fur seal (***Callorhinus ursinus***) and ringed seal (***Phoca hispida***) fat.

5.0 FUTURE ACTIVITIES

The activities which will continue through FY 90 and their projected completion dates are:

1. ***Archival Support*:**
   Sample cataloging- continuous
   Cryogenic storage- continuous
   Evaluation of protocols- continuous
   Monitoring sample stability- continuous

2. ***Planning and Coordination:***
   Plans for FY 90 sample collections- 3/90

3. ***Field Collections (tentative):***
   Belukha whales- 5/90
   Northern fur seals- 7/90
   Ringed and bearded seals- 7-8/90

4. ***Protocol Development:***
   Protocol report to be revised- draft, 9/90

5. ***Survey of Existing Collections:***
   - 9/90

Reports and their due dates are:

Quarterly Tissue Inventory- 1/90
Quarterly Tissue Inventory- 4/89
Quarterly Tissue Inventory- 7/89
Project Report- 10/89

The Tissue Inventory will provide the current inventory of tissues maintained in the Archive and will include the tissues by species, type of tissue, collection date and location, method of preservation, sex, size, and other parameters that may be obtainable from the collecting agency, plus the results of any chemical analyses.

The Project Report will be a final summary report of all project activities occurring during the period, 1987-1990, the tissue inventory, plus the results of any chemical

analyses. To facilitate decisions on the contaminants and types of tissues to be analyzed, a final list of contaminants, species and tissues that prioritizes the potential risks of oil- and gas-related pollutants to marine mammals and human consumers, plus requirements of MMS relative to information needs, will be included in this report.

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APPENDIX A

ALASKAN MARINE MAMMAL TISSUE INVENTORY NATIONAL BIOMONITORING SPECIMEN BANK NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, GAITHERSBURG, MARYLAND

SEPTEMBER 30,1989

NORTHERN FUR SEAL (*CALLORHINUS URSINUS*), ST. PAUL, ALASKA
BERING SEA, JULY 1987

692- FRSL-001 3-year male 57°10.5' 170°09.5' 28 July 1987
Polovina Rookery

Weight, 56.3 kg Standard Length, 114.0 cm Sternal Blubber Thickness, 1.5 cm

NBSB Samples:	Liver	Kidney	Muscle	Blubber	Tooth
Weight A(g)	135.0	93.0	125.0	119.0	
Weight B(g)	125.0	97.0	132.5	114.5	
NBSB ID	M M 1L001	MM1K002	MM1M003	MM1BO04	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Rotterman Samples (present location, NIH, Fredrick, MD):

Blood	5-15 mL	Heart	10 g
Liver	l o g	Spleen	10 g

692- FRSL-002 3-year male 57°10.5' 170°09.5' 28 July 1987
Polovina Rookery

Weight, 77.6 kg Standard Length, 117.3 cm Sternal Blubber Thickness, 2.5 cm

NBSB Samples:	Liver	Kidney	Muscle	Blubber	Tooth
Weight A(g)	117.8	137.2	170.0	156.0	
Weight B(g)	110.5	137.0	143.0	158.0	
NBSB ID	M M I L O 0 5	MM1K006	MM1M007	MM1B008	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Rotterman Samples (present location, NIH, Fredrick, MD):

Blood	5-15 mL	Heart	l o g
Liver	l o g	Spleen	l o g
Muscle	l o g	Skin	

NORTHERN FUR SEAL (*CALLORHINUS URSINUS*), ST. PAUL, ALASKA
BERING SEA, JULY 1987

692- FRSL-003 3-year male 57°10.5' 170°09.5' 28 July 1987
Polovina Rookery

Weight, 84.0 kg Standard Length, 124.0 cm Sternal Blubber Thickness, 3.0 cm

NBSB Samples:

	Liver	Kidney	Muscle	Blubber	Tooth
Weight A(g)	132.0	112.0	152.5	156.5	
Weight B(g)	140.0	103.0	136.0	144.5	
NBSB ID	MM1L009	MM1KO1O	MM 1M011	MM1B012	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Rotterman Samples (present location, NIH, Fredrick, MD):

Blood	5-15 mL	Heart	10 g
Liver	10 g	Spleen	10 g
Muscle	10 g	Skin	

692- FRSL-004 3-year male 57°14.85' 170°05.9' 29 July 1987
Northeast Point Rookery

Weight, 64.7 kg Standard Length, 111.4 cm Sternal Blubber Thickness, 2.5 cm

NBSB Samples:

	Liver	Kidney	Muscle	Blubber	Tooth
Weight A(g)	129.5	92.0	129.5	105.5	
Weight B(g)	149.0	93.5	148.0	101.0	
NBSB ID	MM1L013	MM1K014	MM1M015	MM1B016	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Rotterman Samples (present location, NIH, Fredrick, MD):

Blood	5-15 mL	Heart	l o g
Spleen	10 g	Skin	

NORTHERN FUR SEAL (*CALLORHINUS URSINUS*), ST. PAUL, ALASKA
BERING SEA, JULY 1987

692- **FRSL-005** 2-year male 57”14.85’ 170°05.9’ 29 July 1987
Northeast Point Rookery

Weight, 58.7 kg Standard Length, 110.4 cm Sternal Blubber Thickness, 3.0 cm

NBSB Samples:

	Liver	Kidney	Muscle	Blubber	Tooth
Weight A(g)	145.0	118.5	103.0	157.0	
Weight B(g)	136.0	112.0	105.0	141.0	
NBSB ID	M M 1L017	MM1K018	MM1M019	MM1 B020	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Rotterman Samples (present location, NIH, Fredrick, MD):

Blood	5-15 mL	Heart	l o g
Liver	10 g	Spleen	l o g
Skin			

RINGED SEAL (*PHOCA HISPIDA*), BARROW, ALASKA
CHUKCHI SEA, JULY 1988

692- **RGSL-001** l-year male . 71019' 156°50' 11 July 1988

Weight, 19.5 kg Standard Length, 99cm Axillary Girth, 60 cm
Sternal Blubber Thickness, 3.5 cm

NBSB Samples:

	Liver	Kidney	Blubber	Tooth
Weight A(g)	187.5	64.6	121.0	
Weight B(g)	163.5	69.0	137.0	
NBSB ID	MM2L021	MM2K022	MM2B023	

Histo-Sections (present location, OAD, Anchorage, AK}: Liver and Kidney

Stomach Contents (present location, OAD, Anchorage, AK)

NMFS Samples (present location, NWAFC, Seattle, WA):

Blood	5-15 mL	Bile	1-10 mL
Liver	10 g	Muscle	l o g

692- RGSL-002 <1-year female 71°19' 156°50' 11 July 1988

Weight, 12.7 kg Standard Length, 75 cm Axillary Girth, 48 cm
Sternal Blubber Thickness, 2.5 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	120.5	45.0	70.0
Weight B(g)	129.5	.42.0	78.0
NBSB ID	MM2L024	MM2K025	MM2B026

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Stomach Contents (present location, OAD, Anchorage, AK)

NMFS Samples (present location, NWAFC, Seattle, WA):

Blood	5-15 mL	Bile	1-10 mL
Liver	10 g	Muscle	l o g

RINGED SEAL (*PHOCA HISPIDA*), BARROW, ALASKA
CHUKCHI SEA, JULY 1988

692- RGSL-003 2-year male 71°19' 156°50' 11 July 1988

Weight, 35.4 kg Standard Length, 118 cm Axillary Girth, 70 cm
Sternal Blubber Thickness, 2.5 cm

NBSB Samples:

	Liver	Kidney	Blubber	Tooth
Weight A(g)	155.0	110.0	98.0	
Weight B(g)	150.0	110.5	113.0	
NBSB ID	MM2L027	MM2K028	MM2B029	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Stomach Contents (present location, OAD, Anchorage, AK)

NMFS Samples (present location, NWAFC, Seattle, WA):

Bile	1-10 mL	Muscle	10 g
Liver	10 g		

692- RGSL-004 2-year male 71°19' 156°50' 11 July 1988

Weight, 32.2 kg Standard Length, 108 cm Axillary Girth, 84 cm
Sternal Blubber Thickness, 2.0 cm

NBSB Samples:

	Liver	Kidney	Blubber	Tooth
Weight A(g)	154.0	106.0	98.3	
Weight B(g)	187.0	113.0	98.9	
NBSB ID	MM2L030	MM2K031	MM2B032	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Stomach Contents (present location, OAD, Anchorage, AK)

NMFS Samples (present location, NWAFC, Seattle, WA):

Bile	1-10 mL	Muscle	10 g
Liver	10 g		

RINGED SEAL (*PHOCA H/S/J/DA),* BARROW, ALASKA
CHUKCHI SEA, JULY 1988

692- RGSL-005 l-year female 71°19' 156°50' 11 **July** 1988

Weight, 15.4 kg Standard Length, **84.5 cm** **Axillary** Girth, 63 cm
Sternal Blubber Thickness, **2.7 cm**

NBSB Samples:

	Liver	Kidney	Blubber	Tooth
Weight A(g)	127.0	48.0	141.4	
Weight B(g)	130,6	49.0	150.2	
NBSB ID	MM2L033	MM2K034	MM2B035	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Stomach Contents (present location, OAD, Anchorage, AK)

NMFS Samples (present location, NWAFC, Seattle, WA):

Bile	1-10 **mL**	Muscle	l o g
Liver	10 g		

692- **RGSL-006** <1-year female 71019' 156°50' 12 **July** 1988

Weight, 15.4 kg Standard Length, 88 cm **Axillary** Girth, 58 cm
Sternal Blubber Thickness, 2.8 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	129.3	54.5	102.6
Weight B(g)	128.8	58.0	118.6
NBSB ID	MM2L036	MM2K037	**MM2B038**

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

NMFS Samples (present location, **NWAFC,** Seattle, WA):

Blood	5-15 **mL**	Bile	1-10 **mL**
Liver	10 g	Muscle	l o g

RINGED SEAL (*PHOCA HISPIDA*), BARROW, ALASKA
CHUKCHI SEA, JULY 1988

692- RGSL-007 2-year female 71023' 156°32' 12 July 1988

Weight, 23.1 kg Standard Length, 94cm Axillary Girth, 75 cm
Sternal Blubber Thickness, 2.9 cm

NBSB Samples:

	Liver	Kidney	Blubber	Tooth
Weight A(g)	165.6	86.6	138.5	
Weight B(g)	162.5	84.8	133.6	
NBSB ID	MM2L039	MM2K040	MM2B041	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

NMFS Samples (present location, NWAFC, Seattle, WA):

Blood	5-15 mL	Bile	1-10 mL
Liver	10 g	Muscle	10 g

692- RGSL-008 2-year male 71023' 156°32' 13 July 1988

Weight, 23.1 kg Standard Length, 104 cm Axillary Girth, 63.5 cm
Sternal Blubber Thickness, 2.8 cm

NBSB Samples:

	Liver	Kidney	Blubber	Tooth
Weight A(g)	154.2	89.5	129.2	
Weight B(g)	168.6	95.5	131.0	
NBSB ID	MM2L042	MM2K043	MM2B044	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Stomach Contents (present location, OAD, Anchorage, AK)

NMFS Samples (present location, NWAFC, Seattle, WA):

Blood	5-15 mL	Bile	1-10 mL
Liver	10 g	Muscle	10 g

RINGED SEAL (*PHOCA HISPIDA*), BARROW, ALASKA
CHUKCHI SEA, JULY 1988

692- **RGSL-009** <1-year male 71022' 156°37' 14 July 1988

Weight, 15 kg Standard Length, 75cm Axillary Girth, 63 cm
Sternal Blubber Thickness, 2.4 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	128.1	46.6	86.9
Weight B(g)	130.8	47.6	94.1
NBSB ID	MM2L045	MM2K046	MM2B047

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

Stomach Contents (present location, OAD, Anchorage, AK)

NMFS Samples (present location, NWAFC, Seattle, WA):

Blood	5-15 mL	Bile	1-10 mL
Liver	10 g	Muscle	10 g

692- RGSL-O1O 2-year female 71022' 156°37' 14 July 1988

Weight, 25.4 kg Standard Length, 98 cm Axillary Girth, 83.5 cm
Sternal Blubber Thickness, 3.0 cm

NBSB Samples:

	Liver	Kidney	Blubber	Tooth
Weight A(g)	168.5	78.4	146.7	
Weight B(g)	146.7	76.4	161.0	
NBSB ID	MM2L048	MM2K049	MM2B050	

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

NMFS Samples (present location, NWAFC, Seattle, WA):

Blood	5-15 mL	Bile	1-10 mL
Liver	l o g		

RINGED SEAL (*PHOCA HISPIDA*), NOME, ALASKA
NORTON SOUND, MAY 1989

692- **RGSL-011** l-year male 64°19' 165°15' 26 May 1989

Weight, 33.6 kg Standard Length, **119.5 cm** **Axillary** Girth, 82.5 cm
Sternal Blubber Thickness, 4 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	142.2	115.1	128
Weight B(g)	147.0	104.5	145
NBSB ID	MM3L054	MM3K055	MM3B056

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

ADF&G Samples (present location, **ADF&G,** Nome, AK): lower jaw, front claws, & stomach contents

NMFS Samples (present location, NWAFC, Seattle, WA): Blood, 5-15 mL

692- **RGSL-012** 2-year female 64°19' 165°00' 26 May 1989

Weight, 36.3 kg Standard Length, 124.5 cm **Axillary** Girth, 100 cm
Sternal Blubber Thickness, 3.5 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	160	104.8	147
Weight B(g)	141.4	104.4	148
NBSB ID	MM3L057	MM3K058	MM3B059

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

ADF&G Samples (present location, **ADF&G,** Nome, AK): lower jaw, front claws, stomach contents, & reproductive organs

NMFS Samples (present location, NWAFC, Seattle, WA):
Blood 5-15 mL Bile 1-10 mL

RINGED SEAL (*PHOCA /f/SP/DA),* NOME, ALASKA
NORTON SOUND, MAY 1989

692- RGSL-013 l-year male 64”18’ 156°00’ 31 May 1989

Weight, 31.75 kg Standard Length, 103.5 cm **Axillary** Girth, 79 cm
Sternal Blubber Thickness, 4.5 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	95.2	93.2	149.2
Weight B(g)	110.2	101.3	167.2
NBSB ID	MM3L060	MM3K061	MM3B062

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

ADF&G Samples (present location, **ADF&G,** Nome, AK): lower jaw, front claws, & stomach contents

NMFS Samples (present location, NWAFC, Seattle, WA):
Blood 5-15 mL Bile 1-10 mL

692- **RGSL-014** 1-year male 64°19’ 164°44’ 31 May 1989

Weight, 29.5 kg Standard Length, 101 cm **Axillary** Girth, 74 cm
Sternal Blubber Thickness, 3 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	50.9	67.5	108.4
Weight B(g)	50.6	62.6	123.8
NBSB ID	MM3L063	MM3K064	MM3B065

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

ADF&G Samples (present location, **ADF&G,** Nome, AK): lower jaw, front claws, & stomach contents

NMFS Samples (present location, NWAFC, Seattle, WA): Blood, 5-15 mL

RINGED SEAL (*PHOCA* F//SP/DA), NOME, ALASKA
NORTON SOUND, MAY 1989

692- **RGSL-015** <1-year female 64°18' 156°00' 31 May 1989

Weight, 20 kg Standard Length, 83.2 cm Axillary Girth, 66 cm
Sternal Blubber Thickness, 3.25 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	123.8	68.5	110.1
Weight B(g)	114.9	68.2	103.0
NBSB ID	MM3L066	MM3K067	MM3B068

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

ADF&G Samples (present location, ADF&G, Nome, AK): lower jaw, front claws,

NMFS Samples (present location, NWAFC, Seattle, WA):
Blood 5-15 mL Bile 1-10 mL

BEARDED SEAL (***ERIGNATHUS BARBATUS***), NOME, ALASKA
NORTON SOUND, MAY 1989

692- **BDSL-001** l-year male 64°19' 165°00' 26 May 1989

Weight, 68-90 kg Standard Length, 166.7cm **Axillary** Girth, 99 cm
Sternal Blubber Thickness, **4.5 cm**

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	154	147	158
Weight B(g)	159	129.5	163
NBSB ID	**MM3L051**	MM3K052	MM3B053

Histo-Sections (present location, **OAD,** Anchorage, AK): Liver and Kidney

ADF&G Samples {present location, **ADF&G,** Nome, AK): lower jaw, front claws, & stomach contents

NMFS Samples (present location, NWAFC, Seattle, WA):
Blood 5-15 **mL** Bile 1-10 **mL**

BELUKHA WHALE (*DELPHINAPTERUS LEUCAS*), POINT HOPE, ALASKA
CHUKCHI SEA, MAY 1989

692- **BLKA-001** <5-year female 68°20' 166°50' 26 May 1989

NSB, DWM Number HDL-5-89

Snout-Fluke Notch Length, 342.9 cm
Sternal Blubber Thickness
Fluke Width, 74.9 cm
Color, light gray (immature animal)

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	178.6	148	121.9
Weight B(g)	169.6	169	132.5
NBSB ID	MM3L069	MM3K070	MM3B071

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

NSB, DWM Samples (present location, DWM, Barrow, AK): jaw for aging, liver, kidney, blubber, skin for genetics, & reproductive organs

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692- BLKA-002 >5-year female 68°22' 166°50' 25 May 1989

NSB, DWM Number HDL-3-89

Snout-Fluke Notch Length, 309.9 cm
Sternal Blubber Thickness, 7.6 cm
Fluke Width, 71.1 cm
Color, mottled (mature animal)

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	178.3	155.6	129.9
Weight B(g)	166.6	163.1	132
NBSB ID	MM3L072	MM3K073	MM3B074

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

NSB, DWM Samples (present location, DWM, Barrow, AK): jaw for aging, liver, kidney, blubber, skin for genetics, & reproductive organs

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BELUKHA WHALE (*DELPHINAPTERUS LEUCAS*), POINT HOPE, ALASKA
CHUKCHI SEA, MAY 1989

692- **BLKA-003** **>5-year** female 68°20' 166°50' 25 May 1989

NSB, DWM Number HDL-2-89

Snout-Fluke Notch Length, 348cm
Sternal Blubber Thickness

Fluke Width
Color, mottled (mature animal)

NBSB Samples:

	Liver	Kidney
Weight A(g)	156.1	176.3
Weight B(g)	170.1	175
NBSB ID	MM3L075	MM3K076

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

NSB, DWM Samples (present location, DWM, Barrow, AK): jaw for aging, liver, kidney, & reproductive organs

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692- BLKA-004 **>5-year** male 68°20' 166°50' 19 May 1989

NSB, DWM Number HDL-1-89

Snout-Fluke Notch Length, 348 cm
Sternal Blubber Thickness, 7.0 cm

Fluke Width
Color, mottled (mature animal)

NBSB Samples:

	Liver
Weight A(g)	125.1
Weight B(g)	130.4
NBSB ID	MM3L077

Histo-Sections (present location, OAD, Anchorage, AK): Liver

Stomach Contents (present location, OAD, Anchorage, AK)

NSB, DWM Samples (present location, DWM, Barrow, AK): jaw for aging, liver, blubber, skin for genetics, reproductive organs, & stomach contents

BEARDED SEAL (*ERIGNATHUS BARBATUS*), BARROW, ALASKA
CHUKCHI SEA, JULY, 1989

692-BDSL-002 4-year male 71"31' 157°00' 20 July 1989

Weight, 200 kg Standard Length, 210 cm Axillary Girth, 130 cm
Sternal Blubber Thickness, 4.5 cm

NBSB Samples:

	Liver	Kidney	Blubber
Weight A(g)	149.9	152.6	126.9
Weight B(g)	157.2	166.9	125.1
NBSB ID	MM3L078	MM3K079	MM3B080

Histo-Sections (present location, OAD, Anchorage, AK): Liver and Kidney

NMFS Samples (present location, NWAFC, Seattle, WA):
Liver 10 g Kidney 10 g

692- BDSL-003 5-year male 71°31' 157°00' 20 July 1989

Weight, 225 kg Standard Length, 240 cm Axillary Girth, 138 cm
Sternal Blubber Thickness, 5 cm

NBSB Samples:

	Liver	Blubber
Weight A(g)	155.4	128.5
Weight B(g)	167.8	119.7
NBSB ID	MM3L081	MM3B082

Histo-Sections (present location, OAD, Anchorage, AK): Liver

NMFS Samples (present location, NWAFC, Seattle, WA): Liver, 10 g

APPENDIX B

RINGED SEAL TISSUES COLLECTED BY ADF&G IN 1984 AND PRESENTLY STORED IN THE OCSEAP FREEZER ANCHORAGE, ALASKA

SEPTEMBER 30, 1989

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT NOME AND OFFSHORE, BERING SEA, ALASKA, MARCH 1984

NP-1-84	male	64°33.3' 166°13.5'	6 March 1984

Weight, 40.4 kg — Standard Length, 106.8 cm
Axillary Girth, 95.4 cm — Sternal Blubber Thickness, 3.9 cm

Samples: Liver Blubber, Muscle, Kidney, Brain

NP-2-84	female	64°32.6' 167052.1 '	8 March 1984

Weight, 34.9 kg — Standard Length, 100.2 cm
Axillary Girth, 84.8 cm — Sternal Blubber Thickness, 3.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-3-84	female	64°32.4' 167°44.8'	8 March 1984

Weight, 44.0 kg — Standard Length, 110.0 cm
Axillary Girth, 90.4 cm — Sternal Blubber Thickness, 4.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-4-84	female	64°34.9' 167°44.8'	9 March 1984

Weight, 61.2 kg — Standard Length, 120.8 cm
Axillary Girth, 102.7 cm — Sternal Blubber Thickness, 3.8 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-5-84	male	64°30.2' 168°04.3'	10 March 1984

Weight, 47.2 kg — Standard Length, 107.7 cm
Axillary Girth, 93.9 cm — Sternal Blubber Thickness, 4.3 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT NOME AND OFFSHORE, BERING SEA, ALASKA, MARCH 1984

N P - 6 - 8 4 male 64°30.2' 167°02.7' 10 March 1984

Weight, 32.7 kg Standard Length, 97.1 cm
Axillary Girth, 85.2 cm Sternal Blubber Thickness, 3.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

N P - 7 - 8 4 male 64°30.2' 167°02.7' 10 March 1984

Weight, 53.1 kg Standard Length, 113.9 cm
Axillary Girth, 100.4 cm Sternal Blubber Thickness, 4.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

N P - 8 - 8 4 female 64°30.9' 167°42.0' 10 March 1984

Weight, 63.0 kg Standard Length, 122.9 cm
Axillary Girth, 98.5 cm Sternal Blubber Thickness, 4.5 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

N P - 9 - 8 4 male 64°30.9' 167°42.0' 10 March 1984

Weight, 71.2 kg Standard Length, 127.9 cm
Axillary Girth, 113.5 cm Sternal Blubber Thickness, 5.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

N P - 1 0 - 8 4 female 64°25.4' 165°37.9' 12 March 1984

Weight, 61.7 kg Standard Length, 116.5 cm
Axillary Girth, 103.3 cm Sternal Blubber Thickness, 4.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT NOME AND OFFSHORE, BERING SEA, ALASKA, MARCH 1984

NP-II-84 male 64°24.3' 163°23.8' 12 March 1984

Weight, 67.1 kg Standard Length, l18.6 cm
Axillary Girth, 109.0 cm Sternal Blubber Thickness, 5.4 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-12-84 female 64°18.9' 166°40.4' 13 March 1984

Weight, 68.9 kg Standard Length, 119.7 cm
Axillary Girth, 107.1 cm Sternal Blubber Thickness, 5.3 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-13-84 female 64°03.0' 166°31.9' 13 March 1984

Weight, 63.0 kg Standard Length, 109.2 cm
Axillary Girth, 101.9 cm Sternal Blubber Thickness, 5.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-14-84 male 64°18.9' 166°40.4' 14 March 1984

Weight, 70.7 kg Standard Length, 118.8 cm
Axillary Girth, 116.6 cm Sternal Blubber Thickness, 5.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-15-84 female 64°16.5' 165042.1 ' 14 March 1984

Weight, 28.1 kg Standard Length, 96.7 cm
Axillary Girth, 77.6 cm Sternal Blubber Thickness, 3.2 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT NOME AND OFFSHORE, BERING SEA, ALASKA, MARCH 1984

NP-16-84 female 64”16.5’ 165°42.1’ 14 March 1984

Weight, 54.9 kg Standard Length, 118.4 cm
Axillary Girth, 101.9 cm Sternal Blubber Thickness, 4.o cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-17-84 female 64°20.6’ 166°08.7’ 15 March 1984

Weight, 62.6 kg Standard Length, 125.3 cm
Axillary Girth, 104.6 cm Sternal Blubber Thickness, 5.1 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-18-84 male 64°20.6’ 166°08.7’ 15 March 1984

Weight, 41.3 kg Standard Length, 107.1 cm
Axillary Girth, 88.6 cm Sternal Blubber Thickness, 3.3 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-19-84 male 64°20.6’ 166°08.7’ 15 March 1984

Weight, 46.3 kg Standard Length, 109.6 cm
Axillary Girth, 96.7cm Sternal Blubber Thickness, 4.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

NP-20-84 male 64°20.6’ 166”08.7’ 15 March 1984

Weight, 64.4 kg Standard Length, 126.4 cm
Axillary Girth, 106.3 cm Sternal Blubber Thickness, 4.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-1-84	male	68°54.2' 166°15.9'	1 April 1984

Weight, 23.6 kg — Standard Length, 91.4 cm
Axillary Girth, 74.6 cm — Sternal Blubber Thickness, 3.0 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-2-84	male	68°54.2' 166°15.9'	1 April 1984

Weight, 56.2 kg — Standard Length, l19.2 cm
Axillary Girth, 103.3 cm — Sternal Blubber Thickness, 4.4cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-3-84	male	68°54.2' 166°15.9'	1April 1984

Weight, 25.8 kg — Standard Length, 96.0 cm
Axillary Girth, 77.1 cm — Sternal Blubber Thickness, 2.5 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-4-84	male	68°58.3' 166°41.6'	22 April 1984

Weight, 27.7 kg — Standard Length, 91.0 cm
Axillary Girth, 80.0 cm — Sternal Blubber Thickness, 3.7 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-5-84	male	68°58.2' 166°44.0'	24 April 1984

Weight, 42.2 kg — Standard Length, 112.8 cm
Axillary Girth, 89.0 cm — Sternal Blubber Thickness, 3.3 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-6-84	female	68°58.7' 166°44.4'	24 April 1984

Weight, 30.4 kg — Standard Length, 95,8 cm
Axillary Girth, 80.2 cm — Sternal Blubber Thickness, 2.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-7-84	female	68059.1 ' 167°16.0'	25 April 1984

Weight, 27.2 kg — Standard Length, 100.3 cm
Axillary Girth, 75.9 cm — Sternal Blubber Thickness, 3.0 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-8-84	male	68059.1 ' 167°16.0'	25 April 1984

Weight, 64.4 kg — Standard Length, 117.2 cm
Axillary Girth, 106.0 cm — Sternal Blubber Thickness, 5.1 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-9-84	male	68°51.4' 166°51.0'	25 April 1984

Weight, 18.1 kg — Standard Length, 87.3 cm
Axillary Girth, 70.1 cm — Sternal Blubber Thickness, 2.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-10-84	female	68°50.6' 167°00.9'	25 April 1984

Weight, 20.0 kg — Standard Length, 86.0 cm
Axillary Girth, 70.1 cm — Sternal Blubber Thickness, 2.9 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-11-84 female 68°50.6' 167°00.9' 25 April 1984

Weight, 20.0 kg Standard Length, 85.9 cm
Axillary Girth, 68.0 cm Sternal Blubber Thickness, 2.8 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CLP-12-84 male 68°51.1 ' 167°09.3' 25 April 1984

Weight, 41.7 kg Standard Length, 110.4 cm
Axillary Girth, 89.3 cm Sternal Blubber Thickness, 4.4 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-13-84 female 69°05.6' 166°48.0' 27 April 1984

Weight, 29.0 kg Standard Length, 101.8 cm
Axillary Girth, 77.1 cm Sternal Blubber Thickness, 3.3 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-14-84 female 69°05.6' 166°48.0' 27 April 1984

Weight, 48.5 kg Standard Length, 114.0 cm
Axillary Girth, 90.0 cm Sternal Blubber Thickness, 3.8 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-15-84 male 68°51.1' 167°43.7' 30 April 1984

Weight, 49.0 kg Standard Length, 114.3 cm
Axillary Girth, 95.6 cm Sternal Blubber Thickness, 3.8 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-16-84	female	68"50.4' 167"55.4'	30 April 1984

Weight, 50.8 kg — Standard Length, 115.1 cm
Axillary Girth, 91.8 cm — Sternal Blubber Thickness, 5.2 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-17-84	male	69°05.9' 167°08.3'	4 May 1984

Weight, 24.9 kg — Standard Length, 96.1 cm
Axillary Girth, 71.8 cm — Sternal Blubber Thickness, 2.8 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-18-84	male	69°05.9' 167°08.3'	4 May 1984

Weight, 48.1 kg — Standard Length, 123.0 cm
Axillary Girth, 88.7 cm — Sternal Blubber Thickness, 3.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-19-84	female	69°11.2' 166°36.0'	4 May 1984

Weight, 29.5 kg — Standard Length, 96.6 cm
Axillary Girth, 77.4 cm — Sternal Blubber Thickness, 2.7 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-20-84	male	69°12.5' 166°47.0'	4 May 1984

Weight, 36.3 kg — Standard Length, 108.2 cm
Axillary Girth, 83.3 cm — Sternal Blubber Thickness, 3.3 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-21-84	male	69°06.1' 167°00.0'	4 May 1984

Weight, 24.5 kg — Standard Length, 98.5 cm
Axillary Girth, 68.4 cm — Sternal Blubber Thickness, 2.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-22-84	male	69°06.1' 167°00.0'	4 May 1984

Weight, 29.5 kg — Standard Length, 100.5 cm
Axillary Girth, 77.8 cm — Sternal Blubber Thickness, 2.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-23-84	female	69°00.5' 168°37.6'	5 May 1984

Weight, 33.9 kg — Standard Length, 108.5 cm
Axillary Girth, 89.0 cm — Sternal Blubber Thickness, 3.8 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-24-84	male	69"02.4' 168°51.2'	5 May 1984

Weight, 35.8 kg — Standard Length, 104.4 cm
Axillary Girth, 83.4 cm — Sternal Blubber Thickness, 3.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-25-84	female	69°01.2' 168°36.9'	5 May 1984

Weight, 33.1 kg — Standard Length, 102.1 cm
Axillary Girth, 79.1 cm — Sternal Blubber Thickness, 2.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-26-84	male	69°01.2' 168°36.9'	5 May 1984

Weight, 46.7 kg — Standard Length, 109.3 cm
Axillary Girth, 95.7 cm — Sternal Blubber Thickness, 3.0 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-27-84	male	68°57.5' 168°32.3'	5 May 1984

Weight, 33.1 kg — Standard Length, 103.9 cm
Axillary Girth, 78.6 cm — Sternal Blubber Thickness, 3.3 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-28-84	male	68°58.7' 168°22.3'	5 May 1984

Weight, 32.3 kg — Standard Length, 106.3 cm
Axillary Girth, 79.2 cm — Sternal Blubber Thickness, 2.1 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-29-84	male	68058.7 168°22.3'	5 May 1984

Weight, 59.9 kg — Standard Length, 125.5 cm
Axillary Girth, 98.6 cm — Sternal Blubber Thickness, 2.5 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-30-84	male	68°35.4' 166025.1 '	9 May 1984

Weight, 43.5 kg — Standard Length, 107.3 cm
Axillary Girth, 93.3 cm — Sternal Blubber Thickness, 4.6 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-31-84	female	68°35.4' 166025.1 '	9 May 1984
Weight, 41.3 kg		Standard Length, 103.6cm	
Axillary Girth, 92.2 cm		Sternal Blubber Thickness, 4.5 cm	
Samples:	Liver, Blubber, Muscle, Kidney, Brain		
CL P-32-84	female	68°54.7' 166°03.6'	9 May 1984
Weight, 45.4 kg		Standard Length, 109.5 cm	
Axillary Girth, 93.5 cm		Sternal Blubber Thickness, 4.3 cm	
Samples:	Liver, Blubber, Muscle, Kidney, Brain		
CL P-33-84	male	68°52.8' 166°03.6'	9 May 1984
Weight, 41.7 kg		Standard Length, 112.0 cm	
Axillary Girth, 89.5 cm		Sternal Blubber Thickness, 3.2 cm	
Samples:	Liver, Blubber, Muscle, Kidney, Brain		
CL P-34-84	female	69°10.2' 167°48.2'	11 May 1984
Weight, 34.5 kg		Standard Length, 106.8 cm	
Axillary Girth, 83.9 cm		Sternal Blubber Thickness, 3.2 cm	
Samples:	Liver, Blubber, Muscle, Kidney, Brain		
CL P-35-84	male	69°09.4' 167°33.2'	11 May 1984
Weight, 49.0 kg		Standard Length, 112.5 cm	
Axillary Girth, 97.8 cm		Sternal Blubber Thickness, 4.7 cm	
Samples:	Liver, Blubber, Muscle, Kidney, Brain		

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-36-84	male	69°13.3' 167°23.0'	11 May 1984

Weight, 46.3 kg — Standard Length, 116.7 cm
Axillary Girth, 95.3 cm — Sternal Blubber Thickness, 4.2 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-37-84	male	69°07.0' 167"14.2'	11 May 1984

Weight, 42.2 kg — Standard Length, l12.5 cm
Axillary Girth, 89.5 cm — Sternal Blubber Thickness, 4.1 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-38-84	female	69°07.0' 167°14.2'	11 May 1984

Weight, 38.5 kg — Standard Length, 104.4 cm
Axillary Girth, 91.3 cm — Sternal Blubber Thickness, 4.0 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-39-84	male	69°07.0' 167°14.2'	11 May 1984

Weight, 23.1 kg — Standard Length, 92.0 cm
Axillary Girth, 69.9 cm — Sternal Blubber Thickness, 2.4 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-40-84	male	68°56.3' 167°50.6'	12 May 1984

Weight, 42.2 kg — Standard Length, 112.5 cm
Axillary Girth, 89.6 cm — Sternal Blubber Thickness, 2.5 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA HISPIDA*), TISSUES COLLECTED BY ADF&G AT CAPE LISBURNE, CHUKCHI SEA, ALASKA, APRIL-MAY 1984

CL P-41-84 female 68°56.3' 167°50.6' 12 May 1984

Weight, 50.3 kg Standard Length, 114.7cm
Axillary Girth, 98.8 cm Sternal Blubber Thickness, 4.3 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CLP-42-84 male 68°56.3' 167°50.6' 12 May 1984

Weight, 39.5 kg Standard Length, 110.3 cm
Axillary Girth, 84.1 cm Sternal Blubber Thickness, 3.5 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-43-84 male 68°52.8' 167°31.0' 12 May 1984

Weight, 40.4 kg Standard Length, 116.2 cm
Axillary Girth, 90.9 cm Sternal Blubber Thickness, 3.0 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-44-84 male 68°52.8' 167°31.0' 12 May 1984

Weight, 51.7 kg Standard Length, 119.4 cm
Axillary Girth, 98.6 cm Sternal Blubber Thickness, 4.0 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

CL P-46-84 male 69°11.0' 167°55.4' 13 May 1984

Weight, 35.8 kg Standard Length, 105.4 cm
Axillary Girth, 84.6 cm Sternal Blubber Thickness, 4.0 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

RINGED SEAL (*PHOCA* /#/SP/DA), TISSUES COLLECT BY **ADF&G** AT CAPE **LISBURNE, CHUKCHI SEA,** ALASKA, APRIL-MAY 1984

CL P-47-84 male 68°53.3' 166°10.2' 13 May 1984

Weight, 58.0 kg
Axillary Girth, 107,8 cm
Standard Length, 119.2 cm
Sternal Blubber Thickness, 4.8 cm

Samples: Liver, Blubber, Muscle, Kidney, Brain

APPENDIX C

QUALITY CONTROL ANALYTICAL DATA: ORGANIC CONTAMINANTS

SEPTEMBER 30,1989

U.S. DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
GAITHERSBURG, MARYLAND 20899

552-88-079

REPORT OF ANALYSIS

Determination of Organic Contaminants in Northern Fur Seal Samples from the 1987 Collection

Submitted to:

Paul R. Becker
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Anchorage, AK 99513

INTRODUCTION

As part of the NOAA Marine Mammal Tissue Archival Project, NBS analyzes a fraction of the archived specimens to determine selected organic and inorganic contaminants. These analyses provide accurate baseline data for the following purposes: (1) for use in evaluating the stability of the specimens during long-term storage, (2) for comparison with data obtained from other laboratories analyzing similar samples collected at the same time from the same sites (i.e., quality assurance), and (3) for comparison with data from samples collected in the future to monitor long-term trends in pollution. The results of the analyses of muscle, liver, kidney, and blubber from two northern fur seals collected during the 1987 sample collection are described in this Report of Analysis.

EXPERIMENTAL SECTION

Sample Description. Muscle, liver, kidney, and blubber samples from two northern fur seals were analyzed. The fur seals were harvested during a subsistence hunt on St. Paul Island (Pribilof Islands) in July 1987.

Sample Preparation. The "B" portions of the eight tissue samples were cryogenically homogenized and divided into subsamples of 30 g for organic and inorganic analysis. For organic analysis, a sample of 14-16 g of wet tissue was weighed to the nearest tenth of a milligram. The weighed sample was placed in a mortar containing approximately 50 g of sodium sulfate and then covered with another approximately 50 g portion of sodium sulfate. The tissue plus sodium sulfate was then ground to absorb the water in the tissue. At this point, the sodium sulfate mixture was placed in a glass extraction thimble and Soxhlet extracted for 16 h using 250 mL of methylene chloride.

After Soxhlet extraction, the methylene chloride extract was evaporatively concentrated to approximately 1 mL. The fraction containing the polychlorinated biphenyls (PCBs) and pesticides was separated from the majority of the lipid and biogenic material using size exclusion chromatography. (In the case of the blubber samples, the extract could only be

concentrated to approximately 6 mL; therefore, six size exclusion fractionation were done. The six fractions were then combined and evaporatively concentrated to approximately 1 mL. Another size exclusion fractionation was performed for the combined sample.) This fraction was then evaporatively concentrated to approximately 400 µL for fractionation by normal-phase liquid chromatography on a semi-preparative aminosilane column (LC-NH_2). For the LC-NH_2 fractionation, hexane was used as the mobile phase for the isolation of the PCBS and lower polarity pesticides, and 5% methylene chloride in hexane was used for the isolation of the more polar pesticides. These separate fractions were evaporatively concentrated to approximately 500 µL for GC analysis using electron capture detection (ECD) for the PCB and pesticide fractions.

Nonvolatile Extractable Weight Determination. The percent of nonvolatile extractable was determined for each sample after Soxhlet extraction.[1] The 'extract was evaporatively concentrated to approximately 15 mL (weight known)', and an aliquot of 90 µL (weight known) was placed on an aluminum pan. The extract on the pan was air dried, and the weight of the dried extract was noted. By doing a ratio of weights, the percent of nonvolatile extractable material was calculated.

GC Analysis. For the determination of the PCBS and pesticides, two extracts from each sample were analyzedby GC-ECD. PCB #198 (2,2',3, 3',4,5,5' ,6-octachlorobiphenyl) and perdeuterated 4,4'-DDT were added to the samples prior to extraction as internal standards for the analysis of the PCB and pesticide fractions, respectively. Calibration solutions were Soxhlet extracted, concentrated, and fractionated in the same manner as the tissue samples. The GC conditions for the analysis of the PCB fraction were as follows:

Column:	Immobilized nonpolar stationary phase (DB-5 J&W Scientific) fused silica capillary 60 m x 0.25 mm id.; 0.25µm film thickness
Injector:	Manual, all glass-splitting
Sample size:	2 µL
Injection:	Split
Injector temperature:	280 *C
ECD temperature:	320 "C
Initial column temperature:	200 "C for 30 min
Temperature programming rate:	2 °C/min
Final temperature:	270 "C for 30 min
Carrier gas:	Helium at 580 kPa (40 psig)
Split flow:	25 mL/min
Nitrogen make-up gas:	30 mL/min

For the analysis of the pesticide fraction, the following temperature program was used:

Injector temperature:	250 "C
Initial column temperature:	190 °C for 50 min
Temperature programming rate:	1.5 °C/min to 215°C then 45 "C/rein
Final temperature:	270 "C for 5 min

RESULTS AND DISCUSSION

The percent of nonvolatile extractable material in each sample is summarized in Table 1. The range of percents is from 3% for muscle tissue to 26% for blubber tissue. There is excellent agreement between the results for similar tissues from the two different animals.

PCB and Pesticide Determinations. The results of the PCB and pesticide measurements by GC are summarized in Tables 2, 3, 4 and 5 in terms of nonvolatile extractable weight of the sample. Concentrations were determined for all 20 PCB and all 15 pesticide analytes contained in the NOAA calibration solutions (SRM's 1492 and 1493). In general, the blubber and, in some cases, the kidney have higher concentrations than the liver and muscle samples from the same fur seal. Appendices I to IV contain the concentrations in terms of wet weight of tissue extracted.

Further details and data from these analyses can be found in the notebooks: MMS #12, pages 142-162 and magnetic data disks MMS 71-75.

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[1] Parris, R. M., private communication.

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September 27, 1988

Table 1. Percent of Nonvolatile Extractable in Fur Seal Tissue Samples

Tissue I.D.	Tissue Tvue	Percent Nonvolatile Extractable
MM1M015	Muscle	3.2 ± 0.2
MM1K014	Kidney	4.0 *0.3
MM1L013	Liver	6 . 9 ± 0.5
MM1B016	Blubber	25.6 ± 1.0
MM1M019	Muscle	3.4 ± 0.3
MM1K018	Kidney	3.8 ± 0.3
MM1L017	Liver	7.0 ± 0.6
MM1B020	Blubber	25.5 ± 0.9

Table 2. Concentration (rig/g nonvolatile extractable weigh:) of PCBS in Northern Fur Seal Tissue Samples (Animal No. 1)[a,b]

PCB #	MM1L013 (Liver)	MM1K014 (Kidney)	MM1M015 (Muscle)	MM1B016 (Blubber)
8 (2,4')	<1	4.6 (0.2)	2.6 (0.1)	7.0 (0.1)
18 (2,2' ,5)	1.0 (0.1)	5.7 (0.2)	2.0 (0.1)	3.5 (0.1)
28 (2,4,4')	6.2 (0.2)	22 (0.8)	17 (0.4)	45 (2.5)
52 (2,2',5,5')	19 (0.3)	30 (0.7)	26 (1.6)	85 (1.7)
44 (2,2' ,3,5')	<1	<1	<1	11 (0.5)
66 (2,3' ,4,4')	40 (0.6)	36 (1.0)	38 (1.4)	120 (0.8)
101 (2,2' ,4,5,5')	5.3 (0.1)	19 (0.7)	11 (0.3)	31 (0.6)
77 (3,3' ,4,4')	<2	<2	<2	<2
118 (2,3',4,4' ,5)	21 (0.6)	24 (1.2)	26 (1.5)	94 (5.7)
153 (2,2',4,4' ,5,5')	83 (2.0)	130 (3.0)	150 (8.6)	360 (18)
105 (2,3,3' ,4,4')	7.4 (0.5)	15 (0.5)	13 (0.7)	46 (2.0)
138 (2,2',3,4,4' ,5')	62 (2.9)	90 (2.0)	100 (2.5)	350 (2.6)
126 (3,3',4,4' ,5)	<2	<2	<2	<1
187 (2,2', 3,4',5,5' ,6)	<2	<2	<2	<1
128 (2,2',3,3' ,4,4')	<3	<3	<3	<2
180 (2,2',3,4,4' ,5,5')	16 (0.3)	34 (1.4)	33 (1.3)	145 (1.0)
170 (2,2', 3,3',4,4' ,5)	5.6 (0.3)	16 (0.6)	13 (0.4)	36 (0.7)
195 (2,2', 3,3',4,4' ,5,6)	<1	<1	<1	<2
206 (2,2', 3,3',4,4',5,5' ,6)	<2	<2	<2	<1
209 (deca)	< 3	<3	<3	<2

aTwo tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

bThe < values indicate the minimum detectable level for this compound in this sample.

Table 3. Concentration (rig/g nonvolatile extractable weight of PCBs in Northern Fur Seal Tissue Samples (Animal No. 2)[a,b]

PCB #	MM1LO17 (Liver)	MM1KO18 (Kidney)	MM1MO19 (Muscle)	MM1BO20 (Blubber)
8 (2,4')	<3	<4	<4	<13
18 (2,2',5)	<2	9.0 (0.3)	<3	<lo
28 (2,4,4')	11 (0.3)	62 (1.2)	21 (0.6)	53 (1.5)
52 (2,2',5,5')	14 (0.2)	46 (1.7)	16 (0.5)	49 (1.2)
44 (2,2',3,5')	<1	<2	<2	<5
66 (2,3',4,4')	75 (3.9)	200 (7.5)	91 (1.8)	430 (14.)
101 (2,2',4,5,5')	13 (0.9)	78 (2.3)	25 (2.0)	32 (1.4)
77 (3,3',4,4')	<3	<3	<4	<13
118 (2,3',4,4',5)	96 (3.0)	237 (3.1)	39 (2.2)	380 (20)
153 "(2,2',4,4',5,5')	230 (13)	810 (14)	360 (30)	750 (24)
105 (2,3,3',4,4')	19 (0.8)	100 (2.5)	37 (1.6)	73 (4.0)
138 (2,2',3,4,4',5')	150 (3.8)	540 (18)	210 (3.0)	360 (7.1)
126 (3,3',4,4',5)	<17	<20	<23	<70
187 (2,2',3,4',5,5',6)	<4	<5	<5	<10
128 (2,2',3,3',4,4')	<5	<7	<7	<20
180 (2,2',3,4,4',5,5')	50 (1.6)	150 (2.8)	67 (1.7)	130 (4.9)
170 (2,2',3,3',4,4',5)	20 (1.5)	46 (2.6)	25 (0.8)	47 (1.5)
195 (2,2',3, 3',4,4',5,6)	<1	<1	<1	<3
206 (2,2', 3,3',4,4',5,5',6)	<1	<1	<1	<3
209 (deca)	<1	<1	<1	<3

'Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b]The < values indicate the minimum detectable level for this compound in this sample.

Table 4. Concentration (rig/g nonvolatile extractable weight) of Pesticides in Northern Fur Seal Tissue Samples (Animal No. 1)[a,b]

Pesticide	MM1L013 (Liver)	MM1K014 (Kidney)	MM1M015 (Muscle)	MM1B016 (Blubber)
Hexachlorobenzene	<1	11 (0.2)	<1	7.0 (0.1)
Aldrin	<1	<1	<1	<1
2,4′-DDE	<1	<1	<1	4.4 (0.4)
4,4′-DDE	530 (6.0)	860 (34)	1100 (44)	4000 (140)
2,4′-DDD	17 (0.6)	<1	<1	47 (1.9)
4,4′-DDD	51 (1.4)	74 (3.1)	91 (2.3)	460 (16)
2,4′-DDT	<1	<1	<1	<1
4,4′ -DDT	40 (1.1)	47 (1.9)	55 (2.4)	140 (8.0)
Lindane	14 (0.3)	35 (1.4)	31 (1.0)	100 (2.2)
Heptachlor Epoxide	16 (0.7)	51 (2.0)	72 (3.7)	130 (3.3)
α-Chlordane	2.3 (0.2)	6.0 (0.3)	5.8 (0.5)	17 (0.2)
Trans-nonachlor	85 (2.6)	200 (15)	270 (9.1)	1200 (53)
Dieldrin	14 (0.4)	28 (1.1)	23 (0.8)	100 (2.9)
Heptachlor	<1	<1	<1	<1
Mirex	<2	<2	<2	<1

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.
[b]The < values indicate the minimum detectable level for this compound in this sample.

Table 5. Concentration (rig/g nonvolatile extractable weight) of Pesticides in Northern Pur Seal Tissue Samples (Animal No. 2)[a,b]

Pesticide	MM1L017 (Liver)	MM1K018 (Kidney)	MM1M019 (Muscle)	MM1B020 (Blubber)
Hexachlorobenzene	<1	<2	<2	<5
Aldrin	<2	<2	<2	<5
2,4′-DDE	<3	<4	<4	<lo
4,4′-DDE	1200 (62)	4900 (180)	2100 (140)	4100 (170)
2,4′-DDD	13 (0.5)	12 (0,8)	4.3 (0.3)	1.6 (0.1)
4,4′-DDD	60 (2.8)	240 (11)	96 (2.8)	75 (4.7)
2,4′-DDT	<1	<1	<1	<1
4,4′-DDT	48 (1.5)	190 (8.4)	85 (2.8)	65 (2.6)
Lindane	5.7 (0.2)	49 (1.4)	14 (0.4)	11 (0.6)
Heptachlor Epoxide	35 (1.0)	114 (5.6)	52 (3.4)	58 (1.7)
α-Chlordane	<1	<1	<1	<1
Trans-nonachlor	98 (2.5)	860 (23)	330 (10)	250 (11)
Dieldrin	4.0 (0.1)	20 (0.9)	8.1 (0.4)	4.6 (0.2)
Heptachlor	<1	<2	<2	<5
Mirex	<1	<2	<2	<4

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b]The < values indicate the minimum detectable level for this compound in this sample.

Appendix I. Concentration (rig/g wet weight) of PCBS in Northern Fur Seal Tissue Samples (Animal No. 1)[a,b]

PCB #	MM1LO13 (Liver)	MM1KO14 (Kidney)	MM1MO15 (Muscle)	MM1BO16 (Blubber)
8 (2,4')	<1	0.2 (0.0)	0.1 (0.0)	1.8 (0.0)
18 (2,2' ,5)	0.1 (0.0)	0.2 (0.0)	0.1 (0.0)	0.9 (0.0)
28 (2,4,4')	0.4 (0.0)	0.9 (0.0)	0.5 (0.0)	11.5 (0.7)
52 (2,2' ,5,5')	1.3 (0.0)	1.2 (0.0)	0.8 (0.0)	21.7 (0.4)
44 (2,2' ,3,5')	<1	<1	<1	2.8 (0.1)
66 (2,3' ,4,4')	2.7 (0.0)	1.4 (0.0)	1.2 (0.0)	29.7 (0.2)
101 (2,2' ,4,5,5')	0.4 (0.0)	0.8 (0.0)	0.4 (0.0)	7.8 (0.2)
77 (3,3' ,4,4')	<1	<1	<1	<1
118 (2,3',4,4' ,5)	1.4 (0.0)	0.9 (0.0)	0.8 (0.0)	31.3 (1.9)
153 (2,2',4,4' ,5,5')	5.7 (0.1)	5.2 (0.1)	4.7 (0.3)	120 (6.0)
105 (2,3,3' ,4,4')	0.5 (0.0)	0.6 (0.0)	0.4 (0.0)	15.2 (0.7)
138 (2,2',3,4,4' ,5')	4.3 (0.2)	3.6 (0.1)	3.2 (0.1)	17.5 (0.9)
126 (3,3',4,4' ,5)	<1	<1	<1	<1
187 (2,2',3,4',5,5' ,6)	<1	<1	<1	<1
128 (2,2',3,3' ,4,4')	<1	<1	<1	<1
180 (2,2', 3,4,4' ,5,5')	1.1 (0.0)	1.4 (0.1)	1.1 (0.0)	1.5 (0.0)
170 (2,2',3,3',4,4' ,5)	0.4 (0.0)	0.6 (0.0)	0.4 (0.0)	12.0 (0.2)
195 (2,2', 3,3',4,4' ,5,6)	<1	<1	<1	<1
206 (2,2', 3,3',4,4',5,5' ,6)	<1	<1	<1	<1
209 (deca)	<1	<1	<1	<1

[a] Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b] The < values indicate the ❑inimum detectable level for this compound in this sample.

Appendix II. Concentration (rig/g wet weight) of PCBs in Northern Fur Seal Tissue Samples from (Animal No. 2)[a,b]

PCB #	MM1L017 (Liver)	MM1K018 (Kidney)	MM1M019 (Muscle)	MM1B020 (Blubber)
8 (2,4')	<1	<1	<1	<3
18 (2,2',5)	<1	0.3 (0.0)	<1	<3
28 (2,4,4')	0.8 (0.0)	2.3 (0.0)	0.7 (0.0)	13.5 (0.4)
52 (2,2', 5,5')	1.0 (0.0)	1.8 (0.1)	0.5 (0.0)	12.5 (0.3)
44 (2,2',3,5')	<1	<1	<1	<2
66 (2,3' ,4,4')	5.2 (0.3)	7.8 (0.3)	3.1 (0.1)	111 (3.7)
101 (2,2' ,4,5,5')	0.9 (0.1)	3.0 (0.1)	0.8 (0.1)	8.5 (0.9)
77 (3,3',4,4')	<1	<1	<1	<3
118 (2,3',4,4' ,5)	6.7 (0.2)	9.0 (0.1)	1.3 (0.1)	95.5 (5.0)
153 (2,2',4,4' ,5,5')	15.8 (0.9)	30.8 (0.5)	12.4 (1.0)	191 (6.1)
105 (2,3,3' ,4,4')	1.3 (0.1)	3.9 (0.1)	1.3 (0.0)	18.6 (1.0)
138 (2,2',3,4,4' ,5')	10.8 (0.3)	20.4 (0.7)	7.1 (0.1)	91.6 (1.8)
126 (3,3',4,4' ,5)	<2	<2	<2	<lo
187 (2,2',3,4',5,5' ,6)	<1	<1	<1	<3
128 (2,2',3,3' ,4,4')	<1	<1	<1	<5
180 (2,2', 3,4,4' ,5,5')	3.7 (0.1)	5.9 (0.1)	2.3 (0.1)	32.6 (1.2)
170 (2,2', 3,3',4,4' ,5)	1.4 (0.1)	1.8 (0.1)	0.9 (0.0)	11.9 (0.4)
195 (2,2', 3,3',4,4' ,5,6)	<1	<1	<1	<2
206 (2,2',3,3',4,4', 5,5',6)	<1	<1	<1	<2
209 (deca)	<1	<1	<1	<2

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b]The < values indicate the minimum detectable level for this compound in this sample.

Appendix III. Concentration (rig/g vet weight) of Pesticides in Northern Fur Seal Tissue Samples (Animal No. 1)[a,b]

Pesticide	MM1L013 (Liver)	MM1K014 (Kidney)	MM1M015 (Muscle)	MM1B016 (Blubber)
Hexachlorobenzene	<1	0.2 (0.0)	<1	1.8 (0.0)
Aldrin	<1	<1	<1	<1
2,4'-DDE	<1	<1	<1	1.1 (0.1)
4,4'-DDE	36.6 (0.4)	34.4 (1.4)	36.0 (1.4)	1330 (46.9)
2,4'-DDD	1.2 (0.0)	<1	<1	12.1 (0.5)
4,4'-DDD	3.5 (0.1)	3.0 (0.1)	2.9 (0.1)	118 (4.2)
2,4'-DDT	<1	<1	<1	<1
4,4'-DDT	2.8 (0.1)	1.9 (0.1)	1.8 (0.1)	34.8 (2.0)
Lindane	1.0 (0.0)	1.4 (0.1)	1.0 (0.0)	25.7 (0.6)
Heptachlor Epoxide	1.1 (0.1)	2.0 (0.1)	2.3 (0.1)	34.1 (0.8)
α-Chlordane	0.2 (0.0)	0.2 (0.0)	0.2 (0.0)	4.3 (0.1)
Trans-nonachlor	5.9 (0.2)	8.0 (0.2)	8.8 (0.3)	302 (13.6)
Dieldrin	0.9 (0.0)	1.1 (0.0)	0.7 (0.0)	26.3 (0.7)
Heptachlor	<1	<1	<1	<1
Mirex	<1	<1	<1	<1

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b]The < values indicate the minimum detectable level for this compound in this sample.

Appendix IV. Concentration (rig/g wet weight) of Pesticides in Northern Fur Seal Tissue Samples (Animal No. 2)[a,b]

Pesticide	MM1L017 (Liver)	MM1K018 (Kidney)	MM1M019 (Muscle)	MM1B020 (Blubber)
Hexachlorobenz ene	<1	<1	<1	<2
Aldrin	<1	<1	<1	<2
2,4*-DDE	<1	<1	<1	<3
4,4'-DDE	85.1 (4.3)	187 (6,7)	72.0 (4.6)	1050 (42.4)
2,4'-DDD	0.9 (0.0)	0.5 (0.0)	0.2 (0.0)	0.4 (0.0)
4,4'-DDD	4.2 (0.2)	9.2 (0.4)	3.3 (0.1)	19.0 (1.2)
2,4'-DDT	<1	<1	<1	<1
4,4'-DDT	3.3 (0.1)	7.2 (0.3)	2.9 (0.1)	16.5 (0.7)
Lindane	0.4 (0.0)	1.9 (0.1)	0.5 (0.0)	2.8 (0.2)
Heptachlor Epoxide	2.4 (0.1)	4.3 (0.2)	1.8 (0.1)	14.7 (0.4)
α-Chlordane	<1	<1	<1	<1
Trans-nonachl or	6.8 (0.2)	32.7 (0.9)	11.3 (0.4)	64.8 (2.7)
Dieldrin	0.3 (0.0)	0.8 (0.0)	0.3 (0.0)	1.2 (0.0)
Heptachlor	<1	<1	<1	<2
Mirex	<1	<1	<1	<2

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b]The < values indicate the minimum detectable level for this compound in this sample .

U.S. DEPARTMENT OF COMMERCE
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REPORT OF ANALYSIS

Determination of Organic Contaminants in
Seal Samples from the 1988 Collection

Submitted to:

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INTRODUCTION

As part of the NOAA Alaska Marine Mammal Tissue Archival specimen banking project, NIST analyzes a fraction of the archived specimens to determine selected organic and inorganic contaminants. These analyses provide baseline data for the following purposes: (1) for use in evaluating the stability of the specimens during long-term storage, (2) for comparison with data obtained from other laboratories analyzing similar samples, and (3) for comparison with data from samples collected in the future to monitor long-term trends in pollution. The results of the analyses of liver, kidney, and blubber from two seals collected during the 1988 sample collection are described in this Report of Analysis.

EXPERIMENTAL SECTION

Sample Description. Liver, kidney, and blubber samples from two ringed seals (Phoca hispida) were analyzed. Both seals were 2 year old males. The seals were harvested during a subsistence hunt near Barrow, AK in July 1988.

Sample Preparation. The "B" portions of the six tissue samples were cryogenically homogenized and divided into subsamples of 30 g for organic and 4-6 g for inorganic analysis. For organic analysis, a sample of 14-16 g of wet liver or kidney or 4-6 g of wet blubber was weighed to the nearest tenth of a milligram. The weighed sample was placed in a mortar containing approximately 50 g of sodium sulfate and then covered with another approximately 50 g portion of sodium sulfate. The tissue plus sodium sulfate was then ground to absorb the water in the tissue. At this point, the sodium sulfate mixture was placed in a glass extraction thimble and Soxhlet extracted for 16 h using 250 mL of methylene chloride.

After Soxhlet extraction, the methylene chloride extract was evaporatively concentrated to approximately 1 mL. The fraction containing the polychlorinated biphenyls (PCBs) and pesticides was separated from the majority of the lipid and biogenic material using size exclusion chromatography. (In the case of the blubber samples, the extract could only be concentrated to approximately 4 mL; therefore, three size exclusion fractionation were performed. The three fractions were then combined and

evaporatively concentrated to approximately 1 mL. Another size exclusion fractionation was performed for the combined sample.) This fraction was then evaporatively concentrated to approximately 400 µL for fractionation by normal-phase liquid chromatography on a semi-preparative aminosilane column (LC-NH_2). For the LC-NH_2 fractionation, hexane was used as the mobile phase for the isolation of the PCBS and lower polarity pesticides, and 5% methylene chloride in hexane was used for the isolation of the more polar pesticides. These separate fractions were evaporatively concentrated to approximately 500 µL for GC analysis using electron capture detection (ECD) for the PCB and pesticide fractions,

Nonvolatile Extractable Weight Determination. The percent of nonvolatile extractable was determined for each sample after Soxhlet extraction.[1] The extract was evaporatively concentrated to approximately 15 mL (weight known), and an aliquot of 90 µL (weight known) was placed on an aluminum pan. The extract on the pan was air dried overnight, and the weight of the dried extract was noted. From the ratio of weights, the percent of nonvolatile "extractable material was calculated. The percent water in each sample was determined by weight loss after freeze drying.

GC Analysis. For the determination of the PCBS and pesticides, two extracts from each sample were analyzed by GC-ECD. PCB #103 (2,2',4,5' ,6-pentachlorobiphenyl) and PCB #198 (2,2', 3,3',4, 5,5', 6-octachlorobiphenyl) were added to the samples prior to extraction as internal standards for the analysis of the PCB fraction. Endrin and perdeuterated 4,4'-DDT were added to the samples prior to extraction as internal standards for the analysis of the pesticide fraction. Calibration solutions were Soxhlet extracted, concentrated, and fractionated in the same manner as the tissue samples. The GC conditions for the analysis of the PCB fraction were as follows:

Column:	Immobilized nonpolar stationary phase (DB-5 J&W Scientific) fused silica capillary 60 m x 0.25 mm id.; 0.25pm film thickness
Injector:	Manual, all glass-splitting
Sample size:	2 µL
Injection:	Split
Injector temperature:	280 "C
ECD temperature:	320 "C
Initial column temperature:	200 "C for 30 min
Temperature programming rate:	2 °C/min
Final temperature:	270 "C for 30 min
Carrier gas:	Helium at 280 kPa (40 psig)
Split flow:	25 mL/min
Nitrogen detector make-up gas:	30 mL/min

For the analysis of the pesticide fraction, the following temperature program was used:

Injector temperature:	250 "C
Initial column temperature:	190 'C for 50 min
Temperature programming rate:	1.5 °C/min to 215°C then 45 °C/min
Final temperature:	270 'C for 5 min

RESULTS AND DISCUSSION

The results for the determination of the percent of nonvolatile extractable material in each sample are summarized in Table 1. The range of percents is from 2% for liver tissue to 13% for blubber tissue. There is excellent agreement between the results for similar tissues from the two different animals. The results of the percent water in each tissue are provided to allow conversion of the results to a dry weight loss if desired.

PCB and Pesticide Determinations. The results of the PCB and pesticide measurements by GC are summarized in Tables 2, 3, 4 and 5 in terms of nonvolatile extractable weight of the sample. Concentrations were determined for all 20 PCB congeners and all 15 chlorinated pesticide analytes contained in the NOAA calibration solutions (SRM's 1492 and 1493). Appendices I to IV contain the concentrations in terms of wet weight of tissue extracted.

Further details and data from these analyses can be found in the notebooks: MMS #13, pages 99-111 and optical data disk DV-88.

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[1] Parris, R. M., private communication.

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Table 1. Percent of Nonvolatile Extractable Material in Seal Tissue Samples

Tissue I.D. Extractable	Tissue 'f'we	Percent Nonvolatile	Percent Water
MM2L030	Liver	2.2 ± 0.5	71
MM2K031	Kidney	3.1 ± 0.4	78
MM2B032	Blubber	12.8 ± 0.7	6
MM2L042	Liver	2,9 ± 0.4	71
MM2K043	Kidney	2.8 ± 0.5	77
MM2B044	Blubber	14.0 ± 0.9	8

Table 2. Concentration (rig/g nonvolatile extractable weight) of PCBS in Seal Tissue Samples (Animal No. 1)[a,b]

PCB #	MM2L030 (Liver)	MM2K031 (Kidney)	MM2B032 (Blubber)
8 (2,4')	121 (3)	44 (1)	3.9 (0.1)
18 (2,2',5)	<9	<5	1.0 (0.1)
28 (2,4,4']	94 (3)	15 (1)	49 (2)
52 (2,2' ,5,5')	37 (3)	16 (1)	30 (1)
-44 (2,2' ,3,5')	<6	8.7 (0.4)	4.1 (0.1)
66 (2,3' ,4,4')	125 (4)	66 (2)	104 (2)
101 (2,2' ,4,5,5')	214 (4)	27 (1)	1265 (18)
77 (3,3' ,4,4')	<59	<25	11 (1)
118 (2,3',4,4' ,5)	111 (5)	31 (1)	686 (11)
153 (2,2',4,4' ,5,5')	224 (5)	49 (2)	1392 (35)
105 (2,3,3' ,4,4')	25 (1)	3.6 (0.2)	273 (4)
138 (2,2',3,4,4' ,5')	167 (6)	37 (2)	1037 (14)
126 (3 , 3 ' , 4 , 4 ' , 5)	14 (1)	4.5 (0.2)	96 (1)
187 (2,2', 3,4',5,5' ,6)	46 (1)	9.8 (0.3)	117 (2)
128 (2,2',3,3' ,4,4')	5.8 (0.3)	1.8 (0.1)	71 (1)
180 (2,2',3,4,4' ,5,5')	55 (1)	17 (1)	284 (9)
170 (2,2', 3,3',4,4' ,5)	19 (2)	4.1 (0.3)	94 (2)
195 (2,2', 3,3',4,4' ,5,6)	<2	<1	13 (1)
206 (2,2', 3,3',4,4',5,5' ,6)	<2	<1	8.8 (0.2)
209 (deca)	<2	<1	33 (1)

[a] Two tissue extracts analyzed in triplicate: concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b] The < values indicate the minimum detectable level for this compound in this sample.

Table 3. Concentration (rig/g nonvolatile extractable weight) of PCBS in Seal Tissue Samples (Animal No. 2)[a,b]

PCB #	MM2L042 (Liver)	MM2K043 (Kidney)	MM2B044 (Blubber)
8 (2,4')	70 (2)	43 (1)	386 (8)
18 (2,2',5)	<9	<5	<18
28 (2,4,4')	61 (2)	190 (4)	136 (3)
52 (2,2',5,5')	32 (1)	30 (1)	119 (2)
44 (2,2',3,5')	35 (1)	39 (1)	93 (3)
6 6 (2,3',4,4')	111 (4)	97 (2)	349 (lo)
101 (2,2',4,5,5')	26 (1)	56 (2)	1870 (63)
77 (3,3',4,4']	<90	<66	<12
118 (2,3',4,4',5)	38 (1)	18 (1)	474 (8)
153 (2,2',4,4',5,5')	103 (2)	59 (1)	1546 (22)
105 (2,3,3',4,4')	12 (1)	5.5 (0.3)	126 (3)
138 (2,2',3,4,4',5')	84 (3)	41 (2)	837 (24)
126 (3,3',4,4',5)	6.7 (0.3)	3.9 (0.3)	59 (2)
187 (2,2',3,4',5,5',6)	16 (1)	9.8 (0.4)	100 (4)
128 (2,2',3,3',4,4')	.9.9 (0.3)	1.4 (0.1)	143 (4)
180 (2,2',3,4,4',5,5')	27 (2)	19 (1)	178 (3)
170 (2,2',3,3',4,4',5)	9.0 (0.1)	4.3 (0.1)	41 (1)
195 (2,2',3,3',4,4',5,6)	<3	<2	<2
206 (2,2',3,3',4,4',5,5',6)	<4	<2	<3
209 (deca)	<4	<2	<3

[a] Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b] The < values indicate the minimum detectable level for this compound in this sample.

Table 4. Concentration (rig/g nonvolatile extractable weight) of Pesticides in Seal Tissue Samples (Animal No. 1)[a,b]

Pesticide	MM2L030 (Liver)	MM2K031 (Kidney)	MM2B032 (Blubber)
Hexachlorobenzene	35.2 (1.0)	11.6 (0.7)	16.9 (0.7)
Aldrin	<2	<1	<2
2,4'-DDE	<4	<1	39 (1)
4,4'-DDE	465 (8)	94 (3)	210 (3)
2,4'-DDD	<7	<6	<3
4,4'-DDD	65 (1)	15 (1)	6.0 (0.1)
2,4'-DDT	7.6 (0.2)	3.2 (0.1)	8.5 (0.2)
4,4'-DDT	11 (1)	4.3 (0.3)	5.6 (0.2)
Lindane	45 (1)	<4	19 (1)
Heptachlor Epoxide	116 (3)	9.6 (0.2)	355 (5)
cis-Chlordane	<4	<3	26 (1)
Trans-nonach lor	62 (1)	19 (1)	903 (13)
Dieldrin	41 (1)	7.2 (0.3)	4.4 (0.2)
Heptachlor	<2	<1	<1
Mirex	34 (2)	4.0 (0.1)	140 (3)

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.
[b]The < values indicate the minimum detectable level for this compound in this sample.

Table 5. Concentration (rig/g nonvolatile extractable weight) of Pesticides in Seal Tissue Samples (Animal No. Z)[a,b]

Pesticide	MM2L042 (Liver)	MM2K043 (Kidney)	MM2B044 (Blubber)
Hexachlorobenzene	150 (1)	263 (1)	510 (9)
Aldrin	<5	<3	<5
2,4'-DDE	3.4 (0.1)	1.9 (0.1)	215 (8)
4,4'-DDE	233 (9)	244 (7)	3189 (110)
2,4'-DDD	<4	<4	<5
4,4'-DDD	9.3 (0.2)	4.4 (0.2)	5.5 (0.2)
2,4'-DDT	6.7 (0.2)	9.8 (0.1)	13 (1)
4,4'-DDT	6.2 (0.3)	10.6 (0.2)	16 (1)
Lindane	11 (1)	3.4 (0.1)	188 (4)
Heptachlor Epoxide	100 (2)	10 (1)	313 (4)
cis-Chlordane -	4.5 (0.1)	<2	6.4 (0.1)
Trans-nonachlor	28 (1)	6.6 (0.2)	401 (1)
Dieldrin	109 (2)	11 (1)	232 (2)
Heptachlor	5.6 (0.2)	8.6 (0.3)	39 (1)
Mirex	<2	2.3 (0.1)	<4

[a] Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard. deviation of a single measurement.

[b] The < values indicate the minimum detectable level for this compound in this sample.

Appendix I. Concentration (rig/g wet weight) of PCBs in Seal Tissue Samples (Animal No. 1)[a,b]

PCB #	MM2L030 (Liver)	MM2K031 (Kidney)	MM2B032 (Blubber)
8 (2,4')	2.7 (0.1)	1.4 (0.1)	0.5 (0.1)
18 (2,2',5)	<0.2	<0.2	<0.2
28 (2,4,4')	2.1 (0.1)	0.5 (0.0)	6.3 (0.1)
52 (2,2',5,5')	0.8 (0.1)	0.5 (0.0)	3.9 (0.1)
44 (2,2',3,5')	<0.2	0.3 (0.1)	0.5 (0.1)
66 (2,3',4,4')	2.8 (0.1)	2.0 (0.1)	13 (1)
101 (2,2' ,4,5,5')	4.8 (0.1)	0.8 (0.1)	163 (2)
77 (3,3' ',4,4')	<2	<1	1.5 (0.1)
118 (2,3',4,4' ,5)	2.5 (0.1)	1.0 (0.1)	88.1 (1.4)
153 (2,2',4,4' ,5,5')	5.0 (0.1)	1.5 (0.1)	179 (5)
105 (2,3,3' ,4,4')	0.6 (0.1)	0.1 (0.0)	35.1 (0.5)
138 (2,2',3,4,4' ,5')	3.7 (0.1)	1.1 (0.1)	133 (2)
126 (3,3',4,4' ,5)	0.3 (0.0)	0.1 (0.0)	12.3 (0.2)
187 (2,2', 3,4',5,5' ,6)	1.0 (0.1)	0.3 (0.0)	15.0 (0.2)
128 (2,2',3,3' ,4,4')	0.1 (0.0)	<0.1	9.2 (0.1)
180 (2,2',3,4,4' ,5,5')	1.2 (0.1)	0.5 (0.0)	36.5 (1.2)
170 (2,2', 3,3',4,4' ,5)	0.4 (0.0)	0.1 (0.0)	12.1 (0.2)
195 (2,2', 3,3',4,4' ,5,6)	<0.1	<0.1	1.6 (0.1)
206 (2,2', 3,3',4,4',5,5' ,6)	<0.1	<0.1	1.1 (0.1)
209 (deca)	<0.1	<0.1	4.2 (0.1)

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation, of a single measurement.
'The < values indicate the minimum detectable level for this compound in this sample.

Appendix II. Concentration (rig/g wet weight) of PCBS in Seal Tissue Samples from (Animal No. 2)[a,b]

PCB #	MM2L042 (Liver)	MM2K043 (Kidney)	MM2B044 (Blubber)
8	2.0	1.2	42
(2,4')	(0.1)	(0.1)	(1)
18	<0.2	<0.1	<2
(2,2',5)			
28	1.8	5.3	15
(2,4,4')	(0.1)	(0.1)	(1)
52	0.9	0.8	13
(2,2',5,5')	(0.1)	(0.1)	(1)
44	1.0	1.1	10
"(2,2',3,5')	(0.1)	(0.1)	(1)
66	3.3	2.7	38
(2,3',4,4')	(0.1)	(0.1)	(1)
101	0.8	1.6	205
(2,2',4,5,5')	(0.1)	(0.1)	(7)
77	<3"	<2	<2
(3,3',4,4')			
118	1.1	0.5	52
(2,3',4,4',5)	(0.1)	(0.1)	(1)
153	3.0	1.6	170
(2,2',4,4',5,5')	(0.1)	(0.1)	(3)
105	<0.4	<0.2	14
(2,3,3',4,4')			(1)
138	2.5	1.1	92
(2,2',3,4,4',5')	(0.1)	(0.1)	(3)
126	<0.2	<0.1	6.5
(3,3',4,4',5)			(0.2)
187	0.5	0.3	11
(2,2',3,4',5,5',6)	(0.1)	(0.1)	(1)
128	0.3	<0.1	16
(2,2',3,3',4,4')	(0.1)		(5)
180	0.8	0.5	20
(2,2', 3,4,4',5,5')	(0.1)	(0.1)	(1)
170	0.3	0.1	4.5
(2,2', 3,3',4,4',5)	(0.1)	(0.0)	(0.1)
195	<0.1	<0.1	<0.2
(2,2',3, 3',4,4',5,6)			
206	<0.1	<0.1	<0.3
(2,2', 3,3',4,4',5,5',6)			
209	<0.1	<0.1	<0.3
(deca)			

'Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b]The < values indicate the minimum detectable level for this compound in this sample.

Appendix III. Concentration (rig/g wet weight) of Pesticides in Seal Tissue Samples (Animal No. 1)[a,b]

Pesticide	MM2L030 (Liver)	MM2K031 (Kidney)	MM2B032 (Blubber)
Hexachlorobenzene	0.8 (0.1)	0.4 (0.1)	2.2 (0.1)
Aldrin	<1	<1	<1
2,4′-DDE	<1	<1	5.0 (0.1)
4,4′-DDE	10.4 (0.3)	2.9 (0.1)	27.0 (0.3)
2,4′-DDD	<0.2	<0.2	<1
4,4′-DDD	1.5 (0.1)	0.5 (0.1)	0.8 (0.1)
2,4′-DDT	<0.2	<0.2	1.1 (0.1)
4,4′-DDT	<0.3	<0.2	0.7 (0.1)
Lindane	1.0 (0.1)	<0.2	2.4 (0.1)
Heptachlor Epoxide	2.6 (0.1)	0.3 (0.1)	46 (1)
cis-Chlordane	<0.1	<0.1	3.4 (0.1)
Trans-nonachlor	1.4 (0.1)	0.6 (0.1)	116 (2)
Dieldrin	0.9 (0.1)	<0.3	0.6 (0.1)
Heptachlor	<1	<1	<1
Mirex	0.8 (0.1)	<1	18.0 (0.4)

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.
[b]The < values indicate the minimum detectable level for this compound in this sample.

Appendix IV. Concentration (rig/g wet weight) of Pesticides in Seal Tissue Samples (Animal No. 2)[a,b]

Pesticide	MM2L042 (Liver)	MM2K043 (Kidney)	MM2B044 (Blubber)
Hexachlorobenzene	4.4 (0.1)	7.3 (0.1)	56 (1)
Aldrin	<0.1	<0.1	<0,5
2,4'-DDE	<0.1	<0.1	24 (1)
4,4'-DDE	6.8 (0.3)	6.8 (0.2)	350 (12)
2,4'-DDD	<0.1	<0.1	<0.5
4,4'-DDD	0 . 3 (0.1)	0.1 (0.0)	0.6 (0.1)
2,4'-DDT	0.2 (0.0)	0.3 (0.0)	1.4 (0.1)
4,4'-DDT	0.2 (0.0)	0.3 (0.1)	1.8 (0.1)
Lindane	0.3 (0.0)	<0.1	21 (1)
Heptachlor Epoxide	2.9 (0.1)	0.3 (0.1)	34 (1)
cis-Chlordane	<0.2	<0.1	0.7 (0.1)
Trans-nonachlor	0.8 (0.1)	0.2 (0.1)	44 (1)
Dieldrin	3.2 (0.1)	0.3 (0.1)	26 (1)
Heptachlor	0.2 (0.0)	0.2 (0.0)	4.3 (0.1)
Mirex	<0.1	<0.1	<0.4

[a]Two tissue extracts analyzed in triplicate; concentration value is the mean value, and numbers in parentheses are ±1 standard deviation of a single measurement.

[b]The < values indicate the minimum detectable level for this compound in this sample.