NISTIR 6857

Persistent Organochlorine Pollutants and Elements Determined in Tissues of Rough-Toothed Dolphins (*Steno bredanensis*) Banked from a Mass Stranding Event

John R. Kucklick
Paul R. Becker
William D. J. Struntz
Elizabeth A. Mackey
Barbara J. Porter
Michele M. Schantz
Rabia D. Oflaz
Michael S. Epstein
Stephen A. Wise
Teresa K. Rowles
Wayne E. McFee
Megan K. Stolen

March 2002

NIST CENTENNIAL 1901-2001

National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

NISTIR 6857

Persistent Organochlorine Pollutants and Elements Determined in Tissues of Rough-Toothed Dolphins (*Steno bredadensis)* Banked from a Mass Stranding Event

John R. Kucklick
Paul R. Becker
William D. J. Struntz
Chemical Science and Technology Laboratory
Analytical Chemistry Division
Charleston Laboratory

Elizabeth A. Mackey
Barbara J. Porter
Michele M. Schantz
Rabia D. Oflaz
Michael S. Epstein
Stephen A. Wise
Chemical Science and Technology Laboratory
Analytical Chemistry Division

Teresa K. Rowles
National Oceanic and Atmospheric Administration
Office of Protected Resources
Wayne E. McFee
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Megan K. Stolen
Hubbs-Sea World Research Institute

March 2002

U.S. Department of Commerce
Donald L. Evans, Secretary

National Institute of Standards and Technology
Arden Bement, Jr., Director

PREFACE

On December 14, 1997, personnel from the National Institute of Standards and Technology's (NIST) Charleston Laboratory and the National Oceanic and Atmospheric Administration's Center for Coastal Environmental Health and Biolmolecular Research helped respond to the stranding of 62 rough-toothed dolphins near Apalachicola, FL, Gulf of Mexico. The tissues of 15 animals were sampled for inclusion in the National Marine Mammal Tissue Bank, which is maintained by NIST as part of its National Biomonitoring Specimen Bank. The banking of marine mammal tissues from mass stranding events is conducted by NIST in support of the National Marine Fisheries Service's Marine Mammal Health and Stranding Response Program. Baseline measurements were made on the tissues of these animals for trace elements and persistent organochlorine pollutants. This report presents the results of the analyses made by NIST.

ACKNOWLEDGMENTS

This work was made possible through support of the Marine Mammal Health and Stranding Response Program. The authors would like to express their sincere appreciation to Blair Mase, the NMFS Southeast Regional Stranding Coordinator, and the many volunteers of the Florida stranding network who responded to this mass stranding event and provided assistance in collections for the National Biomonitoring Specimen Bank. Especially important in the endeavor to necropsy the dolphins and collect samples were the efforts of Ruth Ewing of the NMFS Southeast Fisheries Science Center, Bill Fable of the NMFS Panama City Laboratory, Tim Nelson, Catherine Bray Nelson, Terri and Scott Calleson, and Misty Nabers. A special acknowledgment is given to the Florida State Park Rangers who exhibited professionalism of the highest quality, provided a secure necropsy site for those responding, and for the transport of animals from the stranding location to the necropsy site. A special thanks is also given to the NMFS Panama City Laboratory for providing space for processing and freezing samples.

DISCLAIMER

TABLE OF CONTENTS

PREFACE ..... **i**

ACKNOWLEDGMENTS ..... **ii**

DISCLAIMER ..... **iii**

LIST OF FIGURES ..... **v**

LIST OF TABLES ..... **vi**

INTRODUCTION **1**

The Marine Mammal Health and Stranding Response Program and the National Marine Mammal Tissue Bank ***1***
Persistent Organochlorine Pollutants and Trace Elements in Marine Mammals ***1***
The Rough-Toothed Dolphin ***2***
Objectives ***2***

METHODS **3**

Specimen Collection ***3***
Tissue Sample Preparation ***3***
Age Determination ***3***
Analysis of Blubber for Persistent Organochlorine Pollutants by NIST Charleston ***4***
Analysis of Blubber for Persistent Organochlorine Pollutants by NIST Gaithersburg ***6***
Analysis of Liver and Kidney for Trace Elements ***7***
Biological Information ***9***
Blubber Analyses ***10***
Liver and Kidney Analyses ***17***

CONCLUSIONS **24**

REFERENCES **25**

APPENDIX A: Persistent Organochlorine Compounds: Analytical Data **29**

APPENDIX B: Elements: Analytical Data **38**

LIST OF FIGURES

Figure 1: Comparison of the ratios of 4,4'-DDT to 4,4'-DDT + 4,4'-DDE (%) in dolphin species from the Gulf of Mexico. 12
Figure 2: Age versus ΣPCB congeners (ng/g lipid mass) for female rough-toothed dolphins.... 16
Figure 3: Renal and hepatic Se concentrations (mg/kg) in rough-toothed dolphins. 21
Figure 4: Hepatic (A) and renal (B) Se concentrations (mg/kg) as a function of rough-toothed dolphin age estimate (y). 22
Figure 5: Hepatic (A) and renal (B) Hg concentrations (mg/kg) as a function of rough-toothed dolphin age estimate (y). 23
Figure 6: Hepatic Sn concentrations (mg/kg) as a function of rough-toothed dolphin age estimate (y). 24
Figure A1: Chromatograms from the analysis of the PCB (A) and pesticide fractions (B) of RTDL-007 by the NIST Charleston Laboratory. 37

LIST OF TABLES

Table 1: Individual animal and sample information 9
Table 2: Comparison of organochlorine concentrations (ng/g lipid mass) among dolphin species and locations. See footnote for the number of PCB congeners summed to derive ΣPCB. 15
Table 3: Comparison of concentration ranges (mg/kg wet mass) of trace elements in kidneys of rough-toothed dolphins and those of other odontocetae. 18
Table 4: Comparison of concentration ranges (mg/kg of wet mass) of selected trace elements in livers of rough-toothed dolphins with ranges for other odontocetae. 20
Table A1: Organochlorines in SRM 1945 determined by NIST Gaithersburg and NIST Charleston (n = 3 each). Percent difference is the difference between the certified or reference (bold) values ((measured value – certified value/certified value) * 100)........ 30
Table A2: Results of paired PCB and organochlorine pesticides analyses made by NIST Gaithersburg and Charleston laboratories. Values are ng/g wet mass. 31
Table A3: Concentrations (ng/g lipid mass) of PCB congeners determined in three aliquots of RTDL-004 blubber. 33
Table A4: Concentrations (ng/g lipid mass) of organochlorine pesticides determined in three aliquots of RTDL-004 blubber homogenate. 34
Table A5: Concentrations (ng/g lipid mass) of PCB congeners determined in rough-toothed dolphin blubber homogenates. Values for RTDL-001 to -006 are the average of the values determined by the Charleston and Gaithersburg NIST laboratories. 35
Table A6: Concentrations (ng/g lipid mass) of Organochlorine pesticides determined in rough-toothed dolphin blubber homogenates. Values for RTDL-001 to -006 are the average of the values determined by the Charleston and Gaithersburg NIST laboratories. 36
Table B1: Rough-toothed dolphin liver (L) and kidney (K) specimen identification codes, ratios of dry to wet mass, and % total extractable organic content. 39
Table B2: INAA Detection limits for elements in tissue specimens. 40
Table B3: Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass. 41
Table B4: Results of INAA of control materials included with analyses of kidney tissues. Values for SRM 1566a Oyster Tissue are expressed in mg/kg of dry mass and those for the QA Pilot Whale Liver Tissue Homogenate are expressed in mg/kg of wet mass. Uncertainties represent the combined total uncertainty. 53
Table B5: Results of INAA of control materials included with analyses of liver tissues. Values for SRM 1566a Oyster Tissue are expressed on a dry mass basis and Whale Liver Homogenate I are expressed on a wet mass basis. Uncertainty values represent the expanded uncertainties (U; k=2). 54
Table B6: Results of ICP-MS of Whale Liver Homogenate I expressed in mg/kg of wet mass. Uncertainties represent the expanded uncertainties (U; k=2). 55
Table B7: Linear correlation matrix for rough-toothed dolphin age, length, and hepatic element concentrations........ 56
Table B8: Linear correlation matrix for rough-toothed dolphin age, length, and renal element concentrations........ 57

Persistent Organochlorine Pollutants and Elements Determined in Tissues of Rough-Toothed Dolphins (*Steno bredanensis*) Banked from a Mass Stranding

INTRODUCTION

The Marine Mammal Health and Stranding Response Program and the National Marine Mammal Tissue Bank

Through an agreement with the National Marine Fisheries Service (NMFS), Office of Protected Resources, NIST provides a service to the Marine Mammal Health and Stranding Response Program (MMHSRP) by maintaining the National Marine Mammal Tissue Bank (NMMTB) as part of the National Biomonitoring Specimen Bank (NBSB). NIST personnel also develop and test collection and banking protocols, and provide training to other individuals who collect specimens for the bank. One source of specimens for the NMMTB is the mass stranding of cetaceans. These events periodically occur along the coasts of the United States, particularly on the East Coast. Regional Stranding Networks consist of local and regional groups from federal, state, and local agencies; private organizations; and individuals, many of whom are volunteers. These people respond to mass strandings by providing aid to the live-stranded animals, returning the live-stranded animals to the ocean (when and where appropriate), and transporting animals to recovery facilities. They also collect data and samples from animals that die to document the age/sex population structure, life history, health condition, and other information that might be useful for scientific purposes. The stranding network members, when trained appropriately, also collect specimens for contaminant analysis and for the NMMTB.

NIST provides training, sample collection, and banking of marine mammal specimens for the MMHSRP and NMMTB. Additionally, NIST provides retrospective and baseline analysis of organic and inorganic contaminants on selected marine mammal specimens from the bank as part of the National Marine Analytical Quality Assurance Program. Additional details on NIST's role in the NMMTB, MMHSRP, and the National Marine Analytical Quality Assurance Program are provided in Becker *et al.* (1999).

Persistent Organochlorine Pollutants and Trace Elements in Marine Mammals

Contamination of food webs by anthropogenic persistent organochlorine pollutants (POPs), such as polychlorinated biphenyls (PCBs), DDT, toxaphene, and chlordane, was first documented by Jensen (1966) and of marine mammals by Holden and Mardsen (1967). Subsequently, researchers have determined that the release of POPs during their manufacture, storage, and use has resulted in global contamination, particularly of the marine environment (*e.g.,* Tanabe, 1985; Muir *et al.,* 1999). Due to their persistence and highly lipophilic nature, many POPs bioaccumulate and biomagnify in the food chain (*e.g.,* Tanabe, 1985; Muir *et al.*, 1988). POP residues have been detected in all levels of aquatic biota ranging from phytoplankton to marine mammals (Muir *et al.,* 1999). Biological effects of these compounds on mammals include hepatocellular carcinoma; reproductive, endocrine, and developmental toxicity; immunotoxicity, and wasting syndrome (Safe, 1990). Toothed whales (odontocetes) are particularly susceptible to bioaccumulation and the effects of POPs due to many factors including their relatively high trophic position, long life spans, limited metabolic capability to degrade chemical contaminants, and reproductive strategies (Tanabe *et al*., 1994).

For many marine mammal species, the ranges of normal elemental concentrations are not known. Levels of some metals in marine mammal tissues are often higher than concentrations found in terrestrial mammals (*i.e.,* mercury and cadmium) and there are often marked differences in element levels among different marine mammal species. There also may be differences among animals of the same species but from different locations. Concentrations for selected elements in various tissues have been reported for common dolphins (*Delphinus delphinus*), harbor porpoise (*Phocoena phocoena*), pilot whale (*Globicephala melas*), beaked whales (Z*iphiidae*) and many other species of odontocetes or "toothed whales" (*e.g.,* Mackey *et al.,* 1996; Law *et al.,* 1997), but there are no trace element data for rough-toothed dolphins (*Steno bredanensis*).

The Rough-Toothed Dolphin

Rough-toothed dolphins are pelagic odontocetes that are widely distributed in tropical and warm temperate oceans around the world. Most information on this species has come from populations in the eastern Pacific Ocean (Miyazaki and Perrin, 1994), with little available information on the populations inhabiting the Gulf of Mexico or western Atlantic Ocean (Blaylock *et al*., 1995). Growth occurs most rapidly during the first five years of life. Both sexes attain maximum lengths of approximately 280 cm with males reaching sexual maturity at approximately 225 cm or 14 years of age, and females at 210 cm or 10 years of age (Miyazaki and Perrin, 1994). Morphological features that distinguish this species from other members of the delphinid family (e.g., bottlenose dolphin (*Tursiops truncatus*)) include the lack of visible demarcation between beak and melon, and the rugose tooth surface from which its common name is derived. Coloration varies geographically, but animals are generally dark gray dorsally with variable pinkish and white markings ventrally (Miyazaki and Perrin, 1994). Rough-toothed dolphins are social animals, typically found in small groups ranging from 10 to 20 individuals with larger groups reported (Leatherwood *et al*., 1982; Miyazaki and Perrin, 1994). Their diet mainly consists of pelagic fish and squid (Layne, 1965; Clarke, 1986; Barros to McFee, personal communication).

Objectives

The authors are aware of only two previous publications describing organic contaminants in this species- Marsili and Focardi (1997, n = 1) and O'Shea *et al*. (1980, n = 7). The objective of this report is to document POP and inorganic constituents in tissues of rough-toothed dolphins from the Gulf of Mexico. Prior to this report there were no data on POPs or inorganic constituents in this species from this region. This report contains both organic and inorganic data, generated by NIST, for dissemination to sponsors and user groups. These data will help to establish baseline levels of POPs and both essential and potentially toxic elements in the tissues of this species.

METHODS

Specimen Collection

On December 15, 1997, 62 rough-toothed dolphins stranded on the Gulf Coast of Florida near Apalachicola at St. Joseph State Park (29º45.2' N, 85º25' W). All the animals were pushed back out to sea. However, 34 animals restranded and of those, 17 died on site, 1 swam away, and 16 were sent to rehabilitation facilities, of which 4 were released. Fifteen of the restranded animals that died on the beach were necropsied and sampled for the NMMTB. In addition to the tissues sampled for the NMMTB (blubber, kidney, and liver) and real-time contaminant monitoring (blubber, melon, and muscle, NOAA/NMFS/Northwest Fisheries Science Center (NWFSC)), samples were provided to the Armed Forces Institute of Pathology for histological and pathological analyses. Teeth were also removed from the animals for age determination (Table 1). Samples for the NMMTB were collected and processed using standard NIST protocols (Becker *et al.,* 1999). These protocols consist of the removal of tissue specimens from each animal using standard procedures and equipment designed to minimize the contamination of the tissues during removal and handling. Because of the rapid deterioration of tissues following death, it was decided that only animals that strand alive and die of natural causes or are euthanized, or animals that are considered "freshly dead," are sampled.

Materials that contacted the specimens were limited to Teflon and titanium. The tissue samples (blubber, kidney and liver) were excised from the animals using titanium knives, placed in Teflon bags, and transported on ice to the NOAA/NMFS Panama City Laboratory. At the laboratory, each specimen was divided into Samples A and B (approximately 150 g, each) according to the NMMTB protocols (Becker *et al*., 1999), placed in pre-cleaned Teflon sample jars, frozen, and express shipped to the NBSB, NIST Gaithersburg, MD in liquid nitrogen vapor shippers. Upon arrival at NIST, samples were immediately placed in liquid nitrogen-vapor cooled (-150 °C) freezers.

Tissue Sample Preparation

Each tissue specimen to be analyzed (approximately 150 g, each) was homogenized using a cryogenic procedure designed to reduce the likelihood of changes in sample composition due to thawing and refreezing (Zeisler *et al.,* 1983). Subsamples of the tissue homogenate, a frozen (non freeze-dried) powder, were transferred to Teflon jars (10 mL) for storage (at -150 °C) until analyses were performed. Portions used for instrumental neutron activation analysis (INAA) were lyophilized prior to analysis.

Age Determination

Teeth were extracted from the jaws during necropsy or after maceration in the lab. Teeth were sectioned longitudinally to a thickness of 2 mm using a low-speed saw (Isomet 11-1180, Lake Bluff, IL). Sections were then placed in 10% neutral buffered formalin for approximately 24 h. Samples were removed and rinsed in running tap water for approximately 3 h and then soaked in tap water for at least 24 h. Sections were placed in approximately 80 mL of a decalcifying agent.

Decalcification was prolonged (relative to *Tursiops* teeth) and took approximately 6 h to 16 h for completion. Decalcified sections were rinsed in running water for 6 h and then soaked in tap water for at least 24 h.

Teeth were serially sectioned using a sledge-type microtome (American Optical Co., Southbridge, MA) with a freezing attachment. Each 2 mm section was further sectioned to 25 µm then soaked in tap water for at least 1 h to remove any additional acid. Thin sections were stained in Mayer's hematoxylin for 75 min, rinsed in tap water for 1 min, blued in 0.5% ammonium hydroxide, and then rinsed again. Teeth were placed in 50% glycerin for 30 min and then placed in 100% glycerin for 24 h to complete the exchange of water to glycerin. Sections were mounted on slides in 100% glycerin. This method has been used successfully for other small delphinids (Perrin and Myrick, 1980; Myrick *et al.,* 1983).

Sections were examined under 10X to 60X magnification using a stereoscopic microscope (Nikon, Tokyo, Japan). Growth layers were generally read using guidelines developed for *Tursiops* by Hohn *et al*. (1989). Each growth layer group (GLG) consisted of a dark and light staining layer. Sections were read three times in the blind and the average reading was considered the final estimate. In a few cases, when readings were several layers apart, a fourth reading was taken and a subjective decision was made for the final estimation. Several of the teeth had extensive damage caused by extraction and could only provide minimum age estimates. For quality assurance purposes, the process was repeated using a second and sometimes third tooth (when available). In such cases, all sections were evaluated and readings were made from the best-mounted sections. This procedure was necessary for most of the older animals. Ages were estimated to the last fully formed GLG except in younger animals. Animals with less than 8 GLGs were read to the nearest 0.5 GLG and animals <1 GLG were aged to the nearest 0.25 GLG. It has been established with other small delphinids that one GLG corresponds to 1 y of life. This was assumed to be the case for rough-toothed dolphins, although this relationship has not been verified directly.

Analysis of Blubber for Persistent Organochlorine Pollutants by NIST Charleston

Cryo-homogenized blubber samples were shipped from the NMMTB in Gaithersburg, MD to the NIST Charleston Laboratory in a liquid-nitrogen-vapor shipper. Upon arrival specimens were stored at -80 ^{o}C until required for analysis. The Teflon jar containing the sample was removed from the -80 ^{o}C freezer and immediately placed in a small Dewar flask containing approximately 100 mL of liquid nitrogen. Between 0.792 g and 1.21 g of sample was removed from the jar using a clean metal spatula that had been immersed in liquid nitrogen to prevent the frozen sample from adhering to the spatula. The frozen sample was placed in a clean 150 mL beaker and weighed to the nearest 0.001 g. A small Styrofoam block was placed on the balance pan under the beaker to provide insulation and prevent balance drift. The sample was mixed with 30 g of sodium sulfate (Na_2SO_4; combusted at 700 °C for 24 h, then cooled in a desiccator prior to use). The mixture was then transferred to a 33 mL pressurized fluid extractor cell (PFE; Dionex, Salt Lake City, UT) to which 10 g of Na_2SO_4 had been previously added. A small volume (approximately 1 mL) of dichloromethane (CH_2Cl_2) was added to rinse the beaker, and then transferred to the PFE cell. For quality assurance purposes, RTDL-004 was analyzed independently three times, and two blanks and two aliquots of NIST SRM 1945 Organics in

Whale Blubber were prepared and analyzed. Each blank consisted of approximately 45 g of Na_2SO_4 in a PFE cell. The samples of SRM 1945 were prepared in the same manner as the dolphin blubber samples. A mixed internal standard solution containing 4,4'-DDT-d_8, 4,4'-DDE-d_8, 4,4'-DDD-d_8, endosulfan I-d_4, PCB 103, and PCB 198 was then added to the PFE cells, by weighing (to the nearest 0.00001 g) approximately 1 mL of the solution.

Six calibration solutions were prepared by weighing (to the nearest 0.00001 g) portions of SRMs 2261 Chlorinated Pesticides in Hexane, 2262 Chlorinated Biphenyl Congeners in 2,2,4-trimethylpentane, 2274 PCB Congener Solution-II in Isooctane and 2275 Chlorinated Pesticide Solution-II in Isooctane into weighed portions of isooctane. The calibration curve ranged from approximately 5 ng to 1000 ng added to the PFE cell. Approximately 1 mL of the appropriate mixed calibration solution was weighed (to the nearest 0.00001 g) in an HPLC syringe, then added on top of the Na_2SO_4. The mixed internal standard solution was then added to each PFE vial, by weighing (to the nearest 0.00001 g), approximately 1 mL of the solution.

The samples were extracted with CH_2Cl_2 using PFE. The conditions were as follows: the cell temperature was 100 °C, equilibration 5 min, static time 5 min, cell pressure was 6.89 MPa and there were three cycles (one-third of the solvent each time). The sample extracts were then reduced to between 0.5 mL to 1 mL by evaporation in a stream of purified nitrogen using a Turbovap II (Zymark, Hopkinton, MA). High-molecular-mass compounds were removed by size exclusion chromatography (SEC) using a 600 mm x 25 mm (10 µm particle size with 100 Å diameter pores) PLGel column (Polymer Labs, Amherst, CA) as described in Kucklick *et al.* (2001). The extract was then fractionated using a semi-preparative aminopropylsilane column (µBondapak NH_2, Waters) into relatively lower- and higher-polarity fractions (F1 and F2, respectively). F1 consisted of 50 mL of hexane, while F2 consisted of 60 mL of 25% CH_2Cl_2 in hexane. Target compounds contained in F1 included PCBs, heptachlor, oxychlordane, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, hexachlorobenzene (HCB), and mirex. Target analytes in F2 included 4,4'-DDT, *cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, α-, β-, and γ-hexachlorocyclohexane (HCH), heptachlor epoxide, 2,4'- and 4,4'-DDD, and dieldrin.

Organochlorine compounds were determined by injecting each sample twice into a gas chromatograph (GC) with dual micro-electron capture detectors (ECD) (Hewlett Packard 6890, Palo Alto, CA). Organochlorines in F1 and F2 from the aminopropylsilane column were separated using a 60 m 5% phenyl methylpolysiloxane column (DB-5, J&W Scientific, Folsom, CA) with 0.25 mm internal diameter and a 0.25 µm film thickness and a 60 m DB-XLB (proprietary phase, J&W Scientific) with 0.25 mm interior diameter and a 0.25 µm film thickness. The instrument was configured by installing a 5 m x 0.25 mm retention gap to the inlet, then attaching a glass Y connector to the free end. The columns were connected to the Y splitter, then to the ECDs. The injector and detector temperatures were 220 °C and 325 °C, respectively; the carrier and makeup gasses were H_2 (constant velocity of 30 cm/s) and N_2 (60 mL/min), respectively. Samples were injected into the GC (2 µL, splitless injection), and the oven was programmed from 90 °C initially (1 min hold) to 170 °C at 25 °C/min, then 1 °C/min to 260 ^{o}C, then ramped to 300 °C at 15 °C/min (10 min hold, 107 min total run time). The amount of each compound in the unknown was calculated using the mass of internal standard added and the slope and intercept of either the entire six-point calibration curve generated from the response of the calibrants or those generated from the three calibrants which bracketed the concentration. Different internal standards were used to quantify target analytes to avoid suspected interferences and to maximize repeatability and reproducibility. PCB 103 was used to quantify all F1 analytes other than 4,4'-DDE, which was quantified using 4,4'-DDE-d_8. All F2 analytes were quantified using endosulfan I-d_4. Analyses of most F1 target analytes were made with the DB-XLB column (Figure A1-a), as it gave baseline resolution on the majority of PCBs, and using PCB 103 as the internal standard. PCBs 87 and 101 were quantified with the DB-5 column, using PCB 103 as the internal standard, because of coelution problems on the DB-XLB column (Kucklick *et al.,* 2001). All F2 target analytes were quantified using GC-ECD with the DB-5 column and a splitless injection (Figure A1-b). Detection limits were calculated as three times the concentration of a given compound in the mean blank, which gave more conservative detection limits than using the mean blank plus three standard deviations. The total non-volatile solvent extractable material was measured on subsamples (50% of total) taken from the original extracts by first reducing the solvent volume from the extraction with the Turbovap, then allowing the remaining solvent to evaporate at room temperature. The extracts were repeatedly weighed until a stable mass was achieved. The ratio of the residue to the wet mass extracted represents the fraction of the total non-volatile solvent extractable material.

Analysis of Blubber for Persistent Organochlorine Pollutants by NIST Gaithersburg

The NIST Gaithersburg laboratory also analyzed six rough-toothed dolphin blubber samples: RTDL-001 to RTDL-006. The sample extraction and clean up procedures were similar to those detailed above. Briefly, the blubber homogenates were mixed with Na_2SO_4 then added to PFE cells. The cells were spiked with an internal standard mixture containing PCB 103, 198, and perdeuterated 4,4'-DDT. The sample and calibrants were extracted and high-molecular-weight materials were removed from the extracts using SEC. The chlorinated extract was reduced in volume then further isolated using a silica solid-phase extraction column (plus size, Waters Corporation, Milford, MA) that was precleaned using 15 mL of 10% dichloromethane in hexane. The fraction of interest was eluted also with 10% volume fraction of CH_2Cl_2 in hexane. The eluant was concentrated to approximately 0.5 mL for analysis.

The concentrated samples were analyzed using gas chromatography-mass spectrometry (GC-MS, Hewlett Packard 6890/5973). A 0.25 mm x 30 m fused-silica capillary column containing 5% phenyl-substituted methylpolysiloxane phase (HP-5ms, Hewlett Packard), 0.25 μm film thickness was used. The column was held isothermally (60 °C) for 1 min, temperature programmed at 45 °C per min to 180 °C for 30 min, and then temperature programmed at 2 °C per min to 250 °C where it was held isothermally for 15 min. All injections were 2 μL in a pulsed splitless mode. Helium was used as a carrier gas at a constant flow rate of 1 mL per min. The MS transfer line was held at 280 °C. The major ions included 222, 255.95, 289.90, 323.9, 359.85, 393.80, 425.75, 463.75, 497.70 for the PCBs and 284, 181, 389, 353, 246, 371, 409, 235, 243, 195, 263, 272 for the pesticides. Seven-point calibration response curves for the analytes relative to the internal standards were determined by processing gravimetrically-diluted PCB and pesticide calibrant solutions. The percent nonvolatile extractable material (mainly lipid) was determined for each sample after extraction. The extract was evaporatively concentrated to approximately 20 mL (mass known), and an aliquot of 90 μL (mass known) was placed on an aluminum pan. The extract on the pan was air dried, and the mass of the dried extract was noted.

The ratio of the residue to the wet mass extracted represents the fraction of the total non-volatile solvent extractable material.

Analysis of Liver and Kidney for Trace Elements

Instrumental Neutron Activation Analysis (INAA) for 35 Elements in Livers and Kidneys: Each sub-sample selected for INAA was freeze-dried at 1 Pa, -20 °C shelf temperature and -50 °C condenser temperature, for 5 d. Five of the 15 tissues were subjected to additional drying because the tissues did not appear to be dry after 5 d. Subsequent drying, for an additional 5 d, did not result in significant changes in the values for the ratios of dry to wet mass for these tissues. Determination of total extractable organic material showed that those kidney tissues that did not appear to be dry contained greater amounts of lipid than the other tissues. The wet appearance of these sub-samples (from animals identified as RTDL-003, RTDL-005, RTDL-007, RTDL-008, and RTDL-013) was probably due to a relatively high lipid content rather than to insufficient drying. The ratios of dry mass to wet mass, or conversion factors (C.F.), for the 15 kidney and 15 liver tissue samples are listed in Table B1 (in Appendix B) together with the animal and tissue identification codes.

Two disks, approximately 200 mg each, were formed from each of the dried, powdered sub-samples using a commercially available stainless steel die and hydraulic press. Two disks were also formed from SRM 1566a Oyster Tissue, and one from a pilot whale liver tissue homogenate (Whale Liver Homogenate I) that is used for quality assurance in the analysis of marine mammal tissues (Wise *et al.,* 1993, Becker *et al.,* 1999). The mass of each disk was recorded and all were packaged in acid-washed linear polyethylene (LPE) film in preparation for irradiation. Disks were also formed from standards consisting of filter papers containing known amounts of each element.

Analyses of short-lived products of neutron irradiation were performed sequentially over the course of several days. Each sample or aliquot of SRM was irradiated, together with one of the standards, for 120 s in the NIST reactor pneumatic tube irradiation facility, RT-4, at reactor power of 20 MW. After the irradiation, each sample, control, and standard was repackaged in clean LPE film for counting. Each sample was placed at a distance of 18 cm from a germanium detector, and gamma rays were collected for 300 s after a decay time of approximately 120 s for determination of Mg, Cl, Ca, V, Cu, Br, and I. Gamma rays were collected again, after 2 to 3 h of decay, for 20 min at a distance of 8 cm for the determination of Na, K, and Mn.

Analyses of intermediate-lived and long-lived products of neutron irradiation were performed after the analyses of short-lived products. Samples and standards were packaged individually in bags formed from LPE film and placed together in a polyethylene irradiation vessel or rabbit. For the assay of intermediate- and long-lived nuclides, each rabbit was irradiated in a pneumatic rabbit tube irradiation facility at a reactor power of 20 MW for 16 h. After a decay time of approximately 6 d, gamma rays from intermediate-lived nuclides (As, Mo, Cd, La, Sm, and Au) were collected for 2 h from samples positioned 15 cm from an intrinsic germanium detector. After decay times of 4 to 8 weeks, gamma rays from long-lived nuclides (Sc, Fe, Co, Zn, Se, Rb, Sr, Ag, Sn, Sb, Cs, Ba, Ce, Eu, Tb, Hf, Ta, Th, and U) were collected for 8 h from samples positioned approximately 5 cm from the same detector.

Spectral reduction and data analysis were accomplished using a μVAX 3400 computer with Nuclear Data peak search and activation analysis software. Quantitative evaluation was done by the comparator method using all standards from the individual irradiations. Nuclear Data software was used to calculate "standard constants" (the ratio of the amount of activity of a given nuclide that was present immediately after irradiation to the mass of the element, A_o/g) and these constants were used to determine element concentrations of the samples.

Mass fractions of the following elements were at or below the INAA detection limits in these tissues: Sc, V, Sr, Mo, Cd, Sn, Sb, I, Ba, La, Ce, Sm, Eu, Tb, Hf, Ta, Au, Th, and U. INAA detection limits are listed in Table B2 in Appendix B. All results from analysis of individual portions are listed in Table B3 in Appendix B and discussed below.

Sources of uncertainty for this analysis included uncertainty of counting statistics, uncertainty in the element content of the standards, uncertainty in dry mass of materials, and any differences between samples and standards in irradiation and counting geometries. Analysis of portions of SRM 1566a and Whale Liver Homogenate (I) were included for the purpose of quality assurance. Results of analysis of these control materials are shown in Tables B4 and B5 in Appendix B. INAA values agree with the certified or literature values within the total uncertainties listed.

ICP-MS Analysis of Cd, Hg, Pb, Sb, Tl, Th, Mn, Sn, Cu, Ag and Zn in Liver and Kidney Samples: Frozen sub-samples of dolphin tissues weighing between 0.3 g and 0.7 g were transferred to tared 100 mL PFA-Teflon containers using a ceramic spatula. The spatula was cleaned with high-purity water, wiped with a metal-free cloth, and chilled before use. The weighing process was performed rapidly to prevent the defrosting and gelling of the tissue samples. Each container of dolphin tissue was sampled at least two times so that duplicate sample preparations could be made. An acid mixture containing 4 mL of HNO_3 and 2 mL of $HClO_4$ was added to each container, which was then sealed. The samples were dissolved by microwave digestion (Milestone MLS-2100, Monroe, CT). After digestion, the sample containers were cooled, and the samples transferred to 100-mL low-density-polyethylene bottles and diluted to a final volume of approximately 100 mL with high-purity water containing 1% $K_2Cr_2O_7$. The mass and density of each final solution was used to calculate the analyte concentration.

The above elements were determined by inductively coupled plasma mass spectrometry (ICP-MS) using a Perkin Elmer (Boston, MA) Elan 5000 ICP-MS in the TotalQuant II mode and external standards. As a quality assurance check on the ICP-MS measurements, Pb was determined on selected subsamples by electrothermal atomic absorption spectrometry (ETAAS) and Hg was determined by cold-vapor atomic absorption spectroscopy (CVAAS). All results from analysis of individual portions are listed in Table B3 in Appendix B and discussed below. Analysis of Whale Liver Homogenate (I) was included for the purpose of quality control and results are listed in Table B6, Appendix B. Mass fractions of Sb, Tl, and Th were <0.05 mg/kg.

RESULTS AND DISCUSSION

Biological Information

Total length (cm) and animal gender are presented in Table 1. Of the 15 animals, 6 were male and 9 were female; 3 females were pregnant and all fetuses were female. The most common pathological conditions found during the necropsies were ectopic or displaced spleen (9 of 15 animals), pneumonia (8 animals), and fibroid kidneys (7 animals).

Table 1: Individual animal and sample information

NBSB Number	Age (years)	Length (cm)	Lactating (L) or with fetus (F)	Blubber Lipid (percent)	Kidney Lipid (percent)
Male					
RTDL-012	0.5	136	--	54.9	5.9
RTDL-014	2.5	185	--	60.0	7.19
RTDL-004	3	199	--	55.8*	5.92
RTDL-006	4.5	207	--	73.3	6.13
RTDL-002	10	229	--	44.4	6.72
RTDL-005	na**	235	--	42.8	20.5
Female					
RTDL-001	0.8	183	--	66.3	5.25
RTDL-011	3.5	202	--	58.1	9.3
RTDL-015	4	177	--	45.4	6.27
RTDL-010	10	209	--	54.2	12.2
RTDL-009	7.5	228	--	61.1	9.6
RTDL-008	22	221	L	49.1	29.8
RTDL-003	25	235	F	38.0	15.8
RTDL-013	42	253	F	50.4	45.2
RTDL-007	na	241	F	41.1	32.4

*Average of three measurements
**na; not available

The mean lipid (total non-volatile solvent extractable material) content of the female rough-toothed dolphin blubber samples was 51.5% with a range from 38.0% to 66.3% and in males was 55.1% with a range from 42.8% to 73.3% (Table 1). To assess repeatability of lipid determinations, lipid content was measured in triplicate subsamples of RT-004 by NIST Charleston and determined to be 55.8% (1.3%, 1 SD). The lipid content of RTDL-004 blubber was also determined by the NIST Gaithersburg laboratory and found to contain 56.9% lipid. Lipid content was measured in three samples of SRM 1945 and was determined to be 70.1% (0.1%), compared to the certified value of 74.3% ± 0.4%. The percent total extractable organic content of the kidney tissues ranged from 5.25% to 45.2% (mean = 14.5%; median 9.27%) and that of the liver tissues ranged from 3.29% to 6.97% (mean = 4.88%; median = 4.87%).

Blubber Analyses

Quality Control: Several mechanisms were used to assess the accuracy and precision of data and to evaluate the comparability of data generated by the NIST Charleston and NIST Gaithersburg laboratories. POPs were determined by each laboratory in three aliquots of SRM 1945 that were analyzed with the rough-toothed dolphins (Table A1). Duplicate portions of six rough-toothed dolphin blubber specimens (RTDL-001 through RTDL-006) were analyzed by both the NIST Charleston and Gaithersburg laboratories. Results from these analyses are presented in Tables A2 and A3. The largest deviation was observed for PCB 18, where the relative deviation ranged from 33% in RDTL-003 to 164% in RTDL-004. The reason for the deviation was not known as the values for PCB 18 determined in SRM 1945 by both NIST Charleston and NIST Gaithersburg were within the 95% confidence interval of the certified value for this compound (4.48 ng/g wet mass ± 0.88 ng/g wet mass). Repeatability within a batch was assessed by the NIST Charleston Laboratory through three analysis of RTDL-004 made in separate batches (Tables A3 and A4). The average percent relative standard deviation of measurements made on this sample was 6.42% (1.04% to 17.3%).

PCBs and Organochlorine Pesticides: Many target compounds including PCBs, DDTs, chlordanes, mirex, dieldrin, HCHs, and HCB were detected in the nine female and six male (Table 2) rough-toothed dolphins analyzed (Tables A5 and A6, Figures A1-a,b). The concentrations of PCB congeners are given in Table A5. Organochlorine pesticides concentrations in the rough-toothed dolphin samples are given in Table A6. All results and comparisons to other studies are given on a lipid-mass basis unless otherwise noted. The results from the NIST Gaithersburg and NIST Charleston analyses were averaged.

PCBs were the organochlorine compounds found in greatest concentrations in the rough-toothed dolphins in this study. The sum of PCBs (ΣPCBs; sum of 31 individual congeners or congener groups) in female dolphin samples averaged 25,900 ng/g (range: 1,310 ng/g to 49,400 ng/g) (Table A5). ΣPCBs in males averaged 46,900 ng/g ΣPCBs (range: 24,900 ng/g to 73,600 ng/g). PCB congener 153 contributed most to the ΣPCBs with a mean percent contribution of 24% (range: 22% to 29%) in females, and 26% in males (range: 24% to 29%). Other PCB congeners detected at relatively high concentrations included PCBs 99, 101, 118, 138, 180, and 187 (Fig. A1-a).

When compared to cetaceans from studies in other geographic regions, the rough-toothed dolphins from this sample set have lower levels of ΣPCBs (Table 2). For example, higher concentrations of ΣPCBs have been observed in male Risso's dolphins (*Grampus griseus;* mean: 128,000 ng/g) inhabiting coastal Japanese waters (Prudente *et al.* 1997, Table 2) and in stranded male striped dolphins (*Stenella coeruleoalba*) from the western Mediterranean Sea (mean: 1,300,000 ng/g; Kannan *et al*. 1993, Table 2). Kuehl and Haebler (1995) reported that male bottlenose dolphins that stranded on the Gulf Coast of Texas had a mean ΣPCB concentration of 93,000 ng/g, which is higher than that of the rough-toothed dolphins (Table 2). Other studies examining stranded bottlenose dolphins from the Texas (Salata *et al*. 1995) and the Atlantic coasts (Kuehl *et al*., 1991) reported higher mean ΣPCB concentrations- 36,100 ng/g and 60,600 ng/g, respectively (Table 2).

With such a limited data set, and because so little is known about the relationship between the cycling of contaminants and the pelagic food web in the Gulf of Mexico, any conclusions about the differences in mean ΣPCBs between coastal bottlenose dolphins and pelagic rough-toothed dolphins must be made with caution. We speculate that this difference is attributable primarily to habitat differences, as the near-shore waters of the Gulf of Mexico are in much closer proximity to potential point sources of PCBs resulting in higher contamination of the coastal food web and dolphin prey species. The pelagic rough-toothed dolphins' prey may have lower exposures and concentrations of PCBs, accounting for the difference in the ΣPCBs. Additionally, the rough-toothed dolphins feed at a lower tropic level than the bottlenose dolphins, which would result in less biomagnification of contaminant levels.

The suggested toxic threshold concentration of PCBs in marine mammal blubber is 17,000 ng/g lipid mass (Kannan *et al.,* 2000). Additionally, results from Lahvis *et al*. (1995) indicate that even relatively low levels of PCBs and DDTs can have negative effects on immune system function. Based on this criterion, it is likely that for the population represented by this limited sample group, PCBs pose a health risk. Unfortunately, little is understood about the mechanisms of cumulative actions of the complex mixtures of organochlorines to which these dolphins are exposed, and how these compounds impact the animals' health status (Marine Mammal Commission, 1999). Therefore, it is not currently possible to determine whether the health conditions and ultimate deaths of these dolphins were related to body burdens of POPs.

The DDT group compounds (2,4'-DDD, 4,4'-DDD, 2,4' DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT) were the organochlorine pesticide compounds present in the highest concentrations. In females, the average ΣDDT concentration was 14,100 ng/g ranging from 298 ng/g to 34,900 ng/g (Table A6). In males, the mean ΣDDT was 22,100 ng/g, ranging from 10,300 ng/g to 37,900 ng/g (Table A6). 4,4'-DDE was the DDT group compound present in the highest concentration, contributing 71% (range: 48% to 89%) to ΣDDTs in females, and 79% (range: 73% to 92%) in males (Table A6). The male rough-toothed dolphins had mean ΣDDT concentrations similar to those reported previously in several odonteceti species including Dall's porpoise (*Phocoenoides dalli*) from both the northeastern and northwestern Pacific (mean: 17,900 ng/g) and Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) from the North Pacific (mean: 23,900 ng/g; Prudente *et al.*, 1997, Table 2). Coastal bottlenose dolphins from the Gulf of Mexico (Salata *et al.,* 1995) had a mean ΣDDTs of 15,300 ng/g, which was lower than the mean level found in the pelagic rough-toothed dolphins (mean ΣDDTs of 17,400 for both sexes, Table 2). However, the maximum concentrations of ΣDDTs in bottlenose dolphins from both the Gulf of Mexico (74,600 ng/g) and the Atlantic (80,000 ng/g) were more than double those measured in the rough-toothed dolphins (Salata *et al.,* 1995, Kuehl *et al.,* 1991, Table 2).

Prudente *et al.* (1997), Salata *et al.* (1995), Kuehl *et al.* (1991), and Kuehl and Haebler (1995) all reported that 4,4'-DDE contributed the most to ΣDDTs in all cetacean species they studied, consistent with our results. To better evaluate exposure to other DDT compounds and current-use DDT, the percentage ratio of 4,4'-DDT to 4,4'-DDT + 4,4'-DDE was calculated (Figure 1). In females, the mean ratio was 18 (range: 13 to 38) and in males, the mean ratio was 9.2 (range: 3.0 to 16). Interestingly, the ratios were much higher in the rough-toothed dolphins than those from bottlenose dolphins that stranded in the Gulf of Mexico. The mean ratio in bottlenose dolphins that were analyzed by Salata *et al.* (1995) was 4.1, while the mean in dolphins analyzed by Kuehl and Haebler (1995) was 4.2. This difference may be attributable to two reasons. One explanation may be that the range of the rough-toothed dolphins in the Gulf of Mexico includes areas that are more heavily contaminated by current use DDT than the U.S. Gulf Coastal range of bottlenose dolphins. Mexico, which forms the western boundary of the Gulf of Mexico, currently uses DDT for mosquito control in amounts that exceed DDT usage by other Latin American countries (Lopez-Carrillo *et al.,* 1996). If the rough-toothed dolphins feed in this region, it may explain their elevated levels of parent DDT compounds. A second explanation may be that rough-toothed dolphins have less ability than bottlenose dolphins to metabolize DDT compounds, perhaps because this species lacks the CYP2B gene that transcribes the cytochrome P450 mono-oxygenase isozyme responsible for metabolism of these compounds (Stegeman and Hahn, 1994).

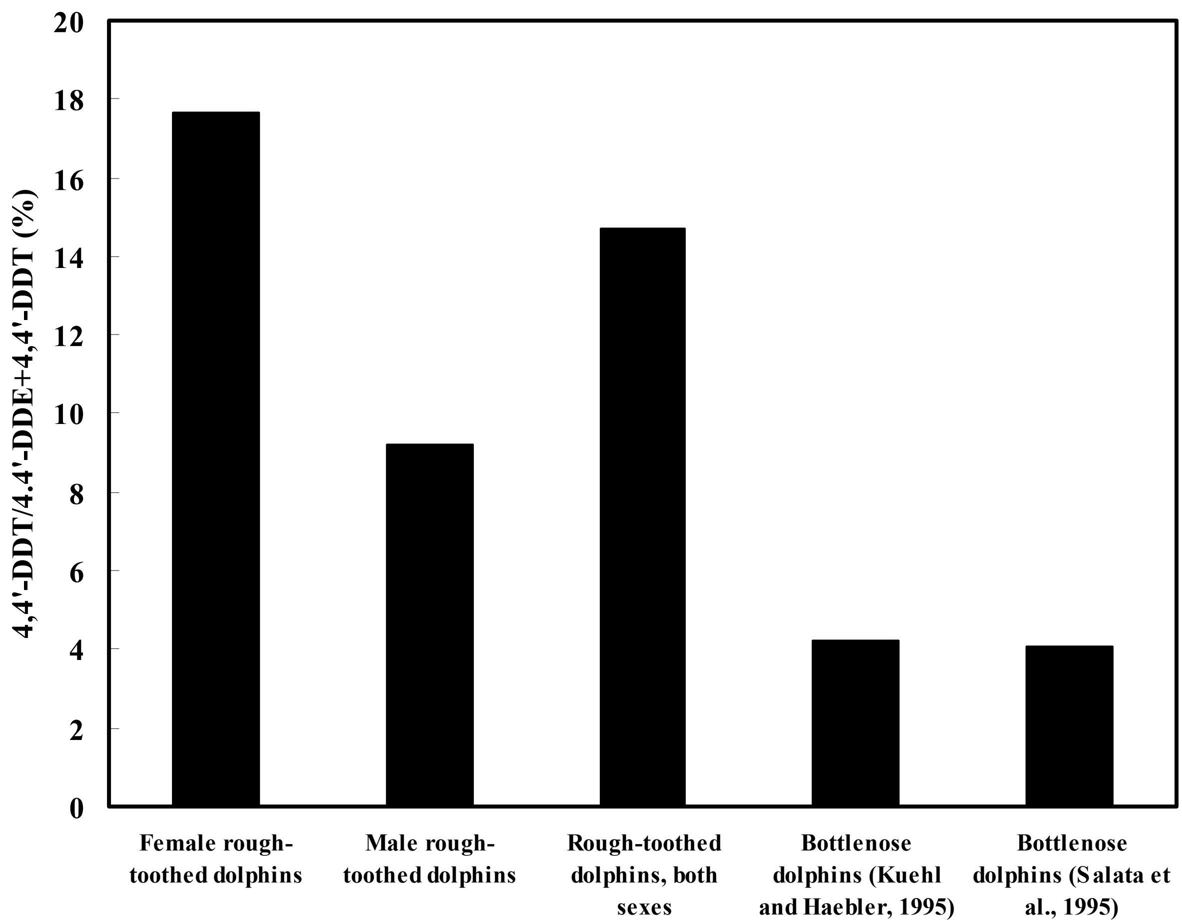


Figure 1: Comparison of the ratios of 4,4'-DDT to 4,4'-DDT + 4,4'-DDE (%) in dolphin species from the Gulf of Mexico.

Following DDTs, the sum of chlordanes (Σchlordanes; the sum of heptachlor, heptachlor epoxide, *cis*-nonachlor, *trans*-nonachlor, *cis*-chlordane, *trans*-chlordane, and oxychlordane) was the organochlorine pesticide group detected at highest concentration. Σchlordanes averaged 3,670 ng/g in females (40.3 ng/g to 12,400 ng/g) and 4,060 ng/g in males (1,620 ng/g to 8,200 ng/g, Table 2). *Trans*-nonachlor contributed the most to Σchlordanes, with a mean percentage of total in females of 61%, ranging from 52% to 80%, and in males of 70%, ranging from 56% to 82%. The highest mean concentrations of Σchlordanes found by Prudente *et al.* (1997) were in male Risso's dolphins from Japanese coastal waters; mean Σchlordanes were 12,800 ng/g, or approximately three times higher than the mean concentration measured in this set of rough-toothed dolphins (Table 2). This difference may be attributable to global fractionation of chlordane compounds resulting in higher levels at higher latitudes, and therefore greater contamination of prey species and ultimately top tier predators, a common trend with many organochlorines (Bidleman *et al.,* 1998). Salata *et al*. (1995) reported a mean Σchlordanes concentration of 3,890 ng/g lipid mass in bottlenose dolphins of both sexes from the Gulf of Mexico, which was lower than the measured mean Σchlordanes concentration in the rough-toothed dolphins from this study (Table 2). However, if only levels of *trans*-nonachlor are compared, the mean concentrations from bottlenose dolphins inhabiting the coastal waters of both the Gulf of Mexico and the Atlantic (2170 ng/g lipid mass and 2930 ng/g lipid mass respectively) are approximately the same as those measured in the rough-toothed dolphins (2600 ng/g) (Salata *et al.,* 1995; Kuehl *et al.,* 1991).

Mirex, an organochlorine widely used as an insecticide and fire retardant until it was banned in 1978 (Smith *et al.,* 1978), was detected in all of the rough-toothed dolphin samples in this study. The mean mirex concentration in female dolphin samples was 376 ng/g and ranged from 33.4 ng/g to 912 ng/g (Table A6). Males had a mean mirex concentration of 710 ng/g with a range from 348 ng/g to 1,145 ng/g (Table A6). Male rough-toothed dolphins had mirex concentrations higher than those reported for male bottlenose dolphins also from the Gulf of Mexico (502 ng/g lipid mass; Kuehl and Haebler, 1995, Table 2). This was also true when the mean from both sexes (517 ng/g) was compared to that reported by Salata *et al*. (1995) for Gulf of Mexico bottlenose dolphins (485 ng/g, Table 2). However, the rough-toothed dolphins had more than double the mean mirex concentration of Atlantic bottlenose dolphins (194 ng/g, Kuehl *et al.,* 1991, Table 2). The difference between concentrations of mirex in the rough-toothed dolphins and bottlenose dolphins from the Atlantic is probably due to extensive mirex application in the southeastern U.S. for fire ant control and because of the compound's chemical properties. Mirex is very hydrophobic and non-volatile, so is therefore unlikely, once it has entered the environment, to volatilize and form a latitudinal concentration gradient as is seen with many other POPs (Smith *et al.,* 1978). The difference in mirex concentrations between animals from the Gulf of Mexico and the Atlantic may make mirex potentially useful as a marker compound to discriminate stocks of rough-toothed dolphins in these two regions. However, there are no data available on contaminant levels in rough-toothed dolphins from the Atlantic, so comparisons are not currently possible.

Dieldrin was detected in all of the rough-toothed dolphin samples analyzed. Dieldrin concentrations in female dolphin samples had a mean of 467 ng/g and ranged from 18.4 ng/g to 1,840 ng/g (Table A6). Males had a mean dieldrin concentration of 306 ng/g and ranged from 189 ng/g to 487 ng/g (Table A6). By comparison, adult male bottlenose dolphins analyzed by Kuehl and Haebler (1995) had a higher mean dieldrin concentration (1,080 ng/g) than that found in the rough-toothed dolphins from this study (Table 2). Salata *et al*. (1995) and Kuehl *et al.*

(1991) also reported higher mean dieldrin concentrations in bottlenose dolphins of both sexes from the Gulf of Mexico and Atlantic (547 ng/g and 1450 ng/g respectively, Table 2).

HCHs were detected at relatively low levels in all individuals analyzed. In females, the mean concentration of ΣHCHs (α-, β-, and γ-HCH) was 69.5 ng/g, ranging from 5.29 ng/g to 268 ng/g. The ΣHCHs in males averaged 23.0 ng/g and concentrations ranged from 14.5 ng/g to 45.1 ng/g (Table A6). In the majority of females, β-HCH contributed the most to ΣHCHs, with a mean contribution of 66% to the ΣHCH (range from 38% to 100%). However, in RTDL-003, only γ-HCH was detected, while in RTDL-008, α-HCH contributed 100% to the ΣHCHs. In males, β-HCH contributed the most to ΣHCHs, contributing an average of 74.5% to the ΣHCH (range from 64% to 85%). The rough-toothed dolphins had lower concentrations of ΣHCHs compared to concentrations found in Dall's porpoise from the Japan Sea (mean: 7,140 ng/g, Prudente *et al*. 1997, Table 2). Coastal bottlenose dolphins from the Gulf of Mexico had mean β-HCH concentrations of 64.2 ng/g (Salata *et al*., 1995, Table 2). This was higher than the mean β-HCH concentration found in the rough-toothed dolphins. HCH patterns in the rough-toothed dolphins, with β-HCH being the dominant congener, were similar to those found by reported by Prudente *et al.* (1997) and Salata *et al.* (1995). Lower ΣHCH concentrations in rough-toothed dolphins relative to animals from waters adjacent to Asia were not surprising because most current HCH use is in India (Iwata *et al.,* 1993). Additionally, Iwata *et al.* (1993) determined that there was a latitudinal concentration gradient with HCHs resulting in higher levels at higher latitudes, which would explain the relatively low levels of HCHs detected in these sub-tropical animals.

HCB concentrations were among the lowest of all POPs detected. Mean lipid mass HCB concentrations in female dolphins was 48.4 ng/g and ranged from < 1 ng/g to 70.9 ng/g (Table A6). Males had a mean HCB concentration of 48.2 ng/g and ranged from 20.8 ng/g to 79.5 ng/g (Table A6). The highest concentration of HCB detected by Prudente *et al.* (1997) was in Dall's porpoises (*Phocoenoides dalli*) from the Sea of Japan, with a mean HCB concentration of 1,430 ng/g (Table 2). These authors suggest that HCB distribution is heavily dependent upon temperature due to its high volatility, with HCB partitioning mainly to cold areas or higher latitudes. This could explain why animals from the sub-tropical Gulf of Mexico, such as the rough-toothed dolphins, or bottlenose dolphins (mean: 510 ng/g; Salata *et al*., 1995, Table 2) have lower concentrations of HCB.

The variability of levels of organochlorines caused by gender and age is an interesting feature of this data set. Unfortunately, the data set is small (n = 15) and limited by the absence of some age groups, thus limiting a complete interpretation. For instance, older males, typically having the highest POP concentrations, are not represented. However, age and gender trends in the POP data can still be observed even with this limitation. One interesting feature of the data, and one of concern, is the relatively high POP concentrations in the immature dolphins (Figure 2).

Table 2: Comparison of organochlorine concentrations (ng/g lipid mass) among dolphin species and locations. See footnote for the number of PCB congeners summed to derive ΣPCB.

Species	n	Sex	ΣPCBs	ΣDDTs	ΣChlordanes	Mirex	Dieldrin	HCB	ΣHCHs	Reference
Rough-toothed dolphin	6	M	**46,900**	**22,100**	**4,060**	**710**	**306**	**62.0**	**23.0**	*this study*
			24,900-73,600	10,300-37,900	1,620-8,200	348-1,150	186-487	20.8-92.0	14.5-23.9	
	9	F	**25,900**	**14,100**	**3,700**	**376**	**467**	**48.2**	**59.5**	*this study*
			1,310-38,100	298-34,900	40.3-12,400	33.4-912	18.4-907	<2-70.9	5.29-267	
Bottlenose dolphin	12	M/F	**60,600**	**15200***	**2930****	**194**	**1,450**	--	--	(1)
			17,400-196,000	519-80,000*	172-9,200**	36-584	74.0-5,820	--	--	
Bottlenose dolphin	9	M	**93,000**	**37,000***	--	**502**	**1,080**	--	--	(2)
			64,000-187,000	15,000/78,000*	--	271-810	290-1,800	--	--	
Bottlenose dolphin	33	M/F	**36,100**	**15,300**	**3,890**	**485**	**547**	**510**	**64.2*****	(3)
			4,100-149,000	428-76,000	190-28,400	167-6,540	28.7-2,030	19.8-2,180	<1-924***	
Risso's dolphin	5	M	**128,000**	--	**12,800**	--	--	--	--	(4)
			88,400-151,000	--	7,210-17,400	--	--	--	--	
Striped dolphin	9	M	**1,300,000**	--	--	--	--	--	--	(5)
			88,400-2,6000,000	--	--	--	--	--	--	
Dall's porpoise	3	M	--	**17,900**	--	--	--	**1,430**	**7,140**	(4)
			--	9,760-33,300	--	--	--	813-2,310	6,260-8,570	
Pacific white-sided dolphin	3	M	--	**23,900**	--	--	--	--	--	(4)
			--	21,600-28,400	--	--	--	--	--	

*4,4'-DDE only
***trans*-nonachlor only
***β–HCH only
(1) Kuehl *et al.* (1991); Western Atlantic (85 PCB congeners summed)
(2) Kuehl *et al.* (1995); Gulf of Mexico (number of PCB congeners summed not stated)
(3) Salata *et al.* (1995); Gulf of Mexico (number of PCB congeners summed not stated)
(4) Prudente *et al.* (1997); North-western Atlantic (55 PCB congeners summed)
(5) Kannan *et al.* (1993); Mediterranean (number of PCB congeners summed not stated)

It is well established that mothers transfer organochlorines to their offspring *via* lactation (*e.g.,* Addison and Brodie, 1987). While the authors could not find any published information on the nursing duration of rough-toothed dolphin calves, there is information on bottlenose dolphins. Assuming that the botttlenose dolphin calves nurse for similar lengths of time, rough-toothed dolphin calves under the age of 18 months were likely receiving most or all of their nutrients from their mothers' milk (Cockroft and Ross, 1990). For calves whose mothers have had previous offspring, the risk of negative health effects from POPs is diminished as females may offload up to 80% of their body burden to their first-born calves (bottlenose dolphins, Cockroft *et al.*, 1989). This would explain the elevated levels seen in the young rough-toothed dolphins (Figure 2). The elevated levels in RTDL-007, a pregnant female, suggest that she was carrying her first calf and had not yet off-loaded her body burden to a previous offspring. Unfortunately, none of the neonates were available for analysis, which could have provided information about parturitional transfer of POPs in this species. Previously, it has been suggested that the predominantly lactational transfer of POPs to first-born calves may have serious health implications including increased mortality (Cockroft *et al., 1989*) Considering that so little is known about many of the details of the rough-toothed dolphins life history, this is an area warranting further study.

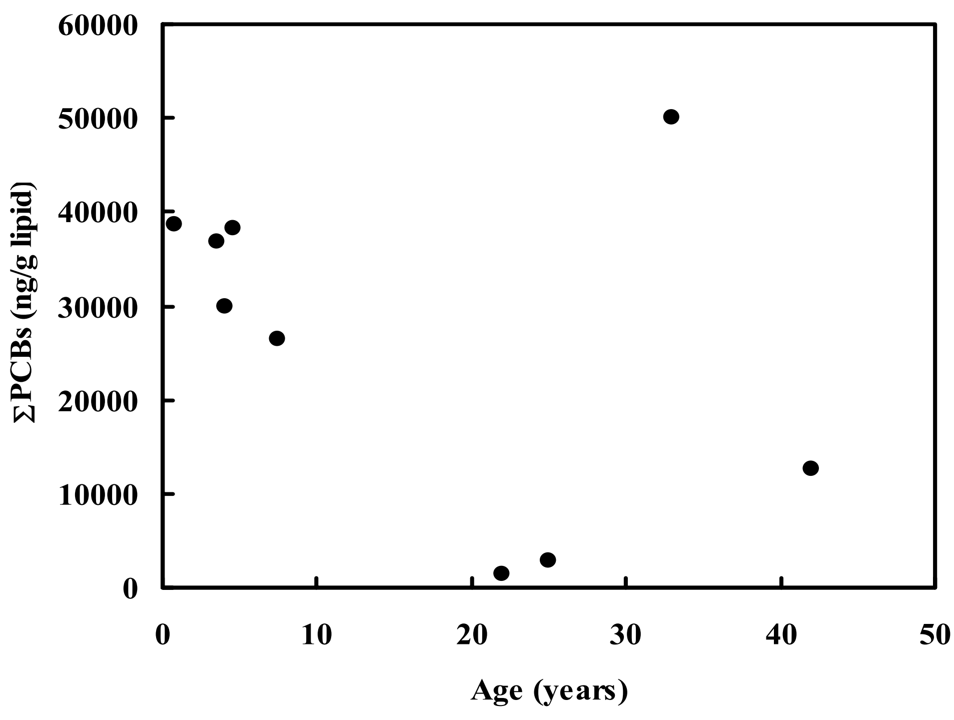


Figure 2: Age versus ΣPCB congeners (ng/g lipid mass) for female rough-toothed dolphins.

Liver and Kidney Analyses

Results of INAA and ICP-MS analyses to determine inorganic constituents in kidney and liver tissues of the 15 rough-toothed dolphins are discussed below. For each method, analyses were performed on duplicate sample portions and results from analyses on these individual portions are presented in Table B3, Appendix B. Duplicate portions of SRM 1566a Oyster Tissue and of Whale Liver Homogenate I were used as control materials for INAA and one portion of Whale Liver Homogenate I was used for the ICP-MS analyses. Results for these materials are shown in Tables B4, B5, and B6 in Appendix B. In general, values determined by INAA and ICP-MS agree with certified values, reference values, or literature values.

Analysis of Duplicate Subsamples: For most elements, the values from INAA and ICP-MS of duplicate portions agree within the total uncertainties listed for each method. Poor agreement between duplicate portions was observed for Pb in all tissues, Ca in three kidney specimens and two liver specimens, Cd in one liver specimen, and for several elements in the kidney tissue with highest lipid content (RTDL-013).

Values for Pb in a given sub-sample varied by as much as two orders of magnitude. It is unlikely that the tissues are inhomogeneous with respect to lead. It is probable that the observed inhomogeneity is the result of contamination of the tissues either during collection or processing of the sub-samples. Identification of the source of contamination is under investigation. For this reason, the values for Pb are not included in this report.

Calcium values from duplicate portions showed poor agreement in several of the specimens. Poor agreement for duplicate portions was observed for liver tissues from RTDL-003 and RTDL-007 and for kidney tissues from RTDL-005, -007, and -008. The kidney tissues of these animals contained greater amounts of lipid material than the others (see Table B1). Although kidney lipid levels were highest for RTDL-013, Ca values in this specimen were below the INAA detection limit of 16 mg/kg. This type of apparent Ca inhomogeneity was found in beluga whale kidney tissues that were known to contain Ca nodules (Becker, 2000). Tissue mineralization is not uncommon and could result in tissues that contain small Ca deposits that are not homogeneously distributed, even after cryogenic homogenization.

The values from the duplicate sub-samples of the kidney tissue containing the highest amount of lipid, from animal RTDL-013, showed poor agreement for the elements Na, Cl, K, and Br which are short-lived NAA products. For this reason, an additional sub-sample was included in the subsequent analysis of long-lived products of NAA. Values among these three portions were inconsistent. The portions from this tissue were too oily to be easily removed from the LPE bags after the long irradiation. It is possible that inconsistent LPE film element content contributed to the observed variation; however it is more likely that the sub-samples from this tissue are inhomogeneous. Values for several of the electrolytes in duplicate portions of the tissues with high lipid content were inconsistent and were generally lower than those in the other tissues. Electrolytes are hydrophilic rather than lipophilic so that these results may be expected.

Electrolytes: Na, Mg, Ca, Cl, K, Br: Although most researchers do not determine electrolyte levels in marine mammal tissues, results of this study were compared with other INAA results from analysis of marine mammal tissues from the NBSB. In general, INAA of marine mammal liver tissues has shown that concentrations of electrolytes vary little from animal to animal, or among species (Mackey *et al.,* 1995). Levels of most of the electrolytes in liver and kidney of rough-toothed dolphins are consistent with this finding. Values of the relative standard deviation for Na, Mg, Cl, K, and Br for these 15 rough-toothed dolphin liver tissues ranged from 9% to 13%. Little variation was observed because these elements are essential and are regulated biochemically. Levels of Na, Mg, Cl, K, Br, and Cs in these tissues are similar to those found in NBSB tissues of several other odontocetae including white-sided dolphin, pilot whale, harbor porpoise, and beluga whale. See Tables 3 and 4.

Levels of Ca were high and amounts in duplicate portions varied greatly in kidneys of three rough-toothed dolphins (RTDL-005, -007, and -008) and in livers of two (RTDL-003, RTDL-007). The three kidney specimens were those with high lipid content (20% to 32%). Calcium values were below the INAA detection limit (of about 16 mg/kg) in the specimen (RTDL-013) containing the largest amount of extractable organic material (45%). Calcium levels found in the rough-toothed dolphins were similar to those found in the beluga whales from Cook Inlet (Becker *et al.,* 2001) which contained calcified nodules and were inhomogeneous with respect to Ca. Tissue calcification has been associated with connective tissue kidney lesions in humans (Selye, 1961) and with carcinoma (see *e.g.,* Davidson *et al,* 1990.)

Table 3: Comparison of concentration ranges (mg/kg wet mass) of trace elements in kidneys of rough-toothed dolphins and those of other odontocetae.

	Rough-Toothed Dolphins n = 15	Beluga Whales n = 10	Beluga Whales n = 37	Common Dolphin n = 18	Harbor Porpoise n = 23
	This work	Becker *et al.* (2001)	Hansen *et al.* (1990)	Law *et al.* (1994)	Law *et al.* (1994)
Na	1021 -2297	1884 - 2350	--	--	--
Mg	47 - 205	86 - 165	--	--	--
Cl	1257 - 2932	1811 - 2688	--	--	--
K	932 - 3013	1814 - 2223	--	--	--
Ca	57 - 1197	69 - 2232[a]	--	--	--
V	≤0.04	≤0.04	--	--	--
Mn	0.172 – 1.06	0.38 - 1.24	--	--	--
Cu	≤4	≤5	--	1.9 - 7.6	2.3 - 15
Br	14.2 - 25.5	15 - 28	--	--	--
Fe	30 - 77	58 - 155, 732[b]	--	--	--
Co	0.004 - 0.013	0.006 - 0.018	--	--	--
Zn	8.6 - 18.7	19 - 30	15 - 40 (27.2)	12 - 35	16 - 45
As	≤0.5 - 0.7	≤0.06 - 0.21[c]	--	0.8 - 1.4 (n = 7)	--
Se	2.4 - 11	0.41 - 3.87	0.34 - 4.24 (2.2)	1.9 - 3.9 (n = 11)	0.6 - 4.9
Rb	0.41 - 1.4	0.7 - 1.8	--	--	--
Ag	≤0.005 - 0.015	≤0.005 - 0.02, 36.7[d]	--	--	--
Cd	0.01 - 1.02[e]	2.2 - 9.0	≤0.015 - 28.7 (10.3)	0.12 - 9.3	≤0.07 - 8.7
Cs	0.025 - 0.068	0.045 - 0.11	--	--	--
Hg	0.9 - 15[e]	--	≤ 0.005 - 8.88	0.3 - 6.0	≤0.01 - 37

[a] These kidneys were inhomogeneous with respect to Ca because of the presence of calcified nodules in the tissue.

[b] Concentrations for nine kidneys ranged from 58 mg/kg to 155 mg/kg; the value for the remaining tissue was 732 mg/kg ± 22 mg/kg (1 SD)

[c] Arsenic levels for seven of the ten kidneys were below the detection limit of 0.06 mg/kg and the remaining three values ranged from 0.14 mg/kg to 0.21 mg/kg.

[d] Silver levels in seven of the ten kidneys were below the below the detection limit of about 0.005 mg/kg, concentrations in two kidneys were 0.01 mg/kg and 0.02 mg/kg, and the remaining value was 37 mg/kg ± 4 mg/kg (1 SD).

[e]Values were determined by ICP-MS

Essential Trace Metals: Mn, Co, Cu, Zn, Se: Levels of four of these essential trace elements in liver tissues of rough-toothed dolphins also showed little animal-to-animal variation. Values for the relative standard deviation for Mn, Co, Cu, and Zn ranged from about 10% to 25%. As was the case with electrolytes, this relatively narrow range of values was expected since these elements are essential and are regulated biochemically. The ranges of values found for these elements in rough-toothed dolphin liver and kidney were generally similar to those reported for other marine mammal species. See Tables 3 and 4.

Although Se is an essential element, much greater animal-to-animal variation was observed for Se concentrations than for the other essential elements. Selenium mass fractions ranged from 2.9 mg/kg to 122 mg/kg in liver tissues and from 2.6 mg/kg to 11.1 mg/kg in kidney tissues. Values for the relative standard deviation of selenium were 40% for concentrations in kidney and 110% for liver. Similar ranges have been reported for other marine mammal species. This comparatively wide range of values was probably due to the role of selenium in metal detoxification (Frost and Lish, 1975; Hammond and Beliles, 1980). Selenium or seleno-proteins may assist in the removal of several toxic metals so that Se concentrations often increase with increasing concentrations of other metals. Koemann *et al.* (1973) first reported a linear correlation between Se and Hg in liver tissues. Since then, many other researchers have also observed this relationship (*e.g.,* Julshamn *et al.,* 1987; Meador *et al.,* 1993; Mackey *et al.,* 1996). Hepatic Se concentrations also increase with those of Ag in several species of odontocetae (Becker *et al.,* 1995).

Selenium values were slightly higher in the rough-toothed dolphin kidneys when compared with levels found in tissues of other species. The Se concentrations in kidney tissues containing a higher amount of lipid appeared to be slightly higher than in tissues with a lower amount of lipid. Selenium values from animals RTDL-003, -005, -007, -008, and -013, ranged from 6.9 mg/kg to 11.1 mg/kg, whereas the range for the remaining tissues was 2.4 mg/kg to 5.9 mg/kg. Selenium values in the liver tissues from those dolphins were also higher (with a range of 33 mg/kg to 122 mg/kg) in the animals whose kidneys contained higher lipid amounts (RTDL-003, -005, -007, -008 and -013) compared to a range of 2.9 mg/kg to 28 mg/kg for the remaining animals. The number of tissues analyzed was insufficient to determine whether this difference was significant. Similar patterns were observed for Hg, which is discussed below.

Potentially Toxic Metals: As, Ag, Cd, Hg: Levels of As in rough-toothed dolphins were below the INAA detection limit of 0.06 mg/kg in 14 of the 15 kidney tissues analyzed and ranged from 0.2 mg/kg to 0.6 mg/kg in rough-toothed dolphin liver tissues. These ranges were consistent with values reported for other species of marine mammal. Hepatic As levels in rough-toothed dolphins were similar to those found in harbor porpoise and the range overlaps ranges reported for several other species of marine mammals (Table 4).

Levels of Ag, Cd, and Hg in rough-toothed dolphin tissues showed much greater animal-to-animal variation than As. The relative standard deviations of the average values for these elements ranged from about 50% to well over 100%, as values for a given element span several orders of magnitude. The elements Ag, Cd, and Hg are probably not essential, and have no known specific biochemical regulatory pathways in mammals. These metals often accumulate in liver and kidney tissues over time (*e.g.,* Mackey *et al.,* 1996). Results from ICP-MS showed that renal Cd values ranged from 0.05 mg/kg to 3.94 mg/kg. These values are similar to the levels found in the kidneys of other marine mammals from the NBSB and with selected literature values (Table 3). Levels of Hg in rough-toothed dolphin kidneys also spanned two orders of magnitude, consistent with ranges observed in other species (see Table 3). Hepatic Hg in rough-toothed dolphins RTDL-003, -007 and -013 represented some of the higher values (175 mg/kg, 180 mg/kg, and 235 mg/kg) observed for tissues from the NBSB. The hepatic Hg values for rough-toothed dolphins were within the range of values reported for other odontocetae such as Mediterranean striped dolphins (*Stenella coeruleoalba;*1.2 mg/kg to 1544 mg/kg; Andre *et al,* 1991) and were similar to the values for harbor porpoise reported by Law *et al.,* 1992. (See Table 4.)

Table 4: Comparison of concentration ranges (mg/kg of wet mass) of selected trace elements in livers of rough-toothed dolphins with ranges for other odontocetae.

Element	Rough-Toothed Dolphins n = 15 *This work*	Pilot Whales n = 9 Mackey *et al. Unpublished*	White-sided dolphin n = 4 Mackey *et al. Unpublished.*	Porpoise n = 37 *Law et a1. 1992*	Common dolphin N = 42 *Law et a1. 1992*	Striped Dolphin n = 7 *Law et a1. 1992*	Harbor Porpoise n = 6 Mackey *et al. unpublished*
Na	1044 - 1704	1238 - 1621	1108 - 1264	--	--	--	1195 - 1703
Mg	120 - 186	94.5 - 182.5	134 - 162	--	--	--	128 - 267
Cl	1343 - 2012	1630 - 2229	1356 - 1528	--	--	--	1589 - 2030
K	2333 - 3565	1998 - 2792	2772 - 3146	--	--	--	2128 - 3307
Ca	23 - 60.5, 243	24 - 68	41 - 58	--	--	--	30 - 63
V	≤0.03	≤0.02	≤0.01 - 0.06	--	--	--	≤0.02
Mn	2.81 - 5.09	1.78 - 3.41	3.10 - 4.12	--	--	--	2.68 - 5.15
Cu	3.55 - 7.31	≤1.3 - 4	3.2 - 8.1	5 - 120	2.7 - 12, 40, 81	3.7 - 12	3.84 - 15.3
Br	14.7 - 24.5	15.6 - 21.2	12.4 - 16.6	--	--	--	11.8 - 16.4
Fe	115 - 615	144 - 806	66 - 296	--	0.8 - 45	0.9 - 9 (n = 4)	1.1 - 4.2
Rb	0.8 - 1.7	1.44 - 2.1	≤1 - 3	--	--	--	1.0 - 1.7
Ag	0.05 - 1.18	0.013 - 0.333	0.27 - 1.50	--	--	--	0.15 - 0.76
Cd	≤0.5	2.8 - 14.3	0.46 - 3.65	<0.06 - 0.44	<0.07 - 6.5	<0.07 - 11	≤0.5
Cs	0.024 - 0.089	≤0.002 - 0.01	0.009 - 0.075	--	--	--	0.033 - 0.5
Hg	3.4 - 235	1.05 - 112	1.0 - 22.7	0.6 - 190	0.14 - 130	0.59 - 22	0.56 - 38.6

Relationship between liver and kidney: In general, no strong relationships were found between element concentrations in kidney and liver. Concentrations of Se in liver and kidney appeared to be correlated with a linear correlation coefficient of 0.75 ($p<0.002$; Figure 3). No other significant linear correlation relationships were observed between the two tissues.

Element Accumulation with Age: Liver and kidney may serve as repositories for some trace elements. Data from this study were analyzed to determine whether any elements increased with increasing animal age. Results indicated that Se, Hg, Ag, and Sn accumulated in rough-toothed dolphin liver and that Hg and Se accumulated in kidney tissues.

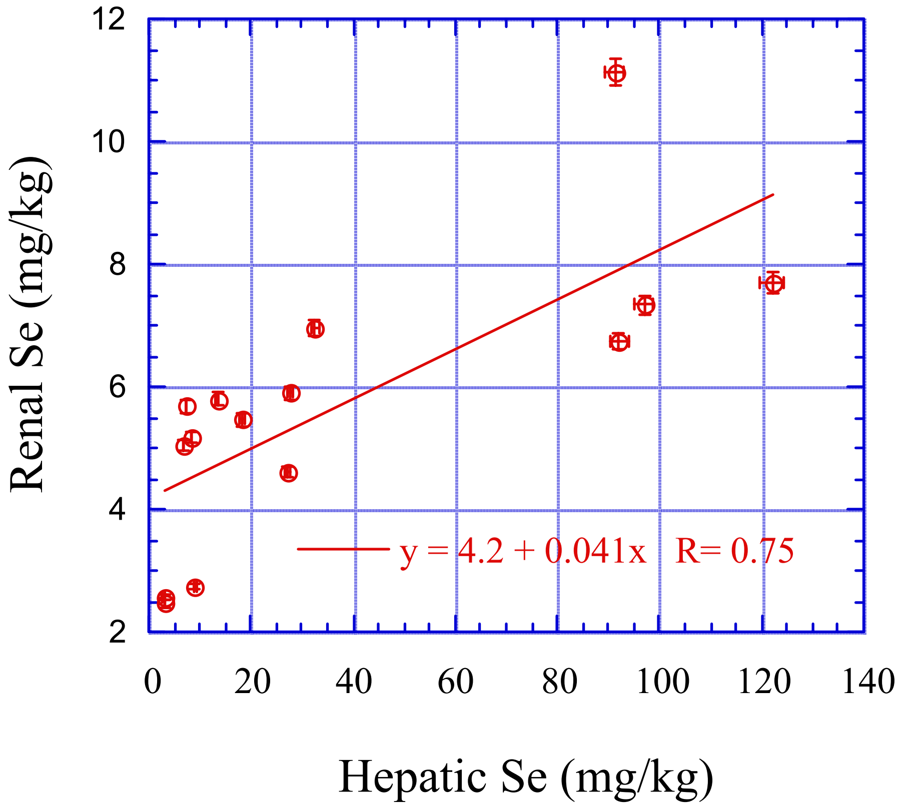
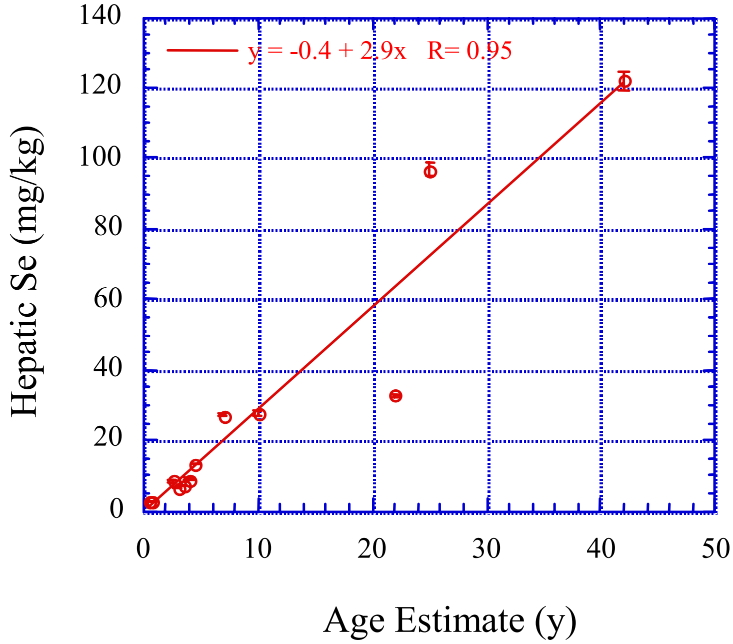


Figure 3: Renal and hepatic Se concentrations (mg/kg) in rough-toothed dolphins.

Several researchers observed that levels of Hg and Se were correlated and increase over time in liver tissue of several mammalian species. This relationship was thought to be the result of Se assisting in the detoxification of Hg or its compounds (Koeman *et al,* 1975; Martoja and Viale 1977). Results of this work indicated that Se and Hg accumulated with age in both liver and kidney of rough-toothed dolphins (Figures 4 and 5). The linear correlation coefficient (r) for hepatic Se concentrations versus age was 0.77, and for hepatic Hg versus age, r = 0.96. The linear correlation coefficient for renal Se concentrations vs. age was 0.95, and that for renal Hg was 0.92. Accumulation of Hg and Se with age was reported in many marine mammal species. (See, e.g., Koeman *et al.,* 1975; Wagemann *et al.,* 1983; Meador *et al.,* 1993.)

Less is known about levels of Sn in marine mammal tissues. Most researchers do not determine Sn. There are some data on levels of the butyltin compounds in marine mammal tissues. Law *et al.* (1998) report that levels of total butyltin compounds in liver tissues of porpoises and grey seals (*Halichoerrs grypus*) ranged from 0.01 mg/kg to 0.6 mg/kg and levels as high as 10 mg/kg have been reported (Iwata *et al.,* 1995). Levels of Sn in livers of these animals ranged from 0.08 mg/kg to 1.10 mg/kg. Levels in kidney tissues ranged from the ICP-MS detection limit of 0.02 mg/kg to 0.14 mg/kg. Hepatic Sn was linearly correlated with animal age (r = 0.95) indicating accumulation in liver tissues with time (Figure 6). Hepatic Ag concentrations (r = 0.90) also increased with animal age. This was also observed for several species of marine mammals from the NBSB (Becker *et al.,* 1995; Mackey *et al.,* 1996).

A)



B)

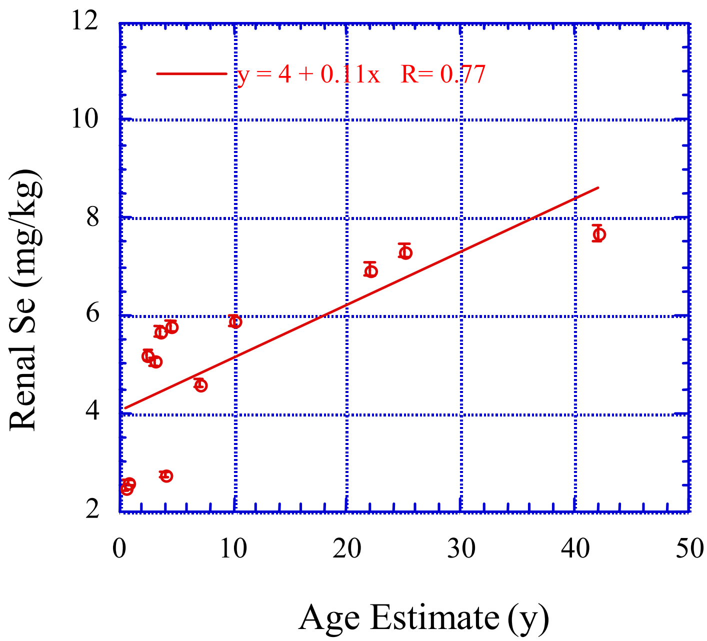


Figure 4: Hepatic (A) and renal (B) Se concentrations (mg/kg) as a function of rough-toothed dolphin age estimate (y).

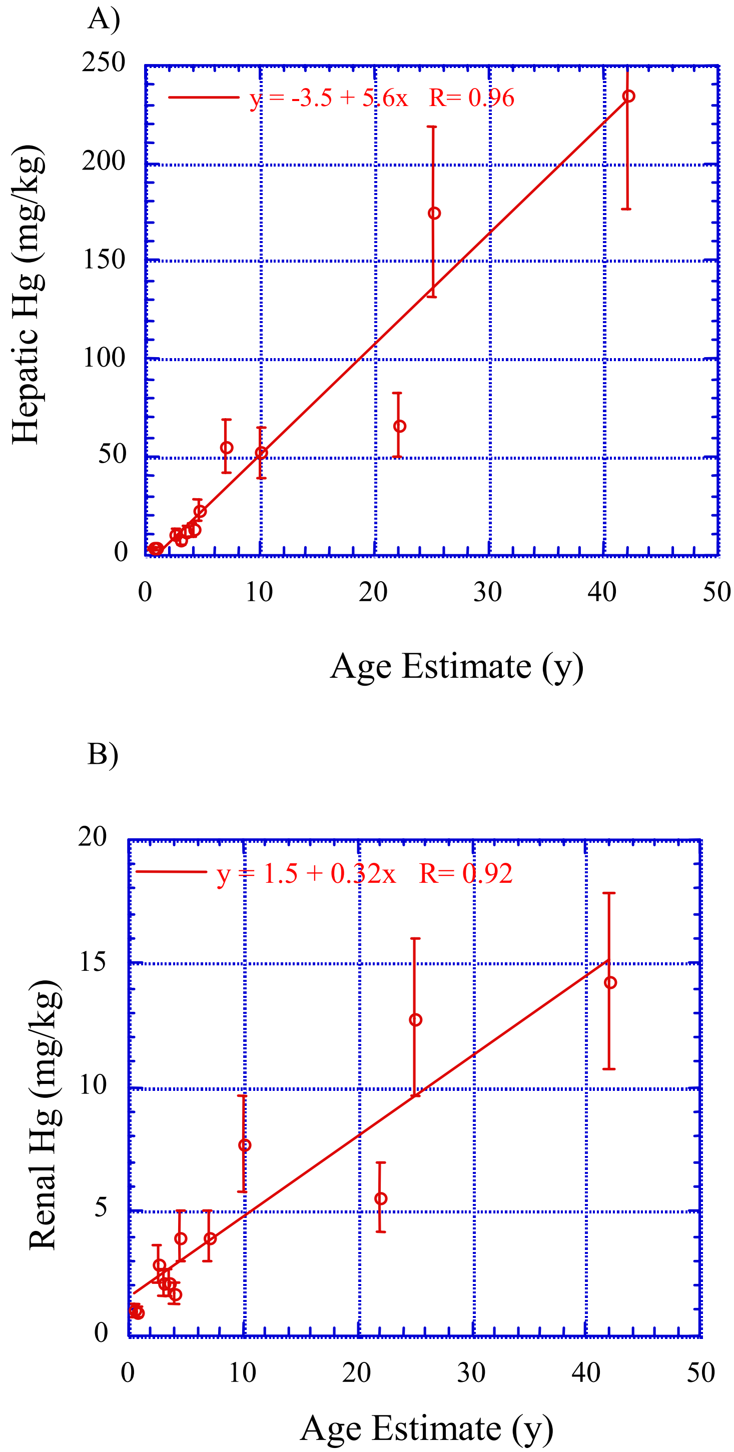


Figure 5: Hepatic (A) and renal (B) Hg concentrations (mg/kg) as a function of rough-toothed dolphin age estimate (y).

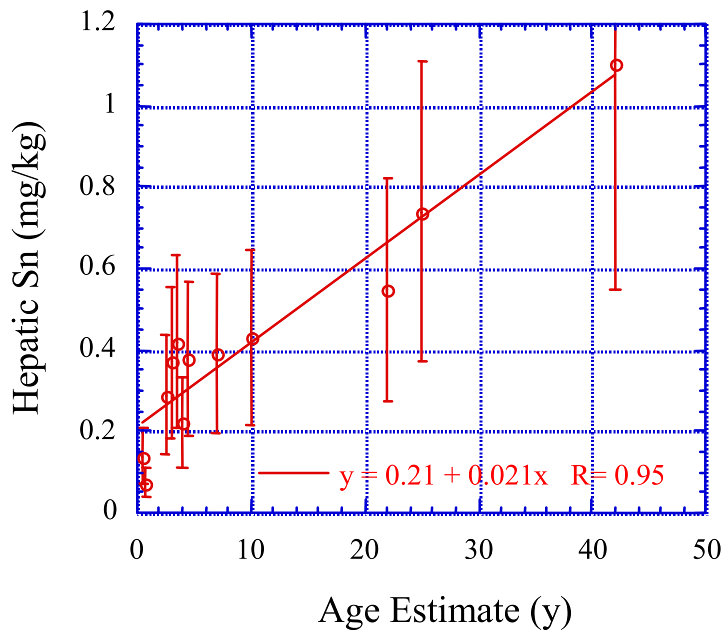


Figure 6: Hepatic Sn concentrations (mg/kg) as a function of rough-toothed dolphin age estimate (y).

Element Correlations: Data were analyzed to determine whether concentrations of any elements were correlated (Tables B7 and B8). Positive linear correlations were observed for Na:Cl; Se:Ag; Hg:Se; Ag:Hg; Hg:Sn; and Se:Sn in liver tissue, and for Se:Hg in kidney. Since Se, Ag, Sn, and Hg were found to increase with animal age, it is possible that there were no direct biochemical relationships between these elements, but simply that they all increased with age. The correlation of Na and Cl may reflect electrolyte balance. Positive linear correlation relationships were also observed for Mn:Zn and Rb:K in kidney tissues.

CONCLUSIONS

This study has documented persistent organic pollutant (POP) and element concentrations in a pelagic species for which little data of this kind are otherwise available. Levels of the POP compounds discussed above were similar to or lower than those found in other species of odontecetes from the Gulf of Mexico as well as other geographical locations (Kuehl *et al.,* 1991; Kuehl and Haebler; 1995, Prudente *et al*., 1997; and Salata *et al*., 1995). However, the rough-toothed dolphins had higher percentage ratios of 4,4'-DDT to 4,4'-DDT + 4,4'-DDE than those measured in bottlenose dolphins from the Gulf of Mexico, suggesting higher exposure to current-use DDTs. Differences in mirex concentrations between rough-toothed dolphins and bottlenose dolphins from the Gulf of Mexico versus bottlenose dolphins from the western Atlantic may prove useful in discriminating between stocks of rough-toothed dolphins from the two regions. Of particular concern were the relatively high concentrations of POPs in the immature dolphins.

The contaminant concentrations versus age structure suggests that there is substantial off-loading of females' body burdens to their calves, which is of concern, as little is known about the potential negative effects on individual animals and population levels.

Element contents of liver and kidney tissues are, in general, consistent with levels found in other odontocetae. Levels of Se and Hg in liver tissues were among some of the higher values found in marine mammal tissues from the NBSB, but were similar to those reported for several other species of odontocetae. The elements Se, Ag, Sn, and Hg accumulate in rough-toothed dolphin liver with age. Results also indicate that Se and Hg accumulate in rough-toothed dolphin kidney. These findings may reflect the protective mechanism of Se in detoxification or removal of Hg in these tissues. Levels of hepatic Hg and Se were higher in the rough-toothed dolphins with Ca inhomogeneity and higher lipid content in the kidney. Additional study is required to determine the significance of this finding.

The mortality event of rough-toothed dolphins in 1997 provided a limited sample set from which much can be learned, but there are still many unanswered questions: e.g., What are contaminant levels in older adult males? How do levels and contaminant profiles from Atlantic rough-toothed dolphins compare with those for rough-toothed dolphins from the Gulf of Mexico? Unfortunately, to address these questions, researchers are dependent on mass-mortality events from which to obtain samples. The MMHSRP administered by NOAA provides the support and coordination for a systematic investigation of mass stranding events and for collection and banking of tissues from these animals so that researchers will have the opportunity to address these questions in the event of future rough-toothed dolphin stranding events.

REFERENCES

Addison, R. F.; Brodie, P. F. *Can. J. Fish. Aquat. Sci.* **1987**, 44, 782.

Andre, J.; Boudou A.; Ribeyre, F.; Bernhard M. *Sci. Total Environ.* **1991,** 104**,** 191.

Becker, P. R.; Pugh, R. S.; Schantz, M. M.; Mackey, E. A.; Demiralp, R.; Epstein, M. S.; Donais, M. K.; Porter, B. J.; Wise, S. A.; Mahoney, B. A. NISTIR 6702. U.S. Dept of Commerce. NIST, Gaithersburg, MD, **2001.**

Becker, P. R.; Porter B. J.; Mackey, E. A.; Schantz, M. M.; Demiralp, R.; Wise, S. A. NISTIR 6279. U.S. Dept of Commerce. NIST, Gaithersburg, MD, **1999**.

Becker, P. R.; Mackey, E.A.; Demiralp, R.; Suydam, R.; Early, G.; B. J. Koster, B. J.; Wise, S. A. *Mar. Pollut. Bull.* **1995**, 30**,** 262.

Bidleman, T. F.; Alegria, H.; Ngabe, B; Green, C. *Atmos. Environ.* **1998**, 32,1849.

Blaylock, R. A.; Hain, J. W.; Hansen, L. J.; Palka, D. L.; Waring, G. T. *NOAA Tech Memo*, Miami, FL. NMFS-SEFSC-363, 211 pp. **1995.**

Clark, M. R. **In:** *Research on Dolphins* (eds. M.M. Bryden and R.J. Harrison), pp. 281-321. Claredon Press, Oxford, **1986.**

Cockroft, V. G.; De Kock, A. C.; Lord, D. A.; Ross, G. J. B. *S. Afr. J. Mar. Sci.* **1989,** 8**,** 207**.**

Cockroft, V. G.; De Kock, A. C.; Ross G. J. B.; Lord. D. A. *S. Afr. Tydskr. Dierk.* **1990,** 25, 144**.**

Davidson, R. M.; Dhekne, R. D.; Moore, W. H.; Butler, D. B. *Clin. Nucl. Med.* **1990,** 15, 692.

Frost D. V.; Lish, P. M. *Annu. Rev. Pharmacol*. **1975,** 15, 259**.**

Hammond P. B.; Beliles, R .P. **In:** *Casarett and Doull's Toxicology: the Basic Science of Poisons*, 2nd ed. (J. Doull, C. D. Klaassen and M. O. Amdur, eds.) Macmillan, New York. pp. 409-467, **1980**.

Hansen, C. T.; Nielsen, C. O.; Dietz, R.; Hansen, M. M. *Polar Biol.* **1990**, 10, 529.

Hohn, A. A.; Scott, M. D.; Wells, R. S.; Sweeney, J. C.; Irvine, A. B. *Mar. Mam. Sci.* **1989,** 5**,** 315.

Holden, A. V.; Mardsen, K. *Nature* **1967,** 216, 1274.

Iwata, H.; Tanabe, S.; Sakai, N.; Tatsukawa, R. *Environ. Sci. Technol.* **1993,** 27, 1080.

Jensen, S. *New Scientist* **1966**, 32, 612.

Julshamn, K.; Andserson, A.; Ringdal, O.; Morkore, J. *Sci Total Environ.* **1987,** 65, 53**.**

Kannan, K.; Blankenship, A.; Jones, P.; Giesy, J. *Human Ecol. Risk Assess.* **2000,** 6,181**.**

Kannan, K.; Tanabe, S.; Borrell, A.; Aguilar, A.; Focardi, S.; Tatsukawa. R. *Arch. Environ. Contam. Toxicol.* **1993,** 25, 227.

Koeman, J. H.; de Ven, W. M.; deGoeij, J. J. M.; Tijoe, P.S.; van Haaftten J. L. *Sci. Total Environ*. **1975,** 3**,** 279**.**

Kucklick, J. R.; Struntz, D. J.; Becker, P. R.; York, G. W.; O'Hara, T. M.; Bohonowych, J. E. *Sci. Total Environ. (In press), 2001.*

Kuehl, D. W.; Haebler, R.; Potter, C. *Chemosphere,* **1991,** 22**,** 1071**.**

Kuehl, D. W.; Haebler, R. *Arch. Environ. Contam. Toxicol.* **1995,** 28, 494.

Lahvis, G. P.; Wells, R. S.; Kuehl, D. W.; Stewart, J. L.; Rhinehart, H. L; Via C. S. *Environ. Health Perspect*. **1995,** 103**,** 67.

Law, R. J. (complier) Collaborative UK Marine Mammal Project: summary of data produced 1988-1992. Fisheries Research Technical Report No. 97. 42 pp. **1994.**

Law, R. J.; Jones, B. R. Baker, J. R.; Kennedy, S.; Milne R.; Morris R. J. *Marine Pollut. Bull.* **1992,** 24, 296**.**

Law, R.; Allchin, J.; Jones, B.; Jepson, P.; Baker, J.; Spurrier, C. *Marine Pollut. Bull.* **1997,** 34**,** 208.

Law R. J.; Blake, S. J.; Jones B. R.; Rogan E. *Marine Pollut Bull.* **1998,** 36, 241**.**

Layne, J. L. *Bull. Fla State Mus. Biol. Sci.* **1965,** 9,131**.**

Leatherwood, S.; Reeves, R. R.; Perrin, W. F.; Evans W. E. *NOAA Tech. Rep*. NMFS *Circ*. 444, 245 pp. **1982**

Lopez-Carrillo, L.; Torres-Arreola, L.; Espinosa-Torres, F.; Jimenez, C.; Cebrian, M.; Waliszewski, S.; Saldate, O. *Environ. Health Perspect.* **1996,** 104, 584**.**

Mackey, E. A.; Demiralp, R.; Becker, P. R.; Greenberg, R. R.; Koster, B. J.; Wise, S. A. *Sci. Tot. Env*. **1995,** 175, 25**.**

Mackey, E. A.; Becker, P. R; Demiralp, R.; Greenberg, R. R; Koster, B. J.; Wise. S. A. *Arch. Contam. Toxicol.* **1996,** 30, 503**.**

Meador, J. P.; Varanasi, U.; Robisch, P. A.; chan S-L. *Canadian J. Fish. Aquatic Sci*. **1993**, 50**,** 2698,

Marine Mammal Commission. Proceedings of the Marine Mammal Commission Workshop, Keystone, Colorado, 12-15 October, 1998. 150 pp. + vii. **1999.**

Marsili, L.; Focardi, S. *Environ. Monit. Assess.* **1997,** 41**,** 129**.**

Martoja, R.;Viale, D. CRC Acad. Sci. Paris, **1977,** 285**,** 109.

Miyazaki, N.; Perrin, W. F. **In**: *Handbook of Marine Mammals, Volume 5 The First Book of Dolphins* (Eds S.H. Ridgway and F.R.S. Harrison). pp. 1-21 Academic Press. London. **1994**.

Muir, D. C. G.; Norstrom, R. J.; Simon, M. *Environ. Sci. Tech.* **1988,** 22, 1071.

Muir, D.; Braune, B.; De March, B.; Norstrom, R.; Wagemann, R.; Lockhart, L.; Hargrave, B.; Bright, D.; Addison, R.; Payne J.; Reimer K.; *Sci. Total. Environ.* **1999,** 230, 83**.**

Myrick, A. C.; Hohn, A. A.; Sloan, P. A.; Kimura, M.; Stanley, D. D. NOAA Technical Memorandum. Southwest Fisheries Center, National Marine Fisheries Service. Report number NOAA-TM-NMFS-SWFC-30. La Jolla, CA. 17 pp. **1983.**

O'Shea, T. J.; Brownell, R. L. Jr.; Clark, D. R.; Walker, W. A.; Gay, M. L.; Lamont T. G. *Pest. Monit. J.* **1980,** 14**,** 35**.**

Perrin, W. F.; Myrick, A. C. (eds.). International Whaling Commission. Special Issue 3. Cambridge. **1980**.

Prudente, M.; Tanabe, S.; Watanabe, M.; Subramnian, A.; Miyazaki, N.; Suarez, P.; Tatsukawa. R. *Mar. Environ. Res.* **1997,** 44, 415.

Safe, S. *CRC Crit. Rev. Toxicol.* **1990**, 21, 51.

Salata, G. G.; Wade, T. L.; Sericano, J. L.; Davis, J. W.; Brooks J. M. *Environ. Pollut.* **1995,** 88, 167**.**

Selye H. J. *Urol*. 86, 687, **1961**

Smith, J. H.; Mabey, W.R.; Bohonos, N.; Holt, B. R.; Lee, S. S.; Chou, T. W.; Bomberger, D. C.; Mill, T. *EPA Report EPA-600/7-78-074,* **1978**

Stegeman, J. J., Hahn. M. E. **In**: *Aquatic Toxicology: Molecular, Biochemical, and Cellular Perspectives* (Eds D.C. Malins and G.K. Ostrander), pp. 87-205. CRC Press, Boca Raton. **1994**.

Tanabe, S. *J. Oceanographic Soc. Japan,* **1985,** 41**,** 358**.**

Tanabe, S.; Iwata, H.; Tatsukawa, R. *Sci. Total. Environ.* **1994,** 154**,** 163**.**

Wise, S. A.; Schantz, M. M.; Koster, B. J.; Demiralp, R.; Mackey, E. A.; Greenberg, R. R.; Burow, M.; Ostapczuk, P.; Lillestolen, T. I. *Fresenius J. Anal. Chem.* **1993,** 345**,** 270.

Zeisler, R.; Langland J. K.; Harrison, S. H. *Anal. Chem.* **1983,** 55, 2431.

APPENDIX A: PERSISTENT ORGANOCHLORINE COMPOUNDS: ANALYTICAL DATA

Table A1: Organochlorines in SRM 1945 determined by NIST Gaithersburg and NIST Charleston (n = 3 each). Percent difference is the difference between the certified or reference (bold) values ((measured value – certified value/certified value) * 100).

Compound	Gaithersburg			Charleston			Certified or	
	Mean	1 SD	%Diff	Mean	1 SD	%Diff	Reference Values	95% CL
PCB 18	4.62	0.2	3	4.68	0.4	5	4.48	0.88
PCB 31	3.34	0.1	7	3.72	0.1	19	**3.12**	**0.69**
PCB 28	12.3	0.4	-13	10.0	0.2	-29	**14.1**	**1.4**
PCB 52	39.9	0.9	-8	35.9	0.4	-18	43.6	2.5
PCB 49	18.4	0.4	-11	16.1	0.3	-22	20.8	2.8
PCB 44	12.3	0.2	1	11.6	0.3	-5	12.2	1.4
PCB 66	24.7	1.0	5	29.5	1.4	25	23.6	1.6
PCB 95	35.0	1.0	4	32.7	0.6	-3	33.8	1.7
PCB 101+90	67.9	2.2	4	81.0	1.7	24	65.2	5.6
PCB 99	50.6	0.7	11	51.4	0.9	13	45.4	5.4
PCB 87	16.6	0.2	-1	22.4	0.9	34	16.7	1.4
PCB 118	74.3	0.6	-0.4	74.1	2.0	-0.7	74.6	5.1
PCB 105	29.7	1.4	-1	22.1	0.8	-27	30.1	2.3
PCB 151+82	28.3	0.9	-2	26.2	1.6	-9	28.7	5.2
PCB 149	82.8	4.2	-22	74.9	2.3	-30	106.6	8.4
PCB 153	225	3.0	6	231	7.8	9	213	19
PCB 138	133	2.1	1	113	7.6	-14	131.5	7.4
PCB 128	22.9	0.5	-3	20.4	1.7	-14	23.7	1.7
PCB 156	10.1	0.3	-2	10.1	0.3	-2	10.3	1.1
PCB 187	111	2.5	5	101	3.6	-4	105.1	9.1
PCB 183	35.8	0.3	-2	34.4	1.3	-6	36.6	4.1
PCB 180	123	1.0	15	129	4.8	21	106.7	5.3
PCB 170	42.3	0.7	4	33.5	1.2	-17	40.6	2.6
PCB 201	16.8	0.4	-1	24.0	0.6	42	16.96	0.89
PCB 195	16.8	0.2	-5	19.5	0.7	10	17.7	4.3
PCB 194	47.6	4.1	20	58.2	2.6	47	39.6	2.5
PCB 206	36.6	1.4	18	44.5	2.1	43	31.1	2.7
PCB 209	15.4	0.3	45	18.4	0.6	74	10.6	1.1
HCB	31.7	1.0	-4	27.1	0.5	-18	32.9	1.7
α-HCH	16.4	0.6	1	15.5	0.6	-4	16.2	3.4
β-HCH	8.40	0.4	5	3.87	0.3	-52	8.00	1.4
γ-HCH	3.19	0.1	-3	3.09	0.1	-6	3.3	0.81
oxychlordane	20.2	0.4	2	20.8	0.7	5	19.8	1.9
heptachlor epoxide	10.4	0.4	-4	9.56	0.3	-11	10.8	1.3
2,4'-DDE	12.2	0.5	-1	10.5	0.2	-15	12.3	0.87
4,4'-DDE	468	9.0	5	556	7.5	25	445	37
trans-chlordane	10.9	0.3	--	10.6	0.4	--	--	--
cis-chlordane	47.4	1.0	1	53.4	1.2	14	46.9	2.8
trans-nonachlor	218	3.5	-6	189	2.4	-18	231	11
cis-nonachlor	49.0	0.7	1	48.8	1.4	0	48.7	7.6
2,4'-DDD	19.2	0.6	6	19.5	1.5	8	18.1	2.8
4,4'-DDD	130	6.1	-3	127	3.0	-5	133	10
2,4'-DDT	95.8	5.0	-10	73.4	6.6	-31	106	14
4,4'-DDT	241	5.5	-1	222	4.1	-9	245	15
dieldrin	40.0	0.4	7	51.0	1.9	36	**37.5**	**3.9**
mirex	29.8	0.6	57	35.1	1.3	86	**18.9**	**2.8**
% lipid	73.9	0.2	0	70.1	0.1	-6	74.3	0.45

Table A2: Results of paired PCB and organochlorine pesticides analyses made by NIST Gaithersburg and Charleston laboratories. Values are ng/g wet mass.

Compound	**RTDL-001**			**RTDL-002**			**RTDL-003**		
	Gaithersburg	Charleston	**Diff. (%)**	Gaithersburg	Charleston	**Diff. (%)**	Gaithersburg	Charleston	**Diff. (%)**
PCB 8	5.81	7.43	24	<2	2.73	--	2.33	2.31	1
PCB 18	10.7	8.23	26	9.53	18.1	62	2.65	1.03	88
PCB 31	19.7	<1	--	8.24	6.44	25	1.41	<1	--
PCB 28	w/ PCB 31	23.1	--	3.68	<1	--	1.79	2.41	30
PCB 52	185	205	10	103	111	7	1.81	1.43	23
PCB 49	180	166	8	51.8	51.9	0	1.19	<1	--
PCB 44	48.2	65.4	30	15.8	17.2	8	2.57	2.59	1
PCB 66	238	293	21	82.3	82	0	6.53	7.9	19
PCB 95	355	345	3	147	167	13	9.53	9.65	1
PCB 101+90	2230	2778	22	416	484	15	32.5	44.5	31
PCB 99	1229	1160	6	659	706	7	28.4	45.6	46
PCB 87	282	269	5	87.5	103	16	13.0	11.4	13
PCB 110	182	189	4	26.3	10.7	84	13.9	12.1	14
PCB 118	1170	1220	4	466	573	21	28.2	35.5	23
PCB 105	285	302	6	87.1	119	31	4.91	8.21	50
PCB 151+82	544	599	10	293	392	29	19.6	20.9	6
PCB 149	1398	1353	3	634	857	30	38.7	50.5	26
PCB 153	6365	5881	8	3774	4795	24	180	247	31
PCB 138	3645	2917	22	2642	2402	10	118	109	8
PCB 128	552	512	8	228	321	34	21.2	18.3	15
PCB 156	151	153	1	36.8	41.7	12	7.01	7.22	3
PCB 187	2399	2301	4	1531	2060	29	114	126	10
PCB 183	628	609	3	528	586	10	31.1	33.9	9
PCB 180	2015	1969	2	1651	2020	20	84.3	111	27
PCB 170	659	632	4	610	604	1	30.2	32.9	9
PCB 201	324	369	13	214	315	38	18.9	20.3	7
PCB 195	87.3	134	42	63.4	115	58	15.4	16.0	4
PCB 194	297	309	4	277	363	27	35.7	35.8	0
PCB 206	173	165	5	144	189	27	35.9	38.4	7
PCB 209	37.8	35.6	6	44.6	49.7	11	26.8	22.6	17
HCB	44.2	46.4	5	8.99	9.86	9	<2	<1	--
α-HCH	50.6	53.9	6	<2	1.59	--	<2	<1	--
β-HCH	115	109	5	4.45	5.11	14	<2	0	--
γ-HCH	13.4	14.3	6	<2	<1	--	<2	5.09	--
oxychlordane	161	151	6	89.6	97.2	8	3.65	4.29	16
heptachlor epoxide	285	328	14	35.4	46.2	26	<2	<1	--
2,4'-DDE	144	149	3	56.7	51.9	9	3.74	3.99	6
4,4'-DDE	10996	11337	3	5822	5950	2	225	217	4
trans-chlordane	91.5	60.7	40	9.56	<1	--	<2	0.38	--
cis-chlordane	806	822	2	33.6	37.8	12	17.5	16.9	3
trans-nonachlor	4923	5092	3	992	1079	8	38.4	39.1	2
cis-nonachlor	1877	1909	2	187	196	5	16.4	15.1	8
2,4'-DDD	201	219	9	26.5	29.8	12	<2	<1	--
4,4'-DDD	4481	4561	2	342	362	6	41.8	36.8	13
2,4'-DDT	443	406	9	299	305	2	10.7	12.3	14
4,4'-DDT	6682	6895	3	666	675	1	25.8	27.7	7
dieldrin	1233	1213	2	90.4	91.9	2	17.4	19.0	9
mirex	265	296	11	246	252	2	17.2	18.6	8
% lipid	67.0	66.3	1	46.2	44.4	4	39.8	38.0	5

Table A2: Continued

Compound	RTDL-004			RTDL-005			RTDL-006		
	Gaithersburg	Charleston	**Diff. (%)**	Gaithersburg	Charleston	**Diff. (%)**	Gaithersburg	Charleston	**Diff. (%)**
PCB 8	3.17	9.60	101	6.04	5.78	4	3.02	3.15	4
PCB 18	6.26	55.9	159	6.01	30.0	133	9.17	42.2	128
PCB 31	6.63	5.10	26	3.23	2.53	24	9.33	<1	--
PCB 28	10.4	17.0	48	5.85	8.22	34	w/ PCB 31	9.75	--
PCB 52	263	331	23	127	148	15	179	168	6
PCB 49	143	170	17	52.6	64.2	20	125	97.5	25
PCB 44	29.6	56.4	62	9.73	24.8	87	23.5	33.0	34
PCB 66	276	267	3	92	115	22	104	126	19
PCB 95	409	551	30	191	235	21	250	265	6
PCB 101+90	972	1328	31	402	526	27	828	887	7
PCB 99	1596	2081	26	1120	1301	15	1091	858	24
PCB 87	275	284	3	105	127	19	140	76.2	59
PCB 110	86.3	104	19	31.6	38.4	19	35.5	43.5	20
PCB 118	1124	1428	24	456	595	26	759	652	15
PCB 105	228	306	29	82.9	113	31	167	151	10
PCB 151+82	1026	1155	12	534	638	18	418	416	0
PCB 149	2319	2578	11	1122	1408	23	1090	982	10
PCB 153	8961	12778	35	8961	9202	3	5292	4413	18
PCB 138	6430	6529	2	4142	4622	11	2989	2111	34
PCB 128	688	893	26	301	398	28	324	341	5
PCB 156	81.1	89.3	10	30.1	35.7	17	49	48.8	0
PCB 187	3439	3409	1	3439	3779	9	1690	1759	4
PCB 183	1738	1652	5	1317	1241	6	560	494	13
PCB 180	4064	5446	29	4064	4250	4	1500	1679	11
PCB 170	1319	1685	24	1319	1220	8	606	518	16
PCB 201	558	854	42	438	569	26	257	273	6
PCB 195	177	265	40	77.8	139	56	77.4	111	36
PCB 194	716	893	22	620	732	17	345	320	8
PCB 206	242	309	24	158	186	16	139	155	11
PCB 209	50.5	58.0	14	53.8	63.3	16	53.8	51.4	5
HCB	43.1	46.5	8	10.2	14.1	32	64.8	69.0	6
α-HCH	4.44	5.08	13	<2	2.41	--	<2	1.80	--
β-HCH	19.8	21.5	8	5.45	6.72	21	9.45	10.3	9
γ-HCH	<2	<1	--	<2	<1	--	<2	<1	--
oxychlordane	285	276	3	124	137	10	121	117	3
heptachlor epoxide	55.5	129	80	22.7	46.7	69	25.7	51.4	67
2,4'-DDE	214	220	3	104	117	12	221	213	4
4,4'-DDE	18105	17744	2	15042	14809	2	5687	5879	3
trans-chlordane	6.32	5.27	18	9.87	<1	--	10.1	<1	--
cis-chlordane	122	129	6	39.4	38.6	2	35.6	39.9	11
trans-nonachlor	3444	3510	2	2145	2029	6	785	755	4
cis-nonachlor	651	625	4	201	210	4	205	213	4
2,4'-DDD	74.6	70.9	5	58.3	59.5	2	46.9	47.6	1
4,4'-DDD	951	937	1	315	323	3	524	553	5
2,4'-DDT	597	575	4	398	441	10	222	248	11
4,4'-DDT	1256	1311	4	451	449	0	625	655	5
dieldrin	251	297	17	73.4	86.9	17	141	133	6
mirex	666	625	6	466	509	9	274	232	17
% lipid	56.9	55.8	2	43.2	42.8	1	72.1	73.3	2

Table A3: Concentrations (ng/g lipid mass) of PCB congeners determined in three aliquots of RTDL-004 blubber.

PCB Congener	RTDL-004 A	B	C	Mean	1 SD*	%RSD
PCB 8	15.0	19.0	17.2	17.1	2.0	11.6
PCB 18	113	95.0	93.3	100	11	11.0
PCB 29	95.0	70.3	72.5	79.3	14	17.3
PCB 31	na**	na	na	--	--	--
PCB 28	40.1	29.7	30.5	33.4	5.8	17
PCB 52	602	579	593	592	12	2.0
PCB 49	315	296	305	305	9.3	3.1
PCB 44	112	103	101	105	5.8	5.5
PCB 95	883	937	987	936	52	5.5
PCB 66	452	463	478	464	13	2.9
PCB 101+90	2300	2330	2380	2340	40	1.7
PCB 99	3480	3500	3730	3570	139	3.9
PCB 87	441	512	509	487	40	8.2
PCB 110	204	186	187	193	10	5.3
PCB 151+82	1860	1930	2070	1953	107	5.5
PCB 149	4100	4380	4620	4370	260	6.0
PCB 118	2370	2470	2560	2470	95	3.8
PCB 153	21500	22400	22900	22300	709	3.2
PCB 105	530	537	549	539	9.8	1.8
PCB 138	10700	11400	11700	11300	513	4.5
PCB 187	8960	9640	6110	8240	1120	14
PCB 183	2620	2900	2960	2830	181	6.4
PCB 128	1460	1580	1600	1547	76	4.9
PCB 201	1390	1500	1530	1473	74	5.0
PCB 156	180	178	160	173	11	6.4
PCB 180	9090	9760	9760	9540	387	4.1
PCB 170	2730	3010	3020	2920	165	5.6
PCB 195	450	462	475	462	12	2.7
PCB 194	1520	1620	1600	1580	53	3.3
PCB 206	510	557	553	540	26	4.8
PCB 209	102	114	104	107	6.0	5.6

*Standard deviation

**na = An unknown compound interfered with PCB 31.

Table A4: Concentrations (ng/g lipid mass) of organochlorine pesticides determined in three aliquots of RTDL-004 blubber homogenate.

Compound	RTDL-004 A	RTDL-004 B	RTDL-004 C	Mean	1 SD*	%RSD
α-HCH	11.5	9.88	9.10	10.2	1.2	12
β-HCH	44.8	52.3	38.5	45.2	6.9	15
γ-HCH	<1	<1	<1	--	--	--
heptachlor	<1	<1	<1	--	--	--
heptachlor epoxide	210	222	231	221	11	4.8
trans-chlordane	8.26	7.08	9.44	8.26	1.2	14
cis-chlordane	215	224	231	223	8.1	3.6
trans-nonachlor	6280	5650	6290	6070	367	6.0
cis-nonachlor	1040	1030	1120	1063	49	4.6
oxychlordane	553	453	494	500	50	10
2,4'-DDE	375	358	394	376	18	4.7
4,4'-DDE	34100	30400	31800	32100	1868	5.8
2,4'-DDT	1060	941	1030	1010	62	6.1
4,4'-DDT	2610	2260	2350	2407	182	7.6
2,4'-DDD	126	124	127	126	1.3	1.0
4,4'-DDD	1770	1540	1680	1663	116	7.0
mirex	1290	1140	1120	1183	93	7.8
HCB	74.3	71.5	83.4	76.4	6.2	8.2
dieldrin	559	530	533	541	16	3.0
Lipid (%)	54.9	57.5	55.0	55.8	1.50	1.3

* Standard Deviation

Table A5: Concentrations (ng/g lipid mass) of PCB congeners determined in rough-toothed dolphin blubber homogenates. Values for RTDL-001 to -006 are the average of the values determined by the Charleston and Gaithersburg NIST laboratories.

	Males						Females								
Compound	**RTDL-002**	**RTDL-004**	**RTDL-005**	**RTDL-006**	**RTDL-012**	**RTDL-014**	**RTDL-001**	**RTDL-003**	**RTDL-007**	**RTDL-008**	**RTDL 009**	**RTDL - 010**	**RTDL - 011**	**RTDL - 013**	**RTDL - 015**
PCB 8	6.15	11.39	13.74	4.24	7.27	8.00	9.94	5.97	7.56	<1	2.16	7.38	7.11	2.80	6.58
PCB 18	40.8	55.7	42.0	35.1	31.9	42.3	14.2	4.68	185	1.20	58.1	36.9	29.8	17.8	43.2
PCB 29	34.5	79.2	44.6	38.9	78.0	79.8	89.6	8.54	65.6	<1	39.1	76.9	67.6	17.5	31.9
PCB 31	17.8	11.7	7.48	12.9	<1	<1	<1	3.54	<1	<1	<1	<1	<1	<1	7
PCB 28	<1	30.5	19.2	13.3	35.5	25.0	34.8	6.34	36.9	<1	23.6	34.7	22.4	4.82	9.91
PCB 52	236	528	320	239	300	330	293	4.16	413	5.28	265	304	281	83.2	226
PCB 49	115	278	136	153	249	251	260	2.81	120	4.32	163	248	215	71.4	117
PCB 44	36.5	76.5	40.2	38.8	106	101	85.3	6.64	59.6	<1	63.2	105	83.8	24.3	37.7
PCB 66	181	482	241	158	452	415	399	18.6	86.2	9.85	221	438	357	119	162
PCB 95	347	853	496	354	508	560	525	24.7	570	2.91	401	518	496	148	391
PCB 101+90	995	2044	1080	1179	2260	2400	3759	99.4	1370	47.5	1460	4260	2070	541	1090
PCB 99	1508	3267	2816	1342	1730	1890	1792	95.7	2300	44.4	1210	1700	1640	488	1360
PCB 87	211	496	270	149	303	301	413	31.3	154	4.98	143	324	272	117	174
PCB 110	40.5	169	81.4	54.3	340	246	278	33.4	91.1	17.2	95.5	324	211	105	34.6
PCB 151+82	1150	2267	1223	971	870	991	1793	82.1	1200	26.4	641	853	858	255	701
PCB 149	228	475	228	219	2020	2290	440	17.0	2560	59.4	1520	1970	2010	653	1720
PCB 118	759	1937	1363	574	1780	1900	858	52.1	962	46.9	1120	1800	1690	523	1160
PCB 153	1651	4348	2943	1426	8690	10100	2064	115	14200	287	6510	8640	8930	2810	7800
PCB 105	9484	19324	21122	6680	447	486	9185	551	205	9.39	281	457	438	135	256
PCB 138	5564	11501	10194	3513	4190	4920	4920	292	6960	105	3140	4230	4410	1450	3790
PCB 187	3977	6077	8395	2372	3460	4120	3526	309	5570	140	2600	3490	3700	1440	3190
PCB 183	1231	3008	2974	725	935	1110	928	83.7	1700	45.3	726	925	991	392	874
PCB 128	608	1405	813	457	743	863	798	50.7	750	22.8	541	746	773	234	562
PCB 201	586	1256	1172	364	563	653	520	50.5	841	28.8	431	553	586	212	497
PCB 156	86.8	151	76.5	67.3	231	230	228	18.3	51.0	9.03	117	236	210	84.2	70.6
PCB 180	4062	8451	9669	2186	3050	3770	2989	252	5770	151	2510	3100	3440	1330	2950
PCB 170	1340	2669	2952	774	955	1180	968	81.2	1720	47.5	791	978	1080	400	896
PCB 195	198	393	252	129	221	269	166	40.4	248	23.2	157	224	244	118	200
PCB 194	709	1429	1573	458	535	691	455	92.0	912	61.8	486	557	641	313	566
PCB 206	369	490	400	202	301	398	254	95.6	246	65.2	302	317	365	220	327
PCB 209	104	96.3	136	72.4	69.8	94.5	55.1	63.4	57.9	39.6	62.2	71.8	86.0	97.7	85.2
ΣPCBs	35877	73578	71092	24922	35463	40715	38099	2592	49412	1305	26081	37523	36203	12406	29335

Table A6: Concentrations (ng/g lipid mass) of Organochlorine pesticides determined in rough-toothed dolphin blubber homogenates. Values for RTDL-001 to -006 are the average of the values determined by the Charleston and Gaithersburg NIST laboratories.

	Males						Females								
Compound	**RTDL-002**	**RTDL-004**	**RTDL-005**	**RTDL-006**	**RTDL-012**	**RTDL-014**	**RTDL-001**	**RTDL-003**	**RTDL-007**	**RTDL-008**	**RTDL-009**	**RTDL-010**	**RTDL-011**	**RTDL-013**	**RTDL-015**
α-HCH	3.96	8.45	5.13	2.61	8.01	6.28	78.4	<2	20.7	5.29	3.56	29.2	7.41	8.02	<1
β-HCH	10.6	36.7	14.2	13.6	15.9	11.2	168	<2	69.4	<1	19.7	52.5	23.2	4.86	8.64
γ-HCH	<2	<2	<2	<2	<2	<2	20.8	9.21	<1	<1	<1	7	<1	<1	<1
ΣHCHs	14.5	45.1	19.3	16.2	23.9	17.5	267	9.21	90.1	5.29	23.3	88.2	30.6	12.9	8.64
heptachlor	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
hepta. epoxide	90.3	164	80.8	52.9	77.3	96.2	460	<2	172	<1	111	214	84.3	16.7	102
trans-chlordane	<1	10.3	<1	<1	8	<1	114	<1	<1	<1	<1	48.8	2.01	6.58	<1
cis-chlordane	78.9	223	90.7	51.9	229	225	1221	44.2	88.8	14.5	104.2	543	196	64.7	98.7
trans-nonachlor	2289	6172	4853	1059	1440	1850	7514	100	5430	21.5	1380	3340	1610	435	1440
cis-nonachlor	423	1132	478	287	586	666	2840	40.5	583	<1	427	1320	591	175	437
oxychlordane	206	498	304	164	233	268	234	10.2	503	4.31	237	228	242	43.4	163
Σchlordanes	3087	8199	5806	1615	2574	3105	12384	195	6777	40.3	2259	5694	2726	742	2240
2,4'-DDE	120	385	257	299	237	242	220	9.95	214	5.88	157	239	213	84.8	116
4,4'-DDE	13001	31809	34710	7954	10200	12400	16756	568	26800	243	8630	10500	10600	2960	8610
2,4'-DDT	667	1040	976	323	549	637	637	29.6	762	<1	616	551	602	<1	415
4,4'-DDT	1481	2278	1047	880	1930	2400	10186	68.9	1310	43.1	1750	4240	2010	532	1290
2,4'-DDD	62	129	137	65.0	61.1	80.3	315	<2	65.8	<1	77	154	71.6	18.0	66.9
4,4'-DDD	778	1675	742	741	1150	1390	6784	101	882	6.02	1050	3080	1200	362	847
ΣDDTs	16109	37317	37868	10262	14127	17149	34898	778	30033	298	12280	18764	14697	3956	11345
mirex	550	1145	1134	348	485	596	421	46.1	912	33.4	414	496	527	165	369
	20.8	79.5	28.3	92.0	72.7	77.3	68.0	<2	31.7	6.04	62.6	70.9	70.2	19.6	56.4
dieldrin	201	487	186	189	361	412	1835	46.9	326	18.4	346	907	367	81.0	280

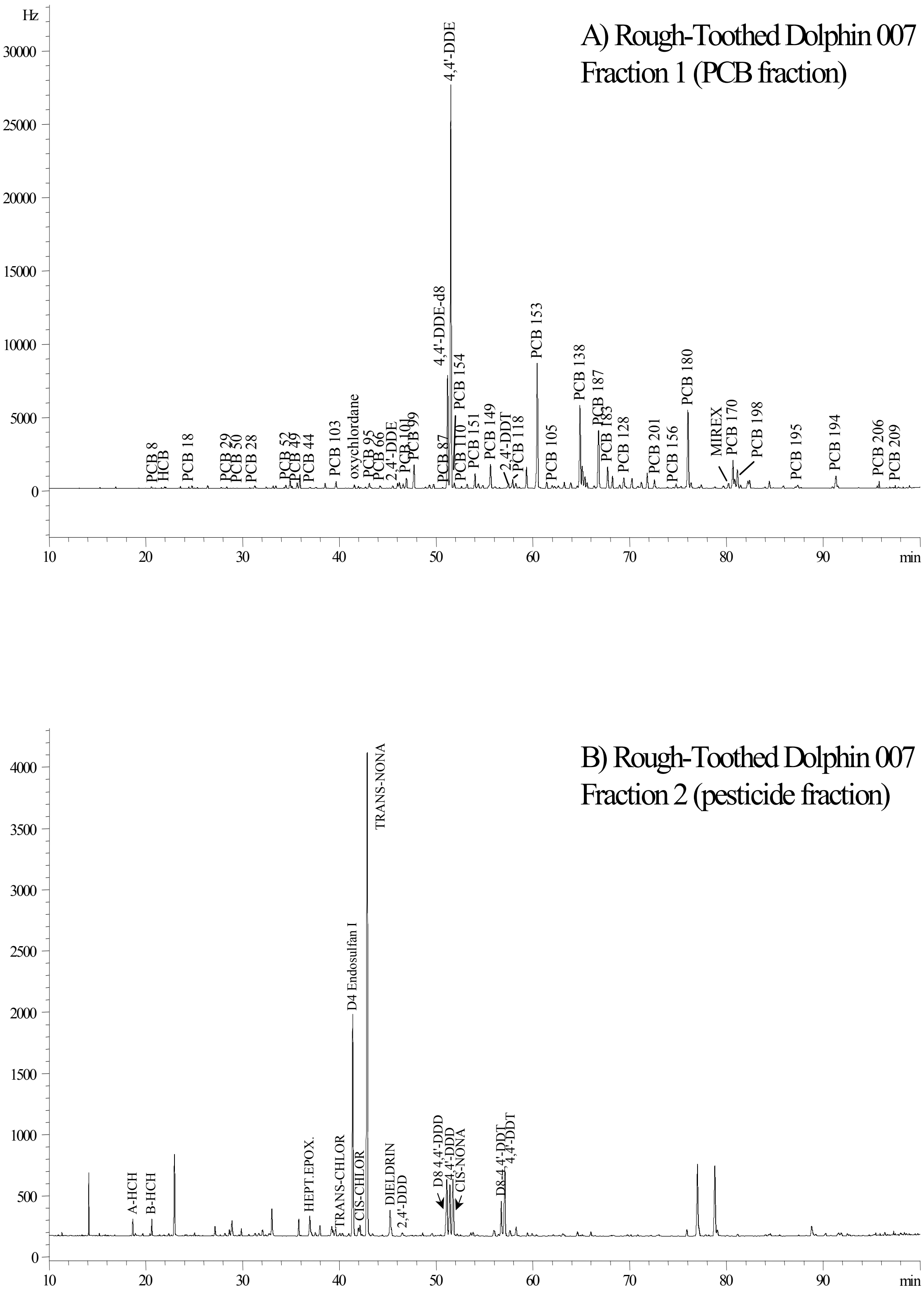


Figure A1: Chromatograms from the analysis of the PCB (A) and pesticide fractions (B) of RTDL-007 by the NIST Charleston Laboratory.

APPENDIX B

ELEMENTS: ANALYTICAL DATA

Table B1: Rough-toothed dolphin liver (L) and kidney (K) specimen identification codes, ratios of dry to wet mass, and % total extractable organic content.

NMMTB Animal Identification	NIST Liver Specimen Identification Code	Dry to Wet Mass Ratio	Total Extractable Organics	NIST Kidney Specimen Identification Code	Dry to Wet Mass Ratio	Total Extractable Organics
RTDL-001	NM8L678.B003	0.2378	3.29	NM8K679	0.2204	5.25
RTDL-002	NM8L681.B003	0.2392	4.02	NM8K682	0.2187	6.72
RTDL-003	NM8L684.B003	0.2676	6.63	NM8K685	0.2483	15.8
RTDL-004	NM8L687.B003	0.2566	4.02	NM8K688	0.2106	5.92
RTDL-005	NM8L690.B003	0.2663	6.21	NM8K691	0.3657	20.5
RTDL-006	NM8L693.B003	0.2566	5.37	NM8K694	0.2250	6.13
RTDL-007	NM8L696.B003	0.2694	3.84	NM8K697	0.3615	32.4
RTDL-008	NM8L699.B003	0.2661	6.97	NM8K700	0.3322	29.8
RTDL-009	NM8L702.B003	0.2407	5.17	NM8K703	0.2360	9.6
RTDL-010	NM8L705.B003	0.2546	5.40	NM8K706	0.2704	12.2
RTDL-011	NM8L708.B003	0.2692	4.87	NM8K709	0.2410	9.3
RTDL-012	NM8L711.B003	0.2619	4.15	NM8K712	0.2205	5.9
RTDL-013	NM8L714.B003	0.2585	3.86	NM8K715	0.5530	45.2
RTDL-014	NM8L717.B003	0.2717	4.02	NM8K718	0.2196	7.19
RTDL-015	NM8L720.B003	0.2519	5.42	NM8K721	0.1977	6.27

Table B2: INAA Detection limits for elements in tissue specimens.

Element	INAA Detection Limit (mg/kg)
Sc	0.0003
V	0.02
Sr	1
Mo	0.5
Cd	0.4
Sn	1
Sb	3
I	3
Ba	5
La	0.01
Ce	0.02
Sm	0.005
Eu	0.0005
Tb	0.001
Hf	0.001
Ta	0.0004
Au	0.004
Th	0.002
U	0.1

Table B3: Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Na			Mg			Cl			K			Ca		
Animal ID	**NBSB Tissue ID**	**(mg/kg)**	**u_{cs}**	**U**	**(mg/kg)**	**u_{cs}**	**U**		**u_{cs}**	**U**		**u_{cs}**	**U**		**u_{cs}**	**U**
RTDL-001	NM8K679.B003.A	1970	18	46	75	15	30	2527	21	55	2964	37	85	50	6	12
	NM8K679.B003.B	1951	18	45	120	10	20	2695	23	60	2817	36	82	64	8	16
	NM8L678.B003.A	1426	6	37	174	6	13	1883	13	53	2854	33	96	57	5	10
	NM8L678.B003.B	1420	6	37	174	7	15	1868	14	54	2937	32	96	58	7	14
RTDL-002	NM8K682.B003.A	1880	17	43	137	10	20	2236	19	49	2184	29	66	110	8	16
	NM8K682.B003.B	1853	17	43	130	10	20	2202	19	49	2174	37	80	131	8	16
	NM8L681.B003.A	1714	7	44	153	5	11	1967	13	55	2362	32	86	40	3	6
	NM8L681.B003.B	1695	7	44	181	8	17	1931	15	56	2303	29	81	48	4	8
RTDL-003	NM8K685.B003.A	1985	18	46	106	10	20	1504	13	34	1594	29	62	360	17	34
	NM8K685.B003.B	1903	18	45	156	15	30	2335	19	50	1532	29	62	320	15	30
	NM8L684.B003.A	1465	6	38	133	5	11	1903	13	53	2525	34	92	30	4	8
	NM8L684.B003.B	1450	6	38	141	6	12	1908	12	53	25001	29	84	456	10	23
RTDL-004	NM8K688.B003.A	1860	17	43	132	9	18	2341	20	52	2640	42	92	150	9	18
	NM8K688.B003.B	1863	17	43	120	9	18	2284	19	50	2482	30	69	136	9	18
	NM8L687.B003.A	1393	6	36	158	5	11	1817	11	50	2882	34	98	32	3	6
	NM8L687.B003.B	1368	6	36	158	6	13	1780	11	49	2878	28	90	30	3	6
RTDL-005	NM8K691.B003.A	2358	22	55	85	7	14	1569	15	37	1629	36	76	935	22	46
	NM8K691.B003.B	2235	21	53	142	12	24	2754	25	63	1591	37	77	1459	37	77
	NM8L690.B003.A	1477	6	38	149	5	11	1754	11	48	2673	29	87	23	4	8
	NM8L690.B003.B	1465	6	38	137	11	22	1736	11	48	2638	28	86	23	3	6
RTDL-006	NM8K694.B003.A	1886	17	43	116	8	16	2334	20	52	2680	39	87	173	9	18
	NM8K694.B003.B	1868	17	43	145	9	18	2278	19	50	2551	41	89	153	9	18
	NM8L693.B003.A	1540	7	40	152	4	9	1883	11	51	2732	33	94	49	4	8
	NM8L693.B003.B	1515	8	40	147	6	13	1831	11	50	2608	34	93	56	4	8
RTDL-007	NM8K697.B003.A	1931	18	45	88	7	14	1094	12	29	1917	17	43	214	10	20
	NM8K697.B003.B	1938	18	45	101	11	22	2177	19	49	2224	38	82	421	20	40
	NM8L696.B003.A	1341	6	35	165	5	11	1824	11	50	3031	31	97	63	5	10
	NM8L696.B003.B	1324	6	35	176	7	15	1809	11	49	2996	31	96	42	4	8
RTDL-008	NM8K700.B003.A	2213	12	39	225	15	30	2396	13	43	1876	34	73	367	15	30
	NM8K700.B003.B	1844	17	43	185	16	32	2049	17	45	1938	37	79	264	13	26
	NM8L699.B003.A	1645	7	43	169	5	11	1857	12	51	2521	32	89	33	4	8
	NM8L699.B003.B	1613	7	42	169	7	15	1842	12	51	2463	35	92	46	5	10

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Na			Mg			Cl			K			Ca		
Animal ID	**NBSB Tissue ID**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**
RTDL-009	NM8K703.B003.A	2244	21	53	106	11	22	2947	25	65	1921	42	88	221	11	22
	NM8K703.B003.B	2215	21	52	123	24	48	2916	24	63	1891	42	88	216	12	24
	NM8L702.B003.A	1591	7	41	126	10	20	1985	12	54	2352	28	80	39	4	8
	NM8L702.B003.B	1563	7	41	119	6	12	1927	12	53	2361	28	81	38	3	6
	NM8K706.B003.B	1706	3	25	63	17	34	1993	17	44	1982	142	285	145	9	18
	NM8L705.B003.A	1553	7	41	146	5	11	1913	12	53	2396	34	90	26	4	8
	NM8L705.B003.B	1540	7	41	149	11	22	1895	12	52	2464	32	88	41	4	8
RTDL-011	NM8K709.B003.A	1820	17	43	112	16	32	2335	21	53	2480	37	82	362	15	30
	NM8K709.B003.B	1769	17	42	136	19	38	2124	18	47	2371	35	78	396	14	29
	NM8L708.B003.A	1446	7	38	176	12	24	1952	15	56	3048	32	98	60	4	8
	NM8L708.B003.B	1435	6	37	182	8	17	1972	12	54	2943	36	102	61	4	8
RTDL-012	NM8K712.B003.A	1977	18	46	148	10	20	2670	22	58	3135	37	86	68	8	16
	NM8K712.B003.B	1933	18	45	113	17	34	2481	21	55	2892	35	81	58	7	14
	NM8L711.B003.A	1048	5	28	182	6	13	1353	9	38	3566	32	108	47	5	10
	NM8L711.B003.B	1039	5	27	191	6	13	1332	9	87	3564	45	125	34	5	10
RTDL-013	NM8K715.B003.A	822	10	23	45	4	8	1006	8	21	803	63	127	<13	--	--
	NM8K715.B003.B	1220	14	33	49	9	18	1507	12	32	1060	68	137	<16	--	--
	NM8L714.B003.A	1518	7	40	161	5	11	1847	11	50	2566	30	87	47	4	8
	NM8L714.B003.B	1505	7	39	153	7	14	1848	11	50	2635	39	101	49	5	10
RTDL-014	NM8K718.B003.A	1793	17	42	106	16	32	2466	21	55	2566	40	88	404	14	29
	NM8K718.B003.B	1841	17	43	84	17	34	2474	20	53	2721	34	78	367	12	25
	NM8L717.B003.A	1365	6	36	167	7	15	1768	11	49	3255	37	109	53	5	10
	NM8L717.B003.B	1367	6	36	184	6	13	1808	11	49	3257	41	114	48	4	8
RTDL-015	NM8K721.B003.A	1982	19	47	135	21	42	2276	19	50	2281	30	68	166	9	18
	NM8K721.B003.B	1953	18	45	129	18	36	2117	18	47	2194	32	71	165	9	18
	NM8L720.B003.A	1658	7	43	118	13	26	2016	12	55	2813	34	97	68	6	12
	NM8L720.B003.B	1659	7	43	123	11	22	2008	12	55	2873	38	104	52	4	8

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Cu			Mn			Br			Fe		
Animal ID	**NBSB Tissue ID**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**
RTDL-001	NM8K679.B003.A	<3	- -	- -	0.57	0.02	0.04	19.5	1.4	2.8	77	1	3
	NM8K679.B003.B	<3	- -	- -	0.61	0.03	0.06	23.5	1.6	3.2	77	1	3
	NM8K679.ICPMS	3.4	- -	0.4	0.72	- -	0.09	- -	- -	- -	- -	- -	- -
	NM8L678B003.A	<3	- -	- -	3.09	0.02	0.08	22.8	1.7	3.4	446	5	15
	NM8L678.B003.B	<3	- -	- -	3.05	0.02	0.09	20.2	1.5	3.0	459	5	15
	NM8L678.ICPMS	5.5	- -	0.6	3.9	- -	0.5	- -	- -	- -	- -	- -	- -
RTDL-002	NM8K682.B003.A	<3	- -	- -	0.55	0.03	0.05	21.4	1.6	3.2	70	1	3
	NM8K682.B003.B	<3	- -	- -	0.55	0.02	0.03	18.4	1.7	3.4	71	1	3
	NM8K682.ICPMS	2.6	0.3	0.3	0.74	- -	0.17	- -	- -	- -	- -	- -	- -
	NM8L681.B003.A	5.4	0.4	0.8	2.82	0.02	0.08	18.4	1.3	2.6	217	2	7
	NM8L681.B003.B	5.6	0.5	1.1	2.80	0.02	0.08	22.2	1.5	3.0	214	2	7
	NM8L681.ICPMS	8.2	- -	5.3	4.3	- -	3.1	- -	- -	- -	- -	- -	- -
RTDL-003	NM8K685.B003.A	<3	- -	- -	0.39	0.02	0.04	19.3	1.6	3.2	66	1	3
	NM8K685.B003.B	<3	- -	- -	0.29	0.02	0.03	19.9	1.6	3.2	60	1	3
	NM8K685.ICPMS	2.1	0.3	0.3	0.48	- -	0.09	- -	- -	- -	- -	- -	- -
	NM8L684.B003.A	6.5	0.3	0.6	3.73	0.02	0.10	21.4	1.7	3.4	243	3	8
	NM8L684.B003.B	5.2	0.4	0.8	3.56	0.03	0.11	21.3	1.4	2.8	245	3	8
	NM8L684.ICPMS	8.5	- -	1.0	4.9	- -	0.6	- -	- -	- -	- -	- -	- -
RTDL-004	NM8K688.B003.A	<4	- -	- -	0.58	0.05	0.11	17.9	1.7	3.4	48	1	2
	NM8K688.B003.B	<4	- -	- -	0.60	0.06	0.12	23.6	1.9	3.8	48	1	2
	NM8K688.ICPMS	3.3	0.4	0.4	0.79	- -	0.13	- -	- -	- -	- -	- -	- -
	NM8L687.B003.A	4.8	0.5	0.9	4.26	0.02	0.11	19.1	1.6	3.2	224	3	8
	NM8L687.B003.B	4.3	0.3	0.5	4.21	0.03	0.12	20.5	1.3	2.6	229	3	8
	NM8L687.ICPMS	5.8	- -	2.1	5.6	- -	2.5	- -	- -	- -	- -	- -	- -
RTDL-005	NM8K691.B003.A	<4	- -	- -	0.45	0.03	0.05	20.6	2.1	4.2	47	1	2
	NM8K691.B003.B	<4	- -	- -	0.48	0.06	0.06	19.1	1.4	2.8	73	1	2
	NM8K691.ICPMS	1.7	0.2	0.2	0.45	- -	0.06	- -	- -	- -	- -	- -	- -
	NM8L690.B003.A	7.5	0.4	0.8	3.30	0.02	0.09	21.6	1.5	3.0	255	3	9
	NM8L690.B003.B	7.1	0.3	0.7	3.34	0.03	0.10	21.9	1.2	2.5	257	3	9
	NM8L690.ICPMS	8.4	- -	1.0	4.2	- -	0.5	- -	- -	- -	- -	- -	- -
RTDL-006	NM8K694.B003.A	<4	- -	- -	0.75	0.07	0.14	19.0	1.6	3.2	49	1	2
	NM8K694.B003.B	<4	- -	- -	0.70	0.02	0.04	19.6	1.8	3.6	47	1	2
	NM8K694.ICPMS	3.5	0.5	0.5	0.90	- -	0.15	- -	- -	- -	- -	- -	- -
	NM8L693.B003.A	6.1	0.3	0.7	4.26	0.02	0.11	24.3	1.8	3.6	170	2	6
	NM8L693.B003.B	6.1	0.3	0.6	4.14	0.04	0.13	24.7	1.4	2.9	167	2	6
	NM8L693.ICPMS	8.1	- -	1.0	5.3	- -	0.6	- -	- -	- -	- -	- -	- -

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Cu			Mn			Br			Fe		
Animal ID	**NBSB Tissue ID**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**
RTDL-007	NM8K697.B003.A	<5	- -	- -	0.55	0.03	0.06	19.5	1.6	3.2	65	1	3
	NM8K697.B003.B	<5	- -	- -	0.43	0.02	0.04	19.5	1.7	3.4	64	1	3
	NM8K697.ICPMS	2.2	- -	0.6	0.53	- -	0.18	- -	- -	- -	- -	- -	- -
	NM8L696.B003.A	6.3	0.4	0.9	3.66	0.03	0.11	19.5	1.5	3.0	262	3	9
	NM8L696.B003.B	6.4	0.4	0.8	3.55	0.03	0.11	19.4	1.4	2.8	272	3	9
	NM8L696.ICPMS	7.8	- -	3.3	5.6	- -	4.0	- -	- -	- -	- -	- -	- -
RTDL-008	NM8K700.B003.A	<5	- -	- -	0.54	0.03	0.06	20.2	1.6	3.2	40	1	2
	NM8K700.B003.B	<5	- -	- -	0.47	0.02	0.05	19.0	1.8	3.6	44	1	2
	NM8K700.ICPMS	2.2	- -	0.6	0.59	- -	0.22	- -	- -	- -	- -	- -	- -
	NM8L699.B003.A	6.2	0.3	0.6	2.90	0.03	0.09	21.8	1.6	3.2	112	1	3
	NM8L699.B003.B	5.7	0.3	0.6	2.76	0.03	0.09	22.1	1.5	3.0	111	1	3
	NM8L699.ICPMS	8.0	- -	5.7	4.4	- -	4.1	- -	- -	- -	- -	- -	- -
RTDL-009	NM8K703.B003.A	<3	- -	- -	0.43	0.06	0.12	22.9	1.5	3.0	42	1	2
	NM8K703.B003.B	<3	- -	- -	0.41	0.02	0.03	20.3	2.0	4.0	41	1	2
	NM8K703.ICPMS	3.3	- -	3.4	0.58	- -	0.09	- -	- -	- -	- -	- -	- -
	NM8L702.B003.A	5.5	0.5	0.9	3.35	0.02	0.10	17.9	1.1	2.2	180	2	6
	NM8L702.B003.B	4.7	0.4	0.9	3.24	0.03	0.03	17.6	1.4	2.8	177	2	6
	NM8L702.ICPMS	9	- -	2	5.1	- -	1.6	- -	- -	- -	- -	- -	- -
RTDL-010	NM8K706.B003.A	<3	- -	- -	0.73	0.03	0.07	21.8	1.6	3.2	449	1	2
	NM8K706.B003.B	<3	- -	- -	0.62	0.02	0.05	17.0	1.5	3.0	47	1	2
	NM8K706.ICPMS	2.5	- -	0.3	0.72	- -	0.12	- -	- -	- -	- -	- -	- -
	NM8L705.B003.A	5.9	0.4	0.8	4.57	0.02	0.12	18.4	1.6	3.2	189	2	6
	NM8L705.B003.B	5.9	0.3	0.7	4.53	0.02	0.13	17.1	1.4	2.8	190	2	6
	NM8L705.ICPMS	8.8	- -	1.2	6.0	- -	1.0	- -	- -	- -	- -	- -	- -
RTDL-011	NM8K709.B003.A	<3	- -	- -	0.44	0.02	0.05	17.7	1.6	3.2	52	1	2
	NM8K709.B003.B	<3	- -	- -	0.43	0.02	0.04	15.6	1.3	2.6	49	1	2
	NM8K709.ICPMS	2.6	- -	0.9	0.65	- -	0.08	- -	- -	- -	- -	- -	- -
	NM8L708.B003.A	4.6	0.3	0.6	3.88	0.02	0.11	20.7	1.5	3.0	202	2	6
	NM8L708.B003.B	4.3	0.3	0.7	3.78	0.08	0.18	19.2	1.7	3.4	201	2	6
	NM8L708.ICPMS	7.6	- -	8.7	7.0	- -	10.0	- -	- -	- -	- -	- -	- -
RTDL-012	NM8K712.B003.A	<3	- -	- -	0.71	0.03	0.06	23.3	1.5	3.0	43	1	2
	NM8K712.B003.B	<3	- -	- -	0.62	0.02	0.04	27.9	1.8	3.6	42	1	2
	NM8K712.ICPMS	3.2	- -	0.4	0.90	- -	0.22	- -	- -	- -	- -	- -	- -
	NM8L711.B003.A	5.1	0.4	0.9	4.44	0.02	0.12	14.4	1.0	2.0	619	7	21
	NM8L711.B003.B	4.9	0.4	0.8	4.42	0.09	0.20	14.9	1.1	2.2	610	7	20
	NM8L711.ICPMS	5.5	- -	0.6	5.7	- -	0.7	- -	- -	- -	- -	- -	- -

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Cu			Mn			Br			Fe		
Animal ID	**NBSB Tissue ID**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**
RTDL-013	NM8K715.B003.A	<2	- -	- -	0.16	0.01	0.02	11.9	1.3	2.6	23	3	6
	NM 8K715.B003.B	<2	- -	- -	0.18	0.01	0.02	16.5	1.3	2.6	32	1	2
	NM 8K715.B003.C	- -	- -	- -	- -	- -	- -	- -	- -	- -	34	1	2
	NM 8K715.ICPMS	1.0	- -	0.7	0.38	- -	0.12	- -	- -	- -	- -	- -	- -
	NM8L714.B003.A	6.2	0.3	0.7	4.37	0.02	0.12	16.5	1.2	2.4	231	3	8
	NM 8L714.B003.B	5.5	0.4	0.9	4.35	0.03	0.12	16.9	1.6	3.2	226	3	8
	NM 8L714.ICPMS	7.7	- -	1.2	6.2	- -	0.7	- -	- -	- -	- -	- -	- -
RTDL-014	NM8K718.B003.A	<3	- -	- -	0.54	0.05	0.09	21.5	1.4	2.8	54	1	2
	NM8K718.B003.B	<3	- -	- -	0.58	0.02	0.05	23.2	1.6	3.2	56	1	2
	NM8K718.ICPMS	3.1	- -	0.4	0.76	- -	0.09	- -	- -	- -	- -	- -	- -
	NM8L717.B003.A	<3	- -	- -	4.66	0.02	0.12	17.4	1.2	2.4	159	2	6
	NM8L717.B003.B	<3	- -	- -	4.64	0.03	0.13	17.3	1.2	2.4	159	2	6
	NM8L717.ICPMS	5.0	- -	0.6	5.2	- -	1.2	- -	- -	- -	- -	- -	- -
RTDL-015	NM8K721.B003.A	<5	- -	- -	0.49	0.02	0.05	18.5	1.7	3.4	35	1	2
	NM8K721.B003.B	<5	- -	- -	0.44	0.02	0.04	16.9	1.5	3.0	33	1	2
	NM8K721.ICPMS	2.1	- -	1.9	0.64	- -	0.42	- -	- -	- -	- -	- -	- -
	NM8L720.B003.A	3.6	0.7	1.3	5.14	0.03	0.14	16.4	1.2	2.4	185	2	6
	NM8L720.B003.B	3.5	0.6	1.2	5.03	0.03	0.14	16.7	1.5	3.0	192	2	6
	NM8L720.ICPMS	4.9	- -	3.3	7.3	- -	6.7	- -	- -	- -	- -	- -	- -

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Co			Zn			As			Se		
Animal ID	**NBSB Tissue ID**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**
RTDL-001	NM8K679.B003.A	0.0041	0.0018	0.0036	15.80	0.08	0.42	<0.34	--	--	2.56	0.02	0.07
	NM8K679.B003.B	0.0040	0.0017	0.0034	15.71	0.08	0.42	<0.20	--	--	2.56	0.02	0.07
	NM8K679.ICPMS	--	--	--	16.6	--	2.1	--	--	--	--	--	--
	NM8L678B003.A	0.0031	0.0002	0.0004	49.5	0.5	1.6	0.42	0.01	0.02	2.85	0.03	0.09
	NM8L678.B003.B	0.0045	0.0003	0.0006	50.7	0.6	1.7	0.29	0.01	0.02	2.92	0.03	0.09
	NM8L678.ICPMS	--	--	--	56.5	--	6.8	--	--	--	--	--	--
RTDL-002	NM8K682.B003.A	0.0094	0.0002	0.0005	15.47	0.08	0.41	<0.32	--	--	5.91	0.05	0.18
	NM8K682.B003.B	0.0081	0.0002	0.0004	15.67	0.08	0.42	<0.29	--	--	5.89	0.05	0.18
	NM8K682.ICPMS	--	--	--	19.3	--	5.1	--	--	--	--	--	--
	NM8L681.B003.A	0.0079	0.0003	0.0006	35.7	0.4	1.2	0.21	0.01	0.02	27.96	0.31	0.92
	NM8L681.B003.B	0.0084	0.0003	0.0006	35.1	0.4	1.2	0.30	0.02	0.04	27.25	0.30	0.90
	NM8L681.ICPMS	--	--	--	49.3	--	38.5	--	--	--	--	--	--
RTDL-003	NM8K685.B003.A	0.0084	0.0002	0.0004	11.58	0.06	0.31	<0.44	--	--	7.83	0.06	0.23
	NM8K685.B003.B	0.0051	0.0002	0.0004	10.35	0.06	0.28	<0.33	--	--	6.81	0.05	0.19
	NM8K685.ICPMS	--	--	--	14.1	--	2.2	--	--	--	--	--	--
	NM8L684.B003.A	0.0075	0.0004	0.0008	48.1	0.5	1.5	0.35	0.02	0.03	95.93	1.07	3.18
	NM8L684.B003.B	0.0076	0.0004	0.0008	48.8	0.5	1.6	0.33	0.03	0.06	97.96	1.09	3.24
	NM8L684.ICPMS	--	--	--	56.1	--	6.5	--	--	--	--	--	--
RTDL-004	NM8K688.B003.A	0.0090	0.0002	0.0005	17.13	0.09	0.30	<0.51	--	--	5.06	0.04	0.15
	NM8K688.B003.B	0.0089	0.0002	0.0005	16.92	0.08	0.29	<0.42	--	--	5.04	0.04	0.15
	NM8K688.ICPMS	--	--	--	20.5	--	3.0	--	--	--	--	--	--
	NM8L687.B003.A	0.0095	0.0003	0.0006	50.5	0.5	1.6	0.53	0.02	0.05	6.59	0.08	0.23
	NM8L687.B003.B	0.0095	0.0002	0.0005	51.7	0.6	1.7	0.38	0.02	0.03	6.78	0.08	0.23
	NM8L687.ICPMS	--	--	--	60.0	--	30.4	--	--	--	--	--	--
RTDL-005	NM8K691.B003.A	0.0058	0.0003	0.0006	15.99	0.1	0.32	<0.51	--	--	6.83	0.06	0.21
	NM8K691.B003.B	0.0056	0.0002	0.0004	15.28	0.09	0.30	<0.42	--	--	6.64	0.06	0.20
	NM8K691.ICPMS	--	--	--	16.1	--	4.5	--	--	--	--	--	--
	NM8L690.B003.A	0.0076	0.0002	0.0004	47.1	0.5	1.5	0.32	0.01	0.03	91.65	1.02	3.03
	NM8L690.B003.B	0.0071	0.0004	0.0008	47.8	0.5	1.5	0.26	0.02	0.04	92.59	1.03	3.06
	NM8L690.ICPMS	--	--	--	54.0	--	6.5	--	--	--	--	--	--
RTDL-006	NM8K694.B003.A	0.0118	0.0002	0.0005	18.94	0.09	0.30	0.62	0.13	0.26	5.86	0.05	0.17
	NM8K694.B003.B	0.0119	0.0002	0.0005	18.51	0.09	0.31	0.40	0.07	0.14	5.75	0.04	0.16
	NM8K694.ICPMS	--	--	--	21.2	--	3.7	--	--	--	--	--	--
	NM8L693.B003.A	0.0108	0.0003	0.0007	44.1	0.5	1.5	0.50	0.01	0.03	13.42	0.15	0.45
	NM8L693.B003.B	0.0113	0.0003	0.0007	44.0	0.5	1.5	0.52	0.02	0.04	13.35	0.15	0.44
	NM8L693.ICPMS	--	--	--	50.3	--	5.9	--	--	--	--	--	--

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Co			Zn			As			Se		
Animal ID	**NBSB Tissue ID**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**
RTDL-007	NM8K697.B003.A	0.0102	0.0003	0.0006	15.67	0.09	0.29	<0.40	--	--	11.03	0.09	0.32
	NM8K697.B003.B	0.0104	0.0003	0.0007	15.50	0.08	0.27	<0.38	--	--	11.21	0.09	0.33
	NM8K697.ICPMS	--	--	--	15.7	--	4.2	--	--	--	--	--	--
	NM8L696.B003.A	0.0075	0.0004	0.0008	31.1	0.3	1.0	0.52	0.01	0.03	89.36	1.00	2.96
	NM8L696.B003.B	0.0103	0.0004	0.0008	32.4	0.4	1.1	0.66	0.03	0.06	93.14	1.04	3.09
	NM8L696.ICPMS	--	--	--	43.0	--	32.7	--	--	--	--	--	--
RTDL-008	NM8K700.B003.A	0.0076	0.0002	0.0004	12.98	0.07	0.23	0.99	0.14	0.28	6.56	0.05	0.19
	NM8K700.B003.B	0.0015	0.0003	0.0006	15.28	0.08	0.27	0.56	0.09	0.18	7.35	0.06	0.22
	NM8K700.ICPMS	--	--	--	16.2	--	6.2	--	--	--	--	--	--
	NM8L699.B003.A	0.0078	0.0003	0.0006	36.8	0.4	1.2	0.46	0.02	0.04	32.53	0.40	1.13
	NM8L699.B003.B	0.0073	0.0003	0.0006	36.9	0.4	1.2	0.48	0.03	0.06	32.70	0.40	1.13
	NM8L699.ICPMS	--	--	--	49.3	--	43.4	--	--	--	--	--	--
RTDL-009	NM8K703.B003.A	0.0067	0.0002	0.0004	12.77	0.07	0.23	<0.38	0.021	--	4.60	0.04	0.14
	NM8K703.B003.B	0.0061	0.0002	0.0004	12.45	0.07	0.22	<0.36	--	--	4.61	0.04	0.14
	NM8K703.ICPMS	--	--	--	14.5	--	2.6	--	--	--	--	--	--
	NM8L702.B003.A	0.0070	0.0003	0.0006	51.6	0.6	1.7	0.34	0.01	0.03	27.54	0.31	.92
	NM8L702.B003.B	0.0072	0.0003	0.0006	50.4	0.5	1.6	0.31	0.02	0.05	26.88	0.30	0.89
	NM8L702.ICPMS	--	--	--	68.3	--	20.3	--	--	--	--	--	--
RTDL-010	NM8K706.B003.A	0.0104	0.001	0.0020	16.04	0.08	0.28	<0.35	--	--	5.68	0.04	0.16
	NM8K706.B003.B	0.0157	0.001	0.0020	14.88	0.08	0.26	<0.29	--	--	5.25	0.04	0.15
	NM8K706.ICPMS	--	--	--	16.9	--	2.8	--	--	--	--	--	--
	NM8L705.B003.A	0.0099	0.0003	0.0007	42.6	0.5	1.4	0.36	0.02	0.04	18.35	0.21	0.62
	NM8L705.B003.B	0.0096	0.0003	0.0006	42.5	0.5	1.4	0.33	0.02	0.05	18.31	0.21	0.61
	NM8L705.ICPMS	--	--	--	50.6	--	7.6	--	--	--	--	--	--
RTDL-011	NM8K709.B003.A	0.0137	0.0003	0.0007	16.90	0.09	0.30	0.51	0.13	0.26	5.82	0.05	0.17
	NM8K709.B003.B	0.0096	0.0002	0.0005	16.17	0.08	0.28	0.38	0.07	0.14	5.53	0.04	0.16
	NM8K709.ICPMS	--	--	--	19.0	--	3.3	--	--	--	--	--	--
	NM8L708.B003.A	0.0103	0.0003	0.0007	43.8	0.5	1.5	0.37	0.002	0.04	7.34	0.08	0.24
	NM8L708.B003.B	0.01005	0.0003	0.0007	43.6	0.5	1.5	0.49	0.03	0.07	7.27	0.08	0.24
	NM8L708.ICPMS	--	--	--	73.1	--	108	--	--	--	--	--	--
RTDL-012	NM8K712.B003.A	0.0184	0.0003	0.0008	17.39	0.09	0.30	<0.35	--	--	2.50	0.02	0.07
	NM8K712.B003.B	0.0057	0.0002	0.0004	17.02	0.09	0.30	<0.22	--	--	2.41	0.02	0.07
	NM8K712.ICPMS	--	--	--	20.7	--	3.6	--	--	--	--	--	--
	NM8L711.B003.A	0.0046	0.0002	0.0004	46.8	0.5	1.5	0.44	0.02	0.04	3.02	0.04	0.11
	NM8L711.B003.B	0.0046	0.0003	0.0006	46.2	0.5	1.5	0.41	0.03	0.06	2.96	0.04	0.11
	NM8L711.ICPMS	--	--	--	51.0	--	5.9	--	--	--	--	--	--

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Co			**Zn**			**As**			**Se**		
Animal ID	**NBSB Tissue ID**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**
RTDL-013	NM8K715.B003.A	0.0055	0.0012	0.0024	6.44	0.03	0.11	0.58	0.04	0.08	5.90	0.04	0.17
	NM 8K715.B003.B	0.0077	0.0014	0.0028	9.41	0.05	0.17	0.74	0.05	0.10	8.42	0.06	0.24
	NM 8K715.B003.C	0.0094	0.0018	0.0036	9.90	0.05	0.17	0.88	0.05	0.10	8.78	0.07	0.26
	NM 8K715.ICPMS	--	--	--	10.6	--	4.0	--	--	--	--	--	--
	NM8L714.B003.A	0.0084	0.0004	0.0008	37.4	0.4	1.2	0.38	0.02	0.04	124.9	1.4	4.2
	NM 8L714.B003.B	0.0080	0.0005	0.0010	35.7	0.4	1.2	0.55	0.04	0.08	118.9	1.3	3.9
	NM 8L714.ICPMS	--	--	--	46.0	--	7.2						
RTDL-014	NM8K718.B003.A	0.0076	0.0002	0.0004	18.04	0.09	0.31	0.13	0.01	--	5.03	0.04	0.15
	NM8K718.B003.B	0.0078	0.0002	0.0004	19.06	0.1	0.34	<0.19	--	--	5.34	0.04	0.15
	NM8K718.ICPMS	--	--	--	19.3	--	2.4	--	--	--	--	--	--
	NM8L717.B003.A	0.0072	0.0003	0.0006	51.7	0.6	1.7	0.61	0.03	0.07	8.42	0.10	0.29
	NM8L717.B003.B	0.0070	0.0002	0.0004	51.7	0.6	1.7	0.59	0.03	0.07	8.41	0.10	0.29
	NM8L717.ICPMS	--	--	--	52.4	--	8.3						
RTDL-015	NM8K721.B003.A	0.0092	0.0002	0.0005	17.23	0.09	0.30	<0.35	--	--	2.82	0.02	0.08
	NM8K721.B003.B	0.0073	0.0002	0.0004	16.65	0.08	0.28	<0.26	--	--	2.69	0.02	0.08
	NM8K721.ICPMS	--	--	--	19.9	--	13.7	--	--	--	--	--	--
	NM8L720.B003.A	0.0089	0.0003	0.0006	61.1	0.7	2.0	0.49	0.02	0.05	8.86	0.10	0.30
	NM8L720.B003.B	0.0092	0.0003	0.0006	62.0	0.7	2.1	0.44	0.03	0.06	9.09	0.10	0.30
	NM8L720.ICPMS	--	--	--	77.2	--	62.2						

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Rb			Ag			Cs		
Animal ID	**NBSB Tissue ID**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**	**mg/kg**	**u_{cs}**	**U**
RTDL-001	NM8K679.B003.A	1.23	0.13	0.25	<0.006	- -	- -	0.049	0.001	0.002
	NM8K679.B003.B	1.16	0.12	0.24	<0.006	- -	- -	0.042	0.001	0.002
	NM8K679.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L678B003.A	1.17	0.04	0.08	0.043	0.004	0.008	0.0307	0.0014	0.0029
	NM8L678.B003.B	1.24	0.05	0.09	0.055	0.003	0.006	0.0305	0.0012	0.0025
	NM8L678.ICPMS	- -	- -	- -	0.06	- -	0.01	- -	- -	- -
RTDL-002	NM8K682.B003.A	0.96	0.10	0.20	<0.006	- -	- -	0.042	0.003	0.006
	NM8K682.B003.B	0.88	0.09	0.18	<0.006	- -	- -	0.042	0.001	0.002
	NM8K682.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L681.B003.A	0.75	0.03	0.06	0.572	0.006	0.018	0.0335	0.0011	0.0023
	NM8L681.B003.B	0.78	0.03	0.06	0.564	0.006	0.018	0.0333	0.0012	0.0025
	NM8L681.ICPMS	- -	- -	- -	0.76	- -	0.49	- -	- -	- -
RTDL-003	NM8K685.B003.A	0.77	0.08	0.16	<0.006	- -	- -	0.045	0.001	0.002
	NM8K685.B003.B	0.63	0.07	0.14	<0.006	- -	- -	0.040	0.001	0.002
	NM8K685.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L684.B003.A	1.01	0.04	0.09	0.886	0.008	0.027	0.0455	0.0015	0.0032
	NM8L684.B003.B	0.85	0.04	0.07	0.918	0.008	0.028	0.0481	0.0017	0.0036
	NM8L684.ICPMS	- -	- -	- -	1.06	- -	0.13	- -	- -	- -
RTDL-004	NM8K688.B003.A	0.97	0.10	0.20	0.012	0.002	0.004	0.032	0.001	0.002
	NM8K688.B003.B	0.88	0.09	0.19	0.008	0.002	0.004	0.031	0.001	0.002
	NM8K688.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L687.B003.A	1.00	0.03	0.07	0.185	0.004	0.009	0.0265	0.0013	0.0027
	NM8L687.B003.B	1.05	0.03	0.07	0.185	0.004	0.009	0.0267	0.0012	0.0025
	NM8L687.ICPMS	- -	- -	- -	0.23	- -	0.07	- -	- -	- -
RTDL-005	NM8K691.B003.A	0.78	0.08	0.17	<0.006	- -	- -	0.040	0.001	0.002
	NM8K691.B003.B	0.71	0.08	0.15	<0.006	- -	- -	0.039	0.001	0.002
	NM8K691.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L690.B003.A	0.97	0.04	0.08	1.002	0.008	0.029	0.0347	0.0015	0.0031
	NM8L690.B003.B	0.91	0.04	0.08	1.008	0.008	0.029	0.0350	0.0013	0.0027
	NM8L690.ICPMS	- -	- -	- -	1.14	- -	0.13	- -	- -	- -
RTDL-006	NM8K694.B003.A	1.33	0.14	0.28	0.017	0.002	0.004	0.049	0.001	0.002
	NM8K694.B003.B	1.31	0.14	0.27	0.013	0.002	0.004	0.048	0.001	0.002
	NM8K694.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L693.B003.A	1.07	0.03	0.07	0.677	0.006	0.020	0.0240	0.0012	0.0025
	NM8L693.B003.B	0.99	0.04	0.08	0.672	0.007	0.022	0.0253	0.0012	0.0025
	NM8L693.ICPMS	- -	- -	- -	0.80	- -	0.09	- -	- -	- -

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

Animal ID	NBSB Tissue ID	Rb mg/kg	u_{cs}	U	Ag mg/kg	u_{cs}	U	Cs mg/kg	u_{cs}	U
RTDL-007	NM8K697.B003.A	1.02	0.11	0.21	<0.006	- -	- -	0.060	0.001	0.002
	NM8K697.B003.B	0.98	0.10	0.21	<0.006	- -	- -	0.061	0.001	0.002
	NM8K697.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L696.B003.A	1.41	0.04	0.09	0.732	0.007	0.023	0.0877	0.0019	0.0044
	NM8L696.B003.B	1.46	0.05	0.10	0.764	0.007	0.023	0.0901	0.0015	0.0037
	NM8L696.ICPMS	- -	- -	- -	0.99	- -	0.78	- -	- -	- -
RTDL-008	NM8K700.B003.A	0.78	0.08	0.16	<0.006	- -	- -	0.030	0.001	0.002
	NM8K700.B003.B	0.82	0.09	0.17	<0.006	- -	- -	0.037	0.001	0.002
	NM8K700.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L699.B003.A	0.93	0.03	0.07	0.667	0.006	0.020	0.0266	0.0011	0.0023
	NM8L699.B003.B	0.89	0.03	0.07	0.656	0.006	0.020	0.0287	0.0012	0.0025
	NM8L699.ICPMS	- -	- -	- -	0.88	- -	0.66	- -	- -	- -
RTDL-009	NM8K703.B003.A	0.97	0.10	0.20	<0.006	- -	- -	0.036	0.001	0.002
	NM8K703.B003.B	0.88	0.09	0.19	<0.006	- -	- -	0.035	0.001	0.002
	NM8K703.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L702.B003.A	0.94	0.03	0.06	0.532	0.006	0.018	0.0275	0.0012	0.0025
	NM8L702.B003.B	0.93	0.03	0.07	0.513	0.005	0.016	0.0267	0.0011	0.0023
	NM8L702.ICPMS	- -	- -	- -	0.69	- -	0.15	- -	- -	- -
RTDL-010	NM8K706.B003.A	1.09	0.11	0.23	<0.006	- -	- -	0.034	0.001	0.002
	NM8K706.B003.B	1.01	0.11	0.21	<0.006	- -	- -	0.031	0.001	0.002
	NM8K706.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L705.B003.A	1.00	0.03	0.07	0.503	0.005	0.016	0.0235	0.0012	0.0025
	NM8L705.B003.B	0.97	0.04	0.08	0.503	0.005	0.016	0.0230	0.0011	0.0023
	NM8L705.ICPMS	- -	- -	- -	0.61	- -	0.07	- -	- -	- -
RTDL-011	NM8K709.B003.A	1.33	0.14	0.28	<0.006	- -	- -	0.039	0.001	0.002
	NM8K709.B003.B	1.16	0.16	0.24	0.055	0.001	0.003	0.037	0.001	0.002
	NM8K709.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L708.B003.A	1.24	0.04	0.08	0.229	0.004	0.010	0.0271	0.0010	0.0021
	NM8L708.B003.B	1.23	0.04	0.08	0.225	0.004	0.010	0.0256	0.0012	0.0025
	NM8L708.ICPMS	- -	- -	- -	0.30	- -	0.21	- -	- -	- -
RTDL-012	NM8K712.B003.A	1.37	0.14	0.28	<0.006	- -	- -	0.069	0.001	0.002
	NM8K712.B003.B	1.33	0.14	0.28	0.0085	0.0016	0.0032	0.068	0.001	0.002
	NM8K712.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L711.B003.A	1.72	0.05	0.11	0.101	0.004	0.008	0.0504	0.0016	0.0034
	NM8L711.B003.B	1.66	0.06	0.12	0.096	0.004	0.008	0.0490	0.0016	0.0034
	NM8L711.ICPMS	- -	- -	- -		- -		- -	- -	- -

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of INAA and ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction, uncertainties associated with counting statistics (u_{cs}), and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

		Rb			Ag			Cs		
Animal ID	**NBSB Tissue ID**	**mg/kg**	u_{CS}	**U**	**mg/kg**	u_{CS}	**U**	**mg/kg**	u_{CS}	**U**
RTDL-013	NM8K715.B003.A	0.31	0.03	0.07	0.0033	0.0007	0.001	0.025	0.001	0.002
	NM 8K715.B003.B	0.44	0.05	0.09	0.0045	0.0006	0.001	0.036	0.001	0.002
	NM 8K715.B003.C	0.47	0.05	0.10	<0.004	- -	- -	0.038	0.001	0.002
	NM 8K715.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L714.B003.A	0.94	0.04	0.09	1.21	0.01	0.04	0.0692	0.0016	0.0036
	NM 8L714.B003.B	0.93	0.04	0.09	1.16	0.01	0.03	0.0698	0.0017	0.0038
	NM 8L714.ICPMS	- -	- -	- -	1.46	- -	0.21	- -	- -	- -
RTDL-014	NM8K718.B003.A	1.06	0.11	0.22	0.018	0.002	0.004	0.041	0.001	0.002
	NM8K718.B003.B	1.09	0.11	0.23	0.021	0.002	0.003	0.044	0.001	0.002
	NM8K718.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L717.B003.A	1.17	0.04	0.08	0.257	0.004	0.010	0.0333	0.0013	0.0027
	NM8L717.B003.B	1.21	0.04	0.08	0.260	0.005	0.012	0.0346	0.0012	0.0025
	NM8L717.ICPMS	- -	- -	- -	0.29	- -	0.04	- -	- -	- -
RTDL-015	NM8K721.B003.A	0.80	0.08	0.17	<0.004	- -	- -	0.026	0.001	0.002
	NM8K721.B003.B	0.76	0.08	0.16	<0.004	- -	- -	0.024	0.001	0.002
	NM8K721.ICPMS	- -	- -	- -	<0.02	- -	- -	- -	- -	- -
	NM8L720.B003.A	1.04	0.04	0.08	0.150	0.004	0.009	0.0245	0.0013	0.0027
	NM8L720.B003.B	1.00	0.04	0.08	0.147	0.005	0.011	0.0262	0.0012	0.0025
	NM8L720.ICPMS	- -	- -	- -	0.19	- -	0.13	- -	- -	- -

*Results are from INAA unless otherwise indicated by the NBSB Tissue ID code.

Table B3 (Continued): Results of ICP-MS analyses of rough-toothed dolphin kidney and liver tissues. Values for mass fraction and expanded uncertainties (U; k=2) are expressed as mg/kg of wet mass.

Animal ID	NBSB Tissue ID	Cd	(U)	Sn	(U)	Hg	(U)
RTDL-001	NM8K679.ICPMS	0.05	0.01	<0.02	- -	0.9	0.1
	NM8L678.ICPMS	0.01	0.003	0.08	0.06	3.4	0.8
RTDL-002	NM8K682.ICPMS	2.44	0.31	0.05	0.23	7.7	2.1
	NM8L681.ICPMS	0.79	0.20	0.43	0.28	52.3	14.9
RTDL-003	NM8K685.ICPMS	1.18	0.16	0.05	0.07	12.8	1.5
	NM8L684.ICPMS	0.69	0.09	0.74	0.09	174.7	20.3
RTDL-004	NM8K688.ICPMS	2.56	0.30	<0.02	- -	2.1	0.3
	NM8L687.ICPMS	0.38	0.06	0.37	0.11	7.9	1.7
RTDL-005	NM8K691.ICPMS	0.83	0.20	0.05	0.08	9.6	1.7
	NM8L690.ICPMS	0.72	0.09	0.78	0.32	179.8	26.6
RTDL-006	NM8K694.ICPMS	3.94	0.46	0.14	0.31	4.0	0.7
	NM8L693.ICPMS	0.85	0.12	0.38	0.07	22.6	2.6
RTDL-007	NM8K697.ICPMS	1.89	0.32	0.04	0.01	14.9	1.7
	NM8L696.ICPMS	0.63	0.17	0.87	0.57	176.8	51.0
RTDL-008	NM8K700.ICPMS	2.25	0.36	0.04	0.06	5.6	0.9
	NM8L699.ICPMS	0.79	0.17	0.55	0.68	66.2	16.1
RTDL-009	NM8K703.ICPMS	1.09	0.14	0.06	0.10	4.0	0.7
	NM8L702.ICPMS	0.38	0.07	0.39	0.20	56.4	11.2
RTDL-010	NM8K706.ICPMS	2.03	0.26	0.02	0.03	3.3	0.5
	NM8L705.ICPMS	1.02	0.12	0.35	0.32	31.5	4.8
RTDL-011	NM8K709.ICPMS	2.90	0.33	0.03	0.09	2.1	0.9
	NM8L708.ICPMS	0.61	0.23	0.42	0.65	12.0	10.1
RTDL-012	NM8K712.ICPMS	0.12	0.17	0.01	0.05	1.0	0.7
	NM8L711.ICPMS	0.03	0.02	0.14	0.23	3.4	0.5
RTDL-013	NM8K715.ICPMS	0.83	0.12	0.13	0.14	14.3	5.8
	NM8L714.ICPMS	0.65	0.08	1.10	0.19	235.2	36.3
RTDL-014	NM8K718.ICPMS	2.45	0.30	0.02	0.05	2.9	0.4
	NM8L717.ICPMS	0.23	0.03	0.29	0.07	11.2	1.4
RTDL-015	NM8K721.ICPMS	1.44	0.16	<0.02	- -	1.7	1.2
	NM8L720.ICPMS	0.25	0.11	0.22	0.35	13.0	3.6

Table B4: Results of INAA of control materials included with analyses of kidney tissues. Values for SRM 1566a Oyster Tissue are expressed in mg/kg of dry mass and those for the QA Pilot Whale Liver Tissue Homogenate are expressed in mg/kg of wet mass. Uncertainties represent the combined total uncertainty.

	Whale Liver Homogenate 1 Aliquot 1	Assigned Values	SRM 1566a Aliquot 1	SRM 1566a Aliquot 2	Average Value	Certified Values
Na	1268 ± 45	1260 ± 30	4190 ± 110	3950 ± 126	4070	4170 ± 130
Mg	129 ± 20	140 ± 5	1200 ± 163	1150 ± 162	1175	1180 ± 170
Cl	1720 ± 53	1730 ± 40	8360 ± 248	8320 ± 247	8340	8290 ± 140
K	2713 ± 40	2640 ± 70	8230 ± 284	7810 ± 263	8020	7900 ± 470
Ca	39 ± 12	46 ± 3	1920 ± 111	1850 ± 110	1885	1960 ± 190
V	≤0.02	≤0.03	4.85 ± 0.22	4.75 ± 0.21	4.80	4.68 ± 0.15
Mn	3.14 ± 0.29	2.81 ± 0.10	12.2 ± 0.5	12.0 ± 1.4	12.1	12.3 ± 1.5
Cu	≤4	2.96 ± 0.55	75 ± 10	71 ± 10	73	66.3 ± 4.3
Br	13.6 ± 3	13.7 ± 0.6	64.1 ± 4	64.5 ± 12	64	Not certified
I	≤2	≤1	≤6	≤7	≤7	4.46 ± 0.42
Sc	≤0.001	≤0.08	0.054 ± 0.002	0.055 ± 0.002	0.055	(0.06)
Fe	448 ± 15	438 ± 10	532 ± 18	518 ± 17	525	539 ± 15
Co	0.014± 0.001	0.014 ± 0.001	0.513 ± 0.014	0.500 ± 0.014	0.51	0.57 ± 0.11
Zn	32.5 ± 0.9	32.2 ± 0.7	820 ± 22	830 ± 23	825	830 ± 57
As	0.33± 0.24	0.53 ± 0.02	13.7 ± 0.4	14.5 ± 0.4	14.1	14.0 ± 1.2
Se	11.6 ± 0.4	11.0 ± 0.3	2.18 ± 0.10	2.15 ± 0.10	2.17	2.21 ± 0.24
Rb	1.9 ± 0.4	2.00 ± 0.06	3.3 ± 0.8	3.2 ± 0.8	3.24	(3)
Sr	≤1.1	≤0.8	Not analyzed	Not analyzed	--	11.1 ± 1.0
Mo	≤0.9	≤0.4	≤2	≤2	≤2	Not certified
Ag	0.183 ± 0.011	0.181 ± 0.005	1.65 ± 0.06	1.69 ± 0.09	1.67	1.68 ± 0.15
Cd	8.65 ± 1.53	8.51 ± 0.22	≤4	≤4	≤4	4.15 ± 0.38
Sn	≤2	≤2	≤7	≤7	≤7	(3)
Sb	≤0.03	≤0.08	≤0.06	≤0.02	≤0.06	(0.01)
Cs	≤0.004	0.004 – 0.007	≤0.02	≤0.02	≤0.02	0.02
Ba	≤9	≤5	≤32	≤32	≤32	Not certified
La	≤0.02	≤0.003	≤0.5	≤0.5	≤0.5	0.3
Ce	≤0.07	≤0.02	0.21 ± 0.03	0.17 ± 0.03	0.19	0.4
Sm	≤0.003	≤0.002	≤0.02	≤0.02	≤0.02	0.06
Eu	≤0.0009	≤0.0006	0.012 ± 0.001	0.013 ± 0.001	0.012	0.01
Tb	≤0.001	≤0.001	≤0.008	≤0.007	≤0.008	0.007
Hf	≤0.001	≤0.001	0.025 ± 0.005	0.032 ± 0.004	0.03	0.04
Ta	≤0.0007	≤0.0005	≤0.003	≤0.003	≤0.003	0.003
Au	≤0.05	≤0.0002	≤0.03	≤0.04	≤0.04	0.01
Th	≤0.002	≤0.001	0.035 ± 0.006	0.034 ± 0.006	0.035	0.04
U	≤0.2	≤0.004	≤0.8	≤0.8	≤0.8	0.13 ± 0.01

Table B5: Results of INAA of control materials included with analyses of liver tissues. Values for SRM 1566a Oyster Tissue are expressed on a dry mass basis and Whale Liver Homogenate I are expressed on a wet mass basis. Uncertainty values represent the expanded uncertainties (U; k=2).

Element	Whale Liver Homogenate I Aliquot 1	Whale Liver Homogenate I Aliquot 2	Average Value	Assigned Values	SRM 1566a Oyster Tissue Aliquot 1	SRM 1566a Oyster Tissue Aliquot 2	Average Value	Certified Values
Na	1205	1272	1239 ± 31	1260 ± 30	4220 ± 20	--	--	4170 ± 130
Mg	135	130	133 ± 10.5	140 ± 5	1180 ± 20	--	--	1180 ± 170
Cl	1594	1691	1594 ± 79.3	1730 ± 40	8120 ± 270	--	--	8290 ± 140
K	2585	2748	2667 ± 90	2640 ± 70	8340 ± 90	--	--	7900 ± 470
Ca	39.7	55.6	48 ± 10.3	46 ± 3	2000 ± 40	--	--	1960 ± 190
V	≤0.02	≤0.02	≤0.02	≤0.03	4.94 ± 0.09	--	--	4.68 ± 0.15
Mn	2.84	2.99	2.92 ± 0.06	2.81 ± 0.10	12.3 ± 1.0	--	--	12.3 ± 1.5
Cu	2.87	2.45	2.66 ± 0.60	2.96 ± 0.55	71 ± 2	--	--	66.3 ± 4.3
Br	14.4	14.3	14.4 ± 2.0	13.7 ± 0.6	66 ± 3	--	--	Not certified
I	≤3	≤3.4	≤3.4	≤1	≤9	--	--	4.46 ± 0.42
Sc	≤0.09	≤0.09	≤0.09	≤0.08	0.050	0.052	0.051 ± 0.001	(0.06)
Fe	394	425	410 ± 20	438 ± 10	528	529	528.5 ± 12	539 ± 15
Co	0.012	0.013	0.013 ± 0.001	0.014 ± 0.001	0.46	0.56	0.51 ± 0.08	0.57 ± 0.11
Zn	29.1	31.4	30.2 ± 0.7	32.2 ± 0.7	829	839	834 ± 5	11.1 ± 1.0
Mo	≤0.41	≤0.31	≤0.4	≤0.4	≤1	nd	≤1	Not certified
Ag	0.17	0.18	0.18 ±0.01	0.181 ± 0.005	1.71	1.72	1.72 ± 0.06	1.68 ± 0.15
Cd	8.44	nd	8.44 ± 0.38	8.51 ± 0.22	3.90	4.21	4.06 ± 0.80	4.15 ± 0.38
Sn	≤2	≤2	≤2	≤2	≤8	≤8	≤8	(3)
Sb	≤0.02	≤0.02	≤0.02	≤0.08	≤0.02	≤0.02	≤0.02	(0.01)
Cs	0.0056	00077	0.007 ± 0.002	0.004 – 0.007	≤0.02	≤0.02	≤0.02	0.02
Ba	≤8	≤4	≤8	≤5	≤15	≤25	≤25	Not certified
La	≤0.006	≤0.003	≤0.006	≤0.003	0.24	0.27	0.26 ± 0.02	(0.3)
Ce	≤0.0013	≤0.0014	≤0.0014	≤0.02	0.197	0.216	0.21 ± 0.01	(0.4)
Sm	≤0.001	≤0.002	≤0.002	≤0.002	0.055	0.050	0.053 ± 0.004	(0.06)
Eu	≤0.0001	≤0.0001	≤0.001	≤0.0006	≤0.01	≤0.01	≤0.01	(0.01)
Tb	≤0.001	≤0.001	≤0.001	≤0.001	≤0.008	≤0.008	≤0.008	(0.007)
Hf	≤0.0001	≤0.0001	≤0.0001	≤0.001	0.023	0.033	0.03 ± 0.01	(0.040)
Ta	≤0.0001	≤0.0001	≤0.0001	≤0.0005	≤0.001	≤0.001	≤0.001	(0.003)
Au	≤0.003	≤0.003	≤0.003	≤0.0002	≤0.014	≤0.014	≤0.014	(0.01)
Th	≤0.00015	≤0.00016	≤0.00016	≤0.001	0.035	0.040	0.038 ± 0.003	(0.04)
U	≤0.08	≤0.05	≤0.08	≤0.004	0.112	0.134	0.12 ± 0.02	0.13 ± 0.01

Table B6: Results of ICP-MS of Whale Liver Homogenate I expressed in mg/kg of wet mass. Uncertainties represent the expanded uncertainties (U; k=2).

Element	ICP-MS Value (mg/kg)	Assigned Values (Wise *et al.*, 1993)
Mn	3.9 ± 0.7	2.81 ± 0.08
Cu	3.88 ± 0.59	2.96 ± 0.20
Zn	36.4 ± 7.9	32.2 ± 0.7
Ag	0.22 ± 0.04	0.181 ± 0.005
Cd	8.91 ± 1.10	8.51 ± 0.22
Sn	0.19 ± 0.04	≤2
Hg	27.0 ± 3.5	28.2 ± 1.1

Table B7: Linear correlation matrix for rough-toothed dolphin age, length, and hepatic element concentrations.

	age	length	Na	Cl	K	Cu	Fe	Co	Zn	Se	Rb	Ag	Cd (ICP)	Hg (ICP)	Sn (ICP)
age	1.00	0.74	0.30	0.17	-0.50	0.57	-0.28	0.09	-0.54	**0.95**	-0.49	**0.90**	0.53	**0.96**	**0.95**
length	0.74	1.00	0.52	0.51	-0.72	0.59	-0.57	0.35	-0.54	0.77	-0.62	**0.85**	0.69	**0.78**	**0.84**
Na	0.30	0.52	1.00	**0.84**	**-0.84**	-0.03	-0.75	0.41	-0.04	0.07	**-0.88**	0.29	0.52	0.07	0.14
Cl	0.17	0.51	**0.84**	1.00	-0.68	-0.18	-0.74	0.49	0.07	0.05	-0.69	0.14	0.38	0.04	0.12
K	-0.50	-0.72	**-0.84**	-0.68	1.00	-0.30	0.61	-0.31	0.23	-0.31	**0.90**	-0.55	-0.68	-0.32	-0.34
Cu	0.57	0.59	-0.03	-0.18	-0.30	1.00	-0.05	-0.11	-0.56	0.64	-0.16	**0.80**	0.62	0.65	0.62
Fe	-0.28	-0.57	-0.75	-0.74	0.61	-0.05	1.00	-0.70	0.08	-0.12	0.71	-0.36	-0.62	-0.13	-0.32
Co	0.09	0.35	0.41	0.49	-0.31	-0.11	-0.70	1.00	-0.17	0.04	-0.33	0.24	0.67	0.04	0.27
Zn	-0.54	-0.54	-0.04	0.07	0.23	-0.56	0.08	-0.17	1.00	-0.44	0.01	-0.53	-0.58	-0.46	-0.57
Se	**0.95**	0.77	0.07	0.05	-0.31	0.64	-0.12	0.04	-0.44	1.00	-0.23	**0.90**	0.40	**1.00**	**0.95**
Rb	-0.49	-0.62	**-0.88**	-0.69	**0.90**	-0.16	0.71	-0.33	0.01	-0.23	1.00	-0.47	-0.56	-0.23	-0.28
Ag	**0.90**	**0.85**	0.29	0.14	-0.55	**0.80**	-0.36	0.24	-0.53	**0.90**	-0.47	1.00	0.67	**0.90**	**0.91**
Cd (ICP)	0.53	0.69	0.52	0.38	-0.68	0.62	-0.62	0.67	-0.58	0.40	-0.56	0.67	1.00	0.40	0.54
Hg (ICP)	**0.96**	**0.78**	0.07	0.04	-0.32	0.65	-0.13	0.04	-0.46	**1.00**	-0.23	**0.90**	0.40	1.00	**0.95**
Sn (ICP)	**0.95**	**0.84**	0.14	0.12	-0.34	0.62	-0.32	0.27	-0.57	**0.95**	-0.28	**0.91**	0.54	**0.95**	1.00

Table B8: Linear correlation matrix for rough-toothed dolphin age, length, and renal element concentrations.

	age	length	Na	Cl	K	Mn	Br	Fe	Co	Zn	As	Se	Rb	Ag	Cd (ICP)	Hg (ICP)	Sn (ICP)
age	1.00	0.74	-0.66	-0.83	-0.93	-0.80	-0.62	-0.31	-0.33	-0.88	0.75	0.77	-0.83	-0.36	-0.17	**0.92**	0.47
length	0.74	1.00	-0.18	-0.58	-0.83	-0.60	-0.60	0.04	-0.28	-0.65	0.85	0.80	-0.66	-0.02	0.15	**0.81**	0.46
Na	-0.66	-0.18	1.00	0.67	0.34	0.40	0.58	0.24	-0.23	0.41	-0.28	-0.20	0.32	0.27	-0.06	-0.30	-0.45
Cl	**-0.83**	-0.58	0.67	1.00	0.67	0.57	0.72	0.15	-0.09	0.50	-0.61	-0.71	0.60	0.23	-0.04	-0.80	-0.39
K	**-0.93**	-0.83	0.34	0.67	1.00	0.78	0.66	0.36	0.27	0.83	-0.72	-0.59	0.88	0.21	0.15	-0.76	-0.39
Mn	**-0.80**	-0.60	0.40	0.57	0.78	1.00	0.63	0.28	0.42	0.83	-0.43	-0.39	0.80	-0.05	0.32	-0.63	-0.28
Br	-0.62	-0.60	0.58	0.72	0.66	0.63	1.00	0.29	0.01	0.47	-0.63	-0.44	0.57	-0.25	-0.26	-0.46	-0.56
Fe	-0.31	0.04	0.24	0.15	0.36	0.28	0.29	1.00	-0.13	0.19	-0.83	0.10	0.35	0.51	0.01	0.06	-0.34
Co	-0.33	-0.28	-0.23	-0.09	0.27	0.42	0.01	-0.13	1.00	0.39	-0.37	0.02	0.51	0.38	0.43	-0.16	-0.08
Zn	**-0.88**	-0.65	0.41	0.50	**0.83**	**0.83**	0.47	0.19	0.39	1.00	-0.72	-0.37	0.76	0.28	0.43	-0.65	-0.32
As (n=5)	0.75	0.85	-0.28	-0.61	-0.72	-0.43	-0.63	-0.83	-0.37	-0.72	1.00	0.89	-0.59	-0.30	-0.38	0.63	0.45
Se	**0.77**	**0.80**	-0.20	-0.71	-0.59	-0.39	-0.44	0.10	0.02	-0.37	0.89	1.00	-0.40	0.05	0.28	0.86	0.24
Rb	**-0.83**	-0.66	0.32	0.60	**0.88**	**0.80**	0.57	0.35	0.51	0.76	-0.59	-0.40	1.00	0.41	0.25	-0.64	-0.31
Ag (n=6)	-0.36	-0.02	0.27	0.23	0.21	-0.05	-0.25	0.51	0.38	0.28	-0.30	0.05	0.41	1.00	0.44	-0.37	-0.39
Cd (ICP)	-0.17	0.15	-0.06	-0.04	0.15	0.32	-0.26	0.01	0.43	0.43	-0.38	0.28	0.25	0.44	1.00	-0.11	0.25
Hg (ICP)	**0.92**	**0.81**	-0.30	**-0.80**	-0.77	-0.63	-0.45	0.06	-0.17	-0.65	0.62	**0.86**	-0.64	-0.38	-0.11	1.00	0.36
Sn (ICP)	0.47	0.46	-0.45	-0.39	-0.39	-0.28	-0.56	-0.34	-0.08	-0.32	0.45	0.24	-0.31	-0.39	0.25	0.36	1.00