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PREFACE

This NIST interagency report presents analytical data on beluga whale tissue samples (liver and blubber) collected and banked as part of the Alaska Marine Mammal Tissue Archival Project (AMMTAP). Measurements of persistent organohalogenated compounds and mercury were made on the tissue of these animals. This report presents the results of the analyses made by NIST.

ACKNOWLEDGEMENTS

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DISCLAIMER

Certain commercial equipment, instruments, or materials are identified in this paper to specify adequately the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

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INTRODUCTION

The Arctic Monitoring and Assessment Programme (AMAP) was established in 1991 as an international effort to assess the status of target contaminants, including persistent organic pollutants (POPs) and heavy metals, in the circumpolar Arctic [1]. AMAP's initial report indicated the ubiquitous presence of contaminants throughout the Arctic. Consequently, the Stockholm Convention on Persistent Organic Pollutants was signed in 2001 to initiate a global banning of these contaminants. Although usages of select POPs have been banned or restricted, the effectiveness of this treaty can only be realized by investigating temporal trends in Arctic marine biota. Since the Stockholm Convention's inception, extensive investigation of marine biota in the eastern Arctic has been conducted, whereas it has been lacking in its western counterpart. To get a comprehensive account of the Arctic's current and predicted environmental status, it is important that temporal trends be assessed throughout the Arctic as regional differences in contaminants likely vary due to factors including proximity to contaminant sources and varying transport and deposition rates.

The beluga whale, *Delphinapterus leucas*, is an Arctic species that feeds close to the top of the food chain, providing the potential to bioaccumulate persistent contaminants in their tissues. Belugas are expected to accumulate organohalogenated compounds and mercury in their tissues because of their relatively long life span (> 30 yr) [2] and their high trophic level. While there have been numerous studies focusing on temporal and spatial trends of these contaminants in Canadian and eastern Arctic beluga [3-5], there is limited information on these trends in Alaskan and western Arctic beluga.

In Alaskan waters there are two genetically isolated populations of beluga whales: Cook Inlet and Bering Sea, the Bering Sea population is represented by four stocks; Bristol Bay, eastern Bering Sea, eastern Chukchi Sea, and Beaufort Sea [6,7]. The Alaskan Peninsula geographically isolates the Cook Inlet animals (living year round in Cook Inlet and in the Gulf of Alaska immediately outside Cook Inlet) from the Bering Sea animals [8]. Since 1992, blubber and liver samples have been collected as part of the Alaska Marine Mammal Tissue Archival Project (AMMTAP) from belugas taken during Alaska Native subsistence hunts in Cook Inlet [9]. In addition, blubber and liver samples have been collected from the eastern Chukchi Sea stock during subsistence hunts since 1989. As there are no overlapping areas of distribution between the Cook Inlet and eastern Chukchi Sea animals, having two distinct populations for comparison provides an opportunity to evaluate possible sources of contamination in the North American Arctic. The Cook Inlet belugas are thought to be affected more by local anthropogenic sources coming from the surrounding more urbanized area of Anchorage, while the eastern Chukchi Sea animals will be affected more by atmospheric and oceanic transport. The eastern Chukchi Sea animals forage between the Russian and United States Arctic. There is a lack of data on POPs in marine mammals from this area of the Arctic and having animals from the Chukchi Sea is a unique opportunity to assess the influences of Asian and Russian production of legacy and emerging POPs to this area of the Arctic.

In this study, aliquots of Cook Inlet and eastern Chukchi Sea beluga blubber and liver samples were analyzed for legacy POPs (i.e., polychlorinated biphenyls (PCBs), dichlorodiphenyl-dichloroethanes (DDTs), chlordanes, hexachlorocyclohexanes (HCHs), hexachlorobenzene

(HCB), pentachlorobenzene, mirex, heptachlor, and heptachlor epoxide), emerging POPs (i.e., polybrominated diphenyl ethers (PBDEs), hexabromocyclododecanes (HBCDs), and perfluorinated compounds (PFCs)), and mercury. The primary objective of this study was to fill in existing temporal and spatial gaps from the Alaskan Arctic by investigating the trends, as well as examining gender differences and possible bioaccumulation with total length, in two separate Alaskan beluga populations.

MATERIALS AND METHODS

Sample Collections

As part of AMMTAP, full-depth blubber and liver tissues were collected from free-ranging beluga whales during native subsistence hunts in Cook Inlet and the eastern Chukchi Sea, Alaska from 1989 to 2006. Collection procedures followed standard AMMTAP protocols designed to preserve sample integrity and minimize sample contamination [10]. Following collection, samples were maintained in liquid nitrogen vapor freezers until cryohomogenization at the National Marine Mammal Tissue Bank (NMMTB) housed at the National Institute of Standards and Technology (NIST) [11]. Information regarding sample identification, year, location, sex, and length is provided in Table 1.

Tissue Preparation

Each tissue specimen 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 [12]. 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.

Table 1. Beluga whale tissue samples that have been analyzed.

Animal Identification Number	Liver Identification Number	Blubber Identification Number	Year	Beluga Stock Population	Sex	Total Length	Percent Lipids
692-BLKA-001	MM3L069	MM3B071	1989	eastern Chukchi Sea	F	343	79.0
692-BLKA-002	MM3L072	MM3B074	1989	eastern Chukchi Sea	F	310	84.2
692-BLKA-003	MM3L075	NA	1989	eastern Chukchi Sea	F	348	NA
692-BLKA-004	MM3L077	NA	1989	eastern Chukchi Sea	M	348	NA
692-BLKA-005	MM4L125	MM4B127	1990	eastern Chukchi Sea	M	394	79.7
692-BLKA-006	MM4L128	MM4B130	1990	eastern Chukchi Sea	M	430	88.3
692-BLKA-007	MM4L131	MM4B133	1990	eastern Chukchi Sea	F	363	78.9
692-BLKA-008	MM4L134	MM4B136	1990	eastern Chukchi Sea	M	364	77.7
692-BLKA-009	MM4L137	MM4B139	1990	eastern Chukchi Sea	M	348	78.0
692-BLKA-010	MM4L140	MM4B142	1990	eastern Chukchi Sea	M	400	85.1
692-BLKA-011	MM4L143	MM4B145	1990	eastern Chukchi Sea	M	433	83.9
692-BLKA-012	MM4L146	MM4B148	1990	eastern Chukchi Sea	F	375	81.7
692-BLKA-013	MM4L149	MM4B151	1990	eastern Chukchi Sea	M	434	91.5
692-BLKA-014	MM4L152	MM4B154	1990	eastern Chukchi Sea	F	351	86.1
692-BLKA-015	MM6L216	MM6B218	1992	Cook Inlet	M	373	82.3
692-BLKA-016	NA	MM9B328	1994	Cook Inlet	M	472	88.8
692-BLKA-017	NA	MM9B329	1994	Cook Inlet	F	305	85.2
692-BLKA-018	NA	MM9B330	1994	Cook Inlet	M	305	82.4
692-BLKA-020	MM10L331	MM10B332	1995	Cook Inlet	F	240	86.6
692-BLKA-021	MM10L333	MM10B335	1995	Cook Inlet	M	409	88.7
692-BLKA-022	MM10L336	MM10B338	1995	Cook Inlet	F	360	80.5
692-BLKA-023	MM10L339	MM10B341	1995	Cook Inlet	F	353	84.6
692-BLKA-024	MM10L342	MM10B344	1995	Cook Inlet	F	368	86.5
692-BLKA-025	MM10L345	MM10B347	1995	Cook Inlet	F	143	66.0
692-BLKA-026	MM10L368	MM10B370	1995	Cook Inlet	M	422	86.3
692-BLKA-027	MM10L371	MM10B373	1995	Cook Inlet	M	377	88.7
692-BLKA-028	MM10L374	MM10B376	1995	Cook Inlet	M	391	85.8
692-BLKA-029	NA	MM10B388	1995	Cook Inlet	M	413	86.3
692-BLKA-031	NA	MM11B418	1996	Cook Inlet	F	367	87.1
692-BLKA-032	MM11L467	MM11B469	1996	Cook Inlet	F	256	NA
692-BLKA-033	MM11L463	MM11B465	1996	Cook Inlet	F	359	87.4
692-BLKA-034	MM11L477	MM11B479	1996	Cook Inlet	F	377	NA
692-BLKA-035	MM11L481	MM11B483	1996	Cook Inlet	M	415	91.8
692-BLKA-036	NA	MM11B486	1996	Cook Inlet	M	429	89.8
692-BLKA-037	MM11L488	MM11B490	1996	Cook Inlet	M	367	91.7
692-BLKA-038	MM13L678	MM13B680	1998	Cook Inlet	F	320	94.0
692-BLKA-039	MM13L682	MM13B683	1998	Cook Inlet	F	126	66.3
692-BLKA-040	MM11L436	MM11B438	1996	eastern Chukchi Sea	M	315	84.2
692-BLKA-041	NA	MM11B442	1996	eastern Chukchi Sea	F	322	88.5
692-BLKA-042	MM11L444	MM11B446	1996	eastern Chukchi Sea	F	393	89.4

Table 1 (Cont.) Beluga whale tissue samples that have been analyzed.

Animal Identification Number	Liver Identification Number	Blubber Identification Number	Year	Beluga Stock Population	Sex	Total Length	Percent Lipids
692-BLKA-043	MM11L420	MM11B422	1996	eastern Chukchi Sea	M	427	89.7
692-BLKA-044	MM11L424	MM11B426	1996	eastern Chukchi Sea	M	415	90.3
692-BLKA-045	MM11L428	MM11B430	1996	eastern Chukchi Sea	M	420	84.1
692-BLKA-046	NA	MM11B434	1996	eastern Chukchi Sea	M	396	87.5
692-BLKA-047	MM11L448	MM11B450	1996	eastern Chukchi Sea	F	333	87.5
692-BLKA-048	MM11L455	MM11B457	1996	eastern Chukchi Sea	F	386	88.7
692-BLKA-049	MM11L459	MM11B461	1996	eastern Chukchi Sea	F	333	84.0
692-BLKA-050	MM13L686	MM13B688	1998	Cook Inlet	F	320	76.4
692-BLKA-051	MM13L689	MM13B691	1998	Cook Inlet	M	450	73.4
692-BLKA-052	MM13L701	MM13B703	1998	Cook Inlet	M	433	83.9
692-BLKA-053	MM13L705	NA	1997	eastern Chukchi Sea	F	255	NA
692-BLKA-054	MM13L715	MM13B716	1997	eastern Chukchi Sea	M	440	87.4
692-BLKA-055	NA	MM13B719	1998	eastern Chukchi Sea	M	419	89.8
692-BLKA-056	MM13L720	MM13B722	1997	eastern Chukchi Sea	M	430	91.0
692-BLKA-057	MM15L109C	MM15B111C	1999	eastern Chukchi Sea	M	405	83.9
692-BLKA-058	MM15L055C	MM15B057C	1999	eastern Chukchi Sea	M	410	83.8
692-BLKA-059	MM15L058C	MM15B060C	1999	eastern Chukchi Sea	M	339	87.6
692-BLKA-060	MM15L112C	MM15B114C	1999	eastern Chukchi Sea	M	390	87.6
692-BLKA-061	MM15L061C	MM15B063C	1999	eastern Chukchi Sea	M	435	82.8
692-BLKA-062	MM15L064C	MM15B066C	1999	eastern Chukchi Sea	M	400	79.1
692-BLKA-063	MM15L115C	MM15B117C	1999	eastern Chukchi Sea	M	304	84.9
692-BLKA-064	MM15L067C	MM15B069C	1999	eastern Chukchi Sea	F	357	85.9
692-BLKA-065	MM15L070C	MM15B072C	1999	eastern Chukchi Sea	M	400	87.4
692-BLKA-066	MM15L073C	MM15B075C	1999	eastern Chukchi Sea	F	338	84.5
692-BLKA-067	MM15L118C	MM15B119C	1999	eastern Chukchi Sea	M	663	85.7
692-BLKA-068	MM15L120C	MM15B121C	1999	eastern Chukchi Sea	F	206	83.4
692-BLKA-069	MM16L232C	MM16B234C	2000	eastern Bering Sea	M	313	88.7
692-BLKA-070	MM16L235C	NA	2000	eastern Bering Sea	F	245	NA
692-BLKA-071	MM16L237C	MM16B239C	2000	eastern Bering Sea	F	238	81.7
692-BLKA-072	MM16L240C	MM16B242C	2000	eastern Bering Sea	M	357	89.0
692-BLKA-073	MM17L314C	MM17B316C	2001	Cook Inlet	F	345	86.4
692-BLKA-074	MM17L317C	MM17B319C	2001	Cook Inlet	F	166	86.2
692-BLKA-075	MM18L347C	MM18B349C	2002	Bristol Bay	M	287	78.5
692-BLKA-076	MM18L413C	MM18B415C	2002	Cook Inlet	M	457	84.1
692-BLKA-077	MM19L469C	MM19B471C	2003	Cook Inlet	F	130	64.1
692-BLKA-078	NA	MM19B468C	2003	Cook Inlet	F	365	86.1
692-BLKA-079	MM20L553C	NA	2003	Cook Inlet	F	366	NA
692-BLKA-080	MM21L711C	MM21B713C	2005	Cook Inlet	M	427	86.7
692-BLKA-081	MM22L869C	NA	2006	Cook Inlet	F	370	NA

NA material was not available

Analysis of Blubber for Persistent Organic Pollutant

Seventy-three beluga blubber samples (approximately 1.0 g) were extracted for determination of POPs using pressurized fluid extraction (PFE) [13]. Briefly, blubber was mixed with 25 g of Na_2SO_4 and the mixture was transferred to PFE cells. An internal standard solution containing a suite of labeled PCB congeners, PBDE congeners, and organochlorine pesticides was added gravimetrically to all PFE cells and samples were extracted with dichloromethane (DCM) using PFE. Following extraction, samples were cleaned up using size exclusion chromatography and solid phase extraction through activated silica. Lipid content was determined gravimetrically from a subsample of the PFE extract prior to cleanup. Next, extracts were cleaned up using an acidified silica solid phase extraction [14]. Two fractions were collected: Fraction 1 for most POPs and Fraction 2 used for HBCD analysis.

Fraction 1 samples were analyzed by using gas chromatography mass spectrometry (GC/MS) with a programmable temperature vaporization (PTV) inlet operated in the solvent vent mode and equipped with a 5 m x 0.25 mm Restek Siltek guard column (Bellefonte, PA) connected to a 0.18 mm x 30 m DB-5MS capillary column, 0.18 μm film thickness (Agilent, Palo Alto, CA). The first injection, with electron impact ionization (EI), was used for the determination of the majority of the analytes; including PCBs, PBDEs, DDTs, HCB, and mirex. Extracts were further analyzed using the instrument above in the negative chemical ionization mode for cyclodiene compounds. The column used was a 0.18 mm x 30 m DB-XLB capillary column, 0.18 μm film thickness (Agilent, Palo Alto, CA). NIST Standard Reference Material (SRM) 1945 Organics in Whale Blubber was analyzed with each set of blubber samples as a control material.

Analysis of Blubber for Hexabromocyclododecane

Fraction 2 from the POP analysis method was solvent exchanged to methanol and analyzed for the alpha, beta, and gamma isomers of HBCD (α−HBCD, β−HBCD, and γ−HBCD) by using liquid chromatography interfaced to a negative electrospray ionization tandem mass spectrometer (LC-MS/MS). The HBCD isomers were separated on an Agilent Eclipse Plus C18 column (3.0 mm x 150 mm x 3.5 μm column) using a flow rate of 0.3 mL/min. Initial conditions began at 90 % 2.5 mM ammonium acetate in 12.5 % water in methanol (volume fraction) and 10 % acetonitrile. The acetonitrile was ramped to 33 % by 12 min and held for 3 min. Acetonitrile was increased to 100 % by 20 min, held for 3 min, and by 28 min reverted back to the original conditions and held for 5 min. The MS/MS method included the optimization parameters and the three most abundant transitions were monitored. NIST SRM 1945 was analyzed with each set of blubber samples as a control material.

Analysis of Liver for Perfluorinated Compound

Sixty-nine beluga liver samples were selected for analysis of PFCs using the methodology described in Reiner et al. [15]. Briefly, 0.5 g of sample was mixed with 0.5 mL of MilliQ water. The internal standard solution containing isotopically labeled perfluorinated compounds was gravimetrically added to each sample and the samples were allowed to equilibrate with the internal standards (20 min). Potassium hydroxide in methanol was added to the samples, and samples were vortexed, sonicated, centrifuged, and the supernatant was transferred to a clean tube. The extraction procedure was repeated and both extracts were combined and evaporated to approximately 3 mL. The extracts were filtered using a Whatman UniPrep 0.2 µm filter (Stanford, ME) and then further evaporated to 1 mL. Ten mL of 50 % (volume fraction) formic acid (98 %, Fluka) in MilliQ water was added to each sample. A Waters Oasis Weak Anion Exchange (WAX) SPE (3 cc, 60 mg, 30 µm; Milford, MA) cartridge was conditioned with methanol and water, and samples were loaded onto the SPE columns on the RapidTrace workstations (Caliper, Hopkinton, MA). Extracts were concentrated in volume, spiked with the recovery standard, vortexed, and transferred to autosampler vials.

Samples were injected onto the LC-MS/MS using the NIST method described in Keller et al. [16]. The MS/MS method included the optimization parameters for each analyte and two to three of the most abundant transitions for each PFC were monitored. NIST QC97LH2 Beluga Whale liver was analyzed with each set of liver samples as a control material.

Analysis of Liver for Perfluorooctane Sulfonamide

Eighteen of the 69 beluga liver samples were extracted and cleaned up using a secondary method for the determination of perfluorooctane sulfonamide (PFOSA). Briefly, 0.5 g of sample was mixed with 0.5 mL of MilliQ water. The internal standard solution was gravimetrically added to each sample and the samples were allowed to equilibrate with the internal standards (20 min). Potassium hydroxide in methanol was added to the samples, and samples were vortexed, sonicated, centrifuged, and the supernatant was transferred to a clean tube. The extraction procedure was repeated and both extracts were combined and evaporated to approximately 3 mL. The extracts were filtered using a Whatman UniPrep 0.2 µm filter (Stanford, ME). A Supelco, Supelclean ENVI-Carb SPE (3 cc, 250 mg 120 – 400 mesh; Bellefonte, PA) cartridge was conditioned with 6 mL methanol followed by 6 mL water. Samples were loaded on the SPE cartridge and eluted immediately using 4.5 mL methanol.

This subset of beluga liver extracts was analyzed using the Phenomonex Luna PFP (2) column (50 mm x 3.0 mm x 5 µm) column. The solvent gradient started at 60 % methanol and 40 % 20 mmol/L ammonium acetate in water (volume fractions, flow rate of 0.3 mL/min) and then increased to 65 % methanol by 5 min, held for 5 min, and then increased to 80 % methanol by 15 min, held for 5 min, before reverting back to original conditions at 20.5 min with a 10 min hold. NIST QC97LH2 was analyzed with each set of liver samples as a control material.

Analysis of Liver for Total Mercury

Sixty-nine beluga liver samples were analyzed for mercury (Hg). The mass fraction of Hg was determined with a direct mercury analyzer DMA 80 (Milestone Scientific, Shelton, CT). The samples were weighed in sample boats, then thermally decomposed, catalytically reduced to Hg^0 and trapped on a gold amalgamation trap. The mercury was then thermally desorbed and the Hg atomic absorption measured at 254 nm. NIST QC97LH2 and SRM 1946 Lake Superior Fish Tissue were analyzed with the liver samples as control materials.

Analysis of Blubber for Lipid (Total Extractable Organics) Determination

Beluga blubber extracts were evaporated under a stream of nitrogen to approximately 4 mL. Thirty percent of the extracts were removed gravimetrically and transferred to tared aluminum pans. Pans were allowed to dry for 24 h or more at room temperature before re-weighing (solvent was known to be gone when the balance reading was stable for longer than 10 sec). All remaining extracts were evaporated to 1 mL.

Statistical Methods

All statistical analyses were performed using JMP 7.0.2 (SAS Institute, Cary, NC) or JMP 9.0.0 (SAS Institute, Cary, NC). Statistical tests were performed for compounds detected in > 70 % of the samples. The mass fractions of compounds less than the reporting limit (RL) were set equal to half the RL prior to running the statistical tests. The distribution of the data was evaluated using the Shapiro-Wilk test. All compounds were either normally or log-normally distributed. If log-normally distributed, the data were logarithmically transformed to meet the criteria for normal distribution and parametric tests were performed. The Pearson product-moment coefficient was used to determine pairwise correlations among individual compounds. Backward stepwise multiple regressions were performed with the beluga location, year, sex, and animal length used as the independent variables. For PFCs, when year was shown to be significant based on the regression, the log-linear regressions, based on the annual geometric means, were modeled using the Arctic Monitoring and Assessment Programme (AMAP) PIA program [17].

RESULTS AND DISCUSSION

Persistent Organic Pollutants

Analytical data for the POPs in the 73 beluga whale blubber samples are presented in Appendix A, Table A1-A5. Individual congener mass fractions are listed in Appendix A, Tables A1-A5. PCBs, DDTs, chlordanes, HCH, HCB, and PBDEs were detected in all blubber samples (Table 2). Pentachlorobenzene, mirex, and heptachlor epoxide were detected less frequently (85 % to 91 % of the samples). Heptachlor was detected infrequently (< 50 %), so it was not included in the statistical analysis. PCBs and DDTs made up greater than 50 % of ΣPOPs measured. The wet mass fractions of ΣPCBs ranged from 138 ng/g to 7510 ng/g (median: 1870 ng/g) and ΣDDTs ranged from 139 ng/g to 6830 ng/g (median: 1520 ng/g). ∑Chlordanes comprised approximately 15% of the ΣPOPs measured (49.1 ng/g to 3700 ng/g; median: 641 ng/g); HCB at 5% (31.1 ng/g to 980 ng/g; median: 220 ng/g); ∑HCHs at 3% (46.0 ng/g to 517 ng/g; median: 118 ng/g); and ∑PBDEs at less than 1% (1.63 ng/g to 39.6 ng/g; median: 10.5 ng/g) of the ΣPOPs measured (Figure 1). Similar ranges have been measured in beluga whales from the northeastern and western Canadian Arctic (Table 3).

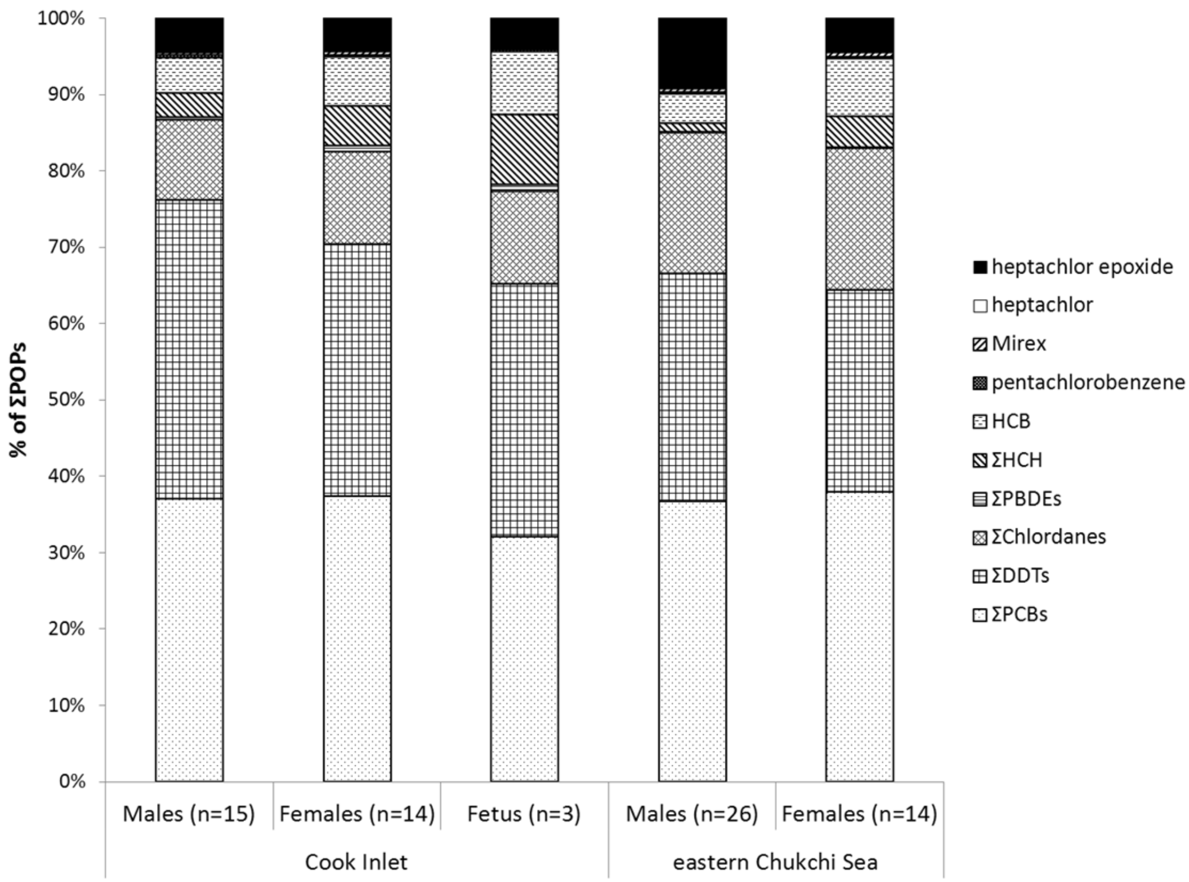

Figure 1. Patterns of individual POPs as percent of ΣPOPs in the blubber of beluga whales.

Table 2. Mass fractions of POPs (ng/g wet mass) in beluga blubber samples.

	Cook Inlet						eastern Chukchi Sea					
	Males			Females			Males			Females		
	Range	Geometric mean	n > RL (n=15)	Range	Geometric mean	n > RL (n=17)	Range	Geometric mean	n > RL (n=26)	Range	Geometric mean	n > RL (n=14)
ΣPCBs*	364-3330	1480	15	138-1580	1580	17	1920-7510	4030	26	481-4290	1330	14
ΣDDTs*	310-3800	1530	15	139-1490	1490	17	1180-6830	3140	26	247-3550	3550	14
Σchlordanes*	129-854	854	15	49.1-505	505	17	845-3700	2020	26	208-2050	2050	14
ΣHCH	63.2-241	241	15	46.0-210	210	17	65.2-292	292	26	69.2-517	517	14
HCB	49.9-368	368	15	31.1-268	268	17	278-840	840	26	53.2-980	980	14
Pentachlorobenzene*	2.09-57.3	57.3	15	1.73-9.72	9.72	17	<RL-68.7	68.7	25	<RL-33.4	33.4	7
Mirex*	4.44-29.9	29.9	15	1.09-11.8	11.8	17	24.2-129	129	26	<RL-37.5	37.5	7
Heptachlor	<RL-5.18	5.18	7	1.92-7.40	7.40	17	<RL	<RL	0	<RL	<RL	0
Heptachlor Epoxide	<RL-414	414	14	<RL-113	113	9	246-1870	1865	26	<RL-491	491	13
ΣPBDEs*	5.41-39.6	15.3	15	1.63-27.6	10.6	17	3.45-28.9	10.4	26	1.63-15.8	4.66	14

n > RL indicates the number of samples above the reporting limit (RL)

Values were calculated with half the RL substituted for non-detects as described in the methods section

Compounds marked with asterisks indicate there are significant differences between beluga stocks ($p < 0.05$)

Table 3. Mean mass fractions (± standard deviation) of POPs (ng/g wet mass) in beluga blubber from Arctic locations.

Location	southern Alaska/Cook Inlet (n=32, males and females)[a]	northeastern Alaska/eastern Chukchi Sea (n=40, males and females)[a]	N. West Greenland (n=54, males only)[b]	Beaufort Sea (n=26, males only)[c]	western Canada/Hedrickson Island (n=10, males only)[d]	Hudson Bay (n=44, males and females)[e]	St. Lawrence River (n=54, males and females)[f]
Years	1992 - 2005	1989 - 2000	1989 - 1990	1993 - 1994	2007	1999 - 2003	1988 - 1999
% lipid	84.2	85.3	89.1	89.9	81.8	89.4	90.1
ΣPCBs	1100 ± 810	3380 ± 1840	5580 ± 2500	5010 ± 1620		105 - 10900	
ΣDDTs	1110 ± 890	2680 ± 1710	4370 ± 1730	3430 ± 640		120 - 9150	
ΣChlordanes	326 ± 210	1680 ± 900	2600 ± 1160	2490 ± 320			
ΣHCH	118 ± 55	147 ± 95	390 ± 140	334 ± 94		32 - 1200	
HCB	157 ± 86	413 ± 219	825 ± 477	956 ± 128			
Pentachlorobenzei	8.61 ± 10.40	26.7 ± 18.7					
Mirex	9.54 ± 6.70	48.0 ± 26.1					
Heptachlor	3.04 ± 1.29	< RL					
Heptachlor Epoxid	149 ± 103	783 ± 560					
ΣPBDEs	14.9 ± 8.9	9.89 ± 6.76			9.27 ± 1.86	4.4 - 130	283 ± 220

[a] This study [b] [18] [c] [19] [d] [20] [e] [21] only ranges were provided [f] [22]

< RL = below the reporting limit; n.m. = not measured; NA = not applicable

The effects of location, year, sex, and length on contaminants were examined using backward stepwise regressions (Table 4). Only contaminants detected in > 85% of the samples were used in the regression model. Spatial trends were observed with significantly higher mass fractions of ΣPCB ($p < 0.0001$), ∑DDT ($p < 0.0001$), ∑Chlordanes ($p < 0.0001$), and pentachlorobenzene ($p=0.0023$) in the eastern Chukchi Sea belugas, while ∑PBDEs were significantly higher in Cook Inlet belugas ($p=0.0028$). The ∑PBDEs contaminant class showed a significant temporal trend ($R^2 = 0.40$; $p < 0.0001$; Figure 2). Regarding sex, males had significantly higher amounts of mirex ($p=0.004$), ∑PCBs ($p < 0.0001$), ∑DDTs ($p < 0.0001$), ∑Chlordanes ($p < 0.0001$), pentachlorobenzene ($p < 0.0001$), and ∑PBDEs ($p=0.0001$) than females in both Cook Inlet and the eastern Chukchi Sea. ∑HCH, showed no significant differences between the sexes ($p=0.057$). ∑HCHs did significantly decrease with increasing animal length with a coefficient of determination (R^2) = 0.18 ($p=0.02$). Conversely, mirex significantly increased with increasing length ($R^2 = 0.39$; $p < 0.0001$) (Figure 3).

Table 4. Summary of statistical findings (p-values) examining the influences of beluga location, year, sex and length on POPs in beluga whales.

Trait	ΣPCBs	ΣDDTs	ΣChlordanes	ΣHCH	Pentachlorobenzene	Mirex	ΣPBDEs
Beluga Location	**< 0.0001**	**< 0.0001**	**< 0.0001**	0.0735	**0.0023**	**< 0.0001**	**0.0028**
Year	> 0.100	> 0.100	> 0.100	> 0.100	> 0.100	> 0.100	**< 0.0001**
Sex	**< 0.0001**	**< 0.0001**	**< 0.0001**	0.0572	**< 0.0001**	**0.0004**	**0.0001**
Length	> 0.100	> 0.100	> 0.100	**0.0201**	> 0.100	**< 0.0001**	> 0.100
Multiple regression	**< 0.0001**	**< 0.0001**	**< 0.0001**	**0.0354**	**< 0.0001**	**< 0.0001**	**< 0.0001**

Bold p-values were considered statistically significant ($p < 0.05$).
Values shown as > 0.100 indicate that the backward stepwise multiple regression model eliminated the model effect and that trait was removed from the total model.

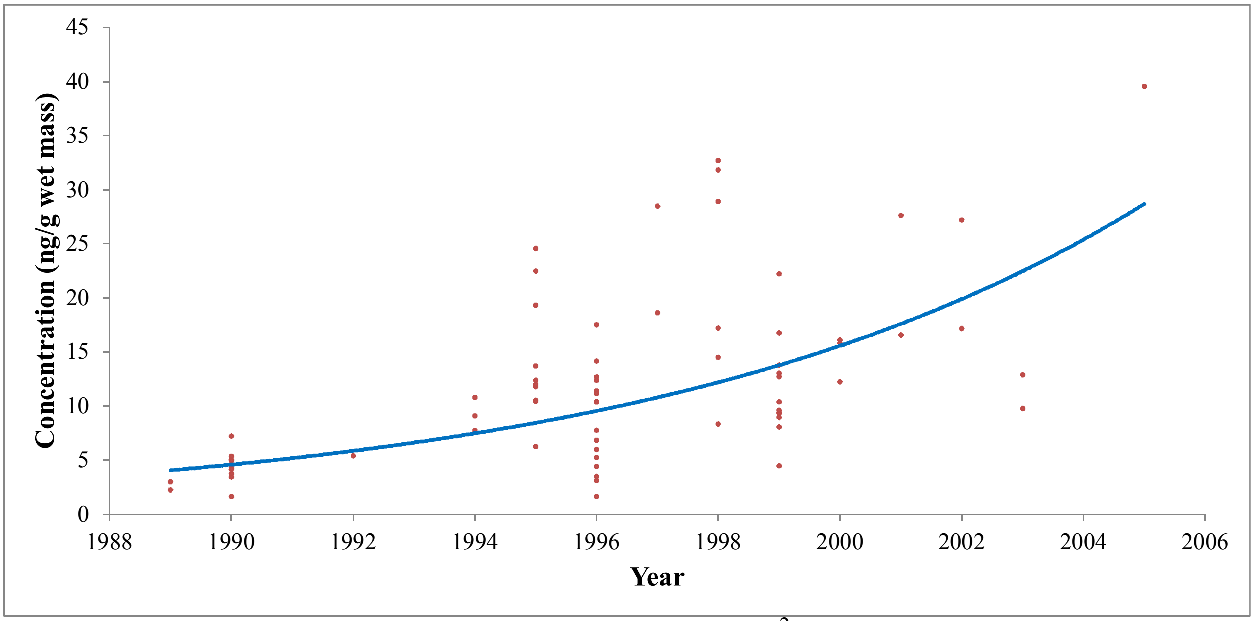

Figure 2. Temporal trend of ΣPBDE (ng/g wet mass) (R^2 = 0.40) in beluga whale blubber. Individual data points are red and the blue line is the log linear regression

As an interesting aside, tissues from three mother-fetus pairs were collected and analyzed to investigate offloading patterns for these contaminants (Table 5). Ratios of each mother-fetus pair were calculated by dividing the contaminant mass fraction of the mother by the contaminant mass fraction of the fetus. Ratio values of < 1.0 indicated a high amount of offloading, while values > 1.0 indicated less offloading from mother to fetus. ∑HCHs, HCB, and pentachlorobenzene appear to demonstrate high offloading tendencies from mother to fetus, with mean ratio values of 0.732, 0.963, and 0.637, respectively. Conversely, mirex shows less of a tendency towards offloading from mother to fetus with mean ratios of 5.93.

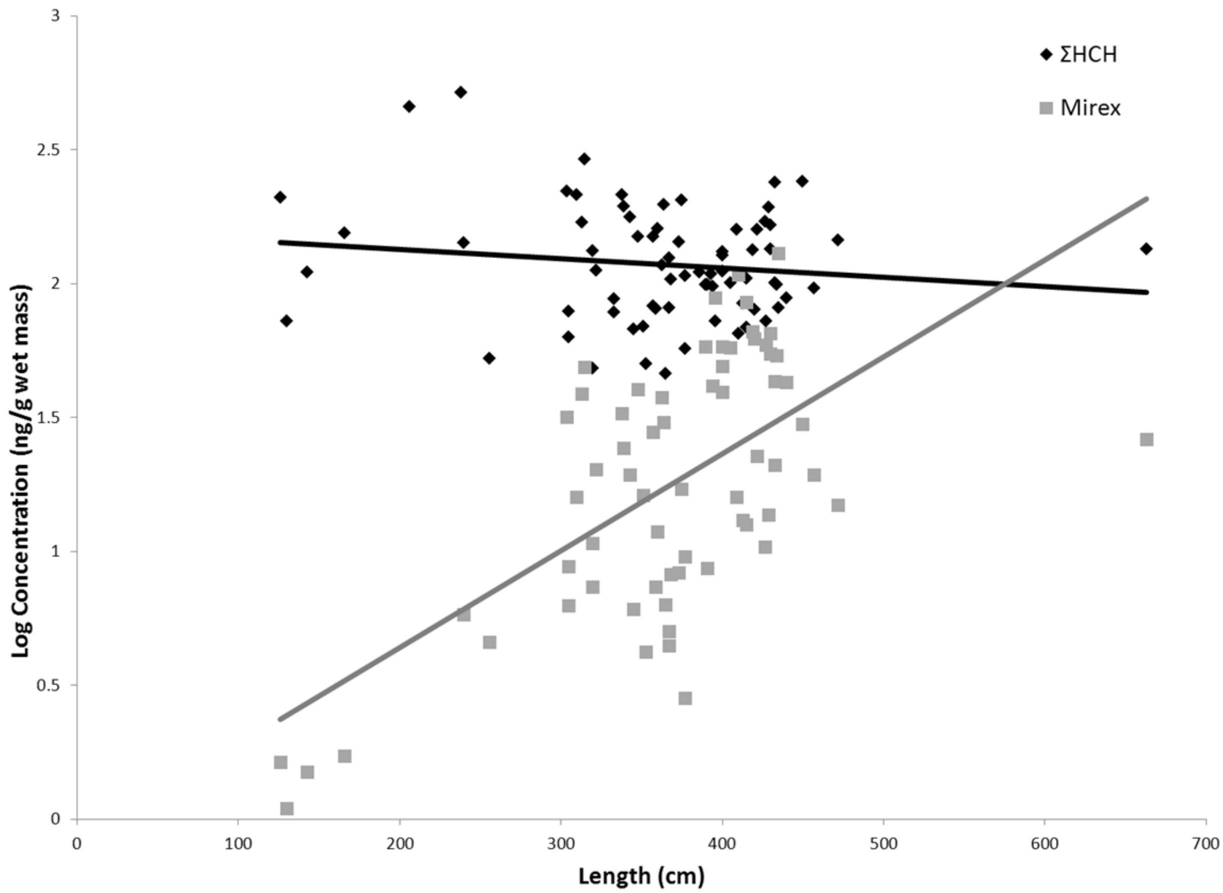

Figure 3. Linear regression between length and log concentration of ΣHCHs and mirex in blubber samples of belugas from Alaska: R^2 for ΣHCH = 0.018 and mirex = 0.39. For both regressions $p < 0.05$.

Table 5. Mass fractions (ng/g, wet mass basis) and ratios of POPs in two matched mother and fetus pairs.

	ΣPCBs	ΣDDTs	ΣChlordanes	ΣHCH	HCB	Pentachlorobenzene	Mirex	Heptachlor	Heptachlor Epoxide	ΣPBDEs
Mother-1 (ng/g)	984	810	322	103	171	4.60	8.17	2.82	58.5	12.4
Fetus-1 (ng/g)	575	577	237	111	138	5.78	1.50	2.19	62.0	10.4
Ratio-1 (mother to fetus)	1.71	1.40	1.36	0.93	1.24	0.80	5.47	1.28	0.94	1.19
Mother-2 (ng/g)	320	1003	1033	132	148	4.58	10.7	1.92	77.6	17.2
Fetus-2 (ng/g)	126	621	675	210	153	8.15	1.6	2.14	44.6	14.5
Ratio-2 (mother to fetus)	2.54	1.62	1.53	0.63	0.96	0.56	6.58	0.89	1.74	1.19
Mother-3 (ng/g)	365	337	265	46	39	1.87	6.3	3.59	<RL	12.9
Fetus-3 (ng/g)	130	169	160	73	57	3.40	1.1	2.93	<RL	9.77
Ratio-3 (mother to fetus)	2.81	1.99	1.66	0.63	0.68	0.55	5.76	1.22		1.32

< RL = below the reporting limit

Hexabromocyclododecanes

The α, β, and γ isomers of HBCDs were investigated in 73 beluga whale blubber samples. The only congener quantifiable in most samples was the α-HBCD, generally at mass fraction < 5 ng/g wet mass. One animal had an unusual pattern of HBCDs and very high mass fraction of the γ-HBCD isomer (Appendix A, Table A6).

Perfluorinated Compounds

Analytical data for perfluorinated compounds (PFCs) in the 69 beluga whales are presented in Appendix A, Table A7. PFCs were detected in all beluga liver samples (Table 6); with PFDA, PFDoA, PFOS, and PFOSA detected in all samples. PFNA, PFUnA, PFTriA, PFTA, and PFHxS were detected less frequently (72 % to 97 % of the samples). Short-chain PFCs (PFOA, PFHpA, and PFHxA) were detected infrequently (< 2 %), so these short-chain PFCs were not included in the statistical analysis. ΣPFC mass fractions (wet-mass basis) ranged from 17.5 ng/g to 240 ng/g (Appendix A, Table A7). PFOS and PFOSA accounted for greater than 50 % of the ΣPFCs measured. The wet-mass mass fraction of PFOS ranged from 1.81 ng/g to 70.3 ng/g (median: 10.8 ng/g). PFOSA was also found ranging from 4.52 ng/g to 65.7 ng/g (median: 22.8 ng/g). The long-chained, PFCAs with odd numbers of carbons, PFUnA and PFTriA, were detected at higher mass fractions compared to even numbered, long-chained PFCAs. PFUnA comprised approximately 15 % of the ΣPFCs measured (median: 8.49 ng/g) and PFTriA made up 7 % of the ΣPFCs measured (median: 4.38 ng/g).

Similar ranges have been measured in beluga whales from the northeastern and western Canadian Arctic (Table 7) [21,20,23]. The relatively high body burden of PFOSA in beluga whales has also been seen in previous studies [20,21]. Higher measurements of PFTA were found in this study compared with beluga whales from northeastern Canada [21]. The prevalence of PFTA that was not seen in the earlier study suggests that there are different transport pathways and/or sources of PFTA that exists in Alaska not found in the northeastern Canadian Arctic [21]. In this study there were statistically significant ($p < 0.05$) associations between all individual PFCAs, between PFCAs and PFOS, and between PFHxS and PFOSA, but not between PFOSA and other compounds (Table 8). These associations are similar to those seen previously in multiple Arctic species (Arctic fox, ringed seal, mink, and polar bears) suggesting exposure to PFCs is from similar transport pathways and/or sources [24], except for PFOSA.

Table 6. Mass fractions of PFCs (ng/g wet mass) in beluga liver samples.

	Cook Inlet						eastern Chukchi Sea					
	Males			Females			Males			Females		
	Range	median	n > RL (n=11)	Range	median	n > RL (n=16)	Range	median	n > RL (n=25)	Range	median	n > RL (n=16)
PFNA*	0.454 - 3.08	1.79	11	< 0.502 - 5.67	1.66	15	0.170 - 2.55	0.670	25	< 0.180 - 5.46	0.960	13
PFDA	0.894 - 4.11	3.15	11	0.309 - 6.98	1.95	16	0.553 - 5.38	2.15	25	0.514 - 14.3	1.59	16
PFUnA*	7.90 - 27.2	20.0	11	<0.678 - 41.6	11.8	15	< 0.497 - 20.8	6.76	24	1.67 - 49.0	4.40	16
PFDoA*	1.01 - 3.48	2.38	11	0.365 - 5.55	1.88	16	0.230 - 3.10	0.898	25	0.191 - 5.55	0.841	16
PFTriA*	6.17 - 48.0	20.0	11	< 0.357 - 82.8	9.77	12	<0.262 - 14.3	2.53	21	< 0.356 - 17.6	1.46	13
PFTA*	1.11 - 13.3	2.94	11	< 0.552 - 21.3	1.46	12	< 0.659 - 7.99	0.982	23	< 0.323 - 4.36	1.55	11
PFHxS*	< 0.0600 - 0.644	0.306	10	< 0.0649 - 3.55	0.301	15	< 0.0246 - 0.366	0.120	15	< 0.0261 - 0.378	0.139	9
PFOS*	14.4 - 30.4	22.5	11	4.61 - 70.3	13.0	16	4.29 - 28.4	9.20	25	1.81 - 38.1	4.76	16
PFOSA*	4.52 - 17.9	11.4	11	10.4 - 27.8	18.4	16	17.7 - 63.8	31.8	25	11.2 - 65.7	27.8	16

n > RL indicates the number of samples above the reporting limit (RL)

Values were calculated with half the RL substituted for non-detects as described in the methods section, but values shown as "<" a specified number describe the actual RL

Compounds marked with asterisks indicate there are significant differences between beluga stock of the log-transformed data ($p < 0.05$)

Table 7. Ranges of PFCs (ng/g wet mass) in beluga livers from Arctic locations.

Location	southern Alaska/Cook Inlet (n=27, males and females)[a]	northeastern Alaska/eastern Chukchi Sea (n=41, males and females)[a]	northeastern Canada/Hudson Bay (n=22, males and females)[b]	Canada/Newfoundland (n=5, males only)[c]	western Canada/Hedrickson Island (n=10, males only)[d]
Years	1992 - 2006	1989 - 2000	1999 - 2003	1996	2007
PFNA	< RL - 5.67	< RL - 5.46	0.69 - 6.58	n.m.	5.72 - 20.3
PFDA	0.309 - 6.98	0.514 - 14.3	2.0 - 18.9	n.m.	5.87 - 33.9
PFUnA	< RL - 41.6	< RL - 49.0	3.8 - 39.6	n.m.	6.47 - 30.7
PFDoA	0.365 - 5.55	0.191 - 5.55	0.80 - 9.89	n.m.	< RL - 5.39
PFTriA	< RL - 82.8	< RL - 17.6	n.m.	n.m.	n.m.
PFTA	< RL - 21.3	< RL - 7.99	< RL - 2.35	n.m.	n.m.
PFHxS	< RL - 3.55	< RL - 0.378	< RL - 3.76	n.m.	n.m.
PFOS	4.61 - 70.3	1.81 - 38.1	3.0 - 109	9.8 - 15.8	4.25 - 20.3
PFOSA	4.52 - 27.8	11.2 - 65.7	4.94 - 156	n.m.	7.76 - 24.5
ΣPFC	18.6 - 240	19.0 - 149	NA	NA	NA

[a] This study [b] [25] [c][23] [d] [20]

< RL = below the reporting limit; n.m. = not measured; NA = not applicable

The effect of beluga location, year, sex, and length for the individual and total PFCs were examined using backward stepwise regressions (Table 9). ΣPFC were significantly higher in the Cook Inlet belugas compared to the eastern Chukchi Sea belugas ($p < 0.05$, see Table 7). Also, spatial trends in PFNA, PFUnA, PFDoA, PFTriA, PFTA, ΣPFCAs, PFHxS, PFOS, and PFOSA were observed between the Cook Inlet and the eastern Chukchi Sea animals, with significantly higher ($p < 0.05$) concentrations of PFNA, PFUnA, PFDoA, PFTriA, PFTA, PFHxS, and PFOS in belugas from Cook Inlet (Table 7 and Table 9). Contrarily, the Chukchi Sea belugas had significantly higher concentrations of PFOSA ($p < 0.05$). The general patterns of PFCs in liver samples from the Cook Inlet population were different when compared with the patterns of PFCs from the eastern Chukchi Sea belugas (Figure 4), as PFOSA comprised greater than 50 % of the ΣPFCs measured in the eastern Chukchi Sea animals and less than 35 % of the ΣPFCs in the Cook Inlet belugas. PFOS and PFUnA were found at the second and third highest percentages of PFCs measured in the eastern Chukchi Sea samples. The most dominant PFC found in belugas from Cook Inlet was PFOS, followed by PFTriA, then PFOSA. The differences between the concentrations and patterns in the two beluga groups suggest that there are either different transport processes and/or sources of PFCs for the two locations.

Table 8. R^2 values from pairwise correlations of PFCs in beluga liver samples. Asterisks (*) indicate there were significant correlations ($p < 0.05$).

	PFNA	PFDA	PFUnA	PFDoA	PFTriA	PFTA	PFHxS	PFOS	PFOSA
PFNA	-	**0.56***	**0.46***	**0.48***	**0.20***	**0.16***	**0.38***	**0.56***	0.01
PFDA		-	**0.74***	**0.74***	**0.42***	**0.35***	**0.16***	**0.52***	0.03
PFUnA			-	**0.74***	**0.64***	**0.37***	**0.26***	**0.64***	0.01
PFDoA				-	**0.52***	**0.47***	**0.26***	**0.57***	0.00
PFTriA					-	**0.60***	**0.15***	**0.51***	0.04
PFTA						-	**0.09***	**0.30***	0.01
PFHxS							-	**0.40***	**0.05***
PFOS								-	0.02
PFOSA									-

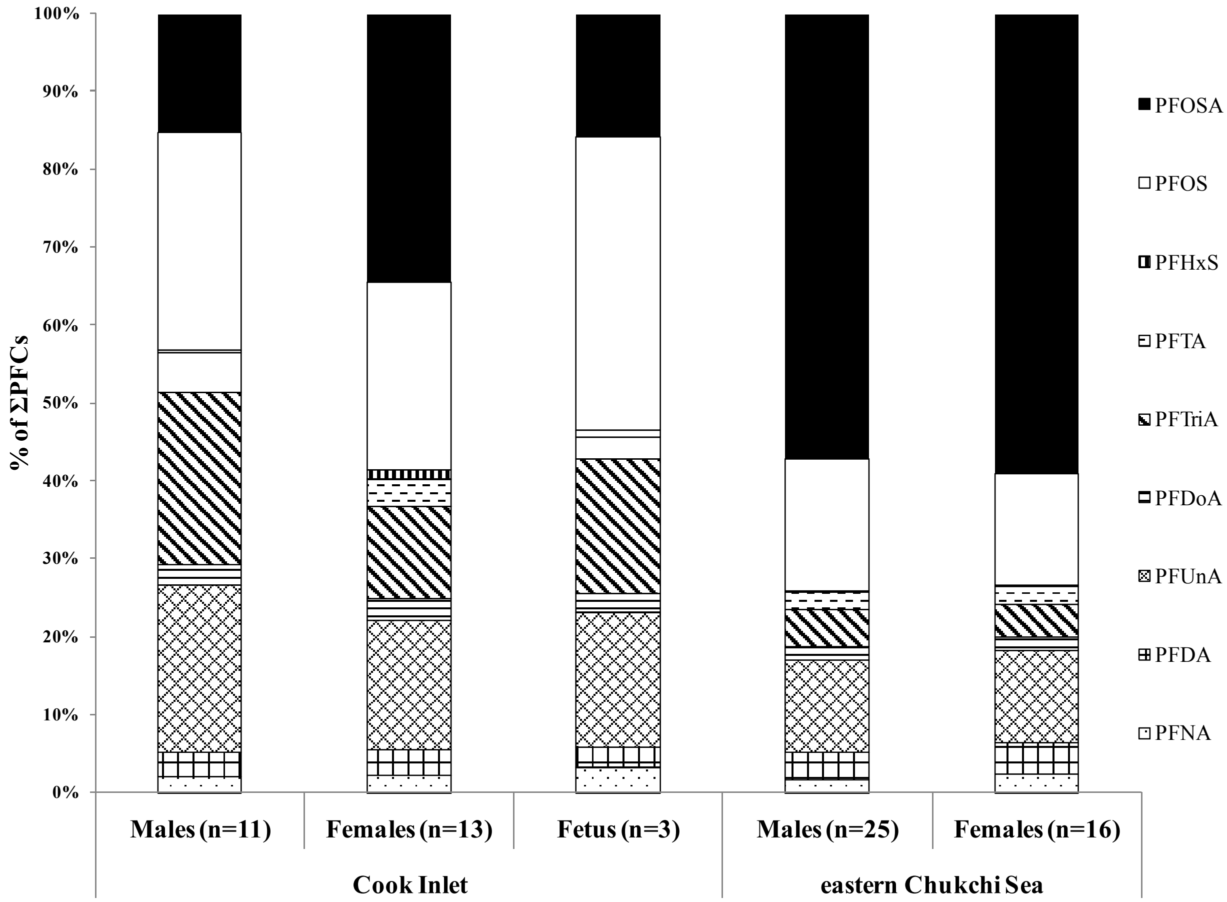

Figure 4. Patterns of individual PFCs as percent of ΣPFC in the livers of beluga whales.

Among the PFCs determined, concentrations of PFNA, PFDA, PFUnA, PFDoA, ΣPFCAs, PFHxS, PFOS, PFOSA, and ΣPFCs showed significant increases from 1989 to 2006 in Alaskan beluga whales ($p < 0.05$) (Figure 5). In fact exponential increases were observed over this time period without any noticeable recent stabilization. Other studies have shown temporal increases of PFC concentrations in marine mammals. For example, one study has shown an increase in PFDA, PFUnA and PFOS concentrations from 1982 to 2003 in ringed seal livers from Greenland [26]. In another study, the concentrations of PFNA, PFDA, and PFOS measured in Baikal seal livers from 2005 showed an increase compared to samples collected in 1992 [27]. A recent study measuring PFCs in peregrine falcon eggs (*Falco peregrines*) shows a similar exponential increase for PFNA, PFDA, PFUnA, PFDoA, PFHxS, and PFOS in eggs collected from 1974–2007 [28]. In contrast, recent measurements of PFOS concentrations in sea turtle plasma and serum have shown a decrease from 2000 to 2008 [29]. Measurements from human plasma and milk from the United States and Europe have shown a decrease in PFOS concentrations after 2000 [30,31]. These decreases are attributed to the phase out of PFOS-based chemistry from the former main manufacturer. Differences in temporal trend data have been attributed to differences in collection locations and localized sources of direct PFC input [29]. It is thought wildlife samples from remote locations may show a reduction in PFC concentrations in years to come due to the delay from long-range transport of PFCs and their precursors [29].

The two beluga populations are geographically separated; therefore the annual trends of PFCs were also examined in the two stocks separately (Table 10). The Cook Inlet belugas tended to have smaller slopes of temporal increases compared to the eastern Chukchi Sea belugas, especially for PFOS, PFNA, PFDA, and PFUnA. The smaller annual increase seen in the Cook Inlet belugas is suggestive of a decrease of PFC inputs from local sources in and around Cook Inlet. The larger annual increase in the eastern Chukchi Sea belugas suggests there are significantly higher inputs of PFCs likely caused by atmospheric transport, oceanic transport, and/or inputs coming from Asia and Russia.

Table 9. Summary of statistical findings (p-values) examining the influences of beluga location, year, sex and length on PFCs in beluga whales.

Trait	**PFNA**	**PFDA**	**PFUnA**	**PFDoA**	**PFTriA**	**PFTA**	**ΣPFCA**	**PFHxS**	**PFOS**	**PFOSA**	**ΣPFC**
Beluga Location	**0.0397**	> 0.100	**0.0056**	**0.0017**	**< 0.0001**	**0.0014**	**0.0003**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**0.0494**
Year	**< 0.0001**	**< 0.0001**	**0.0001**	**< 0.0001**	> 0.100	> 0.100	**< 0.0001**	**0.0085**	**0.0001**	**0.0411**	**0.0052**
Sex	**0.0379**	> 0.100	0.0692	> 0.100	**0.0323**	> 0.100	**0.0310**	> 0.100	**< 0.0001**	> 0.100	0.0939
Length	**0.0026**	> 0.100	> 0.100	> 0.100	> 0.100	> 0.100	> 0.100	0.0688	**0.0009**	> 0.100	> 0.100
Multiple regression	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**0.0014**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**0.0009**

Bold p-values were considered statistically significant ($p < 0.05$).
Values shown as > 0.100 indicate that the backward stepwise multiple regression model eliminated the model effect and that trait was removed from the total model.

Table 10. Percentage of annual increase/decrease of PFCs in Cook Inlet beluga and eastern Chukchi Sea beluga samples from 1989 to 2006.

	Cook Inlet belugas	eastern Chukchi Sea belugas
PFNA	11%	14%
PFDA	8.9%	11%
PFUnA	10%	12%
PFDoA	11%	11%
PFHxS	10%	10%
PFOS	4.0%	9.4%
PFOSA	2.6%	2.6%
PFOSA/PFOS	-	-5.6%

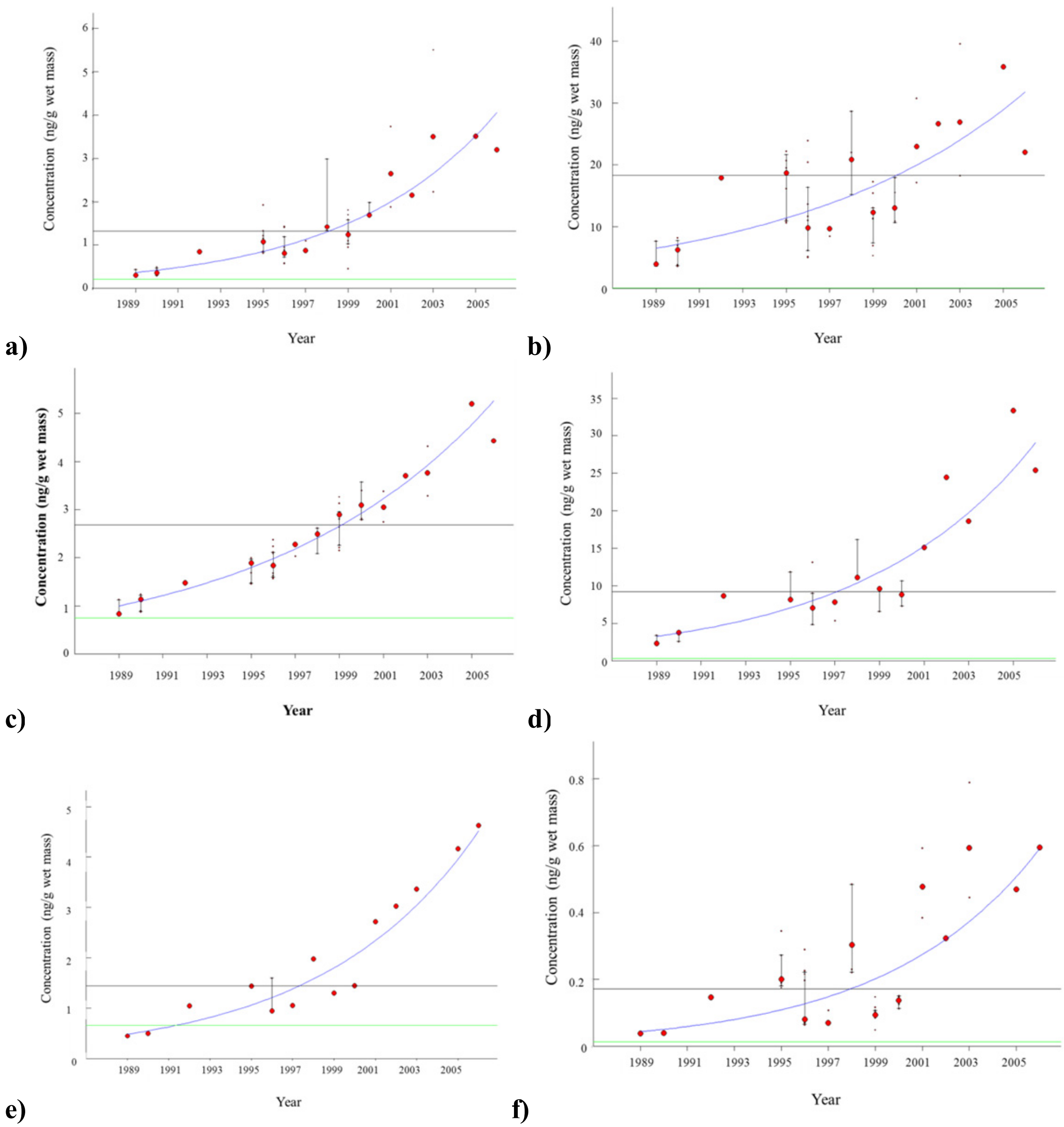

Figure 5. Temporal trend of a) PFNA (R^2 = 0.92), b) PFOS (R^2 = 0.64), c) PFDA (R^2 = 0.97), d) PFUnA (R^2= 0.86), e) PFDoA (R^2= 0.90), and f) PFHxS (R^2= 0.71) concentrations (ng/g wet mass) in beluga livers from Alaska drawn with AMAP PIA program. Data presented as the predicted concentrations based on the regression model taking into account significant factors such as beluga population, sex, and length. Individual data points are black, medians are red, and error bars are the 95 % confidence intervals. The blue lines are the log linear regression, black horizontal lines indicate the overall mean, and green lines are the reporting limit.

Since PFOSA is a precursor of PFOS, the ratio PFOSA/PFOS was also examined. This ratio ranged from 0.3 to 17 depending on the beluga location, year, sex, and length. The belugas from Cook Inlet had a significantly lower PFOSA/PFOS ($p < 0.05$) compared to the belugas from the eastern Chukchi Sea. While there is no significant annual trend in PFOSA/PFOS in the Cook Inlet belugas, there is a significant yearly decrease ($p < 0.05$) of 5.6 % of PFOSA/PFOS in the Chukchi Sea belugas (Table 10). The annual decrease of PFOSA/PFOS in the Chukchi Sea belugas could suggest the increase of PFOS and/or PFOS precursors (not including PFOSA) being transported to the Chukchi Sea. Little is known about the production statistics of PFCs from Asia and Russia. It has been estimated that the production of PFOS based chemistry from China has increased since 2003 [32], but little production information is available for Russia. The Chukchi Sea belugas forage in Arctic water between the United States and Russia and based on prevailing wind and ocean currents, these animals may be more reflective of PFCs emissions coming from Asia and Russia.

For most compounds male belugas had higher concentrations of PFCs when compared with females. Males had significantly higher concentration of PFTriA, ΣPFCAs, and PFOS compared to the females ($p < 0.05$) (Table 9). In contrast, female belugas had significantly higher concentrations of PFNA ($p < 0.05$) (Table 9). Gender related differences may be a result of higher dietary intake and/or gender differences in elimination (urinary and fecal excretion). Although pharmacokinetic studies do not exist for cetaceans and therefore not comparable, other mammal pharmacokinetic studies have shown gender differences in the elimination half-life of some PFCs [33,34]. Other important elimination pathways in female belugas are placental and lactational transfer from mother to calves.

This study included three fetus samples; all were females from Cook Inlet with a total length not exceeding 150 cm. These fetus samples had a PFC pattern more similar to the males than females from Cook Inlet (Figure 4). Paired mother samples were available for two of the fetus liver samples. By examining the ratios of PFC concentrations in the mother to the calf, these samples were used to look at offloading of PFCs in belugas in utero (Table 11). A ratio equal to one indicates equilibrium between the mother and the calf, a ratio greater than one represents retention in the mother, and a ratio less than one represents preferential offloading from mother to calf. Ratios between mother and fetus samples were less than one for all PFCs except PFHxS, suggesting preferential offloading from mother to fetus in utero for most PFCs. Similar to previous human and rodent studies, maternal transfer of PFCs has been shown in utero and through lactation [35-37]. In wild populations, data from mother-calf pairs of bottlenose dolphins (*Tursiops truncatus*) from Sarasota Bay showed higher concentrations of ΣPFCs in calves when compared to their mothers, suggesting in utero and/or lactational transfer of PFCs occurs in marine mammals [38].

Table 11. Mass fractions (ng/g wet mass) and ratios of PFCs in two matched mother and fetus pairs.

	PFNA	PFDA	PFUnA	PFDoA	PFTriA	PFTA	PFHxS	PFOS	PFOSA	ΣPFC
Mother-1 (ng/g)	0.690	0.727	4.32	0.756	< RL	< RL	3.55	10.6	11.1	31.7
Fetus-1 (ng/g)	2.57	1.75	12.8	1.93	15.4	4.69	1.15	39.6	14.7	94.6
Ratio-1 (mother to fetus)	0.27	0.42	0.34	0.39			3.08	0.27	0.76	0.34
Mother-2 (ng/g)	1.61	2.30	10.8	1.25	5.86	1.48	1.35	17.1	14.4	56.1
Fetus-2 (ng/g)	3.56	4.86	28.8	3.75	28.4	3.16	1.32	70.3	19.6	164
Ratio-2 (mother to fetus)	0.45	0.47	0.37	0.33	0.21	0.47	1.02	0.24	0.73	0.34

< RL = below the reporting limit

There was a significant decrease ($p < 0.05$) of PFNA and PFOS with increasing beluga length in the backward stepwise regression (Figure 6). However, the relationship was weak with R^2 for PFNA and PFOS equal to 0.18 and 0.074, respectively. Beluga length did not significantly influence concentrations of any other PFCs in this study. A previous study has suggested that some PFCs decrease with length in bottlenose dolphins [38], while another study has reported an increase of PFCs with length in sea turtles [39]. Furthermore, there are numerous studies that have observed no significant trends between PFC concentrations and length [40,38]. These conflicting results call to the importance of studying species-specific accumulation of PFCs and this emphasizes that length-analyte relationships are complicated.

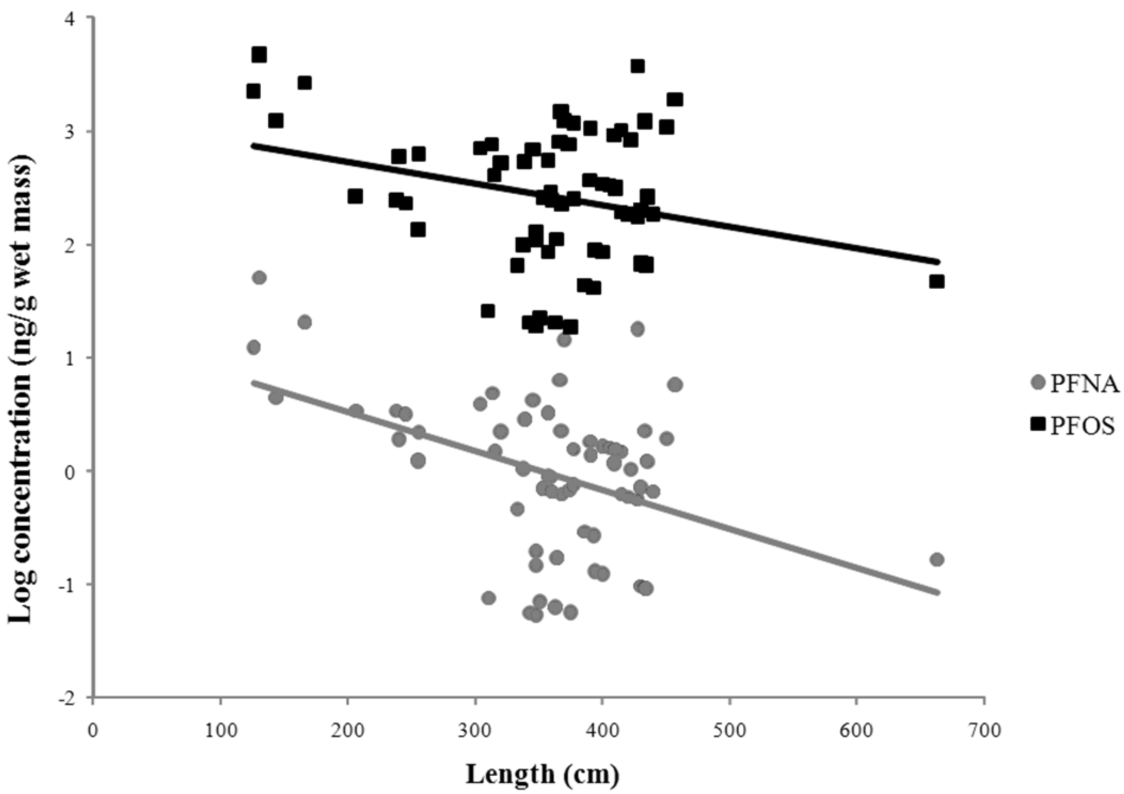

Figure 6. Linear regression between length and log concentration of PFCs (PFNA and PFOS) in livers of belugas from Alaska: R^2 for PFNA = 0.18 and PFOS = 0.074. Data presented as the predicted concentrations of PFNA and PFOS based on the regression model taking into account significant factors such as beluga population, year, and sex. For both regressions $p < 0.05$.

Mercury

Hg was detected in all beluga liver samples analyzed (Appendix A, Table A8); with concentrations ranging from 337 ng/g to 158000 ng/g, wet mass. The levels of Hg in belugas from the Eastern Chukchi Sea were significantly higher ($p < 0.05$) when compared to the total concentrations in belugas from Cook Inlet (Table 12). There was no significant increase or decrease in Hg concentrations observed from 1989 to 2006 and males and females had similar concentrations ($p > 0.05$). A significant ($p < 0.05$) length-Hg concentration relationship was observed in the Alaskan whales; with an increase in length being associated with an increase in Hg (Figure 7).

Table 12. Mass fraction of Hg (ng/g wet mass) in beluga liver samples.

	Cook Inlet						eastern Chukchi Sea					
	Males			Females			Males			Females		
	Range	Geometric mean	n > RL (n=11)	Range	Geometric mean	n > RL (n=16)	Range	Geometric mean	n > RL (n=25)	Range	Geometric mean	n > RL (n=16)
Mercury*	2.87-33.7	6.99	11	0.406-6.67	2.03	16	0.745-158	15.8	25	0.337-91.9	6.35	16

The asterisks indicates there are significant differences between the beluga stock of the log-transformed concentrations ($p < 0.05$)

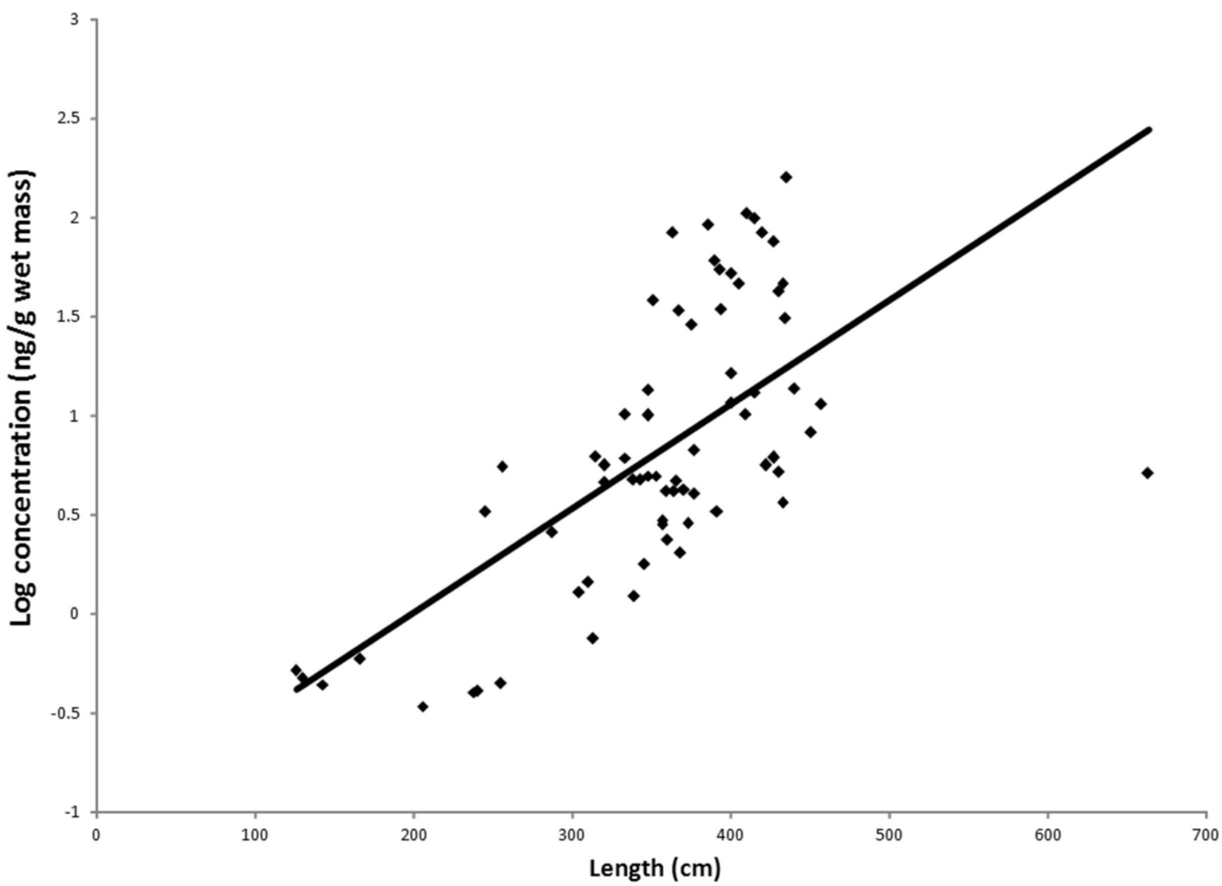

Figure 7. Linear regression between length and log concentration of Hg in livers of belugas from Alaska: R^2 for Hg = 0.41. Data presented as the predicted concentrations of Hg based on the regression model taking into account significant factors such as beluga population, year, and sex. For regression $p < 0.05$.

SUMMARY

In summary, this study showed that the Cook Inlet animals, compared with eastern Chukchi Sea belugas, have different concentrations and patterns of legacy POPs, emerging POPs, and mercury. Differences suggest different sources or transport pathways of these compounds, which can be related to the geographic differences in long-range atmospheric transport of contaminants, oceanic transport, local releases, and/or feeding habits. Besides the geographical differences, concentration differences were related to year, sex, and/or length. Although no annual increase or decrease was seen for the legacy POPs and mercury, there was an annual increase in the concentrations of the emerging POPs, ΣPBDEs and PFCs in the beluga samples. The toxicological implications of the concentrations measured in the blubber and hepatic tissue of beluga whales are unknown, but their potential impact on beluga whale health and human health should be considered.

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APPENDIX A
Organohalogen Contaminants: Beluga Whale Blubber

Table A1. Mass fraction of PCBs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	PCB_8	PCB_18	PCB_29	PCB_50	PCB_28+31	PCB_45	PCB_52	PCB_49	PCB_104	PCB_44	PCB_63
MM3B071	4.17	47.8	<RL	nm	13.4	2.7	102	36.2	nm	24.0	2.0
MM3B074	3.50	46.3	<RL	nm	31.9	7.9	201	72.2	nm	63.6	2.2
MM4B127	<RL	6.59	<RL	0.348	5.8	6.3	266	54.4	<RL	49.6	1.9
MM4B130	<RL	5.00	<RL	0.385	7.7	6.9	296	78.3	<RL	59.1	2.5
MM4B133	3.49	43.2	<RL	nm	7.0	6.5	270	51.0	nm	57.2	2.2
MM4B136	<RL	5.97	<RL	0.323	14.9	5.8	220	71.6	<RL	45.4	1.9
MM4B139	3.40	42.9	<RL	nm	17.6	6.9	267	96.3	nm	63.0	3.0
MM4B142	<RL	8.13	<RL	0.450	12.5	9.1	299	101	<RL	73.3	2.7
MM4B145	<RL	7.88	<RL	0.354	20.0	7.9	281	94.0	<RL	70.7	2.1
MM4B148	4.03	44.8	<RL	nm	17.1	3.5	92.4	27.7	nm	27.7	0.9
MM4B151	<RL	5.48	<RL	0.403	9.3	6.6	301	68.3	<RL	52.4	2.3
MM4B154	5.01	45.8	<RL	nm	7.7	0.4	16.6	5.7	nm	5.3	0.4
MM6B218	<RL	<RL	6.5	nm	11.0	1.6	59.2	21.8	nm	20.5	<RL
MM9B328	<RL	<RL	1.6	nm	6.6	2.7	102	28.0	nm	31.2	<RL
MM9B329	<RL	<RL	4.6	nm	12.7	1.1	41.0	15.6	nm	11.9	<RL
MM9B330	<RL	<RL	2.7	nm	8.1	<RL	15.1	5.4	nm	5.4	<RL
MM10B332	3.66	<RL	8.4	nm	12.2	2.3	72.8	27.2	nm	23.4	1.6
MM10B335	2.53	11.1	<RL	0.191	25.7	5.0	153	59.5	<RL	51.6	2.0
MM10B338	5.22	34.4	8.4	nm	14.5	2.7	93.8	31.7	nm	29.9	<RL
MM10B341	8.77	<RL	7.3	nm	7.8	<RL	9.6	4.0	nm	3.8	<RL
MM10B344	5.16	<RL	5.7	nm	14.1	1.7	54.7	20.1	nm	19.1	<RL
MM10B347	<RL	<RL	1.7	nm	10.6	1.4	42.3	15.6	nm	15.3	<RL
MM10B370	<RL	7.44	<RL	0.089	13.9	3.4	129	47.8	<RL	36.4	1.0
MM10B373	<RL	5.98	<RL	<RL	11.2	2.5	72.7	27.2	<RL	23.8	1.1
MM10B376	<RL	4.92	<RL	<RL	9.6	2.0	64.2	23.5	<RL	20.5	0.9
MM10B388	<RL	5.58	<RL	0.094	11.3	2.7	93.6	35.9	<RL	26.4	0.9
MM11B418	6.26	<RL	0.2	nm	11.2	0.9	26.1	9.4	nm	10.1	<RL
MM11B469	5.11	<RL	0.4	nm	6.1	<RL	9.6	3.4	nm	3.8	<RL
MM11B465	6.33	<RL	<RL	nm	5.8	0.6	19.6	7.3	nm	7.4	<RL
MM11B479	<RL	<RL	1.9	nm	4.1	<RL	7.1	2.7	nm	2.9	<RL
MM11B483	<RL	5.10	<RL	0.118	14.7	2.7	85.4	33.0	<RL	25.5	1.3
MM11B486	<RL	29.6	<RL	0.109	12.3	3.1	99.4	37.7	<RL	31.4	1.0
MM11B490	<RL	3.59	<RL	0.000	8.3	1.7	57.3	21.7	<RL	16.7	0.6
MM13B680	<RL	<RL	7.5	nm	15.7	1.6	58.1	22.0	nm	18.5	<RL
MM13B683	<RL	<RL	2.0	nm	13.2	1.3	47.8	17.8	nm	16.5	<RL
MM11B438	<RL	65.0	<RL	nm	8.1	3.3	213	56.2	nm	33.8	38.5
MM11B442	<RL	43.1	<RL	nm	8.5	0.8	55.9	18.8	nm	11.8	9.6
MM11B446	<RL	47.1	<RL	nm	9.7	0.5	22.3	7.1	nm	6.5	4.0
MM11B422	<RL	5.93	<RL	0.394	8.4	8.2	294	100	<RL	70.2	2.6
MM11B426	<RL	4.23	<RL	0.523	6.7	8.7	369	109	<RL	75.4	3.8
MM11B430	<RL	7.31	<RL	0.384	6.6	8.1	294	94.2	<RL	72.2	2.6
MM11B434	<RL	3.73	<RL	0.446	6.6	6.0	322	85.5	<RL	52.8	2.9
MM11B450	2.05	50.0	<RL	nm	6.5	0.4	17.9	5.5	nm	5.4	2.8
MM11B457	2.20	53.4	<RL	nm	11.4	1.0	39.7	12.8	nm	10.6	6.6
MM11B461	2.60	54.0	<RL	nm	4.4	<RL	20.9	5.8	nm	4.8	3.7
MM13B688	5.46	<RL	5.4	nm	4.6	<RL	8.2	3.0	nm	3.1	<RL
MM13B691	<RL	<RL	2.2	nm	19.8	5.7	209	77.3	nm	61.3	<RL
MM13B703	5.40	<RL	0.5	nm	12.4	3.1	126	38.0	nm	34.2	<RL
MM13B716	1.96	10.0	<RL	0.476	7.8	8.0	285	80.0	<RL	44.0	2.4
MM13B719	<RL	8.40	<RL	0.712	7.1	10.1	417	109	<RL	73.1	3.7
MM13B722	<RL	12.4	<RL	0.572	11.0	10.4	362	117	<RL	83.3	3.2
MM15B111C	<RL	3.59	<RL	0.294	7.2	4.4	235	54.9	<RL	39.5	2.0
MM15B057C	<RL	4.23	<RL	0.444	4.6	6.1	335	72.7	<RL	55.4	2.8
MM15B060C	2.33	51.3	<RL	nm	7.3	1.8	116	36.6	nm	24.7	21.9
MM15B114C	<RL	4.30	<RL	0.274	8.2	4.8	212	70.9	<RL	45.9	2.2
MM15B063C	<RL	3.48	<RL	0.440	4.3	6.5	416	66.1	<RL	55.1	3.5
MM15B066C	<RL	3.16	<RL	0.220	5.4	4.0	187	56.8	<RL	35.0	1.9
MM15B117C	2.30	50.7	<RL	nm	5.7	2.2	113	24.9	nm	20.1	18.3
MM15B069C	2.77	54.9	<RL	nm	7.4	<RL	18.2	6.0	nm	5.4	3.0
MM15B072C	<RL	2.85	<RL	0.199	10.8	3.9	161	55.8	<RL	34.4	1.7
MM15B075C	2.60	51.6	<RL	nm	7.8	2.2	146	36.7	nm	28.0	25.3
MM15B119C	4.46	2.86	<RL	0.170	8.1	3.1	121	34.7	<RL	25.5	1.1
MM15B121C	2.69	56.6	<RL	nm	21.7	4.6	190	52.6	nm	48.2	28.1
MM16B234C	1.69	4.19	<RL	0.267	16.5	3.4	234	82.2	<RL	47.2	2.5
MM16B239C	3.20	83.8	1.6	nm	40.2	3.1	244	133	nm	56.1	34.0
MM16B242C	2.91	3.73	<RL	0.128	15.4	1.9	162	57.1	<RL	33.5	1.7
MM17B316C	<RL	<RL	1.1	nm	11.0	1.0	43.3	16.1	nm	12.2	<RL
MM17B319C	5.55	<RL	2.6	nm	13.0	0.9	28.1	10.0	nm	10.3	<RL
MM18B349C	20.3	42.7	<RL	nm	10.1	1.5	77.0	31.3	nm	22.0	7.6
MM18B415C	<RL	29.6	1.3	nm	11.3	2.9	120	44.5	nm	34.2	<RL
MM19B471C	<RL	<RL	<RL	nm	8.4	0.4	10.6	3.8	nm	4.2	<RL
MM19B468C	5.39	<RL	<RL	nm	6.3	<RL	10.5	3.8	nm	3.5	<RL
MM21B713C	<RL	<RL	4.6	nm	16.4	2.4	85.8	32.6	nm	27.5	<RL

<RL samples are less than the reporting limit
nm compound was not measured

Table A1 (cont.) Mass fraction of PCBs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	PCB_74	PCB_70	PCB_95+121	PCB_66	PCB_56	PCB_92	PCB_101	PCB_99	PCB_79	PCB_119+112	PCB_87
MM3B071	21.8	14.2	79.9	9.0	3.7	43.4	141.1	90.1	1.1	3.4	43.5
MM3B074	50.4	28.1	117	23.9	8.0	93.0	342.2	197.2	1.5	8.2	107.9
MM4B127	47.7	8.2	165	23.0	6.8	66.6	270.9	218.4	<RL	7.8	74.9
MM4B130	54.4	13.0	182	12.5	8.1	86.8	475.6	331.8	0.4	10.4	116.1
MM4B133	60.4	10.5	150	29.8	11.7	126.9	337.2	285.0	2.2	11.1	90.7
MM4B136	41.7	13.6	155	24.0	8.0	66.4	258.8	170.8	<RL	6.3	82.4
MM4B139	41.8	20.2	151	16.3	8.6	133.5	442.2	273.3	2.2	11.3	139.6
MM4B142	50.2	16.2	209	20.5	6.1	97.0	404.0	278.9	0.4	10.9	139.5
MM4B145	71.0	20.5	185	50.8	12.5	84.0	353.7	240.5	<RL	9.3	117.7
MM4B148	23.5	13.3	52.5	21.0	8.0	43.6	147.2	99.9	0.4	4.0	52.3
MM4B151	60.1	9.4	198	34.0	10.6	100.4	343.4	278.4	0.4	10.3	101.1
MM4B154	6.8	6.9	13.2	6.6	2.1	9.2	30.6	23.1	0.5	0.4	9.5
MM6B218	12.1	10.3	42.6	10.1	2.3	17.1	84.3	44.7	<RL	8.7	30.4
MM9B328	23.0	4.4	71.5	18.0	3.2	28.9	114.7	72.7	<RL	8.5	39.1
MM9B329	9.9	9.6	28.8	9.1	3.5	13.4	61.7	39.3	<RL	7.8	23.5
MM9B330	3.9	6.2	11.4	4.7	2.6	4.8	20.7	13.6	<RL	6.8	8.1
MM10B332	16.6	7.2	52.9	15.4	3.2	21.4	95.2	54.5	<RL	8.7	35.6
MM10B335	34.8	29.0	136	25.0	5.4	47.0	223.9	126.0	<RL	4.5	81.3
MM10B338	19.1	13.5	65.7	17.1	4.2	28.8	124.9	74.1	<RL	9.1	45.4
MM10B341	4.0	4.1	6.5	3.0	1.6	2.7	11.5	7.9	<RL	5.7	4.5
MM10B344	12.2	11.0	37.7	11.4	3.0	15.6	73.3	39.7	<RL	7.8	27.0
MM10B347	9.7	9.9	31.2	9.5	2.6	11.0	53.8	27.8	<RL	7.4	20.2
MM10B370	25.2	19.1	121	15.6	5.6	48.1	227.5	120.7	<RL	4.3	74.7
MM10B373	14.4	12.7	68.0	10.6	2.2	24.3	117.1	59.9	<RL	2.1	38.8
MM10B376	13.3	10.7	52.3	9.4	2.3	19.1	92.6	48.1	<RL	1.8	31.2
MM10B388	19.6	13.2	83.0	12.2	2.7	31.2	151.6	83.6	0.1	3.0	53.0
MM11B418	6.4	9.5	18.6	8.1	3.2	6.6	32.2	18.9	<RL	6.3	12.3
MM11B469	2.6	4.6	6.9	3.4	1.9	2.9	12.4	8.0	<RL	5.6	4.9
MM11B465	4.6	5.0	15.6	5.1	1.4	6.3	28.5	17.0	<RL	6.0	10.7
MM11B479	2.1	3.7	5.3	2.5	1.2	2.1	9.3	5.7	<RL	5.9	3.3
MM11B483	18.7	16.0	80.2	13.5	3.9	28.0	139.2	72.9	<RL	2.6	48.8
MM11B486	19.7	15.4	92.9	13.0	3.2	32.2	159.8	82.3	<RL	3.0	55.6
MM11B490	8.9	9.6	51.3	5.3	2.0	17.3	87.4	44.1	<RL	1.6	29.7
MM13B680	12.3	14.2	43.1	11.7	3.8	18.5	79.5	47.9	<RL	7.5	32.0
MM13B683	9.9	13.1	34.1	9.6	2.7	12.6	62.2	31.6	<RL	6.5	23.7
MM11B438	<RL	36.9	30.0	99.8	<RL	58.3	267.2	196.8	1.4	4.7	81.9
MM11B442	0.5	11.8	7.1	27.7	0.4	18.0	77.0	62.7	0.7	3.3	29.0
MM11B446	<RL	6.0	6.1	10.7	2.0	7.0	27.0	23.8	<RL	1.2	10.8
MM11B422	33.3	13.5	202	12.8	5.2	99.8	411.5	287.6	0.4	11.9	142.7
MM11B426	63.6	13.9	234	27.9	8.2	113.9	547.7	400.5	0.5	14.3	171.5
MM11B430	38.6	12.4	184	14.6	5.3	86.2	400.5	297.4	0.4	11.1	130.2
MM11B434	60.0	11.8	193	31.4	8.7	112.0	430.5	335.7	0.4	11.4	120.2
MM11B450	<RL	4.5	5.0	8.2	1.3	5.5	21.7	19.3	<RL	1.2	8.6
MM11B457	<RL	10.9	6.5	18.1	3.2	12.4	46.9	41.6	0.4	2.7	18.1
MM11B461	<RL	4.9	2.4	11.6	1.0	7.9	29.4	26.3	<RL	1.3	10.1
MM13B688	2.3	3.3	6.3	2.7	1.2	2.9	12.2	8.6	<RL	4.8	4.6
MM13B691	37.9	18.5	155	27.2	3.8	63.5	309.2	166.9	0.3	13.2	110.6
MM13B703	28.4	10.7	88.1	24.6	5.4	38.8	170.7	104.0	<RL	9.4	55.9
MM13B716	46.6	8.8	206	29.5	7.0	91.4	333.9	251.1	0.3	9.8	106.9
MM13B719	75.5	12.7	288	38.5	11.3	129.3	484.3	380.7	0.4	13.9	163.0
MM13B722	55.7	15.7	234	22.4	7.3	103.3	515.1	353.5	0.4	11.4	145.2
MM15B111C	38.4	10.6	142	20.9	6.2	78.7	323.9	228.6	0.3	8.0	82.0
MM15B057C	50.2	9.9	228	23.5	7.0	125.5	436.1	367.5	0.4	13.3	127.2
MM15B060C	<RL	19.0	5.1	53.1	1.3	32.5	143.0	103.2	<RL	6.2	48.0
MM15B114C	31.5	11.6	142	13.2	4.7	75.4	324.0	227.5	0.3	9.1	105.5
MM15B063C	52.7	12.4	254	20.0	7.7	151.2	469.6	463.3	0.6	15.5	127.6
MM15B066C	20.3	8.5	118	8.3	3.7	62.1	264.8	192.2	0.2	6.9	80.8
MM15B117C	<RL	23.7	4.6	50.0	2.7	36.2	134.8	116.5	0.9	7.2	40.7
MM15B069C	<RL	4.1	6.4	9.6	8.3	26.6	22.3	17.5	<RL	0.6	8.2
MM15B072C	28.8	11.4	115	14.9	4.4	54.4	242.2	160.9	0.2	6.2	79.1
MM15B075C	<RL	26.8	6.9	64.6	2.6	41.2	162.3	131.7	0.9	7.9	51.5
MM15B119C	25.2	8.5	70.5	15.3	4.9	34.5	144.3	111.1	<RL	4.1	44.8
MM15B121C	<RL	41.3	16.0	77.6	5.7	42.7	186.1	136.6	1.0	8.2	63.7
MM16B234C	59.6	15.0	151	30.6	8.4	66.0	332.1	231.8	<RL	8.1	100.7
MM16B239C	1.6	60.5	39.7	110.2	7.8	90.4	448.0	188.7	1.0	173.0	89.7
MM16B242C	44.0	17.0	105	25.1	7.8	48.9	226.8	176.0	<RL	5.9	69.3
MM17B316C	10.1	8.8	30.4	8.6	3.1	14.2	64.1	37.1	<RL	5.0	22.3
MM17B319C	6.6	9.7	20.7	7.2	3.0	8.0	34.6	20.6	<RL	6.0	13.1
MM18B349C	<RL	20.5	13.0	46.1	0.4	24.7	125.3	78.7	0.3	2.0	43.8
MM18B415C	25.0	9.3	86.0	16.7	2.7	38.7	179.0	96.3	<RL	9.9	65.1
MM19B471C	2.7	4.9	7.6	3.3	1.8	2.8	13.3	8.3	<RL	4.8	5.2
MM19B468C	2.6	3.7	8.3	3.1	2.0	4.3	17.1	12.1	<RL	5.3	6.8
MM21B713C	19.2	15.4	61.5	16.1	3.3	25.4	120.0	68.6	<RL	8.2	45.6

<RL samples are less than the reporting limit
nm compound was not measured

Table A1 (cont.) Mass fraction of PCBs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	PCB_110	PCB_154	PCB_82	PCB_151	PCB_107	PCB_149	PCB_106	PCB_118	PCB_114	PCB_165	PCB_188
MM3B071	50.5	2.9	6.8	51.9	10.2	100.9	9.8	69.2	2.1	23.2	0.2
MM3B074	151.2	4.6	14.0	81.4	13.1	150.6	109.0	115.6	3.2	25.8	0.2
MM4B127	44.0	6.1	7.4	113.9	6.7	235.2	<RL	204.0	4.0	<RL	0.6
MM4B130	86.7	8.2	12.0	220.1	9.7	330.4	<RL	249.3	5.6	0.9	0.9
MM4B133	49.4	7.7	10.1	131.3	9.3	261.8	215.4	225.2	0.6	55.5	0.5
MM4B136	67.1	4.7	6.8	91.4	6.5	188.9	<RL	149.2	3.2	0.4	0.4
MM4B139	176.9	7.6	17.1	137.1	15.9	270.4	199.8	208.8	5.5	58.7	0.6
MM4B142	175.3	7.8	14.6	143.1	13.4	273.7	<RL	257.8	6.5	0.9	0.8
MM4B145	134.0	6.8	12.3	127.9	11.0	253.9	<RL	243.4	6.1	0.8	0.7
MM4B148	58.5	3.0	7.0	55.1	6.8	105.2	80.2	83.4	0.5	22.0	0.3
MM4B151	57.5	8.4	8.5	151.7	9.4	291.4	<RL	252.4	5.0	0.9	0.9
MM4B154	10.6	0.8	<RL	14.2	2.0	26.0	18.0	18.3	0.7	7.9	<RL
MM6B218	36.9	1.5	2.9	25.7	4.7	63.3	46.2	48.3	1.0	0.6	<RL
MM9B328	27.1	2.2	5.1	38.6	4.7	100.1	0.2	81.6	1.7	<RL	<RL
MM9B329	27.7	1.4	3.7	22.9	5.3	48.7	39.6	41.5	1.2	1.7	<RL
MM9B330	8.9	0.6	2.2	9.8	2.0	20.3	<RL	12.9	<RL	0.6	<RL
MM10B332	46.4	2.0	5.8	35.3	8.7	78.4	<RL	57.3	1.5	2.2	0.3
MM10B335	101.0	3.2	9.9	64.8	12.0	149.8	<RL	129.0	3.7	0.3	0.2
MM10B338	44.6	2.3	7.4	41.4	5.7	96.3	<RL	74.3	1.8	2.8	0.3
MM10B341	5.0	<RL	<RL	4.3	1.1	10.4	<RL	7.8	<RL	0.5	<RL
MM10B344	34.1	1.4	2.8	24.1	5.9	54.7	40.2	42.0	1.0	<RL	<RL
MM10B347	28.8	0.7	2.5	15.1	4.0	36.3	<RL	31.5	0.7	0.3	<RL
MM10B370	86.2	3.6	8.2	72.1	9.2	172.5	<RL	118.1	3.4	0.2	0.3
MM10B373	47.8	1.4	4.3	33.8	6.7	82.2	<RL	57.7	1.6	<RL	<RL
MM10B376	40.0	0.9	3.9	25.6	4.8	63.6	<RL	47.0	1.3	<RL	<RL
MM10B388	57.6	2.2	5.6	46.3	7.2	109.5	<RL	84.0	2.4	0.2	<RL
MM11B418	16.1	0.6	2.4	10.7	3.1	23.8	<RL	18.9	0.4	0.9	<RL
MM11B469	5.8	<RL	<RL	5.2	1.2	11.8	<RL	8.9	0.3	0.5	<RL
MM11B465	12.1	0.8	<RL	12.2	2.6	26.0	<RL	17.4	0.7	<RL	0.7
MM11B479	4.6	0.7	<RL	3.3	0.9	8.1	<RL	6.7	<RL	1.9	<RL
MM11B483	58.7	1.7	5.1	38.9	8.2	97.6	<RL	72.8	2.2	<RL	<RL
MM11B486	66.3	2.0	6.5	45.8	7.8	113.8	<RL	79.5	2.4	<RL	<RL
MM11B490	37.3	0.6	3.1	21.1	3.4	53.1	<RL	39.6	1.2	<RL	<RL
MM13B680	36.3	1.8	3.7	28.0	6.5	65.1	<RL	48.2	1.3	<RL	0.3
MM13B683	31.7	0.7	2.7	15.5	4.1	38.7	<RL	34.2	0.8	<RL	<RL
MM11B438	50.6	5.6	4.1	107.6	0.6	228.3	185.1	173.8	2.1	0.3	0.6
MM11B442	31.8	2.1	2.8	36.2	5.5	70.7	62.8	59.8	0.9	20.2	<RL
MM11B446	12.4	0.8	1.6	13.2	2.7	24.8	26.2	24.8	0.5	<RL	<RL
MM11B422	181.3	8.6	15.4	149.0	16.0	284.0	<RL	259.4	7.3	1.0	0.8
MM11B426	138.8	12.1	16.6	201.0	15.0	395.5	<RL	370.7	8.9	1.3	1.3
MM11B430	150.7	8.5	13.7	144.0	11.8	282.8	<RL	266.1	6.6	0.9	0.8
MM11B434	87.0	9.9	10.8	160.5	11.2	323.9	<RL	307.4	6.4	1.0	1.0
MM11B450	10.1	0.8	1.0	11.0	2.2	20.3	21.9	20.6	<RL	<RL	<RL
MM11B457	20.1	1.5	2.4	22.0	3.2	40.7	<RL	42.9	0.6	<RL	<RL
MM11B461	8.8	1.2	1.3	18.0	2.2	36.0	25.5	24.1	<RL	<RL	<RL
MM13B688	4.5	0.5	0.4	6.6	1.1	13.6	<RL	8.5	<RL	0.6	<RL
MM13B691	129.3	5.3	12.3	89.0	17.2	227.0	3.1	176.0	5.1	<RL	0.4
MM13B703	48.3	3.6	6.6	56.4	8.5	138.5	<RL	112.3	3.0	0.7	0.3
MM13B716	85.3	7.0	10.2	125.0	9.7	252.9	<RL	238.5	5.0	<RL	0.6
MM13B719	98.8	11.0	13.0	180.2	11.9	351.8	<RL	378.5	7.9	1.0	0.9
MM13B722	161.4	8.0	16.5	143.3	13.4	325.1	<RL	282.7	7.4	0.8	0.7
MM15B111C	53.1	7.2	6.9	119.0	7.8	255.6	<RL	215.0	4.3	0.6	0.7
MM15B057C	62.6	12.5	9.5	195.7	11.5	367.8	<RL	339.8	6.4	1.2	1.4
MM15B060C	55.3	3.1	5.0	53.6	6.3	113.4	<RL	94.9	1.9	<RL	<RL
MM15B114C	126.1	6.7	10.7	111.6	11.6	224.1	<RL	211.7	5.1	0.7	0.6
MM15B063C	46.1	15.0	8.5	231.4	12.2	455.4	<RL	409.8	7.2	1.4	1.5
MM15B066C	85.6	6.0	8.3	98.4	9.4	201.2	<RL	168.5	4.2	0.5	0.6
MM15B117C	29.9	4.1	3.0	57.1	3.7	117.0	126.4	120.3	1.0	0.3	0.4
MM15B069C	10.6	0.6	1.0	10.9	1.7	21.6	17.0	16.0	<RL	<RL	<RL
MM15B072C	92.6	4.7	7.6	82.4	9.4	167.6	<RL	146.6	3.4	0.4	0.5
MM15B075C	35.5	4.0	4.3	66.8	0.9	141.4	<RL	128.2	2.1	<RL	0.4
MM15B119C	36.4	3.3	4.3	57.3	4.5	117.8	<RL	112.5	2.5	0.2	0.3
MM15B121C	67.4	2.8	5.1	56.0	6.4	121.8	<RL	143.1	2.1	<RL	<RL
MM16B234C	95.3	6.4	9.6	93.3	9.1	188.9	<RL	195.9	5.2	0.5	0.6
MM16B239C	147.2	154.4	10.3	74.6	11.3	146.4	<RL	166.8	2.7	<RL	11.5
MM16B242C	75.7	4.8	6.2	71.1	6.8	138.4	<RL	147.3	3.6	<RL	0.4
MM17B316C	28.0	1.2	2.6	20.1	4.7	47.5	<RL	37.3	0.9	1.5	<RL
MM17B319C	17.0	0.6	1.8	10.9	2.5	25.7	<RL	21.6	0.6	<RL	<RL
MM18B349C	56.7	2.4	3.4	35.7	82.1	86.7	83.8	81.7	2.4	0.3	<RL
MM18B415C	76.7	2.9	11.7	53.4	10.3	136.7	100.9	104.9	2.7	3.7	0.3
MM19B471C	6.8	<RL	1.3	4.5	1.0	9.9	<RL	8.3	0.2	<RL	<RL
MM19B468C	6.4	0.6	1.6	9.6	1.9	18.9	10.4	11.1	0.4	<RL	<RL
MM21B713C	58.4	2.2	5.6	36.0	9.8	87.3	72.4	75.4	2.0	1.5	0.2

<RL samples are less than the reporting limit
nm compound was not measured

Table A1 (cont.) Mass fraction of PCBs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	PCB_146	PCB_153+132	PCB_105	PCB_127	PCB_137	PCB_176	PCB_130	PCB_163	PCB_138	PCB_158	PCB_178
MM3B071	29.3	241.2	16.8	<RL	6.8	1.8	5.1	35.1	133.4	11.2	11.5
MM3B074	32.1	283.4	5.2	27.7	19.2	1.7	5.7	42.4	153.7	15.7	11.0
MM4B127	64.9	593.2	53.8	<RL	17.5	3.1	12.0	61.9	333.4	18.9	24.0
MM4B130	89.0	793.9	71.0	<RL	23.1	4.0	16.7	113.9	519.8	25.1	33.7
MM4B133	70.0	608.2	10.0	59.8	13.3	3.2	12.3	72.6	332.8	26.5	24.8
MM4B136	52.8	439.6	40.4	<RL	12.6	2.5	9.6	49.9	246.6	14.1	18.0
MM4B139	73.7	589.2	9.4	53.2	37.5	3.4	13.0	83.9	326.9	22.0	25.4
MM4B142	78.7	723.0	69.3	<RL	21.6	3.7	14.8	87.8	421.6	25.9	30.3
MM4B145	71.9	639.1	68.9	<RL	19.2	3.5	13.4	74.4	371.5	22.8	26.8
MM4B148	27.4	225.8	4.9	24.9	12.3	1.4	5.1	28.3	131.5	10.7	10.3
MM4B151	85.5	763.5	70.8	<RL	23.0	4.0	15.7	73.9	441.3	24.6	33.3
MM4B154	9.9	78.7	<RL	5.3	4.0	0.5	1.4	9.5	45.5	4.3	6.0
MM6B218	17.9	137.8	12.0	<RL	4.0	<RL	4.6	19.3	68.7	6.7	5.6
MM9B328	27.2	215.0	21.4	0.4	5.7	2.5	7.0	29.1	102.1	5.1	8.0
MM9B329	16.6	133.0	10.6	<RL	4.1	<RL	3.7	16.7	64.6	4.8	5.8
MM9B330	7.0	49.1	3.7	<RL	1.6	<RL	<RL	6.6	24.8	1.4	2.7
MM10B332	22.7	174.5	15.1	<RL	4.7	2.4	5.8	26.5	84.7	6.8	7.0
MM10B335	44.4	368.2	37.1	<RL	10.9	3.3	10.8	45.7	202.2	11.6	13.7
MM10B338	27.6	214.4	19.1	18.1	6.0	2.7	6.6	29.3	105.4	6.7	9.1
MM10B341	3.8	25.1	2.1	<RL	<RL	<RL	<RL	3.1	12.0	0.9	1.4
MM10B344	16.2	121.9	11.2	10.5	3.3	<RL	3.8	17.4	58.7	3.5	5.2
MM10B347	8.8	70.5	8.2	<RL	1.8	<RL	2.1	11.1	34.6	2.3	1.9
MM10B370	52.1	406.1	30.7	<RL	11.3	4.2	13.0	48.8	215.9	9.7	17.2
MM10B373	22.6	177.4	15.0	<RL	5.0	1.8	5.6	23.5	93.1	4.5	6.5
MM10B376	17.0	139.1	12.7	<RL	3.8	1.4	4.4	18.4	71.8	3.9	5.0
MM10B388	33.3	271.3	23.6	<RL	7.9	2.5	8.5	33.3	151.9	7.9	10.4
MM11B418	6.7	52.3	5.5	<RL	1.7	<RL	1.7	7.5	25.1	1.2	2.0
MM11B469	4.0	28.7	2.3	<RL	<RL	<RL	<RL	3.7	14.1	0.5	1.7
MM11B465	8.5	62.3	4.8	<RL	1.6	<RL	2.2	8.5	29.9	2.0	3.1
MM11B479	2.3	17.2	1.8	<RL	<RL	<RL	<RL	2.3	8.8	<RL	0.6
MM11B483	26.6	211.1	20.7	<RL	6.1	2.2	6.9	28.5	116.0	5.2	7.9
MM11B486	29.9	236.1	22.0	<RL	6.6	2.6	7.9	31.1	124.7	5.9	8.9
MM11B490	12.4	102.7	10.2	<RL	2.9	0.9	3.5	13.8	55.9	2.7	2.9
MM13B680	19.1	137.2	12.8	<RL	4.0	2.0	4.7	19.6	68.1	3.2	5.7
MM13B683	9.1	71.7	8.7	<RL	1.9	<RL	2.4	11.1	35.7	2.6	2.1
MM11B438	64.8	585.0	45.2	<RL	15.9	3.4	10.5	77.1	351.0	100.7	<RL
MM11B442	26.4	205.3	18.1	18.1	5.2	1.2	3.6	94.5	129.2	38.2	<RL
MM11B446	9.6	78.8	8.2	<RL	2.1	0.6	1.7	10.1	51.1	16.9	<RL
MM11B422	91.9	772.6	71.3	<RL	24.7	3.8	17.5	101.8	489.1	28.7	34.3
MM11B426	126.2	1117.5	105.5	<RL	34.3	5.3	23.9	128.8	706.8	31.2	49.2
MM11B430	89.3	805.0	71.2	<RL	24.7	3.7	16.8	95.5	513.1	29.0	33.3
MM11B434	109.8	940.6	85.0	<RL	28.6	4.4	20.3	105.9	574.7	24.7	39.5
MM11B450	8.7	67.3	6.7	<RL	1.7	0.6	1.2	8.6	43.6	15.0	<RL
MM11B457	14.6	124.0	13.8	<RL	3.3	0.8	2.7	16.6	82.5	26.0	<RL
MM11B461	12.9	110.6	7.1	<RL	2.3	0.8	1.8	13.4	64.4	21.0	<RL
MM13B688	5.2	36.0	2.1	<RL	<RL	<RL	<RL	4.3	16.6	1.3	2.3
MM13B691	60.3	475.0	44.6	<RL	13.3	5.2	15.4	67.4	241.4	13.1	16.7
MM13B703	40.0	311.0	28.6	<RL	8.7	3.3	9.5	40.7	152.4	11.4	11.1
MM13B716	73.7	602.5	72.3	<RL	18.9	3.6	14.0	76.8	376.6	23.4	24.0
MM13B719	117.6	978.2	114.1	<RL	30.4	5.0	22.4	117.2	611.4	39.7	37.6
MM13B722	91.2	808.1	82.0	<RL	23.4	4.3	17.5	98.0	514.3	26.3	27.8
MM15B111C	79.9	707.5	56.9	<RL	20.4	3.2	15.0	81.6	414.3	21.5	27.7
MM15B057C	129.1	1111.3	90.4	<RL	34.0	5.5	23.3	126.2	674.3	38.6	53.3
MM15B060C	34.0	297.2	25.2	<RL	8.5	1.7	5.5	40.2	177.7	52.2	<RL
MM15B114C	72.9	635.0	55.7	<RL	19.0	3.0	13.3	79.1	373.8	21.3	26.8
MM15B063C	155.1	1441.6	103.1	<RL	42.2	5.9	28.2	153.1	904.1	46.1	60.8
MM15B066C	66.4	576.8	41.5	<RL	17.2	2.8	11.9	70.2	340.0	18.5	24.6
MM15B117C	37.5	353.3	32.0	<RL	10.3	1.7	4.8	43.8	218.2	63.4	<RL
MM15B069C	<RL	61.0	5.1	<RL	1.5	<RL	1.2	8.3	36.1	13.2	<RL
MM15B072C	51.7	431.3	39.7	<RL	12.5	2.3	9.2	54.7	249.7	14.8	18.4
MM15B075C	44.5	387.4	34.2	<RL	11.6	1.9	6.8	50.8	237.4	68.7	<RL
MM15B119C	40.5	335.6	31.1	<RL	10.3	1.6	7.4	40.8	202.4	11.3	13.4
MM15B121C	30.1	294.8	41.7	<RL	8.8	1.3	5.5	43.1	186.2	54.9	<RL
MM16B234C	61.1	587.2	53.4	<RL	14.6	3.2	10.8	57.0	296.4	15.0	18.6
MM16B239C	35.3	402.9	45.9	0.6	9.4	1.8	5.2	49.5	213.8	62.6	<RL
MM16B242C	47.6	439.9	40.1	<RL	11.1	2.5	8.2	42.4	225.1	11.8	14.4
MM17B316C	14.0	107.9	9.8	<RL	2.9	<RL	3.2	15.7	53.2	2.9	4.0
MM17B319C	6.3	49.9	5.4	<RL	1.5	<RL	<RL	7.6	26.2	1.4	1.3
MM18B349C	28.5	215.3	24.1	<RL	4.0	<RL	44.5	32.4	119.5	35.1	<RL
MM18B415C	36.7	284.1	26.9	<RL	7.8	3.4	9.2	41.0	138.3	7.8	10.2
MM19B471C	2.7	20.0	2.2	<RL	<RL	<RL	<RL	2.9	10.2	0.6	0.5
MM19B468C	6.9	46.4	3.1	<RL	1.4	<RL	<RL	6.3	21.7	2.1	2.7
MM21B713C	23.5	182.8	19.3	<RL	5.5	2.1	5.8	26.5	92.3	5.2	6.2

<RL samples are less than the reporting limit
nm compound was not measured

Table A1 (cont.) Mass fraction of PCBs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	PCB_175	PCB_166	PCB_187	PCB_159	PCB_183	PCB_128	PCB_167	PCB_185	PCB_174	PCB_177	PCB_202
MM3B071	<RL	<RL	61.3	<RL	22.5	17.6	2.7	2.3	16.6	8.3	4.7
MM3B074	<RL	<RL	59.7	1.1	22.3	21.6	4.7	2.5	18.8	8.5	4.5
MM4B127	3.5	1.2	112.8	<RL	42.3	44.5	9.3	4.1	30.5	12.5	9.0
MM4B130	5.0	1.6	161.0	<RL	60.4	59.7	13.4	5.8	41.7	17.1	12.9
MM4B133	3.2	3.0	121.9	<RL	46.2	48.4	9.9	4.1	34.5	12.8	9.9
MM4B136	2.8	0.8	88.1	<RL	31.4	32.1	6.9	3.3	23.3	10.0	6.1
MM4B139	3.6	<RL	131.5	<RL	48.3	48.8	11.1	4.6	37.2	14.3	10.1
MM4B142	4.3	1.6	138.7	<RL	52.9	56.4	12.7	5.4	37.1	14.7	11.8
MM4B145	3.9	1.3	126.0	<RL	47.2	50.0	11.2	4.8	33.2	13.7	10.1
MM4B148	<RL	<RL	58.6	<RL	23.8	20.5	5.0	1.9	15.4	7.0	5.6
MM4B151	4.6	1.6	155.5	<RL	58.3	58.6	11.5	5.5	40.0	16.2	13.0
MM4B154	<RL	<RL	35.8	<RL	14.1	5.6	0.9	0.9	5.1	3.1	4.6
MM6B218	0.9	<RL	28.9	<RL	10.8	9.3	2.3	1.1	9.5	7.2	1.7
MM9B328	1.2	1.5	43.8	<RL	16.2	14.8	3.2	1.5	15.2	10.8	2.9
MM9B329	0.9	0.6	29.8	0.5	14.8	9.4	2.4	1.0	8.6	6.9	2.3
MM9B330	<RL	<RL	16.4	<RL	6.6	3.3	0.6	<RL	4.0	3.4	1.3
MM10B332	1.2	1.2	35.4	<RL	13.5	12.1	2.7	1.5	12.9	9.6	1.8
MM10B335	2.3	0.6	68.1	<RL	32.7	28.4	6.4	2.9	21.1	16.2	3.7
MM10B338	1.5	1.7	47.7	<RL	18.8	15.7	3.0	1.5	15.0	11.2	3.0
MM10B341	9.4	<RL	8.9	<RL	3.3	1.8	0.3	<RL	1.8	1.8	1.0
MM10B344	28.8	0.9	27.7	0.8	10.8	8.4	1.9	1.1	8.7	6.7	1.7
MM10B347	<RL	<RL	9.9	<RL	3.8	5.4	0.8	<RL	4.0	2.7	<RL
MM10B370	2.6	0.7	91.2	<RL	35.4	27.1	7.2	3.5	27.0	22.4	5.3
MM10B373	1.1	0.3	34.9	<RL	12.8	12.6	2.9	1.5	11.5	8.8	1.8
MM10B376	0.8	<RL	26.6	<RL	9.6	9.8	2.1	1.1	8.8	6.6	1.4
MM10B388	1.6	0.5	54.0	<RL	24.0	19.9	4.5	2.2	15.9	13.0	3.1
MM11B418	<RL	<RL	12.3	<RL	4.8	3.7	0.6	0.8	3.3	2.8	1.0
MM11B469	<RL	<RL	9.1	<RL	3.5	2.0	0.3	<RL	2.0	2.0	1.0
MM11B465	20.4	0.8	19.6	<RL	7.4	4.4	0.9	<RL	4.8	4.4	1.6
MM11B479	<RL	<RL	4.0	<RL	1.3	1.2	0.3	<RL	0.8	0.8	<RL
MM11B483	1.3	0.4	42.7	<RL	15.4	15.6	3.6	1.7	13.4	10.7	2.3
MM11B486	1.4	0.4	48.9	<RL	17.5	17.1	3.8	2.0	15.7	12.2	2.7
MM11B490	0.5	<RL	14.6	<RL	5.2	7.8	1.5	0.5	5.6	4.0	0.6
MM13B680	0.8	0.5	31.6	<RL	11.2	10.4	2.1	1.2	9.2	7.9	2.1
MM13B683	<RL	<RL	9.2	<RL	3.4	5.6	1.0	<RL	3.9	2.5	<RL
MM11B438	3.1	0.8	123.4	<RL	117.7	43.0	8.2	62.1	31.0	31.3	<RL
MM11B442	1.0	<RL	49.0	<RL	16.1	16.4	4.0	25.3	11.1	5.1	3.8
MM11B446	<RL	<RL	24.7	<RL	8.0	<RL	1.4	13.5	4.5	2.1	2.9
MM11B422	4.8	1.6	160.6	<RL	59.6	67.6	14.9	5.7	40.0	16.4	12.8
MM11B426	7.0	2.5	229.8	<RL	86.6	91.4	20.4	8.0	56.6	23.0	20.3
MM11B430	4.6	1.7	153.3	<RL	58.2	66.5	14.9	5.4	37.9	15.9	12.5
MM11B434	5.9	2.0	187.4	<RL	70.5	73.1	16.4	6.0	45.4	19.4	15.0
MM11B450	<RL	<RL	22.8	<RL	7.1	<RL	1.2	12.3	3.9	1.9	2.8
MM11B457	0.9	<RL	32.0	<RL	10.1	<RL	2.1	17.3	6.1	2.8	3.3
MM11B461	1.0	<RL	32.0	<RL	10.6	<RL	1.8	17.3	6.8	3.1	3.1
MM13B688	0.5	<RL	13.9	<RL	4.8	2.4	0.5	0.7	3.5	3.0	1.4
MM13B691	2.5	0.9	91.4	0.4	32.4	34.6	7.1	3.4	30.4	21.8	5.8
MM13B703	2.4	0.7	59.4	<RL	21.7	21.8	4.7	2.0	18.0	14.2	3.9
MM13B716	3.6	1.4	116.9	<RL	43.6	52.3	9.5	4.3	30.3	14.0	8.1
MM13B719	5.5	2.1	183.6	<RL	69.2	85.4	17.7	6.1	45.1	23.1	12.7
MM13B722	4.2	1.7	137.9	<RL	51.6	65.8	14.8	5.3	37.1	16.9	9.0
MM15B111C	4.0	1.2	132.6	<RL	48.7	53.1	11.3	4.1	33.4	14.3	9.8
MM15B057C	7.8	2.2	248.2	<RL	94.2	86.1	18.8	7.6	59.5	24.1	23.3
MM15B060C	1.4	<RL	58.2	<RL	19.0	21.7	4.5	29.1	14.3	6.4	4.1
MM15B114C	4.0	1.3	125.4	<RL	46.6	50.1	12.4	4.1	30.7	13.1	10.3
MM15B063C	8.8	2.4	280.6	<RL	107.3	108.9	21.9	8.2	67.3	27.2	25.4
MM15B066C	3.5	1.2	118.0	<RL	43.7	44.2	10.6	3.9	28.2	12.2	9.8
MM15B117C	1.5	<RL	67.4	<RL	23.6	27.0	5.8	35.4	15.8	7.0	5.0
MM15B069C	<RL	<RL	18.0	<RL	5.0	<RL	1.1	9.8	4.1	1.9	1.6
MM15B072C	2.7	1.0	89.6	<RL	32.2	32.7	7.8	3.0	21.8	9.5	6.9
MM15B075C	2.1	<RL	77.4	<RL	26.3	29.9	6.2	39.4	19.4	8.2	5.7
MM15B119C	2.0	0.7	63.9	<RL	23.0	27.3	5.9	2.0	15.3	7.1	4.3
MM15B121C	1.1	<RL	39.1	<RL	12.1	25.4	5.3	19.6	11.8	4.5	1.9
MM16B234C	2.4	1.2	81.4	<RL	32.9	39.3	6.7	3.0	19.3	13.7	5.8
MM16B239C	1.1	<RL	46.6	6.1	<RL	28.4	4.6	26.0	12.5	7.4	2.8
MM16B242C	1.9	0.9	63.6	<RL	25.0	29.9	4.9	2.2	14.3	10.3	4.4
MM17B316C	0.5	<RL	22.0	<RL	7.9	7.4	1.5	0.7	6.9	5.1	1.4
MM17B319C	<RL	<RL	7.0	<RL	2.6	3.7	0.6	<RL	2.8	1.9	<RL
MM18B349C	0.7	<RL	38.9	<RL	10.4	17.1	3.4	16.6	10.1	8.9	2.3
MM18B415C	1.7	0.5	57.7	<RL	20.7	20.1	4.6	2.3	20.7	14.0	3.3
MM19B471C	0.4	<RL	3.5	<RL	1.2	1.3	0.3	<RL	0.9	0.8	<RL
MM19B468C	17.0	<RL	16.3	<RL	5.9	3.1	0.8	0.7	3.9	3.6	0.9
MM21B713C	0.9	<RL	32.0	<RL	11.7	14.0	3.0	1.1	10.3	7.9	1.8

<RL samples are less than the reporting limit
nm compound was not measured

Table A1 (cont.) Mass fraction of PCBs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	PCB_156	PCB_201	PCB_157	PCB_172	PCB_197	PCB_180+193	PCB_191	PCB_200	PCB_170	PCB_199	PCB_203+196
MM3B071	2.8	0.2	3.6	5.1	0.5	38.6	0.7	0.4	15.6	7.4	7.2
MM3B074	6.2	<RL	2.9	4.2	0.4	34.8	0.7	0.2	14.8	7.0	7.0
MM4B127	13.4	2.9	4.0	8.2	1.3	97.2	1.5	0.5	42.6	17.4	15.7
MM4B130	20.7	4.1	5.8	12.6	1.9	140.7	2.1	0.6	63.2	26.2	23.5
MM4B133	14.2	4.1	5.9	11.8	1.2	100.8	1.5	0.4	45.8	18.9	17.8
MM4B136	10.2	2.1	3.0	6.0	0.9	68.2	1.1	0.4	29.3	11.8	10.2
MM4B139	20.6	4.1	7.8	12.7	1.2	102.3	1.5	0.4	47.2	19.6	18.0
MM4B142	21.0	3.6	5.4	9.9	1.7	117.0	1.7	0.6	50.9	21.4	19.5
MM4B145	18.2	3.2	4.9	9.2	1.4	105.3	1.6	0.5	46.1	19.1	17.0
MM4B148	6.7	0.6	5.3	5.6	0.7	41.3	0.8	0.4	16.3	7.8	7.4
MM4B151	16.2	4.1	4.7	10.9	1.8	128.6	1.8	0.6	56.5	24.3	21.8
MM4B154	<RL	<RL	2.4	3.6	0.5	26.5	0.4	<RL	11.4	8.6	9.1
MM6B218	3.5	<RL	0.7	2.8	<RL	31.0	0.4	<RL	12.4	4.4	4.0
MM9B328	4.3	1.4	1.1	3.7	<RL	47.0	0.5	<RL	18.7	7.6	7.1
MM9B329	4.0	<RL	0.8	3.3	<RL	41.7	0.8	<RL	16.4	5.5	8.1
MM9B330	1.4	<RL	<RL	1.7	<RL	16.4	15.6	<RL	7.2	4.3	4.5
MM10B332	4.8	<RL	1.4	3.2	<RL	36.8	0.6	<RL	16.9	4.5	4.4
MM10B335	12.0	1.6	2.8	7.2	0.7	93.7	1.5	0.6	39.3	10.9	13.5
MM10B338	5.2	1.6	1.2	4.1	<RL	52.4	0.5	<RL	22.7	8.4	9.3
MM10B341	0.8	<RL	<RL	1.1	<RL	9.3	<RL	<RL	3.8	2.3	2.3
MM10B344	3.3	<RL	0.7	2.8	<RL	29.7	0.6	<RL	12.5	5.5	5.3
MM10B347	1.7	<RL	<RL	1.1	<RL	9.7	<RL	<RL	4.2	<RL	0.9
MM10B370	11.1	2.0	2.9	8.6	0.9	104.3	1.5	0.9	41.3	15.2	14.9
MM10B373	4.8	0.8	1.4	3.1	0.3	34.1	0.5	0.4	13.5	5.2	4.9
MM10B376	3.6	0.7	1.0	2.3	0.3	25.9	0.4	0.3	10.2	4.2	3.9
MM10B388	8.2	1.3	2.0	5.4	0.6	68.1	1.0	0.5	27.8	8.7	10.3
MM11B418	1.3	<RL	<RL	1.3	<RL	12.8	0.4	<RL	5.6	2.7	3.1
MM11B469	0.8	<RL	<RL	1.0	<RL	9.7	<RL	<RL	4.3	2.0	2.2
MM11B465	1.6	<RL	<RL	2.0	<RL	20.6	0.6	<RL	8.3	4.7	5.3
MM11B479	<RL	<RL	<RL	<RL	<RL	3.7	<RL	<RL	1.1	<RL	2.3
MM11B483	6.0	1.0	1.6	3.7	0.4	41.8	0.5	0.4	17.0	6.4	6.0
MM11B486	6.2	1.1	1.6	4.1	0.4	46.1	0.7	0.5	18.0	7.3	6.5
MM11B490	2.4	0.4	0.8	1.1	<RL	12.9	0.2	<RL	5.1	1.7	1.5
MM13B680	3.5	1.5	1.0	2.8	<RL	29.7	0.6	<RL	12.4	5.2	4.8
MM13B683	1.5	<RL	<RL	0.8	<RL	7.8	<RL	<RL	3.3	<RL	<RL
MM11B438	12.1	6.2	4.7	8.6	1.6	103.9	1.1	0.7	44.2	18.5	15.8
MM11B442	8.1	2.6	2.3	4.4	0.8	42.4	0.5	0.4	19.6	7.3	6.3
MM11B446	<RL	2.3	0.9	2.7	0.8	22.0	0.4	<RL	9.8	6.1	6.4
MM11B422	26.5	3.9	6.8	12.4	1.8	138.6	2.0	0.5	63.3	24.7	21.8
MM11B426	33.2	6.3	8.8	18.1	3.0	202.6	2.9	0.8	92.4	39.5	35.4
MM11B430	25.5	3.8	6.8	12.0	1.8	137.8	2.0	0.6	62.3	24.0	21.5
MM11B434	23.3	4.7	7.0	14.7	2.2	171.2	2.7	0.7	75.9	30.1	27.3
MM11B450	<RL	2.4	0.7	2.3	0.8	20.7	0.3	<RL	8.6	5.8	5.8
MM11B457	<RL	2.7	1.4	3.6	0.9	27.6	0.4	<RL	12.7	6.5	6.4
MM11B461	<RL	<RL	1.0	3.3	0.8	28.1	0.4	<RL	11.3	6.2	5.6
MM13B688	0.7	<RL	<RL	1.7	<RL	14.4	<RL	<RL	5.9	3.4	4.0
MM13B691	11.4	3.0	3.1	7.2	1.0	87.7	0.9	0.9	36.0	14.7	12.5
MM13B703	6.8	1.9	1.9	4.9	<RL	59.0	0.6	<RL	24.1	8.8	8.4
MM13B716	18.8	2.7	5.2	8.4	1.1	98.9	1.5	0.5	46.0	15.9	14.6
MM13B719	26.7	4.0	7.9	14.1	1.8	169.5	2.5	0.7	79.3	25.2	23.8
MM13B722	26.2	3.1	7.3	10.9	1.4	125.9	1.9	0.6	58.1	19.0	17.7
MM15B111C	15.7	3.1	4.9	10.0	1.4	118.6	1.8	0.4	51.7	19.7	17.4
MM15B057C	23.6	7.0	7.3	18.7	3.5	226.2	3.2	0.8	97.7	45.2	40.6
MM15B060C	8.9	2.9	2.7	4.9	0.9	47.9	0.5	<RL	20.4	7.9	6.7
MM15B114C	19.1	3.1	5.3	9.6	1.5	112.8	1.7	0.4	48.5	19.6	17.7
MM15B063C	27.3	7.5	9.1	21.2	3.7	266.1	3.8	0.9	114.8	49.7	44.8
MM15B066C	17.3	3.1	4.9	9.2	1.5	105.3	1.5	0.5	45.8	19.4	17.1
MM15B117C	9.1	3.4	3.1	6.9	1.0	63.9	0.7	0.3	26.6	9.9	8.5
MM15B069C	<RL	<RL	0.5	1.8	0.6	14.6	0.3	<RL	6.1	3.3	3.1
MM15B072C	12.3	2.2	3.3	6.4	1.0	71.9	1.0	0.3	31.0	12.6	10.9
MM15B075C	9.9	3.8	3.3	6.0	1.2	68.2	0.6	0.4	29.4	11.4	9.7
MM15B119C	9.0	1.5	2.9	5.0	0.7	56.6	0.9	0.2	25.9	8.8	7.6
MM15B121C	8.7	<RL	3.1	3.6	0.5	31.5	0.5	<RL	15.4	3.8	3.1
MM16B234C	13.5	1.9	3.5	5.5	0.9	69.2	1.2	0.5	29.4	9.3	10.8
MM16B239C	9.5	<RL	2.5	3.5	0.6	35.6	0.7	0.6	15.8	4.2	5.0
MM16B242C	9.1	1.5	2.6	4.1	0.7	51.2	0.8	0.4	21.8	7.1	7.9
MM17B316C	2.5	<RL	0.6	1.9	<RL	21.8	0.3	<RL	9.2	3.6	3.3
MM17B319C	1.0	<RL	<RL	0.7	<RL	6.2	<RL	<RL	2.6	<RL	<RL
MM18B349C	5.8	1.8	2.0	2.3	0.5	25.4	0.2	0.5	11.3	4.4	3.7
MM18B415C	6.7	1.7	1.6	4.8	<RL	55.9	0.5	0.5	22.7	9.1	8.3
MM19B471C	<RL	<RL	<RL	0.6	<RL	2.9	<RL	<RL	1.3	<RL	0.6
MM19B468C	1.3	<RL	<RL	1.8	<RL	15.5	0.3	<RL	6.7	3.3	3.5
MM21B713C	4.5	<RL	1.3	2.7	<RL	30.3	0.4	<RL	12.5	4.4	4.3

<RL samples are less than the reporting limit
nm compound was not measured

Table A1 (cont.) Mass fraction of PCBs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	PCB_189	PCB_208	PCB_195	PCB_207	PCB_194	PCB_205	PCB_206	PCB_209
MM3B071	<RL	0.4	2.1	<RL	2.3	<RL	<RL	nm
MM3B074	<RL	0.4	1.9	<RL	2.2	<RL	<RL	nm
MM4B127	1.2	1.3	2.0	0.8	7.7	0.5	1.7	0.469
MM4B130	1.7	2.0	3.0	1.3	12.1	0.7	3.1	1.13
MM4B133	1.0	1.2	3.5	<RL	7.3	<RL	1.5	nm
MM4B136	0.8	0.7	1.4	0.4	5.0	0.3	0.6	<RL
MM4B139	<RL	1.0	3.5	<RL	7.5	<RL	<RL	nm
MM4B142	1.3	1.6	2.4	1.0	9.1	0.5	2.1	0.562
MM4B145	1.2	1.4	2.2	0.9	8.2	0.5	1.7	0.365
MM4B148	<RL	0.9	2.1	6.2	3.5	<RL	<RL	nm
MM4B151	1.4	1.8	2.6	1.1	10.5	0.6	2.4	0.639
MM4B154	<RL	0.8	2.1	<RL	3.4	<RL	<RL	nm
MM6B218	<RL	<RL	<RL	<RL	3.9	<RL	<RL	<RL
MM9B328	<RL	<RL	1.4	<RL	4.8	<RL	1.1	<RL
MM9B329	<RL	<RL	<RL	<RL	5.4	<RL	<RL	<RL
MM9B330	<RL	<RL	<RL	<RL	3.1	<RL	<RL	<RL
MM10B332	<RL	<RL	37.0	<RL	2.8	<RL	3.5	<RL
MM10B335	1.1	0.6	2.4	0.3	9.8	0.4	0.8	<RL
MM10B338	0.3	<RL	1.8	<RL	6.5	<RL	<RL	<RL
MM10B341	<RL	<RL	<RL	<RL	2.0	<RL	<RL	<RL
MM10B344	<RL	<RL	1.0	<RL	4.2	3.3	<RL	<RL
MM10B347	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
MM10B370	1.2	0.9	2.3	0.6	11.0	0.4	1.3	0.316
MM10B373	0.4	0.3	0.9	0.2	3.4	<RL	<RL	<RL
MM10B376	0.3	0.3	0.7	0.2	2.6	0.2	<RL	<RL
MM10B388	0.7	0.5	1.7	0.3	7.6	0.3	0.7	<RL
MM11B418	<RL	<RL	<RL	<RL	2.4	<RL	<RL	<RL
MM11B469	<RL	<RL	<RL	<RL	2.5	<RL	<RL	<RL
MM11B465	<RL	<RL	0.7	<RL	3.4	<RL	<RL	<RL
MM11B479	<RL	<RL	<RL	<RL	<RL	<RL	4.4	<RL
MM11B483	0.4	0.5	1.0	0.3	4.1	0.2	0.3	<RL
MM11B486	0.5	0.5	1.0	0.3	4.6	0.2	0.4	<RL
MM11B490	<RL	<RL	0.4	<RL	1.0	<RL	<RL	<RL
MM13B680	<RL	<RL	<RL	<RL	3.4	<RL	<RL	<RL
MM13B683	<RL	<RL	<RL	<RL	<RL	<RL	3.9	<RL
MM11B438	0.9	1.2	4.6	1.1	9.3	0.8	<RL	<RL
MM11B442	0.4	0.4	2.5	0.4	<RL	0.5	<RL	<RL
MM11B446	<RL	0.7	2.6	0.7	<RL	0.4	<RL	<RL
MM11B422	1.7	1.7	2.8	1.1	11.0	0.6	2.4	0.649
MM11B426	2.4	3.2	4.2	2.0	17.6	0.9	4.8	1.89
MM11B430	1.7	1.8	2.8	1.1	11.2	0.6	2.4	0.686
MM11B434	2.1	2.2	3.6	1.4	15.0	0.9	3.3	1.36
MM11B450	<RL	0.7	2.5	0.6	<RL	0.5	<RL	<RL
MM11B457	0.3	0.8	3.0	0.9	<RL	0.5	<RL	<RL
MM11B461	<RL	<RL	2.9	0.5	<RL	0.5	<RL	<RL
MM13B688	<RL	<RL	<RL	<RL	3.0	<RL	1.2	<RL
MM13B691	0.9	<RL	2.7	<RL	9.2	0.7	2.3	2.19
MM13B703	0.5	<RL	2.0	<RL	6.0	<RL	1.0	<RL
MM13B716	1.3	1.0	1.9	0.6	8.3	0.5	1.4	0.312
MM13B719	2.2	1.6	3.2	1.0	14.3	0.8	2.5	0.812
MM13B722	1.8	1.1	2.4	0.7	10.8	0.7	1.6	0.542
MM15B111C	1.3	1.3	2.2	0.9	9.5	0.6	1.8	0.666
MM15B057C	2.6	3.9	4.8	2.5	21.0	1.1	5.6	2.54
MM15B060C	0.4	<RL	3.0	0.5	<RL	<RL	<RL	<RL
MM15B114C	1.3	1.4	2.3	0.9	9.4	0.5	1.9	0.684
MM15B063C	2.9	4.0	5.3	2.5	23.9	1.2	6.0	2.86
MM15B066C	1.3	1.4	2.2	0.9	9.4	0.5	1.9	0.756
MM15B117C	0.5	0.7	3.3	0.7	<RL	0.5	<RL	<RL
MM15B069C	<RL	<RL	2.4	<RL	<RL	<RL	<RL	<RL
MM15B072C	0.8	0.7	1.5	0.5	5.7	0.3	0.8	<RL
MM15B075C	0.6	0.6	3.4	0.7	<RL	0.5	<RL	<RL
MM15B119C	0.8	0.6	1.2	0.3	4.3	0.3	0.5	<RL
MM15B121C	<RL	<RL	2.5	<RL	<RL	0.4	<RL	<RL
MM16B234C	0.9	0.8	1.5	0.5	5.3	0.4	0.9	0.304
MM16B239C	<RL	<RL	3.2	<RL	<RL	0.5	<RL	<RL
MM16B242C	0.7	0.6	1.1	0.4	4.0	0.3	0.6	<RL
MM17B316C	<RL	<RL	1.5	<RL	2.4	<RL	0.6	<RL
MM17B319C	<RL	<RL	<RL	<RL	<RL	<RL	2.7	<RL
MM18B349C	0.3	<RL	<RL	0.3	<RL	0.3	<RL	<RL
MM18B415C	<RL	<RL	1.6	0.5	5.5	<RL	1.3	<RL
MM19B471C	<RL	<RL	<RL	<RL	<RL	<RL	2.2	<RL
MM19B468C	<RL	<RL	<RL	<RL	2.3	<RL	3.2	<RL
MM21B713C	<RL	<RL	<RL	<RL	3.1	<RL	3.0	<RL

<RL samples are less than the reporting limit
nm compound was not measured

Table A2. Mass fraction of DDTs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	4,4'-DDE	2,4'-DDE	4,4'-DDD	2,4'-DDD	4,4'_DDT	2,4'_DDT
MM3B071	648.8	24.7	300.4	14.8	241.9	89.1
MM3B074	781.9	36.9	382.3	31.9	267.4	130.1
MM4B127	2163.6	36.5	886.4	36.5	405.1	nm
MM4B130	2693.1	37.6	1260.4	42.2	475.1	nm
MM4B133	1972.8	45.2	620.1	38.0	654.7	218.4
MM4B136	1382.1	31.5	543.5	28.4	370.4	nm
MM4B139	1838.4	45.2	559.1	32.9	593.9	207.7
MM4B142	2611.3	51.8	1094.3	46.0	487.4	nm
MM4B145	2299.0	41.1	1050.1	48.0	473.1	nm
MM4B148	573.7	13.8	302.8	29.7	368.8	93.7
MM4B151	2787.0	41.3	1012.1	37.0	510.1	nm
MM4B154	134.8	4.0	62.7	8.2	103.7	24.8
MM6B218	591.2	21.7	117.2	12.7	102.9	116.6
MM9B328	1086.5	37.3	188.8	15.1	196.4	217.6
MM9B329	428.4	12.6	94.2	9.2	83.9	74.7
MM9B330	164.7	6.7	42.8	7.3	45.9	42.2
MM10B332	648.2	24.0	142.4	10.2	117.6	117.5
MM10B335	1623.9	57.9	672.3	37.0	253.5	nm
MM10B338	916.2	30.3	199.9	17.9	147.5	174.9
MM10B341	88.5	3.8	27.3	4.7	22.0	19.2
MM10B344	476.7	18.9	111.8	12.9	94.0	95.6
MM10B347	334.0	15.6	91.4	10.4	61.9	63.9
MM10B370	1832.7	48.5	533.4	23.0	256.5	nm
MM10B373	750.3	29.0	298.4	16.2	133.8	nm
MM10B376	645.9	24.1	221.2	11.6	106.9	nm
MM10B388	1199.9	35.1	390.2	15.3	193.7	nm
MM11B418	198.0	10.5	56.2	7.1	42.7	41.3
MM11B469	108.0	4.6	27.5	5.0	26.4	23.1
MM11B465	214.7	9.0	47.0	7.8	47.1	52.6
MM11B479	78.6	3.6	19.3	3.8	17.9	15.4
MM11B483	1013.4	37.2	362.3	17.3	171.6	nm
MM11B486	1179.0	40.5	371.1	14.0	181.9	nm
MM11B490	576.2	20.1	185.0	10.5	78.7	nm
MM13B680	632.7	22.4	126.0	11.9	115.0	125.5
MM13B683	408.4	17.6	99.6	9.4	66.1	74.4
MM11B438	1754.7	25.5	209.8	14.5	379.6	264.4
MM11B442	512.9	9.5	104.5	10.0	180.3	102.5
MM11B446	158.1	<RL	51.7	9.0	99.0	46.9
MM11B422	2647.7	41.7	1103.5	41.8	472.7	nm
MM11B426	3925.2	51.0	1605.5	44.1	462.3	nm
MM11B430	2816.7	46.8	1171.2	33.2	472.2	nm
MM11B434	2894.2	31.0	978.4	27.8	483.2	nm
MM11B450	129.7	<RL	45.4	8.2	92.6	42.9
MM11B457	279.5	<RL	89.2	13.8	170.4	89.7
MM11B461	207.5	<RL	40.9	6.5	83.2	57.2
MM13B688	112.6	4.1	26.5	4.3	24.5	23.5
MM13B691	2546.2	76.0	393.6	28.7	344.2	406.7
MM13B703	1471.1	39.9	240.2	18.2	214.5	232.0
MM13B716	1952.7	40.0	830.6	35.4	366.8	nm
MM13B719	2911.5	48.9	1170.5	49.4	535.0	nm
MM13B722	2456.2	52.2	1119.9	49.8	367.3	nm
MM15B111C	2184.4	24.7	676.3	23.4	281.9	nm
MM15B057C	3489.0	39.4	1162.4	35.2	544.7	nm
MM15B060C	771.8	17.4	100.9	7.4	154.9	131.7
MM15B114C	1895.5	28.1	556.8	19.3	346.7	nm
MM15B063C	4803.7	44.5	1499.5	50.6	429.9	nm
MM15B066C	1791.2	25.4	436.8	19.2	241.0	nm
MM15B117C	822.4	14.1	154.3	13.7	225.4	145.0
MM15B069C	130.1	<RL	31.0	5.6	47.1	33.4
MM15B072C	1208.9	22.4	394.4	19.2	256.3	nm
MM15B075C	1080.4	19.1	146.1	13.4	242.0	182.0
MM15B119C	905.4	16.0	297.0	17.4	220.8	nm
MM15B121C	879.8	25.9	206.8	28.5	216.4	167.4
MM16B234C	1508.0	15.3	270.4	8.1	123.0	nm
MM16B239C	1174.8	898.7	249.1	12.1	93.0	54.5
MM16B242C	1174.6	9.0	227.3	6.2	103.8	nm
MM17B316C	430.1	13.7	90.3	6.5	56.0	56.4
MM17B319C	278.3	10.6	57.0	9.0	32.9	40.7
MM18B349C	743.6	31.9	118.6	10.8	141.7	134.0
MM18B415C	1505.2	45.9	192.4	11.8	205.7	251.8
MM19B471C	96.5	4.1	26.2	4.1	14.3	14.7
MM19B468C	165.9	4.9	32.6	5.0	28.4	28.4
MM21B713C	956.2	31.6	164.3	13.5	132.1	147.7

<RL samples are less than the reporting limit
nm compound was not measured

Table A3. Mass fraction of chlordanes (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	oxychlordane	trans-chlordane	cis-chlordane	trans-nonachlor	cis-nonachlor
MM3B071	223.8	4.6	22.5	589.5	91.3
MM3B074	402.1	3.3	18.3	810.2	125.9
MM4B127	619.1	5.5	188.5	1114.0	131.2
MM4B130	656.0	8.2	235.8	1306.0	186.8
MM4B133	508.1	5.3	31.3	1235.9	268.7
MM4B136	527.5	5.2	171.5	993.2	107.6
MM4B139	539.3	4.8	27.9	1211.6	255.2
MM4B142	741.0	6.9	243.6	1350.4	171.6
MM4B145	604.7	9.3	237.0	1334.5	184.7
MM4B148	195.8	6.2	35.9	585.4	152.3
MM4B151	730.3	5.2	231.6	1279.1	141.8
MM4B154	38.7	5.4	26.6	188.5	59.6
MM6B218	80.2	2.4	10.0	198.8	25.8
MM9B328	108.3	2.2	8.4	233.8	28.7
MM9B329	63.0	2.2	8.3	165.0	20.9
MM9B330	28.4	2.2	8.1	77.1	13.1
MM10B332	110.6	0.8	4.5	246.2	31.6
MM10B335	184.6	8.0	90.8	479.8	59.1
MM10B338	124.1	2.3	11.0	328.2	39.1
MM10B341	18.8	2.1	7.4	47.4	9.5
MM10B344	74.2	2.6	11.4	206.5	27.7
MM10B347	58.3	1.9	8.9	145.4	22.1
MM10B370	149.5	5.3	65.3	378.9	37.3
MM10B373	99.8	5.2	49.3	266.8	28.1
MM10B376	98.7	3.1	32.3	194.8	18.3
MM10B388	132.4	3.5	49.1	287.5	26.9
MM11B418	42.0	1.6	6.4	92.6	14.0
MM11B469	15.9	1.9	6.9	40.3	7.3
MM11B465	29.3	2.6	9.6	93.3	15.3
MM11B479	12.3	1.6	5.8	24.4	5.1
MM11B483	105.0	3.7	44.0	249.6	25.9
MM11B486	138.0	2.7	44.1	263.8	24.5
MM11B490	77.6	3.4	29.7	169.0	18.4
MM13B680	80.4	1.7	8.0	200.7	20.8
MM13B683	63.0	1.0	5.4	126.3	14.9
MM11B438	538.1	2.6	12.4	1009.1	71.3
MM11B442	138.8	3.3	14.5	439.8	49.1
MM11B446	52.7	4.4	19.4	207.2	43.8
MM11B422	623.2	7.1	245.2	1408.7	191.9
MM11B426	925.7	6.2	271.2	1597.8	182.7
MM11B430	742.5	4.9	216.2	1378.9	149.8
MM11B434	769.9	5.4	250.4	1498.4	150.2
MM11B450	40.5	4.6	20.7	173.4	40.8
MM11B457	94.5	5.0	24.0	343.2	70.7
MM11B461	54.5	2.9	12.5	230.8	33.2
MM13B688	15.2	1.4	5.5	45.3	6.9
MM13B691	200.2	2.7	15.2	582.7	53.8
MM13B703	159.2	2.2	10.8	391.1	36.2
MM13B716	635.6	5.8	202.3	1131.6	114.6
MM13B719	1148.0	8.3	302.8	1704.1	176.6
MM13B722	860.2	9.0	243.7	1565.2	175.8
MM15B111C	582.6	3.6	173.2	1064.7	112.6
MM15B057C	837.5	3.8	265.7	1515.8	148.7
MM15B060C	291.6	1.2	5.6	512.6	34.2
MM15B114C	574.3	2.6	167.4	992.1	97.0
MM15B063C	1062.6	7.3	343.9	2041.4	243.7
MM15B066C	452.1	2.7	142.8	935.7	96.5
MM15B117C	255.6	2.4	12.2	722.8	93.1
MM15B069C	39.6	2.0	9.4	136.3	20.8
MM15B072C	399.8	3.5	136.9	818.9	94.5
MM15B075C	339.7	2.4	12.1	752.7	74.0
MM15B119C	315.6	3.8	107.2	671.3	87.9
MM15B121C	410.5	3.8	26.5	720.8	89.6
MM16B234C	594.5	2.3	139.0	944.6	62.2
MM16B239C	457.5	5.1	16.2	798.1	73.0
MM16B242C	413.9	2.6	107.8	673.7	49.0
MM17B316C	75.8	1.3	4.5	153.2	16.4
MM17B319C	39.9	1.9	8.7	84.3	15.9
MM18B349C	<RL	2.1	6.4	34.1	5.4
MM18B415C	113.1	1.3	5.7	279.4	23.8
MM19B471C	18.2	0.8	3.7	37.5	7.0
MM19B468C	21.5	1.4	5.5	65.8	9.2
MM21B713C	101.5	1.7	8.8	251.1	26.9

<RL samples are less than the reporting limit

Table A4. Mass fraction of HCHs, HCB, pentachlorobenzene, mirex, heptachlor and heptachloro epoxide (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	a-HCH	b-HCH	g-HCH	HCB	pentachlorobenzene	mirex	heptachlor	heptachlor epoxide
MM3B071	147.1	nm	30.6	227.7	nm	19.2	nm	170
MM3B074	133.3	nm	81.6	979.9	nm	15.9	nm	255
MM4B127	32.0	36.6	28.6	443.0	28.3	41.5	<RL	1084
MM4B130	52.5	55.8	26.4	441.7	34.0	65.0	<RL	1272
MM4B133	70.6	nm	46.8	932.3	nm	37.5	nm	307
MM4B136	88.3	65.6	43.7	470.8	38.9	30.2	<RL	889
MM4B139	106.3	nm	42.8	840.0	nm	40.2	nm	246
MM4B142	62.3	31.0	37.6	477.0	68.7	48.9	<RL	1335
MM4B145	25.2	42.5	33.1	467.2	58.0	43.1	<RL	1054
MM4B148	160.5	nm	43.6	458.7	nm	17.0	nm	162
MM4B151	27.9	41.6	29.3	464.1	24.8	53.6	<RL	1342
MM4B154	57.2	nm	12.0	83.9	nm	16.2	nm	35
MM6B218	54.2	73.6	14.8	160.3	5.1	8.3	2.8	73
MM9B328	57.8	71.1	16.7	233.7	4.4	14.8	2.9	85
MM9B329	28.1	43.3	7.5	98.6	3.0	8.8	3.6	60
MM9B330	33.6	22.9	6.6	49.9	2.1	6.3	2.6	<RL
MM10B332	30.6	92.0	18.8	268.0	9.7	5.8	5.1	89
MM10B335	33.9	102.5	23.1	313.3	26.0	15.9	<RL	326
MM10B338	38.6	106.8	15.3	220.9	4.7	11.8	7.4	113
MM10B341	30.1	15.6	4.3	46.2	2.3	4.2	4.4	<RL
MM10B344	32.1	61.5	9.9	171.1	4.6	8.2	2.8	58
MM10B347	23.3	77.1	10.2	137.6	5.8	1.5	2.2	62
MM10B370	31.8	127.7	<RL	226.8	17.4	22.7	<RL	352
MM10B373	31.2	75.3	<RL	184.0	15.2	9.5	<RL	178
MM10B376	32.7	54.4	12.0	190.6	12.3	8.6	<RL	179
MM10B388	32.4	52.0	<RL	181.9	15.3	13.1	<RL	222
MM11B418	29.8	41.9	9.3	118.5	3.6	5.0	2.2	45
MM11B469	30.0	17.5	4.8	38.8	1.7	4.6	2.7	<RL
MM11B465	31.7	41.2	7.4	51.9	2.1	7.4	2.0	<RL
MM11B479	34.3	17.1	5.6	31.1	1.9	2.8	2.7	<RL
MM11B483	33.8	61.1	9.8	180.9	11.7	12.5	<RL	209
MM11B486	33.9	81.5	77.3	197.3	57.3	13.7	<RL	218
MM11B490	35.7	77.9	11.0	162.0	9.5	4.4	<RL	163
MM13B680	31.2	87.5	13.3	147.8	4.6	10.7	1.9	78
MM13B683	32.9	155.7	21.4	153.3	8.2	1.6	2.1	45
MM11B438	110.4	158.9	22.7	421.1	5.5	48.6	<RL	522
MM11B442	59.5	41.7	10.9	93.7	8.5	20.2	<RL	159
MM11B446	62.6	34.3	11.7	74.6	<RL	<RL	<RL	65
MM11B422	11.4	41.2	19.8	447.0	65.3	58.8	<RL	1138
MM11B426	25.0	25.5	18.1	447.2	50.0	85.2	<RL	1651
MM11B430	16.4	43.6	20.1	482.0	53.9	61.9	<RL	1319
MM11B434	17.5	41.0	13.7	575.7	30.4	88.5	<RL	1341
MM11B450	34.7	32.3	11.1	59.5	0.8	<RL	<RL	51
MM11B457	36.1	58.9	15.1	128.0	2.4	<RL	<RL	83
MM11B461	37.8	39.4	10.6	53.2	<RL	<RL	<RL	61
MM13B688	24.8	18.7	4.8	37.6	1.8	7.4	2.5	<RL
MM13B691	28.4	193.1	19.7	368.1	8.6	29.9	2.5	166
MM13B703	45.4	170.8	22.2	272.8	6.2	20.9	2.4	141
MM13B716	22.1	43.6	22.4	419.2	32.0	42.7	<RL	1154
MM13B719	46.2	49.6	37.7	514.5	16.4	65.8	<RL	1855
MM13B722	50.1	73.3	41.6	607.6	49.4	54.6	<RL	1632
MM15B111C	25.0	59.4	15.9	374.6	26.9	57.7	<RL	1129
MM15B057C	14.3	38.5	12.4	449.3	16.5	107.7	<RL	1470
MM15B060C	63.5	111.1	19.9	278.3	9.5	24.2	<RL	297
MM15B114C	22.0	61.9	15.1	405.6	19.2	58.2	<RL	995
MM15B063C	21.4	42.7	17.3	489.8	13.0	129.0	<RL	1865
MM15B066C	21.1	71.6	18.2	347.0	27.2	58.1	<RL	878
MM15B117C	43.6	156.9	19.7	308.7	5.8	31.7	<RL	268
MM15B069C	26.5	43.3	12.5	91.1	0.6	<RL	<RL	<RL
MM15B072C	30.2	81.1	15.8	339.0	32.5	39.4	<RL	720
MM15B075C	75.2	120.0	18.5	322.5	3.7	32.6	<RL	380
MM15B119C	27.8	91.6	14.5	329.1	25.1	26.2	<RL	633
MM15B121C	228.2	178.6	49.5	661.4	33.4	<RL	<RL	454
MM16B234C	46.0	97.2	25.9	435.9	29.4	38.6	<RL	1039
MM16B239C	88.3	374.5	54.2	672.9	25.1	<RL	<RL	491
MM16B242C	23.6	107.2	19.0	393.4	20.9	27.9	<RL	754
MM17B316C	18.6	44.6	4.5	114.9	4.9	6.1	2.3	64
MM17B319C	50.1	85.8	17.9	145.4	7.9	1.7	2.0	<RL
MM18B349C	44.0	7.3	3.7	30.7	<RL	<RL	<RL	<RL
MM18B415C	14.8	73.6	7.3	222.7	5.7	19.2	5.2	414
MM19B471C	25.0	40.9	6.7	56.9	3.4	1.1	2.9	<RL
MM19B468C	20.0	22.3	3.7	38.7	1.9	6.3	3.6	<RL
MM21B713C	21.8	136.6	12.3	196.9	7.0	10.4	2.2	93

<RL samples are less than the reporting limit
nm compound was not measured

Table A5. Mass fraction of PBDEs (ng/g wet mass) in beluga whale blubber.

Animal Identification Number	NIST Identification Numbers	PBDE_28	PBDE_49	PBDE_47	PBDE_100	PBDE_99	PBDE_155	PBDE_154	PBDE_153	Total PBDEs
692-BLKA-001	MM3B071	<RL	nm	0.726	0.567	<RL	nm	0.309	0.663	2.27
692-BLKA-002	MM3B074	<RL	nm	1.28	0.781	<RL	nm	0.339	0.629	3.03
692-BLKA-005	MM4B127	<RL	0.0685	3.38	<RL	<RL	<RL	<RL	<RL	3.45
692-BLKA-006	MM4B130	<RL	0.179	4.95	0.754	1.33	<RL	<RL	<RL	7.21
692-BLKA-007	MM4B133	<RL	nm	2.52	0.797	<RL	nm	0.277	0.580	4.18
692-BLKA-008	MM4B136	<RL	0.186	3.23	<RL	0.869	<RL	<RL	<RL	4.29
692-BLKA-009	MM4B139	<RL	nm	2.90	0.824	<RL	nm	0.325	0.579	4.63
692-BLKA-010	MM4B142	<RL	0.218	3.93	<RL	0.876	<RL	<RL	<RL	5.03
692-BLKA-011	MM4B145	<RL	0.250	3.75	<RL	0.976	<RL	<RL	<RL	4.98
692-BLKA-012	MM4B148	<RL	nm	1.70	0.755	<RL	nm	0.462	0.841	3.75
692-BLKA-013	MM4B151	<RL	0.202	4.13	<RL	1.02	<RL	<RL	<RL	5.35
692-BLKA-014	MM4B154	<RL	nm	0.294	0.440	<RL	nm	0.288	0.612	1.63
692-BLKA-015	MM6B218	<RL	<RL	2.91	<RL	2.50	<RL	<RL	<RL	5.41
692-BLKA-016	MM9B328	0.588	<RL	6.09	<RL	4.14	<RL	<RL	<RL	10.8
692-BLKA-017	MM9B329	<RL	<RL	5.65	<RL	3.45	<RL	<RL	<RL	9.10
692-BLKA-018	MM9B330	0.680	<RL	3.73	<RL	3.31	<RL	<RL	<RL	7.72
692-BLKA-020	MM10B332	0.924	<RL	12.9	6.88	3.90	<RL	<RL	<RL	24.6
692-BLKA-021	MM10B335	<RL	1.63	13.9	2.10	3.77	<RL	0.679	0.366	22.5
692-BLKA-022	MM10B338	0.652	<RL	7.22	<RL	4.14	<RL	<RL	<RL	12.0
692-BLKA-023	MM10B341	0.744	<RL	2.91	<RL	2.61	<RL	<RL	<RL	6.27
692-BLKA-024	MM10B344	0.745	<RL	7.08	<RL	4.56	<RL	<RL	<RL	12.4
692-BLKA-025	MM10B347	0.574	<RL	5.96	<RL	3.91	<RL	<RL	<RL	10.4
692-BLKA-026	MM10B370	<RL	0.962	11.1	2.03	3.67	<RL	1.04	0.553	19.3
692-BLKA-027	MM10B373	<RL	0.908	6.86	1.26	2.36	<RL	0.419	<RL	11.8
692-BLKA-028	MM10B376	<RL	0.678	6.14	1.19	2.12	<RL	0.409	<RL	10.5
692-BLKA-029	MM10B388	<RL	0.835	8.45	1.48	2.51	<RL	0.418	<RL	13.7
692-BLKA-031	MM11B418	<RL	<RL	6.69	<RL	4.49	<RL	<RL	<RL	11.2
692-BLKA-032	MM11B469	0.567	<RL	3.51	<RL	2.77	<RL	<RL	<RL	6.8
692-BLKA-033	MM11B465	<RL	<RL	4.92	<RL	2.84	<RL	<RL	<RL	7.8
692-BLKA-034	MM11B479	<RL	<RL	<RL	<RL	1.63	<RL	<RL	<RL	1.6
692-BLKA-035	MM11B483	<RL	1.00	7.51	1.31	2.39	<RL	0.470	<RL	12.7
692-BLKA-036	MM11B486	<RL	0.825	7.47	1.31	2.22	<RL	0.547	<RL	12.4
692-BLKA-037	MM11B490	<RL	0.626	6.73	1.11	1.94	<RL	<RL	<RL	10.4
692-BLKA-038	MM13B680	1.11	<RL	11.7	<RL	4.44	<RL	<RL	<RL	17.2
692-BLKA-039	MM13B683	0.744	<RL	8.57	<RL	5.19	<RL	<RL	<RL	14.5
692-BLKA-040	MM11B438	<RL	<RL	6.19	1.91	2.29	nm	<RL	<RL	10.4
692-BLKA-041	MM11B442	<RL	<RL	3.58	1.67	<RL	nm	<RL	<RL	5.2
692-BLKA-042	MM11B446	<RL	<RL	2.10	0.860	1.46	nm	<RL	<RL	4.4
692-BLKA-043	MM11B422	<RL	0.436	8.05	1.11	1.59	<RL	<RL	<RL	11.2
692-BLKA-044	MM11B426	<RL	0.369	9.94	1.52	1.94	<RL	0.404	<RL	14.2
692-BLKA-045	MM11B430	<RL	0.357	8.14	1.14	1.78	<RL	<RL	<RL	11.4
692-BLKA-046	MM11B434	<RL	0.309	11.3	2.15	2.57	0.390	0.789	<RL	17.5
692-BLKA-047	MM11B450	<RL	<RL	1.91	1.19	<RL	nm	<RL	<RL	3.1
692-BLKA-048	MM11B457	<RL	<RL	2.93	1.38	1.69	nm	<RL	<RL	6.0
692-BLKA-049	MM11B461	<RL	<RL	1.72	<RL	1.77	nm	<RL	<RL	3.5
692-BLKA-050	MM13B688	0.487	<RL	4.32	<RL	3.54	<RL	<RL	<RL	8.4
692-BLKA-051	MM13B691	1.02	<RL	21.2	4.09	6.43	<RL	<RL	<RL	32.7
692-BLKA-052	MM13B703	1.70	<RL	21.0	2.57	6.59	<RL	<RL	<RL	31.8
692-BLKA-054	MM13B716	<RL	0.489	13.4	1.93	2.26	<RL	0.497	<RL	18.6
692-BLKA-055	MM13B719	<RL	0.530	20.9	3.15	3.41	<RL	0.967	<RL	28.9
692-BLKA-056	MM13B722	<RL	0.971	19.1	3.04	3.94	0.329	1.06	<RL	28.5
692-BLKA-057	MM15B111C	<RL	0.350	9.45	1.55	1.92	<RL	0.523	<RL	13.8
692-BLKA-058	MM15B057C	<RL	0.249	11.2	2.09	2.24	0.274	0.761	<RL	16.8
692-BLKA-059	MM15B060C	<RL	<RL	4.78	1.62	1.66	nm	<RL	<RL	8.1
692-BLKA-060	MM15B114C	<RL	0.434	8.86	1.47	1.90	<RL	0.366	<RL	13.0
692-BLKA-061	MM15B063C	<RL	0.282	15.4	2.64	2.97	<RL	0.938	<RL	22.2
692-BLKA-062	MM15B066C	<RL	0.346	7.17	1.24	1.63	<RL	<RL	<RL	10.4
692-BLKA-063	MM15B117C	<RL	<RL	5.94	1.71	1.71	nm	<RL	<RL	9.4
692-BLKA-064	MM15B069C	<RL	<RL	1.65	1.13	1.69	nm	<RL	<RL	4.5
692-BLKA-065	MM15B072C	<RL	0.397	6.22	0.975	1.36	<RL	<RL	<RL	9.0
692-BLKA-066	MM15B075C	<RL	<RL	5.79	1.63	2.19	nm	<RL	<RL	9.6
692-BLKA-067	MM15B119C	<RL	0.236	6.50	1.16	1.50	<RL	<RL	<RL	9.4
692-BLKA-068	MM15B121C	<RL	<RL	8.72	1.96	2.05	nm	<RL	<RL	12.7
692-BLKA-069	MM16B234C	<RL	0.978	11.2	1.71	1.68	<RL	0.511	<RL	16.1
692-BLKA-071	MM16B239C	<RL	<RL	10.6	2.55	2.67	nm	<RL	<RL	15.8
692-BLKA-072	MM16B242C	<RL	0.715	8.76	1.27	1.50	<RL	<RL	<RL	12.2
692-BLKA-073	MM17B316C	2.15	<RL	14.4	5.24	5.86	<RL	<RL	<RL	27.6
692-BLKA-074	MM17B319C	<RL	<RL	9.06	3.08	4.42	<RL	<RL	<RL	16.6
692-BLKA-075	MM18B349C	<RL	<RL	11.2	2.45	3.55	nm	<RL	<RL	17.2
692-BLKA-076	MM18B415C	1.01	<RL	14.5	5.01	6.70	<RL	<RL	<RL	27.2
692-BLKA-077	MM19B471C	0.794	<RL	5.65	<RL	3.33	<RL	<RL	<RL	9.8
692-BLKA-078	MM19B468C	0.650	<RL	7.42	<RL	4.84	<RL	<RL	<RL	12.9
692-BLKA-080	MM21B713C	1.59	<RL	23.0	7.36	7.61	<RL	<RL	<RL	39.6

<RL samples are less than the reporting limit
nm compound was not measured

Table A6. Mass fraction of HBCDs (ng/g wet mass) in beluga whale blubber.

NIST Identification Numbers	α-HBCD	β-HBCD	γ-HBCD
MM3B071	< RL	< RL	< RL
MM3B074	< RL	< RL	< RL
MM4B127	0.146	< RL	< RL
MM4B130	0.282	< RL	< RL
MM4B133	< RL	< RL	< RL
MM4B136	0.134	< RL	< RL
MM4B139	0.170	< RL	< RL
MM4B142	0.214	< RL	< RL
MM4B145	0.156	< RL	< RL
MM4B148	< RL	< RL	< RL
MM4B151	0.150	< RL	< RL
MM4B154	< RL	< RL	< RL
MM6B218	< RL	< RL	< RL
MM9B328	0.557	< RL	< RL
MM9B329	1.03	< RL	< RL
MM9B330	< RL	< RL	< RL
MM10B332	0.445	< RL	< RL
MM10B335	1.36	< RL	< RL
MM10B338	0.595	< RL	< RL
MM10B341	< RL	< RL	< RL
MM10B344	< RL	< RL	< RL
MM10B347	< RL	< RL	< RL
MM10B370	1.37	< RL	< RL
MM10B373	1.18	< RL	< RL
MM10B376	7.51	1.11	0.970
MM10B388	1.08	< RL	1.18
MM11B418	0.286	< RL	< RL
MM11B469	0.546	< RL	< RL
MM11B465	0.604	< RL	< RL
MM11B479	0.591	< RL	< RL
MM11B483	1.34	< RL	< RL
MM11B486	1.10	< RL	< RL
MM11B490	0.999	< RL	< RL
MM13B680	1.29	< RL	< RL
MM13B683	0.407	< RL	< RL
MM11B438	< RL	< RL	0.710
MM11B442	< RL	< RL	< RL
MM11B446	< RL	< RL	< RL
MM11B422	0.523	< RL	< RL
MM11B426	0.537	< RL	< RL
MM11B430	0.409	< RL	< RL
MM11B434	0.731	< RL	< RL
MM11B450	< RL	< RL	< RL
MM11B457	< RL	< RL	< RL
MM11B461	< RL	< RL	< RL
MM13B688	0.653	< RL	< RL
MM13B691	22.0	4.50	99.2
MM13B703	2.37	< RL	0.189
MM13B716	1.25	< RL	< RL
MM13B719	2.26	< RL	< RL
MM13B722	2.31	< RL	< RL
MM15B111C	0.632	< RL	< RL
MM15B057C	0.859	0.181	< RL
MM15B060C	< RL	< RL	< RL
MM15B114C	0.561	< RL	< RL
MM15B063C	1.63	< RL	< RL
MM15B066C	0.493	< RL	< RL
MM15B117C	< RL	< RL	< RL
MM15B069C	< RL	< RL	< RL
MM15B072C	0.460	< RL	< RL
MM15B075C	< RL	< RL	< RL
MM15B119C	0.635	< RL	< RL
MM15B121C	< RL	< RL	< RL
MM16B234C	0.813	< RL	< RL
MM16B239C	< RL	< RL	< RL
MM16B242C	0.835	< RL	< RL
MM17B316C	1.35	< RL	< RL
MM17B319C	1.72	< RL	< RL
MM18B349C	1.64	< RL	< RL
MM18B415C	2.69	< RL	< RL
MM19B471C	1.13	< RL	< RL
MM19B468C	1.95	< RL	< RL
MM21B713C	5.14	< RL	< RL

<RL samples are less than the reporting limit

Table A7. Mass fraction of PFCs (ng/g wet mass) in beluga whale livers.

NIST Identification Numbers	PFNA	PFDA	PFUnA	PFDoA	PFTriA	PFTA	PFHxS	PFOS	PFOSA
MM3L069	<RL	0.514	2.18	0.293	1.14	0.832	<RL	1.81	30.4
MM3L072	0.225	0.581	1.92	0.191	0.875	0.552	<RL	3.39	11.2
MM3L075	<RL	0.653	1.75	0.322	1.03	0.941	<RL	2.71	20.8
MM3L077	0.187	0.553	2.66	0.290	1.66	0.935	<RL	5.61	18.4
MM4L125	0.503	1.23	4.65	0.452	1.51	0.743	<RL	7.07	24.0
MM4L128	0.691	1.76	10.2	0.967	2.61	0.982	<RL	8.71	28.5
MM4L131	<RL	0.611	1.67	0.323	1.26	1.13	<RL	2.28	20.1
MM4L134	0.346	0.830	3.76	0.416	1.58	0.576	<RL	7.41	23.1
MM4L137	0.430	1.06	3.56	0.482	1.84	0.866	<RL	6.78	19.1
MM4L140	0.670	1.19	3.16	0.230	1.63	0.834	<RL	4.98	23.2
MM4L143	0.468	1.07	3.49	0.369	2.07	1.10	<RL	6.67	35.6
MM4L146	0.841	1.00	2.65	0.373	1.87	1.50	<RL	5.72	29.8
MM4L149	0.593	1.00	4.27	0.610	1.85	1.15	<RL	6.69	27.0
MM4L152	0.946	2.43	2.92	1.61	1.48	1.65	<RL	2.15	29.3
MM6L216	0.454	0.894	7.90	1.01	6.17	1.10	<RL	17.5	11.0
MM10L331	0.460	1.21	4.23	0.814	<RL	<RL	0.0980	10.2	10.4
MM10L333	1.11	2.06	13.2	1.73	14.2	2.32	0.293	30.2	11.4
MM10L336	1.72	1.76	8.33	1.83	5.49	8.47	0.192	22.1	27.8
MM10L339	<RL	0.309	<RL	0.365	<RL	<RL	<RL	4.61	12.2
MM10L342	0.690	0.727	4.32	0.756	<RL	<RL	3.55	10.6	11.1
MM10L345	2.57	1.75	12.8	1.93	15.4	4.69	1.15	39.6	14.7
MM10L368	2.11	3.15	22.0	2.38	20.0	2.94	0.408	26.8	11.4
MM10L371	1.80	3.82	20.0	2.36	21.4	5.93	0.318	22.0	14.5
MM10L374	1.79	3.30	22.2	2.73	21.4	5.68	0.644	25.4	15.7
MM11L467	0.676	1.23	5.11	0.920	4.82	0.770	0.123	8.85	16.4
MM11L463	0.745	1.67	10.1	1.33	8.48	2.39	0.0394	8.44	16.6
MM11L477	1.29	4.14	23.3	4.49	14.6	3.64	0.236	15.4	29.2
MM11L481	1.63	4.05	19.9	2.56	27.0	8.18	0.162	22.5	9.47
MM11L488	3.08	4.11	26.8	2.63	18.1	1.96	0.151	30.4	17.9
MM13L678	1.61	2.30	10.8	1.25	5.86	1.48	1.35	17.1	14.4
MM13L682	3.56	4.86	28.8	3.75	28.4	3.16	1.32	70.3	19.6
MM11L436	1.62	3.11	8.15	1.20	<RL	1.43	0.0630	10.9	36.4
MM11L444	0.780	1.01	5.22	0.954	0.566	1.55	0.378	3.90	26.7
MM11L420	0.980	5.07	18.3	3.10	11.6	7.63	0.0320	13.8	43.1
MM11L424	0.690	3.11	11.3	1.94	4.36	1.44	0.104	14.4	48.8
MM11L428	1.41	3.66	17.9	2.70	4.41	1.61	0.207	14.3	61.2
MM11L448	0.550	0.843	3.42	0.864	<RL	<RL	0.0310	4.25	38.5
MM11L455	0.960	2.76	7.42	1.60	5.04	1.70	0.139	17.2	65.7
MM11L459	1.16	1.46	4.42	0.819	<RL	<RL	0.0440	4.74	30.0
MM13L686	1.13	1.39	5.46	1.09	<RL	<RL	0.316	10.1	25.4
MM13L689	1.68	1.69	13.9	1.71	13.2	2.01	0.244	22.4	17.8
MM13L701	1.67	2.84	15.5	2.18	15.3	7.23	0.420	22.5	17.6
MM13L705	5.46	4.09	12.8	1.38	4.57	1.61	0.247	14.2	21.1
MM13L715	1.52	2.81	4.53	0.815	1.24	0.749	0.366	16.0	52.3
MM13L720G	0.580	0.721	<RL	0.589	<RL	1.20	<RL	4.29	39.1
MM15L109C	0.560	3.22	11.4	1.63	4.57	0.928	0.113	10.3	39.4
MM15L055C	0.980	5.38	20.8	2.94	7.03	0.858	0.155	20.9	61.4
MM15L058C	0.900	2.53	8.65	1.20	1.53	0.816	<RL	11.4	25.4
MM15L112C	2.36	3.81	9.86	1.13	2.53	1.00	0.255	28.4	61.9
MM15L061C	0.670	5.16	16.6	3.06	14.3	7.99	0.120	18.6	63.8
MM15L064C	1.53	2.94	9.82	1.41	5.38	2.77	0.231	12.2	30.9
MM15L115C	0.460	1.13	4.64	0.671	2.24	0.231	0.100	9.13	34.3
MM15L067C	0.610	1.79	6.50	1.08	1.09	<RL	0.0910	4.77	29.0
MM15L070C	0.170	1.16	5.37	0.898	2.98	0.364	0.0620	9.20	22.1
MM15L073C	1.05	7.00	22.4	2.66	9.13	4.36	<RL	13.1	37.8
MM15L118C	0.600	3.16	9.76	1.70	6.07	4.91	0.0440	10.8	31.8
MM15L120C	5.02	14.3	49.0	5.55	17.6	2.56	0.233	38.1	16.5
MM16L232C	2.55	2.15	4.66	0.640	<RL	<RL	0.140	6.52	17.7
MM16L235C	2.10	1.72	4.37	0.323	1.46	<RL	0.278	14.6	24.2
MM16L237C	2.53	2.49	5.15	0.779	<RL	<RL	0.115	9.50	19.5
MM16L240C	1.85	1.32	4.38	0.724	<RL	<RL	0.134	6.52	24.1
MM17L314C	2.41	2.76	19.6	2.10	11.1	0.743	0.0720	25.7	18.9
MM17L317C	5.67	6.98	41.6	5.55	82.8	21.3	1.01	57.3	18.0
MM18L347C	3.11	1.72	5.22	0.598	2.22	0.376	0.288	26.0	9.09
MM18L413C	2.82	3.54	27.2	3.48	48.0	13.3	0.501	29.5	10.5
MM19L469C	5.43	3.36	22.5	3.47	20.5	1.44	0.672	31.5	21.8
MM20L553C	2.09	3.89	17.8	3.81	16.5	3.57	0.285	10.2	22.5
MM21L711C	1.80	2.59	21.4	2.51	20.6	2.77	0.122	14.4	4.52
MM22L869C	1.70	2.14	15.6	2.11	13.4	1.12	0.563	10.0	25.4

<RL samples are less than the reporting limit

Table A8. Mass fraction of Hg (μg/g wet mass) in beluga whale livers.

NIST Identification Numbers	Total Mercury
MM3L069	4.78
MM3L072	1.44
MM3L075	13.4
MM3L077	4.91
MM4L125	34.2
MM4L128	42.2
MM4L131	83.6
MM4L134	4.14
MM4L137	10.1
MM4L140	51.9
MM4L143	46.5
MM4L146	28.7
MM4L149	30.8
MM4L152	38.1
MM6L216	2.87
MM10L331	0.406
MM10L333	10.1
MM10L336	2.36
MM10L339	4.91
MM10L342	2.02
MM10L345	0.434
MM10L368	5.62
MM10L371	4.00
MM10L374	3.28
MM11L467	5.51
MM11L463	4.15
MM11L477	6.68
MM11L481	13.0
MM11L488	33.7
MM13L678	5.62
MM13L682	0.514
MM11L436	6.20
MM11L444	54.2
MM11L420	75.9
MM11L424	99.2
MM11L428	83.6
MM11L448	6.07
MM11L455	91.9
MM11L459	10.2
MM13L686	4.60
MM13L689	8.22
MM13L701	3.62
MM13L705	0.444
MM13L715	13.7
MM13L720G	5.15
MM15L109C	46.3
MM15L055C	105
MM15L058C	1.22
MM15L112C	60.3
MM15L061C	158
MM15L064C	16.3
MM15L115C	1.29
MM15L067C	2.94
MM15L070C	11.6
MM15L073C	4.73
MM15L118C	5.08
MM15L120C	0.337
MM16L232C	0.745
MM16L235C	3.25
MM16L237C	0.396
MM16L240C	2.81
MM17L314C	1.78
MM17L317C	0.591
MM18L347C	2.59
MM18L413C	11.3
MM19L469C	0.474
MM20L553C	4.67
MM21L711C	6.14
MM22L869C	4.21