Health Consultation

Review of Fish Samples (Screening Data) From the Suqitughneq River

N. E. CAPE WHITE ALICE SITE

ST. LAWRENCE ISLAND, ALASKA

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
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Health Consultation: A Note of Explanation

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Prepared by:

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Summary

The Agency for Toxic Substances and Disease Registry (ATSDR) was requested by the U.S. Army Corps of Engineers (COE) to evaluate whether fish from the Suqitughneq River, St. Lawrence Island, Alaska, are safe to eat. Between the 1950s and the early 1970s, routine military activities at the Northeast Cape of the Island resulted in spills and releases of chemicals, which contaminated the Suqitughneq River and reduced the river's fish population. The fish population in the river is returning and the residents of the villages of Gambell and Savoonga on St. Lawrence Island have expressed a renewed interest in using the fish as a source of food.

In preparing this health consultation, ATSDR reviewed available fish sampling data from a 1999 COE screening sampling event. COE collected the fish samples to assess whether contaminants from former military activities were present in fish from the Suqitughneq River. Often typical of screening assessments, the data consisted of composite samples of several individual whole fish mixed together.

ATSDR's review of the screening data indicates that:

- Polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAHs) are present in some screening composite samples of fish from the Suqitughneq River. While the samples show relatively low levels of PCBs and PAHs when compared to other water bodies in the United States, these screening data cannot be used to determine if fish from the Suqitughneq River are safe to eat. For this reason, ATSDR:
  - Supports additional fish sampling of the Suqitughneq River and nearby water bodies that are used for subsistence fishing.
  - Supports additional studies aimed at characterizing contaminant concentrations in other food sources used by the residents of Gambell and Savoonga.

As a result of these conclusions, ATSDR recommends:

- *Adults and children of Gambell and Savoonga should refrain from eating fish from the Suqitughneq River* until we review additional sampling data and we can more adequately assess this potential exposure pathway. ATSDR recognizes that the residents of Gambell and Savoonga have a subsistence lifestyle. Therefore, a situation may arise where it is necessary to supplement their diet with fish from the Suqitughneq River while at the fishing camp. In these cases ATSDR recommends:
  - Fish should be prepared in a way that will reduce the PCB content.
  - Fish should not be stored in large amounts for later consumption.

When additional fish sampling is done in the future, ATSDR will conduct a public health review of the data and continue consultation with the villages of Gambell and Savoonga.

Statement of Issue

The Agency for Toxic Substances and Disease Registry (ATSDR) was requested by the U.S. Army Corps of Engineers (COE) to evaluate if fish from the Suqitughneq River, St. Lawrence Island, Alaska, are safe to eat. Between the 1950s and the early 1970s, the Northeast Cape was used for military activities. In 1969, diesel fuel from a punctured tank at the military site spilled into a tributary of the Suqitughneq River, eventually contaminating the river's drainage basin. The widespread contamination caused by the spill dramatically reduced the river's fish population. Routine military activities at the Northeast Cape site also resulted in accidental spills of some chemicals, such as polychlorinated biphenyls (PCBs). The Northeast Cape site is now classified as a Formerly Used Defense Site (FUDS). The COE is studying the site to identify the extent of the contamination and to select appropriate cleanup measures (see Figure 1).

Few people live in the Northeast Cape area; however, the Alaska Native villages of Gambell and Savoonga frequently use a nearby fishing camp during the spring and summer (see Figure 2). Since the fuel spill, members of these villages have not used the river as a source of food because of the scarcity of fish. Recently, fish, including Dolly Varden char and Alaska blackfish, have returned to the Suqitughneq River. As a result, community members have expressed a renewed interest in using fish from the Suqitughneq River as a food source—if the fish are safe to eat. In this health consultation, ATSDR evaluates whether contaminants exist at levels that could be harmful to people who eat fish from the Suqitughneq River.

Background

The Northeast Cape FUDS site covers approximately 4 square miles and is located 9 miles west of the northeastern cape of St. Lawrence Island, between Kitnagak Bay to the northeast and Kangighsak point to the northwest (see Figure 1). The Suqitughneq River is the primary stream drainage in the area, extending from the base of the Kinipaghulghat Mountains along the southern portion of the site to the Bering Sea. From the 1950s to the early 1970s, the site was used by the military. Over the years of operation, chemicals such as polychlorinated biphenyls (PCBs) were spilled at the Northeast Cape. A major release of diesel fuel occurred in 1969, when heavy equipment punctured a hole in one of three fuel tanks located at the military facility on Northeast Cape. The damaged fuel tank spilled 180,000 gallons of diesel fuel into a tributary of the Suqitughneq River, causing widespread contamination of the Suqitughneq River drainage basin. Since the 1970s, the site has been inactive; two fuel tanks are empty and one holds rainwater. (COE, 1999b)

Since 1994, the COE has studied the Northeast Cape site to describe the type and extent of contamination remaining after the 1969 spill and to evaluate the impact of this contamination on water quality, as well as its potential affects on local wildlife. In these studies, the COE collected surface water and sediment samples in the vicinity of the spill site. The sampling found PCBs and components of diesel fuels, such as polynuclear aromatic hydrocarbons (PAHs), in both surface water and sediment of the Suqitughneq River.

PCBs and PAHs are of concern because they can accumulate in fish and can harm people who eat the contaminated fish. Fish sampling, however, was not done following the 1969 fuel spill or for many years afterwards because of the scarcity of fish. The COE recently conducted *screening fish sampling* as part of their Tier II Ecological Assessment (July 31 and August 3, 1999). The primary aim of the screening sampling was to conduct a broad-spectrum survey to determine whether additional data should be collected. (COE, 1999b)

Using electrofishing techniques, angling, and minnow traps, the COE collected a total of 217 fish representing four different species (95 ninespine stickleback, 107 Dolly Varden char, 14 Alaska blackfish, and 1 marine sculpin). The samples were collected from four sampling locations along the Suqitughneq River: one upstream control location (slsuq02), one downstream control location (slsut01), the spill tributary (slurc01), and a downstream stressed area near the intertidal lagoon (slsuq01). A control sample was also taken from the Quangeghsaq River (slqan01), a river unaffected by the spill. (See Figure 2 for sampling locations.)

The Suqitughneq and Quangeghsaq Rivers have defined stream channels with cobble/gravel and sand stream beds, while the spill tributary of the Suqitughneq River is characterized by marsh areas and a stream bottom dominated by mud and muck. Both Dolly Varden char and Alaska blackfish were collected throughout the Suqitughneq River drainage area, while ninespine sticklebacks and a marine sculpin were found only at the furthest downstream area, near the intertidal lagoon (slsuq01). (Only one marine sculpin was found.) Dolly Varden char and ninespine stickleback were also captured at the control location along the Quangeghsaq River (slqan01).

For the analysis, the COE combined fish samples of like species into eight whole-fish composite samples, which included four Dolly Varden char composites, two Alaska blackfish composites, and two ninespine stickleback composites. (The one sculpin was not included in the composite analysis.) Table 1 describes information about the composite samples, including the sample locations, the sample identification numbers, the number of individual fish samples in each composite, the length of the fish in each composite sample, and the percent lipid content of each composite sample. COE tested each of the eight composite samples for the presence of 18 individual PAHs and 5 Aroclors of PCBs. (Aroclor is a trade name for mixtures of individual PCBs.)

Discussion

This section describes ATSDR's approach to assessing whether the fish from the Suqitughneq River are safe to eat. ATSDR first describes the sampling results and then describes our public health evaluation of these data.

What contaminants have been detected in fish from the Suqitughneq River ?

PCBs and PAHs were detected in fish from the Suqitughneq River. *PCBs* are synthetic oils once widely used in industrial processes and products. *PAHs* are components of oil or fuels, such as diesel fuels. They are also byproducts of burning oil, coal, or gas. The PAHs and PCBs came from accidental releases at the old military site.

Review of Fish Sampling Screening Data

Results of the 1999 screening sampling indicate that PCBs and/or PAHs are present in some fish from the Suqitughneq River (COE, 1999a). Specifically:

- PCBs were detected at concentrations of 0.14 milligrams per kilograms (mg/kg) and 0.16 mg/kg in two composite samples of Dolly Varden char and at 0.10 mg/kg in one composite sample of Alaska blackfish caught from the tributary where the spill occurred.

- PAHs were detected at a concentration of 0.11 mg/kg in a composite of Alaska blackfish caught from the tributary where the diesel spill occurred in 1969. No PAHs were detected in any other composite sample.

- PCBs or PAHs were not detected in the two nine-sticklespine samples.

No PCBs or PAHs were detected in the two samples from the Quangeghsaq River, the control area unaffected by the spill.

The screening data provide useful information about the type and general trends of contamination in fish. For example, based on a review of these data we know: (1) contaminants are present at relatively low concentrations in composites of Dolly Varden char and Alaska blackfish caught from various locations along the Suqitughneq River drainage; (2) PCBs or PAHs were not detected in composites of fish caught from the Quangeghsaq River, an area unaffected by the spill; and, (3) the nine sticklespine fish appear to be unaffected by PCB and PAH contamination.

How do contaminants get in fish ?

Contaminants such as PCBs settle to the bottom of a river and collect in sediment. PCBs do not decompose easily; they remain in the environment for many years after release. Fish take in PCBs when they eat smaller fish or sediment containing PCBs. In this way, larger and older fish can build up high levels of contaminants.

The screening data provide some general information and suggest relatively low PCB and PAH levels in the fish population in the Suqitughneq River. However, the composite samples for Suqitughneq River lack sufficient detail to determine the contamination levels in individual fish, especially the level of contaminants in edible size fish or edible portions of the fish. Therefore the data is inadequate to determine how much fish or what size fish can be safely eaten. The two primary issues that contribute to our determination that the data are inadequate to determine if the fish are safe to eat are: 1) composite samples consist of whole-fish samples which may not be representative of the portions of the fish commonly consumed by the native population and, 2) composite analysis provides one data point for a sample that is made up of several individual fish of various sizes. Without more detailed sampling, we do not know the highest level of PCBs or PAHs in fish to which an individual could be exposed. Also, composite samples do not provide specific information on the larger, more desirable fish of any one species. For example, the Dolly Varden char from the Suqitughneq River ranged in size from approximately 2 inches to 9 inches, half of the fish were less then 4 inches long. *The samples collected from each location should be representative of the size and type most likely eaten. This is important because larger fish of any one species would be more likely to have accumulated more of the contamination.*

Levels of PCBs and PAHs detected in the screening sampling are similar to levels detected in other parts of the United States. In 1980 and 1981, a survey by the U.S. Fish and Wildlife Service found the average concentration of PCBs in fish at 102 locations nationwide was 0.53 mg/kg. A study by the U.S. Environmental Protection Agency between 1986 and 1989 reported chemical residues in fish at 362 sites nationwide that included industrial and hazardous waste sites. In the study, PCBs were detected at an average concentration of 1.9 mg/kg in bottom feeding and game fish. Information on PAHs in fish is limited, but an assessment of PAH concentrations in fish in Prince William Sound, Alaska, following the 1989 Valdez oil spill found individual PAH levels between 5 and 12 mg/kg. (ATSDR, 1998) (ATSDR, 1995)

Public Health Evaluation

ATSDR reviewed the toxicologic literature in relation to the detected concentrations of PCBs and PAHs in fish from the Suqitughneq River.

PCBs: A wide body of research has shown that exposure to PCBs at high enough levels can cause adverse health effects. Although the PCB levels in fish from the Suqitughneq River are relatively low, ATSDR determined that eating fish every day containing the highest detected level

of PCBs in the screening sample might lead to an *unacceptable exposure, suggesting that further evaluation is warranted.*

Over months or years of eating contaminated fish, PCBs can accumulate to levels that would affect your health. Therefore, people who eat fish regularly can be particularly susceptible to PCBs that build up over time. Some of the ways in which PCBs can affect adults include changes in the blood, liver, and immune function. Children appear to be even more sensitive to the effects of PCBs than adults. Developmental problems have been reported in children whose mothers were exposed to PCBs even before becoming pregnant. PCBs can also pass through a mother's milk to her baby. Babies exposed to PCBs in pregnancy can have lower birth weights and delayed physical development. ATSDR will review future sampling data to assess more fully whether PCB levels could be harmful to people who want to eat fish from the Suqitughneq River.

PAHs: ATSDR evaluated consumption of the relatively low concentrations of PAHs in fish from the Suqitughneq River. ATSDR determined that the amount or dose of PAHs an adult or child would receive based on long-term consumption of fish from the Suqitughneq river *is well below health-based guidelines for PAHs,* suggesting that PAH levels are unlikely to contribute to adverse health effects. ATSDR will review additional sampling data on PAH levels in fish as it becomes available to more definitively assess the health implications for the residents of Gambell and Savoonga.

Special Considerations in Evaluating PCBs and PAHs in Suqitughneq River Fish

ATSDR identified a number of issues that should be considered in our public health evaluation of consumption of Suqitughneq River fish by the residents of Gambell and Savoonga.

- *Potential exposure to PCBs and PAHs in migratory fish of nearby water bodies.* Certain fish species, such as the Dolly Varden char, travel outside the Suqitughneq River drainage basin. Nearby water bodies that are also popular subsistence fishing locations include the Tapisak and Sipenpak Rivers/Lagoons. We do not know if or to what extent contaminants might be present in fish that have migrated from the Suqitughneq River to other popularly fished water bodies or if fish from those water bodies may have accumulated PCBs from other unknown sources.

- *Potential exposure to other dietary sources of contaminants.* The local population relies on a diet of fish, native plants, marine mammals, migratory birds, and free-ranging reindeer. If contaminants have accumulated in plants or wildlife, residents might be exposed to other dietary sources of PCBs and PAHs besides fish. In its October 1999 Exposure Investigation Protocol, ATSDR outlined data needed to adequately assess dietary exposures to contaminants in reindeer. A reindeer sampling program for herds around northwest Alaska already has been conducted by the University of Alaska. Samples were obtained from the recent harvest of reindeer. ATSDR is working with the University and the COE to complete the analysis of these data. Results from this or any other

sampling program will help ATSDR determine the extent of the people's exposure to PCBs, PAHs, or other contaminants from ingesting wildlife as well as the potential that the exposure will have harmful effects.

- *Limitations of available screening data.* As noted, the screening data based on composite samples can provide useful information about the types and general trends of contamination in fish, but the data often lack sufficient detail for determining whether the fish are safe to eat.

ATSDR Child Health Initiative

ATSDR recognizes that infants and children may be more sensitive than adults to environmental exposure in communities faced with contamination of their water, soil, air, or food. This sensitivity is a result of the two following factors: (1) children are smaller than adults and therefore may receive a higher dose of chemical exposure relative to their body weight, and (2) children's developing systems may be more vulnerable to the toxic effects of a chemical. Children also can sustain permanent damage if exposed to toxic substances during critical growth stages. Because of these issues, ATSDR uses health guidelines that are protective for children and considers children as a special population that may be more sensitive than adults to chemical exposures.

The screening data suggest that PCB levels in Suqitughneq River fish slightly exceed the health-based screening value for a child. Scientific information also suggests that children are more sensitive to the effects of PCBs. *As a precautionary measure, children should not eat fish from the Suqitughneq River until we review more detailed sampling data and we can resolve the uncertainties about other potential dietary sources of PCBs and PAHs.* The additional information will help us develop a long-range recommendation.

Conclusions

Based on a review of available data, ATSDR concludes the following:

1. Screening data indicate that PCBs are present in composite samples of Dolly Varden char and Alaska blackfish collected from the Suqitughneq River. The data is insufficient for ATSDR to determine the potential health risk to area residents. The levels of PCBs reported for composite samples are lower than levels reported for many waterways throughout the United States and are lower than FDA guidelines for fish. However, FDA guidelines are inappropriate for this population because the local population on the N E Cape consume large amounts of fish, potentially collecting fish from the same source repeatedly. Therefore, more detailed sampling data are needed before we can determine how much fish from the Suqitughneq River is safe for residents of Gambell and Savoonga to eat.

2. In addition to locally-caught fish, residents of Gambell and Savoonga rely on a diet of locally caught and grown foods that include aquatic mammals, free-ranging reindeer, and plants. Currently, information about whether and to what extent contaminants might be present in other vital food sources is lacking.

Recommendations

ATSDR recommends the following to ensure that residents of Gambell and Savoonga are not exposed to unhealthy levels of contaminants prior to a more representative characterization of the extent of contamination in the Suqitughneq River:

1. Because screening data indicate that contaminants are present in Suqitughneq River fish, ATSDR supports additional sampling of the Suqitughneq River and nearby water bodies that are used for subsistence fishing. ATSDR recommends that future sampling studies:

    - Collect migratory fish from the Tapisak and the Sipenpak Rivers/Lagoons

    - Analyze fish in ways that are representative of the local population's fish eating habits.

    - Determine the magnitude of contamination in individual edible-sized fish samples.

2. ATSDR supports additional studies aimed at characterizing contaminant concentrations in other food sources used by the residents of Gambell and Savoonga.

3. Until ATSDR reviews additional sampling data and we can more fully assess PCB exposure, *adults and children of Gambell and Savoonga should refrain from eating fish from the Suqitughneq River*. This is a precautionary measure, until a more detailed evaluation is complete. By following this recommendation, residents can best protect themselves from potential exposure to PCBs and PAHs.

4. ATSDR recognizes that residents of Gambell and Savoonga rely on local resources for most of their food. Therefore, it may be necessary for the locals to supplement their diet with fish from the Suqitughneq River before we receive additional sampling data. If so:

   - Fish from the Suqitughneq River should be prepared in a way that will reduce the potential PCB content. PCB content in fish can be somewhat reduced by removing skin and trimming away fatty parts of fish before cooking, and then throwing away any oil and drippings produced by cooking. Detailed recommended preparation instructions are provided in Appendix A of this health consultation.

   - Fish should not be harvested the Suqitughneq River for storage and later consumption. This recommendation is to reduce the potential for one person or family to consume a large amount of fish from the river until a more complete evaluation can be conducted.

Prepared by:

Susan McAfee Moore
Chief, Consultations Section
Exposure Investigations and Consultation Branch
Division of Health Assessment and Consultation

Reviewed by:

Leslie Campbell
Office of Tribal Affairs
Division of Health Assessment and Consultation

Gary Campbell
Chief, Federal Facilities Assessment Section
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

Richard Kauffman
Senior Regional Representative, Region 10
Office of Regional Operations

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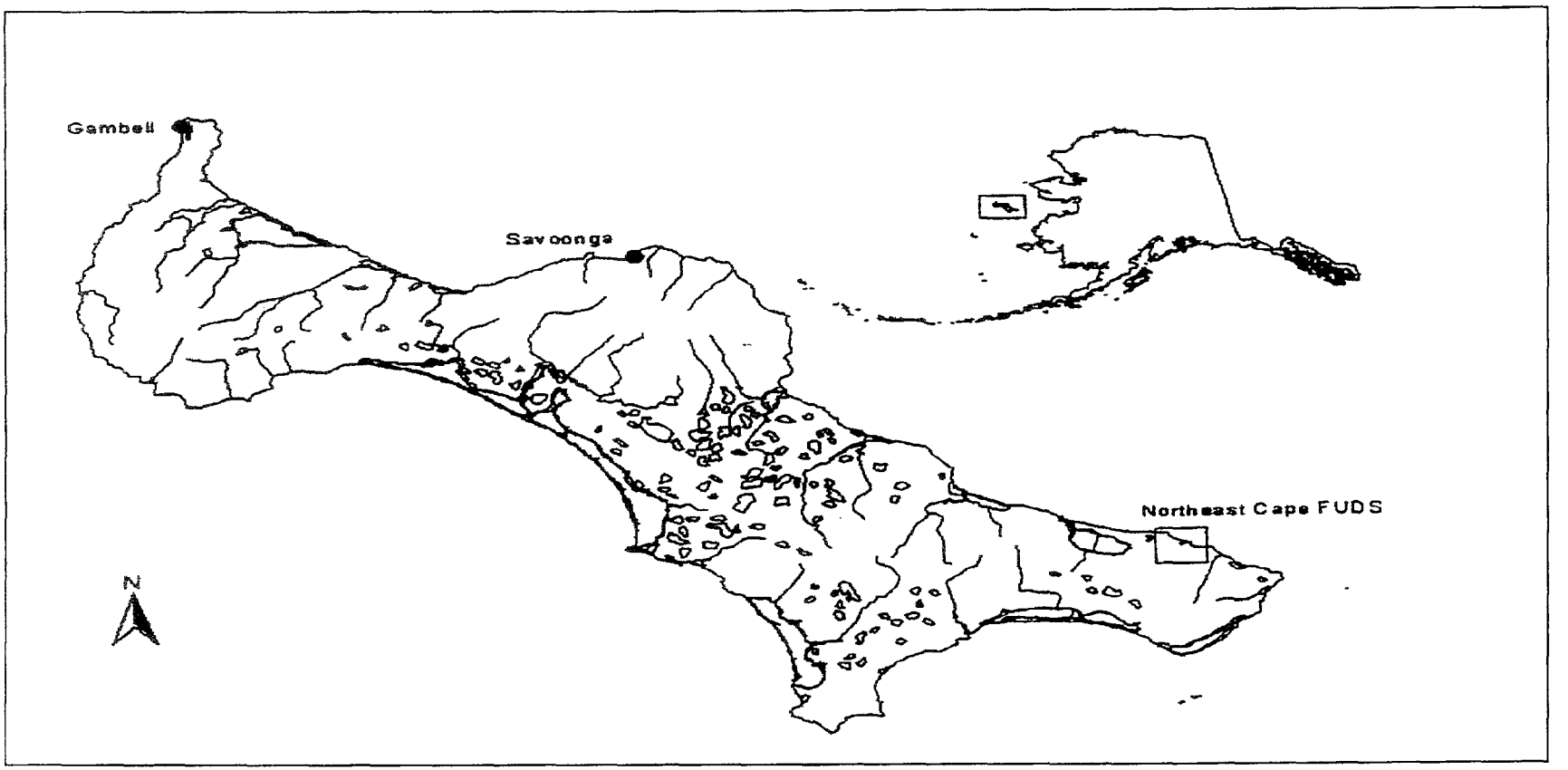
Table 1. Summary of Contaminants in Whole-Fish Composite Samples, St. Lawrence Island, Alaska, October 1999

Sample Location	Composite ID	Number of Individual Samples	Length (inches and [mm])	Lipid %	PCBs (mg/kg)	PAHs (mg/kg)
Downstream Suqitughneq River	Slsuq01aDV Dolly Varden char	66	1.6 - 8.9 (41 - 225)	5.38	0.140	nd
	Slsuq01a9SB ninespine stickleback	75	1.6 - 2.6 (40 - 70)	4.58	nd	nd
Upstream Suqitughneq River	Slsuq02aDV Dolly Varden char	20	4.5 - 8.4 (114 - 212)	5.06	0.160	nd
Downstream Control	Slut01aBF Alaska Blackfish	1	4.7 (118)	4.41	nd	nd
	Slut01aDV Dolly Varden char	4	4.5 - 7.1 (155 - 180)	3.20	nd	nd
Spill Tributary	Slurc01aBF Alaska Blackfish	11	3.5 - 5.9 (90 - 150)	2.06	0.100	0.114
Control (Quangcghsaq River)	Slqan01aDV Dolly Varden char	17	5.4 - 7.7 (137 - 195)	2.49	nd	nd
	Slqan01a9SB ninespine stickleback	20	1.8 - 2.6 (45 - 65)	5.77	nd	nd

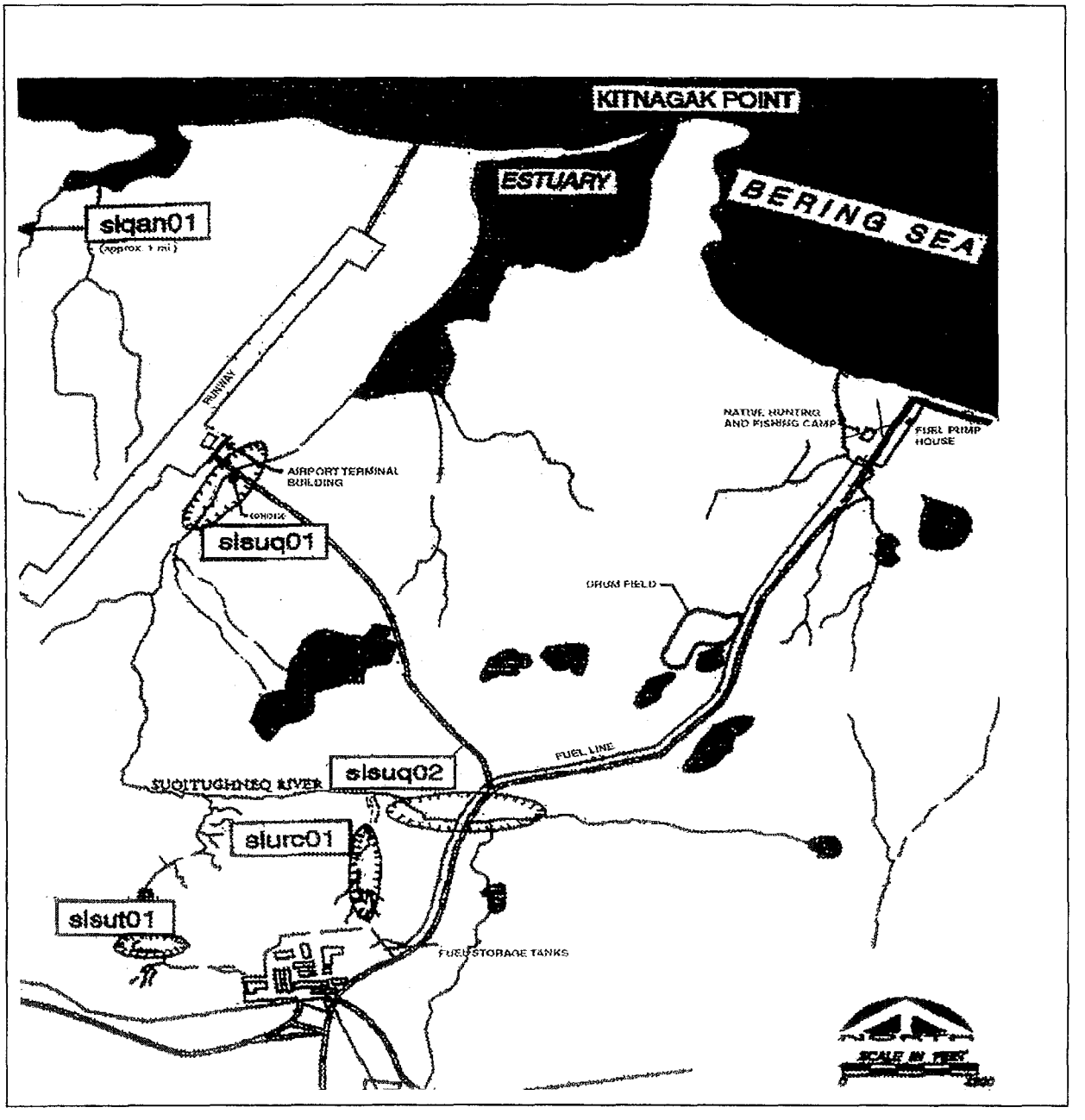
Source: U.S. Army Corp of Engineers, 1999.
Note: The single marine sculpin was not included in the composite analysis.
Key: mm = millimeter; mg/kg = milligrams per kilogram; nd = not detected; PCBs = polychlorinated biphenyls; PAHs = polynuclear aromatic hydrocarbons

Figure 1. St. Lawrence Island and the Northeast Cape FUDS site



Source: Montgomery Watson, 1999.

Figure 2. Northeast Cape Sampling Locations

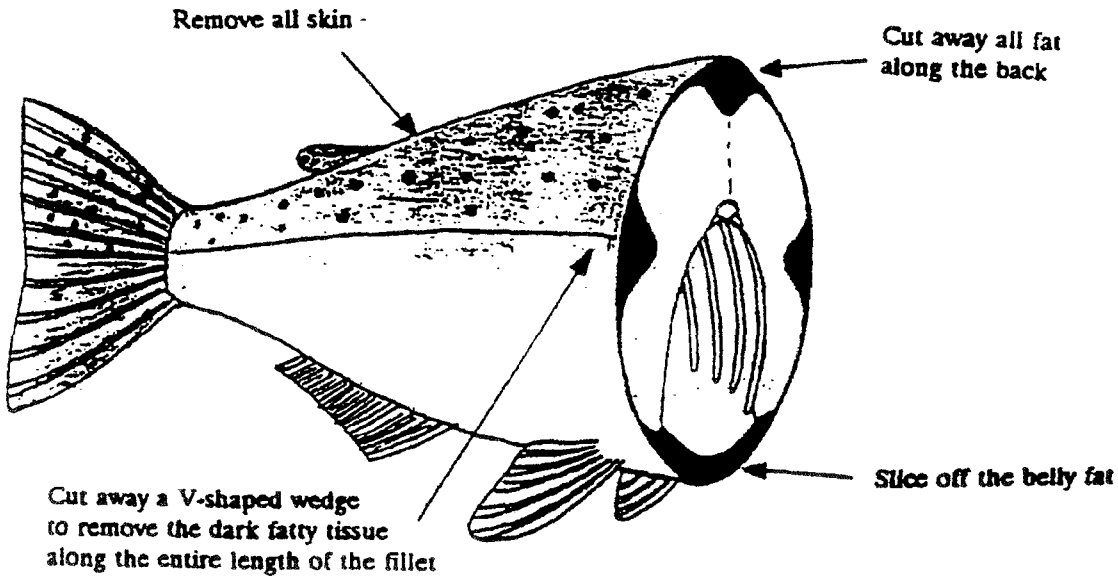


Source: Montgomery Watson, 1999.

APPENDIX A. Cleaning and Cooking Your Fish

Source: Great lakes Sport Fish Advisory Task Force. Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory. September 1993.

Many contaminants, such as PCBs and PAHs, are found at higher levels in the fat of fish. You can reduce the amount of these contaminants in a fish meal by properly trimming, skinning, and cooking your catch. Remove the skin and trim all the fat from the areas shown on the diagram below: the belly flap, the line along the sides of the fish, the fat along the back, and under the skin.



Cooking does not destroy contaminants in fish, but heat from cooking meals remove some of the fat in fish and allows some of the contaminated fat to drip away. Broil, grill, or bake the trimmed skinned fish on a rack so the fat drips away. Do not use the drippings to prepare sauces or gravies.

Table 6-A17. Mean concentrations ± 1 SD, and/or ranges (in brackets), in ng/g ww (lipid weight for several Arctic char entries), of major organochlorines in anadromous and marine fishes collected 1990-1994.

Location	Region and Country	Tissue	n[a]	% lipid	ΣCBz	ΣHCH	ΣCHL	ΣDDT	ΣPCB	Toxaphene	Dieldrin	Mirex	Heptachl.-epoxide	Reference
Anadromous fishes														
Salvelinus alpinus (Arctic char)														
Kangiqsualujjuaq	Ungava Bay, Canada	Muscle and skin	4	10.2±6.1	10.5±3.21	6.10±5.27	22.7±6.8	11.8±4.0	53.8±31.6	155±59	6.2±1.3	<0.1	–	1
Kangiqsujuaq	Hudson Strait, Canada	Muscle and skin	9	8.59±1.98	3.36±2.02	2.02±0.95	9.8±4.9	5.0±3.0	24.0±9.63	76.5±34.7	3.22±1.2	<0.1	–	
Inukjuaq	E. Hudson Bay, Canada	Muscle and skin	4	3.55±1.88	2.45±2.33	3.10±1.76	11.1±12.2	11.8±14.4	56.6±21.7	34.1±31	1.36±0.9	<0.1	–	
Salluit	Hudson Strait, Canada	Muscle and skin	4	6.60±1.95	4.01±1.49	3.31±1.12	12.4±5.8	6.9±4.5	21.9±12.7	86.5±64.4	3.28±0.67	<0.1	–	
Sanikiluaq	S. Hudson Bay, Canada	Muscle and skin	8	4.9±3.2	1.88±0.93	2.06±0.88	7.79±4.39	7.62±4.39	23.6±17.0	33.7±29.3	1.31±0.73	0.46±0.40	–	
Peter Lake	W. Hudson Bay, Canada	Muscle and skin	6	3.24±1.54	2.71±1.08	2.0±0.90	3.89±2.02	4.81±2.13	11.3±3.51	12.9±3.52	0.11±0.04	0.14±0.05	–	
Buchanan Lake	Axel Heiberg Island, Canada	Muscle and skin	10	7.23	–	2.93	9.79	3.65	6.82	17.3	–	–	–	1
Wellington Bay	Victoria Island, Canada	Whole fish excl. liver	3	–	–	–	–	–	2.7-5.3	–	–	–	–	7
Cambridge Bay	Victoria Island, Canada	Whole fish excl. liver	2	–	–	–	–	–	3.4-3.5	–	–	–	–	
Rickardvannet	Spitsbergen	Muscle and skin	4	3.10	–	–	–	–	20±12	–	–	–	–	14
Diesetvannet	Spitsbergen	Muscle and skin	5	2.94	–	–	–	–	2.47	–	–	–	–	
Kola Peninsula	Russia	Muscle and skin	3	4.13±0.76	4.16±0.44	2.92±0.84	3.01±0.74	5.65±0.77	26.6±2.65	35.4±14.0	–	0.59±0.08	–	3
Khatanga River	Russia	Muscle and skin	1	–	0.44	1.05	0.98	1.64	7.6	–	–	0.13	0.15	12
Ob River	Near Salekhard, Russia	Muscle and skin	1	–	0.69	0.81	1.73	2.69	8.4	–	–	0.52	0.18	
The following entries are in ng/g lw														
Somerset Island	Canada	Muscle and skin	8	–	–	83±19	173±98	98±60	35±212	736±427	–	–	–	1
Pond Inlet (Mittimatalik)	Canada	Muscle and skin	10	–	–	69±11	46±13	19±6	173±64	301±78	–	–	–	
Spence Bay (Taluriuaq)	Canada	Muscle and skin	10	–	–	87±6	65±64	23±15	23±53	248±158	–	–	–	
Coregonus nasus (Broad whitefish)														
Campbell Lake	Mackenzie Delta, Canada	Muscle and skin	4	3.21±3.04	0.87±0.90	1.97±2.67	1.62±1.79	1.00±1.31	2.17±1.37	5.03±2.72	0.10±0.10	0.05±0.06	–	2
Kugaluk River	Mackenzie Delta, Canada	Muscle and skin	9	3.75±1.63	1.40±0.83	1.09±0.56	1.69±0.68	0.67±0.30	6.19±3.99	6.85±4.91	0.13±0.19	0.05±0.06	–	
L100	Mackenzie Delta, Canada	Muscle and skin	4	10.8±2.35	4.05±1.54	3.52±2.25	8.90±2.47	4.76±2.18	8.73±5.11	37.6±15.3	1.05±0.38	0.26±0.09	–	
Travaillant Lake	Mackenzie Delta, Canada	Muscle and skin	4	2.58±0.53	0.56±0.15	0.46±0.11	0.67±0.11	0.31±0.05	1.86±0.69	4.30±0.97	0.08±0.02	0.10±0.02	–	
Horseshoe Bend	Mackenzie Delta, Canada	Muscle and skin	9	3.1±0.9	0.29±0.17	0.18±0.11	1.02±0.60	0.15±0.11	0.82±0.42	3.21±1.62	0.10±0.05	0.08±0.06	–	
Ob River	Russia	Muscle and skin	11	1.5±0.5	0.73±0.53	1.52±0.62	1.85±0.78	3.74±1.44	5.66±0.93	3.66±1.49	0.22±0.11	0.18±0.20	–	4
Khatanga River	Russia	Muscle and skin	1	–	0.72	1.72	0.66	2.02	9.2	–	–	0.34	0.22	12
Yenisey River	Near Karaul, Russia	Muscle and skin	2	–	0.8	1.25	0.82	6.165	7.5	–	–	0.261	0.22	
				–	(0.24-1.36)	(0.53-1.92)	(0.46-1.18)	(5.47-6.85)	(6.4-8.6)	–	–	(0.06-0.04)	(0.07-0.08)	
Indigirka River	Near Chokurdakh, Russia	Muscle and skin	1		0.25	0.48	0.29	2.45	10.2	–	–	0	0	
Coregonus autumnalis (Arctic cisco)														
Pechora River	Russia	Liver	5	–	0.37	0.49	0.11	2.24	2.99	–	0.00	0.00	0.04	10
					(0.19-0.46)	(0.17-0.83)	(0.00-0.19)	(1.42-3.15)	(2.34-3.89)				(0.00-0.07)	
Ob River	Russia	Liver	5	–	2.04	0.28	0.04	4.50	17.1	–	0.00	0.00	0.26	
					(0.86-2.86)	(0.22-0.36)	(0.00-0.14)	(2.61-6.43)	(6.98-26.3)				(0.07-0.43)	
Ob River	Near Salekhard, Russia	Liver	2		0.7	2.03	4.45	12.085	25.2			0	0.26	12
				–	0	(1.92-2.14)	(3.37-5.53)	(6.3-17.87)	(39.4-11)	–	–	(0.06-0.07)	(0.4-0.54)	
Khatanga River	Near Khatanga, Russia	Liver	1		0.5	1.54	2.4	3.08	8.4			0.22	0.32	
Coregonus muksun (Muksun)														
Indigirka River	Near Chokurdakh, Russia	Muscle and skin	2	–	0.235	0.755	0.82	2.38	13.75	–	–	0.01	0.025	12
					(0.22-0.25)	(0.74-0.77)	(0.66-0.98)	(1.55-3.21)	(9.1-18.4)			(0-0.01)	(0-0.05)	
Khatanga River	Near Khatanga, Russia	Muscle and skin	1	–	0.53	0.2	1.99	1.71	5	–	–	0.3	0.18	
Coregonus lavaretus pidschian (Pidschian)														
Ob River	Near Salekhard, Russia	Muscle and skin	1	–	0.25	0.39	0.66	0.86	2.5	–	–	0.18	0	12
Gobiidae g. sp.														
Baidaratskaya Gulf	Russia	Muscle and skin	2	–	0.705	0.9	1.73	3.32	8.4	–	–	0.22	0.32	12
					(0.51-0.9)	(0.82-0.98)	(1.57-1.89)	(3.02-3.62)	(7.8-9.2)			(0.35-0.45)	(0.15-0.23)	
Pechora River	Russia	Muscle and skin	1	–	1.04	0.56	1.52	6.33	10.2	–	–	0.07	0.14	
Stenodus leucichthys nelma (Inconnu)														
Yenisey River	Near Karaul, Russia	Muscle and skin	1	–	0.18	0.96	2.12	11.94	27.2	–	–	0.06	0.28	12
Marine Fishes														
Myoxocephalus quadricornis (Fourhorn sculpin)														
Cambridge Bay	Victoria Island, Canada	Muscle and skin	5	2.00	–	1.9	5.10	24.5	50.0	–	1.50	<0.1	–	6
	Whole fish excl.	Liver	24						7.3-230					7
Wellington Bay	Victoria Island, Canada	Muscle and skin	4	1.40	–	1.40	6.30	1.30	(2.4-7.3)	–	1.00	<0.1	–	6
Hall Beach	Foxe Basin, Canada	Whole fish	9	2.00	–	2.2	2.80	2.70		–	0.80	<0.1	–	
Myoxocephalus scorpius (Short-horn sculpin, sea scorpion)														
Cambridge Bay	Victoria Island, Canada	Whole fish excl. liver	10	–	–	–	–	–	(4.4-39)	–	–	–	–	7

Wellington Bay	Victoria Island, Canada	Whole fish excl. liver	1	–	–	–	–	(0.79-2.0)	–	–	–	–		
Disko	Greenland	Liver	2	11.5±0.40	2.2±0.10	5.3±0.60	2.8±0.60	4.3±0.30	5.6±1.40					13
Qeqertar	Greenland	Liver	2	19.5±10.50	6.4±3.00	14.3±7.70	7.1±3.10	9.6±3.90	12.8±4.90					
Scoresbysund	Greenland	Liver	2	26.1±1.90	18.4±1.80	24.6±3.10	31.7±4.90	59.5±5.20	83.6±8.60					
Unartoq	Greenland	Liver	2	28.4±5.50	8.3±4.40	16.1±2.50	11.9±6.80	25.3±12.70	24.1±11.60					
Other unidentified sculpin														
64°02'N,172°21'W	Bering Sea	Whole fish	1	5.4	<0.47	0.74	0.9	6.2	<3.2					19
Reinhardtius hippoglossoides (Turbot, Greenland halibut)														
Cumberland Sound	Baffin Island, Canada	Muscle and skin	10	17.0±3.67	39.8±3.81	15.1±1.62	127±13.7	129±12.9	165±18.5	566±59.3	25.2±3.37	0.99±0.12	–	5
		Liver	15	24.4±5.80	14.6±3.80	18.9±6.30	59±14.6	68±24.8	136±57.5	340±109				
E. Beaufort Sea	Banks Island, Canada	Muscle and skin	10	14.6±3.21	48.4±3.56	13.6±1.28	115±7.91	128±10.4	202±15.8	667±50.1	24.4±3.30	2.84±0.35	–	15
Davis Strait	W. Greenland	Liver	?	20.0±10.00	18.0±13.0	1.9±1.10	36±29.0	106±110.0	119±102.0					
Boreogadus saida (Arctic cod, polar cod)														
Resolute Bay	Lancaster Sound, Canada	Whole fish	3	7.32±0.39	3.98±0.70	3.34±0.48	5.90±1.80	6.53±1.79	6.20±1.24	39.0±11.2	0.94±0.22	0.04±0.03	–	4
73°04'N, 48°10'E	Barents Sea, Norway	Liver	5×5	36 (28-41)	14 (12-16)	9 (7-11)	40 (32-45)	45 (35-50)	91 (72-114)	–	–	–	–	9
76°05'N, 41°00'E	Barents Sea, Norway	Liver	5×5	41 (38-46)	11 (7-14)	10 (9-12)	38 (30-48)	17 (30-48)	82 (65-101)	–	–	–	–	
75°15'N, 54°27'E	Barents Sea, Norway	Liver	5×5	50 (43-55)	7 (6-8)	13 (11-15)	25 (21-27)	11 (21-27)	47 (36-62)	–	–	–	–	
76°39'N,14°52'E	Barents Sea, Norway	Liver	5×5	43 (41-46)	13 (12-15)	9 (8-9)	46 (38-54)	33 (38-54)	47 (37-64)	–	–	–	–	
72°00'N, 13°54'W	Jan Mayen/ North Atlantic Ocean	Liver	2×5 +1×9	50 (46-56)	7 (6.5-7.7)	9 (9-10)	28 (24-32)	13 (12-15)	25 (21-29)	–	–	–	–	11
78°37'N, 01°51'E	Greenland Sea	Liver	2×5 +1×16	38 (30-50)	7 (5.5-9)	11 (8-16)	32 (28-41)	29 (23-35)	72 (39-114)	–	–	–	–	
71°53'N, 09°06'W	Jan Mayen/ North Atlantic Ocean	Liver	5×5	56 (41-68)	8 (6-8.9)	7 (6-8)	52 (40-60)	57 (34-83)	71 (44-111)	–	–	–	–	
West Svalbard	Liver		52	36.8		6.3		28.5	31.5					16
			11×2-11	29-43		2-8		17-53	19-58					
	Muscle and skin		52	1		0.18		0.46	0.6					
			18×2-4	0.9-1.3					0.42-0.89					
Pechora Sea and South Novaya Zemlya	Liver		90	55.1		16.6		31.4	72.7					17
			12×4-14	52 62		15-18		24-54	59-106					
	Muscle and skin		57	0.8		0.22		0.22	0.54					
			14×2-7	0.7-0.8		0.20-0.26		0.12-0.37	0.30-0.86					
70-75°N, 170-180°E	Mid-Arctic Ocean, Aug-Sept 1994	Whole fish	2	2.8	0.8	1.1	3.5	6.1	22.1	32.4	1.0			18
75-80°N, 170-180°E	Mid-Arctic Ocean, Aug-Sept 1994	Whole fish	3	3.4	1.4	1.4	4.8	7.3	23.9	34.1	1.0			
Gadus ogac (Greenland cod)														
Cambridge Bay	Victoria Island, Canada	Whole fish excl. liver	9	–	–	–	–	–	(4.4-39)	–	–	–	–	7
Wellington Bay	Victoria Island, Canada	Whole fish excl. liver	2	–	–	–	–	–	(0.79-2.0)	–	–	–	–	
Gadus morhua (Atlantic cod, cod)														
69°28'N, 35°49'E	Barents Sea, Norway	Liver	25	48 (29-66)	23 (13-44)	12 (9-16)	75 (39-181)	114 (67-201)	392 (158-685)	–	–	–	–	9
74°22'N, 41°02'E	Barents Sea, Norway	Liver	5	49 (43-53)	28 (23-32)	14 (12-16)	140 (97-207)	163 (123-261)	264 (133-456)	–	–	–	–	
77°25'N, 37°07'E	Barents Sea, Norway	Liver	25	55 (41-64)	26 (17-35)	11 (3-17)	76 (52-107)	98 (69-131)	165 (94-344)	–	–	–	–	
76°39'N, 14°52'E	Barents Sea, Norway	Liver	25	41 (19-76)	19 (7-36)	7 (4-12)	108 (60-202)	166 (93-344)	205 (115-420)	–	–	–	–	
71°32'N, 29°00'E	Barents Sea, Norway	Liver	25	40 (5-69)	27 (9-40)	8 (3-11)	137 (91-191)	175 (116-248)	336 (192-603)	–	–	–	–	
62°34'N,06°14'W	Faeroe Islands	Liver	5×5	61 (56-65)	10 (9-11)	5 (4-5)	25 (22-30)	46 (42-50)	63 (52-68)	–	–	–	–	11
67°06'N, 08°31'E	Halten Banken	Liver	5×4-5	56 (35-64)	16 (6-27)	7 (4-9)	111 (60-162)	253 (129-452)	352 (232-519)	–	–	–	–	
66°43'N, 12°56'E	Iceland	Liver	5×5	48 (43-51)	16 (12-19)	9 (7-9)	49 (40-57)	71 (60-98)	76 (63-109)	–	–	–	–	
65°N, 23°W	Iceland	Liver	2	41.1 (38.5-43.8)	13.0	–	–	60.0 (55.0-65.0)	129 (127-132)	–	–	–	–	8
65°N, 13°W	Iceland	Liver	5	51.1 (42.9-57.8)	29.0 (25.0-38.0)	–	–	75.6 (47.0-110)	131 (78.0-174)	–	–	–	–	
66°N, 12°W	Iceland	Liver	1	60.5	32.0	–	–	56.0	75.9	–	–	–	–	
66°30'N, 25°W	Iceland	Liver	5	45.6 (36.5-57.2)	24.6 (21.0-31.0)	–	–	55.6 (41.0-75.0)	97.7 (70.9-129)	–	–	–	–	
66°30'N, 24°W	Iceland	Liver	1	63.6	38.0	–	–	75.0	96.1	–	–	–	–	

Location	Region and Country	Tissue	n[a]	% lipid	ΣCBz	ΣHCH	ΣCHL	ΣDDT	ΣPCB	Toxaphene	Dieldrin	Mirex	Heptachl.-epoxide	Reference
								(75.0-75.0)	(96.1-96.1)					
66°30', 14°W	Iceland	Liver	1	57.4	27.0	–	–	62.0	85.4	–	–	–	–	
66°30'N, 13°W	Iceland	Liver	5	51.5	22.0	–	–	44.0	79.2	–	–	–	–	
				(47.4-53.3)	(18.0-25.0)			(39.0-55.0)	(67.7-97.6)					
Baydaratskaya Gulf	Russia	Muscle and skin	1	–	0.29	1.42	1.75	2.12	9.6	–	–	0.07	0.12	12
Hippoglossoides platesoides (Long rough dab, American plaice)														
69°06'N,42°15'E	Barents Sea, Norway	Liver	5×5	5	3	2	7	11	36	–	–	–	–	9
				(3-10)	(1-5)	(1-3)	(4-11)	(7-15)	(21-48)					
70°36'N,46°47'E	Barents Sea, Norway	Liver	5×5	6	3	2	7	9	22	–	–	–	–	
				(3-11)	(1-4)	(1-3)	(4-11)	(6-14)	(12-35)					
73°04'N, 48°10'E	Barents Sea, Norway	Liver	5×5	7	3	2	7	7	15	–	–	–	–	
				(3-16)	(1-5)	(1-4)	(3-11)	(2-12)	(7-21)					
76°38'N, 36°26'E	Barents Sea, Norway	Liver	5×5	17	8	4	18	18	27	–	–	–	–	
				(11-21)	(5-11)	(3-5)	(14-24)	(13-22)	(18-33)					
76°39'N, 14°52'E	Barents Sea, Norway	Liver	5×5	18	6	3	14	12	16	–	–	–	–	
				(12-22)	(5-7)	(2-4)	(11-17)	(11-15)	(13-19)					
74°00'N, 18°00'E	Barents Sea, Norway	Liver	5×5	8	6	2	18	30	57	–	–	–	–	
				(6-9)	(5-7)	(1-2)	(16-20)	(19-43)	(36-79)					
66°01'N, 11°54'W	Iceland	Liver	5×5	21	10	5	39	47	38	–	–	–	–	11
				(18-27)	(9.4-12.3)	(4.3-5.6)	(32-48)	(34-63)	(30-47)					
Limanda limanda (European yellowtail flounder, Common dab)														
64°N, 23°Whole fish	Iceland	Liver	2	15.2	–	–	–	25.5	45.0	–	–	–	–	8
				(14.6-15.8)				(25.0-26.0)	(40.2-49.8)					
64°30'N, 23°W	Iceland	Liver	1	26.0	–	–	–	38.0	59.8	–	–	–	–	
64°30'N, 16°W	Iceland	Liver	2	20.4	–	–	–	38.5	53.7	–	–	–	–	
				(18.9-21.8)				(34.0-43.0)	(46.7-60.7)					
64°30'N, 16°W	Iceland	Liver	1	23.3	–	–	–	54.0	68.9	–	–	–	–	
66°30'N, 25°W	Iceland	Liver	2	17.1	–	–	–	12.0	44.2	–	–	–	–	
				(14.7-19.6)				(10.0-14.0)	(24.2-64.2)					
66°30'N, 25°W	Iceland	Liver	1	13.2	–	–	–	16.0	35.4	–	–	–	–	
Pleuronectes sp. (Plaice)														
Pechora River	Russia	Muscle and skin	1	–	1.23	0.79	1.12	3.97	6.4	–	–	0.04	0.06	12
Clupea harengus (Atlantic herring)														
64°30'N, 15°W	Iceland	Muscle and skin	1	9.32	1.30	–	–	2.70	3.77	–	–	–	–	8
66°30'N, 24°W	Iceland	Muscle and skin	1	11.9	1.95	–	–	8.05	10.9	–	–	–	–	
Sebastes marinus, mentella (Redfish)														
Davis Strait	W. Greenland	Liver	?	17.0±8.00	3.9±2.10	9.4±1.50	18±13	93±70.0	127±79.0					15
61°26'N, 31°42'W	Irminger Basin/North Atlantic	Liver	5×5	12	4	2	23	77	67	–	–	–	–	11
				(9-16)	(2.6-5)	(2-3)	(12-34)	(54-101)	(35-91)					
66°01'N, 11°54'W	Iceland/North Atlantic	Liver	5×5	14	6	2	15	21	22	–	–	–	–	
				(10-30)	(3.4-12.7)	(2-4)	(9-30)	(13-39)	(14-38)					
71°01'N, 09°01'W	Jan Mayen/North Atlantic	Liver	4×5	23	8	4	20	29	33	–	–	–	–	
				(16-30)	(6-8.9)	(3-6)	(14-27)	(26-36)	(31-37)					
67°06'N, 08°31'E	Halten Banken/North Atlantic	Liver	5×5	25	10	3	51	131	159	–	–	–	–	
				(17-37)	(6.9-13.3)	(2-4)	(46-59)	(91-177)	(114-203)					
59°30'N, 41°45'W	Kap Farvel/North Atlantic	Liver	5×5	12	5	2	29	111	109	–	–	–	–	
				(9-15)	(3.3-5.6)	(1-2)	(25-33)	(98-130)	(79-149)					
60°33'N, 09°33'W	Faeroe Islands	Liver	5×5	24	9	3	49	119	115	–	–	–	–	
				(20-27)	(6-12)	(2-4)	(29-63)	(76-148)	(104-136)					
Eleginus navaga (Navaga)														17
East Pechora Sea		Muscle and skin	5×5	0.7	0.4	0.17	0.59	0.91	1.9	–	–	–	–	
				0.7-0.7	0.33-0.53	0.16-0.18	0.52-0.72	0.8-1.1	1.6-2.4					
		Liver	4×5	21.5	13.4	8.2	61.2	82.4	223	–	–	–	–	
				21-23	12-15	7.3-9.6	53-69	70-97	183-255					
Mallotus villosus (Capelin)														17
East Pechora Sea		Whole fish	3×4-5	1	–	0.39	4.14	5.3	7.2	–	–	–	–	
				1.0-1.1		0.35-0.43	2.8-4.5	5.0-5.5	6.3-8.8					

osme brosme (Tusk)									
Davis Strait	West Greenland	Liver	58.0±9.00	41.0±7.0	13.0±4.00	132±42	552±172.0	522±210.0	15
ximora rostrata (Blue hake)									
Davis Strait	West Greenland	Liver	53.0±6.00	35.0±8.0	6.4±1.80	125±35	762±216.0	615±215.0	15
ntroscyllium fabricii (Black dogfish)									
Davis Strait	West Greenland	Liver	72.0±5.00	27.0±12.0	8.9±4.30	47±13	667±422.0	384±162.0	15
lacrourus bergax (Roughhead grenadier)									
Davis Strait	West Greenland	Liver	43.0±10.00	17.0±12.0	6.3±3.00	86±88	124±173.0	315±381.0	15
narbichas denticulatus (Jelly wolffish)									
Davis Strait	West Greenland	Liver	35.0±8.00	8.2±3.60	5.4±1.90	10±4	24±9.0	38±13.0	15
lydrolagus affinis (Smalleyed rabbit fish)									
Davis Strait	West Greenland	Liver	70.0±9.00	2.5±1.00	9.4±1.50	19±8	298±86.0	212±56.0	15

ndividuals and/or (pools ×individuals)

erences

Muir and Lockhart 1993a: Toxaphene quantified with a single response factor; ΣCBz = Sum of tetra-and pentachlorobenzene and HCBz; ΣHCH = Sum of α-, β-, and γ-HCH;
ΣCHL = Sum of oxy, *cis*-, *trans*-chlordane, heptachlor epoxide, and *cis*-, *trans*-nonachlor; ΣDDT = Sum of *o,p'*-DDT, *p,p'*-DDT, *o,p'*-DDD, *p,p'*-DDD, *o,p'*-DDE, and *p,p'*-DDE; ΣPCB = Sum of 92 peaks or 105 congeners.
Muir *et al.* 1994: As Muir and Lockhart (1) above.
. Savinova and Muir unpubl. data: As Muir and Lockhart (1) above.
. Muir and Lockhart 1994. As Muir and Lockhart (1) above.
. Muir and Lockhart 1996: As Muir and Lockhart (1) above.
. Bright *et al.* 1995b: ΣPCB = Sum of 23 individual or co-eluting congeners.
. Bright *et al.*, unpubl. data: ΣPCB = Sum of 47 congeners.
. Data provided by ICES database 1994: ΣCBz = HCBz only; ΣDDT= *p,p'*-DDE only; ΣPCB = Sum of 11 congeners (101, 105, 118, 128, 138, 153, 156,170, 180, 31, and 52).
. Stange and Klungsøyr 1997: ΣPCB = Sum of 13 congeners; ΣDDT = Sum of *p,p'*-DDD, *p',p*-DDE, and *p',p*-DDT; ΣCHL = Sum of *trans*-nonachlor, oxychlordane, and α- and β-chlordane; ΣCBz = HCBz only; ΣHCH = Sum of α-, β-, and γ-HCH.
. Melnikov *et al.* 1995: ΣCBz = Sum of HCBz and pentachlorobenzene; ΣHCH = α- and γ-HCH; ΣCHL = Sum of heptachlor, *cis*-chlordane, and *trans*-nonachlor; ΣDDT = Sum of *o,p'*-DDT, *p,p'*-DDT, *o,p'*-DDD, *p,p'*-DDD, *o,p'*-DDE, and *p,p'*-DDE;
ΣPCB = Sum of 7-9 congeners.
. Stange *et al.* 1996a: ΣCBz = HCBz only; ΣHCH = α-, β-, and γ-HCH; ΣCHL = Sum of α- and γ-chlordane, oxychlordane and *trans*-nonachlor; ΣDDT = Sum of *p,p'* DDT, *p,p'*-DDD and *p,p'*-DDE; ΣPCB = Sum of congeners 28, 31, 52, 101, 105, 118, 128,138, 149, 153, 156, 170, and 180.
.. Melnikov *et al.* 1995, 1996: ΣCBz = Sum of HCBz and pentachlorobenzene; ΣHCH = α-, β-, and γ-HCH; ΣCHL = Sum of heptachlor, *cis*-, *trans*-chlordane, and *cis*-, *trans*-nonachlor; ΣDDT = Sum of *o,p'*-DDT, *p,p'*-DDT, *o,p'*-DDD, *p,p'*-DDD, *o,p'*-DDE, and *p,p'*-DDE; ΣPCB = Sum of 7-9 congeners.
. Cleemann *et al.* 1996: ΣPCB = Sum of 11 congeners (28, 31, 52, 101, 105, 118, 128, 138, 153, 156, and 180); ΣDDT = Sum of *p,p'*-DDT, *p,p'*-DDD, and *p,p'*-DDE; ΣCBz = HCBz only; ΣCHL = *trans*-nonachlor only; ΣHCH = Sum of α-, β-, and γ-HCH.
. Skotvold 1996: ΣPCB = Sum of 10 congeners (28, 31, 52, 101, 118, 149, 138, 153, 156, and 180).
. Berg *et al.* 1996: ΣPCB = Sum of 19 congeners (28, 74, 99, 101, 105, 110, 118, 128, 138, 141, 153, 156, 157, 170, 180, 187, 194, 206, and 209).
. Killie and Dahle 1996a: ΣPCB = Sum of 11 congeners.
. Killie and Dahle 1996b: ΣPCB = Sum of 11 congeners.
. Muir and Macdonald unpubl. 1996: ΣPCB = Sum of 92 peaks or 105 congeners.
. Rice *et al.* 1992: ΣPCB = Aroclor 1254; ΣCBz = HCB; only non-detects were included in calculation of means as $^1/_2$ detection limit.

able 6-A18. Recent (collected primarily post-1990) mean concentrations (ng/g ww) of organochlorines in marine mammal samples from Arctic waters.

Region	Location	Tissue	Species	Sex	Year	Age, years	Statistic	n	% lipid	ΣCBz[a]	ΣHCH	ΣCHL	ΣDDT	ΣPCB	Toxaphene	Dieldrin	Mirex	Reference
Hudson Strait	Salluit	Blubber	Harp seal	♀		16.9	Mean	8	–	–	–	–	486	897	–	–	–	6
						7.9	SD		–	–	–	–	289	295	–	–	–	
N.E. Greenland	(West Ice)	Blubber	Harp seal	♀	1990	16	Mean	10	92.8	67.0	85.4	418	668	909	–	–	–	1,4
				Pups	1990	–	Mean	10	68.0	170.0	143	360	605	626	–	–	–	
N.E. Greenland	(West Ice)	Blubber	Harp seal	♂	1990	10.9	Mean	8	–	118	36.4	–	946	2830	–	–	–	5
						5.3	SD	–	–	84.5	12.6	–	933	2940	–	–	–	
Barents Sea	N. Norway (Skjanes)	Blubber	Harp seal	♂ ♀	1988/89	–	Mean	13		–	–	–	1600	3800	–	–	–	1
Barents Sea	N. Norway (Jarfjord)	Blubber	Harp seal	♂ ♀	1990	–	Mean	38		–	–	–	3100	3000	–	–	–	1
S. Barents Sea	White Sea	Blubber	Harp seal	Pups	1993	<1	Mean	11	80.4	110	69.3	698	710	1370	2100	82.2	12.0	3
						–	SD	–	9.7	64.8	22.0	300	437	725	1130	35.2	7.5	
S. Barents Sea	East ice	Blubber	Harp seal	♀		14	Mean	7.0	94	260.0	110.0	2290	3270	4420				2
						9-26	Range		92-96	50-640	70-190	350-5250	550-7870	750-9810				
				♂		11.0	Mean	9.0	92	130.0	90.0	1400	2180	2970				2
						6-19	Range		90-94	60-280	50-140	610-2120	1110-3510	1120-5450				
Iceland	Hofn	Blubber	Harbor seal	♂ ♀	1988	–	Mean	7	–	8.00	17.0	–	1550	5220	–	–	–	7
Barents Sea	Jarfjord	Blubber	Harbor seal	♂ ♀	1989/90	–	Mean	7	–		–	–	–	5200	–	–	–	1
Norwegian Sea	Versteralen	Blubber	Harbor seal	♂ ♀	1990	–	Mean	8	–	–	–	–	–	3400	–	–	–	1
S. Barents Sea	Jarfjord	Blubber	Grey seal	♂ ♀	1989	–	Mean	24	–	–	–	–	–	5700	–	–	–	1
						–	SD		1.5	–	–	–	889	614	–	–	–	
				♂	1990	–	Mean	8	95.3	–	–	–	1510	1720	–	–	–	