Health Consultation

Review of Burbot Samples

US ARMY USACE UMIAT AIR FORCE STATION
(a/k/a FORMER UMIAT AIR FORCE STATION)

PRUDOE BAY, NORTH SLOPE BOROUGH, ALASKA

EPA FACILITY ID: AK0000286666

NOVEMBER 13, 2003

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

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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Prepared by:

Federal Facilities Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Summary

Fishing is very important to the Nuiqsut, Alaska community. Subsistence foods make a substantial contribution to their nutritional well being, as well as social, mental, physical, and spiritual well being. As a result of past activities at the former Umiat Air Force Station and atmospheric deposition[1], many Alaskans worry that environmental contamination exists in the Colville River. They are concerned that exposures to contaminants resulting from a subsistence lifestyle can potentially lead to harmful health effects. Because of these concerns, the Agency for Toxic Substances and Disease Registry (ATSDR) reviewed and evaluated the following four potential exposure scenarios:

1. Eating fish from the Colville River every day for 70 years (see page 10).
2. Eating whole burbot in high quantities four months of the year (see page 18).
3. Eating burbot livers four months of the year (see page 19).
4. Eating several burbot livers in one sitting (see page 21).

While polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), and DDT derivatives were detected in fish collected from multiple areas of the Colville River, the levels were very low and exposures to them are not expected to cause harmful health effects. Thus, ***ATSDR determined that it is safe to eat the fish.***

1. ATSDR specifically evaluated a conservative chronic exposure scenario of eating a high quantity of fish (up to 390 grams, almost a pound) from the Colville River every day for 70 years. This ingestion rate was based on information available in the Community Profile Database that was specific to the Nuiqsut community. The concentrations detected in the August 2001 burbot sampling were used as representative concentrations for all fish found in the river, even though this is expected to overestimate the actual concentrations found in other fish. Specifically, whitefish, which are eaten in much higher quantities than burbot, are lower on the food chain, and likely contain lower PCB and DDT concentrations. The estimated exposure doses for both adults and children were well below health effects levels documented in the scientific literature. *Therefore, ATSDR concluded that it is safe to eat fish from the Colville River*.

2. At the request of the community, ATSDR also evaluated an intermediate exposure scenario of eating burbot in high quantities during certain times of the year (i.e., during the seasonal harvest). Based on information available in the Community Profile Database, ATSDR assumed people ate 62 grams of burbot every day for four months (this corresponds to eating about two 1/2-pound meals of burbot each week). Again, the estimated exposure doses were well below health effects levels reported in the scientific literature. *Therefore, ATSDR concluded that it is safe to eat high quantities of burbot during the harvest*.

3. Community members have also expressed concern over eating burbot livers. ATSDR evaluated an intermediate exposure scenario in which the elders of the Nuiqsut

[1] "Atmospheric deposition of PCBs and DDTs is also a significant source of total PCBs and DDTs present in burbot in the main Colville River" (Ecology and Environment 2003).

community ate about six burbot livers per week (59.2 g/day) and children ate about three livers per week (26.8 g/day) during the four-month burbot harvest. Both evaluations showed that the conservatively estimated exposures from eating burbot livers were well below health effects levels documented in the scientific literature. *Thus, ATSDR concluded that it is safe to eat burbot livers during the seasonal harvest.*

4. ATSDR also evaluated an acute scenario in which elders ate six burbot livers (409 g/day) during one meal. Because the resulting exposure dose was below health effects levels reported in the scientific literature, *ATSDR concluded that it is safe to eat several burbot livers in one sitting.*

ATSDR's health conclusions are supported by the fact that there are no fish advisories for the state of Alaska and the Alaska Division of Public Health recommends continued unrestricted consumption of traditional subsistence foods in Alaska (EPA 2003; State of Alaska 1998). The Alaska Division of Public Health evaluated levels of PCBs in freshwater fish and marine mammals and serum levels of PCBs in Alaskan Natives from several studies. They concluded that the benefits of eating traditional foods far outweigh the potential risks of eating trace quantities of PCBs in the food (State of Alaska 1998).

The State of Alaska Department of Health and Social Services released an interim health consultation that examined the potential health implications from eating fish collected in or near the Former Umiat Air Force Station (State of Alaska 2000). Grayling, burbot, and whitefish were collected from the Unit C slough in 1997 and 1998 and from four miles upstream and four miles downstream of the slough in 1998. The state concluded that the concentrations of PCB and DDT detected in the fish were not at levels of health concern. They based their decision on guidance provided by the Great Lakes Sport Fish Advisory Task Force (Great Lakes Fish Advisory Task Force 1993), the U.S. Environmental Protection Agency (EPA) (EPA 1994 as cited in State of Alaska 2000), and the U.S. Food and Drug Administration (FDA) (FDA 2001).

In addition, the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) recently released a *Critical Document Review of Human Health Effects Associated with PCBs at the Colville River Seasonal Slough* (CHPPM 2003). CHPPM reports that a landfill at the former Umiat Air Force Station was a historical source of PCBs to the seasonal slough, however, they note "it is doubtful that the landfill remains an ongoing source of PCBs to the seasonal slough, to downstream Colville River sediments, or the Colville River fishery" (CHPPM 2003). CHPPM concluded that there are no health risks associated with consuming fish from the slough. They compared the total PCB results from three fish sampling investigations to the FDA's tolerance level of 2 ppm and to the Great Lakes Fish Advisory Task Force recommendations (unrestricted fish consumption if the concentration is less than 0.05 ppm) (FDA 2001 and Great Lakes Fish Advisory Task Force 1993). The maximum total PCB concentration detected in the burbot whole body samples was 0.03 ppm, well below FDA's tolerance level and within the unlimited quantity fish consumption category recommended by the Great Lakes Fish Advisory Task Force. Similarly, the maximum total DDT concentration detected in burbot whole body samples was 0.07 ppm, well below FDA's action level of 5 ppm for fish (FDA 2001). While these comparisons do not specifically take into consideration the consumption rate of the Nuiqsut community, they do add further validation and perspective.

Despite this, there are people who might be more sensitive or susceptible to exposure to PCBs and DDTs because of factors such as age, occupation, gender, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people, for example, are often more sensitive to environmental exposures. Though the fish are safe for even the most sensitive and susceptible populations, it is wise to reduce exposure to environmental contamination when possible. If community members are concerned and wish to reduce their exposure to PCBs and DDTs, they can follow these suggestions:

- Eat the less fatty parts of the fish, such as the fillets, and eat fewer livers.
- Remove the skin and trim the fat from the fish.
- Grill, broil, or bake the fish to allow the contaminants from the fatty portions to drain out. This helps remove pollutants stored in the fatty parts of the fish. Avoid frying, since it seals in contaminants that might be in the fish's fat into the portions that are eaten (EPA and ATSDR 2002).
- Do not use cooking liquids or fat drippings from the fish since these liquids retain PCBs.
- Choose to eat younger (or smaller) fish and those lower on the food chain.
- Try to avoid fishing near the Unit C slough at Umiat because the highest concentrations were detected in this area.

For reference, EPA and ATSDR's *A Guide to Healthy Eating of the Fish You Catch* is provided in Appendix B.

Statement of Issue

A Nuiqsut community member requested that ATSDR evaluate the fish data collected from the Colville River in 2001 (Ecology and Environment 2003), taking into consideration specific exposures to the Nuiqsut community.

In 2001, ATSDR released a health consultation that reviewed data from fish that were sampled near the former Umiat Air Force Station in 1997 and 1998 (ATSDR 2001). The health consultation focused on evaluating the potential risk to people who harvest fish in or near the Umiat site. ATSDR determined that human exposures to contaminants in fish at the Umiat site were not occurring at frequencies considered to be a current public health problem. This was due to the small quantity of fish and the current lack of harvesting those fish. Therefore, ATSDR concluded "current Colville River fish contamination data do not indicate the need for public health concerns" (ATSDR 2001).

As part of the health consultation, ATSDR recommended that additional sampling be conducted to better characterize the nature and extent of downstream contamination in the Colville River. To address this issue, 70 burbot (*Lota lota*) were collected from the Colville River in August 2001, from approximately 20 miles upriver of Umiat to approximately 90 miles downriver, near Nuiqsut, Alaska (Ecology and Environment 2003). Burbot was selected because (1) past studies indicated a possible trend of higher concentrations in burbot downstream from Umiat, (2) they are the most numerous resident predatory fish in the Colville River, and (3) they are a species that are actively sought and eaten by the subsistence population (Ecology and Environment 2003).

In this health consultation, ATSDR specifically reviewed and evaluated potential exposures to the Nuiqsut community, which relies on fish from the Colville River as part of their subsistence lifestyle. ATSDR recognizes that the use of these fish, as part of a subsistence diet, has a high cultural and nutritional significance. Therefore, before decisions are made to limit consumption of traditional foods, consideration should be given to the benefits that the foods provide compared to the potential risks, if any, from low levels of chemical contaminants present in the foods. To help the community weigh this information in terms of their own personal values, ATSDR also presents information on, and considers the benefits of, eating fish within this document.

Background

Site Description

Former Umiat Air Force Station

The 8,000-acre former Umiat Air Force Station is located adjacent to the Colville River, approximately 120 miles south of the Prudhoe Bay, in northern Alaska (see Figure 1) (Ecology and Environment 2003). Beginning in 1944, about 115 acres of the site were developed for Department of Defense activities, including the Airstrip Complex, Main Gravel Pad, Unit C slough, and 11 historical oil exploration test well sites (Ecology and Environment 2003). In 1960, the property transferred to the Bureau of Land Management. Ownership of the 115 developed acres currently resides with the Alaska Department of Transportation and Public Facilities (Ecology and Environment 2003).

The site was active from 1944–1960, and was primarily used to refuel military aircraft and explore for oil. Currently, Umiat is a lodging and stopover location for guided hunting and fishing trips in the area and a base for oil exploration activities (Ecology and Environment 2003).

Umiat does not have a year-round residential population—approximately eight people intermittently live at Umiat throughout the year (CHPPM 2003). Additionally, very few workers and visitors stay on site—between 22 and 50 temporary workers and hunting guides and as many as 70 visitors stay at the Umiat lodge over the course of a year (CHPPM 2003).

As a result of past activities, environmental contamination exists at the site, particularly PCBs and DDT originating from an old landfill near a seasonal slough in the Unit C section of Umiat (known as the Unit C slough) (Ecology and Environment 2003). The slough runs for about a half mile before entering the Colville River. Water and fish are present in the slough for about four months of the year, after the spring ice breakup and during heavy rain events. The U.S. Army Corps of Engineers has the responsibility of environmental cleanup at the site.

How do contaminants get in fish?

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

Colville River

The Colville River originates from the headwaters in the Brooks Range and travels for 450 miles before emptying into the Beaufort Sea (Ecology and Environment 2003). It is the largest waterway in the northern slope of Alaska. The discharge near the mouth of the river was estimated to be 16,000 cubic feet per second (Roguski et al. 1971 as cited in Ecology and Environment 2003). The most prevalent fish found in the Colville River include whitefish, Arctic grayling, ciscos, and sticklebacks (Ecology and Environment 1997).

Nuiqsut

Nuiqsut, Alaska, is located in the North Slope Borough about 35 miles south of the Beaufort Sea coast and 154 miles southeast of Barrow (see Figure 1) (ADCED 2003; NSB 2000). It encompasses 9.2 square miles of land near the Colville River Delta, which has traditionally been a gathering and trading place for the Inupiat Eskimos (McPhee Publications 2003; ADCED 2003; TDX 2002). The area that is currently the city of Nuiqsut was formerly the village of Itqilippaa, which was abandoned in the late 1940s. However, in 1973, the area was resettled by 27 families from Barrow (McPhee Publications 2003; ADCED 2003; TDX 2002). The city of Nuiqsut was incorporated in 1975 (ADCED 2003; TDX 2002).

According to the 2000 U.S. Census, 433 people live in Nuiqsut. The majority of the population (88.2%) is Alaskan Native, 10.2% are white, and a small percentage consists of persons of other races (U.S. Census 2000). The median age is 23.8 years. Forty-two children are under the age of six and 19 people are over the age of 65. The population is comprised of about 60% men and 40% women (U.S. Census 2000).

The majority of the population is Inupiat Eskimo who practice a subsistence lifestyle (TDX 2002). Nuiqsut's economy is based on hunting, fishing, whaling, trapping, and craft-making (McPhee Publications 2003). Local harvests include fish (salmon, smelt, cod, burbot, char, grayling, whitefish), land mammals (brown bear, caribou, moose, squirrel), marine mammals (seal, whale), birds (duck, geese, swan, eggs), and vegetation (berries, plants/greens, mushrooms) (see Table 1) (Alaska Department of Fish and Game 2000).

Table 1. Nuiqsut Community 1993 Total Resource Harvest

Resource	Harvest (pounds)	Percent of Total Harvested
Fish	90,490	33.8%
Land Mammals	87,390	32.6%
Marine Mammals	85,216	31.8%
Birds	4,325	1.6%
Vegetation	396	0.1%
Total Harvest	267,817	100%

Source: Alaska Department of Fish and Game 2000
Note: Numbers are rounded.

Species Description

Burbot are also sometimes referred to as cusk, lingcod, ell pout, loache, ling, lawyer, lush, methyl, or mud shark (see picture). They are the only member of the cod family (Gadidae) in North America that lives entirely in fresh water (Alaska Department of Fish and Game 2002).

Note: This picture is from *New York's Unusual Fish--Part I Unusual Fish Species That Anglers May Encounter* first published in the November/December 1991 issue of The Conservationist magazine. Updated June 1999. Authors are John Hasse & Eileen C. Stegemann. Available from URL: http://www.dec.state.ny.us/website/dfwmr/fish/fishspecs/unu1text.html#burbot.

In Alaska, burbot typically reach about 15 to 22 inches, but can grow as long as 46 inches (Alaska Department of Fish and Game 2002). At about 18 inches, they will spawn for the first time, under the ice in late winter (February to March). They are a long-lived species—burbot older than 20 years are not uncommon in Alaska (Alaska Department of Fish and Game 2002). They are also voracious predators. By the age of 5, burbot feed almost entirely on fish, including whitefish, sculpins, lampreys, and other burbot (Alaska Department of Fish and Game 2002). Burbot collected in August 2001 ranged from 5 to 22 years old and the average age was 9 years[2]. They were 11 to 37.5 inches in length and averaged 24.2 inches (Ecology and Environment 2003).

Burbot are somewhat sedentary, hovering near the bottom of the stream (Morrow 1980 as cited in Ecology and Environment 2003). However, they may travel great distances (up to 78 miles) during spawning season (Breeser 1988 as cited in Ecology and Environment 2003). A recent telemetry study performed in the Colville River delta showed burbot moving in and out of shallow ephemeral streams and backwaters from larger rivers and streams and overwintering in deeper lakes or river channels (Morris 2003 as cited in Ecology and Environment 2003).

Review of Data

In August 2001, 70 burbot from the Colville River were collected and analyzed for PCB congeners, Aroclors, DDT, and DDT derivatives (namely, dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)) (Ecology and Environment 2003). Ten burbot were collected from each of the seven reaches along a 110-mile stretch of the Colville River. One reach was located 20 river miles upstream from Umiat, one reach consisted of the 0.5-mile length of the Unit C slough, and the remaining five reaches were located up to 90 miles downstream of Umiat (see Figure 2).

[2] The otoliths were removed for age determination of the fish.

The livers were removed from the burbot and analyzed separately from the rest of the body. After analysis, the results were mathematically combined to obtain whole body concentrations (Ecology and Environment 2003). ATSDR's evaluations are based primarily on the whole body concentrations that include the liver.

> Any single, unique, well-defined chemical compound in the PCB category is called a "congener."
>
> "Isomers" are molecules that have the same chemical formula but have different arrangements of their atoms.

The total PCB concentrations were calculated by summing the individual congener concentrations. The total DDT concentrations were calculated by summing the 2,4- and 4,4-isomers of DDD, DDE, and DDT. Before the concentrations were summed, the data were processed for statistical purposes. Basically, congeners with low abundance (less than 30%) were removed and the nondetects were substituted with one half the detection limit for that sample (see Ecology and Environment 2003 for additional details). The detection limits were sufficiently low. In addition, in order to address the issue of coeluting congeners, one congener label in a coeluting group was retained while the others were removed. ATSDR reviewed this procedure and determined it was acceptable for evaluating health effects. Many of the congeners that were removed due to low abundance were not detected. The congeners that were detected were found very few times in very low concentrations that would not substantially increase the total PCB concentrations.

Because the sampling was conducted for ecological purposes, the burbot analytical results were lipid normalized to increase the power of the statistical tests being performed on the data (see Ecology and Environment 2003 for additional details). However, to evaluate whether health effects are likely to result from eating burbot from the Colville River, ATSDR based its analytical evaluations on the wet weight concentrations in the burbot rather than the lipid normalized data.

> *Wet Weight vs. Lipid-based Concentration*
>
> Wet weight refers to the entire weight of a sample including its contained water. Results of tissue samples collected for the purposes of human health evaluations are typically reported on a wet weight basis.
>
> The concentration of a contaminant present in a specified weight of fat from a tissue sample is known as its lipid-based concentration. Results are reported this way so that concentrations across different data sets can be compared without having to be concerned about the differences in the fat content of the samples.

Discussion

Nutritional Benefits of Eating Fish and Other Traditional Subsistence Foods

ATSDR realizes that the subsistence lifestyle is very important to the Nuiqsut community, as well as other Alaskan Natives. Hunting, fishing, gathering, and preserving the foods give community members a chance to work together, share the resources collected, and celebrate successful harvests (Bureau of Land Management 1996). "The culture of the Inupiat is irrevocably intertwined with the collection of these resources" (Bureau of Land Management 1996).

Traditional foods provide inexpensive and readily available nutrients (such as iron, zinc, copper), omega-3 fatty acids, antioxidants, vitamins, calories, and protein (Nobmann 1997; State of Alaska 1998). In addition, they are lower in carbohydrates and salt than store-bought foods. Traditional foods, which are low in saturated fat and high in monounsaturated fat and Omega-3 fatty acids, are considered to be healthier than and nutritionally superior to "typical American foods" (State of Alaska 1998). In general, subsistence is healthier for Alaskan Natives who are accustomed to eating traditional foods (Bureau of Land Management 1996). It has been shown that people who gather and eat traditional foods have lower incidence of diabetes, cardiovascular disease, and obesity, as well as improved maternal nutrition and neonatal and infant brain development (Nobmann 1997; State of Alaska 1998).

Economically, subsistence foods are very important to remote Alaskan communities because store-bought foods are expensive and many "typical American foods" are not readily available. In addition, a subsistence lifestyle provides meaningful, productive work where paying jobs are scarce (State of Alaska 1998). Not only are the resources used to provide nourishment, but they are also used to make arts and crafts, tools, and clothing (Bureau of Land Management 1996).

Many Alaskans worry that exposures to contaminants resulting from a subsistence lifestyle can potentially lead to cancer, worsen existing conditions such as diabetes and asthma, and increase the incidence of other health problems. To enable informed choices about foods, Alaskans have requested more information about the risk from these exposures and the nutritional benefits of traditional foods. To assist in this effort, ATSDR awarded a grant to the Alaska Native Health Board to support surveys of the dietary habits of Alaskans who regularly eat traditional foods. This grant formed the cornerstone for ATSDR's Alaska Traditional Diet Project, which was developed to assist consumers of Alaskan traditional foods in making informed dietary decisions to prevent adverse health outcomes.

Community members who would like additional information about the ATSDR Alaska Traditional Diet Project may call Leslie Campbell or Bill Cibulas, toll free, at 888-477-8737 or call Richard Kauffman in the ATSDR Region 10 office (Seattle) at 206-553-2632. ATSDR has published information about the project on the following Web site: http://www.atsdr.cdc.gov/alaska.

Public Health Implications of Eating Fish from the Colville River

Is it safe to eat fish from the Colville River?

Yes, it is safe for the Nuiqsut community to eat fish from the Colville River. PCBs, DDT, and DDT derivatives were detected in the burbot collected in August 2001 from the Colville River. However, detected levels were very low and exposures to them are not expected to cause harmful health effects.

To determine whether it is safe to eat Colville River fish, ATSDR evaluated the following four potential exposure scenarios:

1. Eating fish from the Colville River every day for 70 years (chronic exposure).
2. Eating whole burbot in high quantities four months of the year (intermediate exposure).
3. Eating burbot livers four months of the year (intermediate exposure).
4. Eating several burbot livers in one sitting (acute exposure).

1. Evaluation of eating fish from the Colville River

ATSDR evaluated whether eating up to 390 grams of fish (almost a pound) from the Colville River every day for 70 years would result in harmful health effects. This conservative evaluation was based on information available in the Community Profile Database that was specific to the Nuiqsut community and chemical concentrations detected in burbot collected from several areas in the Colville River. The estimated exposure doses for both adults and children were well below health effects levels documented in the scientific literature. Therefore, ATSDR concluded that it is safe to eat fish from the Colville River.

To answer the question whether fish in the Colville River are safe to eat, ATSDR evaluated the burbot data collected in 2001 from several areas along the river (Ecology and Environment 2003). ATSDR decided to use burbot as a representative species of fish that characterizes a maximum/worst-case exposure because (1) PCBs and DDT bioaccumulate in higher food chain species, (2) burbot are a top predatory species in the Colville River, and (3) burbot are actively sought after and eaten by the Nuiqsut community and are the most consumed predatory species of fish.

Why do these chemicals bioaccumulate?

First, PCBs and DDTs stay in the body of the fish, mostly in fatty tissue, and will not readily leave the fatty tissue (bioconcentration). Second, the chemical levels will increase in species higher in the food chain (biomagnification). Thus, a fish that eats organisms (such as other fish) with PCBs and DDTs will have higher amounts of the contaminants in their bodies.

According to the 1993 data within the Community Profile Database[3], burbot only comprise 6.6% of the total fish harvested by the Nuiqsut community. Whereas, various species of whitefish comprise about 85.8% of the total fish harvested (Alaska Department of Fish and Game 2000).

[3] The Community Profile Database was developed by the Division of Subsistence within the Alaska Department of Fish and Game to be a central repository of information on contemporary subsistence uses within Alaskan communities (Alaska Department of Fish and Game 2000).

See Table 2 for the Nuiqsut community 1993 per capita fish harvest. Whitefish are lower on the food chain and would be expected to contain lower PCB and DDT concentrations than burbot. To support this expectation, ATSDR compared the average wet weight concentrations detected in whole body burbot samples to those detected in whitefish, both collected in the slough. The average total PCB and DDT concentrations in burbot collected in 2002 were 0.0103 ppm and 0.0157 ppm, respectively (Ecology and Environment 2003). The average total PCB and DDT concentrations in whitefish collected in 1998 were slightly lower at 0.0077 ppm and 0.0007 ppm, respectively (E&E 1999 as cited in ATSDR 2001). This makes ATSDR's evaluation of whether it is safe to eat fish from the Colville River conservative, since whitefish (the species that are eaten more) contain lower PCB and DDT concentrations than the concentrations used in the health evaluation (concentrations detected in burbot).

Table 2. Nuiqsut Community 1993 Per Capita Fish Harvest

Fish	Per Capita Harvest (pounds)	Percent of Total Fish Harvested
Salmon (predator species)	2.8	1.1%
Smelt (prey species)	0.12	0.05%
Cod (predator species)	0.02	0.01%
Burbot (predator species)	16.5	6.6%
Char (predator species)	4.8	1.9%
Grayling (prey species)	11.3	4.5%
Whitefish (prey species)	215	85.8%
Total Per Capita Fish Harvest	251	100%

Source: Alaska Department of Fish and Game 2000
Note: Numbers are rounded.

PCBs and DDT/DDE/DDD are lipophilic, meaning that they are attracted to lipids (fats) and tend to accumulate in body parts that are more fatty, such as the liver. According to nutrition values found in the Alaska Traditional Knowledge and Native Foods Database, burbot flesh (i.e., fillet) contains 0.8 grams of lipids per 100-gram serving and burbot livers contain 42 grams per serving (ISER 2002). Mixed species of raw whitefish contain 6.1 grams of lipid per 100-gram serving. While this is not a direct comparison between burbot and whitefish, it does show that burbot livers are extremely fatty in comparison to the burbot flesh and whitefish. Therefore, by basing the health evaluation on the whole body concentrations of burbot, ATSDR is including the highly fatty component of the fish (i.e., the liver of burbot).

ATSDR recognizes that the subsistence harvest varies from year to year, depending on successful harvesting of other species, such as caribou and whales. For example, according to the 1985 data for the Nuiqsut community, fish comprised 44.1% of the total harvest and burbot, specifically, consisted of 3.8% of the total fish harvest. Whereas in 1993, fish comprised 33.8% of the total harvest and burbot consisted of 6.6% of the total fish harvest (Alaska Department of Fish and Game 2000). While the percentages changed from year to year, the Nuiqsut community consistently harvested many more whitefish than burbot in both years.

According to the Community Profile Database, each person harvested about 250 edible pounds[4] of fish in 1993. The mean per capita total fish harvest was 312 grams of fish per day (g/day), the 50th percentile use was 338 g/day, and the 95th percentile use[5] was 390 g/day (Alaska Department of Fish and Game 2000). For perspective, an average 8-ounce (1/2-pound) meal is equal to 227 grams. The mean per capita total fish harvest was 219 g/day in 1985 (Alaska Department of Fish and Game 2000). EPA recommends using an intake rate of 170 g/day (95th percentile) for Native American subsistence populations (CRITFC 1994 as cited in EPA 1997). To be conservative, ATSDR chose to use 390 g/day (7/8 of a pound) as the ingestion rate (the 95th percentile use in 1993). This ingestion rate represents an individual who is expected to consume more fish than 95% of the Nuiqsut community. It should be noted that because these ingestion rates are based on harvest data, they may overestimate the amount of fish actually eaten by the community.

There are 454 grams in one pound.

Even though burbot were collected from areas close to Nuiqsut, the community fishes all along the Colville River, including areas near Umiat. There is an unofficial effort to discourage subsistence populations from fishing in the Unit C slough (personal communication with community member, June 2003). Because the community fishes near Umiat and burbot are highly mobile, ATSDR chose to base the health evaluation on all the burbot caught in the Colville River.

To quantitatively evaluate exposures from eating Colville River fish, ATSDR derived exposure doses (i.e, the amount of chemical a person is exposed to over time) and compared them against health-based guidelines. Exposure doses are expressed in milligrams per kilogram per day (mg/kg/day). When estimating exposure doses, health assessors evaluate chemical concentrations to which people could be exposed, together with the length of time and the frequency of exposure. Collectively, these factors influence an individual's physiological response to chemical exposure and potential outcomes. ATSDR used site-specific information regarding the frequency and duration of exposures. In addition, ATSDR employed several conservative assumptions to estimate exposures.

Exposure to a certain chemical does not always result in harmful health effects. The type and severity of health effects expected to occur depend on the exposure concentration, the toxicity of the chemical, the frequency and duration of exposure, and the multiplicity of exposures.

The following equation was used to estimate ingestion of PCBs and DDTs by eating fish:

$$\text{Estimated exposure dose} = \frac{\text{Conc.} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

Conc.: Concentration of chemical in fish tissue in parts per million (ppm, which is also mg/kg)

IR: Ingestion rate: adult = 0.39 kilograms (kg)* of fish per day; child = 0.195 kg of fish or shellfish per day

[4] In general, "edible pounds" is about 70-75% of round weight for fish (Alaska Department of Fish and Game 2000).
[5] The "95th percentile per capita use" is the amount of wild food used by the consumer at the 95th percentile rank (Alaska Department of Fish and Game 2000).

EF: Exposure frequency, or number of exposure events per year of exposure: 365 days/year
ED: Exposure duration: adult = 70 years; child = 6 years
BW: Body weight: adult = 70 kg; child = 16 kg
AT: Averaging time, or the period over which cumulative exposures are averaged (6 years or 70 years x 365 days/year)

* 0.39 kg is the 95th percentile per capita use (high end user) based on the edible amount of total fish harvested by the Nuiqsut community in 1993 (Alaska Department of Fish and Game 2000). A child's ingestion rate was assumed to be half the adult ingestion rate.

It should be noted that ATSDR did not assume that estimated exposures would be reduced by preparation (i.e., removing the fat) and cooking methods. ATSDR also assumed that all PCB and DDT gets into the body (100% bioavailability).

ATSDR analyzed the weight of evidence of available toxicologic, medical, and epidemiologic data to determine whether exposures might be associated with harmful health effects (noncancer and cancer). As part of this process, ATSDR examined relevant health effects data to determine whether estimated doses are likely to result in harmful health effects. As a first step in evaluating noncancer effects, ATSDR compared estimated exposure doses to conservative, chemical-specific health guideline values, including ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs). The MRLs and RfDs are conservative estimates of daily human exposure to a substance that are unlikely to result in noncancer effects over a specified duration. These chemical-specific estimates, which are intended to serve as screening levels, were used by the ATSDR health assessor to identify contaminants and potential health effects that are not expected to cause adverse health effects. *Estimated exposure doses that are less than these values were not considered to be of health concern.* To maximize human health protection, MRLs and RfDs have built-in uncertainty or safety factors, making these values considerably lower than levels at which health effects have been observed. The result is that even if an exposure dose is higher than the MRL or RfD, it does not necessarily follow that harmful health effects will occur. It simply indicates to ATSDR that further evaluation is required before a conclusion can be drawn.

In addition, to screen for cancer effects, estimated chronic-exposure doses were multiplied by EPA's cancer slope factors (CSFs) to measure the relative potency of carcinogens, such as PCBs and DDTs. This calculation estimated a theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a lifetime of exposure. For example, an estimated cancer risk of 1×10^{-6} predicts the probability of one additional cancer over background in a population of 1 million. Because conservative models are used to derive CSFs, the doses associated with these estimated hypothetical risks may be orders of magnitude lower than doses reported in the toxicology literature to cause carcinogenic effects. As such, a low cancer risk estimate indicates that the toxicology literature would support a finding that no excess cancer risk is likely. A higher cancer risk estimate, however, indicates that ATSDR should carefully review the toxicology literature before making conclusions about potential cancer risks.

Sources for Toxicologic, Medical, and Epidemiologic Data

By Congressional mandate, ATSDR prepares toxicological profiles for hazardous substances found at contaminated sites. Two toxicological profiles were used to evaluate potential health effects from ingestion of fish from the Colville River—PCBs (ATSDR 2000) and DDT, DDE, and DDD (ATSDR 2002). ToxFAQs for each are provided in Appendix B. ATSDR's toxicological profiles are available on the Internet at http://www.atsdr.cdc.gov/toxpro2.html or by contacting the National Technical Information Service (NTIS) at 1-800-553-6847.

EPA also develops health effects guidelines, and in some cases, ATSDR relied on EPA's guidelines to evaluate potential health effects. These guidelines are found in EPA's Integrated Risk Information System (IRIS)—a database of human health effects that could result from exposure to various substances found in the environment. IRIS is available on the Internet at http://www.epa.gov/iris. For more information about IRIS, please call EPA's IRIS hotline at 1-301-345-2870 or e-mail at Hotline.IRIS@epamail.epa.gov.

To screen out which chemicals do not require further evaluation, ATSDR calculated exposure doses using the maximum concentrations found in the fish. The resulting exposure doses for Aroclor 1242, 2,4-DDD, 4,4-DDD, 2,4-DDE, 4,4-DDE, 2,4-DDT, and 4,4-DDT were below health guidelines for chronic exposure (i.e., they were below MRLs and RfDs and the cancer risk estimate was low). *Therefore, none of these chemicals were detected at a level of health concern for people eating fish from the Colville River and will not be discussed further.*

Health guideline values were exceeded for total PCBs, Aroclor 1254, Aroclor 1260, and total DDTs. Therefore, ATSDR examined the health effects levels discussed in the scientific literature and more fully reviewed exposure potential for these chemicals. ATSDR reviews available human studies as well as experimental animal studies. This information is used to describe the disease-causing potential of a particular chemical and to compare site-specific dose estimates with doses shown in applicable studies to result in illness (known as the margin of exposure). For cancer effects, ATSDR compares an estimated lifetime exposure dose to available cancer effects levels (CELs), which are doses that produce significant increases in the incidence of cancer or tumors, and reviews genotoxicity studies to understand further the extent to which a chemical might be associated with cancer outcomes. This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the plausibility of harmful health outcomes under site-specific conditions.

When comparing estimated exposure doses to actual health effects levels in the scientific literature, ATSDR estimates doses based on more realistic exposure scenarios. In this level of the evaluation, an average concentration is used to calculate exposure doses to estimate a more probable exposure (see Table 3). This approach is taken because it is highly unlikely that anyone would ingest fish with the maximum concentration on a daily basis and for an extended period of time because not every fish contains the maximum detected concentration of any given chemical. Therefore, it is more likely that fish containing a range of concentrations would be ingested over time.

Table 3. Exposure Doses for Chemicals Exceeding Health Guidelines for the Evaluation of Eating Fish from the Colville River

Chemical	Average Concentration (ppm)	Estimated Exposure Dose (mg/kg/day)	
		Adult	Child
Total PCBs	0.0064	3.59×10^{-5}	7.86×10^{-5}
Aroclor 1254	0.0062	3.43×10^{-5}	7.50×10^{-5}
Aroclor 1260	0.0026	1.43×10^{-5}	3.13×10^{-5}
Total DDTs	0.0041	2.28×10^{-5}	4.98×10^{-5}

Note: Whole body concentrations that include the liver were used to calculate the doses.

PCBs

PCBs are a group of synthetic organic chemicals that can cause a number of different harmful effects. There are no known natural sources of PCBs in the environment. Because they don't burn easily and are good insulating materials, PCBs were used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. The manufacture of PCBs stopped in the United States in August 1977 because there was evidence that PCBs build up in the environment and may cause harmful effects (ATSDR 2000).

PCBs enter the environment as mixtures containing a variety of individual chlorinated biphenyl components, known as congeners. There are 209 possible PCB congeners. Aroclors are commercial PCB mixtures, containing different congener compositions. Aroclors widely used in the United States were 1016, 1232, 1242, 1248, 1254, and 1260. The first two digits indicate the type of mixture and second two digits reveal how much chlorine by weight is in the mixture.

The mixture of PCB congeners found in fish is not going to exactly match the original Aroclor composition because each congener has different physical and chemical properties that affect how it behaves in the environment. For example, less chlorinated PCBs (1–4 chlorines) are readily taken up by organisms, but are also readily eliminated and metabolized. The most highly chlorinated congeners (7–10 chlorines) occur in low concentrations in the environment, and are tightly bound with soil, sediment, and organic matter. Thus, these PCBs are also not significantly bioaccumulated (Bergen et al. 1993; Lacorte and Eggens 1993; McFarland and Clarke 1989 as cited in ATSDR 2000). On the other hand, the penta-, hexa-, and hepta-PCBs are both bioavailable and resistant to degradation in organisms; and these PCBs tend to bioaccumulate in organisms to the greatest extent (Bremle et al. 1995; Koslowski et al. 1994; McFarland and Clarke 1989; Porte and Albaiges 1993; Willman et al. 1997 as cited in ATSDR 2000).

Consuming fish from the Colville River would result in exposure doses ranging from 1.43×10^{-5} to 3.59×10^{-5} mg/kg/day for adults and 3.13×10^{-5} to 7.86×10^{-5} mg/kg/day for children, depending on PCB mixture (see Table 3). Health effects have been observed in female Rhesus monkeys chronically exposed to 5.0×10^{-3} mg/kg/day of Aroclor 1254 (specifically, decreased antibody response and eyelid and toe/finger nail changes; Arnold et al. 1993a, Tryphonas et al. 1989, 1991a as cited in ATSDR 2000). This is the lowest-observed-adverse-effect-level (LOAEL) identified in the scientific literature for chronic exposure to PCB mixtures. ATSDR's estimated exposure doses are more than an order of magnitude below the LOAEL. In addition, it should be noted that a few studies have shown that humans are less sensitive than monkeys on a dose basis (Arnold 1993a, 1995; Emmett et al. 1988a; Fischbein et al. 1979; James et al. 1993; Kimbrough 1995 as cited in ATSDR 2000). ***Therefore, ATSDR does not expect that exposures to PCBs in the fish will cause harmful noncancer health effects.***

Studies of workers provide evidence that exposure to PCBs is associated with certain types of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate commercial PCB mixtures throughout their lives developed liver cancer. Based on the evidence for cancer in animals, the Department of Health and Human Services (DHHS) has stated that PCBs may reasonably be anticipated to be carcinogens. Both EPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probably carcinogenic to humans. Cancer incidence was studied in cohorts of fishermen from the Swedish east and west coasts, who had high intakes of PCBs in fish (Svensson et al. 1995a as cited in ATSDR 2000). There was an indication that the incidence of stomach cancer was elevated, however, the results were confounded by exposure to other contaminants in the fish. The estimated exposure doses from ingesting Colville River fish (1.43×10^{-5} to 3.59×10^{-5} mg/kg/day[6]; see adult exposure doses in Table 3) are well below (more than 27,000 times less than) the CELs reported in the literature (CELs ranged from 1.0–5.4 mg/kg/day in animals; no CELs exist for humans; ATSDR 2000). ***As such, no excess cancers from PCB exposures are expected from consumption of fish caught in the Colville River.***

A portion of the PCB congeners falls into a category of “dioxin-like” PCBs. Because of their structure and mechanism of action, they exhibit toxic behavior similar to that of dioxins. However, their toxicity is 0.00001 to 0.1 times lower than the most toxic dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). A toxic equivalency factor (TEF) approach to evaluating health hazards has been developed and used to some extent to guide public health decisions (see EPA 1996b and ATSDR 2000 for more details). In short, the TEF approach compares the relative potency of individual congeners with that of TCDD, the best-studied member of this chemical class. The concentration or dose of each dioxin-like congener is multiplied by its TEF to arrive at a toxic equivalent (TEQ), and the TEQs are added to give the total toxic equivalency. The total toxic equivalency is then compared to reference exposure levels for TCDD expected to be without significant risk for producing health hazards. This evaluation provided results similar to those discussed above—the exposure doses calculated with this approach yielded results below noncancer and cancer health effects levels for dioxin.

<u>DDTs</u>

DDT and its primary metabolites, DDE and DDD, are manufactured chemicals and are not known to occur naturally in the environment (WHO 1979 as cited in ATSDR 2002). DDT is a pesticide that was once widely used to control insects on agricultural crops and insects that carry diseases like malaria and typhus, but is now used in only a few countries to control malaria. After 1972, the use of DDT was no longer permitted in the United States except in cases of a public health emergency (ATSDR 2002). DDD was also used to kill pests, but to a far lesser extent than DDT. Its use has also been banned in the United States.

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[6] The adult exposure scenario evaluates being exposed to PCBs by eating fish over a lifetime (i.e., 70 years).

Once inside the body, DDT can break down to DDE or DDD (metabolites of DDT). DDT, DDE, and DDD are stored most readily in fatty tissue, especially DDE (ATSDR 2002). Some of these stored amounts leave the body very slowly. Levels in fatty tissues may either remain the same over time or even increase with continued exposure. However, as exposure decreases, the amount of DDT in the body also decreases.

DDT and its metabolites are very persistent and bioaccumulate in the environment. However, concentrations of DDT in all media have been declining since DDT was banned in the United States and most of the world (Arthur et al. 1977; Boul et al. 1994; Van Metre and Callender 1997; Van Metre et al. 1997; Ware et al. 1978 as cited in ATDR 2002). DDE has no commercial use, but is commonly detected along with DDT at concentrations in the environment that often exceed those measured for DDT (ATSDR 2002). The DDT metabolite, 4,4'-DDE, was detected with the highest frequency in fish, followed by 4,4'-DDD and 4,4'-DDT; accumulation of 4,4'-DDE in fish is due to absorption of DDE from the diet rather than to recent exposures to DDT (ATSDR 2002).

Consuming fish from the Colville River would result in exposure doses of 2.28×10^{-5} mg/kg/day for adults and 4.98×10^{-5} mg/kg/day for children (see Table 3). No adverse health effects were observed in weanling rats exposed to 5×10^{-2} mg/kg/day of DDT for 27 weeks (Laug et al. 1950 as cited in EPA 1996a). The same study identified a LOAEL of 0.25 mg/kg/day for chronic exposure (Laug et al. 1950 as cited in EPA 1996a). Another study fed DDT to rats for 2 years and established a LOAEL of 0.5 mg/kg/day (Fitzhugh 1948 as cited in EPA 1996a). ATSDR's estimated exposure doses are well below (more than 1,000 times less than) these health effects levels. ***Therefore, ATSDR does not expect that exposures to DDTs in the fish will cause harmful noncancer health effects.***

Studies in animals have shown that oral exposure to DDT can cause liver cancer. Studies of DDT-exposed workers did not show increases in cancers. Based on all of the evidence available, DHHS has determined that DDT is reasonably anticipated to be a human carcinogen. Similarly, IARC has determined that DDT is possibly carcinogenic to humans and EPA has determined that DDT, DDE, and DDD are probable human carcinogens. The estimated exposure dose from ingesting Colville River fish (2.28×10^{-5} mg/kg/day[7]; see adult exposure dose in Table 3) is well below (more than 14,000 times less than) the CELs reported in the literature (CELs ranged from 0.33–116 mg/kg/day in animals; no CELs exist for humans; ATSDR 2002). ***As such, no excess cancers from DDT exposures are expected from consumption of fish caught in the Colville River.***

ATSDR's evaluation is based on eating the whole fish, including a portion of the liver with every meal. Because PCBs and DDTs accumulate in the liver, actual exposure would be roughly 6.5 times lower if fish livers are not consumed (the concentrations in the whole body samples without the liver were on average 6.5 times lower than concentrations in the whole body samples that included the liver; Ecology and Environment 2003). ATSDR is aware that it is culturally a sign of respect to offer burbot livers to the elders, who may then choose to share it with the young children and/or other members of the family. However, if community members are concerned and want to lower their PCB/DDT exposure, eating fewer livers is one way to reduce exposure to these chemicals.

[7] The adult exposure scenario evaluates being exposed to PCBs by eating fish over a lifetime (i.e., 70 years).

2. Evaluation of eating whole burbot in high quantities four months of the year

ATSDR evaluated whether eating high quantities of burbot during the seasonal harvest would result in harmful health effects. Based on information available in the Community Profile Database, ATSDR assumed people ate 62 grams of burbot every day for four months (this corresponds to eating about two 1/2-pound meals of burbot each week). Again, the estimated exposure doses were well below health effects levels reported in the scientific literature. Therefore, ATSDR concluded that it is safe to eat high quantities of burbot during the harvest.

Because burbot are fished, caught, and eaten seasonally, a member of the Nuiqsut community specifically asked ATSDR to evaluate intermediate health effects from eating burbot in high quantities over a 4-month time frame (from January to April). According to the Community Profile Database, each person harvested about 16.5 pounds of burbot in 1993 (Alaska Department of Fish and Game 2000). Assuming that all burbot were caught from January to April (over 120 days), the mean per capita burbot harvest would be about 62 g/day for that time period (this corresponds to eating about two 1/2-pound meals of burbot each week). To calculate an intermediate exposure dose for screening purposes, ATSDR applied this ingestion rate[8] and the maximum concentration to a modified version of the dose equation described earlier (Dose = Conc. × IR / BW). To screen out which chemicals do not require further evaluation, ATSDR calculated exposure doses using the maximum concentrations found in the burbot. The resulting exposure doses for Aroclor 1242, total DDTs, 2,4-DDD, 4,4-DDD, 2,4-DDE, 4,4-DDE, 2,4-DDT, and 4,4-DDT were below health guidelines for intermediate exposure. *Therefore, none of these chemicals were detected at a level of health concern for people eating burbot from the Colville River.*

Health guidelines were exceeded for total PCBs, Aroclor 1254, and Aroclor 1260. Therefore, ATSDR further examined the intermediate health effect levels reported in the scientific literature and more fully reviewed exposure potential for PCBs. Table 4 displays the estimated exposure doses based on the average concentrations[9] detected in the burbot.

[8] For this evaluation the ingestion rate for a child was assumed to be the same as for an adult. This may overestimate exposures to children and underestimate exposures to adults because adults may be eating more burbot than the children. However, given the data that are available, ATSDR has no way to quantify the actual difference between adults and children. To account for this uncertainty, ATSDR also evaluated the exposures to adults using double the ingestion rate in the equation and arrived at the same conclusions.

[9] During this level of the evaluation an average concentration is used to represent a more realistic exposure scenario. It is highly unlikely that anyone would ingest fish with the maximum concentration on a daily basis and for an extended period of time because not every fish contains the maximum detected concentration.

Table 4. Exposure Doses for Chemicals Exceeding Health Guidelines for the Evaluation of Eating Whole Burbot in High Quantities Four Months of the Year

Chemical	Average Concentration (ppm)	Estimated Exposure Dose (mg/kg/day)	
		Adult	Child
Total PCBs	0.0064	5.74×10^{-6}	2.51×10^{-5}
Aroclor 1254	0.0062	5.48×10^{-6}	2.40×10^{-5}
Aroclor 1260	0.0026	2.29×10^{-6}	1.00×10^{-5}

Note: Whole body concentrations that include the liver were used to calculate the doses.

Consuming burbot from the Colville River from January through April would result in exposure doses ranging from 2.29×10^{-6} to 5.74×10^{-6} for adults and from 1.00×10^{-5} to 2.51×10^{-5} for children depending on PCB mixture (see Table 4). Health effects (specifically, neurobehavioral toxicity) have been observed in monkeys exposed to 7.5×10^{-3} mg/kg/day of a PCB congener mixture from birth to 20 weeks of age (Rice 1997, 1998, 1999b; Rice and Hayward 1997, 1999a as cited in ATSDR 2000). This is the LOAEL identified in the scientific literature for intermediate exposure. ATSDR's estimated exposure doses are at least two orders of magnitude below the intermediate-duration LOAEL, therefore, ***exposures to PCBs by eating burbot in high quantities over a 4-month period are not expected to cause harmful health effects***. Because this is an intermediate exposure scenario, long-term health effects, such as cancer, were not evaluated (long-term health effects from eating fish over a lifetime were evaluated under the first scenario).

3. Evaluation of eating burbot livers four months of the year

ATSDR evaluated an intermediate exposure scenario in which the elders of the Nuiqsut community ate about six burbot livers per week (59.2 g/day) and children ate about three livers per week (26.8 g/day) during the four-month burbot harvest. Because both evaluations resulted in estimated exposures well below levels of health concern documented in the scientific literature, ATSDR concluded that it is safe to eat burbot livers during the seasonal harvest.

Burbot liver has high oil content, making it a highly desired part of the fish to eat especially during harsh winter conditions. It is a sign of respect in the Nuiqsut community to offer the liver to the elders, who may choose to share it with the young children and/or the rest of the family. Therefore, elders and children are expected to be the highest exposed populations. According to the Community Profile Database, 5,949 pounds of burbot were harvested by the Nuiqsut community in 1993 (Alaska Department of Fish and Game 2000). Of the 70 burbot that were sampled in 2001, the livers comprised about 5% of the total whole body weight (Ecology and Environment 2003). Roughly estimated, about 297 pounds of liver was harvested by the community (multiply 5,949 total pounds by 5%). Assuming that all burbot were caught from January to April (over 120 days), this equates to about 1,124 g/day of liver harvested in the community.

- According to the 2000 U.S. Census, 19 people over the age of 65 live in Nuiqsut. Assuming that the elders are the only people eating the burbot liver, their ingestion rate would be 59.2 g/day (U.S. Census 2000). The average liver weight of the 70 burbot that were sampled in 2001 was 68.1 grams (Ecology and Environment 2003); therefore, this ingestion rate corresponds to eating about 6 livers per week during the four-month burbot harvest.

- According to the 2000 U.S. Census, 42 children under the age of 6 live in Nuiqsut. Assuming that the children are the only people eating the burbot liver (which is highly unlikely), their ingestion rate would be 26.8 g/day (U.S. Census 2000). This ingestion rate corresponds to eating about 3 livers per week during the four-month burbot harvest.

To calculate an intermediate exposure dose for screening purposes, ATSDR applied these ingestion rates and the maximum concentration to a modified version of the dose equation described earlier (Dose = Conc. × IR / BW). To screen out which chemicals do not require further evaluation, ATSDR calculated exposure doses using the maximum concentrations found in the burbot livers. The resulting exposure doses for Aroclor 1242, 2,4-DDD, 4,4-DDD, 2,4-DDE, 2,4-DDT, and 4,4-DDT were below health guidelines for intermediate exposure. *Therefore, none of these chemicals were detected at a level of health concern for people eating burbot livers from the Colville River.*

Health guidelines were exceeded for total PCBs, Aroclor 1254, Aroclor 1260, total DDTs, and 4,4-DDE. Therefore, ATSDR further examined the intermediate health effect levels reported in the scientific literature and more fully reviewed exposure potential for PCBs, DDT, and DDE. Table 5 displays the estimated exposure doses based on the average concentrations[10] detected in the burbot livers.

Table 5. Exposure Doses for Chemicals Exceeding Health Guidelines for the Evaluation of Eating Burbot Livers Four Months of the Year

Chemical	Average Concentration (ppm)	Estimated Exposure Dose (mg/kg/day)	
		Elder	Child
Total PCBs	0.128	1.08×10^{-4}	2.14×10^{-4}
Aroclor 1254	0.122	1.03×10^{-4}	2.05×10^{-4}
Aroclor 1260	0.055	4.69×10^{-5}	9.28×10^{-5}
Total DDTs	0.095	8.07×10^{-5}	1.60×10^{-4}
4,4-DDE	0.061	5.15×10^{-5}	1.02×10^{-4}

Note: Liver concentrations were used to calculate the doses.

PCBs

Consuming burbot livers would result in exposure doses ranging from 4.69×10^{-5} to 1.08×10^{-4} for elders and from 9.28×10^{-5} to 2.14×10^{-4} for children depending on PCB mixture (see Table 5). Health effects (specifically, neurobehavioral toxicity) have been observed in monkeys exposed to 7.5×10^{-3} mg/kg/day of a PCB congener mixture from birth to 20 weeks of age (Rice

[10] During this level of the evaluation an average concentration is used to represent a more realistic exposure scenario. It is highly unlikely that anyone would ingest fish with the maximum concentration on a daily basis and for an extended period of time because not every fish contains the maximum detected concentration.

1997, 1998, 1999b; Rice and Hayward 1997, 1999a as cited in ATSDR 2000). This is the LOAEL identified in the scientific literature for intermediate exposure. As noted earlier, a few studies have shown that humans are less sensitive than monkeys on a dose basis (Arnold 1993a, 1995; Emmett et al. 1988a; Fischbein et al. 1979; James et al. 1993; Kimbrough 1995 as cited in ATSDR 2000). ATSDR's estimated exposure doses are at least an order of magnitude below this intermediate-duration LOAEL, therefore, ***exposures to PCBs by eating burbot livers are not expected to cause harmful health effects.*** Because this is an intermediate exposure scenario, long-term health effects were not evaluated. As an additional note, the maximum total PCB concentration found in the liver (0.7 ppm) is lower than FDA's tolerance level of 2 ppm for fish (FDA 2001).

DDTs

Consuming burbot livers would result in exposure doses of 8.07×10^{-5} for elders and 1.60×10^{-4} for children (see total DDT concentrations[11] in Table 5). No adverse health effects were observed in rats exposed to doses ranging from 5×10^{-2} to 9×10^{-2} mg/kg/day of DDT for 27 weeks (Fitzhugh and Nelson 1947, Laug et al. 1950 as cited in ATSDR 2002). 5×10^{-2} is the lowest no-observed-adverse-effects-level (NOAEL) identified in the scientific literature for intermediate exposure. ATSDR's estimated exposure doses are at least two orders of magnitude lower than these NOAELs. As noted earlier, male rats appear to be the most sensitive animals to DDT exposure (EPA 1996a). ***Therefore, exposures to DDTs by eating burbot livers are not expected to cause harmful health effects.*** Because this is an intermediate exposure scenario, long-term health effects were not evaluated. As an additional note, the maximum total DDT concentration found in the liver (1.7 ppm) is lower than FDA's action level of 5 ppm for fish (FDA 2001).

4. Evaluation of eating several burbot livers in one sitting

> *ATSDR evaluated an acute scenario in which elders ate six burbot livers (409 g/day) during one meal. The resulting exposure doses were below health effects levels reported in the scientific literature, therefore, ATSDR concluded that it is safe to eat several burbot livers in one sitting.*

A community member indicated that as a worst-case exposure, an elder may eat up to six livers during one meal. Therefore, ATSDR also evaluated this acute exposure scenario. As noted above, the average liver weight of the 70 burbot that were sampled in 2001 was 68.1 grams (Ecology and Environment 2003). Therefore, if an elder eats six livers in one sitting, his/her ingestion rate is about 409 g/day. To calculate an acute exposure dose, ATSDR applied this ingestion rate and the maximum concentration to the modified version of the dose equation (Dose = Conc. $\times$ IR / BW). To screen out which chemicals do not require further evaluation, ATSDR calculated exposure doses using the maximum concentrations found in the burbot livers. The resulting exposure doses for 2,4-DDD, 2,4-DDE, and 2,4-DDT, were below health

[11] ATSDR's evaluation of total DDT concentrations in the burbot livers also accounts for the amount of 4,4-DDE found in the liver. The toxicological data for DDT, the parent compound, is protective of exposure to its metabolites (i.e., DDE) as well.

guidelines for acute exposure. *Therefore, none of these chemicals were detected at a level of health concern for elders eating up to six burbot livers during one meal.*

Health guidelines were exceeded for total DDTs, 4,4-DDD, 4,4-DDE, and 4,4-DDT and acute health guidelines are not available for the Aroclors and total PCBs. Therefore, ATSDR further examined the acute health effect levels reported in the scientific literature and more fully reviewed exposure potential for these chemicals. Table 6 displays the estimated exposure doses based on the average concentrations detected in the burbot livers.

Table 6. Exposure Doses for Chemicals Exceeding Health Guidelines for the Evaluation of Eating Several Burbot Livers in One Sitting

Chemical	Average Concentration (ppm)	Estimated Exposure Dose for Elders (mg/kg/day)
Total PCBs	0.516	3.02×10^{-3}
Aroclor 1242	0.005	3.06×10^{-5}
Aroclor 1254	0.298	1.74×10^{-3}
Aroclor 1260	0.122	7.13×10^{-4}
Total DDTs	0.144	8.43×10^{-4}
4,4-DDD	0.015	8.53×10^{-5}
4,4-DDE	0.010	5.82×10^{-4}
4,4-DDT	0.028	1.64×10^{-4}

Notes: Liver concentrations were used to calculate the doses.
Averages were calculated using the six highest concentrations.

PCBs

Consuming six burbot livers in one sitting would result in exposure doses ranging from 3.06×10^{-5} to 3.02×10^{-3} for elders, depending on PCB mixture (see Table 6). No adverse health effects were observed in rats exposed to 0.5 mg/kg/day of Aroclor 1254 for 4 days (Carter 1984, 1985 as cited in ATSDR 2000). This is the lowest NOAEL identified in the scientific literature for acute exposure. ATSDR's estimated exposure doses are at least two orders of magnitude below this NOAEL, therefore, ***exposures to PCBs by eating up to six burbot livers are not expected to cause harmful health effects.*** Because this is an acute exposure scenario, long-term health effects were not evaluated.

DDTs

Consuming six burbot livers in one sitting would result in an exposure dose of 8.43×10^{-4} for elders (see total DDT concentrations[12] in Table 6). Health effects (specifically, neurodevelopmental effects) have been observed in mice exposed to a single dose of 0.5 mg/kg/day (Eriksson and Nordberg 1986; Eriksson et al. 1990a, 1990b, 1992, 1993; Johansson et

[12] ATSDR's evaluation of total DDT concentrations in the burbot livers also accounts for the amount of 4,4-DDD, 4,4-DDE, and 4,4-DDT found in the liver. The toxicological data for DDT, the parent compound, is protective of exposure to its metabolites as well.

al. 1995, 1996; Talts et al. 1998 as cited in ATSDR 2002). This is the LOAEL identified in the scientific literature for acute exposure. ATSDR's estimated exposure doses are about three orders of magnitude lower than this LOAEL. ***Therefore, exposures to DDTs by eating up to six burbot livers are not expected to cause harmful health effects.*** Because this is an acute exposure scenario, long-term health effects were not evaluated.

Child Health Considerations

A child's exposure may differ from an adult's exposure in many ways. ATSDR recognizes that infants and children can be more sensitive to contamination of their food than adults because children are smaller; therefore, childhood exposure results in higher doses of chemical exposure per body weight. A child's behavior and lifestyle also influence exposure. Because children can sustain permanent damage if these factors lead to toxic exposure during critical growth stages, ATSDR as part of its public health assessment process is committed to evaluating their special interests at sites such as Umiat.

ATSDR paid special attention to child exposures during the health evaluation. Children are not expected to experience adverse health effects from consuming fish from the Colville River. Even eating up to three burbot livers a week during the harvest (the highest potential exposure scenario evaluated for children) is not expected to cause harmful health effects in children.

Nevertheless, children can also be exposed to PCBs and DDTs both prenatally and from breast milk. These chemicals are stored in the mother's body and can be released during pregnancy, cross the placenta, and enter fetal tissues. Because PCBs and DDTs dissolve readily in fat, they can accumulate in breast milk fat and be transferred to babies and young children. However, in most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs and DDTs in mother's milk (ATSDR 2000). Women should consult their health care provider if they have any concerns about breast-feeding. Because the brain, nervous system, immune system, thyroid, and reproductive organs are still developing in the fetus and child, the effects on these target systems may be more profound after exposure during the prenatal and neonatal periods, making fetuses and children more susceptible to PCBs and DDTs than adults.

Conclusions

- PCBs and DDTs were detected in the burbot collected during the August 2001 sampling in the Colville River. However, the levels were too low to cause harmful health effects for the Nuiqsut community, who subsist on fish from the river. ATSDR has categorized exposure to PCBs and DDTs in fish from the river as "***no apparent public health hazard***." This means that people are being exposed to environmental contamination in the fish, but that the exposures are not at levels expected to cause harmful health effects.

- ATSDR evaluated whether eating up to 390 grams of fish (almost a pound, 7/8) from the Colville River every day for 70 years would result in harmful health effects. This conservative evaluation was based on information available in the Community Profile Database that was specific to the Nuiqsut community and chemical concentrations detected in burbot collected from several areas in the Colville River. The estimated exposure doses for both adults and children were well below health effects levels documented in the scientific literature. *Therefore, ATSDR concluded that it is safe to eat fish from the Colville River*.

- To address a specific community concern, ATSDR evaluated whether eating high quantities of burbot during the seasonal harvest would result in harmful health effects. Based on information available in the Community Profile Database, ATSDR assumed people ate 62 grams of burbot every day for four months (this corresponds to eating about two 1/2-pound meals of burbot each week). Again, the estimated exposure doses were well below health effects levels reported in the scientific literature. *Therefore, ATSDR concluded that it is safe to eat high quantities of burbot during the harvest.*

- Community members have also expressed concern about eating burbot livers. ATSDR evaluated an intermediate exposure scenario in which the elders of the Nuiqsut community ate about six burbot livers per week (59.2 g/day) and children ate about three livers per week (26.8 g/day) during the four-month burbot harvest. Both evaluations resulted in estimated exposures below levels of health concern documented in the scientific literature. *Thus, ATSDR concluded that it is safe to eat burbot livers during the seasonal harvest*.

- ATSDR also evaluated an acute scenario in which elders ate six burbot livers (409 g/day) during one meal. Because the resulting exposure dose was below health effects levels documented in the scientific literature, *ATSDR concluded that it is safe to eat several burbot livers in one sitting.*

Recommendations

- There are no recommendations at this time.

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Data Tables

Table 7. Chemical Concentrations Detected in Burbot Whole Body Samples

Chemical	Minimum (ppm)	Maximum (ppm)	Average (ppm)
Total PCBs	0.0005	0.0324	0.0064
Aroclor 1242	0.00001	0.0006	0.0002
Aroclor 1254	0.0004	0.0333	0.0062
Aroclor 1260	0.0002	0.0146	0.0026
Total DDTs	0.0001	0.0668	0.0041
2,4-DDD	0.0000009	0.0008	0.00005
4,4-DDD	0.000004	0.0116	0.0006
2,4-DDE	0.0000008	0.0005	0.00002
4,4-DDE	0.00009	0.0485	0.0026
2,4-DDT	0.000005	0.0017	0.0001
4,4-DDT	0.00003	0.0075	0.0007

Source: Ecology and Environment 2003

Note: For perspective, lake trout and grayling collected from Schrader Lake, Alaska in 1992 contained average wet weight concentrations of 0.0066 and 0.0013 ppm, respectively, of summed PCB congeners (Wilson et al. 1995 as cited in State of Alaska 1998). Whitefish collected from the greater Alaska area contained average wet weight concentrations ranging from 0.0008 to 0.0044 ppm (Muir & Lockhart 1994 as cited in CHPPM 2003). Arctic char, burbot, lake trout, and walleye collected from various locations in Canada contained average wet weight PCB concentrations ranging from 0.0014 to 0.29 ppm (Muir & Lockhart 1993b, 1994b, 1996b as cited in State of Alaska 1998).

Table 8. Chemical Concentrations Detected in Burbot Liver Samples

Chemical	Minimum (ppm)	Maximum (ppm)	Average (ppm)
Total PCBs	0.006	0.75	0.128
Aroclor 1242	0.0002	0.01	0.003
Aroclor 1254	0.005	1.08	0.122
Aroclor 1260	0.003	0.4	0.055
Total DDTs	0.0019	1.7	0.095
2,4-DDD	0.000006	0.02	0.001
4,4-DDD	0.000007	0.28	0.014
2,4-DDE	0.000007	0.02	0.0005
4,4-DDE	0.001	1.3	0.061
2,4-DDT	0.00002	0.05	0.002
4,4-DDT	0.0004	0.24	0.017

Source: Ecology and Environment 2003

Appendix A
ATSDR Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure].

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

EPA
United States Environmental Protection Agency.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Hazard
A source of potential harm from past, current, or future exposures.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical.

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Incidence
The number of new cases of disease in a defined population over a specific time period.

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

ppm
Parts per million.

Public health action
A list of steps to protect public health.

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Risk
The probability that something will cause injury or harm.

Safety factor [see uncertainty factor]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC)
(http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

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