Human Health Evaluation of Contaminants in Upper Columbia River Fish

August 2012

Prepared by
The Washington State Department of Health
Division of Environmental Public Health
Office of Environmental Health, Safety, and Toxicology
Olympia, Washington

Washington State Department of Health

DOH 334-317 August 2012

Table of Contents

List of Tables

List of Figures

FOREWARD

The Washington State Department of Health (DOH) prepared this technical support document as a basis for evaluating the need for public fish consumption advisories. It represents a scientific analysis of fish tissue sampling data that serves as a precursor to decisions made regarding the need for fish consumption advisories.

For additional information or questions regarding DOH or the contents of this document, please contact the author of this document:

David McBride, MS
Toxicologist
360-236-3176

Washington State Department of Health
Office of Environmental Health, Safety, and Toxicology
P.O. Box 47846
Olympia, Washington 98504-7846
1-877-485-7316
Website: www.doh.wa.gov/fish

For persons with disabilities this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (voice) or 1-800-833-6388 (TTY/TDD).

Acknowledgements

Washington State Department of Health would like to acknowledge and thank the following people for their review, comments, and insight to this study:

U.S. Environmental Protection Agency
Marc Stifelman, Monica Tonel, Helen Bottcher, Kay Morrison, David Charters

Spokane Tribe
Randy Connolly, Fred Kirschner, Tamara Knudson

Coleville Tribe
Patti Bailey, Cindy Marchand

U.S. Department of Interior – National Park Service
Keith Holiday, Daniel Audet

Washington State Department of Ecology
John Roland, Charles Gruenenfelder, Brendan Dowling

Syracuse Research Corporation
Pamela Wadman, Henry Roman, Bill Thayer, Gary Diamond

Industrial Economics
Henry Roman, Whitney Fraser, Pamela Bridgen, John Mason

CH2 M Hill
Marilyn Gauthier

Dunau Associates
Andy Dunau

Washington State Department of Health
Liz Carr, Joanne Snarski, Marilyn Hanna

GLOSSARY

Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Cancer Slope Factor (CSF)	EPA's measure of the ability of a substance to cause cancer based on the dose of the substance received.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) (compare with acute).
Comparison Value (CV)	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
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.
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 come into contact with media containing the substance (e.g., drinking water, breathing air, consuming food, skin contact with soil, etc.). 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 gets into the body through the eyes, skin, stomach, intestines, or lungs.
Environmental Protection Agency (EPA)	The federal agency that develops and enforces environmental laws to protect the environment and the public's health.
Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
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 to a substance occurs when an individual encounters environmental media containing that substance (e.g., inhaling air, drinking water, skin/soil contact, etc.).

Hazardous Substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
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).
Ingestion Rate (IR)	The amount of an environmental medium that could be ingested, typically on a daily basis. Units for IR are usually liter/day for water and mg/day for soil.
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.
kg, g, mg, μg	Kilograms, grams, milligrams, and micrograms
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.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
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), non-cancerous 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 oral reference dose).
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.
Oral Reference Dose (RfD)	An amount of chemical, which if ingested on a daily basis over the course of a lifetime, would not be expected to cause adverse effects. EPA publishes RfDs.
Organic	Compounds that contain carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
Parts Per Billion (ppb)/Parts Per Million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a railroad tank car (13,200 gallons), the water will contain about 1 ppb of TCE.
Route of Exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing (inhalation), eating or drinking (ingestion), or contact with the skin (dermal contact).

EXECUTIVE SUMMARY

Background

The Washington State Department of Health (DOH) works to protect and improve the health of people in Washington State. This includes reducing or eliminating exposures to health hazards in the environment, including contaminants found in fish. This document evaluates fish tissue contaminant data collected during a 2009 fish tissue study as part of the U.S. Environmental Protection Agency's (EPA) Upper Columbia River (UCR) site remedial investigation and feasibility study. Information from this study was used to conduct a human health risk assessment and possibly update existing fish advisories for Lake Roosevelt.

The EPA investigation is studying hazardous waste contamination from past industrial practices in the UCR from the U.S./Canada border to the Grand Coulee Dam and surrounding upland areas. A large metal smelter in Trail, British Columbia, is a primary source of metal contamination to the site. Teck, owner and operator of the smelter, is funding and leading parts of an environmental investigation under EPA's oversight.

Fish Monitoring

As part of the EPA investigation, DOH was responsible for conducting a human health assessment (this document). Our assessment evaluated 2,300 fish samples to determine if consuming fish from the UCR posed a human health risk. These fish samples were collected from six sampling areas within a 150 mile stretch between the U.S./Canada border and the Grand Coulee Dam.

We evaluated data on 385 chemicals from the fish tissue of nine species, which included: burbot, kokanee, lake whitefish, largescale sucker, longnose sucker, mountain whitefish, rainbow trout, smallmouth bass, and walleye. The fish tissue was also evaluated and compared with regional, statewide, and commercially available fish from other studies.

Contaminants of Concern

Of the 385 chemical contaminants evaluated, we narrowed our focus to five chemicals of concern using a screening process using two different consumption rates - one for the general population and one for subsistence fishers. The screening process lead to further evaluation of only a few chemicals of concern: mercury, PBDEs (polybrominated diphenyl ethers), PCBs (polychlorinated biphenyls), and dioxins. Of these chemicals, mercury is the main contaminant of concern in fish in the UCR and PCBs were found at levels of health concern in largescale suckers.

Findings

The UCR fish study conducted in 2009 was the most extensive and thorough chemical monitoring effort in Washington State to date. Analyses of fish tissue from this study found the chemicals of concern are slightly higher than those seen in other fished waterbodies in northeast Washington, and similar to or slightly higher than lakes across Washington State or in commercial markets.

Results of the fish tissue analysis indicate:

- Concentrations of the chemicals of concern are similar to other datasets within the state that have resulted in waterbody specific or commercial fish advisories.

- Mercury and PCBs were found at high enough levels in some fish to warrant fish consumption recommendations to reduce exposure.

- Walleye meal recommendations are less restrictive than the previous advisory (2005) due to a decline in mercury levels.

- Smallmouth bass meal recommendations are less restrictive than the statewide smallmouth bass advisory due to lower mercury levels.

- Health risks associated with the consumption of largescale suckers in the Upper Columbia River is primarily due to PCB concentrations.

- Kokanee, lake whitefish, and rainbow trout are low in contaminants.

RECOMMENDATIONS

DOH encourages all Washingtonians to eat at least two fish meals per week as part of a healthy diet in accordance with American Heart Association recommendations. A variety of fish is an important part of a balanced diet because:

- Fish is an excellent source of protein, vitamins, and minerals.
- The oils in fish are important for unborn and breastfed babies.
- Eating a variety of fish helps to reduce the chances of cardiovascular disease.
- Eating a variety of fish helps to reduce exposure to contaminants of concern.

Most foods, regardless of source, contain some contaminants. Switching from fish to other types of food may not eliminate contaminant exposure. People can safely continue to eat the American Heart Association's recommended two fish meals per week by avoiding fish that are high in contaminants.

If people eat UCR fish that have recommended meal limits (such as largescale suckers or walleye), they should choose other fish that are lower in contaminants in order to get to their two fish meals per week. Good examples of fish that are lower in contaminants include kokanee, lake whitefish, rainbow trout, and many other store-bought fish. For a guide on fish low in contaminants, see www.doh.wa.gov/fish.

The agency provides the following meal advice for anglers and other consumers of UCR fish. This advice is especially important for women of childbearing age and children because young children may be more susceptible than adults to adverse impacts of contaminant exposure. These recommendations are based on a 60 kg (132 lb) adult and on an assumption that a fish meal is 8 ounces of pre-cooked fish. Children should eat proportionally smaller meal sizes.

These recommendations consider exposure to multiple chemicals (such as mercury, PBDEs, and PCBs) in each fish meal.

Based on our UCR fish assessment, DOH recommends that women who are or might become pregnant, nursing mothers, and young children follow these meal recommendations:

- Kokanee 3 meals per week
- Lake whitefish2 meals per week
- Rainbow trout2 meals per week
- Burbot1 meal per week
- Longnose sucker 1 meal per week
- Mountain whitefish1 meal per week
- Smallmouth bass1 meal per week
- Walleye1 meal per week
- Largescale sucker2 meals per month

In addition to the specific meal recommendations based on UCR data, two statewide fish advisories due to mercury apply:

- Largemouth bass2 meals per month
- Northern pikeminnowDo not eat

Also, everyone should limit consumption of largescale suckers to four meals per month.

Washington State Department of Health

Fish Consumption Advisory
Upper Columbia River (includes Lake Roosevelt)
Technical Summary July 2012

Overview

The U.S. Environmental Protection Agency (EPA) has identified the Trail Smelter operated by Teck Cominco (now called Teck) as the primary source of metals and other chemical contaminants in the Upper Columbia River. The Trail Smelter located in Canada 10 miles north of the U.S. border, has been in operation for more than a century.

In 2006, EPA entered into a settlement with Teck to conduct an investigation of the Upper Columbia River to identify contaminants in the river system and if they pose human health and ecological risks.

Fish Monitoring

As part of this ongoing investigation, 2,300 fish were collected from six sampling areas within a 150 mile stretch between the U.S. /Canada border and the Grand Coulee Dam.

The Washington Department of Health analyzed fish tissue from burbot, kokanee, lake whitefish, largescale sucker, longnose sucker, mountain whitefish, rainbow trout, smallmouth bass, and walleye to determine if the levels of metals, pesticides, fire retardants, and other organic chemicals pose human health risks. The fish tissue was evaluated and compared to data from previous studies.

Upper Columbia River Fish Consumption Advisory

Using this new information, the state health department is updating its exisiting fish consumption advisory for the Upper Columbia River.

Women who are or might become pregnant, nursing mothers, and young children are especially at risk and should follow the updated fish consumption advice for the Upper Columbia River on the back of this technical summary.

There is an existing statewide fish advisory for mercury that also affects theUpper Columbia River and is included in this advisory update.

Contaminants of Concern

Mercury is the main contaminant of concern in fish in the Upper Columbia River. Mercury is an element found in rocks and soil. It can be released into the environment from industrial air pollution and mining operations, and through improper disposal of products that contain mercury such as transformers, thermostats, electrical switches, and fluorescent bulbs.

Mercury Health Impacts Mercury can harm the central nervous (brain) and immune systems. If a baby or fetus is exposed to high levels of mercury the child may develop learning and behavioral difficulties. A developing fetus or growing child is more sensitive to mercury than an adult. If a person is exposed to high doses over time it can harm organs, including the kidneys and heart.

PCBs Polychlorinated Biphenyls (PCBs) were found at levels of concern in largescale sucker. PCBs consumed at high levels can impact men and women of all ages.

PCBs are a man-made group of chemicals once used widely in coolants and lubricants for transformers and in plastics. In 1977, PCBs were banned because they stay in the environment for a long time and can harm human and environmental health.

PCBs Health Impacts PCBs may cause a variety of health problems depending on the amount a person is exposed to. If a baby or fetus is exposed to high levels of PCBs while developing, the child may have learning and behavioral difficulties. PCBs may also impact the immune system and have effects on the reproductive system and thyroid hormones. EPA says PCBs probably cause cancer in people.

How do mercury and PCBs get into upper Columbia River fish?

Mercury and PCBs enter rivers, lakes, and streams through rain or snow and are also directly released from industrial (mercury, PCBs) or natural (mercury) sources.

Once mercury and PCBs get into the water, they settle into the sediment. Bacteria in the sediment convert mercury into methylmercury, a more toxic form.

When fish eat smaller organisms contaminated with methylmercury or PCBs, the contaminants build up in the fish's muscle (fillet) and fat, and are added to any contaminants that were already there. The bigger and older a fish is, the more likely it is to have eaten lots of smaller, contaminated fish. People are exposed to mercury and PCBs when they eat fish.

Eat Fish, Be Smart, Choose Wisely.

The American Heart Association recommends eating fish at least two times a week as part of a healthy diet. To get the health benefits of eating fish, make smart choices and choose fish low in chemical contaminants.

Removing fish from your diet won't eliminate your exposure to contaminants. Other foods have chemical contaminants in them, too, but mercury and PCBs are mainly found in fish.

See the back of this technical summary for fish consumption recommendations.

Health Benefits of Fish

The American Heart Association recommends eating fish at least two times per week as part of a healthy diet.

- **Fish is nutritious.** Fish is low in saturated fat and a good source of protein, vitamins, minerals, and omega-3 fatty acids.
- **Fish is good for your heart.** Omega-3s found in fish help prevent heart disease and stroke by reducing blood pressure, inflammation, and blood clotting.
- **Fish is brain food.** Omega-3s may help relieve depression and may decrease the risk of Alzheimer's disease.
- Omega-3s during pregnancy may help with the healthy development of a child's brain, retina, and nerve tissue.

To get the health benefits of eating fish, choose fish low in contaminants. More healthy choices are on our website **www.doh.wa.gov/fish**.

Contact Information

Fish Advisory
Department of Health
Fish Advisories Program
Toll Free: 1-877-485-7316
http://www.doh.wa.gov/fish

Contaminant Study
US Environmental Protection Agency
Upper Columbia River Study
Toll Free: 1-800-424-4372
http://yosemite.epa.gov/R10/cleanup.nsf/sites/upperc

This document is available in other formats for persons with disabilities.
TDD LINE: 1-800-833-6388
DOH 334-298 July 2012

Upper Columbia River Fish Consumption Advisory

Washington State Department of Health

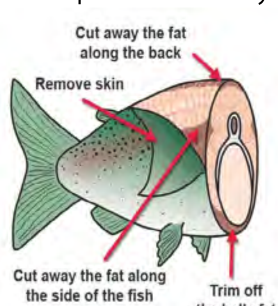
Certain types of fish from the Upper Columbia River and Lake Roosevelt contain toxic chemicals (mercury and PCBs) at levels that may harm your health, depending on how much you eat. If you eat fish from this area follow these recommendations. **This is very important for women who are or might become pregnant, nursing mothers, and young children because they are especially at risk for health problems these chemicals may cause.**

Healthy Choice		Meals Per Week*	
Kokanee		3	**Enjoy these fish.** Kokanee, lake whitefish, and rainbow trout are low in contaminants.
Lake Whitefish		2	
Rainbow Trout		2	
Limit		**Meals Per Week***	
Burbot		1	**Limit these fish.** You can safely eat 4 meals per month of any combination of burbot, longnose sucker, mountain whitefish, smallmouth bass, or walleye. If you eat the recommended amount, no other fish should be eaten that month.
Longnose Sucker		1	
Mountain Whitefish		1	
Smallmouth Bass		1	
Walleye		1	
Caution		**Meals Per Month***	
Largescale Sucker		2	Women of childbearing age and children: limit largescale sucker to 2 meals per month. Everyone else: 1 meal per week.
Largemouth Bass		2	
DO NOT EAT			
Northern Pikeminnow		**AVOID**	**Do not eat.**

* One meal is 8 ounces of uncooked fish for a 160 lb person. If you weigh more or less than 160 lbs, add or subtract 1 ounce for every 20 lbs of body weight.

Preparing Fish the Healthy Way

Fish are part of a healthy diet. You can make it even healthier if you follow these tips. Some chemicals build up in the fat of fish and can be reduced if you prepare and cook fish correctly. Mercury can't be reduced because it builds up in fish muscle (the fillet).



- When cleaning fish, remove the skin, fat, and internal organs before cooking.
- Grill, bake, or broil fish so that the fat drips off while cooking.
- Eat younger and smaller fish (within legal limits).

INTRODUCTION

The Washington State Department of Health (DOH) works to protect and improve the health of people in Washington State. Part of this mission is to reduce or eliminate exposures to health hazards in the environment. DOH's Office of Environmental Health, Safety, and Toxicology (OEHST) conducts environmental health assessments, develops strategies, and provides education and outreach to communities in order to minimize health impacts from exposure to environmental contaminants. One focus of OEHST is on assessment of potential human health impacts from consuming contaminated fish.

In 2009, Teck American Incorporated (TECK) collected and analyzed fish tissue from the Upper Columbic River (UCR) with oversight from the U.S. Environmental Protection Agency (EPA). The goal of this effort was to determine contaminant levels in fish tissues in the UCR region. This study was conducted as part of the UCR site remedial investigation and feasibility study (RI/FS). The study objectives were to investigate the nature and extent of potential health risks from contaminants in UCR fish, provide information to support risk assessments for ecological and human health endpoints, and develop and evaluate potential remedial alternatives in the UCR site (Teck 2009). Fish tissue sampling was conducted in September and October 2009. DOH was asked to assess these data to address potential health impacts to people that eat fish from the UCR. The scope of this assessment is limited to the UCR and to fish data collected by EPA in 2009 as part of the RI/FS investigation. While analyses included many contaminants, DOH identified only five contaminants of concern based on frequency of detection, concentration, and toxicity.

The purpose of this assessment and associated report is to review and evaluate potential health risks that may result from exposure to bioaccumulative contaminants through the consumption of UCR fish based on data collected by EPA. Potential risks from ingestion of each chemical of concern were assessed for non-cancer and cancer endpoints. Potential risks from chemicals with similar non-cancer endpoints were evaluated through an additive process as were cancer risks. Consideration is given to fish life history, chemical toxicity, potential exposure to contaminants by fish consumers (based on estimated consumption), consumer body weight, comparison of contaminant levels with fish from other regions, and the overall health benefits of eating fish. The above factors are considered by DOH to provide advice for consuming fish from the UCR.

BACKGROUND

The Columbia River begins in the Rocky Mountains of British Columbia, Canada, and flows south into Washington State and turns west to form the border between Washington and Oregon before emptying into the Pacific Ocean. The northern reach of the Columbia River within the U.S. border is referred to as the UCR that encompasses that portion of the river behind the Grand Coulee Dam, also known as Lake Roosevelt, and the remaining free flowing portion of the river stretching to the border of Canada (See Figure 1). The UCR is of great regional importance and has been central to the culture and economy for thousands of years. Today the UCR continues its importance due to its extensive recreational use and fishery resources.

Much of the UCR is part of the Lake Roosevelt National Recreation Area (LRNRA), which is managed by the National Park Service (NPS). The UCR site also includes approximately 93 miles of shoreline that lies within the eastern border of the Colville Indian Reservation and a smaller portion on the western border of the Spokane Indian reservation. The LRNRA attracts more than 1.5 million visitors annually (LRF 2012). The LRNRA includes numerous boat launches, campgrounds, and marinas, as well as areas of undeveloped shoreline, which provide opportunities for recreational visitors to fish for a variety of species. The Tribes manage the waters of Lake Roosevelt within the reservations as a subsistence fishery (fishers who rely on noncommercially caught fish and shellfish as a major source of protein in their diets).

EPA is studying hazardous waste contamination in the Columbia River from the U.S./Canada border to the Grand Coulee Dam and surrounding upland areas. The study is called the Remedial Investigation and Feasibility Study (RI/FS). Past studies by federal and state agencies (USGS 2000, DOH 2010) have shown increased levels of hazardous waste contamination in UCR sediments, including heavy metals such as cadmium, copper, lead, mercury, and zinc, and other contaminants like dioxins and dibenzofurans. A review of historical fish tissue data collected in the UCR identified several gaps in the data needed to adequately evaluate potential human health risks (Teck 2009). The primary object of the 2009 fish tissue study was to collect and analyze fish tissue samples and use this information on chemical concentrations to fill data gaps identified in the Quality Assurance Project Plan (QAPP) (Teck 2009). These data were used by DOH to assess potential exposures from fish consumption in the UCR to the general public and subsistence fish consumers and if necessary to update the current DOH fish advisory for the UCR.

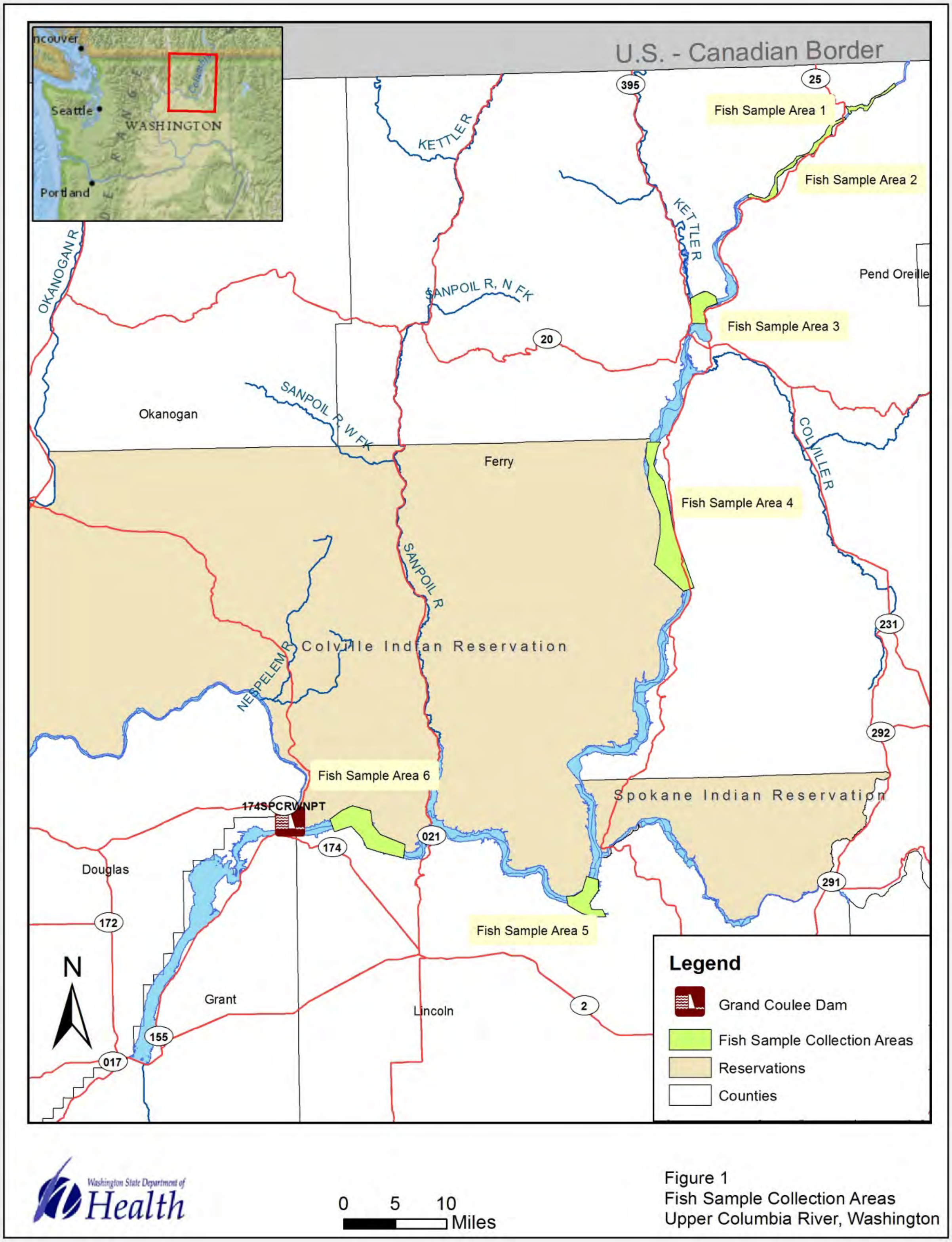
Fish Sample Program/Species

In September through October 2009, fish were collected from six sampling areas within the 150-mile stretch of the UCR, between the U.S./Canada border and the Grand Coulee Dam. The study was conducted in support of the human health and ecological baseline risk assessments. Over 2,300 fish were collected in 3 size classes: large fish (> 30 cm), medium (15-30 cm), and small (< 15 cm); and analyzed as whole fish to simulate wildlife diets. Fish in the large size class also had fillet-only analyses conducted for human health risk assessment. The targeted species covered different trophic levels (omnivore, insectivore, piscivore) and included: burbot (*Lota lota*), kokanee (*Oncorhynchus nerka*), lake whitefish (*Coregonus clupeaformis*), largescale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), mountain whitefish (*Prosopium williamsoni*), northern pikeminnow (*Ptychocheilus oregonensis*), rainbow trout (*Oncorhynchus mykiss*), sculpin (*Cottidae sp.*), smallmouth bass (*Micropterus dolomieui*), walleye (*Stizostedion vitreum*), and yellow perch (*Perca flavescens*). Figure 1 shows sampling/species locations.

Chemicals of Interest

Individual fish of each species were combined to prepare samples of 1 to 5 fish per composite, for each of the 6 fish collection sites (Figure 1). Samples were analyzed for an initial 385 Chemicals of Interest (COI) (Appendix A Table 1a). This list of target analytes was developed using information about known and potential sources and data obtained during other investigations and monitoring events. These initial COIs include 21 common metals and 34 metalloids, 30 pesticides, 50 semi-volatile organic chemicals (SVOCs), 21 polycyclic aromatic hydrocarbons (PAHs), 209 polychlorinated biphenyl (PCB) congeners, dioxins and dibenzofurans, and 20 polybrominated diphenyl ether (PBDE) compounds. Due to past concerns of mercury in walleye and smallmouth bass, fillets in the >30 cm size class were analyzed individually for mercury to allow for better determination of the variation of mercury concentrations within these fish species. Arsenic was analytically speciated to determine the percentage of organic and inorganic arsenic components.

Figure 1: Fish Sample Collection Areas Upper Columbia River, Washington.



METHODS

Data Compilation and Data Reduction

A complete description of the methods used to analyze chemical contaminants concentrations in UCR fish is available in the QAPP for the 2009 Fish Tissue Study (Teck 2009). Additionally, detailed information on the methods and protocols used to maintain the data integrity for fish tissue data compilation and reduction is provided in the Human Health Risk Assessment Work Plan for the UCR site (EPA 2009).

Fish tissue analytical results were downloaded from a password protected UCR project-specific website (http://teck-ucr.exponent.com/). The UCR fish tissue analytical results were compiled and summarized by EPA into Microsoft Excel® spreadsheets. Due to the volume of this material, the data is not included in this report, but is available upon request). Summary statistics were provided for each species, by size class (i.e., length) and fish sampling collection area. Arithmetic mean chemical concentrations were used for screening level comparisons and meal limit calculations. Details of the data analysis are described below. As requested by DOH, non-detected results were included at one-half the detection limit.

Upon receipt of the data, DOH reformatted to standardize chemical nomenclature and concentration units. Fish tissue concentrations reported as dry weight were converted to wet weight as follows:

Wet weight result = dry weight result x (percent solid)/100

EPA provided total PBDE and total PCB concentrations that were calculated as the sum of all congeners, with non-detected values included at one-half the reported detection limit. DOH calculated total dichlorodiphenyltrichloroethane (DDT) concentrations based on the sum of 2,4 and 4,4-DDT as well as DDT breakdown products 2,4- DDD, 2,4-DDE, 4,4-DDD, and 4,4-DDE. Total chlordane, as reported by the laboratory, represents the sum of *cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, and oxychlordane concentrations.

Health Assessment Process

DOH's evaluation of chemicals in fish tissue follows the methodology recommended by EPA for the assessment of cancer and noncarcinogenic toxicity (EPA 2000a). The following is an overview of the steps used by DOH to determine whether fish consumers are potentially overexposed to levels of contaminants in fish and to develop meal recommendations for consuming these fish (Figure 2).

1. Determine mean concentrations of the chemicals in fish tissue.

2. Estimate fish consumption rates to anglers, subsistence population, and tribal members, or any additional high-consuming populations.

3. Once consumption rates have been selected, compare fish tissue chemical concentrations

with corresponding screening level (SL) concentrations. If fish tissue concentrations exceed SLs, continue to evaluate risk. If fish tissue concentrations are below SLs, no further evaluation required.

4. If a contaminant exceeds the SL, fish tissue chemical concentrations and consumption rates are used to calculate the dose of a chemical that a person would receive from consuming fish at a particular consumption rate.

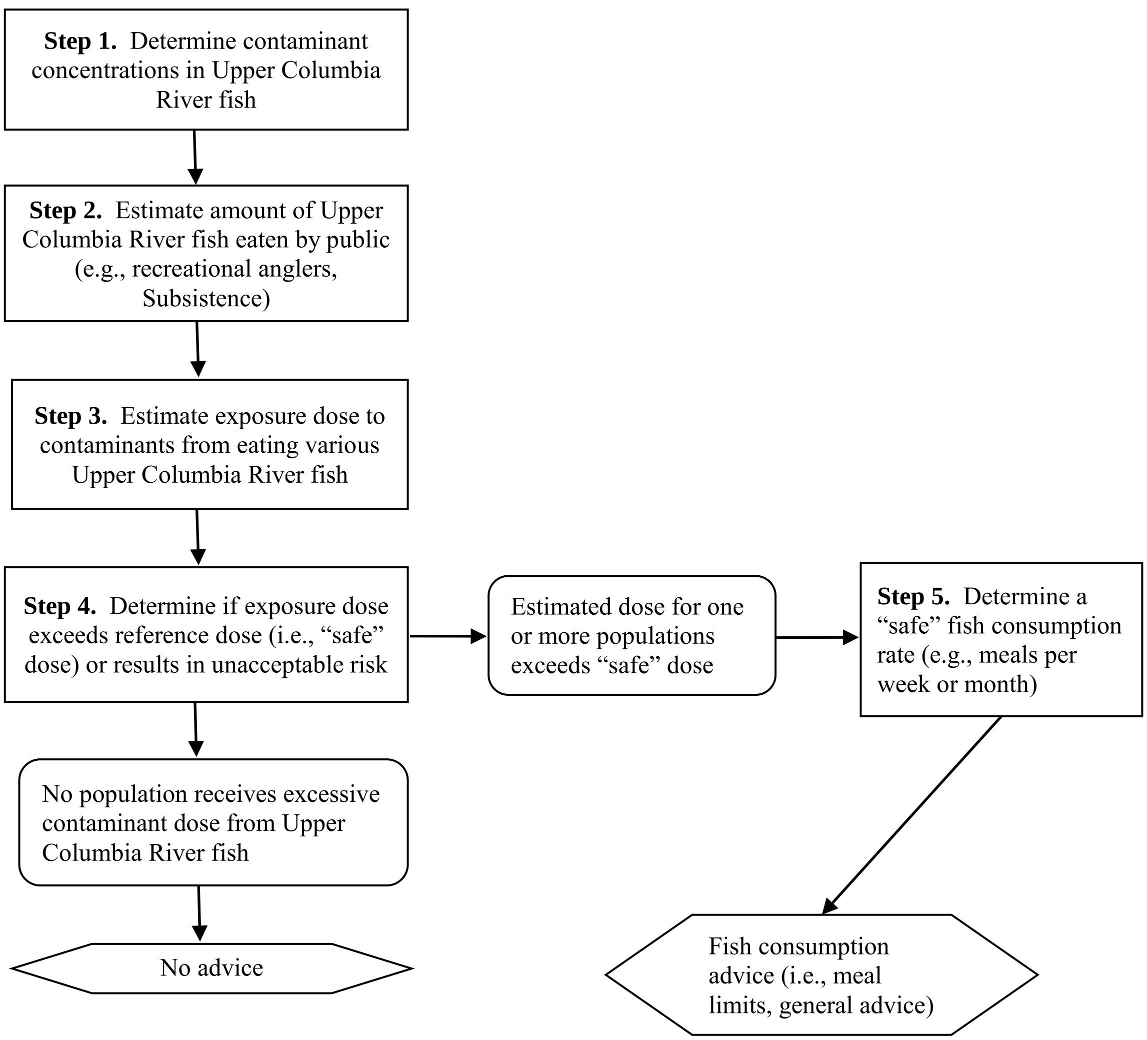
5. Determine if the calculated dose is considered safe. For chemicals that pose a potential non-cancer risk, the calculated dose is compared to an oral reference dose (RfD) specific to each chemical of concern. An RfD is a level of exposure below which non-cancer adverse health effects are not likely to occur. Lifetime increased cancer risk attributable to carcinogenic chemicals (e.g. dioxin like PCBs) in fish is also calculated.

6. If a population is exposed to levels that exceed health benchmarks, DOH then calculates acceptable meal limits based on non-cancer endpoints and possibly cancer endpoints.

In a further step, DOH calculates acceptable meal limits based on exposure to multiple chemicals. This accounts for the combined toxicity of chemicals acting on the same organ systems.

DOH considers the results of the above analysis along with other factors, such as the health benefits of eating fish, the availability of less contaminated fish or food from other sources, and background concentrations to formulate health messages to communicate to the public. The advice derived from this methodology will be geared toward people who regularly eat fish from the UCR (e.g., subsistence populations, anglers).

Figure 2. Flow Chart of DOH Steps Used to Assess Human Exposure to Contaminated Fish.



Identifying and Selecting Fish Consumption Rates

Fish consumption rates are used to calculate screening levels and potential exposures. Ideally, site and species-specific consumption rates would be utilized to provide risk assessors accurate exposure estimates. However, in the absence of specific survey data, DOH has identified three consumption surveys that are relevant to this area. The following describes each of those survey's and identify which rate was selected for the UCR and why. The first is a survey that was conducted by DOH at Lake Roosevelt during 1994 and 1995 to determine the consumption patterns of anglers who regularly fish the Lake Roosevelt (DOH 1997). This survey does have limitations due to methodology employed. Primarily, although the frequency of consumption was obtained, there were difficulties in obtaining portion size consumed at each meal, which complicated calculation of individual consumption rates. The survey population was primarily vacationing boat anglers who consumed on average 42 recreationally caught fish meals per year, which equates to 26.1 grams per day (assuming a meal size of 8 oz.). Additionally, no tribal or subsistence fish consumers were surveyed in this study.

In lieu of accurate site specific fish consumption data that reflects possible high-end consumers, those whose consumption rate is greater than the general public, DOH relied on two other consumption rates to calculate screening levels used to estimate an individual's potential contaminant exposure. The first is the upper level of consumption that DOH utilizes in setting fish advisories above which no consumption advice is given. This rate is used by DOH to set its upper level at which consumption is considered "unlimited" for the general population. This consumption rate is eight meals per month or two meals per week (assuming a meal size is 8 ounces). This level equates to 59.7 grams per day. For comparison, this rate is slightly above Washington State Department of Ecology's value of 54 grams per day default Model Toxics Control Act (MTCA) Cleanup Regulation established in 1991 using information from recreational anglers (MTCA 1991). Furthermore, DOH's two meals per week rate is slightly below the mean consumption rate of 63.2 grams per day reported for fish consumers in the Columbia River Inter-Tribal Fish Commission (CRITFC) fish consumption survey (CRITFC 1994). The CTRIFC survey of the Umatilla, Nez Perce, Yakama, and Warm Springs is unique in that it is an interview-based survey that examines fish consumption rates and patterns of Native Americans who reside in, catch, and consume fish from the Columbia River Basin. It is important to note that the CRITFC study survey did not include Tribes from the UCR whose fish consumption rates may differ from those of the CRITFC survey. The second consumption rate DOH used to establish screening levels for the UCR was based on EPA's subsistence level consumption rate of 142.4 grams per day (EPA 2000b, USDA 1998). This value was based on a review of national data on consumption rates for sport and subsistence fishers and is the 99th percentile of subsistence fishers and the average consumption of uncooked fish and shellfish from estuarine and freshwaters by subsistence fishers (EPA 2000b). This consumption rate falls between the 90th and 95th percentiles of consumption rates reported in the CRITFC study. In summary, DOH uses a general population consumption rate of 59.7 grams per day and a subsistence rate of 142.4 to screen potential exposures.

EPA has provided guidance to be especially protective of recreational fishers and subsistence fishers within the general U.S. population. EPA and DOH recognizes, however, that Native American subsistence fishers are a unique subsistence fisher population that needs to be considered separately. For Native American subsistence fishers, eating fish is simply not a dietary choice that can be completely eliminated if chemical contamination reaches unacceptable levels; rather eating fish is an integral part of their lifestyle and culture. To address the potential for higher fish consumption rates, EPA is currently conducting a fish consumption survey involving the Confederated Tribes of the Colville Reservation. Once this survey is completed, DOH can reassess current default consumption rates used to establish screening levels and estimate potential exposures to contaminants from the consumption of fish. Knowing consumption rates is useful in estimating exposures and thereby estimating potential risks but is not required to calculate safe fish consumption rates.

Screening Levels

Fish tissue chemical screening levels (SLs) were developed to assist in evaluating chemical levels in fish that warrant further scrutiny. Screening levels for each chemical contaminant are defined as the concentration of the chemical in fish tissue that is of potential public health concern and are used as a threshold value against which tissue residue levels of the contaminant in fish can be compared. The SLs were calculated based on both the non-carcinogenic and carcinogenic effects of the chemical contaminant, which are discussed in detail in Volume 1 of EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (EPA 2000b).

In addition to the risks borne by the general population as a result of consuming contaminated fish, populations eating higher-than-average quantities of fish are at greater risk of having higher body burdens of bioaccumulative contaminants. Those at greatest risk include sport and subsistence fishers. Subsistence fishers are defined as fishers who rely on noncommercial caught fish and shellfish as a major source of protein in their diets. Furthermore, these populations, along with pregnant women and children may be at greater risk of incurring adverse effects than other members of the populations because of their proportionally higher consumption rates and/or increased susceptibility to adverse toxicological effects. When setting fish advisories that account for those higher exposed or most vulnerable to the adverse effects of contaminants, we are also protecting the general population as well.

Of the 385 initial COI, those having U.S. EPA Integrated Risk Information System (IRIS) oral reference doses (RfD) or cancer slope factors (CSF) were carried forward in the evaluation (Appendix A Table 2). Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs) were used to evaluate specific health endpoints for total dioxins and PCBS. Screening levels for those chemicals with reference values or cancer slope factors were calculated based on two separate consumption rates, one for the general public of 59.7 grams per day (g/day) corresponding to 8 meals per month and an EPA subsistence consumption rate of 142.4 g/day that corresponds to 19 meals per month. The general equation to derive a screening value is as follows:

Noncarcinogens:

$$\text{Screening Level } (SL_{nc}) = \text{RfD* x BW x UCF / CR}$$

Carcinogens:

$$\text{Screening Level } (SL_{c}) = \text{ARL x BW x UCF / CSF x CR}$$

Where:SL_{nc} = chemical specific noncancer screening concentration (mg/kg)

RfD = chemical specific oral reference dose (mg/kg-day)

BW = average body weight of an child, adult, or woman of childbearing age (kg)

UCF = unit conversion factor ($1x10^3$ g/kg)

CR = consumption rate (g/day)

SL_c = chemical specific cancer screening concentration (mg/kg)

ARL = Acceptable risk level (unitless)

CSF = Chemical specific Cancer Slope Factor (1/mg/kg-day)

or *MRL = Minimal Risk Level (mg/kg) substituted for 2,3,7,8-TCDD or Total PCBs

Calculating Exposure Dose

Exposure doses for those contaminants exceeding SLs were calculated using the mean species-specific contaminant concentration for the various fish species for each of the six fish collection areas in the UCR. Weighted means for the combined fish sampling collection areas were also calculated for each fish species. Weighted mean concentrations were calculated as the sum of composite sample concentration times the number of fish per composite (n) divided by the sum total number of fish in all samples (n) for a given fish species as described in the following equation.

$$Weighted\ mean\ \bar{X} = {(\sum C\ \cdot n)}\Big/{(\sum n)}$$

Where:C = contaminant concentration (mg/kg)
n = number of fish per sample

Estimated doses were calculated for the general population consuming at a rate of 59.7 grams per day (8 meals per month) and for subsistence consumption rate of 142.4 grams per day (19 meals per month) for each sampling area as well as for the entire UCR. Sampling area specific doses for those fish species with fillet concentrations that exceed SLs were calculated to identify potential locations within the UCR where advice to limit consumption may be warranted. Doses were also calculated based an overall weighted mean for a given fish species based on data from the combined collection areas. Both general public and subsistence consumption rates were used to estimate hazards, thereby providing additional information for exposed populations. Exposure equations and parameters are listed in Appendix C, Table 1.

Approach for Assessing Chemicals for Non-cancer Risk

In order to evaluate the potential for non-cancer adverse health effects that might result from exposure to contaminated fish tissue, a dose is estimated for each chemical of concern. The estimated dose for each contaminant is then compared to EPA's oral reference dose (RfDs). RfDs are doses below which non-cancer adverse health effects are not expected to occur (so called "safe" doses). The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure of a chemical to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious non-cancer effects during a lifetime. They are derived from toxic effect levels obtained from human population or laboratory animal studies. These toxic effect levels can be based on either the lowest observed adverse effect level (LOAEL), no-observed adverse effect level (NOAEL), or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. In human or animal studies, the LOAEL is the lowest dose or threshold at which an adverse health effect is seen, while the NOAEL is the highest dose that does not result in any adverse health effects.

Because of uncertainty associated with these data, the toxic effect level is typically divided by "uncertainty factors" resulting in the lower and more protective RfD. If a dose exceeds the RfD, this indicates only the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. If the estimated exposure dose is only slightly above the RfD, then that dose will likely fall well below the toxic effect level. The higher the estimated dose is above the RfD, the closer it will be to the toxic effect level.

Comparisons between the exposure dose and the RfD are called hazard quotients (HQ) and are determined by the following equation:

$$\text{Hazard quotient} = \frac{\text{Estimated Dose (mg/kg-day)}}{\text{RfD (mg/kg-day)}}$$

If the HQ is greater than one, then the RfD is exceeded. Exceeding an RfD does not mean a person will experience an adverse health effect rather that the potential exists for non-cancer effects to occur. The more a HQ exceeds a value of one, the greater potential for adverse health effects.

Non-cancer effects associated with exposure to multiple chemicals detected in fish tissue were evaluated by summing the endpoint-specific HQs for mercury, PBDEs, and PCBs. Many of these COC in this assessment are known to affect multiple endpoints, including developmental, immunological, hepatic, neurological, and reproductive effects. The resulting calculation is referred to as a hazard index (HI) that attempts to account for multiple chemical exposures, and assumes additivity for similar endpoints. ATSDR recommends that interactions between multiple chemicals be assessed for the potential that combined exposures could result in adverse effects that are more (synergistic) or less (antagonistic) severe than would be anticipated from the addition of each chemical dose (ATSDR 2004). In the absence of any data to suggest synergism or antagonism, DOH concurs with ATSDR and recommends that an assumption of additivity be made for chemicals acting on the same target organ. Mechanistic data on how these chemicals cause this effect or interact are lacking, so their combined effect is considered additive for the purpose of this assessment (ATSDR 2004).

The RfD for each contaminant used to calculate hazard quotients should be for the same health endpoint if a hazard index approach is used. The following table shows health endpoint specific RfDs or minimal risk levels (MRLs) [1] for chemicals commonly found in fish (Table 1).
To calculate hazard indices, the health endpoint-specific (e.g. neurological endpoint) hazard

---

[1] Minimal risk levels (MRLs) are derived by the Agency for Toxic Substances and Disease Registry (ATSDR). The methods of derivation are not substantially different from those used by EPA to derive oral reference doses (RfDs).

quotient for each contaminant are calculated as shown below:

$$HQ_{\text{(neurological)}} = \text{Estimated dose} / RfD_{\text{(neurological)}}.$$

Next, hazard quotients are summed to determine the hazard index (HI) for a specific endpoint, as shown below:

$$HI_{\text{(neurological)}} = (HQ_{\text{Mercury (neurological)}} + HQ_{\text{PBDEs (neurological)}} + HQ_{\text{PCBs (neurological)}})$$

The following table shows health endpoint specific RfDs or MRLs for mercury, PBDEs, and PCBs.

Table 1. Endpoint-specific RfDs or MRLs (mg/kg-day) used to calculate an endpoint-specific hazard index.*

Endpoint	Mercury	PBDEs	PCBs
Developmental	$3x10^{-4}$	$1x10^{-4}$	$3x10^{-5}$
Immunological	$3x10^{-4}$	NA	$2x10^{-5}$
Neurological	$1x10^{-4}$	$1x10^{-4}$	$3x10^{-5}$
Reproductive	$4x10^{-4}$	NA	$2x10^{-4}$

*All values taken from US EPA's Integrated Risk Information System or ATSDR's Interaction Profile for Persistent Chemicals found in Fish (Chlorinated Dibenzo-P-Dioxins, Hexachlorobenzene, P,P'-DDE, Methylmercury, and Polychlorinated Biphenyls). NA = Not available

A HI can then be calculated for each of the various endpoints depending on concentration of mercury, PBDEs, or PCBs in a given fish species. The magnitude of the resulting HI is useful in comparing an individual HQ to the combined HI to determine how much a specific contaminant's HQ contributes to the overall HI. Comparison of HQs across health endpoints is not appropriate in that the values do not reflect the overall severity of a given health endpoint relative to another.

Toxicity Values for TCDD-like Congeners

Fish tissue dioxins, dibenzofuran and PCBs were assessed as individual congeners. For congeners that have dioxin-like toxic effects, the fish tissue concentrations were expressed as "TEQ" (toxic equivalent concentration). The TEQ is the concentration of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) that would have the same toxic activity as the congener mixture observed in the tissue.

The TEQ is calculated as the sum of the products of the congener concentrations and congener Toxicity Equivalency Factors (TEF),

$$TEQ = \Sigma (TEF_i \cdot C_i)$$

Where:

TEF_i = Toxicity equivalency factor for congener "i"

C_i = Concentration of congener "i"

The TEF is the relative toxic potency of the conger, relative to that of TCDD. The World Health Organization has developed TEFs for mammals (including humans) for the sub-set of 6 dioxin, 10 dibenzofuran, and 12 PCB congeners that elicit aryl hydrocarbon receptor (AhR)-mediated biochemical and toxic responses similar to TCDD (Van den Berg et al. 2006).

For dioxin-like PCBs, dioxins, and dibenzofurans, congener-specific concentrations were converted to TCDD-TEQ using the TEFs shown in Table 2. Congener-specific TEQ values were summed and expressed as total TCDD-TEQs.

Table 2. Toxicity Equivalence Factors for PCB, Dioxin and Dibenzofuran Congeners.

Class	Congener	CASRN	Mammal Toxicity Equivalence Factor (TEF)
Co-planar PCBs	3,3',4,4'-TCB (77)	32598133	0.0001
	3,4,4',5-TCB (81)	70362504	0.0003
	3,3',4,4'-5-PeCB (126)	57465288	0.1
	3,3',4,4',5,5'-HxCB (169)	32774166	0.03
Mono-ortho PCBs	2,3,3',4,4'-PeCB (105)	32598144	0.00003
	2,3,4,4',5-PeCB (114)	74472370	0.00003
	2,3',4,4',5-PeCB (118)	31508006	0.00003
	2',3,4,4',5-PeCB (123)	65510443	0.00003
	2,3,3',4,4',5-HxCB (156)	38380084	0.00003
	2,3,3',4,4',5'-HxCB (157)	69782907	0.00003
	2,3',4,4',5,5'-HxCB (167)	52663726	0.00003
	2,3,3',4,4',5,5'-HpCB (189)	39635319	0.00003
Dibenzo-p-dioxins	2,3,7,8-TCDD	1746016	1
(PCDDs)	1,2,3,7,8-PeCDD	40321764	1
	1,2,3,4,7,8-HxCDD	39227286	0.1
	1,2,3,6,7,8-HxCDD	57653857	0.1
	1,2,3,7,8,9-HxCDD	19408743	0.1
	1,2,3,4,6,7,8-HpCDD	35822469	0.01

	OCDD	3268879	0.0003
Dibenzofurans (PCDFs)	2,3,7,8-TCDF	51207319	0.1
	1,2,3,7,8-PeCDF	57117416	0.03
	2,3,4,7,8-PeCDF	57117314	0.3
	1,2,3,4,7,8-HxCDF	70648269	0.1
	1,2,3,6,7,8-HxCDF	57117449	0.1
	1,2,3,7,8,9-HxCDF	72918219	0.1
	2,3,4,6,7,8-HxCDF	60851345	0.1
	1,2,3,4,6,7,8-HpCDF	67562394	0.01
	1,2,3,4,7,8,9-HpCDF	55673897	0.01
	OCDF	39001020	0.0003

Toxicity Values for Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are products of incomplete combustion of organic materials; sources are, thus, widespread, including cigarette smoke, municipal waste incineration, wood stove emissions, coal conversion, energy production from fossil fuels, and automobile and diesel exhaust. As PAHs are common environmental contaminants, it is important that public health agencies have a scientifically justified, consistent approach to the evaluation of human health risk from exposure to these compounds, For the majority of PAHs classified as B2, probable human carcinogens, data are insufficient for calculation of a inhalation or drinking water unit risk. Benzo[a]pyrene (BaP) is the most completely studied of the PAHs, and data, while problematic, are sufficient for calculation of quantitative estimates of carcinogenic potency. Toxicity Equivalency Factors (TEFs) are recommended by EPA on an interim basis for risk assessment of chlorinated dibenzodioxins and dibenzofurans. Data for PAHs do not meet all criteria for use of TEF. This assessment presents a different approach to quantitative estimation for PAHs using weighted potential potencies (Schoeny 2006). These estimates are recommended only for evaluation of risk from oral exposure and are proposed only for the assessment of potential carcinogenicity of PAHs.

Oral slope factors (oSF) for Polycyclic Aromatic Hydrocarbon (PAH) compounds were based on the cancer slope factors for benzo(a)pyrene (BaP), multiplied by the Estimated Order of Potency (EOP) values provided in EPA (EPA 1993), as shown below. In cases where EPA did not provide an EOP, values were supplemented by the EOPs provided in Collins et al. (1998).

$$oSF_{(PAH\textit{i})} = oSF_{(BaP)} \cdot EOP_{(PAH\textit{i})}$$

Table 3 summarizes the EOPs used when calculating cancer risks from PAHs.

Table 3. Relative Potency Values for Individual PAH's.

Compound	Relative Potency
Benzo[a]pyrene	1
Benz[a]anthracene	0.1
Benzo[b]fluoranthene	0.1
Benzo[j]fluoranthene	0.1
Benzo[k]fluoranthene	0.01
Dibenz[a,j]acridine	0.1
Dibenz[a,h]acridine	0.1
Dibenz[a,h]anthracene	1
7H-Dibenzo[c,g]carbazole	1
Dibenzo[a,e]pyrene	1
Dibenzo[a,h]pyrene	10
Dibenzo[a,i]pyrene	10
Dibenzo[a,l]pyrene	10
Indeno[1,2,3-c,d]pyrene	0.1
5-Methylchrysene	1
1-Nitropyrene	0.1
4-Nitropyrene	0.1
1,6-Dinitropyrene	10
1,8-Dinitropyrene	1
6-Nitrochrysene	10
2-Nitrofluorene	0.01
Chrysene	0.001

Approach for Assessing Lead Exposures in Children

Potential health effects due to lead exposure were assessed for children and adults. The biokinetics of lead are different from most toxicants because lead is stored in bone and remains in the body long after it is ingested. Because the biokinetics of lead are different, EPA has not developed an RfD for lead and therefore lead exposures must be evaluated differently than for other chemicals such as PCBs and mercury. To evaluate the potential for harm, public health agencies often use a computer model that can estimate blood lead levels in children younger than seven years of age who are exposed to lead-contaminated soil. Children's exposure to lead is evaluated using the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) developed by the EPA. The IEUBK model predicts blood lead levels in a distribution of exposed children based on the amount of lead that is in environmental media (e.g., fish) (EPA 2002a) and to use the results to evaluate the risk of lead poisoning for an average child.

In this assessment, the IEUBK model was used to estimate the percentage of children that could have elevated blood lead levels if they frequently eat lead-contaminated fish. For children who are regularly exposed to lead-contaminated fish, the IEUBK model can estimate the probability that any child could have a blood lead concentrations that exceeds (10 μg/dl). Exceedance of lead exposure will be based on EPA's goal that no individual will have greater than a 5% probability of having a blood lead concentration above the target value of 10 μg/dL.

EPA default values were used in the IEUBK model with the exception of fish consumption rates and site-specific lead fish tissue concentrations. To assess the lead hazard associated with fish consumption, the model requires information on the percentage of total meat consumption consisting of locally caught fish (i.e., average-end recreational estimate for a child or non-tribal high-end consumers) and the average lead concentration in fish tissue. This evaluation uses the same exposure assumptions used in DOH's 2005 data assessment (DOH 2010). In that assessment, DOH utilized a general population fish consumption ingestion rate of 7 g/day (6.5% of total meat), and a non-tribal high-end consumer exposure scenario of children eating 60 g/day (15% of total meat) of fish containing the average concentration of lead in each reach (Appendix B, Table 6) as well as weighted lead means across all FSCAs. IEUBK model input for the percentage of total meat consumed that consisted of locally caught fish were 6.5% for the general population, and 15% for non-tribal high-end consumers.

It is important to note that the IEUBK model is not expected to accurately predict the blood lead level of a child (or a small group of children) at a specific point in time. In part, this is because a child (or group of children) may behave differently and therefore have different amounts of exposure to contaminated soil and dust than the average group of children used by the model to calculate blood lead levels. For example, the model does not take into account reductions in exposure that could result from community education programs. The IEUBK model was also not designed to assess the short-term, periodic, or acute exposures, or the deliberate ingestion (e.g., pica) of soil in which there are excessive soil ingestion rates. Instead, the role of the IEUBK model is to simulate blood lead (PbB) concentrations associated with continuous exposures of sufficient duration to result in a quasi-steady state (EPA 2002a). Infrequent and non-continuous exposures (i.e., less than 1 day per week over a minimum duration of 90 days) would be expected to produce oscillations in blood lead concentrations associated with the absorption and subsequent clearance of lead from the blood between each exposure event. The

IEUBK model, therefore, can only provide an approximation of quasi-steady-state PbB concentrations during non-continuous exposure scenarios (EPA, 2003). Despite this limitation, the IEUBK model is a useful tool to help prevent lead poisoning because of the information it can provide about the hazards of environmental lead exposure.

Approach for Assessing Lead Exposures in Adults

The adult lead model (ALM, Version June 2009) was used to estimate the probability that a fetus born to a mother who frequently eats lead-contaminated fish could have elevated blood lead levels (BLL). The EPA's adult blood lead model is useful to predict blood lead levels in adults and their fetuses. The adult model uses well established default values and is completely different from the IEUBK model. The adult model considers lead exposure through the ingestion of soil and food. In this application, fish ingestion was used to represent maternal exposure. The dose of lead received through this pathway is then converted to a blood lead level by using the ratio of blood lead to lead dose, the Biokinetic Slope Factor (BKSF). As part of the model, the default maternal BLL in the absence of site specific lead exposure pathways (1.0 µg/dL), was incorporated into the calculation.

Exposure was based on a general population scenario of adults eating 59.7 g/day or a non-tribal high-end consumer scenario of adults eating 142.4 g/day of fish containing the average concentration of lead in each reach, 365 days per year (Appendix B Table 6). The weighted mean estimated lead concentrations across all FSCAs are also presented.

In order to protect the developing fetus, EPA's target cleanup goal is that no individual fetus will have a greater than a 5% probability of obtaining a BLLs above 10 µg/dL. To achieve this goal, the central tendency maternal blood lead levels need to be maintained at or below 2.8 ug/dL. Maintenance of the central tendency maternal blood level at or below 2.8 µg/dL should insure a low probability of fetal exposure resulting in blood levels of greater than 10 µg/dL, the same value used for assessment of lead for children in the IEUBK model.

Approach for Assessing Cancer Risks

Some chemicals have the ability to cause cancer. Cancer risk is estimated by calculating a dose and multiplying it by a cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human population data; others are derived from laboratory animal studies involving doses much higher than are typically encountered in the environment. Use of animal data requires extrapolation of the cancer potency obtained from these high dose studies down to real-world, environmentally relevant exposures. This process involves much uncertainty. In the face of uncertainty, EPA generally uses health protective estimates of a substance's carcinogenicity by using the upper 95% confidence limit on the dose response curve as well as by assuming that the cancer dose response relationship is linear at low doses.

Currently, many risk analyses assume that there is no "safe dose" of a carcinogen and that a very small dose of a carcinogen will give a small cancer risk. However, EPA's new "Guidelines for Carcinogen Risk Assessment" stress the need to determine, if possible, a chemical's mode of action in causing cancer. For chemicals that are determined to be carcinogenic via a mutagenic mode of action and for carcinogens for which the mode of action is unknown, EPA generally takes a public health-protective default position in reviewing scientific data. This means animal tumor findings are judged to be relevant to humans and cancer risks are assumed to have no threshold; i.e., there is no dose without any effect. For other modes of action, nonlinear approaches may be considered, under which scenario there would be a dose below which is assumed to carry no cancer risk.

Cancer risk estimates are, therefore, not *yes/no* answers as can be the case with non-carcinogens discussed above but estimates of chance (probability) that are related to exposure. Such estimates, however uncertain, are useful in determining the magnitude of a cancer threat since any level of a carcinogenic contaminant carries an associated risk. The validity of the "no safe dose" assumption for cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered carcinogenic must exceed a threshold of tolerance before initiating cancer. EPA has recently reversed their guidance for assessing cancer risk to include the potential for a threshold response (EPA 2005).

This document presents estimated lifetime increased cancer risk numerically. For instance, a cancer risk of 1×10^{-5} or 1 in 100,000 can be better understood by considering 100,000 exposed individuals required for an attributed exposure to result in a single cancer case over a lifetime (i.e. 70 years). It is important to note that these estimates are for *excess* cancers that might result in addition to those normally expected in an unexposed population. The U.S. EPA's acceptable cancer risk range is 10^{-4} to 10^{-6} when making cleanup decisions at Superfund sites. Furthermore, this document describes theoretical cancer risk that is attributable to site-related contaminants in qualitative terms like low, very low, slight, and no significant increase in theoretical cancer risk. These terms can be better understood by considering the population size required for such an estimate to result in a single cancer case. For example, a low increase in cancer risk indicates an estimate in the range of one excess cancer case per ten thousand persons exposed over a lifetime. A very low estimate might result in one excess cancer case per several tens of thousands exposed over a lifetime and a slight estimate would require an exposed population of several hundreds of thousands to result in a single case. DOH considers theoretical cancer risk insignificant when the estimate results in less than one cancer per one million exposed over a lifetime. Theoretical cancer risks quantified in this document are an upper-bound theoretical estimate. Actual risks are likely to be much lower.

Cancer is a common illness and its occurrence in a population increases with age. Depending on the type of cancer, a population with no known environmental contaminant exposure could be expected to exhibit a substantial number of cancer cases. There are many different forms of cancer that result from a variety of causes. Some forms of cancer are more serious than others and not all are fatal. Approximately one quarter to one third of people living in the United States will develop cancer at some point in their lives. For this assessment, cancer risks were calculated for fish consumers based on their exposure to chemicals having CSFs that can potentially cause cancer in humans. It should be noted that the use of carcinogenic risk as the basis for fish advisories has been called into question (Stone and Hope 2010). The standard methodology of cancer assessment that assumes there is no threshold of effect will likely overestimate actual risks to consumers. Consumption recommendations base on cancer outcomes will likely be overly restrictive and inadvertently limit the recognized health benefits associated with a fish-rich diet.

Calculating Meal Limits for Individual Chemical Exposures

When estimated exposures for any given population exceed comparison values that are considered to be protective (i.e. RfDs or acceptable cancer risks), meal limits are calculated to inform any advice that might be provided to consumers. DOH calculates allowable meal limits based on EPA's RfD, ATSDR's MRL, or EPA's CSF, the average body weight of an individual, and the known contaminant concentration in fish. These calculations allow DOH to formulate advice that will be useful to consumers.

By using the known concentration of a contaminant in a fish species, it is possible to calculate a meal limit for that species that will result in a dose equivalent to the RfD for that contaminant. In this approach, the RfD is used to calculate the quantity of fish a person of a given body weight can safely consume given varying contaminant concentrations found in fish tissue. The equation used to calculate a safe consumption rate is shown below, with exposure parameters as defined in Table 4 (EPA 2000c):

Non-cancer meal equation:

$$Meal\ per\ month\ = \frac{RfD\ \cdot BW\ \cdot\ CF}{MS\ \cdot\ C}$$

Cancer meal equation:

$$Meals\ per\ month = \frac{ARL\ \cdot\ BW\ \cdot\ CF}{MS\ \cdot\ CSF\ \cdot\ C}$$

Table 4. Exposure parameters for calculating fish meal limits.

Parameter	Value	Units	Comments	Source
Allowable Risk Level (ARL)	10^{-5}	unitless		
Conversion Factor (CF)	30.44	Days/month		
Body Weight (BW)	70 or 60 (adult female)	kg	70 kg adult, 60 kg adult female	EPA Exposure Factors Handbook
Concentration in fish (C)	Mean contaminant concentration. .	mg/kg	Specific to fish species	
Meal size	0.227	kg/meal	½ pound meal	DOH
Reference Dose (RfD)	Variable	mg/kg-day	Chemical specific	EPA IRIS or ATSDR MRL
Cancer Slope Factor (CSF)	Variable	$mg/kg\text{-}day^{-1}$	Chemical specific	EPA IRIS

In addition to the calculated meal limits, considerations are given to other factors that will influence the recommendations that ultimately go out to the public. These include but are not limited to chemical background concentrations, the ability to reduce chemical concentrations through cleaning and cooking techniques, chemical concentrations in other food, known benefits of fish consumption, and ease of messaging. To address the later point of ease of messaging, calculated meal limits are given in straightforward, easy to understand rates that include one meal per month, two meals per month, four meals per month, eight meals per month, and unlimited consumption. To accomplish this, calculated meal limits are rounded up or down to fit into these rate categories.

Calculating Meal Limits Based on Multiple Chemical Exposures

Consuming fish can expose a person to more than one chemical at a time. Assessing the combined effect is more difficult and if not impossible to measure all possible interactions between chemicals. The potential exists for many chemical to interact in the body and increase or decrease the potential for adverse health effects. Individual cancer risk estimates can be added since they are measures of probability. However, when estimating non-cancer risk, similarities must exist between the chemicals if the doses are to be added. Groups of chemicals that have similar toxic effects can be added (ATSDR 2004).

In addition to individual contaminant effects discussed above, this assessment also considers the additive non-cancer endpoints of mercury, PBDEs, and PCB exposure. Because mercury, PBDEs, and PCBs have similar toxic endpoints (neurological and developmental endpoints), the preceding equation can be adapted to calculate meal limits that account for additive toxic effects. The adapted equation is shown below:

$$Meals\ per\ month = \left(\frac{BW \cdot CF}{MS}\right) \cdot \left(\left(\frac{RfD_{mercury}}{C_{mercury}}\right) + \left(\frac{RfD_{PCBs}}{C_{PCBs}}\right) + \left(\frac{RfD_{PBDEs}}{C_{PBDEs}}\right)\right)$$

Where: BW = body weight adult, or woman of childbearing age

CF = Conversion Factor (30.44 days/month)

MS = Meal Size (0.227 kg/meal)

RfD* = chemical specific oral reference dose (mg/kg-day)

C = Chemical Concentration of mercury, PCBs, or PBDEs in fish tissue (mg/kg)

*MRL may be substituted for RfD

As with single contaminant meal calculations, calculated meal limits based on multiple contaminants are also rounded up or down to fit one of the five meal rate categories discussed above to simplify the message that goes out to the public.

Uncertainty

The methodology described above involves many uncertainties. Uncertainty with regard to the risk assessment process refers to the lack of knowledge about factors such as chemical toxicity, human variability, human behavior patterns, and chemical concentrations in the environment. Uncertainty can only be reduced through further study.

The majority of uncertainty comes from our knowledge of chemical toxicity. For most chemicals, there is little knowledge of the actual health impacts that can occur in humans from environmental exposures. In the absence of epidemiological or clinical evidence, risk assessors must rely on toxicological experiments performed on animals. These animals are exposed to chemicals at much higher levels than are found in the environment. The critical doses in animal studies are often extrapolated to "real world" exposures for use in human health risk assessments. In order to be protective of human health, uncertainty factors are used to lower that dose in consideration of variability in sensitivity between animals and humans, and the variability within humans. These uncertainty factors can account for a difference of two to three orders of magnitude in the calculation of risk. For this reason, it is important to note that the risk assessment methodology is only a partial guide as to how DOH establishes fish consumption guidance or advisories in the state.

It should be noted that total PBDE screening levels were based on a single RfD value for the most hazardous PBDE and the screening value is therefore likely to be overprotective.

Chromium has evaluated as chromium VI.

RESULTS

Chemicals of Concern (COCs)

Of the 385 initial COI (Appendix A Table 1), 57 chemicals have U.S. EPA IRIS oral RfD, CSF, or ATSDR MRL (Appendix A Table 2) that were used to evaluate chemical concentrations in fish. Fish tissue chemical concentrations from the UCR were compared with the general population and subsistence SLs to determine those chemicals that pose a potential public health risk. Of those chemicals that had SL, those at concentrations above their respective SL in any of the sample matrix types (fillets, fish carcass, offal, or whole body) were considered a COC. Based on the comparison of chemical concentrations with their corresponding SL, one pesticide, aldrin (Appendix A Table 3a); four metals: antimony, cadmium, chromium, and mercury (Appendix A Table 3b-e); one PBDE congener: PBDE-47 (Appendix A Table 3f); total PBDEs (Appendix A Table 3g); total PCBs (Appendix A Table 3h); and total dioxin TEQs (Appendix A Table 3i) exceeded the subsistence screening value and are considered as initial chemicals of concern to be evaluated further (Table 5).

Table 5. Initial Chemicals of Concern (COC).

Chemical	Sample Matrix			
	Carcass	Whole Fish	Offal	Fillet
Aldrin	x			
Antimony	x	x		
Cadmium	x	x		
Chromium		x		
Mercury	x	x		x
PBDE-47	x		x	x
Total PBDEs	x		x	x
Total PCBs	x	x		x
Total Dioxins	x	x		x

Additional filtering of the data was conducted on the initial COC list to focus on concentrations found in the fillets only, the list of COC found in fillets was reduced to five contaminants: mercury, PBDE congener 47, total PBDEs, total PCBs, and total dioxin TEQs as shown in Table 6 (Appendix A Table 4a-e). Lead concentrations were also evaluated using the approach discussed above resulting in a total of six COCs.

Table 6. Final Chemicals of Concern (COC).

Chemical	Sample Matrix
	Fillet
Mercury	x
PBDE-47	x
Total PBDEs	x
Total PCBs	x
Total Dioxins	x
Lead	x

Exceedances in subsistence SLs were seen in mercury levels in multiple fish species throughout the UCR (Appendix A, Table 4a). Only one largescale sucker fillet sample collected in FSCA 6 exceeded the SL for PBDE-47 and only two fish samples, mountain whitefish from FSCA1 and the same largescale suckers sampled from FSCA 6 exceeded SLs for total PBDEs. Screening level exceedances for total PCBs were also seen throughout the UCR study area (Appendix A, Table 4d) and most exceedances occurred in largescale suckers and mountain whitefish. Total dioxin TEQ screening values were exceeded in all six-collection locations in numerous fish species (Appendix A, Table 4e).

Concentrations of COCs in Upper Columbia River Fish Species

The following is a summary of the fillet contaminant data on the five COC. Data are presented three ways: by FSCA, by species, and then summarized by means. Summary descriptive statistics including means and contaminant ranges in fillet tissue for mercury, PBDE-47, total PBDEs, total

PCBs, and dioxins for each of the six FSCAs are presented for the various fish species in Appendix B, Tables 1-5. Descriptive statistics are also presented for lead (Appendix B, Table 6) and will be discussed further in the document. Data on individual fish species for each of the COCs are presented in Appendix B, Tables 7-12. Weighted mean concentrations of COCs are summarized for the nine species with fillet data and shown below (Table 7, Figures 3-7). This summary presents the weighted mean concentrations of the five COCs and lead from all the FSCAs.

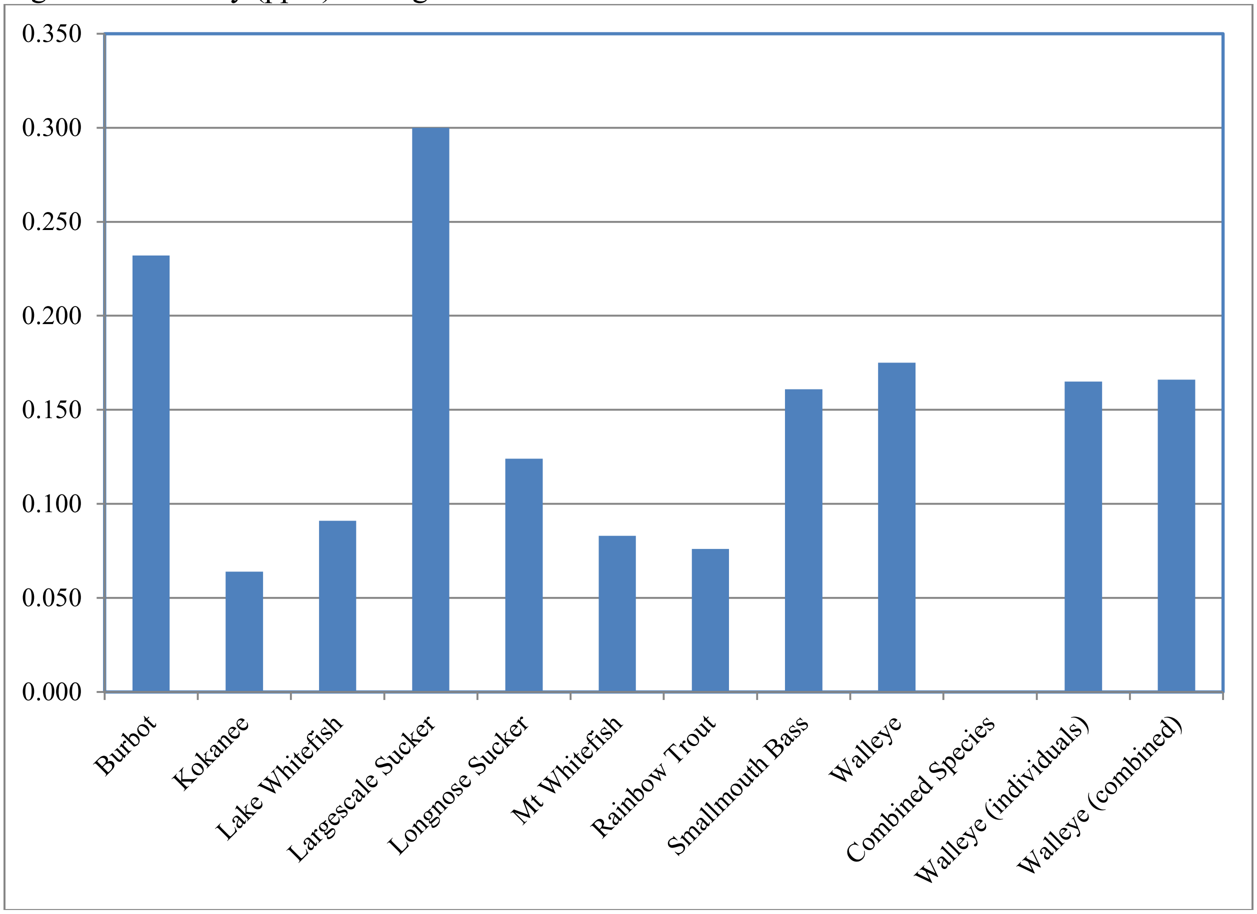
Table 7. Summary of Weighted Mean COC Concentrations in Fillet Tissue from All FSCAs.

Species	Size Class	Mercury (ppm)	PBDE-47 (ppb)	Total PBDEs (ppb)	Total PCBs (ppb)	Total Dioxin (ppb)	Lead (ppm)
Burbot	>30cm	0.232	1.2	2.5	2.2	0.00060	0.024
Kokanee	>30cm	0.064	2.6	5.4	7.8	0.00052	0.004
Lake Whitefish	>30cm	0.091	11.3	17.5	19.8	0.00124	0.009
Largescale Sucker	>30cm	0.300	27.3	34.5	63.0	0.00132	0.176
Longnose Sucker	>30cm	0.124	7.6	9.9	11.9	0.00096	0.024
Mt Whitefish	>30cm	0.083	18.1	27.4	26.7	0.00146	0.007
Rainbow Trout	>30cm	0.076	5.8	12.2	15.5	0.00056	0.028
Smallmouth Bass	>30cm	0.161	4.4	6.7	6.6	0.00064	0.019
Walleye	>30cm	0.166	3.0	5.0	6.2	0.00044	0.030

Mercury Results

Mercury was detected in all fillet samples across all species and fish sampling collection locations, however not all species were collected from each fish collection site (Appendix B, Tables 1 and 7a-i). The species with the highest mercury concentrations throughout all of the FSCAs in the UCR included largescale suckers and burbot (Appendix B, Table1). Largescale sucker had the highest maximum (0.584 ppm) value reported from FSCA 4. The two species with the lowest mercury mean concentrations throughout the UCR included kokanee and rainbow trout with their lowest concentrations of 0.059 ppm and 0.065 ppm in FSCAs 3 and 5, respectively. Weighted mean mercury concentrations ranged from a low of 0.064 ppm for kokanee to a high of 0.300 ppm for largescale suckers. Composite and fillet samples were analyzed for mercury for smallmouth bass in FSCAs five and six and in all FSCAs for walleye with similar results within species (Appendix B, Tables 7h and 7i). As a whole, the average weighted mean mercury concentration for all species in the UCR system was 0.144 ppm. Weighted mean mercury concentrations for all species are depicted in Figure 3.

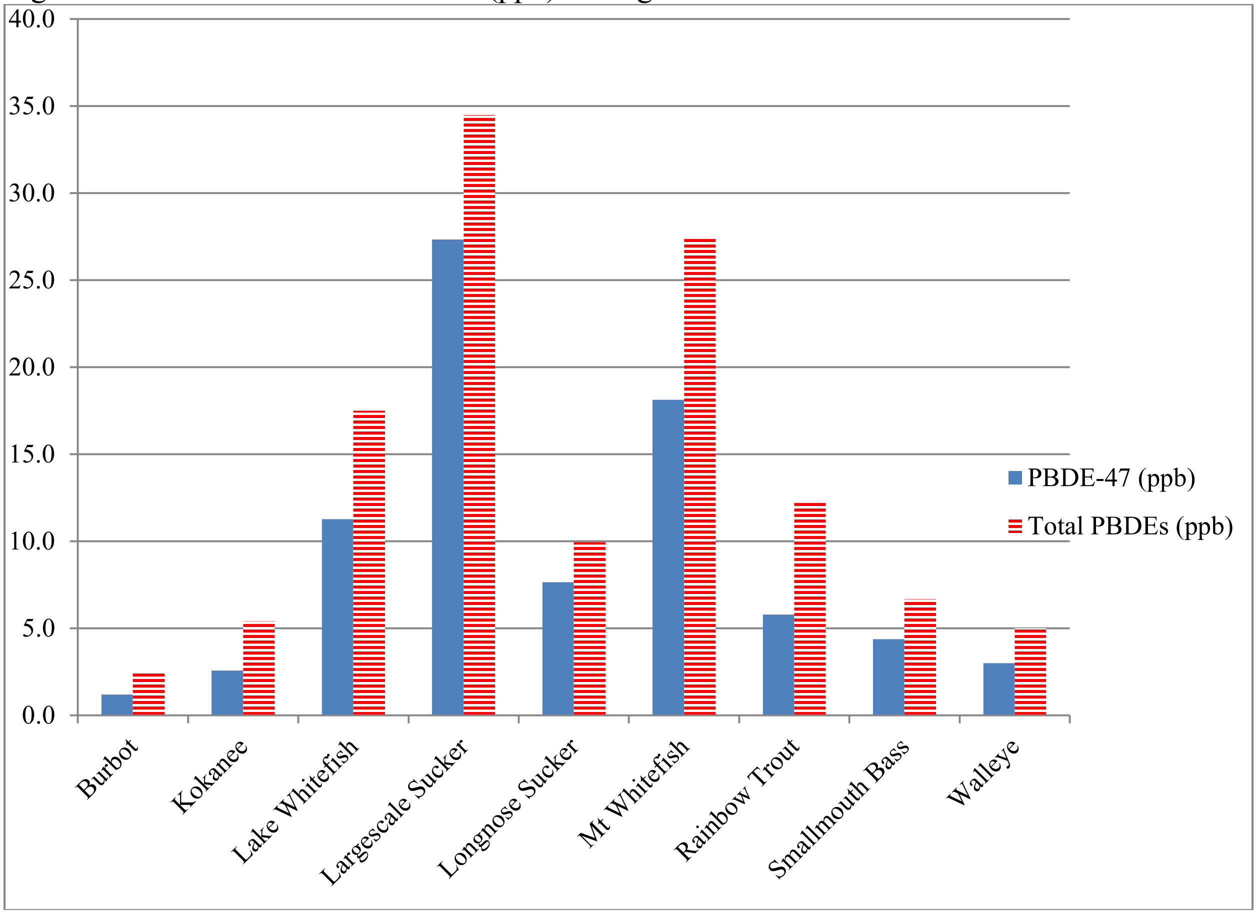
Figure 3. Mercury (ppm) - Weighted Mean Across All FSCAs.



PBDEs

PBDE-47 and total PBDEs were detected at relatively low concentrations throughout the UCR (Appendix B; Tables 2, 3, 8a-I, and 9a-I; and Figure 4). PBDE-47 was detected in all fillet samples with weighted mean concentrations ranging from 1.2 in burbot to 27.3 ppb in largescale suckers. Total PBDE results were reported as consisting of four PBDE congeners (PBDE 47, 99, 153, and 209). Total PBDE weighted mean concentrations ranged from 2.5 ppb to 34.5 ppb across all species. Burbot, walleye, and kokanee had the lowest concentrations of 2.5 ppb, 5.0 ppb, and 5.4 ppb, respectively. Largescale sucker and mountain whitefish had the highest total PBDE concentrations of 34.5 ppb and 27.4 ppb, respectively. Overall weighted means for PBDE-47 and total PBDEs were 9.0 ppb and 13.5 ppb, respectively. PBDE-47 comprised the majority of congeners in the total PBDEs mixture.

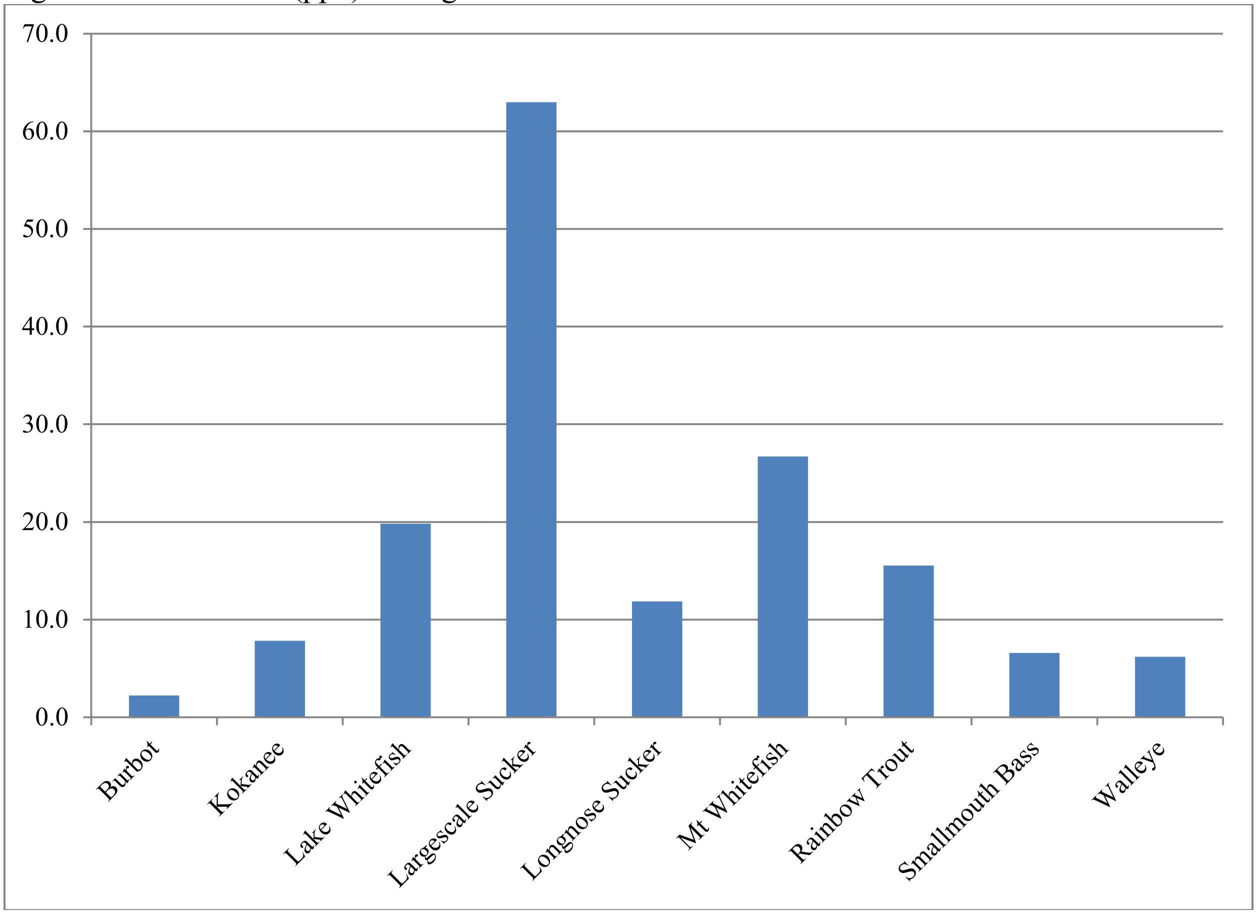
Figure 4. PBDE-47 and Total PBDE (ppb) - Weighted Means Across All FSCAs.



PCBs

Total PCB concentrations were calculated by summing all PCB congeners and using ½ the detection limit for non-detected data. Relatively low total PCB concentrations were observed in all species collected from most of the fish sample collection areas. Burbot, kokanee, smallmouth bass, and walleye all had weighted mean total PCB concentrations of 10 ppb or less with burbot having the lowest mean of 2.2 ppb (Appendix B, Tables 4 and 10a-I, and Figure 5). Highest total PCB concentrations in fillet tissues were seen in lake whitefish, mountain whitefish, and largescale suckers with weighted mean concentrations from the six fish collection sites at 19.8, 26.7, and 63.0 ppb, respectively. As with all contaminant results, nondetected values were included in calculations using ½ the detection limit. The overall weighted mean PCB concentration for all fish species in the UCR was 17.7 ppb.

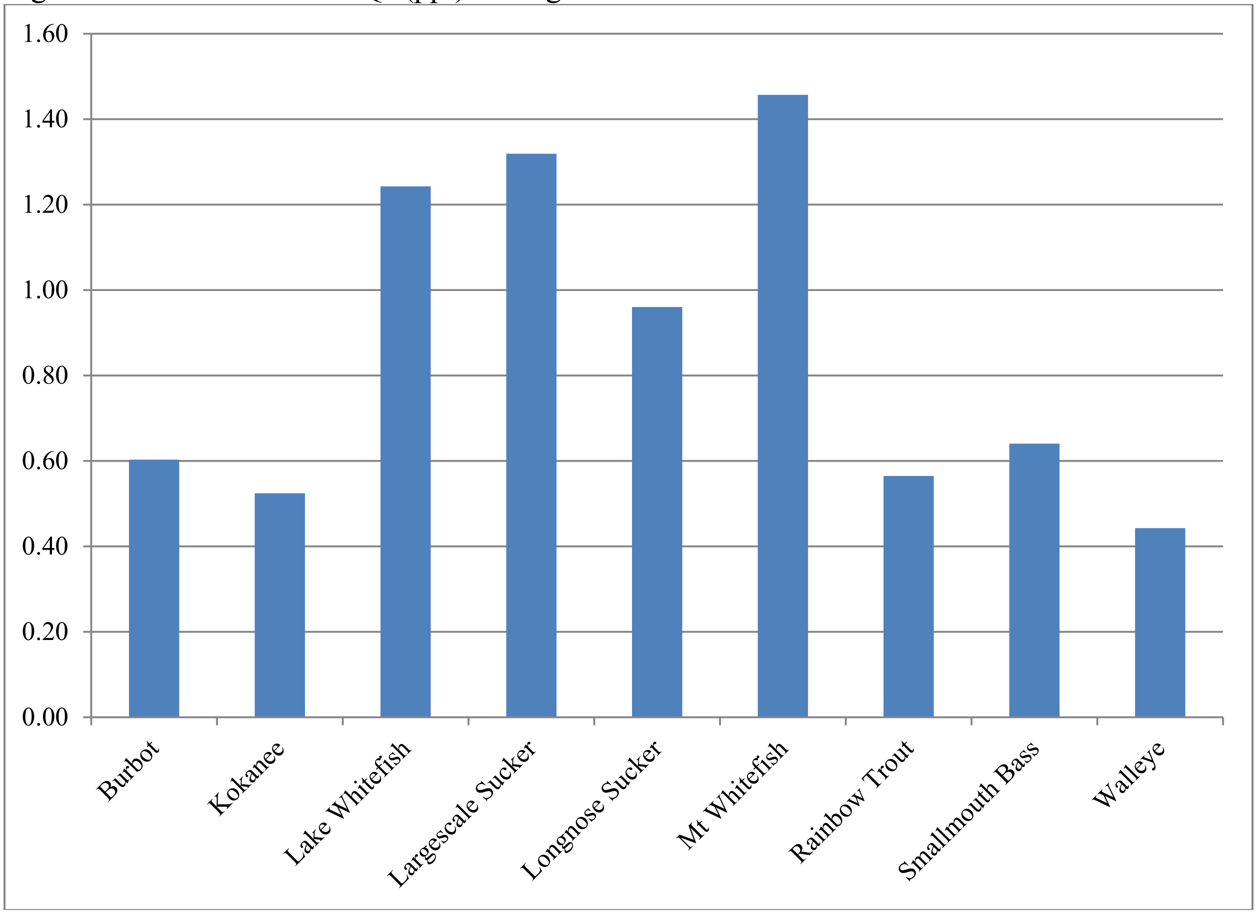
Figure 5. Total PCBs (ppb) - Weighted Means Across All FSCAs.



Dioxins TEQs

Total dioxins TEQs were calculated by summing the dioxin TEQs for all dioxin, dibenzofuran, and PCB congeners having dioxin TEQ values as described above. Non-detected data were evaluated using ½ the detection limit. For all fillet samples as measured in each FSCAs or combined for a weighted average, total dioxin TEQ concentrations were below 2 part per trillion (ppt) (Appendix B, Tables 5 and 11a-I, and Figure 6). The highest overall weighted mean from all six FSCAs was seen in lake whitefish, largescale suckers, and mountain whitefish with total dioxin TEQ concentrations of 1.24 ppt, 1.32 ppt, and 1.46 ppt. All other species were below 1 ppt with walleye having the lowest weighted mean total dioxin TEQ concentrations of 0.44 ppt. Overall dioxin TEQ weighted mean concentration for all species in the UCR was 0.86 ppt.

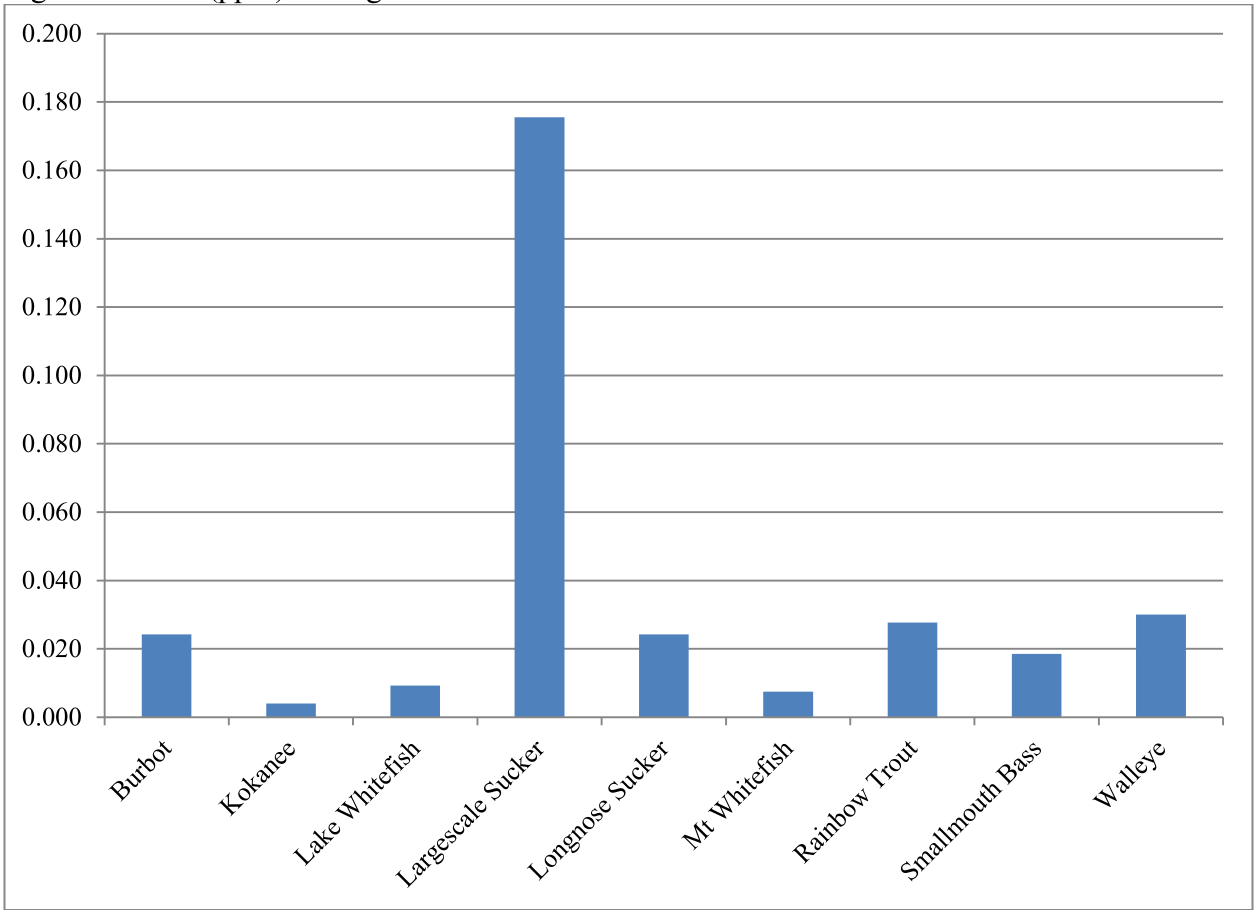
Figure 6. Total Dioxins TEQs (ppt) - Weighted Means Across All FSCAs.



Lead

Fillet lead weighted mean concentrations were below 0.030 ppm in all fish species in the UCR with the exception of largescale suckers (Appendix B, Tables 6 and 12a-i, and Figure 7). Largescale sucker lead levels were nearly six times higher than the next highest species (walleye). Lake whitefish, mountain whitefish, and kokanee had the lowest weighted mean lead levels of 0.009 ppm, 0.007 ppm, and 0.004 ppm. The overall weighted mean concentration of all nine fish species from the UCR was 0.036 ppm.

Figure 7. Lead (ppm) - Weighted Mean Across All FSCAs.



Estimating Exposure to Contaminants in Upper Columbia River Fish

Comparison of Exposure to Reference Doses for Individual Contaminants in Upper Columbia River Fish That Exceeded Screening Levels

Exposure to COC from consuming UCR fish were estimated based on exposure assumptions for both the general and subsistence populations. Dose estimates for mercury, PBDE-47, total PBDEs, total PCBs, and total dioxin, dibenzofuran and dioxin-like PCB TEQs for both the general population and subsistence populations were calculated based on exposure assumptions shown in Table 8 and the following equations.

$$Non-cancer\ Dose\ (mg/kg-day) = \frac{C \times IR \times CF_1 \times EF \times ED \times CF_2}{BW \times AT_{non-cancer}}$$

$$Cancer\ Dose\ (mg/kg-day) = \frac{C \times IR \times CF_1 \times EF \times ED \times CF_2}{BW \times AT_{cancer}}$$

Table 8. Exposure Assumptions Used to Determine Contaminant Doses to the General and Subsistence Level Populations.

Parameter	Value	Unit	Comments
Concentration (C)	species specific	ug/kg	Average fish tissue concentration
Ingestion Rate (IR) - general population	59.7	g/day	DOH unlimited fish consumption rate
Ingestion Rate (IR) - subsistence population	142.4	g/day	EPA Subsistence consumption rate
Conversion Factor1 (CF_1)	0.001	mg/ug	Converts microgram (ug) to milligrams (mg)
Exposure Frequency (EF)	365	days/year	Assumes daily exposure
Exposure Duration (ED)	30	years	General population residence time
	70	years	Subsistence population residence time
Conversion Factor1 (CF_2)	0.001	kg/g	Converts grams (g) to kilograms (kg)
Body Weight (BW)	70 (60)	kg	Adult mean body weight (adult female)
Averaging Time $_{non\text{-}cancer}$ (AT)	10950	days	30 years for general population
Averaging Time $_{non\text{-}cancer}$ (AT)	25550	days	70 years for subsistence population
Averaging Time $_{cancer}$ (AT)	25550	days	70 years
Oral Reference Dose (RfD)	Contaminant-specific	mg/kg-day	Source: EPA
Cancer Slope Factor (CSF)	Contaminant-specific	mg/kg-day^{-1}	Source: EPA

Evaluating Non-cancer Hazards

Tables 1-6 in Appendix C show calculated doses for those contaminants exceeding subsistence level screening valves. Exposure doses shown in Appendix C were compared with their corresponding mercury, total PBDE, total PCB, or total dioxin TEQ reference doses or MRLs for each fish species and sampling collection area. As previously discussed comparisons between the exposure dose and the RfD or MRL results in a ratio known as HQs. If the HQ is greater than one, then the RfD or MRL has been exceeded. Exceeding an RfD or MRL does not mean a person will experience an adverse health effect, only that the potential exists. The more a HQ exceeds a value of one, the greater potential for adverse health effects.

Comparison between the exposure dose and the RfD or MRL as described above are determined by the following equation:

$$Hazard\ Quotient\ (HQ) = \frac{Estimated\ Dose\ \ (mg/kg - day)}{RfD\ \ (mg/kg - day)}$$

General Population HQs

The results of calculated HQs for the separate FSCAs are also shown in Appendix C, Tables 1a-e. Hazard quotients ranged from 0.56 to 4.6 for mercury (Appendix C, Table 1). Five fish species including burbot, largescale suckers, longnose suckers, smallmouth bass, and walleye exceeded a HQ of one for mercury in one or more of the fish sampling collection areas in the UCR. Due to elevated mercury tissue levels relative to other species, largescale suckers and burbot had the highest HQ values. (Appendix C, Table 1a). HQs calculated for individual fish species based on weighted mercury means across FSCAs are presented in Appendix C, Table 2a.

No general population HQ exceedances of one were seen for either PBDE-47 or total PBDEs (Appendix C, Tables 1b and1c) in fillets from any of the six FSCAs. Weighted means for either COC also did not result in HQ exceedances of one for any fish species (Appendix C, Table 2b and 2c).

Estimated doses for five species exceeded the RfD for PCBs for any given FSCA with largescale sucker having the highest HQ of 4.78 (Appendix C, Table 1d). When all FSCAs PCB results were combined, the weighted mean total PCB concentrations exceeded HQ of one for only two fish species, largescale suckers and mountain whitefish (Appendix C, Table 2d).

Four species exceeded a dioxin HQ of one with the highest value seen in largescale suckers from FSCA 6 (Appendix C, Table 1e). Dioxin levels across all FSCAs resulted in three fish species above an HQ of one and the highest ratio was 1.24 in mountain whitefish (Appendix C, Table 2e).

Subsistence Population HQs

Because subsistence screening levels were used to evaluate exposures resulting in exceedances of the RfD for a given fish species in any of the FSCAs, it is not surprising that all subsistence level estimated doses resulted in HQ values greater than one as seen in Appendix C, Tables 1a–e. When individual FSCA contaminant results were combined, the resulting weighted mean concentrations included all samples, including those with HQ below one and therefore, not all calculated HQs for subsistence level exposures were exceeded (Appendix C, Tables 2a-e).

Mercury HQ based on subsistence consumption rates exceeded a value of one in all six fish sampling collection areas in nine different fish species fillet samples (Appendix C Table 1a). Burbot, kokanee, largescale suckers, rainbow trout, smallmouth bass, and walleye HQs were above one in all six locations. The highest HQ were seen in largescale suckers from FSCA 4 and 5 corresponding to mercury concentrations of 0.371 ppm and 0.462 ppm. When mercury concentrations were combined for all FSCAs, HQ values were exceeded for all fish species (Appendix C, Table 2a).

PBDE-47 HQ exceeded a value of one in only one fish sampling collection area, FSCA 6, and for only one fish species, largescale sucker (Appendix C Table 1b). Total PBDE HQ were also greater than one for largescale sucker in FSCA 6 and just slightly below a HQ of one for mountain whitefish collected in FSCA 1 (Appendix C Table 1c). When concentrations are averaged over the entire UCR, no fish species exceeded HQ for either PBDE-47 or total PBDEs (Appendix C, Table 2b-c).

Six fish species exceeded a HQ of one for total PCBs with largescale suckers having the highest HQs for each of the six FSCAs (Appendix C Table 1d) corresponding to the highest PCB concentrations in the UCR. Five fish species exceeded a HQ of one when data were combined for all FSCAs (Appendix C, Table 2d).

Subsistence HQs for dioxin TEQ were generally less than four with highest HQs in mountain whitefish and largescale suckers (Appendix C Table 1e). Weighted mean total dioxin concentrations resulted in HQ that were less three for all fish species. The HQ value for walleye dropped below one when FSCA data were combined (Appendix C, Table 2e).

Assessing Exposure to Multiple Contaminants

Non-cancer effects associated with exposure to multiple chemicals detected in fish tissue that result in similar health endpoints were evaluated by summing hazard quotients (HQs). Mercury, PBDEs, and PCBs are known to affect multiple health endpoints, including developmental, immunological, neurological, and reproductive effects. Combining HQs that correspond to similar health endpoints result in a hazard index (HI) that attempts to account for multiple chemical exposures, and assumes additivity for similar endpoints.

General Population HIs

Appendix C, Table 3 shows general population HQs and HIs based on neurological health endpoints for the various fish species collected in the six FSCAs. Tables 4a-d summarizes general population HQs and HIs across the six FSCAs for each species for neurological, developmental, immunological, and reproductive health endpoints. A HI greater than the threshold of one would warrant further assessment or possible consumption advice to consumers. Neurological HI values based on general population exposure scenarios exceeded one in all but one fish species, kokanee, with the highest HI value of 4.64 calculated for largescale sucker (Appendix C, Table 4a). Developmental HI values exceeded one in largescale suckers (Appendix C, Table 4b). Immunological HI values exceeded one in three fish species including lake whitefish, largescale sucker, and mountain whitefish. For general population exposures, no HI values exceeded one for reproductive health endpoints.

Subsistence Population HIs

Due to a greater than two fold difference in general population versus subsistence population consumption rates, exceedances of the threshold of one for subsistence population HIs were more frequent and of greater magnitude. Table 5 (Appendix C) depicts subsistence population HQs and HIs based on neurological health endpoints for the nine fish species collected in the six FSCAs. Tables 6a-d (Appendix C) summarize subsistence population HQs and HIs across the six FSCAs based on weighted average contaminant concentrations in the various fish species for neurological, developmental, immunological, and reproductive health endpoints. As with HI values for general population, an exceedance of one warrants further assessment or action. Subsistence population neurological, developmental, and immunological HI values exceeded the threshold for every fish species. The highest neurological HI of 12.09 was calculated for largescale suckers (Appendix C, Table 6a). Calculated neurological HI values for kokanee were the lowest at 2.16. Largescale suckers had the highest immunological and Developmental HI of 8.78 and 6.64, respectively, and kokanee had the lowest, 1.30 (Appendix C, Tables 6b-c). Four of the nine fish species exceeded the reproductive HI of one (Appendix C, Table 6d).

Lead Assessment

Average Fish Lead Concentrations and Estimated Blood Lead Levels in Children

The IEUBK model was used to estimate the percentage of children that could have elevated blood lead levels if they frequently eat lead-contaminated fish. Default parameters are used for all model inputs unless stated. Exposure based on a general population scenario of children eating 7 g/day or a non-tribal high-end consumer scenario of children eating 60 g/day of fish containing the average concentration of lead in each FSCA was used (Appendix C, Table 7) and weighted lead means across all FSCAs (Table 9).

Table 9. Summary of IEUBK Model Results for Weighted Lead Mean Concentrations in Fillet Tissue from All FSCAs.

Species	Size Class	Mean Lead Conc. (ppm)	General Population Blood Lead Level (Likelihood of Exceeding BLL of 10 ug/dl)	Subsistence Population Blood Lead Level (Likelihood of Exceeding BLL of 10 ug/dl)
Burbot	>30cm	0.024	0.292	0.298
Kokanee	>30cm	0.004	0.287	0.286
Lake Whitefish	>30cm	0.009	0.288	0.289
Largescale Sucker	>30cm	0.176	0.332	0.398
Longnose Sucker	>30cm	0.024	0.292	0.298
Mt Whitefish	>30cm	0.007	0.287	0.288
Rainbow Trout	>30cm	0.028	0.293	0.298
Smallmouth Bass	>30cm	0.019	0.293	0.295
Walleye	>30cm	0.030	0.293	0.302

GP = General Public Consumption Rate of 59.7 g/day
Sub = Subsistence Population Consumption Rate of 142.4 g/day
IEUBKwin32 Lead Model Version 1.1 Build11

No lead exposures for either the general or subsistence populations resulted in estimated blood lead levels that exceeded EPA's target level of no more than a 5% probability that an individual in the community exceed 10 µg/dL. The percentage of children with BLLs above 10 µg/dL from consuming fish at general population rates from the UCR ranged from 0.286 to 0.415 (Appendix

C, Table 7). Similarly, the probability that a child with BLLs above 10 ug/dl from consuming fish at the subsistence population rate were low and ranged from 0.278 to 2.805. For both populations, largescale suckers were responsible for the highest estimated blood lead levels. When weighted mean values were used, the ranges of those children with BLL above the benchmark dropped slightly to 0.287 to 0.332 and 0.286 to 0.398 in the general and subsistence populations, respectively as shown in Table 9.

Average Fish Lead Concentrations and Estimated Blood Lead Levels in Adults

The adult lead model was used to estimate the probability of a fetus having elevated blood lead levels (BLL) if the pregnant women frequently ate lead-contaminated fish. Only the fish portion of the adult lead model was used; the soil ingestion portion was left out. Exposure was based on a general population scenario of adults eating 17.5 g/day or a non-tribal high-end consumer scenario of adults eating 142.4 g/day of fish containing the average concentration of lead in each reach (Appendix C, Table 8) and weighted lead means across all FSCAs (Table 10).

Table 10. Summary of COC Concentrations in Fillet Tissue from All FSCAs Weighted Values.

			Adult Lead Model Predicted Blood Lead Levels			
Species	Size Class	Lead Mean (ppm)	PbB GP Adult (µg/dL)	PbB GP Fetal 0.95 (µg/dL)	PbB Sub Adult (µg/dL)	PbB Sub Fetal 0.95 (µg/dL)
Burbot	>30cm	0.024	1.6	0.4%	1.7	0.5%
Kokanee	>30cm	0.004	1.5	0.4%	1.5	0.4%
Lake Whitefish	>30cm	0.009	1.5	0.4%	1.6	0.4%
Largescale Sucker	>30cm	0.176	2.0	1.0%	2.7	2.8%
Longnose Sucker	>30cm	0.024	1.6	0.4%	1.7	0.5%
Mt Whitefish	>30cm	0.007	1.5	0.4%	1.6	0.4%
Rainbow Trout	>30cm	0.028	1.6	0.4%	1.7	0.6%
Smallmouth Bass	>30cm	0.019	1.6	0.4%	1.6	0.5%
Walleye	>30cm	0.030	1.6	0.4%	1.7	0.6%

GP = General Public Consumption Rate of 59.7 g/day
Sub = Subsistence Population Consumption Rate of 142.4 g/day

With the exception of large-scale suckers from FSCAs 1 and 2, consuming fish from Lake Roosevelt would result in a probability of less than 5% estimated BLL above 10 µg/dL for an adult (Appendix C, Table C8). When fish tissue lead levels were averaged over the entire UCR, no exceedances of the benchmark would occur. A pregnant mother consuming large-scale suckers at general population rates from the UCR would result in the fetus' BLL 95th percentile ranging from 0.1% to 0.4% above 10 µg/dL and the mother's average BLL ranging from 1.0% to 1.5% above 10 µg/dL. A pregnant mother consuming large-scale suckers at subsistence population rates from the UCR would result in the fetus' BLL 95th percentile ranging from 0.1% to 1.5% above 10 µg/dL and the mother's average BLL ranging from 1.0% to 2.2% above 10 µg/dL. Based on these results, lead fish tissue levels in the UCR are not deemed of significant public health concern and no further assessment.

Cancer Risk Calculations Based on Exposure to Individual Contaminants in Upper Columbia River Fish

Cancer risks were calculated based on input parameters shown in Table 8 above and applied to the following equation:

$$Cancer\ Risk = \frac{C \times IR \times CF_1 \times EF \times CF_2 \times ED \times CSF}{BW \times AT_{cancer}}$$

Exposure doses were used to calculate cancer risks from possible exposure to total PCBs, and total dioxin TEQs for each fish species and fish sampling collection area. Arsenic was not considered in this cancer risk assessment because speciated arsenic levels were undetected in all fish tissue samples. Cancer risks were calculated for both the general and subsistence populations and are shown in Appendix D, Tables D1-4. Cancer risks were calculated for individual fish species for all six FSCAs and summarized using weighted mean total PCBs and total dioxin TEQ concentrations from all six FSCAs (Appendix D, Table 5). For both contaminants that pose potential cancer risks, calculated cancer risks to subsistence populations were greater than risks posed to the general population given the greater consumption rates of the former.

Cancer risks posed by total dioxin like compounds were slightly higher than those posed by total PCBs. For individual FSCAs, total PCB concentrations resulted in a general population cancer risk ranged of 8.2 in 100,000 ($8.2x10^{-5}$) to 1.1 in 1,000,000 ($1.1x10^{-6}$). Subsistence population cancer risks due to total PCB exposure ranged from 4.6 in 10,000 ($4.6x10^{-4}$) to 6.3 in 1,000,000 ($6.3x10^{-6}$) (Appendix D, Table 1). Weighted mean total PCB concentrations for all of the UCR resulted in general population cancer risks ranging from 4.6 in 100,000 ($4.6x10^{-5}$) to 1.6 in 1,000,000 ($1.6x10^{-6}$). Subsistence population cancer risks due to weighted total PCBs ranged from 2.6 in 10,000 ($2.6x10^{-4}$) to 9.1 in 1,000,000 ($9.1x10^{-6}$) (Appendix D, Table 2). Burbot PCB concentrations resulted in the lowest cancer risks due to PCBs in either the general or subsistence populations calculations with risks ranging from 1.1 to 6.3 in 1,000,000 (1.1 to $6.3x10^{-6}$) (Appendix D, Table 1). Largescale sucker PCB concentrations resulted in the highest theoretical cancer risks, ranging from 8.2 in 100,000 ($8.2x10^{-5}$) to 4.6 in 10,000 ($4.6x10^{-4}$) (Appendix D, Table 1) in the general and subsistence populations, respectively. Averaging the mean PCB concentrations from the six FSCAs minimally affected the overall cancer ranges for general or subsistence populations. Burbot cancer risks based on average PCB concentration in the UCR ranged from 1.6 in 1,000,000 ($1.6x10^{-6}$) to 9.1 in 1,000,000 ($9.1x10^{-6}$) for general and subsistence populations, respectively. Largescale sucker cancer risks ranged from 4.5 in 100,000 ($4.6x10^{-5}$) to 2.6 in 10,000 ($2.6x10^{-4}$) for the general and subsistence populations (Appendix D, Table 2).

For individual FSCAs, total dioxin concentrations resulted in a general population cancer risk ranged of 1.0 in 10,000 ($1.0x10^{-4}$) to 7.5 in 1,000,000 ($7.5x10^{-6}$). Subsistence population cancer risks due to total dioxin exposure ranged from 5.7 in 10,000 ($5.7x10^{-4}$) to 4.2 in 100,000 ($4.2x10^{-5}$) (Appendix D, Table 3). Weighted mean total dioxin concentrations for all of the UCR resulted in general population cancer risks ranging from 8.3 in 100,000 ($8.3x10^{-5}$) to 2.5 in 100,000 ($2.5x10^{-5}$). Subsistence population cancer risks due to weighted total dioxins ranged from 4.6 in

10,000 ($4.2.6x10^{-4}$) to 1.4 in 10,000 ($1.4x10^{-4}$) (Appendix D, Table 4). Calculated dioxin cancer risks for individual fish species based on average concentrations from the six FSCAs were highest for mountain whitefish and lowest for walleye (Appendix D, Table 4).

Individual cancer risks associated with total PCBs and total dioxins TEQs were added together to calculate an overall cancer risk posed by consuming fish with multiple contaminants. Unlike non-cancer endpoints where only similar health endpoints are combined to give an overall HI, total cancer risks are combined for all cancers to give an estimate of overall cancer risk. Combining cancer risks for the general population due to total PCBs, and total dioxins TEQs resulted in risks ranging from 3.0 in 100,000 ($3.0x10^{-5}$) to 1.2 in 10,000 ($1.2x10^{-4}$). Overall subsistence risks due to combined cancers risks resulted in a range of 1.7 in 10,000 ($1.7x10^{-4}$) to 6.7 in 10,000 ($6.7x10^{-4}$) (Appendix D, Table 5). For both the general and subsistence populations, the greatest combined cancer risks came from largescale suckers and the lowest cancer risks from walleye. It should be noted that no adjustments were made for potential organic contaminant (PCBs and dioxins) reductions gained from proper cleaning and cooking of fish fillets that would ultimately reduce a person's exposure and thereby reducing possible cancer risks. Additionally, it should be noted that combined cancer risks are likely to overestimate actual risk due to the fact that PCB cancer risks were double counted, once as total PCBs and then again as a component of total dioxin TEQs.

Calculating Consumption Rates and Determining Recommended Meal Limits

As discussed above, DOH developed recommended meal limits of individual UCR fish species based on EPA's RfD or ATSDR's MRLs, an individual's body weight, and the known contaminant concentration in fish. In this approach, the RfD (or MRL) is used to calculate the quantity of fish a person of a given body weight can safely consume, given varying contaminant concentrations found in fish tissue. As noted above, chemicals may have more than one health outcome. Calculation of meal limits based on individual chemicals was conducted by using the most protective value associated with that contaminant. Additionally, when combining contaminants with similar health endpoints, meal limits were calculate for sensitive populations (e.g. women of childbearing age and young children) and the general public if appropriate. Once meal limits have been calculated, values are rounded up or down to fit easily understandable meal rates (i.e. no consumption, one meal per month, two meals per month, four meals per month, eight meals per month, and unlimited).

Calculated Meal Limits Due to Mercury Concentrations

Calculated meal limits based on mercury concentrations for all species in all six FSCAs are presented in Appendix E, Table 1. The lowest calculated meal limit for any given fish species in any of the FSCAs was seen for largescale suckers in FSCA a 5 of 1.7 meals per month. The least restrictive calculated meal limit for any given species or location was 13.6 meals per month for kokanee collected in FSCA3. Weighted mean mercury concentrations from all six FSCAs used to calculate meal limits resulted in five out of the nine fish species being more restrictive than the eight meals per month threshold (Appendix E, Table 5). Elevated mercury levels in largescale suckers resulted in the most restrictive meal limits of 2.7 meals per month based on weighted means across all FSCAs. Relatively low mercury levels in kokanee for combined FSCA resulted in the least restrictive calculated meal limits of 12.6 meals per month.

Calculated Meal Limits Due to Total PBDE Concentrations

Meal limits were calculated based on total PBDEs (i.e. congeners 47, 99, 153, and 209). The RfD for PBDE-47 was used as a surrogate reference dose for total PBDEs. Therefore, toxicity of other PBDE mixtures was assumed to be the same as that of PBDE congener -47. No meal restrictions less than or equal to eight meals per month were calculated based on PBDE concentrations (Appendix E, Table 2). Meal limits ranged from 12.3 to 913.9 meals per month. The most restrictive meal limits was seen in largescale sucker and the least restrictive seen for burbot. When weighted means from all FSCAs were combined, the most restrictive meals limits were calculated for largescale sucker meal limit at 23.3 meals per month and the least restrictive for burbot at 319.3 meals per month (Appendix E, Table 5).

Calculated Meal Limits Due to Total PCB Concentration

Meal limits were calculated based on total PCBs congener concentrations. The RfD for PCB Aroclor 1254 was used as a surrogate reference dose for total PCBs since no RfDs are available for individual PCB congeners and other PCB mixtures. Therefore, toxicity of other PCB mixtures was assumed to be the same as that of Aroclor 1254.

Total PCB concentrations in fillet samples resulted in calculated meal limits ranging from 1.7 to 121.8 meals per month (Appendix E, Table 3) in all FSCAs. The most restrictive meal limits were due to elevated total PCB levels in largescale suckers and the least restrictive due to relatively low concentrations in burbot. Averaged total PCB concentrations in fish from all six FSCAs resulted in two fish species, largescale suckers and mountain whitefish that are more restrictive than the threshold of eight meals per month (Appendix E, Table 5).

Calculated Meal Limits Due to Total Dioxin TEQ Concentrations

Total dioxin TEQ concentrations in fish samples from the UCR resulted in meal limits ranging from 5.2 to 71.3 meals per month (Appendix E, Table 4). Eight fish samples out of forty-four total dioxins samples exceeded the eight meals per week threshold. The most restrictive meal limits were seen in largescale suckers and lake whitefish. Low total dioxin TEQ concentrations for burbot resulted in the least restrictive meal limits for this contaminant. When total dioxin TEQ concentrations were averaged across all FSCAs for each fish species, only mountain whitefish, largescale suckers, and lake whitefish concentrations result in meal limits less than 8 per month (Appendix E, Table 5). In these initial meal limit calculations, no consideration was given to possible contaminant reduction due to cleaning and cooking techniques.

Calculated Meal Limits Based on Multiple Chemical Exposure

Mercury, PBDEs, and PCBs in fish can result in similar health endpoints to consumers as shown in Table 1 above. Developmental and neurological RfDs or MRL have been established for all three contaminants (EPA IRIS, ATSDR) in sensitive populations (i.e., women of childbearing age and young children). Immunological and reproductive effects are limited to mercury and PCBs. Selection of a health endpoint with the most restrictive calculated meal limit (and therefore most protective) based on a chemical's RfD or MRL would then protect for other potential health endpoints that have less restrictive RfDs or MRLs. Given that neurological endpoints are associated with the lowest RfD or MRL, the combined meal limits were calculated based on additive neurological effects of mercury, total PBDEs, and total PCBs and are shown in Appendix E, Table 6 for all FSCAs. Based on the combination of the three contaminants assessed for the nine fish species collected in the UCR, calculated meal limits ranged from 1.1 to 9.5 meals per month. Mountain whitefish were collected in FSCAs 3, 4, or 5 but were not analyzed for mercury or total PCBs and therefore meal limits of 71.9, 52.6, and 21.0 meals per month only reflect total PBDE concentrations. Mean concentrations of mercury, total PBDEs, and total PCBs from the six FSCAs for largescale suckers resulted in the most restrictive calculated meal limits and the least restrictive for kokanee. Rounded meal limits for each fish species for each of the six FSCAs are summarized in Table 11.

Table 11. Calculated Meal Limits Based on Combined Neurological Health Endpoints for All FSCAs.

	Neurological endpoints – Calculated Meals Per Month						
Species	FSCA1	FSCA2	FSCA3	FSCA4	FSCA5	FSCA6	2008 Advisory
Burbot	2	4	4	4	4	4	4
Kokanee	8	UNL	UNL	UNL	UNL	UNL	NA
Lake Whitefish	NA	NA	8	4	4	NA	NA
Largescale Sucker	2	1	2	1	1	1	4
Longnose Sucker	NA	8	NA	4	NA	NA	NA
Mt Whitefish	4	4	UNL	UNL	UNL	NA	NA
Rainbow Trout	4	4	8	8	8	8	NA
Smallmouth Bass	NA	2	4	4	4	4	2*
Walleye	4	4	4	4	4	4	2

NA – not available
* Statewide advisory

Calculated meal limits for the nine fish species based on weighted mean fillet concentrations across all FSCAs of those chemicals that elicit neurological effects aimed at protecting women of childbearing age and young children are summarized in Table 12.

Table 12. Calculated Meal Limits Based on Combined Weighted Means Resulting in Neurological Health Effects for All FSCAs.

Species	Size Class	Mercury (ppm)	Total PBDEs (ppb)	Total PCBs (ppb)	Calculated Meals Per Month	Rounded Meal Limits Per Month	Current Advisory (2008)
Burbot	>30cm	0.232	2.5	2.2	3.3	4	4
Kokanee	>30cm	0.064	5.4	7.8	8.4	unlimited	NA
Lake Whitefish	>30cm	0.091	17.5	19.8	4.6	4	NA

Largescale Sucker	>30cm	0.300	34.5	63.0	1.5	2	4
Longnose Sucker	>30cm	0.124	9.9	11.9	4.6	4	NA
Mt Whitefish	>30cm	0.083	27.4	26.7	4.0	4	NA
Rainbow Trout	>30cm	0.076	12.2	15.5	5.7	4	NA
Smallmouth Bass	>30cm	0.161	6.7	6.6	4.2	4	2*
Walleye	>30cm	0.166	5.0	6.2	4.2	4	2

NA- not available, * 2003 Statewide Mercury Advisory for bass

Calculated meal limits based on weighted mean concentrations across all FSCAs ranged from a low of 1.5 meals per month for largescale suckers to a high of 8.4 meals per month for kokanee. When calculated meals limits are rounded into one of the six meal categories (0, 1 2, 4, 8, and unlimited meals per month), seven of the nine fish species for which fillet tissue chemical data were available fell into the 4 meals per month (one meal per week) category. Largescale suckers were most restrictive at two meals per month and kokanee were the least restrictive (unlimited consumption).

Calculated meal limits for the nine fish species based on weighted mean fillet concentrations across all FSCAs of those chemicals (mercury and total PCBs) that elicit immunological effects aimed at protecting the general population are summarized in Table 13.

Table 13. Calculated Meal Limits Based on Combined Weighted Means Resulting in Immunological Health Effects for All FSCAs.

Species	Size Class	Mercury (ppm)	Total PCBs (ppb)	Calculated Meals per Month	Rounded Meal Limits Per Month	Current Advisory (2008)
Burbot	>30cm	0.232	2.2	10.6	unlimited	NA
Kokanee	>30cm	0.064	7.8	15.5	unlimited	NA
Lake Whitefish	>30cm	0.091	19.8	7.3	8	NA
Largescale Sucker	>30cm	0.300	63.0	2.3	2	NA
Longnose Sucker	>30cm	0.124	11.9	9.3	unlimited	NA
Mt Whitefish	>30cm	0.083	26.7	5.8	4	NA
Rainbow Trout	>30cm	0.076	15.5	9.1	unlimited	NA
Smallmouth Bass	>30cm	0.161	6.6	10.8	unlimited	NA
Walleye	>30cm	0.166	6.2	10.9	unlimited	NA

Calculated meal limits based on weighted mean concentrations across all FSCAs ranged from a low of 2.3 meals per month for largescale suckers to a high of 15.5 meals per month for kokanee. When calculated meals limits are rounded into one of the six meal categories (0, 1 2, 4, 8, and unlimited meals per month), six of the nine fish species for which fillet tissue chemical data were available round to the unlimited consumption category. Largescale sucker were the most restrictive at two meals per month category.

Dose Modifications Due to Food Preparation and Cooking

Chemical contaminants are not distributed uniformly in fish. Fatty tissues typically concentrate organic chemicals such as PCBs and dioxins more readily than lean muscle tissue (ATSDR 2004). Muscle tissue can selectively accumulate other contaminants such as mercury (Mieiro et.al, 2009). This preferential concentrating of certain contaminant in one tissue over another has implications for fish analysis and fish consumers. Consideration is then given to calculated meals limits by accounting for potential reductions in chemical concentrations as the result of cleaning and cooking techniques. The Great Lakes Fish Advisory Task Force, a three state consortium whose goal was to develop fish advisory protocol for the Great Lakes reviewed a number of documents related to contaminant reduction through various preparation methods and determined that a 50% reduction factor provided adequate representation for skin-on fillet samples (Great Lakes 1993). Consequently, exposures and calculated doses calculated for organic chemicals found in UCR fish are modified by 50% to account for loss of chemical contaminants during preparation and cooking to develop recommended meal limits given to the public.

To account for this reduction in organic chemical concentrations in fish tissue, a 50% reduction was factored into calculated meal limits for the nine fish species across all FSCAs of those organic chemicals that elicit either neurological or immunological effects are summarized in Tables 14 and 15. No reductions in mercury concentrations were applied for reasons stated above. Table 14 summarizes calculated meal limits aimed at protecting women of childbearing age and young children.

Table 14. Calculated Meal Limits Based on Combined Weighted Means Resulting in Neurological Health Effects for All FSCAs with 50% Reduction Aimed at Protecting Women of Childbearing Age and Children.

Species	Size Class	Mercury Mean (ppm)	Total PBDEs (ppb)	Total PCBs Mean (ppb)	Calculated Meals Per Month	Rounded Meal Limits Per Month	Current Advisory (2008)
Burbot	>30cm	0.232	1.3	1.1	3.4	4	4
Kokanee	>30cm	0.064	2.7	3.9	10.1	unlimited	NA
Lake Whitefish	>30cm	0.091	8.8	9.9	6.1	8	NA
Largescale Sucker	>30cm	0.300	17.2	31.5	1.9	2	4
Longnose Sucker	>30cm	0.124	5.0	5.9	5.4	4	NA
Mt Whitefish	>30cm	0.083	13.7	13.3	5.7	4	NA
Rainbow Trout	>30cm	0.076	6.1	7.8	7.5	8	NA
Smallmouth Bass	>30cm	0.161	3.3	3.3	4.6	4	2*
Walleye	>30cm	0.166	2.5	3.1	4.5	4	2

When reductions of organic chemicals are considered, calculated meal limits ranged 1.9 to 10.1 meals per month. Rounding to fit meal categories used to inform the public resulted in meal limits ranging from two to unlimited consumption.

Of the non-carcinogenic organic COC, only PCBs were linked to immunological effects. Calculated meal limits were therefore factored in using a 50% reduction in PCBs concentrations along with mercury levels. Protecting against the combined immunological effects resulting from PCB and mercury exposure is aimed at protecting the general population. Meal limits for the general population are summarized in Table 15.

Table 15. Calculated Meal Limits Based on Combined Weighted Means Resulting in Immunological Health Effects for All FSCAs with 50% Reduction Aimed at Protecting the General Population.

Species	Size Class	Mercury Mean (ppm)	Total PCBs Mean (ppb)	Calculated Meals Per Month	Rounded Meal Limits Per Month	Current Advisory (2008)
Burbot	>30cm	0.232	1.1	11.3	unlimited	NA
Kokanee	>30cm	0.064	3.9	22.9	unlimited	NA
Lake Whitefish	>30cm	0.091	9.9	11.8	unlimited	NA
Largescale Sucker	>30cm	0.300	31.5	3.6	4	NA
Longnose Sucker	>30cm	0.124	5.9	13.2	unlimited	NA
Mt Whitefish	>30cm	0.083	13.3	9.9	unlimited	NA
Rainbow Trout	>30cm	0.076	7.8	14.6	unlimited	NA
Smallmouth Bass	>30cm	0.161	3.3	13.4	unlimited	NA
Walleye	>30cm	0.166	3.1	13.3	unlimited	NA

DISCUSSION

The UCR Remedial Investigation and Feasibility Study (RI/FS) collected 9 fish species and analyzed fish fillet tissues, and the remaining portions of the fish, for 385 individual chemicals. Each of the 9-species were collected from within 6 distinct and separate regions (Figure 1). Of the 385 chemicals analyzed for, DOH has identified only 5 chemicals as potential public health concerns: mercury, polybrominated biphenyl congener-47 (PBDE-47), total polybrominated biphenyls (PBDEs), and total polychlorinated biphenyls (PCBs) and total dioxins. The DOH evaluated the fish tissue data to determine whether populations that consume UCR fish are exposed to these chemicals at levels that could cause adverse health concerns. Based on the findings DOH calculated and proposes safe consumption rates for consumers. While DOH considers the risks to all consumers, meal advice is emphasized for pregnant women, those who might become pregnant, and children because mercury, PBDEs, and PCBs have been shown to impact the developing fetus.

When estimated exposures to chemicals for the most sensitive population exceed comparison values by EPA considered to be protective of public health (i.e. oral reference dose or RfDs), DOH calculated meal limits to develop formulate recommendations for consumers. Estimated exposures described previously in this report indicate that some consumers of UCR fish may exceed reference doses (or hazard indices) for certain chemicals of concern or multiple chemicals that act along the same pathways, affecting similar organ systems or other health endpoints.

In formulating meal recommendations, DOH attempts to balance the risks and benefits by accounting for other factors such as background levels of chemicals, chemical concentrations in other foods and other fish, reductions in chemicals from cleaning and cooking techniques, and health benefits of fish consumption.

Presence of Chemicals in Other Fish and Foods

The same chemicals of concern identified in UCR are ubiquitous in the environment and our food supply. In addition to in-river point source discharges directly affecting the UCR these chemicals are globally distributed, and are found in fish that dwell in other waterbodies and other foods. Fish consumption is often the primary pathway most individuals are exposed to persistent bioaccumulative toxics (PBTs). At the same time, fish consumption is also a major source of beneficial omega-3 fatty acids including docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) which are essential nutrients to early childhood brain development and is an excellent source of low-fat protein. Fish is the major dietary source of omega-3 DHA, an essential nutrient required by the brain as it grows.

Fish advisories may have unintended consequences of directing anglers to other locations or other fish species that may have higher contaminant levels, or anglers may simply choose not eat fish at all from sources with known advisories. For this reason, DOH compares site specific chemical levels to regional, state, national, or commercially available fish data as well as chemical levels in other foods. This helps assist consumers in considering other healthy food options without unnecessarily discouraging overall fish consumption.

For this report, comparison data are available for regional, statewide, and commercial fish as well as other foods.

Regional Comparison

The Washington State Department of Ecology recently conducted a study (Background Characterization for Metals and Organic Compounds in Northeast Washington Lakes, Part 2: Fish Tissue) intended to characterize background concentrations of metals and organic compounds in 13 Northeast Washington lakes and 3 rivers (Table 16). The 2010 study provides data on sediments and fish tissue. This regional study serves as the most relevant data comparison for chemical concentrations to fish collected in the UCR (Ecology 2011). The study concludes the origin of the elevated metals and organic compounds is a combination of point-source emissions (i.e. smelters) and broader atmospheric contributions. This health-based comparison is not intended to evaluate actual natural background conditions in the UCR. The benefit of Ecology’s study for the purposes of this evaluation is that the fish were collected from waterbodies considered to be minimally impacted, except for the watershed atmospheric factors discussed above, and that the sampling locations selected are in the immediate fishing area under investigation in the UCR.

Table 16. Lakes and Rivers Sampled for the NW Washington Background Study During 2010-2011.

Sample Type and Year Collected			
Waterbody	County	Year Fish Collected	Elevation (feet)
Swan Lake	Ferry	2010	3,641
Ellen Lake	Ferry	2010	2,300
South Twin Lake	Ferry	2010	2,572
Pierre Lake	Stevens	2010	2,012
Cedar Lake	Stevens	2010	2,135
Pepoon Lake	Stevens	2011	2,450
Bayley Lake	Stevens	2010	2,400
Jumpoff Joe Lake	Stevens	2011	2,030
Sullivan Lake	Pend Oreille	2010	1,380
Leo Lake	Pend Oreille	2010	2,588
Browns Lake	Pend Oreille	2010	3,450
Bead Lake	Pend Oreille	2010/2011	2,850
Upper Priest Lake	Bonner (ID	2010	2,441
St. Joe River	Clearwater (ID)	2010	3,198
Colville River	Stevens	2011	1,660
Pend Oreille River	Pend Oreille	2011	2,127

A total of 32 fillet and 5 whole fish composite samples were analyzed for mercury, PCBs, dioxins and furans, and PBDEs. Fifteen different species were sampled as shown in Table 17. Eight of the 15 were salmonids (e.g., trout, kokanee, whitefish) and seven were spiny-rayed species (e.g., bass, perch,) or other non-salmonids. Rainbow trout, largemouth bass, and largescale suckers were the most frequently collected species. Several species of trout were also collected that were not collected in the UCR RI/FS. These additional trout species vary in size, fat content, and life-history which allowed for only a qualitative comparison with trout species included in the UCR RI/FS. A direct application and comparison with species-specific chemical concentrations between the UCR and the Northeast Background Study is problematic given the differences between species collected, fish sizes, and overall number of samples collected for each study.

Despite these technical difficulties, for the purposes of evaluating consumer angler choices in the area, the following compares mercury and PCB concentrations from fish sampled in the UCR with results from the northeast regional background study. Focus was given to these two chemicals because they account for nearly all of the calculated non-cancer health risks when comparing hazard quotients and hazard index as seen in Table C-6a.

Table 17. Summary of Fish Species Sampled.

Species	Number of Waterbodies	Individuals Per Waterbody
Salmonids		
Rainbow Trout	7	2-8
Kokanee	2	5
Cutthroat	2	5
Brown Trout	2	5
Eastern Brook Trout	1	5
Lake Trout	1	5
Mountain Whitefish	1	4
Tiger Trout	1	5
Non-Salmonids		
Largescale Sucker	5	2-5
Largemouth Bass	4	2-7
Black Crappie	2	6
Yellow Perch	2	6-10
Smallmouth Bass	1	4-5
Burbot	1	3
*Northern Pike	1	12*

*analyzed in three separate size classes.

Mercury

Mercury was analyzed in 31 fillet samples from 16 waterbodies for the regional background study. The mean concentration of mercury for each waterbody and each species collected is shown in Table 18. Additionally, a comparison of mercury concentrations found in similar fish species collected in the UCR is also provided. The mean concentrations for all fish species were 108 ppb and 145 ppb for the Regional and UCR, respectively. The mercury data are summarized separately for salmonids and non-salmonid species for both the Northeast Regional and UCR datasets in Table 19. Grouping of fish allows better comparison of fish with similar life histories (e.g. fish that feed primarily on insects verses those that feed on other fish).

Table 18. Summary of Results for mean Mercury (ppb) in Fish Fillet Samples Analyzed for the Northeast Washington Background Study and the UCR.

Waterbody	Species	Northeast	UCR
Swan Lake	Rainbow Trout	82	76
Cedar Lake	Rainbow Trout	18	76
Pepoon Lake	Largemouth Bass –sm	57	NA
Pepoon Lake	Largemouth Bass -lg	55	NA
Pierre Lake	Largemouth Bass	108	NA
Ellen Lake	Rainbow Trout	32	76
South Twin Lake	Rainbow Trout	31	76
South Twin Lake	Eastern Brook Trout	51	NA
South Twin Lake	Largemouth Bass	159	NA
Sullivan Lake	Kokanee	46	64
Sullivan Lake	Tiger Trout	99	NA
Sullivan Lake	Burbot	245	232
Leo Lake	Black Crappie	186	NA
Leo Lake	Rainbow Trout	47	76
Leo Lake	Yellow Perch	94	NA
Browns Lake	Cutthroat	70	NA
Bayley Lake	Rainbow Trout	214	76
Bead Lake	Kokanee	40	64
Jumpoff Joe Lake	Yellow Perch	29	NA
Jumpoff Joe Lake	Brown Trout	24 U	NA
Jumpoff Joe Lake	Largemouth Bass	211	NA
Upper Priest Lake	Lake Trout	211	NA
Upper Priest Lake	Smallmouth Bass	282	161
Colville River	Rainbow Trout	33	76
Pend Oreille River	Smallmouth Bass	256	161
Pend Oreille River	Brown Trout	94	NA
Pend Oreille River	Northern Pike - sm	177	NA
Pend Oreille River	Northern Pike - med	217	NA

Pend Oreille River	Northern Pike - lg	492	NA
Upper St. Joe River	Cutthroat	37	NA
Upper St. Joe River	Mountain whitefish	50	83

NA: not available

Table 19. Mercury Concentration in Salmonids and Non-Salmonids (ppb).

	Regional Background			UCR		
	All Species	Salmonids	Non-Salmonids	All Species	Salmonids	Non-Salmonids
Median	76	47	186	129	79	175
Mean	108	69	169	145	78.5	198.6
Minimum	18	18	29	63	63	129
Maximum	492	214	492	291	93	291

The results for the median, mean, and minimum mercury concentrations were higher for salmonids, non-salmonids, and all species combined in the UCR, with the exception of the median value for spiny ray species in the UCR. However, maximum values were higher within the Northeast Regional Background results in all categories. No additional statistical comparison can be made due to the small sample size and lack of comparable fish sizes in the regional dataset.

PCBs

A comparison of PCB concentrations in fish species collected in the UCR and the Northeast Regional Background Study waterbodies is shown in Table 20. The results of total PCBs (summed concentrations of the individual PCB congeners) were analyzed from 24 fillet samples from 13 lakes and 1 river from the Northeast Regional Background Study (Ecology 2011). The mean PCB concentrations for all fish species from the regional and UCR studies was 2.0 ppb and 12.9 ppb, respectively.

The PCB data are summarized separately for salmonids and spiny-rays species for both the Northeast Regional Background Study and UCR datasets to better group similar species in Table 21.

Table 20. Summary of Means for PCBs (ppb) in Fish Fillet Samples Analyzed for the Northeast Washington Background Study and the UCR.

Waterbody	Species	Northeast	UCR
Swan Lake	Rainbow Trout	0.72	15.5
Cedar Lake	Rainbow Trout	0.73	15.5
Pepoon Lake	Largemouth Bass	0.08	
Pierre Lake	Largemouth Bass	0.76	
Ellen Lake	Rainbow Trout	0.76	15.5

South Twin Lake	Rainbow Trout	0.42	15.5
South Twin Lake	Eastern Brook Trout	0.89	
South Twin Lake	Largemouth Bass	1.11	
Sullivan Lake	Kokanee	4.30	7.8
Sullivan Lake	Tiger Trout	4.59	
Sullivan Lake	Burbot	1.77	2.2
Leo Lake	Black Crappie	0.78	
Leo Lake	Rainbow Trout	1.79	15.5
Leo Lake	Yellow Perch	1.49	
Browns Lake	Cutthroat	1.24	
Bayley Lake	Rainbow Trout	0.47	15.5
Bead Lake	Kokanee	4.63	7.8
Jumpoff Joe Lake	Yellow Perch	0.07	
Jumpoff Joe Lake	Brown Trout	1.90	
Jumpoff Joe Lake	Largemouth Bass	1.69	
Upper Priest Lake	Lake Trout	15.31	
Upper Priest Lake	Smallmouth Bass	1.59	6.6
Upper St. Joe River	Cutthroat	0.25	
Upper St. Joe River	Mountain Whitefish	0.72	26.7

Table 21. PCB Concentrations in Salmonids and Non-Salmonids (ppb).

	Regional Background			UCR		
	All Species	Salmonids	Non-Salmonids	All Species	Salmonids	Non-Salmonids
Median	1.00	1.00	1.13	15.50	15.50	4.4
Mean	2.00	2.49	1.03	12.86	14.98	4.4
Minimum	0.07	0.25	0.07	2.20	7.80	2.2
Maximum	15.31	15.31	1.77	26.70	26.70	6.6

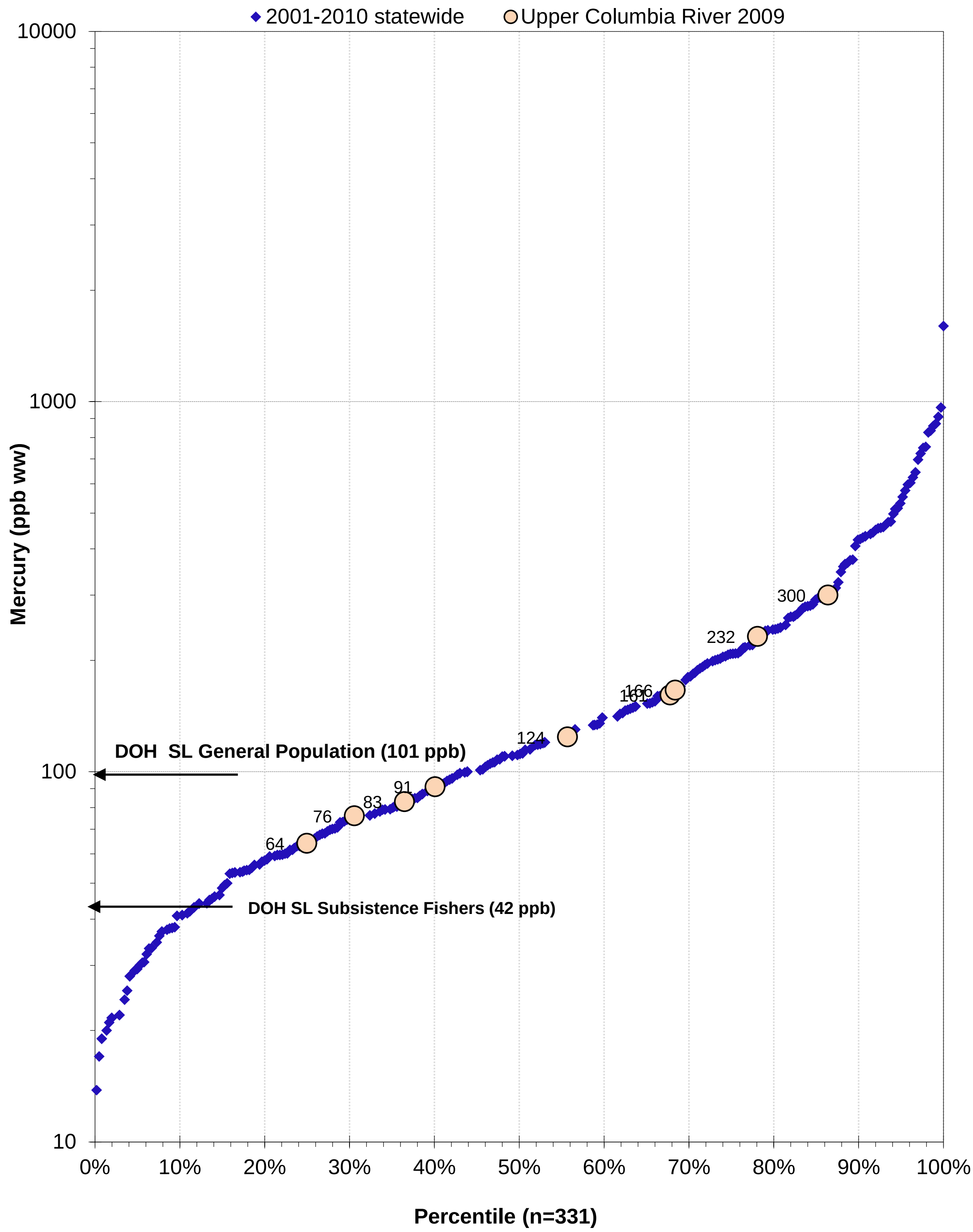
Statewide Comparison

The Washington State Department of Ecology routinely conducts fish tissue monitoring as part of its Washington State Toxics Monitoring Program (WSTMP) and Total Maximum Daily Load (TMDL). The WSTMP was developed in 2000 to conduct exploratory monitoring and trend monitoring, and to cooperate with other agencies to develop monitoring efforts to address issues of concern. The TMDL studies are conducted to assess how waterbodies that exceed water quality criteria can implement strategies to reduce pollution. Between these two programs, thousands of fish have been sample from hundreds of sites across Washington State. Edible fish tissue has been analyzed for mercury, chlorinated pesticides, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzo-p-furans (PCDFs), and lipids. Ultimately these data are collected and stored in the Environmental Information Management system (EIM) which is a searchable database developed and maintained by Ecology. The following sections compare concentrations of mercury, PCBs, PBDEs, and dioxins reported from these TMDL studies with results from the UCR fish tissue analysis results. For the purposes of evaluating angler consumption choices statewide, an examination of the contaminants was performed. While these data are not a direct comparison with UCR fish in that specific species, size classes, and sampling seasons are not always matched, they do provide a snapshot of how UCR data compares to other catchable fish from across Washington State.

Mercury

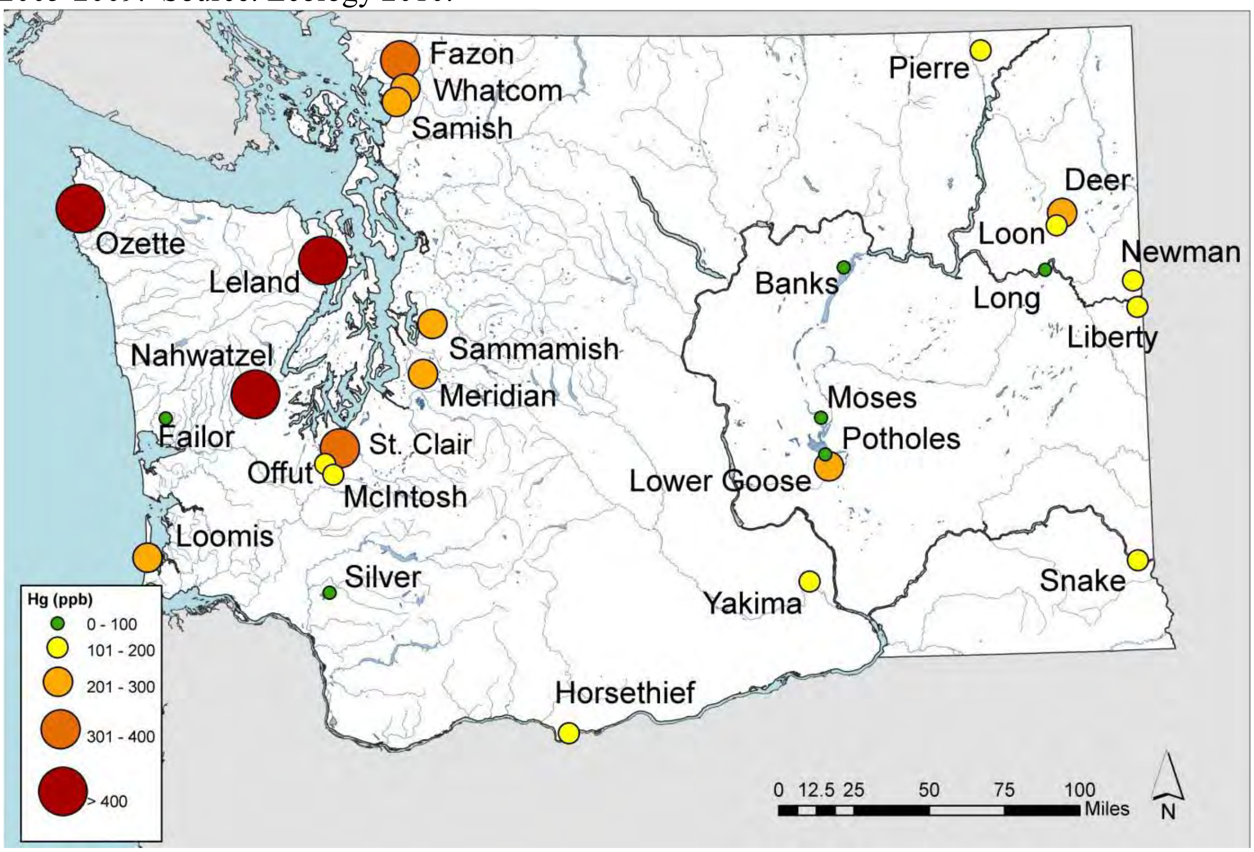
Figure 8 displays the frequency distribution of mercury tissue concentrations from all Washington State freshwater fish available in the Environmental Information Management (EIM) database from 2001 until 2011, as reported by Seiders (Seiders 2012). This data set includes 331reported mercury values ranging from 7 ppb to 1,600 ppb, with a mean and median mercury concentration of 175 ppb and 111 ppb, respectively. UCR weighted mean fish mercury values are shown for the nine fish species collected and range from 64 to 300 ppb mercury. As shown by the distribution, UCR fish fell between the 25th and 85th percentile values of mercury levels measured across Washington State.

Figure 8. Distribution of WSTMP and UCR Fish Mercury Results.



Screening Levels (SL) from Table A2 are displayed for reference. An additional comparison of mercury levels in UCR smallmouth bass is possible based on a study conducted by Ecology aimed at characterizing mercury levels in bass (Ecology 2010). Bass are a ubiquitous species that typically accumulate higher mercury levels than many other species in Washington State. This study reported mercury levels in bass from a subset of frequently fished in Eastern and Western Washington waterbodies. Figure 9 displays standardized bass mercury concentrations from 2005 – 2009 throughout Washington State.

Figure 9. Mercury Concentrations in Standard-Size (356 mm) Bass from Study Lakes During 2005-2009. Source: Ecology 2010.

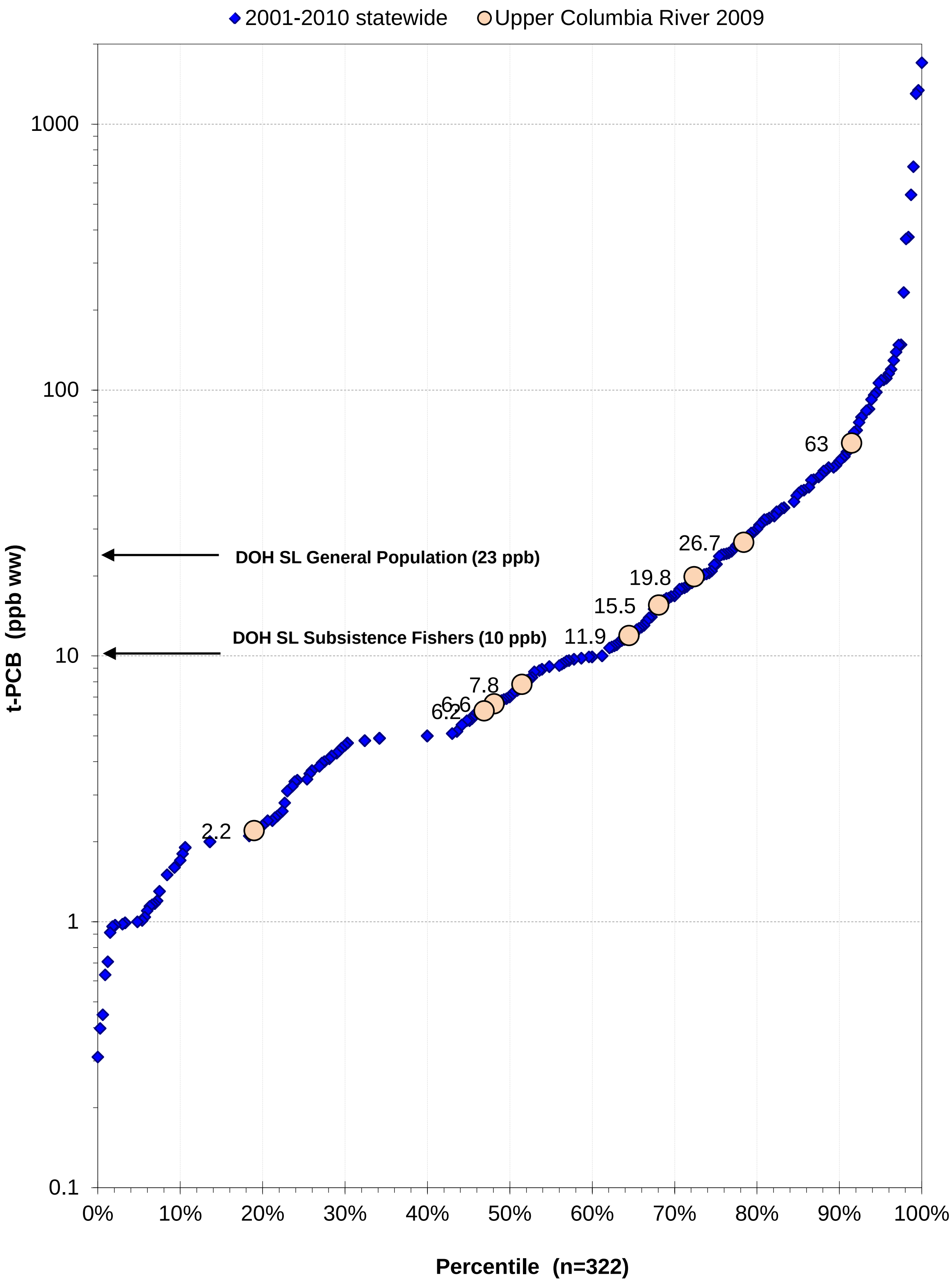


The authors reported that mercury levels in bass from Western Washington waterbodies were significantly higher than those in Eastern Washington waterbodies with mean concentrations of 315 ppb and 139 ppb, respectively. This can be compared to weighted mean mercury concentrations of 161 ppb from smallmouth bass collected from the UCR.

PCBs

Figure 10 displays the frequency distribution of total PCB tissue concentrations from all Washington State freshwater fish available in the EIM database from 2001 until 2011 as reported by Seiders (Seiders 2012). This data set reports 322 total PCB values that range from non-detects to 1,700 ppb, with a mean and median of 38 ppb and 6.9 ppb, respectively. UCR fish PCB weighted mean values are shown as data points for the nine fish species collected and range from 2.2 ppb to 63 ppb total PCBs. As shown by the distribution, UCR fish fall between the 20th and 92nd percentile values of total PCB levels measured across the state. With the exception of two species (largescale suckers and mountain whitefish), the mean concentrations of UCR fish fall below the general population screening level of 23 ppb. Screening Levels (SL) from Table A2 are displayed for reference.

Figure 10. Distribution of WSTMP and UCR Fish t-PCB Results.



PBDEs

Figure 11 displays the frequency distribution of total PBDE tissue concentrations from all Washington State freshwater fish available in the EIM database as from 2001 until 2011 as reported by Seiders (Seiders 2012). Two hundred eighty-five total PBDE values were reported that ranging from non-detected 1,135.6 ppb, with a mean and median of 11 ppb and 2.5 ppb, respectively. UCR fish PBDE weighted mean values are shown as data points for the nine fish species collected that ranging from 2.5 ppb to 34.5 ppb total PBDEs. As shown in the distribution, UCR fish fell between the 50^{th} and 96^{th} percentile values of total PBDE levels measured across Washington State. All mean concentrations of UCR fish fell below both the general and subsistence population screening level of 101 ppb and 42 ppb, respectively. Screening Levels (SL) from Table A2 are displayed for reference.

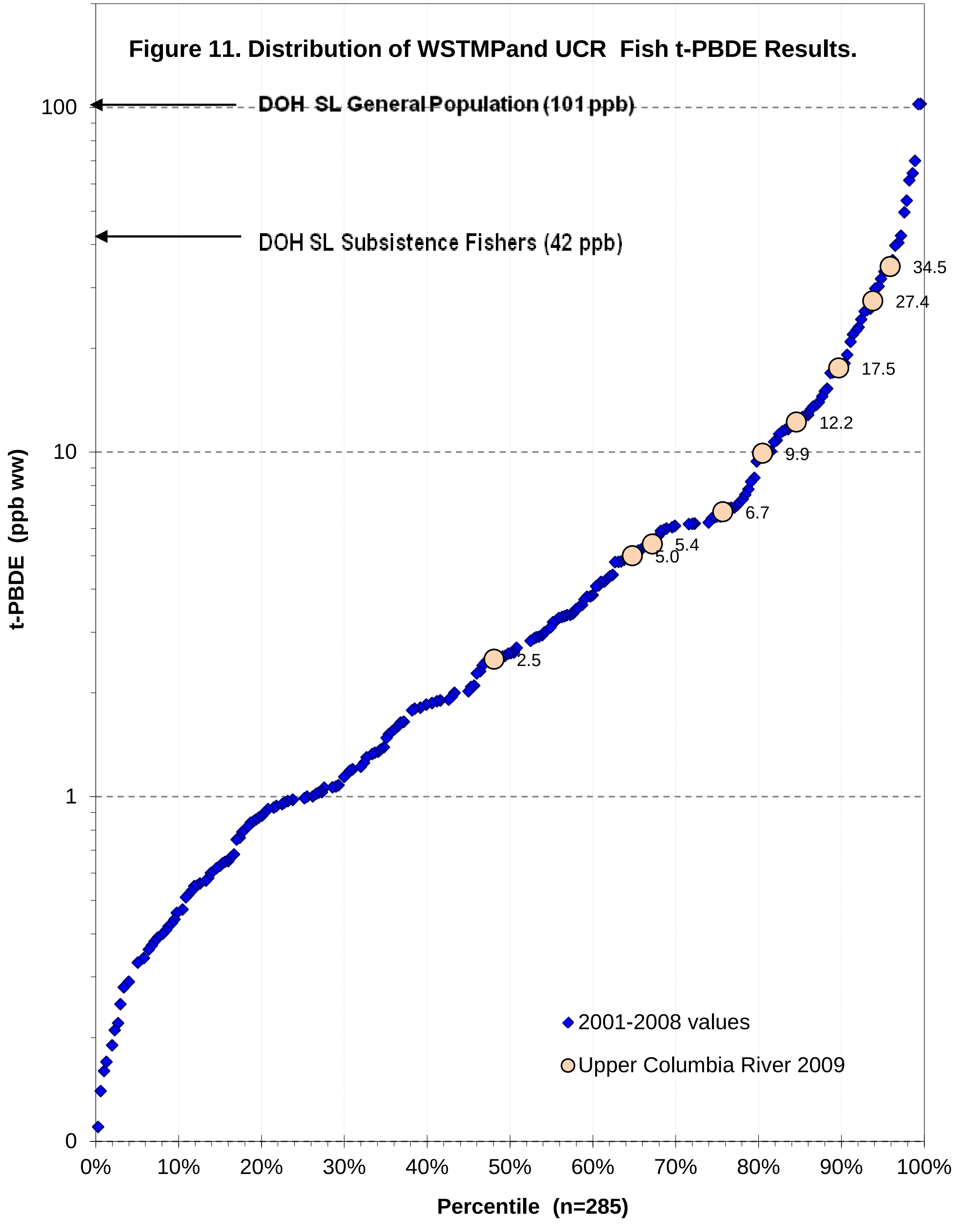
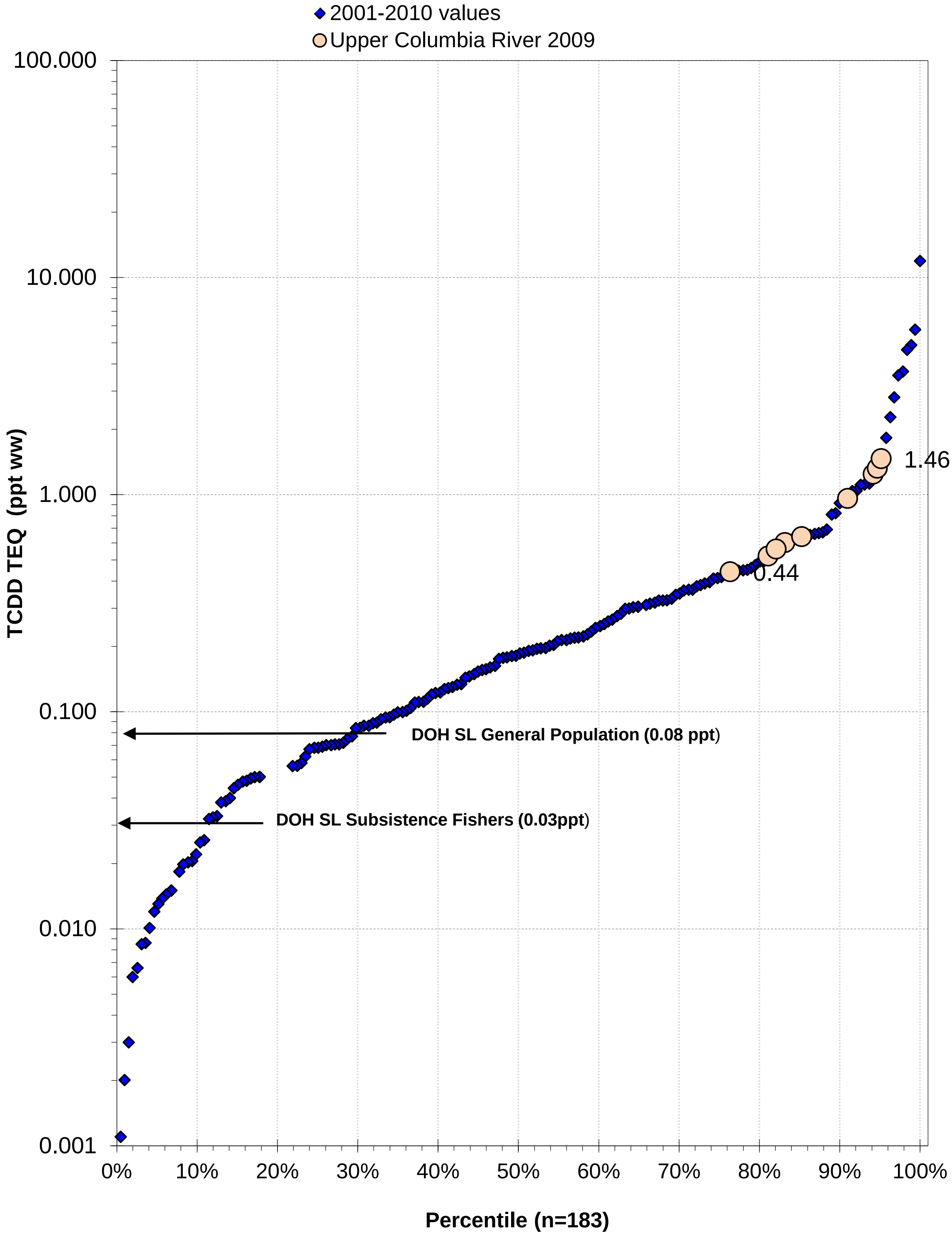


Figure 11. Distribution of WSTMPand UCR Fish t-PBDE Results.
DOH SL General Population (101 ppb)
DOH SL Subsistence Fishers (42 ppb)
t-PBDE (ppb ww)
100
10
1
0
34.5
27.4
17.5
12.2
9.9
6.7
5.4
5.0
2.5
2001-2008 values
Upper Columbia River 2009
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentile (n=285)

Total Dioxins TEQs

Figure 12 displays the frequency distribution of total dioxin TEQ tissue concentrations from all Washington State freshwater fish available in the EIM database as from 2001 until 2011 as reported by Seiders (Seiders 2012). A total of 183 total dioxin TEQ values were reported, ranging from non-detects to 11.9 ppt, with a mean and median of 0.45 ppt and 0.18 ppt, respectively. UCR fish total dioxin TEQ weighted mean values are shown as data points for the nine fish species collected that ranging from 0.44 ppt to 1.46 ppt. As shown in the distribution, UCR fish fell between the 76^{th} and 95^{th} percentile values of total dioxin TEQ levels measured across Washington State. All fish species from the UCR were above DOH screening levels as were more than 70% of fish collected statewide. Screening Levels (SL) from Table A2 are displayed for reference.

Figure 12. Distribution of WSTMP and UCR Fish TCDD-TEQ.



Summary of UCR Data to NE Background Data

While direct comparison of statewide contaminant concentrations with UCR fish tissue levels is limited because water body, species, size classes, and sampling season are not matched, data do provide a relative comparison to put UCR fish into context for angler consumption relative to numerous waterbodies across the state. For mercury and PCBs concentrations, values appear similar to or slightly higher to levels seen around Washington State. Total PBDE and total dioxin TEQ values measured in UCR fish appear consistently higher than the median (50^{th} percentile) values.

Comparison with Commercially Available Fish-Mercury

Similar to the possible effects of alternative fishing options discussed previously, an unintended potential consequence health officials face when issuing fish advisories is the possibility that the advisory, while limiting consumption of fish known to be of concern, may inadvertently lead individuals to purchase and consume fish from other locations or sources that may have equal or greater contaminant concentrations. From 2002 until 2005 the DOH conducted a Behavioral Risk Factor Surveillance System Survey (BRFSS) focusing on fish consumption (DOH 2005). BRFSS is an ongoing state-based telephone survey of randomly selected adults. BRFSS is sponsored by the Center for Disease Control and Prevention (CDC). BRFSS primarily collects data on chronic diseases, injuries, infectious illnesses, and the behavioral factors underlying these conditions. This survey was designed, in part, to address where Washington residents get their fish and how often they consume either sport caught or store bought fish. The survey indicated that nearly 35% of Washingtonians had eaten sport caught fish in the past 12 months preceding the survey and that nearly 75% had consumed store bought fish.

To address the potential exposure to contaminants from fish purchased from stores or consumed in restaurants and to put Washington State's freshwater sport-caught fish into perspective, DOH collected and analyzed mercury and PCBs concentrations in the top nine commercially purchased fish species in Washington State (DOH 2012). The following species were chosen based on frequency of consumption: catfish, cod, flounder, halibut, red snapper, pollock, Chinook salmon, and tuna (canned white and light). Forty small and large grocery stores were randomly sampled using total sales as a proxy for statewide sales of fish. This data was coupled with mercury data collected by the U.S. Food and Drug Administration (FDA 2010) on several other commercially available fish and were used to provide a comparison of locally caught sport fish with fish available from commercial markets.

Mercury concentrations in fish collected in UCR were contrasted with concentrations in commercially available fish collected in Washington State and across the United States (Figure 13). Of all fish species, mercury concentrations were highest in tilefish, large tuna steaks, shark, and swordfish. Mercury concentrations in albacore tuna (white tuna) were almost three times higher than those in light tuna. Current advice from DOH recommends that women of childbearing age and young children should eat not more than one canned albacore tuna meal per week. This is approximately one can for an adult woman and proportionately less for a child, based on his or her body weight. Further, DOH encourages women of childbearing age and young children to choose chunk light tuna over albacore to further reduce mercury exposure.

Mercury concentrations were lowest in commercial catfish and pollack. The highest mercury concentrations in fish from the UCR were seen in largescale suckers and burbot with a weighted mean of 300 ppb and 232 ppb, respectively. These values are similar to canned albacore tuna; one of the most commonly consumed commercially available fish that typically exceeds 350 ppb mercury.

Therefore, DOH recommends that fish consumers substituting commercially available fish for self-caught UCR fish choose wisely and limit consumption of commercial species high in mercury.

Figure 13. Average mercury concentrations in fish from UCR (red bars) and from the U.S. Food and Drug Administration's survey of U.S. fish species 1990 – 2004 (solid bars).

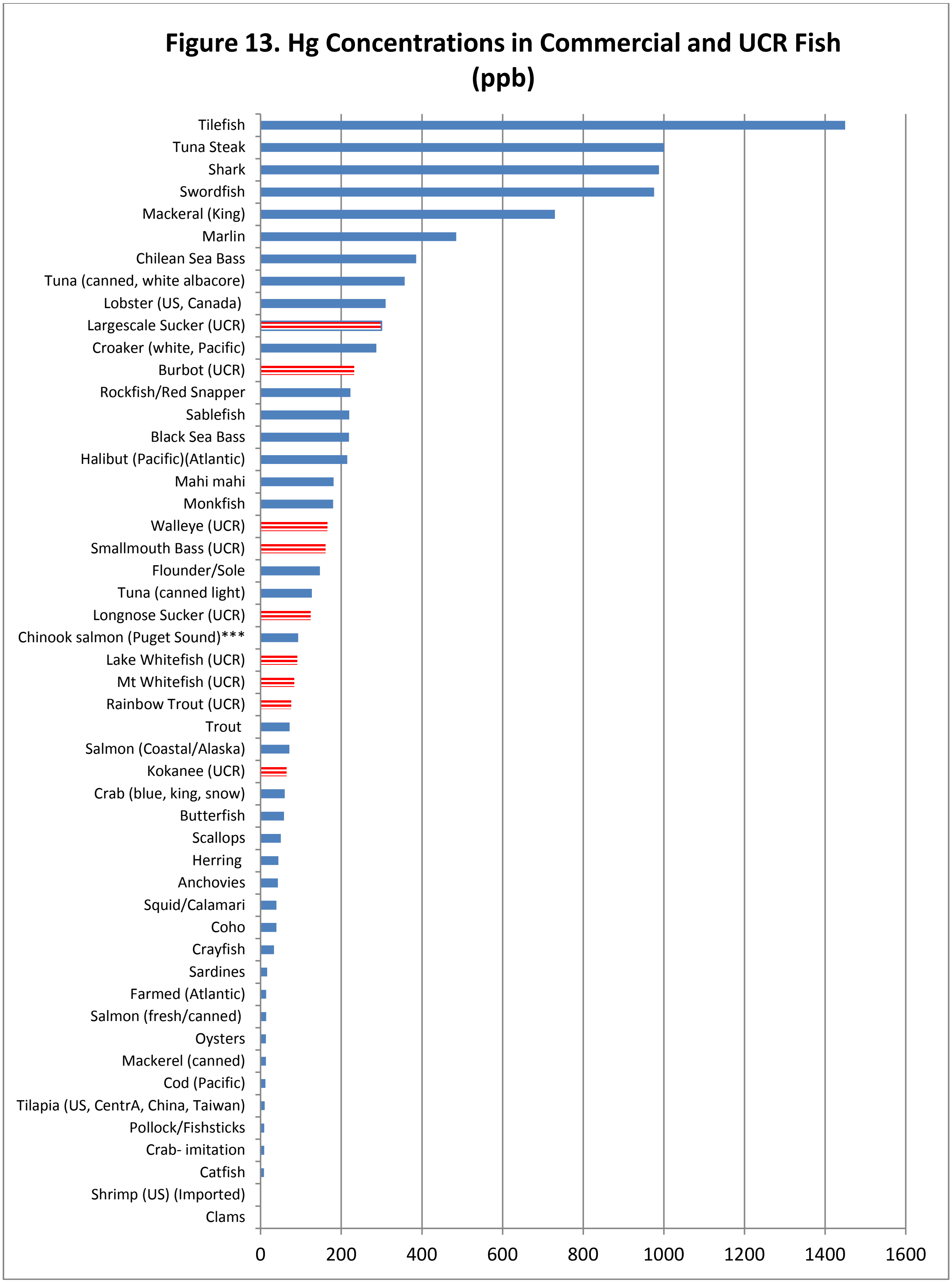
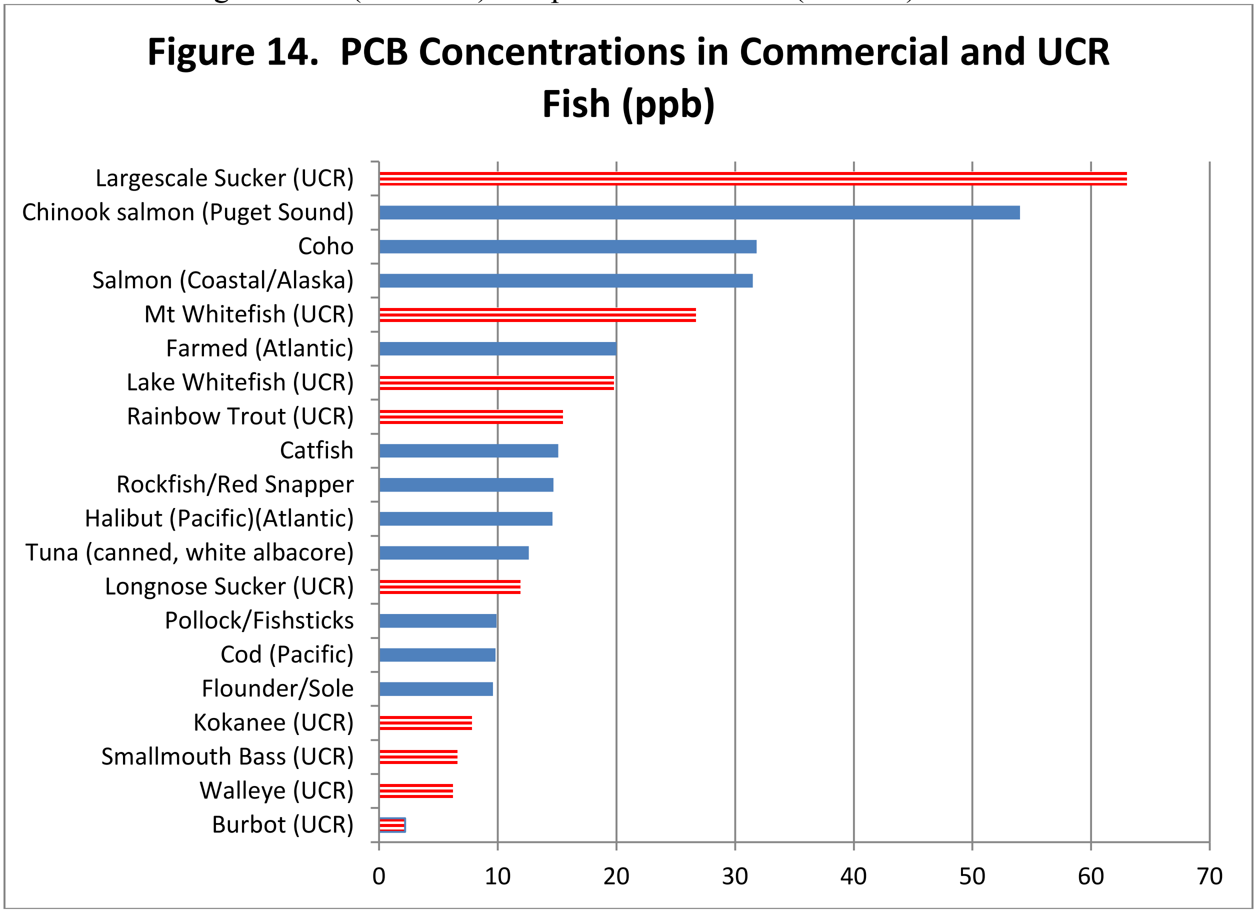


Figure 13. Hg Concentrations in Commercial and UCR Fish (ppb)
Tilefish
Tuna Steak
Shark
Swordfish
Mackeral (King)
Marlin
Chilean Sea Bass
Tuna (canned, white albacore)
Lobster (US, Canada)
Largescale Sucker (UCR)
Croaker (white, Pacific)
Burbot (UCR)
Rockfish/Red Snapper
Sablefish
Black Sea Bass
Halibut (Pacific)(Atlantic)
Mahi mahi
Monkfish
Walleye (UCR)
Smallmouth Bass (UCR)
Flounder/Sole
Tuna (canned light)
Longnose Sucker (UCR)
Chinook salmon (Puget Sound)***
Lake Whitefish (UCR)
Mt Whitefish (UCR)
Rainbow Trout (UCR)
Trout
Salmon (Coastal/Alaska)
Kokanee (UCR)
Crab (blue, king, snow)
Butterfish
Scallops
Herring
Anchovies
Squid/Calamari
Coho
Crayfish
Sardines
Farmed (Atlantic)
Salmon (fresh/canned)
Oysters
Mackerel (canned)
Cod (Pacific)
Tilapia (US, CentrA, China, Taiwan)
Pollock/Fishsticks
Crab- imitation
Catfish
Shrimp (US) (Imported)
Clams
0
200
400
600
800
1000
1200
1400
1600

PCBs: UCR vs. Commercial Fish in Washington Markets

Data on PCB, PBDE and dioxin concentrations in commercially available fish are more limited than mercury concentrations. The primary source of PCB data on commercial fish comes from DOH's 2005 study of contaminants in canned tuna and other frequently consumed store bought fish purchased in Washington State grocery stores (DOH 2005 unpublished data). Preliminary results for total PCBs (Aroclors) indicate that halibut, red snapper, and salmon had PCBs detected (>10% detection frequency). Of the store bought fish species, salmon had the highest average PCB concentrations (31.5 ppb PCBs, total Aroclors). Additional data from the Washington State Department of Fish and Wildlife on PCB levels in Puget Sound Chinook and coho salmon were also included for this assessment (DOH 2006). A comparison of PCB concentrations in fish collected in UCR with concentrations in commercially available fish can be seen in Figure 14. The red bars represent UCR weighted mean concentrations for the various fish species while the blue represent data on store bought fish. Of all fish species, PCB concentrations were highest in UCR largescale sucker (63 ppb) followed by Chinook salmon collected in Puget Sound. The current advice from DOH regarding PCBs in Puget Sound Chinook salmon recommends that women of childbearing age and young children should eat not more than one meal per week. PCB concentrations were lowest in burbot, walleye, smallmouth bass, and kokanee from the UCR. Most fish species from either the UCR or collected from grocery stores were below DOH's general population screening level of 23 ppb.

Figure 14. Mean PCB concentrations (total Aroclors) in fish collected from markets and grocery stores in Washington State (blue bars) compared to UCR fish (red bars).

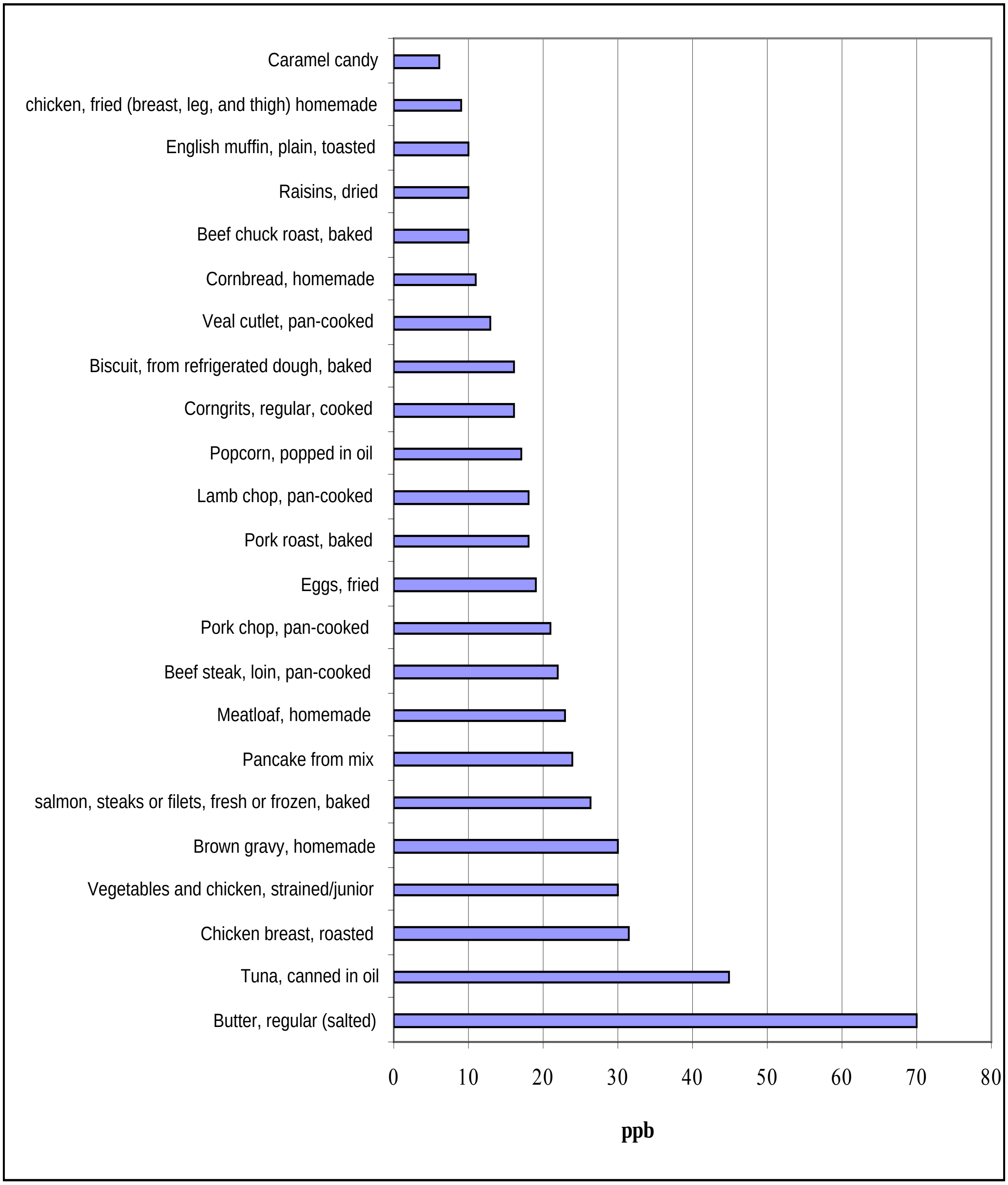


Mercury and PCBs in Other Foods

Mercury is typically not found at significant levels in foods other than fish and fish products. PCBs are found not only in fish but also in meat and dairy products. PCB concentrations in fish, meat, and dairy products vary widely depending on where they are caught or grown and on processing or cooking techniques. PCBs in beef and milk products typically range from less than 1 ppb to several ppb (FDA 2003).

FDA conducted market basket surveys from 1991-2003 and measured PCB concentrations in various foods (Figure 15). Sample sizes were very low for most foods (n = 1) except for tuna (n =14) and popcorn (n = 4). Firm conclusions about PCBs in other foods cannot be made based on these data, but the data do demonstrate that avoiding fish will not completely eliminate dietary exposure to PCBs.

Figure 15. PCB Levels in Other Foods as Tested by the U.S. Food and Drug Administration (FDA 2003).



Note: Sample sizes were very low for most foods (n = 1) except tuna (n =14) and popcorn (n = 4).

Benefits of Fish Consumption

Fish consumption is paradoxical in that not only are there known health risks associated with eating fish, there are also known health benefits gained from consuming fish. As pointed out by the Institute of Medicine, the scientific assessment of balancing the benefits and risks associated with fish consumption is a difficult task (IOM 2007). To help address these opposing effects, several studies have attempted to quantify risks of eating contaminated fish while taking into account the benefits associated with their ingestion (Rembold 2004, Tuomisto et al. 2004, Lund et al. 2004, Sakamoto 2004, SACN 2004). At present, we know that fish is an excellent protein source that is low in saturated fats, rich in vitamin D, omega-3 fatty acids, and other vitamins and minerals.

The primary health benefits of eating fish are well documented and relate to the reduction of cardiovascular disease (Gronbaek 1999, Yuan et al. 2001, Rodriguez et al. 1996, Hu et al. 2002, Marckmann and Gronbaek 1999, Mozaffarian et al. 2003, Simon et al. 1995, Burr et al. 1989, 1994, Singh et al.1997, and Harrison and Abhyankar 2005) and positive pregnancy outcome (Jorgensen et al. 2001, Olsen et al, 1992, Olsen et al 1995, Olsen and Secher 2002, Carlson et al 1993, 1996, Fadella et al. 1996, San Giovanni et al. 2000, and Helland et al. 2003). Limited data also show a link between fish consumption and a decrease in development of some cancers (SACN 2004, IOM 2007). Additionally, eating fish has been associated with impacts on brain function, including protection against cognitive decline (SACN 2004, IOM 2007). These major chronic diseases afflict much of the U.S. population. The health benefits of eating fish are associated with low levels of saturated versus unsaturated fats. Saturated fats are linked with increased cholesterol levels and risk of heart disease while unsaturated fats (e.g., omega-3 polyunsaturated fatty acid) are an essential nutrient. Replacing fish in the diet with other sources of protein may reduce exposure to contaminants but could also result in increased risk for certain diseases (Pan et al., 2012). For example, replacing fish with red meat could increase the risk of cardiovascular disease due to the fact that red meat has higher levels of saturated fat and cholesterol (Law, 2000).

Advisories can be protective while acknowledging the benefits of eating fish by recommending decreased consumption of fish known to have high concentrations of contaminants in favor of fish that are lower in contaminants. DOH supports the American Heart Association and the U.S. Food and Drug Administration recommendation of consuming at least two servings (12 oz.) of fish per week as part of a healthy diet.

Health benefits of eating fish deserve particular consideration when dealing with groups that consume fish for subsistence. Removal of fish from the diet of subsistence consumers may have serious health, social and economic consequences. In order to decrease the potential risks of fish consumption, these populations are encouraged to consume a variety of fish species, to fish from locations with low contamination, and to follow recommended preparation and cooking methods.

Communicating Risk vs. Benefits

All fish contain some level of persistent and bioaccumulative contaminants. A strict risk assessment approach would provide a meal limit, no matter how large or small, for every fish species. While meal limit calculations are a useful and necessary component of providing advice about eating fish, such messages should not stand alone. DOH considers the health benefits of eating fish to be an important part of consumption advice provided to the public. Since methods are not currently available to quantify these benefits of fish consumption, DOH chooses to promote consumption of fish species that are lowest in contaminants. This approach moves away from setting strict limits and toward encouraging consumers to eat fish while remaining smart about their choices.

EPA has recently revised estimates of per capita seafood consumption and found that the average national fish consumption rate is 20 g/day for all respondents (including non-consumers) for anadromous and resident finfish and shellfish from fresh, estuarine, and marine environments (EPA 2002b). This equates to two-three, eight ounce meals per month which is much lower than the American Heart Association's (AHA) recommendation of at least two fish meals per week. The goal of DOH fish advice is to get Washingtonians to eat two fish meals per week (roughly 50 – 65 g/day) while following localized fish advisories and general fish consumption guidance (such as limiting consumption of species high in mercury and/or PCBs and choosing certain preparation methods that may further reduce contaminant concentrations).

Some considerations in risk communication include the importance of gender, age, body weight, genetics, and culture. Pregnant women and women of child-bearing age are key populations to advise about mercury and PCBs in fish because of potential effects on neurological development. In addition, children are at higher risk because they often consume larger meals, pound per pound, than adults and consequently receive a higher dose of contaminants. This consideration applies to adults of various body weights as well; those of higher body weight can eat larger portions while those of lower body weight should eat smaller portions (advice in this report is based on an assumed bodyweight of 60 kg).

It is also essential to understand the importance of fish in different cultures and how communication may need to be tailored appropriately. Connecting with culturally diverse communities often requires outreach that goes beyond traditional governmental methods of communicating such as meetings sponsored by agencies, informational mailings, and press releases. Meeting with community groups at their convenience demonstrates sincerity and can build trust. Good translation of printed material is also a necessity.

DOH believes that recent news articles about meal limits may scare people from consuming fish and prevent some members of the public from getting the benefits of making good fish choices. The public should understand that removing fish from the diet will likely reduce but not eliminate exposure to contaminants and that other sources of protein, such as beef, chicken, and dairy products also contain persistent bioaccumulative toxins (PBTs). The best approach to reducing risk while maintaining a healthy diet is to eat a variety of foods including fish, but to be smart about fish choices.

CONCLUSIONS

The 2009 Fish Tissue Study for the UCR is the most extensive and thorough chemical monitoring effort conducted in Washington State to date. Analyses of fish tissue from the UCR indicates that from a health advisement basis the chemicals of concern are marginally higher to those seen in other fished waterbodies across the northeast region, and similar to or slightly higher than those lakes across Washington State or in commercial markets. Additionally, concentrations of these chemicals are similar to other datasets within the state that have resulted in waterbody specific fish advisories.

The benefits of eating fish should be balanced against the risks associated with contaminants in fish. The results of the fish sampling conducted in the UCR indicate the need for advice for consumers of UCR fish to help reduce exposure to contaminants. Specifically, the results of the UCR RI/FS fish tissue analysis indicate:

- Mercury, polybrominated diphenyl ethers (PBDEs), and Polychlorinated biphenyls (PCBs) were found at high enough levels in some UCR fish to warrant advice that will minimize exposure.

- Walleye meal recommendations are less restrictive than the previous advisory (2005) due to a decline in mercury levels.

- Smallmouth bass meal recommendations are less restrictive than the statewide bass advisory due to lower mercury levels seen in the UCR compared the statewide bass recommendations.

- Health risks associated with the consumption of largescale suckers in the UCR is primarily due to PCB concentrations.

- Kokanee, lake whitefish, and rainbow trout are generally low in contaminants.

- Exceeding recommended meal limits increases one's risk of adverse health effects but does not necessarily result in harmful effects.

RECOMMENDATIONS

Based on this assessment, DOH recommends that women who are or might become pregnant, nursing mothers, and young children follow these meal recommendations:

- Kokanee - 3 meals per week
- Lake whitefish – 2 meals per week
- Rainbow trout – 2 meals per week
- Burbot – 1 meal per week
- Longnose sucker – 1 meal per week
- Mountain whitefish – 1 meal per week
- Smallmouth bass – 1 meal per week
- Walleye – 1 meal per week
- Largescale sucker – 2 meals per month

In addition to the specific meal recommendations based on UCR data, two statewide mercury advisories also apply. They are:

- Largemouth bass – 2 meals per month
- Northern pikeminnow – do not eat

DOH also recommends that everyone limit consumption of largescale suckers to four meals per month due to potential immune system effects from PCBs.

General Fish Consumption Advice

DOH encourages all Washingtonians to eat at least two fish meals per week as part of a heart healthy diet in accordance with American Heart Association (AHA) recommendations. People may eat fish more than two times weekly, but such frequent consumers should take steps to reduce exposure to contaminants in the fish that they eat by following some general advice.

- Eat a variety of fish that are low in contaminants according to guidance provided on the DOH website at http://www.doh.wa.gov/fish/.
- Follow advice provided by DOH and other local health agencies on water bodies to fish.
- Young children and small adults should eat proportionally smaller meal sizes.
- Eat fillets without the skin.
- Consume younger, smaller fish (within legal limits). These fish typically contain lower levels of accumulative contaminants like PCBs and mercury than older, larger fish.
- When cleaning fish, remove the skin, fat, and internal organs before cooking; this will help to reduce the amount of some contaminants.
- Grill, bake, or broil fish so that fat drips off while cooking.

Appendix A

Appendix A. Table 1a - Target Analytes from the 2009 Fish Tissue Study.		
Analyte	Standard Analyte List Measured in All Fish Tissues Collected in 2009	Expanded Analyte List Measured in a Subset of Fish Tissues Collected in 2009
Conventional Parameters		
Total Length	x	x
Total Mass	x	x
Percent Moisture	x	x
Percent Lipids	x	x
Metals/Metalloids		
Aluminum	x	x
Antimony	x	x
Arsenic (Total)	x	x
Arsenic (Inorganic species)		x
Barium	x	x
Beryllium	x	x
Bismuth		x
Boron		x
Cadmium	x	x
Calcium	x	x
Cerium		x
Cesium		x
Chromium	x	x
Cobalt	x	x
Copper	x	x
Dysprosium		x
Erbium		x
Europium		x
Fluoride		x
Gadolinium		x
Gallium		x
Germanium		x
Gold		x
Holmium		x
Indium		x
Iron	x	x
Lanthanum		x
Lead	x	x

Lithium		x
Lutetium		x
Magnesium	x	x
Manganese	x	x
Mercury	x	x
Molybdenum	x	x
Neodymium		x
Nickel	x	x
Niobium		x
Potassium	x	x
Praseodymium		x
Rubidium		x
Samarium		x
Scandium		x
Selenium	x	x
Silver	x	x
Sodium	x	x
Strontium		x
Tantalum		x
Tellurium		x
Terbium		x
Thallium	x	x
Thorium		x
Thulium		x
Tin		x
Titanium		x
Tungsten		x
Uranium	x	x
Vanadium	x	x
Ytterbium		x
Yttrium		x
Zinc	x	x
Zirconium		x
Dioxins/Furans		
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	x	x
1,2,3,4,6,7,8-Heptachlorodibenzofuran	x	x
1,2,3,4,7,8,9-Heptachlorodibenzofuran	x	x
1,2,3,4,7,8-Hexachlorodibenzodioxin	x	x
1,2,3,4,7,8-Hexachlorodibenzofuran	x	x
1,2,3,6,7,8-Hexachlorodibenzodioxin	x	x

1,2,3,6,7,8-Hexachlorodibenzofuran	x	x
1,2,3,7,8,9-Hexachlorodibenzodioxin	x	x
1,2,3,7,8,9-Hexachlorodibenzofuran	x	x
1,2,3,7,8-Pentachlorodibenzofuran	x	x
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	x	x
2,3,4,6,7,8-Hexachlorodibenzofuran	x	x
2,3,4,7,8-Pentachlorodibenzofuran	x	x
2,3,7,8-Tetrachlorodibenzodioxin	x	x
2,3,7,8-Tetrachlorodibenzofuran	x	x
Octachlorodibenzodioxin	x	x
Octachlorodibenzofuran	x	x
PCBs		
Total PCBs	x	x
PCB Congeners (Dioxin-Like Congeners)	x	x
PCB Congeners (All 209 Congeners)	x	x
PAHs		
Acenaphthylene		x
Anthracene		x
Benzo(a)anthracene		x
Benzo(a)pyrene		x
Benzo(b)fluoranthene		x
Benzo(ghi)perylene		x
Benzo(k)fluoranthene		x
Chrysene		x
Dibenzo(a,h)anthracene		x
Fluoranthene		x
Fluorene		x
Indeno[1,2,3-cd]pyrene		x
Phenanthrene		x
Pyrene 4.88		x
PAHs		
Acenaphthylene		x
Anthracene		x
Benzo(a)anthracene		x
Benzo(a)pyrene		x
Benzo(b)fluoranthene		x
Benzo(ghi)perylene		x
Benzo(k)fluoranthene		x
Chrysene		x

Dibenzo(a,h)anthracene		x
Fluoranthene		x
Fluorene		x
Indeno[1,2,3-cd]pyrene		x
Phenanthrene		x
Pyrene		x
Polybrominated Diphenylethers (PBDEs)		
PBDEs (17, 28, 47, 49, 66, 71, 85, 99, 100, 128, 138,		x
153, 154, 183, 184, 190, 191, 203, 206, 209)a		
Pesticides		
2,4'-DDD		x
4,4'-DDD		x
2,4'-DDE		x
4,4'-DDE		x
2,4'-DDT		x
4,4'-DDT		x
Aldrin		x
delta-BHC		x
alpha-Chlordane (cis-)		x
gamma-Chlordane (trans-)		x
cis-Nonachlor		x
trans-Nonachlor		x
Oxychlordane		x
Dieldrin		x
Endrin		x
Endrin aldehyde		x
Endrin ketone		x
Heptachlor		x
Heptachlor epoxide		x
Hexachlorobenzene		x
Hexachlorobutadiene		x
Methoxychlor		x
Toxaphene		x
SVOCs		
1,1'-Biphenyl		x
1,2,4-Trichlorobenzene		x
4-Bromophenyl-phenylether		x

4-Chlorophenyl-phenyl ether		x
bis(2-Ethylhexyl)phthalate		x
Butyl benzyl phthalate		x
Dibenzofuran		x
Di-n-butyl phthalate		x
Di-n-octylphthalate		x
Hexachlorocyclopentadiene		x
Hexachloroethane		x
Pentachlorophenol		x

Appendix A, Table 1b - Targeted Species and Sample Size for the 2009 Fish Tissue Sampling.

Species	Number of Composite Samples					
	FSCA 1	**FSCA 2**	**FSCA 3**	**FSCA 4**	**FSCA 5**	**FSCA 6**
<15 cm Size Class						
Species-specific Composites	6 WB	6 WB	6 WB	6 WB	6 WB	6 WB
≥ 15 to ≤ 30 cm Size Class						
Species-specific Composites	6 WB	6 WB	6 WB	6 WB	6 WB	6 WB
≥ 30 cm Size Class						
Walleye	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Smallmouth Bass	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Burbot	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Largescale Sucker	6F & 6R*	6F & 6R*	6F & 6R*	6F & 6R*	6F & 6R*	6F & 6R*
Lake Whitefish	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Rainbow Trout	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R
Kokanee	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R	6F & 6R

Notes:
FSCA - Fish Sampling Collection Area
WB - Whole body
F - Fillet
R - Remaining tissue after filleting
* Largescale suckers had gut contents removed prior to analysis of the remainder

Appendix A. Table 2a - Screening Levels for Chemicals of Interest.							
ANALYTE	**CASRN**	**RfD (mg/kg-day)**	**CSF (mg/kg-day)-1**	**General Population Screening Level (ppm)**	**Subsistence Screening Level (ppm)**	**Reference**	**Critical Effect**
Metal/oids							
Antimony	7440-36-0	0.0004		0.469	0.197	IRIS 1991	Longevity, blood glucose, cholesterol
Arsenic (inorganic)	7440-38-2	0.0003		0.352	0.147	IRIS 1993	Hyperpigmentation, keratosis, vascular complications
Arsenic (inorganic)	7440-38-2	-	1.5	0.0078	0.0033	IRIS 1998	Cancer 1x10-5
Barium	7440-39-3	0.2		234.5	98.3	IRIS 2005	Nephropathy
Beryllium	7440-41-7	0.002		2.35	0.983	IRIS 1998	Small intestine lesions
Boron	7440-42-8	0.2		234.5	98.3	IRIS 2004	Decrease fetal weight (developmental)
Cadmium	7440-43-9	0.001		1.173	0.492	IRIS 1994	Proteinuria
Chromium (VI)	7440-47-3	0.003		3.52	1.47	IRIS 1998	none reported
Chromium (III)	7440-47-3	1.5		1758.8	737.4	IRIS 1998	none reported
Lead*	7439-92-1	<10 ug/dl		<10 ug/dl	<10 ug/dl	CDC 1991	neurotoxicity
Manganese	7439-96-5	0.14		164.2	68.8	IRIS 1996	CNS effects
Mercury	7439-97-6	0.0001		0.101	0.042	IRIS 2001	Developmental neuropsychological impairment
Molybdenum	7439-98-7	0.005		5.86	2.46	IRIS 1993/98	Increase uric acid levels
Nickel	7440-02-0	0.02		23.5	9.83	IRIS 1996	Decreased body weights
Selenium	7782-49-2	0.005		5.86	2.46	IRIS 1991	Clinical selenosis
Silver	7440-22-4	0.005		5.86	2.46	IRIS 1996	Argyria
Strontium	7440-24-6	0.6		703.5	294.9	IRIS 1996	Rachitic bone
Zinc	7440-66-6	0.3		351.8	147.5	IRIS 2005	Decrease in erthyrocyte Cu, Zn-superoxide dismutase activity
PAHs							
1,1'-Biphenyl	92-52-4	0.05		58.6	24.6	IRIS 1989	Kidney damage

2-Methylnaphthalene	91-57-6	0.004		4.69	1.97	IRIS 2003	Pulmonary alveolar proteinosis
Acenaphthene	83-32-9	0.06		70.4	29.5	IRIS 1994	Hepatotoxicity
Anthracene	120-12-7	0.3		351.8	147.5	IRIS 1993	Cellular necrosis
Benzo[a]anthracene	56-55-3	NA	0.73	0.016	0.007	IRIS 1994	Cancer 1x10-5
Benzo[b]fluoranthene	205-99-2	NA	0.73	0.016	0.007	IRIS 1994	Cancer 1x10-5
Benzo[k]fluoranthene	207-08-9	NA	0.073	0.16	0.07	IRIS 1994	Cancer 1x10-5
Benzo[a]pyrene	50-32-8	NA	7.3	0.0016	0.0007	IRIS 1994	Cancer 1x10-5
Chrysene	21-80-19	NA	0.0073	1.61	0.7	IRIS 1994	Cancer 1x10-5
Dibenzo[a,h]anthene	53-70-3	NA	7.3	0.0016	0.0007	IRIS 1994	Cancer 1x10-5
Fluoranthene	206-44-0	0.04		46.9	19.7	IRIS 1993	Nephroppathy, increase liver weights, hematological alterations
Fluorene	86-73-7	0.04		46.9	19.7	IRIS 1990	Decreased RBC, packed cell volume and hemoglobin
Indeno[1,2,3-cd]pyrene	193-39-5	NA	0.73	0.0161	0.007	IRIS 1994	Cancer 1x10-5
Naphthalene	91-20-3	0.02		23.5	9.83	IRIS 1998	Decreased body weight
Pentachlorophenol	87-86-5	0.005		5.86	2.46	IRIS 2010	Hepatotoxicity
Pyrene	129-00-0	0.03		35.2	14.7	IRIS 1993	Renal tubular pathology, decrease kidney weight
Pest-Herb							
Aldrin	309-00-2	0.00003	17	0.035	0.015	IRIS 1988	Liver toxicity
Chlordane (Total)	57-74-9	0.0005	0.35	0.586	0.246	IRIS 1998	Hepatic Necrosis
DDT (Total)	50-29-3	0.0005	0.34	0.503	0.211	IRIS 1996	Liver lesions/neurological effects
Dieldrin	60-57-1	0.00005	16	0.059	0.025	IRIS 1990	Liver lesions
Endrin	72-20-8	0.0003		0.352	0.147	IRIS 1991/93	Liver lesions
Heptachlor	76-44-8	0.0005	4.5	0.586	0.246	IRIS 1991	Increased liver weight
Heptachor Epoxide	1024-57-3	0.000013	9.1	0.015	0.006	IRIS 1991	Increased liver weight
Methoxychlor	72-43-5	0.005		5.86	2.46	IRIS 1991	Excessive loss of litters
SVOC							
1,2,4-TriChlorobenzene	120-82-1	0.01	0.0036	11.7	4.92	IRIS 1996	Increase adrenal weights
Bis (2-ethylhexyl) Phthalate	117-81-7	0.02	0.014	23.5	9.83	IRIS 1991	Increased liver weight
Butyl benzyl phthalate	85-68-7	0.2		234.5	98.3	IRIS 1993	Increased liver weight

Dibutyl phthalate	84-74-2	0.1		117.3	49.2	IRIS 1990	Increased mortality
Hexachloroethane	67-72-1	0.001		1.17	0.492	IRIS 1991	Atrophy and degeneration of renal tubules
Hexachlorobenzene	118-74-1	0.0008	1.6	0.938	0.393	IRIS 1991/96	Liver effects
Hexachloro-1,3-butadiene	87-68-3	0.001	0.078	1.17	0.49	IRIS 1993	IRIS withdrawn (PPRTV)
Hexachlorocyclopentadiene	77-47-4	0.006		7.04	2.95	IRIS 2001	Chronic irritation
PBDEs							
BDE-47	5436-43-1	0.0001		0.10	0.042	IRIS 2008	Neurobehavioral effects
BDE-99	60348-60-9	0.0001		0.10	0.042	IRIS 2008	Neurobehavioral effects
BDE-153	68631-49-2	0.0002		0.20	0.08	IRIS 2008	Neurobehavioral effects
BDE-209	1163-19-5	0.007		7.04	2.95	IRIS 2008	Neurobehavioral effects
BDE-209	1163-19-5		0.0007	16.75	7.02	IRIS 2008	Cancer 1x10-5
PBDE (Total)		0.0001		0.10	0.042		Neurobehavioral effects
PCBs/Dioxins							
2,3,7,8- TCDD	1746-01-1	1E-09		0.0000012	0.0000005	ATSDR MRL 2005	AH receptor binding
2,3,7,8- TCDD	1746-01-1	-	1.56E+05	0.00000008	0.00000003	ATSDR MRL 2005	Cancer 1x10-5
Furan	110-00-9	0.001		1.173	0.492	IRIS 1989	Liver lesions
PCBs (Total)	1336-36-3	0.00002		0.023	0.010	IRIS 1994	Immune effects
PCBs (Total)	1336-36-3	0.00003		0.030	0.013	ATSDR MRL 2005	Developmental effects
PCBs (Total) (ppb)	1336-36-3	0.00002	2	0.0059	0.0025	IRIS 1994	Cancer 1x10-5
Total Dioxins	-	7E-10		0.0000008	0.0000003	ATSDR MRL 2005	Decreased sperm count and mobility
Total Dioxins	-	-	1.56E+05	0.00000008	0.00000003	ATSDR MRL 2005	Cancer 1x10-5

Reference:

http://www.epa.gov/iris/index.html

ATSDR - http://www.atsdr.cdc.gov/interactionprofiles/ip01.html table 35

GP consumption rate = 59.7 g/d

Subsistence rate = 142.4 g/d

* CDC Blood Lead Level of Concern - http://www.cdc.gov/nceh/lead/ACCLPP/acclpp_main.htm

Mercury, total DDT, and PBDEs were assessed using 60 kg BW

Appendix A. Table 3a - Aldrin Screening.							
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppm)**	**Exceed General Public Screening Level**	**Exceed Subsistence Screening Level**
FSCA 6	Smallmouth Bass	>15 to <=30cm	Fish Carcass	Composite	0.016	No	Yes

Appendix A. Table 3b - Antimony Screening.							
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppm)**	**Exceed General Public Screening Level**	**Exceed Subsistence Screening Level**
FSCA 1	Largescale Sucker	>30cm	Fish Carcass	Single	0.722	Yes	Yes
FSCA 1	Northern Pikeminnow	<=15cm	Whole Fish	Composite	0.205	No	Yes

Appendix A. Table 3c - Cadmium Screening.							
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppm)**	**Exceed General Public Screening Level**	**Exceed Subsistence Screening Level**
FSCA 1	Largescale Sucker	>30cm	Fish Carcass	Single	0.595	Yes	Yes
FSCA 2	Largescale Sucker	>30cm	Fish Carcass	Composite	0.338	No	Yes
FSCA 4	Largescale Sucker	>30cm	Fish Carcass	Single	0.318	No	Yes
FSCA 4	Longnose Sucker	<=15cm	Whole Fish	Composite	0.292	No	Yes
FSCA 5	Largescale Sucker	>30cm	Fish Carcass	Single	0.435	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fish Carcass	Composite	0.306	No	Yes

Appendix A. Table 3d - Chromium Screening.							
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppm)**	**Exceed General Public Screening Level**	**Exceed Subsistence Screening Level**
FSCA 1	Largescale Sucker	<=15cm	Whole Fish	Composite	6.524	Yes	Yes
FSCA 2	Longnose Sucker	<=15cm	Whole Fish	Composite	2.553	No	Yes
FSCA 5	Smallmouth Bass	<=15cm	Whole Fish	Composite	2.563	No	Yes
FSCA 6	Sculpin	<=15cm	Whole Fish	Composite	5.758	Yes	Yes

Appendix A. Table 3e - Mercury Screening.							
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppm)**	**Exceed General Public Screening Level**	**Exceed Subsistence Screening Level**
FSCA 1	Burbot	>30cm	Fillet-skin on	Single	0.276	Yes	Yes
FSCA 1	Burbot	>30cm	Fish Carcass	Single	0.101	Yes	Yes
FSCA 1	Kokanee	>30cm	Fillet-skin on	Composite	0.068	No	Yes
FSCA 1	Kokanee	>30cm	Fish Carcass	Composite	0.048	No	Yes
FSCA 1	Largescale Sucker	>30cm	Fillet-skin on	Single	0.219	Yes	Yes
FSCA 1	Largescale Sucker	>30cm	Fish Carcass	Single	0.100	No	Yes
FSCA 1	Mt Whitefish	>30cm	Fillet-skin on	Single	0.075	No	Yes
FSCA 1	Mt Whitefish	>30cm	Fish Carcass	Single	0.052	No	Yes
FSCA 1	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.076	No	Yes
FSCA 1	Rainbow Trout	>30cm	Fish Carcass	Composite	0.049	No	Yes
FSCA 1	Sculpin	<=15cm	Whole Fish	Composite	0.063	No	Yes
FSCA 1	Walleye	>30cm	Fillet-skin on	Composite	0.190	Yes	Yes
FSCA 1	Walleye	>30cm	Fillet-skin on	Single	0.163	Yes	Yes
FSCA 1	Walleye	>30cm	Fish Carcass	Composite	0.087	No	Yes
FSCA 2	Burbot	>30cm	Fillet-skin on	Single	0.183	Yes	Yes
FSCA 2	Burbot	>30cm	Fish Carcass	Single	0.115	Yes	Yes
FSCA 2	Kokanee	>15 to <=30cm	Whole Fish	Composite	0.063	No	Yes
FSCA 2	Kokanee	>30cm	Fillet-skin on	Composite	0.064	No	Yes
FSCA 2	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.217	Yes	Yes
FSCA 2	Largescale Sucker	>30cm	Fish Carcass	Composite	0.095	No	Yes
FSCA 2	Longnose Sucker	>30cm	Fillet-skin on	Single	0.070	No	Yes
FSCA 2	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.080	No	Yes
FSCA 2	Rainbow Trout	>30cm	Fish Carcass	Composite	0.045	No	Yes
FSCA 2	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.157	Yes	Yes

FSCA 2	Smallmouth Bass	>30cm	Fish Carcass	Single	0.119	Yes	Yes
FSCA 2	Mt Whitefish	>30cm	Fillet-skin on	Single	0.088	No	Yes
FSCA 2	Mt Whitefish	>30cm	Fish Carcass	Single	0.065	No	Yes
FSCA 2	Northern Pikeminnow	<=15cm	Whole Fish	Composite	0.074	No	Yes
FSCA 2	Walleye	>30cm	Fillet-skin on	Composite	0.167	Yes	Yes
FSCA 2	Walleye	>30cm	Fillet-skin on	Single	0.165	Yes	Yes
FSCA 2	Walleye	>30cm	Fish Carcass	Composite	0.073	No	Yes
FSCA 3	Burbot	>30cm	Fillet-skin on	Composite	0.228	Yes	Yes
FSCA 3	Burbot	>30cm	Fish Carcass	Composite	0.114	Yes	Yes
FSCA 3	Kokanee	>15 to <=30cm	Whole Fish	Composite	0.060	No	Yes
FSCA 3	Kokanee	>30cm	Fillet-skin on	Composite	0.059	No	Yes
FSCA 3	Kokanee	>30cm	Fish Carcass	Composite	0.042	No	Yes
FSCA 3	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.081	No	Yes
FSCA 3	Lake Whitefish	>30cm	Fish Carcass	Composite	0.052	No	Yes
FSCA 3	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.222	Yes	Yes
FSCA 3	Largescale Sucker	>30cm	Fish Carcass	Composite	0.109	Yes	Yes
FSCA 3	Northern Pikeminnow	<=15cm	Whole Fish	Composite	0.104	Yes	Yes
FSCA 3	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.077	No	Yes
FSCA 3	Rainbow Trout	>30cm	Fish Carcass	Composite	0.050	No	Yes
FSCA 3	Sculpin	<=15cm	Whole Fish	Composite	0.057	No	Yes
FSCA 3	Smallmouth Bass	<=15cm	Whole Fish	Composite	0.046	No	Yes
FSCA 3	Smallmouth Bass	>15 to <=30cm	Fillet-skin on	Single	0.165	Yes	Yes
FSCA 3	Smallmouth Bass	>15 to <=30cm	Fish Carcass	Single	0.069	No	Yes
FSCA 3	Smallmouth Bass	>15 to <=30cm	Whole Fish	Composite	0.133	Yes	Yes
FSCA 3	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.217	Yes	Yes
FSCA 3	Smallmouth Bass	>30cm	Fish Carcass	Single	0.114	Yes	Yes
FSCA 3	Walleye	<=15cm	Whole Fish	Composite	0.064	No	Yes
FSCA 3	Walleye	>15 to <=30cm	Whole Fish	Composite	0.082	No	Yes

FSCA 3	Walleye	>30cm	Fillet-skin on	Composite	0.170	Yes	Yes
FSCA 3	Walleye	>30cm	Fillet-skin on	Single	0.172	Yes	Yes
FSCA 3	Walleye	>30cm	Fish Carcass	Composite	0.081	No	Yes
FSCA 4	Burbot	>30cm	Fillet-skin on	Composite	0.241	Yes	Yes
FSCA 4	Burbot	>30cm	Fish Carcass	Composite	0.115	Yes	Yes
FSCA 4	Kokanee	>15 to <=30cm	Whole Fish	Composite	0.054	No	Yes
FSCA 4	Kokanee	>30cm	Fillet-skin on	Composite	0.065	No	Yes
FSCA 4	Kokanee	>30cm	Fish Carcass	Composite	0.043	No	Yes
FSCA 4	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.089	No	Yes
FSCA 4	Lake Whitefish	>30cm	Fish Carcass	Composite	0.060	No	Yes
FSCA 4	Largescale Sucker	>30cm	Fillet-skin on	Single	0.371	Yes	Yes
FSCA 4	Largescale Sucker	>30cm	Fish Carcass	Single	0.182	Yes	Yes
FSCA 4	Longnose Sucker	>30cm	Fillet-skin on	Composite	0.188	Yes	Yes
FSCA 4	Longnose Sucker	>30cm	Fish Carcass	Composite	0.081	No	Yes
FSCA 4	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.084	No	Yes
FSCA 4	Rainbow Trout	>30cm	Fish Carcass	Composite	0.051	No	Yes
FSCA 4	Smallmouth Bass	>15 to <=30cm	Whole Fish	Composite	0.053	No	Yes
FSCA 4	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.127	Yes	Yes
FSCA 4	Smallmouth Bass	>30cm	Fish Carcass	Single	0.066	No	Yes
FSCA 4	Walleye	<=15cm	Whole Fish	Composite	0.063	No	Yes
FSCA 4	Walleye	>15 to <=30cm	Whole Fish	Composite	0.140	Yes	Yes
FSCA 4	Walleye	>30cm	Fillet-skin on	Composite	0.138	Yes	Yes
FSCA 4	Walleye	>30cm	Fillet-skin on	Single	0.122	Yes	Yes
FSCA 4	Walleye	>30cm	Fish Carcass	Composite	0.076	No	Yes
FSCA 5	Burbot	>30cm	Fillet-skin on	Composite	0.236	Yes	Yes
FSCA 5	Burbot	>30cm	Fish Carcass	Composite	0.118	Yes	Yes
FSCA 5	Kokanee	>15 to <=30cm	Whole Fish	Composite	0.055	No	Yes
FSCA 5	Kokanee	>30cm	Fillet-skin on	Composite	0.063	No	Yes

FSCA 5	Kokanee	>30cm	Fish Carcass	Composite	0.043	No	Yes
FSCA 5	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.110	Yes	Yes
FSCA 5	Lake Whitefish	>30cm	Fish Carcass	Composite	0.066	No	Yes
FSCA 5	Largescale Sucker	>30cm	Fillet-skin on	Single	0.462	Yes	Yes
FSCA 5	Largescale Sucker	>30cm	Fish Carcass	Single	0.215	Yes	Yes
FSCA 5	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.065	No	Yes
FSCA 5	Sculpin	<=15cm	Whole Fish	Composite	0.049	No	Yes
FSCA 5	Smallmouth Bass	<=15cm	Whole Fish	Composite	0.060	No	Yes
FSCA 5	Smallmouth Bass	>15 to <=30cm	Whole Fish	Composite	0.066	No	Yes
FSCA 5	Smallmouth Bass	>30cm	Fillet-skin on	Composite	0.142	Yes	Yes
FSCA 5	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.147	Yes	Yes
FSCA 5	Smallmouth Bass	>30cm	Fish Carcass	Composite	0.078	No	Yes
FSCA 5	Walleye	<=15cm	Whole Fish	Composite	0.078	No	Yes
FSCA 5	Walleye	>15 to <=30cm	Whole Fish	Composite	0.098	No	Yes
FSCA 5	Walleye	>30cm	Fillet-skin on	Composite	0.184	Yes	Yes
FSCA 5	Walleye	>30cm	Fillet-skin on	Single	0.170	Yes	Yes
FSCA 5	Walleye	>30cm	Fish Carcass	Composite	0.093	No	Yes
FSCA 6	Burbot	>30cm	Fillet-skin on	Composite	0.241	Yes	Yes
FSCA 6	Burbot	>30cm	Fish Carcass	Composite	0.127	Yes	Yes
FSCA 6	Kokanee	>15 to <=30cm	Whole Fish	Composite	0.067	No	Yes
FSCA 6	Kokanee	>30cm	Fillet-skin on	Composite	0.061	No	Yes
FSCA 6	Kokanee	>30cm	Fish Carcass	Composite	0.042	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.257	Yes	Yes
FSCA 6	Largescale Sucker	>30cm	Fish Carcass	Composite	0.099	No	Yes
FSCA 6	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.075	No	Yes
FSCA 6	Rainbow Trout	>30cm	Fish Carcass	Composite	0.045	No	Yes
FSCA 6	Sculpin	<=15cm	Whole Fish	Composite	0.045	No	Yes
FSCA 6	Smallmouth Bass	>15 to <=30cm	Fillet-skin on	Composite	0.176	Yes	Yes
FSCA 6	Smallmouth Bass	>15 to <=30cm	Fish Carcass	Composite	0.084	No	Yes

FSCA 6	Smallmouth Bass	>15 to <=30cm	Whole Fish	Composite	0.055	No	Yes
FSCA 6	Smallmouth Bass	>30cm	Fillet-skin on	Composite	0.175	Yes	Yes
FSCA 6	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.158	Yes	Yes
FSCA 6	Smallmouth Bass	>30cm	Fish Carcass	Composite	0.105	Yes	Yes
FSCA 6	Walleye	<=15cm	Whole Fish	Composite	0.127	Yes	Yes
FSCA 6	Walleye	>15 to <=30cm	Whole Fish	Composite	0.123	Yes	Yes
FSCA 6	Walleye	>30cm	Fillet-skin on	Composite	0.201	Yes	Yes
FSCA 6	Walleye	>30cm	Fillet-skin on	Single	0.197	Yes	Yes
FSCA 6	Walleye	>30cm	Fish Carcass	Composite	0.101	Yes	Yes

Appendix A. Table 3f - PBDE 47 Screening.

FSCA	Species	Size Class	Matrix Type	Sample Type	Mean (ppb)	Exceed General Public Screening Level	Exceed Subsistence Screening Level
FSCA 1	Burbot	>30cm	Fish Offal	Single	57.6	No	Yes
FSCA 2	Largescale Sucker	>30cm	Fish Carcass	Multicoll	67.2	No	Yes
FSCA 2	Smallmouth Bass	>30cm	Fish Offal	Single	53.6	No	Yes
FSCA 4	Largescale Sucker	>30cm	Fish Carcass	Single	43.5	No	Yes
FSCA 5	Largescale Sucker	>30cm	Fish Carcass	Single	89.6	No	Yes
FSCA 5	Walleye	>30cm	Fish Carcass	Multicoll	55.8	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Multicoll	53.7	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fish Carcass	Multicoll	97.7	No	Yes

Appendix A. Table 3g - Total PBDE Screening.

FSCA	Common Name	Size Class	Matrix Type	Sample Type	Mean (ppb)	Exceed General Public Screening Level	Exceed Subsistence Screening Level
FSCA 1	Burbot	>30cm	Fish Offal	Single	85.6	No	Yes
FSCA 1	Largescale Sucker	>30cm	Fish Carcass	Single	53.7	No	Yes
FSCA 1	Mt Whitefish	>30cm	Fillet-skin on	Single	47.9	No	Yes
FSCA 1	Mt Whitefish	>30cm	Fish Offal	Single	71.6	No	Yes
FSCA 1	Walleye	>30cm	Fish Carcass	Multicoll	61.3	No	Yes
FSCA 2	Largescale Sucker	>30cm	Fish Carcass	Multicoll	84.3	No	Yes
FSCA 2	Mt Whitefish	>30cm	Fish Carcass	Single	59.6	No	Yes
FSCA 2	Smallmouth Bass	>30cm	Fish Offal	Single	76.4	No	Yes
FSCA 3	Largescale Sucker	>30cm	Fish Carcass	Multicoll	51.0	No	Yes
FSCA 4	Burbot	>30cm	Fish Carcass	Multicoll	55.0	No	Yes
FSCA 4	Largescale Sucker	>30cm	Fish Carcass	Single	55.3	No	Yes
FSCA 5	Burbot	>30cm	Fish Carcass	Multicoll	65.6	No	Yes
FSCA 5	Largescale Sucker	>30cm	Fish Carcass	Single	111.5	Yes	Yes
FSCA 5	Mt Whitefish	>30cm	Fish Carcass	Multicoll	60.8	No	Yes
FSCA 5	Smallmouth Bass	>30cm	Fish Carcass	Multicoll	58.3	No	Yes
FSCA 5	Walleye	>30cm	Fish Carcass	Multicoll	80.3	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Multicoll	65.5	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fish Carcass	Multicoll	119.8	Yes	Yes
FSCA 6	Walleye	>30cm	Fish Carcass	Multicoll	43.6	No	Yes

Table corrected 8/2010

Appendix A. Table 3h - Total PCBs Screening.

FSCA	Species	Size Class	Matrix Type	Sample Type	Mean (ppb)	Exceed General Public Screening Level	Exceed Subsistence Screening Level
FSCA 1	Burbot	>30cm	Fish Carcass	Single	72.0	Yes	Yes
FSCA 1	Kokanee	>30cm	Fish Carcass	Composite	12.6	No	Yes
FSCA 1	Largescale Sucker	>30cm	Fillet-skin on	Single	41.8	Yes	Yes
FSCA 1	Largescale Sucker	>30cm	Fish Carcass	Single	94.2	Yes	Yes
FSCA 1	Mt Whitefish	>15 to <=30cm	Whole Fish	Composite	10.6	No	Yes
FSCA 1	Mt Whitefish	>30cm	Fillet-skin on	Single	33.9	Yes	Yes
FSCA 1	Mt Whitefish	>30cm	Fish Carcass	Single	53.7	Yes	Yes
FSCA 1	Rainbow Trout	>30cm	Fillet-skin on	Composite	30.9	Yes	Yes
FSCA 1	Rainbow Trout	>30cm	Fish Carcass	Composite	59.1	Yes	Yes
FSCA 1	Sculpin	<=15cm	Whole Fish	Composite	15.8	No	Yes
FSCA 1	Walleye	>30cm	Fish Carcass	Composite	59.1	Yes	Yes
FSCA 2	Burbot	>30cm	Fish Carcass	Single	27.0	Yes	Yes
FSCA 2	Kokanee	>30cm	Fish Carcass	Composite	13.7	No	Yes
FSCA 2	Largescale Sucker	>30cm	Fillet-skin on	Composite	112.0	Yes	Yes
FSCA 2	Largescale Sucker	>30cm	Fish Carcass	Composite	219.9	Yes	Yes
FSCA 2	Longnose Sucker	>30cm	Fish Carcass	Single	24.4	Yes	Yes
FSCA 2	Mt Whitefish	>30cm	Fillet-skin on	Single	21.3	No	Yes
FSCA 2	Mt Whitefish	>30cm	Fish Carcass	Single	40.0	Yes	Yes
FSCA 2	Northern Pikeminnow	<=15cm	Whole Fish	Composite	11.2	No	Yes
FSCA 2	Rainbow Trout	>15 to <=30cm	Whole Fish	Composite	17.8	No	Yes
FSCA 2	Rainbow Trout	>30cm	Fillet-skin on	Composite	28.8	Yes	Yes
FSCA 2	Rainbow Trout	>30cm	Fish Carcass	Composite	65.3	Yes	Yes
FSCA 2	Sculpin	<=15cm	Whole Fish	Composite	10.5	No	Yes

FSCA 2	Smallmouth Bass	<=15cm	Whole Fish	Composite	10.0	No	Yes
FSCA 2	Smallmouth Bass	>30cm	Fillet-skin on	Single	29.1	Yes	Yes
FSCA 2	Smallmouth Bass	>30cm	Fish Carcass	Single	108.1	Yes	Yes
FSCA 2	Walleye	>30cm	Fish Carcass	Composite	58.4	Yes	Yes
FSCA 3	Burbot	>30cm	Fish Carcass	Composite	21.4	No	Yes
FSCA 3	Kokanee	>30cm	Fish Carcass	Composite	11.1	No	Yes
FSCA 3	Lake Whitefish	>30cm	Fillet-skin on	Composite	14.8	No	Yes
FSCA 3	Lake Whitefish	>30cm	Fish Carcass	Composite	25.7	Yes	Yes
FSCA 3	Largescale Sucker	>30cm	Fillet-skin on	Composite	19.1	No	Yes
FSCA 3	Largescale Sucker	>30cm	Fish Carcass	Composite	45.1	Yes	Yes
FSCA 3	Rainbow Trout	>30cm	Fish Carcass	Composite	24.5	Yes	Yes
FSCA 3	Smallmouth Bass	>15 to <=30cm	Fish Carcass	Single	10.9	No	Yes
FSCA 3	Smallmouth Bass	>30cm	Fish Carcass	Single	24.3	Yes	Yes
FSCA 3	Walleye	>30cm	Fish Carcass	Composite	35.3	Yes	Yes
FSCA 4	Burbot	>30cm	Fish Carcass	Composite	23.6	Yes	Yes
FSCA 4	Kokanee	>30cm	Fish Carcass	Composite	11.5	No	Yes
FSCA 4	Lake Whitefish	>30cm	Fillet-skin on	Composite	18.9	No	Yes
FSCA 4	Lake Whitefish	>30cm	Fish Carcass	Composite	31.7	Yes	Yes
FSCA 4	Largescale Sucker	>30cm	Fillet-skin on	Single	56.6	Yes	Yes
FSCA 4	Largescale Sucker	>30cm	Fish Carcass	Single	106.2	Yes	Yes
FSCA 4	Longnose Sucker	>30cm	Fillet-skin on	Composite	15.5	No	Yes
FSCA 4	Longnose Sucker	>30cm	Fish Carcass	Composite	32.8	Yes	Yes
FSCA 4	Rainbow Trout	>30cm	Fish Carcass	Composite	18.0	No	Yes
FSCA 4	Smallmouth Bass	>30cm	Fish Carcass	Single	20.6	No	Yes
FSCA 4	Walleye	<=15cm	Whole Fish	Composite	10.6	No	Yes
FSCA 4	Walleye	>15 to <=30cm	Whole Fish	Composite	45.4	Yes	Yes
FSCA 4	Walleye	>30cm	Fish Carcass	Composite	35.6	Yes	Yes

FSCA 5	Burbot	>30cm	Fish Carcass	Composite	27.2	Yes	Yes
FSCA 5	Kokanee	>30cm	Fish Carcass	Composite	12.0	No	Yes
FSCA 5	Lake Whitefish	>30cm	Fillet-skin on	Composite	28.7	Yes	Yes
FSCA 5	Lake Whitefish	>30cm	Fish Carcass	Composite	45.5	Yes	Yes
FSCA 5	Largescale Sucker	>30cm	Fillet-skin on	Single	66.5	Yes	Yes
FSCA 5	Largescale Sucker	>30cm	Fish Carcass	Single	161.2	Yes	Yes
FSCA 5	Rainbow Trout	>30cm	Fish Carcass	Composite	13.6	No	Yes
FSCA 5	Smallmouth Bass	>30cm	Fish Carcass	Composite	32.9	Yes	Yes
FSCA 5	Walleye	>15 to <=30cm	Whole Fish	Composite	13.3	No	Yes
FSCA 5	Walleye	>30cm	Fish Carcass	Composite	58.2	Yes	Yes
FSCA 6	Burbot	>30cm	Fish Carcass	Composite	23.1	No	Yes
FSCA 6	Kokanee	>15 to <=30cm	Whole Fish	Composite	9.9	No	Yes
FSCA 6	Kokanee	>30cm	Fish Carcass	Composite	11.3	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Composite	76.5	Yes	Yes
FSCA 6	Largescale Sucker	>30cm	Fish Carcass	Composite	135.1	Yes	Yes
FSCA 6	Rainbow Trout	>30cm	Fish Carcass	Composite	17.3	No	Yes
FSCA 6	Smallmouth Bass	>15 to <=30cm	Fish Carcass	Composite	26.4	Yes	Yes
FSCA 6	Smallmouth Bass	>30cm	Fish Carcass	Composite	27.5	Yes	Yes
FSCA 6	Walleye	<=15cm	Whole Fish	Composite	13.4	No	Yes
FSCA 6	Walleye	>15 to <=30cm	Whole Fish	Composite	18.0	No	Yes
FSCA 6	Walleye	>30cm	Fish Carcass	Composite	47.3	Yes	Yes

Appendix A. Table 3i - Dioxin TEQ Noncancer Screening.

FSCA	Species	Size Class	Matrix Type	Sample Type	Mean (ppb)	Exceed General Public Screening Level	Exceed Subsistence Screening Level
FSCA 1	Burbot	>30cm	Fish Carcass	Single	0.00149	Yes	Yes
FSCA 1	Kokanee	>30cm	Fish Carcass	Composite	0.00050	No	Yes
FSCA 1	Largescale Sucker	<=15cm	Whole Fish	Composite	0.00171	Yes	Yes
FSCA 1	Largescale Sucker	>30cm	Fillet-skin on	Single	0.00067	No	Yes
FSCA 1	Largescale Sucker	>30cm	Fish Carcass	Single	0.00156	Yes	Yes
FSCA 1	Longnose Sucker	<=15cm	Whole Fish	Composite	0.00159	Yes	Yes
FSCA 1	Longnose Sucker	>15 to <=30cm	Whole Fish	Composite	0.00229	Yes	Yes
FSCA 1	Mt Whitefish	>30cm	Fillet-skin on	Single	0.00156	Yes	Yes
FSCA 1	Mt Whitefish	>30cm	Fish Carcass	Single	0.00283	Yes	Yes
FSCA 1	Northern Pikeminnow	<=15cm	Whole Fish	Composite	0.00092	No	Yes
FSCA 1	Rainbow Trout	<=15cm	Whole Fish	Composite	0.00155	Yes	Yes
FSCA 1	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.00102	No	Yes
FSCA 1	Rainbow Trout	>30cm	Fish Carcass	Composite	0.00195	Yes	Yes
FSCA 1	Scuplin	<=15cm	Whole Fish	Composite	0.00076	No	Yes
FSCA 1	Smallmouth Bass	<=15cm	Whole Fish	Composite	0.00145	Yes	Yes
FSCA 1	Walleye	>30cm	Fish Carcass	Composite	0.00193	Yes	Yes
FSCA 2	Burbot	>30cm	Fillet-skin on	Single	0.00087	No	Yes
FSCA 2	Burbot	>30cm	Fish Carcass	Single	0.00119	Yes	Yes
FSCA 2	Kokanee	>30cm	Fish Carcass	Composite	0.00066	No	Yes
FSCA 2	Largescale Sucker	<=15cm	Whole Fish	Composite	0.00091	No	Yes
FSCA 2	Largescale Sucker	>15 to <=30cm	Whole Fish	Composite	0.00165	Yes	Yes
FSCA 2	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.00151	Yes	Yes
FSCA 2	Largescale Sucker	>30cm	Fish Carcass	Composite	0.00305	Yes	Yes
FSCA 2	Longnose Sucker	<=15cm	Whole Fish	Composite	0.00103	No	Yes
FSCA 2	Longnose Sucker	>15 to <=30cm	Whole Fish	Composite	0.00152	Yes	Yes

FSCA 2	Longnose Sucker	>30cm	Fillet-skin on	Single	0.00081	No	Yes
FSCA 2	Longnose Sucker	>30cm	Fish Carcass	Single	0.00097	No	Yes
FSCA 2	Mt Whitefish	>30cm	Fillet-skin on	Single	0.00138	Yes	Yes
FSCA 2	Mt Whitefish	>30cm	Fish Carcass	Single	0.00271	Yes	Yes
FSCA 2	Northern Pikeminnow	<=15cm	Whole Fish	Composite	0.00068	No	Yes
FSCA 2	Rainbow Trout	<=15cm	Whole Fish	Composite	0.00087	No	Yes
FSCA 2	Rainbow Trout	>15 to <=30cm	Whole Fish	Composite	0.00062	No	Yes
FSCA 2	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.00091	No	Yes
FSCA 2	Rainbow Trout	>30cm	Fish Carcass	Composite	0.00187	Yes	Yes
FSCA 2	Scuplin	<=15cm	Whole Fish	Composite	0.00083	No	Yes
FSCA 2	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.00065	No	Yes
FSCA 2	Smallmouth Bass	>30cm	Fish Carcass	Single	0.00226	Yes	Yes
FSCA 2	Walleye	>30cm	Fillet-skin on	Composite	0.00056	No	Yes
FSCA 2	Walleye	>30cm	Fish Carcass	Composite	0.00185	Yes	Yes
FSCA 2	Yellow Perch	<=15cm	Whole Fish	Composite	0.00233	Yes	Yes
FSCA 3	Burbot	>30cm	Fillet-skin on	Composite	0.00091	No	Yes
FSCA 3	Burbot	>30cm	Fish Carcass	Composite	0.00122	Yes	Yes
FSCA 3	Kokanee	>30cm	Fillet-skin on	Composite	0.00068	No	Yes
FSCA 3	Kokanee	>30cm	Fish Carcass	Composite	0.00079	No	Yes
FSCA 3	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.00105	No	Yes
FSCA 3	Lake Whitefish	>30cm	Fish Carcass	Composite	0.00184	Yes	Yes
FSCA 3	Largescale Sucker	<=15cm	Whole Fish	Composite	0.00089	No	Yes
FSCA 3	Largescale Sucker	>15 to <=30cm	Whole Fish	Composite	0.00148	Yes	Yes
FSCA 3	Largescale Sucker	>30cm	Fish Carcass	Composite	0.00108	No	Yes
FSCA 3	Longnose Sucker	<=15cm	Whole Fish	Composite	0.00081	No	Yes
FSCA 3	Longnose Sucker	>15 to <=30cm	Whole Fish	Composite	0.00153	Yes	Yes
FSCA 3	Northern Pikeminnow	<=15cm	Whole Fish	Composite	0.00054	No	Yes
FSCA 3	Rainbow Trout	<=15cm	Whole Fish	Composite	0.00082	No	Yes
FSCA 3	Rainbow Trout	>30cm	Fish Carcass	Composite	0.00094	No	Yes

FSCA 3	Scuplin	<=15cm	Whole Fish	Composite	0.00082	No	Yes
FSCA 3	Smallmouth Bass	<=15cm	Whole Fish	Composite	0.00076	No	Yes
FSCA 3	Smallmouth Bass	>15 to <=30cm	Fillet-skin on	Single	0.00089	No	Yes
FSCA 3	Smallmouth Bass	>15 to <=30cm	Fish Carcass	Single	0.00080	No	Yes
FSCA 3	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.00091	No	Yes
FSCA 3	Smallmouth Bass	>30cm	Fish Carcass	Single	0.00091	No	Yes
FSCA 3	Walleye	<=15cm	Whole Fish	Composite	0.00187	Yes	Yes
FSCA 3	Walleye	>30cm	Fish Carcass	Composite	0.00140	Yes	Yes
FSCA 3	Yellow Perch	<=15cm	Whole Fish	Composite	0.00205	Yes	Yes
FSCA 4	Burbot	>30cm	Fish Carcass	Composite	0.00145	Yes	Yes
FSCA 4	Kokanee	>30cm	Fillet-skin on	Composite	0.00054	No	Yes
FSCA 4	Kokanee	>30cm	Fish Carcass	Composite	0.00074	No	Yes
FSCA 4	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.00118	Yes	Yes
FSCA 4	Lake Whitefish	>30cm	Fish Carcass	Composite	0.00208	Yes	Yes
FSCA 4	Largescale Sucker	>15 to <=30cm	Whole Fish	Composite	0.00147	Yes	Yes
FSCA 4	Largescale Sucker	>30cm	Fillet-skin on	Single	0.00143	Yes	Yes
FSCA 4	Largescale Sucker	>30cm	Fish Carcass	Single	0.00222	Yes	Yes
FSCA 4	Longnose Sucker	<=15cm	Whole Fish	Composite	0.00112	No	Yes
FSCA 4	Longnose Sucker	>30cm	Fillet-skin on	Composite	0.00114	No	Yes
FSCA 4	Longnose Sucker	>30cm	Fish Carcass	Composite	0.00184	Yes	Yes
FSCA 4	Rainbow Trout	>30cm	Fish Carcass	Composite	0.00085	No	Yes
FSCA 4	Smallmouth Bass	<=15cm	Whole Fish	Composite	0.00075	No	Yes
FSCA 4	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.00134	Yes	Yes
FSCA 4	Smallmouth Bass	>30cm	Fish Carcass	Single	0.00153	Yes	Yes
FSCA 4	Walleye	<=15cm	Whole Fish	Composite	0.00113	No	Yes
FSCA 4	Walleye	>15 to <=30cm	Whole Fish	Composite	0.00131	Yes	Yes
FSCA 4	Walleye	>30cm	Fish Carcass	Composite	0.00134	Yes	Yes
FSCA 4	Yellow Perch	<=15cm	Whole Fish	Composite	0.00204	Yes	Yes

FSCA 5	Burbot	>30cm	Fish Carcass	Composite	0.00141	Yes	Yes
FSCA 5	Kokanee	>30cm	Fillet-skin on	Composite	0.00053	No	Yes
FSCA 5	Kokanee	>30cm	Fish Carcass	Composite	0.00069	No	Yes
FSCA 5	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.00163	Yes	Yes
FSCA 5	Lake Whitefish	>30cm	Fish Carcass	Composite	0.00245	Yes	Yes
FSCA 5	Largescale Sucker	>30cm	Fillet-skin on	Single	0.00165	Yes	Yes
FSCA 5	Largescale Sucker	>30cm	Fish Carcass	Single	0.00671	Yes	Yes
FSCA 5	Longnose Sucker	>15 to <=30cm	Whole Fish	Composite	0.00148	Yes	Yes
FSCA 5	Scuplin	<=15cm	Whole Fish	Composite	0.00062	No	Yes
FSCA 5	Smallmouth Bass	<=15cm	Whole Fish	Composite	0.00077	No	Yes
FSCA 5	Smallmouth Bass	>30cm	Fish Carcass	Composite	0.00126	Yes	Yes
FSCA 5	Walleye	<=15cm	Whole Fish	Composite	0.00070	No	Yes
FSCA 5	Walleye	>30cm	Fish Carcass	Composite	0.00177	Yes	Yes
FSCA 5	Yellow Perch	<=15cm	Whole Fish	Composite	0.00182	Yes	Yes
FSCA 6	Burbot	>30cm	Fillet-skin on	Composite	0.00053	No	Yes
FSCA 6	Burbot	>30cm	Fish Carcass	Composite	0.00161	Yes	Yes
FSCA 6	Kokanee	>30cm	Fillet-skin on	Composite	0.00058	No	Yes
FSCA 6	Kokanee	>30cm	Fish Carcass	Composite	0.00071	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.00180	Yes	Yes
FSCA 6	Largescale Sucker	>30cm	Fish Carcass	Composite	0.00328	Yes	Yes
FSCA 6	Rainbow Trout	>30cm	Fish Carcass	Composite	0.00065	No	Yes
FSCA 6	Smallmouth Bass	<=15cm	Whole Fish	Composite	0.00075	No	Yes
FSCA 6	Smallmouth Bass	>15 to <=30cm	Fish Carcass	Composite	0.00142	Yes	Yes
FSCA 6	Smallmouth Bass	>30cm	Fish Carcass	Composite	0.00121	Yes	Yes
FSCA 6	Walleye	<=15cm	Whole Fish	Composite	0.00172	Yes	Yes
FSCA 6	Walleye	>15 to <=30cm	Whole Fish	Composite	0.00071	No	Yes
FSCA 6	Walleye	>30cm	Fish Carcass	Composite	0.00196	Yes	Yes
FSCA 6	Yellow Perch	<=15cm	Whole Fish	Composite	0.00271	Yes	Yes

**Non-detect congeners have been evaluated at 1/2 the detection limit.

Appendix A. Table 4a - Mercury Screening in Fillet Tissues.							
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppm)**	**Exceed General Public Screening Level**	**Exceed Subsistence Screening Level**
FSCA 1	Burbot	>30cm	Fillet-skin on	Single	0.276	Yes	Yes
FSCA 1	Kokanee	>30cm	Fillet-skin on	Composite	0.068	No	Yes
FSCA 1	Largescale Sucker	>30cm	Fillet-skin on	Single	0.219	Yes	Yes
FSCA 1	Mt Whitefish	>30cm	Fillet-skin on	Single	0.075	No	Yes
FSCA 1	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.076	No	Yes
FSCA 1	Walleye	>30cm	Fillet-skin on	Composite	0.190	Yes	Yes
FSCA 1	Walleye	>30cm	Fillet-skin on	Single	0.163	Yes	Yes
FSCA 2	Burbot	>30cm	Fillet-skin on	Single	0.183	Yes	Yes
FSCA 2	Kokanee	>30cm	Fillet-skin on	Composite	0.064	No	Yes
FSCA 2	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.217	Yes	Yes
FSCA 2	Longnose Sucker	>30cm	Fillet-skin on	Single	0.070	No	Yes
FSCA 2	Mt Whitefish	>30cm	Fillet-skin on	Single	0.088	No	Yes
FSCA 2	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.080	No	Yes
FSCA 2	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.157	Yes	Yes
FSCA 2	Walleye	>30cm	Fillet-skin on	Composite	0.167	Yes	Yes
FSCA 2	Walleye	>30cm	Fillet-skin on	Single	0.165	Yes	Yes
FSCA 3	Burbot	>30cm	Fillet-skin on	Composite	0.228	Yes	Yes
FSCA 3	Kokanee	>30cm	Fillet-skin on	Composite	0.059	No	Yes
FSCA 3	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.081	No	Yes
FSCA 3	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.222	Yes	Yes
FSCA 3	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.077	No	Yes
FSCA 3	Smallmouth Bass	>15 to <=30cm	Fillet-skin on	Single	0.165	Yes	Yes
FSCA 3	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.217	Yes	Yes
FSCA 3	Walleye	>30cm	Fillet-skin on	Composite	0.170	Yes	Yes
FSCA 3	Walleye	>30cm	Fillet-skin on	Single	0.172	Yes	Yes
FSCA 4	Burbot	>30cm	Fillet-skin on	Composite	0.241	Yes	Yes
FSCA 4	Kokanee	>30cm	Fillet-skin on	Composite	0.065	No	Yes
FSCA 4	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.089	No	Yes
FSCA 4	Largescale Sucker	>30cm	Fillet-skin on	Single	0.371	Yes	Yes
FSCA 4	Longnose Sucker	>30cm	Fillet-skin on	Composite	0.188	Yes	Yes
FSCA 4	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.084	No	Yes
FSCA 4	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.127	Yes	Yes
FSCA 4	Walleye	>30cm	Fillet-skin on	Composite	0.138	Yes	Yes
FSCA 4	Walleye	>30cm	Fillet-skin on	Single	0.122	Yes	Yes
FSCA 5	Burbot	>30cm	Fillet-skin on	Composite	0.236	Yes	Yes

FSCA 5	Kokanee	>30cm	Fillet-skin on	Composite	0.063	No	Yes
FSCA 5	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.110	Yes	Yes
FSCA 5	Largescale Sucker	>30cm	Fillet-skin on	Single	0.462	Yes	Yes
FSCA 5	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.065	No	Yes
FSCA 5	Smallmouth Bass	>30cm	Fillet-skin on	Composite	0.142	Yes	Yes
FSCA 5	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.147	Yes	Yes
FSCA 5	Walleye	>30cm	Fillet-skin on	Composite	0.184	Yes	Yes
FSCA 5	Walleye	>30cm	Fillet-skin on	Single	0.170	Yes	Yes
FSCA 6	Burbot	>30cm	Fillet-skin on	Composite	0.241	Yes	Yes
FSCA 6	Kokanee	>30cm	Fillet-skin on	Composite	0.061	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.257	Yes	Yes
FSCA 6	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.075	No	Yes
FSCA 6	Smallmouth Bass	>15 to <=30cm	Fillet-skin on	Composite	0.176	Yes	Yes
FSCA 6	Smallmouth Bass	>30cm	Fillet-skin on	Composite	0.175	Yes	Yes
FSCA 6	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.158	Yes	Yes
FSCA 6	Walleye	>30cm	Fillet-skin on	Composite	0.201	Yes	Yes
FSCA 6	Walleye	>30cm	Fillet-skin on	Single	0.197	Yes	Yes

Appendix A. Table 4b - PBDE 47 Screening in Fillet Tissues.

FSCA	Species	Size Class	Matrix Type	Sample Type	Mean (ppb)	Exceed General Public Screening Level	Exceed Subsistence Screening Level
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Multicoll	53.7	No	Yes

Appendix A. Table 4c - Total PBDE Screening in Fillet Tissues.

FSCA	Common Name	Size Class	Matrix Type	Sample Type	Mean (ppb)	Exceed General Public Screening Level	Exceed Subsistence Screening Level
FSCA 1	Mt Whitefish	>30cm	Fillet-skin on	Single	47.9	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Multicoll	65.5	No	Yes

Appendix A. Table 4d - Total PCBs Screening in Fillet Tissues.

FSCA	Species	Size Class	Matrix Type	Sample Type	Mean (ppb)	Exceed General Public Screening Level	Exceed Subsistence Screening Level
FSCA 1	Largescale Sucker	>30cm	Fillet-skin on	Single	41.8	Yes	Yes
FSCA 1	Mt Whitefish	>30cm	Fillet-skin on	Single	33.9	Yes	Yes
FSCA 1	Rainbow Trout	>30cm	Fillet-skin on	Composite	30.9	Yes	Yes
FSCA 2	Largescale Sucker	>30cm	Fillet-skin on	Composite	112.0	Yes	Yes
FSCA 2	Mt Whitefish	>30cm	Fillet-skin on	Single	21.3	No	Yes
FSCA 2	Rainbow Trout	>30cm	Fillet-skin on	Composite	28.8	Yes	Yes
FSCA 2	Smallmouth Bass	>30cm	Fillet-skin on	Single	29.1	Yes	Yes
FSCA 3	Lake Whitefish	>30cm	Fillet-skin on	Composite	14.8	No	Yes
FSCA 3	Largescale Sucker	>30cm	Fillet-skin on	Composite	19.1	No	Yes
FSCA 4	Lake Whitefish	>30cm	Fillet-skin on	Composite	18.9	No	Yes
FSCA 4	Largescale Sucker	>30cm	Fillet-skin on	Single	56.6	Yes	Yes
FSCA 4	Longnose Sucker	>30cm	Fillet-skin on	Composite	15.5	No	Yes
FSCA 5	Lake Whitefish	>30cm	Fillet-skin on	Composite	28.7	Yes	Yes
FSCA 5	Largescale Sucker	>30cm	Fillet-skin on	Single	66.5	Yes	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Composite	76.5	Yes	Yes

Appendix A. Table 4e - Dioxin TEQs Screening in Fillet Tissues.							
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppb)**	**Exceed General Public Screening Level**	**Exceed Subsistence Screening Level**
FSCA 1	Largescale Sucker	>30cm	Fillet-skin on	Single	0.00067	No	Yes
FSCA 1	Mt Whitefish	>30cm	Fillet-skin on	Single	0.00156	Yes	Yes
FSCA 1	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.00102	No	Yes
FSCA 2	Burbot	>30cm	Fillet-skin on	Single	0.00087	No	Yes
FSCA 2	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.00151	Yes	Yes
FSCA 2	Longnose Sucker	>30cm	Fillet-skin on	Single	0.00081	No	Yes
FSCA 2	Mt Whitefish	>30cm	Fillet-skin on	Single	0.00138	Yes	Yes
FSCA 2	Rainbow Trout	>30cm	Fillet-skin on	Composite	0.00091	No	Yes
FSCA 2	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.00065	No	Yes
FSCA 2	Walleye	>30cm	Fillet-skin on	Composite	0.00056	No	Yes
FSCA 3	Burbot	>30cm	Fillet-skin on	Composite	0.00091	No	Yes
FSCA 3	Kokanee	>30cm	Fillet-skin on	Composite	0.00068	No	Yes
FSCA 3	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.00105	No	Yes
FSCA 3	Smallmouth Bass	>15 to <=30cm	Fillet-skin on	Single	0.00089	No	Yes
FSCA 3	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.00091	No	Yes
FSCA 4	Kokanee	>30cm	Fillet-skin on	Composite	0.00054	No	Yes
FSCA 4	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.00118	Yes	Yes
FSCA 4	Largescale Sucker	>30cm	Fillet-skin on	Single	0.00143	Yes	Yes
FSCA 4	Longnose Sucker	>30cm	Fillet-skin on	Composite	0.00114	No	Yes
FSCA 4	Smallmouth Bass	>30cm	Fillet-skin on	Single	0.00134	Yes	Yes
FSCA 5	Kokanee	>30cm	Fillet-skin on	Composite	0.00053	No	Yes
FSCA 5	Lake Whitefish	>30cm	Fillet-skin on	Composite	0.00163	Yes	Yes
FSCA 5	Largescale Sucker	>30cm	Fillet-skin on	Single	0.00165	Yes	Yes
FSCA 6	Burbot	>30cm	Fillet-skin on	Composite	0.00053	No	Yes
FSCA 6	Kokanee	>30cm	Fillet-skin on	Composite	0.00058	No	Yes
FSCA 6	Largescale Sucker	>30cm	Fillet-skin on	Composite	0.00180	Yes	Yes

APPENDIX B

Appendix B. Table 1 - Mercury Data Summary for Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 1	Burbot	>30cm	Single	1	100%	0.276	0.276	0.276	NA
FSCA 1	Kokanee	>30cm	Composite	6	100%	0.054	0.075	0.068	0.008
FSCA 1	Largescale Sucker	>30cm	Single	3	100%	0.124	0.272	0.219	0.082
FSCA 1	Mt Whitefish	>30cm	Single	3	100%	0.074	0.077	0.075	0.002
FSCA 1	Rainbow Trout	>30cm	Composite	6	100%	0.039	0.103	0.076	0.023
FSCA 1	Walleye	>30cm	Composite	5	100%	0.129	0.289	0.190	0.069
FSCA 1	Walleye	>30cm	Single	24	100%	0.065	0.327	0.163	0.075
FSCA 2	Burbot	>30cm	Single	3	100%	0.135	0.234	0.183	0.050
FSCA 2	Kokanee	>30cm	Composite	6	100%	0.060	0.069	0.064	0.004
FSCA 2	Largescale Sucker	>30cm	Composite	5	100%	0.070	0.323	0.217	0.110
FSCA 2	Longnose Sucker	>30cm	Single	6	100%	0.023	0.203	0.070	0.068
FSCA 2	Mt Whitefish	>30cm	Single	4	100%	0.050	0.141	0.088	0.041
FSCA 2	Rainbow Trout	>30cm	Composite	6	100%	0.051	0.114	0.080	0.027
FSCA 2	Smallmouth Bass	>30cm	Single	2	100%	0.134	0.181	0.157	0.033
FSCA 2	Walleye	>30cm	Composite	6	100%	0.091	0.215	0.167	0.041
FSCA 2	Walleye	>30cm	Single	42	100%	0.086	0.301	0.165	0.055
FSCA 3	Burbot	>30cm	Composite	5	100%	0.201	0.266	0.228	0.024
FSCA 3	Kokanee	>30cm	Composite	6	100%	0.049	0.065	0.059	0.006
FSCA 3	Lake Whitefish	>30cm	Composite	6	100%	0.053	0.113	0.081	0.022
FSCA 3	Largescale Sucker	>30cm	Composite	5	100%	0.113	0.314	0.222	0.083
FSCA 3	Rainbow Trout	>30cm	Composite	6	100%	0.034	0.119	0.077	0.033
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	100%	0.165	0.165	0.165	NA
FSCA 3	Smallmouth Bass	>30cm	Single	8	100%	0.104	0.410	0.217	0.098
FSCA 3	Walleye	>30cm	Composite	6	100%	0.134	0.212	0.170	0.030

FSCA 3	Walleye	>30cm	Single	45	100%	0.056	0.487	0.172	0.089
FSCA 4	Burbot	>30cm	Composite	6	100%	0.165	0.287	0.241	0.042
FSCA 4	Kokanee	>30cm	Composite	6	100%	0.060	0.072	0.065	0.005
FSCA 4	Lake Whitefish	>30cm	Composite	6	100%	0.074	0.114	0.089	0.017
FSCA 4	Largescale Sucker	>30cm	Single	9	100%	0.073	0.584	0.371	0.193
FSCA 4	Longnose Sucker	>30cm	Composite	5	100%	0.084	0.255	0.188	0.065
FSCA 4	Rainbow Trout	>30cm	Composite	6	100%	0.054	0.117	0.084	0.026
FSCA 4	Smallmouth Bass	>30cm	Single	4	100%	0.076	0.180	0.127	0.046
FSCA 4	Walleye	>30cm	Composite	6	100%	0.119	0.166	0.138	0.021
FSCA 4	Walleye	>30cm	Single	37	100%	0.051	0.279	0.122	0.043
FSCA 5	Burbot	>30cm	Composite	6	100%	0.195	0.268	0.236	0.025
FSCA 5	Kokanee	>30cm	Composite	6	100%	0.058	0.069	0.063	0.005
FSCA 5	Lake Whitefish	>30cm	Composite	4	100%	0.090	0.139	0.110	0.021
FSCA 5	Largescale Sucker	>30cm	Single	4	100%	0.335	0.578	0.462	0.100
FSCA 5	Rainbow Trout	>30cm	Composite	6	100%	0.050	0.073	0.065	0.009
FSCA 5	Smallmouth Bass	>30cm	Composite	3	100%	0.128	0.168	0.142	0.023
FSCA 5	Smallmouth Bass	>30cm	Single	13	100%	0.094	0.233	0.147	0.046
FSCA 5	Walleye	>30cm	Composite	6	100%	0.133	0.249	0.184	0.047
FSCA 5	Walleye	>30cm	Single	32	100%	0.030	0.360	0.170	0.079
FSCA 6	Burbot	>30cm	Composite	5	100%	0.192	0.292	0.241	0.037
FSCA 6	Kokanee	>30cm	Composite	5	100%	0.053	0.068	0.061	0.006
FSCA 6	Largescale Sucker	>30cm	Composite	6	100%	0.196	0.386	0.257	0.072
FSCA 6	Rainbow Trout	>30cm	Composite	6	100%	0.053	0.133	0.075	0.029
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	100%	0.176	0.176	0.176	NA
FSCA 6	Smallmouth Bass	>30cm	Composite	8	100%	0.136	0.227	0.175	0.030
FSCA 6	Smallmouth Bass	>30cm	Single	50	100%	0.069	0.340	0.158	0.058
FSCA 6	Walleye	>30cm	Composite	6	100%	0.180	0.214	0.201	0.012
FSCA 6	Walleye	>30cm	Single	34	100%	0.099	0.355	0.197	0.058

Non-detect results have been evaluated at 1/2 the detection limit.

Appendix B. Table 2 - PBDE 47 Data Summary for Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Burbot	>30cm	Single	1	100%	1.4	1.4	1.4
FSCA 1	Kokanee	>30cm	Multicoll	2	100%	1.7	2.3	2.0
FSCA 1	Largescale Sucker	>30cm	Single	1	100%	12.6	12.6	12.6
FSCA 1	Mt Whitefish	>30cm	Single	1	100%	19.0	19.0	19.0
FSCA 1	Rainbow Trout	>30cm	Multicoll	2	100%	9.6	12.8	11.2
FSCA 1	Walleye	>30cm	Multicoll	2	100%	3.6	3.8	3.7
FSCA 2	Burbot	>30cm	Single	1	100%	0.5	0.5	0.5
FSCA 2	Kokanee	>30cm	Multicoll	2	100%	2.7	2.9	2.8
FSCA 2	Largescale Sucker	>30cm	Multicoll	2	100%	11.3	41.6	26.5
FSCA 2	Longnose Sucker	>30cm	Single	2	100%	1.1	8.0	4.5
FSCA 2	Mt Whitefish	>30cm	Single	2	100%	13.7	21.7	17.7
FSCA 2	Rainbow Trout	>30cm	Multicoll	2	100%	3.2	10.5	6.8
FSCA 2	Smallmouth Bass	>30cm	Single	1	100%	13.4	13.4	13.4
FSCA 2	Walleye	>30cm	Multicoll	2	100%	2.7	3.9	3.3
FSCA 3	Burbot	>30cm	Multicoll	2	100%	0.4	0.5	0.4
FSCA 3	Kokanee	>30cm	Multicoll	2	100%	1.5	2.1	1.8
FSCA 3	Lake Whitefish	>30cm	Multicoll	2	100%	5.0	5.4	5.2
FSCA 3	Largescale Sucker	>30cm	Multicoll	2	100%	15.2	17.3	16.3
FSCA 3	Rainbow Trout	>30cm	Multicoll	2	100%	2.6	4.3	3.5
FSCA 3	Smallmouth Bass	>30cm	Single	3	100%	2.5	2.6	2.6
FSCA 3	Walleye	>30cm	Multicoll	2	100%	2.6	2.7	2.6
FSCA 4	Burbot	>30cm	Multicoll	2	100%	1.7	2.5	2.1

FSCA 4	Kokanee	>30cm	Multicoll	2	100%	2.2	2.5	2.4
FSCA 4	Lake Whitefish	>30cm	Multicoll	2	100%	6.2	9.1	7.6
FSCA 4	Largescale Sucker	>30cm	Single	3	100%	3.0	35.5	21.2
FSCA 4	Longnose Sucker	>30cm	Multicoll	2	100%	7.3	14.2	10.7
FSCA 4	Rainbow Trout	>30cm	Multicoll	2	100%	2.5	6.2	4.3
FSCA 4	Smallmouth Bass	>30cm	Single	1	100%	1.4	1.4	1.4
FSCA 4	Walleye	>30cm	Multicoll	2	100%	1.4	1.5	1.4
FSCA 5	Burbot	>30cm	Multicoll	2	100%	1.3	1.7	1.5
FSCA 5	Kokanee	>30cm	Multicoll	2	100%	2.8	3.3	3.1
FSCA 5	Lake Whitefish	>30cm	Multicoll	2	100%	17.7	24.3	21.0
FSCA 5	Largescale Sucker	>30cm	Single	2	100%	19.9	39.3	29.6
FSCA 5	Rainbow Trout	>30cm	Multicoll	2	100%	2.4	9.4	5.9
FSCA 5	Smallmouth Bass	>30cm	Multicoll	1	100%	5.0	5.0	5.0
FSCA 5	Walleye	>30cm	Multicoll	2	100%	4.4	4.7	4.6
FSCA 6	Burbot	>30cm	Multicoll	2	100%	0.9	1.2	1.1
FSCA 6	Kokanee	>30cm	Multicoll	2	100%	2.2	2.7	2.4
FSCA 6	Largescale Sucker	>30cm	Multicoll	2	100%	43.2	64.1	53.7
FSCA 6	Rainbow Trout	>30cm	Multicoll	2	100%	2.7	3.5	3.1
FSCA 6	Smallmouth Bass	>15 to <=30cm	Multicoll	1	100%	1.9	1.9	1.9
FSCA 6	Smallmouth Bass	>30cm	Multicoll	2	100%	3.1	4.3	3.7
FSCA 6	Walleye	>30cm	Multicoll	2	100%	2.4	2.6	2.5

Appendix B. Table 3 - Total PBDEs Data Summary for Fillet Samples.								
FSCA	**Common Name**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Burbot	>30cm	Single	1	100%	2.7	2.7	2.7
FSCA 1	Kokanee	>30cm	Multicoll	2	100%	4.4	5.2	4.8
FSCA 1	Largescale Sucker	>30cm	Single	1	100%	19.5	19.5	19.5
FSCA 1	Mt Whitefish	>30cm	Single	1	100%	47.9	47.9	47.9
FSCA 1	Rainbow Trout	>30cm	Multicoll	2	100%	20.9	23.3	22.1
FSCA 1	Walleye	>30cm	Multicoll	2	100%	5.8	7.4	6.6
FSCA 2	Burbot	>30cm	Single	1	100%	0.9	0.9	0.9
FSCA 2	Kokanee	>30cm	Multicoll	2	100%	5.9	6.7	6.3
FSCA 2	Largescale Sucker	>30cm	Multicoll	2	100%	14.4	52.1	33.2
FSCA 2	Longnose Sucker	>30cm	Single	2	100%	1.8	10.2	6.0
FSCA 2	Mt Whitefish	>30cm	Single	2	100%	28.2	40.7	34.5
FSCA 2	Rainbow Trout	>30cm	Multicoll	2	100%	7.1	24.5	15.8
FSCA 2	Smallmouth Bass	>30cm	Single	1	100%	19.5	19.5	19.5
FSCA 2	Walleye	>30cm	Multicoll	2	100%	6.0	6.4	6.2
FSCA 3	Burbot	>30cm	Multicoll	2	100%	0.8	1.0	0.9
FSCA 3	Kokanee	>30cm	Multicoll	2	100%	3.3	4.6	4.0
FSCA 3	Largescale Sucker	>30cm	Multicoll	2	100%	20.5	22.1	21.3
FSCA 3	Mt Whitefish	>30cm	Multicoll	2	100%	10.3	12.1	11.2
FSCA 3	Rainbow Trout	>30cm	Multicoll	2	100%	5.8	8.5	7.1
FSCA 3	Smallmouth Bass	>30cm	Single	3	100%	3.4	3.7	3.6
FSCA 3	Walleye	>30cm	Multicoll	2	100%	3.9	3.9	3.9
FSCA 4	Burbot	>30cm	Multicoll	2	100%	3.4	5.3	4.3

FSCA 4	Kokanee	>30cm	Multicoll	2	100%	4.7	5.6	5.2
FSCA 4	Largescale Sucker	>30cm	Single	3	100%	4.0	44.8	26.8
FSCA 4	Longnose Sucker	>30cm	Multicoll	2	100%	9.7	18.1	13.9
FSCA 4	Mt Whitefish	>30cm	Multicoll	2	100%	13.0	17.5	15.3
FSCA 4	Rainbow Trout	>30cm	Multicoll	2	100%	6.1	13.9	10.0
FSCA 4	Smallmouth Bass	>30cm	Single	1	100%	2.1	2.1	2.1
FSCA 4	Walleye	>30cm	Multicoll	2	100%	2.3	2.5	2.4
FSCA 5	Burbot	>30cm	Multicoll	2	100%	2.9	3.3	3.1
FSCA 5	Kokanee	>30cm	Multicoll	2	100%	6.3	7.3	6.8
FSCA 5	Largescale Sucker	>30cm	Single	2	100%	25.4	48.6	37.0
FSCA 5	Mt Whitefish	>30cm	Multicoll	2	100%	33.5	43.3	38.4
FSCA 5	Rainbow Trout	>30cm	Multicoll	2	100%	5.6	18.4	12.0
FSCA 5	Smallmouth Bass	>30cm	Multicoll	1	100%	7.4	7.4	7.4
FSCA 5	Walleye	>30cm	Multicoll	2	100%	6.9	7.6	7.3
FSCA 6	Burbot	>30cm	Multicoll	2	100%	1.9	3.0	2.4
FSCA 6	Kokanee	>30cm	Multicoll	2	100%	4.9	5.8	5.4
FSCA 6	Largescale Sucker	>30cm	Multicoll	2	100%	53.7	77.2	65.5
FSCA 6	Rainbow Trout	>30cm	Multicoll	2	100%	5.6	7.0	6.3
FSCA 6	Smallmouth Bass	>15 to <=30cm	Multicoll	1	100%	3.2	3.2	3.2
FSCA 6	Smallmouth Bass	>30cm	Multicoll	2	100%	5.9	7.9	6.9
FSCA 6	Walleye	>30cm	Multicoll	2	100%	3.7	4.0	3.9

Appendix B. Table 4 - Total PCBs Data Summary for Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Minimum Value (ppb)	Maximum Value (ppb)	Mean (ppb)	Standard Deviation
FSCA 1	Burbot	>30cm	Single	1	2.6	2.6	2.6	NA
FSCA 1	Kokanee	>30cm	Composite	6	6.6	12.5	8.5	2.3
FSCA 1	Largescale Sucker	>30cm	Single	3	26.7	62.0	41.8	18.2
FSCA 1	Mt Whitefish	>30cm	Single	3	18.5	58.3	33.9	21.4
FSCA 1	Rainbow Trout	>30cm	Composite	6	23.7	54.4	30.9	11.8
FSCA 1	Walleye	>30cm	Composite	5	5.8	8.4	6.9	1.1
FSCA 2	Burbot	>30cm	Single	3	1.4	1.8	1.6	0.2
FSCA 2	Kokanee	>30cm	Composite	6	8.0	9.9	8.7	0.7
FSCA 2	Largescale Sucker	>30cm	Composite	5	27.1	230.5	112.0	105.3
FSCA 2	Longnose Sucker	>30cm	Single	6	2.8	14.4	8.8	4.8
FSCA 2	Mt Whitefish	>30cm	Single	4	10.2	32.5	21.3	9.7
FSCA 2	Rainbow Trout	>30cm	Composite	6	10.7	38.3	28.8	9.9
FSCA 2	Smallmouth Bass	>30cm	Single	1	29.1	29.1	29.1	NA
FSCA 2	Walleye	>30cm	Composite	6	5.5	12.3	7.8	2.5
FSCA 3	Burbot	>30cm	Composite	5	1.3	2.0	1.5	0.3
FSCA 3	Kokanee	>30cm	Composite	6	7.7	11.3	8.9	1.4
FSCA 3	Lake Whitefish	>30cm	Composite	6	11.6	18.0	14.8	2.5
FSCA 3	Largescale Sucker	>30cm	Composite	5	10.4	41.8	19.1	13.0
FSCA 3	Rainbow Trout	>30cm	Composite	6	6.4	14.3	9.7	2.7
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	2.9	2.9	2.9	NA
FSCA 3	Smallmouth Bass	>30cm	Single	8	2.1	11.7	5.1	3.0
FSCA 3	Walleye	>30cm	Composite	6	3.3	5.8	4.3	0.9

FSCA 4	Burbot	>30cm	Composite	6	1.5	2.9	2.2	0.6
FSCA 4	Kokanee	>30cm	Composite	6	6.0	8.3	7.2	0.9
FSCA 4	Lake Whitefish	>30cm	Composite	6	15.4	25.6	18.9	3.9
FSCA 4	Largescale Sucker	>30cm	Single	9	6.7	104.8	56.6	34.6
FSCA 4	Longnose Sucker	>30cm	Composite	5	8.3	19.3	15.5	5.0
FSCA 4	Rainbow Trout	>30cm	Composite	6	4.6	13.7	8.7	3.8
FSCA 4	Smallmouth Bass	>30cm	Single	2	3.6	3.6	3.6	0.0
FSCA 4	Walleye	>30cm	Composite	6	3.1	8.7	4.4	2.2
FSCA 5	Burbot	>30cm	Composite	6	2.1	3.6	2.9	0.6
FSCA 5	Kokanee	>30cm	Composite	6	6.4	9.4	7.7	1.2
FSCA 5	Lake Whitefish	>30cm	Composite	4	17.4	39.3	28.7	9.0
FSCA 5	Largescale Sucker	>30cm	Single	4	33.3	88.0	66.5	23.5
FSCA 5	Rainbow Trout	>30cm	Composite	6	5.2	14.4	7.1	3.6
FSCA 5	Smallmouth Bass	>30cm	Composite	3	5.3	7.2	6.4	1.0
FSCA 5	Walleye	>30cm	Composite	6	4.0	11.0	7.6	2.3
FSCA 6	Burbot	>30cm	Composite	5	2.1	2.7	2.4	0.3
FSCA 6	Kokanee	>30cm	Composite	5	4.8	6.6	5.5	0.7
FSCA 6	Largescale Sucker	>30cm	Composite	6	65.6	95.5	76.5	12.0
FSCA 6	Rainbow Trout	>30cm	Composite	6	6.2	11.6	8.0	2.0
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	6.1	6.1	6.1	NA
FSCA 6	Smallmouth Bass	>30cm	Composite	8	4.6	9.7	6.0	1.7
FSCA 6	Walleye	>30cm	Composite	6	4.7	7.9	6.2	1.5

Non-detect congeners have been evaluated at 1/2 the detection limit.

FSCA	Species	Size Class	Sample Type	Number of Samples	Minimum Value (ppb)	Maximum Value (ppb)	Mean (ppb)	Standard Deviation
FSCA 1	Burbot	>30cm	Single	1	0.00013	0.00013	0.00013	NA
FSCA 1	Kokanee	>30cm	Composite	6	0.00036	0.00041	0.00038	0.00002
FSCA 1	Largescale Sucker	>30cm	Single	3	0.00056	0.00087	0.00067	0.00018
FSCA 1	Mt Whitefish	>30cm	Single	3	0.00106	0.00230	0.00156	0.00065
FSCA 1	Rainbow Trout	>30cm	Composite	6	0.00073	0.00186	0.00102	0.00042
FSCA 1	Walleye	>30cm	Composite	5	0.00042	0.00052	0.00049	0.00004
FSCA 2	Burbot	>30cm	Single	3	0.00085	0.00089	0.00087	0.00002
FSCA 2	Kokanee	>30cm	Composite	6	0.00037	0.00057	0.00044	0.00010
FSCA 2	Largescale Sucker	>30cm	Composite	5	0.00054	0.00273	0.00151	0.00102
FSCA 2	Longnose Sucker	>30cm	Single	6	0.00043	0.00094	0.00081	0.00021
FSCA 2	Mt Whitefish	>30cm	Single	4	0.00083	0.00191	0.00138	0.00048
FSCA 2	Rainbow Trout	>30cm	Composite	6	0.00042	0.00114	0.00091	0.00029
FSCA 2	Smallmouth Bass	>30cm	Single	1	0.00065	0.00065	0.00065	NA
FSCA 2	Walleye	>30cm	Composite	6	0.00050	0.00063	0.00056	0.00004
FSCA 3	Burbot	>30cm	Composite	5	0.00087	0.00107	0.00091	0.00009
FSCA 3	Kokanee	>30cm	Composite	6	0.00062	0.00074	0.00068	0.00005
FSCA 3	Lake Whitefish	>30cm	Composite	6	0.00088	0.00133	0.00105	0.00017
FSCA 3	Largescale Sucker	>30cm	Composite	5	0.00034	0.00081	0.00048	0.00019
FSCA 3	Rainbow Trout	>30cm	Composite	6	0.00032	0.00058	0.00041	0.00009
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	0.00089	0.00089	0.00089	NA
FSCA 3	Smallmouth Bass	>30cm	Single	8	0.00088	0.00095	0.00091	0.00002
FSCA 3	Walleye	>30cm	Composite	6	0.00048	0.00050	0.00049	0.00001
FSCA 4	Burbot	>30cm	Composite	6	0.00040	0.00068	0.00048	0.00010

FSCA 4	Kokanee	>30cm	Composite	6	0.00037	0.00062	0.00054	0.00009
FSCA 4	Lake Whitefish	>30cm	Composite	6	0.00083	0.00168	0.00118	0.00035
FSCA 4	Largescale Sucker	>30cm	Single	9	0.00088	0.00222	0.00143	0.00046
FSCA 4	Longnose Sucker	>30cm	Composite	5	0.00097	0.00129	0.00114	0.00012
FSCA 4	Rainbow Trout	>30cm	Composite	6	0.00030	0.00063	0.00039	0.00012
FSCA 4	Smallmouth Bass	>30cm	Single	2	0.00127	0.00141	0.00134	0.00010
FSCA 4	Walleye	>30cm	Composite	6	0.00025	0.00055	0.00039	0.00015
FSCA 5	Burbot	>30cm	Composite	6	0.00042	0.00052	0.00047	0.00004
FSCA 5	Kokanee	>30cm	Composite	6	0.00050	0.00056	0.00053	0.00002
FSCA 5	Lake Whitefish	>30cm	Composite	4	0.00096	0.00197	0.00163	0.00047
FSCA 5	Largescale Sucker	>30cm	Single	4	0.00148	0.00181	0.00165	0.00014
FSCA 5	Rainbow Trout	>30cm	Composite	6	0.00026	0.00054	0.00032	0.00011
FSCA 5	Smallmouth Bass	>30cm	Composite	3	0.00027	0.00030	0.00029	0.00002
FSCA 5	Walleye	>30cm	Composite	6	0.00027	0.00030	0.00029	0.00001
FSCA 6	Burbot	>30cm	Composite	5	0.00046	0.00058	0.00053	0.00005
FSCA 6	Kokanee	>30cm	Composite	5	0.00052	0.00065	0.00058	0.00005
FSCA 6	Largescale Sucker	>30cm	Composite	6	0.00142	0.00243	0.00180	0.00038
FSCA 6	Rainbow Trout	>30cm	Composite	6	0.00029	0.00044	0.00033	0.00006
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	0.00037	0.00037	0.00037	NA
FSCA 6	Smallmouth Bass	>30cm	Composite	8	0.00027	0.00053	0.00033	0.00009
FSCA 6	Walleye	>30cm	Composite	6	0.00029	0.00059	0.00045	0.00010

**Non-detect congeners have been evaluated at 1/2 the detection limit.

Appendix B. Table 6 - Lead Data Summary for Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Nondetect Value (ppm)	Maximum Nondetect Value (ppm)	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 1	Burbot	>30cm	Single	1	100%	NA	NA	0.024	0.024	0.024	NA
FSCA 1	Kokanee	>30cm	Composite	6	100%	NA	NA	0.003	0.006	0.004	0.001
FSCA 1	Largescale Sucker	>30cm	Single	3	100%	NA	NA	0.080	0.775	0.393	0.352
FSCA 1	Mt Whitefish	>30cm	Single	3	67%	0.002	0.002	0.013	0.015	0.010	0.007
FSCA 1	Rainbow Trout	>30cm	Composite	6	100%	NA	NA	0.017	0.076	0.030	0.023
FSCA 1	Walleye	>30cm	Composite	5	60%	0.002	0.004	0.040	0.046	0.027	0.022
FSCA 2	Burbot	>30cm	Single	3	100%	NA	NA	0.014	0.084	0.042	0.037
FSCA 2	Kokanee	>30cm	Composite	6	100%	NA	NA	0.003	0.020	0.008	0.006
FSCA 2	Largescale Sucker	>30cm	Composite	5	100%	NA	NA	0.019	0.739	0.363	0.269
FSCA 2	Longnose Sucker	>30cm	Single	6	100%	NA	NA	0.011	0.059	0.035	0.017
FSCA 2	Mt Whitefish	>30cm	Single	4	50%	0.002	0.003	0.008	0.010	0.006	0.004
FSCA 2	Rainbow Trout	>30cm	Composite	6	100%	NA	NA	0.009	0.042	0.020	0.012
FSCA 2	Smallmouth Bass	>30cm	Single	1	100%	NA	NA	0.006	0.006	0.006	NA
FSCA 2	Walleye	>30cm	Composite	6	83%	0.004	0.004	0.019	0.051	0.033	0.018
FSCA 3	Burbot	>30cm	Composite	5	100%	NA	NA	0.021	0.051	0.028	0.013
FSCA 3	Kokanee	>30cm	Composite	6	100%	NA	NA	0.002	0.004	0.003	0.001
FSCA 3	Lake Whitefish	>30cm	Composite	6	100%	NA	NA	0.008	0.021	0.013	0.005
FSCA 3	Largescale Sucker	>30cm	Composite	5	100%	NA	NA	0.012	0.200	0.073	0.074
FSCA 3	Rainbow Trout	>30cm	Composite	6	83%	0.002	0.002	0.004	0.063	0.015	0.023
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	0%	0.001	0.001	NA	NA	0.001	NA
FSCA 3	Smallmouth Bass	>30cm	Single	8	13%	0.000	0.002	0.004	0.004	0.001	0.001
FSCA 3	Walleye	>30cm	Composite	6	100%	NA	NA	0.005	0.042	0.029	0.019

FSCA 4	Burbot	>30cm	Composite	6	100%	NA	NA	0.018	0.033	0.025	0.006
FSCA 4	Kokanee	>30cm	Composite	6	67%	0.001	0.002	0.002	0.006	0.003	0.002
FSCA 4	Lake Whitefish	>30cm	Composite	6	100%	NA	NA	0.004	0.010	0.007	0.002
FSCA 4	Largescale Sucker	>30cm	Single	9	100%	NA	NA	0.006	0.483	0.151	0.137
FSCA 4	Longnose Sucker	>30cm	Composite	5	100%	NA	NA	0.010	0.014	0.011	0.002
FSCA 4	Rainbow Trout	>30cm	Composite	6	83%	0.002	0.002	0.007	0.076	0.041	0.034
FSCA 4	Smallmouth Bass	>30cm	Single	2	0%	0.001	0.002	NA	NA	0.001	0.001
FSCA 4	Walleye	>30cm	Composite	6	67%	0.002	0.002	0.040	0.050	0.031	0.023
FSCA 5	Burbot	>30cm	Composite	6	100%	NA	NA	0.011	0.021	0.016	0.003
FSCA 5	Kokanee	>30cm	Composite	6	33%	0.001	0.003	0.004	0.009	0.003	0.003
FSCA 5	Lake Whitefish	>30cm	Composite	4	100%	NA	NA	0.005	0.012	0.007	0.003
FSCA 5	Largescale Sucker	>30cm	Single	4	100%	NA	NA	0.041	0.154	0.095	0.050
FSCA 5	Rainbow Trout	>30cm	Composite	6	100%	NA	NA	0.005	0.075	0.035	0.027
FSCA 5	Smallmouth Bass	>30cm	Composite	3	67%	0.001	0.001	0.045	0.057	0.034	0.029
FSCA 5	Walleye	>30cm	Composite	6	100%	NA	NA	0.005	0.045	0.030	0.020
FSCA 6	Burbot	>30cm	Composite	5	100%	NA	NA	0.013	0.024	0.019	0.004
FSCA 6	Kokanee	>30cm	Composite	5	20%	0.001	0.002	0.005	0.005	0.003	0.001
FSCA 6	Largescale Sucker	>30cm	Composite	6	100%	NA	NA	0.031	0.128	0.086	0.037
FSCA 6	Rainbow Trout	>30cm	Composite	6	50%	0.001	0.002	0.017	0.062	0.024	0.030
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	0%	0.001	0.001	NA	NA	0.001	NA
FSCA 6	Smallmouth Bass	>30cm	Composite	8	88%	0.001	0.001	0.005	0.049	0.036	0.020
FSCA 6	Walleye	>30cm	Composite	6	100%	NA	NA	0.004	0.044	0.031	0.019

Non-detect results have been evaluated at 1/2 the detection limit.

Appendix B. Table 7a - Mercury Data Summary for Burbot Fillet Samples.									
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 1	Burbot	>30cm	Single	1	100%	0.276	0.276	0.276	NA
FSCA 2	Burbot	>30cm	Single	3	100%	0.135	0.234	0.183	0.050
FSCA 3	Burbot	>30cm	Composite	5	100%	0.201	0.266	0.228	0.024
FSCA 4	Burbot	>30cm	Composite	6	100%	0.165	0.287	0.241	0.042
FSCA 5	Burbot	>30cm	Composite	6	100%	0.195	0.268	0.236	0.025
FSCA 6	Burbot	>30cm	Composite	5	100%	0.192	0.292	0.241	0.037

Appendix B. Table 7b - Mercury Data Summary for Kokanee Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 1	Kokanee	>30cm	Composite	6	100%	0.054	0.075	0.068	0.008
FSCA 2	Kokanee	>30cm	Composite	6	100%	0.060	0.069	0.064	0.004
FSCA 3	Kokanee	>30cm	Composite	6	100%	0.049	0.065	0.059	0.006
FSCA 4	Kokanee	>30cm	Composite	6	100%	0.060	0.072	0.065	0.005
FSCA 5	Kokanee	>30cm	Composite	6	100%	0.058	0.069	0.063	0.005
FSCA 6	Kokanee	>30cm	Composite	5	100%	0.053	0.068	0.061	0.006

Appendix B. Table 7c - Mercury Data Summary for Lake Whitefish Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 3	Lake Whitefish	>30cm	Composite	6	100%	0.053	0.113	0.081	0.022
FSCA 4	Lake Whitefish	>30cm	Composite	6	100%	0.074	0.114	0.089	0.017
FSCA 5	Lake Whitefish	>30cm	Composite	4	100%	0.090	0.139	0.110	0.021

Appendix B. Table 7d 1 - Mercury Data Summary for Largescale Sucker Fillet Samples.									
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 1	Largescale Sucker	>30cm	Single	3	100%	0.124	0.272	0.219	0.082
FSCA 2	Largescale Sucker	>30cm	Composite	5	100%	0.070	0.323	0.217	0.110
FSCA 3	Largescale Sucker	>30cm	Composite	5	100%	0.113	0.314	0.222	0.083
FSCA 4	Largescale Sucker	>30cm	Single	9	100%	0.073	0.584	0.371	0.193
FSCA 5	Largescale Sucker	>30cm	Single	4	100%	0.335	0.578	0.462	0.100
FSCA 6	Largescale Sucker	>30cm	Composite	6	100%	0.196	0.386	0.257	0.072

Appendix B. Table 7e - Mercury Data Summary for Longnose Sucker Fillet Samples.									
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 2	Longnose Sucker	>30cm	Single	6	100%	0.023	0.203	0.070	0.068
FSCA 4	Longnose Sucker	>30cm	Composite	5	100%	0.084	0.255	0.188	0.065

Appendix B. Table 7f - Mercury Data Summary for Mt Whitefish Fillet Samples.									
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 1	Mt Whitefish	>30cm	Single	3	100%	0.074	0.077	0.075	0.002
FSCA 2	Mt Whitefish	>30cm	Single	4	100%	0.050	0.141	0.088	0.041

Appendix B. Table 7g - Mercury Data Summary for Rainbow Trout Fillet Samples.									
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 1	Rainbow Trout	>30cm	Composite	6	100%	0.039	0.103	0.076	0.023
FSCA 2	Rainbow Trout	>30cm	Composite	6	100%	0.051	0.114	0.080	0.027
FSCA 3	Rainbow Trout	>30cm	Composite	6	100%	0.034	0.119	0.077	0.033
FSCA 4	Rainbow Trout	>30cm	Composite	6	100%	0.054	0.117	0.084	0.026
FSCA 5	Rainbow Trout	>30cm	Composite	6	100%	0.050	0.073	0.065	0.009
FSCA 6	Rainbow Trout	>30cm	Composite	6	100%	0.053	0.133	0.075	0.029

Appendix B. Table 7h - Mercury Data Summary for Smallmouth Bass Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 2	Smallmouth Bass	>30cm	Single	2	100%	0.134	0.181	0.157	0.033
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	100%	0.165	0.165	0.165	NA
FSCA 3	Smallmouth Bass	>30cm	Single	8	100%	0.104	0.410	0.217	0.098
FSCA 4	Smallmouth Bass	>30cm	Single	4	100%	0.076	0.180	0.127	0.046
FSCA 5	Smallmouth Bass	>30cm	Composite	3	100%	0.128	0.168	0.142	0.023
FSCA 5	Smallmouth Bass	>30cm	Single	13	100%	0.094	0.233	0.147	0.046
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	100%	0.176	0.176	0.176	NA
FSCA 6	Smallmouth Bass	>30cm	Composite	8	100%	0.136	0.227	0.175	0.030
FSCA 6	Smallmouth Bass	>30cm	Single	50	100%	0.069	0.340	0.158	0.058

Appendix B. Table 7i -Mercury Data Summary for Walleye Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 1	Walleye	>30cm	Composite	5	100%	0.129	0.289	0.190	0.069
FSCA 1	Walleye	>30cm	Single	24	100%	0.065	0.327	0.163	0.075
FSCA 2	Walleye	>30cm	Composite	6	100%	0.091	0.215	0.167	0.041
FSCA 2	Walleye	>30cm	Single	42	100%	0.086	0.301	0.165	0.055
FSCA 3	Walleye	>30cm	Composite	6	100%	0.134	0.212	0.170	0.030
FSCA 3	Walleye	>30cm	Single	45	100%	0.056	0.487	0.172	0.089
FSCA 4	Walleye	>30cm	Composite	6	100%	0.119	0.166	0.138	0.021
FSCA 4	Walleye	>30cm	Single	37	100%	0.051	0.279	0.122	0.043
FSCA 5	Walleye	>30cm	Composite	6	100%	0.133	0.249	0.184	0.047
FSCA 5	Walleye	>30cm	Single	32	100%	0.030	0.360	0.170	0.079
FSCA 6	Walleye	>30cm	Composite	6	100%	0.180	0.214	0.201	0.012
FSCA 6	Walleye	>30cm	Single	34	100%	0.099	0.355	0.197	0.058

Appendix B. Table 8a - PBDE 47 Data Summary for Burbot Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Burbot	>30cm	Single	1	100%	1.4	1.4	1.4
FSCA 2	Burbot	>30cm	Single	1	100%	0.5	0.5	0.5
FSCA 3	Burbot	>30cm	Multicoll	2	100%	0.4	0.5	0.4
FSCA 4	Burbot	>30cm	Multicoll	2	100%	1.7	2.5	2.1
FSCA 5	Burbot	>30cm	Multicoll	2	100%	1.3	1.7	1.5
FSCA 6	Burbot	>30cm	Multicoll	2	100%	0.9	1.2	1.1

Appendix B. Table 8b - PBDE 47 Data Summary for Kokanee Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Kokanee	>30cm	Multicoll	2	100%	1.7	2.3	2.0
FSCA 2	Kokanee	>30cm	Multicoll	2	100%	2.7	2.9	2.8
FSCA 3	Kokanee	>30cm	Multicoll	2	100%	1.5	2.1	1.8
FSCA 4	Kokanee	>30cm	Multicoll	2	100%	2.2	2.5	2.4
FSCA 5	Kokanee	>30cm	Multicoll	2	100%	2.8	3.3	3.1
FSCA 6	Kokanee	>30cm	Multicoll	2	100%	2.2	2.7	2.4

Appendix B. Table 8c - PBDE 47 Data Summary for Lake Whitefish Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 3	Lake Whitefish	>30cm	Multicoll	2	100%	5.0	5.4	5.2
FSCA 4	Lake Whitefish	>30cm	Multicoll	2	100%	6.2	9.1	7.6
FSCA 5	Lake Whitefish	>30cm	Multicoll	2	100%	17.7	24.3	21.0

Appendix B. Table 8d - PBDE 47 Data Summary for Largescale Sucker Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximu m Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Largescale Sucker	>30cm	Single	1	100%	12.6	12.6	12.6
FSCA 2	Largescale Sucker	>30cm	Multicoll	2	100%	11.3	41.6	26.5
FSCA 3	Largescale Sucker	>30cm	Multicoll	2	100%	15.2	17.3	16.3
FSCA 4	Largescale Sucker	>30cm	Single	3	100%	3.0	35.5	21.2
FSCA 5	Largescale Sucker	>30cm	Single	2	100%	19.9	39.3	29.6
FSCA 6	Largescale Sucker	>30cm	Multicoll	2	100%	43.2	64.1	53.7

Appendix B. Table 8e - PBDE 47 Data Summary for Longnose Sucker Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 2	Longnose Sucker	>30cm	Single	2	100%	1.1	8.0	4.5
FSCA 4	Longnose Sucker	>30cm	Multicoll	2	100%	7.3	14.2	10.7

Appendix B. Table 8f - PBDE 47 Data Summary for Mt. Whitefish Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Mt Whitefish	>30cm	Single	1	100%	19.0	19.0	19.0
FSCA 2	Mt Whitefish	>30cm	Single	2	100%	13.7	21.7	17.7

Appendix B. Table 8g - PBDE 47 Data Summary for Rainbow Trout Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Rainbow Trout	>30cm	Multicoll	2	100%	9.6	12.8	11.2
FSCA 2	Rainbow Trout	>30cm	Multicoll	2	100%	3.2	10.5	6.8
FSCA 3	Rainbow Trout	>30cm	Multicoll	2	100%	2.6	4.3	3.5
FSCA 4	Rainbow Trout	>30cm	Multicoll	2	100%	2.5	6.2	4.3
FSCA 5	Rainbow Trout	>30cm	Multicoll	2	100%	2.4	9.4	5.9
FSCA 6	Rainbow Trout	>30cm	Multicoll	2	100%	2.7	3.5	3.1

Appendix B. Table 8h - PBDE 47 Data Summary for Smallmouth Bass Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppb)	Maximum Detected Value (ppb)	Mean (ppb)
FSCA 2	Smallmouth Bass	>30cm	Single	1	100%	13.4	13.4	13.4
FSCA 3	Smallmouth Bass	>30cm	Single	3	100%	2.5	2.6	2.6
FSCA 4	Smallmouth Bass	>30cm	Single	1	100%	1.4	1.4	1.4
FSCA 5	Smallmouth Bass	>30cm	Multicoll	1	100%	5.0	5.0	5.0
FSCA 6	Smallmouth Bass	>15 to <=30cm	Multicoll	1	100%	1.9	1.9	1.9
FSCA 6	Smallmouth Bass	>30cm	Multicoll	2	100%	3.1	4.3	3.7

Appendix B. Table 8i - PBDE 47 Data Summary for Walleye Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Walleye	>30cm	Multicoll	2	100%	3.6	3.8	3.7
FSCA 2	Walleye	>30cm	Multicoll	2	100%	2.7	3.9	3.3
FSCA 3	Walleye	>30cm	Multicoll	2	100%	2.6	2.7	2.6
FSCA 4	Walleye	>30cm	Multicoll	2	100%	1.4	1.5	1.4
FSCA 5	Walleye	>30cm	Multicoll	2	100%	4.4	4.7	4.6
FSCA 6	Walleye	>30cm	Multicoll	2	100%	2.4	2.6	2.5

Appendix B. Table 9a - Total PBDEs Data Summary for Burbot Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Burbot	>30cm	Single	1	100%	2.7	2.7	2.7
FSCA 2	Burbot	>30cm	Single	1	100%	0.9	0.9	0.9
FSCA 3	Burbot	>30cm	Multicoll	2	100%	0.8	1.0	0.9
FSCA 4	Burbot	>30cm	Multicoll	2	100%	3.4	5.3	4.3
FSCA 5	Burbot	>30cm	Multicoll	2	100%	2.9	3.3	3.1
FSCA 6	Burbot	>30cm	Multicoll	2	100%	1.9	3.0	2.4

Appendix B. Table 9b - Total PBDEs Data Summary for Kokanee Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Kokanee	>30cm	Multicoll	2	100%	4.4	5.2	4.8
FSCA 2	Kokanee	>30cm	Multicoll	2	100%	5.9	6.7	6.3
FSCA 3	Kokanee	>30cm	Multicoll	2	100%	3.3	4.6	4.0
FSCA 4	Kokanee	>30cm	Multicoll	2	100%	4.7	5.6	5.2
FSCA 5	Kokanee	>30cm	Multicoll	2	100%	6.3	7.3	6.8
FSCA 6	Kokanee	>30cm	Multicoll	2	100%	4.9	5.8	5.4

Appendix B. Table 9c - Total PBDEs Data Summary for Lake Whitefish Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 3	Lake Whitefish	>30cm	Multicoll	2	NR	NR	NR	9.0
FSCA 4	Lake Whitefish	>30cm	Multicoll	2	NR	NR	NR	12.4
FSCA 5	Lake Whitefish	>30cm	Multicoll	2	NR	NR	NR	31.3

NOTE: no data provided by EPA on Lake Whitefish total PBDE values

Appendix B. Table 9d - Total PBDEs Data Summary for Largescale Sucker Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Largescale Sucker	>30cm	Single	1	100%	19.5	19.5	19.5
FSCA 2	Largescale Sucker	>30cm	Multicoll	2	100%	14.4	52.1	33.2
FSCA 3	Largescale Sucker	>30cm	Multicoll	2	100%	20.5	22.1	21.3
FSCA 4	Largescale Sucker	>30cm	Single	3	100%	4.0	44.8	26.8
FSCA 5	Largescale Sucker	>30cm	Single	2	100%	25.4	48.6	37.0
FSCA 6	Largescale Sucker	>30cm	Multicoll	2	100%	53.7	77.2	65.5

Appendix B. Table 9e - Total PBDEs Data Summary for Longnose Sucker Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 2	Longnose Sucker	>30cm	Single	2	100%	1.8	10.2	6.0
FSCA 4	Longnose Sucker	>30cm	Multicoll	2	100%	9.7	18.1	13.9

Appendix B. Table 9f - Total PBDEs Data Summary for Mt. Whitefish Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Mt Whitefish	>30cm	Single	1	100%	47.9	47.9	47.9
FSCA 2	Mt Whitefish	>30cm	Single	2	100%	28.2	40.7	34.5
FSCA 3	Mt Whitefish	>30cm	Multicoll	2	100%	10.3	12.1	11.2
FSCA 4	Mt Whitefish	>30cm	Multicoll	2	100%	13.0	17.5	15.3
FSCA 5	Mt Whitefish	>30cm	Multicoll	2	100%	33.5	43.3	38.4

Appendix B. Table 9g - Total PBDEs Data Summary for Rainbow Trout Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Rainbow Trout	>30cm	Multicoll	2	100%	20.9	23.3	22.1
FSCA 2	Rainbow Trout	>30cm	Multicoll	2	100%	7.1	24.5	15.8
FSCA 3	Rainbow Trout	>30cm	Multicoll	2	100%	5.8	8.5	7.1
FSCA 4	Rainbow Trout	>30cm	Multicoll	2	100%	6.1	13.9	10.0
FSCA 5	Rainbow Trout	>30cm	Multicoll	2	100%	5.6	18.4	12.0
FSCA 6	Rainbow Trout	>30cm	Multicoll	2	100%	5.6	7.0	6.3

Appendix B. Table 9h - Total PBDEs Data Summary for Smallmouth Bass Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 2	Smallmouth Bass	>30cm	Single	1	100%	19.5	19.5	19.5
FSCA 3	Smallmouth Bass	>30cm	Single	3	100%	3.4	3.7	3.6
FSCA 4	Smallmouth Bass	>30cm	Single	1	100%	2.1	2.1	2.1
FSCA 5	Smallmouth Bass	>30cm	Multicoll	1	100%	7.4	7.4	7.4
FSCA 6	Smallmouth Bass	>15 to <=30cm	Multicoll	1	100%	3.2	3.2	3.2
FSCA 6	Smallmouth Bass	>30cm	Multicoll	2	100%	5.9	7.9	6.9

Appendix B. Table 9i - Total PBDEs Data Summary for Walleye Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppb)**	**Maximum Detected Value (ppb)**	**Mean (ppb)**
FSCA 1	Walleye	>30cm	Multicoll	2	100%	5.8	7.4	6.6
FSCA 2	Walleye	>30cm	Multicoll	2	100%	6.0	6.4	6.2
FSCA 3	Walleye	>30cm	Multicoll	2	100%	3.9	3.9	3.9
FSCA 4	Walleye	>30cm	Multicoll	2	100%	2.3	2.5	2.4
FSCA 5	Walleye	>30cm	Multicoll	2	100%	6.9	7.6	7.3
FSCA 6	Walleye	>30cm	Multicoll	2	100%	3.7	4.0	3.9

Appendix B. Table 10a - Total PCBs Data Summary for Burbot Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Burbot	>30cm	Single	1	2.6	2.6	2.6	NA
FSCA 2	Burbot	>30cm	Single	3	1.4	1.8	1.6	0.2
FSCA 3	Burbot	>30cm	Composite	5	1.3	2.0	1.5	0.3
FSCA 4	Burbot	>30cm	Composite	6	1.5	2.9	2.2	0.6
FSCA 5	Burbot	>30cm	Composite	6	2.1	3.6	2.9	0.6
FSCA 6	Burbot	>30cm	Composite	5	2.1	2.7	2.4	0.3

Appendix B. Table 10b - Total PCBs Data Summary for Kokanee Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Kokanee	>30cm	Composite	6	6.6	12.5	8.5	2.3
FSCA 2	Kokanee	>30cm	Composite	6	8.0	9.9	8.7	0.7
FSCA 3	Kokanee	>30cm	Composite	6	7.7	11.3	8.9	1.4
FSCA 4	Kokanee	>30cm	Composite	6	6.0	8.3	7.2	0.9
FSCA 5	Kokanee	>30cm	Composite	6	6.4	9.4	7.7	1.2
FSCA 6	Kokanee	>30cm	Composite	5	4.8	6.6	5.5	0.7

Appendix B. Table 10c - Total PCBs Data Summary for Lake Whitefish Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Minimum Value (ppb)	Maximum Value (ppb)	Mean (ppb)	Standard Deviation
FSCA 3	Lake Whitefish	>30cm	Composite	6	11.6	18.0	14.8	2.5
FSCA 4	Lake Whitefish	>30cm	Composite	6	15.4	25.6	18.9	3.9
FSCA 5	Lake Whitefish	>30cm	Composite	4	17.4	39.3	28.7	9.0

Appendix B. Table 10d - Total PCBs Data Summary for Largescale Sucker Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Minimum Value (ppb)	Maximum Value (ppb)	Mean (ppb)	Standard Deviation
FSCA 1	Largescale Sucker	>30cm	Single	3	26.7	62.0	41.8	18.2
FSCA 2	Largescale Sucker	>30cm	Composite	5	27.1	230.5	112.0	105.3
FSCA 3	Largescale Sucker	>30cm	Composite	5	10.4	41.8	19.1	13.0
FSCA 4	Largescale Sucker	>30cm	Single	9	6.7	104.8	56.6	34.6
FSCA 5	Largescale Sucker	>30cm	Single	4	33.3	88.0	66.5	23.5
FSCA 6	Largescale Sucker	>30cm	Composite	6	65.6	95.5	76.5	12.0

Appendix B. Table 10e - Total PCBs Data Summary for Longnose Sucker Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 2	Longnose Sucker	>30cm	Single	6	2.8	14.4	8.8	4.8
FSCA 4	Longnose Sucker	>30cm	Composite	5	8.3	19.3	15.5	5.0

Appendix B. Table 10f - Total PCBs Data Summary for Mt. Whitefish Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Mt Whitefish	>30cm	Single	3	18.5	58.3	33.9	21.4
FSCA 2	Mt Whitefish	>30cm	Single	4	10.2	32.5	21.3	9.7

Appendix B. Table 10g - Total PCBs Data Summary for Rainbow Trout Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Rainbow Trout	>30cm	Composite	6	23.7	54.4	30.9	11.8
FSCA 2	Rainbow Trout	>30cm	Composite	6	10.7	38.3	28.8	9.9
FSCA 3	Rainbow Trout	>30cm	Composite	6	6.4	14.3	9.7	2.7
FSCA 4	Rainbow Trout	>30cm	Composite	6	4.6	13.7	8.7	3.8
FSCA 5	Rainbow Trout	>30cm	Composite	6	5.2	14.4	7.1	3.6
FSCA 6	Rainbow Trout	>30cm	Composite	6	6.2	11.6	8.0	2.0

Appendix B. Table 10h - Total PCBs Data Summary for Smallmouth Bass Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 2	Smallmouth Bass	>30cm	Single	1	29.1	29.1	29.1	NA
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	2.9	2.9	2.9	NA
FSCA 3	Smallmouth Bass	>30cm	Single	8	2.1	11.7	5.1	3.0
FSCA 4	Smallmouth Bass	>30cm	Single	2	3.6	3.6	3.6	0.0
FSCA 5	Smallmouth Bass	>30cm	Composite	3	5.3	7.2	6.4	1.0
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	6.1	6.1	6.1	NA
FSCA 6	Smallmouth Bass	>30cm	Composite	8	4.6	9.7	6.0	1.7

Appendix B. Table 10i - Total PCBs Data Summary for Walleye Fillet Samples.								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Walleye	>30cm	Composite	5	5.8	8.4	6.9	1.1
FSCA 2	Walleye	>30cm	Composite	6	5.5	12.3	7.8	2.5
FSCA 3	Walleye	>30cm	Composite	6	3.3	5.8	4.3	0.9
FSCA 4	Walleye	>30cm	Composite	6	3.1	8.7	4.4	2.2
FSCA 5	Walleye	>30cm	Composite	6	4.0	11.0	7.6	2.3
FSCA 6	Walleye	>30cm	Composite	6	4.7	7.9	6.2	1.5

Appendix B. Table 11a - Total Dioxin TEQ Data Summary for Burbot Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Burbot	>30cm	Single	1	0.00013	0.00013	0.00013	NA
FSCA 2	Burbot	>30cm	Single	3	0.00085	0.00089	0.00087	0.00002
FSCA 3	Burbot	>30cm	Composite	5	0.00087	0.00107	0.00091	0.00009
FSCA 4	Burbot	>30cm	Composite	6	0.00040	0.00068	0.00048	0.00010
FSCA 5	Burbot	>30cm	Composite	6	0.00042	0.00052	0.00047	0.00004
FSCA 6	Burbot	>30cm	Composite	5	0.00046	0.00058	0.00053	0.00005

Appendix B. Table 11b - Total Dioxin TEQ Data Summary for Kokanee Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Kokanee	>30cm	Composite	6	0.00036	0.00041	0.00038	0.00002
FSCA 2	Kokanee	>30cm	Composite	6	0.00037	0.00057	0.00044	0.00010
FSCA 3	Kokanee	>30cm	Composite	6	0.00062	0.00074	0.00068	0.00005
FSCA 4	Kokanee	>30cm	Composite	6	0.00037	0.00062	0.00054	0.00009
FSCA 5	Kokanee	>30cm	Composite	6	0.00050	0.00056	0.00053	0.00002
FSCA 6	Kokanee	>30cm	Composite	5	0.00052	0.00065	0.00058	0.00005

Appendix B. Table 11c - Total Dioxin TEQ Data Summary for Lake Whitefish Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 3	Lake Whitefish	>30cm	Composite	6	0.00088	0.00133	0.00105	0.00017
FSCA 4	Lake Whitefish	>30cm	Composite	6	0.00083	0.00168	0.00118	0.00035
FSCA 5	Lake Whitefish	>30cm	Composite	4	0.00096	0.00197	0.00163	0.00047

Appendix B. Table 11d - Total Dioxin TEQ Data Summary for Largescale Sucker Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Largescale Sucker	>30cm	Single	3	0.00056	0.00087	0.00067	0.00018
FSCA 2	Largescale Sucker	>30cm	Composite	5	0.00054	0.00273	0.00151	0.00102
FSCA 3	Largescale Sucker	>30cm	Composite	5	0.00034	0.00081	0.00048	0.00019
FSCA 4	Largescale Sucker	>30cm	Single	9	0.00088	0.00222	0.00143	0.00046
FSCA 5	Largescale Sucker	>30cm	Single	4	0.00148	0.00181	0.00165	0.00014
FSCA 6	Largescale Sucker	>30cm	Composite	6	0.00142	0.00243	0.00180	0.00038

Appendix B. Table 11e - Total Dioxin TEQ Data Summary for Longnose Sucker Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 2	Longnose Sucker	>30cm	Single	6	0.00043	0.00094	0.00081	0.00021
FSCA 4	Longnose Sucker	>30cm	Composite	5	0.00097	0.00129	0.00114	0.00012

Appendix B. Table 11f - Total Dioxin TEQ Data Summary for Mt. Whitefish Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Mt Whitefish	>30cm	Single	3	0.00106	0.00230	0.00156	0.00065
FSCA 2	Mt Whitefish	>30cm	Single	4	0.00083	0.00191	0.00138	0.00048

Appendix B. Table 11g - Total Dioxin TEQ Data Summary for Rainbow Trout Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Minimum Value (ppb)**	**Maximum Value (ppb)**	**Mean (ppb)**	**Standard Deviation**
FSCA 1	Rainbow Trout	>30cm	Composite	6	0.00073	0.00186	0.00102	0.00042
FSCA 2	Rainbow Trout	>30cm	Composite	6	0.00042	0.00114	0.00091	0.00029
FSCA 3	Rainbow Trout	>30cm	Composite	6	0.00032	0.00058	0.00041	0.00009
FSCA 4	Rainbow Trout	>30cm	Composite	6	0.00030	0.00063	0.00039	0.00012
FSCA 5	Rainbow Trout	>30cm	Composite	6	0.00026	0.00054	0.00032	0.00011
FSCA 6	Rainbow Trout	>30cm	Composite	6	0.00029	0.00044	0.00033	0.00006

Appendix B. Table 11h - Total Dioxin TEQ Data Summary for Smallmouth Bass Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	Species	Size Class	Sample Type	Number of Samples	Minimum Value (ppb)	Maximum Value (ppb)	Mean (ppb)	Standard Deviation
FSCA 2	Smallmouth Bass	>30cm	Single	1	0.00065	0.00065	0.00065	NA
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	0.00089	0.00089	0.00089	NA
FSCA 3	Smallmouth Bass	>30cm	Single	8	0.00088	0.00095	0.00091	0.00002
FSCA 4	Smallmouth Bass	>30cm	Single	2	0.00127	0.00141	0.00134	0.00010
FSCA 5	Smallmouth Bass	>30cm	Composite	3	0.00027	0.00030	0.00029	0.00002
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	0.00037	0.00037	0.00037	NA
FSCA 6	Smallmouth Bass	>30cm	Composite	8	0.00027	0.00053	0.00033	0.00009

Appendix B. Table 11i - Total Dioxin TEQ Data Summary for Walleye Fillet Samples (Total PCB, Dioxin, Furan TEQs).								
FSCA	Species	Size Class	Sample Type	Number of Samples	Minimum Value (ppb)	Maximum Value (ppb)	Mean (ppb)	Standard Deviation
FSCA 1	Walleye	>30cm	Composite	5	0.00042	0.00052	0.00049	0.00004
FSCA 2	Walleye	>30cm	Composite	6	0.00050	0.00063	0.00056	0.00004
FSCA 3	Walleye	>30cm	Composite	6	0.00048	0.00050	0.00049	0.00001
FSCA 4	Walleye	>30cm	Composite	6	0.00025	0.00055	0.00039	0.00015
FSCA 5	Walleye	>30cm	Composite	6	0.00027	0.00030	0.00029	0.00001
FSCA 6	Walleye	>30cm	Composite	6	0.00029	0.00059	0.00045	0.00010

Appendix B. Table 12a - Lead Data Summary for Burbot Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 1	Burbot	>30cm	Single	1	100%	0.024	0.024	0.024	NA
FSCA 2	Burbot	>30cm	Single	3	100%	0.014	0.084	0.042	0.037
FSCA 3	Burbot	>30cm	Composite	5	100%	0.021	0.051	0.028	0.013
FSCA 4	Burbot	>30cm	Composite	6	100%	0.018	0.033	0.025	0.006
FSCA 5	Burbot	>30cm	Composite	6	100%	0.011	0.021	0.016	0.003
FSCA 6	Burbot	>30cm	Composite	5	100%	0.013	0.024	0.019	0.004

Appendix B. Table 12b - Lead Data Summary for Kokanee Fillet Samples.											
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Nondetect Value (ppm)**	**Maximum Nondetect Value (ppm)**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 1	Kokanee	>30cm	Composite	6	100%	NA	NA	0.003	0.006	0.004	0.001
FSCA 2	Kokanee	>30cm	Composite	6	100%	NA	NA	0.003	0.020	0.008	0.006
FSCA 3	Kokanee	>30cm	Composite	6	100%	NA	NA	0.002	0.004	0.003	0.001
FSCA 4	Kokanee	>30cm	Composite	6	67%	0.001	0.002	0.002	0.006	0.003	0.002
FSCA 5	Kokanee	>30cm	Composite	6	33%	0.001	0.003	0.004	0.009	0.003	0.003
FSCA 6	Kokanee	>30cm	Composite	5	20%	0.001	0.002	0.005	0.005	0.003	0.001

Appendix B. Table 12c - Lead Data Summary for Lake Whitefish Fillet Samples.									
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 3	Lake Whitefish	>30cm	Composite	6	100%	0.008	0.021	0.013	0.005
FSCA 4	Lake Whitefish	>30cm	Composite	6	100%	0.004	0.010	0.007	0.002
FSCA 5	Lake Whitefish	>30cm	Composite	4	100%	0.005	0.012	0.007	0.003

Appendix B. Table 12d - Lead Data Summary for Largescale Sucker Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 1	Largescale Sucker	>30cm	Single	3	100%	0.080	0.775	0.393	0.352
FSCA 2	Largescale Sucker	>30cm	Composite	5	100%	0.019	0.739	0.363	0.269
FSCA 3	Largescale Sucker	>30cm	Composite	5	100%	0.012	0.200	0.073	0.074
FSCA 4	Largescale Sucker	>30cm	Single	9	100%	0.006	0.483	0.151	0.137
FSCA 5	Largescale Sucker	>30cm	Single	4	100%	0.041	0.154	0.095	0.050
FSCA 6	Largescale Sucker	>30cm	Composite	6	100%	0.031	0.128	0.086	0.037

Appendix B. Table 12e - Lead Data Summary for Longnose Sucker Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 2	Longnose Sucker	>30cm	Single	6	100%	0.011	0.059	0.035	0.017
FSCA 4	Longnose Sucker	>30cm	Composite	5	100%	0.010	0.014	0.011	0.002

Appendix B. Table 12f - Lead Data Summary for Mt. Whitefish Fillet Samples.											
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Nondetect Value (ppm)**	**Maximum Nondetect Value (ppm)**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 1	Mt Whitefish	>30cm	Single	3	67%	0.002	0.002	0.013	0.015	0.010	0.007
FSCA 2	Mt Whitefish	>30cm	Single	4	50%	0.002	0.003	0.008	0.010	0.006	0.004

Appendix B. Table 12g - Lead Data Summary for Rainbow Trout Fillet Samples.											
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Nondetect Value (ppm)**	**Maximum Nondetect Value (ppm)**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 1	Rainbow Trout	>30cm	Composite	6	100%	NA	NA	0.017	0.076	0.030	0.023
FSCA 2	Rainbow Trout	>30cm	Composite	6	100%	NA	NA	0.009	0.042	0.020	0.012
FSCA 3	Rainbow Trout	>30cm	Composite	6	83%	0.002	0.002	0.004	0.063	0.015	0.023
FSCA 4	Rainbow Trout	>30cm	Composite	6	83%	0.002	0.002	0.007	0.076	0.041	0.034
FSCA 5	Rainbow Trout	>30cm	Composite	6	100%	NA	NA	0.005	0.075	0.035	0.027
FSCA 6	Rainbow Trout	>30cm	Composite	6	50%	0.001	0.002	0.017	0.062	0.024	0.030

Appendix B. Table 12h - Lead Data Summary for Smallmouth Bass Fillet Samples.											
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Frequency of Detection**	**Minimum Nondetect Value (ppm)**	**Maximum Nondetect Value (ppm)**	**Minimum Detected Value (ppm)**	**Maximum Detected Value (ppm)**	**Mean (ppm)**	**Standard Deviation**
FSCA 2	Smallmouth Bass	>30cm	Single	1	100%	NA	NA	0.006	0.006	0.006	NA
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	0%	0.001	0.001	NA	NA	0.001	NA
FSCA 3	Smallmouth Bass	>30cm	Single	8	13%	0.000	0.002	0.004	0.004	0.001	0.001
FSCA 4	Smallmouth Bass	>30cm	Single	2	0%	0.001	0.002	NA	NA	0.001	0.001
FSCA 5	Smallmouth Bass	>30cm	Composite	3	67%	0.001	0.001	0.045	0.057	0.034	0.029
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	0%	0.001	0.001	NA	NA	0.001	NA
FSCA 6	Smallmouth Bass	>30cm	Composite	8	88%	0.001	0.001	0.005	0.049	0.036	0.020

Appendix B. Table 12i - Lead Data Summary for Walleye Fillet Samples.

FSCA	Species	Size Class	Sample Type	Number of Samples	Frequency of Detection	Minimum Nondetect Value (ppm)	Maximum Nondetect Value (ppm)	Minimum Detected Value (ppm)	Maximum Detected Value (ppm)	Mean (ppm)	Standard Deviation
FSCA 1	Walleye	>30cm	Composite	5	60%	0.002	0.004	0.040	0.046	0.027	0.022
FSCA 2	Walleye	>30cm	Composite	6	83%	0.004	0.004	0.019	0.051	0.033	0.018
FSCA 3	Walleye	>30cm	Composite	6	100%	NA	NA	0.005	0.042	0.029	0.019
FSCA 4	Walleye	>30cm	Composite	6	67%	0.002	0.002	0.040	0.050	0.031	0.023
FSCA 5	Walleye	>30cm	Composite	6	100%	NA	NA	0.005	0.045	0.030	0.020
FSCA 6	Walleye	>30cm	Composite	6	100%	NA	NA	0.004	0.044	0.031	0.019

APPENDIX C

Appendix C. Table 1 - Exposure Assumptions Used to Determine Contaminant Doses to the General Population and Subsistence Level Consumers.			
Parameter	**Value**	**Unit**	**Comments**
Concentration (C)	Variable	mg/kg	Mean fish tissue concentration
Concentration (C)	Variable	ug/kg	Mean fish tissue concentration
Conversion Factor$_1$ (CF_1)	0.001	kg/g	Converts contaminant concentration from grams (g) to kilograms (kg)
Conversion Factor$_2$ (CF_2)	0.001	mg/ug	Converts contaminant concentration from micrograms (ug) to milligrams (mg)
Ingestion Rate (IR) - general population	59.7	g/day	DOH unlimited fish consumption rate
Ingestion Rate (IR) - subsistence	142.4		EPA subsistence consumption rate
Conversion Factor$_2$ (CF_2)	0.001	kg/gm	Converts mass of fish from grams (g) to kilograms (kg)
Exposure Frequency (EF)	365	days/year	Assumes daily exposure
Exposure Duration (ED)	30	years	General population estimate of residence time
Exposure Duration (ED)	70	years	Subsistence population estimate of residence time
Body Weight (BW)	70 (60)	kg	Adult mean body weight (adult female)
Averaging Time $_{non\text{-}cancer}$ (AT)	10950	days	30 years for general population
Averaging Time $_{non\text{-}cancer}$ (AT)	25550	days	70 years for subsistence population
Averaging Time $_{cancer}$ (AT)	25550	days	70 years
Reference Dose (RfD)*	Contaminant-specific	mg/kg-day	Source: EPA
Cancer Slope Factor (CSF)**	Contaminant-specific	mg/kg-day^{-1}	Source: EPA

Appendix C Table 1a - Exposure Dose Estimates for Mercury in Fillets.									
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppm)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Population**	**HQ Subsistence Population**
FSCA 1	Burbot	>30cm	FilletSkOn	Single	0.276	2.7E-04	6.6E-04	2.75	6.55
FSCA 1	Kokanee	>30cm	FilletSkOn	Composite	0.068	6.8E-05	1.6E-04	0.68	1.61
FSCA 1	Largescale Sucker	>30cm	FilletSkOn	Single	0.219	2.2E-04	5.2E-04	2.18	5.20
FSCA 1	Mt Whitefish	>30cm	FilletSkOn	Single	0.075	7.5E-05	1.8E-04	0.75	1.79
FSCA 1	Rainbow Trout	>30cm	FilletSkOn	Composite	0.076	7.6E-05	1.8E-04	0.76	1.82
FSCA 1	Walleye	>30cm	FilletSkOn	Composite	0.190	1.9E-04	4.5E-04	1.89	4.52
FSCA 1	Walleye	>30cm	FilletSkOn	Single	0.163	1.6E-04	3.9E-04	1.62	3.86
FSCA 2	Burbot	>30cm	FilletSkOn	Single	0.183	1.8E-04	4.4E-04	1.83	4.36
FSCA 2	Kokanee	>30cm	FilletSkOn	Composite	0.064	6.4E-05	1.5E-04	0.64	1.52
FSCA 2	Largescale Sucker	>30cm	FilletSkOn	Composite	0.217	2.2E-04	5.2E-04	2.16	5.16
FSCA 2	Longnose Sucker	>30cm	FilletSkOn	Single	0.070	7.0E-05	1.7E-04	0.70	1.66
FSCA 2	Mt Whitefish	>30cm	FilletSkOn	Single	0.088	8.8E-05	2.1E-04	0.88	2.10
FSCA 2	Rainbow Trout	>30cm	FilletSkOn	Composite	0.080	7.9E-05	1.9E-04	0.79	1.90
FSCA 2	Smallmouth Bass	>30cm	FilletSkOn	Single	0.157	1.6E-04	3.7E-04	1.56	3.73
FSCA 2	Walleye	>30cm	FilletSkOn	Composite	0.167	1.7E-04	4.0E-04	1.66	3.97
FSCA 2	Walleye	>30cm	FilletSkOn	Single	0.165	1.6E-04	3.9E-04	1.64	3.91
FSCA 3	Burbot	>30cm	FilletSkOn	Composite	0.228	2.3E-04	5.4E-04	2.27	5.41
FSCA 3	Kokanee	>30cm	FilletSkOn	Composite	0.059	5.9E-05	1.4E-04	0.59	1.40
FSCA 3	Lake Whitefish	>30cm	FilletSkOn	Composite	0.081	8.1E-05	1.9E-04	0.81	1.93
FSCA 3	Largescale Sucker	>30cm	FilletSkOn	Composite	0.222	2.2E-04	5.3E-04	2.21	5.27
FSCA 3	Rainbow Trout	>30cm	FilletSkOn	Composite	0.077	7.7E-05	1.8E-04	0.77	1.84
FSCA 3	Smallmouth Bass	>15 to <=30cm	FilletSkOn	Single	0.165	1.6E-04	3.9E-04	1.64	3.91
FSCA 3	Smallmouth Bass	>30cm	FilletSkOn	Single	0.217	2.2E-04	5.2E-04	2.16	5.15
FSCA 3	Walleye	>30cm	FilletSkOn	Composite	0.170	1.7E-04	4.0E-04	1.69	4.04
FSCA 3	Walleye	>30cm	FilletSkOn	Single	0.172	1.7E-04	4.1E-04	1.71	4.08

FSCA 4	Burbot	>30cm	FilletSkOn	Composite	0.241	2.4E-04	5.7E-04	2.40	5.73
FSCA 4	Kokanee	>30cm	FilletSkOn	Composite	0.065	6.5E-05	1.6E-04	0.65	1.55
FSCA 4	Lake Whitefish	>30cm	FilletSkOn	Composite	0.089	8.8E-05	2.1E-04	0.88	2.11
FSCA 4	Largescale Sucker	>30cm	FilletSkOn	Single	0.371	3.7E-04	8.8E-04	3.69	8.81
FSCA 4	Longnose Sucker	>30cm	FilletSkOn	Composite	0.188	1.9E-04	4.5E-04	1.87	4.46
FSCA 4	Rainbow Trout	>30cm	FilletSkOn	Composite	0.084	8.4E-05	2.0E-04	0.84	2.00
FSCA 4	Smallmouth Bass	>30cm	FilletSkOn	Single	0.127	1.3E-04	3.0E-04	1.26	3.01
FSCA 4	Walleye	>30cm	FilletSkOn	Composite	0.138	1.4E-04	3.3E-04	1.38	3.29
FSCA 4	Walleye	>30cm	FilletSkOn	Single	0.122	1.2E-04	2.9E-04	1.21	2.90
FSCA 5	Burbot	>30cm	FilletSkOn	Composite	0.236	2.4E-04	5.6E-04	2.35	5.61
FSCA 5	Kokanee	>30cm	FilletSkOn	Composite	0.063	6.3E-05	1.5E-04	0.63	1.50
FSCA 5	Lake Whitefish	>30cm	FilletSkOn	Composite	0.110	1.1E-04	2.6E-04	1.09	2.61
FSCA 5	Largescale Sucker	>30cm	FilletSkOn	Single	0.462	4.6E-04	1.1E-03	4.60	10.96
FSCA 5	Rainbow Trout	>30cm	FilletSkOn	Composite	0.065	6.5E-05	1.5E-04	0.65	1.54
FSCA 5	Smallmouth Bass	>30cm	FilletSkOn	Composite	0.142	1.4E-04	3.4E-04	1.41	3.37
FSCA 5	Smallmouth Bass	>30cm	FilletSkOn	Single	0.147	1.5E-04	3.5E-04	1.46	3.49
FSCA 5	Walleye	>30cm	FilletSkOn	Composite	0.184	1.8E-04	4.4E-04	1.83	4.36
FSCA 5	Walleye	>30cm	FilletSkOn	Single	0.170	1.7E-04	4.0E-04	1.69	4.03
FSCA 6	Burbot	>30cm	FilletSkOn	Composite	0.241	2.4E-04	5.7E-04	2.40	5.73
FSCA 6	Kokanee	>30cm	FilletSkOn	Composite	0.061	6.1E-05	1.5E-04	0.61	1.45
FSCA 6	Largescale Sucker	>30cm	FilletSkOn	Composite	0.257	2.6E-04	6.1E-04	2.55	6.09
FSCA 6	Rainbow Trout	>30cm	FilletSkOn	Composite	0.075	7.5E-05	1.8E-04	0.75	1.78
FSCA 6	Smallmouth Bass	>15 to <=30cm	FilletSkOn	Composite	0.176	1.7E-04	4.2E-04	1.75	4.17
FSCA 6	Smallmouth Bass	>30cm	FilletSkOn	Composite	0.175	1.7E-04	4.1E-04	1.74	4.15
FSCA 6	Smallmouth Bass	>30cm	FilletSkOn	Single	0.158	1.6E-04	3.7E-04	1.57	3.75
FSCA 6	Walleye	>30cm	FilletSkOn	Composite	0.201	2.0E-04	4.8E-04	2.00	4.76
FSCA 6	Walleye	>30cm	FilletSkOn	Single	0.197	2.0E-04	4.7E-04	1.96	4.68

shaded value HQ > 1

Appendix C Table 1b - Exposure Dose Estimates for PBDE 47 in Fillets.									
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppb)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Public**	**HQ Subsistence Population**
FSCA 6	Largescale Sucker	>30cm	FilletSkOn	Multicoll	53.7	4.6E-05	1.1E-04	0.46	1.09

shaded value HQ > 1

Appendix C Table 1c - Exposure Dose Estimates for Total PBDE in Fillets.									
FSCA	**Common Name**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppb)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Public**	**HQ Subsistence Population**
FSCA 1	Mt Whitefish	>30cm	FilletSkOn	Single	47.9	4.1E-05	9.7E-05	0.41	0.97
FSCA 6	Largescale Sucker	>30cm	FilletSkOn	Multicoll	65.5	5.6E-05	1.3E-04	0.56	1.33

shaded value HQ > 1

Appendix C Table 1d - Exposure Dose Estimates for Total PCBs in Fillets.									
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppb)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Public**	**HQ Subsistence Population**
FSCA 1	Largescale Sucker	>30cm	FilletSkOn	Single	41.8	3.6E-05	8.5E-05	1.78	4.25
FSCA 1	Rainbow Trout	>30cm	FilletSkOn	Composite	30.9	2.6E-05	6.3E-05	1.32	3.14
FSCA 1	Mt Whitefish	>30cm	FilletSkOn	Single	33.9	2.9E-05	6.9E-05	1.44	3.44
FSCA 2	Largescale Sucker	>30cm	FilletSkOn	Composite	112.0	9.6E-05	2.3E-04	4.78	11.39
FSCA 2	Mt Whitefish	>30cm	FilletSkOn	Single	21.3	1.8E-05	4.3E-05	0.91	2.17
FSCA 2	Rainbow Trout	>30cm	FilletSkOn	Composite	28.8	2.5E-05	5.9E-05	1.23	2.93
FSCA 2	Smallmouth Bass	>30cm	FilletSkOn	Single	29.1	2.5E-05	5.9E-05	1.24	2.96
FSCA 3	Lake Whitefish	>30cm	FilletSkOn	Composite	14.8	1.3E-05	3.0E-05	0.63	1.51
FSCA 3	Largescale Sucker	>30cm	FilletSkOn	Composite	19.1	1.6E-05	3.9E-05	0.82	1.95
FSCA 4	Lake Whitefish	>30cm	FilletSkOn	Composite	18.9	1.6E-05	3.8E-05	0.81	1.92
FSCA 4	Largescale Sucker	>30cm	FilletSkOn	Single	56.6	4.8E-05	1.2E-04	2.42	5.76
FSCA 4	Longnose Sucker	>30cm	FilletSkOn	Composite	15.5	1.3E-05	3.2E-05	0.66	1.58
FSCA 5	Lake Whitefish	>30cm	FilletSkOn	Composite	28.7	2.4E-05	5.8E-05	1.22	2.92
FSCA 5	Largescale Sucker	>30cm	FilletSkOn	Single	66.5	5.7E-05	1.4E-04	2.83	6.76
FSCA 6	Largescale Sucker	>30cm	FilletSkOn	Composite	76.5	6.5E-05	1.6E-04	3.26	7.78

shaded value HQ > 1

Appendix C Table 1e - Exposure Dose Estimates for Total Dioxin TEQs in Fillets.									
FSCA	**Species**	**Size Class**	**Matrix Type**	**Sample Type**	**Mean (ppb)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Public**	**HQ Subsistence Population**
FSCA 1	Largescale Sucker	>30cm	FilletSkOn	Single	0.0007	5.70873E-10	1.36168E-09	0.57087346	1.36168141
FSCA 1	Mt Whitefish	>30cm	FilletSkOn	Single	0.0016	1.32653E-09	3.16413E-09	1.32653404	3.164128092
FSCA 1	Rainbow Trout	>30cm	FilletSkOn	Composite	0.001	8.72741E-10	2.08171E-09	0.87274075	2.081713268
FSCA 2	Burbot	>30cm	FilletSkOn	Single	0.0009	7.45107E-10	1.77727E-09	0.74510679	1.777273148
FSCA 2	Largescale Sucker	>30cm	FilletSkOn	Composite	0.0015	1.28611E-09	3.06772E-09	1.2861137	3.067715083
FSCA 2	Longnose Sucker	>30cm	FilletSkOn	Single	0.0008	6.91249E-10	1.64881E-09	0.69124919	1.648808792
FSCA 2	Mt Whitefish	>30cm	FilletSkOn	Single	0.0014	1.1792E-09	2.81269E-09	1.17919657	2.812689987
FSCA 2	Rainbow Trout	>30cm	FilletSkOn	Composite	0.0009	7.77288E-10	1.85403E-09	0.77728798	1.854033643
FSCA 2	Smallmouth Bass	>30cm	FilletSkOn	Single	0.0007	5.58071E-10	1.33114E-09	0.55807122	1.331144754
FSCA 2	Walleye	>30cm	FilletSkOn	Composite	0.0006	4.73573E-10	1.12959E-09	0.47357292	1.129594357
FSCA 3	Burbot	>30cm	FilletSkOn	Composite	0.0009	7.79598E-10	1.85954E-09	0.77959772	1.85954298
FSCA 3	Kokanee	>30cm	FilletSkOn	Composite	0.0007	5.82971E-10	1.39054E-09	0.58297117	1.390537594
FSCA 3	Lake Whitefish	>30cm	FilletSkOn	Composite	0.001	8.92951E-10	2.12992E-09	0.89295073	2.12991934
FSCA 3	Smallmouth Bass	>15 to <=30cm	FilletSkOn	Single	0.0009	7.59783E-10	1.81228E-09	0.75978311	1.812279975
FSCA 3	Smallmouth Bass	>30cm	FilletSkOn	Single	0.0009	7.72279E-10	1.84209E-09	0.77227934	1.842086745
FSCA 4	Kokanee	>30cm	FilletSkOn	Composite	0.0005	4.6231E-10	1.10273E-09	0.4623102	1.102729851
FSCA 4	Lake Whitefish	>30cm	FilletSkOn	Composite	0.0012	1.00359E-09	2.39383E-09	1.00359255	2.393828808
FSCA 4	Largescale Sucker	>30cm	FilletSkOn	Single	0.0014	1.22006E-09	2.91015E-09	1.22005613	2.910150633
FSCA 4	Longnose Sucker	>30cm	FilletSkOn	Composite	0.0011	9.72286E-10	2.31915E-09	0.97228551	2.319153369

FSCA 4	Smallmouth Bass	>30cm	FilletSkOn	Single	0.0013	1.14462E-09	2.73022E-09	1.14462081	2.730217807
FSCA 5	Kokanee	>30cm	FilletSkOn	Composite	0.0005	4.51736E-10	1.07751E-09	0.45173577	1.077507099
FSCA 5	Lake Whitefish	>30cm	FilletSkOn	Composite	0.0016	1.39399E-09	3.32503E-09	1.3939893	3.325026396
FSCA 5	Largescale Sucker	>30cm	FilletSkOn	Single	0.0017	1.40867E-09	3.36005E-09	1.40867342	3.360051837
FSCA 6	Burbot	>30cm	FilletSkOn	Composite	0.0005	4.55701E-10	1.08697E-09	0.45570137	1.086966073
FSCA 6	Kokanee	>30cm	FilletSkOn	Composite	0.0006	4.96663E-10	1.18467E-09	0.49666296	1.18467011
FSCA 6	Largescale Sucker	>30cm	FilletSkOn	Composite	0.0018	1.53583E-09	3.66335E-09	1.53583007	3.663353467

shaded value HQ > 1

Appendix C. Table 2a - Exposure Dose Estimates and HQs for Weighted Mercury Concentration in Fillets Across All FSCAs.

Species	Size Class	Mercury (ppm)	Estimated Dose General Public (mg/kg-day)	Estimated Dose Subsistence (mg/kg-day)	HQ General Population	HQ Subsistence Population
Burbot	>30cm	0.232	2.3E-04	5.5E-04	2.31	5.51
Kokanee	>30cm	0.064	6.4E-05	1.5E-04	0.64	1.52
Lake Whitefish	>30cm	0.091	9.1E-05	2.2E-04	0.91	2.16
Largescale Sucker	>30cm	0.300	3.0E-04	7.1E-04	2.99	7.12
Longnose Sucker	>30cm	0.124	1.2E-04	2.9E-04	1.23	2.94
Mt Whitefish	>30cm	0.083	8.3E-05	2.0E-04	0.83	1.97
Rainbow Trout	>30cm	0.076	7.6E-05	1.8E-04	0.76	1.80
Smallmouth Bass	>30cm	0.161	1.6E-04	3.8E-04	1.60	3.82
Walleye	>30cm	0.166	1.7E-04	3.9E-04	1.65	3.94
Walleye (composite)	>30cm	0.175	1.7E-04	4.2E-04	1.74	4.15
Walleye (individuals)	>30cm	0.165	1.6E-04	3.9E-04	1.64	3.92

Shaded value HQ > 1

Appendix C. Table 2b - Exposure Dose Estimates and HQs for Weighted PBDE 47 Concentration in Fillets Across All FSCAs.						
Species	**Size Class**	**PBDE-47 (ppb)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Population**	**HQ Subsistence Population**
Burbot	>30cm	1.2	1.0E-06	2.4E-06	0.01	0.02
Kokanee	>30cm	2.6	2.2E-06	5.3E-06	0.02	0.05
Lake Whitefish	>30cm	11.3	9.6E-06	2.3E-05	0.10	0.23
Largescale Sucker	>30cm	27.3	2.3E-05	5.6E-05	0.23	0.56
Longnose Sucker	>30cm	7.6	6.5E-06	1.6E-05	0.07	0.16
Mt Whitefish	>30cm	18.1	1.5E-05	3.7E-05	0.15	0.37
Rainbow Trout	>30cm	5.8	4.9E-06	1.2E-05	0.05	0.12
Smallmouth Bass	>30cm	4.4	3.7E-06	8.9E-06	0.04	0.09
Walleye	>30cm	3.0	2.6E-06	6.1E-06	0.03	0.06

Shaded value HQ > 1

Appendix C. Table 2c - Exposure Dose Estimates and HQs for Weighted Total PBDE Concentration in Fillets Across All FSCAs.						
Species	**Size Class**	**Total PBDEs (ppb)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Population**	**HQ Subsistence Population**
Burbot	>30cm	2.5	2.1E-06	5.1E-06	0.02	0.05
Kokanee	>30cm	5.4	4.6E-06	1.1E-05	0.05	0.11
Lake Whitefish	>30cm	17.5	1.5E-05	3.6E-05	0.15	0.36
Largescale Sucker	>30cm	34.5	2.9E-05	7.0E-05	0.29	0.70
Longnose Sucker	>30cm	9.9	8.5E-06	2.0E-05	0.08	0.20
Mt Whitefish	>30cm	27.4	2.3E-05	5.6E-05	0.23	0.56
Rainbow Trout	>30cm	12.2	1.0E-05	2.5E-05	0.10	0.25
Smallmouth Bass	>30cm	6.7	5.7E-06	1.4E-05	0.06	0.14
Walleye	>30cm	5.0	4.3E-06	1.0E-05	0.04	0.10

Shaded value HQ > 1

Appendix C. Table 2d - Exposure Dose Estimates and HQs for Weighted Total PCB Concentration in Fillets Across All FSCAs.						
Species	**Size Class**	**Total PCBs (ppb)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Population**	**HQ Subsistence Population**
Burbot	>30cm	2.2	1.9E-06	4.5E-06	0.10	0.23
Kokanee	>30cm	7.8	6.7E-06	1.6E-05	0.33	0.80
Lake Whitefish	>30cm	19.8	1.7E-05	4.0E-05	0.84	2.02
Largescale Sucker	>30cm	63.0	5.4E-05	1.3E-04	2.69	6.41
Longnose Sucker	>30cm	11.9	1.0E-05	2.4E-05	0.51	1.21
Mt Whitefish	>30cm	26.7	2.3E-05	5.4E-05	1.14	2.71
Rainbow Trout	>30cm	15.5	1.3E-05	3.2E-05	0.66	1.58
Smallmouth Bass	>30cm	6.6	5.6E-06	1.3E-05	0.28	0.67
Walleye	>30cm	6.2	5.3E-06	1.3E-05	0.26	0.63

Shaded value HQ > 1

Appendix C. Table 2e - Exposure Dose Estimates and HQs for Weighted Total Dioxin TEQ Concentration in Fillets Across All FSCAs						
Species	**Size Class**	**Total Dioxins (ppb)**	**Estimated Dose General Public (mg/kg-day)**	**Estimated Dose Subsistence (mg/kg-day)**	**HQ General Population**	**HQ Subsistence Population**
Burbot	>30cm	0.00060	5.1E-10	1.2E-09	0.51	1.23
Kokanee	>30cm	0.00052	4.5E-10	1.1E-09	0.45	1.07
Lake Whitefish	>30cm	0.00124	1.1E-09	2.5E-09	1.06	2.53
Largescale Sucker	>30cm	0.00132	1.1E-09	2.7E-09	1.13	2.68
Longnose Sucker	>30cm	0.00096	8.2E-10	2.0E-09	0.82	1.95
Mt Whitefish	>30cm	0.00146	1.2E-09	3.0E-09	1.24	2.96
Rainbow Trout	>30cm	0.00056	4.8E-10	1.1E-09	0.48	1.15
Smallmouth Bass	>30cm	0.00064	5.5E-10	1.3E-09	0.55	1.30
Walleye	>30cm	0.00044	3.8E-10	9.0E-10	0.38	0.90

Shaded value HQ > 1

Appendix C. Table 3 - General Population Hazard Quotient (HQ) and Hazard Index (HI) for Each FSCA - Neurological Endpoint.

FSCA	Species	Size Class	Sample Type	Mercury HQ	Total PBDEs HQ	Total PCBs HQ	HI
FSCA 1	Burbot	>30cm	Single	2.75	0.023	0.074	2.84
FSCA 1	Kokanee	>30cm	Composite	0.68	0.041	0.243	0.96
FSCA 1	Largescale Sucker	>30cm	Single	2.18	0.166	1.189	3.54
FSCA 1	Mt Whitefish	>30cm	Single	0.75	0.409	0.962	2.12
FSCA 1	Rainbow Trout	>30cm	Composite	0.76	0.189	0.877	1.83
FSCA 1	Walleye	>30cm	Composite	1.89	0.056	0.197	2.15
FSCA 2	Burbot	>30cm	Single	1.83	0.008	0.047	1.88
FSCA 2	Kokanee	>30cm	Composite	0.64	0.054	0.248	0.94
FSCA 2	Largescale Sucker	>30cm	Composite	2.16	0.284	3.184	5.63
FSCA 2	Longnose Sucker	>30cm	Single	0.70	0.051	0.251	1.00
FSCA 2	Mt Whitefish	>30cm	Single	0.88	0.294	0.606	1.78
FSCA 2	Rainbow Trout	>30cm	Composite	0.79	0.135	0.819	1.75
FSCA 2	Smallmouth Bass	>30cm	Single	1.56	0.166	0.826	2.56
FSCA 2	Walleye	>30cm	Composite	1.66	0.053	0.220	1.94
FSCA 3	Burbot	>30cm	Composite	2.27	0.008	0.044	2.32
FSCA 3	Kokanee	>30cm	Composite	0.59	0.034	0.252	0.87
FSCA 3	Lake Whitefish	>30cm	Composite	0.81	NA	0.421	1.23
FSCA 3	Largescale Sucker	>30cm	Composite	2.21	0.181	0.544	2.94
FSCA 3	Mt Whitefish	>30cm	Multicoll	NA	0.095	NA	0.095
FSCA 3	Rainbow Trout	>30cm	Composite	0.77	0.061	0.276	1.11
FSCA 3	Smallmouth Bass	>30cm	Single	2.16	0.030	0.145	2.34
FSCA 3	Walleye	>30cm	Composite	1.69	0.033	0.122	1.85
FSCA 4	Burbot	>30cm	Composite	2.40	0.037	0.064	2.50
FSCA 4	Kokanee	>30cm	Composite	0.65	0.044	0.205	0.90
FSCA 4	Lake Whitefish	>30cm	Composite	0.88	NA	0.537	1.42
FSCA 4	Largescale Sucker	>30cm	Single	3.69	0.228	1.610	5.53
FSCA 4	Longnose Sucker	>30cm	Composite	1.87	0.119	0.441	2.43
FSCA 4	Mt Whitefish	>30cm	Multicoll	NA	0.130	NA	0.130
FSCA 4	Rainbow Trout	>30cm	Composite	0.84	0.085	0.248	1.17
FSCA 4	Smallmouth Bass	>30cm	Single	1.26	0.018	0.102	1.38
FSCA 4	Walleye	>30cm	Composite	1.38	0.020	0.124	1.52

FSCA 5	Burbot	>30cm	Composite	2.35	0.027	0.082	2.46
FSCA 5	Kokanee	>30cm	Composite	0.63	0.058	0.220	0.91
FSCA 5	Lake Whitefish	>30cm	Composite	1.09	NA	0.816	1.91
FSCA 5	Largescale Sucker	>30cm	Single	4.60	0.315	1.890	6.80
FSCA 5	Mt Whitefish	>30cm	Multicoll	NA	0.328	NA	0.328
FSCA 5	Rainbow Trout	>30cm	Composite	0.65	0.102	0.201	0.95
FSCA 5	Smallmouth Bass	>30cm	Composite	1.41	0.063	0.183	1.66
FSCA 5	Walleye	>30cm	Composite	1.83	0.062	0.215	2.11
FSCA 6	Burbot	>30cm	Composite	2.40	0.021	0.068	2.49
FSCA 6	Kokanee	>30cm	Composite	0.61	0.046	0.156	0.81
FSCA 6	Largescale Sucker	>30cm	Composite	2.55	0.558	2.174	5.29
FSCA 6	Rainbow Trout	>30cm	Composite	0.75	0.054	0.226	1.03
FSCA 6	Smallmouth Bass	>30cm	Composite	1.74	0.059	0.171	1.97
FSCA 6	Walleye	>30cm	Composite	2.00	0.033	0.177	2.21

Shaded value HI >1

Appendix C. Table 4a - General Population Hazard Quotient (HQ) and Hazard Index (HI) - Neurological Endpoint.											
Species	**Size Class**	**Mercury Mean (ppm)**	**Mercury Dose (mg/kg-day)**	**Mercury HQ**	**Total PBDEs (ppb)**	**PBDE Dose (mg/kg-day)**	**Total PBDEs HQ**	**Total PCBs Mean (ppb)**	**PCB Dose (mg/kg-day)**	**Total PCBs HQ**	**HI**
Burbot	>30cm	0.232	2.0E-04	1.98	2.5	2.1E-06	0.021	2.2	1.9E-06	0.063	2.06
Kokanee	>30cm	0.064	5.5E-05	0.55	5.4	4.6E-06	0.046	7.8	6.7E-06	0.223	0.81
Lake Whitefish	>30cm	0.091	7.8E-05	0.78	17.5	1.5E-05	0.149	19.8	1.7E-05	0.563	1.49
Largescale Sucker	>30cm	0.300	2.6E-04	2.56	34.5	2.9E-05	0.294	63.0	5.4E-05	1.791	4.64
Longnose Sucker	>30cm	0.124	1.1E-04	1.06	9.9	8.5E-06	0.085	11.9	1.0E-05	0.337	1.48
Mt Whitefish	>30cm	0.083	7.1E-05	0.71	27.4	2.3E-05	0.234	26.7	2.3E-05	0.759	1.70
Rainbow Trout	>30cm	0.076	6.5E-05	0.65	12.2	1.0E-05	0.104	15.5	1.3E-05	0.441	1.19
Smallmouth Bass	>30cm	0.161	1.4E-04	1.37	6.7	5.7E-06	0.057	6.6	5.6E-06	0.187	1.62
Walleye	>30cm	0.166	1.4E-04	1.42	5.0	4.3E-06	0.043	6.2	5.3E-06	0.176	1.63

Shaded value HQ > 1

Table 4b - General Population Hazard Quotient (HQ) and Hazard Index (HI) - Developmental Endpoint.								
Species	**Size Class**	**Mercury Mean (ppm)**	**Mercury Dose (mg/kg-day)**	**Mercury HQ**	**Total PCBs Mean (ppb)**	**PCB Dose (mg/kg-day)**	**Total PCBs HQ**	**HI**
Burbot	>30cm	0.232	2.0E-04	0.66	2.2	1.9E-06	0.063	0.72
Kokanee	>30cm	0.064	5.5E-05	0.18	7.8	6.7E-06	0.223	0.40
Lake Whitefish	>30cm	0.091	7.8E-05	0.26	19.8	1.7E-05	0.563	0.82
Largescale Sucker	>30cm	0.300	2.6E-04	0.85	63.0	5.4E-05	1.791	2.64
Longnose Sucker	>30cm	0.124	1.1E-04	0.35	11.9	1.0E-05	0.337	0.69
Mt Whitefish	>30cm	0.083	7.1E-05	0.24	26.7	2.3E-05	0.759	0.99
Rainbow Trout	>30cm	0.076	6.5E-05	0.22	15.5	1.3E-05	0.441	0.66
Smallmouth Bass	>30cm	0.161	1.4E-04	0.46	6.6	5.6E-06	0.187	0.64
Walleye	>30cm	0.166	1.4E-04	0.47	6.2	5.3E-06	0.176	0.65

Shaded value HQ > 1

Table 4c - General Population Hazard Quotient (HQ) and Hazard Index (HI) - Immunological Endpoint.								
Species	**Size Class**	**Mercury Mean (ppm)**	**Mercury Dose (mg/kg-day)**	**Mercury HQ**	**Total PCBs Mean (ppb)**	**PCB Dose (mg/kg-day)**	**Total PCBs HQ**	**HI**
Burbot	>30cm	0.232	2.0E-04	0.66	2.2	1.9E-06	0.095	0.75
Kokanee	>30cm	0.064	5.5E-05	0.18	7.8	6.7E-06	0.334	0.52
Lake Whitefish	>30cm	0.091	7.8E-05	0.26	19.8	1.7E-05	0.845	1.10
Largescale Sucker	>30cm	0.300	2.6E-04	0.85	63.0	5.4E-05	2.686	3.54
Longnose Sucker	>30cm	0.124	1.1E-04	0.35	11.9	1.0E-05	0.506	0.86
Mt Whitefish	>30cm	0.083	7.1E-05	0.24	26.7	2.3E-05	1.138	1.37
Rainbow Trout	>30cm	0.076	6.5E-05	0.22	15.5	1.3E-05	0.662	0.88
Smallmouth Bass	>30cm	0.161	1.4E-04	0.46	6.6	5.6E-06	0.280	0.74
Walleye	>30cm	0.166	1.4E-04	0.47	6.2	5.3E-06	0.264	0.74

Shaded value HQ > 1

Species	Size Class	Mercury Mean (ppm)	Mercury Dose (mg/kg-day)	Mercury HQ	Total PCBs Mean (ppb)	PCB Dose (mg/kg-day)	Total PCBs HQ	HI
Burbot	>30cm	0.232	2.0E-04	0.49	2.2	1.9E-06	0.010	0.50
Kokanee	>30cm	0.064	5.5E-05	0.14	7.8	6.7E-06	0.033	0.17
Lake Whitefish	>30cm	0.091	7.8E-05	0.19	19.8	1.7E-05	0.084	0.28
Largescale Sucker	>30cm	0.300	2.6E-04	0.64	63.0	5.4E-05	0.269	0.91
Longnose Sucker	>30cm	0.124	1.1E-04	0.26	11.9	1.0E-05	0.051	0.31
Mt Whitefish	>30cm	0.083	7.1E-05	0.18	26.7	2.3E-05	0.114	0.29
Rainbow Trout	>30cm	0.076	6.5E-05	0.16	15.5	1.3E-05	0.066	0.23
Smallmouth Bass	>30cm	0.161	1.4E-04	0.34	6.6	5.6E-06	0.028	0.37
Walleye	>30cm	0.166	1.4E-04	0.35	6.2	5.3E-06	0.026	0.38

Table 4d - General Population Hazard Quotient (HQ) and Hazard Index (HI) - Reproductive Endpoint.

Shaded value HQ > 1

Appendix C. Table 5 - Subsistence Population Hazard Quotient (HQ) and Hazard Index (HI) for Each FSCA - Neurological Endpoint.

FSCA	Species	Size Class	Sample Type	Mercury HQ	Total PBDEs HQ	Total PCBs HQ	HI
FSCA 1	Burbot	>30cm	Single	6.55	0.056	0.175	6.78
FSCA 1	Kokanee	>30cm	Composite	1.61	0.098	0.580	2.29
FSCA 1	Largescale Sucker	>30cm	Single	5.20	0.397	2.836	8.43
FSCA 1	Mt Whitefish	>30cm	Single	1.79	0.975	2.296	5.06
FSCA 1	Rainbow Trout	>30cm	Composite	1.82	0.450	2.092	4.36
FSCA 1	Walleye	>30cm	Composite	4.52	0.134	0.471	5.12
FSCA 2	Burbot	>30cm	Single	4.36	0.019	0.111	4.49
FSCA 2	Kokanee	>30cm	Composite	1.52	0.128	0.592	2.24
FSCA 2	Largescale Sucker	>30cm	Composite	5.16	0.676	7.595	13.43
FSCA 2	Longnose Sucker	>30cm	Single	1.66	0.122	0.598	2.38
FSCA 2	Mt Whitefish	>30cm	Single	2.10	0.701	1.445	4.24
FSCA 2	Rainbow Trout	>30cm	Composite	1.90	0.321	1.955	4.17
FSCA 2	Smallmouth Bass	>30cm	Single	3.73	0.396	1.970	6.10
FSCA 2	Walleye	>30cm	Composite	3.97	0.126	0.526	4.62
FSCA 3	Burbot	>30cm	Composite	5.41	0.018	0.105	5.53
FSCA 3	Kokanee	>30cm	Composite	1.40	0.081	0.602	2.08
FSCA 3	Lake Whitefish	>30cm	Composite	1.93	NA	1.004	2.93
FSCA 3	Largescale Sucker	>30cm	Composite	5.27	0.433	1.297	7.00
FSCA 3	Mt Whitefish	>30cm	Multicoll	NA	0.228	NA	0.228
FSCA 3	Rainbow Trout	>30cm	Composite	1.84	0.145	0.659	2.64
FSCA 3	Smallmouth Bass	>30cm	Single	5.15	0.072	0.347	5.57
FSCA 3	Walleye	>30cm	Composite	4.04	0.079	0.290	4.41
FSCA 4	Burbot	>30cm	Composite	5.73	0.088	0.152	5.97
FSCA 4	Kokanee	>30cm	Composite	1.55	0.105	0.489	2.15
FSCA 4	Lake Whitefish	>30cm	Composite	2.11	NA	1.281	3.39
FSCA 4	Largescale Sucker	>30cm	Single	8.81	0.545	3.841	13.20
FSCA 4	Longnose Sucker	>30cm	Composite	4.46	0.283	1.052	5.80
FSCA 4	Mt Whitefish	>30cm	Multicoll	NA	0.311	NA	0.311
FSCA 4	Rainbow Trout	>30cm	Composite	2.00	0.203	0.592	2.79
FSCA 4	Smallmouth Bass	>30cm	Single	3.01	0.042	0.244	3.30
FSCA 4	Walleye	>30cm	Composite	3.29	0.048	0.296	3.63
FSCA 5	Burbot	>30cm	Composite	5.61	0.064	0.195	5.86
FSCA 5	Kokanee	>30cm	Composite	1.50	0.138	0.525	2.16
FSCA 5	Lake Whitefish	>30cm	Composite	2.61	NA	1.947	4.56

FSCA 5	Largescale Sucker	>30cm	Single	10.96	0.752	4.508	16.22
FSCA 5	Mt Whitefish	>30cm	Multicoll	NA	0.781	NA	0.78
FSCA 5	Rainbow Trout	>30cm	Composite	1.54	0.244	0.479	2.26
FSCA 5	Smallmouth Bass	>30cm	Composite	3.37	0.150	0.436	3.95
FSCA 5	Walleye	>30cm	Composite	4.36	0.148	0.513	5.03
FSCA 6	Burbot	>30cm	Composite	5.73	0.049	0.163	5.94
FSCA 6	Kokanee	>30cm	Composite	1.45	0.109	0.373	1.93
FSCA 6	Largescale Sucker	>30cm	Composite	6.09	1.332	5.186	12.61
FSCA 6	Rainbow Trout	>30cm	Composite	1.78	0.128	0.540	2.45
FSCA 6	Smallmouth Bass	>30cm	Composite	4.15	0.141	0.409	4.70
FSCA 6	Walleye	>30cm	Composite	4.76	0.079	0.422	5.26

Shaded values HI > 1

Appendix C. Table 6a - Subsistence Population Hazard Quotient (HQ) and Hazard Index (HI) - Neurological Endpoint.											
Species	**Size Class**	**Mercury Mean (ppm)**	**Mercury Dose (mg/kg-day)**	**Mercury HQ**	**Total PBDEs (ppb)**	**PBDE Dose (mg/kg-day)**	**Total PBDEs HQ**	**Total PCBs Mean (ppb)**	**PCB Dose (mg/kg-day)**	**Total PCBs HQ**	**HI**
Burbot	>30cm	0.232	5.5E-04	5.51	2.5	5.1E-06	0.051	2.2	4.5E-06	0.151	5.71
Kokanee	>30cm	0.064	1.5E-04	1.52	5.4	1.1E-05	0.110	7.8	1.6E-05	0.531	2.16
Lake Whitefish	>30cm	0.091	2.2E-04	2.16	17.5	3.6E-05	0.356	19.8	4.0E-05	1.344	3.86
Largescale Sucker	>30cm	0.300	7.1E-04	7.12	34.5	7.0E-05	0.702	63.0	1.3E-04	4.271	12.09
Longnose Sucker	>30cm	0.124	2.9E-04	2.94	9.9	2.0E-05	0.202	11.9	2.4E-05	0.804	3.95
Mt Whitefish	>30cm	0.083	2.0E-04	1.97	27.4	5.6E-05	0.557	26.7	5.4E-05	1.810	4.34
Rainbow Trout	>30cm	0.076	1.8E-04	1.80	12.2	2.5E-05	0.248	15.5	3.2E-05	1.053	3.10
Smallmouth Bass	>30cm	0.161	3.8E-04	3.82	6.7	1.4E-05	0.136	6.6	1.3E-05	0.446	4.40
Walleye	>30cm	0.166	3.9E-04	3.94	5.0	1.0E-05	0.102	6.2	1.3E-05	0.420	4.46

Shaded values HI > 1

Table 6b - Subsistence Population Hazard Quotient (HQ) and Hazard Index (HI) - Developmental Endpoint.								
Species	**Size Class**	**Mercury Mean (ppm)**	**Mercury Dose (mg/kg-day)**	**Mercury HQ**	**Total PCBs Mean (ppb)**	**PCB Dose (mg/kg-day)**	**Total PCBs HQ**	**HI**
Burbot	>30cm	0.232	5.5E-04	1.84	2.2	4.5E-06	0.151	1.99
Kokanee	>30cm	0.064	1.5E-04	0.51	7.8	1.6E-05	0.531	1.04
Lake Whitefish	>30cm	0.091	2.2E-04	0.72	19.8	4.0E-05	1.344	2.06
Largescale Sucker	>30cm	0.300	7.1E-04	2.37	63.0	1.3E-04	4.271	6.64
Longnose Sucker	>30cm	0.124	2.9E-04	0.98	11.9	2.4E-05	0.804	1.79
Mt Whitefish	>30cm	0.083	2.0E-04	0.66	26.7	5.4E-05	1.810	2.47
Rainbow Trout	>30cm	0.076	1.8E-04	0.60	15.5	3.2E-05	1.053	1.65
Smallmouth Bass	>30cm	0.161	3.8E-04	1.27	6.6	1.3E-05	0.446	1.72
Walleye	>30cm	0.166	3.9E-04	1.31	6.2	1.3E-05	0.420	1.73

Shaded values HI > 1

Table 6c - Subsistence Population Hazard Quotient (HQ) and Hazard Index (HI) - Immunological Endpoint.								
Species	**Size Class**	**Mercury Mean (ppm)**	**Mercury Dose (mg/kg-day)**	**Mercury HQ**	**Total PCBs Mean (ppb)**	**PCB Dose (mg/kg-day)**	**Total PCBs HQ**	**HI**
Burbot	>30cm	0.232	5.5E-04	1.84	2.2	4.5E-06	0.227	2.06
Kokanee	>30cm	0.064	1.5E-04	0.51	7.8	1.6E-05	0.797	1.30
Lake Whitefish	>30cm	0.091	2.2E-04	0.72	19.8	4.0E-05	2.015	2.74
Largescale Sucker	>30cm	0.300	7.1E-04	2.37	63.0	1.3E-04	6.407	8.78
Longnose Sucker	>30cm	0.124	2.9E-04	0.98	11.9	2.4E-05	1.206	2.19
Mt Whitefish	>30cm	0.083	2.0E-04	0.66	26.7	5.4E-05	2.714	3.37
Rainbow Trout	>30cm	0.076	1.8E-04	0.60	15.5	3.2E-05	1.579	2.18
Smallmouth Bass	>30cm	0.161	3.8E-04	1.27	6.6	1.3E-05	0.669	1.94
Walleye	>30cm	0.166	3.9E-04	1.31	6.2	1.3E-05	0.631	1.94

Shaded values HI > 1

Table 6d - Subsistence Population Hazard Quotient (HQ) and Hazard Index (HI) - Reproductive Endpoint.								
Species	**Size Class**	**Mercury Mean (ppm)**	**Mercury Dose (mg/kg-day)**	**Mercury HQ**	**Total PCBs Mean (ppb)**	**PCB Dose (mg/kg-day)**	**Total PCBs HQ**	**HI**
Burbot	>30cm	0.232	5.5E-04	1.38	2.2	4.5E-06	0.023	1.40
Kokanee	>30cm	0.064	1.5E-04	0.38	7.8	1.6E-05	0.080	0.46
Lake Whitefish	>30cm	0.091	2.2E-04	0.54	19.8	4.0E-05	0.202	0.74
Largescale Sucker	>30cm	0.300	7.1E-04	1.78	63.0	1.3E-04	0.641	2.42
Longnose Sucker	>30cm	0.124	2.9E-04	0.74	11.9	2.4E-05	0.121	0.86
Mt Whitefish	>30cm	0.083	2.0E-04	0.49	26.7	5.4E-05	0.271	0.76
Rainbow Trout	>30cm	0.076	1.8E-04	0.45	15.5	3.2E-05	0.158	0.61
Smallmouth Bass	>30cm	0.161	3.8E-04	0.96	6.6	1.3E-05	0.067	1.02
Walleye	>30cm	0.166	3.9E-04	0.98	6.2	1.3E-05	0.063	1.05

Shaded values HI > 1

Appendix C. Table 7 - Lead Data Summary for Fillet Samples with IEUBK Results.

						IEUBK	
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Mean (ppm)**	**GP Blood Lead Level (% above 10 ug/dl)**	**Sub Blood Lead Level (% above 10 ug/dl)**
FSCA 1	Burbot	>30cm	Single	1	0.024	0.292	0.337
FSCA 1	Kokanee	>30cm	Composite	6	0.004	0.287	0.286
FSCA 1	Largescale Sucker	>30cm	Single	3	0.393	0.415	2.805
FSCA 1	Mt Whitefish	>30cm	Single	3	0.010	0.288	0.300
FSCA 1	Rainbow Trout	>30cm	Composite	6	0.030	0.294	0.354
FSCA 1	Walleye	>30cm	Composite	5	0.027	0.293	0.346
FSCA 2	Burbot	>30cm	Single	3	0.042	0.298	0.390
FSCA 2	Kokanee	>30cm	Composite	6	0.008	0.288	0.295
FSCA 2	Largescale Sucker	>30cm	Composite	5	0.363	0.403	2.479
FSCA 2	Longnose Sucker	>30cm	Single	6	0.035	0.296	0.369
FSCA 2	Mt Whitefish	>30cm	Single	4	0.006	0.287	0.290
FSCA 2	Rainbow Trout	>30cm	Composite	6	0.020	0.291	0.327
FSCA 2	Smallmouth Bass	>30cm	Single	1	0.006	0.287	0.290
FSCA 2	Walleye	>30cm	Composite	6	0.033	0.295	0.363
FSCA 3	Burbot	>30cm	Composite	5	0.028	0.294	0.349
FSCA 3	Kokanee	>30cm	Composite	6	0.003	0.286	0.283
FSCA 3	Lake Whitefish	>30cm	Composite	6	0.013	0.289	0.308
FSCA 3	Largescale Sucker	>30cm	Composite	5	0.073	0.307	0.493
FSCA 3	Rainbow Trout	>30cm	Composite	6	0.015	0.290	0.313
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	0.001	0.286	0.278
FSCA 3	Smallmouth Bass	>30cm	Single	8	0.001	0.286	0.278
FSCA 3	Walleye	>30cm	Composite	6	0.029	0.294	0.351
FSCA 4	Burbot	>30cm	Composite	6	0.025	0.293	0.340

FSCA 4	Kokanee	>30cm	Composite	6	0.003	0.286	0.283
FSCA 4	Lake Whitefish	>30cm	Composite	6	0.007	0.287	0.293
FSCA 4	Largescale Sucker	>30cm	Single	9	0.151	0.331	0.834
FSCA 4	Longnose Sucker	>30cm	Composite	5	0.011	0.289	0.303
FSCA 4	Rainbow Trout	>30cm	Composite	6	0.041	0.297	0.387
FSCA 4	Smallmouth Bass	>30cm	Single	2	0.001	0.286	0.278
FSCA 4	Walleye	>30cm	Composite	6	0.031	0.294	0.357
FSCA 5	Burbot	>30cm	Composite	6	0.016	0.290	0.316
FSCA 5	Kokanee	>30cm	Composite	6	0.003	0.286	0.283
FSCA 5	Lake Whitefish	>30cm	Composite	4	0.007	0.287	0.293
FSCA 5	Largescale Sucker	>30cm	Single	4	0.095	0.314	0.576
FSCA 5	Rainbow Trout	>30cm	Composite	6	0.035	0.296	0.369
FSCA 5	Smallmouth Bass	>30cm	Composite	3	0.034	0.295	0.366
FSCA 5	Walleye	>30cm	Composite	6	0.030	0.294	0.354
FSCA 6	Burbot	>30cm	Composite	5	0.019	0.295	0.366
FSCA 6	Kokanee	>30cm	Composite	5	0.003	0.286	0.283
FSCA 6	Largescale Sucker	>30cm	Composite	6	0.086	0.311	0.541
FSCA 6	Rainbow Trout	>30cm	Composite	6	0.024	0.292	0.337
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	0.001	0.286	0.278
FSCA 6	Smallmouth Bass	>30cm	Composite	8	0.036	0.296	0.372
FSCA 6	Walleye	>30cm	Composite	6	0.031	0.294	0.357

GP = General Public Consumption Rate of 59.7 g/day
Sub = Subsistence Population Consumption Rate of 142.4 g/day

Appendix C. Table 8 - Lead Data Summary for Fillet Samples

FSCA	Species	Size Class	Sample Type	Number of Samples	Mean (ppm)	Adult Lead Model Predicted Blood Lead Levels			
						PbB GP adult (ug/dl)	PbB GP fetal 0.95 (ug/dl)	PbB Sub adult (ug/dl)	PbB Sub fetal 0.95 (ug/dl)
FSCA 1	Burbot	>30cm	Single	1	0.024	1.1	0.1%	1.2	0.1%
FSCA 1	Kokanee	>30cm	Composite	6	0.004	1.0	0.1%	1.0	0.1%
FSCA 1	Largescale Sucker	>30cm	Single	3	0.393	2.1	1.3%	3.7	**6.9%**
FSCA 1	Mt Whitefish	>30cm	Single	3	0.010	1.0	0.1%	1.1	0.1%
FSCA 1	Rainbow Trout	>30cm	Composite	6	0.030	1.1	0.1%	1.2	0.1%
FSCA 1	Walleye	>30cm	Composite	5	0.027	1.1	0.1%	1.2	0.1%
FSCA 2	Burbot	>30cm	Single	3	0.042	1.1	0.1%	1.3	0.2%
FSCA 2	Kokanee	>30cm	Composite	6	0.008	1.0	0.1%	1.1	0.1%
FSCA 2	Largescale Sucker	>30cm	Composite	5	0.363	2.0	1.1%	3.5	**5.9%**
FSCA 2	Longnose Sucker	>30cm	Single	6	0.035	1.1	0.1%	1.2	0.2%
FSCA 2	Mt Whitefish	>30cm	Single	4	0.006	1.0	0.1%	1.0	0.1%
FSCA 2	Rainbow Trout	>30cm	Composite	6	0.020	1.1	0.1%	1.1	0.1%
FSCA 2	Smallmouth Bass	>30cm	Single	1	0.006	1.0	0.1%	1.0	0.1%
FSCA 2	Walleye	>30cm	Composite	6	0.033	1.1	0.1%	1.2	0.1%
FSCA 3	Burbot	>30cm	Composite	5	0.028	1.1	0.1%	1.2	0.1%
FSCA 3	Kokanee	>30cm	Composite	6	0.003	1.0	0.1%	1.0	0.1%
FSCA 3	Lake Whitefish	>30cm	Composite	6	0.013	1.0	0.1%	1.1	0.1%
FSCA 3	Largescale Sucker	>30cm	Composite	5	0.073	1.2	0.1%	1.5	0.3%
FSCA 3	Rainbow Trout	>30cm	Composite	6	0.015	1.0	0.1%	1.1	0.1%
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	0.001	1.0	0.1%	1.0	0.1%
FSCA 3	Smallmouth Bass	>30cm	Single	8	0.001	1.0	0.1%	1.0	0.1%
FSCA 3	Walleye	>30cm	Composite	6	0.029	1.1	0.1%	1.2	0.1%

FSCA 4	Burbot	>30cm	Composite	6	0.025	1.1	0.1%	1.2	0.1%
FSCA 4	Kokanee	>30cm	Composite	6	0.003	1.0	0.1%	1.0	0.1%
FSCA 4	Lake Whitefish	>30cm	Composite	6	0.007	1.0	0.1%	1.1	0.1%
FSCA 4	Largescale Sucker	>30cm	Single	9	0.151	1.4	0.3%	2.0	1.1%
FSCA 4	Longnose Sucker	>30cm	Composite	5	0.011	1.0	0.1%	1.1	0.1%
FSCA 4	Rainbow Trout	>30cm	Composite	6	0.041	1.1	0.1%	1.3	0.2%
FSCA 4	Smallmouth Bass	>30cm	Single	2	0.001	1.0	0.1%	1.0	0.1%
FSCA 4	Walleye	>30cm	Composite	6	0.031	1.1	0.1%	1.2	0.1%
FSCA 5	Burbot	>30cm	Composite	6	0.016	1.0	0.1%	1.1	0.1%
FSCA 5	Kokanee	>30cm	Composite	6	0.003	1.0	0.1%	1.0	0.1%
FSCA 5	Lake Whitefish	>30cm	Composite	4	0.007	1.0	0.1%	1.0	0.1%
FSCA 5	Largescale Sucker	>30cm	Single	4	0.095	1.3	0.2%	1.6	0.5%
FSCA 5	Rainbow Trout	>30cm	Composite	6	0.035	1.1	0.1%	1.2	0.2%
FSCA 5	Smallmouth Bass	>30cm	Composite	3	0.034	1.1	0.1%	1.2	0.2%
FSCA 5	Walleye	>30cm	Composite	6	0.030	1.1	0.1%	1.2	0.1%
FSCA 6	Burbot	>30cm	Composite	5	0.019	1.1	0.1%	1.1	0.1%
FSCA 6	Kokanee	>30cm	Composite	5	0.003	1.0	0.1%	1.0	0.1%
FSCA 6	Largescale Sucker	>30cm	Composite	6	0.086	1.2	0.2%	1.6	0.4%
FSCA 6	Rainbow Trout	>30cm	Composite	6	0.024	1.1	0.1%	1.2	0.1%
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	0.001	1.0	0.1%	1.0	0.1%
FSCA 6	Smallmouth Bass	>30cm	Composite	8	0.036	1.1	0.1%	1.2	0.2%
FSCA 6	Walleye	>30cm	Composite	6	0.031	1.1	0.1%	1.2	0.1%

GP = General Public Consumption Rate of 59.7 g/day
Sub = Subsistence Population Consumption Rate of 142.4 g/day
ALM, Version June 2009

Appendix D

Appendix D. Table 1 - Total PCB Fillet Cancer Risks.									
FSCA	**Species**	**Size Class**	**Sample Type**	**Number of Samples**	**Mean (ppb)**	**General Population Dose (mg/kg-day)**	**Subsistence Population Dose (mg/kg-day)**	**General Population Cancer Risk**	**Subsistence Population Cancer Risk**
FSCA 1	Burbot	>30cm	Single	1	2.6	9.45E-07	5.26E-06	1.9E-06	1.1E-05
FSCA 1	Kokanee	>30cm	Composite	6	8.5	3.12E-06	1.74E-05	6.2E-06	3.5E-05
FSCA 1	Largescale Sucker	>30cm	Single	3	41.8	1.53E-05	8.51E-05	3.1E-05	1.7E-04
FSCA 1	Mt Whitefish	>30cm	Single	3	33.9	1.24E-05	6.89E-05	2.5E-05	1.4E-04
FSCA 1	Rainbow Trout	>30cm	Composite	6	30.9	1.13E-05	6.28E-05	2.3E-05	1.3E-04
FSCA 1	Walleye	>30cm	Composite	5	6.9	2.54E-06	1.41E-05	5.1E-06	2.8E-05
FSCA 2	Burbot	>30cm	Single	3	1.6	5.99E-07	3.34E-06	1.2E-06	6.7E-06
FSCA 2	Kokanee	>30cm	Composite	6	8.7	3.19E-06	1.78E-05	6.4E-06	3.6E-05
FSCA 2	Largescale Sucker	>30cm	Composite	5	112.0	4.09E-05	2.28E-04	8.2E-05	4.6E-04
FSCA 2	Longnose Sucker	>30cm	Single	6	8.8	3.22E-06	1.79E-05	6.4E-06	3.6E-05
FSCA 2	Mt Whitefish	>30cm	Single	4	21.3	7.79E-06	4.34E-05	1.6E-05	8.7E-05
FSCA 2	Rainbow Trout	>30cm	Composite	6	28.8	1.05E-05	5.86E-05	2.1E-05	1.2E-04
FSCA 2	Smallmouth Bass	>30cm	Single	1	29.1	1.06E-05	5.91E-05	2.1E-05	1.2E-04
FSCA 2	Walleye	>30cm	Composite	6	7.8	2.83E-06	1.58E-05	5.7E-06	3.2E-05
FSCA 3	Burbot	>30cm	Composite	5	1.5	5.63E-07	3.14E-06	1.1E-06	6.3E-06
FSCA 3	Kokanee	>30cm	Composite	6	8.9	3.24E-06	1.80E-05	6.5E-06	3.6E-05
FSCA 3	Lake Whitefish	>30cm	Composite	6	14.8	5.41E-06	3.01E-05	1.1E-05	6.0E-05
FSCA 3	Largescale Sucker	>30cm	Composite	5	19.1	6.99E-06	3.89E-05	1.4E-05	7.8E-05
FSCA 3	Rainbow Trout	>30cm	Composite	6	9.7	3.55E-06	1.98E-05	7.1E-06	4.0E-05
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	2.9	1.06E-06	5.91E-06	2.1E-06	1.2E-05

FSCA 3	Smallmouth Bass	>30cm	Single	8	5.1	1.87E-06	1.04E-05	3.7E-06	2.1E-05
FSCA 3	Walleye	>30cm	Composite	6	4.3	1.56E-06	8.71E-06	3.1E-06	1.7E-05
FSCA 4	Burbot	>30cm	Composite	6	2.2	8.20E-07	4.56E-06	1.6E-06	9.1E-06
FSCA 4	Kokanee	>30cm	Composite	6	7.2	2.63E-06	1.47E-05	5.3E-06	2.9E-05
FSCA 4	Lake Whitefish	>30cm	Composite	6	18.9	6.90E-06	3.84E-05	1.4E-05	7.7E-05
FSCA 4	Largescale Sucker	>30cm	Single	9	56.6	2.07E-05	1.15E-04	4.1E-05	2.3E-04
FSCA 4	Longnose Sucker	>30cm	Composite	5	15.5	5.67E-06	3.16E-05	1.1E-05	6.3E-05
FSCA 4	Rainbow Trout	>30cm	Composite	6	8.7	3.19E-06	1.78E-05	6.4E-06	3.6E-05
FSCA 4	Smallmouth Bass	>30cm	Single	2	3.6	1.32E-06	7.32E-06	2.6E-06	1.5E-05
FSCA 4	Walleye	>30cm	Composite	6	4.4	1.59E-06	8.87E-06	3.2E-06	1.8E-05
FSCA 5	Burbot	>30cm	Composite	6	2.9	1.05E-06	5.86E-06	2.1E-06	1.2E-05
FSCA 5	Kokanee	>30cm	Composite	6	7.7	2.83E-06	1.57E-05	5.7E-06	3.1E-05
FSCA 5	Lake Whitefish	>30cm	Composite	4	28.7	1.05E-05	5.84E-05	2.1E-05	1.2E-04
FSCA 5	Largescale Sucker	>30cm	Single	4	66.5	2.43E-05	1.35E-04	4.9E-05	2.7E-04
FSCA 5	Rainbow Trout	>30cm	Composite	6	7.1	2.58E-06	1.44E-05	5.2E-06	2.9E-05
FSCA 5	Smallmouth Bass	>30cm	Composite	3	6.4	2.35E-06	1.31E-05	4.7E-06	2.6E-05
FSCA 5	Walleye	>30cm	Composite	6	7.6	2.76E-06	1.54E-05	5.5E-06	3.1E-05
FSCA 6	Burbot	>30cm	Composite	5	2.4	8.76E-07	4.88E-06	1.8E-06	9.8E-06
FSCA 6	Kokanee	>30cm	Composite	5	5.5	2.01E-06	1.12E-05	4.0E-06	2.2E-05
FSCA 6	Largescale Sucker	>30cm	Composite	6	76.5	2.80E-05	1.56E-04	5.6E-05	3.1E-04
FSCA 6	Rainbow Trout	>30cm	Composite	6	8.0	2.91E-06	1.62E-05	5.8E-06	3.2E-05
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	6.1	2.23E-06	1.24E-05	4.5E-06	2.5E-05
FSCA 6	Smallmouth Bass	>30cm	Composite	8	6.0	2.20E-06	1.23E-05	4.4E-06	2.5E-05
FSCA 6	Walleye	>30cm	Composite	6	6.2	2.27E-06	1.26E-05	4.5E-06	2.5E-05

Appendix D. Table 2 - Summary of Total PCB Fillet Cancer Risks Based on Weighted Means.						
Species	**Size Class**	**UCR Mean (ppb)**	**General Population Dose (mg/kg-day)**	**Subsistence Population Dose (mg/kg-day)**	**General Population Cancer Risk**	**Subsistence Population Cancer Risk**
Burbot	>30cm	2.2	8.14E-07	4.53E-06	1.6E-06	9.1E-06
Kokanee	>30cm	7.8	2.86E-06	1.59E-05	5.7E-06	3.2E-05
Lake Whitefish	>30cm	19.8	7.24E-06	4.03E-05	1.4E-05	8.1E-05
Largescale Sucker	>30cm	63.0	2.30E-05	1.28E-04	4.6E-05	2.6E-04
Longnose Sucker	>30cm	11.9	4.34E-06	2.41E-05	8.7E-06	4.8E-05
Mt Whitefish	>30cm	26.7	9.75E-06	5.43E-05	2.0E-05	1.1E-04
Rainbow Trout	>30cm	15.5	5.67E-06	3.16E-05	1.1E-05	6.3E-05
Smallmouth Bass	>30cm	6.6	2.40E-06	1.34E-05	4.8E-06	2.7E-05
Walleye	>30cm	6.2	2.27E-06	1.26E-05	4.5E-06	2.5E-05

Appendix D. Table 3 - Total Dioxin TEQ Fillet Cancer Risks.

FSCA	Species	Size Class	Sample Type	Number of Samples	Mean (ppb)	General Population Dose (mg/kg-day)	Subsistence Population Dose (mg/kg-day)	General Population Cancer Risk	Subsistence Population Cancer Risk
FSCA 1	Burbot	>30cm	Single	1	0.00013	4.81E-11	2.68E-10	7.5E-06	4.2E-05
FSCA 1	Kokanee	>30cm	Composite	6	0.00038	1.38E-10	7.68E-10	2.2E-05	1.2E-04
FSCA 1	Largerscale Sucker	>30cm	Single	3	0.00067	2.45E-10	1.36E-09	3.8E-05	2.1E-04
FSCA 1	Mt Whitefish	>30cm	Single	3	0.00156	5.69E-10	3.16E-09	8.9E-05	4.9E-04
FSCA 1	Rainbow Trout	>30cm	Composite	6	0.00102	3.74E-10	2.08E-09	5.8E-05	3.2E-04
FSCA 1	Walleye	>30cm	Composite	5	0.00049	1.78E-10	9.92E-10	2.8E-05	1.5E-04
FSCA 2	Burbot	>30cm	Single	3	0.00087	3.19E-10	1.78E-09	5.0E-05	2.8E-04
FSCA 2	Kokanee	>30cm	Composite	6	0.00044	1.61E-10	8.96E-10	2.5E-05	1.4E-04
FSCA 2	Largerscale Sucker	>30cm	Composite	5	0.00151	5.51E-10	3.07E-09	8.6E-05	4.8E-04
FSCA 2	Longnose Sucker	>30cm	Single	6	0.00081	2.96E-10	1.65E-09	4.6E-05	2.6E-04
FSCA 2	Mt Whitefish	>30cm	Single	4	0.00138	5.05E-10	2.81E-09	7.9E-05	4.4E-04
FSCA 2	Rainbow Trout	>30cm	Composite	6	0.00091	3.33E-10	1.85E-09	5.2E-05	2.9E-04
FSCA 2	Smallmouth Bass	>30cm	Single	1	0.00065	2.39E-10	1.33E-09	3.7E-05	2.1E-04
FSCA 2	Walleye	>30cm	Composite	6	0.00056	2.03E-10	1.13E-09	3.2E-05	1.8E-04
FSCA 3	Burbot	>30cm	Composite	5	0.00091	3.34E-10	1.86E-09	5.2E-05	2.9E-04
FSCA 3	Kokanee	>30cm	Composite	6	0.00068	2.50E-10	1.39E-09	3.9E-05	2.2E-04
FSCA 3	Lake Whitefish	>30cm	Composite	6	0.00105	3.83E-10	2.13E-09	6.0E-05	3.3E-04
FSCA 3	Largerscale Sucker	>30cm	Composite	5	0.00048	1.74E-10	9.67E-10	2.7E-05	1.5E-04
FSCA 3	Rainbow Trout	>30cm	Composite	6	0.00041	1.49E-10	8.30E-10	2.3E-05	1.3E-04
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	1	0.00089	3.26E-10	1.81E-09	5.1E-05	2.8E-04
FSCA 3	Smallmouth Bass	>30cm	Single	8	0.00091	3.31E-10	1.84E-09	5.2E-05	2.9E-04
FSCA 3	Walleye	>30cm	Composite	6	0.00049	1.78E-10	9.91E-10	2.8E-05	1.5E-04

FSCA 4	Burbot	>30cm	Composite	6	0.00048	1.75E-10	9.74E-10	2.7E-05	1.5E-04
FSCA 4	Kokanee	>30cm	Composite	6	0.00054	1.98E-10	1.10E-09	3.1E-05	1.7E-04
FSCA 4	Lake Whitefish	>30cm	Composite	6	0.00118	4.30E-10	2.39E-09	6.7E-05	3.7E-04
FSCA 4	Largerscale Sucker	>30cm	Single	9	0.00143	5.23E-10	2.91E-09	8.2E-05	4.5E-04
FSCA 4	Longnose Sucker	>30cm	Composite	5	0.00114	4.17E-10	2.32E-09	6.5E-05	3.6E-04
FSCA 4	Rainbow Trout	>30cm	Composite	6	0.00039	1.43E-10	7.98E-10	2.2E-05	1.2E-04
FSCA 4	Smallmouth Bass	>30cm	Single	2	0.00134	4.91E-10	2.73E-09	7.7E-05	4.3E-04
FSCA 4	Walleye	>30cm	Composite	6	0.00039	1.44E-10	8.02E-10	2.2E-05	1.3E-04
FSCA 5	Burbot	>30cm	Composite	6	0.00047	1.71E-10	9.52E-10	2.7E-05	1.5E-04
FSCA 5	Kokanee	>30cm	Composite	6	0.00053	1.94E-10	1.08E-09	3.0E-05	1.7E-04
FSCA 5	Lake Whitefish	>30cm	Composite	4	0.00163	5.97E-10	3.33E-09	9.3E-05	5.2E-04
FSCA 5	Largerscale Sucker	>30cm	Single	4	0.00165	6.04E-10	3.36E-09	9.4E-05	5.2E-04
FSCA 5	Rainbow Trout	>30cm	Composite	6	0.00032	1.17E-10	6.50E-10	1.8E-05	1.0E-04
FSCA 5	Smallmouth Bass	>30cm	Composite	3	0.00029	1.04E-10	5.80E-10	1.6E-05	9.0E-05
FSCA 5	Walleye	>30cm	Composite	6	0.00029	1.04E-10	5.82E-10	1.6E-05	9.1E-05
FSCA 6	Burbot	>30cm	Composite	5	0.00053	1.95E-10	1.09E-09	3.0E-05	1.7E-04
FSCA 6	Kokanee	>30cm	Composite	5	0.00058	2.13E-10	1.18E-09	3.3E-05	1.8E-04
FSCA 6	Largerscale Sucker	>30cm	Composite	6	0.00180	6.58E-10	3.66E-09	1.0E-04	5.7E-04
FSCA 6	Rainbow Trout	>30cm	Composite	6	0.00033	1.21E-10	6.75E-10	1.9E-05	1.1E-04
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	1	0.00037	1.34E-10	7.45E-10	2.1E-05	1.2E-04
FSCA 6	Smallmouth Bass	>30cm	Composite	8	0.00033	1.21E-10	6.72E-10	1.9E-05	1.0E-04
FSCA 6	Walleye	>30cm	Composite	6	0.00045	1.65E-10	9.18E-10	2.6E-05	1.4E-04

Appendix D. Table 4 - Summary of Total Dioxin TEQ Fillet Cancer Risks.						
Species	**Size Class**	**Total Dioxin TEQ (ppb)**	**General Population Dose (mg/kg-day)**	**Subsistence Population Dose (mg/kg-day)**	**General Population Cancer Risk**	**Subsistence Population Cancer Risk**
Burbot	>30cm	0.00060	2.20E-10	1.23E-09	3.4E-05	1.9E-04
Kokanee	>30cm	0.00052	1.92E-10	1.07E-09	3.0E-05	1.7E-04
Lake Whitefish	>30cm	0.00124	4.54E-10	2.53E-09	7.1E-05	3.9E-04
Largerscale Sucker	>30cm	0.00132	94.82E-10	2.68E-09	7.5E-05	4.2E-04
Longnose Sucker	>30cm	0.00096	3.51E-10	1.95E-09	5.5E-05	3.0E-04
Mt Whitefish	>30cm	0.00146	5.32E-10	2.96E-09	8.3E-05	4.6E-04
Rainbow Trout	>30cm	0.00056	2.06E-10	1.15E-09	3.2E-05	1.8E-04
Smallmouth Bass	>30cm	0.00064	2.34E-10	1.30E-09	3.6E-05	2.0E-04
Walleye	>30cm	0.00044	1.62E-10	9.00E-10	2.5E-05	1.4E-04

Appendix D. Table 5 - Summary of Total Fillet Cancer Risks.							
Species	**Size Class**	**PCB General Population Cancer Risk**	**PCB Subsistence Population Cancer Risk**	**Dioxin General Population Cancer Risk**	**Dioxin Subsistence Population Cancer Risk**	**Total Cancer Risk General Population**	**Total Cancer Risk General Population**
Burbot	>30cm	1.6E-06	9.1E-06	3.4E-05	1.9E-04	3.6E-05	2.0E-04
Kokanee	>30cm	5.7E-06	3.2E-05	3.0E-05	1.7E-04	3.6E-05	2.0E-04
Lake Whitefish	>30cm	1.4E-05	8.1E-05	7.1E-05	3.9E-04	8.5E-05	4.7E-04
Largescale Sucker	>30cm	4.6E-05	2.6E-04	7.5E-05	4.2E-04	1.2E-04	6.7E-04
Longnose Sucker	>30cm	8.7E-06	4.8E-05	5.5E-05	3.0E-04	6.3E-05	3.5E-04
Mt Whitefish	>30cm	2.0E-05	1.1E-04	8.3E-05	4.6E-04	1.0E-04	5.7E-04
Rainbow Trout	>30cm	1.1E-05	6.3E-05	3.2E-05	1.8E-04	4.4E-05	2.4E-04
Smallmouth Bass	>30cm	4.8E-06	2.7E-05	3.6E-05	2.0E-04	4.1E-05	2.3E-04
Walleye	>30cm	4.5E-06	2.5E-05	2.5E-05	1.4E-04	3.0E-05	1.7E-04

APPENDIX E

Appendix E. Table 1 - Calculated Meal Limits for Fillet Samples Based on Mercury Concentrations.

FSCA	Species	Size Class	Sample Type	Mean (ppm)	Meals Per Month	Rounded Meal Limit
FSCA 1	Burbot	>30cm	Single	0.276	2.9	2
FSCA 1	Kokanee	>30cm	Composite	0.068	11.8	Unlimited
FSCA 1	Largescale Sucker	>30cm	Single	0.219	3.7	4
FSCA 1	Mt Whitefish	>30cm	Single	0.075	10.7	Unlimited
FSCA 1	Rainbow Trout	>30cm	Composite	0.076	10.5	Unlimited
FSCA 1	Walleye	>30cm	Composite	0.190	4.2	4
FSCA 1	Walleye	>30cm	Single	0.163	4.9	4
FSCA 2	Burbot	>30cm	Single	0.183	4.4	4
FSCA 2	Kokanee	>30cm	Composite	0.064	12.5	Unlimited
FSCA 2	Largescale Sucker	>30cm	Composite	0.217	3.7	4
FSCA 2	Longnose Sucker	>30cm	Single	0.070	11.5	Unlimited
FSCA 2	Mt Whitefish	>30cm	Single	0.088	9.1	Unlimited
FSCA 2	Rainbow Trout	>30cm	Composite	0.080	10.1	Unlimited
FSCA 2	Smallmouth Bass	>30cm	Single	0.157	5.1	4
FSCA 2	Walleye	>30cm	Composite	0.167	4.8	4
FSCA 2	Walleye	>30cm	Single	0.165	4.9	4
FSCA 3	Burbot	>30cm	Composite	0.228	3.5	4
FSCA 3	Kokanee	>30cm	Composite	0.059	13.6	Unlimited
FSCA 3	Lake Whitefish	>30cm	Composite	0.081	9.9	Unlimited
FSCA 3	Largescale Sucker	>30cm	Composite	0.222	3.6	4
FSCA 3	Rainbow Trout	>30cm	Composite	0.077	10.4	Unlimited
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	0.165	4.9	4
FSCA 3	Smallmouth Bass	>30cm	Single	0.217	3.7	4
FSCA 3	Walleye	>30cm	Composite	0.170	4.7	4
FSCA 3	Walleye	>30cm	Single	0.172	4.7	4
FSCA 4	Burbot	>30cm	Composite	0.241	3.3	4
FSCA 4	Kokanee	>30cm	Composite	0.065	12.3	Unlimited
FSCA 4	Lake Whitefish	>30cm	Composite	0.089	9.1	Unlimited
FSCA 4	Largescale Sucker	>30cm	Single	0.371	2.2	2
FSCA 4	Longnose Sucker	>30cm	Composite	0.188	4.3	4
FSCA 4	Rainbow Trout	>30cm	Composite	0.084	9.6	Unlimited
FSCA 4	Smallmouth Bass	>30cm	Single	0.127	6.3	8
FSCA 4	Walleye	>30cm	Composite	0.138	5.8	4
FSCA 4	Walleye	>30cm	Single	0.122	6.6	8
FSCA 5	Burbot	>30cm	Composite	0.236	3.4	4

FSCA 5	Kokanee	>30cm	Composite	0.063	12.8	Unlimited
FSCA 5	Lake Whitefish	>30cm	Composite	0.110	7.3	8
FSCA 5	Largescale Sucker	>30cm	Single	0.462	1.7	2
FSCA 5	Rainbow Trout	>30cm	Composite	0.065	12.4	Unlimited
FSCA 5	Smallmouth Bass	>30cm	Composite	0.142	5.7	4
FSCA 5	Smallmouth Bass	>30cm	Single	0.147	5.5	4
FSCA 5	Walleye	>30cm	Composite	0.184	4.4	4
FSCA 5	Walleye	>30cm	Single	0.170	4.7	4
FSCA 6	Burbot	>30cm	Composite	0.241	3.3	4
FSCA 6	Kokanee	>30cm	Composite	0.061	13.2	Unlimited
FSCA 6	Largescale Sucker	>30cm	Composite	0.257	3.1	4
FSCA 6	Rainbow Trout	>30cm	Composite	0.075	10.7	Unlimited
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	0.176	4.6	4
FSCA 6	Smallmouth Bass	>30cm	Composite	0.175	4.6	4
FSCA 6	Smallmouth Bass	>30cm	Single	0.158	5.1	4
FSCA 6	Walleye	>30cm	Composite	0.201	4.0	4
FSCA 6	Walleye	>30cm	Single	0.197	4.1	4

Non-detect results have been evaluated at 1/2 the detection limit.

Appendix E. Table 2 - Calculated Meal Limits for Fillet Samples Based on Total PBDE Concentrations.						
FSCA	**Common Name**	**Size Class**	**Sample Type**	**Mean (ppb)**	**Meals Per Month**	**Rounded Meal Limit**
FSCA 1	Burbot	>30cm	Single	2.7	294.0	Unlimited
FSCA 1	Kokanee	>30cm	Multicoll	4.8	166.7	Unlimited
FSCA 1	Largescale Sucker	>30cm	Single	19.5	41.3	Unlimited
FSCA 1	Mt Whitefish	>30cm	Single	47.9	16.8	Unlimited
FSCA 1	Rainbow Trout	>30cm	Multicoll	22.1	36.3	Unlimited
FSCA 1	Walleye	>30cm	Multicoll	6.6	122.0	Unlimited
FSCA 2	Burbot	>30cm	Single	0.9	864.9	Unlimited
FSCA 2	Kokanee	>30cm	Multicoll	6.3	127.6	Unlimited
FSCA 2	Largescale Sucker	>30cm	Multicoll	33.2	24.2	Unlimited
FSCA 2	Longnose Sucker	>30cm	Single	6.0	134.5	Unlimited
FSCA 2	Mt Whitefish	>30cm	Single	34.5	23.3	Unlimited
FSCA 2	Rainbow Trout	>30cm	Multicoll	15.8	51.0	Unlimited
FSCA 2	Smallmouth Bass	>30cm	Single	19.5	41.3	Unlimited
FSCA 2	Walleye	>30cm	Multicoll	6.2	129.5	Unlimited
FSCA 3	Burbot	>30cm	Multicoll	0.9	913.9	Unlimited
FSCA 3	Kokanee	>30cm	Multicoll	4.0	202.2	Unlimited
FSCA 3	Largescale Sucker	>30cm	Multicoll	21.3	37.8	Unlimited
FSCA 3	Mt Whitefish	>30cm	Multicoll	11.2	71.9	Unlimited
FSCA 3	Rainbow Trout	>30cm	Multicoll	7.1	113.1	Unlimited
FSCA 3	Smallmouth Bass	>30cm	Single	3.6	225.8	Unlimited
FSCA 3	Walleye	>30cm	Multicoll	3.9	206.5	Unlimited
FSCA 4	Burbot	>30cm	Multicoll	4.3	185.9	Unlimited
FSCA 4	Kokanee	>30cm	Multicoll	5.2	155.5	Unlimited
FSCA 4	Largescale Sucker	>30cm	Single	26.8	30.0	Unlimited
FSCA 4	Longnose Sucker	>30cm	Multicoll	13.9	57.9	Unlimited
FSCA 4	Mt Whitefish	>30cm	Multicoll	15.3	52.6	Unlimited
FSCA 4	Rainbow Trout	>30cm	Multicoll	10.0	80.6	Unlimited
FSCA 4	Smallmouth Bass	>30cm	Single	2.1	389.2	Unlimited
FSCA 4	Walleye	>30cm	Multicoll	2.4	337.9	Unlimited
FSCA 5	Burbot	>30cm	Multicoll	3.1	257.5	Unlimited
FSCA 5	Kokanee	>30cm	Multicoll	6.8	118.4	Unlimited
FSCA 5	Largescale Sucker	>30cm	Single	37.0	21.8	Unlimited
FSCA 5	Mt Whitefish	>30cm	Multicoll	38.4	21.0	Unlimited
FSCA 5	Rainbow Trout	>30cm	Multicoll	12.0	67.2	Unlimited
FSCA 5	Smallmouth Bass	>30cm	Multicoll	7.4	109.1	Unlimited
FSCA 5	Walleye	>30cm	Multicoll	7.3	110.7	Unlimited
FSCA 6	Burbot	>30cm	Multicoll	2.4	330.9	Unlimited

FSCA 6	Kokanee	>30cm	Multicoll	5.4	149.7	Unlimited
FSCA 6	Largescale Sucker	>30cm	Multicoll	65.5	12.3	Unlimited
FSCA 6	Rainbow Trout	>30cm	Multicoll	6.3	127.6	Unlimited
FSCA 6	Smallmouth Bass	>15 to <=30cm	Multicoll	3.2	252.8	Unlimited
FSCA 6	Smallmouth Bass	>30cm	Multicoll	6.9	116.1	Unlimited
FSCA 6	Walleye	>30cm	Multicoll	3.9	208.5	Unlimited

Appendix E. Table 3 - Calculated Meal Limits for Fillet Samples Based on Total PCB Concentrations.

FSCA	Species	Size Class	Sample Type	Mean (ppb)	Meals Per Month	Rounded Meal Limit
FSCA 1	Burbot	>30cm	Single	2.6	72.6	Unlimited
FSCA 1	Kokanee	>30cm	Composite	8.5	22.0	Unlimited
FSCA 1	Largescale Sucker	>30cm	Single	41.8	4.5	4
FSCA 1	Mt Whitefish	>30cm	Single	33.9	5.5	4
FSCA 1	Rainbow Trout	>30cm	Composite	30.9	6.1	8
FSCA 1	Walleye	>30cm	Composite	6.9	27.0	Unlimited
FSCA 2	Burbot	>30cm	Single	1.6	114.5	Unlimited
FSCA 2	Kokanee	>30cm	Composite	8.7	21.5	Unlimited
FSCA 2	Largescale Sucker	>30cm	Composite	112.0	1.7	2
FSCA 2	Longnose Sucker	>30cm	Single	8.8	21.3	Unlimited
FSCA 2	Mt Whitefish	>30cm	Single	21.3	8.8	Unlimited
FSCA 2	Rainbow Trout	>30cm	Composite	28.8	6.5	8
FSCA 2	Smallmouth Bass	>30cm	Single	29.1	6.5	8
FSCA 2	Walleye	>30cm	Composite	7.8	24.2	Unlimited
FSCA 3	Burbot	>30cm	Composite	1.5	121.8	Unlimited
FSCA 3	Kokanee	>30cm	Composite	8.9	21.2	Unlimited
FSCA 3	Lake Whitefish	>30cm	Composite	14.8	12.7	Unlimited
FSCA 3	Largescale Sucker	>30cm	Composite	19.1	9.8	Unlimited
FSCA 3	Rainbow Trout	>30cm	Composite	9.7	19.3	Unlimited
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	2.9	64.6	Unlimited
FSCA 3	Smallmouth Bass	>30cm	Single	5.1	36.7	Unlimited
FSCA 3	Walleye	>30cm	Composite	4.3	43.9	Unlimited
FSCA 4	Burbot	>30cm	Composite	2.2	83.7	Unlimited
FSCA 4	Kokanee	>30cm	Composite	7.2	26.0	Unlimited
FSCA 4	Lake Whitefish	>30cm	Composite	18.9	9.9	Unlimited
FSCA 4	Largescale Sucker	>30cm	Single	56.6	3.3	4
FSCA 4	Longnose Sucker	>30cm	Composite	15.5	12.1	Unlimited
FSCA 4	Rainbow Trout	>30cm	Composite	8.7	21.5	Unlimited
FSCA 4	Smallmouth Bass	>30cm	Single	3.6	52.1	Unlimited
FSCA 4	Walleye	>30cm	Composite	4.4	43.1	Unlimited
FSCA 5	Burbot	>30cm	Composite	2.9	65.2	Unlimited
FSCA 5	Kokanee	>30cm	Composite	7.7	24.3	Unlimited
FSCA 5	Lake Whitefish	>30cm	Composite	28.7	6.5	8
FSCA 5	Largescale Sucker	>30cm	Single	66.5	2.8	2
FSCA 5	Rainbow Trout	>30cm	Composite	7.1	26.6	Unlimited

FSCA 5	Smallmouth Bass	>30cm	Composite	6.4	29.2	Unlimited
FSCA 5	Walleye	>30cm	Composite	7.6	24.8	Unlimited
FSCA 6	Burbot	>30cm	Composite	2.4	78.3	Unlimited
FSCA 6	Kokanee	>30cm	Composite	5.5	34.1	Unlimited
FSCA 6	Largescale Sucker	>30cm	Composite	76.5	2.5	Unlimited
FSCA 6	Rainbow Trout	>30cm	Composite	8.0	23.6	Unlimited
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	6.1	30.8	Unlimited
FSCA 6	Smallmouth Bass	>30cm	Composite	6.0	31.1	Unlimited
FSCA 6	Walleye	>30cm	Composite	6.2	30.2	Unlimited

Non-detect congeners have been evaluated at 1/2 the detection limit.

Appendix E. Table 4 - Calculated Meal Limits for Fillet Samples Based on Total Dioxin TEQ Concentrations.

FSCA	Species	Size Class	Sample Type	Mean (ppb)	Meals Per Month	Rounded Meal Limit
FSCA 1	Burbot	>30cm	Single	0.00013	71.3	Unlimited
FSCA 1	Kokanee	>30cm	Composite	0.00038	24.9	Unlimited
FSCA 1	Largescale Sucker	>30cm	Single	0.00067	14.0	Unlimited
FSCA 1	Mt Whitefish	>30cm	Single	0.00156	6.0	8
FSCA 1	Rainbow Trout	>30cm	Composite	0.00102	9.2	Unlimited
FSCA 1	Walleye	>30cm	Composite	0.00049	19.2	Unlimited
FSCA 2	Burbot	>30cm	Single	0.00087	10.7	Unlimited
FSCA 2	Kokanee	>30cm	Composite	0.00044	21.3	Unlimited
FSCA 2	Largescale Sucker	>30cm	Composite	0.00151	6.2	8
FSCA 2	Longnose Sucker	>30cm	Single	0.00081	11.6	Unlimited
FSCA 2	Mt Whitefish	>30cm	Single	0.00138	6.8	8
FSCA 2	Rainbow Trout	>30cm	Composite	0.00091	10.3	Unlimited
FSCA 2	Smallmouth Bass	>30cm	Single	0.00065	14.3	Unlimited
FSCA 2	Walleye	>30cm	Composite	0.00056	16.9	Unlimited
FSCA 3	Burbot	>30cm	Composite	0.00091	10.3	Unlimited
FSCA 3	Kokanee	>30cm	Composite	0.00068	13.7	Unlimited
FSCA 3	Lake Whitefish	>30cm	Composite	0.00105	9.0	Unlimited
FSCA 3	Largescale Sucker	>30cm	Composite	0.00048	19.7	Unlimited
FSCA 3	Rainbow Trout	>30cm	Composite	0.00041	23.0	Unlimited
FSCA 3	Smallmouth Bass	>15 to <=30cm	Single	0.00089	10.5	Unlimited
FSCA 3	Smallmouth Bass	>30cm	Single	0.00091	10.4	Unlimited
FSCA 3	Walleye	>30cm	Composite	0.00049	19.3	Unlimited
FSCA 4	Burbot	>30cm	Composite	0.00048	19.6	Unlimited
FSCA 4	Kokanee	>30cm	Composite	0.00054	17.3	Unlimited
FSCA 4	Lake Whitefish	>30cm	Composite	0.00118	8.0	Unlimited
FSCA 4	Largescale Sucker	>30cm	Single	0.00143	6.6	8
FSCA 4	Longnose Sucker	>30cm	Composite	0.00114	8.2	Unlimited
FSCA 4	Rainbow Trout	>30cm	Composite	0.00039	23.9	Unlimited
FSCA 4	Smallmouth Bass	>30cm	Single	0.00134	7.0	8
FSCA 4	Walleye	>30cm	Composite	0.00039	23.8	Unlimited
FSCA 5	Burbot	>30cm	Composite	0.00047	20.1	Unlimited
FSCA 5	Kokanee	>30cm	Composite	0.00053	17.7	Unlimited
FSCA 5	Lake Whitefish	>30cm	Composite	0.00163	5.7	4
FSCA 5	Largescale Sucker	>30cm	Single	0.00165	5.7	4
FSCA 5	Rainbow Trout	>30cm	Composite	0.00032	29.4	Unlimited

FSCA 5	Smallmouth Bass	>30cm	Composite	0.00029	32.9	Unlimited
FSCA 5	Walleye	>30cm	Composite	0.00029	32.8	Unlimited
FSCA 6	Burbot	>30cm	Composite	0.00053	17.6	Unlimited
FSCA 6	Kokanee	>30cm	Composite	0.00058	16.1	Unlimited
FSCA 6	Largescale Sucker	>30cm	Composite	0.00180	5.2	4
FSCA 6	Rainbow Trout	>30cm	Composite	0.00033	28.3	Unlimited
FSCA 6	Smallmouth Bass	>15 to <=30cm	Composite	0.00037	25.6	Unlimited
FSCA 6	Smallmouth Bass	>30cm	Composite	0.00033	28.4	Unlimited
FSCA 6	Walleye	>30cm	Composite	0.00045	20.8	Unlimited

**Non-detect congeners have been evaluated at 1/2 the detection limit.

Appendix E. Table 5 - Summary of Calculated Meal Limits Based on Weighted Mean Concentrations for Fillet Samples from the UCR.

Species	**Size Class**	**Mercury (ppm)**	**Mercury Meal Limit**	**Total PBDEs (ppb)**	**Meals Per Month**	**Total PCBs (ppb)**	**Total PCBs Meal Limit**	**Total Dioxin TEQ (ppb)**	**Total Dioxin TEQ Meal Limit**
Burbot	>30cm	0.232	3.5	2.5	319.3	2.2	84.3	0.00060	15.6
Kokanee	>30cm	0.064	12.6	5.4	148.7	7.8	24.0	0.00052	17.9
Lake Whitefish	>30cm	0.091	8.8	17.5	46.0	19.8	9.5	0.00124	7.6
Largescale Sucker	>30cm	0.300	2.7	34.5	23.3	63.0	3.0	0.00132	7.1
Longnose Sucker	>30cm	0.124	6.5	9.9	80.9	11.9	15.8	0.00096	9.8
Mt Whitefish	>30cm	0.083	9.7	27.4	29.4	26.7	7.0	0.00146	6.4
Rainbow Trout	>30cm	0.076	10.6	12.2	65.9	15.5	12.1	0.00056	16.6
Smallmouth Bass	>30cm	0.161	5.0	6.7	120.4	6.6	28.5	0.00064	14.7
Walleye	>30cm	0.166	4.8	5.0	160.9	6.2	30.3	0.00044	21.2

Appendix E. Table 6 - Calculated Meal Limits for Neurological Health Endpoints for FSCAs.

FSCA	Species	Size Class	Sample Type	Mercury Mean (ppm)	Meals Per Month	Total PCBs Mean (ppb)	Meals per Month	Rounded Meal Limit
FSCA 1	Burbot	>30cm	Single	0.276	2.7	2.6	2.8	2
FSCA 1	Kokanee	>30cm	Composite	0.068	4.8	8.5	7.9	8
FSCA 1	Largescale Sucker	>30cm	Single	0.219	19.5	41.8	2.1	2
FSCA 1	Mt Whitefish	>30cm	Single	0.075	47.9	33.9	3.4	4
FSCA 1	Rainbow Trout	>30cm	Composite	0.076	22.1	30.9	4.0	4
FSCA 1	Walleye	>30cm	Composite	0.190	6.6	6.9	3.7	4
FSCA 2	Burbot	>30cm	Single	0.183	0.9	1.6	4.2	4
FSCA 2	Kokanee	>30cm	Composite	0.064	6.3	8.7	8.1	unlimited
FSCA 2	Largescale Sucker	>30cm	Composite	0.217	33.2	112.0	1.3	1
FSCA 2	Longnose Sucker	>30cm	Single	0.070	6.0	8.8	7.6	8
FSCA 2	Mt Whitefish	>30cm	Single	0.088	34.5	21.3	4.1	4
FSCA 2	Rainbow Trout	>30cm	Composite	0.080	15.8	28.8	4.2	4
FSCA 2	Smallmouth Bass	>30cm	Single	0.157	19.5	29.1	2.9	2
FSCA 2	Walleye	>30cm	Composite	0.167	6.2	7.8	4.0	4
FSCA 3	Burbot	>30cm	Composite	0.228	0.9	1.5	3.4	4
FSCA 3	Kokanee	>30cm	Composite	0.059	4.0	8.9	8.7	unlimited
FSCA 3	Lake Whitefish	>30cm	Composite	0.081	NA	14.8	6.2	8
FSCA 3	Largescale Sucker	>30cm	Composite	0.222	21.3	19.1	2.6	2
FSCA 3	Mt Whitefish	>30cm	Multicoll	NA	11.2	NA	71.9	unlimited
FSCA 3	Rainbow Trout	>30cm	Composite	0.077	7.1	9.7	6.9	8
FSCA 3	Smallmouth Bass	>30cm	Single	0.217	3.6	5.1	3.4	4
FSCA 3	Walleye	>30cm	Composite	0.170	3.9	4.3	4.3	4
FSCA 4	Burbot	>30cm	Composite	0.241	4.3	2.2	3.2	4
FSCA 4	Kokanee	>30cm	Composite	0.065	5.2	7.2	8.5	unlimited
FSCA 4	Lake Whitefish	>30cm	Composite	0.089	NA	18.9	5.3	4
FSCA 4	Largescale Sucker	>30cm	Single	0.371	26.8	56.6	1.4	1
FSCA 4	Longnose Sucker	>30cm	Composite	0.188	13.9	15.5	3.2	4
FSCA 4	Mt Whitefish	>30cm	Multicoll	NA	15.3	NA	52.6	unlimited
FSCA 4	Rainbow Trout	>30cm	Composite	0.084	10.0	8.7	6.5	8
FSCA 4	Smallmouth Bass	>30cm	Single	0.127	2.1	3.6	5.7	4
FSCA 4	Walleye	>30cm	Composite	0.138	2.4	4.4	5.2	4
FSCA 5	Burbot	>30cm	Composite	0.236	3.1	2.9	3.2	4
FSCA 5	Kokanee	>30cm	Composite	0.063	6.8	7.7	8.4	unlimited

FSCA 5	Lake Whitefish	>30cm	Composite	0.110	NA	28.7	3.9	4
FSCA 5	Largescale Sucker	>30cm	Single	0.462	37.0	66.5	1.1	1
FSCA 5	Mt Whitefish	>30cm	Multicoll	NA	38.4	NA	21.0	unlimited
FSCA 5	Rainbow Trout	>30cm	Composite	0.065	12.0	7.1	8.0	8
FSCA 5	Smallmouth Bass	>30cm	Composite	0.142	7.4	6.4	4.7	4
FSCA 5	Walleye	>30cm	Composite	0.184	7.3	7.6	3.7	4
FSCA 6	Burbot	>30cm	Composite	0.241	2.4	2.4	3.2	4
FSCA 6	Kokanee	>30cm	Composite	0.061	5.4	5.5	9.5	unlimited
FSCA 6	Largescale Sucker	>30cm	Composite	0.257	65.5	76.5	1.4	1
FSCA 6	Rainbow Trout	>30cm	Composite	0.075	6.3	8.0	7.5	8
FSCA 6	Smallmouth Bass	>30cm	Composite	0.175	6.9	6.0	4.0	4
FSCA 6	Walleye	>30cm	Composite	0.201	3.9	6.2	3.6	4

APPENDIX F: CHEMICAL SPECIFIC INFORMATION

The following section is a synopsis of information on the five chemicals of concern. This information was summarized from ATSDR documents, EPA IRIS, and journal articles.

Mercury

Mercury is widespread in the environment as a result of natural and anthropogenic releases. Everyone is exposed to small amounts of mercury over the course of a lifetime. Most atmospheric mercury is elemental mercury vapor and inorganic mercury, and mercury present in water, soil, plants, and animals is typically present as organic or inorganic forms. Organic mercury is found primarily in the form of methylmercury.

Mercury is released into surface waters from natural weathering of rocks and soils and from volcanic activity. Mercury is also released into the atmosphere as a result of anthropogenic activities, burning fossil fuels, and disposal of consumer products (i.e., mercury thermometers, fluorescent bulbs, dental amalgams). Global cycling of mercury via air deposition occurs when mercury evaporates from soils and surface waters into the atmosphere. From the atmosphere, mercury is redistributed on land and surface water, and then it is absorbed by soil or sediments. Once inorganic mercury is released into the environment, bacteria convert it into organic mercury (methylmercury), the primary form that accumulates in fish and shellfish.

Nearly all of the mercury found in fish and other aquatic organisms is in the methylmercury form. In the aquatic food chain, methylmercury biomagnifies (becomes concentrated) as it is passed from lower to higher trophic levels through consumption of prey organisms. Fish at the top of the food chain can biomagnify methylmercury approximately 1 to 10 million times greater than concentrations in the surrounding waters. Long-lived predatory ocean fish may have increased methylmercury content because of exposure to natural and industrial sources of mercury. Methylmercury concentrations in fish varies not only by species and size of the fish, but also by harvest location. The top ten commercial fish species (shrimp, canned tuna, salmon, pollock, tilapia, catfish, crab, cod, flatfish, and clams) represent about 85% of the seafood market and contain a mean mercury level of approximately 0.1 ppm

Some states have issued advisories about consumption of fish containing mercury. For example, DOH issued a Washington statewide fish consumption advisory for women of childbearing age and young children based on elevated levels of mercury in various commercially bought fish as well as freshwater bass caught for recreation (http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/MercuryAdvisories.aspx).

In mammals, most organic mercury compounds are readily absorbed by ingestion and appear in the lipid fraction of blood and brain tissue. Organic mercury readily crosses the blood-brain barrier and also crosses the placenta. Fetal blood mercury levels are equal to or higher than maternal levels. Methylmercury also appears in human milk. Organic mercury compounds are most toxic in the central nervous system and may also affect the kidneys and immune system. Methylmercury is toxic to the cerebral and cerebellar cortex in the developing brain and is a known teratogen (an agent which can cause a birth defect). In Minamata Bay, Japan, mothers who were exposed to high amounts of mercury but were asymptomatic gave birth to severely affected infants. The infants often appeared normal at birth but developed psychomotor retardation, blindness, deafness, and seizures over time. Since the fetus is susceptible to neurotoxic effects of methylmercury, several studies have focused on subclinical effects among children whose mothers were exposed to high levels of methylmercury. In the 1970s, a study was done on Iraqi children exposed to high levels of methylmercury in contaminated seeds. Children whose mothers had hair mercury levels in the range of 10 ppm - 20 ppm demonstrated motor retardation. Additionally, two prospective epidemiologic studies were conducted in the Seychelles and the Faroe Islands. Results from the Faroe Islands suggest that exposure in utero to mercury were associated with subtle adverse effects on the developing brain (maximum level in hair was 39.1 ppm and in blood was 351 ppb). Memory, attention, and language tests were inversely associated with higher methylmercury exposures in children up to 7 years of age. In the Seychelles study, adverse effects on development or IQ have not been found up to 66 months of age. The Faroe Islands and Seychelles studies are continuing in order to provide a long-term developmental evaluation of exposed children. Similar effects were seen in a study of New Zealand children exposed *in utero* to methylmercury from fish consumed by their mothers, providing further support to the developmental effects seen in Faroese children.

In 1998, the National Academy of Sciences (NAS) was directed by the U.S. Congress to evaluate methylmercury toxicity and provide recommendations on exposure limits. The study established a reference dose for mercury of 0.1µg/kg-day (µg/kg = ppb). The EPA has recently (2001) reconfirmed 0.1 µg/kg/day as its oral reference dose (RfD). This RfD is based on health effects data specific to the protection of the developing fetus. As the developing fetus represents the population of greatest concern, the RfD is considered protective of all other populations that are less exposed and/or less sensitive. The current action level of FDA for mercury in fish tissue is 1 ppm (1000 ppb). While FDA has not changed the 1.0 ppm action level in a recent reassessment (2003), the agency is re-evaluating it in light of significant new data on the health effects of methyl mercury from consumption of fish.

Polychlorinated biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are persistent environmental contaminants that are ubiquitous in the environment due to intensive historical industrial use. PCBs were used as commercial mixtures (Aroclors) that contain up to 209 different chlorinated biphenyl congeners which are structurally similar compounds that vary in toxicity. A smaller subset of 50 to 60 congeners is commonly found in Aroclor mixtures. Each congener has a biphenyl ring structure but differs in the number and arrangement of chlorine atoms substituted around the biphenyl ring. The name Aroclor 1254, for example, means that the molecule contains 12 carbon atoms (the first 2 digits) and approximately 54% chlorine by weight (second 2 digits). Each mixture (1016, 1242, 1254, and 1260) contained many different PCB congeners. PCBs are lipid soluble and very stable; their stability depends on the number of chlorine atoms and their position on the biphenyl molecule. PCBs' lipophilic character and resistance to metabolism enhances concentration in the food web and exposure to humans and wildlife.

In 1971, the sole U.S. producer of PCBs (Monsanto Chemical Company) voluntarily stopped open-ended uses of PCBs and in 1977 ceased their production. Because PCBs do not burn easily and are good insulators, they were commonly used as lubricants and coolants in capacitors, transformers, and other electrical equipment. Old capacitors and transformers that contain PCBs are still in operation. Over the years, PCBs have been spilled, illegally disposed, and leaked into the environment from transformers and other electrical equipment. PCBs in the environment have decreased since the 1970s but are still detectable in our air, water, soil, food, and in our bodies.

PCBs are lipid (fat) soluble and very stable; their stability depends on the number of chlorine atoms in the molecule and on the position of the chlorine atom(s) on the molecule. The breakdown of PCBs in water, sediment, and soil occurs over many years and is often incomplete. Lower chlorinated PCBs (PCBs with fewer chlorine atoms in the molecules) are more easily broken down in the environment, while adsorption of PCBs generally increases as chlorination of the compound increases. The highly chlorinated Aroclors (i.e., 1248, 1254, and 1260) resist both chemical and biological degradation in the environment. Microbial degradation of highly chlorinated PCBs to lower chlorinated biphenyls has been reported under anaerobic (oxygen free) conditions, as has the mineralization of biphenyl and lower chlorinated biphenyls by aerobic (oxygen dependent) microorganisms. Although they are slow processes, volatilization and biodegradation are the major pathways of removal of PCBs from water and soil, and volatilization is more significant for lower chlorinated congeners. In water, photolysis (break-down by light) appears to be the only viable chemical degradation process. The chemical composition of the original PCB mixtures released to the environment changes over time since the individual congeners degrade and partition at different rates.

Many PCB congeners persist in ambient air, water, marine sediments, and soil at low levels throughout the world. The half-life of PCBs (the time it takes for one-half of the PCBs to breakdown) in the air is 10 days or more, depending on the type of PCB. PCBs in the air can be carried long distances and may be deposited onto land or water. Once in water, most PCBs tend to adsorb to organic particles and sediments. The rate and extent of degradation is a function of temperature and the degree to which PCBs are bound to organic material and hence unavailable for degradation.

PCBs' lipophilic character (their tendency to accumulate in fat) and resistance to metabolism enhances concentration in the food web and exposure to humans and wildlife. In the UCR and other water bodies, sediment-associated PCBs are accumulated in the bodies of aquatic organisms, which are in turn consumed by creatures higher in the food web (PCBs can biomagnify in both fresh and saltwater ecosystems). Fish, birds, and mammals tend to accumulate certain congeners over time in their fatty tissue. Concentrations of PCBs can reach levels hundreds of thousand times higher than the levels in surrounding waters. Bioconcentration is the uptake of a chemical from water alone, while bioaccumulation is the result of combined uptake via food, sediment, and water. These processes can lead to high levels in the fat of predatory animals. Also, PCBs can biomagnify in fresh and saltwater ecosystems. Humans may be exposed to detectable quantities of PCBs when they eat fish, use fish oils in cooking, or consume meat, milk or cheese; the half life of PCBs in humans is estimated to be 2–6 years.

Toxic responses to PCBs include dermal toxicity, immunotoxicity, carcinogenicity, and adverse effects on reproduction, development, and endocrine functions. Several epidemiological studies indicate that consumption of background levels of PCBs may cause slight but measurable impairments in physical growth and learning behavior in children while others have not.

Some PCB congeners have a structure and biological activity that is similar to dioxin. Dioxins are a family of chemicals produced by incomplete burning of organic material through natural and industrial processes. Like PCBs, dioxins (a family of chemicals called furans which are very similar to dioxins) are persistent in the environment and have been shown to be toxic through a particular mechanism shared by certain PCB congeners. Toxic equivalency factors (TEFs) are used to account for the potential of those PCB congeners which exert dioxin-like toxicity. TEFs are available for twelve dioxin-like PCB congeners. The larger the TEF, the more toxic the PCB congener is. Each congener is multiplied by its TEF to give the dioxin toxic equivalent value (TEQ). The TEQs for each congener are then summed to give the overall PCB-TEQ. TEFs for each congener are based on the toxicity of one well studied dioxin congener known as 2,3,7,8-tetrachlorodibenzo-p-dioxin.

EPA has determined that PCBs are probable human carcinogens and assigned them the cancer weight-of-evidence classification B2 based on animal studies. Human studies are being updated; current available evidence is inadequate but suggestive regarding cancer risk to humans from PCB exposure. The upper-bound cancer slope factor for PCBs is 2.0 $(mg/kg /day)^{-1}$. Part of the uncertainty in assessing PCB effects from consuming fish is that PCB congeners selectively bioaccumulate in fish in different patterns than found in commercial mixtures of PCBs or in the environment. The congener mix encountered by a fetus during pregnancy and via nursing may be quite different than congener patterns initially released into the environment. Since PCB congeners differ in their potency and the specific ways they interact with biological systems, health criteria based on data from Aroclor mixtures fed to animals may not account for biodegradation or selective accumulation by an organism. EPA has addressed this uncertainty by a policy decision to use an upper bound, health-protective estimate of the PCB cancer potency factor when computing cancer risks for PCBs found in fish tissue.

Washington State DOH recently conducted a thorough review of the scientific literature on PCB toxicity in an attempt to set a state standard for PCB exposure through consumption of fish and shellfish. DOH concluded that ATSDR’s MRL of 0.02 ug/kg/day for chronic-duration oral exposure to PCBs would be protective of the most sensitive population (fetus) for the most sensitive endpoints reviewed (immune and developmental). EPA verified an RfD of 0.02 ug/kg-day for Aroclor 1254, based on dermal/ocular and immunological effects in monkeys.

Polybrominated diphenyl ethers (PBDEs)

A relatively new area of concern for human health is the widespread environmental presence of polybrominated diphenyl ethers (PBDEs), which are flame retardants used in a variety of consumer and industrial products. PBDEs were recently identified as bioaccumulative in the environment and have been detected in a variety of human tissues and in other organisms. Given the long life of many PBDE products and the length of time they remain in the environment, exposure can continue for years after their introduction into the environment. Washington State has developed a draft chemical action plan to identify efforts the state may take to reduce threats posed by some PBDEs.

Information on possible health impacts of PBDEs comes primarily from animal toxicity studies. In general, specific PBDE congeners found in penta-PBDE commercial products are more toxic than octa-PBDE and deca-PBDE. Deca-PBDE breaks down to penta-PBDE and the most sensitive toxic effect associated with penta-PBDE congeners appears to be developmental neurotoxicity, penta-PBDE may also impact thyroid and other hormone systems. Octa-PBDE showed fetal toxicity and liver changes in rat and rabbit studies, while dietary intake of deca-PBDE was associated with liver, pancreas and thyroid tumors at very high doses in rodent studies. Washington State’s PBDE chemical action plan states that human health risks are associated with PBDE exposure, although pathways and levels that may result in harm are not clearly understood. While consumption of food, including fish, may be an important exposure pathway for these chemicals, the indoor environment poses a unique exposure pathway for PBDEs unlike pathways for other persistent bioaccumulative toxins.

Five congeners (PBDE-47, -99, -100, -153, and -154) predominate in human tissues, usually accounting for more than 90% of the total PBDE body burden in most individuals not occupationally exposed. PBDE-47, -99, and -100 are present in the penta-BDE technical mixture, whereas PBDE-153 and -154 are constituents of both the penta-BDE and octa-BDE technical mixtures. Growing evidence suggests that the more highly brominated congeners of the deca-

BDE technical mixture break down in the environment (e.g., lose bromine atoms through sunlight degradation and biotic metabolism) and subsequently form lower brominated PBDE congeners commonly found in humans.

EPA has recently updated the toxicity data for PBDEs based on animal studies showing similar adverse neurodevelopmental effects similar to those observed with mercury and PCBs. Based on recent research in animals (rats), EPA's new reference dose values are as follows:

- BDE-47 RfD corresponds to 1.0 x 10^{-4} mg/kg-day
- BDE-99 RfD corresponds to 1.0 x 10^{-4} mg/kg-day
- BDE-153 RfD corresponds to 2,0 x 10^{-4} mg/kg-day
- BDE-209 RfD corresponds to 0.007 mg/kg-day

Dioxins

Dioxins refer to a family of complex but related chlorinated compounds with similar chemical structures and biological activity. This family is composed of specific compounds from three chemical groups: polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and polychlorinated biphenyls (PCBs). Of these, only a subset exhibit dioxin-like toxicity: 7 of the 75 PCDD compounds, 10 of the 135 PCDF compounds, and 12 of the 209 PCB compounds. In total, 29 compounds are identified as having varying levels of "dioxin-like" toxicity. Dioxin and its related congeners are often of special concern to EPA because dioxin has a very high potency for causing cancer and other adverse effects in exposed individuals.

The primary sources of dioxin releases to the environment are from combustion processes such as commercial, municipal or medical waste incineration, from burning fuels (e.g., fossil fuels, wood, coal, oil), and burning of household trash. Chlorine bleaching of pulp and paper, certain types of chemical manufacturing and industrial processing can generate small quantities of dioxin and dioxins have also been detected at low concentrations in cigarette smoke, home-heating systems, and exhaust from cars. Burning of materials that contain chlorine, such as plastics, wood treated with pentachlorophenol (PCP), and pesticide-treated waste produce dioxins. Dioxins can also be formed naturally during forest fires and volcanic eruptions.

When released into the air, dioxins disperse and travel long distances and eventually deposit from the atmosphere onto land, surface water, and vegetation. Dioxins are extremely persistent compounds, remaining in the environment long after they are released. Environmental levels from both human-made and natural sources will take years to decline. Dioxins are soluble in organic solvents and fats. Terrestrial animals and fish consume dioxins that may be on plants and in the air, water, sediment, and soil. Once ingested, dioxins are broken down very slowly and are difficult for the body to excrete. Consequently, concentrations usually increase at each step in the food chain, a process known as biomagnification. Low levels of dioxins in water, sediment, soil, and vegetation can result in elevated concentrations in terrestrial and aquatic animals. Since dioxins are almost insoluble in water, they tend to move into the fat of animals and plants.

In general, the toxicity of the different PCDD, PCDF, and PCB congeners depends on the number and arrangement of the chlorine atoms on the dibenzodioxin, dibenzofuran,or PCB ring structures. The relative toxicity of a congener, which is based on one well studied dioxin congener known as 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), is expressed in terms of a "toxicity equivalency factor" (TEF). Given measured concentration values for each congener (actually, groups of congeners) and the TEF for that group, the "toxicologically equivalent concentration" (TEQ) for a mixture of PCDDs, PCDFs, and PCBs is calculated as follows:

$$TEQ = \Sigma (TEF_i \times C_i)$$

where:

TEF_i = Toxicity equivalency factor for congener group "i"
C_i = Concentration of congener group "i"

The TEQ is the concentration of TCDD that is predicted to be of equal toxicity to the sum of the toxicity of all the different PCDDs and PCDFs present at the site. Risks from the calculated TEQ are therefore based on the toxicity factors for TCDD.

Dioxins interfere with the basic and common Ah (aryl hydrocarbon) receptor involved in cellular regulatory processes. The Ah receptor is a member of a family of gene regulatory proteins. When dioxins interact with this receptor a chain of events begins that, to a certain extent, the body is able to interrupt and correct. However, studies in animals show dioxins given in large enough quantities or at important stages of development can alter normal growth and function of almost every system in the body.

2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), the most toxic of the dioxin congeners can cause chloracne (a condition of acne like lesions on the face and neck). Exposure to high levels of dioxins can cause liver damage, developmental effects and impaired immune function. EPA (2011) based its new RfD (assigned a value of 7.0×10^{-10} mg/kg-day) on decreased sperm count and motility in men exposed to TCDD as boys. Cancer is also a health effect of concern for dioxins. Several studies suggest that workers exposed to high levels of 2,3,7,8-TCDD over many years have an increased risk of developing cancer. The relationship of apparent increases in cancer in these occupationally exposed populations to calculations of general population risk remains uncertain. Animal studies have conclusively shown that 2,3,7,8-TCDD is a carcinogen capable of increasing the incidence of tumors at multiple sites. EPA considers TCDD to be a probable human carcinogen and developed a cancer slope factor of 1.56×10^{5} mg/kg-day^{-1}.

Lead

Lead is a naturally-occurring element. The widespread use of certain products (such as leaded gasoline, lead-containing pesticides, and lead-based paint) and the emissions from certain industrial operations have resulted in substantially higher levels of lead in many areas of Washington state and the environment in general. Elimination of lead in gasoline and solder used in food and beverage cans has greatly reduced people’s exposure to lead.

Children six years old and younger are particularly vulnerable to the effects of lead. Currently, the main pathways for lead exposure in children are ingestion of chips and dust from leaded paint, contaminated soil and house dust, and drinking water in homes that have plumbing materials containing lead. Compared with older children and adults, young children tend to ingest more dust and soil and absorb more of the lead they swallow. Because children’s brains are developing rapidly, they may be more sensitive to the neurological effects of lead than adults. Pregnant women and women of childbearing age should also be aware of lead in their environment because an expectant mother’s exposure to lead can harm her fetus.

Lead poisoning can affect almost every system of the body and often occurs with no obvious or distinctive symptoms. Depending on the amount of exposure a child has, lead can cause behavior and learning problems, central nervous system damage, kidney damage, reduced growth, hearing impairment, and anemia.

Exposure to lead can be monitored by measuring the level of lead in the blood. For children, the Centers for Disease Control and Prevention (CDC) has defined an elevated blood lead level (BLL) as greater than or equal to 10 µg/dL, meaning 10 µg/dL is defined as a toxicological level of concern by the CDC). However, evidence is growing that damage to the central nervous system resulting in learning problems can occur at blood lead levels less than 10 µg/dL. Deficits in cognitive and academic skills associated with lead exposure occur at blood lead concentrations lower than 5 µg/dL. About 2.2% of children in the United States have blood lead levels greater than 10 µg/dL.

Because of chemical similarities to calcium, lead can be stored in bone for many years. Even after exposure to environmental lead has been reduced, lead stored in bone can be released back into the blood where it can have harmful effects. Normally this release occurs relatively slowly. However, certain conditions, such as pregnancy, lactation, menopause, and hyperthyroidism can cause more rapid release of the lead, which could lead to a substantial rise in blood lead level.

In adults, lead can cause health problems such as high blood pressure, kidney damage, nerve disorders, memory and concentration problems, difficulties during pregnancy, digestive problems, and pain in the muscles and joints. These have usually been associated with blood lead levels greater than 30 µg/dL.

References

ATSDR 2004. Interaction Profile for: Persistent Chemicals Found in Fish (Chlorinated Dibenzo-p-dioxins, Hexachlorobenzene, p'p-DDE, Methymercury, and Polychlorinated Biphyenls). U.S. Department of Health and Human Services, Public Health Service, Agency of Toxic Substances and Disease Registry. May 2004

Burr ML, Fehily AM, Gilbert JF, Robers S, Holliday RM, Sweetnam PM, Elwood PC and Deadman NM. 1989. Effects of changes in fat, fish, and fiber intakes on death and myocardial reinfarction trial (DART). Lancet. 2:757-761.

Burr ML, Sweetnam PM, and Fehily AM. 1994. Diet and reinfarction. Eur Heart J. 15:1152-3.

Carlson SE, Werkman SH, Rhodes PG, Tolley EA. 1993. Visual-acuity development in healthy preterm infants: effect of marine-oil supplementation. Am J Clin Nutr. 58:35-42.

Carlson SE, Werkman SH, Tolley EA.1996. Effect of long-chain n-3 fatty acid supplementation on visual acuity and growth of preterm infants with and without bronchopulmonary dysplasia. Am J Clin Nutr. 63:687-697.

Collins, JF, JP Brown, GV Alexeeff, and AG Salmon. 1998. Potency Equivalency Factors for Some Polycyclic Aromatic Hydrocarbons and Polycyclic Aromatic Hydrocarbon Derivatives. Regulatory Toxicology and Pharmacology 28:45-54.

CRITFC 1994. A Fish Consumption Survey of the Umatilla, Nez Perce, Yakima, and Warm Springs Tribes of the Columbia River Basin 1994. Technical Report 94-3. Columbia River Inter-Tribal Fish Commission, Portland, OR http://maps.critfc.org/tech94_03report.html

DOH 2006. Washington State Department of Health. Human Health Evaluation of Contaminants in Puget Sound Fish. October 2006. http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-104.pdf

DOH 2010. Draft Health Consultation: Lake Roosevelt Fish Non-Tribal Exposure, Northeast, Washington. EPA Facility ID: WA0000530279.

DOH 2012. Washington State Department of Health Fish Advisory Program. Healthy Fish Guide. http://www.doh.wa.gov/ehp/oehas/fish/fishchart.htm

Ecology 2011. Background Characterization for Metals and Organic Compounds in Northeast Washington Lakes. Part 2: Fish Tissue. December 2011. Washington State Department of Ecology. Publication No. 11-03-054. Available at www.ecy.wa.gov/biblio/1103054.html

Ecology 2010. Measuring Mercury Trend in Freshwater Fish in Washington State. 2009 Sampling Results. Meredith C, Furl C, and Friese M. Washington State Department of Ecology, Environmental Assessment Unit. Olympia, WA. October 2010. Publication No. 10-03-058 http://www.ecy.wa.gov/biblio/1003058.html

EPA 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. EAP/600/R-93/089

EPA 2000a. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volumes 1-4. November 2000; EPA 823-B-00-008. http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/index.cfm

EPA 2000b. EPA National Guidance: Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories – Volume 1. Volume 1: Fish Sampling and Analysis – Third Edition EPA 823-B-00-007 http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/risk/index.cfm

EPA 2000c. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2. Risk Assessment and Fish Consumption Limits, Third Edition. November 2000; EPA 823-B-00-008. http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/risk/volume2_index.cfm

EPA 2002a. U.S. Environmental Protection Agency. Technical Review Workgroup for Lead. *User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children,* (IEUBK) *Windows version 1.0*, OSWER Directive No.9285.7-42. Document No. EPA 540-K-01-005 Washington, DC: May 2002.

EPA 2002b. Estimated per Capita Fish Consumption in the United States. August 2002. U.S. Environmental Protection Agency, Washington, DC EPA-821-C-02-003. http://water.epa.gov/scitech/swguidance/standards/criteria/health/upload/consumption_report.pdf

EPA. 2003. Assessing Intermittent or Variable Exposures at Lead Sites. Office of Emergency and Remedial Response. OSWER # 9285.7-76. EPA-540-R-03-008. Available online at: http://www.epa.gov/superfund/lead/products/twa-final-nov2003.pdf

EPA 2005. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum. U.S. Environmental Protection Agency. Washington, DC. EPA/630/P-03/001F March 2005.

EPA 2009. Human Health Risk Assessment Workplan for the Upper Columbia River Site Remedial Investigation and Feasibility Study. Prepared for U.S. Environmental Protection Agency, Region 10 by Syracuse Research Corporation. Final – March 2009.

Fadella G., Govoni M, Alessandroni R, Marchiani E, Salvioli GP, Biagi PL, Spano C. 1996. Visual evoked potentials and dietary long chain polyunsaturated fatty acids in preterm infants.

FDA 2003. U.S. Food and Drug Administration. Center for Food Safety and Applied Nutrition Office of Food Safety Total Diet Study 2003. Revision 2. http://www.fda.gov/downloads/Food/FoodSafety/FoodContaminantsAdulteration/TotalDietStudy/UCM184303.pdf

FDA 2010. U.S. Food and Drug Administration. Mercury Levels in Commercial Fish and Shellfish (1990-2010). http://www.fda.gov/food/foodsafety/product-specificinformation/seafood/foodbornepathogenscontaminants/methylmercury/ucm115644.htm

Harrison N, Abhyankar B. 2005. The Mechanism of Action of Omega-3 Fatty Acids in Secondary Prevention Post-Myocardial Infarction. Curr Med Res Opin. 21(1):95-100.

Helland IB, Smith L, Saarem K, Saugstad OD, Drevon CA. 2003. Maternal supplementation with very-long-chain n-3 fatty acids during pregnancy and lactation augments children's IQ at 4 years of age. Pediatrics. 111:e39-344.

Hu FB, Bronner L, Willet WC, Stampfer MJ, Rexrode KM, Albert CM, Hunter D and Manson JE. 2002. Fish and omega-3 fatty acid intake and risk of coronary heart disease in women. JAMA 287:1815-1821.

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

IOM 2007. Seafood Choices – Balancing the Benefits and Risks. Committee on Nutrient Relationships in Seafood: Selections to Balance Benefits and Risks, Food Nutrition Board. Institute of Medicine of the National Academies. National Academies Press. Washington, DC.

Jorgensen MH, Hernell O, Hughes E, Michaelsen KF. 2001. Is there a relation between docosahexanoic acid concentration in mothers' milk and visual development in term infants? J Pediatr Gastroenterol Nutr. 32:293-6.

Law M. 2000. Dietary fat and adult diseases and the implications for childhood nutrition: and epidemiologic approach. Am J Clin Nutr. 200 Nov;72(5 Suppl):1291-1296S.

LRF 2012. Lake Roosevelt Forum 2012. http://www.lrf.org/Recreation.html

Lund E., Engeset D, Alsaker,E., Skeie G, Hjartaker A, Lundebye AK, and Niebor E. Cancer risk and salmon intake. Science. July 23, 2004; 305(5683):476-7. et al. 2004

Marckmann P and Gronbaek M. 1999. Fish consumption and coronary heart disease mortality. A systematic review of prospective cohort studies. Eur J Clin Nutr. 53:585-90.

Mieiro CL, Pacheco M, Pereira M, and Duarte AC. Mercury distribution in key tissues of fish (Liza aurata) inhabiting a contaminated estuary-implications for human and ecosystem health risk assessment. J Environ Monit. 2009 May; 11(5):1004-12

Mozaffarian D, Lemaitre RN, Kuller LH, Burke GL, Tracy RP and Siscovick DS. 2003. Cardiac benefits of fish consumption may dpend on the type of fish meal consumed: the Cardiovascular Health Study. Circulation. 107:1372-7.

MTCA 1991. Model Toxics Control Act.
https://fortress.wa.gov/ecy/publications/publications/9159.pdf

Olsen SF, Hansen HS, Secher NJ, Jensen B, Sandstrom B. 1995. Gestation length and birth weight in relation to intake of marine n-3 fatty acids. Br J Nutr. 73:397-404.

Olsen SF and Secher NJ. 2002. Low consumption of seafood in early pregnancy as a risk factor for preterm delivery: prospective cohort study. BMJ. Feb 23;324(7335):447.

Olsen SF, Sorensen JD, Secher NJ, Hedegaard M, Henriksen TB, Hanse HS, Grant A. 1992. Randomized controlled trial of effect of fish-oil supplementation on pregnancy duration. Lancet. 339:1003-1007.

Pan A, Sun Q, Bernstein, AM, Schulze MD, Manson JE, Stampfer MJ, Willett WC, and Hu FB. 2012. Red meat consumption and mortality: results from 2 prospective cohort studies. Ach. Intern Med. 2012, April 9. 172(7):555-63.

Rembold 2004. Health benefits of eating salmon. Science. July 23, 2004;305(5683):475.

Rodriguez BL, Sharp DS, Abbott RD, Burchfiel CM, Masaki K, Chyou PH, Huang B, Yano K, and Curb JD. 1996. Fish intake may limit the increase in risk of coronary heart disease morbidity and mortality among heavy smokers: The Honolulu Heart Program. Circulation. 94:952-956.

SACN 2004. Advice on fish consumption: benefits and risks. Scientific Advisory Committee on Nutrition. TSO. United Kingdom. 204 pgs.

Sakamoto M, Kubota M. Liu SJ, Murata K, Nakai K, and Satoh H. 2004. Maternal and Fetal Mercury and n-3 Polyunsaturated Fatty Acids as a Risk and Benefit of Fish Consumption to Fetus. Environ. Sci. Technol. 2004. 38:3860-3863.

San Giovanni JP, Partra-Cabrera S, Colditz GA, Berkey CS and Dwyer JT. 2000. Meta-analysis of dietary essential fatty acids and long-chain polyunsaturated fatty acids as they relate to visual resolution acuity in healthy preterm infants. Pediatrics. 105:1292-1298.

Schoeny, R. AND K. Poirier. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. U.S. Environmental Protection Agency, Office of Research and Development, Office of Health and Environmental Assessment, Washington, DC, EPA/600/R-93/089 (NTIS PB94116571).

Seiders 2012. Washington State Dept. of Ecology personal communications. Mercury data extracted from EIM from 2001 through December 2010 courtesy of Keith Seiders, May 2012.

Stone and Hope. 2010 Caringogenic risk as the basis for fish advisories: A critique. Intergrated Environmental Assessment and Management. Vol 6:1;180-83.

Simon JA, Hodgkins ML, Browner WS, Neuhaus, JM, Bernert JT Jr, and Hulley SB. Serum fatty acids and the risk of coronary heart disease. Am J Epidemiol. 142:469-76.1995

Singh RB, Niaz MA, Sharma JP, Kumar R, Rastogi V, and Moshiri M. 1997. Randomized, double-blind, placebo-controlled trial of fish oil and mustard oil in patients with suspected acute myocardial infarction: the Indian experiment of infarct survival-4. Cardiovasc Drugs Ther. 11, 485-491.

Tanner J, Friedman M, Lincoln D, Ford L, and Jaffee M. Mercury Content of Common Foods Determined by Neutron Activation Analysis. 1972. Science 22, Vol. 177 no. 4054; 1102-1103.

Teck 2009 (Teck American Incorporated) 2009. Upper Columbia River: quality assurance project plan for the 2009 fish tissue study. Prepared for Teck American Incorporated. Prepared by

Parametrix, Inc., Integral Consulting Inc., Exponent in association with Hydroqual. September 2009.

Tuomisto JT, Tainio M, Niittynen M, Verkasalo P, Vartiainen T, Kiviranta H, and Pekkanen J. 2004. Risk-benefit analysis of eating farmed salmon. Science. July 23, 2004; 305(5683):476-7.

USDA 1998. USDA/ARS (U.S. Department of Agriculture, Agricultural Research Service). *1998. 1994-1996 Continuing Survey of Foods Intakes by Individuals and 1994-1996 Diet and Health Knowledge Survey*. CD-ROM, accession number PB-98-500457. (Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Phone: 203-487-4650.)

USGS 2000. Contaminant Trends in Sport Fish from Lake Roosevelt and the Upper Columbia River, Washington, 1994-1998. U.S. Geological Survey. Water-Resources Investigation Report 00-4024. Tacoma, Washington, 2000.

Van den Berg M, LS Birnbaum, M Denison, M De Vito, W Farland, M Feeley, H Fiedler, H Hakansson, A Hanberg, L Haws, M Rose, S Safe, D Schrenk, C Tohyama, A Tritscher, J Tuomisto, M Tysklind, N Walker, and RE Peterson. 2006. The 2005 World Health Organization (WHO) Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicological Sciences 93(2):223-241.

Yuan JM, Ross RK, Gao YT and Yu MC. 2001. Fish and shellfish consumption in relation to death from myocardial infaraction among men in Shanghai, China. Am J Epidemiol. 154:809-16.