

Contaminants in Okanagan Fish: Recent Analyses and Review of Historic Data

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Summary

Contaminants such as metals (e.g., mercury), pesticides (e.g., DDT), and industrial chemicals (e.g., PCBs) are found in small—and sometimes large—amounts throughout the environment. When these contaminants enter aquatic ecosystems, many of them can accumulate to high concentrations in the tissues of fish at the top of the food chain. Okanagan Nation people have been catching and consuming resident fish in the Okanagan Valley lakes and rivers for millennia, and some continue to do so. Other people are concerned about the quality of fish, including contaminant levels. Fish are an excellent source of protein and omega-3 fatty acids, and people should be encouraged to eat them. However, concrete information needs to be provided about how much fish of which species people can safely eat so that they can benefit from including resident fish in their diet.

This report has three purposes:
1. To compile and analyse historical and current data on fish contaminant concentrations in the Okanagan Nation traditional territory, focusing on resident fish species that people eat or are likely to want to eat (rainbow trout, lake trout, kokanee, burbot, bass);
2. To review consumption advisory literature from North America;
3. To recommend a sampling protocol for determining if consumption advisories are needed.

Note that although the Okanagan people traditionally harvested anadromous salmon for food and ceremonial purposes, these fish have not been analysed for contaminants and, therefore, are not included in this study. Furthermore, the current numbers of sockeye, chinook, and steelhead that return to Okanagan waters are not sufficiently high to support a food fishery. If the numbers increase in the future and the Okanagan people once again harvest these anadromous species for eating, it may be necessary to take some samples for contaminant analysis.

Resident fish from the Okanagan Valley have been sampled and analysed for contaminant content since 1970. Since then, samples have been collected sporadically and for a wide range of fish species. The sum data set includes about 600 entries, from which it is possible to analyse historical trends for some species. The data suggest that, on the whole, mercury, DDT, and PCB concentrations have declined from the 1970s to 2006, though some of these contaminants remain at levels above Health Canada guidelines in certain species.

Examining only data collected from 2000 to 2006 reveals that most samples are within Health Canada's consumption guidelines for most contaminants. There are two exceptions: (i) lake trout from Kalamalka Lake had DDT levels above the consumption guideline of 5 ppm in two of five cases, and (ii) bass, collected from Skaha Lake, Osoyoos Lake, and Okanogan River downstream of Osoyoos, had mercury levels above a Health Canada recommendation of 0.2 ppm (recommended for people who eat a lot of fish) in 7 of 30 samples (23%). These seven samples were still below the consumption guideline of 0.5 ppm for average consumers. No fish were found to have arsenic, lead, or PCBs above guidelines. PBDEs were measured in a small number of rainbow trout in 2005 and bass in 2006. Concentrations were low compared with limited data on freshwater fish in nearby watersheds; there are no consumption guidelines for PBDEs.

Health Canada's consumption guidelines are determined for commercial fish and fish products eaten by the Canadian population at large and are based on the assumption that people eat 20 grams of fish per day (equivalent to a single serving of 140 grams per week). However, First Nation people traditionally consumed far greater quantities of fish on a more frequent basis. There are a few examples from elsewhere in Canada where attempts have been made to determine advisories specific to First Nation consumers of locally harvested fish. These advisories have resulted in specific recommendations about how much of a particular species that has grown to a particular size and was caught at a particular location can be eaten on a weekly or monthly basis.

In the United States, the Environmental Protection Agency provides extensive guidance about how to set consumption advisories. The EPA includes information about setting threshold levels with which to compare contaminant concentrations in sampled fish. The threshold levels are determined for individual contaminants based on a number of variables, one of which is the amount of fish consumed per day. The EPA sets a subsistence diet at 142 grams of fish per day. Most of the 2000–2006 fish samples from the Okanagan Valley data set have contaminant levels that exceed EPA's recommended threshold levels for a subsistence diet. However, 142 grams of fish per day may be an overestimate of the quantity eaten by Okanagan Nation members.

At present, we don't know how much fish Okanagan people are eating, nor how frequently. It is critical to know these consumption patterns before a contaminant monitoring program can be established and before consumption advisories can be decided upon. Therefore, we recommend that a first step is to conduct a survey of the people to establish their current and/or desired fish eating habits. When this information is known, an appropriate threshold level can be determined (preferably in consultation with a public health or medical officer who understands the needs of the community), and a sampling program can be developed to target fish species at locations fished by Okanagan people.

Any consumption advisories that are issued should provide people with information about the many health benefits of including fish in their diet and about how to prepare and cook fish to minimize contaminant intake. The information must then be communicated to the Okanagan people through appropriate mechanisms, which may include producing brochures, speaking at public education gatherings, and informing community health practitioners.

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Introduction

Throughout their history in the Okanagan Valley, the people of the Okanagan Nation have been consuming resident fish such as rainbow trout, kokanee, and burbot and using them for ceremonial purposes (Hewes 1998, Ernst 2000). Today, rainbow trout and burbot continue to be harvested, but most if not all people have stopped eating kokanee because of concerns about the quality of the fish (H. Wright, Okanagan Nation Alliance, pers. comm.). Although commercially bought foods now form a large part of their diet, many Okanagan Nation members would like to eat fish harvested from local lakes and rivers (H. Wright, pers. comm.). Fish is a low-fat food and is an excellent source of protein and omega-3 fatty acids. These fatty acids are important for reducing the risk of heart disease (Albert et al. 1998, Kris-Etherton et al. 2002) and for brain development, especially in the fetus and infant (Farquharson et al. 1992, Makrides et al. 1994). In addition to their nutritional benefits, fish harvested from local waterbodies are important to the Okanagan people for cultural and ceremonial reasons. So that the Okanagan people can harvest fish and be confident in their quality, it may be necessary to issue advisories that recommend which fish to eat, how frequently it's safe to eat them, and which fish to avoid or limit in the diet. Even if there are no concerns about contaminants in some or all fish, it is still necessary to collect data and disseminate information so that people can make informed choices about their use of locally harvested fish.

Contaminants

Fish contaminants of concern considered in this report include heavy metals (arsenic, lead, and mercury), pesticide residues (DDT [1,1,1-trichloro-2,2-bis(*p*-chlorophenyl) ethane] and its metabolites), industrial chemicals (PCBs [polychlorinated biphenyls] and PBDEs [polybrominated diphenyl ethers]), and other chemicals such as dioxins and furans. There are additional pesticide contaminants detectable in Okanagan fish tissue, and these will be discussed briefly in the results. Certain contaminants such as mercury (specifically methylmercury), DDT, PCBs, and dioxins/furans accumulate in aquatic food chains so that the concentration in the tissue of an animal is greater at each higher level in the food chain. This phenomenon, known as biomagnification, has been demonstrated in a variety of environments (Clarkson 1995, Cabana and Rasmussen 1996). As a result of biomagnification, animals that are at or near the top of a food chain—for example, predatory fish, birds of prey, humans—can accumulate a high contaminant concentration by virtue of eating contaminated food.

The main contaminants of concern, listed above, enter the environment in a number of ways and have a range of effects on people's health. Briefly, arsenic, a metal found naturally in rocks and soils, has been used in metal production and wood preservative manufacturing, as well as in compounds such as herbicides (CCME 2001c). Its use has declined since the 1980s because of its toxicity, but it still enters the atmosphere through the burning of fossil fuels and waste materials. Inorganic arsenic is considered to be a human carcinogen that targets organs including the bladder, liver, and lungs (Health Canada 2006a).

Lead is a trace element found in nature, but people use it or have used it in various products including batteries, gasoline, paints, and metal products. Lead is also released to the atmosphere from burning solid waste, coal, and oil and from emissions by iron and steel producers (ASTDR

1997). The toxic effects of lead include kidney and neurological damage and gastrointestinal symptoms (ASTDR 1992).

Mercury is a naturally occurring metal in the Earth's crust and can be released to the atmosphere by forest fires and volcanic explosions. It is also released through human activities such as mining, fossil fuel burning, waste incineration, metal smelting, and flooding for reservoir development (CCME 2000). In the Okanagan, dairy plants discharged mercury to the environment for several decades, ending in 1968 (SOHU 1970). Mercury is often measured and reported as total mercury (as in this report), but the most toxic form of mercury is actually methylmercury, which binds strongly with proteins and therefore can accumulate in animal tissues. Methylmercury easily passes into the brain and is especially harmful to the developing nervous system of the fetus and of young children (Health Canada 2004b). In adults, high levels of mercury exposure can affect vision, hearing, muscle coordination, and memory.

DDT is an insecticide that began to be used in the 1940s; in Canada, its use was restricted in the 1970s and banned in 1985 (CCME 1999). DDT still enters the Canadian environment, mostly by transport in the air from countries where it's still in use or by being released from historically contaminated soils and sediments. DDT binds well to fats in the body, so it accumulates in the fatty tissues of animals. DDT has been shown to cause reproductive problems and the formation of tumours in animals (CCME 1999), and it has been labeled by the EPA as a probable cause of cancer in humans as well as a cause of nervous system damage (ATSDR 2002). However, the effects of DDT in humans are disputed, with some studies suggesting that it causes little harm (Rogan and Chen 2005).

PCBs are chemicals first manufactured in the late 1920s for use in various industrial materials including caulking, oils, and paint additives, as well as in coolants and lubricants for electrical equipment (CCME 2001a). A North American ban on manufacturing and importing PCBs was put in place in 1977, but these chemicals are persistent and continue to contaminant animals and other parts of the environment. At high levels of exposure, PCBs can cause a variety of health problems, including cancer. At low levels of exposure, the health effects of PCBs are less well documented, but they may cause reproductive and developmental problems (Health Canada 2005b).

PBDEs are man-made chemicals used as flame retardants in numerous consumer products (Health Canada 2006b). These chemicals, which are added to products such as plastics, electrical and electronic equipment, non-clothing textiles, and foam slowly come back out of the products over time. This process can occur when a product is being made or used, or after it's no longer in use. PBDEs are measurable throughout the environment in air, water, soil, and food, and they accumulate in fatty tissues. The health effects of PBDEs are not well documented in humans, but high doses given to animals can affect their behaviour, nervous system, liver, and thyroid (Health Canada 2006b).

Dioxins and furans are by-products of human activities including waste incineration, fuel combustion by cars, and electric power generation, and they are also released through natural sources such as forest fires and volcanic eruptions (CCME 2001b). In studies on animals, dioxins and furans have caused a variety of health problems, including skin and liver disorders, effects on the immune system and reproduction, and cancer (Health Canada 2004a). The effects of dioxins and furans in humans are less well studied, but they appear to be similar to those found in animal studies.

Guidelines

Various government agencies determine maximum tolerable limits for contaminants—the contaminant concentration that a person can ingest and remain at an acceptably low risk for health effects—and they then set guidelines for safe food consumption. The guidelines always provide a wet weight concentration (P. Duchesne, Health Canada, pers. comm.), generally in parts per million (ppm; µg/g), that can be present in a food item when a consumer eats the item at a certain frequency. Throughout this report, contaminant guidelines and contaminant concentrations will be given as wet weight measurements unless otherwise indicated.

In Canada, Health Canada determines guidelines, tolerances, and maximum limits for consumption of contaminated foods. Although different terms are used for different contaminants, they all indicate the same thing: the maximum permissible concentration of a contaminant in a specific food (P. Duchesne, pers. comm.). In this report, we will use the term 'guideline' when referring in general to Health Canada's maximum permissible concentrations.

Note that Health Canada develops its consumption guidelines for commercially available foods rather than for locally harvested foods. The Canadian guidelines for safe concentrations of contaminants in commercial fish and fish products are provided as a concentration in edible fish tissue, shown in Table 1. The guidelines are calculated for an average consumer eating 20 grams of commercially bought fish per day or 140 grams per week (M. Feeley, Health Canada, pers. comm.). According to Health Canada, a single serving of fish is 50–100 grams (Health Canada 1997), so their guideline for mercury (0.5 ppm; Table 1) allows a person to eat fish once or twice a week, provided the fish has 0.5 ppm or less mercury in its edible portions. Note that two of the guidelines—for mercury and PCBs—are under review to ensure that they are consistent with the most recent scientific data (P. Duchesne, pers. comm.). Other guidelines are dated and may be revisited in the future; for example, the lead tolerance level was developed when lead solder was still used in food storage cans. There is currently no consumption guideline for PBDEs.

When concerns arise about a contaminant in a particular animal species at a specific location, such as in a single lake, a regulatory agency (often the provincial government) may issue a consumption advisory. An advisory differs from a guideline in that the advisory indicates what animal is affected, where it is found, and how much—if any—of the animal can be safely eaten. Advisories are discussed in more detail later in this report.

Most guidelines and advisories issued in Canada do not specifically address subsistence use of traditional fish resources, whereby First Nation people harvest fish from local sources and may consume large quantities on a frequent basis. Nonetheless, the First Nations and Inuit Health Branch of Health Canada does provide some advice for mercury, the contaminant of greatest concern in fish. They recommend that people who eat "a lot of fish" (amount not specified), such as subsistence consumers, should limit their consumption to fish with a tissue concentration less than 0.2 ppm (Environment Canada 2002a; K. Lydon-Hassen, Health Canada, pers. comm.). This recommendation is *not* a formal guideline, however. In addition, Health Canada states that they will evaluate contaminant concentrations in traditional foods on a case-by-case basis, if they receive a request from a concerned First Nation community or other party (P. Duchesne, pers. comm.).

The Environmental Protection Division of the BC Ministry of Environment also supplies some guidance about mercury for people whose diet "is based primarily on fish" (MOE 2001). In this case, guidelines are provided on a sliding scale that indicates the amount of fish that can be eaten given the mercury concentration in the fish tissue (Table 1). For example, if the mercury concentration is 0.5 ppm, then a person can eat 210 grams of fish each week. If the mercury concentration is only 0.2 ppm, then a person can eat 525 grams each week.

Table 1. The guidelines, tolerances, and limits established by Health Canada and the BC Ministry of Environment for various contaminants found in fish tissue. All values are in wet weight. Data from CFIA 2005, Health Canada 2005a, and MOE Undated.

Contaminant	Health Canada; for commercial fish and fish products		Environmental Protection Division, BC Ministry of Environment; for human consumption of fish			
	Type	**ppm[a]**	**Type**	**ppm[a]**		
Arsenic	Tolerance	3.5	--	--		
Lead	Tolerance	0.5	Alert level	0.8		
Mercury	Guideline	0.5 (under review)	Guideline (sliding scale of mercury concentration and safe fish weight to eat per week)	**ppm**	**grams**	
				0.1	1,050	~4.6 8oz meals
				0.2	525	2 meals/wk
				0.3	350	3 " /mo
				0.4	260	1 " /wk
				0.5	210	
Mercury	Recommendation for people who eat a lot of fish	0.2	--	--		
DDT	Limit	5.0	--	--		
PCBs	Guideline	2.0 (under review)	Recommended maximum concentration	2.0		
PBDEs	--	--	--	--		
Dioxin	Limit	20 ppt[b] (under review)	--	--		
All other agricultural chemicals & derivatives	Limit	0.1	--	--		

[a] parts per million, or µg/g
[b] parts per trillion, or pg/g

Purpose

Members of the Okanagan Nation would like to have compiled information about the historical and current state of contaminants in the freshwater fish of the Okanagan Basin to compare with the existing guidelines and to determine whether specific consumption advisories are required. Having this information available and specifically relevant to the Okanagan fish will help Okanagan Nation fisheries managers determine the need for developing specific fish consumption advisories for species and locations fished in the Okanagan. Thus, this study has three purposes:

1. To compile and analyse historical and current data on fish contaminant concentrations in the Okanagan Nation traditional territory, focusing on resident fish species that people eat or are likely to want to eat (rainbow trout, lake trout, kokanee, burbot, bass);
2. To review consumption advisory literature from North America;
3. To recommend a sampling protocol for determining if consumption advisories are needed.

Note that although the Okanagan people traditionally harvested anadromous salmon for food and ceremonial purposes, these fish have not been analysed for contaminants and, therefore, are not included in this study. Furthermore, the current numbers of sockeye, chinook, and steelhead that return to Okanagan waters are not sufficiently high to support a food fishery. If the numbers increase in the future and the Okanagan people once again harvest these anadromous species for eating, it may be necessary to take some samples for contaminant analysis.

Methods

To address the first purpose of the study, we requested data from a variety of sources, including

- BC Ministry of Environment, Penticton and Kamloops regions;
- Environment Canada;
- Interior Health (formerly South Okanagan Health Unit).

We also found relevant data in a variety of reports, including

- BC-Canada Okanagan Basin Agreement, 1971 study;
- Washington State Department of Ecology reports.

We entered all available data into a single electronic spreadsheet (printed in Appendix B). We then checked the data for completeness and removed any incomplete records for current status and historical trends analyses. For these analyses, we looked for data that had five or more data points for a contaminant measured in a particular species in a given year. All data shown graphically in this report met this criterion; however, some of the data included in tables had fewer than five data points. The spreadsheet in Appendix B includes all data that we came across, regardless of the tissue type sampled. For the analyses, only muscle or muscle+skin data were used, because data for other tissue types were patchy, and Health Canada guidelines are intended for the edible portion of a fish, generally considered to be the muscle tissue.

To address the second and third purposes of the study, we conducted literature searches on the Internet and through library search engines, and contacted specific agencies.

Historical and Current Data

Data on contaminant levels in fish have been collected in the Okanagan Valley since the early 1970s, with the greatest amount of historical data coming from a large research study, the Okanagan Basin Agreement (OBA) study, carried out in 1971. The data from 1971 include 14 fish species sampled from all of the large lakes in the valley bottom: Wood, Kalamalka, Okanagan, Skaha, Vaseux, and Osoyoos. In addition, a few samples were taken from seven small lakes at higher elevation (termed headwater lakes). Rainbow trout and kokanee were the two species sampled most frequently during the OBA study, and the contaminants analysed were DDT, lead, and mercury. The OBA study also analysed contaminants in a handful of fish that had been collected between 1948 and 1956 and stored at UBC. Since the OBA study, various agencies have collected data from Okanagan lakes on a sporadic basis.

For Wood Lake, three fish samples were analysed by the Ministry of Environment in 1972, and no more have been collected.

For Kalamalka Lake, the Ministry of Environment analysed DDT, mercury, and PCBs in lake trout and a few rainbow trout in both 1978 and 1979. Since then, a handful of lake trout have been analysed in 1984, 1988, 2001, 2002, and 2005.

For Okanagan Lake, the South Okanagan Health Unit and Ministry of Environment analysed rainbow trout in the early to mid-1970s for mercury and DDT content. In 1981, the DDT and mercury content of five burbot samples were analysed. In 1988, 1990, and 1993, the Ministry of Environment again sampled rainbow trout for arsenic, lead, mercury, DDT, and PCBs. In 2005, the Okanagan Nation Alliance and Ministry of Environment partnered to analyse rainbow trout for arsenic, lead, mercury, DDT, and PCBs, as well as PBDEs and a common dioxin in a few of the fish.

For Skaha Lake, a single burbot was analysed in 1986. Okanagan Nation Alliance and Ministry of Environment analysed 10 kokanee in 2005 and 10 bass in 2006 for arsenic, lead, mercury, DDT, and PCBs. PBDEs were also measured in four of the bass.

For Vaseux Lake, no samples were obtained following the OBA study until 1998 when Environment Canada sampled five fish species for mercury, PCBs, and DDT content. These data are not included in this report, however, due to concerns about data quality assurance. Environment Canada may release these data at a later date. The species that Environment Canada sampled in 1998 were 18 northern pikeminnow, 4 yellow perch, 3 largescale suckers, 2 carp, and 1 smallmouth bass. Smallmouth bass is the only one of these species focused on in this report.

For Osoyoos Lake, Washington State's Department of Ecology measured DDT in six fish species in 1995, and Environment Canada then analysed mercury, DDT, and PCBs in seven fish species in 1998. As with Environment Canada's Vaseux samples, the 1998 Osoyoos samples (7 carp, 6 northern pikeminnow, 3 yellow perch, 2 pumpkinseed, 2 black crappie, 2 smallmouth bass, and 1 rainbow trout) are not included in this report. Okanagan Nation Alliance and Ministry of Environment measured arsenic, lead, mercury, DDT, and PCBs in 10 kokanee in

2005 and in 10 bass and one burbot in 2006. Some of the 2006 samples were also sampled for PBDEs.

In addition to the data obtained for Okanagan Valley lakes, we searched for fish tissue data from the Upper Nicola and Similkameen regions of the Okanagan traditional territory, and for data from Okanagan River. Environment Canada apparently has data for the Similkameen and Ashnola rivers from circa 2003, but we were unable to confirm this or to obtain the data. We found a small amount of data for the Upper Nicola (metals in rainbow trout and kokanee from Stump Lake in 1991 and in rainbow trout from Pennask Lake in 2001). We did not find data for Okanagan River in BC, but Washington State's Department of Ecology has sampled several sites in the Okanogan River south of the international border. Data exist for 1983, 1984, 1994, and 2001 for DDT, PCBs, and mercury content of various species. We included these data in our analyses, because the Okanogan River is a continuation of BC's Okanagan system.

Cautions with the Data

Although numerous Okanagan fish tissue samples have been analysed in the past 35 years, there are several problems and concerns with some of the data, including incomplete reporting of units and other information, possible differences in analytic techniques, and small sample sizes.

The most glaring problem is that several of the data sets do not specify whether measurements are stated as a dry weight or a wet weight. In general, most laboratories analyse wet tissue samples, but some have dried the samples for metal analyses. All contaminant guidelines are given as wet weights, so to compare data with the guidelines, wet weight measurements are required. In two instances with some of the 1970s data—mercury in lake trout from Kalamalka Lake and mercury and DDT in rainbow trout from Okanagan Lake—the data come from sources that do not specify analytic techniques. In these cases, the data are included in tables and graphs in this report with a note that the data may actually be dry weights. If they *are* dry weights and still fall within the consumption guideline, then it is certain that their wet weight equivalent will also be within the consumption guideline, because a wet weight concentration is always lower than its equivalent dry weight concentration (see Appendix A for an example calculation). If, however, these unknown data are higher than the consumption guideline, then they may or may not be cause for concern; these cases are mentioned specifically in the Results and Discussion section below.

A second problem is incomplete information in data sets, most often encountered when measurements were clearly stated as dry weights but no moisture content information was given to make the calculation from dry to wet weight. Again, when these data are included in tables or graphs in this report, they are labeled as dry weights and discussed accordingly.

A third problem lies in the fact that the data compiled in this report come from numerous studies done over a time span of 35 years. The analytic methods used to determine contaminant concentrations undoubtedly differ among the data sets obtained, but in most cases the methods used are not known. In addition, laboratory techniques may have improved over time, such that contaminants can be more accurately determined at lower levels of detection today compared with the 1970s. In this report, we make the assumption that all methods are comparable.

Lastly, small sample sizes frequently meant that data could not be used to examine trends over time. These data are discussed in the text if they exceeded consumption guidelines. Many of the cases of small sample size involved fish species that are not generally caught for consumption, such as black crappie, northern pikeminnow, peamouth chub, and bluegill sunfish. Given that these species are not ones that people usually catch to eat, they have not been included in the analyses. The data remain in the data spreadsheet, however (see Appendix B).

Results and Discussion of Data

General Results

Over 600 fish (or composite fish samples) have been collected in the Okanagan and analysed for contaminant concentrations over the past 35 years. Samples have been taken from a wide variety of species in all large valley lakes, several headwater lakes, and the Okanogan River downstream of Osoyoos Lake. The contaminants tested vary considerably among studies and locations, with a resulting patchwork of available data to work with. Table 2 summarizes the data compiled for this report.

As mentioned above, we focused our analysis on fish species most likely to be of interest for food and ceremonial uses. The species selected were rainbow trout, lake trout, kokanee, burbot, and bass. These species also had the greatest amount of available data (with the exception of burbot). For the most part, sufficient data for analyses were only available for mercury, DDT, and PCBs. With current data (2000-2006), we were also able to analyse arsenic, lead, PBDEs, and dioxin content.

Because contaminants can accumulate over the course of an organism's life, large and long-lived fish often contain a higher concentration of a particular contaminant, per gram of body weight, than smaller fish. This relationship—greater contaminant load with larger, older fish—has been reported in other studies (Voiland et al. 1991). We looked at the relationship for each of mercury, DDT, and PCBs with fish length and fish weight. We had sufficient data to examine this relationship for rainbow trout, lake trout, kokanee, and smallmouth bass (Figures 1–4). On each figure, the Health Canada guidelines for consumption of commercial fish are indicated with dashed lines, and the First Nations and Inuit Health Branch's mercury recommendation for those who eat a lot of fish is indicated with a dotted line.

In rainbow trout, there were slight increases in mercury and DDT concentrations with larger fish; however, in many cases, large fish had contaminant levels comparable to smaller fish (Figure 1). There were a few samples with high concentrations: Three fish exceeded the 0.5 ppm guideline for mercury, and five additional fish the 0.2 ppm recommendation. Ten fish exceeded the 5 ppm DDT guideline, one by more than 10 times (a 1971 sample from Kalamalka Lake). PCB concentrations were well below the 2 ppm guideline.

For lake trout, there were too few data to get a good indication of the relationship between mercury and fish length; for fish weight there were a few more data points and they did not show a trend (Figure 2). Very large fish (>7 kg) tended to have very high DDT concentrations, but so did many fish in the 2–6 kg range. There were few lake trout samples analysed for small fish (<50 cm and <2 kg). Most notable with the DDT graphs for lake trout is that the majority of fish sampled had DDT levels above the 5 ppm guideline. PCBs in lake trout showed no trend with length, and if anything, a decrease in concentration in heavier fish.

Table 2. Summary of all fish contaminant data compiled for waterbodies in the Okanagan Nation Territory. All data are in Appendix B. Species and contaminant codes are listed after the table.

Waterbody	Year	Number and Species	Contaminants	Comments
Agur Lake	1971	1 RB	Hg, DDT	
Alex Lake	1971	2 RB	Hg, DDT	
Ellison Lake	1972	1 CP, 1 LSS, 1 NPM	Pb, Hg, DDT	
Fish Hawk Lake	1971	1 RB	Hg, DDT	
Hydraulic Lake	1971	1 RB	Hg, DDT	
Jackpine Lake	1971	2 RB	Hg, DDT	
Kalamalka Lake	1971	2 CP, 4 KO, 1 LSS, 2 LT, 2 MWF, 1 PMC, 10 RB	Pb, Hg, DDT	
	1972	1 LT, 1 NPM	Pb, Hg, DDT	Dry weights
	1978	31 LT	Hg, DDT, PCBs	Muscle & liver samples, ?Hg dry or wet weight
	1979	15 LT, 4 RB	Hg, DDT, PCBs	Muscle & liver samples, ?Hg dry or wet weight
	1984	3 LT, 3 RB	DDT	
	1988	2 LT	As, Pb, Hg, DDT, PCBs	
	2001-05	5 LT	Hg, DDT, PCBs	
Okanagan Lake	1970	29 RB	Hg (6), DDT (23)	?Dry or wet weights
	1971	2 BU, 1 CP, 9 KO, 2 LSS, 4 LWF, 6 MWF, 5 NPM, 1 PMC, 15 RB	Pb, Hg, DDT	
	1974	26 RB	Hg, DDT	?Dry or wet weights
	1975	38 RB	Hg, DDT	?Dry or wet weights
	1981	5 BU	Hg, DDT	?Dry or wet weights
	1988	16 RB	As, Pb, Hg, DDT, PCBs	
	1990	10 RB	As, Pb, Hg, DDT, PCBs	
	1993	8 RB	As, Pb, Hg, DDT, PCBs	
	2005	10 RB	As, Pb, Hg, MeHg, DDT, PCBs, PBDEs, Dioxin	PBDEs measured on 6 only Dioxin measured on 5 only
Okanogan River	1983-84	2 BLS, 1 LMB, 1 MWF	DDT, PCBs	Muscle & liver samples
	1994	1 CP, 2 LSS	DDT, PCBs	
	2001	6 CP, 9 MWF, 9 SMB	DDT, PCBs	
	2001	10 SMB	Hg	
Osoyoos Lake	1971	2 CM, 1 CP, 2 KO, 1 LSS, 1 LWF, 1 MWF, 1 NPM,	Pb, Hg, DDT	

		2 PE, 4 RB, 2 SMB		
	1989	1 LMB	Hg, DDT	
	1995	4 CP, 2 LSS, 2 LWF, 1 MWF, 3 SMB, 8 YP,	DDT, (PCBs)	PCBs for 2 LSS only
	1998	1 RB, 1 SMB	As, Pb, Hg, DDT, PCBs	
	2000	1 SMB	As, Pb, Hg, DDT, PCBs	Dry weights
	2005	10 KO	As, Pb, Hg, MeHg, DDT, PCBs	
	2005	1 SMB	As, Pb, Hg, DDT	
	2006	10 SMB, 1 BU	As, Pb, Hg, MeHg, DDT, PCBs, PBDEs	PBDEs measured only on 4 SMB & 1 BU
Pennask Lake (Nicola drainage)	2001	6 RB	As, Pb, Hg	Muscle & liver samples
Pinaus Lake	1971	2 RB	Hg, DDT	
Skaha Lake	1971	1 CM, 6 KO, 1 LNS, 1 LSS, 3 LWF, 1 MWF, 1 NPM, 1 PMC, 1 RB	Pb, Hg, DDT	
	1986	1 BU	Hg, DDT	Muscle & liver samples, ?Dry or wet weights
	2005	10 KO	As, Pb, Hg, MeHg, DDT, PCBs	
	2006	7 SMB, 3 LMB	As, Pb, Hg, MeHg, DDT, PCBs, PBDEs	PBDEs measured only on 3 SMB & 1 LMB
Stump Lake (Nicola drainage)	1991	10 KO, 10 RB	As, Pb, Hg	Muscle & liver samples (no Hg for liver)
Swalwell Lake	1971	1 RB	Hg, DDT	
Vaseux Lake	1971	1 KO, 1 LWF, 1 PE, 1 LSS, 1 NPM	Pb, Hg, DDT	
Wood Lake	1971	2 KO, 1 RB	Pb, Hg, DDT	
	1972	1 KO, 1 RB, 1 NPM	Pb, Hg, DDT	

Species codes

BB	Brown bullhead	KO	Kokanee	NPM	Northern pikeminnow (formerly N. squawfish)
BC	Black crappie	LMB	Largemouth bass	PE	Perch
BLS	Bridgelip sucker	LNS	Longnose sucker	PMC	Peamouth chub
BU	Burbot	LSS	Largescale sucker	PS	Pumpkinseed (=Bluegill)
CM	Chiselmouth	LT	Lake trout	RB	Rainbow trout
CP	Carp	LWF	Lake whitefish	SMB	Smallmouth bass
FC	Freshwater clam	MWF	Mountain whitefish	YP	Yellow perch

Contaminant codes

As	Arsenic	DDT	Pesticide: 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl) ethane
Pb	Lead	PBDEs	Polybrominated diphenyl ethers
Hg	Mercury	PCBs	Polychlorinated biphenyls
MeHg	Methylmercury		

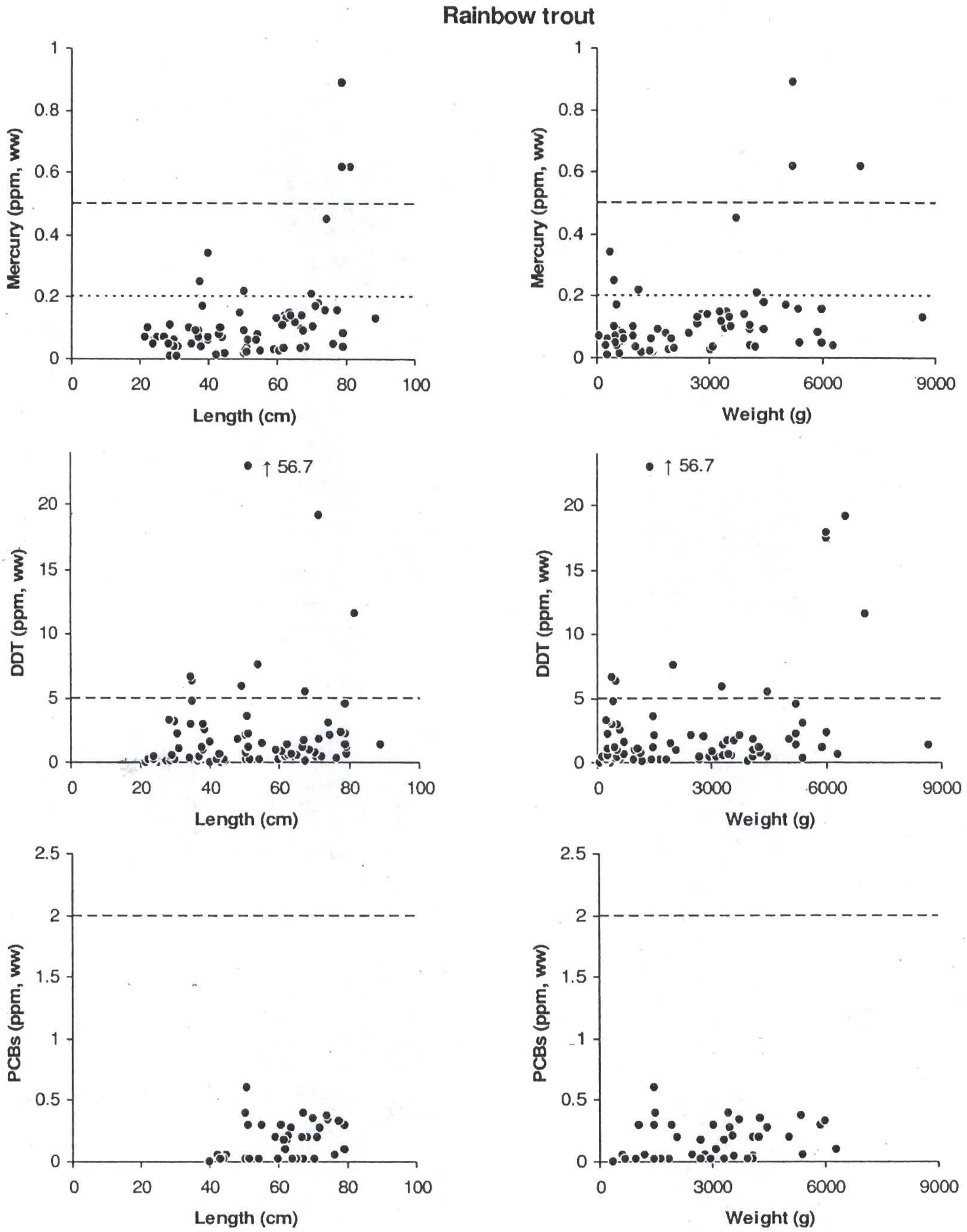


Figure 1. The relationship between contaminant concentration and rainbow trout length and weight. Only data confirmed as wet weight (ww) measurements were used. The data were pooled from all lakes sampled and from all dates (1970–2005). Dashed line indicates Health Canada consumption guideline; dotted line indicates recommendation made for people who consume a lot of fish (see text for details).

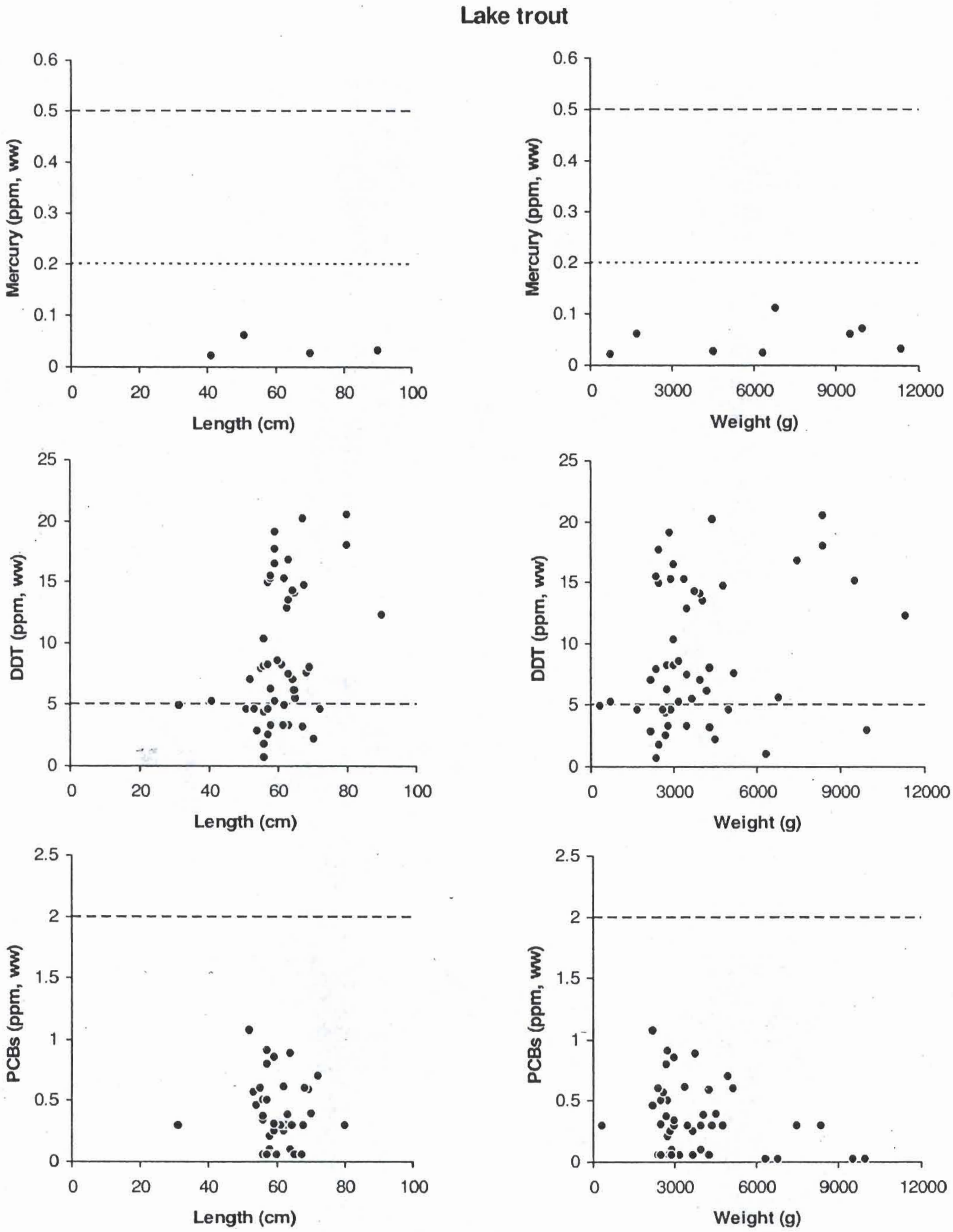


Figure 2. The relationship between contaminant concentration and lake trout length and weight. Only data confirmed as wet weight (ww) measurements were used. The data, all from Kalamalka Lake, were pooled from all dates (1970–2005). Dashed line indicates Health Canada consumption guideline; dotted line indicates recommendation made for people who consume a lot of fish (see text for details).

In kokanee, mercury showed a minimal increase in concentration in larger fish. DDT showed a small decrease and was below the guideline—with one notable exception: one kokanee sample (from Kalmalka Lake, 1971) was measured with DDT of 68.7 ppm (Figure 3). In the few available kokanee with PCB data, the concentrations were a tiny fraction of the guideline level. Based on their life history of living to only age 3 or 4, we would not expect kokanee to accumulate contaminants to the same degree as longer-lived species such as rainbow trout and lake trout. The data compiled here show that kokanee do tend to have lower concentrations of mercury, DDT, and PCBs in their muscle tissue compared with trout.

In smallmouth and largemouth bass, species that reach lengths less than 50 cm and can live up to about 15 years (Scott and Crossman 1973). Mercury tended to increase in longer and heavier fish, with some exceptions (Figure 4). There were no clear relationships between PCBs and fish length or weight. DDT concentrations were slightly higher in fish >40 cm and >1 kg compared with smaller fish. However, for all samples, DDT concentrations were within Health Canada's guidelines. PCBs and mercury were also within guideline levels, although eight smallmouth bass and two largemouth bass were at or above the 0.2 ppm mercury recommendation.

Overall, there is some indication that certain contaminants are found at greater concentration in larger fish, but this is not always the case. Also, the longer-lived trout species tend to have greater contaminant concentrations than the shorter-lived kokanee.

Historical Trends

Two fish–lake combinations had enough data to examine trends in mercury, DDT, and PCBs over time: rainbow trout in Okanagan Lake and lake trout in Kalamalka Lake. In addition, a few data were available to look at changes between past and present in Skaha Lake kokanee, Osoyoos Lake smallmouth bass, and burbot.

<u>Rainbow trout:</u> Of all species, the largest historical data set exists for rainbow trout in Okanagan Lake. Mercury and DDT data go back to the early 1970s, though not all are known wet weight measurements. Nonetheless, some early 1970s data points are clearly above the consumption guidelines for both of these contaminants (Figure 5). If the unknown data points are in fact dry weights, then most of these points would drop below the guideline levels when converted to wet weight. However, if they truly are wet weights, then rainbow trout in Okanagan Lake in the 1970s frequently bore high loads of mercury and especially DDT. The range of data points in the early 1970s from close to zero to above the guidelines may, in part, be explained by fish size. As described earlier, there is some indication that large fish accumulate higher contaminant loads, though this isn't always the case.

By the late 1980s and early 1990s, the contaminant load in rainbow trout muscle was within the guideline levels for both mercury and DDT. In the case of mercury, most samples were also below the recommended level for people who eat a lot of fish. Compared with the early 1990s, the 2005 data show that mercury levels haven't changed and DDT levels have both a lower average and range.

PCBs have only been measured in Okanagan Lake rainbow trout since 1988, and they appear to have declined since then, though at no time have they been above the guideline. On Figure 5, the

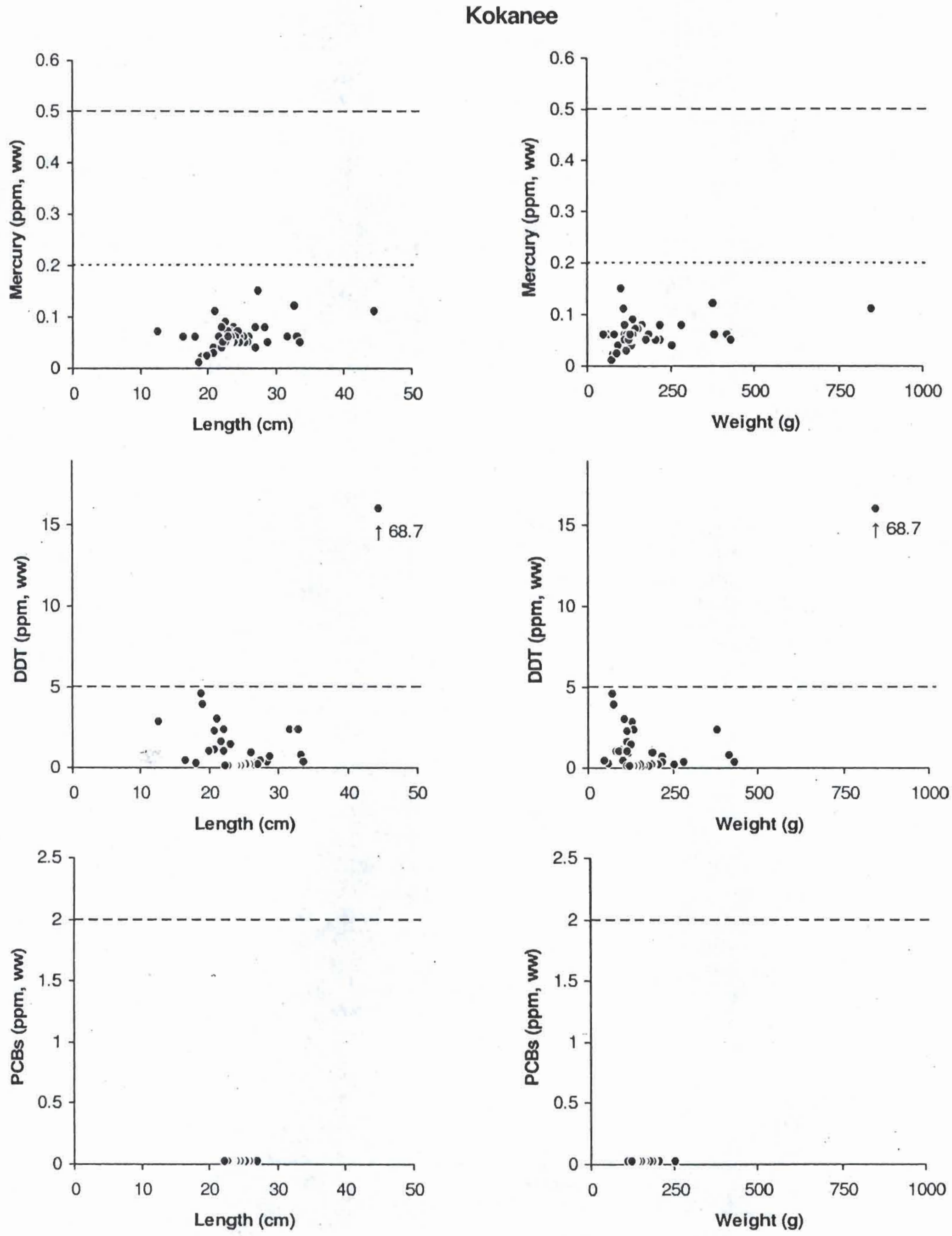


Figure 3. The relationship between contaminant concentration and kokanee length and weight. Only data confirmed as wet weight (ww) measurements were used. The data were pooled from all lakes sampled and from all dates (1970–2005). Dashed line indicates Health Canada consumption guideline; dotted line indicates recommendation made for people who consume a lot of fish (see text for details).

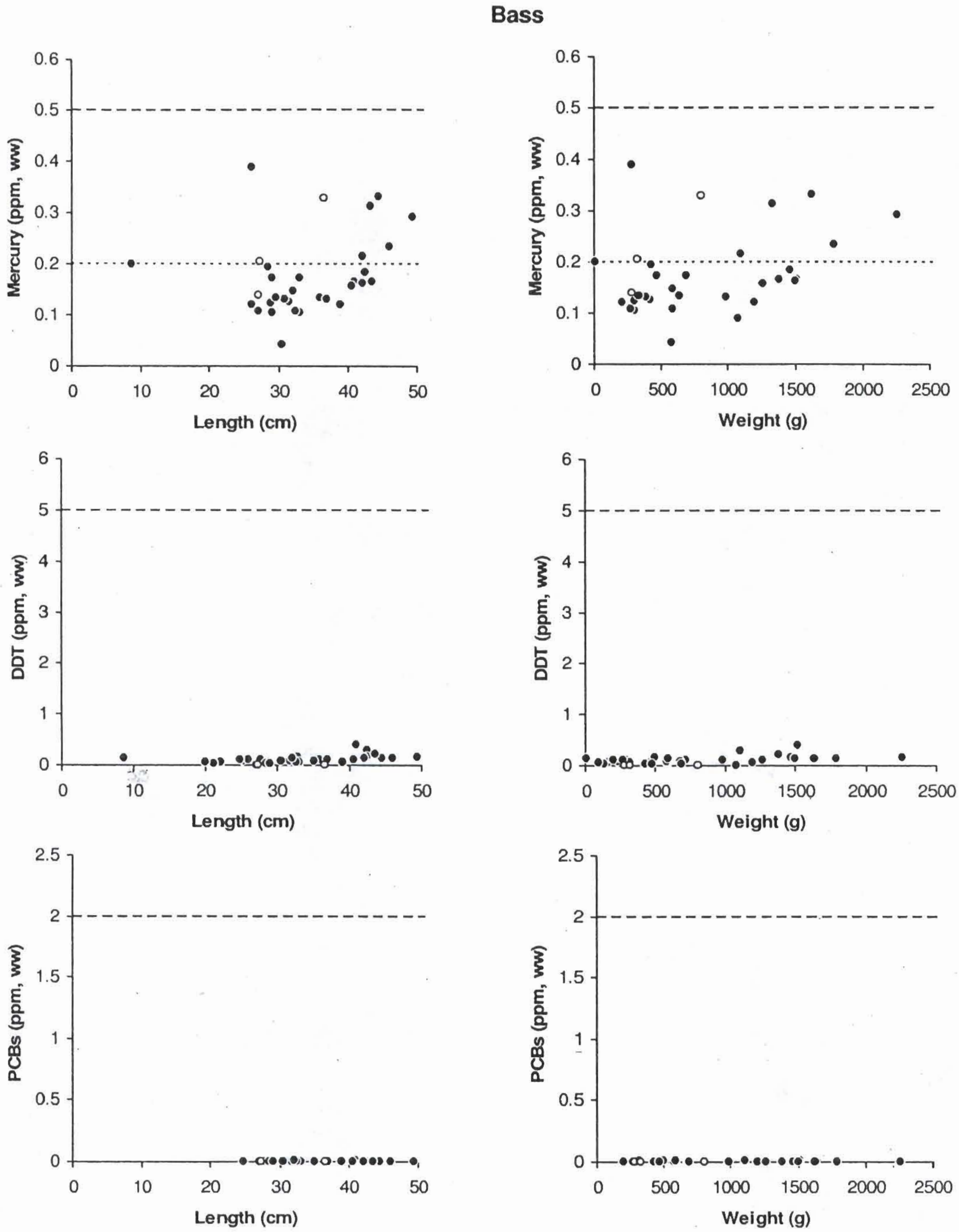


Figure 4. The relationship between contaminant concentration and bass length and weight. Solid circles are smallmouth bass; open circles are largemouth bass. Only data confirmed as wet weight (ww) measurements were used. The data were pooled from Skaha Lake, Osoyoos Lake, and Okanogan River and from all dates (1970–2006). Dashed line indicates Health Canada consumption guideline; dotted line indicates recommendation made for people who consume a lot of fish (see text for details).

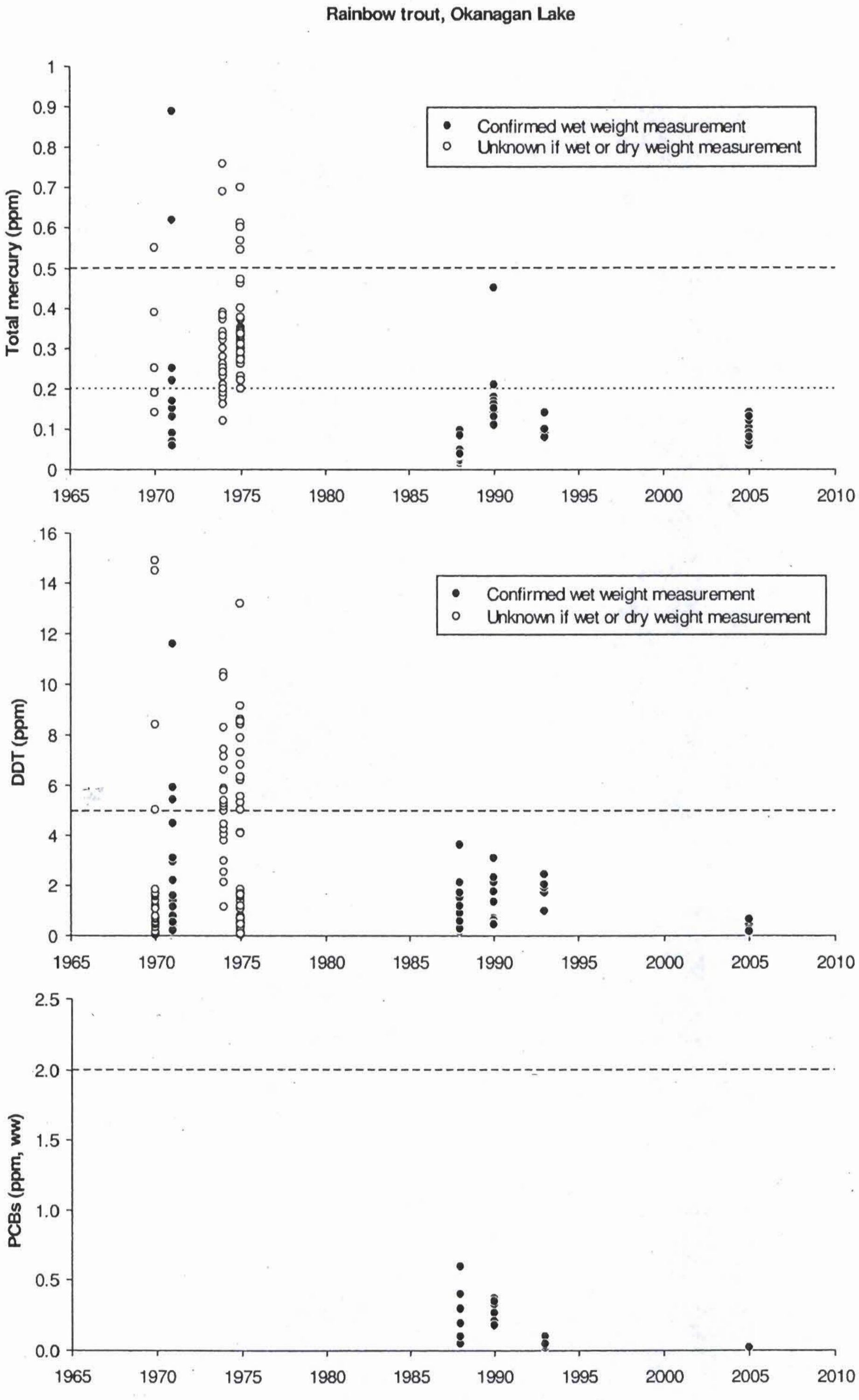


Figure 5. Total mercury, DDT, and PCB concentrations in rainbow trout from Okanagan Lake, 1970 to 2005. Dashed line indicates Health Canada consumption guideline; dotted line indicates recommendation made for people who consume a lot of fish (see text for details).

single point shown for 2005 includes ten fish, all of which had PCB levels below the detection limit of 0.05 ppm.

Lake trout: Lake trout in Kalamalka Lake have tended to be fairly low in mercury content, in all cases below the 0.2 ppm recommendation, and they have not changed since the early 1970s (Figure 6). DDT concentration, however, more frequently exceeds the guideline than not, and in two fish sampled in the late 1970s, the level was more than seven times the guideline. Clearly, lake trout accumulate and biomagnify DDT to high levels. Even in recent samples, of which there are only five, high DDT concentrations have been measured. With the exception of one lake trout sampled in 1988, PCBs have remained below the guideline since the mid-1970s. Five lake trout have been sampled since 2000, and all had PCB values at or below 0.03 ppm.

Kokanee: The only data available to make a historical comparison for kokanee come from Skaha Lake. Analyses of mercury and DDT were done on six fish in 1971 and on ten fish in 2005. Between these two years, average mercury concentration has remained relatively stable, though the range has decreased (Table 3). Even though DDT levels in 1971 were below the guideline, they have nonetheless declined significantly over 35 years.

Bass: The only data available to make a historical comparison for bass come from Osoyoos Lake and are for smallmouth bass. These data indicate that mercury has always been below the 0.5 ppm guideline (Table 3). The average mercury concentration in 2006 is one-third lower than it was in 1971, but the range of concentrations in 2006 still includes several fish with mercury concentrations higher than the 1971 average. DDT declined between 1971 and the mid-1990s, but in 2006 DDT concentrations were slightly higher on average and the range included two fish with concentrations (0.21 and 0.40 ppm) that were higher than any of those measured in 1971. The 2006 DDT concentrations are, nonetheless, well within Health Canada's DDT guideline of 5.0 ppm. The researchers who conducted the 1971 OBA study also analysed two smallmouth bass that had been collected from Osoyoos Lake twenty years earlier, in 1951. The DDT concentrations of those two fish were 0.61 and 0.80 ppm. Though still well below the guideline, these additional early data suggest that DDT levels in the food web have decreased over time.

Burbot: Because burbot are a species targeted by some Okanagan people (H. Wright, Okanagan Nation Alliance, pers. comm.), we provide a brief note on the historical data available for this species. Unfortunately, there are few data available and most of them do not specify wet weight versus dry weight measurements. If we take the worst case scenario and assume wet weights, the data show that burbot muscle samples from 1971 to 2006 have not exceeded the consumption guidelines of 5 ppm for DDT and 0.5 ppm for mercury (Table 3). However, mercury concentrations during this period have increased and have consistently been at or above the recommendation for people who eat a lot of fish. Interpreting these data is difficult, though, because only two samples have been taken in the last 20 years and these are from two different lakes, both of which are different from the lake sampled in 1971 (Table 3). During the 35-year period (1971–2006), DDT concentrations in burbot appear to have decreased, but again, data are available for only two samples from the past 20 years.

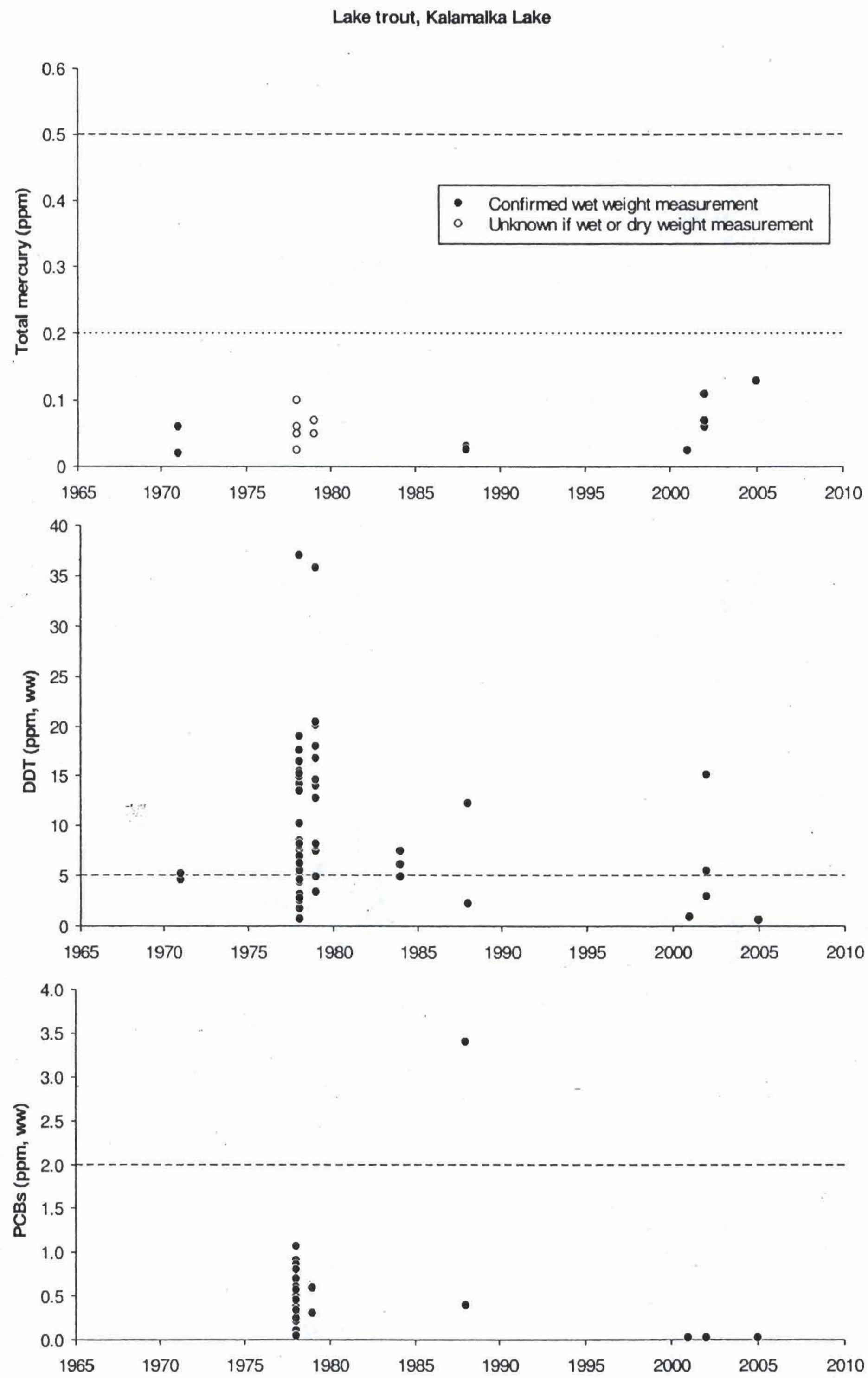


Figure 6. Total mercury, DDT, and PCB concentrations in lake trout from Kalamalka Lake, 1971 to 2005. Dashed line indicates Health Canada consumption guideline; dotted line indicates recommendation made for people who consume a lot of fish (see text for details).

Table 3. Historical comparisons for mercury (Hg) and DDT in kokanee, smallmouth bass, and burbot. Data are averages with the range of concentrations in parentheses below, except where there was only one sample (N=1). Concentrations are in ppm (μg/g) and are given as wet weight except where noted.

Species, lake, and contaminant	1971	1995-98	2005	2006
Kokanee, Skaha, Hg	0.07 (0.05–0.12)	--	0.05 (0.05–0.07)	--
Kokanee, Skaha, DDT	1.29 (0.30–2.36)	--	0.09 (0.07–0.11)	--
Smallmouth bass, Osoyoos, Hg	0.30 (0.20–0.39)	0.09 (N=1)	0.10 (N=1)	0.19 (0.12–0.33)
Smallmouth bass, Osoyoos, DDT	0.13 (0.11–0.14)	0.06 (0.007–0.09)	<0.10 (N=1)	0.16 (0.07–0.40)
	1971 (Okanagan)	**1981[a] (Okanagan)**	**1986[a] (Skaha)**	**2006 (Osoyoos)**
Burbot, Hg	0.20 (0.11–0.28)	0.26 (0.18–0.33)	0.29 (N=1)	0.33 (N=1)
Burbot, DDT	0.27 (0.14–0.39)	0.15 (0.09–0.20)	0.14 (N=1)	0.12 (N=1)

[a] Unknown if wet or dry weight measurement

Overall, the available historical trends data indicate that contaminant loads in resident fish have decreased in Okanagan Valley lakes over time. The greatest decline over a period of 35 years was in DDT, although in some species, mercury and PCBs have also declined over time. The decline in DDT levels in fish tissue is consistent with the 1985 ban on use of this pesticide. The contaminant load and degree of change depends on the species, with larger species—rainbow trout and lake trout—containing more contaminants in the 1970s than the smaller kokanee and bass. Lake trout, in particular, showed exceedingly high DDT concentrations in the 1970s but did not seem to accumulate much mercury. Rainbow trout accumulated both mercury and DDT. Burbot, which in Canada reach lengths of about 94 cm and live for 10–15 years (Scott and Crossman 1973), appear to be accumulating as much mercury today as 35 years ago, but their DDT levels seem to have declined. PCB concentrations in Okanagan fish appear to have declined over time, but few data are available and only for rainbow and lake trout.

Current Status

For people currently consuming or wanting to consume fish, it is particularly helpful to analyse the contaminant load in recently sampled fish. Here, we examine contaminants in four species—rainbow trout, lake trout, kokanee, and bass—sampled in the period 2000–2006. Data are pooled among lake and river samples. There is only one current data point for burbot (one fish sampled from Osoyoos Lake in 2006), and the data were discussed earlier (Table 3). The contaminant concentrations are compared with Health Canada's current guidelines for consumption of commercial fish, and also with the BC Ministry of Environment's current guidelines for fish containing mercury (Table 1).

For the four species, arsenic, lead, and PCBs are all well below the guidelines for human health (Figure 7). Dioxin is also below the guideline, but there are only five samples, all of rainbow trout, available for this contaminant.

Total mercury is also below the 0.5 ppm guideline for all four species, but in seven bass (23% of all bass samples), mercury is above the recommended limit of 0.2 ppm for consumers who eat a lot of fish. Two of the bass with higher mercury concentrations were sampled from Skaha Lake, three from Osoyoos Lake, and two from Okanogan River near Omak.

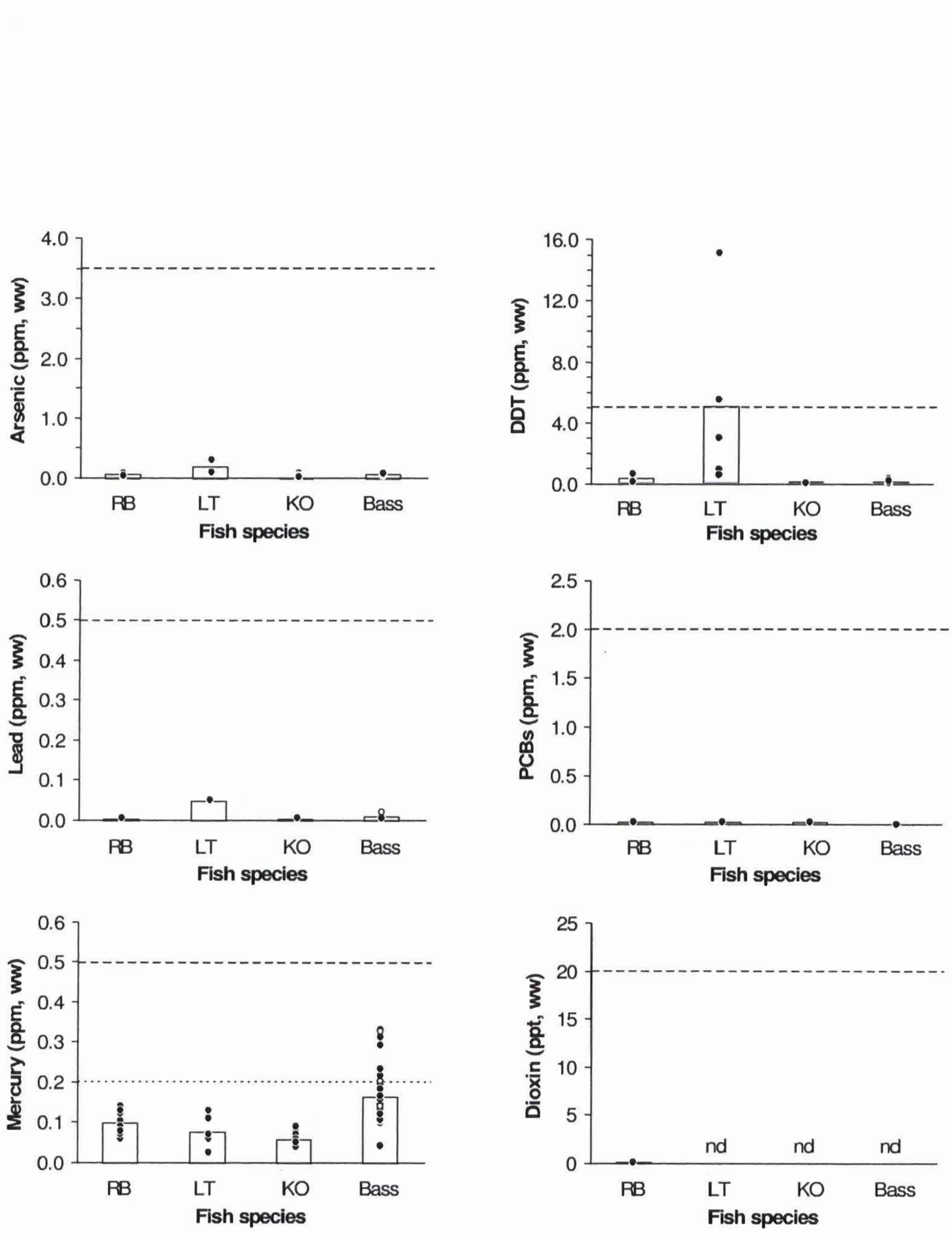
DDT levels are low in three of the four species, but the average DDT in lake trout (all from Kalamalka Lake) is at the Health Canada guideline and two fish exceeded this level.

PBDEs were analysed in two of the species: bass and rainbow trout. Bass had concentrations ranging from <1 to 3.7 ppb and rainbow trout from 9.0 to 26.4 ppb. Because there are no PBDE consumption guidelines, we compare these concentrations with data from other freshwater fish. In a study of the Columbia River, British Columbia, from 1992–2000, mountain whitefish had concentrations of <1 to 131 ppb (Rayne et al. 2003). In a 1999 study of Spokane River, Washington, largescale suckers had concentrations of 105 ppb, rainbow trout of 297 ppb, and mountain whitefish of 1250 pp (Johnson and Olson 2001). Compared with these data, the PBDE concentrations in Okanagan fish are at the lower end. However, a Health Canada fish and seafood survey conducted in 2002 found much lower levels in commercially available fish: 1.1 ppb in wild char and 1.3 ppb in wild salmon (Health Canada 2002b).

Kokanee and bass are the only fish species with current data from more than one lake. For kokanee, comparing Osoyoos and Skaha lakes reveals that the average and range of values is similar between the two lakes for arsenic, lead, mercury, and PCBs (Figure 8). DDT has a higher average and higher upper limit in kokanee from Osoyoos Lake, but even so, DDT in kokanee from both lakes is significantly below the guideline. The slight differences between kokanee from the two lakes may be explained by a different sex ratio caught in each lake or even by the month when samples were collected (Bryan 2006). The Skaha kokanee were mostly females caught in October, and the Osoyoos kokanee were mostly males caught during the summer.

For bass in Osoyoos and Skaha lakes, the average and range of values is similar between the two lakes for arsenic, lead, mercury, PCBs, and PBDEs (Figure 9). As with the kokanee in Osoyoos Lake, DDT has a higher average and higher upper limit in bass from this lake. Again, DDT concentrations in bass from both lakes are within the Health Canada guideline. The Skaha Lake data included both smallmouth and largemouth bass. For most of the contaminants, largemouth bass had lower concentrations than smallmouth bass, but the reverse was true for lead and mercury. There were only three largemouth bass samples analysed, however.

For many of the recently collected and analysed fish samples, pesticide scans have been completed during analysis. These pesticides include organochlorine compounds (e.g., aldrin, dieldrin, endosulfan, lindane, and mirex) and organophosphorus compounds (e.g., aldicarb, diazinon, and malathion). Health Canada's limit for agricultural chemicals and their derivatives (not including DDT) is 0.1 ppm for all fish products (Table 1). None of the samples analysed



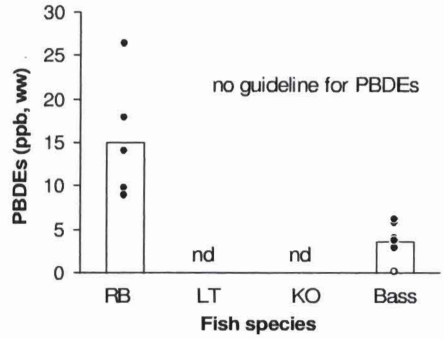


Figure 7. Current status (2000–2006) of contaminants in four species of fish from Okanagan lakes and Okanogan River. Symbols show individual fish, and bars show the average value. Dashed line indicates Health Canada consumption guideline; dotted line indicates recommendation made for people who consume a lot of fish (see text for details). RB = rainbow trout, LT = lake trout, KO = kokanee, Bass = smallmouth bass (solid circles) and largemouth bass (open circles), nd = no data. Note that dioxin data are reported in units of ppt (pg/g) and PBDEs in units of ppb (ng/g).

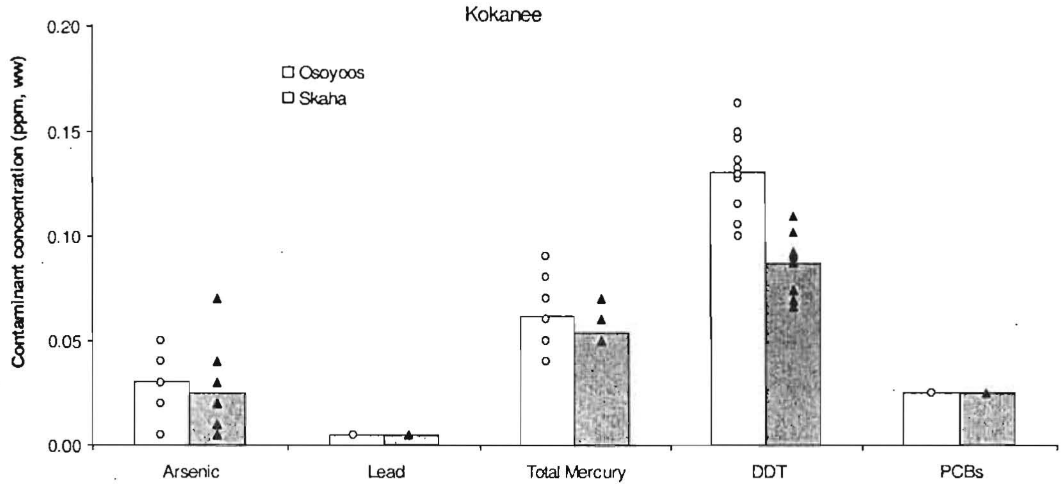


Figure 8. Current status (2000–2005) of contaminants in kokanee from two Okanagan lakes. The bars show the average value and the symbols show individual fish.

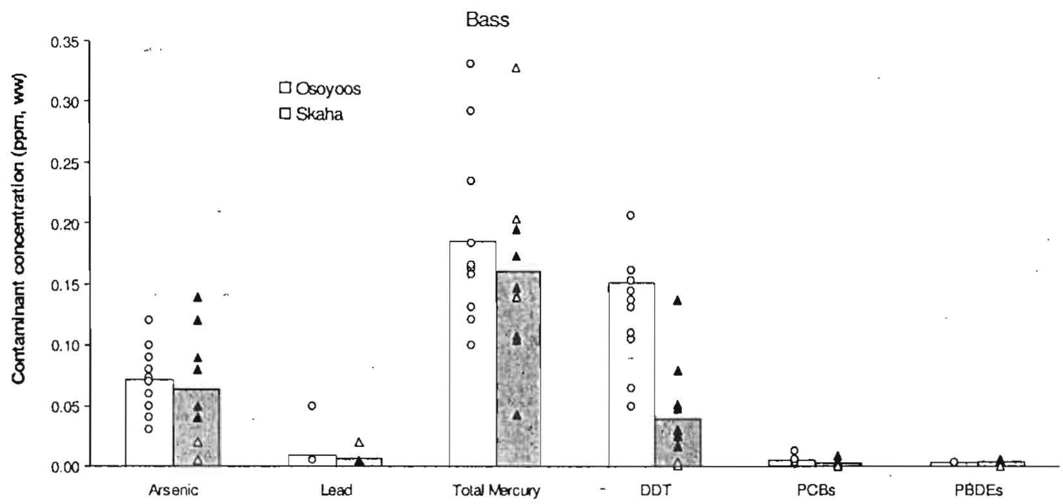


Figure 9. Current status (2000–2006) of contaminants in bass from two Okanagan lakes. The bars show the average value and the symbols show individual fish. All data for Osoyoos Lake are smallmouth bass. For Skaha Lake, solid triangles are smallmouth bass and open triangles are largemouth bass (the average is for all bass combined).

since 2000 have had any organochlorine pesticide (other than DDT) at or above 0.1 ppm. There are few data from before 2000. Sixteen rainbow trout samples from 1988 did not have detectable organochlorine compounds (except DDT and PCBs) or organophosphorus compounds (Jensen 1989). However, three rainbow trout samples collected from Okanagan Lake in 1990 had dieldrin concentrations of 0.86, 0.98, and 1.2 ppm. No other data are available for dieldrin before 2000. Organophosphorus pesticides in recent samples were analysed at a detection limit that is higher than the Health Canada limit, so it is not possible to know if the samples were above or below the limit of 0.1 ppm (Bryan 2006).

Overall in the Okanagan Nation Territory, two of the four species with current data merit caution relative to the human health contaminant guidelines: (i) lake trout can have unacceptably high DDT levels, and (ii) bass can have mercury levels above the recommended level for people who eat a lot of fish. Unfortunately, the phrase "a lot of fish" is not defined, so consumers are left to guess at how much fish this constitutes. By following the Health Canada guidelines, rainbow trout, kokanee, and bass fished from Okanagan lakes could be eaten once a week at a serving size of 140 grams (20 g/day = 140 g/week). According to BC Ministry of Environment's mercury guideline for people with a diet based primarily on fish, it would be safe to consume 1,050 grams per week of kokanee, 750 grams per week of rainbow trout or lake trout, and 350 grams per week of bass. These fish weights were derived from the BC Ministry of Environment sliding scale by considering the *most* contaminated sample of each species (not the average mercury concentrations). The average DDT concentration in lake trout places it at the guideline level, allowing one meal of 140 grams each week. But, since two samples exceeded the guideline, lake trout should probably be consumed more cautiously.

Note that the above discussion is based on Health Canada and BC Ministry of Environment guidelines. It does not constitute an advisory or a recommendation about eating Okanagan fish.

Discussion of Consumption Advisories in North America

A consumption advisory indicates what species is affected, where it is found, and how much or how frequently a person can eat that species and remain within consumption guidelines. Therefore, advisories are determined using consumption guidelines set in Canada by Health Canada and in the United States by the Food and Drug Administration (FDA) or the Environmental Protection Agency (EPA). The guidelines themselves are developed based on tolerable daily intakes—in other words, the amount of contaminant per kilogram of body weight that a person can consume each day without harmful effects or with only low risk of harmful effects. Fish consumption advisories in both Canada and the United States are frequently issued because of high mercury content in species targeted by recreational fishers. Less frequently do advisories address First Nations directly and acknowledge that they may be eating a larger quantity of foods harvested from the land, but there are some exceptions described below. An important aspect of fish consumption advisories is communicating them to the target audience in ways that are accessible and meaningful. Surveys have been done elsewhere in North America that suggest many people who participate in recreational fisheries are either unaware of advisories or don't consider the information when consuming fish (Burger 2000, Imm et al. 2005).

Consumption Advisories in Canada

In Canada, the federal government issues some blanket advisories that cover commercial fish and fish products. Currently, Health Canada has only one advisory in place for finfish, and this concerns mercury levels in fish muscle. Health Canada advises that people limit their consumption of certain types of fish (shark, swordfish, and fresh and frozen tuna) to one meal per week. They further recommend that pregnant women, women of child-bearing age, and young children limit consumption of these species to one meal per month (Health Canada 2002a). In March 2007, tinned albacore tuna was also added to the list of fish with an advisory for some groups in the population, including pregnant women and young children (Health Canada 2007).

Each province and territory is responsible for determining and issuing fish consumption advisories specific to their lakes and rivers (and coastlines). These advisories tend to pertain to recreational fisheries. In British Columbia, current fish consumption advisories state that mercury concentrations may be high in large lake trout (>45 cm long) from Jack of Clubs Lake in the central interior and in bull trout from Williston Lake and lake trout from Pinchi Lake, both in northern BC. The advisories, which are published annually in the *BC Sport Fishing Regulations* (MOE 2006), recommend that anglers limit their consumption of these fish from these locations. In addition, in BC there is a general advisory issued by the Ministry of Health against eating fish liver (R. Copes, BC Centre for Disease Control, pers. comm.). When this advisory was first made in the mid-1990s, it was communicated to recreational fishers by local medical health officers and to First Nations by the First Nations and Inuit Health Branch of Health Canada (R. Copes, pers. comm.). However, the advisory does not currently appear in the sport fishing regulations where the three existing advisories for mercury can be found. Nor does the information seem to exist on the Ministry of Health website. The three advisories that do exist (though not relevant to the Okanagan Territory) are advertised primarily through the angling regulations. Since First Nation people do not require an angling license, they are unlikely to read the advisories. Although it's not currently an issue in the Okanagan because no advisories exist here, it points to a potential communication gap for First Nations.

In some other Canadian provinces, fish consumption advisories provide more detailed advice than that given by the *BC Sport Fishing Regulations*. For example, the Ontario Ministry of the Environment (OME) publishes the *Guide to Eating Ontario Sport Fish* which states how many meals per month a person can safely eat of a specific fish species of a specific length from a specific location (OME 2005). They further divide their advice for the general population and the sensitive population (defined as women of child-bearing age and children under age 15). Although the monitoring of fish and setting of advisories is more extensive in Ontario than in BC, there still may be some problems with communicating the information to the target audience. A three-year survey of over 6,000 people who fished in the Great Lakes found that although many fishers were aware of the guide to eating sport fish, there was little evidence that they used the information to determine how much fish to include in their diet (Fish and Wildlife Nutrition Project 2001).

Consumption Advisories in the United States

In the United States, the FDA and the EPA have issued a joint advisory about mercury and fish consumption to pregnant and nursing women, women who may become pregnant, and young children. In addition to this federal advisory, numerous fish consumption advisories (3,221 in 2004 according to EPA 2005) are in place for recreational and subsistence fishers in local waterbodies. These advisories are usually determined and issued at state, regional, local, and tribal levels and can be accessed through the EPA at www.epa.gov/waterscience/fish/advisories/. Many of these advisories pertain to specific waterbodies and fish species, while others are general advisories for a state. Organisations such as the Great Lakes Information Network, operated from Michigan, help to disseminate fish contamination advisories issued by the states (and Ontario and Quebec) that border the Great Lakes.

Consumption Advisories Specific to Subsistence Fishers

In general, neither guidelines nor advisories in Canada consider the subsistence use of fish, and little advice is provided to First Nation people about eating foods harvested from the land. As mentioned in the Introduction, the First Nations and Inuit Health Branch of Health Canada recommends that people who eat a lot of fish limit their consumption to fish with no more than 0.2 ppm of mercury (K. Lydon-Hassen, Health Canada, pers. comm.). However, this is not an official guideline, and "a lot" is not defined. Also as mentioned earlier, the Environmental Protection Division of the BC Ministry of Environment makes suggestions about mercury for people whose diet "is based primarily on fish" (MOE 2001). They provide a sliding scale of the amount of fish that can be eaten according to the mercury concentration in the fish tissue, with the range from 210 grams per week of fish with 0.5 ppm mercury to 1,050 grams per week of fish with 0.1 ppm mercury. Dr. Ray Copes, the Director of Environmental Health at BC's Centre for Disease Control, recommends that people who eat fish frequently (which he defines as three or more meals per week on an ongoing basis) should ask their physician about mercury testing if they are concerned about the fish they are eating (R. Copes, BC Centre for Disease Control, pers. comm.). He also stresses that although he does receive reports of people with high blood mercury levels due to fish consumption, all of the cases to date have been the result of eating store-bought fish.

In northern Canada, the Northern Contaminants Program focuses its research efforts on reducing contaminants in traditionally harvested foods and on providing information (NCP 2006). Although this program doesn't issue advisories, it helps to communicate any that are issued by a territorial health department (G. Somers, Indian and Northern Affairs Canada, pers. comm.). For example, the Nunavut Department of Health and Social Services issued a "public health message" about the nutritional value and safety of traditional foods (Government of Nunavut, undated). The message states the importance of including traditional foods in the diet. It also recommends that pregnant women should choose more of certain foods and less of others in order to protect their unborn child from possible contaminants.

In addition, the Northern Contaminants Program recently funded a project in the Northwest Territories to conduct health risk assessments for mercury in local fish. The study was conducted because, although 16 fish consumption advisories are in place, there is no regular sampling program to update them, and health officials needed to know whether actual fish consumption was putting people at risk of high mercury concentrations (J. MacKinnon, Government of the Northwest Territories, pers. comm.). The study was lead by the Centre for Indigenous Peoples' Nutrition and Environment (CINE) at McGill University, Montreal. The project team examined data for average and maximum mercury concentrations in local fish as well as estimates of fish consumption by the First Nation communities throughout the territory (Culhane et al. 2005). They then calculated the possible exposure of different gender–age groups to mercury contamination and compared these exposures to Health Canada's guidelines. They found that average fish consumers (the amount of fish varied by community and gender–age group from 1–101 grams per person per day) were not exposed to excessive mercury, but that some heavy fish consumers (amounts of fish not specified) did exceed mercury guidelines (Culhane et al. 2005).

In Ontario, a partnership of the Assembly of First Nations, Chiefs of Ontario, Health Canada, and 34 First Nation communities conducted a study titled the Effects on Aboriginals in the Great Lakes Environment (EAGLE) Project. One of the EAGLE Project's aims was to develop fish consumption guidelines specific to First Nation communities (EAGLE 2001). They developed a software program that calculates fish consumption guidelines for specific sites, fish species, and contaminants. The software was then used to generate tables for the First Nation communities in the Great Lakes basin to indicate how many fish of a particular species and size could be eaten per month when fished at a particular location. The calculations in the software were based on those used by the OME in preparing the *Guide to Eating Ontario Sport Fish*, but some variables were changed to make them more relevant to the First Nation communities.

In Alberta, a partnership of the Alberta Treaty 8 Health Authority, the eight First Nations in northern Alberta, and Health Canada began a study to develop fish consumption guidelines for people who rely on traditional foods in their diet (NREI 2004). The study first determined food consumption patterns by the eight First Nations, and then collected and analysed fish samples from locally fished waterbodies. In addition, they conducted a health-risk assessment to examine the toxicological values used for assessing data. The assessment indicated, for example, that 0.2 ppm (the current recommendation by Health Canada's First Nations and Inuit Health Branch for people who eat a lot of fish, such as subsistence consumers) is a reasonable value to use as a mercury guideline (L. Muskwa, Alberta Treaty 8 Health Authority, pers. comm.). The data and information collected are currently being assessed for a subsistence diet by Alberta's provincial health ministry to determine whether advisories are necessary (L. Muskwa, pers. comm.).

In the United States, the EPA provides guidance for conducting fish contaminant monitoring programs and recommends threshold levels at which contaminants may affect human health. (The term 'threshold level' is used here instead of 'guideline' to indicate the amount of a contaminant that may affect human health. Threshold level is a generic term and does not refer to a regulated or legislated contaminant concentration. On the other hand, a guideline is put in place by Health Canada and must be adhered to in commercial products.) EPA's guidance and recommendations are available for subsistence fishers (EPA 2000a) and are discussed in more detail below in the section *How Advisories Are Determined in the US*. Some US First Nations are also conducting work to establish fish consumption guidelines that are specific to their lifestyle. For example, the St. Regis Mohawk Tribe in New York proposed setting a tribal safe fish consumption level that would take into account dietary habits and cultural lifestyles of their people (IEN 2003). The tribal safe fish consumption level was to be released in spring of 2004, but we've not been able to find any further information about it.

How Advisories Are Determined in Canada

A recent Environment Canada report outlined the procedure that's used for issuing fish consumption advisories for mercury in each province and territory, and showed that the process varies considerably throughout the country and often involves numerous provincial and federal ministries (Wood and Trip 2001). A flow chart given in that report indicates that there are two pathways for issuing advisories in BC. In one, samples are collected and analysed by the provincial Ministry of Environment and federal Department of Fisheries and Oceans (DFO). The data may go to Health Canada or the provincial Ministry of Health for a health risk assessment. This information is fed back to DFO which consults other agencies to determine if fish harvest closures or other restrictions should be put in place, and then DFO and Health Canada issue news releases. Various closures are in effect for shellfish harvest along the BC coast (Environment Canada 2002b), but it appears that no such closures or restrictions are currently in effect for inland waterbodies.

The second pathway for advisories in BC goes through the provincial Ministry of Environment, which publishes consumption warnings in the annual *Freshwater Sport Fishing Regulations Synopsis*. Although there is currently no defined provincial protocol for collecting and testing fish samples (T. Ovanin, Ministry of Environment, pers. comm.), there are ways in which contaminant levels are assessed if fish samples happen to be collected and tested. The local branch of Ministry of Health will interpret contaminant data that it receives and the local Medical Health Officer makes a decision about the need for an advisory aimed at recreational fishers and how the advisory should be worded (R. Copes, BC Centre for Disease Control, pers. comm.). This procedure is currently underway on southern Vancouver Island where elevated mercury levels were measured in large (>40 cm) smallmouth bass, and the Vancouver Island Health Authority is assessing the data to determine if a consumption advisory should be included in the sport fishing regulations (D. Epps, Ministry of Environment, pers. comm.). In addition, a provincial working group is in place and is determining what type of protocol could be implemented in BC to collect and analyse fish, assess possible health risks (for mercury, at this point), and translate the results into advisories to the public (T. Ovanin, pers. comm.). Note that the BC Ministry of Health only assesses fish contaminant data to issue advisories to recreational fishers; for First Nation consumers, data are interpreted and advisories issued by the First Nations and Inuit Health Branch of Health Canada.

According to Wood and Trip's 2001 review, other provinces and territories have either more or less complicated flow charts for issuing consumption advisories. One of the most straightforward appears to be Ontario's process: the Ministry of the Environment (OME) and the Ministry of Natural Resources collect samples, and the OME analyses the fish and assesses the results using Health Canada's guidelines (OME 2005). When sampling, they collect a minimum of 10 fish of each species to be tested from a particular location. The OME then recommends size-specific consumption limits for each fish species tested from each location sampled and publishes the recommended limits in tables in the *Guide to Eating Ontario Sportfish* (OME 2005).

Currently, there is no standard method in Canada for establishing fish consumption advisories. Each provincial and territorial government follows a different process, and other groups interested in determining the need for advisories must establish their own process. Wood and Trip (2001) recommended that Canada establish a uniform procedure for issuing fish consumption advisories and for informing the public about them. However, as far as we can find out, no standard procedure has yet been established.

How Advisories Are Determined in the United States

The US Environmental Protection Agency (EPA) developed a series of four volumes titled *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories*. The purpose of the publication is to provide guidance to officials at the state, regional, local, and tribal levels who are designing and conducting fish contaminant monitoring programs and issuing fish consumption advisories (EPA 2000a). This guidebook provides step-by-step detail on every aspect of selecting target species, sampling locations, and which contaminants to test. It recommends a two-tier approach, with the first tier being a screening process to determine where the majority of monitoring effort should be directed. The second tier, called an intensive study, collects further data for a particular location and species in order to be able to confidently assess the risk to human health and determine whether an advisory is necessary. EPA recommends conducting an intensive study in two phases, the first to test replicate samples from larger fish in the population, and the second to test replicate samples from smaller size classes if the initial tests show high contamination. They generally divide a target species into three size (age) classes that span the range of sizes that people are allowed to harvest.

The samples themselves are recommended to be composite samples of a single fish species with the smallest individual in the composite being no smaller than 75% of the size (usually based on length) of the largest individual in the composite (EPA 2000a). They then provide a statistical model that can be used to determine the optimal number of fish in each composite and the optimal number of replicates to collect. In this way, sufficient samples can be tested for statistical power in assessing the health risk without wasting resources by testing more samples than necessary. Lastly, contaminant concentrations in the samples are compared with a screening value (contaminant threshold level) and if the samples significantly exceed the screening value, then a fish consumption advisory is warranted.

Clearly, the screening value—defined by the EPA as the threshold contaminant concentration that is of potential public health concern—makes a difference to whether or not an advisory would be issued. Volume I of the EPA guidebook recommends screening values based on carcinogenic and noncarcinogenic effects of contaminants (EPA 2000a). EPA developed recommended screening values both for recreational fishers and for subsistence fishers. These screening values are calculated using different consumption rates: 17.5 grams per day for recreational fishers and 142.4 grams per day for subsistence fishers. Because of the difference in these consumption rates, the screening value at which a consumption advisory would be made for subsistence fishers is much lower than the screening value for recreational fishers. In addition, these EPA screening values are lower than the FDA (Food and Drug Administration) action levels (Table 4). The FDA action levels, which are equivalent in intent to the Health Canada guidelines used throughout this report, are set for commercial foods only. They are not intended to protect recreational or subsistence fishers who may consume large amounts of fish harvested repeatedly from the same locations (EPA 2000a). Therefore, both the FDA and the EPA have agreed that it is inappropriate to use the FDA action levels when determining the need for a recreational or subsistence fish consumption advisory. Table 4 compares the EPA's recommended screening values with both the FDA action levels and the Health Canada guidelines for the contaminants included in this report. Whereas the FDA action levels are similar to Health Canada guidelines, the EPA screening values are always lower, especially for subsistence fishers where they are 1–3 orders of magnitude lower than Health Canada and FDA levels. In addition to recommending screening values, the EPA discusses how to set screening values for a specific population according to variables such as consumption rates, body weight, and risk level for negative contaminant effects.

Table 4. A comparison of guidelines and action levels for contaminants in fish tissue among three government agencies: Health Canada, the US Food and Drug Administration, and the US Environmental Protection Agency.

Contaminant	Health Canada guideline	FDA action level	EPA screening value for recreation	EPA screening value for subsistence
Arsenic (ppm)	3.5[b]	--	0.026	0.00327
Lead (ppm)	0.5	--	--	--
Mercury (ppm)	0.5 0.2[c]	1.0	0.4[e]	0.049[e]
DDT (ppm)	5.0[b]	5.0	0.117	0.0144
PCBs (ppm)	2.0	2.0[d]	0.02	0.00245
Dioxin (ppt)[a]	20[b]	--	0.256	0.0315
PBDEs	--	--	--	--

[a] parts per trillion, or pg/g (parts per million is μg/g)
[b] limit, not guideline
[c] recommendation for people who consume a lot of fish
[d] tolerance level, not action level
[e] methylmercury

Volume II of the EPA guidebook includes an alternate approach to determining whether fish contaminant levels warrant a consumption advisory. The guidebook provides tables that indicate the number of 227-gram meals of fish a person can eat per month when the fish tissue has a certain contaminant concentration. In other words, it is possible to use data from a monitoring program to determine the monthly number of meals that can be eaten and then use this information in an advisory. The EPA determines monthly consumption limits using a risk-based approach, which means that the calculations have incorporated information about the health risks associated with a particular contaminant and with the concentration of that contaminant (EPA 2000b). Depending on the contaminant, the health risks may be carcinogenic ("cancer health endpoints") or noncarcinogenic ("noncancer health endpoints"). By way of example, the EPA's table of monthly fish consumption limits for mercury is reproduced here (Table 5; EPA 2000b). The EPA also provides information about modifying consumption limits if a person is exposed to multiple sources of a particular contaminant (e.g., eats a variety of contaminated fish species, drinks contaminated water, etc.) or if a person is exposed to multiple contaminants.

Table 5. The EPA's monthly fish consumption limits for methylmercury. (Since methylmercury is the most toxic form of mercury, it is a conservative approach to assume that total mercury measured in fish tissue is entirely composed of methylmercury.) In this table, the EPA uses a risk-based consumption limit and noncancer health endpoints (see text for details).

Fish meals/month	Mercury concentration in fish tissue (ppm wet weight)
>16	0–0.029
16	>0.029–0.059
12	>0.059–0.078
8	>0.078–0.12
4	>0.12–0.23
3	>0.23–0.31
2	>0.31–0.47
1	>0.47–0.94
0.5	>0.94–1.9
None	>1.9

Volume III of the EPA guidebook provides information about developing an advisory program and establishing fish advisories (EPA 1996). Specifically, it discusses (i) options for limiting the consumption of contaminated fish, (ii) potential social, economic, cultural, and nutritional impacts of limiting the consumption of fish, and (iii) ways to compare the health risks from eating contaminated fish to the impacts from limiting fish consumption. Lastly, Volume IV of the EPA guidebook covers the topic of effectively communicating consumption advisories to the target audience. It includes advice about the format and tone of an advisory, the type of information that may be included beyond the specific consumption advice, and ways to disseminate the information (EPA 1995).

Determining the Need for Advisories in the Okanagan Nation Territory

Based solely on the available data for Okanagan fish and on the current Health Canada guidelines, it appears that—at the moment—only two species need to be further investigated to determine if advisories are necessary. These are bass, which can exceed Health Canada's mercury recommendation for people who eat a lot fish, and lake trout, which can exceed Health Canada's DDT guideline.

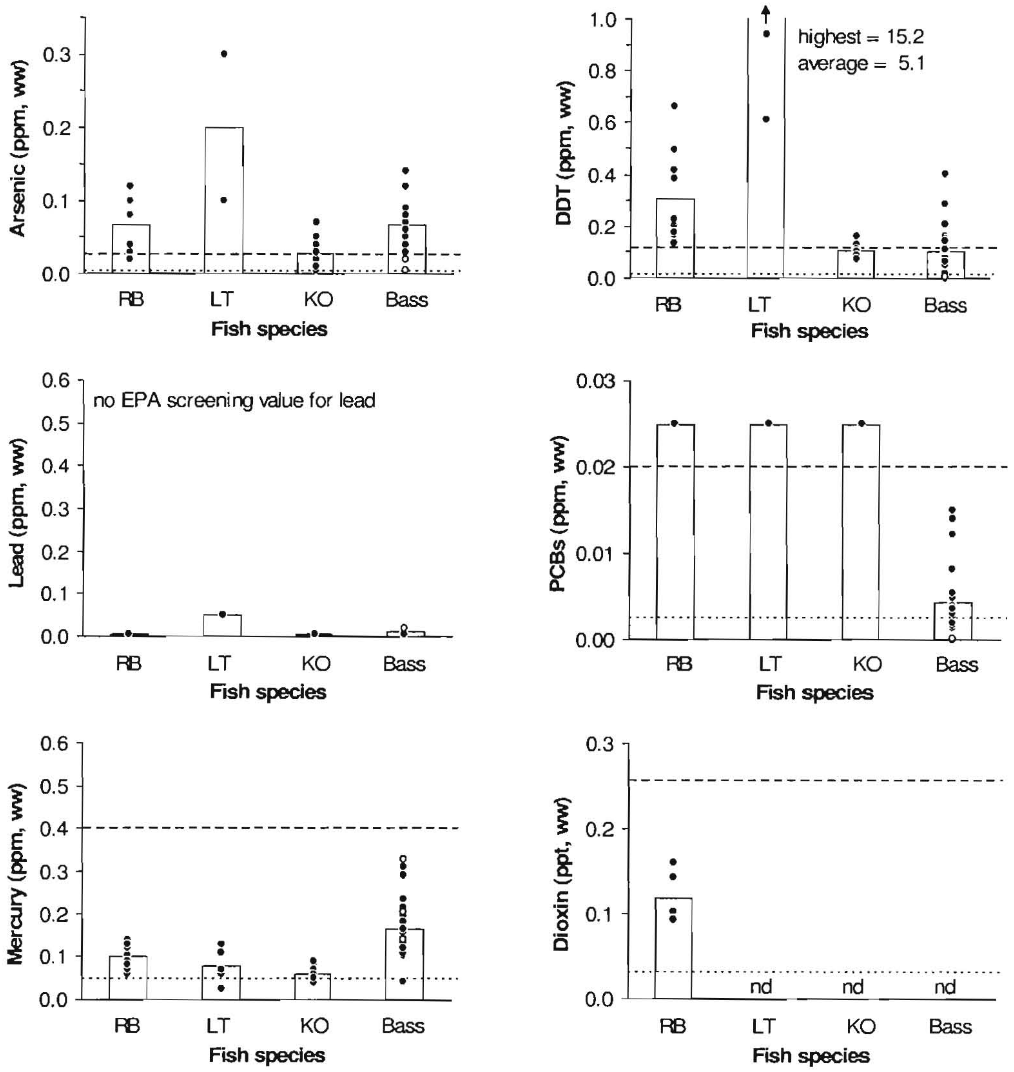
A considerable amount of data already exists for lakes in the Okanagan Valley, but for some species or locations there are few current data points to use in evaluating the possible need for advisories. Therefore, some additional screening—as with the EPA's Tier 1 approach—may be useful, and it would be best directed by knowing which species Okanagan people are fishing, where they are fishing, and how much they are eating. In addition, it would be helpful to know if there are species that people would like to fish or would like to eat more frequently, so that information can be gathered to answer any concerns about contaminant issues. By having a better idea of the actual and desired fish consumption rates and patterns among the Okanagan people, a fish contaminant monitoring program can use resources most efficiently to focus on particular species and locations.

Another item to consider is the threshold level at which potential health impacts could occur for each contaminant of concern. This threshold level would then be used to determine the need for an advisory. Most provinces and territories use the Health Canada guidelines and limits discussed throughout this report (Table 1), but they may or may not be appropriate for subsistence consumption of fish. As mentioned earlier, the FDA and EPA in the United States have agreed that the FDA's action levels should not in fact be used to determine the risk to public health from eating locally caught fish by either recreational or subsistence fishing. A public health or medical officer should be able to help decide the most appropriate threshold levels to use for the Okanagan Nation, given people's actual or desired food consumption patterns.

Following from the discussion above of EPA's recommended screening values (the term they use for their threshold levels), we can go through the exercise of reevaluating the current status of fish contaminants in the Okanagan Valley lakes. Figure 10 shows the same data as in Figure 7, but instead of including the Health Canada guidelines, Figure 10 includes EPA's recommended screening values (SVs) for recreational fishers (dashed line) and subsistence fishers (dotted line). The results in Figure 10 can be summarized as follows:

- Arsenic: all samples are at or above the subsistence SV; most are above the recreational SV;
- Lead: there is no recommended SV;
- Mercury: most samples are above the subsistence SV, but none exceed the recreational SV;
- DDT: most samples exceed the subsistence SV, and all rainbow trout and lake trout samples exceed the recreational SV;
- PCBs: most bass samples exceed the subsistence SV, and the average values for rainbow trout, lake trout, and kokanee all exceed the recreational SV;
- Dioxin: the five samples from rainbow trout exceed the subsistence SV but not the recreational SV;
- PBDEs: there is no recommended SV.

Although the contaminant concentrations in Okanagan fish exceed the EPA's subsistence SVs most of the time, it's important to consider that the SVs have been set for people who eat 142.4 grams of fish every day. This amount may be an overestimate, as suggested by studies of fish consumption by several First Nation communities in eastern North America. Fish consumption rates in the 1990s were estimated at 23 g/day for Ojibwa members (Dellinger et al. 1997), 23 g/day for Mohawk from Kahnawake (Chan et al. 1999), 25 g/day for Mohawk from Akwesasne (Forti et al. 1995), and 26 g/day for Wisconsin Chippewa members (Peterson et al. 1994). These values are much closer to those used by Health Canada (20 g/day), suggesting that the Health Canada guidelines may in fact be appropriate. Since we don't know how much fish or what species Okanagan people are consistently eating (or would like to eat), nor how frequently they eat fish, we must interpret the comparison of Okanagan fish to EPA screening values with caution. Local consumption patterns must be considered in determining appropriate threshold levels with which to compare contaminant concentrations in Okanagan fish samples.



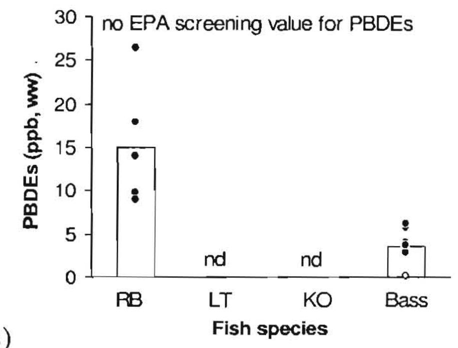


Figure 10. The current status (2000–2006) data shown in Figure 7 compared with Environmental Protection Agency (EPA) screening values. Screening values are for recreational fishers (dashed line) and subsistence fishers (dotted line). Symbols show individual fish, and bars show the average value. RB = rainbow trout, LT = lake trout, KO = kokanee, Bass = smallmouth bass (solid circles) and largemouth bass (open circles), nd = no data. Note that dioxin data are reported in units of ppt (pg/g) and PBDEs in units of ppb (ng/g).

An alternative way to examine the current fish contaminant data for the Okanagan (as shown in Figure 10) is to compare the data to the monthly fish consumption limits developed by the EPA (e.g., Table 5). For example, we can consider the fish sample with the highest mercury concentration in each of the four species for which current data exist. Using the most contaminated sample, rather than the average value, is a conservative approach. Comparing the samples on the Figure 10 mercury graph to Table 5 indicates that for rainbow trout with 0.14 ppm mercury and lake trout with 0.13 ppm mercury, a person could eat four meals per month (here, one meal=227 grams wet weight fish). Kokanee, at 0.09 ppm, could be eaten eight times per month, but bass, at 0.331 ppm, could be eaten only twice in a month. Note as well that these meal limits are calculated for a 70-kg person, so they would have to be adjusted for a smaller person. By comparing the Okanagan data with the EPA consumption limits—or similar consumption limits derived specifically for the Okanagan people—it would be possible to establish an advisory that recommends a specific quantity of fish that people can eat over a given time period. The EPA guidebook volume II (EPA 2000b) gives instructions for modifying the information included in its monthly fish consumption tables.

Overall, there are some potential issues with contaminants in Okanagan fish, depending in large part on how frequently people eat fish and how much they eat for each meal. These issues need to be followed up first with a survey of the Okanagan people to determine their current and desired fish consumption patterns, and then with a structured monitoring program (see Recommendations below). It will then be possible to determine if advisories are needed and, if so, to provide specific recommendations that can be easily used by the Okanagan people in planning their meals. However, it is also important to communicate the health benefits of eating fish. Fish are a low-fat food that is an excellent source of protein and omega-3 fatty acids. These fatty acids are important for reducing the risk of heart disease (Albert et al. 1998, Kris-Etherton et al. 2002) and for brain development, especially in the fetus and infant (Farquharson et al. 1992, Makrides et al. 1994). Therefore, when advisories are issued, people should be encouraged to eat fish and should be given specific recommendations about how to do so in the best way to protect their health. For example, information about methods to trim and cook fish helps people prepare meals to reduce contaminant exposure. There are several examples (generally from US states) of existing brochures and information pages (e.g., State of New Jersey 1998, CalEPA 2001, Maine CDC 2005, Oceans Alive 2005) that provide advice about safe consumption of fish, usually both commercially available and locally caught fish, while stressing the benefits of including fish in the diet.

Recommendations

1. Determine the fish consumption habits of Okanagan Nation people. Possible questions to ask in a survey:

- What fish species do you catch to eat?
- Where do you fish for them?
- When (time of year) do you fish for them?
- What size range of fish do you keep to eat?
- What parts of the fish do you eat (muscle, liver, other)?
- How often do you eat the fish you catch (every day, twice a week, once a week, etc.)?
- How much fish do you eat for each meal?

- What other species do you not currently catch to eat but you would like to?
- What concerns you most about resident fish?
- How much store-bought fish do you eat (species, amount, frequency)?
- Are you, or is anyone in your home, pregnant or of child-bearing age? What fish (species, amount, frequency, etc.) do they eat?
- How many children are in your home? What fish (species, amount, frequency, etc.) do they eat?

2. Based on the information gathered by surveying people's fish consumption patterns and desires, decide which species and locations to focus on for a contaminant monitoring program.

3. Determine the parameters of a contaminant monitoring program.
- Sampling frequency: At least once every five years. Every year or every second year for contaminants of concern.
- Sample number: Minimum of five single or composite samples of a particular species, but 10–15 would probably be ideal. (Consult the EPA's guidebook, EPA 2000a and 2000b, for statistical models to determine optimum sample number for statistical power and cost efficiency.)
- Contaminants to measure: This will depend on the fish species being targeted and data collected to date. Based on the current data presented in this report, DDT (in lake trout especially) and mercury should be measured. A pesticide scan should be done at least once every five years, unless specific concerns are noted. (The pesticide scan analyses, as with all contaminant analyses, must be performed with a detection limit that is at or below the consumption guideline value so that the data can be compared with the guideline.) PBDEs should be measured regularly (every 2–5 years) to determine if their concentrations in fish are increasing.

4. Determine the threshold levels to use as consumption guidelines when interpreting fish contaminant data. The threshold levels may be guidelines already in place (such as Health Canada's guidelines) or values recommended by other organizations (such as EPA's screening values) or newly calculated values specific to the Okanagan Nation. Determining the most appropriate threshold levels will require consultation with a public health or medical officer who understands the need and desire of Okanagan people to include local fish in their diet.

5. Produce fish consumption advisories that, in addition to providing any needed information about contaminants and recommended consumption rates, outline the health benefits of eating fish. Advisories should encourage fish consumption as well as advising which species to avoid or limit in the diet. Advisories should also include advice on preparing and cooking fish to reduce contaminant exposure. Lastly, any advisories issued must be actively communicated to the target audience, and this may require using a variety of means, such as distributing brochures or wallet-sized cards with colour-coded consumption charts, holding public education gatherings, and informing community health practitioners.

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Appendix A

Example calculations for converting between dry and wet weight concentrations

A fish of 800 grams total weight and 75% moisture content has:

- a wet weight of 800 grams, or 800 g_{wet}
- a dry weight of 200 grams [= wet weight – water weight = 800 – (800 × 0.75)], or 200 g_{dry}

If this fish has a mercury concentration of 0.35 ppm wet weight (or 0.35 $\mu g/g_{wet}$), then dry weight can be calculated as:

$$\text{Dry weight} = \frac{\mu g/g_{wet} \times g_{wet}}{g_{dry}} = \frac{0.35 \times 800}{200} = 1.4\ \mu g/g_{dry}$$

or

$$\text{Dry weight} = \frac{\mu g/g_{wet}}{\text{proportion}_{dry}} = \frac{0.35}{0.25} = 1.4\ \mu g/g_{dry}$$

If this fish has a mercury concentration of 0.35 ppm dry weight (or 0.35 $\mu g/g_{dry}$), then wet weight can be calculated as:

$$\text{Wet weight} = \frac{g_{dry} \times \mu g/g_{dry}}{g_{wet}} = \frac{200 \times 0.35}{800} = 0.0875\ \mu g/g_{wet}$$

or

$$\text{Wet weight} = \mu g/g_{dry} \times \text{proportion}_{dry} = 0.35 \times 0.25 = 0.0875\ \mu g/g_{wet}$$

Appendix B

<u>All data compiled for fish contaminants in Okanagan Valley fish.</u>

Data sheets begin on the next page.

Fish codes

BB	Brown bullhead
BC	Black crappie
BLS	Bridgelip sucker
BU	Burbot
CM	Chiselmouth
CP	Carp
FC	Freshwater clam
KO	Kokanee
LMB	Large mouth bass
LNS	Longnose sucker
LSS	Large scale sucker
LT	Lake trout
LWF	Lake whitefish
MWF	Mountain whitefish
NPM	Northern pikeminnow (formerly N. squawfish)
PE	Perch
PMC	Peamouth chub
PS	Pumpkinseed (=Bluegill)
RB	Rainbow trout
SMB	Small mouth bass
YP	Yellow perch

Agency codes

DOE (WA)	Department of Ecology, Washington State
MOE	BC Ministry of Environment (name has changed several times from 1970-2005; always coded as MOE)
OBA study	Canada-BC Okanagan Basin Agreement study
ONA	Okanagan Nation Alliance
SOHU	South Okanagan Health Unit

Laboratory codes

Maxxam	Maxxam Analytical Services (note: Me-Hg always analysed by Flett when Maxxam identified as lab)
MEL	Manchester Environmental Lab
MOE lab	Ministry of Environment and Parks Environmental Laboratory
PESC	Pacific Environmental Science Centre (Environment Canada)
PSC An.	PSC Analytical Services (now Maxxam)
Zenon	Zenon Environmental Incorporated (now Maxxam)

Data column codes

na	not analysed (this noted only when data source stated it)
nd	not detected (but detection limit not given)
<	Entries with < symbol are below detection limit given; e.g. <0.1 where 0.1 is detection limit (note: data not included if <detection limit and limit was greater than Health Cda guideline)
N	sample size when a composite sample analysed

Reference codes

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BC Gov't 1974	BC Government. 1974. Kalamalka-Wood Lake Basin, Water Resource Management Study. Department of Lands, Forests and Water Resources, Victoria BC.
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Fischnaller et al 2003	Fischnaller S, P Anderson, & D Norton. 2003. Mercury in edible fish tissue and sediments from selected lakes and rivers of Washington State. Pub. No. 03-03-026. Washington State Department of Ecology.
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Jensen 1989	Jensen, E.V. 1989. Contaminants in rainbow trout--an update for Okanagan Lake. Unpublished report. Waste Mgmt Program. DATA SHEETS
Jensen 1989	Jensen, EV. 1989. Contaminants in rainbow trout: an update for Okanagan Lake. Ministry of Environment, Penticton, BC. +data sheets.
Jensen 2006	Electronic files from Axys, Maxxam, and Flett; received by Vic Jensen in Jan/Feb 2006
Jensen file A	Data sheet in File folder: Osoyoos Lake Fish Misc
Jensen file B	File folder: 40.39.01.02
Jensen file C	Raw data sheets in File folder: Frost bite derby 1988
Jensen file D	Raw data sheets in File folder: Frost bite derby 1990
Jensen file E	Raw data sheets in File folder: Frost bite derby 1993
Jensen file F	Memo in File 40.3901
Jensen file G	Compiled data table, May24/78. File folder 40:39:01:02
Jensen file H	Compiled data table, May31/79. File folder Fish Testing Misc.
Jensen file I	Raw data sheets. File folder: Kal Fish Testing Various
Jensen file J	File folder: Fish Testing Misc.
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Serdar 2003	Serdar D. 2003. TMDL Technical Assessment of DDT and PCBs in the Lower Okanogan River Basin. WA State Dept of Ecology. Pub No. 03-03-013. [Note: 2001 data and text given in this report also appears, word for word, in DOE publication marked **]
Serdar et al 1998	Serdar D, D Davis and A Johnson. 1998. DDT in Osoyoos Lake Fish. Washington State Department of Ecology, Olympia WA. Ecology Pub No. 98-337.
SOHU 1974	South Okanagan Health Unit Annual Report 1974

Unique code for complete data set	Fish code from original source	Fish spp	Lake / River	Sample type	Year sampled	Agency	Analysing Lab	Lab Requisition #, if avail.	Data Source	N for a composite/pooled sample	Fish Length (cm)	Fish Weight (grams)	Lipids PCB (%)	Moisture (%)	Total Arsenic (ug/g dw)	Total Arsenic (ug/g ww)	Total Lead (ug/g dw)	Total Lead (ug/g ww)	Total Hg (ug/g dw)	Total Hg (ug/g ww)	Total Hg (ug/g, dw or ww?)	Methyl Hg (ug/g ww)	Total DDT (ug/g dw)	Total DDT (ug/g ww)	DDT (ug/g, dw or ww?)	Total PCBs (ug/g dw)	Total PCBs (ug/g ww)	Dioxins/Furans Lipids (%)	Dioxin 2,3,7,8-TCDD (pg/g ww)	PBDE Lipids (%)	PBDEs (ug/g ww)
Unq. Code	Src. code	Species	Lake / Riv	Sample	Year	Agency	Lab	Req. #	Source	N	Lgth (cm)	Wght (g)	%Lip PCB	%Moist	As (dw)	As (ww)	Pb (dw)	Pb (ww)	Hg (dw)	Hg (ww)	Hg (?)	MeHg (ww)	DDT (dw)	DDT (ww)	DDT (?)	PCB (dw)	PCB (ww)	Lip D&F	Diox (ww)	Lip PBDE	PBDE (ww)
UC001	02-128230	CP	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	55 2	2135	1.04											0.327			0.013				
UC002	02-128231	CP	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	51 4	1749	0.84											0.434			0.009				
UC003	02-128232	CP	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	7	46.3	1348	1.55											0.249			0.010				
UC004	02-128233	CP	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	61.9	3345	3.43											0.311			0 026				
UC005	02-128234/35	CP	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	58.4	2740	3											0.249			0.036				
UC006	02-128236	CP	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	55	2393	3.09											0.236			0.022				
UC007	02-128237	MWF	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	36 3	315	0.79											0.515			0 024				
UC008	02-128238	MWF	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	33	229	1 31											0.361			0.020				
UC009	02-128245	MWF	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	29	167	1.17											0.174			0.012				
UC010	02-128239/40	MWF	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	10	36.5	453	4 26											0.599			0.042				
UC011	02-128241	MWF	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	10	33.4	331	4 7											0 382			0 020				
UC012	02-128249	MWF	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	10	28.4	209	4 58											0.185			0.030				
UC013	02-128242	MWF	Ok Riv–Mons	muscle	2001	DOE (WA)	MEL		Serdar 2003	9	32.6	301	2 96											0 127			0.020				
UC014	02-128243	MWF	Ok Riv–Mons	muscle	2001	DOE (WA)	MEL		Serdar 2003	9	24.6	127	3 07											0.140			0.011				
UC015	02-128244	MWF	Ok Riv–Mons	muscle	2001	DOE (WA)	MEL		Serdar 2003	8	22	81	1.55											0.081			0.005				
UC016	02-128246	SMB	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	1	42.4	1111	3.21											0.288			0.015				
UC017	02-128247	SMB	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	4	31.6	472	1.39											0.077			0.002				
UC018	02-128248	SMB	Ok Riv–Orov	muscle	2001	DOE (WA)	MEL		Serdar 2003	1	24.8	206	1 6											0.104			0.002				
UC019	02-128250	SMB	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	7	35	685	1.17											0.088			0.003				
UC020	02-128251	SMB	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	7	28 7	320	1.42											0.060			0.008				
UC021	02-128252	SMB	Ok Riv–River	muscle	2001	DOE (WA)	MEL		Serdar 2003	7	21 3	133	0.95											0.028			nd				
UC022	02-128253	SMB	Ok Riv–Mons	muscle	2001	DOE (WA)	MEL		Serdar 2003	5	32 7	496	1.35											0 167			0 014				
UC023	02-128254	SMB	Ok Riv–Mons	muscle	2001	DOE (WA)	MEL		Serdar 2003	5	27.6	276	1.12											0.102			0 002				
UC024	02-128255	SMB	Ok Riv–Mons	muscle	2001	DOE (WA)	MEL		Serdar 2003	5	20	98	0.7											0.063			nd				
UC025		BLS	Ok Riv--belov	muscle	1984				Hopkins et al. 1985				2 7											3.244			nd				
UC026		LMB	Ok Riv--belov	muscle	1984				Hopkins et al. 1985				4.2											1.732			0.022				
UC027		CP	Ok Riv–abov	muscle	1994				Davis & Serdar 1996		60.2	3766	9.1											2.706			0 045				
UC028		BLS	Ok Riv–at Ol	whole body	1983				Hopkins et al 1985				2.1											1.784			0.583				
UC029		MWF	Ok Riv–at Ol	whole body	1983				Hopkins et al 1985				8.3											0.811			0.122				
UC030		LSS	Ok Riv–abov	whole body	1994				Davis & Serdar 1996		47.8	1141	8.4											0 901			0.056				
UC031		LSS	Ok Riv–abov	whole body	1994				Davis & Serdar 1996		48.6	1129	6.1											1.319			0.072				
UC032		BLS	Ok Riv–belov	liver	1984				Hopkins et al 1985				23.1											14.300			0 210				
UC033		LMB	Ok Riv–belov	liver	1984				Hopkins et al 1985				not available											2.840			nd				
UC034	OM-44	SMB	Ok Riv--near	muscle	2001	DOE (WA)			Fischnaller et al 2003		29	309	1 01							0.104											
UC035	OM-46	SMB	Ok Riv–near	muscle	2001	DOE (WA)			Fischnaller et al 2003		27	273	0 76							0.107											
UC036	OM-48	SMB	Ok Riv–near	muscle	2001	DOE (WA)			Fischnaller et al 2003		26	218	1 06							0 121											
UC037	OM-42	SMB	Ok Riv–near	muscle	2001	DOE (WA)			Fischnaller et al 2003		28.8	303	0 93							0.125											
UC038	OM-29	SMB	Ok Riv–near	muscle	2001	DOE (WA)			Fischnaller et al 2003		31.5	412	0.81							0.127											
UC039	OM-41	SMB	Ok Riv–near	muscle	2001	DOE (WA)			Fischnaller et al 2003		30.8	388	0.88							0.132											
UC040	OM-30	SMB	Ok Riv--near	muscle	2001	DOE (WA)			Fischnaller et al 2003		29.6	332	0.6							0.133											
UC041	OM-40	SMB	Ok Riv--near	muscle	2001	DOE (WA)			Fischnaller et al 2003		36	641	1 04							0 133											
UC042	OM-39	SMB	Ok Riv–near	muscle	2001	DOE (WA)			Fischnaller et al 2003		42.1	1102	1.8							0.217											
UC043	OM-28	SMB	Ok Riv–near	muscle	2001	DOE (WA)			Fischnaller et al 2003		43.3	1330	2.36							0.312											
UC044		RB	Wood	muscle+skin	1971	OBA study			Northcote et al 1972		21.5	83						<0 04		0.070				0.010							
UC045		KO	Wood	muscle+skin	1971	OBA study			Northcote et al 1972	10	201	82						<0.04		0.060				0.980							
UC046		KO	Wood	muscle+skin	1971	OBA study			Northcote et al 1972	8	221	118						<0.04		0 080				0.940							
UC047		RB	Wood	muscle+skin	1972	MOE			BC Gov't 1974	1	23 9	136						<0.2						0.420							
UC048		KO	Wood	muscle+skin	1972	MOE			BC Gov't 1975	10	20	91						<0.2		<0.05				1 010							
UC049		NPM	Wood	muscle+skin	1972	MOE			BC Gov't 1976	9	48.7	1742						<0.2		0.090				7.400							
UC050		CP	Ellison	muscle+skin	1972	MOE			BC Gov't 1977	2	38.4	977						<0.2		0 070				0.010							
UC051		LSS	Ellison	muscle+skin	1972	MOE			BC Gov't 1978	6	35.8	516						<0.2		0 130				0 220							
UC052		NPM	Ellison	muscle+skin	1972	MOE			BC Gov't 1979	10	31.8	382						<0.2		<0 05				0.290							
UC053	o1	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		27.0	257 8	2.3	79.2		0.030		<0.01		0.040		0.006		0.127			<0.05				
UC054	o2	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		25.8	205 4	3.3	76.1		0 030		<0.01		0.050		0.012		0.146			<0.05				
UC055	o3	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		25.5	206.1	4 3	76 4		0.050		<0 01		0.050		0.013		0 149			<0.05				
UC056	o4	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		25.4	193.0	3 2	77 6		0.040		<0 01		0.060		0.011		0 132			<0.05				
UC057	o5	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		24.8	188.8	2 9	76 8		0.020		<0 01		0.060		0.008		0 136			<0 05				
UC058	o6	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		24 7	178.2	3 5	78 7		0.050		<0.01		0 050		0.005		0.100			<0 05				
UC059	o7	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		23.8	166.0	3.2	76 8		<0.01		<0.01		0 060		0.010		0.115			<0 05				
UC060	o8	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		23.4	159.8	3.5	76 2		0 020		<0 01		0.070		0.012		0.105			<0.05				
UC061	o9	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		23.2	155.0	2 5	78		0.040		<0.01		0.070		0.009		0 163			<0 05				
UC062	o10	KO	Osoyoos	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		22 8	138.5	2.8	77.3		0.020		<0.01		0.090		0.016		0.129			<0.05				
UC104		LMB	Osoyoos	muscle	1989				Johnson & Norton 1990				1.1							0 070				0 211			nd				
UC105	438241	YP	Osoyoos	muscle	1995				Serdar et al 1998		18.5	71.0	0 85											0 053							
UC106	438243	YP	Osoyoos	muscle	1995				Serdar et al 1998		19.9	91.0	1 1											0.051							
UC107	438244	YP	Osoyoos	muscle	1995				Serdar et al 1998		20.6	104 0	0.97											0.061							
UC108	438242	YP	Osoyoos	muscle	1995				Serdar et al 1998		21.2	113.0	1 12											0.068							
UC109	438245/46	YP	Osoyoos	muscle	1995				Serdar et al 1998		22 0	122 0	0.6											0 042							
UC110	438239	YP	Osoyoos	muscle	1995				Serdar et al 1998		22 3	131.0	0 99											0.070							
UC111	438238	YP	Osoyoos	muscle	1995				Serdar et al 1998		22 8	133 0	0 99											0.070							
UC112	438240	YP	Osoyoos	muscle	1995				Serdar et al 1998		24 5	175 0	0 87											0.064							
UC113	438247	SMB	Osoyoos	muscle	1995				Serdar et al 1998		22 2	164 0	1.04											0.043							
UC114	438248	SMB	Osoyoos	muscle	1995				Serdar et al 1998		25 2	234.0	1.11											0.083							
UC115	438232	SMB	Osoyoos	muscle	1995				Serdar et al 1998		35 8	724.0	0 97			nd								0.093							
UC116	438249	MWF	Osoyoos	muscle	1995				Serdar et al 1998		31 3	306 0	4 06											0.105							
UC117	438236	CP	Osoyoos	muscle	1995				Serdar et al 1998		43 8	1170 0	1.41											0.223							
UC118	438237	CP	Osoyoos	muscle	1995				Serdar et al 1998		47 8	1515 0	2.78											0.653							
UC119	438233	CP	Osoyoos	muscle	1995				Serdar et al 1998		49 5	1638.0	2 8											0.552							
UC120	438234/35	CP	Osoyoos	muscle	1995				Serdar et al 1998		53.9	2219 0	1.58											0 321							
UC121	438251	LWF	Osoyoos	muscle	1995				Serdar et al 1998		51 0	1245 0	7 51											0 987							
UC122	438252/53	LWF	Osoyoos	muscle	1995				Serdar et al 1998		55 5	1508 0	5.53											1 240							
UC123		LSS	Osoyoos	whole body	1995				Serdar et al 1998		49 3	1209 0	5 08											1 040			0 066				

Unq. Code	Src. code	Species	Lake / Riv	Sample	Year	Agency	Lab	Req. #	Source	N	Lgth (cm)	Wght (g)	%Lip PCB	%Moist	As (dw)	As (ww)	Pb (dw)	Pb (ww)	Hg (dw)	Hg (ww)	Hg (?)	MeHg (ww)	DDT (dw)	DDT (ww)	DDT (?)	PCB (dw)	PCB (ww)	Lip D&F	Diox (ww)	Lip PBDE	PBDE (ww)
UC124		LSS	Osoyoos	whole body	1995				Serdar et al 1998		47.8	1214.0	5.82											0.577			0.024				
UC125		SMB	Osoyoos	muscle	2005	MOE	PSC An	5E+07	Jensen file A				1.6			<0.2		<0.1		0.100				<0.1							
UC126		SMB	Osoyoos	muscle	2000	MOE	PESC	5E+07	Jensen file A		39	1500			1.100		<0.2		0.700				0.074				<0.01				
UC127		SMB	Osoyoos	muscle	1998	MOE	PESC	5E+07	Jensen file A			1077		73.8					0.345	0.090			0.025	0.007							
UC128		RB	Osoyoos	muscle	1998	MOE	PESC	5E+07	Jensen file A		40	360		85					2.270	0.341			0.061	0.009			<0.01				
UC129		RB	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	5	38.5	612						<0.04		0.050				2.560							
UC130		RB	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	2	37.2	547						<0.04		0.090				0.280							
UC131		RB	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	2	28.9	287						<0.04		0.010				0.370							
UC132		RB	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	2	27.4	240						<0.04		0.060				0.110							
UC133		KO	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	10	22.1	135						<0.04		0.040				2.320							
UC134		KO	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	6	20.9	117						<0.04		0.030				2.260							
UC135		MWF	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	5	33.7	448						<0.04		0.100				1.890							
UC136		LWF	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	10	38.6	805						<0.04		0.050				0.580							
UC137		CP	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	2	42.4	1161						<0.04		0.090				0.560							
UC138		SMB	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	3	26	289						<0.04		0.390				0.110							
UC139		SMB	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	2	8.7	6.5						<0.04		0.200				0.140							
UC140		PE	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	4	19.9	109						<0.04		0.500				<0.01							
UC141		PE	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	3	11.4	12.3						<0.04		0.090				0.270							
UC142		LSS	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	10	45.4	1180						<0.04		0.100				0.330							
UC143		NPM	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	1	38.9	669						<0.04		0.570				2.620							
UC144		CM	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	10	25.2	207						<0.04		0.080				0.440							
UC145		CM	Osoyoos	muscle+skin	1971	OBA study			Northcote et al 1972	1	21.9	133						<0.04		1.130				0.080							
UC182		KO	Vaseux	muscle+skin	1971	OBA study			Northcote et al 1972	10	33.2	417						<0.04		0.060				0.790							
UC183		LWF	Vaseux	muscle+skin	1971	OBA study			Northcote et al 1972	10	33.5	427						<0.04		0.100				2.000							
UC184		PE	Vaseux	muscle+skin	1971	OBA study			Northcote et al 1972	10	26.7	279						<0.04		0.140				0.240							
UC185		LSS	Vaseux	muscle+skin	1971	OBA study			Northcote et al 1972	6	40.4	750						<0.04		0.140				0.280							
UC186		NPM	Vaseux	muscle+skin	1971	OBA study			Northcote et al 1972	2	22.3	120						<0.04		0.150				0.120							
UC187		BU	Skaha	liver	1986	MOE			Jensen file B												<0.05				#####						
UC188	s1	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		24.5	147.9	1.0	80.3		0.070		<0.01		0.070		0.015		0.109			<0.05				
UC189	s2	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		24.1	138.0	0.6	80.5		0.040		<0.01		0.060		0.009		0.066			<0.05				
UC190	s3	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		23.8	135.8	1.1	80.2		0.020		<0.01		0.050		0.007		0.092			<0.05				
UC191	s4	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		23.6	122.2	0.9	81.6		0.030		<0.01		0.060		0.011		0.091			<0.05				
UC192	s5	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		23.4	135.5	1.2	80		0.010		<0.01		0.050		0.011		0.090			<0.05				
UC193	s6	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		23.3	129.6	1.1	80.8		<0.01		<0.01		0.050		0.007		0.087			<0.05				
UC194	s7	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		23.1	123.7	0.8	82.2		0.030		<0.01		0.050		0.008		0.069			<0.05				
UC195	s8	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		22.9	122.6	1.2	81.4		0.030		<0.01		0.050		0.009		0.101			<0.05				
UC196	s9	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		22.7	114.1	0.4	82.1		<0.01		<0.01		0.050		0.008		0.090			<0.05				
UC197	s10	KO	Skaha	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		22.3	124.7	1.2	80		0.010		<0.01		0.050		0.006		0.074			<0.05				
UC198		BU	Skaha	muscle	1986	MOE			Jensen file B												0.290				0.140						
UC199		RB	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	3	34.4	486.0						<0.04		0.100				0.310							
UC200		KO	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	33.6	432.0						<0.04		0.050				0.300							
UC201		KO	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	31.8	382.0						<0.04		0.060				2.360							
UC202		KO	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	32.8	360.0						<0.04		0.120				2.300							
UC203		KO	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	23.1	129.0						<0.04		0.060				1.380							
UC204		KO	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	22.2	114.0						<0.04		0.080				1.020							
UC205		KO	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	5	16.5	48.0						<0.04		0.060				0.380							
UC206		MWF	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	28.2	253.0						<0.04		0.070				1.720							
UC207		LWF	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	42.8	1233.0						<0.04		0.060				8.750							
UC208		LWF	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	42.7	1192						<0.04		0.040				0.860							
UC209		LWF	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	8	42.1	1032.0						<0.04		0.070				1.080							
UC210		LSS	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	40.5	768.0						<0.04		0.140				0.430							
UC211		LNS	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	2	44	1138.0						<0.04		0.110				1.870							
UC212		PMC	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	8	23	144						<0.04		0.180				0.800							
UC213		NPM	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	2	45.9	1387						<0.04		0.520				0.760							
UC214		CM	Skaha	muscle+skin	1971	OBA study			Northcote et al 1972	10	30	343						<0.04		0.080				0.390							
UC215		RB	Okanagan	muscle	1988	MOE	MOE lab	00403058	Jensen file C		44.6	1190		70.8	<25		<10		0.060	0.018				0.150			<0.1				
UC216		RB	Okanagan	muscle	1988	MOE	MOE lab	00403064	Jensen file C		50.2	1502		67.6	<25		<10		0.060	0.019				2.140			0.400				
UC217		RB	Okanagan	muscle	1988	MOE	MOE lab	00403059	Jensen file C		51.1	1077		73.4	<25		<10		0.140	0.037				1.100			0.300				
UC218		RB	Okanagan	muscle	1988	MOE	MOE lab	00403056	Jensen file C		42.2	624		78.4	<25		<10		0.070	0.015				0.260			<0.1				
UC219		RB	Okanagan	muscle	1988	MOE	MOE lab	00403066	Jensen file C		50.8	1474		68.9	<25		<10		0.090	0.028				3.630			0.600				
UC220		RB	Okanagan	muscle	1988	MOE	MOE lab	00405338	Jensen file C		51	1474		71	<25		<10		0.070	0.020				1.200			0.300				
UC221		RB	Okanagan	muscle	1988	MOE	MOE lab	00405337	Jensen file C		55	1956		65.4	<25		<10		0.070	0.024				1.500			0.300				
UC222		RB	Okanagan	muscle	1988	MOE	MOE lab	00403061	Jensen file C		59	2070		68.9	<25		<10		0.100	0.031				1.000			0.200				
UC223		RB	Okanagan	muscle	1988	MOE	MOE lab	00403060	Jensen file C		60.7	3033		69.5	<25		<10		0.090	0.027				0.840			0.300				
UC224		RB	Okanagan	muscle	1988	MOE	MOE lab	00405345	Jensen file C		62	3118		63.1	<25		<10		0.090	0.033				0.440			0.100				
UC225		RB	Okanagan	muscle	1988	MOE	MOE lab	00403065	Jensen file C		67	3430		70.3	<25		<10		0.330	0.098				1.700			0.400				
UC226		RB	Okanagan	muscle	1988	MOE	MOE lab	00405341	Jensen file C		68.5	4111		63.9	<25		<10		0.110	0.040				0.910			0.200				
UC227		RB	Okanagan	muscle	1988	MOE	MOE lab	00403062	Jensen file C		66.6	4252		69.2	<25		<10		0.120	0.037				1.200			0.200				
UC228		RB	Okanagan	muscle	1988	MOE	MOE lab	00403063	Jensen file C		76.4	5415		67.4	<25		<10		0.150	0.049				0.270			<0.1				
UC229		RB	Okanagan	muscle	1988	MOE	MOE lab	00405339	Jensen file C		79.2	5897		70.8	<25		<10		0.290	0.085				1.200			0.300				
UC230		RB	Okanagan	muscle	1988	MOE	MOE lab	00405340	Jensen file C		79.2	6294		65.7	<25		<10		0.110	0.038				0.590			0.100				
UC231		RB	Okanagan	muscle	1990	MOE	Zenon	00424851	Jensen file D		72	4480				<10		<10		0.180				0.460			0.270				
UC232		RB	Okanagan	muscle	1990	MOE	Zenon	03002305	Jensen file D		71.3	5050				<10		<10		0.170				1.743			0.200				
UC233		RB	Okanagan	muscle	1990	MOE	Zenon	03002302	Jensen file D		74.5	3740				<10		<10		0.450				2.142			0.340				
UC234		RB	Okanagan	muscle	1990	MOE	Zenon	03002304	Jensen file D		62.2	3320				<10		<10		0.140				1.363			0.180				
UC235		RB	Okanagan	muscle	1990	MOE	Zenon	00424848	Jensen file D		74	5390				<10		<10		0.160				3.101			0.370				
UC236		RB	Okanagan	muscle	1990	MOE	Zenon	00424849	Jensen file D		77.5	6010				<10		<10		0.160				2.336			0.330				
UC237		RB	Okanagan	muscle	1990	MOE	Zenon	00424850	Jensen file D		69.9	4260				<10		<10		0.210				0.700			0.350				
UC238		RB	Okanagan	muscle	1990	MOE	Zenon	00424852	Jensen file D		63.5	3460				<10		<10		0.150				0.610			0.270				
UC239		RB	Okanagan	muscle	1990	MOE	Zenon	00424853	Jensen file D		62.6	3540				<10		<10		0.130				0.480			0.210				
UC240		RB	Okanagan	muscle	1990	MOE	Zenon	00424854	Jensen file D		61.4	2690				<10		<10		0.110				0.430			0.180				
UC241	93001240	RB	Okanagan	muscle	1993	MOE	Zenon	1E+07	Jensen file E															2.430			0.100				
UC242	93001241	RB	Okanagan	muscle	1993	MOE	Zenon	1E+07	Jensen file E															2.090			0.070				
UC243	93001242	RB	Okanagan	muscle	1993	MOE	Zenon	1E+07	Jensen file E			4100	15	65.7		<10		<10		0.090				1.810			0.040				
UC244	93001243	RB	Okanagan	muscle	1993	MOE	Zenon	1E+07	Jensen file E			1000	2	76.1						0.100				0.984			0.020				
UC245	93001244	RB	Okanagan	muscle	1993	MOE	Zenon	1E+07	Jensen file E			2500	27	62.8						0.080				2.070			0.050				
UC246	93001245	RB	Okanagan	muscle	1993	MOE	Zenon	1E+07	Jensen file E			3600	18	64.4						0.100				1.700			0.040				
UC247	93001246	RB	Okanagan	muscle	1993	MOE	Zenon	1E+07	Jensen file E				12	67.2						0.100				1.910			0.100				

Unq. Code	Src. code	Species	Lake / Riv	Sample	Year	Agency	Lab	Req. #	Source	N	Lgth (cm)	Wght (g)	%Lip PCB	%Moist	As (dw)	As (ww)	Pb (dw)	Pb (ww)	Hg (dw)	Hg (ww)	Hg (?)	MeHg (ww)	DDT (dw)	DDT (ww)	DDT (?)	PCB (dw)	PCB (ww)	Lip D&F	Diox (ww)	Lip PBDE	PBDE (ww)
UC248	93001247	RB	Okanagan	muscle	1993	MOE	Zenon	1E+07	Jensen file E			2800	12	66.9						0.140				2.049			0.050				
UC249	RBT1	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		70.4	4100	8.0	72.2		0.120		<0.01		0.103		0.015		0.382			<0.05	6.400	<0.206		
UC250	RBT2	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		67.3	3950	10.4	68.3		<0.2		<0.01		0.140		0.035		0.135			<0.05	7.100	<0.189		
UC251	RBT3	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		65.0	3314	4.3	74		<0.2		<0.01		0.120		0.023		0.494			<0.05	4.900	<0.286		
UC252	RBT4	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		64.0	2951	5.3	73.8		0.030		<0.01		0.140		0.023		0.417			<0.05	5.700	<0.186		
UC253	RBT5	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		59.8	2700	4.8	75.1		<0.2		<0.01		0.130		0.017		0.202			<0.05	4.300	<0.319		
UC254	RBT6	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		54.4	1650	6.7	74.6		0.020		<0.01		0.080		0.019		0.216			<0.05				
UC255	RBT7	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		50.5	1650	3.5	73.5		0.040		<0.01		0.090		0.017		0.168			<0.05				
UC256	RBT8	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		51.6	1450	3.6	74.3		0.040		<0.01		0.060		0.014		0.228			<0.05				
UC257	RBT9	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		44.0	972	3.1	76.7		0.080		<0.01		0.070		0.012		0.178			<0.05				
UC258	RBT10	RB	Okanagan	muscle	2005	ONA+MOE	Maxxam		Bryan 2006		43.1	712.5	0.8	78.9		0.040		<0.01		0.080		0.008		0.664			<0.05				
UC259		BU	Okanagan	muscle	1981	MOE			Jensen file F		67	1900									0.230				0.200						
UC260		BU	Okanagan	muscle	1981	MOE			Jensen file F		60	2000									0.260				0.200						
UC261		BU	Okanagan	muscle	1981	MOE			Jensen file F		81	3250									0.330				0.130						
UC262		BU	Okanagan	muscle	1981	MOE			Jensen file F		66	2000									0.180				0.110						
UC263		BU	Okanagan	muscle	1981	MOE			Jensen file F		71	2000									0.300				0.090						
UC264		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			283									0.370										
UC265		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			453									0.120										
UC266		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			3369									0.260				4.460						
UC267		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			3567									0.210				3.780						
UC268		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			3675									0.200				4.260						
UC269		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			3744									0.340				4.960						
UC270		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			4091									0.690				4.050						
UC271		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			4190									0.320				5.880						
UC272		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			4304									0.230				5.130						
UC273		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			4360									0.390				#####						
UC274		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			4417									0.230				6.610						
UC275		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			4601									0.180				4.440						
UC276		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			4615									0.250				7.420						
UC277		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			4870									0.760				5.160						
UC278		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			5252									0.180				5.250						
UC279		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			5493									0.380				1.160						
UC280		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			5676									0.300				2.520						
UC281		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			5691									0.240				2.120						
UC282		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			6115									0.190				#####						
UC283		RB	Okanagan	muscle	1974	SOHU			SOHU 1974			6413									0.330				7.160						
UC284		RB	Okanagan	muscle	1974	MOE			Jensen 1989			7250									0.280				5.810						
UC285		RB	Okanagan	muscle	1975	MOE			Jensen 1989			1500									0.280				0.060						
UC286		RB	Okanagan	muscle	1975	MOE			Jensen 1989			3900									0.370				1.070						
UC287		RB	Okanagan	muscle	1975	MOE			Jensen 1989			510									0.320				1.820						
UC288		RB	Okanagan	muscle	1975	MOE			Jensen 1989			520									0.460				1.390						
UC289		RB	Okanagan	muscle	1975	MOE			Jensen 1989			6500									0.400				1.560						
UC290		RB	Okanagan	muscle	1975	MOE			Jensen 1989			740									0.260				0.160						
UC291		RB	Okanagan	muscle	1975	MOE			Jensen 1989			800									0.350				0.550						
UC292		RB	Okanagan	muscle	1975	MOE			Jensen 1989			870									0.340				0.120						
UC293		RB	Okanagan	muscle	1975	MOE			Jensen 1989			1430									0.200				0.340						
UC294		RB	Okanagan	muscle	1975	MOE			Jensen 1989			1870									0.230				5.010						
UC295		RB	Okanagan	muscle	1975	MOE			Jensen 1989			2950									0.260				0.770						
UC296		RB	Okanagan	muscle	1975	MOE			Jensen 1989			3050									0.220				0.470						
UC297		RB	Okanagan	muscle	1975	MOE			Jensen 1989			3760									0.260				0.640						
UC298		RB	Okanagan	muscle	1975	MOE			Jensen 1989			5080									0.370				0.100						
UC299		RB	Okanagan	muscle	1975	MOE			Jensen 1989			5540									0.270				1.660						
UC300		RB	Okanagan	muscle	1975	MOE			Jensen 1989			5730									0.280				1.620						
UC301		RB	Okanagan	muscle	1975	MOE			Jensen 1989			5770									0.300				0.700						
UC302		RB	Okanagan	muscle	1975	MOE			Jensen 1989			5950									0.290				1.050						
UC303		RB	Okanagan	muscle	1975	MOE			Jensen 1989			7370									0.330				8.390						
UC304		RB	Okanagan	muscle	1975	MOE			Jensen 1989			7540									0.270				1.200						
UC305		RB	Okanagan	muscle	1975	MOE			Jensen 1989			8500									0.290				0.430						
UC306		RB	Okanagan	muscle	1970	SOHU			Jensen 1989			2720									0.190										
UC307		RB	Okanagan	muscle	1970	SOHU			Jensen 1989			1820									0.140										
UC308		RB	Okanagan	muscle	1970	SOHU			Jensen 1989			3180									0.250										
UC309		RB	Okanagan	muscle	1970	SOHU			Jensen 1989			6800									0.550										
UC310		RB	Okanagan	muscle	1970	SOHU			Jensen 1989			9070									0.390										
UC311		RB	Okanagan	muscle	1970	SOHU			Jensen 1989			9070									0.550										
UC312		RB	Okanagan	muscle	1970	SOHU			Jensen 1989			2900													#####						
UC313		RB	Okanagan	muscle	1970	SOHU			Jensen 1989			2910													#####						
UC314		RB	Okanagan	muscle	1974	SOHU			Jensen 1989			3180									0.190				2.990						
UC315		RB	Okanagan	muscle	1974	SOHU			Jensen 1989			4550									0.160				5.390						
UC316		RB	Okanagan	muscle	1974	SOHU			Jensen 1989			5460									0.200				4.260						
UC317		RB	Okanagan	muscle	1974	SOHU			Jensen 1989			5910									0.200				4.440						
UC318		RB	Okanagan	muscle	1974	SOHU			Jensen 1989			7270									0.280				8.280						
UC319		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			850									0.346				8.630						
UC320		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			1430									0.470										
UC321		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			1870									0.375										
UC322		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			3050									0.569										
UC323		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			3900									0.310				4.130						
UC324		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			5100									0.610				6.210						
UC325		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			5700									0.545				5.310						
UC326		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			5800									0.341				5.550						
UC327		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			6500									0.600				9.150						
UC328		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			7700									0.700				7.290						
UC329		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			8500									0.336										
UC330		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			5900													6.310						
UC331		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			4700													8.530						
UC332		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			5710													7.860						
UC333		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			7600													#####						
UC334		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			1500													4.100						
UC335		RB	Okanagan	muscle	1975	SOHU			Jensen 1989			5500													6.820						

Unq. Code	Src. code	Species	Lake / Riv	Sample	Year	Agency	Lab	Req. #	Source	N	Lgth (cm)	Wght (g)	%Lip PCB	%Moist	As (dw)	As (ww)	Pb (dw)	Pb (ww)	Hg (dw)	Hg (ww)	Hg (?)	MeHg (ww)	DDT (dw)	DDT (ww)	DDT (?)	PCB (dw)	PCB (ww)	Lip O&F	Diox (ww)	Lip PBDE	PBDE (ww)
UC336		RB	Okanagan	muscle	1970	MOE			Jensen 1989			1500													0 060						
UC337		RB	Okanagan	muscle	1970	MOE			Jensen 1989			5080													0.100						
UC338		RB	Okanagan	muscle	1970	MOE			Jensen 1989			870													0 120						
UC339		RB	Okanagan	muscle	1970	MOE			Jensen 1989			740													0.160						
UC340		RB	Okanagan	muscle	1970	MOE			Jensen 1989			7540													1.200						
UC341		RB	Okanagan	muscle	1970	MOE			Jensen 1989			1430													0.340						
UC342		RB	Okanagan	muscle	1970	MOE			Jensen 1989			850													0 430						
UC343		RB	Okanagan	muscle	1970	MOE			Jensen 1989			520													1 390						
UC344		RB	Okanagan	muscle	1970	MOE			Jensen 1989			3050													0.470						
UC345		RB	Okanagan	muscle	1970	MOE			Jensen 1989			800													0 550						
UC346		RB	Okanagan	muscle	1970	MOE			Jensen 1989			3760													0 640						
UC347		RB	Okanagan	muscle	1970	MOE			Jensen 1989			5770													0.700						
UC348		RB	Okanagan	muscle	1970	MOE			Jensen 1989			2950													0.770						
UC349		RB	Okanagan	muscle	1970	MOE			Jensen 1989			5950													1.050						
UC350		RB	Okanagan	muscle	1970	MOE			Jensen 1989			3900													1.070						
UC351		RB	Okanagan	muscle	1970	MOE			Jensen 1989			6500													1.560						
UC352		RB	Okanagan	muscle	1970	MOE			Jensen 1989			5730													1.620						
UC353		RB	Okanagan	muscle	1970	MOE			Jensen 1989			5540													1.660						
UC354		RB	Okanagan	muscle	1970	MOE			Jensen 1989			5100													1.820						
UC355		RB	Okanagan	muscle	1970	MOE			Jensen 1989			1870													5.010						
UC356		RB	Okanagan	muscle	1970	MOE			Jensen 1989			7370													8.390						
UC357		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	1	88.9	8674						<0.04		0 130				1 340							
UC358		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	1	81.3	7021						<0.04		0.620				11.600							
UC359		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	1	78 7	5216						na		na				4.480							
UC360		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	1	78 7	5216						<0.04		0.890				2.200							
UC361		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	1	78.7	5216						<0.04		0.620				1.380							
UC362		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	67 5	4459						<0 04		0.090				5.430							
UC363		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	6	49 3	3287						<0.04		0.150				5 910							
UC364		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	1	50.5	1150						<0.04		0.220				0.760							
UC365		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	8	40.1	720						<0.04		0.060				1.580							
UC366		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	38.3	547						<0.04		0.170				2.920							
UC367		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	7	37.1	526						<0 04		0 070				0.420							
UC368		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	7	37 6	479						<0.04		0.250				1.130							
UC369		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	8	24.2	291						<0.04		0.060				0 210							
UC370		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	29.1	285						<0.04		0.060				0.540							
UC371		RB	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	30.1	284						<0.04		0.060				3 110							
UC372		PMC	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	5	23.2	147						<0.04		0.210				0.270							
UC373		NPM	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	1	53	1817						<0.04		1.790				5.500							
UC374		NPM	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	3	47.1	1458						<0.04		0.590				3.610							
UC375		NPM	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	5	44.7	1268						<0.04		0.130				0.450							
UC376		NPM	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	3	37.6	607						<0.04		0.450				2.250							
UC377		NPM	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	3	35.8	544						<0 04		0.240				1.600							
UC378		MWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	2	36	616						<0.04		0 150				1.820							
UC379		MWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	9	26.9	267						<0 04		0 060				2 050							
UC380		MWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	6	27.4	229						<0.04		0 020				1 390							
UC381		MWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	1	27 3	202						<0.04		0 070				0 920							
UC382		MWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	7	27	200						<0.04		0.090				0.080							
UC383		MWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	4	26.5	182						<0.04		0.060				0.860							
UC384		LWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	37.8	613						<0.04		0.070				1.880							
UC385		LWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	36.5	515						<0 04		0.050				0.570							
UC386		LWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	36.3	480						<0.04		0 140				0.900							
UC387		LWF	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	35.5	476						<0.04		0 070				4 160							
UC388		LSS	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	2	42.1	835						<0.04		0 270				0 200							
UC389		LSS	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	40.6	798						<0 04		0 160				0 990							
UC390		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	28.5	283						<0 04		0.080				0.320							
UC391		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	9	28.8	220						<0.04		0.050				0.640							
UC392		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	27	218						<0.04		0 080				0.310							
UC393		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	26 1	190						<0.04		0 060				0.880							
UC394		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	11	12 6	130						<0.04		0.070				2.860							
UC395		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	21.7	114						<0.04		0.060				1 600							
UC396		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	21.2	108						<0 04		0 110				2.990							
UC397		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	27.4	102						<0.04		0 150				0.410							
UC398		KO	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	10	18.1	60						<0 04		0 060				0 290							
UC399		CP	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	9	52 3	2366						<0.04		0.110				1.000							
UC400		BU	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	5	74.1	3748						<0 04		0 280				0.390							
UC401		BU	Okanagan	muscle+skin	1971	OBA study			Northcote et al 1972	8	63.2	1929						<0.04		0 110				0.140							
UC402	20	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		59.0	3200.0		40 5							<0 05			5 240			<0.1				
UC403	13	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		57.7	2800 0		62.5							<0.05			3 260			<0 1				
UC404	29	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		68.0	5200.0		63.8							<0.05			7 590			0.600				
UC405	23	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		62.0	3700 0		64 6							<0.05			37 050			0 250				
UC406	31	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		72.0	5000 0		64 7							<0.05			4.630			0 700				
UC407	25	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		64 0	3800.0		67							<0.05			14.240			0.890				
UC408	14	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		58 0	2400 0		67.4							<0.05			15 420			<0 1				
UC409	21	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		60 0	3200 0		67.4							<0.05			8.520			<0 1				
UC410	16	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		58 0	2900.0		68							<0.05			15 270			0.100				
UC411	4	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		56 0	2400.0		68.3							<0 05			0 680			<0 1				
UC412	7	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		56 0	2750 0		68 9							<0 05			8 060			0 500				
UC413	26	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		64 0	4000 0		69.1							<0 05			7 000			0 100				
UC414	1	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		52	2200.0		69 5							0 050			7.000			1.070				
UC415	24	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		63.0	4100 0		69.5							0.060			13.540			0.380				
UC416	27	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		65 0	3700.0		69.6							<0 05			5 520			<0 1				
UC417	9	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		57.0	2500.0		69 7							<0.05			14.910			0.500				
UC418	28	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		67 0	4300 0		69 8							<0 05			3.160			<0.1				
UC419	30	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		69.0	4300.0		69.8							<0 05			7.970			0 590				
UC420	5	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		56.0	2500 0		70							<0 05			1 710			<0 1				
UC421	6	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		56 0	2700 0		70.1							<0.05			4 370			0 370				
UC422	22	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		62 0	3400 0		70.1							<0 05			15.210			0.610				
UC423	11	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		57 0	2750 0		70.5							<0 05			8 180			0.910				

Unq. Code	Src. code	Species	Lake / Riv	Sample	Year	Agency	Lab	Req. #	Source	N	Lgth (cm)	Wght (g)	%Lip PCB	%Moist	As (dw)	As (ww)	Pb (dw)	Pb (ww)	Hg (dw)	Hg (ww)	Hg (?)	MeHg (ww)	DDT (dw)	DDT (ww)	DDT (?)	PCB (dw)	PCB (ww)	Lip D&F	Diox (ww)	Lip PBDE	PBDE (ww)
UC424	12	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		57.0	2900.0		71							<0.05			4.600			<0.1				
UC425	17	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		59.0	2500.0		71.1							0.060			17.600			0.310				
UC426	15	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		58.0	2750.0		71.2							<0.05			6.220			0.210				
UC427	19	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		59.0	3000.0		71.8							<0.05			16.450			0.860				
UC428	18	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		59.0	2850.0		71.9							0.050			19.030			0.250				
UC429	10	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		57.0	2700.0		72.8							<0.05			2.570			0.800				
UC430	3	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		54.0	2200.0		72.9							0.060			2.800			0.460				
UC431	8	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		56.0	3000.0		72.9							<0.05			10.270			0.340				
UC432	2	LT	Kalamalka	muscle	1978	MOE ?			Jensen file G		53	2600.0		73							0.100			4.620			0.570				
UC433	1	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		63	3500.0									0.050			3.300			0.300				
UC434	2	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		61.5	3500.0									0.050			3.330			0.300				
UC435	3	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		62.5	3500.0									0.050			7.460			0.300				
UC436	4	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		62.5	3500.0									0.050			12.830			0.300				
UC437	5	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		62.8	7500.0									0.050			16.770			0.300				
UC438	6	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		55.0	2400.0									0.050			7.930			0.600				
UC439	7	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		61.0	3000.0									0.050			8.190			0.300				
UC440	8	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		62.5	3900.0																			
UC441	9	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		67.0	4400.0									0.050			20.160			0.300				
UC442	10	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		64.5	4000.0									0.050			14.060			0.300				
UC443	11	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		80.0	8400.0									0.070			18.020			0.300				
UC444	12	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		67.5	4800.0									0.050			35.760			0.300				
UC445	13	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		67.5	4800.0									0.050			14.660			0.300				
UC446	14	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		31.3	343.0									0.050			4.950			0.300				
UC447	15	LT	Kalamalka	muscle	1979	MOE ?			Jensen file H		80.0	8400.0									0.050			20.510			0.300				
UC448	16	RB	Kalamalka	muscle	1979	MOE ?			Jensen file H		34.7	401.0									0.050			2.980							
UC449	17	RB	Kalamalka	muscle	1979	MOE ?			Jensen file H		28.2	248.0									0.050			3.230							
UC450	18	RB	Kalamalka	muscle	1979	MOE ?			Jensen file H		34.9	433.0									0.050			4.720							
UC451	19	RB	Kalamalka	muscle	1979	MOE ?			Jensen file H		34.5	388.0									0.050			6.610							
UC452		LT	Kalamalka	muscle	1988	MOE	MOE lab	00403052	Jensen file I		80-100	11340.0		49.4	<25.0		<10.0		0.060	0.030				12.280			3.400				
UC453		LT	Kalamalka	muscle	1988	MOE	MOE lab	00402965	Jensen file I		70.0	4536.0		62.5	<25.0		<10.0		0.070	0.026				2.200			0.400				
UC454		LT	Kalamalka	muscle	2001	MOE	PSC An.	5E+07	Jensen file I			6350.0				0.300				<0.05				0.940			<0.05				
UC455		LT	Kalamalka	muscle	2002	MOE	PSC An.	5E+07	Jensen file I			9525.0	27	40.5						0.060				15.150			<0.05				
UC456		LT	Kalamalka	muscle	2002	MOE	PSC An.	50068869 & 50069810	Jensen file I			9979.0	19	59.6						0.070				3.000			<0.05				
UC457		LT	Kalamalka	muscle	2002	MOE	PSC An.	5E+07	Jensen file I			6804.0	7							0.110				5.560			<0.05				
UC458		LT	Kalamalka	muscle	2005	ONA+MOE	Maxxam	5E+07	Bryan 2006		?	?		63.6		<0.2		<0.1		0.130		0.035		0.613			<0.05				
UC459	1	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		63	3500.0									0.050			9.920			0.300				
UC460	2	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		61.5	3500.0									0.050			7.060			0.300				
UC461	3	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		62.5	3500.0									0.050			1.890			0.300				
UC462	4	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		62.5	3500.0									0.050			6.040			0.300				
UC463	5	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		62.8	7500.0									0.050			7.030			0.300				
UC464	6	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		55.0	2400.0									0.050			28.280			0.300				
UC465	7	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		61.0	3000.0									0.050			######			0.300				
UC466	8	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		62.5	3900.0									0.050			19.440			0.300				
UC467	9	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		67.0	4400.0									0.050			33.420			0.300				
UC468	10	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		64.5	4000.0									0.050			19.130			0.300				
UC469	11	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		80.0	8400.0									0.060			15.190			0.300				
UC470	12	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		67.5	4800.0									0.050			60.810			0.300				
UC471	13	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		67.5	4800.0																			
UC472	14	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		31.3	343.0																			
UC473	15	LT	Kalamalka	liver	1979	MOE ?			Jensen file H		80.0	8400.0									0.060			49.780			0.300				
UC474	1	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		52	2200.0		67.6							<0.05			15.890			1.580				
UC475	2	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		53	2600.0		56.3							<0.05			13.300			0.630				
UC476	3	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		54.0	2200.0		52.3							<0.05			15.260			0.750				
UC477	4	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		56.0	2400.0		67.2							<0.05			12.150			0.880				
UC478	5	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		56.0	2500.0		54.9							<0.05			9.540			0.460				
UC479	6	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		56.0	2700.0		47.5							<0.05			1.390			<0.1				
UC480	7	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		56.0	2750.0		68.4							<0.05			11.640			0.120				
UC481	8	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		56.0	3000.0		50.6							<0.05			9.300			0.430				
UC482	9	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		57.0	2500.0		68.1							<0.05			34.250			1.050				
UC483	10	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		57.0	2700.0		51.5							<0.05			10.110			0.700				
UC484	11	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		57.0	2750.0		59.8							<0.05			17.650			0.690				
UC485	12	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		57.0	2900.0		59.2							<0.05			11.600			0.650				
UC486	13	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		57.7	2800.0		47.7							<0.05			5.870			0.730				
UC487	14	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		58.0	2400.0		60.7							<0.05			12.730			2.030				
UC488	15	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		58.0	2750.0		55.2							<0.05			10.150			0.700				
UC489	16	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		58.0	2900.0		75.9							0.070			41.270			0.900				
UC490	17	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		59.0	2500.0		59.4							<0.05			33.520			1.370				
UC491	18	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		59.0	2850.0		63							<0.05			26.540			0.790				
UC492	19	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		59.0	3000.0		63.1							<0.05			5.330			0.860				
UC493	20	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		59.0	3200.0		61.2							<0.05			25.480			3.810				
UC494	21	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		60.0	3200.0		65.1							<0.05			15.000			1.760				
UC495	22	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		62.0	3400.0		57.3							<0.05			12.830			20.600				
UC496	23	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		62.0	3700.0		51.4							<0.05			12.050			1.550				
UC497	24	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		63.0	4100.0		60.3							<0.05			9.270			1.400				
UC498	25	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		64.0	3800.0		41.1							<0.05			11.180			1.230				
UC499	26	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		64.0	4000.0		50.2							<0.05			13.950			2.190				
UC500	27	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		65.0	3700.0		50.7							<0.05			3.500			0.510				
UC501	28	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		67.0	4300.0		73.6							<0.05			10.670			0.760				
UC502	29	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		68.0	5200.0		59.4							<0.05			3.100			<0.1				
UC503	30	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		69.0	4300.0		59.4							<0.05			5.160			0.680				
UC504	31	LT	Kalamalka	liver	1978	MOE ?			Jensen file G		72.0	5000.0		59.4							<0.05			12.790			3.620				
UC505		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	1	71.1	6512.0						na		na				19.180							
UC506		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	1		6000.0						na		na				17.850							
UC507		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	1		6000.0						<0.04		0.050				17.430							
UC508		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	2	53.8	2019.0						<0.04		0.060				7.610							

Unq. Code	Src. code	Species	Lake / Riv	Sample	Year	Agency	Lab	Req. #	Source	N	Lgth (cm)	Wght (g)	%Lip PCB	%Moist	As (dw)	As (ww)	Pb (dw)	Pb (ww)	Hg (dw)	Hg (ww)	Hg (?)	MeHg (ww)	DDT (dw)	DDT (ww)	DDT (?)	PCB (dw)	PCB (ww)	Lip D&F	Diox (ww)	Lip PBDE	PBDE (ww)
UC509		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	1	51	1415 0						<0 04		0 020				56.670							
UC510		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	9	38	557 0						<0 04		0.040				0 910							
UC511		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	2	35	495 0						<0 04		0.050				6 320							
UC512		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	5	31	297.0						<0 04		0 040				1.080							
UC513		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	10	30.8	295.0						<0.04		0 010				2 220							
UC514		RB	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	10	30	259.0						<0.04		0.040				0.230							
UC515		KO	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	1	44.5	849.0						<0.04		0.110				68.720							
UC516		KO	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	10	20.9	94.0						<0 04		0 040				1.120							
UC517		KO	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	10	19.1	76 0						<0.04		0.020				3.880							
UC518		KO	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	10	18.8	73.0						<0.04		0 010				4.590							
UC519		MWF	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	2	41.4	1033.0						<0 04		0 050				15.810							
UC520		MWF	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	1	28.4	251.0						<0 04		0 010				12.250							
UC521		CP	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	10	47.6	1746 0						<0 04		0 070				2 730							
UC522		CP	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	4	38.6	1702.0						<0.04		0.090				4.180							
UC523		LSS	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	6	35.9	489 0						<0 04		0 120				0.140							
UC524		PMC	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	2	24.8	171.0						<0.04		0.220				2.070							
UC525		LT	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	5	50.6	1704						<0.04		0 060				4.610							
UC526		LT	Kalamalka	muscle+skin	1971	OBA study			Northcote et al 1972	10	41.1	748						<0.04		0 020				5.260							
UC527		LT	Kalamalka	muscle	1984	MOE	MOE lab		Jensen file J		63													7.420							
UC528		RB	Kalamalka	muscle	1984	MOE	MOE lab		Jensen file J		51													3.610							
UC529		RB	Kalamalka	muscle	1984	MOE	MOE lab		Jensen file J		51													2.180							
UC530		RB	Kalamalka	muscle	1984	MOE	MOE lab		Jensen file J		48													1.770							
UC531		LT	Kalamalka	muscle	1984	MOE	MOE lab		Jensen file J		64.5	4250												6.130							
UC532		LT	Kalamalka	muscle	1984	MOE	MOE lab		Jensen file J		62													4.890							
UC533		LT	Kalamalka	muscle+skin	1972	MOE			BC Gov't 1974	10	55 9	2571					<0.2		<0.05				3.200								
UC534		NPM	Kalamalka	muscle+skin	1972	MOE			BC Gov't 1974	8	33 8	799					<0.2		<0 05				#####								
UC535		RB	Agur	muscle	1971	OBA study			Koshinsky & Andres 197	8	25.3							nd		0.070				0.010							
UC536		RB	Alex	muscle	1971	OBA study			Koshinsky & Andres 197	8	27 3							nd		0 070				0.070							
UC537		RB	Alex	muscle	1971	OBA study			Koshinsky & Andres 197	3	36.5							nd		0 090				0.100							
UC538		RB	Fish Hawk	muscle	1971	OBA study			Koshinsky & Andres 197	8	22.5							nd		0 100				0.180							
UC539		RB	Hydraulic	muscle	1971	OBA study			Koshinsky & Andres 197	4	28.6							nd		0.110				0.150							
UC540		RB	Jackpine	muscle	1971	OBA study			Koshinsky & Andres 197	8	28							nd		0.050				0 020							
UC541		RB	Jackpine	muscle	1971	OBA study			Koshinsky & Andres 197	4	43.5							nd		0 100				0.030							
UC542		RB	Pennask Lak	muscle	2001	MOE	PESC		B Grace					77.9	<4	<0.884	<4	<0.884	0 092	0 020											
UC543		RB	Pennask Lak	muscle	2001	MOE	PESC		B Grace					77.7	<4	<0.892	<4	<0 892	0 120	0.027											
UC544		RB	Pennask Lak	muscle	2001	MOE	PESC		B Grace					75.2	<4	<0.992	<4	<0.992	0.095	0.024											
UC545		RB	Pennask Lak	muscle	2001	MOE	PESC		B Grace					77.2	<4	<0 912	<4	<0.912	0.110	0.025											
UC546		RB	Pennask Lak	muscle	2001	MOE	PESC		B Grace					76 9	<4	<0 924	<4	<0.924	0.048	0.011											
UC547		RB	Pennask Lak	muscle	2001	MOE	PESC		B Grace					77 5	<4	<0.9	<4	<0.9	0.129	0.029											
UC548		RB	Pinaus	muscle	1971	OBA study			Koshinsky & Andres 197	8	28.4							nd		0.050				0.030							
UC549		RB	Pinaus	muscle	1971	OBA study			Koshinsky & Andres 197	5	40.1							nd		0.070				0.030							
UC550		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.100											
UC551		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.140											
UC552		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.090											
UC553		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.110											
UC554		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0 180											
UC555		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.080											
UC556		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.090											
UC557		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0 090											
UC558		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		1.000		0 130											
UC559		RB	Stump Lake	muscle	1991	MOE			B Grace							<10		1.000		0.160											
UC560		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.110											
UC561		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.100											
UC562		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.090											
UC563		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0 080											
UC564		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0 060											
UC565		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0 060											
UC566		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0 090											
UC567		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.070											
UC568		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0 060											
UC569		KO	Stump Lake	muscle	1991	MOE			B Grace							<10		<1		0.050											
UC570		RB	Swalwell	muscle	1971	OBA study			Koshinsky & Andres 197	7	24.1							nd		0.050				0 060							
UC571		RB	Pennask Lak	liver	2001	MOE	PESC		B Grace					78.4	<4	<0.884	<4	<0.884	0.029	0 006											
UC572		RB	Pennask Lak	liver	2001	MOE	PESC		B Grace					78.1	<4	<0.892	<4	<0.892	0 016	0.004											
UC573		RB	Pennask Lak	liver	2001	MOE	PESC		B Grace					79	<4	<0.992	<4	<0.992	0.049	0.010											
UC574		RB	Pennask Lak	liver	2001	MOE	PESC		B Grace					77 9	<4	<0.912	<4	<0 912	0.022	0.005											
UC575		RB	Pennask Lak	liver	2001	MOE	PESC		B Grace					77.9	<4	<0.924	<4	<0 924	0.009	0 002											
UC576		RB	Pennask Lak	liver	2001	MOE	PESC		B Grace					79.5	<4	<0 9	<4	<0.9	0.067	0.014											
UC577		RB	Stump Lake	liver	1991	MOE			B Grace							3.550		0.410		na											
UC578		RB	Stump Lake	liver	1991	MOE			B Grace							3 210		0 421		na											
UC579		RB	Stump Lake	liver	1991	MOE			B Grace							2 320		0.720		na											
UC580		RB	Stump Lake	liver	1991	MOE			B Grace							3.150		0.455		na											
UC581		RB	Stump Lake	liver	1991	MOE			B Grace							1 760		0 224		na											
UC582		RB	Stump Lake	liver	1991	MOE			B Grace							1 400		0 470		na											
UC583		RB	Stump Lake	liver	1991	MOE			B Grace							3 990		0 509		na											
UC584		RB	Stump Lake	liver	1991	MOE			B Grace							2.920		0 687		na											
UC585		RB	Stump Lake	liver	1991	MOE			B Grace							2 270		0 522		na											
UC586		RB	Stump Lake	liver	1991	MOE			B Grace							3 060		0 617		na											
UC587		KO	Stump Lake	liver	1991	MOE			B Grace							2 320		0.508		na											
UC588		KO	Stump Lake	liver	1991	MOE			B Grace							2.930		0 563		na											
UC589		KO	Stump Lake	liver	1991	MOE			B Grace							2 740		0 545		na											
UC590		KO	Stump Lake	liver	1991	MOE			B Grace							2.740		0 583		na											
UC591		KO	Stump Lake	liver	1991	MOE			B Grace							2 250		0 558		na											
UC592		KO	Stump Lake	liver	1991	MOE			B Grace							2 650		0 560		na											
UC593		KO	Stump Lake	liver	1991	MOE			B Grace							3 850		0 650		na											
UC594		KO	Stump Lake	liver	1991	MOE			B Grace							3 200		0 653		na											
UC595		KO	Stump Lake	liver	1991	MOE			B Grace							2.480		0 573		na											
UC596		KO	Stump Lake	liver	1991	MOE			B Grace							2 370		0 410		na											

Unq. Code	Src. code	Species	Lake / Riv	Sample	Year	Agency	Lab	Req. #	Source	N	Lgth (cm)	Wght (g)	%Lip PCB	%Moist	As (dw)	As (ww)	Pb (dw)	Pb (ww)	Hg (dw)	Hg (ww)	Hg (?)	MeHg (ww)	DDT (dw)	DDT (ww)	DDT (?)	PCB (dw)	PCB (ww)	Lip D&F	Diox (ww)	Lip PBDE	PBDE (ww)
UC597*		RB	Kalamalka	muscle+skin	1951/71*				Northcote et al 1972	1	22 6	150						nd		0.1				2 81							
UC598*		CM	Skaha	muscle+skin	1948/71*				Northcote et al 1972	1	22 3	160						nd		0.65				0 43							
UC599*		CM	Ok Riv--betw	muscle+skin	1951/71*				Northcote et al 1972	10	15.2	36.7						nd		0 08				0 47							
UC600*		CP	Osoyoos	muscle+skin	1956/71*				Northcote et al 1972	1	38	1065						nd		0 06				2 96							
UC601*		SMB	Osoyoos	muscle+skin	1951/71*				Northcote et al 1972	2	13 9	37						nd		0.26				0.8							
UC602*		SMB	Osoyoos	muscle+skin	1951/71*				Northcote et al 1972	1	10	13						nd		na				0.61							
UC603*		PE	Osoyoos	muscle+skin	1951/71*				Northcote et al 1972	2	11 3	17						na		na				0.46							
UC604*		NPM	Osoyoos	muscle+skin	1951/71*				Northcote et al 1972	1	14 6	34						na		na				0 92							
UC605*		NPM	Osoyoos	muscle+skin	1956/71*				Northcote et al 1972	3	29.3	31.6						na		0.21				4 88							
UC606	SKA-1	SMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		28.5	423.2	0.73	78.9		0.09		<0 01		0.195		0.06		0.0253			0.0026			0.82	0.004
UC607	SKA-2	SMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		29.0	472 3	1 53	76.1		0.05		<0.01		0.173		0.155		0.0299			0 0032				
UC608	SKA-3	SMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		33.0	692 0	0 71	77 15		0 12		<0.01		0.173		0.158		0.017			0 0014			1.04	0 0058
UC609	SKA-4	SMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		33.0	594.3	0.7	79 1		0 09		<0.01		0.104		0.085		0 048			0 0033				
UC610	SKA-5	SMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		32.5	585.2	0.38	79 8		0.04		<0.01		0.108		0.102		0.0509			0 0033				
UC611	SKA-6	SMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		30.5	581 4	1.24	78.6		0 14		<0 01		0.043		0.036		0 0788			0.0016			1 28	0.0062
UC612	SKA-7	SMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		32 0	590.1	1 28	79.2		0.08		<0.01		0.147		0.11		0.1374			0.0082				
UC613	SKA-8	LMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		36.5	803.3	0 14	81 8		<0.01		<0.01		0.328		0.247		0.0017			9E-05			0 42	7E-05
UC614	SKA-9	LMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		27.0	286.0	0 46	81 4		0.02		<0.01		0 14		0.147		0 0009			2E-05				
UC615	SKA-10	LMB	Skaha	muscle	2006	MOE+ONA	Various		Jensen 2006		27 3	321 1	0.48	80.5		<0.01		0.02		0 204		0.175		0.0036			7E-05				
UC616	OS-1	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		37.0	982.6				0.04		<0.01		0.131		0.106		0.1049			0.003				
UC617	OS-2	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		44.5	1630.0				0.03		<0.01		0.331		0.272		0.1367			0.0043				
UC618	OS-3	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		49.5	2259.4	1 885	75.4		0 073		<0.01		0 292		0.245		0.1616			0 0041			2.33	0.0033
UC619	OS-4	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		46.0	1786.8				0.05		<0.01		0.235		0.223		0.1311			0 0041			1 72	0.0032
UC620	OS-5	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		41.0	1516.2				0.07		<0.01		0.165		0.136		0.4044			0.0122				
UC621	OS-6	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		42.5	1464 5				0.06		<0.01		0 183		0 147		0.1534			0.0039				
UC622	OS-7	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		39.0	1198 2				0.12		<0.01		0.121		0.108		0.0652			0.002				
UC623	OS-8	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		42 0	1499.0				0.09		<0 01		0.162		0.14		0.1444			0.0049				
UC624	OS-9	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		40.5	1261 4				0 08		<0.01		0.158		0 123		0.1103			0.0036			1.82	0.0029
UC625	OS-10	SMB	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		43 5	1385.2				0.08		<0.01		0.166		0.134		0.206			0.0055			3.01	0.0038
UC626	OS-11	BU	Osoyoos	muscle	2006	MOE+ONA	Various		Jensen 2006		83.0	3000.0	0.47	81 5		0.08		<0.01		0.334		0 254		0.1168			0 0055			0.49	0 0031
UC627	OKFS-8	RB	Okanagan	muscle	2005	MOE+ONA	Various		Jensen 2006		55 5	1850.0																		3 25	0.0179
UC628	OKFS-12	RB	Okanagan	muscle	2005	MOE+ONA	Various		Jensen 2006		48 6	1260.0																		2.72	0.0097
UC629	OKFS-14	RB	Okanagan	muscle	2005	MOE+ONA	Various		Jensen 2006		41.0	1395.0																		3.49	0.014
UC630	OKFS-23	RB	Okanagan	muscle	2005	MOE+ONA	Various		Jensen 2006		44.9	1050.0																		2.6	0.014
UC631	OKFS-24	RB	Okanagan	muscle	2005	MOE+ONA	Various		Jensen 2006		48 6	1155 0																		2.36	0.009
UC632	OKFS-27	RB	Okanagan	muscle	2005	MOE+ONA	Various		Jensen 2006		58 3	2350.0																		3.29	0.0264

* samples with an asterisk on both the unique code and the year are data from Northcote et al 1972. In these cases, the fish had been collected from 1948-1956 and were analysed in 1971.