2016

# Mercury in Fish

## In Alberta Water Bodies 2009–2013

Alberta Government

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# Executive Summary

Mercury enters the environment through various natural processes and human activities. Methylmercury is transformed from inorganic forms of mercury via methylation by micro-organisms in natural waters, and can accumulate in some fish. Humans are exposed to very low levels of mercury directly from the air, water and food. Fish consumers may be exposed to relatively higher levels of methylmercury by eating mercury-containing fish from local rivers and lakes. Methylmercury can accumulate in the human body over time. Because methylmercury is a known neurotoxin, it is necessary to limit human exposure.

From 2009 to 2013, the Departments of Environment and Parks (AEP) and Health (AH) initiated a survey of mercury levels in fish in selected water bodies in Alberta. These water bodies are extensively accessed by the public for recreational activities.

This report deals with (1) concentrations of total mercury levels in various fish species collected from the water bodies in Alberta, (2) estimated exposures, (3) fish consumption limits, (4) fish consumption advisories, and (5) health benefits of fish consumption. The results indicate that:

1. Concentrations of total mercury in fish in the water bodies in Alberta were within the ranges for the same fish species from other water bodies elsewhere in Canada and the United States.
2. The estimated human exposures to mercury were high for the high fish intake group (over 100 grams/day) who consume walleye, northern pike, lake trout, and lake whitefish from some rivers, lakes and reservoirs in Alberta.
3. Restriction of consumption of walleye, northern pike, lake trout, and lake whitefish from some water bodies was indicated by the health risk assessment, especially for women of reproductive age, pregnant women and young children.
4. Fish consumption advisories are voluntary measures to reduce potential health risk to local fish consumers. The balance between risk and benefits of consumption of mercury-containing fish needs to be understood and considered by consumers.

The Science Advisory Committee reviewed this document and made recommendations. The Public Health Management Committee made the final decisions on fish consumption advisories and measures to inform the public accordingly.

# Acknowledgments

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# 1. Introduction

Mercury (Hg) occurs naturally in the environment. There are three forms of mercury: elemental (metallic) mercury, inorganic mercury salts and organic mercury compounds. Mercury enters the environment through natural processes and human activities. The form of mercury most commonly found in the air is volatile elemental mercury. Methylmercury (MeHg) is often formed from other forms of mercury during natural biological processes such as methylation by micro-organisms in the water and sediment. MeHg can accumulate in some fish. People are exposed to very low levels of mercury in the air, water and food. Some people may be exposed to relatively higher levels of MeHg through eating mercury-containing fish. MeHg accumulates in the human body over time. Because MeHg is a known neurotoxin, it is necessary to limit human exposure.

To protect public health, Health Canada has proposed mercury guidelines, and advisories for different fish consumer groups (Health Canada,1979; Feeley and Lo, 1998; Health Canada 2007, Feeley 2008) based on total mercury (THg) or MeHg. These values are expressed either in units of μg THg or MeHg per g of fish flesh or as a Provisional Tolerable Daily Intake (pTDI) in units of μg THg or MeHg per kg of consumer body mass per day (see Section 2.1):

1. 0.5 μg THg/g for all commercial fish/seafood (Guideline);
2. 1.0 μg THg/g for certain commercial fish species such as fresh and frozen tuna, shark, swordfish, escolar, marlin and orange roughy which are known to be consumed less frequently (Advisory); and
3. 0.2 μg THg/g for subsistence consumers (Advisory)
4. 0.2 μg MeHg/kg bw/d pTDI for women of reproductive age and young children (Guideline);
5. 0.47 μg MeHg/kg bw/d pTDI for the general population (Guideline).

The guidelines for commercial fish/seafood are used as a general screening criterion, with the knowledge that most species of commercial fish usually contain lower levels (< 0.1 μg/g) of mercury. This guideline is enforceable by the Canadian Food Inspection Agency (CFIA) for commercial fish. For example, the CFIA has been monitoring total mercury (THg) levels in commercial fish caught from Lake Athabasca in Alberta since the early 1990s. The recommendation for subsistence consumers proposed by Health Canada since the 70's is used for First Nations and Inuit people relying on subsistence fresh water fishing when Medical Services Branch became aware of long term fish consumption patterns of over 100 g/d (Health Canada 1979). The First Nations and Inuit subsistence consumers should limit their fish consumption if the mercury levels in fish are over 0.2 μg THg/g. Over 0.5 μg THg/g fish consumption should be avoided for any consumer.

Fish consumption advisories are developed based on these pTDIs. These advisories provide the public with a warning of potential health risk resulting from consuming

local mercury-containing fish. Fish consumption advisories are designed to minimize the potential health risks to fish consumers who can voluntarily restrict their fish consumption.

From 2009 to 2013, the Departments of Environment and Parks (AEP) and Health (AH) initiated a survey of mercury levels in fish in selected water bodies in Alberta. These water bodies are extensively accessible to the public for recreational activities.

Environment Canada sampled and tested fish from Alberta lakes for mercury during the same time period. The results of these analyses are included in this report.

The results related to mercury in fish are discussed as follows:

1. mercury concentrations in fish,
2. comparison of mercury concentrations in the same fish species in the rivers and lakes in Canada and the U.S.,
3. local fish consumption rates,
4. estimated exposures for women at reproductive age, children and adults,
5. fish consumption advisories, and
6. health benefits of fish consumption.

# 2. Materials and Methods

## 2.1 Units Used for Expressing Mercury Data

A summary of the different units that may be used for expressing relevant mercury data is provided in Table 1. For the purposes of this report, to facilitate comparison of values reported from different sources, all data on mercury concentration in fish will be expressed as μg of mercury per g of fish, i.e. μg/g, which is equivalent to one unit of mercury per million units of fish (ppm). Likewise, human exposure will be expressed as μg of mercury per kg of human body mass, per day, i.e. μg/kg/d. Consumption advisories will be determined from human exposure limits and expressed as g of fish consumed per week, i.e. g/wk.

**Table 1 Units Used for Expressing Mercury Data related to Fish**

| Measure | Preferred Unit | Alternate Unit | Equivalent Units |
|---|---|---|---|
| Hg Concentration | μg of Hg per g of fish, wet weight **μg/g** | mg of Hg per kg of fish, wet weight **mg/kg** | 1 part Hg per million parts of fish **ppm** |
| pTDI for mercury by humans | μg of MeHg per kg of human body weight (mass) per day **μg MeHg/ kg BW/ d** | | |
| Recommended fish consumption limits | g / mercury-containing fish fillet consumed per week **g / wk** | oz / mercury-containing fish fillet consumed per week **oz / wk** | 1 oz = 28.35 g |

## 2.2 Field Collection

Field collection at 16 sampling sites (Figure 1) was conducted by AEP between September 2009 and January 2010. Sampling sites included:

1. Calling Lake
2. Chrystina Lake (Swan Hills area)
3. Cowoki Reservoir
4. Crawling Valley Reservoir
5. Edith Lake
6. Hay River at mouth of Chinchaga River
7. Isle Lake
8. McGregor Lake
9. Lake Athabasca
10. Little Bow Reservoir
11. Kehewin Lake
12. Rolling Hills Reservior

13. Sturgeon Lake
14. Touchwood Lake
15. Wabamun Lake
16. Whitefish Lake

Field collection at twenty sampling sites (Figure 1) was conducted by AEP between January 2010 and January 2011. Sampling sites included:

1. Amisk Lake
2. Bistcho Lake
3. Dore Lake[1]
4. Chinchaga River
5. Isle Lake
6. Kinnaird Lake
7. Lac Bellevue
8. Laurier Lake
9. Len Thompson (Lacombe)
10. Lesser Slave Lake East Basin
11. Lesser Slave Lake West Basin
12. Long Lake
13. Meander River
14. Pinehurst Lake
15. Pitchimi Lake
16. Richardson Lake[2]
17. Skeleton Lake
18. Snipe Lake
19. North Wabasca Lake
20. Winagami Lake

Field collection at 14 sampling sites (Figure 2) was conducted by AEP between January 2011 and January 2012. Sampling sites included:

1. Baptiste Lake
2. Beaver Lake
3. Bourque Lake
4. Calling Lake
5. Cross (Steele) Lake
6. Heart Lake
7. Hutch Lake
8. Kirby Lake
9. Loon River
10. McMillan Lake
11. Moose Lake
12. Nipisi Lake

[1] Collection performed for Environment Canada

[2] Collection performed for Environment Canada (northern pike and walleye) and for AEP (lake whitefish)

13. Peerless Lake
14. Wolf Lake

Field collection at 21 sampling sites (Figure 2) was conducted by AEP between January 2012 and January 2013. Sampling sites included:

1. Baptiste Lake
2. Eagle Lake
3. Elinor Lake
4. Ethel Lake
5. Goodfish Lake
6. Gregoire Lake
7. Hilda Lake
8. Keho Lake
9. Lac la Nonne
10. Lac Ste Anne
11. Lake Isle
12. Marie Lake
13. McLeod Lake
14. Moonshine Lake
15. Moose Lake
16. Pigeon Lake
17. Pine Lake
18. Rock Island Lake
19. Sylvan Lake
20. Whitefish Lake
21. Wizard Lake

Fish species caught for mercury analysis included

1. Walleye (*Sander vitreus*)
2. Northern pike (*Esox lucius*)
3. Lake trout (*Salvelinus namaycush*)
4. Lake whitefish (*Coregonus clupeaformis*)
5. Brook trout (*Salvelinus fontinalis*)
6. Rainbow trout (*Oncorhynchus mykiss*)
7. Cisco (*Coregnous zenithicus*)
8. Yellow perch (*Perca flavescens*)
9. Burbot (*Lota lota*)

Fish were collected by gill-netting, angling and electrofishing. Each sample was kept on ice, and then frozen flat before shipment. Some fish from Lake Athabasca, Richardson Lake and Dore Lake were obtained from individual anglers. Samples were individually bagged and tagged with a label with a unique number.[3]

[3] See Appendix A for sampling methods for Environment Canada

In 2009/2010, the samples were shipped to the Biogeochemical Analytical Laboratory, Department of Biological Sciences at the University of Alberta for mercury testing.

In 2010/2011, 2011/2012 and 2012/2013, the samples were shipped to the Alberta Centre for Toxicology at the University of Calgary for mercury testing.

The sample size, and mean of weight and fork length are summarized in Tables 2, 3, 4 and 5.


**Figure 1 Sampling Locations for 2009/2010 and 2010/2011**


**Figure 2 Sampling Locations for 2011/2012 and 2012/2013**

## Table 2 Sample Size and Mean of Weight and Length, 2009/2010

| Lake and Species | Sample Size | Length (cm) | Wet Weight (g) |
|---|---|---|---|
| *Calling Lake* | | | |
| Northern pike | 7 | 67 | 1,964 |
| Walleye | 10 | 54 | 1,456 |
| *Chrystina Lake* | | | |
| Brook trout | 15 | 33 | 340 |
| *Cowoki Reservoir* | | | |
| Northern pike | 6 | 75 | 3,409 |
| Walleye | 4 | 59 | 2,563 |
| *Crawling Valley Reservoir* | | | |
| Northern pike | 8 | 63 | 1,588 |
| Walleye | 11 | 48 | 1,057 |
| *Edith Lake* | | | |
| Brook trout | 20 | 31 | 352 |
| *Hay River* | | | |
| Walleye | 4 | 49 | 1,277 |
| *Isle Lake* | | | |
| Northern pike | 20 | 53 | 1,104 |
| Walleye | 21 | 50 | 1,247 |
| *Kehewin Lake* | | | |
| Northern pike | 10 | 64 | 1,635 |
| Walleye | 10 | 45 | 957 |
| *Lake Athabasca* | | | |
| Lake trout | 30 | 70 | 2,872 |
| Lake whitefish | 4 | 44 | 969 |
| Northern pike | 29 | 70 | 2,936 |
| Walleye | 30 | 50 | 1,453 |
| *Little Bow Reservoir* | | | |
| Northern pike | 9 | 63 | 1,489 |
| *McGregor Lake* | | | |
| Northern pike | 2 | 82 | 4,200 |
| Walleye | 12 | 58 | 1,893 |
| *Rolling Hills Reservoir* | | | |
| Northern pike | 6 | 80 | 3,700 |
| Walleye | 7 | 61 | 2,523 |
| *Sturgeon Lake* | | | |
| Lake whitefish | 10 | 49 | 1,255 |
| Northern pike | 10 | 61 | 1,573 |
| Walleye | 10 | 46 | 917 |
| *Touchwood Lake* | | | |
| Lake whitefish | 9 | 57 | 1,648 |
| Northern pike | 10 | 86 | 4,317 |
| Walleye | 10 | 63 | 2,051 |
| *Wabamun Lake* | | | |
| Lake whitefish | 13 | 47 | 1,017 |
| Northern pike | 10 | 74 | 3,092 |
| *Whitefish Lake* | | | |
| Lake whitefish | 6 | 67 | 3,486 |
| Northern pike | 7 | 81 | 3,816 |
| Walleye | 6 | 58 | 1,935 |

## Table 3 Sample Size and Mean of Weight and Length, 2010/2011

| Lake and Species | Sample Size | Length (cm) | Wet Weight (g) |
|---|---|---|---|
| *Amisk Lake* | | | |
| Northern pike | 11 | 53 | 835 |
| Walleye | 10 | 43 | 665 |
| *Bitscho Lake* | | | |
| Northern pike | 10 | 75 | 3,226 |
| Walleye | 10 | 46 | 1,548 |
| *Chinchaga River* | | | |
| Walleye | 5 | 42 | 718 |
| *Dore Lake*[a] | | | |
| Northern pike | 20 | 69.8 | 2,808 |
| Walleye | 20 | 46.1 | 1,051 |
| *Isle Lake* | | | |
| Northern pike | 10 | 75 | 3,092 |
| Lake whitefish | 13 | 47 | 1,017 |
| *Kinnaird Lake* | | | |
| Northern pike | 11 | 56 | 1,380 |
| Walleye | 10 | 48 | 1,080 |
| *Lac Bellevue* | | | |
| Walleye | 12 | 44 | 912 |
| *Laurier Lake* | | | |
| Northern pike | 4 | 81 | 3,128 |
| *Len Thompson* | | | |
| Rainbow trout | 10 | 33 | 493 |
| *Lesser Slave Lake East Basin* | | | |
| Northern pike | 9 | 69 | 2,301 |
| Walleye | 14 | 52 | 1,136 |
| *Lesser Slave Lake West Basin* | | | |
| Northern pike | 16 | 76 | 2,913 |
| Walleye | 15 | 59 | 1,155 |
| *Long Lake* | | | |
| Northern pike | 6 | 51 | 826 |
| Walleye | 2 | 46 | 953 |
| *Meander River* | | | |
| Northern pike | 7 | 59 | 1,414 |
| Walleye | 3 | 39 | 587 |
| *North Wabasca Lake* | | | |
| Northern pike | 10 | 82 | 4,294 |
| Walleye | 10 | 57 | 1,746 |
| *Pinehurst Lake* | | | |
| Northern pike | 10 | 55 | 1,575 |
| Walleye | 8 | 54 | 1,839 |
| *Pitchimi Lake* | | | |
| Lake trout | 15 | 79 | 4,671 |
| *Richardson Lake* | | | |
| Northern pike[a] | 19 | 76.0 | 4,066 |
| Walleyet[a] | 20 | 47.4 | 1,289 |
| Lake whitefish | 20 | 46 | 1,172 |
| *Skeleton Lake* | | | |
| Northern pike | 7 | 52 | 845 |
| Walleye | 9 | 51 | 1,462 |
| *Snipe Lake* | | | |
| Northern pike | 10 | 75 | 2,969 |
| Walleye | 10 | 55 | 1,846 |

| Lake and Species | Sample Size | Length (cm) | Wet Weight (g) |
|---|---|---|---|
| *Winigami Lake* | | | |
| Northern pike | 11 | 64 | 1,533 |
| Walleye | 10 | 59 | 2,069 |

[a] Data source – Environment Canada

## Table 4 Sample Size and Mean of Weight and Length, 2011/2012

| Lake and Species | Sample Size | Length (cm) | Wet Weight (g) |
|---|---|---|---|
| *Baptiste Lake* | | | |
| Northern pike | 10 | 67 | 1,984 |
| Walleye | 8 | 43 | 738 |
| *Beaver Lake* | | | |
| Lake whitefish | 10 | 52 | 1,438 |
| Northern pike | 11 | 67 | 2,210 |
| Walleye | 15 | 51 | 1,304 |
| *Bourque Lake* | | | |
| Lake whitefish | 10 | N/A | 849 |
| Northern pike | 8 | N/A | 1,502 |
| Walleye | 10 | N/A | 1,701 |
| *Calling Lake* | | | |
| Northern pike | 10 | 64 | 1,390 |
| Walleye | 12 | 51 | 1,076 |
| *Cross (Steele)Lake* | | | |
| Northern pike | 10 | 66 | 1,860 |
| *Heart Lake* | | | |
| Lake whitefish | 7 | 59 | 2,371 |
| Northern pike | 14 | 73 | 2,662 |
| Walleye | 27 | 55 | 1,964 |
| *Hutch Lake* | | | |
| Walleye | 10 | 53 | 1,993 |
| *Kirby Lake* | | | |
| Lake whitefish | 21 | 55 | 1,625 |
| Northern pike | 20 | 73 | 2,784 |
| *Loon River* | | | |
| Walleye | 4 | 55 | 989 |
| *McMillan Lake* | | | |
| Northern pike | 13 | 70 | 1,948 |
| *Moose Lake* | | | |
| Northern pike | 17 | N/A | 1,167 |
| Walleye | 10 | N/A | 1,633 |
| *Nipisi Lake* | | | |
| Northern pike | 20 | 74 | 2,706 |
| *Peerless Lake* | | | |
| Lake trout | 9 | 71 | 3,824 |
| Walleye | 16 | 55 | 1,526 |
| *Wolf Lake* | | | |
| Lake whitefish | 10 | N/A | 1,723 |
| Northern pike | 10 | N/A | 1,258 |
| Walleye | 10 | N/A | 973 |

## Table 5 Sample Size and Mean of Weight and Length, 2012/2013

| Lake and Species | Sample Size | Length (cm) | Wet Weight (g) |
|---|---|---|---|
| *Baptiste Lake* | | | |
| Lake whitefish | 5 | 40 | 908 |
| Northern pike | 10 | 60 | 1,370 |
| Walleye | 33 | 49 | 1,061 |
| *Eagle Lake* | | | |
| Northern pike | 13 | 49 | 777 |
| Walleye | 23 | 48 | 1,323 |
| *Elinor Lake* | | | |
| Lake whitefish | 14 | 51 | 1,347 |
| Northern pike | 8 | 73 | 1,625 |
| Walleye | 17 | 53 | 1,968 |
| *Ethel Lake* | | | |
| Lake whitefish | 12 | 59 | 2,360 |
| Northern pike | 9 | 54 | 740 |
| Walleye | 19 | 48 | 1,009 |
| *Goodfish Lake* | | | |
| Northern pike | 7 | 63 | 1,541 |
| Walleye | 9 | 50 | 1,261 |
| *Gregoire Lake* | | | |
| Lake whitefish | 4 | 53 | 2,243 |
| Walleye | 9 | 50 | 1,273 |
| *Hilda Lake* | | | |
| Northern pike | 8 | 56 | 1,128 |
| Walleye | | 19 | 46 |
| *Keho Lake* | | | |
| Lake whitefish | 30 | 45 | 874 |
| Northern pike | 30 | 63 | 1,506 |
| Walleye | | | 24 |
| *Lac la Nonne* | | | |
| Lake whitefish | 15 | 52 | 1,634 |
| Northern pike | 8 | 55 | 1,028 |
| Walleye | 17 | 41 | 684 |
| *Lac Ste Anne* | | | |
| Walleye | 7 | 43 | 798 |
| *Lake Isle* | | | |
| Northern pike | 12 | 49 | 813 |
| *Marie Lake* | | | |
| Lake whitefish | 8 | 45 | 794 |
| Northern pike | 7 | 66 | 1,986 |
| Walleye | 12 | 49 | 1,133 |
| *McLeod Lake* | | | |
| Rainbow Trout | 7 | 31 | 339 |
| *Moonshine Lake* | | | |
| Rainbow Trout | 24 | 29 | 294 |
| *Moose Lake* | | | |
| Cisco | 26 | 40 | 900 |
| Lake whitefish | 5 | 60 | 2,582 |
| Northern pike | 50 | 66 | 1,759 |
| Walleye | 48 | 55 | 1,625 |
| Yellow Perch | 36 | 22 | 155 |

| Lake and Species | Sample Size | Length (cm) | Wet Weight (g) |
|---|---|---|---|
| *Pigeon Lake* | | | |
| Lake whitefish | 38 | 54 | 1,934 |
| Walleye | 31 | 49 | 1,115 |
| *Pine Lake* | | | |
| Northern pike | 5 | 58 | 1,418 |
| Walleye | 5 | 48 | 1,112 |
| *Rock Island Lake* | | | |
| Northern pike | 17 | 58 | 1,290 |
| Walleye | 19 | 51 | 1,509 |
| *Sylvan Lake* | | | |
| Lake whitefish | 24 | 39 | 597 |
| Walleye | 15 | 37 | 584 |
| *Whitefish Lake* | | | |
| Lake whitefish | 4 | 47 | 962 |
| Northern pike | 4 | 66 | 1,689 |
| Walleye | 16 | 55 | 1,526 |
| *Wizard Lake* | | | |
| Northern pike | 15 | 50 | 841 |

## 2.3 Laboratory Analysis

In 2009/2010, laboratory analysis was performed in the Biogeochemical Analytical Laboratory, Department of Biological Sciences at the University of Alberta. In 2010/2011, 2011/2012 and 2012/2013, laboratory analyses were performed by the Alberta Centre for Toxicology at the University of Calgary, Alberta. The analytical method was based on the modified USEPA methods 200.7 and 200.8 (USEPA 2001). The Environment Canada laboratory used the USEPA method 7473 (USEPA 2007) (Appendix A).

## 2.4 Estimation of Exposure Ratio

Estimated daily intake (EDI), μg/d, was calculated as follows:

EDI = C * IR *BF/BW

C is a representative measure of THg concentrations in fish muscle (μg/g). From a human health perspective, the amount of MeHg is of most interest. In mercury analyses of fish, the THg in the sample is measured, which is the sum of all forms of mercury present, rather than MeHg because the analysis of MeHg is more expensive. Some studies reported that the percentage of MeHg in THg in fish ranged from 81% to 95% (CFIA 2003). For the purposes of health risk assessments, 100% of THg is assumed to be MeHg, thereby erring on the side of caution.

IR is the human rate of fish consumption (g/d).

BF is bioavailability factor (assumed to be 100%, unitless, the maximum possible and most cautious assumption for this factor).

BW is average body weight in humans (kg). The average of body weight for male and female adults in Alberta is 73 kg. The average human body weights used by Health Canada are 65 kg for women of reproductive age, 26.4 kg for the five to 11 year old group, and 14.4 kg for the one to four year old group (Health Canada 2007).

Exposure ratio (ER, unitless) was calculated by using the following equation:

ER= EDI / pTDI

The provisional tolerable daily intake (pTDI, μg MeHg/kg bw/d) is determined by toxicological risk assessment on mercury (Health Canada 2007). The pTDI for MeHg is the maximum amount of mercury that can be ingested on a daily basis over a lifetime without increased risk of adverse health effects. Health Canada proposed a pTDI of mercury as 0.2 μg Hg/kg bw/d for women of reproductive (childbearing) age and for children. Children refer to two age groups: the five to 11 year old group and the one to four year old group. Health Canada proposed a pTDI of MeHg as 0.47 μg

Hg/kg bw/d for adults (adult men and adult women who are not of reproductive age).

## 2.5 Consumption Limits

For quantitative fish advisories, the lifetime average consumption limits (weekly basis) are calculated. The calculation of the consumption limits (CR, g fish per week) is based on the following equation:

CR = pTDI * BW (7 d/wk) / C

Where pTDI is provisional tolerable daily intake (µg MeHg/kg bw/d),
BW is body weight (mass) in humans (kg), and
C (µg Hg / g fish) is the measured THg concentration in fish muscle.

The consumption limits that correspond to the Health Canada pTDI and the commercial fish Hg recommendation (maximum concentration of 0.5 µg Hg /g fish) are provided below as a reference point.

Consumption Limits for adult men and adult women not of reproductive age
CR = (0.47µg MeHg/kg bw/d)(73 kg)(7 d/wk) / (0.5 µg Hg / g fish) = 480 g fish /week

Consumption Limits for women of reproductive age
CR = (0.2µg MeHg/kg bw/d)(65 kg)(7 d/wk) / (0.5 µg Hg / g fish) = 180 g fish /week

Consumption Limits for children age 5 – 11 (body weight 26.4 kg)
CR = (0.2µg MeHg/kg bw/d)(26.4 kg)(7 d/wk) / (0.5 µg Hg / g fish) = 74 g fish /week

Consumption Limits for children age 1 – 4 (body weight 14.4 kg)
CR = (0.2µg MeHg/kg bw/d)(14.4 kg)(7 d/wk) / (0.5 µg Hg / g fish) = 40 g fish /week

# 3. Results and Discussions

## 3.1 Concentrations in Fish

The total mercury concentrations in wet weight in fish are summarized in Tables 6, 7, 8, and 9 and Figures 3, 4, 5, and 6. THg concentrations exceeding the 0.5 μg/g commercial fish limit are shown in **bold**.

The average THg concentrations exceeded 0.5 μg/g (ppm) in northern pike in the following water bodies:

1. Amisk Lake
2. Cowoki Reservoir
3. Elinor Lake
4. Hilda Lake
5. McGregor Lake
6. Pinehurst Lake
7. Rolling Hills Reservoir
8. Touchwood Lake
9. Whitefish Lake

The average THg concentrations exceeded 0.5 μg/g (ppm) in walleye in the following water bodies:

1. Amisk Lake
2. Baptiste Lake
3. Cowoki Reservoir
4. Crawling Valley reservoir
5. Dore Lake
6. Elinor Lake
7. Hay River at mouth of Chinchaga River
8. Hilda Lake
9. Kinnaird Lake
10. Lac la Nonne
11. McGregor Lake
12. Pinehurst Lake
13. Rolling Hills Reservoir
14. Touchwood Lake and
15. Whitefish Lake
16. Wolf Lake

The average THg concentrations exceeded 0.5 μg/g (ppm) in lake whitefish from Whitefish Lake and in lake trout in Pitchimi Lake.

**Table 6 Total Mercury Levels in Fish, 2009/2010** (µg/g, wet weight)

| Lake and Species | Mean | Min | Max |
|---|---|---|---|
| *Calling Lake* | | | |
| Northern pike | 0.10 | 0.05 | 0.18 |
| Walleye | 0.15 | 0.06 | 0.41 |
| *Chrystina Lake* | | | |
| Brook trout | 0.20 | 0.10 | 0.60 |
| *Cowoki Reservoir* | | | |
| Northern pike | **0.59** | 0.37 | 0.88 |
| Walleye | 0.47 | 0.41 | 0.49 |
| *Crawling Valley Reservoir* | | | |
| Northern pike | 0.38 | 0.20 | 0.54 |
| Walleye | **0.54** | 0.25 | 1.39 |
| *Edith Lake* | | | |
| Brook trout | 0.17 | 0.09 | 0.49 |
| *Hay River* | | | |
| Walleye | **0.61** | 0.45 | 0.75 |
| *Isle Lake* | | | |
| Northern pike | 0.12 | 0.04 | 0.22 |
| Walleye | 0.20 | 0.07 | 0.37 |
| *Kehewin Lake* | | | |
| Northern pike | 0.39 | 0.09 | 0.61 |
| Walleye | 0.29 | 0.11 | 0.63 |
| *Lake Athabasca* | | | |
| Lake trout | 0.27 | 0.15 | 0.43 |
| Lake whitefish | 0.11 | 0.06 | 0.25 |
| Northern pike | 0.21 | 0.08 | 0.50 |
| Walleye | 0.26 | 0.14 | 0.65 |
| *Little Bow Reservoir* | | | |
| Northern pike | 0.47 | 0.31 | 0.87 |
| *McGregor Lake* | | | |
| Northern pike | **1.0** | 0.87 | 1.13 |
| Walleye | **0.62** | 0.41 | 0.89 |
| *Rolling Hills Reservoir* | | | |
| Northern pike | **1.04** | 0.85 | 1.23 |
| Walleye | **1.13** | 0.69 | 1.89 |
| *Sturgeon Lake* | | | |
| Lake whitefish | 0.03 | 0.02 | 0.06 |
| Northern pike | 0.15 | 0.04 | 0.40 |
| Walleye | 0.18 | 0.08 | 0.31 |
| *Touchwood Lake* | | | |
| Lake whitefish | 0.11 | 0.04 | 0.20 |
| Northern pike | **0.86** | 0.48 | 1.12 |
| Walleye | **0.94** | 0.66 | 1.23 |
| *Wabamun Lake* | | | |
| Lake whitefish | 0.03 | 0.00 | 0.08 |
| Northern pike | 0.38 | 0.21 | 0.60 |
| *Whitefish Lake* | | | |
| Lake whitefish | **0.72** | 0.43 | 0.93 |
| Northern pike | **0.64** | 0.27 | 0.87 |
| Walleye | **0.87** | 0.75 | 1.02 |

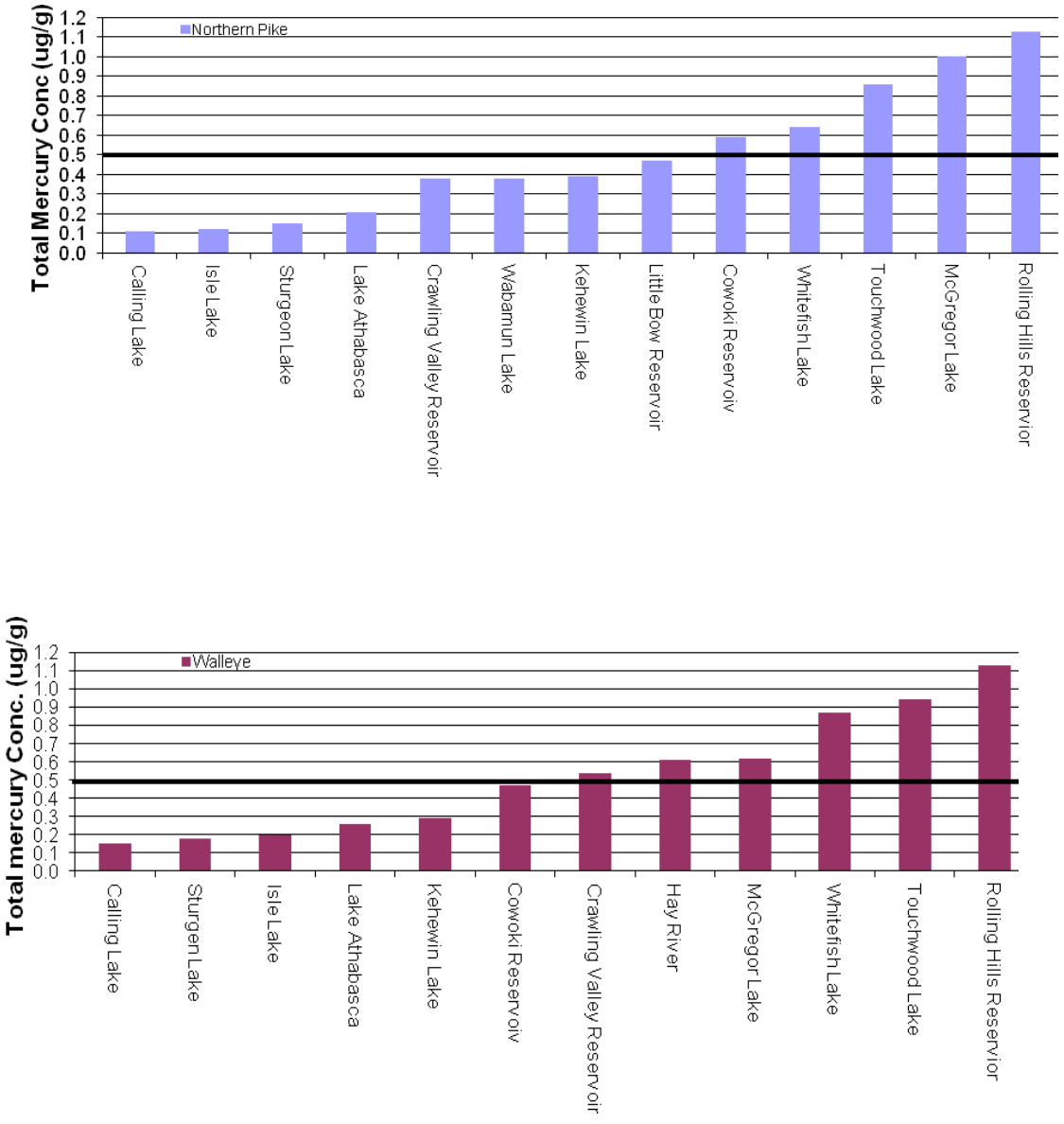



**Figure 3 Mean Concentrations of Total Mercury in Fish, 2009/2010**

## Table 7 Total Mercury Levels in Fish, 2010/2011 (µg/g, wet weight)

| Lake and Species | Mean | Min | Max |
|---|---|---|---|
| *Amisk Lake* | | | |
| Northern pike | **0.54** | 0.26 | 0.85 |
| Walleye | **0.89** | 0.29 | 1.36 |
| *Bitscho Lake* | | | |
| Northern pike | 0.08 | 0.04 | 0.25 |
| Walleye | 0.12 | 0.04 | 0.25 |
| *Chinchaga River* | | | |
| Walleye | 0.44 | 0.28 | 0.68 |
| *Dore Lake*[a] | | | |
| Northern pike | 0.34 | 0.17 | 1.13 |
| Walleye | **0.57** | 0.22 | 0.90 |
| *Isle Lake* | | | |
| Northern pike | 0.38 | 0.21 | 0.6 |
| Lake whitefish | 0.03 | 0 | 0.08 |
| *Kinnaird Lake* | | | |
| Northern pike | 0.43 | 0.16 | 0.77 |
| Walleye | **0.67** | 0.21 | 1.01 |
| *Lac Bellevue* | | | |
| Walleye | 0.35 | 0.16 | 0.75 |
| *Laurier Lake* | | | |
| Northern pike | 0.47 | 0.36 | 0.56 |
| *Len Thompson (Lacombe)* | | | |
| Rainbow trout | 0.14 | 0.09 | 0.19 |
| *Lesser Slave Lake East Basin* | | | |
| Northern pike | 0.40 | 0.25 | 0.62 |
| Walleye | 0.33 | 0.15 | 0.65 |
| *Lesser Slave Lake West Basin* | | | |
| Northern pike | 0.33 | 0.23 | 0.45 |
| Walleye | 0.35 | 0.17 | 0.75 |
| *Long Lake* | | | |
| Northern pike | 0.34 | 0.09 | 0.63 |
| Walleye | 0.43 | 0.11 | 0.75 |
| *Meander River* | | | |
| Northern pike | 0.19 | 0.08 | 0.27 |
| Walleye | 0.17 | 0.15 | 0.21 |
| *North Wabasca Lake* | | | |
| Northern pike | 0.31 | 0.13 | 0.52 |
| Walleye | 0.27 | 0.08 | 0.56 |
| *Pinehurst Lake* | | | |
| Northern pike | **0.81** | 0.24 | 1.19 |
| Walleye | **0.60** | 0.27 | 1.11 |
| *Pitchimi Lake* | | | |
| Lake trout | **0.75** | 0.39 | 1.22 |
| *Richardson Lake* | | | |
| Northern pike[a] | 0.28 | 0.10 | 0.58 |
| Walleye[a] | 0.23 | 0.13 | 0.38 |
| Lake whitefish | 0.07 | 0.02 | 0.16 |
| *Skeleton Lake* | | | |
| Northern pike | 0.12 | 0.06 | 0.29 |
| Walleye | 0.16 | 0.04 | 0.33 |
| *Snipe Lake* | | | |
| Northern pike | 0.05 | 0.02 | 0.14 |
| Walleye | 0.04 | 0.02 | 0.1 |

| Lake and Species | Mean | Min | Max |
|---|---|---|---|
| *Winigami Lake* | | | |
| Northern pike | 0.12 | 0.1 | 0.17 |
| Walleye | 0.19 | 0.09 | 0.28 |

[a] Data source – Environment Canada

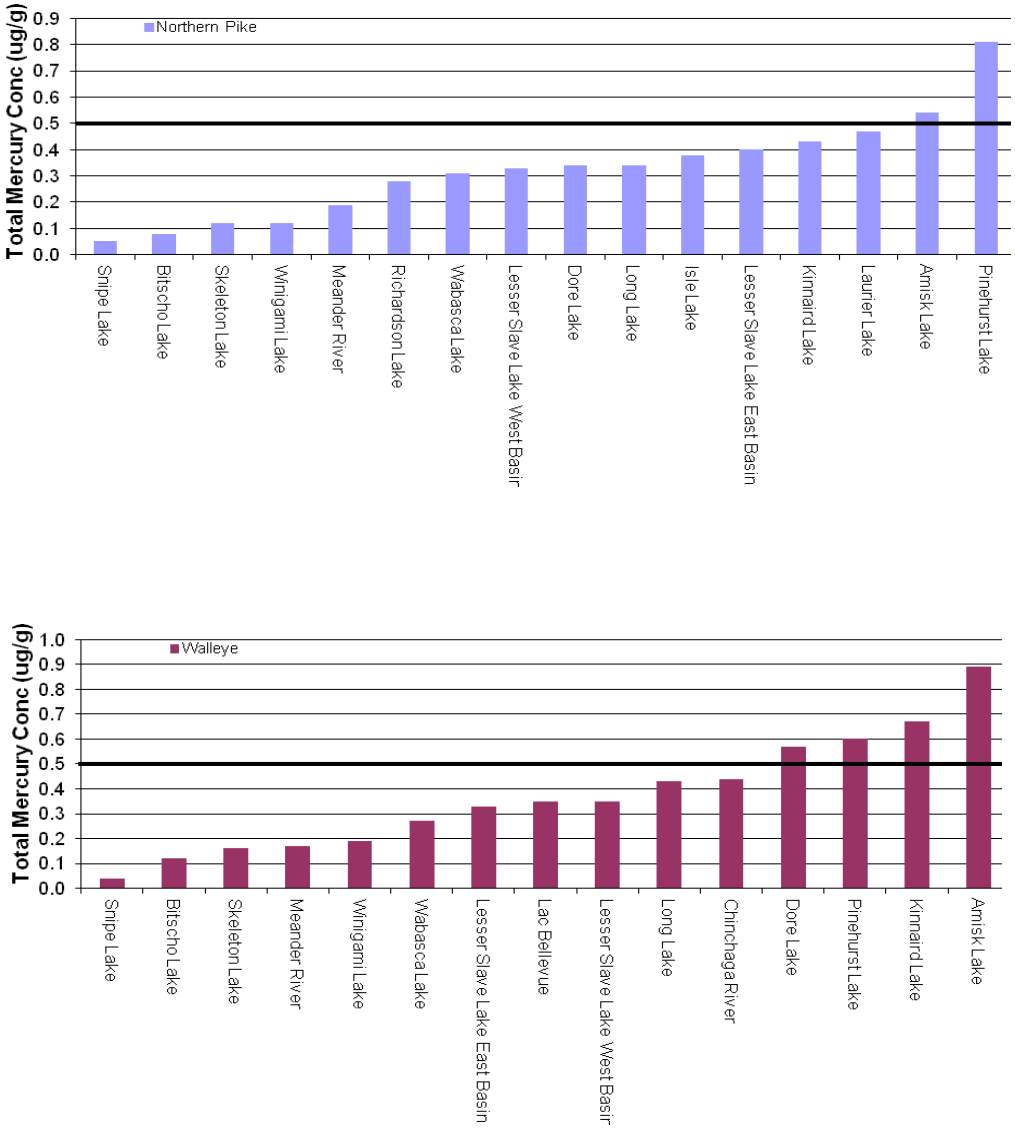
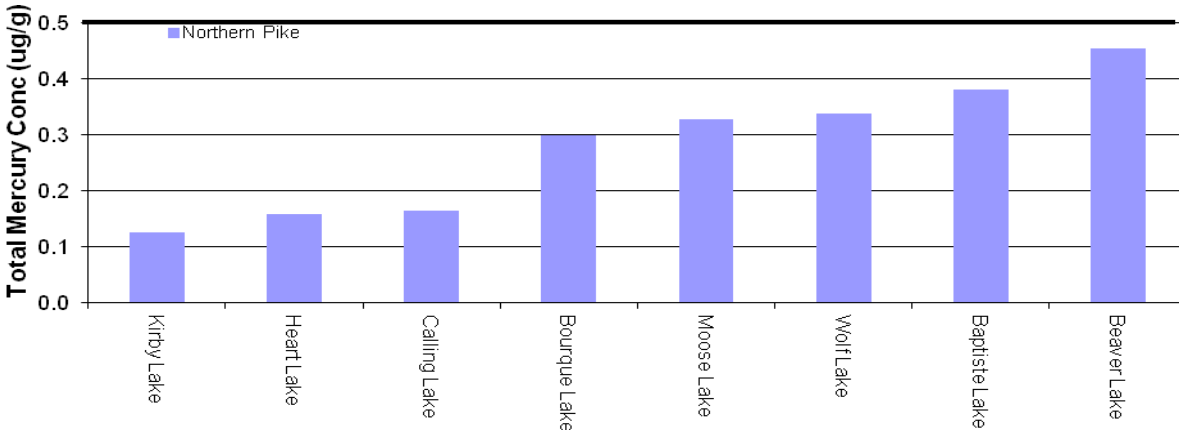



**Figure 4 Mean Concentrations of Total Mercury in Fish, 2010/2011**

## Table 8 Total Mercury Levels in Fish, 2011/2012 (µg/g, wet weight)

| Lake and Species | Mean | Min | Max |
|---|---|---|---|
| *Baptiste Lake* | | | |
| Northern pike | 0.38 | 0.14 | 0.72 |
| Walleye | 0.21 | 0.11 | 0.53 |
| *Beaver Lake* | | | |
| Lake whitefish | 0.10 | 0.06 | 0.15 |
| Northern pike | 0.45 | 0.21 | 1.11 |
| Walleye | 0.35 | 0.13 | 0.69 |
| *Bourque Lake* | | | |
| Lake whitefish | 0.07 | 0.02 | 0.19 |
| Northern pike | 0.30 | 0.12 | 0.51 |
| Walleye | 0.36 | 0.28 | 0.54 |
| *Calling Lake* | | | |
| Northern pike | 0.16 | 0.08 | 0.49 |
| Walleye | 0.15 | 0.06 | 0.32 |
| *Cross (Steele)Lake* | | | |
| Northern pike | 0.21 | 0.07 | 0.30 |
| *Heart Lake* | | | |
| Lake whitefish | 0.02 | 0.01 | 0.04 |
| Northern pike | 0.16 | 0.06 | 0.23 |
| Walleye | 0.11 | 0.04 | 0.32 |
| *Hutch Lake* | | | |
| Walleye | 0.11 | 0.09 | 0.13 |
| *Kirby Lake* | | | |
| Lake whitefish | 0.02 | 0.01 | 0.05 |
| Northern pike | 0.13 | 0.02 | 0.54 |
| *Loon River* | | | |
| Walleye | 0.34 | 0.19 | 0.60 |
| *McMillan Lake* | | | |
| Northern pike | 0.39 | 0.21 | 0.60 |
| *Moonshine Lake* | | | |
| Rainbow Trout | 0.07 | 0.04 | 0.12 |
| *Moose Lake* | | | |
| Northern pike | 0.33 | 0.09 | 0.64 |
| Walleye | 0.49 | 0.29 | 0.67 |
| *Nipisi Lake* | | | |
| Northern pike | 0.11 | 0.05 | 0.19 |
| *Peerless Lake* | | | |
| Lake trout | 0.15 | 0.05 | 0.31 |
| *Wolf Lake* | | | |
| Lake whitefish | 0.10 | 0.05 | 0.24 |
| Northern pike | 0.34 | 0.12 | 0.50 |
| Walleye | **0.59** | 0.25 | 0.73 |



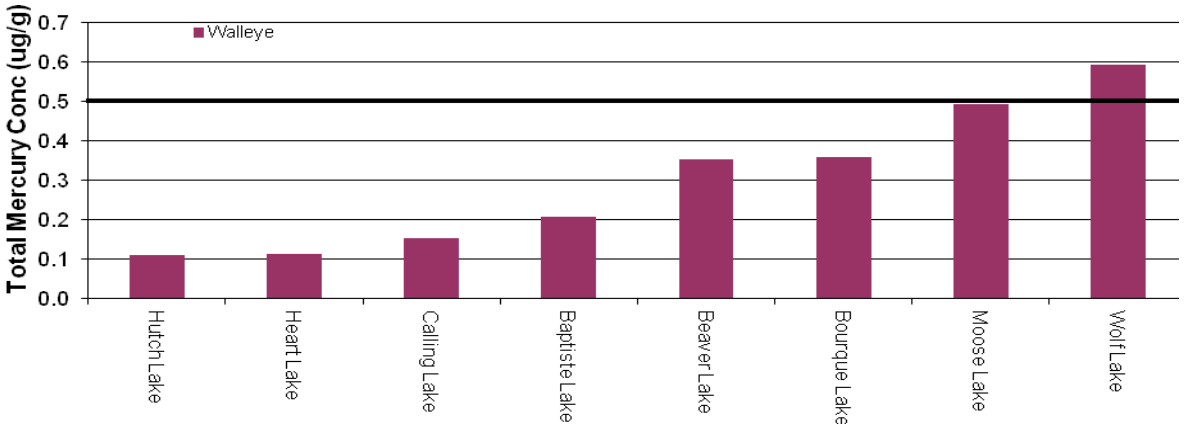




**Figure 5 Mean Concentrations of Total Mercury in Fish, 2011/2012**

## Table 9 Total Mercury Levels in Fish, 2012/2013 (µg/g, wet weight)

| Lake and Species | Mean | Min | Max |
|---|---|---|---|
| *Baptiste Lake* | | | |
| Lake whitefish | 0.19 | 0.12 | 0.23 |
| Northern pike | 0.35 | 0.23 | 0.64 |
| Walleye | **0.52** | 0.25 | 0.96 |
| *Eagle Lake* | | | |
| Northern pike | 0.07 | 0.05 | 0.09 |
| Walleye | 0.21 | 0.07 | 0.51 |
| *Elinor Lake* | | | |
| Lake whitefish | 0.11 | 0.02 | 0.27 |
| Northern pike | **0.70** | 0.32 | 1.89 |
| Walleye | **0.73** | 0.23 | 1.59 |
| *Ethel Lake* | | | |
| Lake whitefish | 0.04 | 0.02 | 0.08 |
| Northern pike | 0.42 | 0.10 | 0.61 |
| Walleye | 0.45 | 0.24 | 0.89 |
| *Goodfish Lake* | | | |
| Northern pike | 0.46 | 0.27 | 0.58 |
| Walleye | 0.28 | 0.17 | 0.45 |
| *Gregoire Lake* | | | |
| Lake whitefish | 0.05 | 0.03 | 0.06 |
| Walleye | 0.19 | 0.13 | 0.27 |
| *Hilda Lake* | | | |
| Northern pike | **0.50** | 0.31 | 0.79 |
| Walleye | **0.67** | 0.34 | 0.98 |
| *Keho Lake* | | | |
| Lake whitefish | 0.11 | 0.04 | 0.39 |
| Northern pike | 0.14 | 0.09 | 0.26 |
| Walleye | 0.22 | 0.14 | 0.59 |
| *Lac la Nonne* | | | |
| Lake whitefish | 0.07 | 0.03 | 0.23 |
| Northern pike | 0.31 | 0.19 | 0.43 |
| Walleye | **0.55** | 0.20 | 1.17 |
| Yellow perch | 0.08 | 0.07 | 0.09 |
| *Lac Ste Anne* | | | |
| Walleye | 0.14 | 0.04 | 0.24 |
| *Lake Isle* | | | |
| Northern pike | 0.07 | 0.06 | 0.09 |
| *Marie Lake* | | | |
| Lake whitefish | 0.04 | 0.02 | 0.16 |
| Northern pike | 0.24 | 0.08 | 0.41 |
| Walleye | 0.19 | 0.10 | 0.37 |
| *McLeod Lake* | | | |
| Rainbow Trout | 0.05 | 0.03 | 0.07 |
| *Moonshine Lake* | | | |
| Rainbow Trout | 0.07 | 0.04 | 0.12 |
| *Moose Lake* | | | |
| Cisco | 0.09 | 0.04 | 0.16 |
| Lake whitefish | 0.06 | 0.03 | 0.11 |
| Northern pike | 0.38 | 0.11 | 1.32 |
| Walleye | 0.49 | 0.18 | 0.77 |
| Yellow perch | 0.05 | 0.00 | 0.12 |

| Lake and Species | Mean | Min | Max |
|---|---|---|---|
| *Pigeon Lake* | | | |
| Lake whitefish | 0.04 | 0.02 | 0.06 |
| Walleye | 0.14 | 0.05 | 0.28 |
| *Pine Lake* | | | |
| Northern pike | 0.22 | 0.14 | 0.34 |
| Walleye | 0.27 | 0.12 | 0.66 |
| *Rock Island Lake* | | | |
| Northern pike | 0.08 | 0.03 | 0.33 |
| Walleye | 0.11 | 0.04 | 0.30 |
| *Sylvan Lake* | | | |
| Lake whitefish | 0.12 | 0.03 | 0.22 |
| Walleye | 0.21 | 0.10 | 0.64 |
| *Whitefish Lake* | | | |
| Lake whitefish | 0.12 | 0.01 | 0.32 |
| Northern pike | **0.66** | 0.46 | 0.83 |
| Walleye | **0.78** | 0.41 | 1.30 |
| *Wizard Lake* | | | |
| Northern pike | 0.20 | 0.10 | 0.35 |

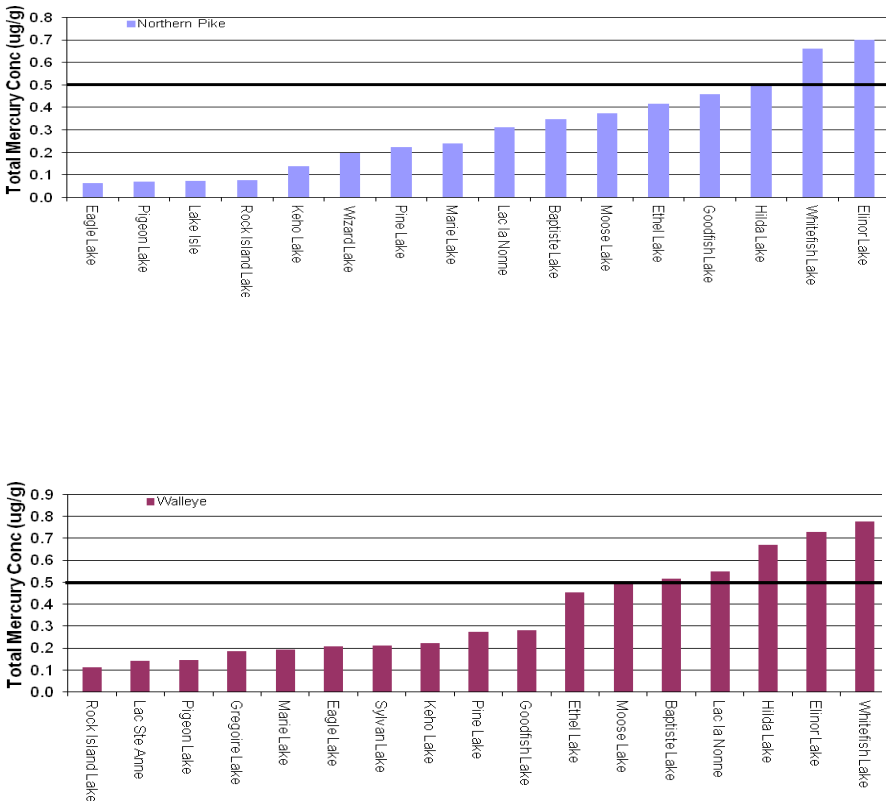



**Figure 6 Mean Concentrations of Total Mercury in Fish, 2012/2013**

Mean THg concentrations in walleye, northern pike and lake whitefish collected in previous studies from other water bodies of Alberta are listed in Table 10 (AHW 2009a, b, c, d). There have been recent concerns raised about mercury releases from oil sands development leading to increasing mercury levels in fish in the Athabasca River ecosystem. Evans and Talbot (2012) performed an extensive analysis of data for mercury in walleye, northern pike and lake whitefish. For the Athabasca River (1984-2003) they found decreasing trends for mercury in walleye and lake whitefish. For western Lake Athabasca and its delta, they found a decreasing trend for northern pike (1981-2009) and no trend for walleye (1981-2005). A recent study on mercury deposition in the Athabasca region has shown that there is an increase in mercury concentrations near oil sands operations (Kirk et al. 2014). The increased concentration could impact aquatic ecosystems.

Mean THg concentrations determined by Environment Canada for Lake Athabasca from 2010 to 2013 were consistent with the results obtained by Departments of Environment and Sustainable Resource Development and Health (Appendix A).

Mean THg concentrations in walleye collected in Rolling Hills Reservoir and Touchwood Lake in 2009/2010, in Amisk Lake, Kinnaird Lake, and Pinehurst Lake in 2010/2011, and in Elinor Lake, Hilda Lake, and Whitefish Lake in 2012/2013 were higher than those collected in other water bodies of Alberta previously.

Mean THg concentrations in northern pike collected in McGregor Lake, Rolling Hills Reservoir, Touchwood Lake and Whitefish Lake in 2009/2010, in Amisk Lake and Pinehurst Lake in 2010/2011 and in Elinor Lake and Whitefish Lake in 2012/2013 were higher than those collected in other water bodies of Alberta previously.

Mean THg concentrations in lake whitefish collected in Whitefish Lake in 2009/2010 were higher than those collected in other water bodies of Alberta previously.

The average THg concentrations in Canadian market fish reported by Health Canada ranged from 0.02 to 1.82 μg/g (Health Canada 2007). Compared to Canadian market fish for different fish species, mean THg concentrations in local fish were within the range of Canadian market fish.

Mean THg levels for walleye and northern pike from other water bodies in Canada and the U.S. reported in the literature are summarized in Table 11. Mean THg concentrations for the same fish species collected in the water bodies of Alberta in 2009/2013 were well within the ranges for the same fish species reported in the literature for other North American freshwater fish.

Mean THg concentration in fish fillets varied in other lakes, rivers and reservoirs in Canada and the U.S. The highest mean mercury levels in walleye and Northern pike in the water bodies in eastern and northern Canada ranged from 3.73 to 6.44 μg/g, respectively. High levels tended to be found in larger, older fish. Fish absorb MeHg directly through their gills or through the consumption of prey which contain mercury.

MeHg is tightly bound to proteins in all fish tissue so larger, older fish contain higher mercury (Munn and Short 1997, Neumann and Ward 1999).

Trophic level is a major factor in mercury accumulation in predatory (fish-eating) fish through biomagnification (Cabana et al. 1994). Bottom-feeding species may accumulate high mercury concentrations from direct contact with contaminated sediment or by eating benthic invertebrates and epibenthic organisms. Predatory fish species may accumulate and biomagnify mercury concentrations via several trophic levels of the food web (Suedel et al. 1994). Predators are commonly used as good indicators of mercury contamination. In this survey, the higher mercury levels were observed in walleye and northern pike which are highly piscivorous predatory fish.

## Table 10 Mean THg Concentrations in Fish Muscles in Alberta Water Bodies

| | Mean (μg/g, ww) | Location | Reference |
|---|---|---|---|
| Walleye | 0.28 – 0.47 | Athabasca River | AHW 2009a, 2009b, 2009c, 2009d |
| | 0.42 | Christina Lake | |
| | 0.30 | Clearwater River | |
| | 0.13 – 0.16 | Gregoire Lake | |
| | 0.27 | Keho Lake | |
| | 0.43 | Milk River Ridge Reservoir | |
| | 0.63 | Lac la Nonne | |
| | 0.13 | Lac Ste. Anne | |
| | 0.41 | Lake Newell | |
| | 0.11 | Pigeon Lake | |
| | 0.52 – 0.79 | Pine Coulee Reservoir | |
| | 0.41 | Pine Lake | |
| | 0.79 | Red Deer River | |
| | 0.68 | South Saskatchewan River | |
| | 0.13 | Winefred Lake | |
| Northern pike | 0.42 | Christina Lake | AHW 2009a, 2009b, 2009c, 2009d |
| | 0.15 – 0.30 | Clearwater River | |
| | 0.15 -0.21 | Gregoire Lake | |
| | 0.22 | Keho Lake | |
| | 0.56 | Lac la Nonne | |
| | 0.14 | Lac Ste. Anne | |
| | 0.23 | Lake Newell | |
| | 0.27 – 0.59 | Little Bow River downstream | |
| | 0.04 – 0.29 | Little Bow River downstream | |
| | 0.21 | Milk River Ridge Reservoir | |
| | 0.11 - 0.22 | Muskeg River | |
| | 0.18 | Oldman River | |
| | 0.13 | Pine Coulee Reservoir | |
| | 0.27 | Pine lake | |
| | 0.27 | Red Deer River | |
| | 0.35 | South Saskatchewan River | |
| | 0.44 – 0.56 | Twin Valley Reservoir | |
| | 0.27 – 0.49 | Willow Creek Downstream | |
| | 0.08 – 0.13 | Winefred Lake | |
| Lake whitefish | 0.09 – 0.17 | Athabasca River | AHW 2009a, 2009b, 2009c, 2009d |
| | 0.09 | Christina Lake | |
| | 0.04 | Gregoire Lake | |
| | 0.10 | Keho Lake | |
| | 0.13 | Lake Newell | |
| | 0.14 | Milk River Ridge Reservoir | |
| | 0.02 | Pigeon Lake | |
| | 0.13 | South Saskatchewan River | |
| | 0.08 | Winefred Lake | |

## Table 11 Mean THg Levels in Fish Muscles Reported in the Literature

| Species | Mean (μg/g, ww) | Location | Reference |
|---|---|---|---|
| Walleye | 0.5 | Northwest Ontario lakes (used as a reference for Wabigoon system) | Neff et al. 2012 |
| | 0.15 – 0.45 | Lake Ontario (seasonal differences) | Zhang et al. 2012 |
| | 0.078 – 2.3 dry weight | Boreal lakes within 107 km of Sudbury | Yang et al. 2010 |
| | 0.15 to 0.6 | Great Lakes with Lake Erie lowest to Lake Superior highest | Bhavsar et al. 2010 |
| | 0.05 – 0.99 | 18 Lakes, Northern Glaciated Plains, US | Selch et al. 2007 |
| | 0.19 – 0.30 | Reservoirs, Manitoba, Canada | Bodaly et al. 2007 |
| | 0.42 – 2.98 | Wabigoon River system, Ontario | Kinghorn et al. 2007 |
| | 0.98 – 1.00 | 19 undisturbed lakes, Haute Mauricie, Quebec, Canada | Garcia and Carignan, 2005 |
| | 1.29 – 3.73 | 18 disturbed lakes, Haute Mauricie, Quebec, Canada | Garcia and Carignan, 2005 |
| | 0.759 | Water bodies in northeastern of US and Canada (N=19,178) | Kamman et al. 2005 |
| | 0.58 | Great Lakes, US | Gerstenberger and Dellinger, 2002 |
| | 0.47 | Lakes in Northern Canada | Lockhart et al. 2005 |
| | 0.05 – 1.34 | Canadian Arctic, Canada | Braune et al. 1999 |
| | 0.32 – 1.26 | 29 Lakes in the La Grande complex watershed, Quebec, Canada | Verdon et al. 1991 |
| | 0.19 – 1.43 | Mackenzie River Basin Lakes | Evans et al. 2005 a |
| Northern pike | 0.4 | Northwest Ontario lakes (used as a reference for Wabigoon system) | Neff et al. 2012 |
| | 0.2 – 0.35 | Lake Ontario (seasonal differences) | Zhang et al. 2012 |
| | 0.5 | Twin Valley Reservoir , southern Alberta: 2 year old | Brinkmann & Rasmussen 2010 |
| | 1.22 | Twin Valley Reservoir , southern Alberta: 5 - 6 year old | Brinkmann & Rasmussen 2010 |
| | 0.2 – 0.23 | Great Lakes, Lake Huron lowest to Lake Superior highest | Bhavsar et al. 2010 |
| | 0.26 – 0.32 | Reservoirs, Manitoba, Canada | Bodaly et al. 2007 |
| | 0.44 – 2.14 | Wabigoon River system, Ontario, Canada | Kinghorn et al. 2007 |
| | 1.00 – 2.55 | 19 undisturbed lakes, Haute Mauricie, Quebec, Canada | Garcia and Carignan, 2005 |
| | 1.90 – 6.44 | 18 disturbed lakes, Haute Mauricie, Quebec, Canada | Garcia and Carignan, 2005 |
| | 0.645 | lakes, rivers and reservoirs in northeastern of US and Canada (N=19,178) | Kamman et al. 2005 |
| | 0.16 – 1.1 | Mackenzie River Basin, Canada | Evans, et al. 2005a |
| | 0.12 – 0.74 | Mackenzie River Basin, Canada | Evans, et al. 2005b |
| | 0.378 | Lakes in Northern Canada | Lockhart et al. 2005 |
| | 0.623 – 1.51 | Yukon River, Kuskokwim River, US | Jewett et al. 2003 |
| | 0.11 – 0.63 | Canadian Arctic, Canada | Braune et al. 1999 |
| | 0.25 – 0.90 | 29 Lakes in the La Grande complex watershed, Quebec, Canada | Verdon et al. 1991 |

| | | | |
|---|---|---|---|
| Lake whitefish | <0.1 | Northwest Ontario lakes (used as a reference for Wabigoon system) | Neff et al. 2012 |
| | 0.06 – 0.07 | Reservoirs, Manitoba, Canada | Bodaly et al. 2007 |
| | 0.08 – 0.31 | Wabigoon River system, Ontario | Kinghorn et al. 2007 |
| | 0.54 – 1.18 | 19 undisturbed lakes, Haute Mauricie, Quebec, Canada | Garcia and Carignan, 2005 |
| | 0.51 – 1.18 | 18 disturbed lakes, Haute Mauricie, Quebec, Canada | Garcia and Carignan, 2005 |
| | 0.209 | Water bodies in northeastern of US and Canada (N=19,178) | Kamman et al. 2005 |
| | 0.01 | Great Lakes, US | Gerstenberger and Dellinger, 2002 |
| | 0.04 – 0.35 | Mackenzie River Basin, Canada | Evans, et al. 2005 |
| | 0.11 – 0.13 | Lakes in Northern Canada | Lockhart et al. 2005 |
| | 0.02 – 0.82 | Canadian Arctic, Canada | Braune et al. 1999 |
| | 0.07 – 0.30 | 29 Lakes in the La Grande complex watershed, Quebec, Canada | Verdon et al. 1991 |

## 3.2 Local Fish Consumption Rates

Three surveys of fish consumption patterns were conducted in communities of Central Alberta between 1997 and 2000. The first survey was conducted by Alberta Health and Wellness in Swan Hills communities in 1997 (AHW 1997). The second survey was conducted by the First Nations and Inuit Health Branch (FNIHB) of Health Canada for the First Nations people living in the Lesser Slave Lake area in 1999 (Health Canada 1999). The third survey was conducted by the Environmental Health Sciences Program at the University of Alberta for the residents living in the communities near the Athabasca River and tributaries at Hinton (EHSUA 2000).

**Table 12 Local Fish Consumption Rates in Communities of Central Alberta**

| **Intake** | **Subsistence Consumer** Lesser Slave Lake* | | **Local Fish Consumer** Swan Hills | | **Local Fish Consumer** Athabasca River | |
|---|---|---|---|---|---|---|
| **Group** | mean (g/d) | %** (n=125) | mean (g/d) | % (n=127) | mean (g/d) | % (n=45) |
| High (>100g/d) | 273 | 5 | 167 | 2 | 121 | 2 |
| Medium (30-99 g/d) | 46 | 14 | 47 | 13 | 51 | 6 |
| Low (5-29 g/d) | 13 | 38 | 13 | 28 | 15 | 26 |
| Very Low (< 4g/d) | 1.6 | 43 | 2 | 57 | 1.0 | 66 |

* mean from Phase I and Phase II studies (Health Canada 1999). ** % of surveyed population

Fish consumption rates in different intake groups from these surveys are summarized in Table 12. A small proportion of local anglers and First Nations people consumed local fish over 100 g/d. Five per cent of the First Nations people in the Lesser Slave Lake communities were high consumers who ate local fish at an average of 273 g/d, much higher than the 2% of those in Swan Hills communities who were high consumers at an average of 167 g/d and those in the communities nearby Hinton who were high consumers at an average rate of 121 g/d. The local fish consumption rates in the survey of the Lesser Slave Lake were similar with the results of the Swan Hills survey in medium, low and very low intake groups. The majority of local fish consumers (85%-92%) consumed fish at a low rate of 1.0 - 15 g/d. The majority of the First Nations group (81%) consumed fish at a low rate of 1.6 – 13 g/d.

The most common fish species consumed by the surveyed populations were rainbow trout, northern pike, walleye, lake whitefish, and lake trout by the First Nations people in the Lesser Slave Lake communities, walleye, northern pike, perch, brook trout, Lake whitefish and arctic grayling by the residents in Swan Hills communities, and rainbow trout, arctic grayling, mountain whitefish, Northern pike and walleye by the residents in the communities nearby Hinton.

The results from the above surveys were derived from adults only. Fish consumption rates could vary in different subpopulations (USEPA 2000). Children may consume larger quantities compared to their body weight than adults. Prenatal exposure may occur through pregnant women. For the purpose of risk management, these subpopulations are considered as potential high risk groups for exposure to mercury from fish consumption.

## 3.3 Estimated Exposures

Exposure ratios were estimated for consuming walleye and northern pike. Estimated exposure ratios based on the estimated fish consumption divided by the pTDIs from Health Canada are summarized in Table 13 for women of reproductive age and Table 14 for adults. Specific fish consumption rates were not available for women of reproductive age and young children. As a result, the estimation of exposures for young children was not performed. The fish consumption rate for all adults was used for estimating exposures for women of reproductive age.

In general, the estimated exposure ratios were greater than one for the high intake group, especially for a subpopulation of women of reproductive age if consuming predatory fish like the larger walleye and Northern pike. The values of pTDIs were derived from risk assessment approaches with many assumptions and uncertainties. The risk assessment is specifically designed to avoid underestimating risk. The results do not mean that specific individuals or populations face inevitable or even likely health consequences from mercury exposure. An estimated exposure ratio greater than one should be used as a reference point for making risk management decisions. In particular, those exposure scenarios with an exposure ratio greater than one warrant closer attention including providing information about maximum recommended fish consumption to allow consumers to make safe eating choices.

Many factors influence the estimated exposure levels such as body weight and consumption rates. The body weight of 73 kg used in this assessment was derived from the 1994 National Population Health survey in Alberta adults. In this report, the age-specific body weights for women at reproductive age and young children in Alberta were not available. The average body weights used by Health Canada were 65 kg for women of reproductive age, 26.4 kg for five -11 year old group, and 14.4 kg for one - four year old group. The consumption rates used in this report were based on the three surveys of adults living in Central Alberta. The estimated exposure was solely based on fish from local specific sources. People may also be exposed to mercury from market fish and other market food items.

## Table 13 Estimated Exposure Ratios for Women of Reproductive Age[a]

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Amisk Lake* | | | |
| Northern pike | 7.1 | 2.1 | 11 |
| Walleye | 12 | 3.4 | 19 |
| *Baptiste Lake (2011/2012)*[b] | | | |
| Northern pike | 1.9 | < 1 | 3.0 |
| Walleye | 1.4 | < 1 | 2.3 |
| *Baptiste Lake (2012/2013)*[b] | | | |
| Lake whitefish | 2.4 | < 1 | 3.9 |
| Northern pike | 4.6 | 1.3 | 7.3 |
| Walleye | 6.8 | 2.0 | 10.7 |
| *Beaver Lake* | | | |
| Lake whitefish | 1.3 | < 1 | 2.1 |
| Northern pike | 5.9 | 1.7 | 9.4 |
| Walleye | 4.6 | 1.4 | 7.3 |
| *Bitscho Lake* | | | |
| Northern pike | 1.0 | < 1 | 1.7 |
| Walleye | 1.6 | < 1 | 2.5 |
| *Bourque Lake* | | | |
| Lake whitefish | < 1 | < 1 | 1.5 |
| Northern pike | 3.9 | 1.1 | 6.2 |
| Walleye | 4.7 | 1.4 | 7.5 |
| *Calling Lake* | | | |
| Northern pike | 2.2 | < 1 | 3.4 |
| Walleye | 2.0 | < 1 | 3.2 |
| *Chinchaga River* | | | |
| Walleye | 5.8 | 1.7 | 9.1 |
| *Chrystina Lake* | | | |
| Brook trout | 2.6 | < 1 | 4.2 |
| *Cowoki Reservoir* | | | |
| Northern pike | 7.7 | 2.3 | 12 |
| Walleye | 6.1 | 1.8 | 9.8 |
| *Crawling Valley Reservoir* | | | |
| Northern pike | 5.0 | 1.5 | 7.9 |
| Walleye | 7.1 | 2.1 | 11 |
| *Cross (Steele)Lake* | | | |
| Northern pike | 2.8 | < 1 | 4.4 |
| *Dore Lake*[c] | | | |
| Northern pike | 2.2 | < 1 | 3.5 |
| Walleye | 2.9 | < 1 | 4.6 |
| *Eagle Lake* | | | |
| Northern pike | < 1 | < 1 | 1.4 |
| Walleye | 2.7 | < 1 | 4.3 |
| *Edith Lake* | | | |
| Brook trout | 2.2 | < 1 | 3.5 |
| *Elinor Lake* | | | |
| Lake whitefish | 1.4 | < 1 | 2.3 |
| Northern pike | 9.2 | 2.7 | 14.5 |
| Walleye | 9.6 | 2.8 | 15.2 |

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Ethel Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 5.4 | 1.6 | 8.6 |
| Walleye | 5.9 | 1.7 | 9.4 |
| *Goodfish Lake* | | | |
| Northern pike | 6.0 | 1.8 | 9.5 |
| Walleye | 3.7 | 1.1 | 5.8 |
| *Gregoire Lake* | | | |
| Lake whitefish | < 1 | < 1 | 1.0 |
| Walleye | 2.4 | < 1 | 3.8 |
| *Hay River* | | | |
| Walleye | 8.0 | 2.3 | 23 |
| *Heart Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 2.1 | < 1 | 3.3 |
| Walleye | 1.5 | < 1 | 2.3 |
| *Hilda Lake* | | | |
| Northern pike | 6.5 | 1.9 | 10.4 |
| Walleye | 8.8 | 2.6 | 13.9 |
| *Hutch Lake* | | | |
| Walleye | 1.5 | < 1 | 2.3 |
| *Isle Lake (2009/2010)*[b] | | | |
| Northern pike | 1.6 | < 1 | 2.5 |
| Walleye | 2.6 | < 1 | 4.2 |
| *Isle Lake (2010/2011)*[b] | | | |
| Northern pike | 5.0 | 1.5 | 7.9 |
| Lake whitefish | < 1 | < 1 | 1.0 |
| *Kehewin Lake* | | | |
| Northern pike | 5.1 | 1.5 | 8.1 |
| Walleye | 3.8 | 1.1 | 6.0 |
| *Keho Lake* | | | |
| Lake whitefish | 1.4 | < 1 | 2.2 |
| Northern pike | 1.8 | < 1 | 2.9 |
| Walleye | 2.9 | < 1 | 4.6 |
| *Kinnaird Lake* | | | |
| Northern pike | 5.6 | 1.7 | 8.9 |
| Walleye | 8.8 | 2.6 | 14 |
| *Kirby Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 1.6 | < 1 | 2.6 |
| *Lac Bellevue* | | | |
| Walleye | 4.6 | 1.4 | 7.3 |
| *Lac la Nonne* | | | |
| Lake whitefish | < 1 | < 1 | 1.5 |
| Northern pike | 4.1 | 1.2 | 6.5 |
| Walleye | 7.2 | 2.1 | 11.4 |
| Yellow Perch | < 1 | < 1 | 1.6 |
| *Lac Ste Anne* | | | |
| Walleye | 1.8 | < 1 | 2.9 |

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Lake Athabasca* | | | |
| Lake trout | 3.5 | < 1 | 5.6 |
| Lake whitefish | 1.4 | < 1 | 2.3 |
| Northern pike | 2.7 | < 1 | 4.4 |
| Walleye | 3.4 | < 1 | 5.4 |
| *Lake Isle (2012/2013)*[b] | | | |
| Northern Pike | < 1 | < 1 | 1.5 |
| *Laurier Lake* | | | |
| Northern pike | 6.1 | 1.8 | 9.8 |
| *Len Thompson* | | | |
| Rainbow Trout | 1.8 | < 1 | 2.9 |
| *Lesser Slave Lake East Basin* | | | |
| Northern pike | 5.2 | 1.5 | 8.3 |
| Walleye | 4.3 | 1.3 | 6.9 |
| *Lesser Slave Lake West Basin* | | | |
| Northern pike | 4.3 | 1.3 | 6.9 |
| Walleye | 4.6 | 1.4 | 7.3 |
| *Little Bow Reservoir* | | | |
| Northern pike | 6.1 | 1.7 | 9.8 |
| *Long Lake* | | | |
| Northern pike | 4.5 | 1.3 | 7.1 |
| Walleye | 5.6 | 1.7 | 8.9 |
| *Loon River* | | | |
| Walleye | 4.4 | 1.3 | 7.0 |
| *Marie Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 3.1 | < 1 | 5.0 |
| Walleye | 2.5 | < 1 | 4.0 |
| *McGregor Lake* | | | |
| Northern pike | 13 | 3.8 | 21 |
| Walleye | 8.1 | 2.4 | 13 |
| *McLeod Lake* | | | |
| Rainbow Trout | < 1 | < 1 | 1.0 |
| *McMillan Lake* | | | |
| Northern pike | 5.1 | 1.5 | 8.1 |
| *Meander River* | | | |
| Northern pike | 2.5 | 0.7 | 4.0 |
| Walleye | 2.2 | 0.7 | 3.5 |
| *Moonshine Lake* | | | |
| Rainbow Trout | < 1 | < 1 | 1.4 |
| *Moose Lake (2011/2012)*[b] | | | |
| Northern pike | 4.3 | 1.3 | 6.8 |
| Walleye | 6.4 | 1.9 | 10.2 |
| *Moose Lake (2012/2013)*[b] | | | |
| Cisco | < 1 | < 1 | < 1 |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 1.4 | < 1 | 2.2 |
| Walleye | 2.4 | < 1 | 3.8 |
| Yellow Perch | < 1 | < 1 | < 1 |
| *Nipisi Lake* | | | |
| Northern pike | 1.4 | < 1 | 2.3 |

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *North Wabasca Lake* | | | |
| Northern pike | 4.1 | 1.2 | 6.4 |
| Walleye | 3.5 | 1.0 | 5.6 |
| *Peerless Lake* | | | |
| Lake trout | 1.9 | < 1 | 3.0 |
| *Pigeon Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Walleye | 1.9 | < 1 | 3.0 |
| *Pine Lake* | | | |
| Northern pike | 2.9 | < 1 | 4.6 |
| Walleye | 3.6 | 1.1 | 5.7 |
| *Pinehurst Lake* | | | |
| Northern pike | 11 | 3.1 | 17 |
| Walleye | 7.9 | 2.3 | 13 |
| *Pitchimi Lake* | | | |
| Lake trout | 9.8 | 2.9 | 16 |
| *Richardson Lake* | | | |
| Northern pike[c] | 3.7 | 1.1 | 5.9 |
| Walleye[c] | 3.0 | < 1 | 4.8 |
| Lake whitefish | 1.0 | < 1 | 1.5 |
| *Rock Island Lake* | | | |
| Northern Pike | 1.0 | < 1 | 1.6 |
| Walleye | 1.5 | < 1 | 2.3 |
| *Rolling Hills Reservoir* | | | |
| Northern pike | 14 | 4.0 | 22 |
| Walleye | 15 | 4.3 | 24 |
| *Skeleton Lake* | | | |
| Northern pike | 1.6 | 1.0 | 2.5 |
| Walleye | 2.1 | 1.0 | 3.3 |
| *Snipe Lake* | | | |
| Northern pike | 0.7 | < 1 | 1.0 |
| Walleye | 0.5 | < 1 | 1.0 |
| *Sturgeon Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 1.9 | < 1 | 3.1 |
| Walleye | 2.3 | < 1 | 3.8 |
| *Sylvan Lake* | | | |
| Lake whitefish | 1.5 | < 1 | 2.4 |
| Walleye | 2.7 | < 1 | 4.4 |
| *Touchwood Lake* | | | |
| Lake whitefish | 1.4 | < 1 | 2.3 |
| Northern pike | 11 | 3.3 | 189 |
| Walleye | 12 | 3.6 | 20 |
| *Wabamun Lake* | | | |
| Lake whitefish | 0.46 | 0.13 | 0.73 |
| Northern pike | 4.98 | 1.47 | 7.91 |
| *Whitefish Lake(2009/2010)*[b] | | | |
| Lake whitefish | 9.4 | 2.8 | 150 |
| Northern pike | 8.4 | 2.5 | 13 |
| Walleye | 11 | 3.3 | 18 |

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Whitefish Lake(2012/2013)*[b] | | | |
| Lake whitefish | 1.6 | < 1 | 2.6 |
| Northern pike | 8.6 | 2.5 | 13.7 |
| Walleye | 10.1 | 3.0 | 16.1 |
| *Winigami Lake* | | | |
| Northern pike | 1.6 | 1.0 | 2.5 |
| Walleye | 2.5 | 1.0 | 4.0 |
| *Wizard Lake* | | | |
| Northern pike | 2.6 | < 1 | 4.1 |
| *Wolf Lake* | | | |
| Lake whitefish | 1.4 | < 1 | 2.1 |
| Northern pike | 4.4 | 1.3 | 7.0 |
| Walleye | 7.7 | 2.3 | 12.3 |

Note: mean of total mercury listed in Tables 6, 7, 8, and 9; body weight = 65 kg; pTDI = 0.2 μg/kg bw/d for women
[a] Exposure ratios are rounded to 2 significant figures in keeping with the precision of the data they are based upon [b] Sampling year for lake if lake was sampled in different years [c] calculations based on data from Environment Canada

## Table 14 Estimated Exposure Ratios for Adults

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Amisk Lake* | | | |
| Northern pike | 2.7 | 1.0 | 4.3 |
| Walleye | 4.4 | 1.3 | 7.0 |
| *Baptiste Lake (2011/2012)*[a] | | | |
| Northern pike | < 1 | < 1 | 1.1 |
| Walleye | < 1 | < 1 | < 1 |
| *Baptiste Lake (2012/2013)*[a] | | | |
| Lake whitefish | < 1 | < 1 | 1.5 |
| Northern pike | 1.7 | < 1 | 2.7 |
| Walleye | 2.6 | < 1 | 4.1 |
| *Beaver Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 2.2 | < 1 | 3.6 |
| Walleye | 1.8 | < 1 | 2.8 |
| *Bitscho Lake* | | | |
| Northern pike | <1 | <1 | 0.6 |
| Walleye | 1.0 | <1 | 0.9 |
| *Bourque Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 1.5 | < 1 | 2.3 |
| Walleye | 1.8 | < 1 | 2.8 |
| *Calling Lake* | | | |
| Northern pike | < 1 | < 1 | 1.3 |
| Walleye | < 1 | < 1 | 1.2 |
| *Chinchaga River* | | | |
| Walleye | 2.2 | 1.0 | 3.5 |
| *Chrystina Lake* | | | |
| Brook trout | 1.0 | <1 | 1.6 |
| *Cowoki Reservoir* | | | |
| Northern pike | 2.9 | <1 | 4.6 |
| Walleye | 2.3 | <1 | 3.7 |
| *Crawling Valley Reservoir* | | | |
| Northern pike | 1.6 | <1 | 3.0 |
| Walleye | 2.6 | <1 | 4.2 |
| *Cross (Steele)Lake* | | | |
| Northern pike | 1.0 | < 1 | 1.7 |
| *Dore Lake*[b] | | | |
| Northern pike | < 1 | < 1 | 1.3 |
| Walleye | 1.1 | < 1 | 1.7 |
| *Eagle Lake* | | | |
| Northern pike | < 1 | < 1 | < 1 |
| Walleye | 1.0 | < 1 | 1.6 |
| *Edith Lake* | | | |
| Brook trout | <1 | <1 | 1.4 |
| *Elinor Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 3.5 | 1.0 | 5.5 |
| Walleye | 3.6 | 1.1 | 5.7 |

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Ethel Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 2.1 | < 1 | 3.3 |
| Walleye | 2.2 | < 1 | 3.6 |
| *Goodfish Lake* | | | |
| Northern pike | 2.3 | < 1 | 3.6 |
| Walleye | 1.4 | < 1 | 2.2 |
| *Gregoire Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Walleye | < 1 | < 1 | 1.5 |
| *Hay River* | | | |
| Walleye | 3.0 | <1 | 4.8 |
| *Heart Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | < 1 | < 1 | 1.2 |
| Walleye | < 1 | < 1 | < 1 |
| *Hilda Lake* | | | |
| Northern pike | 2.5 | < 1 | 3.9 |
| Walleye | 3.3 | < 1 | 5.3 |
| *Hutch Lake* | | | |
| Walleye | < 1 | < 1 | < 1 |
| *Isle Lake (2009/2010)*[a] | | | |
| Northern pike | < 1 | < 1 | < 1 |
| Walleye | 1.0 | < 1 | 1.6 |
| *Isle Lake (2010/2011)*[a] | | | |
| Northern pike | 1.9 | 1.0 | 3.0 |
| Lake whitefish | < 1 | <1 | <1 |
| *Kehewin Lake* | | | |
| Northern pike | 1.9 | <1 | 3.1 |
| Walleye | 1.4 | <1 | 2.3 |
| *Keho Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | < 1 | < 1 | 1.1 |
| Walleye | 1.1 | < 1 | 1.7 |
| *Kinnaird Lake* | | | |
| Northern pike | 2.1 | 1.0 | 3.4 |
| Walleye | 3.3 | 1.0 | 5.3 |
| *Kirby Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | < 1 | < 1 | < 1 |
| *Lac Bellevue* | | | |
| Walleye | 1.7 | 1.0 | 2.8 |
| *Lac la Nonne* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 1.5 | < 1 | 2.5 |
| Walleye | 2.7 | < 1 | 4.3 |
| Yellow Perch | < 1 | < 1 | < 1 |
| *Lac Ste Anne* | | | |
| Walleye | < 1 | < 1 | 1.1 |

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Lake Athabasca* | | | |
| Lake trout | 1.3 | < 1 | 2.1 |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 1.0 | < 1 | 1.7 |
| Walleye | 1.3 | < 1 | 2.0 |
| *Lake Isle (2012/2013)*[a] | | | |
| Northern Pike | < 1 | < 1 | < 1 |
| *Laurier Lake* | | | |
| Northern pike | 2.3 | 1.0 | 3.7 |
| *Len Thompson* | | | |
| Rainbow Trout | 1.0 | < 1 | 1.1 |
| *Lesser Slave Lake East Basin* | | | |
| Northern pike | 2.0 | 1.0 | 3.2 |
| Walleye | 1.6 | 1.0 | 2.6 |
| *Lesser Slave Lake West Basin* | | | |
| Northern pike | 1.6 | 1.0 | 2.6 |
| Walleye | 1.7 | 1.0 | 2.8 |
| *Little Bow Reservoir* | | | |
| Northern pike | 2.3 | < 1 | 3.7 |
| *Long Lake* | | | |
| Northern pike | 1.7 | 1.0 | 2.7 |
| Walleye | 2.1 | 1.0 | 3.4 |
| *Loon River* | | | |
| Walleye | 1.7 | < 1 | 2.6 |
| *Marie Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 1.2 | < 1 | 1.9 |
| Walleye | < 1 | < 1 | 1.5 |
| *McGregor Lake* | | | |
| Northern pike | 5.0 | 1.5 | 7.9 |
| Walleye | 3.1 | < 1 | 4.9 |
| *McLeod Lake* | | | |
| Rainbow Trout | < 1 | < 1 | < 1 |
| *McMillan Lake* | | | |
| Northern pike | 1.9 | < 1 | 3.1 |
| *Meander River* | | | |
| Northern pike | 1.0 | <1 | 1.5 |
| Walleye | 1.0 | <1 | 1.3 |
| *Moonshine Lake* | | | |
| Rainbow Trout | < 1 | < 1 | < 1 |
| *Moose Lake (2011/2012)*[a] | | | |
| Northern pike | 1.6 | < 1 | 2.6 |
| Walleye | 2.4 | < 1 | 3.9 |
| *Moose Lake (2012/2013)*[a] | | | |
| Cisco | < 1 | < 1 | < 1 |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | < 1 | < 1 | < 1 |
| Walleye | < 1 | < 1 | 1.4 |
| Yellow Perch | < 1 | < 1 | < 1 |

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Nipisi Lake* | | | |
| Northern pike | < 1 | < 1 | < 1 |
| *North Wabasca Lake* | | | |
| Lake Whitefish | 3.6 | 1.0 | 5.7 |
| Northern pike | 1.5 | 1.0 | 2.4 |
| Walleye | 1.3 | < 1 | 2.1 |
| *Peerless Lake* | | | |
| Lake trout | < 1 | < 1 | 1.1 |
| *Pigeon Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Walleye | < 1 | < 1 | 1.1 |
| *Pine Lake* | | | |
| Northern pike | 1.1 | < 1 | 1.8 |
| Walleye | 1.4 | < 1 | 2.2 |
| *Pinehurst Lake* | | | |
| Northern pike | 4.0 | 1.2 | 6.4 |
| Walleye | 3.0 | 1.0 | 4.7 |
| *Pitchimi Lake* | | | |
| Lake trout | 3.7 | 1.1 | 5.9 |
| *Richardson Lake* | | | |
| Northern pike[b] | 1.4 | < 1 | 2.2 |
| Walleye[b] | 1.1 | < 1 | 1.8 |
| Lake whitefish | < 1 | < 1 | 1.0 |
| *Rock Island Lake* | | | |
| Northern pike | 1.0 | < 1 | 1.6 |
| Walleye | 1.5 | < 1 | 2.3 |
| *Rolling Hills Reservoir* | | | |
| Northern pike | 5.2 | 1.5 | 8.2 |
| Walleye | 5.6 | 1.6 | 8.9 |
| *Skeleton Lake* | | | |
| Northern pike | 1.0 | < 1 | 1.0 |
| Walleye | 1.0 | < 1 | 1.3 |
| *Snipe Lake* | | | |
| Northern pike | < 1 | < 1 | < 1 |
| Walleye | < 1 | < 1 | < 1 |
| *Sturgeon Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | < 1 | < 1 | 1.2 |
| Walleye | < 1 | < 1 | 1.4 |
| *Sylvan Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Walleye | 1.0 | < 1 | 1.7 |
| *Touchwood Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 4.3 | 1.2 | 6.8 |
| Walleye | 4.7 | 1.3 | 7.4 |
| *Wabamun Lake* | | | |
| Lake whitefish | 0.17 | <1 | 0.28 |
| Northern pike | 1.89 | 1.0 | 3.0 |

| Lake and Species | Local Consumer High Intake (170 g/d) | Local Consumer Medium Intake (50 g/d) | Subsistence Consumer High Intake (270 g/d ) |
|---|---|---|---|
| *Whitefish Lake (2009/2010)*[a] | | | |
| Lake whitefish | 3.6 | 1.0 | 5.7 |
| Northern pike | 3.2 | < 1 | 5.0 |
| Walleye | 4.3 | 1.3 | 6.8 |
| *Whitefish Lake(2012/2013)*[a] | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 3.3 | < 1 | 5.2 |
| Walleye | 3.8 | 1.1 | 6.1 |
| *Winigami Lake* | | | |
| Northern pike | 1.0 | < 1 | 1.0 |
| Walleye | 1.0 | < 1 | 1.5 |
| *Wizard Lake* | | | |
| Northern pike | < 1 | < 1 | 1.5 |
| *Wolf Lake* | | | |
| Lake whitefish | < 1 | < 1 | < 1 |
| Northern pike | 1.7 | < 1 | 2.7 |
| Walleye | 2.9 | < 1 | 4.7 |

Note: mean of total mercury listed in Tables 6, 7, 8 and 9; body weight = 73 kg; pTDI = 0.47 μg/kg bw/d for adults.
[a] Sampling year for lake if lake was sampled in different years [b] calculations based on data from Environment Canada

## 3.4 Consumption Limits

For the purpose of quantitative fish advisories, the lifetime consumption limits were calculated for subgroups of women, young children and adults if total mercury levels in fish exceeded 0.2 μg/g (Table 15).

These consumption limits were specific to fish species and site. The values provide the information on the maximum amount of local fish that can be safely consumed on a weekly basis for a lifetime by the identified subpopulations for fish specified from the specified locations. Fish preparation and cooking methods do not reduce the concentrations of total mercury in fish (Morgan et al. 1997).

## Table 15 Lifetime Fish Consumption Limits[a]

| Lake and Species | THg μg/g | Women g/week | Children (5-11 yr) g/week | Children (1-4 yr) g/week | Adults g/week |
|---|---|---|---|---|---|
| *Amisk Lake* | | | | | |
| Northern pike | 0.54 | 170 | 68 | 37 | 440 |
| Walleye | 0.89 | 100 | 42 | 23 | 270 |
| *Baptiste Lake* | | | | | |
| Northern pike | 0.38 | 240 | 97 | 53 | 633 |
| Walleye | 0.52 | 176 | 72 | 39 | 465 |
| *Beaver Lake* | | | | | |
| Northern pike | 0.45 | 201 | 82 | 44 | 530 |
| Walleye | 0.35 | 258 | 105 | 57 | 680 |
| *Bourque Lake* | | | | | |
| Northern pike | 0.30 | 305 | 124 | 67 | 804 |
| Walleye | 0.36 | 253 | 103 | 56 | 667 |
| *Chinchaga River* | | | | | |
| Walleye | 0.44 | 210 | 84 | 46 | 550 |
| *Cowoki Reservoir* | | | | | |
| Northern pike | 0.59 | 150 | 63 | 34 | 410 |
| Walleye | 0.47 | 190 | 79 | 41 | 490 |
| *Crawling Valley Reservoir* | | | | | |
| Northern pike | 0.38 | 240 | 97 | 53 | 630 |
| Walleye | 0.54 | 170 | 68 | 37 | 440 |
| *Cross (Steele)Lake* | | | | | |
| Northern pike | 0.21 | 430 | 174 | 95 | 1134 |
| *Dore Lake*[b] | | | | | |
| Northern pike | 0.34 | 268 | 109 | 59 | 707 |
| Walleye | 0.57 | 159 | 65 | 35 | 420 |
| *Eagle Lake* | | | | | |
| Walleye | 0.21 | 438 | 178 | 97 | 1157 |
| *Elinor Lake* | | | | | |
| Northern pike | 0.70 | 130 | 53 | 29 | 343 |
| Walleye | 0.73 | 125 | 51 | 28 | 329 |
| *Ethel Lake* | | | | | |
| Northern pike | 0.42 | 219 | 89 | 48 | 578 |
| Walleye | 0.45 | 201 | 82 | 44 | 531 |
| *Goodfish Lake* | | | | | |
| Northern pike | 0.46 | 198 | 81 | 44 | 524 |
| Walleye | 0.28 | 324 | 131 | 72 | 854 |
| *Hay River* | | | | | |
| Walleye | 0.61 | 150 | 61 | 33 | 400 |
| *Hilda Lake* | | | | | |
| Northern pike | 0.50 | 182 | 74 | 40 | 481 |
| Walleye | 0.67 | 136 | 55 | 30 | 358 |
| *Isle Lake* | | | | | |
| Northern pike | 0.38 | 240 | 97 | 53 | 630 |
| *Kehewin Lake* | | | | | |
| Northern pike | 0.39 | 230 | 95 | 52 | 620 |
| Walleye | 0.29 | 310 | 130 | 70 | 830 |
| *Keho Lake* | | | | | |
| Walleye | 0.22 | 410 | 166 | 91 | 1081 |

| Lake and Species | THg µg/g | Women g/week | Children (5-11 yr) g/week | Children (1-4 yr) g/week | Adults g/week |
|---|---|---|---|---|---|
| *Kinnaird Lake* | | | | | |
| Northern pike | 0.44 | 210 | 84 | 46 | 550 |
| Walleye | 0.67 | 140 | 55 | 30 | 360 |
| *Lac Bellevue* | | | | | |
| Walleye | 0.35 | 260 | 106 | 58 | 690 |
| *Lac la Nonne* | | | | | |
| Northern pike | 0.31 | 292 | 118 | 65 | 770 |
| Walleye | 0.55 | 166 | 67 | 37 | 437 |
| *Lake Athabasca* | | | | | |
| Lake trout | 0.27 | 340 | 140 | 75 | 890 |
| Northern pike | 0.21 | 430 | 180 | 96 | 1,100 |
| Walleye | 0.26 | 350 | 140 | 78 | 920 |
| *Laurier Lake* | | | | | |
| Walleye | 0.47 | 190 | 79 | 43 | 510 |
| *Lesser Slave Lake East Basin* | | | | | |
| Northern pike | 0.33 | 280 | 110 | 61 | 730 |
| Walleye | 0.35 | 260 | 110 | 58 | 690 |
| *Lesser Slave Lake West Basin* | | | | | |
| Northern pike | 0.40 | 230 | 92 | 50 | 600 |
| Walleye | 0.33 | 280 | 110 | 61 | 730 |
| *Little Bow Reservoir* | | | | | |
| Northern pike | 0.47 | 190 | 79 | 43 | 510 |
| *Long Lake* | | | | | |
| Northern pike | 0.34 | 270 | 110 | 59 | 710 |
| Walleye | 0.43 | 210 | 86 | 47 | 560 |
| *Loon River* | | | | | |
| Walleye | 0.34 | 271 | 110 | 60 | 715 |
| *Marie Lake* | | | | | |
| Northern pike | 0.24 | 378 | 153 | 84 | 998 |
| *McGregor Lake* | | | | | |
| Northern pike | 1.00 | 91 | 37 | 20 | 240 |
| Walleye | 0.62 | 150 | 60 | 33 | 390 |
| *McMillan Lake* | | | | | |
| Northern pike | 0.39 | 233 | 95 | 52 | 616 |
| *Moose Lake* | | | | | |
| Northern pike | 0.38 | 243 | 99 | 54 | 640 |
| Walleye | 0.49 | 185 | 75 | 41 | 489 |
| *North Wabasca Lake* | | | | | |
| Northern pike | 0.31 | 290 | 120 | 65 | 770 |
| Walleye | 0.27 | 340 | 140 | 75 | 890 |
| *Pine Lake* | | | | | |
| Northern pike | 0.22 | 408 | 166 | 90 | 1077 |
| Walleye | 0.27 | 333 | 135 | 74 | 878 |
| *Pinehurst Lake* | | | | | |
| Northern pike | 0.81 | 110 | 46 | 25 | 300 |
| Walleye | 0.60 | 150 | 62 | 34 | 400 |
| *Pitchimi Lake* | | | | | |
| Lake trout | 0.75 | 120 | 49 | 27 | 320 |
| *Richardson Lake*[b] | | | | | |
| Northern pike | 0.28 | 320 | 130 | 71 | 843 |
| Walleye | 0.23 | 393 | 160 | 87 | 1038 |
| Walleye | 1.1 | 81 | 33 | 18 | 210 |

| Lake and Species | THg μg/g | Women g/week | Children (5-11 yr) g/week | Children (1-4 yr) g/week | Adults g/week |
|---|---|---|---|---|---|
| *Rolling Hills Reservoir* | | | | | |
| Northern pike | 1.0 | 88 | 36 | 19 | 230 |
| Walleye | 1.1 | 81 | 33 | 18 | 210 |
| *Sylvan Lake* | | | | | |
| Walleye | 0.21 | 433 | 176 | 96 | 1142 |
| *Touchwood Lake* | | | | | |
| Northern pike | 0.86 | 106 | 43 | 23 | 280 |
| Walleye | 0.94 | 97 | 39 | 21 | 260 |
| *Wabamun Lake* | | | | | |
| Northern pike | 0.38 | 239 | 97 | 53 | 632 |
| *Whitefish Lake* | | | | | |
| Lake whitefish | 0.72 | 130 | 51 | 38 | 330 |
| Northern pike | 0.66 | 138 | 56 | 31 | 364 |
| Walleye | 0.87 | 100 | 42 | 23 | 280 |
| *Wizard Lake* | | | | | |
| Northern pike | 0.20 | 462 | 188 | 102 | 1220 |
| *Wolf Lake* | | | | | |
| Northern pike | 0.34 | 269 | 109 | 59 | 709 |
| Walleye | 0.59 | 154 | 62 | 34 | 405 |

Note: body weight = 73 kg for adults, 65 kg for women, 26.4 for children 5 – 11 yr, and 14.4 kg for children 1 – 4 yr; pTDI = 0.2 μg/kg bw/d for women at reproductive age and young children, and 0.47 μg/kg bw/d for adults.
[a] Consumption limits are rounded to 2 significant figures in keeping with the precision of the data they are based upon. Numbers were rounded down to 0 in keeping with the precautionary basis for these limits
[b] calculations based on data from Environment Canada

## 3.5 Fish Consumption Advisories

Fish consumers may be exposed to MeHg by consuming locally-caught fish. MeHg is rapidly absorbed after ingestion and distributed throughout the body (WHO 1990). MeHg in the body is relatively stable and can cross the placental and blood/brain barriers (Kerper et al. 1992). The half-life of MeHg in the human body varies from 44 to 80 days (USEPA 2000). MeHg leaves the human body via urine, feces and breast milk. Small amounts of ingested MeHg are eliminated from the body with no overall adverse effects. At high exposure levels, MeHg produces a variety of health effects. Larger amounts of MeHg may damage the nervous system. Neurotoxicity may occur in the developing embryo or fetus during pregnancy and in young children. As a result, it is prudent to reduce MeHg exposure for women of reproductive age and young children. The pTDIs proposed by Health Canada are intended to protect susceptible populations.

Because mercury occurs naturally, mercury is found in all commercial or non-commercial fish and other foods at low levels. People are exposed to very low levels of mercury via sources such as breathing the air, mercury amalgam dental fillings and eating other foods. Alberta Health and Wellness conducted a survey of mercury levels in blood, urine and hair in adults and children living in the Wabamun Lake and surrounding area communities in 2006 (AHW 2006). The survey found that the

average levels of total mercury in blood, urine and hair in Alberta participants were lower than people living in other areas and countries.

MeHg levels are high enough in some fish species in some rivers and lakes that limitation of fish consumption is warranted. Although fish consumers may be exposed to relatively higher levels of MeHg if they eat large amounts of local mercury-containing fish, the results from three surveys from Northern Alberta indicated that local fish consumption is not the primary source of dietary mercury intake for most surveyed populations.

In order to protect all human consumers, issuing a fish consumption advisory is one risk management option. Fish consumption advisories are designed to reduce potential health risks of consumption for local fish consumers. Advisories should provide the necessary information to the public, so that local fish consumers can voluntarily restrict their fish consumption to a level judged to be safe. Fish consumption advisories elicit voluntary actions unlike mandatory measures such as catch and release regulations or outright fishing bans which restrict consumer actions.

Since the early 1990s, some fish consumption advisories related to mercury have been issued and published in the *Alberta Guide to Sportfishing Regulation* annually. In Alberta, the provincial government is responsible for issuing and reviewing fish consumption advisories for non-commercial fish. The Ministries of Alberta Environment and Sustainable Resource Development and Alberta Health established the process to issue food consumption advisories in 1997. The advisories can take the form of non-consumption or restricted-consumption advisories for adults and sensitive subpopulations.

### 3.6 Benefits of Fish Consumption

The benefits and risk of fish consumption is a recent focus of public health interest. Fish is an important source of nutrition for people, because it contains beneficial nutrients like the long-chain omega-3 fatty acids like eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), vitamin D, selenium and iodine. Fish is considered an excellent source of high quality protein. The benefits of fish consumption include the prevention of cardiovascular diseases, myocardial infarction (heart attack) and arrhythmia, especially reduction of risk for ischemic heart disease and stroke (Zhang et al. 1999; Chan and Egeland 2004; Bouzanc et al. 2005; Konig et al. 2005; Kris-Etherton et al. 2005; Stern 2005).

Health Canada reviewed the evidence showing an association between reduced risk of sudden cardiac death and fish consumption frequency at least once per week (Health Canada 2007). In one small case-control study (78 cases, 156 controls), researchers found that a reduced risk of myocardial infarction with fish consumption of at least one meal per week was evident while noting that the beneficial polyunsaturated fatty acid levels from fish in human plasma also positively correlated with higher mercury exposure (Hallgren et al. 2001).

In contrast, a larger continuing Finnish population-based cohort study (1857 and 1871 men, respectively) found that the higher mercury levels in human hair samples may attenuate the observed benefits of the omega-3 fatty acids for reducing cardiovascular disease risk (Virtanen et al. 2012, 2005). Mozaffarian et al. (2012) found in two prospective cohort studies (6045 men and women) in the U.S. that elevated mercury (measured in toenails) showed no adverse effects on risk of hypertension.

Fish consumption is important for neurodevelopment in infant and young children. DHA is an integral structural component of the brain and essential nutrient for pregnant women. DHA can be easily and rapidly absorbed into the developing fetal brain during gestation and in the early years of life of young children (Dovydaitis 2008). DHA was found to improve the visual-motor development in healthy term infants (Uauy et al. 2003; Oken et al. 2008). Some studies showed that fish consumption can increase a child's intelligence quotient (Helland et al. 2003; Cohen et al. 2005a; Dunstan et al. 2008). Meanwhile, the Cohen et al. (2005b) analysis indicated that excessive prenatal exposure to MeHg could decrease a child's intelligence quotient.

A cohort study found that maternal fish consumption was associated with subtle neurodevelopment deficits in children (Debes et al. 2006). In another study, researchers found that the benefits of modest fish consumption (1-2 servings per week) for women of reproductive age outweighed the potential risks from exposure to MeHg in fish (Mozaffarian and Rimm, 2006).

Although scientific evidence in the literature does not adequately demonstrate causation of all adverse health effects, evidence is generally accepted that there are nutritional benefits from fish consumption. However, consuming large quantities of fish containing high Hg levels should be avoided. (Cohen et al. 2005c; Mozaffarian and Rimm 2006; Domingo 2007; Mahaffey et al. 2008; Oken and Bellinger 2008).

From a nutritional perspective, regular fish consumption is beneficial to the general population. From a toxicological perspective, fish is associated with environmental contaminants like methylmercury, which pose a potential threat to humans. Fish consumers can be understandably confused by the conflicting message. People appeared to be influenced more strongly by the danger message (toxicological risk of mercury) as compared to beneficial (nutritional) message (Verbeke et al. 2008). Following the release of some national fish consumption advisories in the U.S. in 2001, some pregnant women reduced their fish consumption (Oken et al. 2003).

Schoeman et al.(2009) performed a systematic review of 48 published studies on mercury exposures in women of reproductive age looking for evidence of adverse neurodevelopmental effects and found, based on analyses (McDowell et al. 2004) of the U.S. National Health and Nutrition Examination Survey (NHANES) measures of mercury in hair, that there were no findings of adverse effects for geometric mean mercury in maternal hair levels for mothers consuming fish one or two times a month,

with only isolated reports of some adverse effects at geometric mean mercury in maternal hair levels for women consuming fish three or more times a month.

Communication to the public about the competition between benefits and risks is important to include in a fish consumption advisory. Fish consumption advisories should enable people to make informed decisions about what is a safe amount of fish consumption in order to address risks posed by environmental hazards, and to optimize the nutritional benefits of fish consumption with regard to preventable disease while improving neurodevelopment in infants and young children.

The establishment of guidelines for fish consumption is an important part of public health practice. The American Heart Association recommended fish consumption of at least two servings per week (125 g uncooked fish per serving) (Levenson and Axelrad 2006). For commercial fish, Health Canada's current advice is provided in Canada's Food Guide. For large predatory fish[4], adults can eat up to 150 g **per week**. Women who are or may become pregnant and breastfeeding mothers can eat up to 150 g **per month**. Young children between five and 11 years of age can eat up to 125 g **per month**. Very young children between one and four years of age should eat no more than 75 g per month of large predatory fish species. Choosing fish known to have lower levels of mercury is a sensible choice from pregnant and breastfeeding women.

Fish consumers can ingest both omega-3 fatty acids and MeHg. MeHg may attenuate the beneficial effects from the omega-3 fatty acids so the balance between the risks and benefits of consuming mercury-containing fish needs to be considered before issuing local fish consumption advisories (Mergler et al. 2007). For local fish, the fish-species-specific, site-specific consumption limits were calculated in this report. Unless local residents in Alberta consume commercial fish every day, recommended consumption amounts of local fish for different groups are presented in Table 16. If local residents do consume commercial fish frequently, they should reduce any additional exposure to local fish accordingly.

## 3.7 Criteria for Issuing Fish Consumption Advisories

As recommended by the Public Health Management Committee, the criteria for issuing fish consumption advisories are that

1. If mercury levels are higher than 0.5 mg/kg (commercial fishing guideline), the advisory would be “avoid consuming fish”
2. If mercury levels are between 0.2 - 0.5 mg/kg (Health Canada recommendation for subsistence consumers), the advisory would provide “consumption limits”
3. If mercury levels are less than 0.2 mg/kg, advisory would not be issued,

[4] Predatory fish known to have comparatively high mercury levels in market samples include fish like: barracuda, escolar, marlin, sea bass, shark, swordfish, bigeye tuna and fresh or frozen tuna (Health Canada 2007).

4. If fish sample size are less than 5 per location, advisory would not be issued, and
5. If the lakes are used for commercial fishing, advisories would not be issued until consulting with Canadian Food Inspection agency.

# 4. Conclusions

Concentrations of total mercury in fish collected from water bodies in Alberta in 2009/2013 were within the ranges reported in the literature for the same fish species from other rivers and lakes elsewhere in Canada and the U.S.

The estimated mercury exposures warranted limitation of consumption for the higher fish intake group (over 100 g/d). Restricted consumption was indicated for specific groups, such as women of reproductive age, pregnant women and young children. The mercury levels in fish were in general between 0.2 - 0.5 μg/g, and people in specific groups should limit fish consumption. Fish consumption advisories apply to local First Nations residents and recreational anglers.

Fish consumption advisories promote voluntary reductions in consumption to minimize potential health risk to local fish consumers. The balance between potential health risk and health benefits of consumption of mercury-containing fish needs to be considered.

The Science Advisory Committee reviewed the human health risk assessment document. The recommendations are made as below:

1. Consumption limits should be set for Alberta fish consumers to make informed decisions as outlined in this report;
2. The health benefits of fish consumption should be balanced with any mercury-related health risk; and
3. Mercury levels in fish in water bodies of Alberta should continue to be monitored.

Alberta Office of the Chief Medical Officer of Health issued the fish consumption advisories (Table 16). The information of new advisories is posted on Alberta government website:
http://mywildalberta.com/Fishing/SafetyProcedures/FishConsumptionAdvisory.aspx .

## Table 16 Recommended Fish Consumption Limits

| ***Water Body/Fish Species*** | **Fish** Sized over lbs | **Consumption Limit (servings per week)** **Women** | **Children (5-11 yr)** | **Children (1-4 yr)** | **Adults** |
|---|---|---|---|---|---|
| *Amisk Lake* | | | | | |
| Northern pike | 2 | avoid | avoid | avoid | 6 |
| Walleye | 1 | avoid | avoid | avoid | 4 |
| *Baptiste Lake* | | | | | |
| Northern pike | 4 | 3 | 1 | 0.5 | no limit |
| Walleye | 2 | avoid | avoid | avoid | 6 |
| *Beaver Lake* | | | | | |
| Northern pike | 5 | 3 | 1 | 0.5 | no limit |
| Walleye | 3 | 3 | 1 | 0.5 | no limit |
| *Bourque Lake* | | | | | |
| Northern pike | 3 | 4 | 2 | 1 | no limit |
| Walleye | 4 | 3 | 1 | 0.5 | no limit |
| *Chinchaga River* | | | | | |
| Walleye | 2 | 3 | 1 | 0.5 | no limit |
| *Cowoki Reservoir* | | | | | |
| Northern pike | 8 | avoid | avoid | avoid | 5 |
| *Crawling Valley Reservoir* | | | | | |
| Northern pike | 3 | 3 | 1.5 | 0.5 | no limit |
| Walleye | 2 | avoid | avoid | avoid | 6 |
| *Cross (Steele)Lake* | | | | | |
| Northern pike | 4 | 6 | 2.5 | 1.5 | no limit |
| *Dore Lake*[a] | | | | | |
| Northern pike | 6 | 4 | 2 | 1 | no limit |
| Walleye | 2 | avoid | avoid | avoid | 5 |
| *Eagle Lake* | | | | | |
| Walleye | 3 | 6 | 2.5 | 1.5 | no limit |
| *Elinor Lake* | | | | | |
| Northern pike | 4 | avoid | avoid | avoid | 5 |
| Walleye | 4 | avoid | avoid | avoid | 4 |
| *Ethel Lake* | | | | | |
| Northern pike | 2 | 3 | 1 | 0.5 | no limit |
| Walleye | 2 | 3 | 1 | 0.5 | no limit |
| *Goodfish Lake* | | | | | |
| Northern pike | 3 | 3 | 1 | 0.5 | no limit |
| Walleye | 3 | 4 | 2 | 1 | no limit |
| *Hilda Lake* | | | | | |
| Northern pike | 2 | 2 | 1 | 0.5 | 6 |
| Walleye | 2 | avoid | avoid | avoid | 5 |
| *Isle Lake* | | | | | |
| Walleye | 3 | 6 | 2.5 | 1.5 | no limit |
| Northern pike | 7 | 3 | 1 | 0.5 | no limit |
| *Kehewin Lake* | | | | | |
| Northern pike | 4 | 3 | 1.5 | 0.5 | no limit |
| Walleye | 2 | 4 | 2 | 1 | no limit |
| *Keho Lake* | | | | | |
| Walleye | 4 | 5 | 2 | 1 | no limit |
| *Kinnaird Lake* | | | | | |
| Northern pike | 3 | 3 | 1 | 0.5 | no limit |
| Walleye | 2 | avoid | avoid | avoid | 5 |

| ***Water Body/Fish Species*** | **Fish** Sized over lbs | **Consumption Limit (servings per week)** **Women** | **Children (5-11 yr)** | **Children (1-4 yr)** | **Adults** |
|---|---|---|---|---|---|
| *Lac Bellevue* | | | | | |
| Walleye | 2 | 3 | 1 | 0.5 | no limit |
| *Lac la Nonne* | | | | | |
| Northern pike | 2 | 4 | 2 | 1 | no limit |
| Walleye | 2 | avoid | avoid | avoid | 6 |
| *Lake Athabasca* | | | | | |
| Lake trout | 6 | 5 | 2 | 1 | no limit |
| Northern pike | 6 | 5 | 2 | 1 | no limit |
| Walleye | 3 | 5 | 2 | 1 | no limit |
| *Lesser Slave Lake* | | | | | |
| Northern pike | 5 | 3 | 1 | 0.5 | no limit |
| Walleye | 3 | 4 | 2 | 1 | no limit |
| *Little Bow Reservoir* | | | | | |
| Northern pike | 3 | 2 | 1 | 0.5 | 6 |
| *Long Lake* | | | | | |
| Northern pike | 2 | 4 | 2 | 1 | no limit |
| *Loon River* | | | | | |
| Walleye | 2 | 4 | 2 | 1 | no limit |
| *Marie Lake* | | | | | |
| Northern pike | 4 | 5 | 2 | 1 | no limit |
| *McGregor Lake* | | | | | |
| Walleye | 4 | avoid | avoid | avoid | 5 |
| *McMillan Lake* | | | | | |
| Northern pike | 4 | 3 | 1 | 0.5 | no limit |
| *Moose Lake* | | | | | |
| Northern pike | 5 | 3 | 1 | 0.5 | no limit |
| Walleye | 4 | 2 | 1 | 0.5 | no limit |
| *North Wabasca Lake* | | | | | |
| Northern pike | 9 | 4 | 2 | 1 | no limit |
| Walleye | 4 | 4 | 2 | 1 | no limit |
| *Pine Lake* | | | | | |
| Northern pike | 3 | 5 | 2 | 1 | no limit |
| Walleye | 2 | 4 | 2 | 1 | no limit |
| *Pinehurst Lake* | | | | | |
| Northern pike | 3 | avoid | avoid | avoid | 4 |
| Walleye | 4 | avoid | avoid | avoid | 5 |
| *Pitchimi Lake* | | | | | |
| Lake trout | 10 | avoid | avoid | avoid | 4 |
| *Richardson Lake*[a] | | | | | |
| Northern pike | 9 | 4 | 2 | 1 | no limit |
| Walleye | 3 | 5 | 2 | 1 | no limit |
| *Rolling Hills Reservoir* | | | | | |
| Northern pike | 8 | avoid | avoid | avoid | 3 |
| Walleye | 6 | avoid | avoid | avoid | 3 |
| *Sylvan Lake* | | | | | |
| Walleye | 1 | 6 | 2.5 | 1.5 | no limit |
| *Touchwood Lake* | | | | | |
| Northern pike | 10 | avoid | avoid | avoid | 4 |
| Walleye | 5 | avoid | avoid | avoid | 3 |
| *Wabamun Lake* | | | | | |
| Northern pike | 7 | 3 | 1 | 0.5 | no limit |

| ***Water Body/Fish Species*** | **Fish** Sized over lbs | **Consumption Limit (servings per week)** **Women** | **Children (5-11 yr)** | **Children (1-4 yr)** | **Adults** |
|---|---|---|---|---|---|
| *Whitefish Lake* | | | | | |
| Lake whitefish | 8 | avoid | avoid | avoid | 5 |
| Northern pike | 4 | avoid | avoid | avoid | 5 |
| Walleye | 4 | avoid | avoid | avoid | 4 |
| *Wizard Lake* | | | | | |
| Northern pike | 2 | 6 | 2.5 | 1.5 | no limit |
| *Wolf Lake* | | | | | |
| Northern pike | 3 | 4 | 2 | 1 | no limit |
| Walleye | 2 | avoid | avoid | avoid | 5 |

*1 lb = 454 grams. **1 serving = 75 grams, ½ cup, 2.5 ounces, or a piece of cooked fish that fits into the palm of your hand. *** "Women" refers women at reproductive age (15-49 yr) and pregnant women. Adult$^{+}$ includes adults and child over 12 yr. [a] calculations based on data from Environment Canada

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# Appendix A

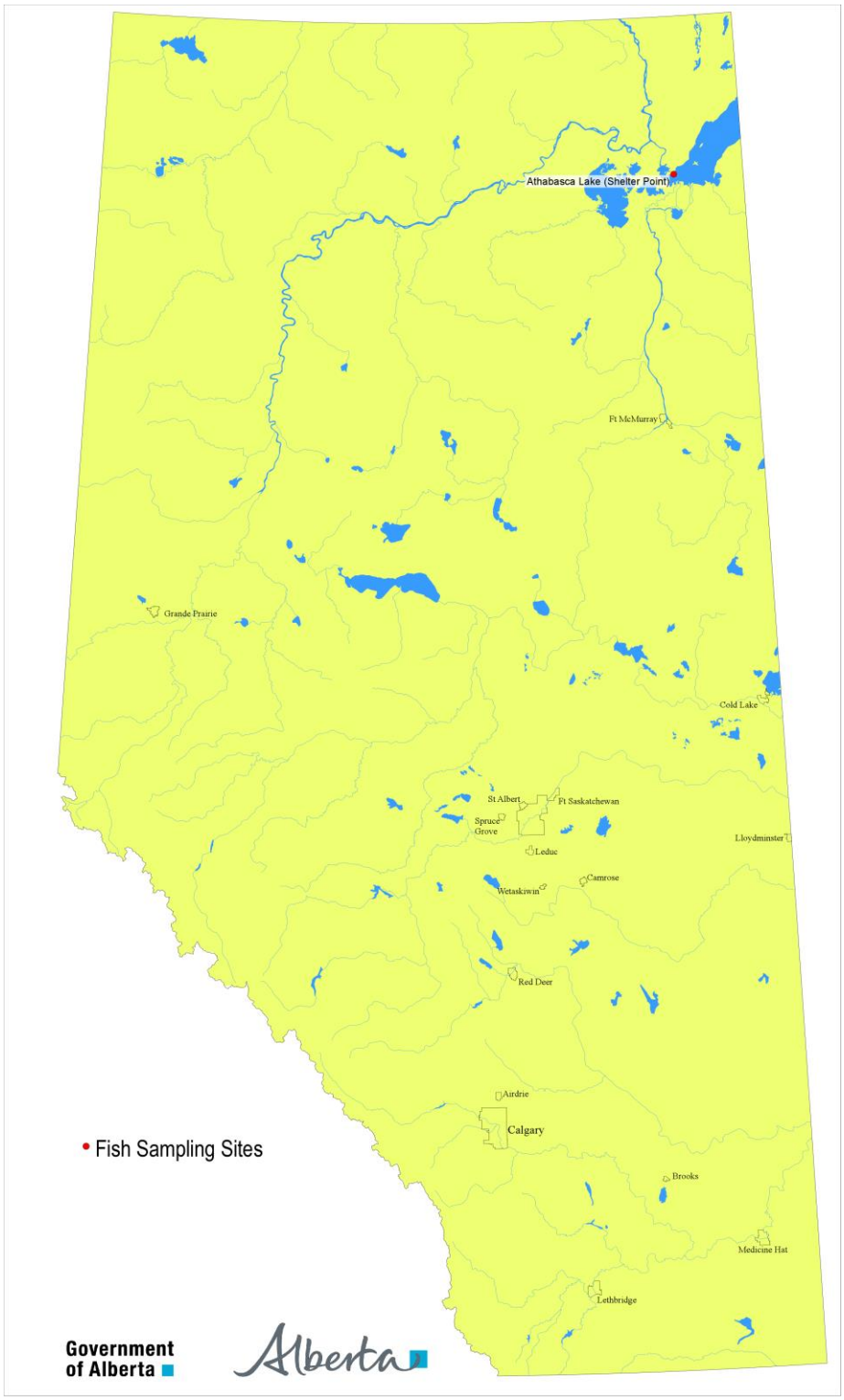
# Data from Environment Canada

## A.1 Field Collection

For samples tested by Environment Canada, the fish were harvested by a local fisherman in December or January and shipped whole and frozen to Saskatoon where they were processed. Processing included determinations of fish total and fork length, round weight, sex and liver weight and gonad weight. Aging structures were removed with otoliths used for lake trout, burbot and walleye, and cleithra for northern pike.

## A.2 Laboratory Analysis

Fish samples were analyzed at the Environment Canada laboratory for total mercury by employing the cold vapor absorption spectrometry procedure (CVAAS) using a Milestone Direct Mercury Analyzer following USEPA method 7473 (USEPA 2007). A subsample of ca. 0.1-0.2 g of frozen boneless dorsal fillet was used for each analysis; results are expressed on a wet weight basis. For each series of runs, certified reference materials and blanks were run at the beginning and at the end of each batch of 20 samples. One sample was run in triplicate during each series run; for analyses run for 2012 fish, the mean relative standard deviation of the triplicates was 6.3% (n=18) with similar results with other runs. Certified reference materials and percent recoveries (mean percent of certified values ± 1 standard deviation) were NIST 2976 (99.18 ± 1.5%) from the National Institute of Standards and Technology (Standard Reference Materials Program, Gaithersburg, USA) and DORM 3 (99.4 ± 2.16%) and DOLT 4 (99.4 ± 1.14%) from National Research Council Canada (Certified Reference Materials program, Ottawa). The method detection limit, determined as 3× the standard deviation of the blanks, was 0.3 ng Hg (approximately 2 ng/g ww).




**Sampling Location for Lake Athabasca**

**Sample Size and Mean of Weight and Length for Lake Athabasca**

| Lake and Species | Sample Size | Fork Length (cm) | Wet Weight (g) |
|---|---|---|---|
| *2010/2011* | | | |
| Lake trout | 20 | 69.8 | 3,395 |
| *2011/2012* | | | |
| Burbot[a] | 10 | 61.1 | 1,671 |
| Lake trout | 23 | 64.2 | 3,123 |
| *2012/2013* | | | |
| Burbot[a] | 20 | 74.3 | 3,031 |
| Northern pike | 24 | 67.3 | 2,703 |
| Walleye | 21 | 57.7 | 2,432 |

Data source – Environment Canada. Fish samples were collected between December 2010 and December 2013
[a] Burbot length are total length.

**Total Mercury Levels in Fish for Lake Athabasca (µg/g, wet weight)**

| Lake and Species | Mean | Min | Max |
|---|---|---|---|
| *2010/2011* | | | |
| Lake trout | 0.25 | 0.16 | 0.34 |
| *2011/2012* | | | |
| Burbot | 0.11 | 0.04 | 0.18 |
| Lake trout | 0.21 | 0.13 | 0.27 |
| *2012/2013* | | | |
| Burbot | 0.18 | 0.11 | 0.36 |
| Northern pike | 0.25 | 0.05 | 0.69 |
| Walleye | 0.43 | 0.18 | 0.80 |

Data source – Environment Canada

# Appendix B

# Guide for Use of Food Consumption Advisory Information

1. **Where to find food consumption advisory information?**

   *Fish consumption advisories*

   http://mywildalberta.com/Fishing/SafetyProcedures/FishConsumptionAdvisory.aspx

   *Wild game meat consumption advisories*

   http://www.albertaregulations.ca/huntingregs/gamemanage.html

2. **What are criteria for issuing food consumption advisories?**

   The criteria for issuing fish consumption advisories are

   1. If mercury levels are higher than 0.5 mg/kg (commercial fishing guideline), the advisory would be “avoid consuming fish”,
   2. If mercury levels are between 0.2 - 0.5 mg/kg (Health Canada recommendation for subsistence consumers), the advisory would provide “consumption limits”,
   3. If mercury levels are less than 0.2 mg/kg, advisory would not be issued,
   4. If the fish sample size is less than 5 per location, advisory would not be issued, and
   5. If the lakes are used for commercial fishing, advisories would not be issued until consulting with Canadian Food Inspection agency.

   The criteria for issuing wild game meat consumption advisories are based on the guidelines proposed by national or international regulatory agencies such as Health Canada and World Health Organization.

3. **How to find fish species and size?**

   The fish species are indicated under the “Species” in the table. Meanwhile, please check fish weight under the “Fish Size” in the table. If fish weighs less than the weight indicated in the table, there is no advisory against eating this size of fish.

4. **How to find meal size and frequency?**

   Please go to the “Consumption Limits”, the meal size and frequency indicated as “servings per week”. Check specific information on meal size and frequency for women, young children groups and adults.