

GREAT LAKES **FISH** CONSUMPTION

ADVISORIES



The Public Health Benefits and Risks

Discussion Paper prepared by the Health Professionals Task Force
for the International Joint Commission

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Executive Summary

At the request of the Commissioners of the International Joint Commission, the Health Professionals Task Force (HPTF) prepared this discussion paper to stimulate a review of the current approaches to advising the public about fish consumption in the U.S. and Canada. Recent literature on human toxicants and their biologic effects was reviewed along with data on human consumption patterns of Great Lakes fish, and fish contaminant levels for mercury and polychlorinated biphenyls. In addition, verbal and written testimony from public health experts, state and federal regulatory agencies, environmental organizations and concerned citizens from both countries were considered. The advisories themselves were collected and several of the current approaches used were assessed with the objective of providing guidance to the Commissioners.

It is the opinion of the HPTF members that the International Joint Commission should support a more effective approach to the development of fish consumption advisories, through better protection of those people at risk, without deterring the majority of people from fish consumption. To develop such an approach, environmental monitoring and exposure assessments (to track trends in persistent organic pollutants) are urgently needed. Dietary exposures and their associated risk factors can be accurately determined and communicated to appropriate at-risk populations.

While the HPTF focused on two of the four major pollutants (i.e., mercury and polychlorinated biphenyls) found in the Great Lakes, members are also of the opinion that to adequately protect Great Lakes fish eaters there is a need to monitor a variety of other groups of chemicals.

Members of the HPTF believe in primary prevention, which demands that efforts are continued to reduce contaminant levels in all Great Lakes fish. Through better awareness and education about fish consumption advisories, improved public health could be achieved.

Introduction

The International Joint Commission (IJC) in its tenth Biennial report committed to give further consideration to the issue of fish consumption advisories (IJC, 2000). This discussion paper was prepared by the Health Professionals Task Force (HPTF) for the IJC and examines the public health issues arising from fish consumption advisories that exist in all jurisdictions throughout the Great Lakes basin. The HPTF in its review of fish consumption advisories also sought to provide guidelines to the IJC to improve the effectiveness of fish advisories, particularly for at-risk populations. Fish consumption advisories are primarily generated as a result of concerns about the health effects of ingesting fish contaminated by persistent organic pollutants such as mercury and polychlorinated biphenyls (PCBs). Information on current fish consumption advisories can be found in the US Environmental Protection Agency's (EPA) fact sheet, "National Listing of Fish and Wildlife Advisories" (USEPA 2003). The fact sheet also includes information on Canadian advisories.

This discussion paper focuses on mercury and polychlorinated biphenyls (PCBs). They are the two most pervasive contaminants found in the waters of the Great Lakes and dominate the typical contaminant pattern seen in fish. For more complete reviews of the literature and the potential risks to human health, readers are directed to recent reports by the Agency for Toxic Substances and Disease Registry (ATSDR, 1999 and 2000) and the National Research Council (2000).

In preparing this report, the following observations were used by the HPTF to assist in the development of the guidelines provided herewithin for more effective fish consumption advisories:

1. Progress has been made in reducing many persistent organic pollutants such as the organochlorine compounds in the water and in fish commonly consumed, though this reduction appears to have leveled off in recent years (LaRoe, 1995, USEPA 2002). Concern remains about several groups of unmonitored chemicals including pharmaceuticals, flame-retardants and high – volume chemicals such as biodegradable pesticides, given they are persistent, but usually biodegradable, and not all of them are bioaccumulative (IJC 2000, 2002).
2. Mercury, a neurotoxin, continues to be a major concern in the Great Lakes basin. A majority of the fish consumption advisories for the Great Lakes and connecting waters focus on mercury contamination.
3. Evidence from past epidemiological outbreaks associated with well documented severe exposures to Mercury (e.g., Minimata, Grassy Narrows, and Iraq) indicates a human health risk is associated with consuming fish containing high or elevated (above background levels) concentrations of mercury and persistent organic pollutants (NRC 2000). Recent scientific evidence also suggests subtle effects are occurring at low doses.

4. Certain subpopulations, especially the developing fetus, are most susceptible to low dose exposures of methylmercury and PCBs, with neurodevelopmental effects being perhaps the most sensitive adverse human health indicator from these exposures.
5. Fish is an important nutritional component of many people's diets and a good source of n-3 (Omega 3) fatty acids (McIvor, 2001)¹. Additionally, fish are high in protein and low in saturated fats (Johnson et al., 1998).
6. Alternative protein sources have been shown to contain other contaminants of concern. Avoiding native fish and substituting grocery-purchased fish or other protein sources may lessen health risks associated with some of the known contaminants.
7. In June 1999, the World Health Organization (WHO) convened the 53rd Joint FAO/WHO Expert Committee on Food Additives and published their report, "Safety Evaluation of Certain Food Additives and Contaminants" (WHO, 1999). The WHO report concluded:

*"...The Committee noted that fish makes an important contribution to nutrition, especially in certain regional and ethnic diets, and **recommended that its nutritional benefits be weighed against the possibility of harm when limits on methyl mercury concentrations in fish or fish consumption are being considered.**"*

(page 93, World Health Organization, 1999)

1 Omega 3 fatty acids are long-chain polyunsaturated fatty acids, important components of cell membranes and precursors of a variety of biologically active compounds. For normal growth, development and function of neural and visual function infants require polyunsaturated fatty acids, provided in breast milk and in infant formula (Health Canada, 2001, 2002). Fish, baked or broiled, is low in fat with the exception of Atlantic mackerel, salmon and lake whitefish. Fish is a dietary source of sodium, potassium, selenium, Vitamin A, folic acid and niacin (Health Canada, 2001).

Fish Consumption Advisories

Fish consumption advisories warn people about the risk of consuming contaminated fish. The objective of an advisory is to 1) provide information about the chemical contaminants in sport fish; 2) educate consumers about waterbodies and fish species of concern and methods to reduce their exposure; and 3) indicate benefits of fish consumption (Johnson et al., 1998). Depending upon specific bodies of water and the species of concern, fish consumption advice ranges from advice to not eat any fish to advice specifying the maximum numbers of meals that may be safely consumed. All Great Lakes fish consumption advisories do specify information on which parts of the fish should be avoided and what preparatory/cooking methods should be used to reduce exposure to contaminants of concern. Typically, advisories are stricter for women of childbearing years, for women who may be pregnant or nursing, and for very young children. For example, the Guide to Eating Ontario Sport Fish (the Guide) contains detailed advice on selecting fish for eating from Ontario lakes and rivers including the Great Lakes (OME, 2003). It clearly recommends not eating any organs, fat or skin of any fish. Included in the Guide's general recommendations is advice to 1) eat smaller fish; 2) eat bass, pike, walleye, perch, and pan fish from the Great Lakes instead of fatty species such as salmon and trout; and 3) allow fat to drip away when cooking fish.

Use of the Guide was studied by Health Canada between 1995 and 1997 (Grondin, J. and LaRue, R., 2000). When deciding whether to eat their catch, 38% of fish eaters surveyed used only conventional sources of information, with media being the most often cited source. But when government sources were cited, fifteen percent of survey respondents used only the Guide. Thirty-four percent of survey respondents used only unconventional sources of information, citing interpersonal contacts as the most commonly used source of information. The Health Canada study also found fish eaters believed that the most credible informal information came from local sources such as bait shop owners.

The USEPA National Listing of Fish and Wildlife Advisories for 2001 (USEPA 2002) includes the contaminants of concern, fish species and its size, the year the advisory was introduced, the current status of the advisory (i.e., active or rescinded) and the advisory type. The five advisory types are 1) no consumption for the general population; 2) no consumption for the sensitive subpopulations of children and pregnant women; 3) restricted consumption for the general population; 4) restricted consumption for sensitive subpopulations; and 5) public fishing bans.

All the Great Lakes and their connecting waters are currently under advisories for one or more contaminants (Table 1, USEPA 2003). The four primary contaminants, PCBs, dioxin, mercury and chlordane, plus DDT (and its degradation products, DDE and DDD) were at least partly responsible for 96% of the total number of fish consumption advisories in effect in 2002 in the U.S., and 75% of all advisories issued are at least in part because of mercury contamination (USEPA 2003).

Table 1. Fish Advisories Issued for the Great Lakes

Great Lakes	PCBs	Dioxins	Mercury	Chlordane
Lake Superior	✓	✓	✓	✓
Lake Michigan	✓	✓	✓	✓
Lake Huron	✓	✓	✓	✓
Lake Erie	✓	✓	✓	
Lake Ontario	✓	✓		

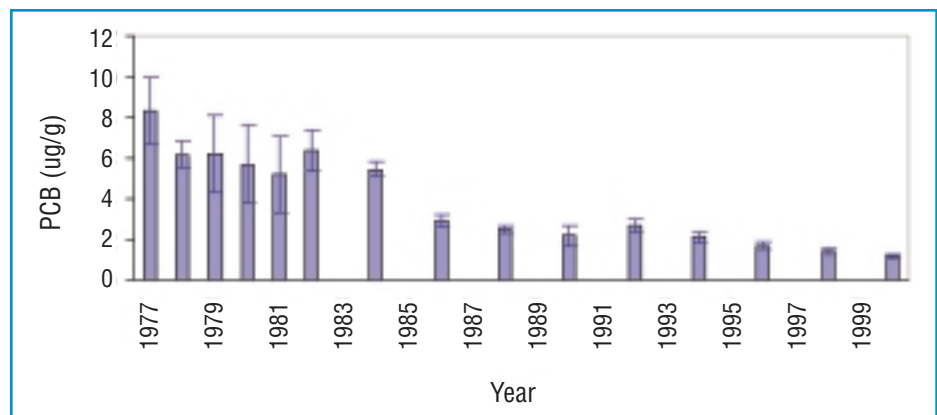
Groups of chemicals such as heavy metals, organochlorine pesticides, and other numerous chemical compounds including, but not limited to, creosote, mirex, polyaromatic hydrocarbons, hexachlorobenzene, and pentachlorophenol, make up the remaining 4% of all fish consumption advisories in the U.S. (USEPA, 2003). Of the remaining 4% a majority of these advisories are a result of a New York statewide advisory for the contaminant mirex.

Fish Contaminant Levels

Fish and other seafood have been reported as major dietary sources of mercury for humans (ATSDR, 1999). Mercury accumulates from ingestion of organic (methyl mercury) and inorganic forms of mercury in the water and in the prey upon which freshwater and marine fish feed. It accumulates in the tissues of the fish and is biomagnified in larger, older and predatory fish. In 1998, mean tissue concentrations of mercury in Great Lakes predatory fish such as walleye, pike, bass, and chain pickerel were greater than 0.5 ppm with maximum levels exceeding 2 ppm (USEPA, 2001). It is also interesting to note that ocean species such as swordfish and shark may have tissue levels of methylmercury of 1 ppm or greater (ATSDR, 1999). The Canadian Food Inspection Agency (CFIA, 2002) reported average tissue concentrations for mercury at levels below 0.5 ppm in marine fish and shellfish, excluding swordfish, shark, and fresh or frozen tuna. More detailed information on the maximum allowed/recommended levels of mercury and PCBs in fish for the U.S., Canada and by the World Health Organization can be seen in Appendix 1. Also examples of tolerable intake levels of mercury or methyl mercury and PCBs are mentioned. For mercury, some Great Lakes states have increased protection for sensitive populations by using a separate threshold for the release of issue advisories (Appendix 2).

PCB trends in lake trout and walleye have been reported for selected locations in the Great Lakes from the 1970's, including data through 1990 for Lake Superior, and data through 1992 for Lakes Michigan, Huron, Ontario and Erie (De Vault 1996). More recent data provided by the USEPA Great Lakes National Program Office examined levels of PCBs in fish for site-specific areas. The data showed an overall decrease in the PCB concentrations in the fish analyzed (Figures 1 to 5, USEPA 2002)².

Figure 1.
PCBs in
Lake Ontario
Whole Lake
Trout



2 PCB Levels in Whole Lake Trout (1977-2000). ug/g wet weight +/- 95% C.I., composite samples, 600-700mm size range. Lake Erie data are for walleye in the 400-500 mm size range. Note the different scales between lakes.

Figure 2.
PCBs in Lake
Huron Whole
Lake Trout

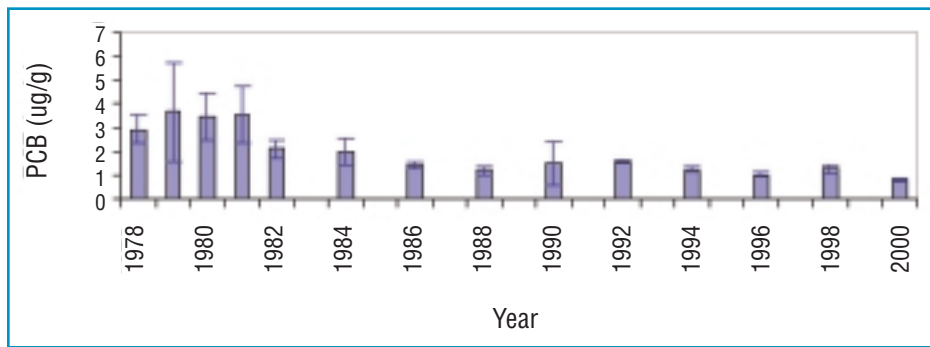


Figure 3.
PCBs in Lake
Michigan Whole
Lake Trout

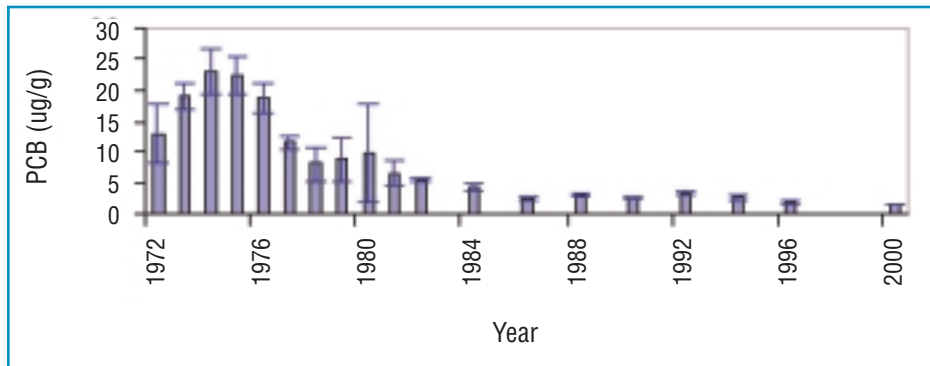


Figure 4.
PCBs in Lake
Superior Whole
Lake Trout

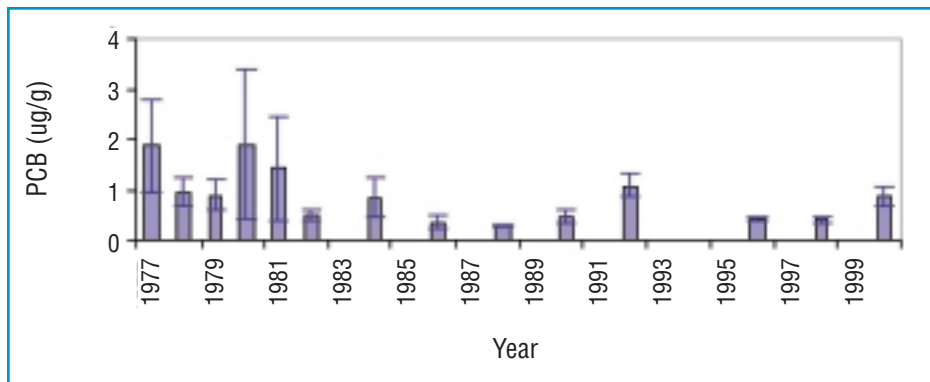
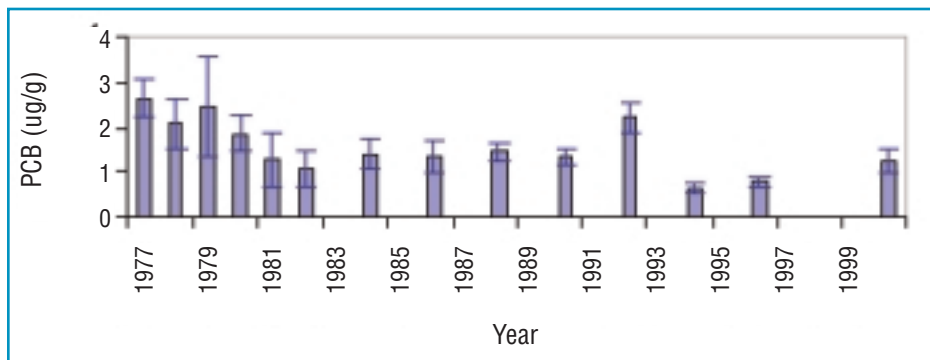


Figure 5.
PCBs in Lake
Erie Whole
Walleye



As noted previously, fish consumption is not limited to Great Lakes fish alone. Consumers may additionally eat wild and farmed fish (e.g., freshwater and/or marine species). Some of these marine fish can be a source of persistent toxic contaminants that may pose a health risk to regular weekly consumers (Hightower et al., 2003, Easton, et al., 2002). For example, in a recent advisory issued by Health Canada, Canadians were advised to limit their consumption of fresh shark, swordfish and tuna. Mercury in these marine species has been found at levels in the range of 0.5 to 1.5 ppm (Health Canada, 2002).

Understanding Who Is Eating Great Lakes Fish

In a Health Canada study conducted between 1995 and 1997, Canadian Great Lakes sport fishers were surveyed for their fish consumption patterns, including their fishing habits, advisory compliance and knowledge (Grondin and LaRue, 2000). The results showed that 66% of respondents stated they primarily fished for pleasure, while only 6% fished for food. Respondents who ate their catch stated they liked the fish because it tasted good, but also expressed concerns about polluted water and contaminated fish. Results also showed that 52% of the fish eaters consumed less than 12 meals per year of fish they caught, 22% ate 12 to 25 fish meals per year, 21% ate 26 to 95 fish meals per year, while only 6% ate more than 96 fish meals per year. The study found that as fish consumption increased, so did the likelihood that parts other than fillets were consumed. The results also showed that those who did not eat their catch were younger, employed, and more likely to report an income of \$60,000 or more. Younger respondents indicated the main reason for not eating the fish they caught was their belief that the water was polluted or the fish were contaminated.

Research by Velicer and Knuth (1994) assessed perceptions toward fish consumption and health advisories among opinion leaders, anglers, migrant farm workers, low-income individuals, and experts from fisheries and health care. Similar to that of the Health Canada study noted above, they found that the primary motive for fishing was for pleasure and not for food. Additionally, their results showed that migrant workers and low-income individuals were either non-eaters or frequent consumers of fish. Their results also found that opinion leaders, low-income individuals, and Hispanic migrants used more risk-reducing preparation and cooking techniques than did African-American migrant workers. Opinion leaders and experts in fisheries and health had a greater awareness of advisories. Recent research by Velicer and Knuth (2000) showed that low-income individuals and migrant workers were less aware of advisories and were more likely to rely on mass media and friends for information about consumption advisories.

Tilden et al. (1997) surveyed adults of the eight U.S. Great Lakes states to determine demographics, fish consumption patterns, and sport fish consumption advisory awareness. They found that although half of the Great Lakes sport fish consumers they questioned were aware of the health advisories, awareness was especially low among women and minorities. Their work also showed that awareness was greater in Caucasians, those individuals having college degrees, and those consuming more than 23 meals per year of Great Lakes sport fish. In an earlier study, Connelly and Knuth (1995) found similar results: awareness of consumption advisories was lower among younger anglers, those with lower incomes, and non-Caucasians. They also noted that 40% of respondents thought that the health risks from eating contaminated sport fish were minor compared to other risks. Lastly, Johnson et al. (1998) concluded that populations at risk for exposure to mercury, PCBs, and other persistent organic pollutants included aboriginal people, subsistence and sport anglers, elderly people, women of childbearing years (including those pregnant or nursing), and children.

Human Behavior and Risk Perceptions Regarding Fish Consumption Advisories

In its review of available information, the HPTF noted that despite public concerns about consuming contaminated fish, many subpopulations in North America desire to catch and consume fish from their native habitats for esthetic purposes (e.g., fishing is fun), social interactions (e.g., encourages family activity), or due to economic reasons (e.g., more affordable than supermarket fish). Wheatley and Wheatley (2000) noted that each of these desires reflects benefits that must be weighed against the risks of consuming contaminated fish. An earlier study of Canadian Indigenous People (Wheatley and Paradis, 1996) suggested that the indirect effects they found were apparently due to the change in behavior (i.e., reduced fish consumption) in response to knowledge about environmental contaminants levels and/or advisories and could lead to social/cultural disruption, change of lifestyle, socio-economic damage and change of diet leading to increasing incidences of diabetes, substance abuse and violent behavior.

Understanding the basis for fishing practices, consumption patterns, and compliance with fish advisories is dependent upon knowledge of widely different ethnic, cultural, and socio-economic factors. There are many aspects that need to be taken into consideration in developing the appropriate message for a targeted population/audience. Fish Advisories need to take into consideration not only site-specific data (e.g., contaminant levels, fish species, and fish size), but also cultural and socio-economic factors (e.g., cultural habits and language barriers).

Of equal importance, if fish consumption advisories are to reach their intended audience and incite the needed change in fish consumption behavior, distribution of the advisory (targeted populations), advisory design (contents and format), and the use of the advisories (public outreach) are critical factors, which must be addressed (Burger, 2001).

Approaches to Fish Advisories

Experts that have been involved in trying to improve the effectiveness of fish consumption advisories readily understand the difficulties in evaluating their similarities and differences. Not only were the fish advisory processes different among the eight Great Lake states, but also their cancer risk policies, resulting in inconsistent advice for a specific level of contamination in sport fish (Fischer et al. 1995, Johnson et al. 1998)³.

The following examples are illustrative of the current thinking (i.e., approaches) in the Great Lakes region. One approach has been to issue advisories for the general population, as well as for certain (targeted) segments of the population that may be at higher risk. These advisories have tended to advise avoidance of consuming Great Lakes fish by species, and/or by lake and fish over a certain size, particularly for women of childbearing age. Alternatively, another approach promotes how to reduce the toxic exposure when eating Great Lakes fish so one can obtain the health benefits of eating traditional fish diets while minimizing the health risks from exposure to contaminants in fish.

In evaluating these approaches, The Health Professionals Task Force reviewed epidemiological studies done in the Great Lakes and other parts of the world and found the following conclusions:

- a) Neurobehavioral effects were documented in newborns, infants, and children from prenatal exposure to PCBs at past and current levels from consumption of Great Lakes fish (Fein et al., 1984; Jacobson et al., 1990; Jacobson et al., 1996; Lonky et al., 1996; Stewart et al., 2000).
- b) Maternal consumption of Lake Ontario Great Lakes fish increases the risk of prenatal exposure to PCBs (Stewart et al., 1999).
- c) Exposure to PCBs was associated with lower scores on several measures of memory and learning in older adult fish-eating cohort (Schantz et al., 2001).
- d) Serum PCB levels and consumption of Great Lakes fish were significantly associated with changes in thyroid hormones in women and men (Persky et al., 2001).
- e) Mercury was related to neuropsychological dysfunction in children of the Faroe Islands using various tests including language, attention, memory, and to a lesser extent visiospatial, and motor functions (Granjean et al., (1997, 1998)).

3 “While the sport fish advisories used the USFDA tolerances as a reference, most states’ regulatory and other public health advisory programs (such as private drinking water) used USEPA cancer and noncancer risk assessment methodologies which produced very different risk estimates results than the USFDA approach. The various states’ public health policies tolerated cancer risks up to one cancer in one million lifetimes and regulatory programs up to one in ten thousand lifetimes (Anderson, 1995a). States assessed noncancer risk by using the USEPA reference dose (RfD) and reference concentration (RfC) process and most relied upon the available RfDs from the USEPA integrated risk information system (IRIS) database (Anderson, 1994a). Further, by 1990, there was growing agreement that the USFDA tolerances for market fish were not adequately protective for anglers who consumed sport fish and thus invalidating the basis for most advisories.” (Fischer et al. 1995, pg. 2).

- f) Suboptimal neurodevelopment in Dutch neonates was related to high levels of PCBs, chlorinated dibenzo-p-dioxins (CDDs), and chlorinated dibenzofurans (CDFs) in breast milk, and increased hypotonia (decreased muscle control) was associated with high levels of coplanar PCBs in breast milk (Huisman et al., 1995).
- g) Levels of PCBs and other organochlorines in the Great Lakes fish and wildlife populations have decreased substantially (DeVault, 1996 and USEPA, 2002).
- h) Body burdens of mercury in exposed populations of fish consumers in the Great Lakes basin do not demonstrate that large percentages are at risk (Gerstenberger et al., 1997). Rather, the evidence shows that methyl mercury exposures in excess of the Reference Dose (RfD) or those needed to produce whole blood mercury concentrations exceeding 6 micrograms/L (Fg/L) in women of childbearing age is a rare event even among frequent fish consumers like the Ojibwe tribe of the upper Great Lakes. The average mercury concentration in the fish consumed by the Ojibwe fisheaters is less than 0.5 ppm (Dellinger, 2003).
- i) The average concentration of mercury in commercially caught fish is 0.17 ppm (U.S. Food and Drug Administration – FDA, see Appendix 3). While fish provides many essential nutrients in the diet, especially Omega 3 fatty acids, recent evidence suggests that the presence of mercury could mitigate the positive cardiac effects of these Omega 3 fatty acids (Guallar et al., 2002).
- j) Alternative diets including hamburgers, fried chicken, and dairy products, have been found to contain significant levels of dioxins and other persistent contaminants (Schechter A. and Li L., 1997).

Two examples of Health Advisories:

1. New York State Department of Health Advisory for Women, Infants and Children, 2003

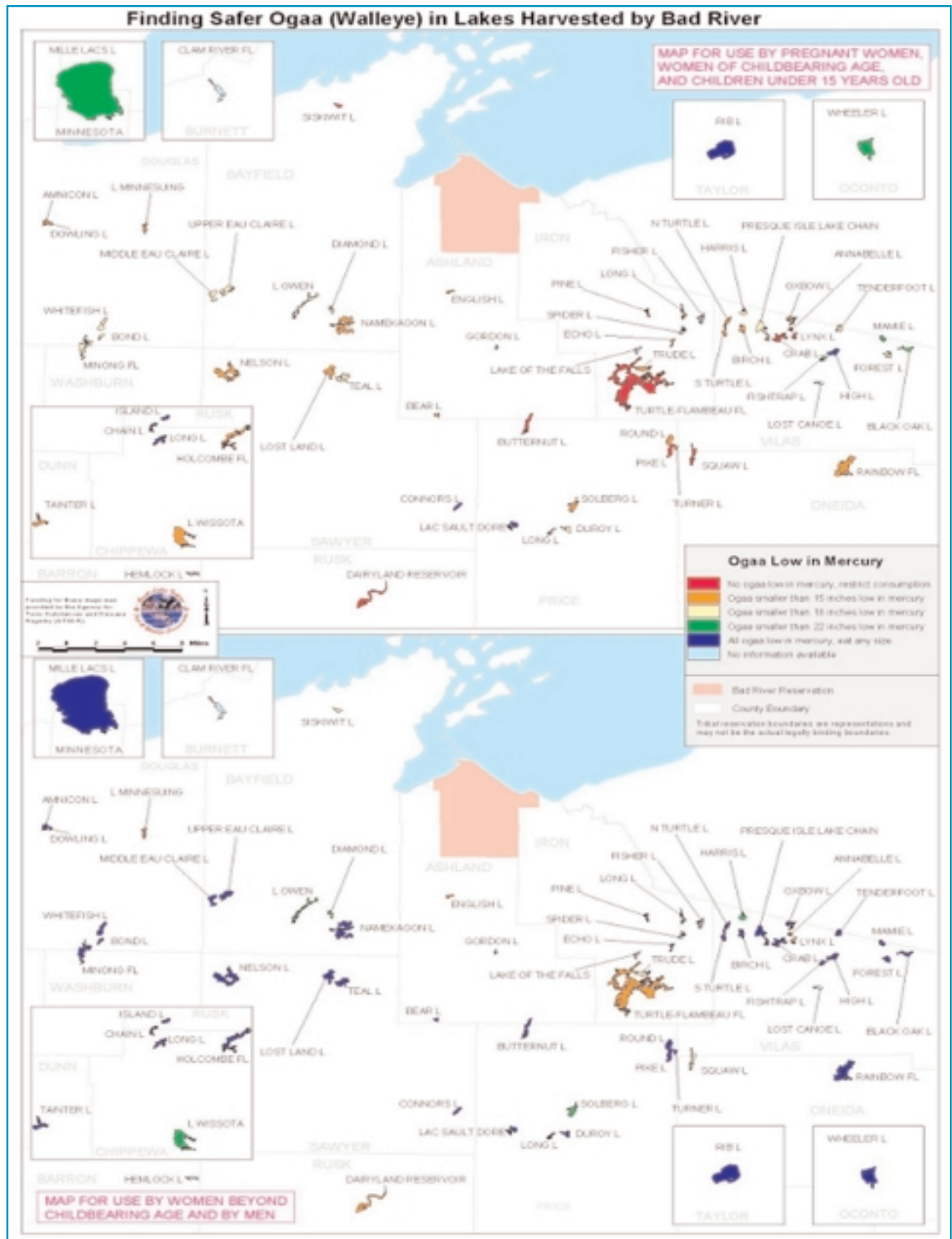
Health advice is also given for infants, children under the age of 15 and women of childbearing age. Department of Health in the State of New York recommends that groups not eat any fish from the specific water bodies listed in the advisory. The reason for this specific advice is that chemicals may have a greater effect on developing in young children or in the fetus. They also build up in women's bodies and are often passed on in mothers' milk. Waters that have specific advisories have at least one species of fish with an elevated contaminant level, which means that a contamination source is or was in, or near, the water.

2. Mercury maps produced by the Great Lakes Indian Fish and Wildlife Commission (GLIFWC)

These maps may be viewed at www.glifwc.org. The Geographic Information System (GIS) maps identify which freshwater lakes have the lowest levels of mercury contamination in the fish. Through the use of color codes, two maps are produced: one map for women of childbearing age and children, and the other map for men and women beyond childbearing years. Using these maps, one can choose areas that are known to have fish with lower levels of contaminants and thereby minimize the health risks to the individual fish eater and their family (Figure 6, (GLIFWC, 2003 and LeCapitaine, 2002)).

The HPTF believes that these examples of fish consumption advisories have their respective merits. However, neither approach sufficiently addresses the needs of all consumers of Great Lakes fish (i.e. sport and subsistence fishers and at-risk populations). A more effective approach to reducing exposure to contaminants in fish needs to be developed that considers identifying a window of opportunity in which advice that is given maximizes the benefits and minimizes the risk of consuming Great Lake's fish. To do so requires site-specific data, consideration for socioeconomic factors and the identification of any cultural barriers when communicating the risks and benefits of fish consumption to local populations.

Figure 6.
Sample GIS Mercury Map (GLIFWC, 2003 and LeCapitaine M., 2002)



Recommended Guidance for Effective Fish Advisories

The HPTF believes that the development of fish consumption advisories to protect public health should

- 1) be simple to permit effective comprehension and retention of information by the targeted population;
- 2) utilize the precautionary principle to reduce exposures based on a likelihood of harm;
- 3) indicate that fish is a significant dietary source of protein for many including Aboriginal and immigrant populations and avoid implying support for alternative protein sources with equivalent or higher risks to human health;
- 4) be widely distributed with targeted messages so that individuals can exercise their personal judgment about the risks to themselves or to their offspring from consuming contaminated fish;
- 5) be science-based and rely on animal studies, toxicological assessments, as well as occupational and epidemiological studies;
- 6) be targeted to at-risk populations specifically to women expecting to become or currently pregnant, nursing mothers and young children;
- 7) contain information concerning the comparative benefits and disadvantages of consuming fish and/or other protein sources in clear terms to the general population;
- 8) be updated regularly and based on continued monitoring and surveillance for both Canada and the United States;
- 9) be written in clear, simple terms, using informal native language of the targeted population and be culturally specific and designed to reach minority communities within each region; and
- 10) be well publicized and made easily accessible to the public, and recommend actions or steps that can be accomplished by the affected communities.

Appendix 1a. Examples of maximum allowed or recommended levels of mercury (Hg) in fish in the United States / Canada and by the World Health Organization WHO/FAO (based on submissions to UNEP)

Country/ Organization	Fish Type	Mercury		
		Maximum allowed/ recommended levels in fish (1)	Type of measure	Tolerable intake levels (1)
United States	Fish, shellfish and other aquatic animals (FDA)	1 ppm methyl Hg(2)	FDA Action level	US EPA reference dose: 0.1Fg methyl Hg/kg body weight per day
	States, tribes and territories are responsible for issuing fish consumption advise for locally-caught fish; trigger level for many state health departments	0.5 ppm methyl Hg	Local trigger level	
Canada (Health Canada)	All fish except shark, swordfish or fresh or frozen tuna (expressed as total mercury in the edible portion of fish)	0.5ppm total Hg	Guidelines/Tolerances of Various Chemical Contaminants in Canada	Provisional Tolerable Daily Intake: 0.47Fg Hg/kg body weight per day for most of the population and 0.2Fg Hg/kg/day women of childbearing age and young children.
	Maximum allowable limit for those who consume large amounts of fish, such as Aboriginal people	0.2ppm total Hg		
WHO	All fish except predatory fish	0.5 mg methyl Hg/kg	Fao/WHO Codex Alimentarius guideline level	0.47 ug/kg/day
	Predatory fish (such as shark, swordfish, tuna, pike and others)	1 mg methyl Hg/kg		JECFA provisional tolerable weekly intake: 3.3 Fg methyl Hg/kg body weight per week.

(1) Units as used in references “mg/kg” equals Fg/g and ppm (parts per million). It is assumed here that fish limit values not mentioned as “wet weight” or “wet flesh” are most likely also based on wet weight, as this is normally the case for analysis on fish for consumers.

(2) This value is misleading as a majority of the states use a dose-based methodology as recommended by EPA's national guidance for establishing advisories. This approach results in varying thresholds associated with various levels of consumption. As an example, most states use a value close to 0.2ppm for 1 meal per week in their advisories.

Source: UNEP, December 2002

Appendix 1b.

Examples of maximum allowed or recommended levels of polychlorinated biphenyls (PCBs) in fish in the United States / Canada and by the World Health Organization (WHO)

Country/ Organization	Fish Type	PCBs		
		Maximum allowed/ recommended levels in fish (1)	Type of measure	Tolerable intake levels (1)
United States	Fish, shellfish and other aquatic animals (FDA) States, tribes and territories are responsible for issuing fish consumption advice for locally-caught fish; trigger level for many state health departments	The Food and Drug Administration (FDA) requires that infant eating fish and shellfish, contain no more than 0.2-3 parts of PCBs per million parts (0.2-3 ppm) of food	FDA Action level	
Canada (Health Canada)	All fish except shark, swordfish or fresh or frozen tuna (expressed as total mercury in the edible portion of fish) Maximum allowable limit for those who consume large amounts of fish, such as Aboriginal people	2ppm	Guidelines/Tolerances of Various Chemical Contaminants in Canada	
WHO	All fish except predatory fish Predatory fish (such as shark, swordfish, tuna, pike and others)		Fao/WHO Codex Alimentarius guideline level	JECFA provisional tolerable monthly intake:70pg/kg bw per month

(1) Units as used in references "mg/kg" equals Fg/g and ppm (parts per million). It is assumed here that fish limit values not mentioned as "wet weight" or "wet flesh" are most likely also based on wet weight, as this is normally the case for analysis on fish for consumers.

Source:

Appendix 2.

Survey of Fish Advisory Systems by Great Lakes State, noting Threshold Levels for Sensitive Populations for Mercury

State	Threshold General Population (ppm)	Threshold Sensitive Populations (ppm)	Consumption Recommendations – Sensitive Populations
Illinois	0.50	0.50	No consumption
Indiana	0.16	0	Ranges from four 8-ounce meals per month to consumption (0.65 ppm) depending on level of mercury contamination; statewide advisory recommends one 8-ounce meal per month (all freshwaters not under a specific advisory)
Michigan	0.50	0.50	On 8-ounce meal per month; no consumption at 1.5 ppm; statewide advisory recommends one 8-ounce meal per month of eight species from all inland lakes
Minnesota	0.16	0.05	Ranges from unlimited consumption to no consumption (at 2.8 ppm) depending on level of mercury contamination; statewide advisory recommends the same range
New York	1.00	1.0*	No consumption; statewide advisory recommends four 8-ounce meals per month
Ohio	0.05	0.05	Ranges from four 8-ounce meals per month to no consumption (at 1.0ppm) depending on level of mercury contamination; statewide advisory recommends four 8-ounce meals per month for waters not under a specific advisory
Pennsylvania	0.13	0.13	Ranges from four 8-ounce meals per month to no consumption of species
Wisconsin (Candy S. Schrank, Aquatic Toxicologist, Wisconsin, DNR)	0.16 to 0.5	0.05 to 1.0	Statewide advisory recommends four 8-ounce meals per month of six species and one 8-ounce meal per month of other sport fish (all freshwaters not under a specific advisory), no consumption at 1.0 ppm. Site-specific recommendation may be 'do not eat' or '1 meal/month'

* consumption limits more stringent for sensitive populations

Source: Combination of The State PIRGs (In: Brain Food, What women should know about mercury contamination of fish), April 2001, written by The Environmental Working Group, a nonprofit environmental research organization based in Washington, D.C. and written correspondence from state experts identified above.

Appendix 3.

Fish and Shellfish with Much Lower Mercury Levels

Species	Mean (PPM)	Range (PPM)	No. of Samples
Grouper (Mycteroperca)	0.43	0.05-1.35	64
Tuna (fresh or frozen)	0.32	ND-1.30	191
*Lobster Northern (American)	0.31	0.05-1.31	88
Grouper (Epinephelus)	0.27	0.19-0.33	48
*Halibut	0.23	0.02-0.63	29
*Sablefish	0.22	ND-0.70	102
*Pollock	0.20	ND-0.78	107
*Tuna (canned)	0.17	ND-0.75	248
*Crab Blue	0.17	0.02-0.50	94
*Crab Dungeness	0.18	0.02-0.48	50
*Crab Tanner	0.15	ND-0.38	55
*Crab King	0.09	0.02-0.24	29
*Scallop	0.05	ND-0.22	66
*Catfish	0.07	ND-0.31	22
*Salmon (fresh, frozen or canned)	ND	ND-0.18	52
*Oysters	ND	ND-0.25	33
*Shrimps	ND	ND	22

* Fish and shellfish among the most consumed of the domestic seafood market

Source: U.S. Food and Drug Administration (May 2001)

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