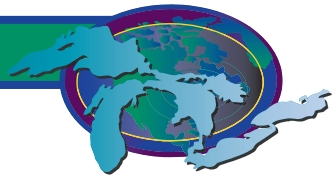

Contaminants in Sport Fish

Indicator #4201

Overall Assessment

Status: **Mixed**
Trend: **Improving**
Rationale: **Concentrations of organochlorine contaminants in Great Lakes sportfish are generally decreasing. However, in the U.S., PCBs still drive advisories for limiting consumption of Great Lakes sportfish. In Ontario, most of the consumption advisories are driven by PCBs, mercury, and dioxins. Toxaphene also contributes to Ontario consumption advisories for sportfish from Lake Superior and Lake Huron.**

Lake-by-Lake Assessment

Contaminant concentrations in sportfish from both GLNPO and OMOE programs determine the advised maximum frequency of fish-eating meals. OMOE calculates and issues its own advice, while GLNPO compares contaminant concentrations of collected samples (3 composites of fish per site) to the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory categories (see State of the Ecosystem, Program History below). U.S. data for contaminants in sportfish cannot be used for statistical trend analysis and are not intended as public advice for consumption. Individual states and tribes issue consumption advice. Trend discussions in the lake-by-lake assessments below are based on OMOE data.

Lake Superior

Status: Mixed
Trend: Improving
Rationale: PCB concentrations in Lake Superior lake trout have declined considerably over the period of record. In the late 1970s, PCB concentrations exceeded the current OMOE "do not eat" consumption limit (see figure 2). Since 1990, concentrations have generally fluctuated between 0.153 ppm and 0.610 ppm, which would permit the consumption of 2 to 4 meals per month. PCB concentrations in GLNPO sportfish fillets currently fall into the one meal per month consumption advisory (see figure 1).

Mercury levels in walleye from Lake Superior have ranged from 0.62 ppm to 0.30 ppm between 1973 and 2002, and, with the exception of a maximum level reached in 1989 (0.84 ppm), have declined over the last few decades. In the last 5 years of the period of record, levels of mercury in walleye have been around 0.30 ppm, permitting the consumption of 4 meals per month for the sensitive population. Mercury concentrations in lake trout permit the consumption of 8 meals per month (see figure 4). These mercury levels are similar to those found in fish from other Ontario lakes and rivers. Mercury concentrations in GLNPO sportfish fillets range between the one meal per week and 2 meals per week consumption advisories (see figure 3).

Toxaphene concentrations have historically been high in fish from Lake Superior due to atmospheric deposition. In lake trout, concentrations have ranged from 0.810 ppm to 0.214 ppm between 1984 and 2003 (see figure 5). In 1993, levels of toxaphene in lake trout exceeded 1 ppm. The most current concentrations, however, do not result in any fish consumption advisories. No toxaphene or DDT protocols exist to compare with concentrations found in GLNPO sportfish (see figure 8).

Lake Michigan

Status: Mixed
Trend: Improving
Rationale: GLNPO data for PCB concentrations in sportfish from Lake Michigan can be used to discern general trends due to multiple collection sites. These data display a general decline in PCB concentrations in coho and Chinook salmon fillets. No OMOE samples were collected from Lake Michigan. Current concentrations range between the one meal per week and the one meal per month consumption advice categories (see figure 1).

Mercury concentrations in GLNPO sportfish fillets range between the one meal per week and one meal per month consumption advice categories (see figure 3).

All GLNPO sportfish fillets fall into the unlimited consumption category of the draft chlordane addendum to the protocol (see figure 7).

No toxaphene or DDT protocols exist to compare with concentrations found in GLNPO sportfish (see figure 8).

Lake Huron

Status: Mixed
Trend: Improving
Rationale: PCB levels in Lake Huron lake trout declined substantially between 1976 and 2004. In 1976, concentrations exceeded 4 ppm, well above the "do not eat" consumption limit of 1.22 ppm for the general population. Current PCB concentrations in lake trout slightly exceed 0.153 ppm, allowing for the safe consumption of a maximum of 4 meals per month. Current GLNPO data for PCB concentrations in sportfish hover around the one meal per week consumption advice category (see figure 1).

Mercury levels in walleye from Lake Huron have ranged from 0.48 ppm to 0.16 ppm between 1976 and 2004. With the exception of a maximum level reached in 1984 (0.59 ppm), there has been a general decline over the last few decades. During the last decade, levels of mercury have remained below the first level of consumption restriction (0.26 ppm) for the sensitive population (see figure 4). Mercury concentrations in GLNPO sportfish fillets fall into the one meal per week category (see figure 3).

All GLNPO sportfish fillets fall into the unlimited consumption category of the draft chlordane addendum to the protocol (see figure 7).

No toxaphene or DDT protocols exist to compare with concentrations found in GLNPO sportfish (see figure 8).

Lake Erie

Status: Mixed
Trend: Improving
Rationale: Trend data are sparse for Lake Erie as lake trout are less abundant in this lake. PCB levels in lake trout declined between 1984 and 2003, but current concentrations restrict consumption to 2 meals per month for the general population. The sensitive population is advised not to consume these fish (see figure 2). Current GLNPO data for PCB concentrations in sportfish fall into the one meal per week consumption advice category (see figure 1).

Mercury levels in walleye have declined considerably over the period of record, from 0.76 ppm in 1970 to 0.18 ppm in 2004. Over the past two decades, levels of mercury have remained between 0.10 and 0.20 ppm, and they do not restrict consumption of walleye or lake trout (see figure 4). Mercury concentrations in GLNPO sportfish fall into the two meals per week category.

All GLNPO sportfish fillets fall into the unlimited consumption category of the draft chlordane addendum to the protocol (see figure 7).

No toxaphene or DDT protocols exist to compare with concentrations found in GLNPO sportfish (see figure 8).

Lake Ontario

Status: Mixed
Trend: Improving
Rationale: Historically, the highest concentrations of PCBs in sportfish have been found in Lake Ontario. From the late 1970s to 1999, PCBs in lake trout from Lake Ontario were at or near the "do not eat" consumption limit. Substantially lower concentrations have been found in the most recent samples in 2002 and 2004, and the current levels would permit consumption of 2 meals per month. Current GLNPO data for PCB concentrations in sportfish fall into the one meal per week category (see figure 1).

Annual mean mercury levels in walleye have fluctuated between 0.32 ppm and 0.11 ppm between 1975 and 2005, although there has been no major decline observed. Over the past 3 years, mercury concentrations have remained below the first level of consumption restriction for the sensitive population (see figure 4). Mercury concentrations in GLNPO sport fish fall into the one meal per week category (see figure 3).

High levels of mirex have been found in fish from Lake Ontario, and it has historically been a source of fish consumption restrictions. Levels of mirex in lake trout from Lake Ontario have declined significantly from 0.302 ppm to 0.036 ppm between 1978 and 2004, with a maximum of 0.387 ppm in 1985. The current concentration of mirex no longer restricts consumption of lake trout (see figure 6). Photomirex is a breakdown product of mirex, which also bioaccumulates in fish and has historically caused consumption restrictions in some Lake Ontario species. Levels in lake trout have declined from 0.044 to 0.015 ppm between 1994 and 2004 (see figure 6).

All GLNPO sportfish fillets fall into the unlimited consumption category of the draft chlordane addendum to the protocol (see figure 7).

No toxaphene or DDT protocols exist to compare with concentrations found in GLNPO sportfish (see figure 8).

Purpose

- To assess potential human exposure to persistent bioaccumulative toxic (PBT) contaminants through consumption of popular sport species
- To assess the levels of PBT contaminants in Great Lakes sport fish
- To identify trends over time of PBT contaminants in Great Lakes sport fish or in fish consumption advisories

In addition to an indicator of human health, contaminants in fish are an important indicator of contaminant levels in an aquatic ecosystem because of the bioaccumulation of organochlorine chemicals in their tissues. Contaminants that are often undetectable in water can be detected in fish.

Ecosystem Objective

Great Lakes sport fish should be safe to eat and concentrations of toxic contaminants in sport fish should not pose a risk to human health. Unlimited consumption of all Great Lakes sport fish should be available to all citizens of the Great Lakes basin.

State of the Ecosystem

Program History

Annex 2 of the Great Lakes Water Quality Agreement (United States and Canada 1987) requires Lakewide Management Plans (LaMPs) to define "…the threat to human health posed by critical pollutants… including their contribution to the impairment of beneficial uses." Both the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory (Great Lakes Sport Fish Advisory Task Force 1993) and the Guide to Eating Ontario Sport Fish (OMOE 2005) are used to assess the status of the ecosystem by comparing contaminant concentrations in fish to levels that invoke consumption advice. Contaminants upon which consumption advisories are based in Canada and the U.S. include PCBs, dioxin, mercury, toxaphene, chlordane and mirex (Table 1).

Lake	Contaminants that Fish Advisories are based on in Canada and the United States
Superior	Dioxin, PCBs, toxaphene, mercury, chlordane
Huron	Dioxin, PCBs, toxaphene, mercury, chlordane
Michigan	PCBs, mercury, dioxin, chlordane
Erie	PCBs, dioxin, mercury
Ontario	PCBs, dioxin, mercury, mirex, toxaphene

Table 1. Contaminants on which the fish advisories are based on by lake for Canada and the United States.
Source: Compiled by U.S. EPA, Great Lakes National Program Office

Both the United States and Canada (Ontario) collect and analyze sport fish to determine contaminant concentrations, to relate those concentrations to health protection values and to develop consumption advice to protect human health. The Great Lakes Fish Monitoring Program (U.S. EPA Great Lakes National Program Office (GLNPO)) and the Sport Fish Contaminant Monitoring Program (Ontario Ministry of the Environment (OMOE)) have been monitoring contaminant levels in Great Lakes fish for over three decades.

To demonstrate trends in organic contaminant levels, average-size, 60cm (23.6 inches) lake trout were chosen by OMOE as the representative fish species due to their presence in all of the Great Lakes, their potential for exploitation by anglers and their high accumulation rates for organic contaminants. To demonstrate trends in mercury levels, average-size, 45cm (17.7 inches) walleye were chosen by OMOE due to high mercury accumulation rates. Health Canada sets Tolerable Daily Intakes (TDI) for certain contaminants of concern, including PCBs, mercury, dioxins (including dioxins, furans and dioxin-like PCBs), mirex, photomirex,

toxaphene and chlordane. TDIs are defined as the quantity of a chemical that can be consumed on a daily basis, for a lifetime, with reasonable assurance that one's health will not be threatened, and they are used in the calculation of sport fish consumption limits which are listed in the Guide to Eating Ontario Sport Fish (Table 2, OMOE 2005).

In alternating years in the U.S., either coho salmon or Chinook salmon are captured and fillets are analyzed for a suite of persistent, bioaccumulative toxic (PBT) chemicals. The GLNPO program was not designed to determine trends in levels of contaminants in sport fish. Rather, the GLNPO program can compare yearly mean concentration levels to a set standard, the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory (Table 3, Great Lakes Sport Fish Advisory Task Force 1993). The Protocol for PCBs is used as a standardized fish advisory benchmark for this indicator, and it is applied to historical GLNPO data to track trends in fish consumption advice. Individual Great Lakes states and tribes issue specific consumption advice for how much fish and which fish are safe to eat for a wide variety of contaminants. Due to gaps and variability in GLNPO salmon fillet data, statistically significant trends are difficult to discern.

Advised meals per month		Concentration of PCBs (ppm)
Sensitive*	General	
8	8	< 0.153
4	4	0.153 – 0.305
Do not eat	2	0.305 – 0.610
Do not eat	1	0.610 – 1.22
Do not eat	Do not eat	>1.22

Table 2. Consumption limits used for the *Guide to Eating Ontario Sport Fish* (based on Health Canada TDIs).

* Women of childbearing age and children under 15

Source: Ontario Ministry of the Environment (2005)

Consumption Advice Groups	Concentration of PCBs (ppm)	Concentration of Mercury (ppm)**	Concentration of Chlordane (ppm)***
Sensitive* and General			
Unrestricted Consumption	0 – 0.05	0 <= 0.05	0 - 0.15
2 meals/ week	NA	> 0.05 <= 0.11	NA
1 meal/ week	0.06 – 0.2	> 0.11 <= 0.22	0.16 - 0.65
1 meal/ month	0.21 – 1.0	> .22 <= 0.95	0.66 - 2.82
6 meals/ year	1.1 – 1.9	NA	2.83 - 5.62
Do not eat	>1.9	> 0.95	> 5.62

Table 3. Uniform Great Lakes Sport Fish Consumption Advisory.

*Women of childbearing age and children under 15

**Draft Protocol for Mercury-based Fish Consumption Advice

***Discussion Paper for Chlordane HPV

Source: Great Lakes Sport Fish Advisory Task Force (1993)

Advice for the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory was calculated for sensitive populations based on a weight of evidence of non-cancer developmental effects. The general population is advised to follow the same advice based on potential cancer risk. Health Canada does not consider PCBs (especially environmental levels) to be carcinogens. Therefore, non-cancer endpoints were used to calculate the Tolerable Daily Intakes (TDI) for PCBs. This TDI was applied more-or-less equally to both sensitive and general populations. For mercury, Health Canada and U.S. states assign separate TDIs or RfDs (references doses) for the general and sensitive populations.

Other important differences between the GLNPO and OMOE programs include composited fish analysis versus individual fish analysis, skin-on versus skin-off fillets, and whole fillet analysis versus dorsal plug analysis, respectively. For this reason, only general comparisons between GLNPO and OMOE data should be made.

Contaminants in Great Lakes Sport Fish

Since the 1970s, there have been declines in the levels of many PBT chemicals in the Great Lakes basin due to bans on the use and/or production of harmful substances and restrictions on emissions. However, because of their ability to bioaccumulate and persist in the environment, PBT chemicals continue to be a significant concern. Historically, PCBs have been the contaminant that most frequently limited the consumption of Great Lakes sport fish. In some areas, dioxins, toxaphene (Lake Superior) or mirex/photomirex (Lake Ontario) have been the consumption-limiting contaminant. Recently Health Canada has revised downward its TDIs for PCBs and dioxins, which has increased the frequency of consumption restrictions caused by PCBs and dioxins and decreased relative frequency for toxaphene and mirex/photomirex.

The following figures illustrate the relationships between contaminant concentrations in sportfish and the resultant fish consumption

advisories. Data and advisories are presented for: PCBs in Chinook salmon (2003) and lake trout (2005-2006) by lake (Figure 1 and Figure 2); mercury in Chinook salmon (2003) and lake trout (2004-2006) by lake (Figure 3 and Figure 4); toxaphene in lake trout from Lake Superior over time (Figure 5); mirex and phtomirex in lake trout from Lake Ontario over time (Figure 6); chlordane in Chinook salmon (2000) by lake (Figure 7); and DDT and toxaphene in coho salmon or Chinook salmon (2000) by lake (Figure 8).

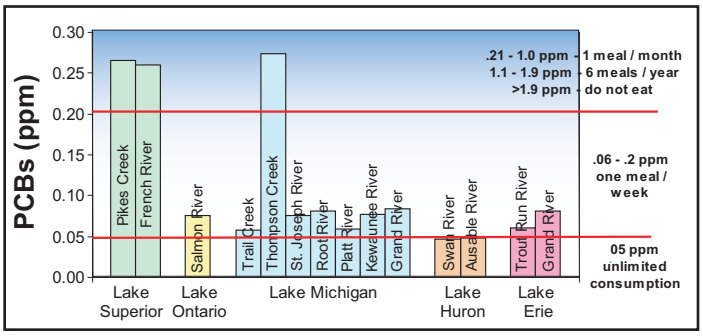

Figure 1. ΣPCBs in GLNPO Chinook salmon fillet composites (2003) compared to the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory.

Advisory limits for sensitive populations (women of child-bearing age and children under 15 years of age) are used in graph.

Source: U.S. EPA Great Lakes National Program Office, 2006

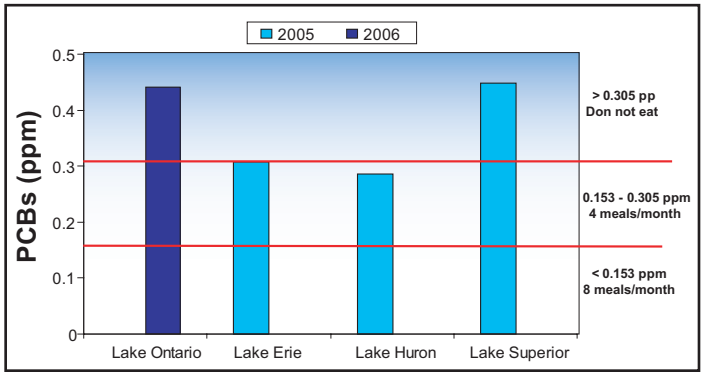

Figure 2. ΣPCBs in OMOE individual 60 cm lake trout compared to the Ontario Sport Fish Consumption Guidelines.

Advisory limits for sensitive populations (women of child-bearing age and children under 15 years of age) are used in graph.

Source: Ontario Ministry of the Environment, 2006

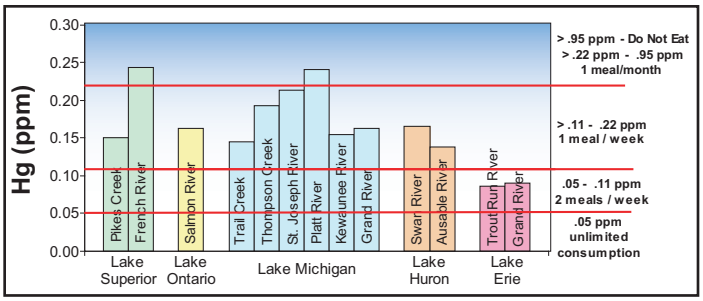

Figure 3. Mercury in GLNPO Chinook salmon fillet composites (2003) compared to the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory.

Advisory limits for sensitive populations (women of child-bearing age and children under 15 years of age) are used in graph.

Source: U.S. EPA Great Lakes National Program Office, 2006

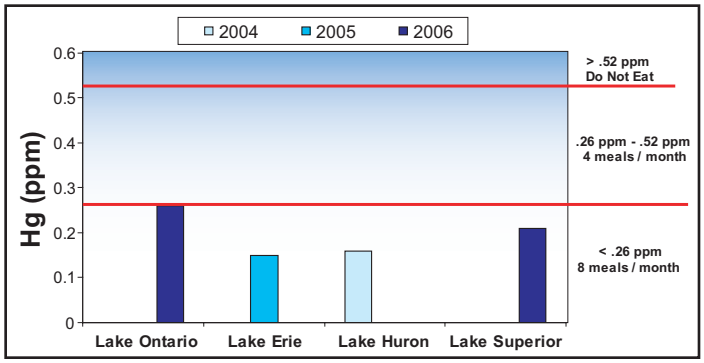

Figure 4. Hg in OMOE individual 60 cm lake trout compared to the Ontario Sport Fish Consumption Guidelines. Advisory limits for sensitive populations (women of child-bearing age and children under 15 years of age) are used in graph.

Source: Ontario Ministry of the Environment, 2006

Pressures

Organochlorine contaminant levels in fish in the Great Lakes are generally decreasing. As these contaminants continue to decline, mercury will become a more important contaminant of concern in Great Lakes fish.

Concentrations of PBT contaminants such as PCBs have declined in lake trout throughout the Great Lakes basin. However, concentrations still exceed current consumption limits. Regular monitoring must continue in the Great Lakes basin to maintain trend data. In many areas of the Great Lakes, dioxins (including dioxins, furans and dioxin-like PCBs) are now the consumption-limiting contaminant and need to be monitored more frequently. The focus should also turn to PBT contaminants of emerging concern, such as brominated flame retardants, before their concentrations in sport fish reach levels that may affect human health.

In the U.S., state and tribal governments provide information to consumers regarding consumption of sport-caught fish. Neither the guidance nor advice of a state or tribal government is regulatory. However, some states use the federal commercial fish guidelines for the acceptable level of contaminants when giving advice for eating sport-caught fish. Consumption advice offered

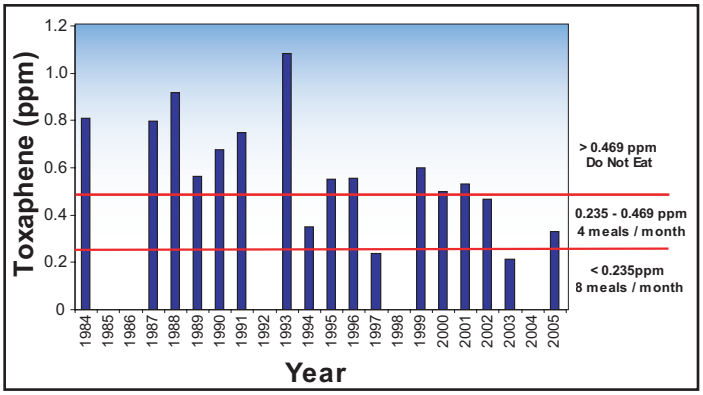

Figure 5. Toxaphene in OMOE individual 60 cm lake trout from Lake Superior compared to the Ontario Sport Fish Consumption Guidelines.

Advisory limits for sensitive populations (women of child-bearing age and children under 15 years of age) are used in graph.

Source: Ontario Ministry of the Environment, 2006

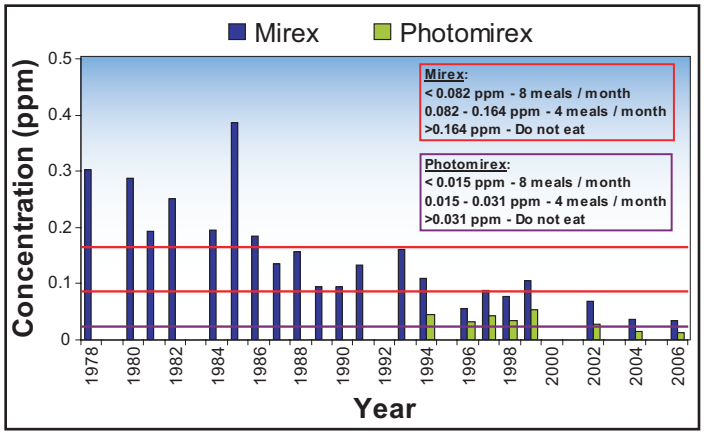

Figure 6. Mirex and photomirex in OMOE individual 60 cm lake trout compared to the Ontario Sport Fish Consumption Guidelines.

Advisory limits for sensitive populations (women of child-bearing age and children under 15 years of age) are used in graph.

Source: Ontario Ministry of the Environment, 2006

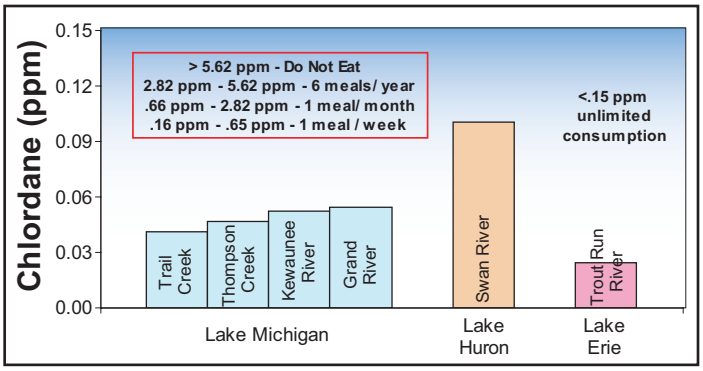

Figure 7. Total chlordane in GLNPO Chinook salmon fillet composites (2000) compared to the Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory-Draft Chlordane Addendum.

Advisory limits for sensitive populations (women of child-bearing age and children under 15 years of age) are used in graph.

Source: U.S. EPA Great Lakes National Program Office, 2006

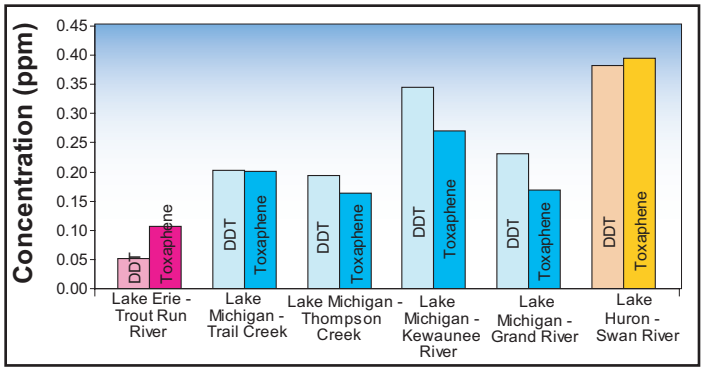

Figure 8. Total DDT and toxaphene in 2000 GLNPO sport fish composites - *No Consumption Advice*.

Coho salmon fillets in Lake Erie and Lake Michigan, and Chinook salmon fillets in Lake Huron.

Source: U.S. EPA Great Lakes National Program Office, 2006

by most agencies is based on human health risk. This approach involves interpretation of studies on health effects from exposure to contaminants. Each state or tribe is responsible for developing fish consumption advisories for protecting the public from pollutants in fish and tailoring this advice to meet the health needs of its citizens. As a result, the advice from different states and tribal programs is sometimes somewhat different for the same lake and species within that lake.

Additional information about the toxicity of a larger suite of chemicals is needed. The health effects of multiple contaminants, including endocrine disruptors, also need to be addressed.

Management Implications

Health risk communication is a crucial component to the protection and promotion of human health in the Great Lakes. Enhanced partnerships between states and tribes involved in the issuing of fish consumption advice and U.S. EPA headquarters will improve U.S. commercial and non-commercial fish advisory coordination. In Canada, acceptable partnerships exist between the federal and provincial agencies responsible for providing fish consumption advice to the public.

At present, PCBs and chlordane are the only PBT chemicals that have uniform fish advisory protocols across the U.S. Great Lakes basin, but an advisory for mercury is being drafted. There is a need to establish additional uniform PBT advisories in order to limit

confusion of the public that results from issuing varying advisories for the same species of sport fish across the basin.

In order to best protect human health, increased monitoring and reduction of PBT chemicals need to be made a priority. In particular, monitoring of contaminant levels in environmental media and biomonitoring of human tissues need to be addressed, as well as assessments of frequency and type of fish consumed. This is of particular concern in sensitive populations because contaminant levels in some fish are higher than in others. In addition, improved understanding of the potential negative health effects from exposure to PBT chemicals is needed.

In March, 2004, the U.S. Food and Drug Administration and the U.S. EPA jointly released a consumer advisory on methylmercury in fish. The joint advisory advises women who may become pregnant, pregnant women, nursing mothers, and young children to avoid eating some types of fish and to eat fish and shellfish that are lower in mercury. While this is a step forward toward uniform advice regarding safe fish consumption, the national advisory is not consistent with some Great Lakes state's advisories. Cooperation among national, state, and tribal governments to develop and distribute the same message regarding safe fish consumption needs to continue. Health Canada has had a similar advisory since 1999.

Comments from the author(s)
Support is needed for the states from GLNPO and U.S. EPA headquarters to help facilitate a meeting to review risk assessment protocols.

Historical long term fish contaminant monitoring data sets, which were assembled by several jurisdictions for different purposes, need to be more effectively utilized. Relationships between the data sets need to be evaluated to allow for comparison and combined use of existing data from the various sampling programs. These data could be used in expanding this indicator to other contaminants and species and for supplementing the data used in this illustration.

Coordination of future monitoring would greatly assist the comparison of fish contaminants data among federal, provincial, state and tribal jurisdictions.

Agreement is needed on U.S. fish advisory health benchmarks for the contaminants that cause fish advisories in the Great Lakes. Suggested starting points are: The Great Lakes Protocol for PCBs and Chlordane and U.S. EPA's reference dose for mercury. Ontario remains consistent with Health Canada's TDIs throughout the province.

Acknowledgments
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Data
Great Lakes Fish Monitoring Program, Great Lakes National Program Office;
Sport Fish Contaminant Monitoring Program, Ontario Ministry of Environment;
Minnesota DNR salmon fillet data for Lake Superior.

Last Updated
State of the Great Lakes 2007