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| **Report No.:** | WMPPT-2013-03-13 | **Date:** | February 22, 2013 |
| **To:** | Grand River Water Management Plan Project Team | | |
| **From:** | Nigel Ward, Ecologist; Claire Holeton, Water Quality Specialist | | |
| **Subject:** | Current Status of the Broad Water Objective for Human Consumption of Fish | | |

## SUMMARY:

This report summarizes the current watershed status of toxic compounds in fish as it relates to human consumption of sport fish.

OMOE guidelines for the consumption of sport fish have been used to assess the status of the broad water objective that strives for high water quality, such that fish consumption is not impeded by aquatic sources of contaminants in the watershed. Advisories based on elevated levels of bioaccumulative toxins are predominantly due to contamination by mercury or PBCs. Since the distribution of these contaminants is widespread and they are known to travel large distances through the atmosphere, it is unlikely they represent localized sources within the watershed. Where relatively higher levels of these toxins cause more stringent restrictions, they can be linked, at least in part, to accumulation of toxins in fish through bioaccumulation due to a piscivorous diet or greater longevity. A small number of restrictions are based on high dioxin/furan concentrations. These restrictions have a localized distribution area, which includes to Canagagigue Creek and the adjacent reaches of the Grand River, and are likely the result of legacy contamination at a single source. Data also suggests that additional sources of contaminants outside the watershed (e.g. in Lake Erie) may be transported into the watershed with fish that travel large distances, such as rainbow trout.

## REPORT:

### *Rationale for the broad water objective to support the human consumption of fish*

The consumption of fish has been extensively noted to have benefits to human health. The omega-3 fatty acids present in fish are a required component of our diet; however, the consumption of fish can pose a potential health risk due to the increased exposure to toxins that bioaccumulate and may be present in fish. Fish can absorb and accumulate toxins through the food web or from exposure to waterborne toxins in their local environment (e.g., contaminated sediments). Guidelines for fish consumption, such as those recommended by the Ontario Ministry of the Environment (OMOE 2011), have consequently been designed as guidelines to minimize the health risks associated with potential exposure to environmental toxins from the consumption of sport fish.

The broad water objective: "*Water quality does not restrict human consumption of fish*" strives for high water quality, such that fish consumption is not impeded by aquatic sources of toxins in

the watershed. OMOE guidelines for the consumption of fish have been used to assess the status of this broad water objective.

### *OMOE Sport Fish Contaminant Monitoring Program*

The ministry guidelines use a risk assessment approach to advise the maximum number of meals containing sport fish to limit intake levels of contaminants below levels which may pose a health risk. The guidelines are location-specific and are derived from surveys of the contaminant levels in sport fish. Recommendations are based on the contaminants found in fish according to their location, species and total length in relation to the associated risk of human consumption. Separate sets of recommendations are made for the general population and sensitive members of the population. The "sensitive population" refers to those who may be more sensitive to potential contaminants: women of child-bearing age and children under the age of fifteen. The assessment detailed below focused only on the recommendations for the general population.

The advised dietary restrictions based on the average level of contaminants in each species and size of fish are rated between eight, and zero meals per month, where a "meal" is approximately 227 grams. Ratings range from 8 which is least restrictive (toxins below advisory level; no more than 8 meals/month recommended) to 0 which is most restrictive (toxin concentrations greatly exceed advisory, not recommended for consumption). A rating of 8 is a low restriction on consumption and represents a baseline value, since it is the highest/best rating the OMOE will assign. Most sport fish in the province contain very low concentrations of toxins, but consumption of a high number fish will increase the risk of exposure to contaminants through bioaccumulation.

### *Status of advisories for consumption of sport fish in the Grand River watershed*

Advisories based on samples of fish collected at 27 locations in the Grand River watershed under the OMOE Sport Fish Contaminant Monitoring Program have been summarized according to the level of consumption restriction and linked cause (i.e., type of contaminant). The level of restriction has been categorised in this report as "*least restrictive*", "*moderately restrictive*", "*restrictive*", "*very restrictive*" or "*do not eat*", according to OMOE recommendations for maximal consumption of 8, 4, 2, 1 or 0 meals/month, correspondingly.

A total of 20 species of sport fish were sampled in the Grand River watershed by the OMOE Sport Fish Contaminant Monitoring Program (OMOE 2011). The occurrence of each advisory level varied between fish species, as shown in Figure 1, which summaries the highest level of restriction of any size fish, for each species. Some species (e.g., black crappie, brown trout, pumpkinseed) did not have advisories above baseline levels, irrespective of location. Other species (e.g. northern pike, common carp, channel catfish) had a relatively high number of advisories restricting consumption to very low levels or recommendations against any consumption. These patterns are likely linked to differences in the longevity and feeding habit of each species. For instance, carp can be long-lived and tend to acquire large amounts of contaminants in their old age, particularly since they are bottom feeders, which exposes them to high concentrations of contaminants that have accumulated in sediments. This is supported

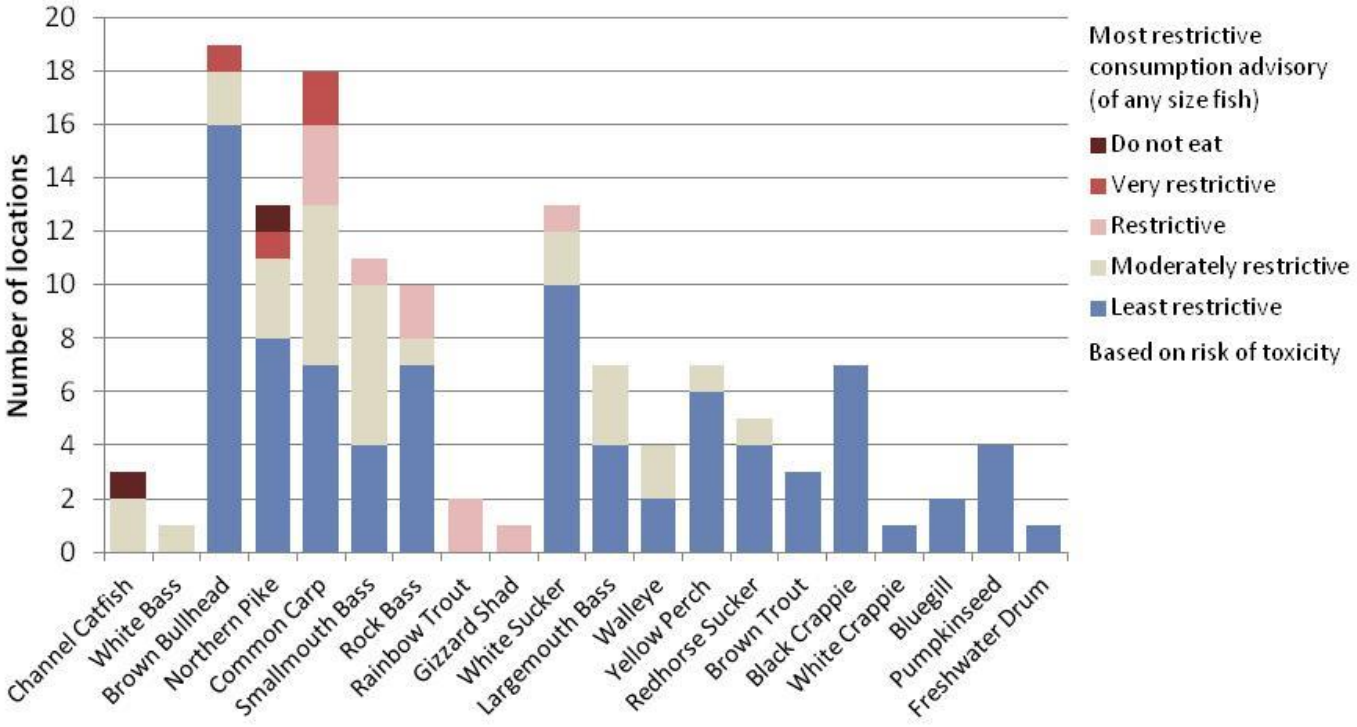


**Figure 1. Frequency of advisory levels among species of sport fish in the Grand River watershed, categorized according to the highest level of consumption restriction of any size fish in that species by OMOE (2011).**

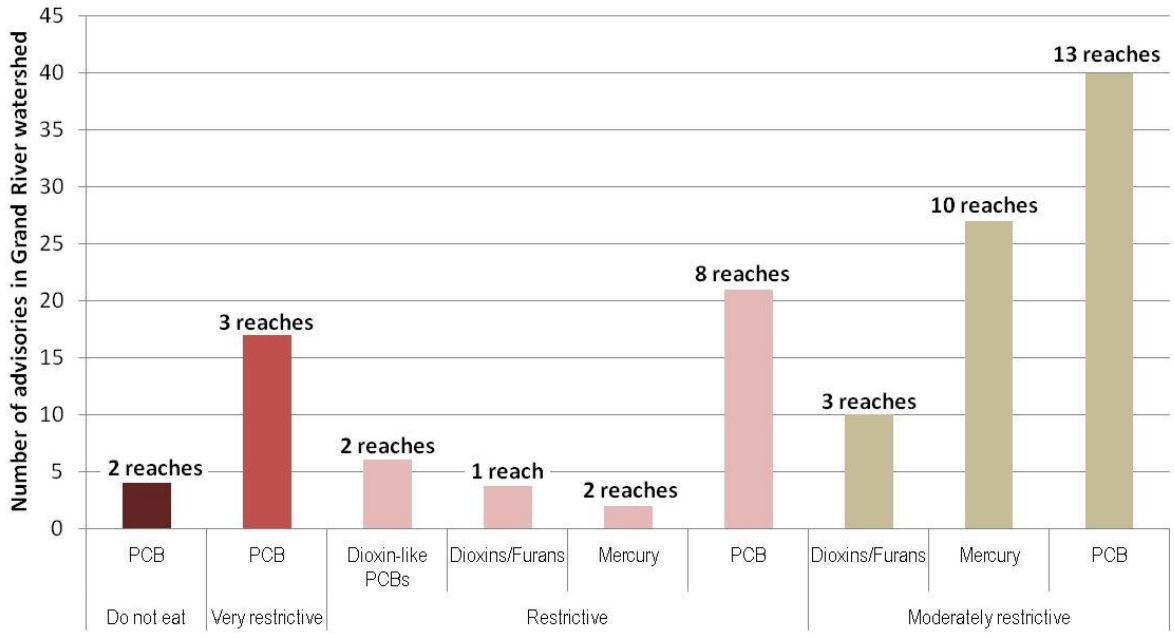


**Figure 2. Total number of advisories (for each species and size class) that are above the least restrictive recommendations for consumption according to OMOE (2011). Recommendations are grouped according to the contaminant causing each advisory. The number of locations affected by each type of advisory are noted at the top of each bar.**

by the OMOE advisories which indicated that carp tend to be highly contaminated when they reach a large size. Similarly, since northern pike are a top-level predator, they have high exposure to contaminants which bioaccumulate. Piscivorous fish (those that prey on other fish) have a diet that is more likely to contain contaminants which bioaccumulate since they can biomagnify at each link in the food web. Therefore, larger piscivorous fish tend to have a relatively high risk to humans if consumed.

Of the 27 locations or reaches within the Grand River watershed for which OMOE has data on which to base an advisory, 14 (52%) had the lowest possible level of restriction (i.e., maximum 8 meals/month) for any species of sport fish that were sampled. Advisories more restrictive than the baseline level are summarized in Figure 2, according to the contaminant which is responsible for increased risk to human health.

Of all restrictions above baseline levels, advisories that were moderately restrictive (no more than 4 meals/month) were the most widespread (Figure 2). These advisories were mostly caused by high concentrations of mercury and/or polychlorinated biphenyls (PCBs) in fish samples. Only two reaches in the watershed had advisories that recommended certain species not be consumed in any amount: large northern pike (>75cm) in the central Grand River (Mannheim weir to Caledonia dam); and large channel catfish in the southern Grand River (Dunnville dam to Lake Erie), both which were based on high concentrations of PCBs. Other compounds (dioxins/furans and dioxin-like PCBs) were only found to be high enough to cause restriction of consumption in a small number of reaches (Table 1).

**Table 1. Relative level of restriction on fish consumption according to advisories for the general population (OMOE 2011) in the Grand River watershed that are based on exposure to dioxin/furans or dioxin-like PCBs.**

| Reach | Species | Size (cm) | Restriction level | Cause for restriction |
|---|---|---|---|---|
| **Canagagigue Creek** | | | | |
| (downstream of Elmira) | Common carp | >50 | Restrictive | dioxin/furans |
| | Common carp | 40-50 | Moderate | dioxin/furans |
| | White sucker | >35 | Moderate | dioxin/furans |
| | Rock bass | >15 | Moderate | dioxin/furans |
| (upstream of Elmira) | Common carp | >50 | Moderate | dioxin/furans |
| **Grand River** | | | | |
| (Belwood dam to Mannheim weir) | Common carp | >60 | Moderate | dioxin/furans |
| (Caledonia dam to Lake Erie) | Rainbow trout | >55 | Restrictive | dioxin-like PCBs |

### *Origin of contaminants in fish captured in the Grand River watershed*

The Grand River watershed is not unique in having restrictions for the consumption of some species of fish; the majority of water bodies in North America also have dietary constraint advisories. It is important to note that contaminants found in sport fish do not necessarily originate from local sources. Some of these toxins can be transported through the atmosphere from hundreds to thousands of kilometres away before being deposited into water bodies via precipitation. Mercury and PCBs are two of the many toxins that are can be transported long

distances and cause the potential contamination in sport fish, even amongst isolated water bodies.

Many fish do not have a fixed distribution; instead, they may travel between areas to feed, for refuge, or for spawning. Since they often move, the contaminants that they have accumulated from exposure through diet or the environment will also be transported. Some species travel long distances, providing that they do not have physical (dams, obstructions, low flow) or physiological (ecological requirements such as water temperature and dissolved oxygen) barriers. Certain fish, such as rainbow trout can also travel to and from Lake Erie, taking up contaminants they would otherwise not have had exposure to within the Grand River watershed. This is an important consideration when interpreting the fish consumption restrictions within the Grand River watershed in the context of the original sources of the contaminants.

In the cross-border report "State of the Great Lakes 2009" (EC & USEPA 2009) it was noted that the contaminants responsible for advisories in Lake Erie on the Ontario side were PCB, dioxin and mercury. Interestingly, the MOE data summarized above indicates these three contaminants are the most widespread occurring contaminants (chiefly PCBs and mercury) in the Grand River watershed. Furthermore, PCBs and mercury are examples of contaminants that are known to travel long distances via the stratosphere and as such, their original source may have been from locations distant from the watershed. Natural sources of mercury exist in the environment; however, the widespread distribution of mercury in fish tissues does not suggest a localized source in the Grand River watershed.

In contrast to the widespread distribution of PCB and mercury, fish contaminated with dioxins or furans have a localized distribution in Canagagigue Creek and adjacent reaches in the Grand River (Table 1). These contaminants are often precursors or a side product of the manufacture of synthetic chemical products and can persist for many years. Their occurrence is related to an historic source of pollution. Riverbed sediments in Canagagigue Creek adjacent to the site of the Uniroyal Chemical Ltd. Plant are known to contain high concentrations of dioxins and furans (OMOE 1997) as well as other toxic compounds with similar sources (e.g. DDT; OMOE 1988). These compounds can accumulate in the tissues of aquatic organisms exposed to contaminated sediments (e.g. benthic organisms) and then biomagnify through the food chain. They have also been show to disperse to downstream reaches during high flow events, attached to suspended sediments (Stone and Haight 2000).

More detailed information and updates regarding the restrictions consumption of fish in specific areas of the watershed can be found in the most recent version of the MOE *Guide to Eating Ontario Sport Fish.*

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