Hamilton Harbour Area of Concern

Status Assessment for the Restrictions on Wildlife Consumption Beneficial Use

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Hamilton Harbour Remedial Action Plan
Executive Summary

Hamilton Harbour was identified as a Great Lakes Area of Concern (AOC) in 1985 due to severely degraded environmental conditions caused primarily by local pollution from industrial and municipal activities (IJC, 1985). A Remedial Action Plan (RAP) was developed to address environmental issues and guide restoration of beneficial use impairments (BUIs) within the AOC. Degraded sediment quality throughout the harbour has been associated with a number of impaired beneficial uses and remains a primary concern in the AOC. Studies have shown that high levels of polychlorinated biphenyls (PCBs) measured in sediment, especially in Windermere Arm, may be bioavailable to aquatic biota. Because PCBs are persistent and bioaccumulative, the main route of exposure for wildlife in aquatic ecosystems is the consumption of contaminated aquatic prey species such as fish.

A screening level assessment was conducted following the tiered approach of the ‘Decision-Making Framework for Assessing the Status of the Wildlife Consumption Beneficial Use in Areas of Concern’ with an emphasis on aquatic wildlife species that may be exposed to local sources of PCBs through their feeding habits. This assessment evaluates evidence of current or historical exposure of wildlife to local sources of PCBs within the AOC. Tissue concentrations were used to assess the risk to human health by comparing an estimated PCB dose for each species to the Health Canada Tolerable Daily Intake (TDI) guideline for PCBs. Finally, for wildlife with elevated PCB levels, consideration was given as to whether these species are currently being consumed by local residents or if there may be a desire to consume them from within the AOC in the future. If wildlife are not being consumed, they are not considered to be a risk to human health – an important distinction of this beneficial use.

Mute Swan and Canada Geese were considered ‘not impaired’ due to the lack of exposure pathway to local PCB sources. Mallard Duck and Lesser Scaup were both identified as species that may potentially be exposed to PCBs in sediment from Hamilton Harbour; however, there was insufficient data available to assess tissue concentrations. Presumably this is because they do not accumulate high levels of PCBs from the sediment. Despite the uncertainty, they were considered ‘not impaired’ in this assessment due to enforcement of by-laws within the AOC and surrounding area that prevent the use of firearms, as well as the protected status of ducks, geese
High PCB concentrations in Herring Gull raise concerns about consumption this species from the Hamilton Harbour AOC. Despite elevated PCB levels, Herring Gull is not a species that is typically consumed by humans. Furthermore, firearms restrictions suggest that the exposure pathway to human consumers is eliminated, therefore does not constitute a beneficial use, and results from the assessment of this species following the decision-making framework lead to a recommended status of ‘not impaired’. Given current PCB tissue concentrations in American Mink, consumption of this species would not result in exceedances of Health Canada’s TDI for a 70 kg adult consuming up to 227 g of muscle meat per day and was therefore considered ‘not impaired’. This is considered an overestimate of the amount that is consumed from the AOC, given that mink is typically considered a fur-bearing mammal. Because there is an open season for harvesting Snapping Turtle in the Hamilton Harbour AOC there is a potential route for human consumption, although it is suspected that consumption rates are low. PCB levels indicated an increased risk to human health from consumption of Snapping Turtle eggs and possibly from consumption of adult turtles. Snapping Turtle (adult and eggs) were therefore considered ‘impaired’ under this assessment.

Overall, results suggest a lack of impairment for the consumption of all wildlife species included in this assessment with the exception of Snapping Turtle. Continued monitoring of contaminants in Herring Gull eggs is recommended, as it will provide valuable information regarding current exposure and long-term trends of contaminants in wildlife from the Hamilton Harbour AOC. Consumers of Snapping Turtle (adults and eggs) should follow the recommended cleaning and cooking guidelines provided in the Ontario Fish Consumption Guide to minimize their exposure and ongoing monitoring of Snapping Turtle eggs should continue under the Restrictions on Fish Consumption Beneficial Use. It is believed that all sources of PCBs in the AOC are known and once mitigation of ongoing sources (i.e., Strathearne Avenue slip) is complete, the resultant improvement in suspended sediment and bottom sediment quality will reduce, and eventually eliminate, exposure of aquatic biota to local sources in Hamilton Harbour. PCB tissue concentrations in wildlife are expected to continue declining as the AOC continues to recover through remedial actions and natural processes.
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1 Background

The Hamilton Harbour Area of Concern (AOC) includes the 2,150 ha sheltered embayment at the west end of Lake Ontario, as well as the surrounding watershed drained by three main tributaries: Grindstone Creek, Red Hill Creek, and Spencer Creek. Within the AOC there are a number of sites of ecological significance, including important nesting, migration stopover and foraging habitat for migratory and non-migratory bird species. On the west end of the Harbour, Cootes Paradise provides coastal marsh habitat important for fish spawning and refuge, and is home to a variety of fish and wildlife species. Windermere Arm and Windermere Basin, located in close proximity to the shipping canal and industrial port in the southeast corner of the Harbour, provide ice-free water and an abundance of food that has attracted regionally rare wintering species to the area (Weseloh et al., 1995). Hamilton Harbour also serves as a breeding ground for many waterfowl species, with a large abundance and variety of species recorded in the harbour and surrounding area (Dobos et al., 1988; Gebauer et al. 1992; Blokpoel and Tessier 1991; Zanchetta et al., 2016).

Hamilton Harbour was designated a Great Lakes AOC in 1985 due to severely degraded environmental quality and ecosystem health caused by local pollution and extensive land use changes which resulted in impairment of a number of beneficial uses (IJC, 1985). Historical discharges from industrial and municipal activities have resulted in degraded water and sediment quality in Hamilton Harbour. Of particular concern are polychlorinated biphenyls (PCBs) which have settled into sediment and continue to be a primary concern due to their persistent, bioaccumulative and toxic nature (HH RAP, 1992a, b). Numerous exceedances of sediment quality guidelines have been reported since the 1970’s, with the highest concentrations occurring in Windermere Arm from sewage treatment plants and storm water outfall discharges (HH RAP, 1992a,b; Labencki, 2008; K. Stevack, University of Guelph, unpublished; Burniston et al., 2016).

Wildlife studies have shown that PCBs accumulated at higher concentrations, compared to other contaminants, in wildlife from the Hamilton Harbour AOC (Hughes et al., 2010). The main route of exposure of PCBs to wildlife in aquatic ecosystems is through the consumption of contaminated aquatic prey species such as fish. Long-term monitoring of fish and waterfowl populations have documented high levels of contaminants, and adverse effects such as low
reproductive success, elevated deformity rates, altered secondary sexual characteristics, elevated mutation rates, and altered immune function (Gilbertson and Reynolds 1972; Gilbertson 1974; Gilbertson et al. 1976; Struger et al. 1987, 1993; Bishop et al. 1995, 1996, 1998; HH RAP 1992a; Weseloh et al. 1995; Yauk and Quinn 1996; Grasman et al. 1996, 2000; de Solla et al. 1998, 2002; Fox et al. 1998, 2002, 2007; HH RAP, 2003). Significant progress has been made through the implementation of the Remedial Action Plan (RAP), which was developed to guide restoration and protection efforts with the ultimate goal of restoring beneficial uses and delisting the AOC (HH RAP, 1989, 1992a, 1992b, 2003). Remedial and management actions have been undertaken to restore many of the Beneficial Uses within the Hamilton Harbour AOC and ongoing monitoring is being conducted to measure changes in water quality and ecosystem health in response these actions. Water quality parameters, sediment toxicity and fish consumption guidelines throughout the AOC have been reported regularly; however, reporting of contaminants in wildlife and the potential risk they may pose to human health have been insufficient.

### 1.1 Restrictions on Wildlife Consumption Beneficial Use Impairment

In 1991 the International Joint Commission (IJC) approved guidelines for listing and delisting Great Lakes AOCs. The intent of these guidelines was to provide direction and focus in the development of RAPs with the ultimate goal of restoring the beneficial use impairments (BUIs) and delisting the AOC. The IJC Listing Criteria for the Restrictions on Fish and Wildlife Consumption BUI stated (IJC, 1991):

> “When contaminant levels in fish or wildlife populations exceed current standards, objectives or guidelines, or when public health advisories are in effect for human consumption of fish or wildlife. Contaminant levels in fish and wildlife must be due to contaminant input from the watershed.”

Since their initial listing, many AOCs have worked with RAP stakeholders to develop comprehensive restoration targets and delisting objectives specific to the needs of each individual AOC. Insufficient contaminant data for wildlife species that are consumed by humans, and a lack of guidelines for consumption have led many AOCs to consider fish and wildlife consumption separately.
An important distinction for this Beneficial Use is the focus on the protection of human health. The status assessment for the *Restrictions on Wildlife Consumption* BUI must therefore provide evidence of the following:

1) Pathway of wildlife exposure to a local contaminant source.
2) Resultant tissue concentrations of contaminant of concern in wildlife that is elevated compared to an appropriate human health benchmark or guideline.
3) Evidence of human consumption of wildlife species.

For example, the Niagara River AOC (Canadian Section) re-designated the BUI status to ‘not impaired’ for wildlife based on the results of a community survey that indicated that wildlife from the area were not being consumed on an ongoing basis (Dillon Consulting Ltd. 2007). If wildlife is not being consumed, there is no risk to human health in a particular area.

1.1.1 **Environmental Conditions and Problem Definition (Stage 1 RAP, 1989)**

The Stage 1 RAP report, first released in 1989 and updated in 1992, described the environmental conditions and problems in the Hamilton Harbour AOC (HH RAP 1989, 1992a). The report identified the beneficial use *Restrictions on Fish and Wildlife Consumption* as ‘impaired’ due to elevated levels of PCBs in fish and waterfowl. The report acknowledged that although hunting is not permitted within the AOC boundaries, and therefore human exposure to contaminants through wildlife consumption is potentially eliminated, there may be risk to hunters in other areas from migratory birds that spend time in Hamilton Harbour (HH RAP, 1989). Despite the lack of guidelines for comparison, PCB concentrations measured in liver and muscle tissue of resident mallard ducks (*Anas platyrhynchos*) exposed to contaminated sediment in Windermere Basin in 1990 suggested that there may be cause for concern (Gebauer and Weseloh, 1993).

1.1.2 **Goals, Options, and Recommendations (Stage 2 RAP, 1992)**

The Stage 2 RAP identified remedial actions required to restore BUIs and delist the AOC (HH RAP, 1992b). In 1998 the RAP Forum, a stakeholder group with representatives from federal and provincial government, industry, municipalities, and other harbour interest groups, was formalized and tasked with revising the Stage 2 RAP (Hall et al., 2006). An
update of the Stage 2 RAP report was released in 2002 which reported on the status of remedial actions and monitoring activities, identified timelines and responsible agencies, and recommended additional remedial actions required to restore BUIs (HH RAP, 2003).

The Stage 2 RAP report included improved wildlife health and contaminant monitoring to contribute to the goal of attaining healthy, self-sustaining resident and non-resident wildlife populations (HH RAP, 2003). The report further identified a lack of available information on wildlife contamination and called for the development of wildlife consumption guidelines.

1.1.3 Remedial Action Plan Stakeholder Forum (2012)

In 2012, RAP stakeholders convened to consider new information that had emerged since the previous Stakeholders Forum in 2002, and to review and update the delisting objectives defined for the Hamilton Harbour AOC. Criteria presented to the stakeholders indicated that objectives used to define BUIs should be reasonable, and consistent with other Canadian AOCs, achievable by the community and measurable (HH RAP, 2011).

The Bay Area Implementation Team (BAIT) and technical committees for each of the BUIs compiled a fact sheet for each beneficial use explaining the proposed status change and identifying the most recent research available. This update included the proposed separation of the BUI Restrictions on Fish and Wildlife Consumption into two distinct beneficial uses where fish and wildlife would be considered individually. The recommendations concerning wildlife consumption were (HH RAP Stakeholder Forum, 2012):

1. That the beneficial use Restrictions on Fish and Wildlife Consumption status regarding wildlife consumption be updated to ‘not impaired’.

2. That no further assessment regarding wildlife consumption for the Restrictions on Fish and Wildlife Consumption beneficial use be necessary prior to delisting.

The RAP Team acknowledged the fact that there are no federal or provincial guidelines or regulations for the protection of human consumers of wildlife for which to compare contaminant levels against. The rationale for this re-designation, however, emphasized the
fact that consumption of wildlife should not be considered a beneficial use for the Hamilton Harbour AOC due to the limited (or non-existent, in many cases) harvest of wildlife from this area. Removal of wildlife consumption as a beneficial use was considered reasonable since there is very little consumption of wildlife from Hamilton Harbour or Cootes Paradise, partially due to the stringent restrictions in place prohibiting the discharge of a firearm within the AOC boundaries.

Feedback from the RAP Forum on the recommended changes to the beneficial use indicated that stakeholders were hesitant to update the status to ‘not impaired’ because they did not want to give the impression that wildlife is safe to consume without sufficient data to support such a claim. One of the reasons stated for the current low level of wildlife consumption is the reduced population levels of traditionally hunted species. Recovery of wildlife population levels are anticipated due to ongoing remedial and management actions within the AOC and it was requested that the wildlife consumption BUI remain part of that recovery process.

As a result of the feedback from the RAP Stakeholder Form, the status of ‘Requires Further Assessment’ remains for the Restrictions on Wildlife Consumption beneficial use. It was further agreed to keep the wording of the delisting objective from the Stage 2 Update (2002) which states that the beneficial use will be considered ‘not impaired’ when there are no restrictions on consumption of wildlife from the Harbour attributable to local sources (HH RAP, 2003).
1.3 Scope and Objectives

This report will assess the current status of the *Restrictions on Wildlife Consumption* Beneficial Use in the Hamilton Harbour AOC with a focus on aquatic wildlife species that may be exposed to local sources of PCBs through their feeding habits. A screening level assessment was conducted following the *Decision-Making Framework for Assessing the Status of the Wildlife Consumption Beneficial Use in Areas of Concern* (Figure 1, Chapter 3).

The key objectives of this evaluation were to:

- Identify aquatic wildlife species of interest in the Hamilton Harbour AOC based on potential pathways for contaminant exposure and evidence of current ongoing (or desired) harvest.

- Review available data on PCB concentrations in aquatic wildlife from the Hamilton Harbour AOC during the early 1990’s to present, including the most recently available data collected by the Canadian Wildlife Services (CWS) for PCB concentrations in Snapping Turtle (*Chelydra serpentina*), Herring Gull (*Larus argentatus*), and American Mink (*Neovison vison*).

- Identify available consumption guidelines for human consumers of aquatic wildlife species of interest and compare current PCB levels in aquatic wildlife from Hamilton Harbour to available guidelines.

- Provide a recommendation for the status of the *Restrictions on Wildlife Consumption* Beneficial Use in the Hamilton Harbour AOC.
2 Literature Review & Methodology

A literature review was conducted to identify availability of data reporting tissue PCB concentrations in aquatic wildlife from the Hamilton Harbour AOC. In addition, this report presents the most recent data available from CWS for tissue and/or egg PCB concentrations in Snapping Turtle (*Chelydra serpentina*), Herring Gull (*Larus argentatus*), and American Mink (*Neovison vison*). A brief description of the methodology employed by each study is presented in this section. Studies investigating contaminants in wildlife collected from Lake Ontario and other areas in the Great Lakes basin will also be discussed where applicable for comparative purposes.

**Herring Gull (*Larus argentatus*)**

The CWS Great Lakes Herring Gull Monitoring Program (GLHGMP) provides data on spatial and temporal trends of contaminant levels in Herring Gull feeding in the Great Lakes. Monitoring in Hamilton Harbour began in 1981 with eggs collected from colonies at Eastport (Piers 26-27), Windermere Basin, or Neare and Farr Islands in the north east corner of Hamilton Harbour. Sample collection (Mineau *et al.*, 1984; Pekarik and Weseloh, 1998; Hebert *et al.*, 1999) and analytical methods (Norstrom *et al.*, 1990; Norstrom and Simon, 1991; Simon and Wakeford, 2000; Neugebauer *et al.*, 2000; Won *et al.*, 2001) have been described in detail. Briefly, a pooled sample of 10 to 13 eggs per nest was analyzed for concentrations of mercury, polychlorinated dibenzo-\(p\)-dioxins and dibenzofurans (PCDD/Fs) and PCBs from 15 Annual Monitoring Colonies (AMCs) throughout the Great Lakes, including four AOCs (Hamilton Harbour, Toronto Harbour, Niagara River, and Detroit River).

PCB concentrations measured in eggs of Herring Gulls collected from the Hamilton Harbour AMC in 1982, 1984, 1986, 1987, 1989, 1991 and 1992 were reported by Weseloh *et al.* (1995). Spatial trends of contaminants among the Great Lakes AMCs, including Hamilton Harbour, have been previously described using mean contaminant levels in eggs collected from 2003 to 2007 (Hughes *et al.*, 2010). PCB contaminant levels in Herring Gull eggs (measured) and pectoral muscle (estimated) collected from the Hamilton Harbour AMC between 2010 and 2015 are presented in this report. PCB concentrations for this time period are presented as mean sum PCBs measured from 6 pools of Herring Gull eggs (1 pool per year) collected using the sampling methods previously described. PCB concentrations measured in Herring Gull eggs were used to
calculate liver concentration estimates using a sum PCB lipid weight ratio of 0.77 for egg/liver as described in Braune and Norstrom (1989). Liver PCB concentrations were then converted to muscle concentrations using a mean sum PCB lipid weight ratio of 0.75 for liver/muscle from Wan et al. (2006) and based on a mean of 6.25% lipid in muscle for nesting gulls from Chantry Island (Great Lakes reference site on Lake Huron) in 1975 (ECCC, unpublished).

**Snapping Turtle (Chelydra serpentina)**

Between 2001 and 2004 the CWS performed an extensive Great Lakes basin-wide study that measured contaminant levels in Snapping Turtle eggs. Complete details regarding sample collection and contaminant analysis can be found in Hughes et al. (2010) and de Solla et al. (2007, 2008). Eggs were collected from two locations within the Hamilton Harbour AOC: Cootes Paradise and Grindstone Creek. PCB concentrations measured in Snapping Turtle eggs from Hamilton Harbour were compared to a remote reference upstream site, Tiny Marsh, located near the shore of Lake Huron, as well as a second non-AOC reference site downstream on the St. Lawrence River. Entire clutches of eggs were collected within 48 h of oviposition and a subset of five eggs (including a mixture of eggs from the top, bottom and middle of the nest) was selected for contaminant analysis. Previously reported Snapping Turtle egg PCB concentrations for Grindstone Creek and Cootes Paradise will be discussed briefly in this report, in addition to presenting egg (measured) and muscle (estimated) concentrations for the period of 2012-2014. PCB concentrations measured in eggs from 49 clutches collected throughout Cootes Paradise and Grindstone Creek were used to estimate muscle concentrations using a sum PCB lipid wt. ratio of 0.4 egg/muscle derived from Russell et al. (1999) and based on a mean of 0.42% lipid in muscle for turtles collected from Great Lakes sites throughout southern Ontario (Hebert et al., 1993).
American Mink (*Neovison vison*)

Contaminant levels in mink collected from Hamilton Harbour during 2004 and 2005 have previously been reported and compared to mink collected from a non-AOC reference site on eastern Lake Ontario, as well as three inland Ontario reference sites (Hughes *et al.*, 2010). Mink collected from Hamilton Harbour were captured either near Cootes Paradise marsh at the western end of the harbour, or south of the City of Hamilton. A detailed description of capture locations and sampling methods can be found in Hughes *et al.* (2010). Mink livers were analyzed for PCB concentrations according to the methods of Norstrom *et al.* (1988). The current report presents sum PCB concentrations for 7 mink collected as road-kill in close proximity (6.5 km) to Hamilton Harbour between 2004 and 2012 (including those previously reported by Hughes *et al.*, 2010). PCB concentrations measured in liver tissue were used to estimate muscle concentrations using a sum PCB ratio of 1.74 for liver/muscle from Henny *et al.* (1981) for wild mink.

**Waterfowl**

Weseloh *et al.* (1995) reported contaminant data for waterfowl collected from the Hamilton Harbour AOC by CWS during the 1980’s, including PCB concentrations in liver and pectoral muscle tissue concentrations from Mallard Duck, Lesser Scaup (*Aythya affinis*) and Canada Goose (*Branta canadensis*).
3 Decision-Making Framework for Assessing the Status of the Restrictions on Wildlife Consumption Beneficial Use

The Decision-Making Framework for Assessing the Status of the Restrictions on Wildlife Consumption Beneficial Use in Areas of Concern (i.e., “the framework”) (Figure 1) provides a systematic approach to assessing the status of this beneficial use through a series of detailed questions that allow for a decision to be reached at multiple stages throughout the process. This framework was developed based on the key elements of the risk assessment process, taking into consideration the goals of the RAP process, and limited availability of site-specific data.

The questions provided in the framework address local contaminant conditions (Tier 1) and potential routes of exposure for aquatic wildlife (Tier 2). Once wildlife species have been identified that may be exposed to local sources of PCBs through their feeding habits, tissue PCB concentrations can be compared to available guidelines (Tier 3). In lieu of federal or provincial human health guidelines for the consumption of wildlife, related exposure guidelines and consumption advisories should be identified for RAP stakeholders to consider using professional judgement. These exposure guidelines can then be applied to the development of a site-specific risk estimation if there is sufficient data available to identify rates and quantity of wildlife consumption by local residents (Tier 4). At this point in the framework, the majority of AOCs will be able to reach a conclusion determining whether consumption of wildlife from the AOC poses an acceptable (i.e., beneficial use is ‘not impaired’) or unacceptable (i.e., beneficial use is ‘impaired’) risk to human health. However, if a conclusion has not been reached at this point in the process, the framework provides opportunities to compare AOC conditions to an appropriate reference site (Tier 5) or to apply a weigh-of-evidence approach (Tier 6) to strengthen the status assessment. This section will address each tier of the assessment framework in detail, as applicable to the Hamilton Harbour AOC.
Figure 1 Decision-making framework for assessing the status of the Restrictions on Wildlife Consumption beneficial use in Canadian Areas of Concern.
3.1 Contaminant Conditions in the Hamilton Harbour AOC (Tier 1)

The first step in the framework to assessing the Restrictions on Wildlife Consumption Beneficial Use is to classify contaminant conditions within the AOC by determining whether there is ongoing or historical contamination attributable to local sources. In the Hamilton Harbour AOC it has been well established that historical discharges of PCBs into the Harbour have resulted in contaminated sediment and therefore pose a potential risk to aquatic biota (HH RAP 1989a,b).

Although PCB concentrations declined substantially from the 1980’s to the early 1990’s, recent measurements suggest that surface sediment in some areas of Hamilton Harbour and Windermere Arm remain elevated above the Canadian Council of Ministers of the Environment (CCME) Probable Effect Level (PEL) of 277 ng/g dry wt. (CCME, 2001), and the Provincial Sediment Quality Guideline (PSQG) Lowest Effect Level (LEL) of 70 ng/g dry wt. (MOEE, 1993) for total PCBs (Labencki, 2008; Burniston et al., 2016; K. Stevack, University of Guelph, unpublished data).

Temporal trends in PCB congener patterns measured in sediment from Windermere Arm (the area of the harbour with the highest PCB concentrations) suggest a consistent PCB source over time, with a congener pattern indicative of a relatively high bioaccumulation potential (Labencki, 2008). The potential for PCBs to persist in sediment and bioaccumulate in aquatic organisms has resulted in an emphasis on remedial actions related to contaminated sediments in the Hamilton Harbour AOC over the past 30 years. The Stage 2 RAP Update (2002) stressed the importance of managing contaminant levels in sediment, particularly in the Windermere Arm, by linking PCB concentrations measured in fish with those measured in sediment from Hamilton Harbour (HH RAP, 2003). The report further attributed the ‘impaired’ status of the Restrictions on Dredging, Degradation of Benthos, and Restrictions on Fish and Wildlife Consumption BUlIs to elevated sediment PCB concentrations (HH RAP, 1992b).
Restrictions on Dredging Activities

Status: Impaired

Elevated contaminant levels, particularly PCBs and Polycyclic Aromatic Hydrocarbons (PAHs), in harbour sediment have resulted in restrictions to dredging of sediment from the navigational areas. Previously dredged sediments have been secured in confined disposal facilities; however, an alternative disposal location or method will need to be developed due to the limited capacity of the existing disposal facility. At this time, remedial dredging in Windermere Arm is not recommended due to the risk of exposing more highly contaminated sub-surface sediment (Labencki, 2008).

Degradation of Benthos

Status: Impaired

Monitoring has confirmed impairment of the benthic community structure throughout Hamilton Harbour. Benthic communities reported in 1984 were dominated by pollution-tolerant species, which is consistent with reported conditions of high sediment contaminant levels and extended periods of low to no oxygen (HH RAP, 1992a). A survey conducted in 2000 indicated that the benthic community remained ‘impaired’ at more than half of the sites surveyed with a low taxon diversity, and strong evidence of toxicity at 21 sites (Milani and Grapentine, 2006). Completed upgrades to wastewater treatment plants (WWTPs) discharging into the harbour and ongoing sediment remediation work at Randle Reef (to address PAH contamination) and the ArcelorMittal Dofasco boat slip are expected to result in natural recovery of the benthic community.

Restrictions on Fish Consumption

Status: Impaired

Restricted consumption of 21 fish species is advised in Hamilton Harbour due to elevated contaminant levels, with PCBs being the main driver of consumption advisories (MOECC, 2015; Neff et al., 2016). A number of projects have been completed that have resulted in the elimination of discharges of persistent toxic substances, and addressed other problems associated with municipal and industrial discharges into the harbour. A decline in PCB concentrations in fish tissue is expected to result from these projects and is being used as a
surrogate for improvements in local sediment and water quality conditions. However, it is important to note that many Hamilton Harbour sport fish are migratory and may accumulate high tissue concentrations of PCB from sources outside of the AOC, or may move contaminants from Lake Ontario into the Hamilton Harbour food chain.

### 3.2 Wildlife Contaminant Exposure (Tier 2)

Given the historical conditions in Hamilton Harbour and ongoing concerns regarding resuspension and bioavailability of PCBs from sediment (Tier 1), the next step in evaluating the Restrictions on Wildlife Consumption Beneficial Use is to understand the potential pathways through which wildlife may be exposed to PCBs (Tier 2). In addition to determining which species are potentially exposed to local sources of PCBs on an ongoing basis, the second tier of this assessment also considers evidence of PCB contamination in wildlife from the Hamilton Harbour AOC due to historical conditions. For the purpose of this assessment, the exposure pathway (or lack thereof) will only be identified for wildlife species that are traditionally hunted and consumed by humans.

#### 3.2.1 Exposure Pathway

Food web dynamics and feeding behaviour play an important role in the accumulation of contaminants in aquatic wildlife. The primary route of PCB exposure for wildlife tends to be through consumption of contaminated prey, with the highest rates of bioaccumulation in species such as mink that feed at the top of the food chain. When tissue PCB concentrations are not available, as is the case for muskrat from the Hamilton Harbour AOC, identifying pathways for PCB exposure can be used as a line of evidence for identifying potential risk to human consumers.

**Herring Gull (Larus argentatus)**

Herring Gulls primarily eat fish and invertebrates, although they will also opportunistically feed on garbage and other food items. Because they are a non-migratory as adults and tend to remain near their breeding grounds, foraging relatively short distances from their colony, they have been widely used as an indicator species of health and contaminant exposure in fish-eating wildlife species within the Great Lakes. Herring Gull eggs are also able to
provide important information about contaminant accumulation, because of their relatively high lipid content (de Solla et al., 2016).

**Snapping Turtle (Chelydra serpentine)**

Snapping Turtles are opportunistic omnivores and spend most of their time underwater. Their diet typically consists of approximately 1/3 vegetation, 1/3 fish, and 1/3 miscellaneous food sources, including amphibians, reptiles, birds, bird eggs, crustaceans (Alexander, 1943). In the Hamilton Harbour AOC Snapping Turtles reside along the western edge of the Harbour, primarily in Cootes Paradise, with home ranges of 0.1-28.4 ha (Bishop et al., 1994; Pettit et al., 1995). The Snapping Turtle population in the AOC has been declining since the late 1980’s, and in 2015 was estimated to be approximately 100–150 individuals (S. Richler, RBG, pers. comm.). The small home range and long lifespan of Snapping Turtles make them a good indicator of local sources of contaminants. Snapping Turtle eggs are commonly used as indicators of wetland health and contaminant bioavailability, as well as providing spatial and temporal trends for persistent contaminants such as PCBs (Golden and Rattner, 2003).

**American Mink (Neovison vison)**

American Mink are carnivorous aquatic mammals common throughout Ontario. Their webbed feet make them excellent swimmers and divers and they spend the majority of their time in or around water. Mink feed on rodents, fish, crustaceans, frogs, and birds. Because of their high trophic level, they are vulnerable to the effects of PCBs and can accumulate high levels through food sources (Basu et al., 2007).

**Muskrat (Ondatra zibethicus)**

Muskrats live in wetlands and have historically been, and in some areas continue to be, an important traditional food source for First Nations communities. They typically eat a variety of plants, including cattails, sedges, arrowhead, and pondweed. When plant food is scarce they have been known to eat animals such as snails, fish, frogs, and salamanders. Because muskrat feed lower on the food chain than mink, with animals comprising a small portion of their diet, it is expected that PCB burdens will be lower in muskrat. If contaminant levels
measured in mink are below the level at which there is potential concern for human consumption, then it is assumed that levels in muskrat can also be considered acceptable.

**Mallard Duck (Anas platyrhynchos)**

Mallard Ducks are commonly found across North America, and are a species that is traditionally hunted and consumed. They are generalist foragers and will eat a variety of foods. Mallards are a dabbling duck, which means that they feed primarily in shallow waters by tipping headfirst into the water and grazing on aquatic vegetation and seeds. Although they are not exposed to contaminants through the food chain, there is potential for mallards to be indirectly exposed to contaminants in sediment while feeding.

**Mute Swan (Cygnus olor)**

The Mute Swan (Cygnus olor) is a non-native species in Canada that has become abundant in the Great Lakes region (Knapton, 1993; Petrie and Francis, 2003). Mute Swan feed mainly by grazing on aquatic vegetation in shallow waters, but will sometimes eat small aquatic animals such as frogs, fish, and insects (Bailey *et al.*, 2008; Ciaranca *et al.*, 1997). They tend to skim plants from the water’s surface, but may submerge themselves to reach deeper plants, or rake the bottom with feet to dig up plants. An individual bird can uproot as much as 9.0 kg (wet wt) of vegetation each day (Willey and Halla, 1972; Fenwick, 1983). In the Hamilton Harbour AOC there tends to be two distinct feeding populations of Mute Swans, with one group feeding in Hamilton Harbour and the other throughout Cootes Paradise marsh during the summer months; However low water and ice conditions during the winter often result in movement of swans from Cootes to the Harbour (T. Theysmeýer, Royal Botanical Gardens, pers. comm.). Because of the differences in habitat, Mute Swans feeding in Hamilton Harbour are not likely exposed to contaminated sediment through feeding. While swans feeding in Cootes Paradise are more likely to be exposed to bottom sediments, there is no known source of PCB contamination in this part of the AOC.

**Canada Goose (Branta canadensis)**

Canada Geese have become abundant in many urban areas and are often considered a nuisance. The Hamilton Harbour AOC is host to “resident” populations and also acts as a stopover for migrating populations during spring and fall. Although geese spend a large...
portion of their time on the water, they are ground feeders and tend to feed exclusively on grain and turf grasses and therefore are not exposed to AOC contaminant sources through feeding.

**Lesser Scaup (Aythya affinis)**

The Lesser Scaup is one of the most common species of diving duck in North America. The lower Great Lakes, including Hamilton Harbour, provide important staging habitats for Lesser Scaup during spring and fall migrations (Petrie and Badzinski, 2006). They feed by sifting through bottom sediments, eating mainly mollusks, snails, crustaceans, macroinvertebrates and aquatic plants, with zebra mussels comprising a large portion of their diet on the lower Great Lakes. Lesser Scaup may therefore may be exposed to contaminants through feeding in the Hamilton Harbour AOC. It is not known how long of a duration Lesser Scaup remain at these staging areas before migrating to nesting areas, making it difficult to determine the source of contaminant exposure. However, they do appear to be spending substantially longer periods on the lower Great Lakes in recent years (Petrie and Badzinski, 2006). Research conducted by the Long Point Waterfowl and Wetlands Research Fund has further illustrated that Lesser Scaup do not necessarily visit the same stopover sites during spring and fall migration (Petrie and Badzinski, 2007b).

### 3.2.2 Tissue PCB Concentrations

PCB levels in wildlife from the Hamilton Harbour AOC that have been exposed to local contaminant sources provide important information that can be used to inform consumption guidelines and assess the risk of wildlife consumption to human health for particular wildlife species. This section investigates tissue PCB concentrations in wildlife species that have been identified as having increased potential to bioaccumulate PCBs due to their feeding dynamics and/or are traditionally hunted and consumed by humans. Because muscle tissue is the primary food source for human consumers of wildlife, PCB concentrations measured directly from muscle are most informative. In the absence of this information, however, appropriate conversion factors can be applied to concentrations measured in other tissues (e.g., liver, eggs) from the species of interest in order to estimate...
muscle concentration. This estimated muscle concentration can then be compared to appropriate consumption advisories or guidelines (Tier 3).

**Herring Gull (Larus argentatus)**

Contaminant levels in Herring Gull eggs have been well studied throughout the Great Lakes through the GLHGMP. PCB concentrations measured in wildlife eggs can be difficult to interpret in terms of risk to human health, unless the eggs are being consumed directly. However, they can provide important information about spatial and temporal trends of contaminants, and can be useful in deriving estimates for tissue concentrations in adults. PCB concentrations measured in eggs from Herring Gull collected from Hamilton Harbour have been well documented (Table 1) and have declined significantly since monitoring began in 1981 (Hughes *et al*., 2010; de Solla *et al*., 2016; Hughes *et al*., 2016).

PCB levels measured in Herring Gull eggs collected during 2003-2007 contributed to a high overall contaminant ranking (4 out of 15) for Hamilton Harbour compared to other sites in the Great Lakes basin. However, PCB concentrations measured in eggs collected during this time period were not significantly different compared to those collected at the Lake Ontario reference colony at Snake Island; however, PCB concentrations were significantly higher in Hamilton Harbour compared to Chantry Island on Lake Huron (upstream Great Lakes reference site) during the same time period (Hughes *et al*., 2010). One possible explanation for this could be that Herring Gull in Hamilton Harbour are exposed to PCBs from sources outside of the AOC – For example, through the consumption of migratory fish that have accumulated high PCB concentrations from Lake Ontario.

The most recent PCB concentrations (4.45 ± 0.80 µg/g wet wt) measured in eggs collected between 2010 and 2015 indicate that PCB levels are continuing to decline in Herring Gull from the Hamilton Harbour AOC (Tables 2 & 3). Using concentrations measured in eggs, a mean sum PCB concentration of 6.07 ± 0.16 µg/g wet wt (max. 7.46 µg/g) was derived for adult Herring Gull pectoral muscle during the period of 2010-2015.
### Table 1

Mean sum PCB concentration (µg·g⁻¹ wet wt) in Herring Gull eggs from the Hamilton Harbour Area of Concern as previously reported for individual year between 1981 and 2007, and for pooled eggs collected between 2010 and 2015.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Sum PCB (µg·g⁻¹ wet wt)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>36a</td>
<td>Weseloh et al., 1995</td>
</tr>
<tr>
<td>1981</td>
<td>16</td>
<td>de Solla et al., 2016</td>
</tr>
<tr>
<td>1982</td>
<td>15</td>
<td>Weseloh et al., 1995</td>
</tr>
<tr>
<td>1984</td>
<td>20</td>
<td>Weseloh et al., 1995</td>
</tr>
<tr>
<td>1986</td>
<td>12</td>
<td>Weseloh et al., 1995</td>
</tr>
<tr>
<td>1987</td>
<td>8.3</td>
<td>Weseloh et al., 1995</td>
</tr>
<tr>
<td>1989</td>
<td>16</td>
<td>Weseloh et al., 1995</td>
</tr>
<tr>
<td>1991</td>
<td>8.1</td>
<td>Weseloh et al., 1995</td>
</tr>
<tr>
<td>1992</td>
<td>14</td>
<td>Weseloh et al., 1995</td>
</tr>
<tr>
<td>2006</td>
<td>7.3</td>
<td>Hughes et al., 2010</td>
</tr>
<tr>
<td>2007</td>
<td>7.4</td>
<td>Hughes et al., 2010</td>
</tr>
<tr>
<td>2013</td>
<td>3.8</td>
<td>de Solla et al., 2016</td>
</tr>
<tr>
<td>2010-2015</td>
<td>4.5</td>
<td>This Report, Table 3</td>
</tr>
</tbody>
</table>

* Arithmetic mean

### Snapping Turtle (*Chelydra serpentine*)

A survey of temporal trends in Snapping Turtle eggs collected between 1981 and 1990 showed elevated PCB concentrations at Cootes Paradise compared to the majority of locations measured within the Great Lakes basin (Bishop *et al.*, 1996). The high PCB concentrations found in Snapping Turtle from Cootes Paradise is likely due to their consumption of large fish species that migrate to the wetland from Hamilton Harbour and other areas of Lake Ontario. For example, Snapping Turtle in Cootes Paradise have been known to consume carp, which frequented the wetland prior to the completion of a fishway at the mouth of Desjardins Canal in 1996 (Bishop *et al.*, 1996; RBG, 2015).

Although studies investigating contaminant levels in Snapping Turtles from the Hamilton Harbour AOC tend to focus on Cootes Paradise (Table 2), a survey of environmental contaminants in Snapping Turtle eggs collected throughout the Great Lakes during 1984 found the highest concentration of PCBs (12.2 µg/g wet wt as PCB 1254:1260) in Snapping Turtle eggs from Grindstone Creek (Struger *et al.*, 1993). A follow up study of eggs
collected between 2001-2004 from both Grindstone Creek and Cootes Paradise reported mean sum PCB concentrations of 1.71 and 1.31 µg/g wet wt, respectively (COSEWIC, 2008; de Solla et al., 2007, 2008; Hughes et al., 2010). While there is evidence of decreasing levels of contaminant exposure in eggs between 1984 and 2002, PCB concentrations within the AOC remain significantly elevated compared to reference sites (Hughes et al., 2010). A mean sum PCB concentration of $1.54 \pm 1.11$ µg/g wet wt measured in eggs collected from 49 clutches throughout Cootes Paradise and Grindstone Creek, between 2012 and 2014 indicated that levels may be continuing to decline. However, levels as high as 6.10 µg/g wet wt were reported during this period (Table 3).

Table 2  Sum PCBs concentrations (µg·g⁻¹ wet wt) in Snapping Turtle eggs collected from Cootes Paradise between 1984 and 2002 and pooled eggs collected from Grindstone Creek and Cootes Paradise from 2012 to 2014.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Sum PCB (µg·g⁻¹ wet wt)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>1.31</td>
<td>Struger et al., 1993</td>
</tr>
<tr>
<td></td>
<td>1.30</td>
<td>Bishop et al., 1996; Ashpole et al., 2004</td>
</tr>
<tr>
<td>1986</td>
<td>2.10</td>
<td>Bishop et al., 1995</td>
</tr>
<tr>
<td></td>
<td>1.72</td>
<td>Bishop et al., 1995</td>
</tr>
<tr>
<td></td>
<td>1.65</td>
<td>Bishop et al., 1995</td>
</tr>
<tr>
<td>1988</td>
<td>3.26</td>
<td>Bishop et al., 1996</td>
</tr>
<tr>
<td>1989</td>
<td>2.13</td>
<td>Bishop et al., 1996</td>
</tr>
<tr>
<td></td>
<td>2.08</td>
<td>Bishop et al., 1998</td>
</tr>
<tr>
<td>1990</td>
<td>3.27</td>
<td>Bishop et al., 1996</td>
</tr>
<tr>
<td></td>
<td>3.57</td>
<td>Bishop et al., 1998</td>
</tr>
<tr>
<td>1998</td>
<td>2.96</td>
<td>de Solla et al., 2002</td>
</tr>
<tr>
<td>1999</td>
<td>1.90</td>
<td>Ashpole et al., 2004</td>
</tr>
<tr>
<td>2002</td>
<td>1.31</td>
<td>COSEWIC, 2008</td>
</tr>
<tr>
<td>2012-2014</td>
<td>1.54</td>
<td>This report, Table 3</td>
</tr>
</tbody>
</table>

When converted to estimates for PCB levels in muscle tissue, the resultant concentrations of $0.30 \pm 0.21$ µg/g wet wt are relatively low (Table 3). In terms of evaluating the risk to human health, the estimated muscle PCB concentrations may underestimate the actual exposure from turtle meat when traditional cooking methods are employed, such as the preparation of a turtle soup which may contain multiple tissues and organs which may have a higher fat content. Bryan et al. (1987) determined that fat, even in small amounts, can
elevate contaminant levels in turtle meat. This can be addressed through proper preparation and cooking practices that reduce the amount of fat consumed.

**American Mink (Neovison vison)**

Mink collected from Hamilton Harbour during 2004-2005 had higher mean liver PCB concentration (0.219 ± 0.152 µg/g wet wt) compared to mink collected from two reference locations (0.048 ± 0.015 and 0.083 ± 0.058 µg/g wet wt) in Ontario; However, overall sum PCB burdens were not statistically different from reference sites and were within the mid-range of values compared to other Great Lakes locations (Hughes et al., 2010). Mean sum PCB concentration in mink collected between 2004-2012 was 0.28 ± 0.36 µg/g (wt wt) in liver (measured) and 0.16 ± 0.21 µg/g (wt wt) in muscle (estimated) (Table 3).

**Mallard Duck (Anas platyrhynchos)**

In 1986, a survey of organochlorine contaminant levels in waterfowl species from Hamilton Harbour indicated that Mallards had some of the lowest PCB concentrations (1.3 µg·g⁻¹ wet wt as PCB 1254:1260 in muscle), compared to other duck species (Weseloh et al., 1995). Additional research exposing domestically-raised Mallards to contaminated sediment in the Hamilton Harbour confined disposal facility during 1990 show that they were able to accumulate PCBs at an average rate of 0.016 µg·g⁻¹ per day over a ten-day period (Gebauer and Weseloh, 1993). While this research is not indicative of PCB levels in wild birds, it was able to illustrate the potential bioavailability of sediment PCBs to aquatic biota that may feed in this area of the Harbour. Despite the low levels of PCBs measured in wild duck, mallards have been included in this assessment due to their status as a species that is traditionally hunted and consumed by humans, and their potential to be indirectly exposed to contaminants in sediment while feeding.

**Mute Swan (Cygnus olor)**

The Mute Swan has been the subject of many studies investigating metal contaminant burdens and lead poisoning in Europe (e.g., Eskildsen and Grandjean, 1984; Mudge, 1983; O’Halloran et al., 1988) and (to a lesser extent) in North America (e.g., Beyer et al., 1998; Schummer et al., 2011). Although there has been a fair amount of attention given to the disruptive foraging behavior of Mute Swan in the lower Great Lakes, there is insufficient
evidence to evaluate PCB contaminant burdens on Mute Swan in Hamilton Harbour. Because Mute Swan are not likely (to currently be or historically have been) exposed to local sources of PCBs through feeding (Tier 2, 3.2.1) and there is no evidence to suggest that swans in the Hamilton Harbour AOC have elevated tissue PCB levels, they are not considered to pose a risk to human health.

Furthermore, the Mute Swan is a federally protected species in Canada under the *Migratory Birds Convention Act (1994)* and therefore hunting of Mute Swan is illegal. This status is currently under review (Meyer et al., 2012) but any changes would not affect the recommended status under the *Restrictions on Wildlife Consumption Beneficial Use for Hamilton Harbour* due to the lack of evidence for PCB exposure.

**Canada Goose (*Branta canadensis*)**

Because Canada Geese feed primarily on turf grass, they are not exposed to contaminated sediments through feeding and tend to accumulate very low levels of contaminants compared to other species of waterfowl. For example, Canada Geese captured throughout New York state between 1983 and 1984 had significantly lower PCB levels compared to ducks, including Mallard and Scaup (Foley, 1992). Canada Geese collected along the southern shore of Lake Ontario exhibited low concentrations of PCB residues in both fat (0.1 ± 0.03 µg/g wet wt) and muscle (< 0.1 µg/g wet wt) (Foley, 1992). In Hamilton Harbour, Canada Goose eggs collected in 1987 and 1989 had lower levels of all organochlorine contaminants measured, including PCBs (≤ 0.7 µg/g wet wt), compared to other species (Weseloh et al., 1995). Because there is no route through which Canada Geese would potentially be exposed to local sources of PCBs (Tier 2, 3.2.1), as confirmed by historical tissue concentration measurements, they are not considered to pose a risk to human health and will not be considered further in this assessment.
Table 3  Sum PCB concentrations (µg·g⁻¹ wet wt) in aquatic-feeding wildlife in the Hamilton Harbour Area of Concern from 2004-2015. PCB concentrations are based on collected tissues of Snapping Turtles (eggs), Herring Gulls (eggs) and mink (liver) that were quantified in the laboratory. Corresponding estimated sum PCB concentrations were determined for muscle of these species using methods described in the footnotes. Mean, standard deviation (SD), minimum and maximum concentrations are provided. Data provided by: K.D. Hughes, S.R. de Solla, & P.A. Martin, Environment and Climate Change Canada.

<table>
<thead>
<tr>
<th></th>
<th>Snapping Turtles</th>
<th>Herring Gulls</th>
<th>Mink</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grindstone Creek &amp; Cootes Paradise³</td>
<td>Hamilton Harbour Colony³</td>
<td>Hamilton Harbour³</td>
</tr>
<tr>
<td></td>
<td>49 Egg Clutches</td>
<td>6 Egg Pools</td>
<td>7 Mink</td>
</tr>
<tr>
<td>Mean Sum PCBs</td>
<td>1.54</td>
<td>4.45</td>
<td>0.28</td>
</tr>
<tr>
<td>SD</td>
<td>1.11</td>
<td>0.80</td>
<td>0.36</td>
</tr>
<tr>
<td>Min.</td>
<td>0.07</td>
<td>3.76</td>
<td>0.01</td>
</tr>
<tr>
<td>Max</td>
<td>6.10</td>
<td>5.70</td>
<td>0.80</td>
</tr>
</tbody>
</table>

³ Egg clutches were collected from multiple locations along Grindstone Creek and Cootes Paradise with five eggs from a single clutch pooled for chemical analysis.

³ Herring Gull colony is Neare Island in Hamilton Harbour where a single egg pool comprised of 13 eggs was chemically analyzed per year.

³ Mink were collected as road-kill within 6.5km of Hamilton Harbour.

⁴ Egg to muscle concentrations estimated using sum PCB lipid wt ratio of 0.4 for egg/muscle from Russell et al. (1999) and based on mean of 0.42% lipid in muscle of turtles from southern Ontario Great Lakes sites (Hebert et al. 1993).

⁵ Egg to liver concentrations estimated using sum PCB lipid wt ratio of 0.77 for egg/liver from Braune and Norstrom (1989). Liver to muscle concentrations estimated using mean sum PCB lipid wt ratio of 0.75 for liver/muscle in Herring Gulls from Wan et al. (2006) and based on a mean of 6.25% lipid in muscle of nesting gulls from Chantry Island in 1975 (ECCC, unpublished).

⁶ Liver to muscle concentrations estimated using sum PCB ratio of 1.74 for liver/muscle from Henny et al. (1981) in wild mink.

Notes:

- Estimated PCB concentrations were determined using reported relationships or patterns between various tissue types in these three species based on a review of the scientific literature. These relationships are based on the assumption that distribution of PCBs among tissues in the animal are in steady state equilibrium at the time of collection.

- Estimated tissue concentrations may be slightly underestimated since quantified sum PCB concentrations are based on varying numbers of PCB congeners used to calculate the sum with the majority (77%) of sum PCBs in tissues comprised of the sum concentration of 62 individual or co-eluting congeners and the remaining tissues comprised of 34-38 individual or co-eluting PCB congeners.
Lesser Scaup (*Aythya affinis*)

PCB concentrations measured in Lesser Scaup from Hamilton Harbour in 1986 were among the highest (9.7 µg/g wet wt, as PCB 1254: 1260 in pectoral muscle) for all species of waterfowl collected (Weseloh *et al.*, 1995). However, preliminary results from the Long Point Waterfowl and Wetlands Research Fund study investigating contaminant burdens of Lesser Scaup staging on the lower Great Lakes during spring and fall migration, indicate that PCBs are not being acquired by scaup at levels that would be expected to impact their health or reproduction (Petrie and Badzinski, 2007a).

### 3.3 Consumption Guidelines (Tier 3)

Despite recognition that there has been an ongoing need for clear and concise guidance, there are currently no federal or provincial guidelines for evaluating safe consumption of wildlife, with respect to PCB contamination. This section explores available exposure guidelines, including human health benchmark doses and maximum levels for retail foods (Tier 3, 3.3.1). These guidelines are then compared to measured PCB tissue concentrations in wildlife from the Hamilton Harbour AOC to assess whether consumption poses a potential hazard to human consumers (Tier 3, 3.3.2). The assessment focuses on wildlife species that have been identified as potentially exposed to local sources of PCBs through feeding (Tier 2) and/or those for which high tissue PCB concentrations (Tier 2) have been reported – namely, Herring Gull, Snapping Turtle, American Mink, and Mallard Duck. While Lesser Scaup were identified as a species that is potentially exposed to PCBs in sediment through feeding, there is insufficient data available to assess the risk to human health from eating these birds at this time.

#### 3.3.1 Human Health Benchmarks and Exposure Guidelines

Exposure guidelines for the protection of human health are typically expressed as a specific amount of the contaminant per unit body weight of the consumer over a given period of exposure (i.e., µg PCB kg⁻¹ · bw · d⁻¹). Alternatively, they can be expressed as maximum acceptable contaminant concentrations per unit lipid weight (i.e., µg PCB g⁻¹ lipid) in retail foods such as poultry or fish. PCB guidelines for residues in food and human health benchmark doses are discussed below and summarized in Table 4.
**Tolerance for Residues in Food**

Because of the lack of guidelines for wild game, the use of residue limits for store-bought poultry have been applied to sites where wildlife represents a potential pathway for contaminant exposure to human consumers. For example, Health Canada advised that contaminant levels found in pectoral muscle of Mallards, Canada Geese and other gamebirds collected throughout Ontario during 1987 to 1995 (reported by Braune et al., 1999 and Braune and Malone, 2006) did not pose a health hazard to human consumers. At the time that the recommendation was made, the most appropriate guidelines available were maximum levels (MLs) for chemical contaminant residues in poultry from Health and Welfare Canada (0.5 µg g⁻¹ lipid) and the U.S. Food and Drug Administration (US FDA) (3.0 µg g⁻¹ lipid) (Table 4). While these guidelines were developed to protect against harmful health effects from consumption of particular food items, there remains a large amount of uncertainty in its applicability to wild game. Furthermore, the tolerance guideline for PCB residues in food (fish, meat & dairy, eggs, poultry) is currently under review in Canada and the U.S. For these reasons, guidelines for safe levels of PCBs in food items were considered in this assessment for comparative purposes only, and were not applied directly to evaluating the risk to human health from consumption of wildlife from the Hamilton Harbour AOC.

**Benchmark Doses for PCB Exposure**

Human health benchmark doses for PCB exposure have been used to evaluate the safety and develop advisories for the consumption of fish and wildlife from several contaminated areas in the Great Lakes basin (Tables 7 & 8, Appendix). These benchmark doses are calculated by evaluating available scientific studies that have investigated the adverse health effects of PCB exposure and derived a Lowest Observed Adverse Effect Level (LOAEL), or No Observed Adverse Effect Level (NOAEL). Because these data typically come from lab exposures on animals, uncertainty factors are applied to the calculation of exposure guidelines to account for inter- and intra-species variation between and within animal and human populations.

A variety of different guidelines have been developed by governments and agencies around the world, each with its advantages and disadvantages. While the U.S Environmental Protection Agency (US EPA) Acceptable Daily Exposure (ADE) dose (US EPA, 1995) and the Agency for
Toxic Substances and Disease Registry (ATSDR) Minimal Risk Level (MRL) (ATSDR, 1998) have been used to assess wildlife consumption in areas around the Great Lakes, this assessment will consider PCB concentrations in wildlife from the Hamilton Harbour AOC as they relate to guidelines for Tolerable Daily Intake (TDI).

A TDI dose represents the total amount of a particular compound that a person can ingest daily, on a body weight (bw) basis, throughout their lifetime without deleterious effects. TDI values are calculated based on non-carcinogenic effects and are intended to be protective of potential developmental effects of exposure to PCBs in human consumers. Although this provides robust safety margins, consumption of foods with elevated PCB concentrations that may exceed the recommended intake should be limited to avoid a significant exceedance of the health benchmark dose. A review of PCDD/F and coplanar PCBs by the WHO concluded that daily intake of these compounds was negligible relative to total body burden and therefore recommended the use of a 1 month period for evaluating tolerable intake, resulting in a Provisional Tolerable Monthly Intake (TMI) value of 70 pg kg\(^{-1}\) bw mo\(^{-1}\) based on Toxic Equivalents (TEQ) (WHO, 2001). The use of TEQ allows the toxicity of individual compounds within a mixture to be determined by applying a Toxic Equivalency Factor (TEF) as described by Van den Berg et al. (1998). Because this method requires information about the concentration of individual PCB congeners, it is not appropriate for the present data set. In Canada a TDI value of 1 µg kg\(^{-1}\).bw d\(^{-1}\), originally established as a temporary guideline (Grant, 1983), is still applied by Health Canada for the assessment of human exposure to PCBs through food (Van Oostdam et al., 1999, 2005; Health Canada, 2004; Berti et al., 1998) and will be used in this assessment to classify the risk to human health from the consumption of wildlife from the Hamilton Harbour AOC.
Table 4 Human health benchmark doses for PCB exposure. Exposure guidelines presented in this table were prepared by various regulatory agencies and tolerance levels for residues in packaged food (poultry) as well as tolerable intake levels for human health.

<table>
<thead>
<tr>
<th>Agency</th>
<th>Guideline/Regulation</th>
<th>PCB Concentration</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Canada (historical)</td>
<td>Maximum level (poultry)</td>
<td>Tolerable Intake for Human Health: -</td>
<td>0.5 µg g⁻¹ lipid Health &amp; Welfare Canada, 1991</td>
</tr>
<tr>
<td>U.S FDA</td>
<td>Tolerance level (poultry)</td>
<td>Tolerable Intake for Human Health: -</td>
<td>3.0 µg g⁻¹ lipid U.S FDA, 1979</td>
</tr>
<tr>
<td>WHO</td>
<td>Tolerable monthly intake (TMI)</td>
<td>Tolerable Intake for Human Health: 70 pg kg⁻¹ bw mo⁻¹</td>
<td>- WHO, 2001</td>
</tr>
<tr>
<td>Health Canada</td>
<td>Tolerable Daily Intake (TDI)</td>
<td>Tolerable Intake for Human Health: -</td>
<td>- Grant, 1983⁺</td>
</tr>
</tbody>
</table>

*Value reported as still in use by Health Canada (Health Canada, 2004; Van Oostdam, 1999, 2005; Berti et al., 1998)

Abbreviations: FDA – Food and Drug Administration; WHO – World Health Organization
3.3.2 Risk to Human Health

To classify the risk to human health associated with consumption of contaminated wildlife, information about meal size and frequency of consumption are required in order to compare the intake rate of each species to Health Canada’s TDI. Conder and Arblaster (2016) describe common approaches to determining wild game consumption rates for use in site-specific human health risk assessments, including the use of site-specific surveys as well as non-site specific approaches that can be used when limited information is available. While it is beyond the scope of this assessment to collect new site-specific information, consideration will be given to estimated intake rates and PCB dose, calculated using average adult body weight (70 kg) and meal size (227 g) values used by the Ontario Ministry of the Environment and Climate Change (MOECC) to calculate sport fish consumption advisories (MOECC, 2015).

Sum PCB dose calculations for each species, based on the most recent tissue concentrations available (Tier 2, 3.2.2), are summarized in Table 5 and compared to the Health Canada TDI to determine whether exceedance of this guideline would be expected from consumption of each species. Results indicate that given current PCB concentrations in American Mink, consumption of mink would not result in exceedances of Health Canada’s TDI. In addition, Mink is typically considered a furbearing mammal and generally not consumed by humans. Elevated PCB concentrations in Herring Gull (adult muscle) and Snapping Turtle eggs would result in exceedances of the TDI for a 70 kg adult consuming a 227 g serving daily, while adult Snapping Turtle fell slightly below the guideline. Because the meal size and adult body weigh assumptions used in these calculations are likely overestimates in relation to consumption of wildlife from the Hamilton Harbour AOC, the result is a conservative evaluation of risk to human health.
Table 5  Estimated $\Sigma$PCB dose (µg·kg$^{-1}$ bw) based on tissue PCB concentrations in wildlife from the Hamilton Harbour AOC. Calculations were performed using adult muscle (estimated) or egg (measured) PCB concentrations, an average consumer body weight of 70 kg and standard meal size of 227 g. Values for PCB dose per serving were then evaluated against the Health Canada Tolerable Daily Intake guideline (1 µg kg$^{-1}$ bw d$^{-1}$).

<table>
<thead>
<tr>
<th>Species (sampling years)</th>
<th>Mean $\Sigma$PCB Concentration (µg/g wet wt)</th>
<th>$\Sigma$PCB Dose Per 227 g Serving (µg/kg bw)</th>
<th>Exceed Health Canada TDI Guideline of 1 µg kg$^{-1}$ bw d$^{-1}$? (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herring Gull Adult (2010-2015)</td>
<td>6.07</td>
<td>19.68</td>
<td>Y</td>
</tr>
<tr>
<td>Snapping Turtle Adult (2012-2014)</td>
<td>0.30</td>
<td>0.97</td>
<td>N</td>
</tr>
<tr>
<td>Snapping Turtle Eggs (2012-2014)</td>
<td>1.54</td>
<td>4.99</td>
<td>Y</td>
</tr>
<tr>
<td>American Mink Adult (2004-2012)</td>
<td>0.16</td>
<td>0.52</td>
<td>N</td>
</tr>
</tbody>
</table>

Note: Standard adult body weight (70 kg) and meal size (227 g) values used in calculations are meant to provide non-site specific estimates and may not be appropriate for the Hamilton Harbour AOC. These estimates do not account for consumption by children or other sensitive populations.
Status of Wildlife Consumption in the Hamilton Harbour AOC

3.4 Consumption of Contaminated Wildlife (Tier 4)

Although elevated PCB levels have been measured in Herring Gull from the AOC, it is not typically a species that is hunted for consumption and the enforcement of by-laws that restrict the use of firearms within the Hamilton Harbour AOC and surrounding area (City of Hamilton, 2005; City of Burlington, 1991; RBG, 1989) means that exposure of local residents to elevated levels of contaminants in these birds would be eliminated. These by-laws are applicable to hunting for all waterfowl found within the Hamilton Harbour AOC, including species such as Lesser Scaup for which limited information on PCB concentration may be available, and therefore they are not considered to pose a risk to human health. Furthermore, ducks, geese and swans are federally protected species under the Migratory Birds Convention Act (1994) and therefore hunting these species anywhere in Canada is illegal during migration between March and September (with a continuous close season for swan).

First Nations’ aboriginal and treaty right to hunt and fish has been recognized and affirmed by Section 35(1) of the Constitution Act, 1982 (Constitution Act, 1982, s 35). However, it is not known whether local First Nations communities are currently consuming wildlife from within the AOC, or if there is a desire to do so in the future. Based on the results of this assessment (Tier 3, 3.3.2 & Table 5), the only wildlife that would potentially be of concern would be Herring Gull (which are not likely consumed) and Snapping Turtle eggs. If adult Snapping Turtle or American Mink from the AOC are being consumed, it would be beneficial to determine the frequency of consumption and appropriate meal sizes. An open dialogue between the RAP team and local First Nations will help to better understand consumption patterns for wildlife collected from the Hamilton Harbour AOC.

There is currently an open season for harvesting Snapping Turtle in the Hamilton Harbour AOC that runs from July 15th to September 15th, despite the fact that they are recognized as a Specially Protected Reptile under the Ontario Fish and Wildlife Conservation Act, 1997, and a Species of Special Concern under the Ontario Endangered Species Act, 2007, and Federal Species at Risk Act, 2002. There is some evidence that (likely a small fraction of) the local population in the area surrounding the AOC may be exposed to tissue of adult turtles as well as Snapping Turtle eggs (T. Theysmeyer, pers. comm.). Results from this assessment (Tier 3, 3.3.2 & summarized in
Table 5), suggest that consumption of 227 g or less of muscle meat from Snapping Turtle would not result in exceedance of the TDI for a 70 kg adult. However, it is important that consumers understand proper cleaning and/or cooking guidelines that are recommended as a way to minimize potential contaminant exposure from wildlife consumption. In Ontario the Guide to Eating Ontario Fish includes advice for consumption of Snapping Turtle, stating (MOECC, 2015, p.19):

“Snapping Turtles may have high levels of contaminants in their fat, liver, eggs and, to a lesser extent, muscle. If you plan to eat Snapping Turtles, trim away the fat prior to cooking the meat or preparing soup. Also, avoid eating the liver and eggs of the turtle. Women of child-bearing age and children under 15 should avoid eating any part of the Snapping Turtles, including soups made with their meat.”

4 Conclusions and Recommendations

This assessment followed the Decision-Making Framework for Assessing the Status of the Wildlife Consumption Beneficial Use in Areas of Concern as it relates to the Hamilton Harbour AOC (Figure 2). The objectives of the assessment were to provide evidence of wildlife exposure to local sources of contaminants (Tier 2, 3.2.1) which have resulted in elevated tissue concentrations (Tier 2, 3.2.2) above available guidelines for the protection of human health (Tier 3, 3.3.2), as well as evidence that contaminated wildlife are being consumed by local residents (Tier 4, 3.4).

Table 6 summarizes the answers (yes/no) from each tier of the framework and the resultant status recommendation for seven wildlife species from the Hamilton Harbour AOC. Overall, the results from this screening-level assessment suggest that consumption of most aquatic wildlife from the Hamilton Harbour AOC do not pose a risk to human health; however, moderately high PCB levels found in Snapping Turtle eggs suggest that consumption of turtles and their eggs should be limited.
Figure 2 Results of assessment for the Restrictions on Wildlife Consumption Beneficial Use in the Hamilton Harbour AOC.
**Waterfowl**

The feeding behaviour of waterfowl species such as Mute Swan and Canada Geese suggest they are not likely exposed to local contaminants in sediments and therefore they were considered ‘not impaired’ and were not evaluated beyond Tier 2 of the assessment framework. Mallard Duck and Lesser Scaup, on the other hand, were identified as a species that is potentially exposed to PCBs in sediment through feeding. Insufficient data was available to assess the risk to human health from eating these species from the AOC, therefore the status assessment for these species followed Tiers 1-4 of the framework before recommending they be considered ‘not impaired’ due to lack of exposure pathway for human consumers.

**American Mink**

Assessment results for American Mink indicate that they are exposed to local sources of PCBs through feeding. However, consumption of these species is not expected to result in exceedances of Health Canada’s TDI and therefore does not pose an unacceptable risk to human health. These results are considered to be conservative, given that the amount of mink consumed from the AOC is likely far lower than estimated and therefore a status of ‘not impaired’ was recommended.

**Herring Gull**

High PCB concentrations calculated for pectoral muscle of Herring Gull collected between 2010-2015 raise concerns about consumption of resident waterfowl from the Hamilton Harbour AOC. Despite the elevated levels of PCBs in muscle tissue of Herring Gull, firearm restrictions within the Hamilton Harbour AOC suggest that the exposure pathway to human consumers is eliminated at this point in time and therefore does not constitute a beneficial use and should be considered ‘not impaired’.

**Snapping Turtle**

Because there is an open season for harvesting Snapping Turtle in the Hamilton Harbour AOC there is a potential route for human consumption. Muscle concentrations estimated for Snapping Turtle collected from Cootes Paradise and Grindstone Creek between 2012-2014 were moderately high. Rates of consumption for Snapping Turtles within the AOC are not known; however, it is suspected that they are low and based on opportunistic consumption.
Table 6 Summary of results from the assessment on the status of the Restrictions on Wildlife Consumption Beneficial Use in the Hamilton Harbour Area of Concern. Species listed were evaluated for (ongoing or historical) exposure to an AOC contaminant source (Tier 2), resultant tissue concentrations were then used to determine PCB dose which was compared against Health Canada’s Tolerable Daily Intake guideline (1 µg kg\(^{-1}\) d\(^{-1}\)) (Tier 3). For species that exceeded the guideline, the pathway for human exposure to contaminated wildlife was evaluated (Tier 4) and a final status recommendation was provided for each species.

<table>
<thead>
<tr>
<th>Wildlife Species</th>
<th>Tier 2</th>
<th>Tier 3</th>
<th>Tier 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Is there ongoing exposure to AOC contaminants?</td>
<td>Is there wildlife contamination due to historical conditions?</td>
<td>Does ∑PCB dose exceed Health Canada Tolerable Daily Intake (1 µg kg(^{-1}) d(^{-1}))?</td>
</tr>
<tr>
<td>Mute Swan</td>
<td>No</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>Canada Goose</td>
<td>No</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>Lesser Scaup</td>
<td>Yes</td>
<td>Yes</td>
<td>n/a</td>
</tr>
<tr>
<td>Mallard Duck</td>
<td>No</td>
<td>Yes</td>
<td>n/a</td>
</tr>
<tr>
<td>American Mink</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Herring Gull</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Snapping Turtle</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Eggs</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

TDI – tolerable daily intake; n/a – no data available for wildlife species in the Hamilton Harbour AOC to assess parameter
A – Not Impaired status recommended based on lack of pathway for human exposure (Tier 4, 3.4); B – Not Impaired status recommended because estimated dose does not exceed Health Canada TDI for PCBs (Tier 2, 3.3.2); C – Not Impaired status recommended due to lack of evidence that wildlife are exposed to & accumulating PCBs from local sources (Tier 2, 3.2).
5 Future Monitoring or Actions Required

- As fish and wildlife habitat is restored within the Hamilton Harbour AOC and populations begin to recover, it will be important to maintain partnerships and communication with RAP Stakeholders to assist in identifying future concerns relating to this Beneficial Use (e.g., changes in food chain dynamics that may affect exposure of wildlife to PCBs in sediment).

- Continued monitoring of Herring Gull through the GLHGMP would provide valuable information regarding current exposure and long-term trends of contaminants in wildlife from the Hamilton Harbour AOC.

- Ongoing monitoring of Snapping Turtle eggs from Cootes Paradise and Grindstone Creek should continue under the Restrictions on Fish Consumption Beneficial Use.
References


Fenwick, G.H. 1983. Feeding behaviour of waterfowl in relation to changing food resources in Chesapeake Bay. Dissertation, Johns Hopkins University, Baltimore, Maryland, USA.


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Royal Botanical Gardens (RBG). 1989. RBG By-Law No. 01-3_C 3(a).


Appendix

Great Lakes AOC Consumption Advisories and Delisting Guidelines

This section summarizes consumption advisories and delisting criteria related to the Restrictions on Fish and Wildlife Consumption BUI in Canadian and U.S AOCs.

Fish Consumption Advisories

Fish consumption advisories are sometimes applied to wild game in the absence of available guidelines for human consumption of wildlife required to develop appropriate advisories. However, this approach fails to consider differences in consumption rates that would be expected due to legal hunting restrictions (e.g., by-laws restricting the use of firearms, harvest limits, etc.), as well as differences in the harvestable amount of meat and consumption patterns for different species. Because of the large differences that have been found in consumption rates of wildlife and fish from many locations, it is recommended that alternative guidelines be explored that would provide an appropriate level of protection to human consumers of wildlife.

In Ontario, the MOECC produces an annual Guide to Eating Ontario Fish that includes consumption advice derived from Health Canada Tolerable Daily Intake (TDI) values and based on a meal size of 227 g for a 70 kg adult (MOECC, 2015). Figure 4 provides a summary of the guidelines used in Ontario (general and sensitive populations) and Michigan to provide consumption advice, as number of recommended meals per month, based on tissue PCB concentrations. Additional guidance for tracking monthly intake is provided in the Guide to Eating Ontario Fish.

Table 7 Fish consumption advisories (meals/month) for general and sensitive populations in Ontario, compared to advisories for Michigan, based on tissue PCB concentration (ppb).

<table>
<thead>
<tr>
<th>Consumption Advisory (meals/month)</th>
<th>Ontario General</th>
<th>Ontario Sensitive</th>
<th>Michigan</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&gt; 844</td>
<td>&gt; 211</td>
<td>&gt; 2600</td>
</tr>
<tr>
<td>1-2 meals/yr</td>
<td>422-844</td>
<td>105-211</td>
<td>430-2600</td>
</tr>
<tr>
<td>1</td>
<td>211-422</td>
<td>70-105</td>
<td>210-430</td>
</tr>
<tr>
<td>2</td>
<td>105-211</td>
<td>53-70</td>
<td>110-210</td>
</tr>
<tr>
<td>4</td>
<td>70-105</td>
<td>53-70</td>
<td>50-110</td>
</tr>
<tr>
<td>8</td>
<td>53-70</td>
<td>70-105</td>
<td>30-50</td>
</tr>
<tr>
<td>12</td>
<td>26-53</td>
<td>53-70</td>
<td>20-30</td>
</tr>
<tr>
<td>16</td>
<td>&lt; 26</td>
<td>26-53</td>
<td>10-20</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>&lt; 26</td>
<td>&lt; 10</td>
</tr>
</tbody>
</table>
Wildlife Consumption Advisories

Wildlife consumption advisories have been issued in a number of Great Lakes AOCs due primarily to mercury and PCB contamination (Table 8). In the majority of locations, contaminant burdens in wildlife are measured only when there is a known or suspected local contaminant source and ongoing monitoring data is often not available. Because available data is often limited by sample size, species variety, and sampling dates, it is difficult to form a complete picture of the conditions in each area. Furthermore, without knowledge of background levels of contaminant burdens for other areas within the region or lake-wide, it may be difficult to determine whether high contaminant levels are from local sources.
Table 8 Wildlife consumption advisories and delisting guidelines for Great Lakes Areas of Concern in Canada and the United States.

<table>
<thead>
<tr>
<th>State/ Province</th>
<th>AOC</th>
<th>Current Wildlife Consumption Advisories</th>
<th>Delisting Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario</td>
<td>Hamilton Harbour</td>
<td><strong>Impaired</strong></td>
<td>When there are no restrictions on consumption of wildlife from the Harbour attributable to local sources</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Snapping Turtles</strong>: Province-wide advisory to trim away fat and avoid eating liver and eggs; <strong>Do not eat</strong> advisory (any part of turtle) for children and women of child-bearing age.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Clair River</td>
<td></td>
<td>When the general guidance for the consumption of indicator wildlife (e.g., Snapping Turtles, geese) are no different than the non-AOC sites in the Great Lakes.</td>
</tr>
<tr>
<td>Wisconsin¹</td>
<td>Lower Green Bay and Fox River</td>
<td><strong>Impaired</strong></td>
<td>Wildlife consumption advisories are the same or lower than those in the associated Great Lake or appropriate control site.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Waterfowl</strong>: <strong>Do not eat</strong> consumption advisories indicated for specific areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mallards</strong>: advised to remove skin &amp; fat (entire AOC)</td>
<td></td>
</tr>
<tr>
<td>Milwaukee Estuary²</td>
<td><strong>Impaired</strong></td>
<td><strong>Waterfowl</strong>: Preliminary results (assessment ongoing 2013-2016) suggest that consumption advisory will remain in place but are not attributable to sources within the AOC.</td>
<td></td>
</tr>
<tr>
<td>Sheboygan River³</td>
<td><strong>Impaired</strong></td>
<td><strong>Mallard &amp; Lesser Scaup</strong>: <strong>do not eat</strong></td>
<td>Waters within the Sheboygan River AOC are no longer listed as impaired due to wildlife consumption advisories listed in the annual Wisconsin Migratory Bird Regulations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Canada Goose</strong>: advisory to remove all skin and visible fat prior to cooking</td>
<td></td>
</tr>
</tbody>
</table>

¹ WDNR, 2015a
² WDNR, 2014.
³ WDNR, 2015b
### Table 8 Cont’d

<table>
<thead>
<tr>
<th>State/Province</th>
<th>AOC</th>
<th>Current Wildlife Consumption Advisories</th>
<th>Delisting Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohio&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Ashtabula River Black River Cuyahoga River</td>
<td>Not impaired&lt;sup&gt;*&lt;/sup&gt;</td>
<td>No wildlife consumption advisories of 1 meal/month (or more stringent) have been issued by the Ohio Department of Health that can be attributed to sources within the AOC.</td>
</tr>
<tr>
<td></td>
<td>Maumee River</td>
<td>Impaired - Ottawa River only</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Snapping Turtle: 1 meal/wk due to mercury</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Advisory for turtles is similar to the statewide advisory for fish consumption and not considered impaired.</td>
<td></td>
</tr>
<tr>
<td>New York&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Buffalo River Eighteenmile Creek Niagara River (US) Rochester Embayment St. Lawrence River (Massena)</td>
<td>Impaired (fish only)</td>
<td>No wildlife consumption guidelines due to local contaminant sources in AOCs.</td>
</tr>
<tr>
<td>Michigan&lt;sup&gt;6&lt;/sup&gt;</td>
<td></td>
<td>Not impaired</td>
<td>1. The wildlife consumption advisories in the AOC are the same as or less restrictive than the associated Great Lake or appropriate control site.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No advisories currently in place.</td>
<td>2. A comparison study of tissue contaminant levels demonstrates that there is no statistically significant difference in tissue concentrations of contaminants in the AOC compared to control site(s) that are causing wildlife consumption advisories.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Analysis of trend data (if available) for wildlife with consumption advisories shows similar trends to other appropriate Great Lakes.</td>
</tr>
</tbody>
</table>

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<sup>4</sup> Ohio EPA, 2008  
<sup>5</sup> NYDEH, 2014  
<sup>6</sup> MDEQ, 2008