

RESTRICTIONS ON FISH CONSUMPTION (BUI #1)



BACKGROUND

Fishing is a popular recreational activity and a great way to enjoy the outdoors and nature. Fish can be a nutritious part of a balanced diet and provide an excellent source of protein, omega-3 fats, and other essential nutrients. The ability to eat fish from the Great Lakes is defined as a beneficial use under the Canada-U.S. Great Lakes Water Quality Agreement; however, as a result of various pollution sources, chemicals can accumulate in fish and may pose a human health risk if consumed—resulting in an impairment of this beneficial use. As such, this beneficial use impairment (BUI) is used as an indicator related to the protection of human health and the condition of the environment in Great Lakes Areas of Concern.

In most Areas of Concern (AOCs), including the Niagara River, restrictions on fish consumption are typically due to the presence of legacy contaminants such as polychlorinated biphenyls (PCBs) that persist in the environment and can accumulate in fish tissue. In Ontario, the fish consumption beneficial use has been listed as 'Impaired' for the Niagara River since the completion of the RAP Stage 1 Report (1993) because of contaminants (i.e., PCBs, mercury, mirex) in edible portions of Niagara River fish that prevented unlimited consumption [of fish] by humans (i.e., 8 or more meals per month). The beneficial use has remained impaired in subsequent RAP Reports (NRRAP 1995, Mackay 2007, NRRAP 2009). It is important to note that the guidelines used to determine how many meals per month of a particular fish that can be consumed have become more stringent over time. While the levels of contaminants like PCBs have declined over the past 30 years, improved analytical methods and the adoption of more stringent standards continue to identify issues with fish consumption for some of these legacy contaminants.

Since the 1970s, the Ontario Ministry of Environment, Conservation and Parks (MECP) has monitored specific chemicals in fish flesh through the province-wide Fish Contaminant Monitoring Program. The information and data from this monitoring program are used to produce fish consumption advisories which are published in the *Guide to Eating Ontario Fish*, referred to in this document as “the *Guide*” (www.ontario.ca/fish). Fish consumption advisories provided by MECP are based on the guidelines developed using tolerable daily intakes from the Food Directorate of Health Canada (Bhavsar et al. 2011).

The current edition of the *Guide* provides advisories on eating fish from over 2,400 fishing locations across Ontario, including the Upper and Lower Niagara River (MECP 2017). The consumption advisories

provided in the *Guide* are based on a skinless, boneless dorsal fillet meal of 227 g or 8 oz (about the size of an average dinner plate or two adult palms) for an average adult weighing approximately 70 kg (154 lbs). The advisories are communicated as the number of meals per month (for different fish species and different sized fish) that can safely be consumed to protect human health. Furthermore, the advisories in the *Guide* vary depending on the waterbody, fish species, fish size, and the consumer (i.e., general or sensitive population). Advisories are typically more restrictive (fewer meals per month recommended) for the sensitive population, which are women of child-bearing age (i.e., women who are pregnant, nursing or those who intend to become pregnant) and children under the age of 15. That is because they are more at risk of being affected by lower levels of contaminants in the fish they eat.

According to current benchmarks applied by the MECP, consumption advisories are sub-divided into three levels of restrictions¹: UNRESTRICTED is defined as being able to eat 8 or more meals per month of the desired fish, PARTIALLY RESTRICTED means that a consumer should use caution and limit consumption of the desired fish per month (ranging from 1, 2 or 4 meals/month), while RESTRICTED consumption occurs when a consumer is advised not to eat any meals of a particular size of the fish (Gandhi et al. 2015).

According to the Canada-U.S. Great Lakes Water Quality Agreement (Annex 1), an Area of Concern (AOC) is a geographic area where significant impairment of beneficial uses has occurred as a result of human activities at the local level (IJC 2012). The Remedial Action Plans (RAPs) address human-made sources of contaminants that are within the geographic scope of the AOC (Table 1). In the Canadian waters of the Niagara River, most fish consumption advisories are due to PCBs (Bhavsar et al. 2011). Historically, mirex/photomirex was also linked to fish consumption restrictions in the Lower Niagara River and Lake Ontario, with the source mainly being industry on the U.S. side of the Niagara River. Mirex was banned in the 1970s and a recent, long-term study shows a 90% decrease of mirex in Lake Ontario fish from 1975-2010 (Gandhi et al. 2015). As of 2019, there are no consumption restrictions for Niagara River fish due to mirex or photomirex (MECP, unpublished data). Both mirex and photomirex continue to be selectively monitored as part of the large analytical suite of measurements conducted through Ontario's Fish Contaminant Monitoring Program (S. Bhavsar, pers. comm., 2020). There are also consumption advisories related to mercury, lead, and dioxins/furans but, for the Niagara River AOC, it is important to note that:

- mercury is a global pollutant with its major source coming from atmospheric deposition (Bhavsar et al. 2011) and there are no known local sources (Mackay 2007).

¹ Unrestricted consumption = 8 or more meals per month; Partially restricted = 1, 2, or 4 meals per month; Restricted = 0 meals per month.

- dioxins/furans are only listed for advisories related to eating Brown Bullhead in the Upper Niagara River and are at levels which are UNRESTRICTED (the advisory allows consumption of 16 and 32 meals per month, depending on the size of the fish); there are no advisories related to dioxins/furans for any other species in the Niagara River;
- Lead is only associated with restrictions on eating one species, Redhorse Sucker, from the Upper Niagara River; with the advisory also linked to mercury and PCBs. The consumption of Redhorse Sucker is unrestricted for fish <45 cm, partially restricted for some sizes, and completely restricted for the sensitive population if the fish is >55 cm.

Table 1. Description of contaminants that are associated with complete or partial restriction of fish consumption in the Ontario side of the Niagara River (MECP 2017, Health Canada 2016, Health Canada 2005a, Health Canada 2005b, Health Canada 2013, Gandhi et al. 2015).

Contaminant	Description
Mercury	Mercury is a naturally-occurring metal in soil, rocks, and water bodies. It is also be released into the environment as a result of human activities involving combustion processes such as coal-fired power generation, metal mining, and waste incineration, resulting in greatly increased environmental amounts since the industrial revolution. Inorganic forms of mercury can be converted to methylmercury by bacteria and is absorbed by a fish from water passing over its gills or through its diet. Fish at the top of the food chain (e.g., Walleye and Pike) tend to have higher levels of mercury in their flesh.
Polychlorinated biphenyls (PCBs) & dioxin-like PCBs	PCBs are a group of chlorinated organic compounds first commercially developed in the late 1920s for sealing and caulking compounds, paint additives, and coolants or lubricants for electrical equipment. A North American ban was placed on manufacturing and importing PCBs in 1977; however, the ban did not include PCBs already in use which are still being phased out today. PCBs can persist in the environment for decades and can accumulate in the aquatic ecosystem. Low levels of PCBs are unlikely to cause adverse health effects in humans except for people who consume large amounts of fish or other wildlife.
Lead	Lead is a naturally-occurring metal that was heavily mined and used in North America beginning in the 1900s to produce batteries, bullets, paints, and for plumbing. Human exposure to lead is through ingestion or inhalation. Young children and pregnant women are more at risk to the effects of lead. Levels of lead in the environment have declined significantly over the last few decades. In Ontario, it is only occasionally at levels requiring restrictions on consuming fish. In the Niagara River, it is associated only with the consumption of Redhorse Sucker from the Upper portion of the river.

There are several ways that people can reduce their risk of consuming contaminants from the fish they catch and eat from the Great Lakes, including the Niagara River. The following recommendations and practices can help anglers make the best decisions for safely consuming their catch:

- follow the advice in the *Guide*;
- choose smaller and/or leaner fish species; avoid large, predatory fish and bottom feeders;
- remove visible fat and skin from fish before eating;
- cook fish on a grill, rack or broiler pan to allow fat to drip away; and,
- do not eat organs.

Some contaminants such as mercury are found throughout the fish flesh and cannot be removed via the trimming of skin or fat. Therefore, it is best to limit the amount of fish eaten or choose smaller sized fish. For more information about eating Niagara River fish, visit ontario.ca/fishguide or ourniagarariver.ca/fish.

This document is focused only on the Canadian side on the Niagara River. While the Niagara River is a connecting channel shared by the United States and Canada, there are different consumption restrictions and/or advisories that are determined by a distinction in program approaches, availability of data, and other information for their respective waters. Some information about the U.S. BUI status is provided in the section called ‘Binational Connection: BUI Status on the U.S. side of the Niagara River’.

BUI DELISTING CRITERIA REVIEW & RECOMMENDATION

The delisting criteria are locally-developed, AOC-specific goals used to measure progress and assess the condition of each of the BUIs of an AOC. The delisting criteria should be specific, measurable, and feasible. The Niagara River’s (Ontario) BUI delisting criteria were last formally reviewed and updated as part of the Niagara River RAP Stage 2 Update (2009). A recent review by staff from ECCC and MECP (as part of a COA Task Team in 2017) indicated that some BUIs may need to be updated and/or revised. As a result, in November 2018, the NRRAP Implementation Committee agreed that the delisting criteria for the remaining BUIs should be reviewed by the Coordinating Committee (or suitable expert working group) and potential revisions be brought forward to the Implementation and Public Advisory Committees for discussion.

A slightly different approach was taken for the *Restrictions on Fish Consumption* BUI delisting criteria because generic language was recently suggested by scientific experts for consideration by all Canadian AOCs (Bhavsar et al. 2018) and recommended as part of the ECCC/MECP Task Team review. The proposed Canadian AOC-wide generic delisting criterion, as well as the rationale for these revisions and the approach for assessing the BUI, were peer-reviewed and published in the *Journal of Aquatic Ecosystem Health and Management*, using the Toronto Region AOC as a case study.

The Niagara River RAP proposes to adopt the Canadian AOC-wide generic criterion with some minor revisions. The proposed revised criteria are similar to the 2009 version in that they use the goal of unrestricted fish consumption, focus on locally-controllable sources of contaminants (to concentrate on feasible, local remedial actions), and incorporate a comparison to a suitable non-AOC reference site. The recent revisions propose the use of a community survey to determine the fish consumption specific to the AOC. An assessment framework is provided in this document. As with other BUIs, the delisting criteria apply to the waters of the Niagara River (Ontario) Area of Concern (as per the GLWQA 2012).

The *Restrictions of Fish Consumption* BUI will no longer be impaired when...

	Recommended Delisting Criteria (2020)	RAP Stage 2 Update Report (2009)
(1)	consumption advisories for fish of interest in the AOC are unrestricted;	No restrictions on the consumption of sport fish in the Ontario portion of the AOC due to locally-controllable contaminant (PCBs and dioxin-like PCBs) sources. The probable sources of contaminants causing the restrictions will be considered; locally controllable contaminant sources will be addressed by the Niagara River RAP. Any regional or upstream sources that are likely the cause of remaining restrictions on sport fish consumption in the AOC will be identified and referred to a broader regional program (i.e., Lake Ontario Lakewide Management Plan ² , Lake Erie Lakewide Management Plan and Niagara River Toxic Management Plan). Restrictions on sport fish consumption in the AOC will be evaluated through comparison to restrictions present in appropriate fish species from a suitable non-AOC reference site or sites.
OR (2)	consumption advisories for fish of interest are no more restrictive than the advisories for suitable reference sites due to contaminants (PCBs and dioxin-like PCBs) from locally-controllable sources;	if a contaminated site (as designated by the Niagara River Contaminated Sediment Technical Advisory Group) fails to meet the criteria described above in regard to fish and wildlife consumption, then a risk based Contaminated Sediment Management Strategy must be in place with appropriate monitoring and mitigation measures and/or administrative controls.
OR (3)	multiple lines of evidence indicate improving conditions over time and all feasible remedial actions are complete.	

² This is the terminology used prior to 2012. The Lakewide Management Plan is now referred to as Lakewide Action and Management Plan (IJC 2012).

Description of delisting criteria revisions and application guidance

The Niagara River RAP proposed revised delisting criteria uses different tiers of multiple lines of evidence to determine if the fish consumption beneficial use is impaired or not. As noted in the previous section, the proposed criteria and related assessment framework are based on the generic Canadian AOC-wide version (Bhavsar et al. 2018). The proposed revised criteria are similar to the 2009 version in that they refer to goal of unrestricted consumption, they reference locally-controllable sources of contaminants (to focus on feasible, local actions), and use a comparison to a suitable reference site. A major difference between the revised Niagara River delisting criteria (2020 version) and the 2009 version is the addition of a criterion that applies a multiple lines of evidence approach towards an improving trend, and the removal of the criterion that mentioned contaminated sediment sites in the AOC. There are no contaminated sediment sites on the Canadian side of the Niagara River proper (only one site remaining in the watershed—Lyons Creek East). This matter is addressed by a separate BUI (*Degradation of Benthos*), and the Lyons Creek East site will continue to be monitored and assessed through its own delisting criteria, regardless of the status of the Fish Consumption BUI.

A description of the main components of the proposed revised criteria are provided below. Guidance on their application using the assessment framework is provided in the following section.

Fish of Interest

The re-designation of this BUI principally hinges on what local anglers are choosing to consume and whether the consumption of those “fish of interest” is more restricted than an appropriate reference location. Since preferences and patterns of eating fish could vary widely by location, type of fish and communities, a reliable fish consumption survey should be conducted to understand the potential use of the fish resources within the AOC. A survey was conducted in 1995-1996, led by Health Canada’s Great Lakes Health Effect Program, to examine fish consumption at five different Areas of Concern, including the Niagara River (Sheeshka 1997). That comprehensive survey interviewed over 600 people about their shoreline fishing and fish consumption habits in the Niagara River. However, the survey focused only on shoreline fishers, did not specifically engage with Indigenous peoples or account for their traditional uses, and the information is now over 20 years old. Thus, beginning in 2019, the Niagara River RAP Team initiated a new fish consumption survey to understand which fish people are eating from the Niagara River, and how much they have eaten over the last year. The information gathered through the survey can be used to understand local fish consumption, properly define the “beneficial use”, and to assess the delisting criteria relative to the advisories given for the fish species specifically consumed in the AOC (rather than all of the fish monitored).

Unrestricted OR no more restrictive

Fish consumption advisories are produced by the Ontario Ministry of Environment, Conservation and Parks through its Fish Contaminant Monitoring Program (see the background section for more information). Not all the advisories published in the *Guide* result in restrictions to eating fish and there may be different levels of restrictions to different consumer populations (i.e., general or sensitive population). The level of restriction applies to Tier 1 and 2 of the criteria. When assessing the Tier 1 criterion, the goal is for unrestricted fish consumption (meaning 8 or more meals per month of a desired fish species). For the tier 2 criterion, the goal is for consumption advisories to be no more restrictive (i.e., no worse) than a reference site (see below for details on appropriate reference locations). The information in the *Guide* should be used to determine the level of restriction for the AOC and its appropriate reference sites. Bhavsar et al. (2018) suggests that the level of restriction and consumer population chosen for the BUI assessment should be consistent with, and based on, the degree of consumption in the local fishing community (e.g., from a local fish consumption survey). In other words, if the community survey indicates that most fish consumers in the AOC are in the general or sensitive population for certain fish, then the assessment should focus on the potential restrictions of fish consumption for that consumer population and types of fish consumed.

Comparison to reference site

The Niagara River, linking Lake Erie to Lake Ontario, is one of five bi-national connecting channels that hydrologically connect the Great Lakes. Connecting channels are unique environments in the world and outside of the Great Lakes these types of connecting channels are not common (Rozon et al. 2016), making finding an appropriate reference site challenging. Bhavsar et al. (2018) suggest that in situations where reference locations are limited (e.g., due to a paucity of comparable fish contaminant data for fish species and sizes of interest), it may be advisable to expand the comparison to locations within reasonable proximity of the AOC or consider multiple locations within the broader Great Lakes. Using this rationale, the Niagara River RAP suggests that the fish consumption advisories for the fish of interest (from a local survey of anglers) from each of the Lower and Upper Niagara River should be compared to relevant areas of each of its respective connecting Great Lakes (e.g., Lower Niagara River to relevant non-AOC locations in the Western basin of Lake Ontario; and, Upper Niagara River to relevant non-AOC locations in the Eastern basin of Lake Erie). This approach is similar to comparisons made for other Niagara River BUIs (e.g., fish populations) and may account for regional issues or conditions beyond the scope of the AOC program.

Contaminants from locally-controllable sources

Contaminants in the water that accumulate in fish tissue can come from various sources: direct (point sources such as effluent pipes) or indirect (nonpoint sources such as runoff, atmospheric deposition). They can be natural or anthropogenic (human-made). The RAP program is intended to address sources that are human-made and within the Niagara River AOC that can be targeted for remedial action.

The contaminants causing the majority of complete or partial fish consumption restrictions in the Niagara River are PCBs and dioxin-like PCBs. The RAP Team can utilize information from other sources such as the Niagara River Toxics Management Plan (e.g., Upstream-Downstream Monitoring Program and caged mussel biomonitoring) to determine if these contaminants are from locally-controllable sources. Any regional or upstream sources that are likely the cause of remaining restrictions on fish consumption in the AOC will be identified and referred to a broader regional program (i.e., Lake Ontario Lakewide Action and Management Plan, Lake Erie Lakewide Action and Management Plan, and/or Niagara River Toxics Management Plan).

PROPOSED ASSESSMENT FRAMEWORK

The Niagara River RAP proposes assessing the status of the BUI using a multiple lines of evidence tiered-approach, modified from Bhavsar et al. (2018) to ensure linkage to the three delisting criteria and recommendations. This approach is similar to that taken at other AOCs and for the Niagara River RAP *Beach Closings* BUI. The framework sets out the order in which the three delisting criteria are examined and evaluated—referred to as “tiers” (Fig. 1). Based on the outcomes of the tiered evaluation(s), a recommendation is made to either maintain the ‘Impaired’ BUI status or to pursue the re-designation of the BUI to ‘Not Impaired’ given the evidence used in the assessment framework. Below is a brief description of the tiers and their proposed application.

Tier 1: According to Bhavsar et al. (2018), this component of the delisting criterion should be used to examine whether contaminant levels in fish at an AOC are resulting in restrictions for eating fish at a frequency that are below a desired level determined by consumption surveys of people fishing at the AOC. A method for calculating statistical comparison of advisories is described in Bhavsar et al. 2011. If the Tier 1 criterion is met, then the RAP Team may suggest proceeding with the BUI’s status re-designation to ‘Not Impaired’ and the other tiers are not assessed.

Tier 2: Should Tier 1 fail, the second Tier examines the advisories for the fish of interest (from local survey of anglers) compared to a suitable reference site. Fish consumption advisories from each of the Upper Niagara River (Lake Erie to the top of the Niagara Falls) and Lower Niagara River (from the bottom of Niagara Falls to Lake Ontario) should be compared to relevant areas of the respective connecting Great

Lake (e.g., Lower Niagara River to relevant non-AOC locations in the Western basin of Lake Ontario; and, Upper Niagara River to relevant non-AOC locations in the Eastern basin of Lake Erie). For example, the Upper Niagara River fish advisories (currently referred to as 'Lake Ontario 1a' in the *Guide*) could be compared to Lake Erie Zone 4 Eastern basin (from Long Point to the Niagara River). The Lower Niagara River consumption advisories (referred to as 'Lake Ontario 1b' in the *Guide*) could be compared to Lake Ontario Zone 2 (open water from Niagara River to Clarkson Harbour). The advisories given for the Niagara River AOC locations should be no more restrictive (no worse) than the appropriate reference sites noted. A description of locally-controllable sources of contaminants is explained in the rationale section. If the Tier 2 criterion is met, then the RAP Team may suggest proceeding with the BUI's status re-designation to 'Not Impaired' and the other tier is not assessed.

Tier 3: This level of assessment is conducted when Tier 1 and Tier 2 fail. This tier considers other quantitative and qualitative lines of evidence along with professional judgement to understand the current status of contaminants related to fish consumption restrictions in the AOC. The multiple lines of evidence suggested are temporal trends of fish contaminant levels, trends in young-of-the-year or forage fish in an AOC compared to a reference site (e.g., the nearby connecting Great Lakes), trends of the contaminant levels in sediments or water. Professional judgement could also include examining the ecological aspects of the fish of interest (such as their feeding ecology, growth, condition, and spatial movements) because these can be factors in how/where contaminants bioaccumulate and may confound cause-effect linkages between cleanup activities and the status of the BUI or of AOC-specific issues.

If the multiple lines of evidence indicate that conditions are improving over time and there are no additional, feasible remedial actions that can be undertaken locally to improve fish consumption, then the RAP Team may suggest proceeding with the BUI's status re-designation. However, if more actions can be implemented to address local contaminant sources, then those should be identified and implemented through the RAP with the BUI remaining 'Impaired' until the delisting criteria can be met.

A diagram of the proposed assessment framework (Fig. 1) is provided on the following page.

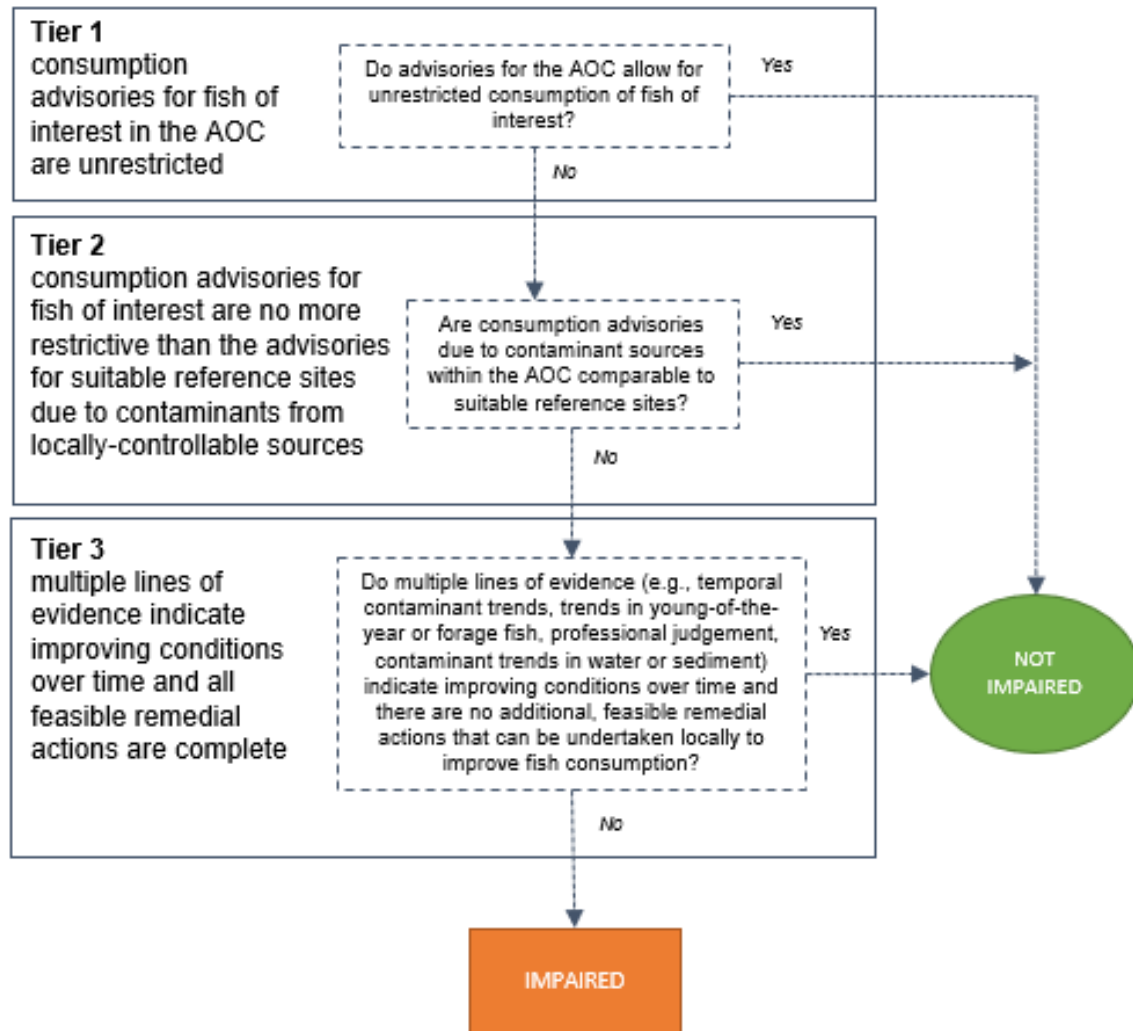


Figure 1. Niagara River AOC proposed Fish Consumption BUI Assessment Framework (modified from Bhavsar et al. 2018).

The Binational Connection: BUI Status on the U.S. side of the Niagara River

This section provides information on the status of the fish consumption BUI on the U.S. side of the Niagara River. To learn more about the efforts to improve U.S. AOCs, including the Niagara River, visit www.epa.gov/great-lakes-aocs.

In New York, the NYSDEC is responsible for fish sampling and analysis to provide the contaminant data that the Department of Health uses in setting the advisories. The state of New York has a general advisory to eat no more than four meals of fish per month from its fresh waters (NYSDOH 2019). For certain specific waterbodies, the New York State Department of Health issues more restrictive advisories. As of 2019, the *Restrictions of Fish and Wildlife Consumption* BUI in the Niagara River (NY) AOC is listed as 'Impaired' because there are restrictions for a number of fish species (NYSDOH 2019, NYSDEC 2012). Further monitoring and assessment management actions have been identified by the U.S. RAP Team, including continued periodic fish sampling and analysis (NYSDOH 2019, NYSDEC 2012). Data from the most recent sampling event is expected to be available in 2020 (M. Filipski, NYSDEC, pers. comm. 2019).

The wildlife consumption BUI on the Ontario side of the Niagara River is not considered impaired (NRRAP 2009) but it is listed as 'impaired' in New York. There are no wildlife consumption advisories specific to the U.S. Niagara River. There is state-wide advice for eating snapping turtles and wild waterfowl (NYSDOH, 2019). The NYSDOH recommends that women of childbearing age, infants, and children under the age of 15 should avoid eating snapping turtles or soups made with their meat due to PCB contamination. All others can reduce exposure by carefully trimming away all fat and discarding the fat, liver, and eggs prior to cooking the meat or preparing soup. In addition, mergansers should not be eaten as they are the most contaminated of the waterfowl species (NYSDOH 2019). People can eat up to two meals per month of other wild waterfowl and the skin and fat should be removed before cooking and the stuffing discarded after cooking. Wood ducks and Canada geese are less contaminated than other wild waterfowl species and diving ducks are more contaminated than dabbling ducks (NYSDOH 2019).

Several remediation projects to address known sources of PCBs, mirex, and dioxins on the U.S. side of the Niagara River have been completed (NYSDEC 2012). According to the 2012 RAP Stage 2 Addendum, remediation of 36 of 44 hazardous waste sites found to be potential sources of PCB, mirex, and/or dioxin contamination to the Niagara River were completed. A full list of remediation projects completed or underway is available in Appendix 1 of the Niagara River (U.S.) RAP Stage 2 Addendum (NYSDEC 2012).

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