NIAGARA RIVER
Remedial Action Plan

Delisting Strategy:
Niagara River (Ontario) Area of Concern

May 2021

FINAL

Delisting Strategy:
Niagara River (Ontario) Area of Concern
2021

RAP Implementation and Public Advisory Committee acceptance: April 22, 2021

Last updated: May 2021

Suggested Citation:

Green, N., Chambers, M., MacDougall, T., Marklevitz, S., and C. Vieira (eds). 2021**.** Delisting Strategy: Niagara River (Ontario) Area of Concern. Welland, ON. pp. 71

TABLE OF CONTENTS

ACKNOWLEDGMENTS

This project was made possible through funding support from the Government of Canada and the Province of Ontario, in partnership with the Niagara Peninsula Conservation Authority.

The lead authors gratefully acknowledge each of the Technical Working Group members (noted below) for contributing their expertise, time, and effort toward to this process including reviewing and revising delisting criteria, proposing the remaining actions for relevant BUIs, and preparing and editing the BUI summary sections. Thank you to the Niagara River RAP Implementation Committee and Public Advisory Committee for their support and feedback during the development of this document.

Special thanks to Mark Filipski, U.S. RAP Coordinator with the NYSDEC, for preparing the "American Connection" section and for facilitating a data gathering exercise with his U.S. colleagues that supported our review of the 'Degradation of Fish Populations' BUI.

List of Technical Working Group members for each of the remaining Niagara River (ON) BUIs

Restrictions on Fish Consumption
Satyendra Bhavsar, MECP
Mark Chambers, ECCC
Natalie Green, NPCA
Mark Filipski, NYSDEC
Tom MacDougall, MNRF (LEMU)
Cheriene Vieira, MECP

Degradation of Fish Populations
Andrew Drake, DFO
Joad Durst, MNRF (Vineland)
Natalie Green, NRRAP/NPCA
Stephen Marklevitz, MNRF (LEMU)
Tom MacDougall, MNRF (LEMU)

Degradation of Wildlife Populations
Amanda Bichel, Birds Canada
Corey Burant, Niagara Parks
Mark Chambers, ECCC
Natalie Green, NPCA
Shane de Solla, ECCC
Pam Martin, ECCC
Jacob Orlandi, MNO
Derrick Pont, MNO
Cheriene Vieira, MECP

Degradation of Benthos
Mark Chambers, ECCC
Matt Graham, ECCC
Natalie Green, NPCA
Rupert Joyner, ECCC
Danielle Milani, ECCC
Lisa Richman, MECP
Roger Santiago, ECCC
Cheriene Vieira, MECP

Beach Closings
Mark Chambers, ECCC
Tom Edge, McMaster University
Natalie Green, NRRAP/NPCA
Anthony Habjan, NRPHU
Brett Ruck, Town of NOTL
Cheriene Vieira, MECP

Loss of Fish and Wildlife Habitat
Corey Burant, NPC
Joad Durst, MNRF (Vineland)-retired
Deanna Lindblad, MNRF (Vineland)
Mark Filipski, NYSDEC
Tara Gaade, NPCA
Steve Gillis, NPCA
Natalie Green, NPCA
Geoff Verkade, NPCA

EXECUTIVE SUMMARY

In 1987, the Niagara River was listed as one of 43 original Great Lakes' Areas of Concern requiring a locally-developed and implemented Remedial Action Plan (RAP) to improve the river's water quality and ecosystem health. Since that time, partners involved in the RAP have made tremendous progress in protecting and restoring the Niagara River. An infographic summarizing the progress and key activities related to the Niagara River RAP since 1987 is provided on the following page. Of the fourteen (14) potential ecosystem impairments used to target restoration efforts, only five (5) impairments related to fish consumption, fish & wildlife populations, sediment contamination, water quality, and habitat remain in the Niagara River. As progress continues in the Niagara River, it is imperative that there is a clear and evidence-based course of action to guide involvement from partner organizations over the next 3-5 years. Through collaborative efforts and input from RAP partners, the Niagara River (Ontario) Delisting Strategy was developed to provide the most up-to-date summary of information about the Niagara River's remaining BUIs. It provides guidance for applying specific delisting criteria and identifies the remaining priority actions and appropriate lead organization(s) involved in the RAP who will implement the activities for each impairment. It is anticipated that this document will be used by the RAP partners to ensure continued, targeted efforts toward delisting the Niagara River, together!

BRIEF HISTORY OF PROGRESS ON THE NIAGARA RIVER REMEDIAL ACTION PLAN

1987 Niagara River is identified as one of 43 Areas of Concern needing clean-up (Remedial Action Plan).

1993

Environmental Conditions and Problem Definition (Stage 1) Report completed for the Canadian side of the Niagara River.

1995 Roughly **10,000** cubic metres of contaminated soils removed from Welland Reef site.

Studies show a **reduction of over 50%** for 10 priority toxic chemicals. **2007**

2009

Stage 2 Remedial Action Plan Update Report is completed. Confirmed **no issues** with fish tumours, bird reproduction, and dredging.

2015–17

Study to monitor the condition of the fish populations in the Niagara River.

Over 60 fish species identified!

Tracking of bacterial pollution sources at local beaches conducted.

Queen's Royal Beach has problems needing more investigation.

2017–21

Construction of **5 coastal wetlands** in the Upper Niagara River.

2018–19

Studies show no issues with algae and plankton that are important parts of the food chain.

Two related ecosystem indicators are officially changed to '**Not Impaired**' in 2019.

WETLAND STATS

- 7.5 acres of habitat created
- 320 fallen Ash trees
- 560 conifers
- 800 tonnes of boulders
- 1,500 live stakes planted
- 1,200 m of shoreline improved

2019

Sediment and benthic invertebrates (bugs) collected from Lyons Creek East Contaminated Sediment site for ongoing monitoring.

2018–20

Monitoring and priority remedial actions done to reduce pollution issues at Queen's Royal Beach.

Over **$230,000** spent on monitoring & cleanup activities.

2020

Construction of bioswale in Simcoe Park to reduce pollution issues at Queen's Royal Beach.

Monitoring indicates that beach water quality targets are met.

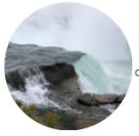
2019–21

Online and in-person angler survey conducted to understand fish consumption.

2020–21

Riparian (riverside) habitat assessment and plantings (8 km stretch) adds to approx. 2 km riparian habitat created as part of previous 2018–19 project.

2021



A Niagara River (Ontario) Delisting Strategy completed to identify and guide efforts to address remaining problems.

NIAGARA RIVER Remedial Action Plan

LIST OF ACRONYMS

AOC..... Area of Concern
BUI ..... Beneficial Use Impairment
CFU ..... Colony Forming Units
COA..... Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health
COSEWIC ..... Committee on the Status of Endangered Wildlife in Canada
DFO..... Department of Fisheries and Oceans
ECCC ..... Environment and Climate Change Canada
GIS ..... Geographic Information System
GLMMP ..... Great Lakes Marsh Monitoring Program
GLWQA ..... Great Lakes Water Quality Agreement (between Canada and United States)
IBI..... Index of Biotic Integrity
IJC..... International Joint Commission
KSSO ..... King Street Storm Sewer Outlet
LEMU ..... Lake Erie Management Unit
LID..... Low Impact Development
LNR ..... Lower Niagara River
MECP ..... Ministry of the Environment, Conservation and Parks
MNO..... Métis Nation of Ontario
MNRF ..... Ministry of Natural Resources and Forestry
MOHLTC ..... Ministry of Health and Long-Term Care
NOTL..... Niagara-on-the-Lake (Town of)
NPC..... Niagara Parks Commission
NPCA ..... Niagara Peninsula Conservation Authority
NRPHU..... Niagara Region Public Health Unit
NRRAP..... Niagara River Remedial Action Plan
NRTMP..... Niagara River Toxics Management Plan
NYSDEC..... New York State Department of Environmental Conservation
NYSDOH ..... New York State Department of Health
PAH..... Polycyclic aromatic hydrocarbon
PBDE..... Polybrominated diphenyl ether
PCB..... Polychorinated biphenyl
QRB..... Queen’s Royal Beach
RAP..... Remedial Action Plan
UNR..... Upper Niagara River

USACE ..... United States Army Corps of Engineers
USEPA ..... United States Environmental Protection Agency
USFWS..... United States Fish and Wildlife Service
USGS ..... United States Geological Survey

INTRODUCTION

The Niagara River is a 58 km bi-national connecting channel linking Lake Erie to Lake Ontario. It is unique from the other Great Lakes' connecting channels as it is naturally divided into an upper and lower portion by the mighty Niagara Falls—a 50m drop in elevation of the Niagara River that gave rise to hydroelectric power generation as well as industrial and residential development. The Niagara River provides many benefits to humans and wildlife including serving as a source of drinking water, power generation, and provides numerous recreational opportunities such as fishing, sightseeing, and boating. The Niagara River corridor is recognized as an Important Bird Area for supporting thousands of migrating birds and was recently designated by the United States as a Ramsar Wetland of International Importance for its unique ecological significance.

Pollution problems throughout the Great Lakes basin became a matter of public interest as early as the 1900s when the International Joint Commission (IJC) was formed to oversee boundary water issues between Canada and the United States. Water pollution issues mainly related to sewage discharge impacting human health were noted in the Niagara River as early as 1918 (IJC, 1918). Despite many regulations, policies, and infrastructure efforts to control and treat pollution, water quality problems persisted. Through the 1987 Protocol to the Canada-U.S. Great Lakes Water Quality Agreement (GLWQA), the Niagara River was listed as one of 43 original Areas of Concern (AOC) requiring a Remedial Action Plan (RAP) to guide cleanup efforts and restore beneficial uses. The RAPs are developed and implemented by a local team of key partners (federal, provincial, and municipal governments, First Nations and Métis communities, environmental organizations, the conservation authority, industry, scientists, non-government organizations, and the public) that work together to complete priority actions for the restoration, protection, and improvement of the Niagara River's ecosystem health.

In 2012, the scope of the GLWQA was revised to specifically state that the BUIs apply to the "Waters of the Great Lakes", including the connecting channels (Canada and United States of America 2012). For the Niagara River, this means that the geographic scope of the AOC is the connecting channel itself flowing from Lake Erie to Lake Ontario (Figure 1). The land area that drains into the river is referred to as the AOC watershed and is not part of the AOC proper. Restoration efforts and the criteria for delisting the AOC are focused on the river itself but some projects (e.g., storm sewer microbial trackdown studies and sediment monitoring in Lyons Creek East) are implemented in the AOC watershed, particularly where watershed contribute to or impact a BUI. Although the Niagara River is one of five bi-national AOCs, there are separate (but complementary) RAP efforts on both sides of the border but coordination and information sharing between the two RAPs is ongoing. While the focus and information in this document is intended for the Ontario side of the Niagara River AOC, to acknowledge the cooperation and alignment with U.S. counterparts, this report includes a section about the U.S. side of the Niagara River AOC. As such, whenever the "Niagara River AOC" is mentioned herein, it refers to the Ontario side of the Niagara River

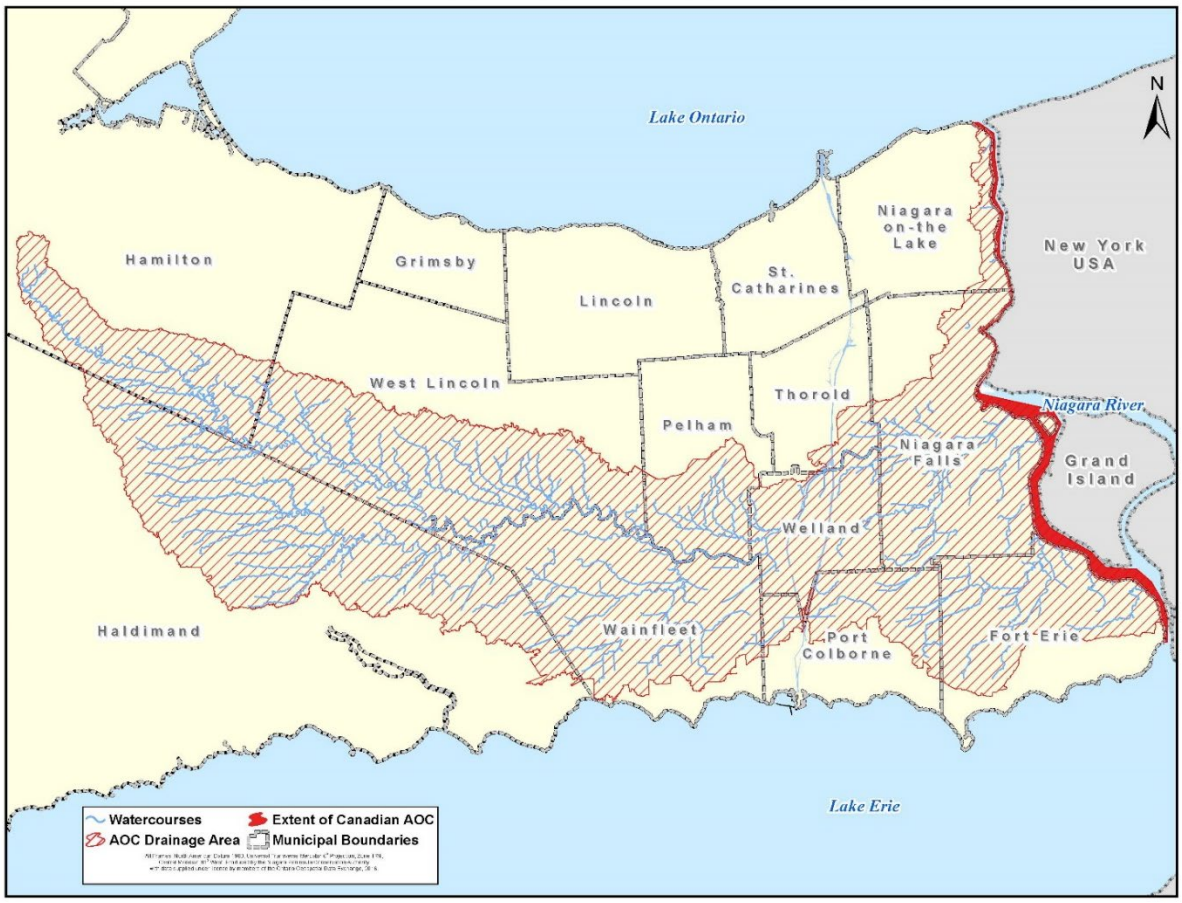


***Figure 1**. Map showing the extent of the Niagara River AOC and its watershed (Ontario side only).*

proper. For information about the efforts on the U.S. side of the Niagara River, visit www.epa.gov/great-lakes-aocs/about-niagara-river-aoc.

Within the scope of the GLWQA's Annex 1 (Areas of Concern), there are fourteen potential ecosystem indicators, referred to as Beneficial Use Impairments (BUI), that relate to the economic, human health, and environmental beneficial uses that are provided by the Waters of the Great Lakes. Each of the indicators provide information about the chemical, physical, or biological integrity of the aquatic ecosystem and define the status of AOCs. Currently, there are five beneficial uses listed as 'Impaired' on the Canadian side of the Niagara River AOC and six remaining on the American side (Table 1). Only the Canadian BUIs with an impaired status are addressed in this document as no further actions are required for those designated as 'Not Impaired', and the U.S. RAP has its own plan in place for addressing impairments on the U.S. side of the river.

Delisting criteria developed under the RAP are specific goals used to measure progress and assess the condition of each of the BUIs. The delisting criteria are specific, measurable, feasible/realistic, and time-bounded. When appropriate RAP actions are complete and scientific evidence shows that all BUIs meet their specific delisting criteria, the AOC can be proposed for delisting. Delisting criteria for the Canadian side of the Niagara River AOC were first developed in 1995 in the Stage 2 RAP Report. The

first set of criteria were developed using sixteen high-level water use goals to reflect an ecosystem approach rather than specific issues related to each BUI (NRRAP, 1995).

Table 1. List of the 14 potential beneficial use impairments noted in Annex 1 of the 2012 GLWQA along with their respective Canadian and American status. The date indicates the year the BUI status in official documents.

GLWQA Beneficial Use Impairment	CDN STATUS	US STATUS
1. Restrictions on fish/wildlife consumption	Impaired for fish	Impaired
2. Tainting of fish/wildlife flavour	Not Impaired (1993)	Not Impaired (1994)
3. Degradation of fish/wildlife populations	Impaired	Impaired
4. Fish tumours or deformities	Not Impaired (2009)	Not Impaired (2016)
5. Bird/animal deformities or reproduction	Not Impaired (2009)	Impaired
6. Degradation of benthos	Impaired	Impaired
7. Restriction on dredging activities	Not Impaired (2009)	Impaired
8. Eutrophication or undesirable algae	Not Impaired (2019)	Not Impaired (1994)
9. Restrictions on drinking water consumption	Not Impaired (1993)	Not Impaired (1994)
10. Beach closings	Impaired	Not Impaired (1994)
11. Degradation of aesthetics	Not Impaired (1993)	Not Impaired (1994)
12. Added costs to agriculture or industry	Not Impaired (1993)	Not Impaired (1994
13. Degradation of phytoplankton and zooplankton populations	Not Impaired (2019)	Not Impaired (1994)
14. Loss of Fish and Wildlife Habitat	Impaired	Impaired

Given the 2012 revision to the geographical scope of Great Lakes AOCs, there was a need to review and re-align the Niagara River AOC's delisting criteria. In November 2018, the Niagara River RAP Implementation and Public Advisory Committee agreed that ad-hoc Technical Working Groups should be formed to critically review and revise the remaining BUI criteria, as appropriate. Beginning in mid-2019 until mid-2020, experts from various organizations collaboratively reviewed and revised each set of the Niagara River's five remaining BUI delisting criteria. Primer documents were prepared to communicate and seek feedback on the proposed changes from the Niagara River RAP Implementation and Public Advisory Committee. Once approved by the RAP Committees, each primer document was posted and

promoted online and through the RAP's E-newsletter for a 45-day public review period. All feedback received was compiled and revisions to the primer and/or BUI criteria were made, as required. Final acceptance of the revised criteria is documented in the Implementation and Public Advisory Committee meeting records. This document reflects the final accepted version of each set of BUI criteria and information as presented in the primers.

As progress continues in the AOC and the RAP approaches its targeted delisting criteria, it is imperative that there is a clear and evidence-based course of action and involvement from partner organizations over the next 3-5 years. A key component of this Niagara River (Ontario) Delisting Strategy is the identification of priority remaining actions related to management, remediation, monitoring, data gathering/analysis, outreach, and assessment/reporting for each of the five remaining BUIs (refer to the 'Remaining Actions' section in each BUI chapter of this document). The remaining actions were identified by the relevant technical work group experts during and after the revision of delisting criteria and began being implemented as early as 2019. The actions in this document are intended to guide efforts by RAP partners to remove the Niagara River's remaining five BUIs. While experts have done their best to identify all possible actions to remove a BUI, it is possible that fewer or additional actions may be required to achieve the goals of the BUI delisting criteria. It is recommended that the RAP partners review this document and create work plans annually to ensure continued, targeted efforts toward delisting.

PURPOSE

The purpose of the Niagara River (Ontario) Delisting Strategy is to provide the most up-to-date summary of information about the Niagara River's remaining BUIs, impart guidance on BUI removal through the specific delisting criteria, and to identify the recommended remaining priority actions to lead organization(s) involved in the RAP for each of the remaining impaired beneficial uses.

The information, BUI delisting criteria, and remedial and monitoring actions in this document supersede the information and recommendations in previous RAP reports and will be used for all future assessments pertaining to the Canadian side of the AOC.

SUMMARY OF DELISTING CRITERIA

There are five remaining beneficial use impairments in the Niagara River (ON) Area of Concern. The table below is a summary of the current delisting criteria for each of the remaining BUIs for quick reference. For more information about the BUIs, including how to apply the delisting criteria and a list of remaining actions, please refer to the next section “Overview of Remaining Beneficial Use Impairments”.

BUI Name	**I.D.**	**The BUI will no longer be impaired when:**
Restrictions on Fish Consumption	1-1	consumption advisories for fish of interest in the AOC are unrestricted; *OR*
	1-2	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; *OR*
	1-3	multiple lines of evidence indicate improving conditions over time and all feasible remedial actions are complete.
Degradation of Fish Populations	3A	multiple lines of evidence indicate similarity between the Niagara River fish community and expectations based on the adjoining Great Lakes.
Degradation of Wildlife Populations	3B-1	a monitoring plan is developed and there is a commitment confirmed by local partners for long-term implementation at suitable wetland sites along the upper Niagara River; *AND*
	3B-2	breeding colonial waterbird populations within the Niagara River AOC are the same as (or better than) suitable reference sites; *AND*
	3B-3	temporal trends in contaminant concentrations in eggs, tissues, or whole-body burden of sentinel species in the Niagara River AOC are stable or declining; *AND*
		spatial comparisons show that contaminant concentrations in eggs, tissues, or whole-body burden of sentinel species in the Niagara River AOC are the same as (or better than) suitable reference sites; *OR*
		If the contaminant concentrations in 3a or 3b are not met, then they must not exceed established thresholds associated with potential population-level effects (i.e., reproductive impacts).

BUI Name	I.D.	The BUI will no longer be impaired when:
Degradation of Benthos	6-1	acute and chronic toxicity, community composition, and abundance in the benthic community are similar to non-AOC reference sites; *AND*
		concentrations of biomagnifying contaminants (e.g., PCBs and dioxin-like PCBs) within benthic invertebrate tissues are comparable to a suitable non-AOC reference site; *OR*
	6-2	if a contaminated site[1] fails to meet criteria 1a and 1b, then benthic invertebrate tissue contaminant concentrations are greater than reference sites but below concentrations considered to impair the beneficial uses associated with the consumption of fish and wildlife; *OR*
	6-2	if a contaminated site[1] fails to meet the criteria above, then a risk based contaminated sediment management approach/strategy must be in place with appropriate monitoring and mitigation measures and/or administrative controls.
Beach Closings	10-1	prominent sources of fecal pollution that could contaminate the beach or recreational waters are known and remedial actions to address known sources are identified and completed; *AND*
	10-2	at least 80% of the geometric mean results of recreational water samples (when sampled at least once per week) meet the Ontario Ministry of Health Recreational Water Quality Guideline (≤200 CFU/100 mL) each swimming season for a minimum of three years; *AND*
	10-3	risk management actions (e.g., postings, signage, education, rain rule) are in place to protect human health
Loss of Fish and Wildlife Habitat	14-1	5-7 identified coastal wetland habitat projects on the Canadian side of the Upper Niagara River are complete; *AND*
	14-2	at least 75% of the Niagara River (Canadian) shoreline is naturally vegetated; *AND*
	14-3	there is a minimum 5-metre wide 'no mow' vegetated buffer along the publicly managed Canadian shoreline of the Upper Niagara River; *AND*
	14-4	the existing areal extent of unique wildlife habitat (i.e., Niagara Gorge) is at least 80% secured and managed for long-term conservation purposes.

[1] Refers to the original 14 contaminated sediment sites identified in the Niagara River AOC watershed (NRRAP 1995a).

OVERVIEW OF REMAINING BENEFICIAL USE IMPAIRMENTS

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. GLWQA; however, due to 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.

In most 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 limited consumption [of fish] by humans (i.e., < 8 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 while 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). The *Guide* provides advisories on eating fish from over 2,400 fishing locations across Ontario, including the Upper and Lower Niagara River. Fish consumption advisories provided by MECP in the *Guide* are developed using tolerable daily intakes from the Food Directorate of Health Canada (Bhavsar et al. 2011) and 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 because they are more at risk of being affected by lower levels of contaminants. The sensitive population includes 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.

According to current benchmarks applied by the MECP, consumption advisories are sub-divided into three levels of restrictions[2]: 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).

In the Canadian waters of the Niagara River, most fish consumption advisories are due to PCBs (Bhavsar et al. 2011) (Table 2). 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).
- dioxins/furans are listed for advisories related to eating Brown Bullhead in the Upper Niagara River and are at levels which are UNRESTRICTED (the advisory relates to greater than 8 meals and 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 solely 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.

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

Table 2. 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 can 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 increased levels in the environment 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 continue to be 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 unless consumed above recommended levels 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 solely 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. Information about the U.S. BUI status is provided in the section called ‘The American Connection: BUI Status on the U.S. side of the Niagara River’.

BUI DELISTING CRITERIA & APPLICATION GUIDANCE

While generic language was suggested by scientific experts for consideration by all Canadian AOCs (Bhavsar et al. 2018), the Niagara River RAP adopted the criteria with minor revisions for additional clarity in their application/assessment. The delisting criteria use three tiers of multiple lines of evidence to determine if the fish consumption beneficial use is impaired or not. Based on the outcomes of the tiered assessment framework (below), a recommendation is made to either maintain the 'Impaired' BUI status or to change the status to 'Not Impaired'.

The *Restrictions on Fish Consumption* BUI (#1) will no longer be impaired when:

1) consumption advisories for fish of interest in the AOC are unrestricted; 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; OR
3) multiple lines of evidence indicate improving conditions over time and all feasible remedial actions are complete.

Each delisting criterion is an assessment tier which uses multiple lines of evidence to determine if the fish consumption beneficial use is impaired or not (modified from Bhavsar 2018). 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'. Not all the tiers need to be met for BUI removal (page 14).

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.

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).

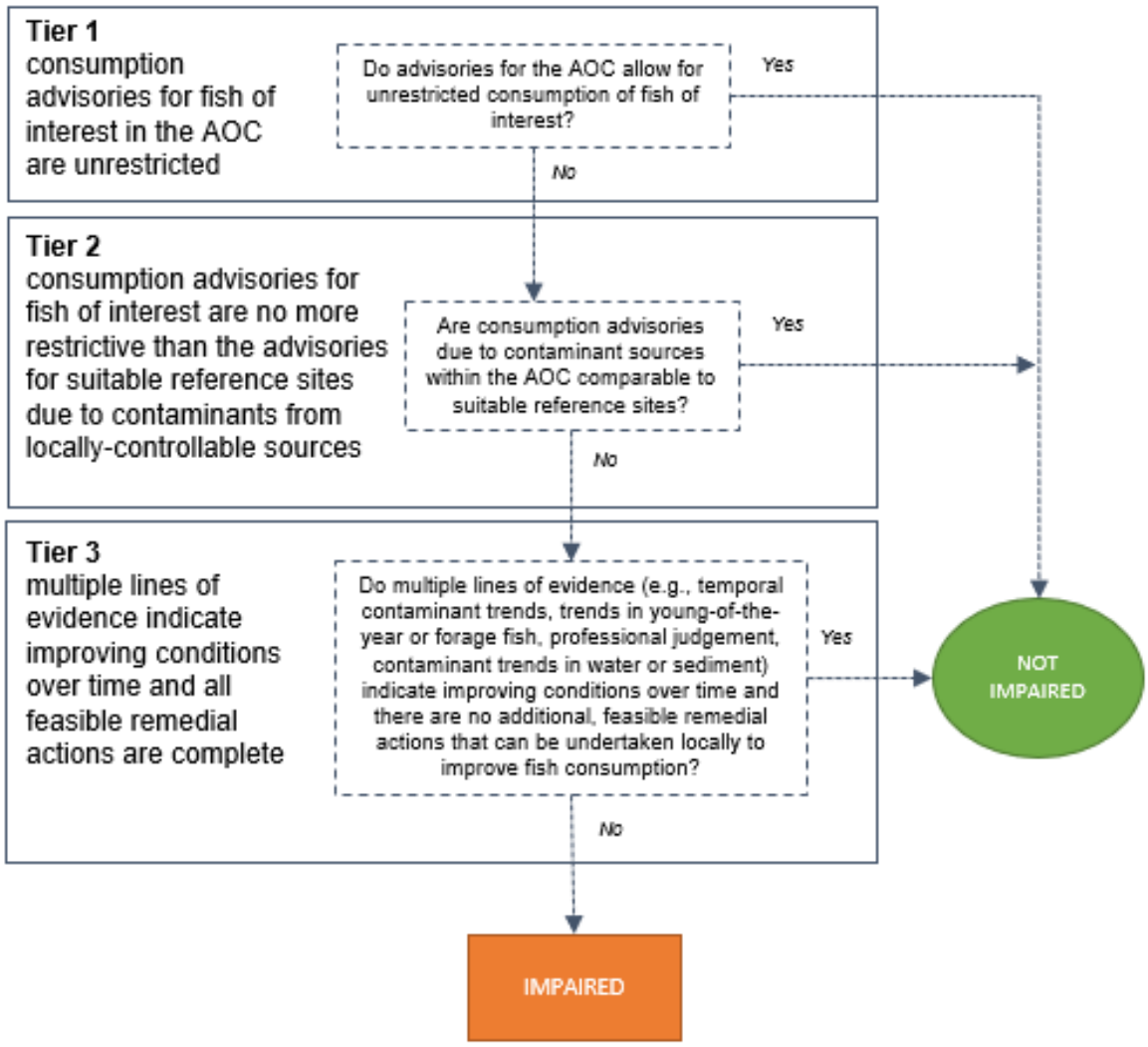
Unrestricted OR no more restrictive: Fish consumption advisories are produced by the Ontario Ministry of the Environment, Conservation and Parks through its Fish Contaminant Monitoring Program (see the background section for more information). Not all the advisories published in the *Guide* result in 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).

TIERED ASSESSMENT FRAMEWORK



REMAINING ACTIONS: Restrictions on Fish Consumption BUI

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
DATA COLLECTION								
1.1	Administer the online fish consumption survey of Niagara River anglers to determine fish of interest.	●	●	●				NRRAP
1.2	Conduct in-person surveys of anglers at various locations along the Canadian side of the Niagara River to determine fish of interest.		●	●				NRRAP
1.3	Engage with local Indigenous communities to gather information about their Niagara River fish consumption.	●		●				ECCC, MECP, NRRAP
1.4	Translate fish consumption survey into other relevant languages (e.g., Arabic, French, Spanish, Mandarin, Vietnamese) and administer to non-English speaking anglers, where possible.		●	●				NRRAP
1.5	Collect fish samples from the Niagara River to measure contaminants in fish tissues as part of the Ontario Fish Contaminants Monitoring Program.		●	●	●			MECP
1.6	Gather information from ongoing water quality monitoring programs (e.g., Upstream-Downstream, mussel biomonitoring) to support the multiple lines of evidence required to assess the delisting criteria (i.e., contaminants related to fish consumption advisories).					●		NRRAP, ECCC, MECP
1.7	Gather information from ongoing sediment monitoring programs (e.g., NRTMP, Upstream-Downstream, Niagara Bar location) to support the multiple lines of evidence required to assess the delisting criteria (i.e., contaminants related to fish consumption advisories).					●		MECP, ECCC
OUTREACH AND EDUCATION								
1.8	Develop and distribute ‘Eat Safe Fish’ educational materials (based on the Guide to Eating Ontario Fish) to share information about Niagara River fish consumption.	●						NRRAP
1.9	Create and maintain a webpage on the Niagara River RAP website to share information about eating safe fish from the Niagara River.		●				●	NRRAP
1.10	Translate outreach materials into other relevant languages to reach non-English speaking fishers.		●					NRRAP

[Continued on following page]

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
OUTREACH AND EDUCATION (continued)								
1.11	Continue to produce and make available the *Guide to Eating Ontario Fish*.						●	MECP
1.12	Install signage at key Niagara River fishing locations to inform anglers where to find information about fish consumption.					?		To be determined
REPORTING								
1.13	Compile all Niagara River fish consumption survey results and prepare a summary report.				●	●		NRRAP
1.14	Gather all relevant information and assess the status of the BUI.					●		MECP (TBD)
	• If not impaired, proceed with re-designation process			?	?			
	• If still impaired, further discussions will be required.			?	?			

DEGRADATION OF FISH POPULATIONS (BUI #3A)

BACKGROUND

Fish play integral roles in aquatic ecosystems and form valuable fisheries providing economic and social benefits to local communities. While populations of large top-predators such as Bass, Walleye (pickerel), and Muskellunge are often highly desired sport and commercial fisheries, populations of smaller bodied prey species (e.g., Emerald Shiner) are equally important for their role in maintaining the biological integrity of aquatic ecosystems. Biological integrity is defined as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of natural habitat of the region" (Karr & Dudley 1981).

The *Degradation of Fish and Wildlife Populations* BUI[3] is an environmental indicator that can provide information about biological, and chemical (water quality), physical integrity (habitat condition/availability integrity in the Niagara River AOC given water quality issues and habitat loss may be driving factors leading to changes in the fish community structure. For example, a stressed ecosystem (e.g., impacted by water pollution) may result in changes to the community structure, such as changes in the number of native species, reduced numbers of sensitive species, increase of pollution-tolerant species and fewer top predators and trophic specialists.

Due to the fast flows and short retention time, the Niagara River's water chemistry, productivity, and plankton community is similar to the water that enters the river from Lake Erie (Rozon et al. 2016). Among the Great Lakes connecting channels, the Niagara River is particularly unique because of its drop in elevation (nearly 100 m over a distance of 58 km) with more than half of this drop occurring at the Niagara Falls (56 m) (NRRAP 1993). Niagara Falls (consisting of three separate waterfalls) physically divide the river into an upper and lower portion, which limits fish movement between the sections and results in distinct fish communities (Yagi & Blott 2016). The Niagara River provides important spawning, nursery, and feeding habitats for a diverse array of fish (NRRAP 1993) including coldwater (e.g., Chinook Salmon, Lake Trout, Rainbow Trout, Brown Trout and Coho Salmon), coolwater (e.g., Smallmouth Bass, Walleye, Muskellunge, Yellow Perch) and warmwater (e.g., Carp, Crappie, and Largemouth Bass) fish species. The Upper Niagara River (Lake Erie to the top of Niagara Falls) is similar to Lake Erie with angler harvest (by total numbers of fish) dominated by Smallmouth Bass, Yellow Perch, Rock Bass, and Rainbow Smelt (NRRAP 1993). The Lower Niagara River (bottom of Niagara Falls to Lake Ontario) has coldwater

[3] The Niagara River Remedial Action Plan (RAP) has historically divided this indicator into two separate sub-BUIs focused on either fish or wildlife populations with their own specific delisting criteria. This chapter is for the fish portion of the BUI only. The wildlife component is discussed in the following section.

fisheries similar to Lake Ontario with angler harvest (by weight) dominated by Rainbow Trout, Lake Trout, Coho Salmon, and White Bass (NRRAP 1993, Yagi & Blott 2016).

When originally listed, the Niagara River AOC was said to support a vibrant sport fishery with an impressive array of fish species (NRRAP 1993a); however, the beneficial use indicator has been listed as 'Impaired' since the inception of the RAP program (refer to Table 1 for details on the BUI status over time in major RAP Reports). The RAP Stage 1 Report (1993a) states that the fish populations in the Niagara River reflected those in the nearby Great Lakes and were generally not degraded; but noted reduced populations of Lake Sturgeon, Emerald Shiner, and Northern Pike in the upper Niagara River. These anecdotal observations along with concerns in the Welland River, a tributary of the Niagara River, resulted in the Degradation of Fish Populations BUI on the Canadian side of the AOC being listed as 'Impaired'. Despite some limited monitoring efforts on the Niagara River proper between 1997-2011, the status of the BUI remained 'Impaired' on the Canadian side of the AOC largely due to the conditions of the fish populations in the Welland River. During this time, extensive monitoring and remediation efforts (e.g., removal of fish barriers) were implemented in the Welland River watershed. Before 2012, the AOC included the Niagara River proper as well as the entire watershed. In 2012, the scope of the GLWQA was clarified and states that the BUIs apply to the "Waters of the Great Lakes" which resulted in a need to re-examine the status of the Fish Populations BUI in the context of the Niagara River proper. If an assessment indicates that the Fish Populations BUI status is 'Impaired' due to factors related to the tributaries, then these tributary issues can be considered in addressing the BUI.

To directly address the Fish Populations BUI status in the Niagara River proper, a status assessment is underway to confirm whether the BUI is impaired or not. In order to better understand the Niagara River's fish community and obtain standardized data, scientists from Fisheries and Oceans Canada conducted seasonal (spring, summer, and fall) fish community sampling in the Lower and Upper Niagara River from 2015-2017. The comprehensive study used boat electrofishing techniques to sample 10 sites (6 UNR, 4 LNR) which were aligned with historical MNRF sites and comparable to sampling used in other connecting channels (i.e., Detroit River and St. Clair River). In 2019, the RAP Team also conducted a survey of Niagara River fisheries experts from both the U.S. and Canada to gather more information about the fishes observed in the river using various sampling techniques. The *Degradation of Fish Populations* BUI status assessment is expected in 2021.

BUI DELISTING CRITERIA & APPLICATION GUIDANCE

The delisting criterion was carefully developed through several scientific discussions between technical experts to ensure the criterion was specific, measurable, feasible, relevant, and within the scope and abilities of the RAP program. The following section provides further details on the rationale and the suggested methodology for how to apply the criterion for a BUI assessment.

The *Degradation of Fish Populations* BUI (#3A) will no longer be impaired when:

1) multiple lines of evidence indicate similarity between the Niagara River fish community and expectations based on the adjoining Great Lakes.

Multiple lines of evidence: The Technical Working Group determined that traditional assessment tools such as direct population assessments or an Index of Biological Integrity (IBIs) were not entirely applicable to assess the status of fish populations in the Niagara River AOC, because of the unique characteristics and complexities of connecting channels, the lack of historical information, and the lack of suitable non-AOC reference sites. The technical working group recommends that using a multiple lines of evidence approach which includes biological metrics that provide quantitative and/or qualitative information. Based on available data and sampling limitations in the Niagara River, the multiple lines of evidence are species composition, trophic composition, ecological guilds, and then applying expert judgement to make an assessment.

From "Fish community populations" to "Fish community: While the BUI refers to Fish Populations, the assessment relies on a community because, ecologically-speaking, the terms "population" and "community" have different meanings. "Populations" typically refers to a group of individuals of a single species (e.g., Walleye or Perch). "Community" typically references two or more populations of different species that occupy the same environment. Using "fish community" to evaluate the condition of the Niagara River is appropriate because it shows impact more broadly from aquatic ecosystem stressors (ecosystem approach) and is most consistent with fishery management goals and objectives for Lake Erie and Lake Ontario (Great Lakes Fishery Commission 2003, 2017). The use of both terms in sequence in the 2009 delisting criteria led to misinterpretation which a specific reference to "fish community" will clarify.

Expectations based on the adjoining Great Lakes: There are issues with finding an appropriate reference site for the Niagara River. The Great Lakes' connecting channels are globally unique environments displaying characteristics of both lacustrine (lake) and riverine (river) environments. They contain aquatic habitats similar to other large rivers but have flows and productivity driven by the dynamics in the adjoining lakes. While other connecting channels such as St. Marys River, St. Clair River, Detroit River, and St. Lawrence River may have comparable habitats, they are also AOCs and the comparison would be to another degraded location. The technical working group recommends that comparisons should be to the adjoining Great Lake (i.e., Upper Niagara River and eastern basin of Lake Erie, Lower Niagara River and western basin of Lake Ontario) with expert judgment used to examine any observed differences. Expert judgment can account for the unique ecological and hydrological conditions of connecting channels and broader lake-wide/regional fisheries conditions beyond the scope of the AOC, while also accounting for

migratory species and sampling limitations (i.e., gear type, techniques) due to the fast-flowing riverine conditions and the Niagara Falls.

Aligning the delisting criterion with the GLWQA: The delisting criterion aligns with the purpose and scope of the Canada-U.S. GLWQA. The criterion specifically aligns with the geographic scope of the GLWQA (i.e., Waters of the Great Lakes) and with its goal of ensuring an AOC is no worse than other Great Lakes' locations. It also addresses the biological integrity[4] component and resiliency of an aquatic ecosystem by specifically referring to the status of the fish community.

[4] Biological integrity is defined as the capability of supporting and maintaining a balanced integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of natural habitat of the region. An aquatic system exhibiting integrity can withstand and recover from natural ecological disruptions as well as anthropogenic disruptions (Karr & Dudley 1981).

REMAINING ACTIONS: Degradation of Fish Populations

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
DATA COLLECTION								
3.1	Develop and administer a survey applying professional judgment to identify which fishes are expected in the Niagara River and to validate the presence/absence of the remaining fish on the Niagara River fishes list.	●						DFO, MNRF, NRRAP
3.2	Finalize the list of expected Niagara River fishes using the information gathered from the professional judgment survey (above).	●						DFO, MNRF, NRRAP
ASSESSMENT								
3.3	Discuss and select the multiple lines of evidence that should be used for the delisting criteria and BUI assessment to determine its status.	●						DFO, MNRF, NRRAP
3.4	Gather all relevant information and assess the status of the BUI.		●	●				DFO
	• If not impaired, proceed with re-designation process			?	?			NRRAP
	• If still impaired, further discussions will be required.			?	?			

DEGRADATION OF WILDLIFE POPULATIONS (BUI #3B)

BACKGROUND

Wildlife, particularly species which are part of the aquatic ecosystem, are important ecological indicators commonly used for understanding the overall condition of the waters of the Great Lakes in an AOC. Aquatic wildlife species used for this indicator are typically those that spend most (or all) of their lives near water and rely on the Niagara River for breeding and feeding, such as colonial waterbirds, marsh-dependent birds, amphibians and reptiles. The species used to assess this impairment are intended to represent the biological integrity (i.e., the condition of organisms) of the aquatic ecosystem and the water's chemical and physical condition in response to stressors within the AOC such as, legacy pollutants or poor habitat quantity or quality. Broader stressors (e.g., climate change, diet, competition, or disease) are not typically considered as causes of impairment within the scope of the RAP program since they are beyond the scope and scale of local actions which the RAP can address within its purview. Habitat degradation is addressed through separate criteria although it is still considered as a factor in the context of population impacts.

The *Degradation of Fish and Wildlife Populations* BUI[5] is an environmental indicator intended to understand the condition of and impacts to the Niagara River's wildlife related to historic pollution or habitat conditions due to issues occurring within the geographic scope of the Niagara River AOC.

There are two well-established monitoring programs that have been integral to understanding the impact of pollution on aquatic wildlife in an AOC. Since the 1970s, Environment and Climate Change Canada (ECCC) has monitored the spatial and temporal trends of contaminants as well as the number of nests of Great Lakes colonial waterbirds (e.g., herons, gulls, terns). These bird species are important because they are top predators in the food web, they nest in colonies near water, and obtain almost all of their food (fish and aquatic invertebrates) from the water (United States Fish and Wildlife Service 2002). The Great Lakes Marsh Monitoring Program (GLMMP) was established in 1995, as a partnership between Birds Canada, ECCC, and the U.S. Environmental Protection Agency. The program focuses on marshes in the Great Lakes basin with a special emphasis on coastal Great Lakes marshes since many of these locations experienced declines in health due to heavy pollution and development (Birds Canada 2009a).

[5] The Niagara River Remedial Action Plan (RAP) has historically divided this indicator into two separate sub-BUIs focused on either fish or wildlife populations with their own specific delisting criteria. This chapter is for the wildlife portion of the BUI only. The fish component is discussed in the previous section.

When the Niagara River was first listed as an AOC, the status of wildlife populations was unknown as there was limited information available (NRRAP 1993a). The RAP Stage 1 Report (1993a) noted that while the Niagara Peninsula has a wide diversity of bird species, a number of wildlife species were endangered or extinct; however, these appeared to be widespread in the developed portion of Ontario, rather than linked to an AOC-specific issue. A follow-up to the RAP Stage 1 Report which added long-term data (1977-1990) missing from the Stage 1 Report illustrated that levels of contaminants were declining in colonial waterbird eggs and the number of nests had been increasing since the 1970s (NRRAP 1993b). Since that time, the Niagara River corridor was identified as an important staging and migration area for waterfowl and designated an Important Bird and Biodiversity Area in 1996 because it supports one of the largest and most diverse concentrations of gulls in the world (Important Bird Areas Canada 2020). The Niagara River corridor also supports several of Canada's species-at-risk, including 44 species (mammals, birds, amphibians, insects, plants, and fungi) listed as Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (A. Bichel, pers. comm. 2020). Furthermore, the Niagara River corridor is home to the only known population of Dusky Salamander in Ontario (NRRAP 1993a, MECP 2020). In 2007, a technical review was conducted to review the impairment status, delisting criteria, and monitoring/assessment needs for all of the remaining impairments at the time (Mackay 2007). The technical review suggested that the wildlife portion of the *Degradation of Fish and Wildlife Populations* BUI status be changed to 'Impaired' mainly because of watershed-wide habitat issues and contaminant issues at Lyons Creek East, which are being addressed through the *Degradation of Benthos* BUI. Consequently, the BUI status was changed from 'Unknown' to 'Impaired' through the completion of the RAP Stage 2 Update Report (NRRAP 2009), despite evidence suggesting improved health of colonial waterbirds nesting within the Niagara River. Recently, the Niagara River (Ontario) RAP team identified the need for updated monitoring efforts to validate earlier findings of improvements in colonial waterbird populations. As a result, scientists at ECCC conducted a 2-year study examining the spatial and temporal contaminant trends and nest counts in colonial waterbirds. A report on their findings was completed in 2020.

After the release of the Stage 2 RAP Update Report, Birds Canada completed a report summarizing 2 years of water quality, bird, and amphibian monitoring at various locations throughout the watershed, with only one Niagara River site (Archer et al. 2010). Due to the lack of sites in the Niagara River AOC itself, the RAP Team suggested further site identification/validation. In 2020, the NPCA and Birds Canada staff conducted preliminary monitoring and verification of site suitability along the Upper Niagara River. It was determined that the sites, while vegetated, do not meet the Marsh Monitoring Protocol site criteria. As such, the preliminary studies in Canada and a 5-year study in the U.S. both noted low detections of amphibians and breeding marsh birds likely due to the unique conditions of a connecting channel (i.e., fast water flows) which does not provide the suitable habitat required for these target species. It is possible that, over a longer period of time, the recently constructed coastal wetlands will further establish

and may support species other than fish. Work is currently underway in partnership with Birds Canada to establish appropriate long-term monitoring at locations within the AOC, namely at restored and existing coastal wetland sites in the Upper Niagara River between Fort Erie and Niagara Falls, Ontario.

BUI DELISTING CRITERIA & APPLICATION GUIDANCE

The delisting criteria are aligned with the geographic scope of the Niagara River AOC and focus on the condition of colonial waterbirds as well as establishing a long-term monitoring plan for select sites along the Canadian side of the Niagara River. This section provides a description of the main components and guidance on application of each criterion including suggestions for sentinel species and reference sites.

The *Degradation of Wildlife Populations* BUI (#3B) will no longer be impaired when:

1) a monitoring plan is developed and there is a commitment confirmed by local partners for long-term implementation at suitable wetland sites along the upper Niagara River; *AND*
2) breeding colonial waterbird populations within the Niagara River AOC are the same as (or better than) suitable reference sites; *AND*

3a) temporal trends in contaminant concentrations in eggs, tissues, or whole-body burden of sentinel species in the Niagara River AOC are stable or declining; *AND*

3b) spatial comparisons show that contaminant concentrations in eggs, tissues, or whole-body burden of sentinel species in the Niagara River AOC are the same as (or better than) suitable reference sites; *OR*

3c) If the contaminant concentrations in 3a or 3b are not met, then they must not exceed established thresholds associated with potential population-level effects (i.e., reproductive impacts).

Long-Term Monitoring Plan: This first criterion was originally meant to examine the overall community of marsh birds and amphibians breeding within the Niagara River AOC watershed. However, recent preliminary research and public feedback resulted in a change to this criterion as it was deemed unrealistic within the context of the Niagara River AOC proper. Rather, to meet this criterion, a long-term monitoring plan will be put in place, and implemented by local partners even after the BUI is removed. Breeding birds and amphibians can help determine the success of recent habitat improvements. The recently constructed coastal wetlands in the Upper Niagara River (to address BUI 14) were primarily intended to improve fish habitat with an understanding that there could be secondary benefits for other wildlife species (e.g., a feeding area for herons or insectivorous birds). Preliminary monitoring indicated low numbers of breeding birds/amphibians on both sides of the Niagara River likely linked to the unique conditions of a connecting channel (i.e., fast water flows) and lack of suitable habitat for these particular species rather than pollution concerns typical of an AOC. Currently, there are no further short-term remedial actions to improve these sites as they need time (~10 years+) to establish. A monitoring plan, and long-term adaptive management can help to track progress and see whether they continue to

succeed. Given the length of time it may take for the restoration sites to fully establish and support wildlife species, criterion 1 is to ensure a monitoring plan is created to be implemented after the BUI has been re-designated. This adaptive management approach ensures that the local partners will continue to collect valuable/meaningful data to adjust/modify the restoration strategy as the sites establish and progress.

The monitoring plan should consider existing protocols, strategies, and programs that can be utilized to implement the long-term plan. For example, the *Marsh Monitoring Program Participant's Handbook for Surveying Marsh Birds* (Birds Canada 2009a) and *Marsh Monitoring Program Participant's Handbook for Surveying Amphibians* (Birds Canada 2009b) identify appropriate target species and provide guidance on monitoring protocols. The Niagara Parks Commission has also identified the need for long-term monitoring in its Environmental Stewardship Strategy and Urban Forest Management Strategy. A proposed long-term monitoring plan developed through this criterion will aim to support the goals in each of these strategies to ensure continued implementation by Niagara Parks with support from NPCA and volunteers. Furthermore, the monitoring plan should focus on monitoring habitat establishment of the restored (or suitable existing) coastal wetland sites along the Upper Niagara River to help inform an adaptive management approach and adjust/modify the restoration strategy as these sites establish and progress.

Breeding colonial waterbird populations: Criterion 2 refers to the population status of colonial waterbirds (e.g., Ringed-bill Gull (*Larus delawarensis*), Herring Gull (*Larus argentatus*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Common Tern (*Sterna hirundo*) and Double-crested Cormorant) that breed and forage in the Niagara River AOC rather than species that migrate through the area or use the Niagara River as a stopover in the winter months. Colonial waterbirds have historically been used to estimate population trends in the Great Lakes during four decadal surveys (1977-2007) and annually at Weseloh Rocks from 2010-2017. The assessment of breeding colonial waterbird population trends can be conducted using historical nest count data; however, it should be clear that there is no recent colonial waterbird survey data from Weseloh Rocks due to high water levels since 2017. As such, another approach to consider for assessing this criterion is through artificial incubation of eggs collected from nesting site(s) in the Niagara River AOC. The artificial incubation approach is used to infer the status of waterbird populations through examining embryonic mortality due to contaminants.

Historically, the colony at Weseloh Rocks has been monitored on the Canadian side of the Niagara River AOC; however, since 2017, the site has been impacted by high water levels across the Great Lakes. Another potential site within the Niagara River AOC with a known colonial waterbird colony is located at the North Breakwall on the U.S. side of the Niagara River near the Buffalo Harbour. While this site is on the U.S. side, it is still a relevant location because it is within the geographic boundary of the Niagara River AOC, the waterbirds are expected to consume Niagara River fish, and results should be indicative of local Niagara River conditions.

To meet the criterion, results of breeding waterbird populations from sites in the Niagara River AOC must be compared to an appropriate reference site(s); however, finding a suitable reference location for the Niagara River is challenging because the Great Lakes' connecting channels (i.e., Niagara River, Detroit River, St. Clair River, St. Marys River, St. Lawrence River) are globally unique environments displaying characteristics of both lacustrine (lake) and riverine (river) environments. They contain aquatic habitats similar to other large rivers but have flows and productivity driven by the dynamics in their adjoining Great Lakes. While other connecting channels such as St. Marys River, St. Clair River, Detroit River, and St. Lawrence River may have comparable habitats, they are also AOCs and the comparison would be to another degraded location. Reference locations should be outside of the Niagara River AOC but within the eastern basin of Lake Erie to account for regional impacts. For other Niagara River BUIs such as the *Degradation of Fish Populations* (#3A), the connecting Great Lakes were recommended as reference sites (i.e., Upper Niagara River compared to eastern basin of Lake Erie and Lower Niagara River with the western basin of Lake Ontario). Similarly, it is suggested that to assess criterion 2 & 3 known colonial waterbird nesting sites located in the eastern basin of Lake Erie should be used to compared to the site in the Upper Niagara River. Reference sites should have known colonial waterbird colonies to accommodate monitoring. There are two potential reference locations to consider for comparison located in the eastern basin of Lake Erie: Mohawk Island (monitored in 2018) and Port Colborne (monitored annually for contaminants in Herring Gull eggs since 1974). Figure 2 is a map of nearby colonial waterbird monitoring locations.

Temporal contaminant concentrations: Criterion 3 has been divided into three parts for clarity. The first two parts (a & b) must both be met while part 3c only applies should part 3a or 3b fail to be met. Criterion 3a specifically refers to contaminant trends declining (or stable) over time. Contaminants of interest for the assessment of this criterion include (but are not limited to) polychlorinated biphenyls (PCBs), organochlorine compounds, and polybrominated diphenyl ethers (PBDEs) as these have relevance to the historical contaminant issues in the Niagara River. Contaminant concentrations can be measured in the eggs, tissues, or whole-body burden of wildlife species (e.g., Herring Gull, Snapping Turtle, or Double-crested Cormorant) that breed within the Niagara River AOC. Gulls and cormorants have established, known nesting colonies and feed within the Niagara River; therefore, their contaminant concentrations are reflective of Niagara River conditions.

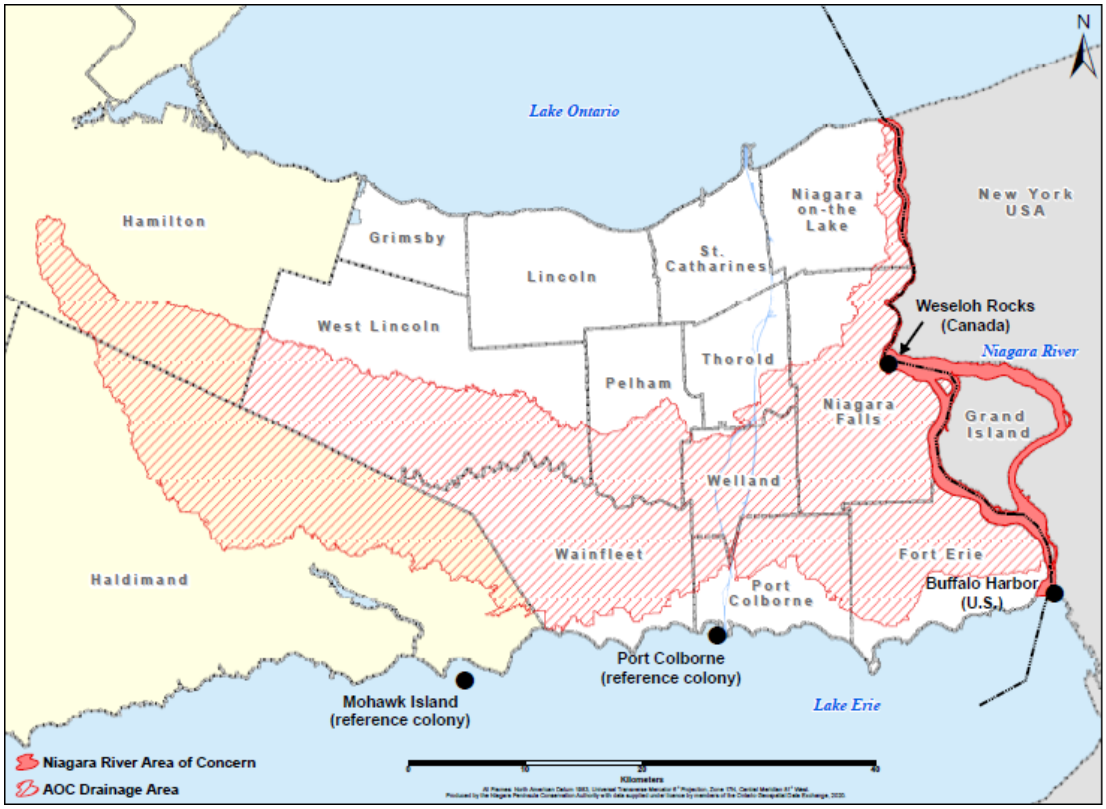


Figure 2. *Map of colonial waterbird nesting colonies in the Niagara River Area of Concern and eastern basin of Lake Erie.*

Spatial contaminant comparisons: Criterion 3b specifically refers to spatial contaminant concentration compared to other relevant locations (e.g., nearby reference locations, other Great Lakes AOCs). Contaminants of interest for the assessment of this criterion include (but are not limited to) polychlorinated biphenyls (PCBs), organochlorine compounds, and polybrominated diphenyl ethers (PBDEs) as these have relevance to the historical contaminant issues in the Niagara River. Contaminant concentrations can be measured in the eggs, tissues, or whole-body burden of wildlife species (e.g., Herring Gull, Double-crested Cormorant) that breed within the Niagara River AOC. There is some anecdotal evidence that Snapping Turtles nest and feed near the Upper Niagara River or at the mouths of certain tributaries; therefore, these may be considered as additional information about contaminant concentrations in wildlife to assess this criterion. Reference locations should be outside of the Niagara River AOC and could include other Great Lakes locations such as two known nearby reference locations in the eastern basin of Lake Erie: Mohawk Island (monitored in 2018) and Port Colborne (monitored annually for contaminants in Herring Gull eggs since 1974). Refer to Figure 2 for a map of nearby colonial waterbird monitoring locations. Furthermore, comparisons could be made to other nearby Great Lakes AOCs (e.g., Detroit River or Hamilton Harbour) for added information/context.

Population-level effect: Criterion 3c related to the population-level effect only applies if criteria 3a and 3b are not met. Criterion 3c is meant to examine the concentration of contaminants (e.g., PCBs, organochlorides, PBDEs) in eggs or tissues of Niagara River wildlife (as noted in parts 3a and 3b) compared to established thresholds (from the scientific literature) to infer population-level effects by examining reproductive impacts. For clarity, this criterion does not directly measure population-level effects, rather the assessment of this criterion would use clutch size, fecundity, viability of eggs, and hatchability of eggs to extrapolate potential population-level effects in Niagara River colonial waterbirds. If parts 3a and 3b are met, then there is no requirement to assess this criterion.

REMAINING ACTIONS: Degradation of Wildlife Populations

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
MONITORING								
3.5	Complete colonial waterbird survey (year 2 of 2; year 1 done in 2018) and data analysis to evaluate criterion 2 and 3, related to contaminants/body burdens.	●						ECCC
3.6	Identify and validate potential wildlife monitoring sites to support preparation of monitoring plan.		●					Birds Canada
3.7	Develop a long-term monitoring plan leveraging established monitoring protocols, existing programs, and relevant strategies for partners to implement beyond the RAP initiative.			●				Birds Canada, Niagara Parks, NPCA
REPORTING								
3.8	Prepare report on colonial waterbird study results (per 3.5), including recommendations about re-designation or further remedial actions required.		●					ECCC
3.9	Finalize monitoring plan and confirm commitment from local partners to implement the plan in an ongoing basis (post-RAP).			●			●	Birds Canada Niagara Parks NPCA
BUI ASSESSMENT								
3.10	Gather all relevant information and assess the status of the BUI.			●				NRRAP
	• If not impaired, proceed with re-designation process				?	?		
	• If still impaired, further discussions will be required to determine next steps.				?	?		

Note: The numbering of actions in this section continues from the previous fish populations BUI list of remaining actions.

DEGRADATION OF BENTHOS (BUI #6)

BACKGROUND

Benthos are the community of invertebrate organisms (e.g., crayfish, insects, worms) which live in or near the bottom of freshwater systems such as lakes, rivers and streams—at least for a part of their life cycle. Benthic invertebrates (or "benthos") are an important part of the food chain as a source of food for fish and aquatic birds. These bottom-dwelling organisms are also excellent indicators of local sediment and water quality conditions, because their limited mobility means they are continuously subjected to pollutants and environmental stream conditions within a small area. Benthos are used as ecosystem health indicators through a scientific sampling technique referred to as biomonitoring. Toxic chemicals such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and metals found in sediments can accumulate in benthos and move up through the food chain as the organisms are eaten by fish and wildlife. Certain benthos species can tolerate living in polluted sediment (e.g., aquatic worms, midge larvae) while others are very sensitive to pollution (e.g., caddisflies, stoneflies, and mayflies). The presence of more sensitive benthos is generally indicative of good water and sediment quality.

Specific to the Niagara River Area of Concern, the status of the *Degradation of Benthos* ecosystem indicator has been 'Impaired' since the completion of the Niagara River RAP Stage 1 Report, mainly because of contaminated sediments in the Welland River and other small tributaries near the Niagara River (NRRAP 1993). The 1993 report indicated that benthos in the Niagara River itself were relatively sparse due to lack of suitable substrate related to the high-velocity water flow but, in backwater areas, benthos abundance and diversity were not impaired. In 1995, a RAP Stage 1 Update Report provided scientific evidence that identified the impaired status of benthos in the Niagara River watershed was due to contaminated sediments at 14 potential sites identified for further investigation (NRRAP 1995a). Based on the sediment conditions, the sites were prioritized into three categories (Level 1, 2, 3) (Figure 3). The Level 1 sites were those with previously known contamination requiring remediation, while all of the Level 2 and 3 sites were remediated and/or reviewed and are now determined to have little to no risk to living organisms (humans and wildlife) and therefore, no further action is required at these sites. In April 1995, recommendations to address specific sources at contaminated sites were identified in the RAP Stage 2 Report (NRRAP 1995b) and remediation activities began shortly thereafter.

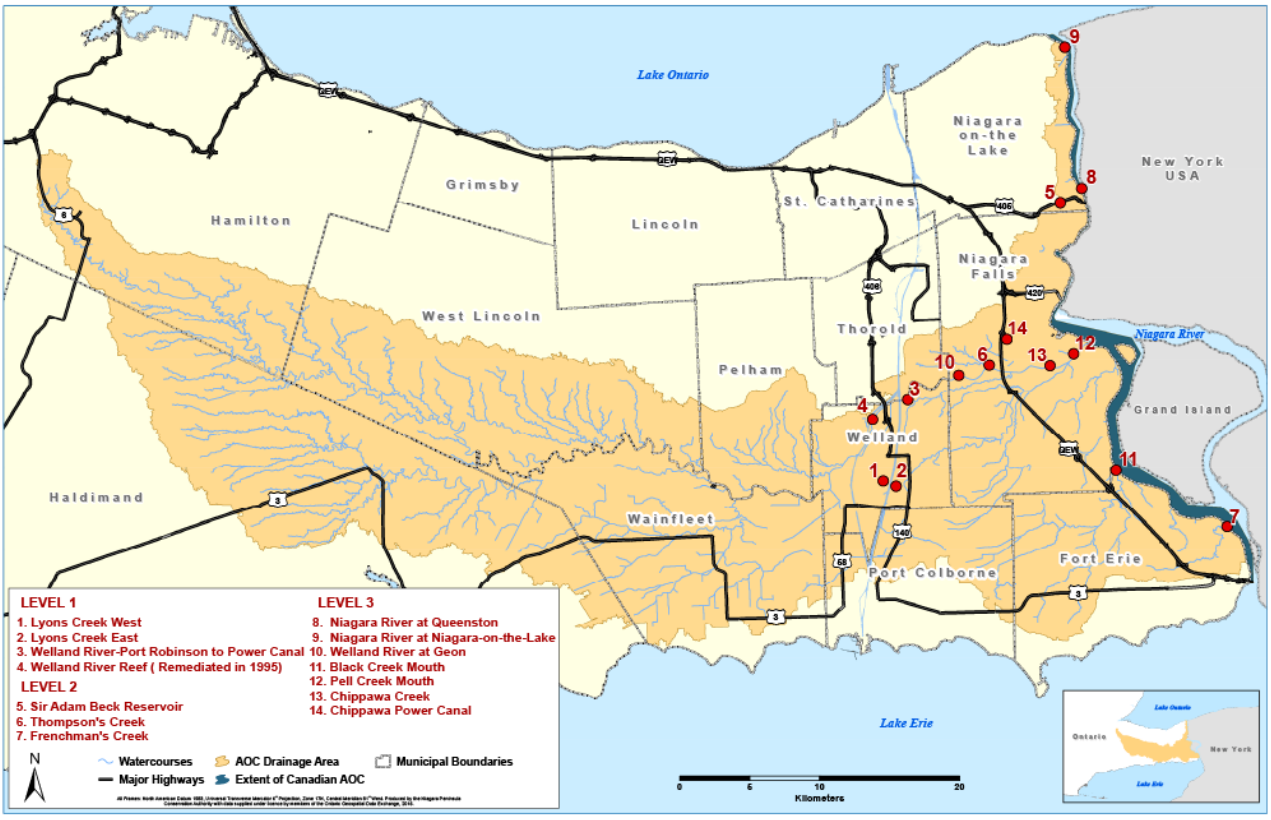


Figure 3. *Map of contaminated sediment sites (level 1, 2, 3) in the Niagara River Area of Concern watershed. The level 1 sites were those with known contamination requiring remediation. The level 2 and 3 sites were shown to have little to no risk to living organisms (humans and wildlife) and no further action required.*

Of the four sites identified as Level 1 (i.e., Welland River Reef, Welland River at Port Robinson, Lyons Creek West, and Lyons Creek East), only the Welland River Reef required remediation due to high levels of chromium, copper, nickel, and PAHs. The site was dredged in 1995 and post-remediation monitoring concluded that the benthic communities were becoming re-established at levels similar to the remainder of the Welland River (Golder 2013). The Welland River at Port Robinson site was shown to be impacted by the nearby Welland River Reef site, but a follow-up assessment in 2003 showed that further remedial actions would have little impact on fish or benthos; therefore, no further action was required (Golder 2013). The Lyons Creek West site was contaminated with PCBs and arsenic which were removed in 2007. In 2014, a natural recovery strategy was implemented by Transport Canada for the Lyons Creek West site (NRRAP 2015). The fourth site is Lyons Creek East, in which sediments are contaminated with PCBs. The site is made up of a series of Provincially-Significant Wetlands and contain rare species. After several studies – including an ecological risk assessment and human health risk assessment – and following public consultation, Monitored Natural Recovery was selected as the option to minimize the disruption and mobilization of PCB-contaminated sediments at Lyons Creek East. This decision followed the 2008 Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment. In 2011, a multi-agency Administrative Controls Protocol was developed and is in place that

commit signatory agencies to collaborate on the long-term protection, monitoring, and awareness efforts regarding the contaminated sediments at Lyons Creek East (NRRAP 2011).

In 2013, a technical assessment of the status of benthos was conducted for 13 of the 14 contaminated sites in the Niagara River Area of Concern's watershed originally noted in the RAP Stage 1 Update (NRRAP 1995a). The 14th site, Welland River Reef, was not included in the assessment because the site was remediated in 1995 and shown to have re-established benthos (Golder 2013). The technical assessment indicated that 11 of the 13 sites met the delisting criteria and the BUI was 'Not Impaired' for those sites (Golder 2013). In addition, the BUI was determined to be 'Not Impaired' at the other two remaining sites, Lyons Creek East and West, based on the assessment that concluded there was minimal risk to wildlife and given management strategies (e.g., Lyons Creek East Monitored Natural Recovery Administrative Controls Protocol) were in place to mitigate potential risks (Golder 2013).

Monitoring at Lyons Creek East continues through coordinated efforts between Environment and Climate Change Canada (ECCC) and the Ministry of the Environment, Conservation and Parks (MECP) to confirm the progress of natural recovery and burial of contaminated sediment by cleaner sediments, as well as determine/measure the reduction of risk to organisms. As part of this ongoing long-term monitoring, sediment cores and fish samples from the Lyons Creek East site were collected by MECP researchers in the fall of 2015. Results indicated that mean PCB concentrations at specific zones did not meet the RAP targets and recommended that further sampling be conducted to better understand the spatial extent of the contaminated sediment and the ecological risk assessment targets (Richman 2018). In 2019, scientists from ECCC and MECP collected sediment and benthos samples from specific locations along Lyons Creek East in order to contrast and compare with past results to determine changes over time. Furthermore, as a means of validating the scientific biomagnification model and provide evidence about actual PCB bioaccumulation in organisms higher up in the food chain, scientists from MECP have collected and are analyzing concentrations of PCBs in young-of-the-year fish from Lyons Creek East. ECCC scientists are currently analyzing contaminant levels in snapping turtle eggs for similar reasons. The results from these updated studies will inform future direction of the long-term monitoring plan for Lyons Creek East.

For more information about the recent monitoring efforts at Lyons Creek East, please visit www.ourniagarariver.ca/lyonscreek-monitoring2019. You may also download all of the reports and technical documents related to the Degradation of Benthos indication from our online document library: www.ourniagarariver.ca/document-library.

BUI DELISTING CRITERIA & APPLICATION GUIDANCE

The *Degradation of Benthos* BUI delisting criteria incorporate components of the Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment (ECCC/MECP 2008) and applies the framework to specific contaminated sites in the Niagara River AOC watershed (i.e., the original 14 contaminated sediment sites identified in NRRAP 1995a). The criteria and associated Tiered Assessment Framework (see page 34) provided below are updated from the Golder (2013) report.

The *Degradation of Benthos* BUI will no longer be impaired when:

1a) acute and chronic toxicity, community composition, and abundance in the benthic community are similar to non-AOC reference sites, *AND*

1b) concentrations of biomagnifying contaminants (e.g., PCBs and dioxin-like PCBs) within benthic invertebrate tissues are comparable to a suitable non-AOC reference site; *OR*

2) if a contaminated site fails to meet criteria 1a and 1b, then benthic invertebrate tissue contaminant concentrations are greater than reference sites but below concentrations considered to impair the beneficial uses associated with the consumption of fish and wildlife.

3) if a contaminated site fails to meet the criteria above, then a risk based contaminated sediment management approach/strategy must be in place with appropriate monitoring and mitigation measures and/or administrative controls.

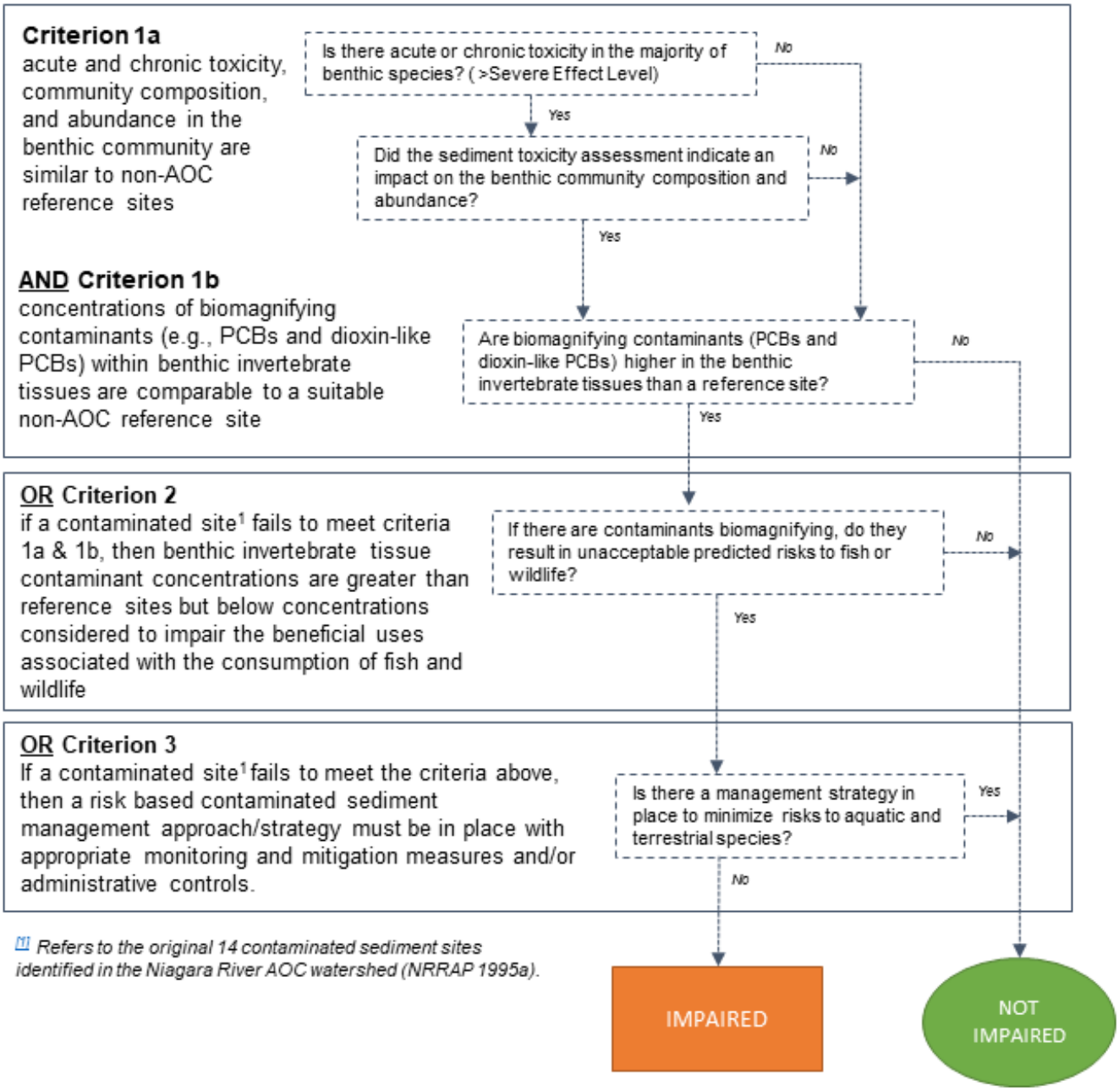
Criterion 1a - Acute/Chronic Toxicity: This criterion refers to two questions in the tiered assessment framework related to acute (short-term) and chronic (long-term) toxicity impacts on benthic invertebrates as well as the status of the benthic community composition and abundance compared to a non-AOC reference site.

Criterion 1b - Biomagnifying contaminants: The contaminants of concern relevant to this BUI are those that biomagnify (e.g., PCBs, dioxin-like PCBs). For this criterion, the concentrations of biomagnifying contaminants within benthic invertebrate tissues should be no different than a suitable non-AOC reference site. Benthic invertebrate tissue concentrations in reference areas are expected to be low for industrial compounds (e.g., PCBs, dioxin-like PCBs) as these substances do not occur naturally.

Criterion 2 - Predicted risk: This criterion is met if tissue residues of contaminants that cause acute or chronic toxicity, or which biomagnify are within ranges that do not result in predicted risk to fish or terrestrial consumers of benthic organisms. If unacceptable risks are predicted, then the assessment proceeds to evaluating the ability to meet Criterion 3. If Criterion 1a and b or Criterion 2 criterion are met, then the RAP Team may suggest proceeding with the BUI's status re-designation to 'Not Impaired' and Criterion 3 is not assessed.

Criterion 3 - Sediment Management Approach/Strategy: This criterion only applies should a contaminated sediment site (as per NRRAP 1995a) fail criteria 1-2 above. It is meant to ensure that there is a plan in place to manage sediment contaminants to minimize risks to aquatic and terrestrial species. If there is a sediment management approach (e.g., Monitored Natural Recovery) in place and the associated long-term monitoring indicates that the approach is achieving its targets/objectives, then the criterion is met and the BUI can be deemed 'Not Impaired' for the purpose of the RAP.

TIERED ASSESSMENT FRAMEWORK



REMAINING ACTIONS: Degradation of Benthos

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
DATA COLLECTION								
6.1	Collect sediment samples from Lyons Creek East Contaminated Sediment Site (zones 1-2), an adjacent property, and a reference site (Tee Creek).	●		●				MECP
6.2	Collect benthic invertebrate samples from Lyons Creek East Contaminated Sediment Site (zones 1-2) to measure PCB levels in tissues.	●						ECCC
6.3	Conduct a pore water study (*in situ* sediment and water in zones 1-4) in Lyons Creek East Contaminated Sediment Site and a reference site.			●	?			ECCC
6.4	Collect surface water samples (during deployment and retrieval of polyethylene devices) from Lyons Creek East Contaminated Sediment Site (zones 1-4), stormwater retention ponds, and reference site (Tee Creek)			●				MECP
6.5	Conduct bathymetric measurements in Lyons Creek East zones 1-3 to support future decision-making and review of Monitored Natural Recovery.			●	?			ECCC
6.6	Conduct a young-of-the-year fish monitoring study in Lyons Creek East Contaminated Sediment Site (zones 1-7) and reference site (Tee Creek) to measure PCB levels in fish tissues.	●		●	?			MECP
6.7	Collect Snapping Turtle eggs from Lyons Creek East Contaminated Sediment Site (zones 1-4) to measure PCB levels.			●	●			ECCC
6.8	Complete vertical groundwater measurements to understand groundwater flow/gradients into the bottom sediments of Lyons Creek East.			?	●			ECCC
6.9	Conduct hydrodynamic studies in Lyons Creek East zones 1-3 to support future decision-making and review of Monitored Natural Recovery.				●			ECCC / MECP
6.10	Identify areal extent and depth of local source locations likely to contribute elevated levels of PCBs to Lyons Creek East through coring in zones 3-4 (i.e., depositional areas, are sediments being transported from other locations?)				?	?		ECCC / MECP
6.11	Collect sediment samples from Lyons Creek East Contaminated Sediment Site (zones 1-7) and a reference site (Tee Creek) to measure PCB levels (as per triennial long-term monitoring).				●			MECP
6.12	Collect benthic invertebrate samples from Lyons Creek East Contaminated Sediment Site (zones to be determined) to measure PCB levels in tissues (as per triennial long-term monitoring).				●			ECCC
6.13	Conduct creek flow measurements in Lyons Creek East zones 1-3 (particularly in the spring and event monitoring).				●			ECCC/ MECP/ NPCA

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
LONG-TERM MANAGEMENT ACTIONS								
6.14	Coordinate the review and update of the multi-agency Lyons Creek Administrative Controls Protocol document.			●	●			NPCA/NRRAP
6.15	Finalize the updated long-term monitoring plan for Lyons Creek East (to be implemented beyond the RAP)					●	●	MECP
6.16	If required, determine the need for further active management options.						●	ECCC / MECP
REPORTING								
6.17	Prepare a summary report on sediment, water, and fish contaminant monitoring studies to support decision-making.					●		MECP
6.18	Prepare summary report on Snapping Turtle egg contaminant studies (2018 & 2021) to support decision-making.				●			ECCC
6.19	Prepare a summary report on the invertebrate bioaccumulation study to support decision-making.					●		ECCC
6.20	Review all relevant information to determine the effectiveness of the Monitored Natural Recovery at Lyons Creek East and decide on next steps.					●		MECP, ECCC, NRRAP
6.21	Gather all relevant information and assess the status of the BUI.					●		NRRAP
	• If not impaired, proceed with re-designation process					?		
	• If still impaired, further discussions will be required.					?		

BEACH CLOSINGS (BUI #10)

BACKGROUND

Swimming is a fun and healthy way for people to enjoy the waters of the Great Lakes and is considered one of the Great Lakes' beneficial water uses. However, it is sometimes unsafe for people to swim at certain beaches. There are various natural and human-induced factors that can lead to the waters of a beach being unsafe for swimming, including large numbers of swimmers, wind and waves, large number of birds, heavy rainfall, algal blooms, stormwater outflows, sewer overflows, and runoff from the land. Swimming in waters that have bacterial pollution from these various sources could cause infections of the ear, eye, nose, throat, and skin and may cause diarrhea if that water is ingested. Waterborne illnesses can be caused by different viruses, protozoa or bacteria pathogens. Enteric and fecal coliform bacteria (normally found in human/animal feces) such as *Escherichia coli* (*E. coli*) are the most common indicator of fecal contamination.

In the Niagara region, the Niagara Region Public Health Unit (NRPHU), regularly monitors 23 designated public swimming beaches from May (Victoria Day) to September (Labour Day) annually to prevent and reduce the occurrence of waterborne illnesses in recreational water users. The determination for whether a beach is a public swimming beach is made by the local municipality. The NRPHU advises the public if a location is safe or unsafe for swimming through signage at the beach location and web-site announcements. Effective January 2018, under the Recreational Water Protocol, the Ontario Ministry of Health and Long-Term Care (MOHLTC) changed part of the provincial guideline for recreational water use at public beaches from a geometric mean of ≤ 100 *E. coli* colony forming units (CFU) per 100 mL to ≤ 200 *E. coli* CFU/100 mL (MOHLTC, 2018). This change aligns with the national guideline established by Health Canada. In the Niagara Region, beaches are considered safe for swimming when the geometric mean *E. coli* levels are ≤ 200 CFU/100mL and there are no severe hazards to human health (e.g., algae, chemical spill, etc.). If water samples do not meet these requirements, a beach can be posted or closed. A posting means the beach is unsafe for swimming due to poor water quality and/or potential hazards to human health (e.g., algae in the water) as it may cause illness or infections. A beach is closed when there is a high risk of impacting human health due to poor water quality or immediate health hazards that make it unsafe for recreational body contact (e.g., blue-green algae, chemical spill, oil). To date, no Niagara Region beaches have ever been 'closed' due to water quality and/or severe health hazards (A. Habjan, personal communication, May 2019).

Beaches are reviewed by the NRPHU every few years. As popularity and municipal resources (e.g., change rooms, parking, garbage removal, beach raking/maintenance) are added at a beach it can be added to the sampling schedule and those decreasing in popularity can be removed from the sampling schedule. Locations that are removed from the sampling schedule are no longer considered public

swimming beaches and are not 'closed' in the water quality context described above. Historically, there were six beaches located in the Niagara River (King's Bridge Park Beach, Dufferin Islands Beach, Bowen Road Beach, Princess Street Beach, and Ball Street Beach, and Queen's Royal Beach). Only the Queen's Royal Beach (QRB), located in the Town of Niagara-on-the-Lake (NOTL), is still considered a public swimming beach within the Ontario waters of the Niagara River AOC. The first four locations were located on Niagara Parks Commission property and are no longer considered public swimming beaches due to reasons unrelated to water quality (NRRAP 2009). The Ball Street beach, located approx. 500 meters upstream of QRB on the Niagara River, was removed from the NRPHU sampling schedule in 2009 and is no longer monitored as it did not have obvious sources of contamination and was not a priority for the NRPHU (NRRAP 2009; A. Habjan, personal communication, June 2019). Two other beaches, located in the Niagara River watershed (Binbrook Conservation Beach, Chippawa Creek Conservation Beach), were part of a 2007 technical review and were shown to be likely impacted by waterfowl and agricultural sources based on mass-balance modelling, not human sewage sources. Furthermore, these two conservation area beaches are located within man-made lakes in the Upper Welland River watershed and are not likely to impact the Niagara River's water quality (NRRAP 2009). For the purposes of the RAP, only the QRB is applicable to assessing the *Beach Closings* BUI.

The QRB is located near the mouth of the Niagara River as it meets Lake Ontario. Its iconic gazebo and scenic views make this beach a popular location for weddings, sightseeing by tourists, as well as a location for wading, stand-up paddle boarding, and as a launching point for kayaks. In 2017, the NRPHU determined that several beaches (including QRB) would be removed from their sampling schedule to allow for increased sampling and data accuracy at the most popular beaches (A. Habjan, personal communication, May 2019). To fulfill the RAP goals and the Town of NOTL's desire to maintain the QRB as a public swimming beach, partner organizations involved in the Niagara River RAP worked together to ensure the beach would be monitored. The Town of NOTL, with funding support from Environment and Climate Change Canada (ECCC) & Ontario Ministry of Environment, Conservation and Parks (MECP) and technical support from NRPHU and the Niagara Peninsula Conservation Authority, monitored water quality at Queen's Royal Beach three times per week during the swimming season 2018-2020. During that time, the NRPHU provided training for Town of NOTL water quality staff and conducted sample analysis to ensure adherence to the sample collection and analysis protocols for quality assurance and for comparison to previous sampling. Future monitoring at Queen's Royal Beach, as for any public beach, will be contingent on municipal/Regional funding and support.

Since the completion of the Niagara River RAP Stage 2 Update (2009), research and monitoring activities have been a priority for understanding and addressing issues at the QRB in the Niagara River. A 2007 technical review of beaches indicated that only QRB had a potential human source of bacterial contamination (NRRAP 2009) likely from the stormwater outfall near the beach. A microbial source track-down was undertaken in 2010 to investigate the potential source(s) of fecal contamination at 15 Niagara

Region beaches, including QRB. Microbial source tracking techniques compare the similarity of microorganisms from fecal pollution sources and water samples to make inferences about the source of water contamination (Edge et al. 2011). The 2010 study revealed that *E. coli* concentrations were higher at QRB than any other Niagara Region beach, particularly after rainfall. In addition, a microbial DNA marker indicating human sewage contamination was most frequently detected at QRB. Therefore, more focused water sampling efforts were undertaken in the vicinity of the QRB and lower Niagara River from 2011-2014. The main findings of the microbial source tracking studies were:

- Water quality at most of the 15 Niagara Region beaches studied in 2010 were relatively clean and usually below 100 *E. coli* CFU/100 mL;
- *E. coli* concentrations were higher at QRB than any other Niagara Region beach, particularly after rainfall;
- *E. coli* concentrations at QRB were highly correlated with the stormwater outfall at the beach;
- A microbial DNA marker indicating human sewage contamination was detected more often at QRB than any other Niagara Region beach;
- The Niagara River proper delivers low concentrations of *E. coli* to QRB. The characterization of the *E. coli* shows it to be more frequently associated with a human source rather than a wildlife source;
- A stormwater outfall at QRB delivers high concentrations of *E. coli* which is frequently impacted by human sewage sources associated with rain events.

Overall, the microbial source tracking studies indicated that the stormwater outfall at QRB was likely a critical source location that required further investigation and remediation. In 2017, the Town of NOTL received funding from ECCC to investigate the King Street Storm Sewer Outlet (KSSO), which discharges east of the QRB and was noted as the potential source location for contamination at the beach. A consulting firm (GM BluePlan Engineering) was retained by the Town of NOTL to conduct a detailed investigation of the KSSO catchment area which identified prominent sources of *E. coli* to the outfall at QRB, including improper sewer connections, abandoned infrastructure, low flow cross-connections, and stormwater infrastructure in poor condition. In May 2019, GMBluePlan completed a draft report outlining its findings and recommendations for infrastructure improvements in the Town of NOTL to reduce bacterial loadings to the storm sewer, and ultimately, to QRB. The report is awaiting final approval and will be used by NOTL with input from the RAP Team to prioritize remedial actions toward improving water quality at the QRB.

BUI DELISTING CRITERIA & APPLICATION GUIDANCE

The following criteria apply only to the public swimming beaches in the waters of the Niagara River, which is currently only Queen's Royal Beach in the Town of Niagara-on-the-Lake. The BUI delisting criteria and application guidance are provided below.

The *Beach Closings* BUI (#10) will no longer be impaired when:

1) Prominent sources of fecal pollution that could contaminate the beach or recreational waters are known and remedial actions to address known sources are identified and completed; *AND*
2) At least 80% of the geometric mean results of recreational water samples (when sampled at least once per week) meet the Ontario Ministry of Health Recreational Water Quality Guideline (≤200 CFU/100 mL) each swimming season for a minimum of three years; *AND*
3) Risk management actions (e.g., postings, signage, education, rain rule) are in place to protect human health.

Issue Identification and Remedial Actions: The first criterion is meant to ensure a course of action is identified and completed should any significant sources of fecal pollution be found. Remedial actions noted in this criterion should target locally-controllable (within the Niagara River AOC) anthropogenic sources (e.g., human sewage rather than waterfowl fecal waste) as these are tied to the legacy concerns of the AOC and RAP program.

Water Quality: The water quality target (# *E. coli* CFU/100 mL) was updated to reflect the recent change to the MOHLTC guideline effective January 2018 from ≤100 CFU/100 mL to ≤200 CFU/100 mL which is consistent with the approach and guidelines used by the NRPHU for local beach monitoring. The local health unit uses the geometric mean of five samples against the MOHLTC guidelines to determine whether a beach is safe or unsafe for swimming. The 80% target and wording are consistent with the draft 2018 Lake Ontario Lakewide Management and Action Plan which states that if a beach is open 80% of the time or more it is considered in 'good' condition, 70-79.9% is considered 'fair', and <70% is considered poor (ECCC/USEPA 2018). Furthermore, the criterion is also similar to language used in the Blue Flag Canada beach criteria (i.e., 80% of geometric mean results are below the limit value). The Blue Flag designation is an internationally-recognized eco-label for beaches that meet strict criteria in four categories (one being water quality) (Environmental Defence 2018). Given the dynamic nature of beach environments and natural influences, it is unlikely for a beach to be entirely free of bacteria above thresholds 100% of the time (ECCC/USEPA 2018).

The monitoring requirements to meet the BUI delisting criterion is outlined as at least a minimum of one weekly sample but could be more often. The NRPHU samples the most popular beaches 6 days per week while less popular, less maintained beaches are sampled 1-5 days per week. Since sampling at QRB is no longer conducted by the NRPHU, it was important to indicate the minimum frequency of sample

collection to meet the criterion. The frequency of sampling should be at least once per week but could be more often, if resources allow. For 2018 and 2019, the beach was sampled 3 times per week. Overall, criterion 2 is meant to provide scientific evidence about the quality of the water and measurable information about the efficacy of remedial actions completed through criterion 1. If an assessment shows criterion 2 is not met even after prominent sources of human sewage contamination are addressed, then experts should provide evidence-based reasons for exceedances that may not be anthropogenic (i.e., rainfall events, bather load, wildlife).

Risk Management: Measuring the level of *E. coli* in recreational waters is not the only tool to protect human health from waterborne illness. This is to ensure there are long-term management actions in place for the protection of human health when there are potential exceedances of water quality guidelines (e.g., due to weather or wildlife). Risk management actions can include (but are not limited to): website announcements, on-site postings at public beaches, media releases, automated phones/hotlines, public health unit disclosure systems, rain rules (e.g., do not swim within 48 hrs of heavy rain event), etc.

REMAINING ACTIONS: Beach Closings BUI

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
REMEDIAL ACTION(S)								
10.1	Disconnect the wading pool in Simcoe Park from the lateral storm sewer connection and connect to the sanitary sewer system.	●						NOTL
10.2	Implement grate improvements to the Wellington Street storm sewer inlet to prevent racoon entry.	●						NOTL
10.3	Implement storm grate outlet improvement and structural lining of storm sewer on Davy Street.		●					NOTL
10.4	Repair the laterals with large and medium joint offsets at property line.		●					NOTL
10.5	Remediate the sanitary manhole with the Region of Niagara sewage forcemain connection.		●					NOTL, Niagara Region
10.6	Rehabilitate the storm manhole and outlet in poor condition located on King Street and Front Street.	●	●					NOTL
10.7	Abandonment of poor condition mainline sanitary sewer on King street.		●					NOTL
10.8	Implement low-impact development (LID) stormwater management techniques in Simcoe Park to reduce bacterial loadings to the storm sewer system.		●					NOTL, ECCC, MECP
	• If *E. coli* results do not improve after LID construction in Simcoe Park, then LID techniques at the storm outfall near QRB (King Street Storm Outlet) could be considered.			N/A				
10.9	Implement regular maintenance of catchbasins and storm drains in the King Street Storm Outlet (KSSO) catchment area, including (but not limited to): • Perform sump maintenance (annually) to remove sediment and debris in catchbasins. • Flush the King Street Storm Outlet catchment area once grates installed on Wellington Street storm inlet (min. once per year thereafter). After flushing, conduct a visual inspection of storm sewer sumps to ensure they are free of debris. If not, they must be cleaned. • Manual labour required where difficult truck access is noted (e.g. Simcoe Park) for catchbasin sump cleaning in spring and fall annually.	● ● 	● ● ●				● ● ●	NOTL

[Continued on following page]

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
WATER QUALITY MONITORING								
10.10	Collect water samples from QRB three times per week during the swimming season and analyze for levels of *E. coli* (note: this sampling began in 2018).	●	●					NOTL (collection) NRPHU (analysis)
10.11	Confirm that the QRB will continue to be monitored at least once per week during the swimming season and analyze for levels of *E. coli* beyond the RAP.		●				●	NOTL (collection) NRPHU (analysis)
10.12	Collect monthly (May-Oct) water samples from the stormwater outfall near QRB for *E. coli* testing.	●	●					NPCA, NOTL
10.13	Collect water samples from the storm sewer catchment area to validate the efficacy of the LID stormwater management techniques.		●					NOTL
10.14	Collect water samples from QRB and stormwater outfall to be tested for presence/absence of human DNA markers.	●	●					NOTL
OUTREACH & EDUCATION								
10.15	Notify the public of beach postings at QRB due to elevated levels of *E. coli* using existing methods such as NRPHU website and signage at the beach (NOTL Parks & Recreation Dept.).	●	●				●	NRPHU, NOTL
10.16	Continue to communicate information to public about making safe swimming choices (e.g., avoid swimming 24-48h after rainfall, check NRPHU website before entering water, wash hands after swimming, etc.).	●	●				●	NRPHU (2019) NOTL (2020 - beyond)
10.17	Design and install improved signage at the QRB to communicate beach postings, swimming safety, and risk management practices (e.g., rain rule, washing hands, etc.).			●				NOTL, NRRAP, NRPHU
10.18	Design/install interpretive signage to highlight the LID project at Simcoe Park.		●					NOTL, NRRAP
REPORTING								
10.19	Gather all relevant water quality information for the past three years at QRB and assess the status of the BUI.		●	●				NRRAP
	• If not impaired, proceed with re-designation process			?	?			
	• If still impaired, further discussions will be required.			?	?			

LOSS OF FISH AND WILDLIFE HABITAT (BUI #14)

BACKGROUND

Habitat generally refers to the physical environment that is occupied by a plant or animal such as wetlands, forests, or grasslands. Suitable habitat is critical for supporting fish and wildlife survival, through all seasonal and life history stages (e.g., reproduction, feeding, overwintering) and is thus essential for overall ecosystem health.

The *Loss of Fish and Wildlife Habitat* BUI is intended to provide information about physical integrity in Great Lakes AOCs and may link to other ecosystem issues such as changes in fish or wildlife community structure. The *Loss of Fish and Wildlife Habitat* BUI is one of the most common issues within AOCs (including the Niagara River). It is typically associated with the loss of riparian (shoreline) vegetation, coastal wetlands, or underwater fish habitat (IJC 2019) due to the removal or alteration of naturally occurring habitat through shoreline hardening or infilling, destruction or draining of wetlands, removal of shoreline vegetation or dredging of deep-water shoals, etc. In the past, issues have been flagged with respect to water level fluctuations and associated impacts due to binational water controls (e.g., hydropower generation). It is recognized that these issues exist, but they are outside of the jurisdiction that the RAP can address (refer to www.ijc.org/en/nbc for more information). For the Canadian Niagara River AOC, the relevant habitat-related issues are linked to the historical loss of riparian vegetation and coastal wetlands in the upper portion of the Niagara River.

The *Loss of Fish and Wildlife Habitat* BUI has been recognized since the completion of the RAP Stage 1 Report (1993a) with the focus being primarily on habitat within watersheds draining to the Niagara River. The Stage 1 report indicated a “large loss in aquatic habitat in the tributary streams due to filling, channelization, drainage, shoreline reconstruction and development” but indicated that fish habitat within the Niagara River itself was largely unchanged by human activity (NRRAP 1993a). The subsequent RAP Stage 2 Report (1995) which outlined recommendations and broad goals for the improvement of the Niagara River ecosystem (including proposed delisting criteria to guide remediation activities) maintained the ‘Impaired’ *Loss of Fish and Wildlife Habitat* BUI status. In 2009, the Niagara River RAP released its Stage 2 Update report which described achievements since 1995, provided updated delisting criteria to reflect standards at the time, and applied the criteria to assess the status of the remaining impaired beneficial uses resulting in some BUI status changes (NRRAP 2009). The *Loss of Fish and Wildlife Habitat* BUI remained impaired and delisting criteria and remedial actions were focused on issues in the Welland River watershed rather than the Niagara River. A subsequent BUI Status Assessment completed in 2014 showed that the delisting criteria were met through the completion of several projects by RAP partners aimed at fish barrier removals, habitat acquisition, restoration, and protection in the Welland

River and its watershed (NRRAP 2014). The 2012 revision of the GLWQA, and its clarification that BUIs apply to the “Waters of the Great Lakes”, has narrowed the focus of the Niagara River AOC to the main channel of the river. With a renewed focus on the Niagara River proper, and a recognition of current habitat issues within the revised bounds of the AOC, the *Loss of Fish and Wildlife Habitat* BUI remains. Ongoing progress aimed at addressing these issues require new BUI delisting criteria suited to assessing habitat status within the Niagara River proper.

Riparian habitat refers to the lands adjacent to streams and rivers. It is the interface between aquatic and terrestrial ecosystems. This transition area provides various benefits including serving as habitat for wildlife, mitigating erosion, and functioning as a buffer to improve the water quality of runoff. Past practices along the Niagara River (i.e., urbanization, cutting trees or mowing to the edge of the river) have resulted in erosion, poor slope stability, and have encouraged the establishment of invasive plant species. Subsequent shoreline hardening to mitigate these effects ultimately results in the loss of important shoreline habitat for various species such as insects, birds and amphibians. As of 2020, it is estimated that approximately 75% of the entire Canadian side of the Niagara River shoreline is vegetated, but the width of the riparian buffer is limited in some areas of the Upper Niagara River (C. Burant, Niagara Parks Commission, pers. comm.). In a 2016 study, the Upper Niagara River’s Canadian shoreline edge has recently been characterized as having limited areas with gradual land to water interface including typical transition from upland to wetland vegetation; Gonder’s Flats being one exception (Yagi & Blott 2016). The Niagara Parks Commission (NPC), with support from Environment and Climate Change Canada (ECCC), has since begun naturalizing and improving riparian/shoreline habitat, including the planting of 50,000+ native plants and anchoring natural wood structures along 8 km of shoreline along the Upper Niagara River between 2018 and 2019. This is intended to provide new wildlife habitat and benefit fish through improved land-water interfaces, added shade and food (insects), and reduced soil erosion that improves water quality in the river.

Coastal wetlands are critical for spawning and rearing of young-of-the-year and forage fish. They are key to waterfowl nesting and stopovers and prevent erosion of the shoreline by slowing wave action. A nearshore vegetation assessment by the Ministry of Natural Resources and Forestry (MNRF) in 2015 indicated that approximately 75% of the historic coastal wetlands were lost on the Canadian side of the Niagara River (NPC in prep). Yagi & Blott (2016) indicated that existing patches of coastal wetlands in the Upper Niagara River were not linked to the shoreline, but rather occurred at the base of a vertical bank, or several meters out from shore. The loss of a graduated shoreline structure was attributed to several factors including infilling of former lowlands along the river (particularly at tributary mouths), shoreline armouring, and maintenance to remove large woody debris from the river edge. They recommended that coastal wetlands be constructed at suitable locations in the Upper Niagara River, particularly immediately downstream of each of the small tributaries entering the river. As a result, the Niagara Parks Commission, with support from the MNRF and ECCC, began restoring coastal wetland

habitat at key locations along the Upper Niagara River where tributaries intersect the river (to maximize the capture of sediment and biotic drift). The coastal wetland restoration designs, informed by work underway by New York State, vary slightly depending on the features and needs of each location. Generally, the restoration involves: cutting the riverbank to create a gentler, more stable slope; planting native vegetation (shrubs, aquatic and semi-aquatic vegetation); and installing rock and woody debris anchored to the riverbed to create a foothold for sediment to collect and wetlands to establish over time. Since 2016, over 865 meters of new coastal wetland habitat covering 2.9 hectares (7.2 acres) has been installed using over 250 Ash trees that had succumbed to the Emerald Ash Borer (an invasive insect), 400 recycled Christmas trees, and 560 tonnes of boulders (C. Burant, NPC, pers. comm.). As planned, the sites have already begun to establish with native aquatic vegetation and various wildlife species.

BUI DELISTING CRITERIA & APPLICATION GUIDANCE

The new delisting criteria focus on the Niagara River's coastal wetland and riparian habitat as these are the most critical for improving habitat in the AOC (Yagi & Blott 2016). These new delisting criteria consider a binational approach so that goals on both sides of the Niagara River are aligned, linked to relevant work underway to improve habitat, and are based on well-established scientific literature (i.e., *How Much Habitat Is Enough? ECCC 2013*).

The Loss of Fish and Wildlife Habitat (BUI #14) will no longer be impaired when:

1) 5-7 identified coastal wetland habitat projects on the Canadian side of the Upper Niagara River are complete;
2) at least 75% of the Niagara River (Canadian) shoreline is naturally vegetated;
3) there is a minimum 5-metre wide 'no mow' vegetated buffer along the publicly managed Canadian shoreline of the Upper Niagara River; and
4) the existing areal extent of unique wildlife habitat (i.e., Niagara Gorge) is at least 80% secured and managed for long-term conservation purposes.

Coastal Wetland Habitat: The importance of coastal wetland projects was identified for several years. Beginning in 2015, the Ontario Ministry of Natural Resources and Forestry in collaboration with the Niagara Parks Commission initiated the identification of opportunities for coastal wetland creation along the Upper Niagara River. As a result, seven potential locations were noted as the most feasible options for restoration and enhancement of coastal wetland habitat (pending archeological assessments/approvals) (Fig. 4, #1-7). The design concepts and implementation of these coastal wetland habitat projects were based on restoration efforts on the American side of the Niagara River AOC. The U.S. projects (Fig. 4, #8-21) are being implemented through separate U.S. Remedial Action Plan actions and are not included as part of this delisting criterion. As of 2019, four of the seven proposed Canadian projects have been completed and one more is planned for construction in the summer of 2020. Two

more sites will need to be assessed for archeology prior to making any further decisions on wetland construction. Since 2016, over 865 meters of new coastal wetland habitat covering 2.9 hectares (7.2 acres) has been installed using over 250 Ash trees that had succumbed to the Emerald Ash Borer (an invasive insect), 400 recycled Christmas trees, and 560 tonnes of boulders (C. Burant, NPC, pers. comm.) As planned, the sites have already begun to establish with native aquatic vegetation and various wildlife species. For this delisting criterion, “complete” means that the activities related to the construction of the coastal wetland project are done, not necessarily follow-up monitoring to assess wetland function. It is expected that natural processes will continue to build upon the constructed elements and that these wetlands will continue to evolve and improve.

Riparian Habitat (length): This criterion refers to the percent length of riparian habitat along the entire Canadian side of the Niagara River. The term ‘naturally vegetated’ follows *How Much Habitat is Enough? Third Edition* (ECCC 2013) and was not specifically defined in that document. For the RAP, the term ‘naturally vegetated’ means that shoreline is not hardened or negatively altered and is comprised of vegetation that is not mowed lawn (e.g., wildflowers, tall grasses, trees, shrubs), though not necessarily dominated by native species. While it is not a requirement for the AOC program, the RAP Team acknowledges that planting native species is important and preferable but is not a requirement to meet this delisting criterion. There are efforts underway by partners such as the Niagara Parks Commission to increase the percentage of native species within the riparian area of the Canadian side of the Niagara River shoreline through its Urban Forestry Management Strategy. Between 2018 and 2019, 8 km of shoreline along the Upper Niagara River has been naturalized and improved through the planting of 50,000+ native plants and anchoring natural wood structures. To assess this criterion, a geographic information system (GIS) desktop exercise combined with on-the-ground surveys could be used to quantify and confirm the length of Canadian shoreline that is vegetated.

Riparian Habitat Buffer (width): This criterion only applies to areas of the Canadian Upper Niagara River shoreline (from Fort Erie to the top of Niagara Falls) that are managed by the Niagara Parks Commission. While the scientific literature suggests a minimum 30-meter naturally vegetated riparian buffer along streams, this guideline is not feasible for the Niagara River due to the location of the Niagara Parkway (within 10-20 meters of the river). Therefore, following the advice of the Niagara Parks Commission, the RAP Team proposes a minimum 5-meter wide vegetated riparian buffer along the Upper Niagara River which is realistic, feasible, and would still provide many of the ecological benefits previously mentioned in the Background section (i.e., habitat, filter runoff, prevent erosion). Should the land-use and topography allow for it, Niagara Parks may consider expanding the buffer in some locations. While it is not a requirement for the AOC program, the RAP Team acknowledges that planting native species is important and that there are efforts underway by partners such as the Niagara Parks Commission to increase native species within the riparian area through its Urban Forestry Management Strategy (NPC in prep).

Therefore, the intent of this criterion is not necessarily to increase native plant species, but rather to increase the width of the riparian area in the feasible locations[6] along Upper Niagara River by discouraging mowing to the edge of the Niagara River shoreline. To assess this criterion, a GIS desktop exercise combined with on-the-ground surveys will be used to quantify the amount of riparian habitat width along the Upper Niagara River Canadian shoreline and confirm adherence to the NPC's 'no-mow' practices.

Protection of unique habitat: This criterion is the only one from the last official set of *Loss of Fish and Wildlife Habitat* BUI delisting criteria (NRRAP 2009) that applies to the current geographic scope of the Niagara River AOC. It aligns with a key guiding principle in *How Much Habitat Is Enough?:* "Conserve it first" which is predicated on protecting existing habitat as being more efficient and effective than restoration (ECCC, 2013). The basis for the criterion is to acknowledge the existing protection of the unique habitat in the Niagara River corridor, specifically the Niagara Gorge (not including the tablelands). In 2014, a BUI status assessment report indicated that the criterion was met based on a GIS mapping exercise which showed 100% of the Niagara Gorge is secured and managed for long-term conservation purposes (NRRAP 2014). Nonetheless, the RAP Team noted that capturing the long-term conservation of the unique Niagara Gorge was important and recommended that the criterion remain in the updated version of the delisting criteria.

[6] Approximately 20% of the Canadian shoreline cannot be vegetated due to necessary hard infrastructure (i.e., the break-wall, marina and coal docks in Fort Erie, power generation in Niagara Falls) (C. Burant, Niagara Parks Commission, pers. comm. 2020).

Figure 4. *Map of the completed and planned coastal wetland habitat sites along the Upper Niagara River. Locations #1-7 are Canadian projects, #8-21 are American projects. Last updated 2020*

REMAINING ACTIONS: Loss of Fish and Wildlife Habitat BUI

#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
REMEDIAL ACTIONS								
14.1	Conduct an archeology survey at sites, as necessary (e.g., Miller's Creek).	●	●					Niagara Parks
14.2	Complete coastal wetland topographic / bathymetry surveys for each of the feasible remaining sites identified in 2015 (Frenchman's Creek [2020], Black Creek [2021])		●	●				Niagara Parks
14.3	Construct coastal wetland habitat at the remaining sites: Frenchman's Creek and Black Creek.		●	●				Niagara Parks
14.4	As an alternative coastal wetland habitat site to Miller's Creek (which will require a Stage 3 archeological assessment), enhance & expand existing wetland habitat near Service Road 3 in the Upper Niagara River.			●				Niagara Parks
14.5	Confirm there is a plan in place to enhance existing coastal wetland habitat (where feasible) beyond the scope of the RAP.					●		NRRAP, Niagara Parks
14.6	Identify where riparian buffer plantings should/could be completed along the Canadian side of the Upper Niagara River (see #14.9 & 14.10).			●	●			NPCA, Niagara Parks
14.7	Implement 'no-mow' practices along the along the Canadian side of the Upper Niagara River.	●	●	●	●	●	●	Niagara Parks
14.8	Increase and enhance the 'no-mow' areas with native vegetation to create riparian buffers along the Canadian side of the Upper Niagara River.	●	●	●	●	●	●	Niagara Parks
DATA GATHERING & SYNTHESIS								
14.9	Conduct a geographic information system (GIS) desktop exercise combined with on-the-ground surveys to quantify and confirm the length of Canadian shoreline that is vegetated.			●	●			NPCA, Niagara Parks
14.10	Conduct a GIS desktop exercise combined with on-the-ground surveys to quantify the width of the Upper Niagara River that is vegetated and confirm adherence to the Niagara Parks' no mow practices.			●	●			NPCA, Niagara Parks

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#	Recommended Action	2019	2020	2021	2022	2023	Beyond	Lead(s)
OUTREACH & EDUCATION								
14.11	Create educational materials (e.g., video and/or signage) to build awareness in the community about the importance of coastal wetland habitat projects and no-mow riparian buffers in the Niagara River.				●			NRRAP, Niagara Parks
REPORTING								
14.12	Prepare a report summarizing the GIS analysis to determine if the riparian criteria (2 & 3) have been met. If not, then recommendations should be made for enhancing/improving riparian habitat.				●			NPCA, Niagara Parks
14.13	Gather all relevant information and assess the status of the BUI.					●		NRRAP
	• If not impaired, proceed with re-designation process					?		
	• If still impaired, further discussions will be required to determine next steps.					?		

THE AMERICAN CONNECTION: An Overview of Remaining BUIs in the Niagara River (U.S.) AOC

The Niagara River is one of five AOCs shared by the U.S. and Canada—the others are the St. Marys River, St. Clair River, Detroit River, and St. Lawrence River. Although the Niagara River is a bi-national AOC, there are different issues and separate (but complementary) RAP efforts on both sides of the border. Both RAP Teams ensure consistent information exchange and attempt coordination on similar issues (e.g., habitat). There are six remaining BUIs on the U.S. side of the Niagara River (refer to Table 1). To honour the binational cooperation and collaboration, this section provides information on the BUI status 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. A full list of remediation projects completed or underway is available the Niagara River (U.S.) RAP Stage 2 Addendum (NYSDEC 2012).

RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION

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 (NYSDOH) 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 several 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 2021 (M. Filipski, NYSDEC, pers. comm. 2020).

The wildlife portion of this BUI is not considered impaired on the Ontario side of the Niagara River, but it is listed as 'impaired' in New York. There are no wildlife consumption advisories specific to the U.S. side of the Niagara River but there is state-wide advisories 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 dabbler 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 have been completed.

DEGRADATION OF FISH & WILDLIFE POPULATIONS

At the time of the development of the Niagara River (U.S.) RAP, fish and wildlife populations in the Niagara River clearly had declined from historic levels; however, this impairment was considered "likely" due to a lack of sufficient evidence to show whether the habitat and toxicity issues specific to the AOC were significant enough to be the cause of the declines. The RAP stated that possible causes of declines in fish populations were human-induced alterations to the River such as significant water diversions and withdrawals, exotic species introductions, and contaminants. Possible causes for loss of wildlife populations were uptake of contaminants, loss and degradation of physical habitat, and human disturbance. However, the RAP stated that no *likely* causes of declining populations were identified. Despite the ongoing lack of evidence for AOC-related causes of population declines, a decision was made to change this BUI's status to "impaired" in December 2011 (NYSDEC 2012). Recovery of populations will depend to a large extent on completion of habitat restoration projects in the AOC (further discussed in the Habitat section below). Ongoing monitoring has shown that contaminant levels within the Niagara River have decreased since its designation as an AOC. Continued work to eliminate remaining sources of contaminants, especially in sediment, may also benefit fish and wildlife population levels.

Additionally, several specific efforts should aid the recovery of certain populations. A contractor for the U.S. Fish and Wildlife Service (USFWS) will conduct phase 1 of a mussel restoration project in 2021 to investigate the possibility of establishing native mussel populations in restored wetland areas or other areas along the river. The contractor will develop a detailed workplan for field work and will conduct initial surveys within the U.S. side of the upper Niagara River to determine the location and extent of current populations and identify locations of potential native mussel habitat. A second phase of surveys is envisioned, dependent on funding, before the contractor makes final recommendations on the feasibility of native mussel restoration. If restoration appears feasible, those efforts would be phase 3 of the project.

Recovery of Lake Sturgeon populations in the Niagara River is dependent upon having adequate habitat where juveniles can find safety from predators. The USFWS is conducting a juvenile sturgeon habitat study in the upper Niagara River, but the habitat needs are currently unknown. Once the USFWS has identified those needs, the goal is to create the ideal Lake Sturgeon habitat at an appropriate location. In the meantime, monitoring of Lake Sturgeon (as well as other important fishes such as, Muskellunge, Lake Trout is ongoing.

Bird or Animal Deformities or Reproductive Problems

During development of the U.S. RAP, there was no evidence of bird or animal deformities or reproductive problems; however, the impairment was considered “likely” because both young-of-the-year and adult fish were found to have contaminants at levels higher than standards for the protection of wildlife. Similar to the *Degradation of Fish and Wildlife Populations* BUI, a decision was made to change the status of this BUI to “impaired” in December 2011 (NYSDEC 2012). In place of the previous focus on contaminant levels in fish, the U.S. side now considers contaminant levels in Herring Gull and Double-crested Cormorant eggs and in mink livers as a means of evaluating the status of this BUI. Egg contaminant data show the Niagara River (NY) AOC comparing favorably to other locations throughout the Great Lakes. However, despite the general improvement in contaminant levels within the Niagara River, the available mink data indicate that this impairment continues to exist. A 2014-15 mink study found average PCB levels in mink livers above the lowest observed adverse effect level (Haynes et. al. 2016); therefore, additional control of PCB sources is needed to address this BUI. After sources have been addressed, another mink contaminant study will be needed to re-evaluate the BUI status.

Degradation of Benthos

Since the development of the U.S. Stage 1 RAP, this impairment was found at certain tributary mouths and nearshore areas based on the observed macroinvertebrate community structure and sediment toxicity testing. The likely cause of the impairment was hexachlorocyclohexane and PCB contamination in the sediment (NYSDEC 1994). Benthos was noted as not impaired in the main channel of the River due to the absence of substantial deposits of fine-grained sediments; however, more recent information has shown that that the amount of fine-grained sediment present is larger than anticipated. Therefore, the evaluation of the *Degradation of Benthos* BUI now includes much of the main channel of the upper River.

Over the past 20 years, several projects have addressed contaminated sediment in the Niagara River and its tributaries. In addition, many projects have addressed potential sources of contamination, including point sources and hazardous waste sites. Ongoing monitoring has documented significant improvements in water quality since the Niagara River’s AOC designation in 1987. However, the extent of contamination remaining in sediment, and the degree to which it may be contributing to beneficial use impairments, is only now becoming better defined as a result of extensive sampling performed in 2017 and 2018. One additional sampling event planned for 2021 should provide enough data to complete all necessary characterization of sediments.

Actions to remediate contaminated sediment in certain areas are anticipated; however, these actions are likely to be predominantly in tributaries rather than in the River itself (whereby the status of BUI is evaluated). Therefore, in 2019, the United States Geological Survey (USGS) began a study of sediment toxicity and the status of benthic macroinvertebrate communities in the Niagara River proper. The study

called for the collection of samples from 60 locations in the upper river, selected based on sediment contaminant data that the U.S. Army Corps of Engineers (USACE) collected in 2018. Due to the difficulty in identifying a reference site for the Niagara River, the sampling locations included "within AOC reference sites" in areas where the 2018 data show negligible sediment contamination. The USGS collected samples at 30 locations in 2019, and at the remaining 30 locations in 2020. The results of the study will determine whether this BUI may be removed in the short term or whether sediment remediation will be necessary first.

Restriction on Dredging Activities

On the U.S. side, this BUI's geographic scope focuses on the federal navigation channel that exists in the Buffalo Outer Harbor, the Black Rock Canal, and a portion of the upper Niagara River. Dredging of the navigation channel in some areas of the Buffalo Harbor and in the Black Rock Canal is necessary for the purpose of commercial navigation. When the U.S. RAP was published, open lake disposal of the dredged sediment was not possible due to the high levels of contamination. The condition of sediment has improved, and removal of the BUI may be possible within several years.

Much of the Buffalo Outer Harbor's federal navigation channel currently does not require regular dredging due to the large size of the Harbor and the fact that its use by commercial vessels is well below historic levels. Areas that may need dredging are generally in good condition based on available information. The USACE recently evaluated sediment in the sections of the Buffalo Outer Harbor where maintenance dredging is conducted, and results indicate that these sediments would likely meet requirements for open-water placement.

In 2015, the USACE conducted a major dredging project within the federal navigation channel of the Black Rock Canal to remove contaminated sediment. The dredged channel has not been reassessed since that time. Areas of the Black Rock Canal outside the navigation channel are known to require remediation; therefore, a reassessment should wait until remediation is complete. If at that point sediment within the navigation channel meets requirements for open-water placement, removal this of BUI may be considered.

Loss of Fish and Wildlife Habitat

Habitat loss on the U.S. side has occurred to a lesser degree in the lower River than in the upper River, where the loss has been dramatic due to physical disturbances associated with industrial and residential development. Examples of physical disturbances include bulkheading, filling, dredging, and the development of marinas and private docks along the shore. The diversion of varying amounts of water for power generation has also impacted habitat in the upper River.

Since the completion of the U.S. RAP in 1994, over 45 habitat protection and improvement efforts of varying scale have been initiated through various funding sources. Most of those projects are complete. Several years ago, the Niagara River Remedial Advisory Committee formed a Loss of Habitat Working

Group to identify remaining actions needed to restore habitat and remove this BUI. The Working Group spent considerable time evaluating additional potential habitat improvement projects and recommended a set of projects that, in conjunction with past projects, would bring about cumulative restoration sufficient to remove the *Loss of Fish and Wildlife Habitat* BUI. The list of projects was accepted by the full Remedial Advisory Committee. These projects, now referred to as the 'AOC Habitat Restoration Plan', will cumulatively restore approximately 100 acres of primarily shallow water/coastal wetland habitat. This habitat type was identified as critical for the Niagara River as it's related to AOC-specific causes and because it supports several of the River-dependent species linked to the *Degradation of Fish and Wildlife Populations* BUI.

Implementation of the Habitat Restoration Plan is well under way, in part because the U.S. Environmental Protection Agency was able to provide funding for some of the projects prior to the official adoption of the Plan. The Plan includes five wetland projects around Grand Island, New York that will all be complete by fall 2021. One additional project is now nearing completion while four others are in the design process.

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Appendix 1: Process for re-designating the status of a BUI in the Niagara River (Ontario) AOC (modified from the Canada-Ontario re-designation process).

STEP 1: COMPLETE ACTIONS

The RAP member organizations complete the necessary actions (for a BUI) as noted in the Delisting Strategy. When all actions are completed, the RAP Committee is notified and recommends completing an assessment of the BUI.

STEP 2: ASSESS

All relevant information for the BUI is compiled and an assessment report is prepared to synthesize evidence and evaluate whether the BUI delisting criteria have been met. The report will make a recommendation to change the BUI's status (proceed to step 3) or to complete additional actions (return to step 1).

STEP 3: GET FEEDBACK

The Assessment Report is presented to the RAP Committee for feedback and endorsement. If accepted, the report is posted on the RAP website for at least 30 days and input is sought from RAP partners, public, U.S. RAP agencies, and Indigenous communities

STEP 4: REVIEW & INCORPORATE

Document and review feedback received and revise the Assessment Report, as required. Summarize the review process (e.g., engagement techniques, results, feedback) and incorporate into the report. If the recommended BUI status change is supported, proceed to official submission (step 5)

STEP 5: SUBMIT FOR APPROVAL

Submit the final Assessment Report with a recommendation to change the BUI status to the COA Annex 1 Co-Leads for review and endorsement. When approved, the RAP may officially change the status of the BUI.

Appendix 2: Delisting Framework

In Canada, the official re-designation of BUI status and delisting of an AOC is the responsibility of the Canada-Ontario Agreement Co-Leads. When appropriate remedial actions are complete and monitoring/assessments produce evidence that support delisting criteria, the RAP Team prepares a recommendation to re-designate the applicable BUI. Once all BUIs are designated not impaired, the process can begin to delist the AOC through the development of a RAP Completion Report (which in the past was called a “Stage 3 RAP report”). The RAP Team seeks input from RAP partners, Indigenous communities, public, U.S. agencies, and the International Joint Commission on the recommendation to delist the AOC, with the case explained in full in the RAP Completion Report. If delisting the AOC is supported, the RAP Team submits the RAP Completion Report to the Parties (Canada and Ontario) for a decision.

Delisting a binational AOC, such as the Niagara River, either domestically or binationally is to be pursued on a case-by-case basis and will consider the following:

- A Party (U.S. or Canada) shall remove a BUI designation when the established criteria have been met.
- A Party may elect to identify an AOC as an AOC in Recovery when all remedial actions identified in the RAP have been implemented and monitoring confirms that recovery is progressing in accordance with the RAP. A Party shall monitor and take further action, if required, to restore beneficial uses within an AOC in Recovery.
- A Party shall remove the designation of an AOC or AOC in Recovery when environmental monitoring confirms that beneficial uses have been restored in accordance with the criteria established in the RAP.
- A Party shall solicit a review and comments from the State and Provincial Governments, Tribal Governments, First Nations, Métis, Municipal Governments, watershed management agencies, other local public agencies, the Public, and the International Joint Commission:
    - prior to the designation of an AOC in Recovery; and
    - prior to the removal of a designation as an AOC or an AOC in Recovery.
- The Parties solicit review comments (as warranted) from the appropriate federal, state, and provincial agencies, First Nations, Métis, and the International Joint Commission.
- After considering all comments, the Parties communicate feedback and decision to delist the AOC to the RAP Team.