

DEGRADATION OF FISH POPULATIONS (BUI #3A)



BACKGROUND

Fish play integral roles in aquatic ecosystems and form valuable fisheries that provide economic and social benefits to local communities. While populations of large top-predators such as Bass, Walleye (pickerel), and Muskellunge often form highly desired sport and commercial fisheries, populations of smaller bodied prey species (e.g., Emerald Shiner) have an equally important 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 Canada-U.S. Great Lakes Water Quality Agreement (GLWQA) (IJC 2012) commits both countries to “maintain the chemical, physical, and biological integrity of the Waters of the Great Lakes”.

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 Areas of Concern (AOCs). The *Degradation of Fish and Wildlife Populations* BUI¹ is an environmental indicator intended to provide information about biological integrity in the Niagara River AOC and can provide information about the state of its chemical integrity (water quality) or physical integrity (habitat condition/availability) because 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 and increase of pollution-tolerant species, fewer top predators and trophic specialists.

The Niagara River, which links Lake Erie to Lake Ontario, is one of five bi-national connecting channels that hydrologically connect the Laurentian Great Lakes. Connecting channels are unique environments

¹ 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 will be reviewed through a separate process and will be discussed in a separate chapter.

and uncommon in the world (Rozon et al. 2016). Connecting channels contain aquatic habitats similar to other large rivers but have high water with short retention time—making them very difficult to assess (Rozon et al. 2016). 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). The 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 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 1993); 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 (1993) 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 because of the condition of the fish populations of the Welland River. 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.

Table 1. Status of the *Degradation of Fish Populations* BUI and reasons provided in each report.

RAP REPORT	STATUS	REASONS PROVIDED
Stage 1 Report (1993)	Impaired	<ul style="list-style-type: none">• Fish populations in the Niagara River itself reflect the populations of the nearby Great Lakes and are not generally degraded (Page ES-X)• Niagara River contains impressive array of fishes with diverse sport fishery (Page 2-17)• A reduction in fish populations has been noted for the Upper Niagara River (sturgeon, emerald shiner, northern pike).• Potential causes listed: habitat degradation, salmonid stocking (increased competition for food), chronic/acute toxicity from spills, ice boom (delays warming of water) (Page 7-14)• Fish populations are degraded in the Welland River
Stage 2 Report (1995)	Impaired	<ul style="list-style-type: none">• Not specifically addressed. This document was intended to outline remedial actions, not review the status.
Technical Review of Impairments and Delisting Criteria (2007)	Impaired	<ul style="list-style-type: none">• Proposed revisions to the delisting criteria (not adopted)• Suggested using multiple lines of evidence for assessment (species diversity/population trends, contaminants, physiological health, other evidence if applicable)• BUI status assessment mainly focused on the Welland River rather than the Niagara River proper.• Fish community “likely impaired due to some combination of stressors related to impacts on habitat and riparian function, poor water quality due to non-point sources and flow reversals in the Welland River”.
Stage 2 Update Report (2009)	Impaired	<ul style="list-style-type: none">• Delisting criteria updated. No further description of the status of fish populations.

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. Data analysis of these most recent studies (DFO and professional judgment survey) to support a BUI status assessment was placed on hold until the delisting criterion was appropriately reviewed and updated. The *Degradation of Fish Populations* BUI status assessment is expected in 2020.

DELISTING CRITERIA REVIEW & RECOMMENDATIONS

Delisting criteria for the Canadian side of the AOC were first developed in 1995 through the RAP Stage 2 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). There were seven goals identified as being related to the *Degradation of Fish and Wildlife Populations* BUI, but only one was specific to the BUI (NRRAP 1995). In 2007, a group of technical experts (coordinated by Environment and Climate Change Canada) reviewed all of the remaining Niagara River BUIs and their delisting criteria (as per the 1995 Stage 2 Report), including the *Degradation of Fish Populations* sub-BUI. An outcome of this review was an update on the status of the remaining BUIs and proposed revisions to the delisting criteria (Mackay 2007). However, the delisting criteria recommendations from the 2007 technical review were never adopted and different criteria were endorsed by the Coordinating Committee as documented in the RAP Stage 2 Update Report (NRRAP 2009, Appendix 12). As per the 2009 RAP Stage 2 Update Report, the delisting criterion is:

*“The Degradation of Fish Populations BUI will no longer be impaired when:
maintenance of fish community populations on the Canadian side of the Niagara
River at or above suitable non-AOC reference sites OR meets fish community
objective(s) identified through a fisheries management plan by
Ontario Ministry of Natural Resources”*

In 2012, the scope of the GLWQA was revised and specifically states that the BUIs apply to the “Waters of the Great Lakes”, including the connecting channels (IJC 2012). This change led to a need to review the delisting criteria to ensure they were aligned with the GLWQA, while being realistic and scientifically-defensible. In 2018, the Niagara River RAP Team agreed that the 2009 delisting criterion for the *Degradation of Fish Populations* sub-BUI (NRRAP 2009) required revisions for two main reasons:

- 1) There are no suitable non-AOC reference sites. The Niagara River, like other connecting channels in the Great Lakes, are globally unique environments and all connecting channels in the Great Lakes are AOCs.
- 2) No binational fish community objectives or fisheries management plans specific to the Niagara River currently exist, and there are no plans for future development.

To address these issues, in November 2018, the RAP Coordinating Committee formed an expert technical working group to lead the revision of the fish populations sub-BUI delisting criterion. The technical working group consisted of the RAP Project Manager and representatives from Fisheries and

Oceans Canada and the Ontario Ministry of Natural Resources and Forestry. The group also solicited further expertise from U.S. counterparts at the New York State Department of Environmental Conservation (NYSDEC) and the United States Fish and Wildlife Service (USFWS). Over the course of eight separate meetings, the technical expert working group revised the delisting criterion and propose the following for the *Degradation of Fish Populations* sub-BUI:

*“The Degradation of Fish Populations BUI will no longer be impaired when:
multiple lines of evidence indicate similarity between the Niagara River fish
community and expectations based on the adjoining Great Lakes.”*

The proposed 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. If accepted, the revised BUI delisting criterion will be adopted by the Niagara River RAP Committee and will supersede the 2009 criterion.

Rationale for delisting criteria revisions

This section highlights the Technical Working Group’s rationale for the revisions and provides clear guidance for interpreting the language of the criterion.

Introduction of “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”

Ecologically, 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” as a BUI indicator is appropriate because it shows impact more broadly from aquatic ecosystem stressors and most consistent with an ecosystem approach for evaluating the condition of the Niagara River. The use of both terms in sequence in the 2009 delisting criteria led to misinterpretation which a specific reference to “fish community” will clarify.

From “suitable non-AOC reference sites” to “expectations based on the adjoining Great Lakes”

The technical working group noted an issue with finding appropriate reference sites 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 Great Lakes Water Quality Agreement

The revised wording of the delisting criterion aligns with the purpose and scope of the Great Lakes Water Quality Agreement “to restore and maintain the chemical, physical, and biological integrity of the Waters of the Great Lakes” (IJC 2012). The revised 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 integrity² component and resiliency of an aquatic ecosystem by specifically referring to the status of the fish community.

² 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).

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