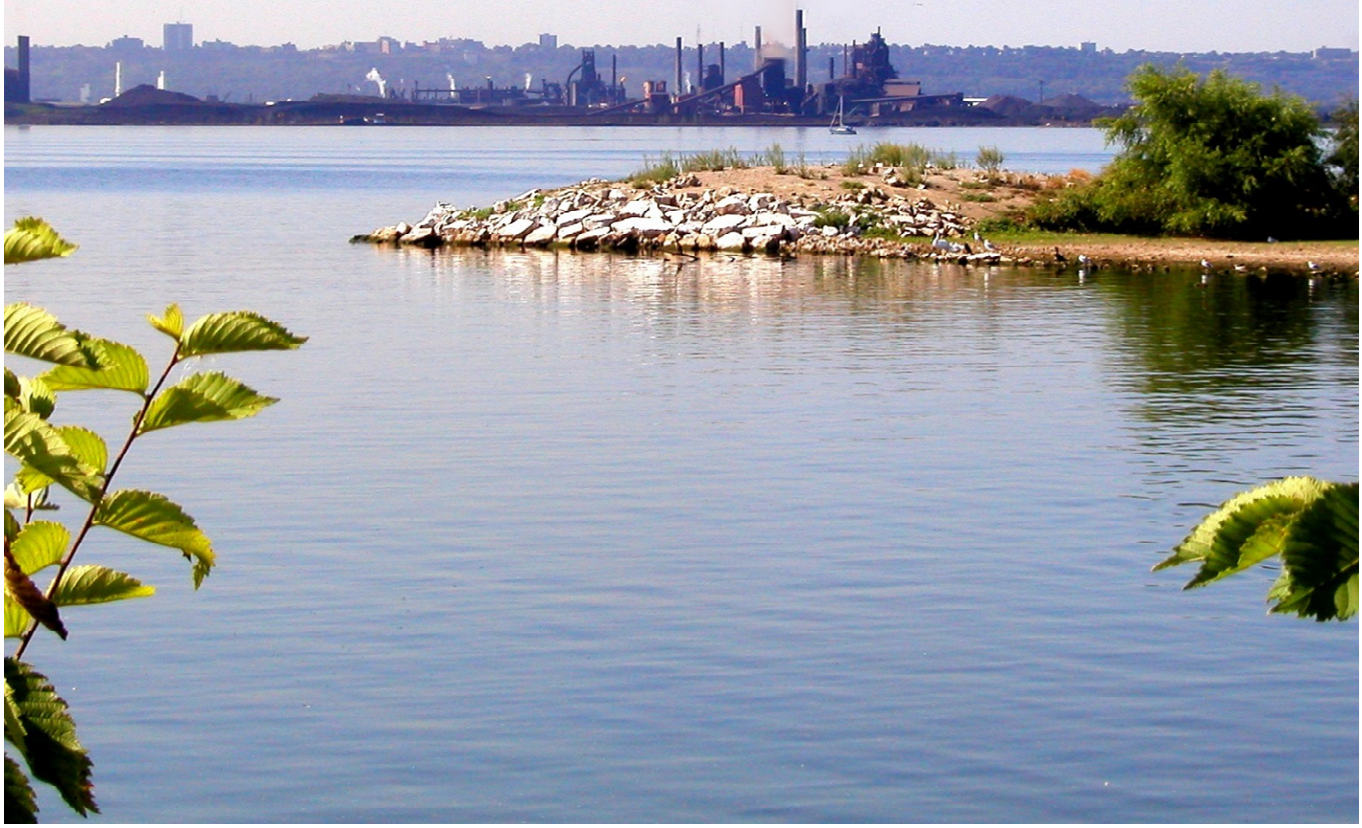
Hamilton Harbour Remedial Action Plan

2018 Fact Sheets

Progress towards Delisting



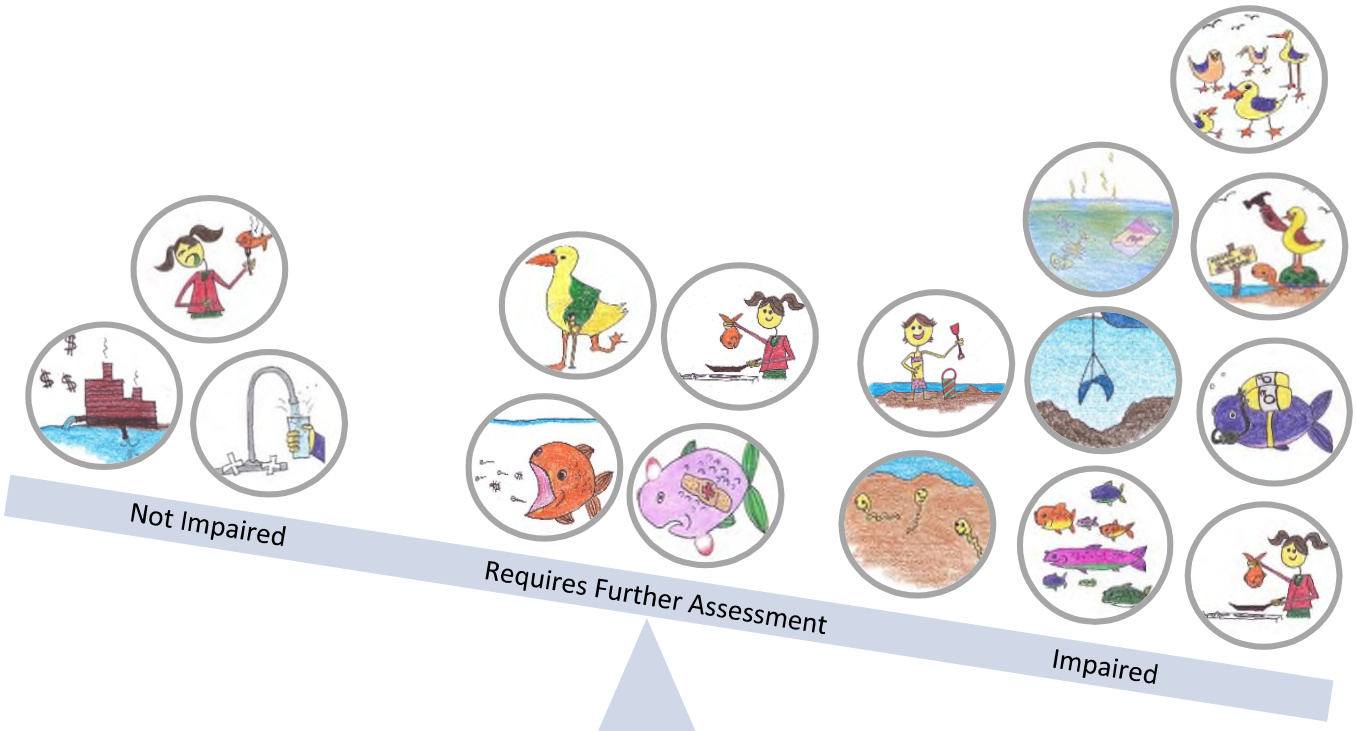
HAMILTON HARBOUR

REMEDIAL ACTION PLAN

Background

Hamilton Harbour has a long history of pollution dating back over 150 years, warranting the title of Area of Concern (AOC) in 1987. The Hamilton Harbour Remedial Action Plan is responsible for implementing actions to remediate the Harbour. Hamilton Harbour has 11 uses that are considered impaired (need remediation) or require more information, whereas 3 are considered not impaired.

This booklet outlines the current status of each Beneficial Use Impairment (BUI) as the Harbour makes progress towards delisting as an AOC. More information on the 3 Beneficial Uses that are not impaired can be found in the 2012 Fact Sheets.



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Produced by the Hamilton Harbour Remedial Action Plan
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2018 Status Summary of the Beneficial Uses

Impaired

1a	Restrictions on Fish Consumption	Impaired
3a	Degradation of Fish Populations	Impaired
3b	Degradation of Wildlife Populations	Impaired
6	Degradation of Benthos	Impaired
7	Restrictions on Dredging Activities	Impaired
8	Eutrophication or Undesirable Algae	Impaired
10	Beach Closings	Impaired
11	Degradation of Aesthetics	Impaired
14	Loss of Fish and Wildlife Habitat	Impaired

Requires Further Assessment

1b	Restrictions on Wildlife Consumption	Requires Further Assessment
4	Fish Tumours or Other Deformities	Requires Further Assessment
5	Bird or Animal Deformities or Reproductive Problems	Requires Further Assessment
13	Degradation of Phytoplankton and Zooplankton Populations	Requires Further Assessment

Not Impaired

2	Tainting of Fish and Wildlife	Not Impaired
9	Restrictions on Drinking Water Consumption	Not Impaired
12	Added Costs to Agriculture and Industry	Not Impaired

2018 Hamilton Harbour RAP Fact Sheet

BUI 1a Restrictions on Fish Consumption

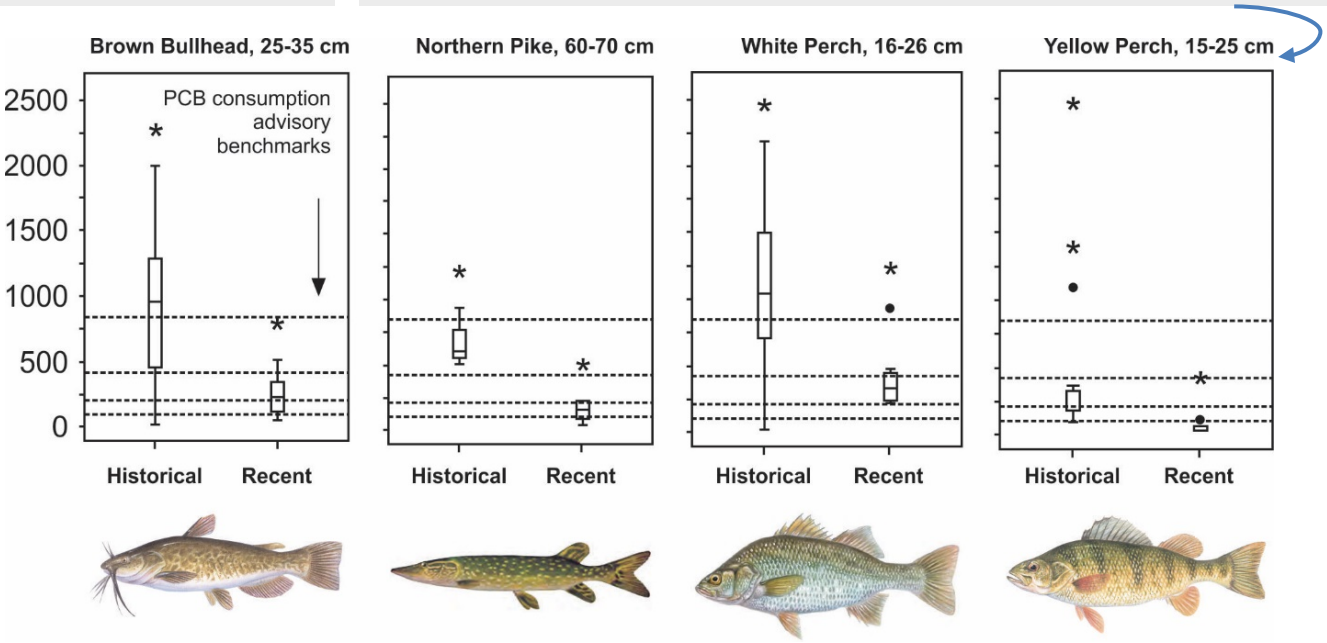
Delisting Criteria: There is no significant difference in the fish consumption advisories for Hamilton Harbour compared to reference location(s) and the contaminants of concern are declining in Hamilton Harbour fish.

Note: for all AOCs, a criteria change to "consumption advisories for fish of interest in the AOC are non-restrictive or no more restrictive than the advisories for suitable reference site(s) due to contaminants from locally-controllable sources" has been recommended (Bhavsar et al. 2018). This change will be proposed for Hamilton Harbour in 2019.

Did you know?

PCBs or polychlorinated biphenyls are the driver of the fish consumption advisories in Hamilton Harbour.

PCB levels in four fish species were significantly lower from 2005-2013 than previous years. However, concentrations are elevated compared to both nearby Lake Ontario reference areas and other AOCs, and are greater than consumption advisory benchmarks. While conditions are improving, remediation is still ongoing (Neff et al. 2016, Illustration credit: MOECC).



A survey of fish consumption from 1995-1997 found that only 20% of Hamilton Harbour respondents ate their catch in comparison to a 38% average of five AOCs sites. In response to, "Why don't you eat your catch?": 70% reported polluted water and 32% reported dirty/contaminated fish as the reason (Scott 1998). As fishing and eating patterns in the Harbour may have changed in the last 20 years a new fish consumption survey is being planned for 2019.

What Was the Original Problem?

PCBs, mercury, Mirex, and pesticides were listed as the causes of impairment in fish. The latter three were never specific Hamilton Harbour issues, but were included in historical RAP documents as these were general issues in Lake Ontario fish. In 1992 it was recognized that some species on the advisory list (e.g., prey fish such as Smelt, Alewife, and Gizzard Shad) accumulate contaminants lake-wide due to migration into Lake Ontario and move contaminants into the Hamilton Harbour food chain.

Other AOC Comparisons

Most AOCs have similar delisting criteria, but Niagara River and Toronto and Region AOCs are specific in that there must be no restrictions attributable to locally controllable contaminant sources. The Niagara River AOC has a qualifier that if conditions can't be met, then a risk-based Contaminated Sediment Management Strategy must be in place with appropriate monitoring and mitigation measures and/or administrative controls.

How are Improvements Being Made?

1. Windermere Basin PCBs have been dredged/capped.
2. Abatement actions to control the source of Strathearne Slip PCBs are progressing through the Ministry of the Environment, Conservation and Parks.
3. ArcelorMittal Dofasco is obtaining provincial approval to manage PCB, PAH, and metal contaminated sediment at the head of the Kenilworth Boat Slip.
4. The Municipal/Industrial Strategy for Abatement reduced chemical inputs into the Harbour by industry and municipal WWTPs through optimization, upgrades, and implementation of sewer use control programs.
5. Installation of a leachate collection system in the 1990s at the historical Rennie and Brampton Street landfills prevented materials (including PCBs) from entering the Red Hill Creek and Harbour.
6. Natural sediment deposition will continually cap and bury PCB contaminated sediments over time.

Windermere Basin has been remediated and made into a wetland

What Still Needs to Happen?

- An online survey of public and Indigenous anglers, plus shoreline surveys in 2019.
- Remediation of Kenilworth and Strathearne Boat Slips.
- Periodic sampling of fish in Hamilton Harbour to update fish consumption advisories.
- A status assessment of the beneficial use impairment will be undertaken.

Where Can I Learn More?

Bhavsar et al. 2018. Assessing fish consumption Beneficial Use Impairment (BUI) at Great Lakes Areas of Concern: Toronto case study. Aquatic Ecosystem Health and Management 21(3):318-330.
MOECC. 2017. 2017-2018 Guide to Eating Ontario Fish: ontario.ca/page/eating-ontario-fish-2017-18
BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard
Neff et al. 2016. Improvements in fish polychlorinated biphenyl and other contaminant levels in response to remedial actions in Hamilton Harbour, Ontario, Canada. Aquatic Ecosystem Health and Management 19(2): 161-170.
Labencki. 2011. 2008 Field Season in the Hamilton Harbour Area of Concern. Hamilton Harbour PCB Assessment.
Scott. 1998. Down by the Bay: a profile of shoreline fishing and fish consumption in the Hamilton Harbour area
Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

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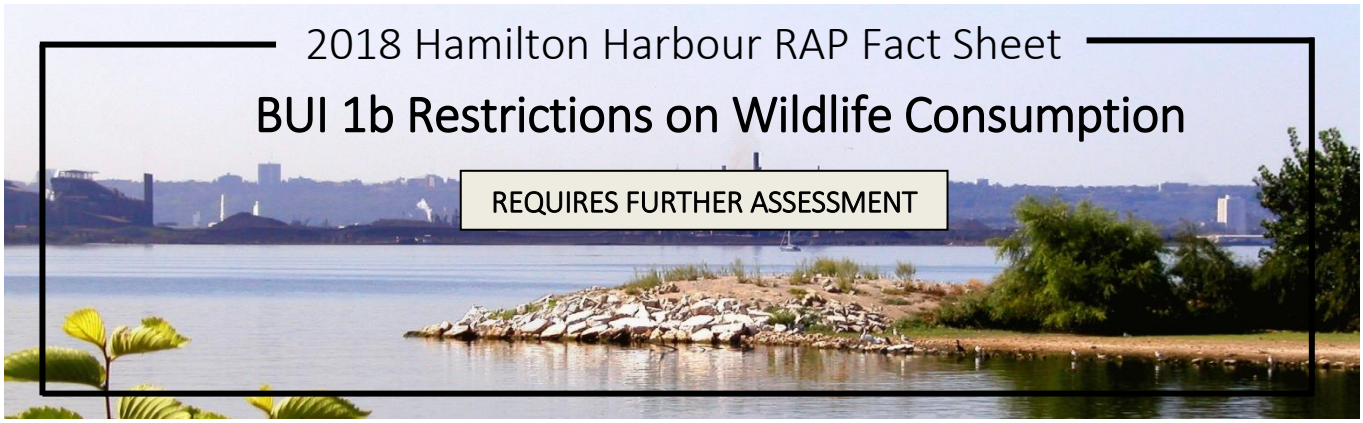
BUI 1b Restrictions on Wildlife Consumption



Delisting Criteria: There are no restrictions on consumption of wildlife from the Harbour attributable to local sources.

Note: A status change from 'Required Further Assessment' to 'Not Impaired' is being proposed in 2019 for this BUI.

Did you know?

PCBs (polychlorinated biphenyls) are a contaminant of concern in Hamilton Harbour with the potential to result in consumption advisories when found in high concentrations in fish and wildlife.

PCB sources have been identified and projects are ongoing to reduce PCB availability through BUI 6 Degradation of Benthos (e.g., Windermere Basin, Strathearne Slip, and Kenilworth Boat Slip remediation).

In April 2017, the Ministry of Natural Resources and Forestry removed the open season for hunting snapping turtles, making it illegal to hunt them or harvest their eggs in Ontario.

A change in status from 'Requires Further Assessment' to 'Not Impaired' was recommended by a recent status update report (Dahmer 2016). The study found that PCB uptake by humans is unlikely due to:

1) a lack of PCB exposure pathway for wildlife,
2) decreasing contaminant availability to wildlife,
3) and/or laws that prevent people from taking wildlife (i.e., discharge of a firearm/bow and/or the killing or harming of specific wildlife).

What Was the Original Problem?

Although PCB concentrations in mallard ducks and snapping turtles were above U.S. standards, information on wildlife contamination in Hamilton Harbour was considered data deficient. There were also reduced population levels of traditionally hunted species.

Other AOC Comparisons

Only the St. Clair River AOC is impaired for the wildlife portion of this BUI. Their delisting criteria states that it will be not impaired when the general guidance for the consumption of indicator wildlife (e.g., snapping turtles, geese) are no different than the non-AOC sites in the Great Lakes. Niagara River AOC (Canadian Section) re-designated the BUI status to 'not impaired' based on the results of a community survey that indicated that wildlife from the area were not being consumed on an ongoing basis.

How are Improvements Being Made?

1. Actions were taken to discourage the use of Confined Disposal Facilities by waterfowl following a study in 1993 by the Canadian Wildlife Service. This interrupted the PCB exposure pathway.
2. Windermere Basin was dredged, capped, and made into a wetland in 2013. Other local PCB sources have been identified and are in various stages of remediation. See BUI 6 Degradation of Benthos and BUI 1a Restrictions on Fish Consumption Fact Sheets for more information.
3. Environment and Climate Change Canada measures contaminants in gulls, cormorants, turtles, and frogs to confirm improvements in response to continued restoration efforts in the Harbour. See the BUI 5 Bird or Animal Deformities or Reproductive Problems Fact Sheet for more information.
4. A status update (Dahmer 2016) recommends a status of "Not Impaired" for the following reasons:
    a. All waterfowl are protected by by-laws that prevent the use of firearms within the AOC.
    b. Ducks, geese, and swans are also federally protected under the Migratory Birds Convention Act (1994). Additionally, Mute Swan and Canada Geese lack an exposure pathway to local PCB sources.
    c. Mink consumption would not result in exceedances of Health Canada Tolerable Daily Intake
    d. Snapping turtle and egg harvest was banned in April 2017 under the Ontario Fish and Wildlife Conservation Act.

What Still Needs to Happen?

- No further remedial actions beyond those already in the works for other BUIs were envisioned.
- The Remedial Action Plan will engage the public and Indigenous communities on the recommended status change from 'impaired' to 'not impaired' as part of an assessment in 2019.

Where Can I Learn More?

Ontario Environmental Registry. 2018: ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTMxMDUy&statusId=MjAwNjQw&language=en [accessed January 2019]

BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard

Dahmer. 2016. Hamilton Harbour Area of Concern Status Assessment for the Restrictions on Wildlife Consumption Beneficial Use. 53 pp.

City of Hamilton. 2005. Discharge of Firearms By-Law No. 05-114: hamilton.ca/NR/rdonlyres/6B512F07-8535-4A14-AC46-D24735E4AD6F/0/05114.pdf

Gebauer and Weseloh. 1993. Accumulation of Organic Contaminants in Sentinel Mallards Utilizing Confined Disposal Facilities at Hamilton Harbour, Lake Ontario, Canada. Arch. Environ. Contam. Toxicol. 25: 234-243.

City of Burlington. 1991. Discharge of firearms By-Law 83-1991: burlington.ca/clerks/by-laws/html/83-1991.htm

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

Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

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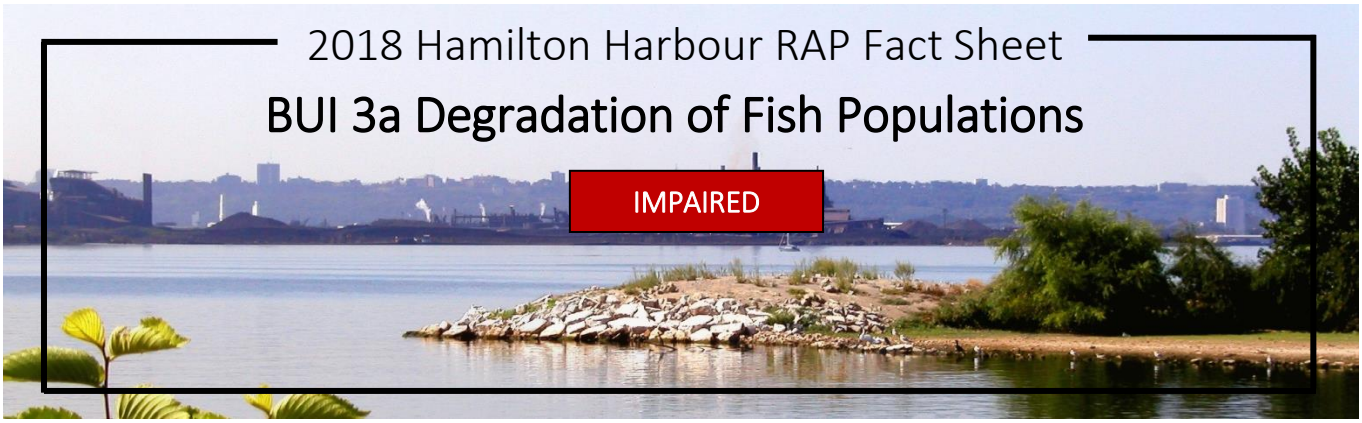
BUI 3a Degradation of Fish Populations



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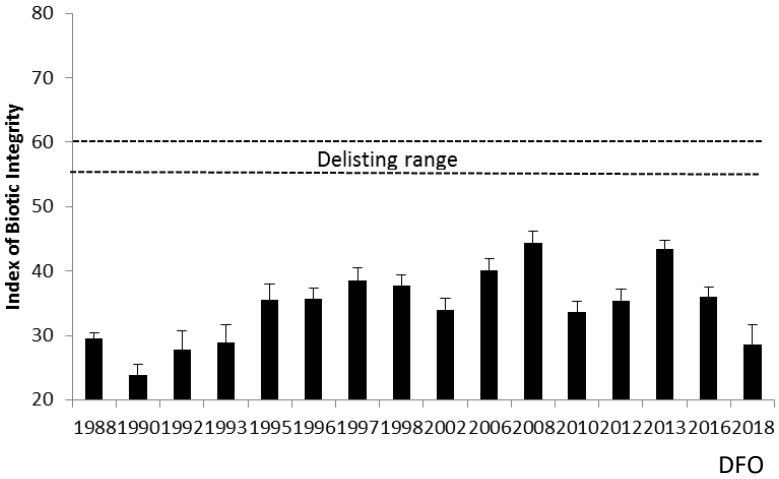
Delisting Criteria: the nearshore fish community has the following structure:

a. Shift from a fish community indicative of eutrophic environments (e.g. White Perch, Alewife, bullheads, and carp) to a self-sustaining community more representative of a mesotrophic environment with a balanced trophic composition that includes top predators (e.g. Northern Pike, Largemouth Bass and Walleye) and other native species (e.g. Suckers, Yellow Perch and sunfishes).
b. Attain an Index of Biotic Integrity (IBI) of 55-60 for Hamilton Harbour and maintain the target score for two sequences of monitoring carried out a minimum of every three years. The IBI incorporates components of native species richness, numbers and biomass; piscivore biomass; non-native species; and reflects water quality and the quality of fish habitat.

Did you know?

Changes in the fish community are measured by standardized federal boat electrofishing (1988-2018) and provincial trap netting (2006-2018) programs.

IBI (Index of Biotic Integrity) is a fish community indicator. Higher values indicate a diverse fish community with few non-native fishes, good water quality, good physical habitat supply, and top predator abundance. Hamilton Harbour's fish community is diverse, but still weighted toward pollution tolerant and non-native species and falls short of the delisting targets; improvements in the IBI were seen in the mid-1990s to mid-2000s, but the IBI has recently declined.

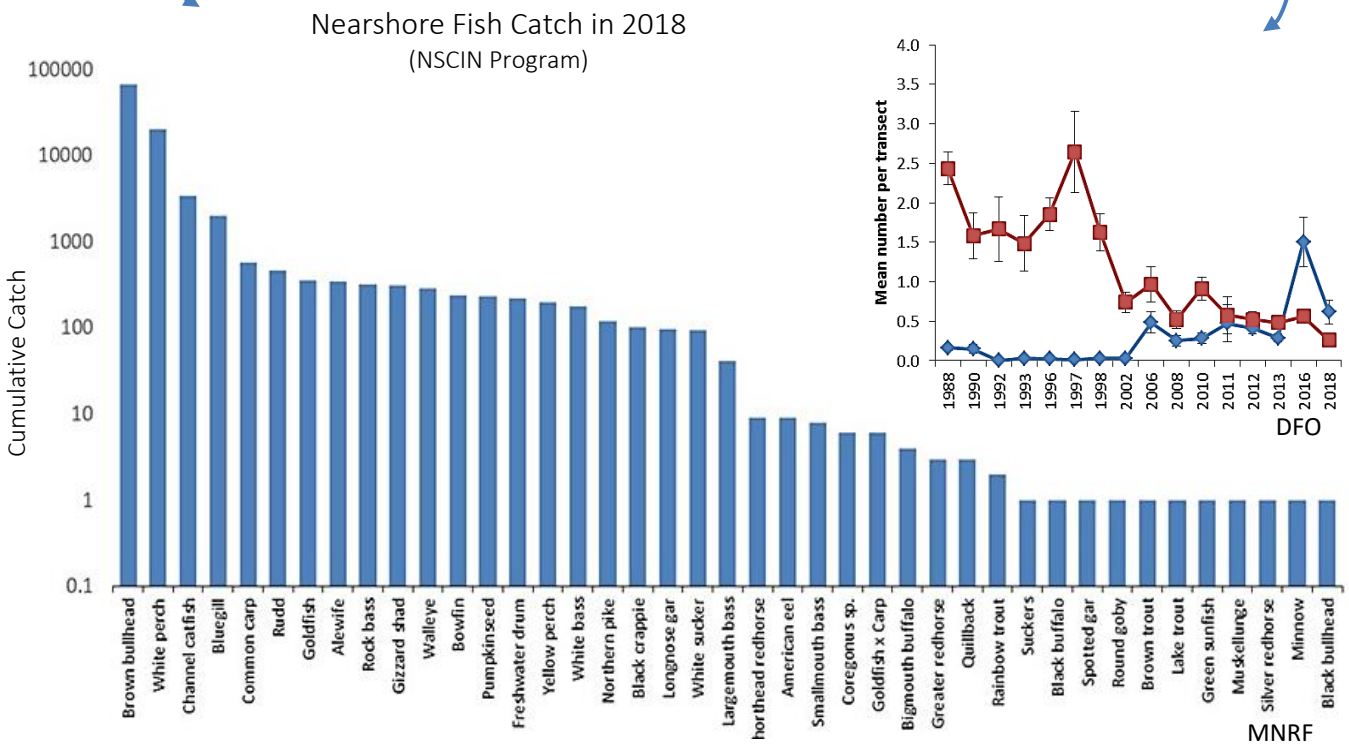


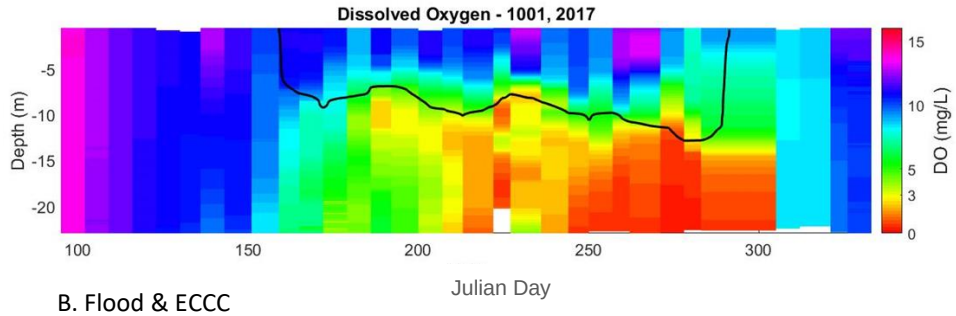
DFO

Walleye were stocked to increase the number of top predators (piscivores) in the system needed to restore the fish community. Pictured is a four-year old Hamilton Harbour Walleye in 2016.

The Harbour supports 41 fish species. Although gains in desired species have occurred recently (e.g., Walleye, Bowfin), the Hamilton Harbour fish community is still dominated by warm-water, pollution tolerant fishes like Brown Bullhead. Improvements in water quality including phosphorus levels, suspended sediments, dissolved oxygen as well as the quantity and quality of habitat are needed to support a more balanced fish community.

The catch of Common Carp has declined in the Hamilton Harbour system, but the catch of other non-native species such as Goldfish and Rudd have increased.





B. Flood & ECCC

Deep-water hypoxia (low oxygen) develops in the summer and limits the type of fish that can be found in the Harbour. See BUI 14 Degradation of Fish and Wildlife Habitat for more information.

What Was the Original Problem?

The fish community was dominated by non-native and pollution tolerant species; 70% of the Harbour wetlands had been filled to create port and industrial land; and very few aquatic plants grew in the nearshore zone of the Harbour. A seasonal lack of oxygen (hypoxia) in the bottom waters did not supply habitat conditions required by cold water species (e.g., Cisco) that once resided in the Harbour (Bowlby et al. 2016). Cootes Paradise and the mouth of the Grindstone Creek were dominated by Common Carp that destroyed vegetation used by other species as habitat.

Other AOC Comparisons

Other AOCs have targets tailored to their specific fish communities or populations. Some refer to biomass increases (Toronto and Region), IBI scores (Bay of Quinte), a Fisheries Management Plan (St. Lawrence River and Niagara River), or comparison to a suitable reference site (St. Marys River). An IBI score is desired by more AOCs because it is measureable and can be compared across locations (AOC and non-AOC).

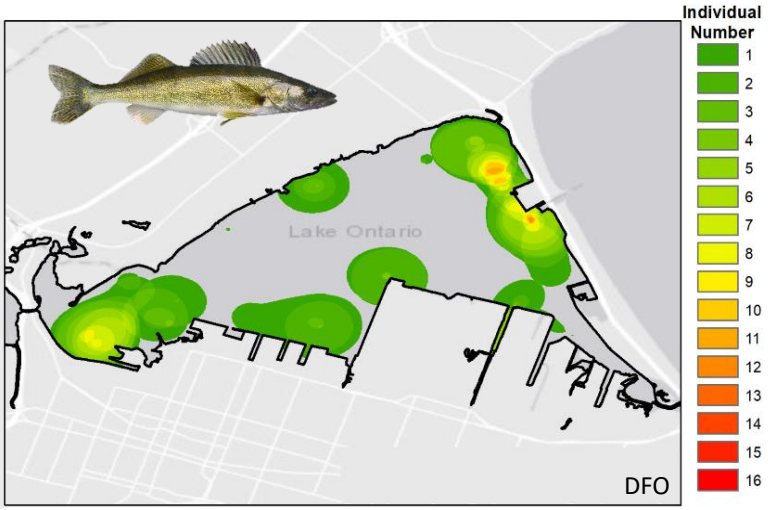
How are Improvements Being Made?


M. Pricop

1. The Ministry of Natural Resources and Forestry (MNRF) has reintroduced Walleye into Hamilton Harbour (2012) and continues to stock every other year (most recently in 2018). Stocked Walleye are the most abundant top predator in recent trap net catches.

2. The Acoustic Telemetry Project tracks fish movement in the Harbour and helps the RAP gain an understanding of locations that act as seasonal refuges for top predator species (e.g., Walleye, Northern Pike) during poor water conditions such as after an algal bloom. This information feeds into management actions to install fish habitat in appropriate locations that will help restore fish populations and improve IBI scores. The project also helps track the success of the Walleye introductions, as seasonal movements are captured. The project has been ongoing since 2015 and is led by Fisheries and Oceans Canada, Carleton University, and Conservation Halton. See BUI 14 Loss of Fish and Wildlife Habitat Fact Sheet for more information on habitat restoration that supports fish populations.

Acoustic Telemetry helps link fish populations to habitat preference and habitat restrictions. Habitat for fish (pictured here is Walleye) becomes restricted to several areas after the onset of an algal bloom and low oxygen (hypoxia) in the summer. Acoustic Telemetry helps scientists understand where to install fish habitat to best support spawning and regeneration of fish populations.



3. Dissolved Oxygen Modelling by the University of Toronto in tandem with the Acoustic Telemetry Project can help inform decisions on the most suitable locations for fish habitat in the Harbour based on the extent and movement of the hypoxic layer (low oxygen) and will help boost IBI scores. See BUI 14 Loss of Fish and Wildlife Habitat Fact Sheet for more information on this project.

4. Fish habitat creation and remediation projects have been implemented to address historical fish habitat losses (1992-present; e.g. Wildlife Islands). See BUI 14 Loss of Fish and Wildlife Habitat Fact Sheet.

5. Invasive species management: the fishway at the entrance to Cootes Paradise has excluded large Common Carp from the marsh since 1996 allowing for regrowth of aquatic vegetation and habitat for other fishes. Carp numbers and biomass have declined significantly since 1997.

   During the spring and fall fish migrations, the Royal Botanical Gardens staff sort and assist the desired species across the Fishway into Cootes Paradise Marsh and send non-native species like carp back to the Harbour. The number of Bowfin (top predator) caught at the Fishway increased from 15 in 1997 to 178 in 2017.


N. Mulliah

What Still Needs to Happen?


DFO

- Restoration of native fish predators: continued stocking of Walleye until population becomes self-sustaining. Identification of factors that will lead to improved reproductive success for top predators including Walleye, Northern Pike, and Smallmouth Bass.
- Research that addresses the management of priority species including Walleye, Northern Pike, Largemouth and Smallmouth Bass, and Bowfin, as well as invasive fishes through the Acoustic Telemetry project and dissolved oxygen modelling.
- Water quality improvements addressed under BUI 8 Eutrophication and Undesirable Algae will account for a major portion of the fishery changes in the Harbour. The restoration of the Cootes Paradise Marsh and the mouth of the Grindstone Creek as defined in BUI 14 Loss of Fish and Wildlife Habitat will aid to restructure the fish community.
- Continued management of Common Carp and other non-native species (e.g. Goldfish).
- The fish community will take years to respond to improvements to water quality and habitat. It will however be possible to track trends via the IBI scores every few years in response to management actions.

Where Can I Learn More?

Bowlby and Hoyle. 2017. Developing Restoration targets for nearshore fish populations in two Areas of Concern in Lake Ontario. Aquatic Ecosystem Health and Management 20(3):242-251.

Boston et al. 2016. The fish community of Hamilton Harbour, Lake Ontario: Status, stressors, and remediation over 25 years. Aquatic Ecosystem Health and Management 19(2):206-218.

Bowlby et al. 2016. Evaluation of the Remedial Action Plan goal for dissolved oxygen in Hamilton Harbour: A goal based on habitat requirements for Cisco. Aquatic Ecosystem Health and Management 19(2):134–140.

Stewart et al. 2012. Fish Community Objectives for Lake Ontario. Ontario Ministry of Natural Resources and Great Lakes Fishery Commission.

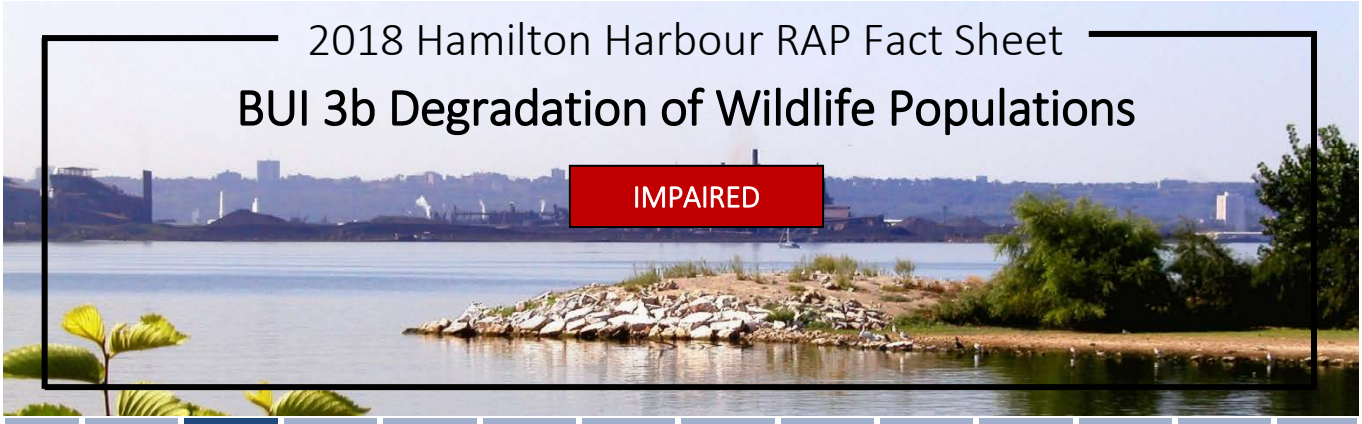
Bowlby, McCormack, and Heaton. 2010. Hamilton Harbour and Watershed Fisheries Management Plan. Ontario Ministry of Natural Resources and Royal Botanical Gardens.

Brousseau, and Randall. 2008. Assessment of long-term trends in the littoral fish community of Hamilton Harbour using an Index of Biotic Integrity. Can. Tech. Rep. Fish. Aquatic. Sci. 2811.

Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

2018 Hamilton Harbour RAP Fact Sheet

BUI 3b Degradation of Wildlife Populations



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Delisting Criteria:

1. Colonial waterbirds: The overall objective is to have a sustainable mixed community of colonial waterbirds. In general, are aiming for an increase of the rarer species and a reduction in the number of over-abundant species. Management of colonial waterbirds and achieving specific populations of particular species requires an adaptive management approach to ensure sustainable populations continue to the extent possible after delisting.

Targets (Number of Nests)

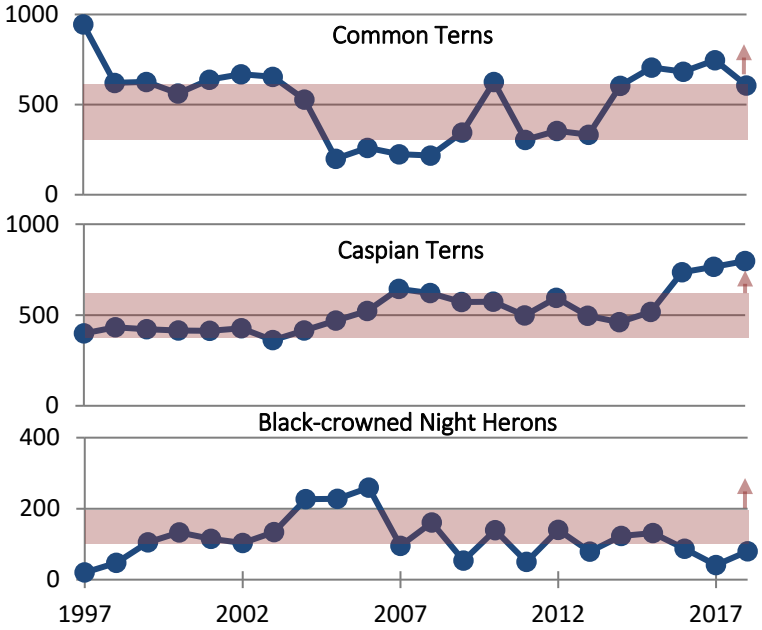
Ring-billed Gulls < 10,000	Common Terns 300-600+
Herring Gulls 200-300+	Caspian Terns 400-600+
Double-crested Cormorants < 2,500	Black-crowned Night Herons 100-200+

2. Other wildlife including waterfowl: No target will be suggested for other species of birds or animals, but a target for habitat (BU xiv) has been suggested which will enhance wildlife populations generally. In addition, management of some species may be necessary as a result of habitat enhancement.

Note: A status change from 'impaired to 'not impaired' is being proposed for this BUI in 2019.

Did you know?

Colonial waterbirds are species that gather in large assemblages when nesting. A recent report (Gilroy 2018) suggests a status change to 'not impaired' as nest targets for a sustainable mixed community have been met and 10-year funding has been secured to continue adaptive management.

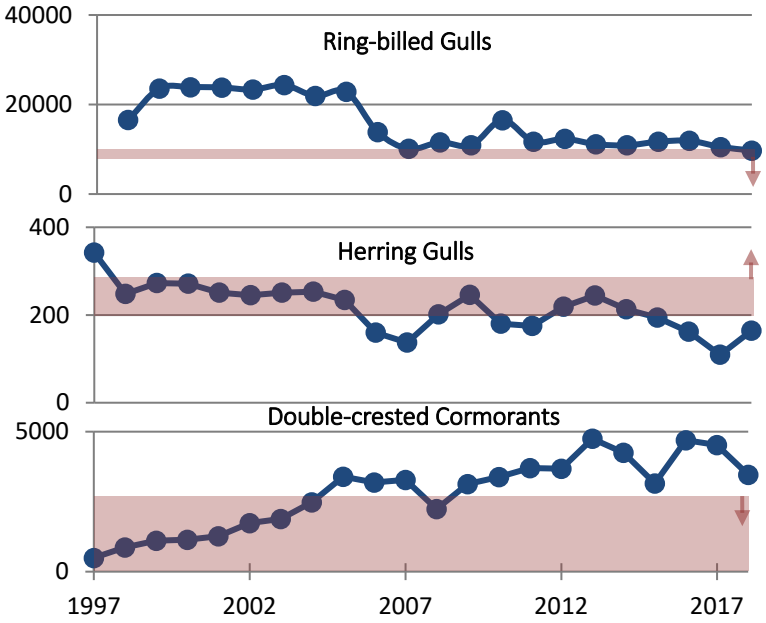


Goal Exceeded ✓

Goal Exceeded ✓

Goal Met* ✓

*Small fluctuations in numbers reflect the difficulty in finding Black-crowned Night Heron colonies as they are not site-specific. Due to limited access, colonies on industrial property are not counted, but are known to exist every year.



Goal Met ✓

Goal Met** ✓

Goal Met*** ✓

** Herring Gulls are declining throughout the Great Lakes Basin and local nest counts reflect the basin-wide population.
*** Cormorants are actively managed across the Great Lakes Basin and local nest counts reflect the basin-wide population.

What Was the Original Problem?

Nesting habitat was contaminated or temporary and communities were dominated by a few abundant species; clean, permanent and species appropriate habitat creation and management was required.

Other AOC Comparisons

Most AOCs target "self-sustaining and healthy communities of indicator wildlife species". Toronto and Region & Niagara River AOCs list specific species, comparison to reference, but no targeted numbers.

How are Improvements Being Made?

1. Islands were constructed to create colonial waterbird nesting habitat (Northeast Islands, Windermere Basin Wetland, LaSalle shoals).
2. Colonial waterbird populations are actively managed by reserving nesting space for rarer species and discouraging overabundant colonies from occupying all available nesting habitat.

Dancing Santa & flying raptors discourage some species, while tarps reserve space others.

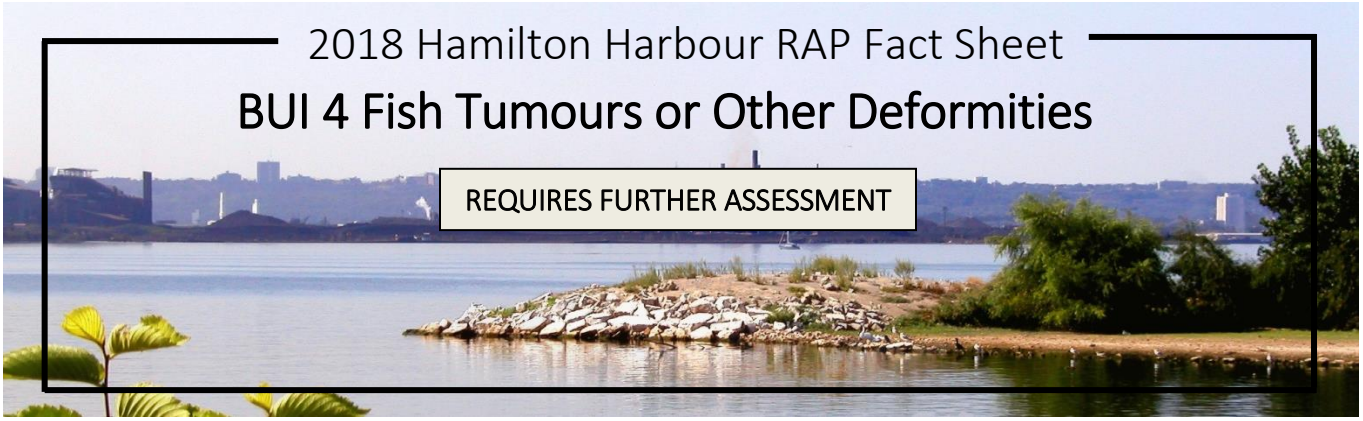
What Still Needs to Happen?

- No further actions beyond the long-term management of a sustainable mixed community.
- The Remedial Action Plan will engage the public and Indigenous communities on the recommended status change from 'impaired' to 'not impaired' as part of an assessment in 2019.

Where Can I Learn More?

Gilroy. 2018. Status Assessment Report of the BUI "Degradation of Wildlife Populations" for the Hamilton Harbour AOC.
BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard
Pynenburg, et al. 2017. Efficacy of decoys and familiar versus unfamiliar playback calls in attracting Common Terns to a rehabilitated wetland on Lake Ontario. Aquatic Ecosystem Health and Management 20(3):285-294.
Zanchetta, et al. 2016. Population trends of colonial waterbirds nesting in Hamilton Harbour in relation to changes in habitat and management. Aquatic Ecosystem Health and Management 19(2):192-205.

Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca



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BUI 4 Fish Tumours or Other Deformities

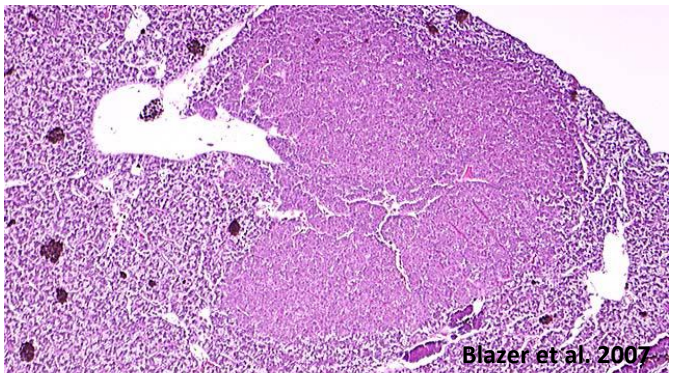
REQUIRES FURTHER ASSESSMENT

Delisting Criteria: Incidence rates of fish tumours in brown bullheads, as an indicator species, do not statistically exceed rates at relevant reference site(s).

Did you know?

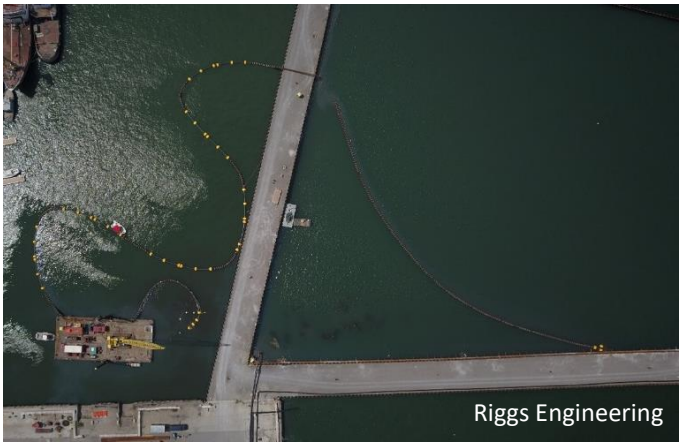
Contaminants such as polycyclic aromatic hydrocarbons, or PAHs, have been linked to increased liver tumor incidence in fish. Brown Bullheads (pictured here) generally have a small home range, so liver tumours in these fish are an indication of local contamination.

Liver tumours are usually microscopic (pictured below) and can not be seen by the naked eye.



Sampling in 2012 revealed no liver tumours in Brown Bullheads from Hamilton Harbour. A more diverse age class was sampled than previous years and could be compared to a tumour reference database for non-AOC sites (ECCC unpubl data). Generally, tumour rates exceeding 2% are considered abnormal (above background) for this species (Baumann 2010).

Although every caution will be taken to ensure dredging at Randle Reef will not release PAHs, experts recommend resampling Brown Bullheads during and after dredging as confirmation. Temporary spikes in tumour rates have been observed at other AOCs with dredging projects (Baumann & Harshbarger 1998). Pictured here is the hydraulic dredge used for containment of PAH contaminated sediment at Randle Reef.



What Was the Original Problem?

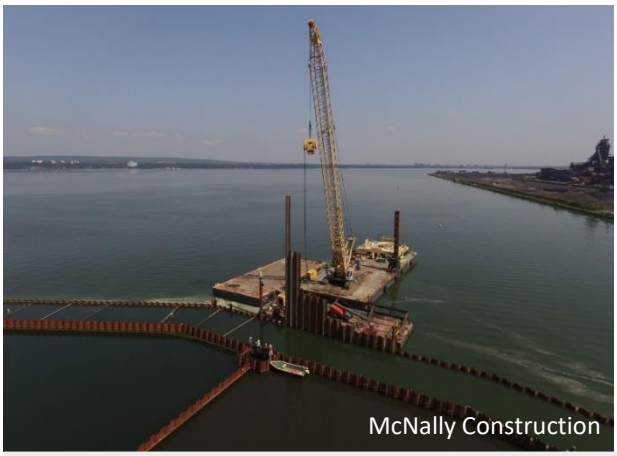
Hamilton Harbour was the original Canadian AOC to be listed as "having a Brown Bullhead population with external and liver tumour epizootics during studies carried out prior to the mid 1990s" (Baumann 2010). When sampled in 2001, 2005, and 2007, the Harbour had higher incidence of Brown Bullhead liver tumours when compared to one reference site (nearby Jordan Harbour). However, this may be explained by the sampling of older fish in Hamilton Harbour, as tumor rates often increase with age. External tumours are no longer used to assess the BUI as they can be the result of viruses and have not been linked directly to contamination in the Great Lakes.

Other AOC Comparisons

Only two Canadian AOCs are listed as impaired for fish tumours (St. Mary's River and Detroit) and three AOCs require further assessment (St Clair River, Thunder Bay, and Bay of Quinte). Most require either a liver tumour prevalence rate that is not significantly different from a reference site and/or a rate of less than 5% to change the BUI status to unimpaired.

How are Improvements Being Made?

1. The Municipal/Industrial Strategy for Abatement (MISA) reduced industry and municipal inputs of chemicals into Hamilton Harbour.
2. Natural burying of historical sediments by "cleaner" fill from the watershed is ongoing.
3. The capping of Randle Reef is underway: walls were built in 2016-17, separating the most contaminated sediments (heavy metals and PAHs) from the Harbour. In 2018-19, the structure is being filled with contaminated sediment from outside the walls via hydraulic dredging. Once capped, the PAHs from this site will no longer be available to aquatic life. See BUI 6 Degradation of Benthos Fact Sheet for more information.



The last pile being installed at Randle Reef. The walls were built in 2017 and contain the most contaminated sediment in the Harbour

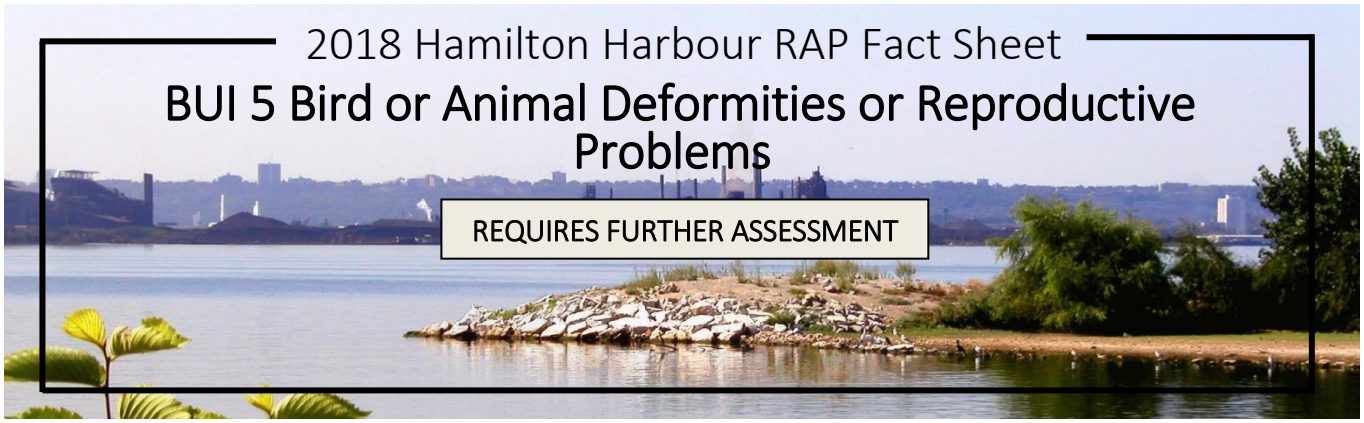
What Still Needs to Happen?

- Resampling of Brown Bullheads during Randle Reef dredging and 3 years after capping.
- A status update incorporating new data.

Where Can I Learn More?

BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard
Mahmood et al. 2014 A Bayesian methodological framework for setting fish tumour occurrence delisting criteria: A case study in St. Marys River area of concern. Journal of Great Lakes Research 40(3):88-101.
Gilroy et al. 2012. Assessment of the health status of wild fish from the Wheatley Harbour Area of Concern, Ontario, Canada. Environmental Toxicology and Chemistry 31(12): 2798-2811.
Baumann. 2010. Data Analysis and Fish Tumor BUI Assessment for the Lower Great Lakes and Interconnecting Waterways.
Blazer et al. 2007. Manual for the Microscopic Diagnosis of Proliferative Liver and Skin Lesions in the Brown Bullhead (*Ameiurus nebulosus*). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-12/036.
Baumann and Harshbarger. 1998. Long term trends in liver neoplasm epizootics of Brown Bullhead in the Black River, Ohio. Environmental Monitoring and Assessment 53: 213-223.

Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca



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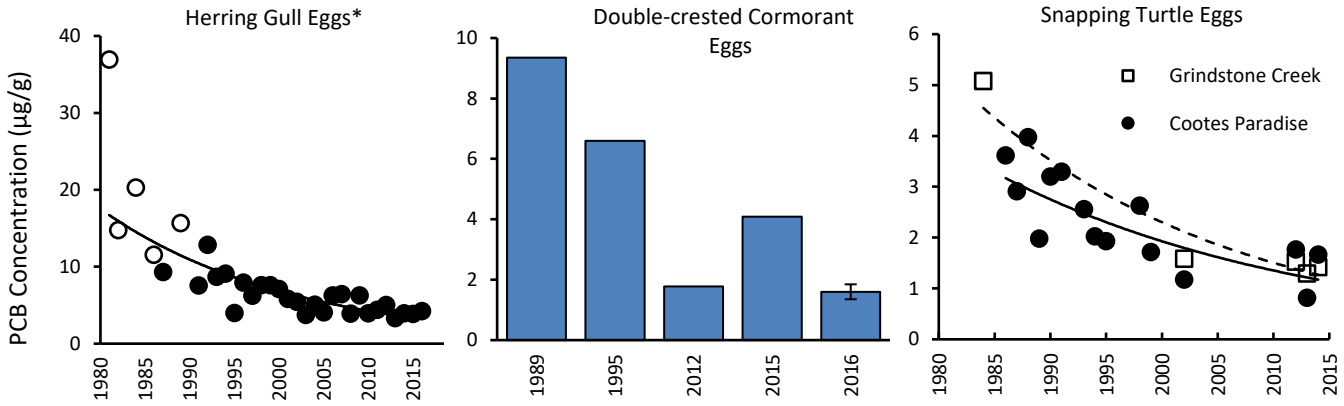
Delisting Criteria: The types and frequency of deformities and/or reproductive impairments associated with contaminant exposure are similar to those seen at a suitable reference site(s), and do not result in a population level effect as examined through sentinel species (e.g. snapping turtles and herring gulls).

Did you know?

There has been a 30+ year decline in PCB levels (polychlorinated biphenyl) and other contaminants like dioxins, furans, mercury, and organochlorines in herring gull, cormorant and snapping turtle eggs collected from Hamilton Harbour (Hughes et al. 2018 and Hughes et al. in prep).



* Closed circles represent a different estimation method than open circles (see Hughes et al. 2018)

The most recent status update found that concentrations of PCBs and other contaminants were not sufficiently elevated to adversely impact the reproductive success and development of herring gulls and cormorants nesting in Hamilton Harbour (Hughes et al. 2018)

Hatching success and development of snapping turtles at Cootes Paradise and Grindstone Creek were generally similar to that of turtles at the reference location in four study years between 2012–2016 (ECCC in prep.).

What Was the Original Problem?

Deformities such as crossed bills were seen in colonial waterbird colonies in the 1970s. These were considered to be the result of historical industrial and municipal inputs to the Harbour and airborne contaminants falling within the watershed. Snapping turtles had reproduction anomalies and high PCB levels. Cootes Paradise Marsh generally lacks frogs despite the fact that it is a wetland.

Other AOC Comparisons

The Detroit River is the only Canadian AOC with this BUI listed as impaired and include in their criteria that they must maintain conditions for a minimum of three years using the same sentinel species as Hamilton Harbour.

How are Improvements Being Made?

1. The Municipal/Industrial Strategy for Abatement (MISA) has reduced inputs of contaminants directly to Hamilton Harbour. Similar measures to prevent or diminish air borne contaminants getting into the watershed have been ongoing at an international level.
2. PCBs in Windermere Basin have been capped and other known sources of PCBs are being addressed through remedial actions at Strathearne Boat Slip and Kenilworth Boat Slip. See BUI 6 Degradation of Benthos Fact Sheet for more information.
3. A status update of colonial waterbird deformities and reproduction problems was completed in 2018 and recommends a status of not impaired (Hughes et al. 2018).

What Still Needs to Happen?

- Remedial actions for PCBs in the Strathearne Boat Slip and Kenilworth Boat Slip (as addressed under BUI 6 Degradation of Benthos).
- Status updates for snapping turtles and northern leopard frogs are anticipated in 2019. A status change may be proposed for this BUI.
- If a change in status is proposed, the Remedial Action Plan will engage the public and Indigenous communities on the recommended status change as part of an assessment in 2019.

Where Can I Learn More?

Hughes, et al. 2018. Assessment of the Wildlife Reproduction & Deformities Beneficial Use Impairment in the Hamilton Harbour Area of Concern – Colonial Waterbirds. Environment and Climate Change Canada – Ecotoxicology and Wildlife Health Division Report. 37 pp.

BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard

Bishop, et al. 2016. Contaminant concentrations and biomarkers in 21-day old Herring Gulls (*Larus argentatus*) and Double-crested Cormorants (*Phalacrocorax auritus*) from eastern Lake Ontario, and from Hamilton Harbour in western Lake Ontario in 1989 and 1990. Aquatic Ecosystem Health and Management 19(2): 181-191.

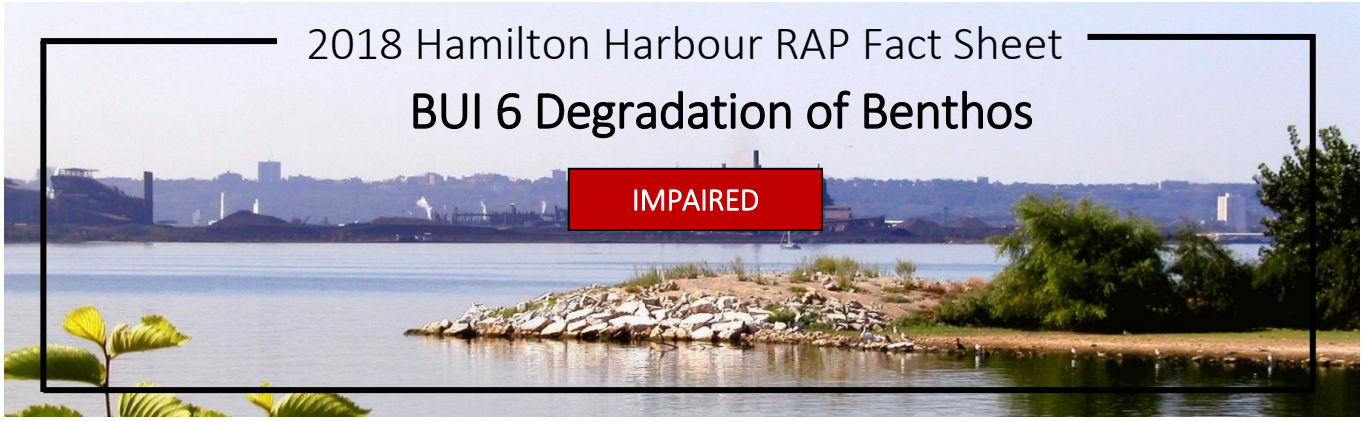
Hughes, et al. 2016. Long-term trends in legacy contaminants in aquatic wildlife in the Hamilton Harbour Area of Concern. Aquatic Ecosystem Health and Management 19(2): 171-180.

Hughes, et al. 2010. Current Status and Trends of Aquatic Wildlife in the Hamilton Harbour Area of Concern.

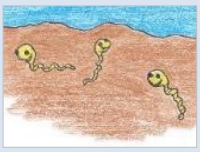
Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

2018 Hamilton Harbour RAP Fact Sheet

BUI 6 Degradation of Benthos



Delisting Criteria: Remedial actions to address contaminated sediment have been implemented and follow-up monitoring demonstrates improved benthic community structure and a reduction in acute and chronic toxicity attributable to contaminants in Hamilton Harbour sediments relative to historical surveys.



Progress should continue to be made towards these desired outcomes:

1. Littoral Zone (depth < upper limit of maximum extent of anoxic conditions)
   - Benthic community structure (BCS) is not different from that of appropriate reference conditions and BCS is not correlated to sediment contaminant levels among sites.
   - Acute and chronic sediment toxicity attributable to contaminants in sediments are not different from appropriate reference conditions.

2. Profundal Zone (depth > upper limit of maximum extent of anoxic conditions)
   - BCS is not correlated to sediment contaminant levels among sites.
   - Acute and chronic sediment toxicity attributable to contaminants in sediments are not different from appropriate reference conditions.

Did you know?

Benthos are the organisms that live in bottom sediments. The primary goal is to improve benthic community numbers and diversity by remediating severely contaminated areas. In Hamilton Harbour, nutrient enrichment and lack of oxygen are additional stressors to the benthos.

Contaminants in bottom sediment including metals, PAHs (polycyclic aromatic hydrocarbons), and PCBs (polychlorinated biphenyls) have decreased in most areas of the Harbour, with the exception of Windermere Arm. Windermere Arm and Randle Reef are the largest contributors of PCBs and PAHs to the Harbour, respectively (Milani et al. 2017).

An Engineered Containment Facility (ECF) is being constructed over Randle Reef, the largest volume of polycyclic aromatic hydrogen (PAH) contaminated sediment in the Great Lakes. The structure is scheduled be completed in 2022 and will hold seven football fields worth of contaminated sediment.

What Was the Original Problem?

The benthic communities in 1964 and 1984 were dominated by pollution-tolerant worms. Stress on the benthos was caused by toxic chemicals in the sediment and extended periods of low oxygen.

Other AOC Comparisons

Hamilton Harbour has the most contaminated sediment of all Canadian AOCs. Each impaired AOC (e.g., Niagara River and Toronto and Region) has distinct delisting criteria due to the uniqueness of each contaminated area and their management actions.

How are Improvements Being Made?

1. The walls of the Engineered Containment Facility (ECF) at Randle Reef were built in 2016-2017 and contain the most highly PAH contaminated sediment. Next steps include dredging of contaminated sediments from around the container and capping the structure.
2. Abatement actions to control the source of Strathearne Slip PCBs are progressing through the Ministry of the Environment, Conservation and Parks.
3. ArcelorMittal Dofasco is obtaining provincial approval to manage PCB, PAH, and metal contaminated sediment at the head of Kenilworth Boat Slip.
4. Contaminated sediments at Windermere Basin (including PCBs) have been dredged and capped.
5. The Municipal/Industrial Strategy for Abatement (MISA) program reduced chemical inputs into the Harbour by industry and municipal wastewater treatment plants.
6. Phosphorus loading from municipal wastewater treatment plants have improved, and will continue to improve following current upgrades at the Woodward Wastewater Treatment Plant.
7. Projects that mitigate urban runoff (Low Impact Development, bioswales, combined sewer overflows, etc.) have the ancillary benefit of reducing contaminant loads to the Harbour.

What Still Needs to Happen?

- Continue exploring the source of contamination in Windermere Arm and complete the remediation of the Kenilworth and Strathearne Boat Slips.
- Benthic surveys 1 and 5 years after the Randle Reef ECF is built to provide an indicator of success.
- Nutrient management through BUI 8 Eutrophication or Undesirable Algae should continue to reduce the impacts of seasonal lack of oxygen to the benthos in the long-term.
- A status update should be made when all scientifically and economically reasonable actions have been implemented. Anticipate years of natural recovery before reaching desired outcomes.

Where Can I Learn More?

Unmarked photos sourced from: ECCC

BARC. 2018. Randle Reef Updates: randlereef.ca

Bowman and Wilton. 2018. Benthic Invertebrate Assessment of RBG Wetlands 2014 and 2015. RBG Report No. 2018-9. Royal Botanical Gardens. Hamilton, Ontario.

Milani et al. 2017. Trends in sediment quality in Hamilton Harbour, Lake Ontario. Aquatic Ecosystem Health and Management 20(3): 295-307.

Graham et al. 2017. Environmental monitoring to guide and assess the effectiveness of Randle Reef sediment remediation on the recovery of Hamilton Harbour. Aquatic Ecosystem Health and Management 20(3): 308-318.

BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard

Milani and Grapentine. 2016. Prioritization of sites for sediment remedial action at Randle Reef, Hamilton Harbour. Aquatic Ecosystem Health and Management 19(2): 150-160.

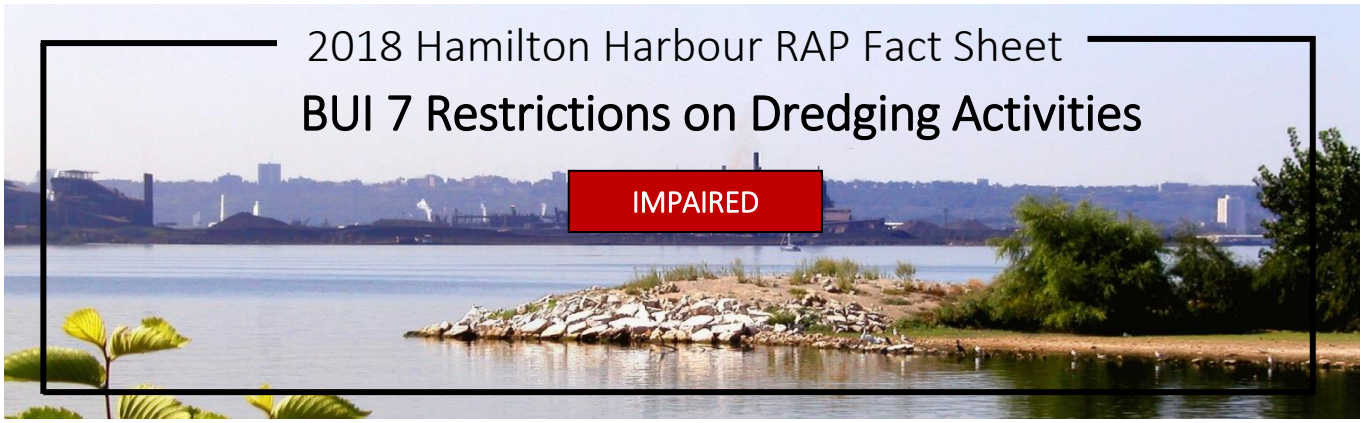
Milani and Grapentine. 2016. Hamilton Harbour 2014 survey of benthic conditions and trends from 1990 or 2000. Water Science and Technology Directorate, Environment and Climate Change Canada. Burlington, ON.

Dermott and Bonnell. 2010. Benthic fauna in Hamilton Harbour and adjacent Lake Ontario 2002-2005 in comparison to 1964. Aquatic Ecosystem Health & Management, 13(4): 413-428.

Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

2018 Hamilton Harbour RAP Fact Sheet

BUI 7 Restrictions on Dredging Activities



Delisting Criteria: When contaminants in sediments do not exceed biological and chemical standards, criteria, or guidelines such that there are no restrictions on disposal activities associated with navigational dredging.

Note: In 2012 a decision to update the status of this BUI was deferred. The status was impaired prior to this.

Did you know? This BUI relates to routine dredging of navigational channels to maintain adequate depth for the safe passage of boats and ships, as well as the management of dredged contaminated sediment.

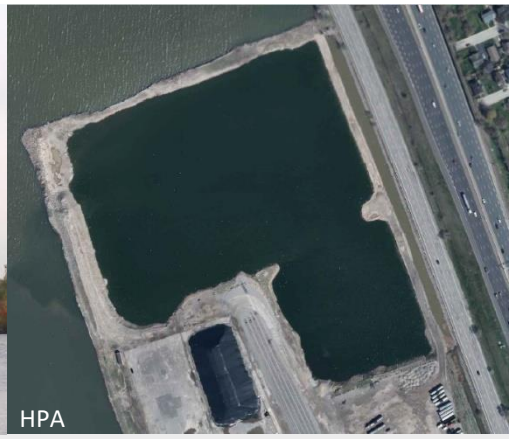
In 1993, Ontario developed the Provincial Sediment Quality Guidelines (PSQGs) and a procedure to assess whether dredged material could be disposed of in open water.

Chemical specific guidelines are used in both Canada and the U.S. to assess the suitability of disposing the dredged material in open water of the Great Lakes.

Contaminants in sediment have not restricted dredging activities where it is required for navigational purposes, but have simply necessitated alternate means of disposal. The use of upland disposal sites or confined disposal facilities (CDFs) to contain contaminated material has had the duel benefit of reducing exposure of aquatic life to contaminants in sediments, and also reducing the habitat effects associated with open water disposal.

In Hamilton Harbour, material from navigational dredging is currently analyzed and either placed in confined disposal facilities (CDFs) or sent for offsite disposal at a registered waste receiver.

J. O'Connor



Once the confined disposal facility located at the southeastern shore of the Harbour is full, an alternative option for management of navigational dredegate will be needed (e.g., remediation, new disposal location).

What Was the Original Problem?

Historical management practices of sediment from navigational dredging included open water disposal. This Beneficial Use was considered impaired when the RAP was established in 1987 because open-water disposal of Hamilton Harbour sediment was an issue due to contamination. However, Provincial Sediment Quality Guidelines (MOE, 1993) were developed in 1993 to manage contaminated dredgeate and sediment from Hamilton Harbour has been disposed of in accordance with the Guidelines ever since. Despite this, the delisting criteria reflect the earlier scenario/issue.

Other AOC Comparisons

Unlike Hamilton Harbour, many AOCs have contaminated sediments in sites that are not and never will be considered for navigational or commercial dredging. For all AOCs, any chemical contamination of sediments may also be addressed under other pertinent BUIs, e.g. BUI 1 Restrictions on Fish and Wildlife Consumption, BUI 4 Fish Tumours or Other Deformities, BUI 5 Bird or Animal Deformities or Reproductive Problems, and BUI 6 Degradation of Benthos.

How are Improvements Being Made?

1. The development of Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario (May 2008) provides information on Ontario's Provincial Sediment Quality Guidelines and outlines an approach to characterize and manage contaminated sediments that may pose a risk to aquatic organisms and to fish-eating birds and mammals.
2. The capping of Randle Reef is underway: walls were built in 2016-17, separating the most contaminated sediments (heavy metals, and PAHs) from the Harbour. In 2018-19, the structure is being filled with contaminated sediments via hydraulic dredging. By 2020 dredging will be once again permitted in the navigational channels at Randle Reef.

What Still Needs to Happen?

- The hydraulic dredging and/or management of contaminated sediments in the Harbour so that navigational dredging is no longer restricted in slips.

Where Can I Learn More?

BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard
Fletcher, Welsh, and Fletcher. 2008. Guidelines for Identifying, Assessing and Managing contaminated Sediments in Ontario: An Integrated Approach. Ministry of the Environment, Toronto, Ontario.
EC & MOE. 2007. Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediments. Environment Canada, Ontario-Region and Ministry of the Environment, Toronto, Ontario.
Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

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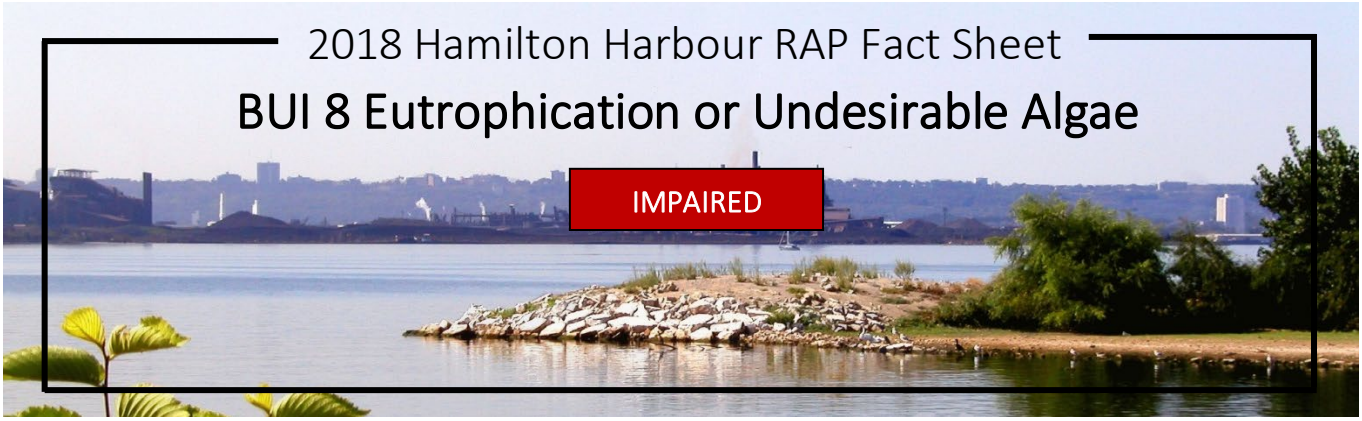
BUI 8 Eutrophication or Undesirable Algae



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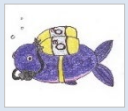
Delisting Criteria: There are no persistent adverse water quality conditions attributable to cultural eutrophication for a period of three consecutive years. Listed are the anticipated environmental conditions for Hamilton Harbour (Table A), Cootes Paradise and Grindstone Creek area (Table B), and the annual average net loading targets required by major Harbour point sources to achieve those conditions (Table C).



Tables are presented at the end of this Fact Sheet.

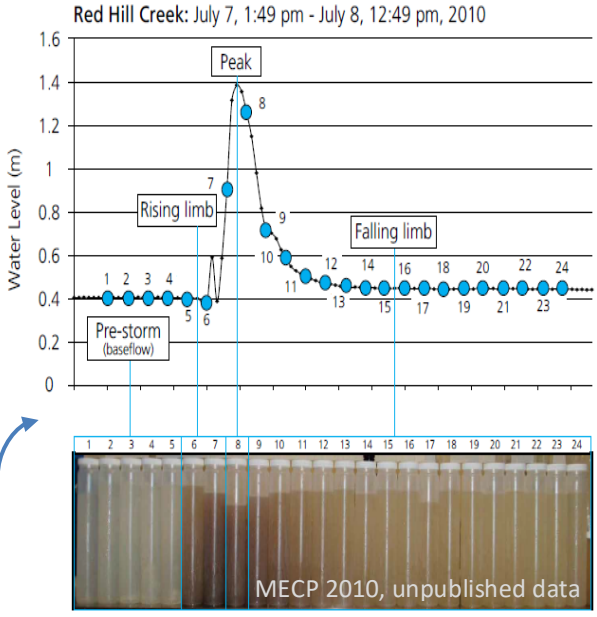
Did you know?

Eutrophication is a process which is caused when too many nutrients (primarily phosphorus) enter a body of water. These nutrients enhance the growth of algae, including some species that are undesirable and/or can potentially produce toxins.

Eutrophication causes a lack of oxygen (hypoxia) in the water as dead algae decomposes. The lack of oxygen has the potential to negatively impact fish habitat and populations, zooplankton and phytoplankton, benthos, beaches, and aesthetics, thus has ties to several of Hamilton Harbour's BUIs.

Phosphorus naturally occurs in the water, but human activity has made inputs excessive. Some sources include wastewater treatment plants, combined sewer overflows, runoff from farm fields and urban areas, poorly maintained septic systems, nurseries, and erosion of rivers during high flow events.

After the upgrades to the wastewater treatment plants are completed, the majority of phosphorus loads to the Harbour will be from the watersheds.



The impact of a major storm event on water quality can be seen visually through the relative colouring (muddy appearance) of the water from a local creek as phosphorus is often sediment bound.

What Was the Original Problem?

Phosphorus concentrations supported excessive algal growth in the Hamilton Harbour system. Excessive algae created a high oxygen demand and hypoxic bottom waters during the summer. Blooms also reduced fish habitat through shading/hypoxia, and interfered with the normal food web.

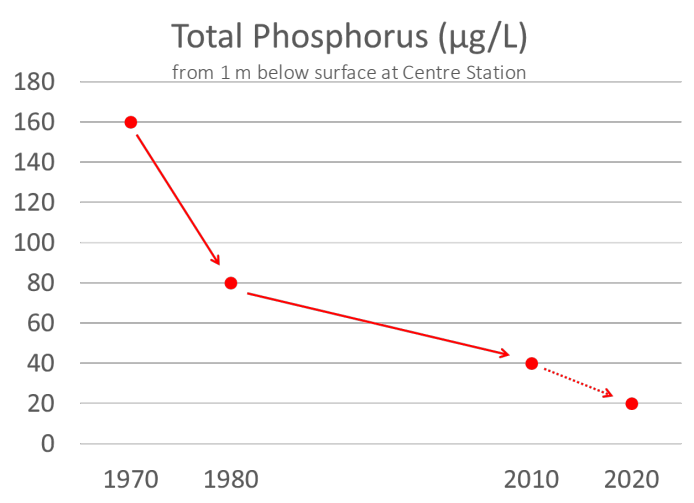
Other AOC Comparisons

AOCs use a variety of measures for evaluating this BUI. For example, Toronto and Region AOC targets watersheds and stormwater inputs. Others compare phosphorus concentrations to a local reference, or require the absence of algal blooms or oxygen stress. Blooms can also occur in non-AOC and remote areas such as Algonquin Park.

A Hiccup in the Recovery Process

Inputs of phosphorus to the Harbour have lessened through time.

However, in waterbodies that have been polluted for a long time, nutrients like phosphorus can be bound to the sediments. Phosphorus can return to the water after mixing during storms or when low oxygen conditions trigger a chemical reaction that releases it from sediment particles. This phosphorus is subsequently made available to algae again.



Dashed line represents the phosphorus reduction goal for Hamilton Harbour. Adapted from HHRAP 2018 and HHRAP 1992.

In Hamilton Harbour, an accumulation of bioavailable phosphorus has been observed in the bottom waters since the early 2000s. The cause of this change is not known, but may be related to decreases in iron entering the Harbour in combination with a lack of oxygen (Markovic et al. in prep.). Iron is a metal that binds phosphorus in the presence of oxygen. As oxygen levels decline, phosphorus that is normally bound to iron in the sediment is released. Ongoing release of phosphorus from the sediments may continue to impair water quality in Hamilton Harbour for some time.

Despite this, efforts to reduce the amount of phosphorus entering the Harbour remain critical and important to management strategies to reduce or reverse the extent of eutrophication.

Time is needed to naturally flush out this historic buildup of phosphorus from the Hamilton Harbour system and is necessary before improvements in water quality will be seen. It is an internationally recognized phenomenon and a hiccup in the recovery process.


Hamilton Conservation Authority


J. Vanden Byllaardt


City of Hamilton


Brighton Beach Bioswale


Conservation Halton

How are Improvements Being Made?

1. ArcelorMittal Dofasco and Stelco dramatically improved discharges to the Harbour.
2. City of Hamilton optimized combined sewer overflows (CSO) to reduce raw sewage overflow.
3. Halton's Skyway WWTP underwent tertiary upgrades in 2016 and is meeting phosphorus targets.
4. Woodward WWTP is undergoing tertiary upgrades with a projected completion in 2021.
5. Common Carp, which resuspend sediment and phosphorus, are declining over time.
6. Urban stormwater runoff and low impact development (LID) initiatives are reducing runoff to the Harbour (e.g., rain gardens, bioswales, Piers 5-8 redevelopment).

What Still Needs to Happen?

- Dundas WWTP upgrades and reduction of phosphorus loads to West Pond and Cootes Paradise.
- Lessen use of the CSO system following increased capacity at Woodward WWTP and connect the Aberdeen pump station to the Main/King CSO.
- Continue education and stewardship programs to decrease watershed phosphorus loads.
- Adopt strategies for capturing phosphorus from urban and rural run-off such as implementing LID and green infrastructure, and reducing erosion from construction sites.
- Continue studies of legacy phosphorus in the sediment and impact on the system's recovery time.
- Continue to develop water quality targets for Cootes Paradise and Grindstone Marshes.
- The Harbour has a relatively short residence time so some degree of water quality improvement should be realized following implementation of all management actions and flushing of legacy phosphorus; however, the actual recovery time is not known.

Where Can I Learn More?

HHRAP. 2018. Contaminant Loadings and Concentrations to Hamilton Harbour: 2008-2016 Update.

Arhonditsis et al. 2018. Uncertainty Analysis by Bayesian Inference. In: Recknagel F., Michener W. (eds) Ecological Informatics. Springer. Pg 215-249.

BARC. 2017. Towards Safe Harbour Report Card: hamiltonharbour.ca/reportcard

Hiriart-Baer et al. 2016. Hamilton Harbour over the last 25 years: Insights from a long-term comprehensive water quality monitoring program. Aquatic Ecosystem Health and Management 19(2):124-133.

Kim et al. 2016. Modelling phosphorus dynamics in Cootes Paradise marsh: Uncertainty assessment and implications for eutrophication management. Aquatic Ecosystem Health and Management 19(4):368-381.

Long et al. 2015. Estimation of tributary total phosphorus loads to Hamilton Harbour, Ontario, Canada, using a series of regression equations. Journal of Great Lakes Research 41:780-793.

Long et al. 2014 Evaluation of stormwater and snowmelt inputs, land use and seasonality on nutrient dynamics in the watersheds of Hamilton Harbour, Ontario, Canada. Journal of Great Lakes Research 40:964-979.

Gudimov et al. 2011. Predicting the response of Hamilton Harbour to the nutrient loading reductions: A modelling analysis of the "ecological unknowns" Journal of Great Lakes Research. 37: 494-506.

Gudimov et al. 2010. Eutrophication risk assessment in Hamilton Harbour: System analysis and evaluation of nutrient loading scenarios. Journal of Great Lakes Research 36(3):520-539.

Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

TABLE A: Environmental Conditions – Hamilton Harbour

	Final Goals	Compliance Criteria
Phosphorus concentration	≤ 20 µg/L	15 of 17 epilimnetic integrated samples analyzed weekly* at the centre station from June to September are at or better than the targeted goal * Although weekly sampling is recommended at only one location, there will be periodic sampling of a larger number of locations Harbour-wide to confirm representativeness of the centre station.
Chlorophyll a concentration	≤ 10 µg/L	
Secchi disc transparency	≥ 2.5 m	
Un-ionized Ammonia concentration	≤ 0.02 mg/L	Biweekly epilimnetic integrated samples from ice-out to the end of May, and weekly epilimnetic integrated samples in June at the centre station do not exceed the targeted goal
Minimum Dissolved Oxygen concentration	≥ 6 ppm; but ≥ 3 ppm during allowable exceedence period	During June to September inclusive, the water column at centre station should have a minimum 4 metre thick layer of water with a temperature <20°C and a DO >6 mg/L. Compliance with this goal is to occur in at least 15 of 17 profiles measured weekly, and during any exceedence episode, the water column at centre station should still have a minimum 2 metre thick layer of water with a temperature <20°C and a DO >3 mg/L.

TABLE B: Environmental Conditions – Cootes Paradise and Grindstone Marsh Area

	Cootes Paradise	Grindstone Marsh Area
Phosphorus concentration	60-70 *µg/L**	60-70 *µg/L**
Chlorophyll a concentration	*20 µg/L**	*20 µg/L**
Secchi disc transparency	*1.5 m**	*1 m**
Un-ionized Ammonia concentration	< 0.02 mg/L	< 0.02 mg/L
Minimum Dissolved Oxygen concentration	*> 5 ppm**	*> 5 ppm**
Submergent/ emergent aquatic plant area	*230 ha*	*40 ha*
Suspended solids	*25 ppm**	*25 ppm**

*A technical team is working to develop final goals.

** Effluent concentration calculated as a 6-month average (May – October and November – April, inclusive).

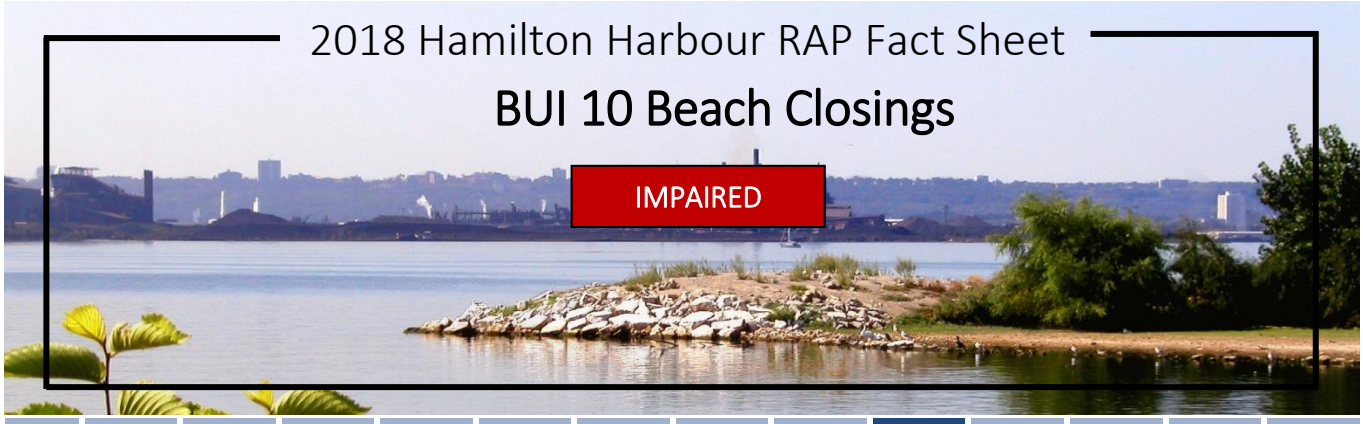
TABLE C: Net Loading Targets – Annual Average (kg/day)

	Phosphorus	Ammonia	Suspended Solids
Hamilton Global Targets	**82**	**1048**	**2193**
Woodward WWTP (secondary & tertiary effluent)	(72)	(977)	(1227)
CSOs	(10)	(72)	(966)
Dundas WWTP (King)	0.05 mg/l**	TBD *	TBD *
Skyway WWTP	17	115	280
Streams ***	-	-	-
Industry (combined)	-	270	-
U. S. Steel Canada (Stelco)	-	-	1500
ArcelorMittal Dofasco	-	-	1500

*** Problem areas in the watershed (hotspots) being identified and targeted instead of setting stream targets.

2018 Hamilton Harbour RAP Fact Sheet

BUI 10 Beach Closings



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Delisting Criteria: Hamilton Harbour public beaches (Bayfront Park and Pier 4 Park) meet the provincial beach management protocol 80% or more of the swimming season for a minimum of three consecutive years.*

*The provincial threshold for safe swimming changed from 100 to 200 CFUs/100 ml of *E. coli* in 2018.

Note: A delisting criteria update to remove park names and add risk management & communication is being proposed in 2019 to bring it in line with other AOCs, like Toronto and Region.

Did you know?

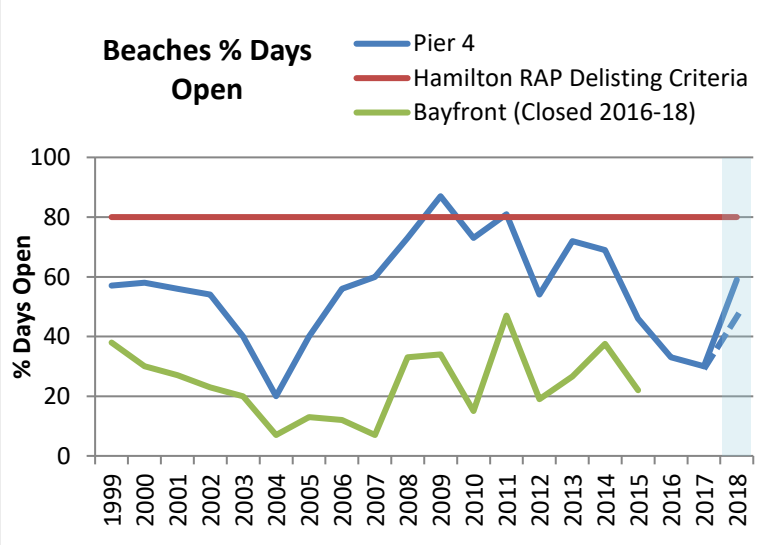
Beach closings can be due to high levels of bacteria (*E. coli*) or toxin-producing algal blooms. Hamilton Public Health Services tests the water quality at beaches.

Toxic algal blooms are an increasing problem for beach closings. Blooms generate offshore, circulate towards the beaches, and generally last throughout the swimming season.


J. Vanden Byllaardt

Pier 4 Park Beach was open in 2018. Enhanced bird and beach management improved the water quality. Bayfront Park Beach remains closed as a bathing beach.

In 2018, Pier 4 Park Beach was open 59% of the swimming season at the new threshold of 200 CFUs/100 ml (or 48% had the threshold remained at 100 CFUs/100 ml, see dotted line). In the absence of the large bloom of 2018, the beach could have been open 85% of the season.



City of Hamilton

What Was the Original Problem?

A 1930 Hamilton Harbour Commissioners by-law prohibited swimming due to health concerns about *E. coli* from raw sewage entering the water. Vast improvements were made to address human sewage and in 1995 the two man-made beaches were open for public swimming. New technologies determined that the current *E. coli* related closures are related to gulls and waterfowl (Edge & Hill 2007). Knowing the cause of beach closings is important in determining the remediation strategies to reduce the human health risk.

Other AOC Comparisons

The majority of AOCs have delisting criteria specifying *E. coli* related closures only and must show that exceedances are rare and associated with significant rainfall events (e.g., Niagara River, Toronto and Region). A few AOCs specify that an exceedance must be linked to human-based sources of pollution, not natural sources such as waterfowl (e.g., Bay of Quinte, St. Mary's River). Some must meet the criteria for a longer period of time (3-5 years) or have pollution control plans actively implemented.

How are Improvements Being Made?

1. Combined sewer overflow (CSO) tanks built in West Hamilton reduce and/or prevent raw sewage from entering the Harbour.
2. "Don't Feed the Birds" signage discourage the public from feeding wildlife.
3. Beach grooming, deterrent vegetation, buoys, fencing and bird scaring are strategies used by the City of Hamilton to deter birds at Pier 4 Park Beach (since 2005) and Bayfront Park Beach (2010).
4. A 2017 AECOM study looked into several options for improving Bayfront Beach for swimming.

What Still Needs to Happen?

- Bird management and beach grooming are ongoing at Pier 4 Park Beach. Control of surface water run-off from nearby paved surfaces is under consideration for Pier 4 Park Beach.
- In 2019, new beach sand will be installed at Pier 4 Park Beach.
- By 2022, upgrades to Woodward Wastewater Treatment Plant will reduce the supply of nutrients that promote nuisance algae in the Harbour and will divert additional stormwater flows that may also contribute nutrients that impact the beaches
- Urban and rural non-point source actions are being promoted with the community stakeholders and municipalities to address nutrients that are coming in through stormwater runoff.
- Delisting Criteria to be updated to include risk management and risk communication criteria.

Where Can I Learn More?

City of Hamilton website: hamilton.ca/beaches

Milne, Gilpin, and Fortuna. 2017. A review of Hamilton Harbour Beaches: Towards delisting 2020, successes and challenges. Aquatic Ecosystem Health & Management 20 (3):278-284.

Edge and Hill. 2007. Multiple lines of evidence to identify the sources of fecal pollution at a freshwater beach in Hamilton Harbour, Lake Ontario. Water Research. 41: 3585-3594.

Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

2018 Hamilton Harbour RAP Fact Sheet

BUI 11 Degradation of Aesthetics

i ii iii iv v vi vii viii ix x **xi** xii xiii xiv

Delisting Criteria: The waters are free of any substance due to human activity which produces a persistent objectionable deposit, unnatural colour or turbidity, unnatural odour (e.g. oil slick, surface scum, algae) for a period of three consecutive years.

Note: A change in the delisting criteria to remove the term algae will be proposed in 2019. Algae is already assessed under BUI 8 Eutrophication or Undesirable Algae.

Did you know?

The Harbour is monitored for four aesthetics indicators: clarity, colour, odour, and debris.

An aesthetics monitoring program began in 2012 at the centre of the Harbour and the Fishway. In 2018 it expanded to include the northeastern shoreline, La Salle Park, Pier 8, and the Waterfront Trail.

The Harbour does not have the same severe persistent aesthetic issues as in the past, such as oil slicks, although incidents affecting aesthetics happen occasionally.


J. Vanden Byllaardt

K. O'Connor

Algal blooms last weeks to months and affect clarity and colour of Hamilton Harbour's water. In 2018 vacuum trucks removed floating masses of decaying algae in the West Harbour.

Oil sheens have been reported in Strathearne Slip; one of the source areas has been identified. An oily Canada Goose was found in 2018; however, the source was not located in the Harbour.

Localized litter and debris accumulates in marina corners, but this issue is not uncommon in urban areas and non-AOC marinas. Litter is removed by the City of Hamilton and businesses reliant on recreation.

Rain events can flush unnatural debris (e.g. plastics) from watersheds and storm sewers; while large rain events can occasionally result in combined sewer overflows.

What Was the Original Problem?

Aesthetics was deemed impaired in 1992 with the causes listed as occasional oil sheens, algal blooms, objectionable turbidity, floating scum, debris, and putrid material (HHRAP 1992). "Algae" was added into the delisting objective in a 2012 update.


ECCC, 1967


Hamilton Spectator, 1953

Other AOC Comparisons

Most AOC targets are similar to Hamilton Harbour's with two exceptions: Hamilton Harbour is the only AOC that includes algae directly in the delisting criteria (i.e., it overlaps with the Eutrophication or Undesirable Algae BUI) and has a qualifier that the conditions must be maintained for three consecutive years. The St. Clair River AOC dropped the two year qualifier to avoid a single event causing an issue. Some AOCs rely on lack of public complaints as proof of delisting. The Hamilton Harbour aesthetics monitoring follows the quantitative approach of the Toronto and Region AOC.

How are Improvements Being Made?

1. Randle Reef Remediation project is underway to cap and contain the coal tar pollution and eliminate the black tar-like "blobs" reported floating on the nearby surface in the early 2000s. Navigational restrictions were put in place as well to restrict boat traffic and minimize stirring up the material from the sediment.
2. Improvements to wastewater treatment plants (WWTPs) and real-time control of combined sewer overflows (CSOs) improves aesthetics in the Harbour through reduction of nutrients that stimulate algae growth and suspended solids that affect clarity. Skyway WWTP upgraded to tertiary treatment in 2016 and Woodward WWTP upgrades are underway.
3. Spill regulations and industrial pollution prevention plans (e.g., Municipal-Industrial Strategy for Abatement, MISA) helped dramatically improved industrial discharges to Hamilton Harbour.
4. Yellow Fish Road™ teaches "Only Rain Down the Drain" helping to prevent oil/materials pollution.
5. Localized debris in shoreline corners is removed by the City of Hamilton and businesses reliant on recreation/tourism.
6. The City of Hamilton's "Own Your Throne" campaign is educating the public on proper disposal of non-flushable items (e.g., tampon applicators, needles, wipes) that can otherwise end up in Hamilton Harbour through the combined sewer system.

What Still Needs to Happen?

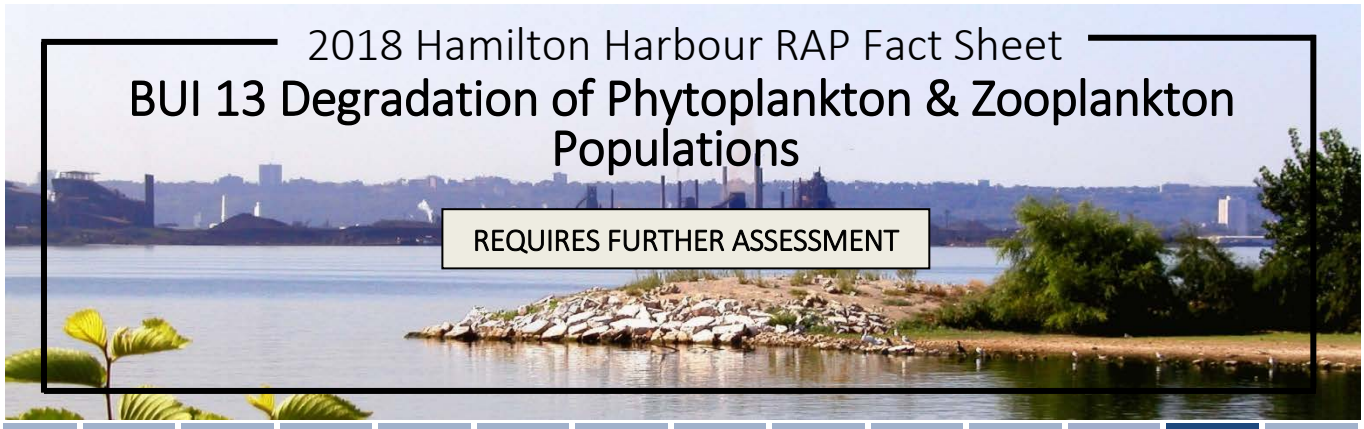
- A status update, including a public perception survey was started in 2018.
- The Remedial Action Plan will make a recommendation regarding the inclusion of algae in the delisting criteria.

Where Can I Learn More?

City of Hamilton. 2018. Flushables – Own Your Throne: hamilton.ca/home-property-and-development/water-sewer/flushables-own-your-throne
BARC. 2018. Yellow Fish Road: hamiltonharbour.ca/yellow_fish_road
BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard
Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

2018 Hamilton Harbour RAP Fact Sheet

BUI 13 Degradation of Phytoplankton & Zooplankton Populations



Delisting Criteria: When phytoplankton and zooplankton community structure does not significantly diverge from unimpacted control sites of comparable physical and chemical characteristics. Further in the absence of community structure data, this use will be considered restored when phytoplankton and zooplankton bioassays confirm no significant toxicity in ambient waters.

Note: At the 2012 Stakeholder Forum an update to the criteria was deferred. A 2018 status update recommends an 'Impaired' status (Currie et al. 2018).

Did you know? This BUI differs from the Eutrophication and Undesirable Algae BUI because it looks at the interactions of organisms (i.e., food webs), rather than algae alone.

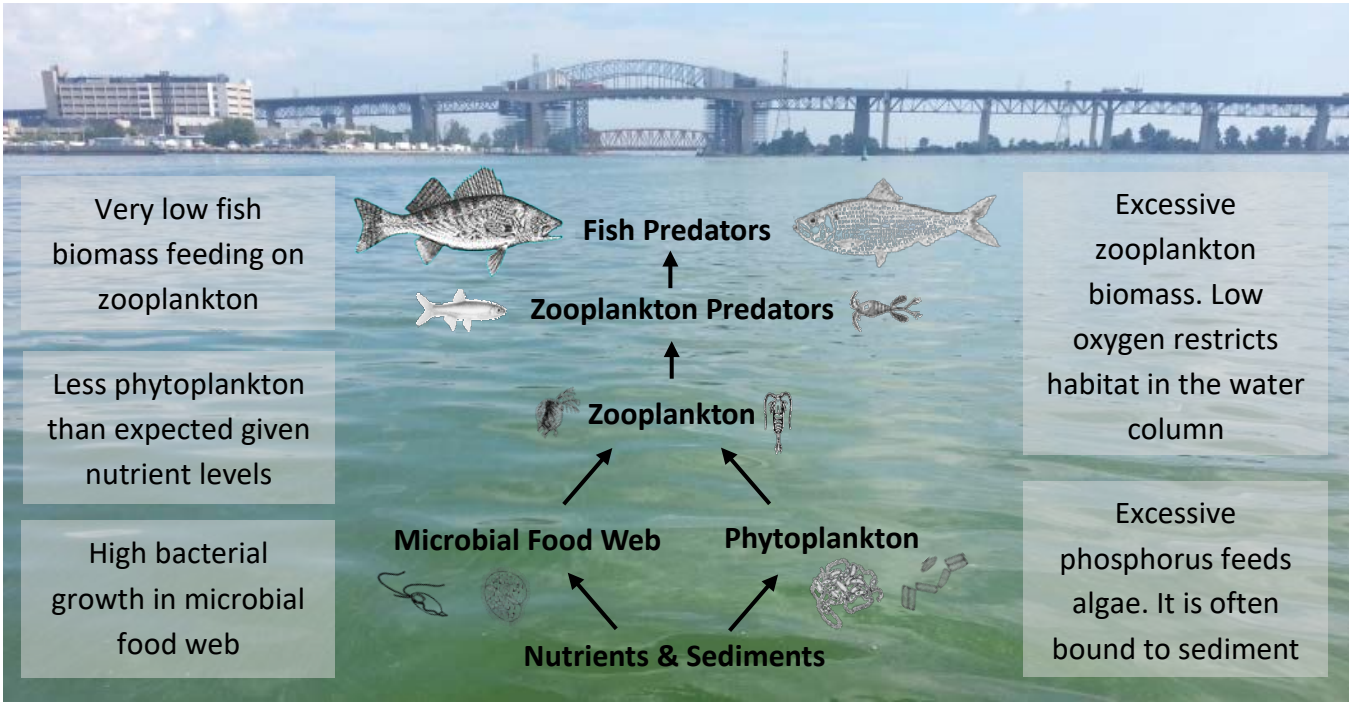
Phytoplankton are algae that live in the water column and thrive on phosphorus.

The microbial food web is all the bacteria at the bottom of the food chain.

Zooplankton are microscopic animals that eat algae & microbes.

Fish and larger predators eat zooplankton in the Harbour.

An impaired status is recommended because the Harbour has a disrupted community structure:



*Biomass is the total mass of organisms in an area.

What Was the Original Problem?

Phosphorous from sewage treatment plants and industrial contaminants were creating chemically driven, unhealthy populations. Hamilton Harbour phytoplankton and zooplankton communities were described as being reflective of a eutrophic system due to their high numbers, high level of activity, and the associated low oxygen conditions of the Harbour.

Other AOC Comparisons

The Bay of Quinte AOC and Toronto and Region AOC were assessed in the same manner. The Bay of Quinte AOC is the only impaired AOC. It has adopted a 40+ year labour intensive (and expensive) method of long-term, bi-weekly monitoring of phytoplankton and zooplankton communities. The Niagara River AOC is proposing a status change from 'requires further assessment' to 'unimpaired' based on 2014 June - October monthly sampling of six monitoring sites along the Niagara River.

How are Improvements Being Made?

1. Various projects aim to move the Harbour from a eutrophic state towards a mesotrophic state (WWTP upgrades, CSO containment, improved industrial discharges, watershed stewardship, etc.). See BUI 8 Eutrophication and Undesirable Algae Fact Sheet for more information.
2. The lower food web in the Harbour is periodically monitored (May – Oct., 2002- 2016) and assessed by Fisheries and Oceans Canada to determine the baseline status and progress towards delisting. The Ministry of Environment, Conservation and Parks has also conducted sampling.
3. The Ministry of Natural Resources and Forestry began stocking a top predator, Walleye, in the Harbour in 2012 and continues to stock every other year beginning in 2016.

What Still Needs to Happen?

- Continued stewardship to reduce phosphorus inputs to the Harbour from the watershed.
- Assessment of lower food web communities and oxygen conditions after Woodward WWTP upgrades are complete.
- Continued stocking of native predators. Potentially consider other fishes in addition to Walleye.
- The Remedial Action Plan will engage the public and Indigenous communities on the recommended status change.

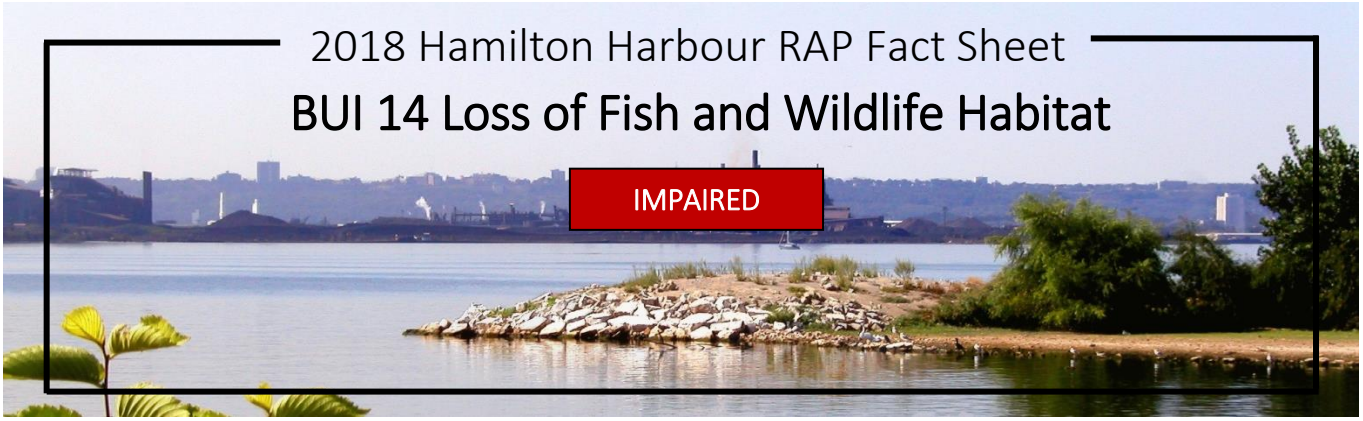
Where Can I Learn More?

Currie et al. 2018. Status Assessment for Hamilton Harbour Area of Concern BUI 13: Degradation of phytoplankton and zooplankton populations using a functional food web approach. Report to the Hamilton Harbour RAP.
BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard
Bowen and Currie. 2017. Elevated zooplankton production in a eutrophic Lake Ontario embayment: Hamilton Harbour 2002-2014. Aquatic Ecosystem Health & Management 20(3):230-241.
Munawar and Fitzpatrick. 2017. Microbial - Planktonic food-web dynamics of a eutrophic embayment of Lake Ontario: Hamilton Harbour. Aquatic Ecosystem Health & Management 20(3):214-229.
Munawar et al. 2017. Phytoplankton ecology of a culturally eutrophic embayment: Hamilton Harbour, Lake Ontario. Aquatic Ecosystem Health & Management 20(3): 201-213.
Munawar and Fitzpatrick. 2011. The application of Vollenweider's eutrophication models for assessing ecosystem health: Hamilton Harbour (Lake Ontario) example. Aquatic Ecosystem Health & Management 14(2):204-208.
Dermott et al. 2007. Assessment of lower food web in Hamilton Harbour, Lake Ontario, 2002 -2004. Canadian Technical Reports of Fisheries and Aquatic Science. 2729.

Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca

2018 Hamilton Harbour RAP Fact Sheet

BUI 14 Loss of Fish and Wildlife Habitat



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Delisting Criteria:

1. Emergent and submergent aquatic plants measure ≥ 500 hectares (230 ha in Hamilton Harbour + Windermere Basin and 270 ha in Cootes Paradise + Grindstone Creek Marshes*).
2. Improved littoral shore (0-5 m depth) measures ≥ 15 kilometres.
3. Wildlife habitat measures ≥ 300 hectares.
4. Colonial nesting waterbird island habitat measures ≥ 1.5 hectares.
5. The quality and quantity of fish and wildlife habitat in Hamilton Harbour (including Windermere Basin, Cootes Paradise, and Grindstone Creek Marshes) improves to support the fish and wildlife populations identified in Beneficial Use iii.

* Breakdown: Cootes Paradise = 230 ha, and Grindstone Creek = 40 ha

Did you know?

Habitat includes the physical, chemical, and biological environment in which an animal lives. For fish, this includes dissolved oxygen, water temperature, aquatic plants, food, and substrate (e.g., rocks). For colonial waterbirds nesting in Hamilton Harbour, this includes adequate space to nest.

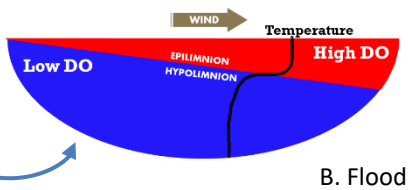
The amount and quality of habitat has improved in some areas of the Harbour; however, more aquatic vegetation is needed in Grindstone and Cootes Paradise Marshes in order to delist.

Lake Ontario water level regulation impacts regeneration of marsh vegetation especially under high water conditions like in 2017.

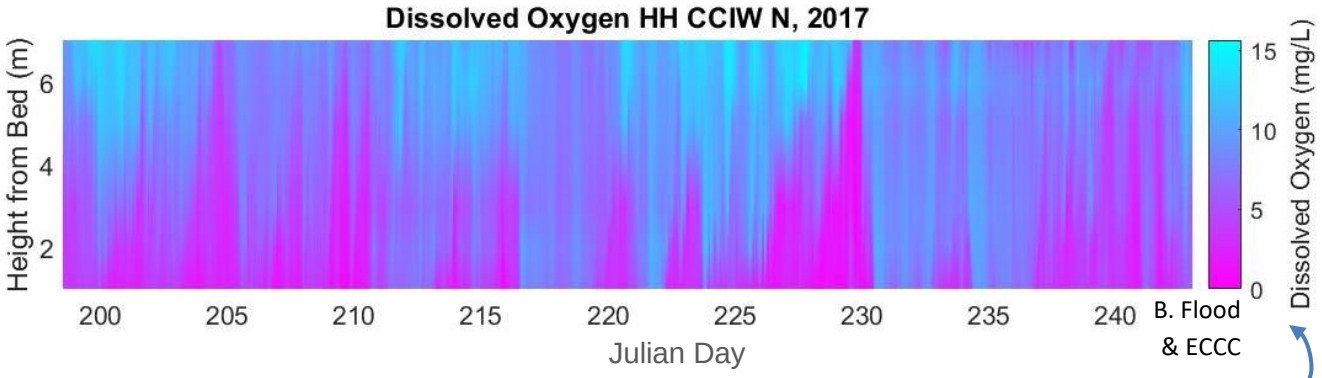
TOTAL VEGETATION (HA)

YEAR	Cootes Paradise	Grindstone Marsh
2017	79	20
2016	135	21
2015	131	20
2014	106	19
2013	69	15
2012	49	17

In the Hamilton Harbour system, a low dissolved oxygen (DO) or hypoxic layer that develops throughout the summer restricts the amount and type of habitat available to fish seasonally. Sloshing of this layer due to wind (seiche) results in upwelling of poor quality water in some areas.

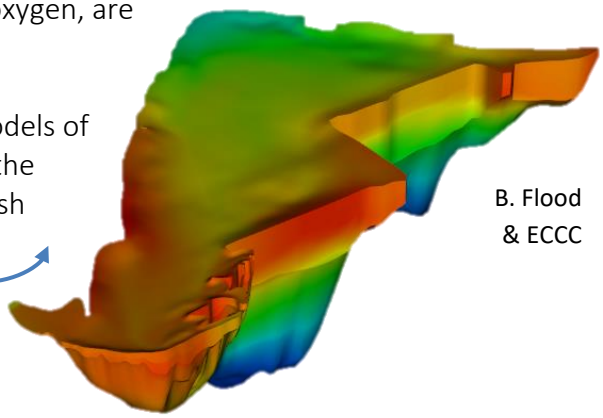


B. Flood



B. Flood & ECCC

Habitat suitability analysis once suggested that the north shore would be preferred by fish. Recent evidence shows this area does not meet expectations (Boston et. al 2016). Rapid fluctuations of dissolved oxygen, including time periods with low oxygen, are thought to limit fish usage of the north shore.



B. Flood & ECCC

The Acoustic Telemetry Project in tandem with 3D models of temperature and dissolved oxygen levels are helping the RAP understand the locations where installations of fish habitat would best support fish populations (Fisheries and Oceans Canada, University of Toronto). Preliminary analysis suggests that the West Harbour is one of the preferred locations by fish, especially during low oxygen conditions following an algal bloom. In the 3D model pictured here, blue represents cold, oxygen-poor waters while red represents warm, oxygen-rich waters.

What Was the Original Problem?

Cootes Paradise Marsh, Grindstone Creek Marsh, and the littoral shore of Hamilton Harbour were severely degraded. 70% of wetland habitat in Hamilton Harbour had been lost to infilling for industry and the port. Hamilton Harbour had lost most of its underwater reefs and shoals used by fish for spawning and nursery habitat. Colonial waterbirds resided on port lands that were contaminated and slated for development.

Contaminated sediment and low oxygen conditions of Hamilton Harbour limited both the diversity and abundance of benthic organisns (fish food) and resident fish, as well as prevented coldwater Lake Ontario fishes from using historically important habitat in Hamilton Harbour.

Other AOC Comparisons

This tends to be the most detailed of the BUIs for other AOCs with many specifically outlining a certain quantity and quality of hectares of habitat desired and/or connectivity.

How are Improvements Being Made?

Fish Habitat Creation:

a. Fish habitat has been added or improved in 8 locations in the Harbour for existing spawners (e.g., Walleye, Pike, Bass) and to promote the return of Lake Herring and Lake Whitefish.

b. Annual marsh plantings for Cootes Paradise and Grindstone Creek Marshes as well as protection of plantings from nuisance wildlife browsing promote diverse and quality habitat.
c. Nuisance and invasive species management (e.g., *Phragmites*) at Cootes Paradise and Grindstone Creek Marshes and in Windermere Wetland to ensure quality of recovered wetland habitat.
d. Sherman Inlet was restored to its natural shape. The Hamilton Port Authority is preserving the Inlet as natural space in perpetuity.
e. The exclusion of large Common Carp by the Fishway promotes aquatic plant reestablishment in Cootes Paradise.

f. Examples of watershed projects that are helping to improve conditions for Hamilton Harbour fish include: enhanced stream morphology (e.g., Hidden Valley Park), addition of riparian habitat (e.g., McMarsh – McMaster University), and the creation of spawning habitat in Lower Spencer Creek (Hamilton Conservation Authority).
g. Improvements to inflowing water quality from WWTP upgrades, fine-tuning combined sewer overflow (CSO) operations, eliminating cross-connections, and Low Impact Development installations. See BUI viii Eutrophication or Undesirable Algae Fact Sheet for more information.

<u>Colonial Waterbird Habitat Creation:</u>

a. Islands were constructed north of the Canada Centre for Inland Waters and in Windermere Basin. See BUI 3b Degradation of Wildlife Populations for more information on the bird island management.

<u>Research and Monitoring to Resolve Habitat Issues:</u>

a. Fish habitat in terms of temperature, dissolved oxygen, clarity, turbidity, and submerged aquatic vegetation (SAV) has been measured and assessed by Fisheries and Oceans Canada (DFO) since 1992. Royal Botanical Gardens assesses habitat in Cootes Paradise and Grindstone Creek Marshes.
b. Dissolved oxygen modelling by the University of Toronto determines the most suitable locations for fish habitat in the Harbour based on the extent and movement of the hypoxic layer (low oxygen) and can inform decisions on habitat placement.
c. The Acoustic Telemetry project led by DFO compliments the dissolved oxygen study by confirming where fish species (e.g., stocked Walleye) are accessing habitat during seasonal movements and low oxygen conditions.

What Still Needs to Happen?

- Restoration of aquatic vegetation needs to continue to occur in Cootes Paradise and Grindstone Creek Marshes (Carroll's Bay).
- Fish habitat will be installed along Piers 5-8 during shoreline reconstruction.

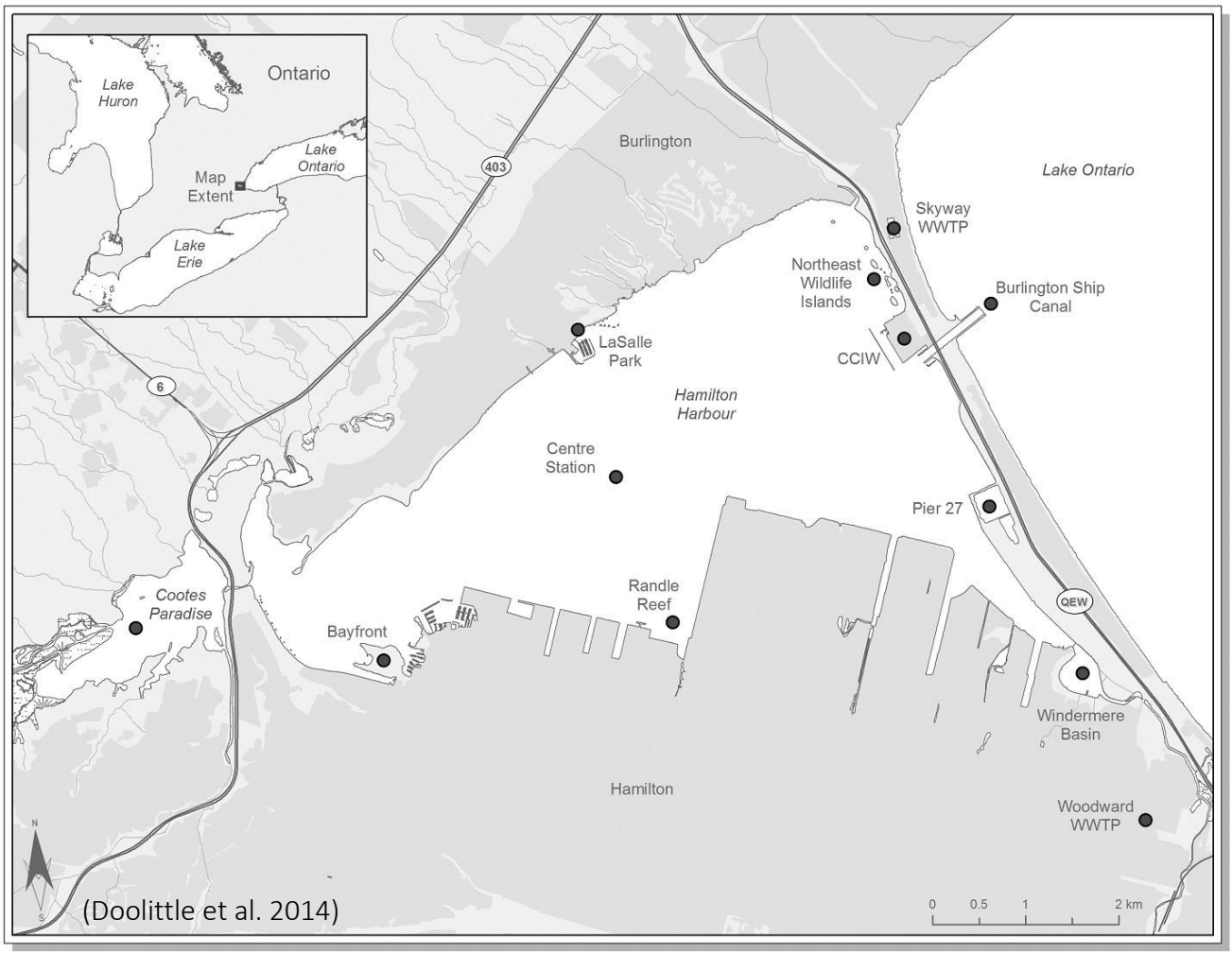
- Improvements in water quality are required for submerged aquatic vegetation to establish. Planned tertiary upgrades at the Woodward WWTP, along with improvements in urban and rural runoff, will substantially reduce phosphorus and suspended solids loadings to the Harbour. Upgrades to the Dundas WWTP will be undertaken in the coming years (outlets to West Pond in Cootes Paradise). See BUI 8 Eutrophication or Undesirable Algae Fact Sheet for more information.
- Research on upwelling of hypoxic waters, as well as refuges for fish (e.g., Walleye, Pike) throughout the seasons is needed to inform habitat restoration/management efforts and is being provided by the Dissolved Oxygen Modelling and Acoustic Telemetry Projects.
- Additional improvements to aquatic habitat will result from remedial actions related to toxic contaminants, see BUI 6 Degradation of Benthos Fact Sheet for more information.
- Management of invasive and nuisance species (e.g. Common Carp, Mute Swans, Canada Geese) to prevent the destruction of new and existing vegetation in the marsh areas.
- Management of invasive plants (e.g., *Phragmites*) to ensure quality of recovered habitat.

Continued restoration of aquatic vegetation to the entire Cootes Paradise and Grindstone Creek Marshes is the prime ingredient for improving the quantity and quality of habitat and delisting Hamilton Harbour as an Area of Concern.

- Reports outlining the current status of the habitat delisting criteria goals and habitat suitability.

Where Can I Learn More?

BARC. 2017. Toward Safe Harbour Report Card: hamiltonharbour.ca/reportcard
Bowlby et al. 2016. Evaluation of the Remedial Action Plan goal for dissolved oxygen in Hamilton Harbour: A goal based on habitat requirements for Cisco. Aquatic Ecosystem Health and Management 20(3):242-251.
Leisti et al. 2016. Aquatic vegetation trends from 1992 to 2012 in Hamilton Harbour and Cootes Paradise, Lake Ontario. Aquatic Ecosystem Health and Management 19(2):219-229.
Doolittle et al. 2010. Spatial Framework for Storage and Analyses of Fish Habitat Data in Great Lakes' Areas of Concern: Hamilton Harbour Geodatabase Case Study.
HHRAP. Fish and Wildlife Habitat Restoration Project Annual Reports (1995-2007 series)
Most references can be provided as a PDF upon request. Visit hamiltonharbour.ca



(Doolittle et al. 2014)

HAMILTON HARBOUR

REMEDIAL ACTION PLAN