LAKE ONTARIO CANADIAN NEARSHORE Assessment

2019 HIGHLIGHTS REPORT

Canada

Cat. No.: En164-71/3-2019-1E-PDF
ISBN: 978-0-660-39916-4
EC21052

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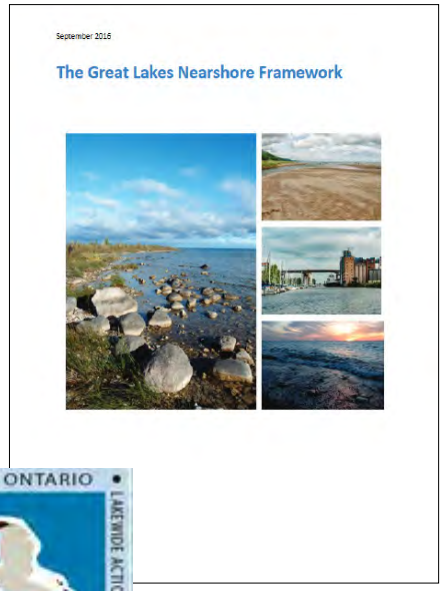


This document supports Canadian commitments in the 2012 Great Lakes Water Quality Agreement.

The Great Lakes Water Quality Agreement, Environment and Climate Change Canada and the United States Environmental Protection Agency, 2012
https://binational.net/wp-content/uploads/2014/05/1094_Canada-USA-GLWQA-_e.pdf

The Great Lakes Nearshore Framework, Environment and Climate Change Canada and the United States Environmental Protection Agency, 2016
https://binational.net/wp-content/uploads/2016/09/Nearshore-Framework-EN.pdf

Many thanks go to the individuals and agencies who provided data, advice and reviews of this first nearshore assessment of Lake Ontario, Niagara River and St. Lawrence River. This assessment would not be possible without the contributions from: Mary Thorburn, Satyendra Bhavsar, and Ashleigh Boucher (the Ontario Ministry of Environment, Conservation and Parks); Dr. Lee Grapentine (ECCC); Gabrielle Parent-Doliner (Swim Drink Fish Canada); Richard Stumpf (National Oceanic and Atmospheric Administration); Dr. R. Shuchman, (Michigan Tech Research Institute); Peter Zuzek and Kevin Grootendorst (Zuzek Inc.) and ECCC program staff. Supporting Documents and Data Sources are listed at the end of this document.

OVERALL ASSESSMENT OF THE STATE OF NEARSHORE WATERS Resources

Lake Ontario Canadian Nearshore Assessment, 2019 Results.
Cat. No.: En164-71/3-2019E-PDF; ISBN: 978-0-660-36631-9

Canadian Great Lakes Nearshore Assessment, Detailed Methodology.
Cat. No.: En164-71/1-2021E-PDF; ISBN: 978-0-660-39154-0

Assessment data available from Government of Canada
Open Data: https://open.Canada.ca/en/open-data

The Great Lakes Nearshore Framework

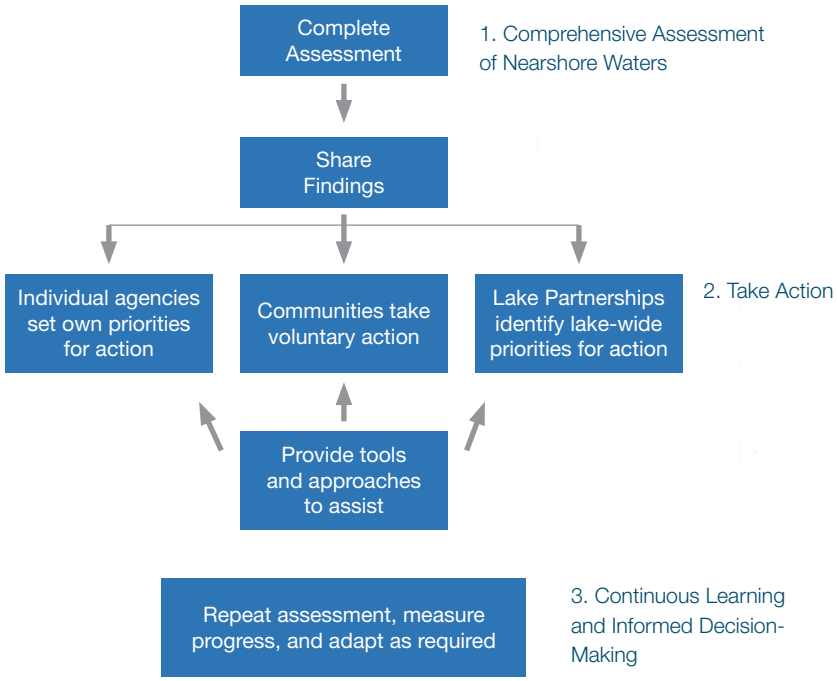
The Nearshore Waters

The waters of the Great Lakes, together with their 16,000 kilometres of coastline, connecting river systems and watersheds are globally significant ecosystems. Nearshore areas are a key priority for restoration and protection because they are the source of drinking water for most communities within the basin, are the areas of the lakes where most human recreation (e.g., swimming, boating, fishing, wildlife viewing) occurs, and are the critical ecological link between watersheds and the open waters of the Great Lakes.

About the Framework

As envisioned by the updated Great Lakes Water Quality Agreement (GLWQA) of 2012, Canada is implementing a "Nearshore Framework" to provide a cumulative effects assessment of nearshore waters; share the information from the assessment; identify areas that would benefit from protection, restoration or prevention activities; and identify causes of impairment and threats. Data used in the assessment came from existing monitoring programs, from a range of partners, and varied in type, format and resolution. Key considerations in the selection of data were the spatial and temporal resolution, availability of the data, and amount of processing required. Using a weight of evidence approach, disparate data that traditionally has been evaluated separately was integrated into the first cumulative assessment of the Lake Ontario Canadian Nearshore. Through the sharing of these assessment results and with added detailed local information from communities and organizations, users can set their own priorities and take action. This document describes the findings of the Lake Ontario, Niagara and St. Lawrence River assessment.

Nearshore Framework Components



Long Term Outcomes:

- Improved water quality and ecosystem health at both the local and lake-wide scale;
- Improved and more resilient structure and function of nearshore ecosystems;
- Reduced cumulative impacts of human activities in nearshore areas;
- Decrease in unsustainable uses of nearshore waters;
- Increased provision of ecosystem services from Great Lakes waters; and
- Increased public and partner awareness of the value, stewardship of, and investment in the Great Lakes.

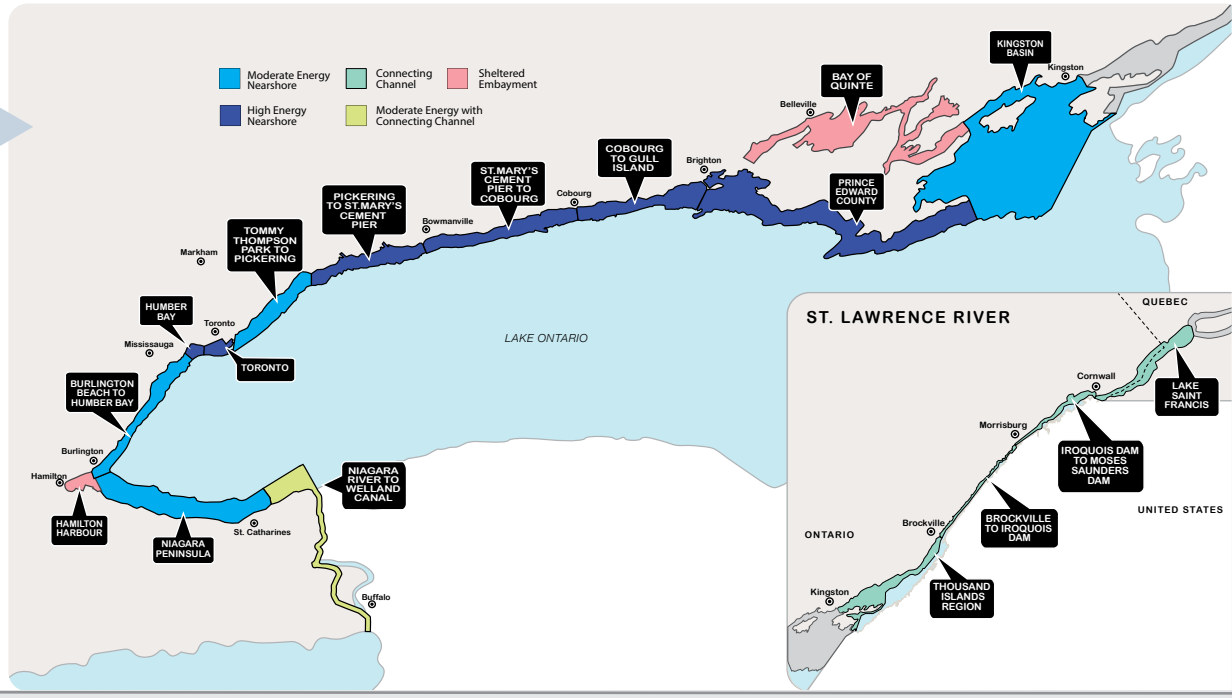
Canadian Assessment Methodology

1

The nearshore was delineated into distinct Regional Units using physical characteristics such as bathymetry (up to 30 m depth), bottom substrate type, wave energy and littoral cells. The units were then classified based on their overall ecological type. These Regional Units provide an ecologically relevant scale for the assessment.

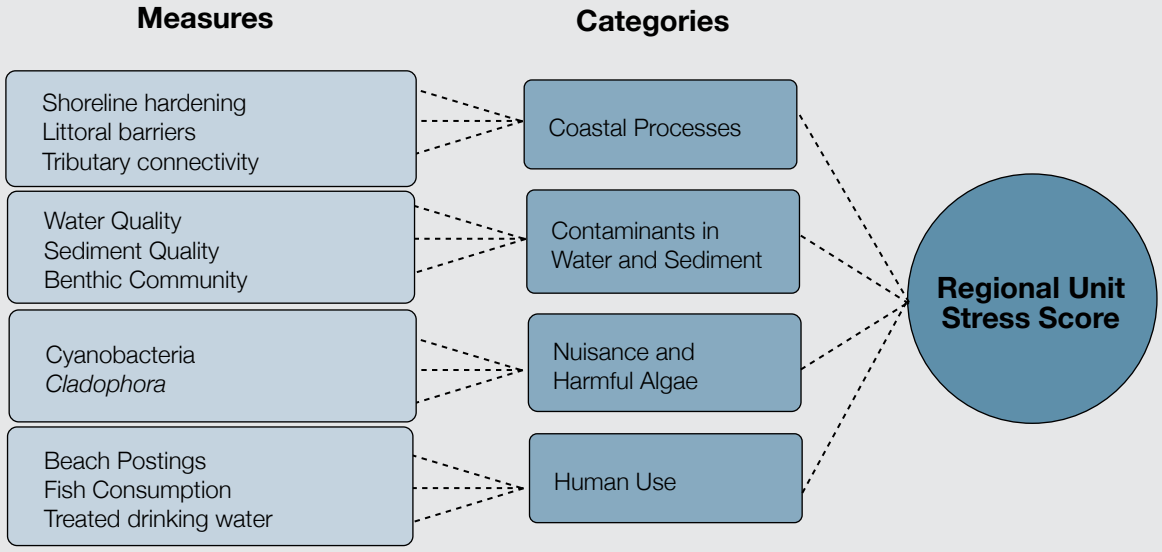
2

The assessment consists of 11 individual measures grouped into four categories that were developed with consideration of the GLWQA General Objectives. Each measure was evaluated to be of low, moderate or high stress based on documented ecological thresholds or best professional judgement, and then grouped into an overall cumulative assessment for each Regional Unit. A special status was assigned to Regional Units where there is concern to human and ecosystem health due to Cyanobacteria.

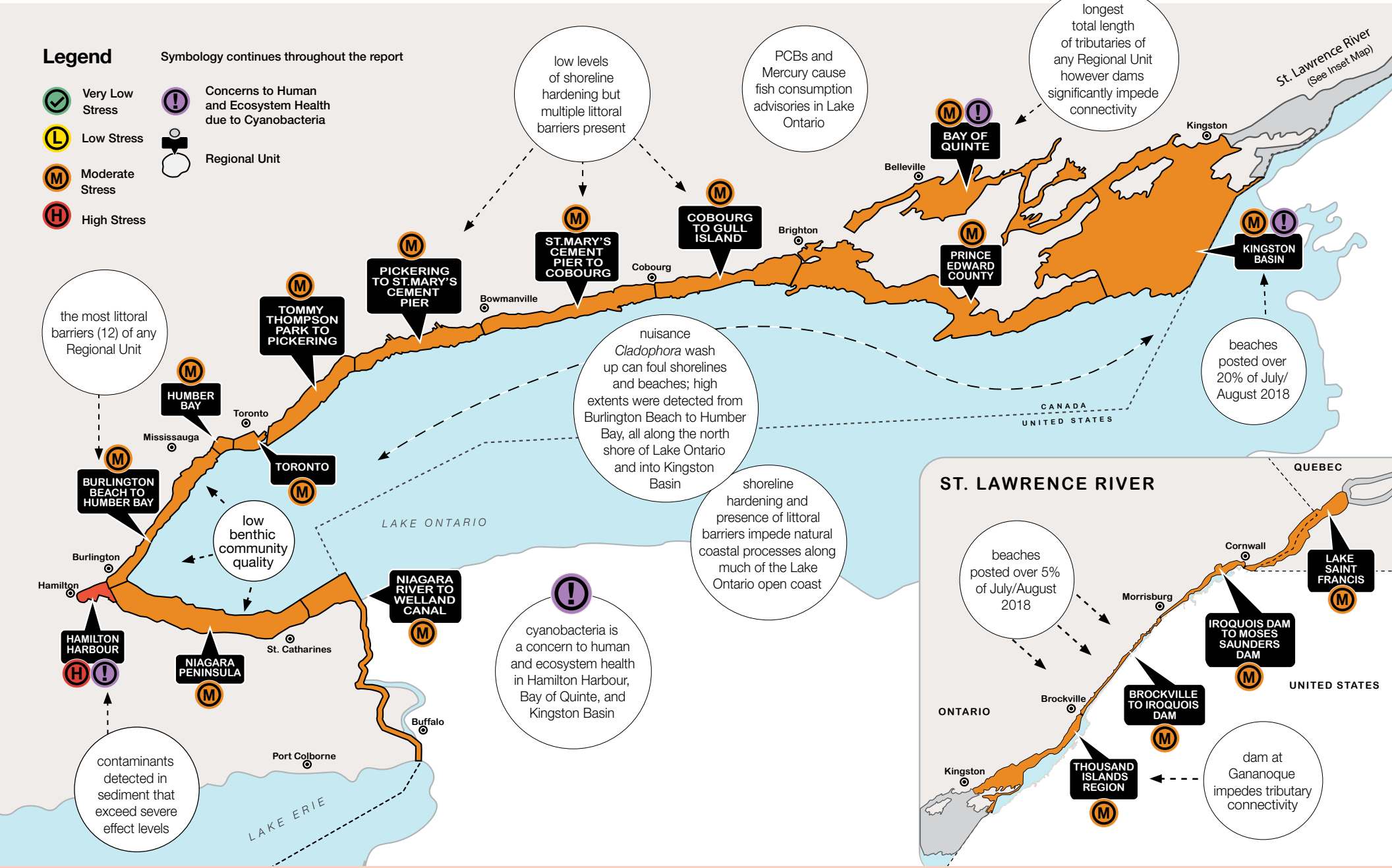


General Objectives state the waters of the Great Lakes should...

- Support healthy & productive habitats to sustain native species
  Be free from negative impacts on chemical, physical or biological integrity
- Be free from pollutants harmful to humans, wildlife, aquatic organisms
- Be free from nutrients in amounts that promote excessive algae & cyanobacteria growth, interfere with ecosystem health or human uses
- Be a source of safe, high quality drinking water, allow for consumption of fish/wildlife, swimming and other recreational uses



Nearshore Assessment Lake Ontario 2019



Description of Assessment Measures & Thresholds

Nuisance & Harmful Algae

Cyanobacteria	*Cladophora*
Cyanobacteria, a blue-green algae, occurs naturally in freshwater, however an overgrowth of cyanobacteria can result in a harmful algae bloom that can release toxins dangerous to human and ecosystem health. Cyanobacteria is assessed by calculating the extent of a bloom in a Regional Unit in 10-day satellite composites (June – Oct., 2016-2018). An additional flag is assigned to Regional Units where cyanobacteria is a source of high stress, as it is considered a serious concern. Thresholds for severity are based on World Health Organization guidelines; thresholds for extent are based on best professional judgement.	*Cladophora* is a native green algae that typically grows on hard substrate in shallow waters. It can become a nuisance when it detaches from the bottom and washes onto shore where it can foul beaches and water intakes. *Cladophora* is assessed by calculating the percent of the total mapped area classified as submerged aquatic vegetation (SAV) in a 2016-2018 satellite-derived product. This measure is NA in Regional Units lacking hard substrate and with limited light availability, and in areas with coastal wetlands. Thresholds based on best professional judgement.
L No cyanobacteria bloom detected in any 10-day composite	L <20% coverage
	M 20-35% coverage
H Cyanobacteria bloom detected in one or more 10-day composites	H >35% coverage

L Low Stress

M Moderate Stress

H High Stress

Contaminants in Water & Sediment

Water Quality	Sediment Quality	Benthic Community
Contaminants in water can have acute and chronic impacts on aquatic organisms that depend on water for some part of their life cycle. Water quality is assessed by determining the number of sampling events for which contaminant levels exceeded Provincial or Federal water quality guidelines at Provincial long-term monitoring stations for the most recent sample years (2006, 2009, 2012). Thresholds are based on best professional judgement.	Contaminants in bottom sediment have the potential to be released into the water column and enter the food chain, which can lead to toxic and reproductive effects in species, as well as bioaccumulation in aquatic life. Sediment quality is assessed using the severity of median contaminant levels in sediment for four categories (metals, organochlorine pesticides, PAHs and PCBs) at Provincial long-term monitoring stations (2007, 2010, 2014, 2016). Thresholds are based on best professional judgement using Provincial & Federal Guidelines.	The general health of an ecosystem may be reflected in the benthic invertebrate community, as composition can vary from habitat conditions and human stressors. Contaminants in benthic communities can bioaccumulate or biomagnify in the food chain and become a source of contamination to other aquatic life and to humans. The benthic community is assessed through statistical analysis of survey sites (2006, 2007, 2009-2012, 2014) using total benthos, taxon richness and evenness. Thresholds were set by a statistical analysis.
L 0 exceedances	L • PCBs < No Effect Level • Organochlorine pesticides & PAHs < Lowest Effect Levels • Metals < Probable or Severe Effect Levels	L Benthic community condition is functional
M 1 - 2 exceedances	M • PCBs > No Effect Level OR • Organochlorine pesticides & PAHs > Lowest Effect Levels but <Severe Effect Levels OR • Metals > Probable Effect Levels but < Severe Effect Levels	M Benthic community condition degraded but functional
H >2 exceedances	H Any contaminant > Severe Effect Level	H Benthic community condition degraded and not functional

Description of Assessment Measures & Thresholds (cont.)

Coastal Processes

Shoreline Hardening	Littoral Barriers	Tributary Connectivity
Across the Great Lakes, much of the nearshore, waters edge or back of beach has been altered with engineered structures or artificial material. Hardened shorelines reduce coastal resiliency by altering sediment dynamics, accelerating erosion, increasing water turbidity and destroying local vegetation. Shoreline hardening is assessed by determining the percent of the total length of shoreline in a Regional Unit that is hardened. Thresholds are based on best professional judgement.	The supply, transport and deposition of sediment are natural processes that form and maintain coastal features like wetlands and beaches. Artificial shore perpendicular structures (littoral barriers) can disrupt natural movements of sediment and affect the integrity of ecosystems. Littoral barriers is assessed by counting the number of littoral barriers (>100 m in length) in a Regional Unit. Thresholds are based on best professional judgement.	Connectivity between watersheds and the nearshore supports healthy habitats and promotes natural physical processes. Barriers to connectivity can restrict access of fishes to spawning/nursery habitats and alter nutrient flows and coastal processes. Tributary connectivity is assessed by calculating the percent of the total length of tributaries flowing into a Regional Unit that are connected to the nearshore. Thresholds are based on the State of the Great Lakes sub-indicator for Aquatic Habitat Connectivity.
L <25% of the shoreline has been hardened	L 0 littoral barriers	L >75% of the total length of tributaries are connected to the Regional Unit
M 25-50% of the shoreline has been hardened	M 1 littoral barrier	M 25 to 75% of the total length of tributaries are connected to the Regional Unit
H >50% of the shoreline has been hardened	H >1 littoral barrier	H < 25% of the total length of tributaries are connected to the Regional Unit

Human Use

Beach Postings	Fish Consumption	Treated Drinking Water
Across Lake Ontario, public beaches are popular recreation spots and use should not be restricted by environmental quality concerns. Poor water quality at beaches due to bacterial contamination can have negative effects on human health and limit recreational use. Beach postings are assessed by calculating the average percent of time that beaches within a Regional Unit were posted as unsafe for swimming during July and August of 2018.Thresholds based on best professional judgement.	In Lake Ontario, fish such as Walleye, Yellow Perch and Northern Pike provide a diverse and accessible source of food. Depending on the size and location, harmful substances such as mercury and PCBs can result in consumption advisories in fish species. Fish consumption is assessed by calculating the average number of meals per month recommended for Walleye (class size: 35-55 cm), Yellow Perch (class size: 20-30 cm) and Northern Pike (class size: 50-70 cm) within a Regional Unit. Thresholds based on best professional judgement through consultation with MECP.	The Great Lakes are a source of drinking water for millions of Canadians and should not have an adverse impact on human health. Water intended for human consumption should not contain disease-causing organisms (e.g. E.coli) or other hazardous concentrations of toxic chemicals or radioactive substances. Treated drinking water is assessed by determining whether adverse water quality incidents were reported at any water treatment plants between 2013 and 2017. Thresholds based on Ontario Drinking Water Quality Standards.
L Beaches posted for 5% or less of the time	L ≥ 8 meals per month	L No adverse water quality incidents
M Beaches posted 5 to 20% of the time	M 1-7 meals per month	
H Beaches posted more than 20% of the time	H <1 meal per month	H One or more adverse water quality incidents reported

Niagara River to Welland Canal

Ecological Unit Type:
Moderate Energy Nearshore (with Connecting Channel)
Area (ha): 9,400

M Moderate Stress

Niagara River to Welland Canal is under moderate stress from the cumulative impact of lack of tributary connectivity, contaminants in water and nuisance algae. Barriers impede connectivity for most of the tributaries west of the Welland Canal. Results from Niagara River Upstream/Downstream monitoring for the ten-year period between 2005 and 2015 indicate that 14 compounds exceed water quality guidelines and are part of the Niagara River Toxic Management Plan "priority toxics." The river is an Area of Concern. Nuisance algae *Cladophora* was detected along the coast between Niagara-on-the-Lake and the Welland Canal. This section of shoreline has also been extensively hardened.

Niagara Falls:

- Natural Wonder of Canada
- Power Generation supplies 25% of all power used in NY State and ON
- Regulated hydrology - ensures enough flow for tourism

Niagara River:

- Niagara River Corridor Important Bird Area
- Significant decrease in wetland extent from historic estimates
- Habitat: Lower Niagara River - important spawning and nursery area for Lake Sturgeon

M Coastal Processes

M SHORELINE HARDENING
41% hardened

L LITTORAL BARRIERS
0 littoral barriers

H TRIBUTARY CONNECTIVITY
22% of the total length of tributaries are hydrologically connected to Lake Ontario

H Contaminants in Water and Sediment

H WATER QUALITY
ECCC's Niagara River Upstream/ Downstream Monitoring program 2005-2015 results (Hill 2018) from Niagara-on-the-Lake for PCBs, Organochlorine Pesticides, PAHs, Iron

? SEDIMENT QUALITY AND BENTHIC COMMUNITY
Data Gap: no sampling station within Regional Unit

M Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

H *CLADOPHORA*
Covers 48%

L Human Use

M BEACH POSTINGS
Monitored beaches were posted 14% of the time in July & August

L FISH CONSUMPTION
≤ 9 meals/month

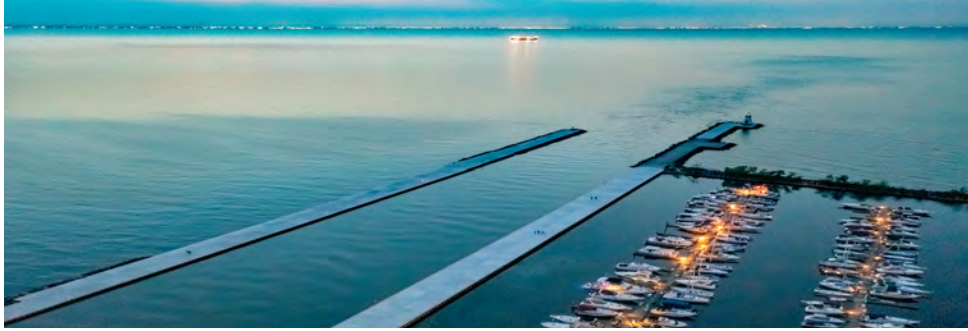
L DRINKING WATER
No adverse water quality incidents

Niagara Peninsula

Ecological Unit Type:
Moderate Energy Nearshore
Area (ha): 26,800

M Moderate Stress

The Niagara Peninsula is under moderate stress from the cumulative impact of shoreline hardening, littoral barriers, a degraded benthic community and nuisance algae. There are six littoral barriers that, combined with extensive shoreline hardening are disrupting the natural flow of sediment and resulting in high stress to coastal processes. The relative evenness, total benthos and taxon richness in the benthic invertebrate community indicates low community quality. Nuisance *Cladophora* was detected along the shore, at its most dense near Port Dalhousie and between Jordan Station and Grimsby. The average number of meals recommended per month for Northern Pike is 0, due to PCBs.



- Significant decrease in wetland extent from historic estimates
- Lake Ontario and the Niagara Escarpment create a unique local climate supporting grape and tender fruit production

Jordan Harbour:

- Historically important feeding area for American Eel
- Largest wetland feature in the Niagara Peninsula region
- Key habitat for waterfowl

H Coastal Processes

H SHORELINE HARDENING
64% hardened

H LITTORAL BARRIERS
6 littoral barriers

M TRIBUTARY CONNECTIVITY
51% of the total length of tributaries are hydrologically connected to Lake Ontario

M Contaminants in Water and Sediment

L WATER QUALITY
No contaminants found in excess of guidelines

M SEDIMENT QUALITY
Evidence of contamination due to PCBs

H BENTHIC COMMUNITY
Low community quality

M Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

M *CLADOPHORA*
Covers 34%

M Human Use

M BEACH POSTINGS
Monitored beaches were posted 6% of the time in July & August

M FISH CONSUMPTION
≤ 5 meals/month

L DRINKING WATER
No adverse water quality incidents

Hamilton Harbour

Ecological Unit Type:
Sheltered Embayment
Area (ha): 2,100

High Stress

Concerns due to Cyanobacteria

Hamilton Harbour is under high stress from the cumulative impact of a degraded benthic community, contaminants in sediment, harmful algae and beach postings. There are concerns to human and ecosystem health due to cyanobacteria blooms between 2016 and 2018. The harbour is an Area of Concern. The release of metals, PCBs and PAHs by past industrial practices make this the largest contaminated sediment site in the Canadian Great Lakes. In Provincial long-term monitoring data, five metals were detected at levels above the severe effect level in sediment and benthic community quality is low. Pier 4 beach was posted as unsafe for swimming 100% of the time in August 2018.

- Hypoxia detected by local monitoring programs
- Cootes paradise extensive wetland system
- Randle Reef - largest contaminated sediment remediation project in Canada
- Former habitat for American Eel, Lake Whitefish and Lake Herring
- Grindstone Creek - spawning habitat for Rainbow Trout and Chinook Salmon

Coastal Processes

SHORELINE HARDENING
84% hardened

LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

TRIBUTARY CONNECTIVITY
81% of the total length of tributaries are hydrologically connected to Lake Ontario

Contaminants in Water and Sediment

WATER QUALITY
No contaminants found in excess of guidelines

SEDIMENT QUALITY
Evidence of contamination due to metals, organochlorine pesticides, PAHs and PCBs

BENTHIC COMMUNITY
Low community quality

Nuisance and Harmful Algae

CYANOBACTERIA
Significantly impacted by blooms in 2016 and 2018

CLADOPHORA
Not applicable: conditions not conducive to *Cladophora* growth

Human Use

BEACH POSTINGS
Monitored beaches were posted 55% of the time in July & August

FISH CONSUMPTION
≤ 8 meals/month

DRINKING WATER
Not applicable: no drinking water plant intake

Burlington Beach to Humber Bay

Ecological Unit Type:
Moderate Energy Nearshore
Area (ha): 12,600

(M) Moderate Stress

Burlington Beach to Humber Bay is under moderate stress from the cumulative impact of shoreline hardening, littoral barriers, a degraded benthic community and nuisance algae. There are twelve littoral barriers in the Regional Unit, the most of any, which disrupt natural sediment flow. The added impact of extensive shoreline hardening is causing high stress on coastal processes. Relative quality of the benthic invertebrate community is low. Exposed bedrock provides suitable substrate for nuisance algae, and extensive *Cladophora* growth was detected along the entire coast. Two of the nine beaches (Coronation Park West and Jack Darling Memorial Park) were open for swimming 100% of the time in July and August 2018.

- Rural headwaters, with moderate natural cover
- Credit River - High fish and mussel diversity
- Credit River and Bronte Creek historically important habitat for Atlantic Salmon

Rattray Marsh - Located at Sheridan Creek mouth

- Last remaining Baymouth Bay coastal wetland between Burlington and Oshawa
- Provincially Significant Wetland
- Area of Natural & Scientific Interest

(H) Coastal Processes

(H) SHORELINE HARDENING
80% hardened

(H) LITTORAL BARRIERS
12 littoral barriers

(M) TRIBUTARY CONNECTIVITY
39% of the total length of tributaries are hydrologically connected to Lake Ontario

(M) Contaminants in Water and Sediment

(L) WATER QUALITY
No contaminants found at levels in excess of guidelines

(M) SEDIMENT QUALITY
Evidence of contamination due to organochlorine pesticides, PAHs and PCBs

(H) BENTHIC COMMUNITY
Low community quality

(M) Nuisance and Harmful Algae

(L) CYANOBACTERIA
No blooms

(H) *CLADOPHORA*
Covers 46%

(M) Human Use

(M) BEACH POSTINGS
Monitored beaches were posted 20% of the time in July & August

(M) FISH CONSUMPTION
≤ 6 meals/month

(L) DRINKING WATER
No adverse water quality incidents

Humber Bay

Ecological Unit Type:
High Energy Nearshore
Area (ha): 1,500

M Moderate Stress

Humber Bay is under moderate stress from the cumulative impact of tributary connectivity, shoreline hardening, a degraded benthic community and beach postings. Mimico Creek remains connected to the nearshore, but barriers on the Humber River impede connectivity for approximately 97% of the total length of tributaries. The length of shoreline is just over 11 km, however only 4 km is not hardened. Much of the river mouth as well as shoreline around Humber Bay Park has been hardened with shore protection features. The benthic invertebrate community condition is low. Sunnyside Beach is one of the most frequented beaches in Lake Ontario, and in July and August 2018 it was posted as unsafe for swimming 34% of the time.

- Smallest Regional Unit in Lake Ontario
- Humber River Wetlands are Provincially Significant
- Humber Bay is within the Toronto and Region Area of Concern
- Urbanization dominates the watershed

Humber River:

- 60 km long
- Historical importance for Atlantic Salmon

H Coastal Processes

H SHORELINE HARDENING
66% hardened

NA LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

H TRIBUTARY CONNECTIVITY
3% of the total length of tributaries are hydrologically connected to Lake Ontario

M Contaminants in Water and Sediment

L WATER QUALITY
No contaminants found in excess of guidelines

M SEDIMENT QUALITY
Evidence of contamination due to PAHs and PCBs

H BENTHIC COMMUNITY
Low community quality

L Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

L *CLADOPHORA*
Covers 19%

M Human Use

H BEACH POSTINGS
Monitored beaches were posted 27% of the time in July & August

L FISH CONSUMPTION
≤ 11 meals/month

NA DRINKING WATER
Not applicable: no drinking water plant intake

Toronto

Ecological Unit Type:
High Energy Nearshore
Area (ha): 2,700

M Moderate Stress

The Toronto Regional Unit is under moderate stress from the cumulative impact of lack of tributary connectivity, shoreline hardening and nuisance algae. The Regional Unit includes the Toronto and Region Area of Concern. A barrier on the Don River impedes connectivity for just under 300 km of tributary length. The Leslie Street Spit has significantly altered the shoreline, restricting natural sediment supply to the Toronto Islands. As a result, shore protection features have been built to save the islands from erosion and flooding. Nuisance *Cladophora* was detected around the Toronto Islands and the Outer and Main Harbour Channels along the west side of Tommy Thompson Park. Although the most populated area in Canada, Toronto's five beaches have excellent quality.

- Most highly populated watershed in Canada
- Waterfront & inner harbour used extensively for recreation
- Leslie Street Spit - Important Bird Area
- Tommy Thompson Park: Man-made ecological feature provides habitat for amphibians and reptiles

Toronto Islands

- Chain of 15 small islands, south of mainland Toronto
- Portions designated Areas of Natural and Scientific Interest

Toronto Scarp

- Off-shore bluff depth increases from 20m to 60m
- Important congregation area for salmonids

H Coastal Processes

H SHORELINE HARDENING
52% hardened

H LITTORAL BARRIERS
2 littoral barriers

H TRIBUTARY CONNECTIVITY
6% of the total length of tributaries are hydrologically connected to Lake Ontario

M Contaminants in Water and Sediment

L WATER QUALITY
No contaminants found at levels of guidelines

M SEDIMENT QUALITY
Evidence of contamination due to organochlorine pesticides, PAHs and PCBs

M BENTHIC COMMUNITY
Moderate community quality

M Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

H *CLADOPHORA*
Covers 49%

L Human Use

L BEACH POSTINGS
Monitored beaches were posted 4% of the time in July & August

L FISH CONSUMPTION
≤ 12 meals/month

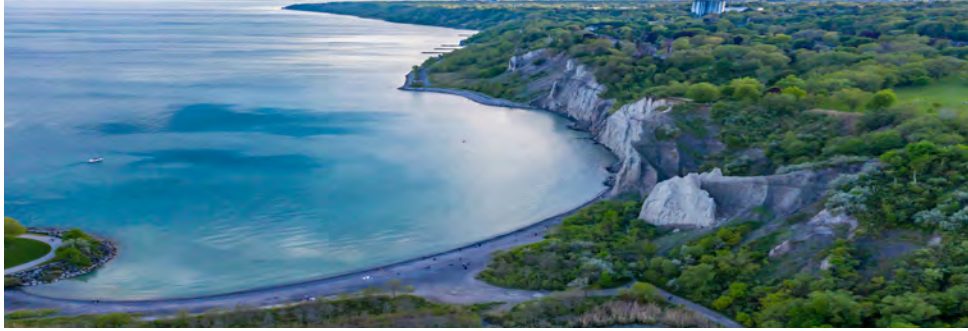
L DRINKING WATER
No adverse water quality incidents

Tommy Thompson Park to Pickering

Ecological Unit Type:
Moderate Energy Nearshore
Area (ha): 11,100

M Moderate Stress

Tommy Thompson Park to Pickering is under moderate stress from the cumulative impact of shoreline hardening, littoral barriers and nuisance algae. The longest stretch of natural shoreline is in this Regional Unit (5 km along the east side of Tommy Thompson Park) however over 50% of the remaining shoreline has been hardened, removing vegetation along the Scarborough Bluffs and undermining their stability. Six littoral barriers – the second most of any Regional Unit – disrupt natural sediment flow. Nuisance *Cladophora* washes onto and fouls beaches. Rouge Beach was posted as unsafe for swimming 24% of the time in July and August 2018.



- Stonehooking: Removed rocky substrate that previously buffered the coast from wave action
- Significant decrease in wetland extent from historic estimates
- Canada's first National Urban Park: Rouge National Urban Park
- Ashbridges Bay restoration of cobble shoreline habitat

Scarborough Bluffs

- 100m high
- 15km long

H Coastal Processes

H SHORELINE HARDENING
55% hardened

H LITTORAL BARRIERS
6 littoral barriers

M TRIBUTARY CONNECTIVITY
65% of the total length of tributaries are hydrologically connected to Lake Ontario

M Contaminants in Water and Sediment

L WATER QUALITY
No contaminants found at levels of guidelines

M SEDIMENT QUALITY
Evidence of contamination due to PCBs

M BENTHIC COMMUNITY
Moderate community quality

M Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

H *CLADOPHORA*
Covers 35%

M Human Use

M BEACH POSTINGS
Monitored beaches were posted 11% of the time in July & August

M FISH CONSUMPTION
≤ 7 meals/month

L DRINKING WATER
No adverse water quality incidents

Pickering to St. Mary's Cement Pier

Ecological Unit Type:
High Energy Nearshore
Area (ha): 12,400

Moderate Stress

Pickering to St. Mary's Cement Pier is under moderate stress from the cumulative impact of lack of tributary connectivity, littoral barriers and nuisance algae. Barriers along Duffins Creek, Oshawa Creek and East Oshawa Creek impede connectivity for approximately 760 km of tributaries. Four littoral barriers impact natural coastal processes that supply sediment and maintain barrier beaches. Nuisance *Cladophora* was detected along much of the coast and is a local concern, as dense mats have been observed at beaches in the Regional Unit. Two of five beaches (Darlington Provincial Park and Lakeview Park West) were open for swimming 100% of the time in July and August 2018. Lakeview Park East was posted 43% of the time in July and August 2018.

- Duffins Creek, historical importance to Atlantic Salmon
- Durham Region Coastal Wetlands: 18 coastal wetlands between Ajax and Clarington
- endangered Piping Plover nested at Darlington Provincial Park
- Headland outcrops and embayments featuring drowned river valleys

400 hectares of coastal wetland habitat in Oshawa at:

- Darlington Provincial Park
- Second Marsh
- McLaughlin Bay Wildlife Reserve

Coastal Processes

SHORELINE HARDENING
22% hardened

LITTORAL BARRIERS
4 littoral barriers

TRIBUTARY CONNECTIVITY
47% of the total length of tributaries are hydrologically connected to Lake Ontario

Contaminants in Water and Sediment

WATER QUALITY
No contaminants found at levels of guidelines

SEDIMENT QUALITY
Data Gap: no sampling stations within Regional Unit

BENTHIC COMMUNITY
Data Gap: no sampling stations within Regional Unit

Nuisance and Harmful Algae

CYANOBACTERIA
No blooms

CLADOPHORA
Covers 40%

Human Use

BEACH POSTINGS
Monitored beaches were posted 18% of the time in July & August

FISH CONSUMPTION
≤ 7 meals/month

DRINKING WATER
No adverse water quality incidents

St. Mary's Cement Pier to Cobourg

Ecological Unit Type:
High Energy Nearshore
Area (ha): 16,100

M Moderate Stress

The Regional Unit is under moderate stress from the cumulative impact of littoral barriers, nuisance algae, consumption advisories for fish and beach postings. At St. Mary's Cement, the shore has been infilled and the wharf acts as a barrier to sediment that naturally moves east. Nuisance *Cladophora* was detected at the west and east ends of the Regional Unit. Newcastle Beach was open for swimming 100% of the time in July and August 2018, but the four other beaches were posted, on average, 22% of the time. The average recommended number of meals per month for Walleye is 0, due to mercury and PCBs. The industrial harbour at Port Hope is an AOC with ongoing initiatives to remove and manage contaminated sediment.

- Barriers impede connectivity to Lake Ontario at: Bowmanville Creek, Ganaraska River and Cobourg Creek
- Historic spawning site for Lake Sturgeon (Ganaraska-Cobourg Creeks)
- Watershed is primarily agricultural with moderate natural cover
- Large harbours interspersed by eroding bluffs

M Coastal Processes

L SHORELINE HARDENING
20% hardened

H LITTORAL BARRIERS
3 littoral barriers

M TRIBUTARY CONNECTIVITY
42% of the total length of tributaries are hydrologically connected to Lake Ontario

? Contaminants in Water and Sediment

L WATER QUALITY
No contaminants found in excess of guidelines

? SEDIMENT QUALITY
Data Gap: no sampling stations within Regional Unit

? BENTHIC COMMUNITY
Data Gap: no sampling stations within Regional Unit

M Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

M *CLADOPHORA*
Covers 20%

M Human Use

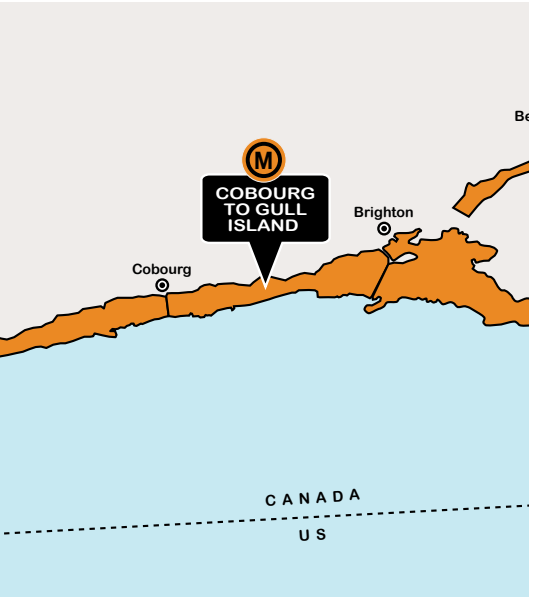
M BEACH POSTINGS
Monitored beaches were posted 17% of the time in July & August

M FISH CONSUMPTION
≤ 6 meals/month

L DRINKING WATER
No adverse water quality incidents

Cobourg to Gull Island

Ecological Unit Type:
High Energy Nearshore
Area (ha): 15,000



Moderate Stress

Cobourg to Gull Island is under moderate stress from the cumulative impact of littoral barriers, nuisance algae and fish consumption advisories. Two littoral barriers at harbours in the west affect sediment transport towards the large sand beach at Presqu'ile Provincial Park. Nuisance *Cladophora* is a local concern related to beach fouling. The average number of recommended meals per month is 0 for Northern Pike, due to mercury and PCBs. Two (Presqu'ile Provincial Park and Victoria Beach) of the three beaches were open for swimming for 100% of the time in July and August 2018.

- Rural watershed with agricultural land and large forested areas
- Diverse Shoreline, Eroding glacial till bluffs in the west Cobble beaches in the east

Presqu'il Provincial Park Important Bird Area:

- Gull Island: most diverse water bird colony on the Great Lakes
- Greater Scaup and Whimbrel: present during spring migration in globally significant numbers

Coastal Processes

SHORELINE HARDENING
23% hardened

LITTORAL BARRIERS
2 littoral barriers

TRIBUTARY CONNECTIVITY
81% of the total length of tributaries are hydrologically connected to Lake Ontario

Contaminants in Water and Sediment

WATER QUALITY
No contaminants found in excess of guidelines

SEDIMENT QUALITY
Evidence of contamination due to PCBs

BENTHIC COMMUNITY
High community quality

Nuisance and Harmful Algae

CYANOBACTERIA
No blooms

CLADOPHORA
Covers 33%

Human Use

BEACH POSTINGS
Monitored beaches were posted 8% of the time in July & August

FISH CONSUMPTION
≤ 6 meals/month

DRINKING WATER
No adverse water quality incidents

Prince Edward County

Ecological Unit Type:
High Energy Nearshore
Area (ha): 50,400

Moderate Stress

Prince Edward County is under moderate stress from the cumulative impact of lack of tributary connectivity, the presence of nuisance algae and fish consumption advisories. Barriers impede connectivity for approximately 275 km of tributary length, mostly along Melville, Consecon and Bloomfield Creeks. Nuisance *Cladophora* was detected around Salmon Point, Point Petre and east along the coast to Prince Edward Point. The average recommended meals per month (4) for fish is restrictive due to PCBs and mercury. Three of five beaches were open for swimming 100% of the time in July and August 2018 (Cedardale, North Beach Provincial Park and Sandbanks Provincial Park – Lake Ontario Beach).

- 3 National Wildlife Areas: Wellers Bay, Scotch Bonnet Island and Prince Edward Point
- World's largest baymouth barrier dune formation at Sandbanks Provincial Park

Presqu'ile and Prince Edward Shoreline:

- Extensive barrier beach system
- Sheltered embayment wetlands

Two Important Bird Areas:

- Presqu'ile Provincial Park: Nesting King Rails (nationally endangered) and Least Bitterns (nationally vulnerable)
- Prince Edward County South Shore: Shoals and deep waters are important waterfowl staging and wintering areas

Coastal Processes

SHORELINE HARDENING
25% hardened

LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

TRIBUTARY CONNECTIVITY
66% of the total length of tributaries are hydrologically connected to Lake Ontario

Contaminants in Water and Sediment

WATER QUALITY
No contaminants found in excess of guidelines

SEDIMENT QUALITY
Data Gap: no sampling stations within Regional Unit

BENTHIC COMMUNITY
Moderate community quality

Nuisance and Harmful Algae

CYANOBACTERIA
No blooms

CLADOPHORA
Covers 24%

Human Use

BEACH POSTINGS
Monitored beaches were posted 6% of the time in July & August

FISH CONSUMPTION
≤ 4 meals/month

DRINKING WATER
No adverse water quality incidents

Bay of Quinte

Ecological Unit Type:
Sheltered embayment
Area (ha): 32,100

Moderate Stress

Concerns due to Cyanobacteria

Bay of Quinte is under moderate stress from the cumulative impact of lack of tributary connectivity, contaminants in sediment and harmful algae. It is an Area of Concern. There are concerns due to cyanobacteria blooms detected in 2016, 2017 & 2018. Of the tributaries downstream of a waterfall, barriers impede connectivity for 91% of the total length. PCBs were detected in sediment at levels that could impact the food chain. The Centennial Park, Northport Beach was open 100% of the time in July and August 2018.

- Watershed extends to southern limits of the Canadian Shield - longest total length of tributaries
- High extent of coastal wetlands
- High natural cover with some agricultural activity
- Important spawning area for Lake Whitefish & Lake Herring
- Historic importance for American Eel
- Prince Edward Bay: important habitat for Lake Sturgeon
- Production power house for Walleye

Coastal Processes

SHORELINE HARDENING
25% hardened

LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

TRIBUTARY CONNECTIVITY
9% of the total length of tributaries are hydrologically connected to Lake Ontario

Contaminants in Water and Sediment

WATER QUALITY
No contaminants found in excess of guidelines

SEDIMENT QUALITY
Evidence of contamination due to organochlorine pesticides, PAHs and PCBs

BENTHIC COMMUNITY
High community quality

Nuisance and Harmful Algae

CYANOBACTERIA
Significantly impacted by blooms in 2016 and 2018, and to a lesser extent in 2017

CLADOPHORA
Not applicable: conditions not conducive to *Cladophora* growth

Human Use

BEACH POSTINGS
Monitored beaches were posted 5% of the time in July & August

FISH CONSUMPTION
≤ 7 meals/month

DRINKING WATER
No adverse water quality incidents

Kingston Basin

Ecological Unit Type:
Moderate Nearshore Energy
Area (ha): 106,900

Moderate Stress

Concerns due to Cyanobacteria

Kingston Basin is under moderate stress from the cumulative impact of a degraded benthic community, harmful and nuisance algae and beach postings. There are concerns to human and ecosystem health due to a mild cyanobacteria bloom in August 2017 that covered just over 2% of the Regional Unit. The relative evenness, total benthos and taxon richness in the benthic invertebrate community indicates low community quality, and PCBs were detected in sediment at levels that could impact the food chain. Nuisance *Cladophora* was detected in the nearshore. Of seven beaches, four were always open and one (Reddendale Crerar Beach) was posted 100% of the time in July and August 2018.

- Watershed: significant natural cover
- Coastal wetlands in embayments
- Partially sheltered from Lake Ontario by islands and shoals
- Kingston Waterfront - heavily developed, hardened with littoral barriers

Two Important Bird Areas:

- Amherst Island: Secluded bays, sand and gravel beaches, northeast sandbar
- Wolfe Island: Staging waterfowl and shorebird habitat

Coastal Processes

SHORELINE HARDENING
36% hardened

LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

TRIBUTARY CONNECTIVITY
29% of the total length of tributaries are hydrologically connected to Lake Ontario

Contaminants in Water and Sediment

WATER QUALITY
No contaminants found in excess of guidelines

SEDIMENT QUALITY
Evidence of contamination due to organochlorine pesticides, PAHs and PCBs

BENTHIC COMMUNITY
Low community quality

Nuisance and Harmful Algae

CYANOBACTERIA
Mild bloom in 2017

CLADOPHORA
Covers 42%

Human Use

BEACH POSTINGS
Monitored beaches were posted 24% of the time in July & August

FISH CONSUMPTION
≤ 8 meals/month

DRINKING WATER
No adverse water quality incidents

Thousand Islands Region

Ecological Unit Type:
Connecting Channel
Area (ha): 28,500

M Moderate Stress

The Thousand Islands Region is under moderate stress from the cumulative impact of lack of tributary connectivity, shoreline hardening and fish consumption advisories. A barrier at Gananoque impedes connectivity for just under 1,000 km of tributaries. Much of the shoreline is hardened and the longest segment of shoreline that remains natural is approximately 4.5 km. Fish consumption restrictions are due to mercury and the average recommended number of meals per month for Yellow Perch is 6, the second lowest of all Regional Units.

- Diverse and Naturalized Watershed: Bays, fringe wetlands and diverse tributaries

Thousand Islands National Park multi-species action plan -2015:

- Targets 4 endangered species
- Benefits another 30 (species of conservation concern)
- 120 km of coast

Frontenac Arch Biosphere Reserve:

- Considered one of Canada's most biodiverse regions
- Frontenac Arch - granite bridge between the Canadian Shield and Adirondack Mountains
- Spans the coast from Gananoque to Brockville

H Coastal Processes

M SHORELINE HARDENING
39% hardened

NA LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

H TRIBUTARY CONNECTIVITY
13% of the total length of tributaries are hydrologically connected to the St. Lawrence River

L Contaminants in Water and Sediment

L WATER QUALITY
No contaminants found in excess of guidelines

L SEDIMENT QUALITY
Metals detected but not at levels of concern

L BENTHIC COMMUNITY
High community quality

L Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

NA *CLADOPHORA*
Not applicable: conditions not conducive to *Cladophora* growth

M Human Use

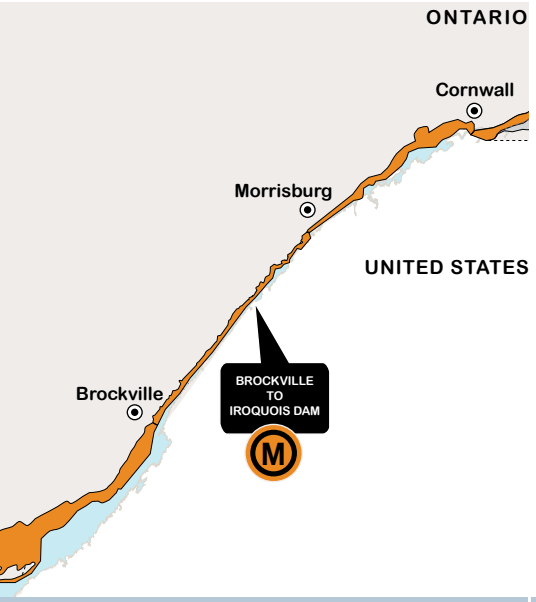
M BEACH POSTINGS
Monitored beaches were posted 10% of the time in July & August

M FISH CONSUMPTION
≤ 6 meals/month

L DRINKING WATER
No adverse water quality incidents

Brockville to Iroquois Dam

Ecological Unit Type:
Connecting Channel
Area (ha): 5,000



M Moderate Stress

Brockville to Iroquois Dam is under moderate stress from the cumulative impact of shoreline hardening, fish consumption advisories and beach postings. Approximately 47 km of the shoreline has been hardened, mostly from small scale armouring. Fish consumption restrictions are due to mercury, and the average recommended meals per month for Yellow Perch is 4, the lowest of all Regional Units. Although beach postings exceed the threshold for low stress, only one (St. Lawrence Park) of the two beaches was posted as unsafe for swimming and only in August 2018.

- St. Lawrence River approximately 1 km wide here
- Eastern limit of the Frontenac Arch Biosphere Reserve
- Tributaries include critical habitat for the Species at Risk Eastern Pondmussel

Iroquois Dam:

- Dam Elevation 30m
- Controls St. Lawrence Seaway water levels

M Coastal Processes

H SHORELINE HARDENING
55% hardened

NA LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

L TRIBUTARY CONNECTIVITY
88% of the total length of tributaries are hydrologically connected to the St. Lawrence River

L Contaminants in Water and Sediment

L WATER QUALITY
No contaminants found in excess of guidelines

L SEDIMENT QUALITY
No contaminants found in excess of guidelines

L BENTHIC COMMUNITY
High community quality

L Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

NA *CLADOPHORA*
Not applicable: conditions not conducive to *Cladophora* growth

M Human Use

M BEACH POSTINGS
Monitored beaches were posted 6% of the time in July & August

M FISH CONSUMPTION
≤ 4 meals/month

L DRINKING WATER
No adverse water quality incidents

Iroquois Dam to Moses Saunders Dam

Ecological Unit Type:
Connecting Channel
Area (ha): 7,600

M Moderate Stress

Iroquois Dam to Moses Saunders Dam is under moderate stress. The Regional Unit has the least amount of shoreline hardening and the highest tributary connectivity. Benthic invertebrate community quality is moderate and beaches were posted as unsafe for swimming just under 6% of the time in July and August 2018. There are 13 beaches, the most of any Regional Unit, and only three (Riverside Cedar Camping, Lakeview Park and Upper Canada Migratory Bird Sanctuary) had postings during July and August 2018. The average recommended number of meals per month for Walleye is 16, the highest number across the Regional Units.

- Watershed: predominantly natural with some agricultural areas

Lake St. Lawrence:

- Created by the Moses Saunders Power Dam
- Warm-water
- Highly productive fishery

Lake Ontario - St. Lawrence River Regulation Plan (Plan 2014):

- Dictates water releases at the Moses Saunders Power Dam
- Return of more natural variability in water levels

L Coastal Processes

L SHORELINE HARDENING
18% hardened

NA LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

L TRIBUTARY CONNECTIVITY
95% of the total length of tributaries are hydrologically connected to the St. Lawrence River

M Contaminants in Water and Sediment

? WATER QUALITY
Data Gap: no sampling stations within Regional Unit

? SEDIMENT QUALITY
Data Gap: no sampling stations within Regional Unit

M BENTHIC COMMUNITY
Moderate community quality

L Nuisance and Harmful Algae

L CYANOBACTERIA
No blooms

NA *CLADOPHORA*
Not applicable: conditions not conducive to *Cladophora* growth

M Human Use

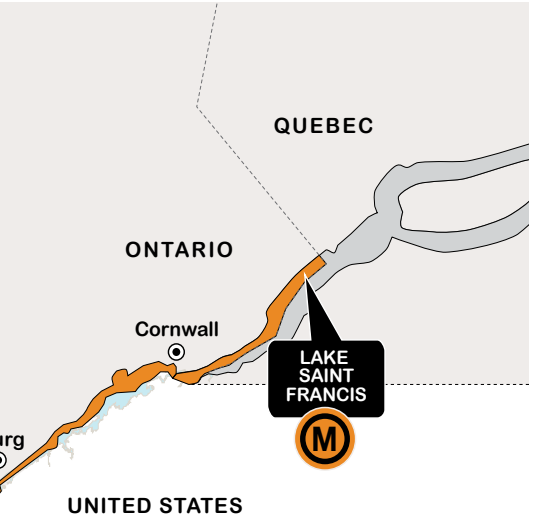
M BEACH POSTINGS
Monitored beaches were posted 6% of the time in July & August

M FISH CONSUMPTION
≤ 6 meals/month

L DRINKING WATER
No adverse water quality incidents

Lake Saint Francis

Ecological Unit Type:
Connecting Channel
Area (ha): 27,400



M Moderate Stress

The Canadian portion of Lake Saint Francis is under moderate stress. Although it remains a binational AOC, many issues have been successfully remediated. There is extensive shoreline hardening and just under 300 km of tributaries are disconnected from the nearshore. A Contaminated Sediment Management Plan is in place for localized mercury hotspots, but there were no exceedances in contaminants detected in water or sediment at long-term ambient monitoring sites. The two monitored beaches (Charlottenburg Park and Glengarry Park) were open for swimming 100% of the time in July and August 2018.

- Significant decrease in wetland extent from historic estimates
- Lake Saint-Francois National Wildlife Area
- Wetland of International Significance under the Ramsar Convention
- Watershed is a mix of natural cover and agriculture

Mohawks of Akwesasne territory spans 3 jurisdictions:

- Ontario
- Quebec
- New York State

H Coastal Processes

H SHORELINE HARDENING
60% hardened

NA LITTORAL BARRIERS
Not applicable: Littoral drift is not a significant process in this Regional Unit

M TRIBUTARY CONNECTIVITY
65% of the total length of tributaries are hydrologically connected to the St. Lawrence River

L Contaminants in Water and Sediment

L WATER QUALITY
No contaminants found in excess of guidelines

L SEDIMENT QUALITY
No exceedances

L BENTHIC COMMUNITY
High community quality

? Nuisance and Harmful Algae

? CYANOBACTERIA
Data Gap: data unavailable

NA *CLADOPHORA*
Not applicable: conditions not conducive to *Cladophora* growth

L Human Use

L BEACH POSTINGS
Monitored beaches were never posted in July & August

M FISH CONSUMPTION
≤ 3 meals/month

L DRINKING WATER
No adverse water quality incidents

Major Threats to Lake Ontario Nearshore Waters

Contaminants

Some nearshore areas in Lake Ontario are moderately or highly stressed from contaminated sediment and advisories to fish consumption. PCBs were often detected in sediment in concentrations above the Provincial No Effect Level (NEL), indicating a risk of bioaccumulation in the food chain. Organochlorine pesticide and PAH levels in sediment are a source of moderate or high stress in the west (Hamilton Harbour to Toronto) and the east (Bay of Quinte, Kingston Basin) ends of the lake. Nearly all Regional Units have metals detected in sediment above Provincial Lowest Effect Levels (LELs), but this generally reflects background conditions and are not at levels of concern.

Contaminants in Hamilton Harbour exceeded guidelines in all categories (metals, PCBs, Organochlorine pesticides and PAHs) and this is the only area where metals exceeded Federal Probable Effect Levels (PEL) and Provincial Severe Effect Levels (SEL). Hamilton Harbour is a Great Lakes Area of Concern (AOC) with localized contaminated sediment that is undergoing remediation as part of current management planning and action. In the Niagara River to Welland Canal Regional Unit, ECCC's Niagara River Upstream/Downstream Monitoring Program indicates that the river remains a source of high stress based on PCBs, Organochlorine Pesticides, PAHs and iron in water at Niagara-on-the-Lake. The Niagara River provides approximately 85% of the incoming flow to Lake Ontario. Elsewhere, Provincial long-term sensing site data indicates that no contaminants were in excess of water quality guidelines.

Although contaminants in water and sediment have been of concern for decades across Lake Ontario, the temporal and spatial coverage as well as the parameters measured are limited. Regular monitoring of contaminants in water, sediment, and nearshore fish and benthic community analysis at a scale that is regionally appropriate and offers coverage at the lake scale would improve understanding of contaminants in Lake Ontario and St. Lawrence River. In addition, many recent and emerging contaminants (e.g.Per- and polyfluoralkyl substances [PFAS]) are not understood well enough to determine their impacts.

Loss of Natural Resiliency

Recently, the impacts of a changing climate have become apparent and water levels have reached the highest since record keeping began approximately 100 years ago. This has resulted in flooding in coastal communities and severe storm damage. Features such as coastal wetlands, barrier beaches and vegetation buffers that provide natural resilience to cycles of high and low lake levels have been lost. A common response to flooding and storm damage has been the construction of shoreline protection structures (e.g. rock revetments and retaining walls) which further decrease the natural resiliency of the coast. From the Niagara Peninsula to Kingston, Lake Ontario's shores have been altered with shoreline armouring and littoral barriers. This type of shoreline hardening not only reduces natural coastal resiliency but also, as experienced in 2017 and 2019, often fails to prevent flooding and excessive storm damage from high water levels.

The inability of natural features to perform their full range of functions means that shorelines are exposed and vulnerable. Current research suggests that fluctuations in water levels will be more extreme with climate change and that warmer winter temperatures may result in an ice-free Lake Ontario by mid-century.[1] In order to mitigate storm damage, new approaches that incorporate natural resiliency back into the shoreline are needed. After decades of building and rebuilding shore protection structures, adopting mechanisms that enhance coastal wetland extent, maintain barrier beaches, and include vegetated strips along the shore will help to increase natural resilience of shorelines and maintain ecosystem health and good water quality.[2]

Areas of Concern

Great Lakes Areas of Concern (AOCs) are geographic areas in the Great Lakes identified in the mid-1980s because water quality and ecosystem health were severely degraded by human activities to the point that beneficial uses were impaired. Working with community members and local governments, Canada and Ontario are implementing Remedial Action Plans (RAPs) to restore AOCs. Considerable progress has been made but ecological issues remain in the Lake Ontario (Hamilton Harbour, Toronto and Region, Port Hope, Bay of Quinte), Niagara River and St. Lawrence River (at Cornwall) AOCs.

Shoreline armouring reduces natural resiliency

High water levels damage and limit access to public spaces

Major Threats to Lake Ontario Nearshore Waters

Nuisance and Harmful Algae

Cladophora, a green filamentous algae that occurs naturally in shallower depths of some of the Great Lakes, has become a particular concern in Lake Ontario. It grows on hard substrate, submerged rocks or logs in phosphorus rich, clear water and when it dies off, wind and wave action cause it to wash up on shore. As it decomposes, it can become unsightly and produce a pungent odour that fouls shorelines and beaches. In addition, decomposing *Cladophora* has the potential to promote bacterial growth that may pose a health risk to humans. It is therefore considered a nusiance algae. Regional Units with extensive coverage of *Cladophora* detected include the Niagara River to Welland Canal, Burlington Beach to Humber Bay, Toronto, Tommy Thompson Park to Pickering, Pickering to St. Mary's Cement Pier and Kingston Basin. In these areas *Cladophora* is considered to be a source of high stress.

Harmful algae, cyanobacteria, is a source of high stress in Hamilton Harbour, the Bay of Quinte and Kingston Basin. Through production of toxins, they pose a significant threat to human and ecological health. During summer months, the Bay of Quinte and Hamilton Harbour are routinely impacted by cyanobacteria blooms, detected by satellite derived products in 2016 through 2018. To a much lesser extent and frequency, intermittent blooms are detected in Kingston basin (2017). The warm and typically slow moving water in Hamilton Harbour and the Bay of Quinte, along with adequate sources of nutrients (phosphorus), create conditions conducive to cyanobacteria growth. Numerous wastewater treatment plants and run-off from agricultural and industrial activities provide a significant source of phosphorus. Invasive dreissenid mussels, established in the mid-1990's, excrete highly bioavailable phosphorus through their filter feeding, amplifying harmful and nuisance growth. Both Bay of Quinte and Hamilton Harbour are Areas of Concern that have identified phosphorus reduction targets and actions to reduce nutrients contributing to harmful algae blooms. Significant investment has been made in sewage treatment plant upgrades to reduce nutrients to both areas. While land based efforts continue, scientists are researching nutrient release from bottom sediments and their role in harmful algae blooms.

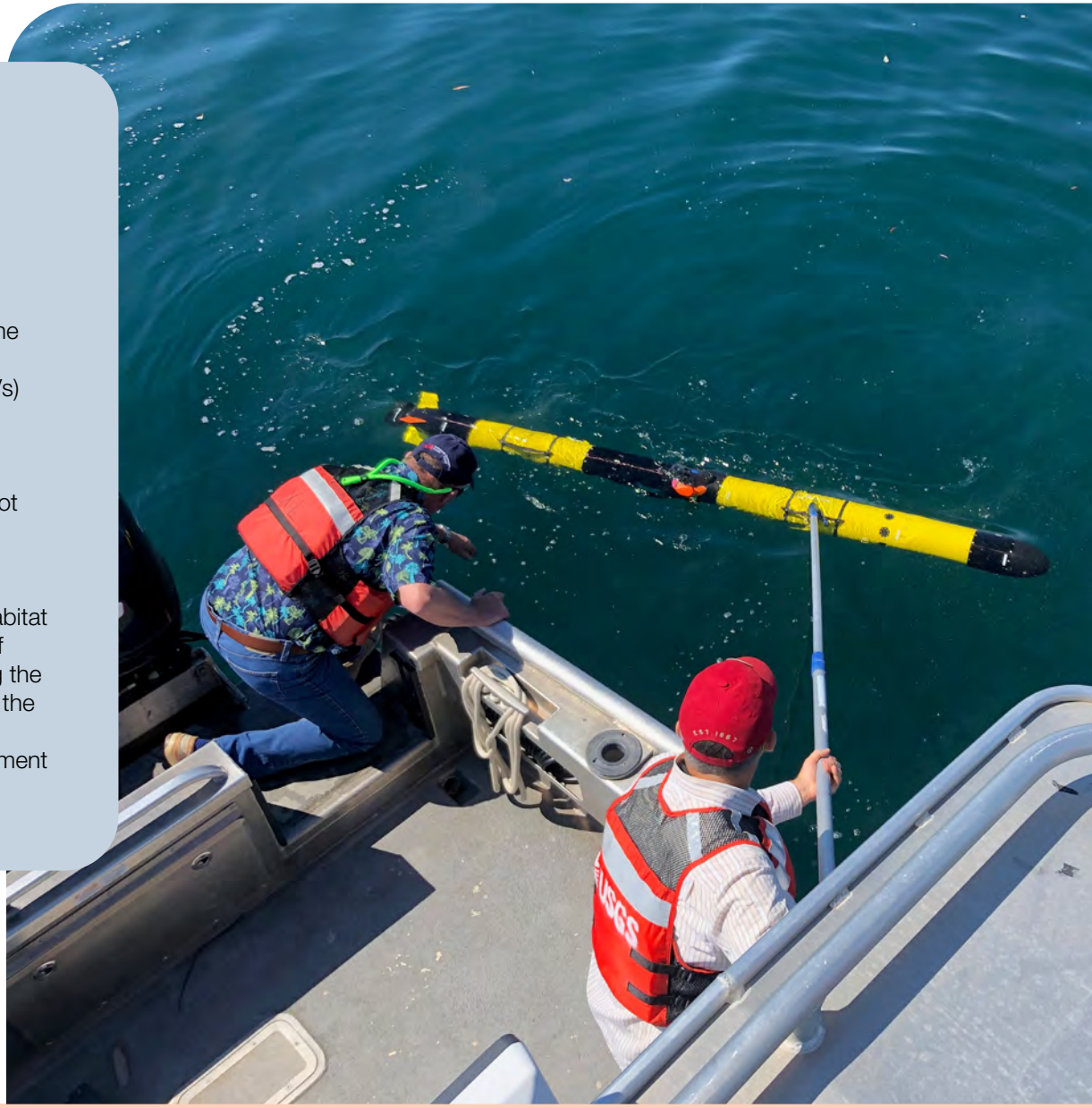
Information to Action Case Study: Tracking *Cladophora* in Lake Ontario

CASE STUDY

Tracking *Cladophora* in Lake Ontario

Currently, there is a lack of information regarding distribution, growth and impacts of *Cladophora*. Federal and provincial scientists are studying *Cladophora* at several discrete sites in the lake. New practices and technologies such as satellite remote sensing and the use of Autonomous Underwater Vehicles (AUVs) offer promising methods to provide better information at larger geographic scales.

Although satellites can tell you where *Cladophora* is, they cannot determine quantity. A collaborative study between ECCC and the United States Geological Survey will demonstrate the utility of underwater remote sensing by developing a robot-deployed computer vision system, capable of automatically classifying habitat types and mapping *Cladophora* biomass. The emerging field of underwater remote sensing holds great promise for automating the collection of data about habitat and biology over large areas of the lakes. In-lake sampling paired with shoreline *Cladophora* citizen-science monitoring could provide a more robust assessment to target specific locations and determine needed action.



Nearshore Framework Next Steps

The Nearshore Framework Assessment Cycle

The results of this assessment will be updated and included in the 2023 Lake Ontario Lakewide Action and Management Plan (LAMP). The assessment will be repeated on a regular cycle to monitor change over time. A number of data gaps have been identified and will be considered within the lakewide management process when Cooperative Science and Monitoring priorities are identified. Progress continues for the remaining Canadian Great Lake nearshore assessments as respective LAMPs are developed. Assessments of Lakes Erie, Ontario, Huron and Superior will be combined and reported as the first cumulative nearshore assessment of the Canadian Great Lakes in 2022.

This report reflects the best efforts using readily accessible data. Methods and the decisions made for this assessment have been documented and revisions or improvements based on advances in science and expert judgment are part of the Framework's iterative learning process. This first assessment of Lake Ontario has exposed several limitations that are specific to Lake Ontario's data availability. These include the lack of consistent, current and reliable data on nearshore water quality, sediment quality and benthic invertebrate communities. AOCs are rich sources of site-specific data, but for purposes of data integration and the overall assessment, it was only possible to use lakewide datasets. Another limitation that may be addressed by ongoing efforts is to gain a better understanding of the distribution, biomass and wash-up of nuisance algae (*Cladophora*) as it is a recognized major issue in the central to western end of the lake (see text box pg. 27).

Data Sources

MEASURE	DATA SOURCE(S)	YEARS ASSESSED
Shoreline Hardening	Zuzek, Inc. Shoreline Hardening and Littoral Sediment Budgets. Shoreline Hardening Methodology and Guidance Document; 2015 Southwestern Ontario Orthophotography (SWOOP) used for delineation.	2013, 2015, 2018 (Imagery) 2019 (delineation)
Littoral Barriers		
Tributary Connectivity	Ontario Ministry of Natural Resources and Forestry. Ontario Hydro Network – Watercourse (1:200,000);	2019
	Ontario Ministry of Natural Resources and Forestry. Ontario Dam Inventory; FishWerks	2018
Water Quality	Ontario Ministry of Environment, Conservation and Parks. Great Lakes Nearshore – Water Chemistry.	2006, 2009, 2012
Sediment Quality	Ontario Ministry of Environment, Conservation and Parks. Great Lakes Nearshore – Sediment Chemistry.	2007, 2010, 2014, 2016
Benthic Community	Environment and Climate Change Canada. (2006-07, 2010-12, 2014); Ontario Ministry of Environment, Conservation and Parks. Ontario Benthos Biomonitoring Network (2006, 2009, 2012); Grapentine, L. Classification of Benthic Community Quality for Regional Units. 2019	2006, 2007, 2009, 2010-2012, 2014
Cyanobacteria	National Oceanic & Atmospheric Association. Harmful Algal Bloom Monitoring. 10-day composite images from the MODIS satellite, with Cyanobacteria Index algorithm.	June-October 2016-2018
Cladophora	Michigan Tech Research Institute. Satellite-Derived Lake Submerged Aquatic Vegetation (SAV) Mapping. MTRI depth variant algorithm using Landsat 8 satellite collected during vegetative growing season.	2016-2018
Beach Postings	Swim Drink Fish Canada. SWIMGuide.	July-August, 2018
Treated Drinking Water	Ontario Ministry of Environment, Conservation and Parks. Drinking Water Treatment Plant Monitoring data.	2015 & 2017
Fish Consumption	Ontario Ministry of Environment, Conservation and Parks. Guide to Eating Ontario Fish Advisory Database.	2013 - 2017

Additional Resources:

1. Seglenieks, F. (2018). The Modelling of Future Great Lakes Water Levels. Presented at the ECCC Workshop Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands.

2. Zuzek Inc. (2019). Adapting to the Future Storm and Ice Regime in the Great Lakes; Stream 1 Report. Prepared by Zuzek Inc.

OVERALL ASSESSMENT OF THE STATE OF NEARSHORE WATERS Resources

Lake Ontario Canadian Nearshore Assessment, 2019 Results.
Cat. No.: En164-71/3-2019E-PDF; ISBN: 978-0-660-36631-9

Canadian Great Lakes Nearshore Assessment, Detailed Methodology.
Cat. No.: En164-71/1-2021E-PDF; ISBN: 978-0-660-39154-0

Assessment data available from Government of Canada
Open Data: https://open.Canada.ca/en/open-data