

LAKE ERIE CANADIAN NEARSHORE Assessment

2018 HIGHLIGHTS
REPORT

Lake Erie Canadian nearshore assessment : highlights report (2019)

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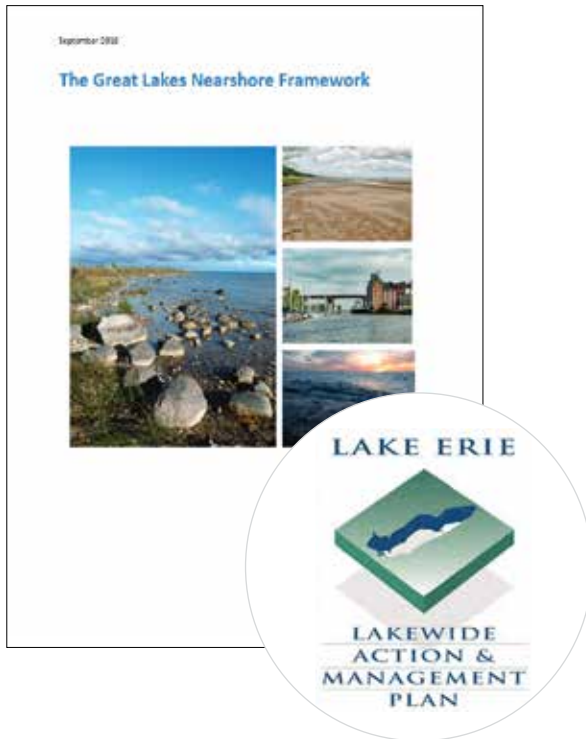
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Aussi disponible en français



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>

Acknowledgements

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OVERALL ASSESSMENT OF THE STATE OF NEARSHORE WATERS Resources

Lake Erie Canadian Great Lakes Nearshore Assessment, 2018 Results.
En164-71/2-2018E-PDF; ISBN: 978-0-660-39156-4

Canadian Great Lakes Nearshore Assessment, Detailed Methodology.
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](https://open.Canada.ca/en/open-data)

The Great Lakes Nearshore Framework

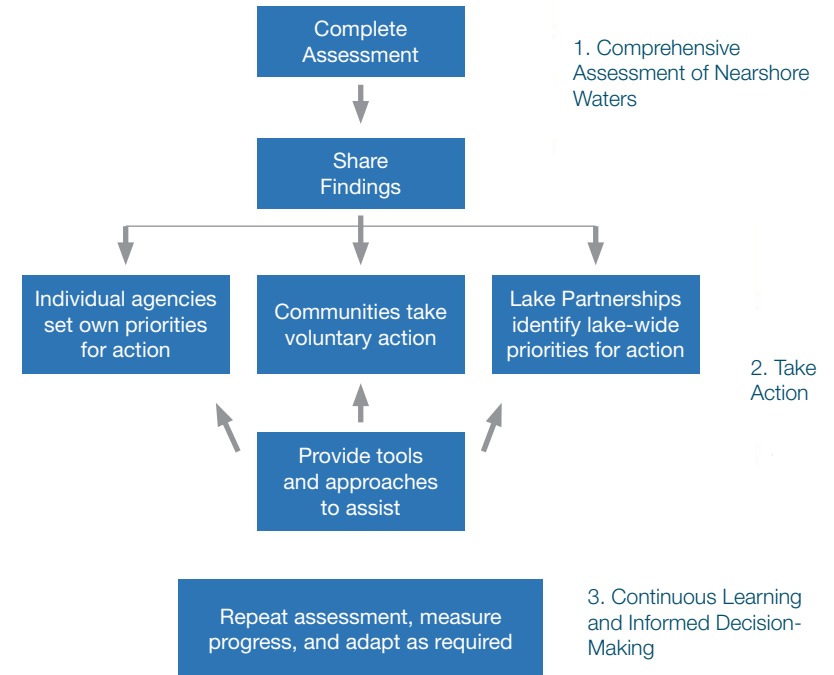
The Nearshore Waters

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 Erie 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 Erie, St. Clair River, Lake St. Clair and Detroit River assessment.

Nearshore Framework Components



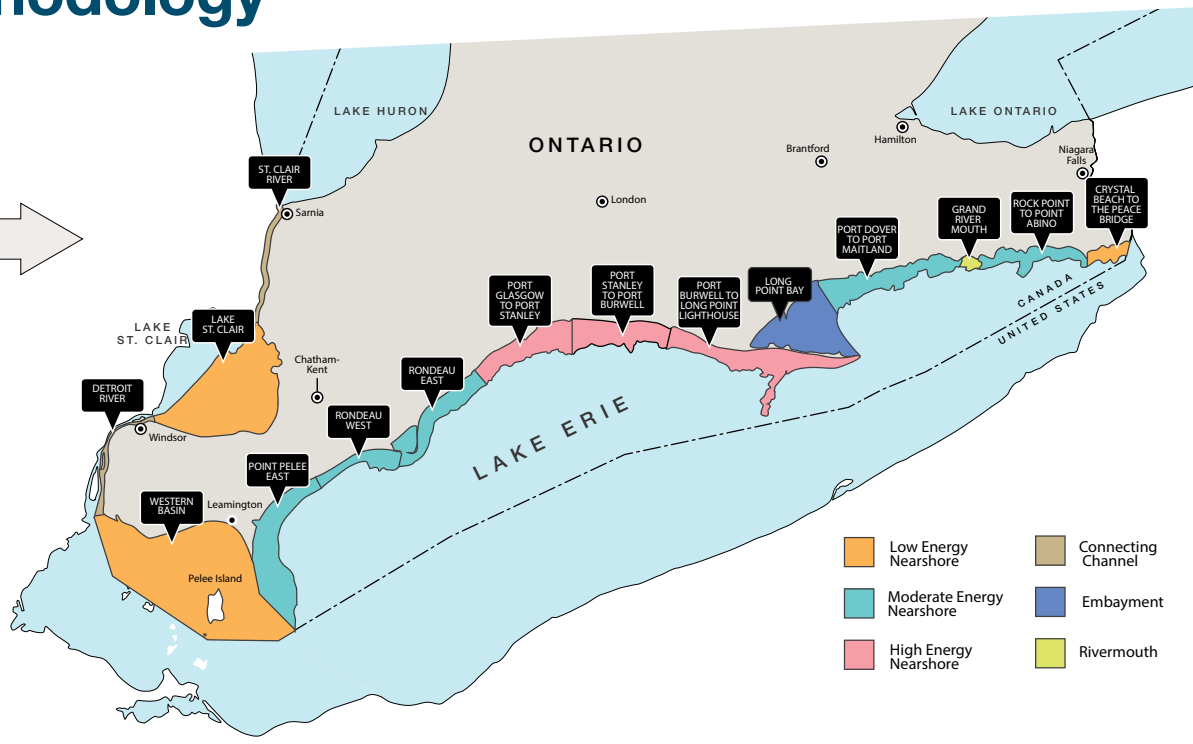
Long Term Outcomes:

- 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 15 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 12 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...

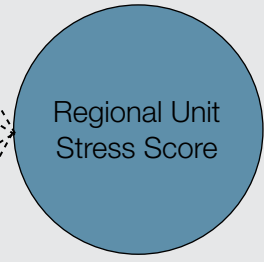
- Support healthy & productive habitats to sustain native species
Be free from negative impacts on chemical, physical or biological integrity
- Be free from pollutants harmful to humans, wildlife, aquatic organisms
- Be free from nutrients in amounts that promote excessive algae & cyanobacteria growth, 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

MEASURES

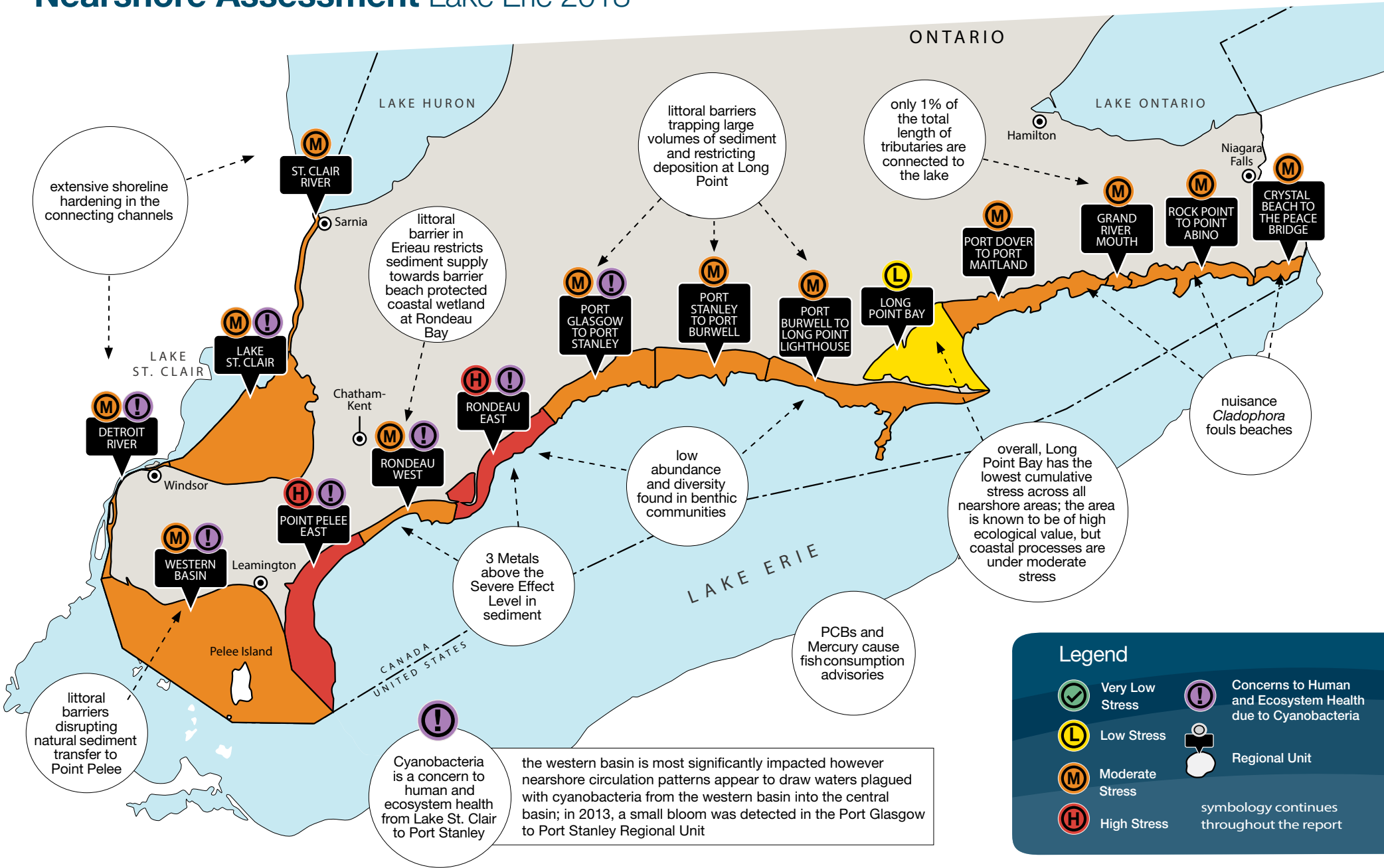
- Shoreline Hardening
Littoral Barriers
Tributary Connectivity
- Water Quality
Sediment Quality
Benthic Community
- Cyanobacteria
Cladophora
Hypoxia
- Beach Postings
Fish Consumption
Treated Drinking Water

CATEGORIES

- Coastal Processes
- Contaminants in Water & Sediment
- Nuisance & Harmful Algae
- Human Use



Nearshore Assessment Lake Erie 2018



Description of Assessment Measures & Thresholds

Nuisance & Harmful Algae

CYANOBACTERIA	CLADOPHORA	DISSOLVED OXYGEN/ HYPOXIA
<p>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., 2012-2017). 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 binational and domestic nutrient management efforts.</p>	<p><i>Cladophora</i> is a native filamentous 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. <i>Cladophora</i> 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.</p>	<p>Dissolved oxygen (DO) is the amount of oxygen available to aquatic organisms. Concentrations of DO below acceptable levels can lead to hypoxic conditions (i.e. little to no oxygen) and have adverse impacts on aquatic species in the nearshore. Dissolved oxygen is assessed using concentrations observed at Federal water quality monitoring sites for the most recent sample years (2012 and 2014). Thresholds are based on the Canadian Water Quality Guidelines for the Protection of Aquatic Life.</p>
<p>L Western Basin: No cyanobacteria bloom that exceeds 20% of the Regional Unit area detected in any 10-day composite</p> <p>Other Regional Units: No cyanobacteria bloom detected in any 10-day composite</p>	<p>L <20% coverage</p>	<p>L All samples greater than 6 mg/L</p>
<p>H Western Basin: Cyanobacteria bloom that exceeds 20% of the Regional Unit area detected in one or more 10-day composites</p> <p>Other Regional Units: Cyanobacteria bloom detected in one or more 10-day composites</p>	<p>M 20-35% coverage</p> <p>H >35% coverage</p>	<p>M One or more samples between 2 and 6 mg/L</p> <p>H One or more samples <2 mg/L</p>

Contaminants in Water & Sediment

WATER QUALITY	SEDIMENT QUALITY	BENTHIC COMMUNITY
<p>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 (2007, 2010, 2014 & 2016). Thresholds are based on best professional judgement.</p>	<p>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.</p>	<p>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 2004 survey sites using total benthos, taxon richness and evenness. Thresholds were set by a statistical analysis.</p>
<p>L 0 exceedances</p>	<p>L <ul style="list-style-type: none"> PCBs < No Effect Level Organochlorine pesticides & PAHs < Lowest Effect Levels Metals < Probable or Severe Effect Levels </p>	<p>L Benthic community condition is functional</p>
<p>M 1 - 2 exceedances</p>	<p>M <ul style="list-style-type: none"> PCBs > No Effect Level OR Organochlorine pesticides & PAHs >Lowest Effect Levels but >Severe Effect Levels Metals > Probable Effect Levels but < Severe Effect Levels </p>	<p>M Benthic community condition degraded but functional</p>
<p>H >2 exceedances</p>	<p>H Any contaminant > Severe Effect Level</p>	<p>H Benthic community condition degraded and not functional</p>

Description of Assessment Measures & Thresholds cont.

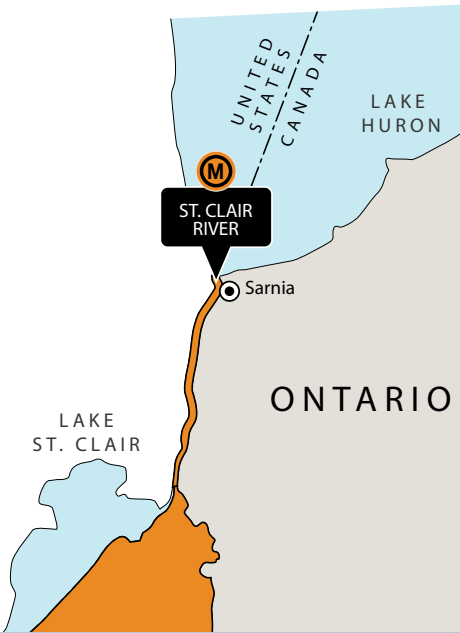
Coastal Processes

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 & eliminating 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 Aquatic Habitat Connectivity sub-indicator.
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 barriers	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 Erie, 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 2015 & 2016. Thresholds based on best professional judgement.	In Lake Erie, fish such as Walleye, Yellow Perch and Smallmouth Bass 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 Smallmouth Bass (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	

St. Clair River



M Moderate Stress

The St. Clair River is under moderate stress from the cumulative impact of shoreline hardening and contaminants causing fish consumption advisories. Shoreline hardening is the most extensive of all Regional Units. Of 56 km, only 6 km remains natural and these segments are mostly restricted to the area around Clay Creek. Fish consumption advisories are amongst the most restrictive across all Regional Units. Although the St. Clair River is a Great Lakes Area of Concern (AOC) due to mercury contaminated sediment, contaminant levels were low in sediment and water at provincial long-term monitoring sites. Three priority sediment zones contaminated with mercury are the subject of management planning and action in the Area of Concern.

Ecological Unit Type:
Connecting Channel

Area (ha): **1,800**



Industrialization, urbanization, and agriculture along the river

Change in water level from **Lake Huron to Lake St. Clair** is about **5 feet**

Spawning Habitat for **Lake Sturgeon**

Heavily **developed & armoured** shoreline

Watershed: primarily **agricultural**

Important transportation route; **no dams & no locks**

M Coastal Processes

H **SHORELINE HARDENING**
90% hardened

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

L **TRIBUTARY CONNECTIVITY**
86% of the total length of tributaries are hydrologically connected to the river

L Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

? **BENTHIC COMMUNITY**
Data Gap: no sampling station within Regional Unit

L **SEDIMENT QUALITY**
No contaminants found at levels of concern at ambient monitoring stations (see note above regarding localized contaminated sediment zones at Sarnia)

? Nuisance & Harmful Algae

? **CYANOBACTERIA**
Data Gap: data unavailable

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

NA **DISSOLVED OXYGEN/HYPOXIA**
Not Applicable: conditions not conducive to the development of hypoxic zones

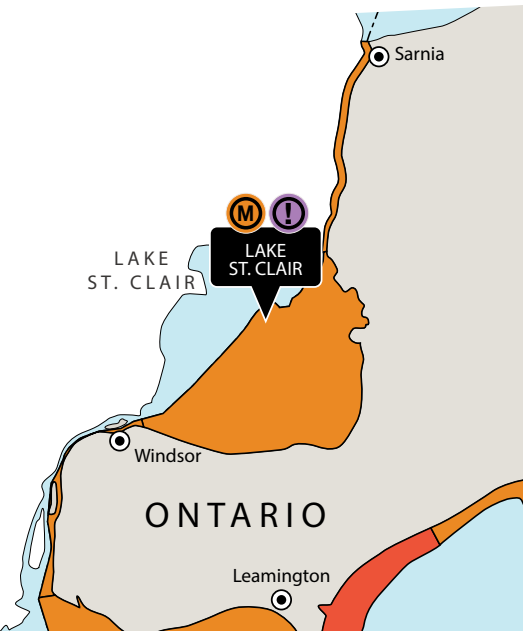
M Human Use

NA **BEACH POSTINGS**
Not applicable: no monitored beaches within the Regional Unit

M **FISH CONSUMPTION**
≤ 4 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Lake St. Clair



M Moderate Stress

! Concerns due to Cyanobacteria

Lake St. Clair is under moderate stress from the cumulative impact of littoral barriers, harmful algae, fish consumption advisories and beach postings. There are concerns to human and ecosystem health due to cyanobacteria blooms in 2016 & 2017. The total length of tributaries draining into Lake St. Clair is the highest of all Regional Units (>8,000 km) however connectivity is impeded in the Upper Thames watershed and on the North Sydenham River. Fish consumption advisories are amongst the most restrictive across all Regional Units. Of three beaches, the West Belle River beach was posted as unsafe for swimming for 100% of the time in July and August 2015.

Ecological Unit Type:
Low Energy Nearshore

Area (ha): **87,000**

Thames River

**High turbidity
nutrient enriched**

Strong influence on water chemistry close to the south shore

St. Clair River Delta: LARGEST DELTA in the Great Lakes with Significant coastal wetlands

Tributaries contain **Critical Habitat** for
5 Aquatic Species at Risk

3 Fish | 2 Molluscs

Walpole Island First Nations refer to the delta as **Bkejwanong** - "where the waters divide"

Very Shallow
max depth **6 m**



M Coastal Processes

M **SHORELINE HARDENING**
29% hardened

H **LITTORAL BARRIERS**
2 littoral barriers

M **TRIBUTARY CONNECTIVITY**
55% of the total length of tributaries are hydrologically connected to Lake St. Clair

M Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

? **BENTHIC COMMUNITY**
Data Gap: no sampling station within Regional Unit

M **SEDIMENT QUALITY**
Evidence of contamination due to PCBs

H Nuisance & Harmful Algae

H **CYANOBACTERIA**
Bloom detected in 2016 and 2017

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

? **DISSOLVED OXYGEN/HYPOXIA**
Data Gap: no sampling station within Regional Unit

M Human Use

H **BEACH POSTINGS**
Monitored beaches were posted 66% of the time in July & August

M **FISH CONSUMPTION**
≤ 6 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Detroit River



M Moderate Stress

! Concerns due to Cyanobacteria

The Detroit River is under moderate stress from the cumulative impact of shoreline hardening, harmful algae and contaminants in fish causing consumption advisories. There are concerns to human and ecosystem health due to a cyanobacteria bloom in 2016, likely a consequence of downstream drift from Lake St. Clair. Much of the shoreline has been modified. Fish consumption advisories are amongst the most restrictive across all Regional Units. The Detroit River is an Area of Concern. Mercury in water and PCBs in sediment were detected at provincial long-term monitoring stations.

Ecological Unit Type:
Connecting Channel

Area (ha): **5,000**

94% of the inflow to Lake Erie's western basin

Detroit River Marshes evaluated as a Provincially Significant Wetland

Spawning Habitat for **Lake Sturgeon**

Critical Habitat for the endangered **Northern Madtom** fish

Heavily **developed & armoured** shoreline

Watershed: primarily **agricultural**

Important transportation route; **no dams & no locks**



M Coastal Processes

H **SHORELINE HARDENING**
84% hardened

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

L **TRIBUTARY CONNECTIVITY**
100% of the total length of tributaries are hydrologically connected to the river

M Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

? **BENTHIC COMMUNITY**
Data Gap: no sampling station within Regional Unit

M **SEDIMENT QUALITY**
Evidence of contamination due to PCBs

H Nuisance & Harmful Algae

H **CYANOBACTERIA**
Bloom detected in 2016

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

NA **DISSOLVED OXYGEN/HYPOXIA**
Not Applicable: conditions not conducive to the development of hypoxic zones

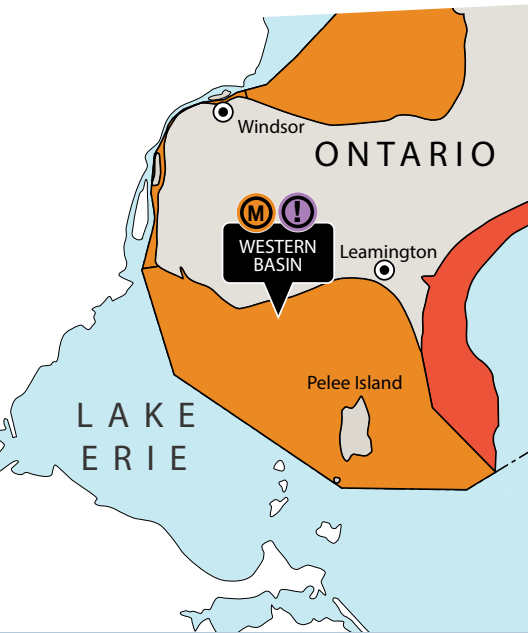
M Human Use

NA **BEACH POSTINGS**
Not applicable: no monitored beaches within the Regional Unit

M **FISH CONSUMPTION**
≤ 5 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Western Basin



M Moderate Stress

! Concerns due to Cyanobacteria

The Western Basin is under moderate stress from the cumulative impact of littoral barriers, contaminants in sediment, water and in fish causing consumption advisories, harmful algae and beach postings. There are concerns to human and ecosystem health due to cyanobacteria blooms in 2013 & 2015 - 2017. In August 2015, the bloom covered upwards of 60% of the Regional Unit. Fish consumption advisories amongst the most restrictive across all Regional Units. During July and August 2016, Holiday Beach was posted as unsafe for swimming 100% of the time.



Ecological Unit Type:
Low Energy Nearshore

Area (ha): **157,900**

87% of the shoreline is hardened

5 littoral barriers impact sediment supply to **Point Pelee National Park**

40% Binalational Target: **reduction** in spring & annual **Phosphorous** loads (total and soluble reactive) from priority Tributaries

Watershed = **Agricultural**

Very Shallow Average depth **7.5 m**

Spawning & nursery area for **Walleye**

Middle Island = southern most point in **Canada** (41° north latitude)

M Coastal Processes

M **SHORELINE HARDENING**
43% hardened

H **LITTORAL BARRIERS**
5 littoral barriers

L **TRIBUTARY CONNECTIVITY**
78% of the total length of tributaries are hydrologically connected to Lake Erie

M Contaminants in Water & Sediment

M **WATER QUALITY**
1 sample recorded at levels above guidelines (mercury)

M **BENTHIC COMMUNITY**
Average abundance, diversity and proportion of sensitive species

M **SEDIMENT QUALITY**
PCBs found above the No Effect Level and 3 PAHs found above the Lowest Effect Level

H Nuisance & Harmful Algae

H **CYANOBACTERIA**
Significantly impacted by blooms in 2013, 2015, 2016, and 2017

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

L **DISSOLVED OXYGEN/HYPOXIA**
Levels of dissolved oxygen are within acceptable range for aquatic life

M Human Use

H **BEACH POSTINGS**
Monitored beaches were posted 47% of the time in July & August

M **FISH CONSUMPTION**
≤ 7 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Point Pelee East



H High Stress

! Concerns due to Cyanobacteria

Point Pelee East is under high stress from the cumulative impact of low benthic community quality, harmful algae and beach postings. There are concerns to human and ecosystem health due to cyanobacteria blooms in 2012 – 2017. Portions of the shoreline are subject to high erosion rates, especially along Point Pelee National Park, due to restricted sediment transport caused by littoral barriers in the Western Basin Regional Unit. Benthic community reflects high stress as the relative abundance and diversity of benthic invertebrate communities is low. In July 2016, all four beaches were open but in August 2016 and the 2015 Hillman Beach and Getty's Beach were posted as unsafe for swimming 40% of the time.

Ecological Unit Type:
Moderate Energy Nearshore

Area (ha): **43,200**



Point Pelee National Park (most southern tip of mainland Canada)

Globally unique
Sand Spit Savannah

Critical Habitat for:
**Channel Darter
Spotted Gar
Lake Chubsucker**

Stopover habitat for
**migratory birds &
Monarch butterflies**

RAMSAR wetland

large areas of **coastal wetlands**

Watershed: primarily **agricultural**

Wheatley Harbour = largest fish-processing centre on the Great Lakes & major freshwater commercial fishing port

Wheatley Provincial Park contains a provincially significant wetland

M Coastal Processes

M **SHORELINE HARDENING**
39% hardened

M **LITTORAL BARRIERS**
1 littoral barrier

L **TRIBUTARY CONNECTIVITY**
100% of the total length of tributaries are hydrologically connected to Lake Erie

H Contaminants in Water & Sediment

? **WATER QUALITY**
Data Gap: no sampling station within Regional Unit

H **BENTHIC COMMUNITY**
Low abundance and diversity

? **SEDIMENT QUALITY**
Data Gap: no sampling station within Regional Unit

H Nuisance & Harmful Algae

H **CYANOBACTERIA**
A significant portion impacted in 2013 & 2015, and to a lesser extent in 2014 & 2016

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

? **DISSOLVED OXYGEN/HYPOXIA**
Data Gap: no sampling station within Regional Unit

M Human Use

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

L **FISH CONSUMPTION**
≤ 14 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Rondeau West



M Moderate Stress

I Concerns due to Cyanobacteria

Rondeau West is under moderate stress from the cumulative impact of harmful algae, as well as contaminants in sediment and water. There are concerns to human and ecosystem health due to cyanobacteria blooms in 2014 – 2016 that covered over 2% of the Regional Unit. These blooms are likely to have travelled from the Western Basin. At provincial long-term monitoring stations three metals (arsenic, iron and manganese) above the severe effect level were detected in sediment. The jetty at Erieau is not a source of stress in this Regional Unit, but traps sediment supplied by naturally eroding bluffs from travelling east.

Ecological Unit Type:
Moderate Energy Nearshore

Area (ha): **10,900**

Nearshore backed by Eroding Bluffs

Clay substrate

Jetty @ town of Erieau **restricts** sediment supply towards Rondeau Provincial Park

aquatic Species at Risk: **Silver Chub, Eastern Pondmussel, Spotted Gar**



L Coastal Processes

M **SHORELINE HARDENING**
35% hardened

L **LITTORAL BARRIERS**
0 littoral barriers

L **TRIBUTARY CONNECTIVITY**
100% of the total length of tributaries are hydrologically connected to Lake Erie

M Contaminants in Water & Sediment

M **WATER QUALITY**
1 sample recorded at levels above guidelines (mercury)

L **BENTHIC COMMUNITY**
High proportion of sensitive species

H **SEDIMENT QUALITY**
3 metals found above the Severe Effect Level

H Nuisance & Harmful Algae

H **CYANOBACTERIA**
Significant bloom in 2015, and to a much lesser extent in 2014 & 2016

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

L **DISSOLVED OXYGEN/HYPOXIA**
Levels of dissolved oxygen are within acceptable range for aquatic life

L Human Use

M **BEACH POSTINGS**
Monitored beaches were posted 19% of the time in July & August

L **FISH CONSUMPTION**
≤ 16 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Rondeau East



H High Stress

I Concerns due to Cyanobacteria

Rondeau East is under high stress from the cumulative impact of harmful algae and contaminants in water and sediment. There are concerns to human and ecosystem health due to cyanobacteria blooms in 2013 – 2015 that travelled from the western basin. Benthic community abundance and proportion of sensitive species is low. At provincial long-term monitoring stations three metals (arsenic, iron and manganese) above the severe effect level were detected in sediment. The littoral barrier at Erieau acts as a sediment trap, restricting sand supply from the Rondeau West Regional Unit to the barrier protected coastal wetland at Rondeau Provincial Park.

Ecological Unit Type:
Moderate Energy Nearshore

Area (ha): **23,900**

Rondeau Provincial Park

2nd oldest provincial park in Ontario

Low-lying sand spit with ridges and sloughs

Major **waterfowl** staging area (**Important Bird Area**)



Rondeau Bay = critical habitat for aquatic Species at Risk

Watershed: primarily **agricultural**

~2,000 hectares of wetlands

Eastern & central portion feature high bluffs

L Coastal Processes

L **SHORELINE HARDENING**
24% hardened

M **LITTORAL BARRIERS**
1 littoral barrier

L **TRIBUTARY CONNECTIVITY**
100% of the total length of tributaries are hydrologically connected to Lake Erie

H Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

H **BENTHIC COMMUNITY**
Slightly above average abundance, average diversity & proportion of sensitive species

H **SEDIMENT QUALITY**
3 metals found above the Severe Effect Level

H Nuisance & Harmful Algae

H **CYANOBACTERIA**
Impacted by blooms in 2013 and 2014 with slightly larger coverage in 2015

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

? **DISSOLVED OXYGEN/HYPOXIA**
Data Gap: no sampling station within Regional Unit

M Human Use

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

L **FISH CONSUMPTION**
≤ 11 meals/month

NA **DRINKING WATER**
Not applicable: no drinking water plant

Port Glasgow to Port Stanley



M Moderate Stress

I Concerns due to Cyanobacteria

Port Glasgow to Port Stanley is under moderate stress from the cumulative impact of contaminants in water and harmful algae. There are concerns to human and ecosystem health due to a cyanobacteria bloom in July 2013 that covered more than 2% of the Regional Unit that travelled from the western basin. The relative abundance, diversity and proportion of sensitive species in the benthic community is average quality. There are two beaches and only one had postings; the Port Stanley East Rest beach was open for swimming 100% of the time in July and August 2015 & 2016. This is the only Regional Unit under low stress for all three Coastal Process measures and retains the highest amount of natural shoreline.



Ecological Unit Type:
High Energy Nearshore

Area (ha): **24,400**

Eroding Bluffs generate sediment for Long Point

Nearshore habitat supports Lake Erie's Fishery

Watershed: highly **agricultural**

John E. Pearce Provincial Park characterized by unique **Carolinian forest** atop eroding bluffs

L Coastal Processes

L **SHORELINE HARDENING**
5% hardened

L **LITTORAL BARRIERS**
0 littoral barriers

L **TRIBUTARY CONNECTIVITY**
99% of the total length of tributaries are hydrologically connected to Lake Erie

L Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

M **BENTHIC COMMUNITY**
Slightly above average abundance, average diversity & proportion of sensitive species

L **SEDIMENT QUALITY**
Some metals found in sediment but not at levels of concern

H Nuisance & Harmful Algae

H **CYANOBACTERIA**
Cyanobacteria bloom was detected in 2013

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

L **DISSOLVED OXYGEN/HYPOXIA**
Levels of dissolved oxygen are within acceptable range for aquatic life

L Human Use

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

L **FISH CONSUMPTION**
≤ 11 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Port Stanley to Port Burwell



M Moderate Stress

Port Stanley to Port Burwell is under moderate stress from the cumulative impact of littoral barriers and low dissolved oxygen. The three littoral barriers trap large volumes of sand and modify nearshore substrate. Benthic community measures indicate high stress as the relative proportion of sensitive species is low. This is the only Regional Unit where dissolved oxygen was below the acceptable range for aquatic life, and in 2012, hypoxic conditions were responsible for dead fish washing up onto the shore. A binational target of 40% reduction in western and central basin total phosphorus loads has been set to reduce central basin hypoxia.



Ecological Unit Type:
Moderate Energy Nearshore

Area (ha): **25,100**

2 Large jetties **trap sediment** & modify nearshore substrate

small, localized **Smallmouth Bass** fishery

Town of **Port Stanley** founded because of fishing activity

Presence of **Silver Chub** & **Lake Sturgeon**

2 Provincial Parks with sandy beaches **Port Burwell** **Port Bruce**

M Coastal Processes

L **SHORELINE HARDENING**
10% hardened

H **LITTORAL BARRIERS**
3 littoral barriers

M **TRIBUTARY CONNECTIVITY**
75% of the total length of tributaries are hydrologically connected to Lake Erie

M Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

H **BENTHIC COMMUNITY**
Low proportion of sensitive species

L **SEDIMENT QUALITY**
Metals found in sediment but not at levels of concern

M Nuisance & Harmful Algae

L **CYANOBACTERIA**
No blooms

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

M **DISSOLVED OXYGEN/HYPOXIA**
4 of 23 recent samples are below acceptable range for aquatic life

L Human Use

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

L **FISH CONSUMPTION**
≤ 11 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Port Burwell to Long Point Lighthouse



M Moderate Stress

Port Burwell to Long Point Lighthouse is under moderate stress from the cumulative impact of littoral barriers, lack of tributary connectivity and degraded benthic community. A dam on Big Otter Creek impedes connectivity for upwards of 185 km of tributaries. The pier at Port Burwell traps longshore transport of sediment to Long Point, starving the sand spit of sediment needed for beach replenishment. The benthic community is highly stressed as the relative abundance and diversity of species is low. Of the three beaches, two were open for swimming 100% of the time in July and August 2015 & 2016 (Old Park and New Park Beaches).

Ecological Unit Type:
High Energy Nearshore

Area (ha): **35,100**

Clear Creek Ridge extends underwater **half the width** of Lake Erie

Eroding **high bluffs** in the west

1.5 km **sandy beaches** at Long Point Provincial Park

Presence of **Eastern Sand Darter**: small, endangered nearshore fish

Landuse is **highly agricultural**

M Coastal Processes

L **SHORELINE HARDENING**
10% hardened

M **LITTORAL BARRIERS**
1 littoral barrier

M **TRIBUTARY CONNECTIVITY**
66% of the total length of tributaries are hydrologically connected to Lake Erie

H Contaminants in Water & Sediment

? **WATER QUALITY**
Data Gap: no sampling station within Regional Unit

H **BENTHIC COMMUNITY**
Low abundance and diversity

? **SEDIMENT QUALITY**
Data Gap: no sampling station within Regional Unit

L Nuisance & Harmful Algae

L **CYANOBACTERIA**
No blooms

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

L **DISSOLVED OXYGEN/HYPOXIA**
Levels of dissolved oxygen are within acceptable range for aquatic life

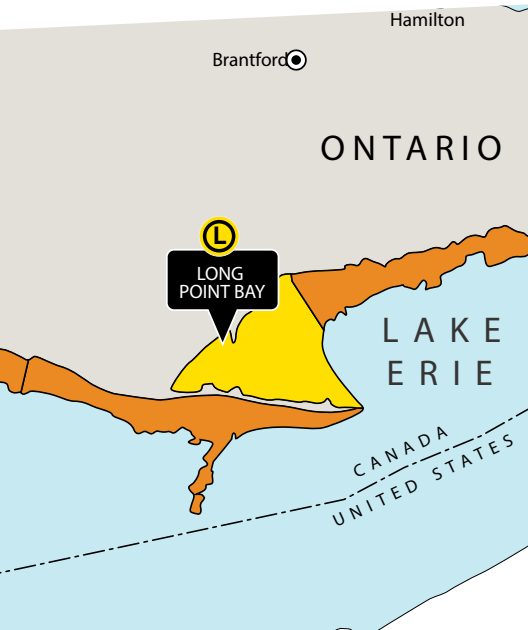
L Human Use

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

L **FISH CONSUMPTION**
≤ 16 meals/month

NA **DRINKING WATER**
Not applicable: no drinking water plant

Long Point Bay



L Low Stress

Long Point Bay is the only Regional Unit under overall low stress. Coastal processes are under moderate stress from the cumulative impact of lack of tributary connectivity and littoral barriers. Seven barriers impede connectivity for approximately 350 km of tributaries, particularly along Big Creek. Relative to the other Regional Units, benthic community quality is high and characterized by high abundance, diversity and proportion of sensitive species. As the beach at Turkey Point Provincial Park was open for swimming 100% of the time in July and August 2015 & 2016, this is the only Regional Unit with no beach postings.



Ecological Unit Type:
Sheltered Embayment

Area (ha): **48,900**

Long Point Peninsula = longest freshwater sand spit in the world

Phragmites = threat to coastal wetland health

Atlantic Flyway: > 300 different migratory bird species

Largest Coastal wetland in Lake Erie, ~9,000 hectares

2 National Wildlife Areas:
Long Point & Big Creek

2 Provincial Parks:
Turkey Point & Long Point

1 World Biosphere Reserve: **Long Point**

1 Ramsar Site: **Long Point**

1 Important Bird Area: **Long Point Peninsula and Marshes**

M Coastal Processes

L **SHORELINE HARDENING**
22% hardened

M **LITTORAL BARRIERS**
1 littoral barrier

M **TRIBUTARY CONNECTIVITY**
37% of the total length of tributaries are hydrologically connected to Lake Erie

L Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

L **BENTHIC COMMUNITY**
High abundance, diversity and proportion of sensitive species

L **SEDIMENT QUALITY**
No contaminants found at levels of concern

L Nuisance & Harmful Algae

L **CYANOBACTERIA**
No blooms

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

L **DISSOLVED OXYGEN/HYPOXIA**
Levels of dissolved oxygen are within acceptable range for aquatic life

L Human Use

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

L **FISH CONSUMPTION**
≤ 11 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Port Dover to Port Maitland



M Moderate Stress

Port Dover to Port Maitland is under moderate stress from the cumulative impact of shoreline hardening and nuisance algae. The length of shoreline is roughly 75 km, and the longest stretch that remains natural is only 3 km. A high proportion of nuisance *Cladophora* was detected and is a source of high stress as the accumulation can foul beaches and the nearshore. The distribution of *Cladophora* is fairly even in the Regional Unit within the photic (light) zone. The one beach in the Regional Unit was open for swimming 100% of the time in July and August 2016, but in 2015 was posted in both July & August.



Ecological Unit Type:
Moderate Energy Nearshore

Area (ha): **29,000**

2 Provincial Parks: **Selkirk** and **James N. Allan**

History of **intense industry** at Nanticoke

Nearshore Shoals provide local fishing opportunities

Town of **Port Dover** founded because of **fishing activity**

Shoreline: dominated by **bedrock headlands** and **shoals**

Sandy beaches between headlands

Accumulation of *Cladophora* (**nuisance algae**) fouts beaches

M Coastal Processes

H **SHORELINE HARDENING**
61% hardened

M **LITTORAL BARRIERS**
1 littoral barrier

L **TRIBUTARY CONNECTIVITY**
91% of the total length of tributaries are hydrologically connected to Lake Erie

L Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

L **BENTHIC COMMUNITY**
High diversity

L **SEDIMENT QUALITY**
No contaminants found at levels of concern

M Nuisance & Harmful Algae

L **CYANOBACTERIA**
No blooms

H **CLADOPHORA**
Covers 53%

L **DISSOLVED OXYGEN/HYPOXIA**
Levels of dissolved oxygen are within acceptable range for aquatic life

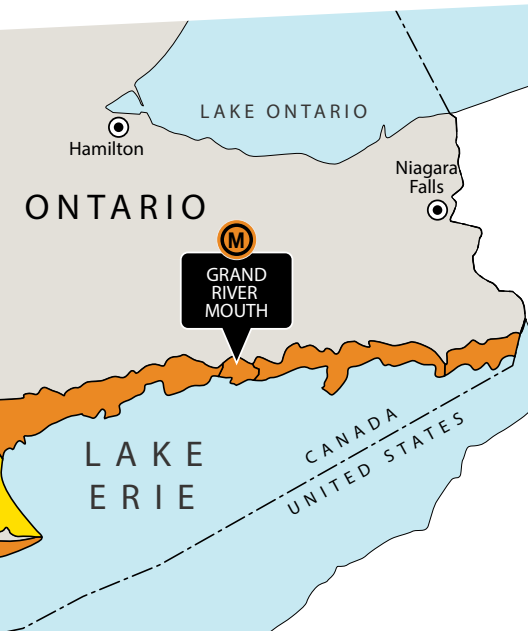
L Human Use

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

L **FISH CONSUMPTION**
≤ 10 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Grand River Mouth



M Moderate Stress

The Grand River Mouth is under moderate stress, primarily due to very poor tributary connectivity. The dam at Dunnville impedes tributary connectivity for 6,000 km of tributary length or 99% of the total. This is a significant source of stress on the nearshore, with potential adverse impacts on the health of the aquatic ecosystem. Although this is the smallest Regional Unit by area, it extends up river to Dunnville and has approximately 50 km of shoreline, with hardening at the mouth of the river and on the east bank.



Ecological Unit Type:
Large Rivermouth

Area (ha): **3,200**

Provincially Significant Wetlands
at river mouth threatened by invasive Phragmites

Critical Habitat for Mapleleaf
Mussel

Grand River = **largest river** on the
north shore of Lake Erie

Dunnville Dam impedes **fish passage**:
Only **1%** of the river's **6,000** km of tributaries are
hydrologically connected

1 Provincial Park **Rock Point**
beach features **coral reef fossils**
embedded in limestone shelf

H Coastal Processes

M **SHORELINE HARDENING**
26% hardened

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

H **TRIBUTARY CONNECTIVITY**
1% of the total length of
tributaries are hydrologically
connected to Lake Erie

L Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in
excess of guidelines

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

L **SEDIMENT QUALITY**
Metals found in sediment but
not at levels of concern

L Nuisance & Harmful Algae

L **CYANOBACTERIA**
No blooms

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

L **DISSOLVED OXYGEN/HYPOXIA**
Levels of dissolved oxygen are
within acceptable range for
aquatic life

L Human Use

L **BEACH POSTINGS**
Monitored beaches were
posted 3% of the time
in July & August

L **FISH CONSUMPTION**
≤ 11 meals/month

L **DRINKING WATER**
No adverse water quality
incidents

Rock Point to Point Abino



M Moderate Stress

Rock Point to Point Abino is under moderate stress from the cumulative impact of shoreline hardening, a degraded benthic community, nuisance algae and beach postings. Of the 63 km of shoreline, only 14 km remains natural and in small segments (none longer than 1.5 km) interspersed between long stretches of altered shoreline. Benthic community composition includes slightly high diversity but low proportion of sensitive species. Nuisance *Cladophora* is a source of high stress as the accumulation can foul beaches and much of the nearshore. *Cladophora* growth was most dense east of the Welland Canal. There are ten beaches, the most of all Regional Units, each of which was posted on average for over 10% of the time in July and August 2015 & 2016.



Ecological Unit Type:
Moderate Energy Nearshore

Area (ha): **15,400**

Small, **Narrow** Watershed

Welland Canal connects Lake Erie to Lake Ontario & allows **> 3,000 vessels** a year to bypass Niagara Falls

~ 40,000,000 metric tonnes of cargo/year

10 beaches used heavily for **recreation**

Shoreline habitat important for **Species at Risk**

Rocky nearshore provides **major** spawning area for **Smallmouth Bass**

Accumulation of *Cladophora* (**nuisance algae**) along the coast

M Coastal Processes

H **SHORELINE HARDENING**
76% hardened

M **LITTORAL BARRIERS**
1 littoral barrier

L **TRIBUTARY CONNECTIVITY**
100% of the total length of tributaries are hydrologically connected to Lake Erie

M Contaminants in Water & Sediment

? **WATER QUALITY**
Data Gap: no sampling Station within Regional Unit

M **BENTHIC COMMUNITY**
Average abundance, slightly high diversity and slightly low proportion of sensitive species

? **SEDIMENT QUALITY**
Data Gap: no sampling Station within Regional Unit

M Nuisance & Harmful Algae

L **CYANOBACTERIA**
No blooms

H **CLADOPHORA**
Covers 38%

? **DISSOLVED OXYGEN/HYPOXIA**
Data Gap: no sampling station within Regional Unit

M Human Use

H **BEACH POSTINGS**
Monitored beaches were posted 30% of the time in July & August

L **FISH CONSUMPTION**
≤ 10 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Crystal Beach to the Peace Bridge



M Moderate Stress

Crystal Beach to the Peace Bridge is under moderate stress from the cumulative impact of shoreline hardening, littoral barriers and beach postings. With only 6 km of 26 km unaltered, shoreline hardening is extensive. Combined with the presence of four littoral barriers, coastal processes related to sediment supply and deposition are under stress. Of the six beaches, Windmill Point Park and Campground was open for 100% of the time in July and August 2015 & 2016 – all other beaches were posted, on average, 39% of the time. Nuisance *Cladophora* was detected in the nearshore, and is known to foul beaches.

Ecological Unit Type:
Low Energy Nearshore

Area (ha): **6,600**

SMALL Watershed: mixed use agriculture & urban

Bedrock headlands with **sand embayments**

Point Abino headland shelters from large westerly waves

Smallmouth Bass spawning area

Point Abino Wetland Complex: **provincially significant wetland** with spawning habitat for **Yellow Perch**

Crystal Beach - popular summer tourist destination



H Coastal Processes

H **SHORELINE HARDENING**
75% hardened

H **LITTORAL BARRIERS**
4 littoral barriers

L **TRIBUTARY CONNECTIVITY**
100% of the total length of tributaries are hydrologically connected to Lake Erie

M Contaminants in Water & Sediment

L **WATER QUALITY**
No contaminants found in excess of guidelines

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

M **SEDIMENT QUALITY**
Evidence of contamination due to PCBs

L Nuisance & Harmful Algae

L **CYANOBACTERIA**
No blooms

M **CLADOPHORA**
Covers 30%

L **DISSOLVED OXYGEN/HYPOXIA**
Levels of dissolved oxygen are within acceptable range for aquatic life

M Human Use

H **BEACH POSTINGS**
Monitored beaches were posted 33% of the time in July & August

L **FISH CONSUMPTION**
≤ 10 meals/month

L **DRINKING WATER**
No adverse water quality incidents

Major Threats to Lake Erie Nearshore Waters

Shoreline Alteration

Results from this condition assessment show a lakewide trend of moderate to high stress in the Coastal Processes category. Of the 15 Lake Erie Regional Units, only five have less than 25% of the coast hardened, all within the central basin between Rondeau East and Long Point Bay. Barriers to littoral transport are a concern in nine Regional Units. The existence of these artificial barriers threatens important ecosystems. Coastal wetlands at Point Pelee National Park, Rondeau Bay and Long Point were formed over thousands of years behind the protection of sandy depositional barrier beaches that rely on a continuous supply of sand and gravel from longshore sediment transport. The stability of these barrier beach systems and coastal wetlands they shelter are threatened by not only the lack of sand supply caused by shoreline hardening and littoral barriers, but the added current and future impact from climate change such as reduced winter

Harmful Algae

During the summer months, harmful algal blooms are a regular occurrence in the western basin of Lake Erie. Resulting from excessive nutrient input, shallow depths and warm waters, blooms of cyanobacteria produce toxins (i.e., microcystin) in such concentrations that they can pose a significant threat to human and ecological health. In August 2014, detections of these toxins resulted in the closure of a drinking water treatment plant in Toledo, Ohio, as well as at private water intakes on Pelee Island. This incident affected more than 500,000 people who were advised against drinking or recreating in Lake Erie water.

The western basin is the area most significantly impacted by cyanobacteria blooms. Results of this assessment revealed that in 2013, 2015, 2016 and 2017 the extent of blooms was over 20% of the area. These blooms are largely driven by excess nutrient input from the Maumee River, but localized harmful algal blooms associated with tributary inputs occur in nearshore areas on

ice cover, high water levels and increased wave action from more intense storms. The protective barrier beach at Rondeau Bay was breached in 2018 and the coastal wetland is now exposed and vulnerable to Lake Erie wave action.

Landowners are often compelled to construct walls and structures with concrete and rip-rap to protect properties, roads, and buildings along the shore. The cost to protect the shoreline is high and often exceeds the value of the infrastructure that communities are trying to protect. Armouring the shoreline is for the most part, unsustainable in the long-term as it can scour the lake bottom and undermine the structure. Expert opinion is that the severity of coastal hazards has reached the point where innovative solutions are needed – including land use changes, large-scale habitat restoration and migration of development further from the coast.¹

the south shore of Lake St. Clair and at Leamington. Nearshore circulation patterns (wind and wave action) draw waters plagued with cyanobacteria from the western basin eastward into the central basin (also a factor driving hypoxia; as algae decomposes at the lake bed, oxygen levels are depleted). In 2013, a bloom was detected in the Port Glasgow to Port Stanley Regional Unit, likely having travelled over 100 km from the western basin.

There is broad consensus among the scientific community that the primary driver of these harmful algal blooms is excesses in phosphorus input from non-point sources. For the most part, this driver is manageable, and the governments of Canada and the United States have developed phosphorus reduction plans for Lake Erie², with a goal to reduce bloom extent and severity to those detected in 2012 (a mild bloom year) 9 years out of 10. With partners, concerted efforts are being made to reduce phosphorus.



Rondeau Bay breached barrier beach



Intense wave action on the shores



Satellite Image of 2014 Algae Bloom

Nearshore Framework Next Steps

The Nearshore Framework Assessment Cycle

The results of this assessment have been included in the 2018 Lake Erie 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 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 Erie has brought to light several limitations that may be improved upon in future including: the lack of information on nearshore bathymetry and substrate characteristics; understanding the distribution and wash-up of nuisance algae (*Cladophora*), and methods to confirm biological health in the Regional Units.

TAKING ACTION Case Study: The Niagara Coastal Community Collaborative

Upon learning of the preliminary assessment results, local environmentalists with an interest in collaborating to improve the overall health of their coast approached ECCC and in the fall of 2017, The Niagara Coastal Community Collaborative was formed. Comprised of local environmental non-government organizations, the Niagara Peninsula Conservation Authority, educational institutions, municipalities and federal and provincial agencies, The Collaborative adopted a flexible structure in which members commit to developing shared solutions and implementing actions within their own abilities and resources, towards improving coastal health. The Collaborative has identified the three ecological coastal priorities to focus their efforts: Nature Based Shorelines, Habitat and Species and Healthy Beaches.

Under the model of Collective Impact³, The Collaborative has been actively working to improve their understanding of the coast and to fill knowledge gaps. In partnership with ECCC researchers, they developed a Citizen Science *Cladophora* monitoring program, to track nuisance algae wash-up onto local beaches. Swim Drink Fish (SDF) and Niagara College Canada partnered with The Collaborative to host SDF's Lake



Erie recreational monitoring hub. As part of this work, The Collaborative will conduct citizen science recreational water quality monitoring of area beaches throughout the summers of 2019 to 2021. The Collaborative developed their own website (www.niagaracoastal.ca), online mapping tool and social media presence. Through the work of The Collaborative, additional community support is being built, and engagement enhanced, to leverage additional stakeholder knowledge and strive to improve the Lake Erie Shoreline.



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.	2015 (Imagery)
Littoral Barriers		2018 (delineation)
Tributary Connectivity	Ontario Ministry of Natural Resources and Forestry. Ontario Hydro Network – Watercourse (1:200,000);	2018
	Ontario Ministry of Natural Resources and Forestry. Ontario Dam Inventory.	2018
Water Quality	Ontario Ministry of Environment, Conservation and Parks. Great Lakes Nearshore – Water Chemistry.	2007, 2010, 2014 & 2016
Sediment Quality	Ontario Ministry of Environment, Conservation and Parks. Great Lakes Nearshore – Sediment Chemistry.	2007, 2010, 2014 & 2016
Benthic Community	Ciborowski, J. et al. 2004. Lake Erie Collaborative Comprehensive Survey (ECCS); Grapentine, L. Classification of Benthic Community Quality for Regional Units. 2018	2004 (data)
		2018 (statistical analysis)
Cyanobacteria	National Oceanic & Atmospheric Association. Harmful Algal Bloom Monitoring. 10-day composite images from the MODIS satellite, with Cyanobacteria Index algorithm.	June-October 2012-2017
<i>Cladophora</i>	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
Dissolved Oxygen/ Hypoxia	Environment and Climate Change Canada. Great Lakes Water Quality Monitoring and Surveillance Data. Lake Erie.	2012 & 2014
Beach Postings	Swim Drink Fish Canada. SWIMGuide.	July-August, 2015 - 2016
Treated Drinking Water	Ontario Ministry of Environment, Conservation and Parks. Drinking Water Treatment Plant Monitoring data.	2013 - 2017
Fish Consumption	Ontario Ministry of Environment, Conservation and Parks. Guide to Eating Ontario Fish Advisory Database.	2015 & 2017

Other Resources:

1. Chatham-Kent Lake Erie Shoreline Study: Zuzek Inc, 2019. Chatham-Kent Lake Erie Shoreline Study; Open File. Prepared for the Municipality of Chatham-Kent and the Lower Thames Valley Conservation Authority
2. Canada-Ontario Lake Erie Action Plan, February 2018:
https://www.canada.ca/content/dam/eccc/documents/pdf/great-lakes-protection/dap/action_plan.pdf
3. Kania, John, and Mark Kramer. "Collective Impact." Stanford Social Innovation Review 9, no. 1 (Winter 2011): 36-41

OVERALL ASSESSMENT OF THE STATE OF NEARSHORE WATERS Resources

Lake Erie Canadian Great Lakes Nearshore Assessment, 2018 Results. En164-71/2-2018E-PDF; ISBN: 978-0-660-39156-4

Canadian Great Lakes Nearshore Assessment, Detailed Methodology. 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](https://open.Canada.ca/en/open-data)