STATE OF THE GREAT LAKES 2025 REPORT

An overview of the status and trends of the Great Lakes ecosystem

EPA Canada

What are the Great Lakes Indicators Telling Us?

Can we drink the water?

Yes, once treated. The Great Lakes remain a source for producing high-quality drinking water.

Can we swim at the beaches?

Yes. However, some beaches are occasionally unsafe for swimming due to bacterial contamination, indicating pathogen risks.

Can we eat the fish?

Generally, yes. Great Lakes fish can be safely eaten by following consumption advisories. However, unrestricted consumption of many fish is not yet possible, which has a greater impact on communities that heavily rely on fish for food, and cultural, spiritual, or economic purposes.

Have levels of toxic chemicals declined in the environment?

Generally, yes. Many chemicals, such as PCBs and mercury, have declined significantly in the Great Lakes over the long term, however rates of decline have slowed in more recent years. Concentrations of some toxic chemicals still pose threats to human health and the environment.

Are the lakes supporting healthy wetlands and populations of native species?

Yes and no. Healthy coastal wetlands exist in each Great Lake basin. However, Great Lakes coastal wetlands vary in quality, with the healthiest areas generally occurring in northern locations where the footprint of human activity is lowest. Changes have taken place in the food webs of the Great Lakes to varying degrees, and the impacts of stressors such as invasive Dreissenid Mussels continue. Populations of native fish species such as Lake Trout and Lake Sturgeon have increased in response to restoration efforts in several areas across the Great Lakes.

Are nutrients in the lakes at acceptable levels?

No. High nutrient concentrations in parts of Lake Erie and in some embayments in other parts of the Great Lakes still contribute to blooms of toxic cyanobacteria and nuisance algae. Very low nutrient levels in the offshore waters of lakes Michigan, Huron, and Ontario have resulted in algal and organism production rates below desired levels. Only Lake Superior has relatively good nutrient conditions, which helps to maintain a healthy food web.

Are we limiting new introductions and the impacts of non-native and invasive species?

Yes and no. The rate of introduction of new non-native species to the Great Lakes basin has greatly declined. However, the impacts of established invasive species persist, and invasive species continue to spread within and between the Great Lakes.

Is groundwater negatively affecting the water quality of the lakes?

Generally, no. Groundwater typically provides good quality water to tributaries in the Great Lakes basin and to the Great Lakes. However, in some watersheds in the Great Lakes basin, groundwater contains elevated levels of pollutants, such as nitrate and chloride. There are also groundwater sites contaminated by other chemicals that are being actively investigated and remediated.

Are land use changes or other stressors impacting the lakes?

Yes. Watershed stressors such as population growth, land-use activities, habitat loss and degradation, and other factors contribute to impairments of Great Lakes water quality and ecosystem health.

Overall, the Great Lakes are assessed by the State of the Great Lakes indicators as **Fair** and the trend is **Unchanging**. There has been tremendous progress to restore and protect the Great Lakes, including the reduction of toxic chemicals, and a reduction in the establishment of new non-native aquatic species. Some indicators demonstrate that there are still significant challenges, including the impacts of nutrients, especially in Lake Erie and localized areas of the other Great Lakes, and the impacts of invasive species. The coordinated actions of many agencies, organizations, groups and individuals are accelerating efforts to protect and restore the Great Lakes so they can continue to be a reliable source for drinking water, fishing, recreation and other uses that support the region's economy.

What Is the Status of Each Lake?

Lake Superior's forested watershed and coastal wetlands help maintain water quality and a healthy aquatic ecosystem – Lake Superior is assessed as **Good** and **Unchanging**.

Lake Michigan's habitats support a diverse array of plant and animal species and its waters provide opportunities for swimming and recreational use. However, invasive species and other stressors affect water quality and the lake's food web – Lake Michigan is assessed as **Fair** and **Unchanging**.

Lake Huron provides opportunities for swimming and recreational use. It remains healthy despite algal blooms in some nearshore areas – Lake Huron is assessed as **Fair** to **Good** and **Unchanging**.

Lake Erie's successful Walleye hatches from previous years continue to support excellent recreational and commercial fisheries. However, elevated nutrient concentrations and algal blooms are persistent problems – Lake Erie is assessed as **Poor** and **No Trend**.

Lake Ontario shows improvements in Lake Trout and Lake Sturgeon populations, but nuisance algae like *Cladophora* is distributed across broad regions of the lake's nearshore zones – Lake Ontario is assessed as **Fair** and **Unchanging**.

Assessing the Great Lakes

Why are the Great Lakes important?

The Great Lakes contain one-fifth of the world's fresh surface water supply and together are one of the largest freshwater ecosystems on Earth, supporting rare and globally unique species. They provide a source of drinking water to approximately 20 million Americans and 10 million Canadians and are important to the economies of both Canada and the United States, supporting manufacturing, transportation, farming, tourism, recreation, energy production and other forms of economic growth. To the Indigenous communities around the basin, the Great Lakes waters, plants and wildlife provide a continuation of lifeways and a sense of identity.

How are governments working together to protect the Great Lakes?

The Great Lakes Water Quality Agreement, signed by the Governments of Canada and the United States, commits both countries to work cooperatively to restore and protect the water quality and ecosystem health of the Great Lakes. Canada and the United States work with Tribes, First Nations, Métis, provincial, state and municipal governments, watershed management agencies, other local public agencies, industry and the public to sustain a healthy Great Lakes ecosystem for the benefit of present and future generations of Canadians and Americans. For over half a century, the two countries and their many Agreement partners have worked together to protect this valuable resource.

How is the health of the Great Lakes assessed?

The Governments of Canada and the United States, together with their many Agreement partners, assess the overall health of the Great Lakes using a suite of ecosystem indicators. The indicators of ecosystem health are aligned with the General Objectives of the Great Lakes Water Quality Agreement. For this report, the nine indicators are supported by 42 sub-indicators with input from over 200 experts who contributed, analyzed, and reviewed available data to reach consensus on the current assessments. Data for most sub-indicators includes information current to 2022 or 2023. Status assessments* are generally described in terms of Good, Fair, or Poor conditions. Trends* are typically described as Improving, Unchanging, No Trend, or Deteriorating and are generally assessed over a 10-year period. Refer to the State of the Great Lakes 2025 Technical Report for all sub-indicator report assessments. *See page 42 for definitions.

What is assessed and how is the Great Lakes assessment used?

The suite of Great Lakes indicators focuses on the basin-wide assessments that include offshore or open water conditions, with some nearshore or land-based stresses included where they have an impact on the offshore water quality of the Great Lakes. The indicators are not designed to assess regional or local conditions.

Great Lakes indicator assessments help governments identify current and emerging challenges to Great Lakes water quality and ecosystem health. Indicator assessments also help governments evaluate the effectiveness of environmental programs and policies in place to address challenges and identify priorities. In addition, indicator assessments help inform and engage other stakeholders, including the public, and provide information that in turn supports efforts to restore and protect the Great Lakes.

Assessing the Great Lakes

2025 assessment of the nine Great Lakes indicators of ecosystem health

Great Lakes Indicator	2025 Assessment: Status and Trend
Drinking Water	**Status:** Good; **Trend:** Unchanging
Beaches	**Status:** Good; **Trend:** Unchanging
Fish Consumption	**Status:** Fair; **Trend:** Improving
Toxic Chemicals	**Status:** Fair; **Trend:** Unchanging to Improving
Habitat and Species	**Status:** Fair; **Trend:** Unchanging
Nutrients and Algae	**Status:** Poor to Fair; **Trend:** Unchanging
Invasive Species	**PREVENTION** **Status:** Good; **Trend:** No Trend
	IMPACT **Status:** Poor; **Trend:** No Trend
Groundwater	**Status:** Good; **Trend:** Undetermined
Watershed Impacts and Changes in Physical Conditions	**WATERSHED IMPACTS** **Status:** Fair; **Trend:** No Trend
	Changes in Physical Conditions: No Overall Assessment

STATUS

Good **Fair** **Poor** **Undetermined**

Impacts of Changing Physical Conditions in the Great Lakes

Changing physical conditions, such as warming waters, reduced ice cover, and altered precipitation patterns, can impact nutrient delivery and habitat quality. As changes are observed in the Great Lakes ecosystem, basin-wide and lake assessments remain critical to assess the impacts of these changes in order to protect and restore the Great Lakes.

DRINKING WATER

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should be a source of safe, high quality drinking water."

Status: GOOD
Trend: UNCHANGING

Approximately 10 million Canadians and 20 million Americans get their drinking water from public water supplies and municipal water systems supplied by surface waters of the Great Lakes.

Drinking Water

Assessment Highlights

The overall status of treated drinking water sourced from the Great Lakes is **Good** and the 10-year trend is **Unchanging**. The Great Lakes continue to be a good source for producing high-quality drinking water. As with all source waters, water from the Great Lakes must be treated to ensure it is safe to consume.

Ontario and U.S. state agencies assess the quality of treated drinking water for microbial, radiological, and chemical parameters in comparison to health standards. Monitoring protocols and reporting requirements regarding treated drinking water quality vary by country. Health-based violations of treated drinking water occur infrequently in both Canada and the U.S.

In Ontario, it is estimated that 65% of the population is supplied with treated drinking water sourced from the Great Lakes. In 2023, over 99.9% of municipal residential treated drinking water quality tests from systems using the Great Lakes as source water met Ontario Drinking Water Quality Standards.

Of the approximately 20 million U.S. residents served by the public water supplies sourced by the Great Lakes in 2023, 97% were serviced with drinking water that met all applicable health-based standards. Water treated at 99% of community water systems that draw from the Great Lakes met health-based standards. This indicator utilizes violations associated with source water that is processed and treated at the plant, such as violations associated with filtration, corrosion control, and/or maximum contaminant levels because they are indicative of source water quality. Violations associated with the distribution system, such as high levels of disinfection byproducts, lead service line replacement and public education were excluded from the report.

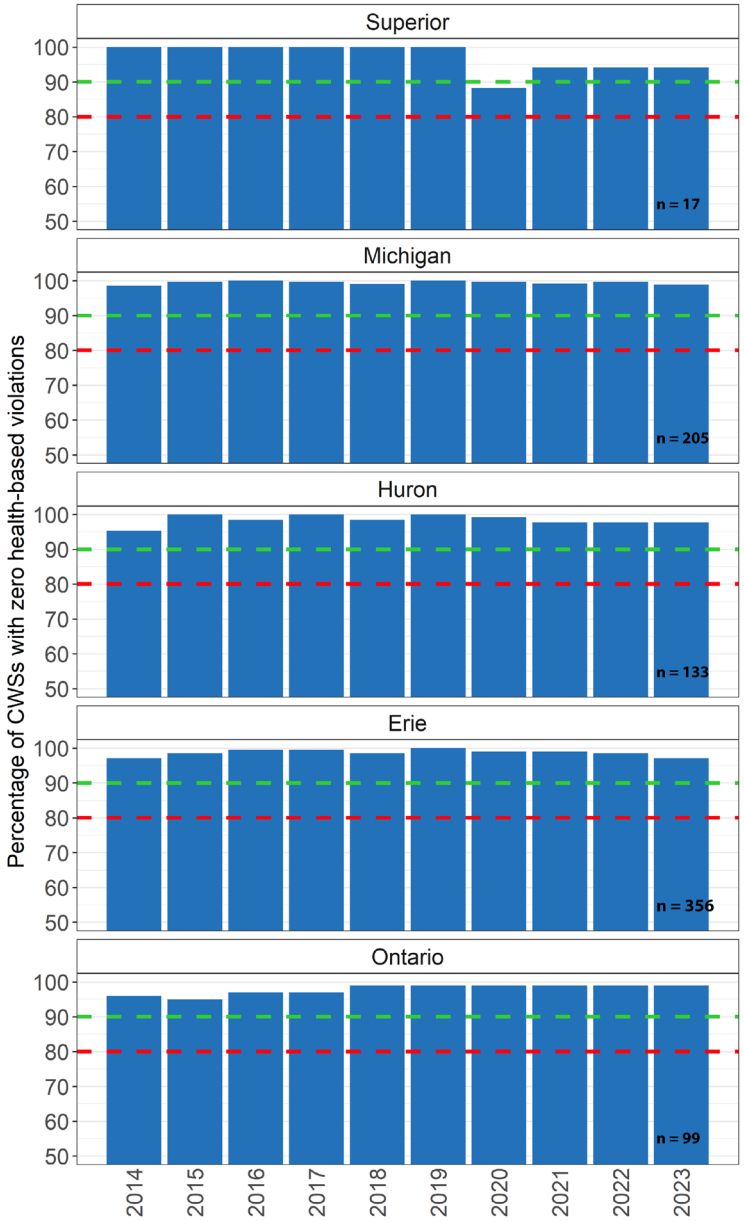
Sub-indicator supporting the Drinking Water assessment					
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Treated Drinking Water	Good & Deteriorating to Unchanging	Good & Unchanging	Good & Unchanging	Good & Unchanging	Good & Unchanging to Improving

STATUS

Good **Fair** **Poor** **Undetermined**

Drinking Water

Percentage of the U.S. Community Water Systems (CWS) from 2014-2023 meeting all health-based standards associated with processing and treating water in the plant before it leaves to the distribution system. Green and red dashed lines represent the Good-Fair and Fair-Poor status thresholds, respectively. N = number of U.S. water systems evaluated for the assessment.



BEACHES

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should allow for swimming and other recreational use, unrestricted by environmental quality concerns."

Status: GOOD
Trend: UNCHANGING

Great Lakes beaches are enjoyed by millions of residents and tourists each year and contribute significantly to local economies; however, some beaches are posted as unsafe for swimming or recreational use at times for various reasons such as bacterial contamination.

Beaches

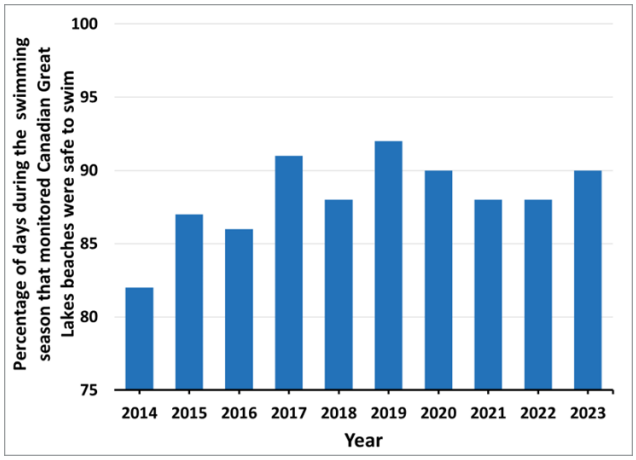
Assessment Highlights

The overall status of Beaches is **Good** and the 10-year trend is **Unchanging**. The Beaches indicator shows that most monitored Great Lakes beaches are safe for swimming and recreational use throughout much of the swimming season.

Each year, over 700 beaches along the Great Lakes shoreline are monitored for *Escherichia coli* (*E. coli*) as a measure of the risk to human health from fecal material contamination. These data are used to provide information to assess each Great Lake and the Great Lakes as a whole. Sources of *E. coli* can include overflow from wastewater treatment plants, runoff from the land, improperly working septic systems and large flocks of waterbirds.

The U.S. and Canada use different *E. coli* thresholds to determine when a beach is unsafe for swimming. Using data from the 2020 to 2023 swimming seasons, the percentage of days that monitored Canadian Great Lakes beaches met Ontario *E. coli* standards for swimming averaged 89% over this period. The U.S. Great Lakes beaches monitored from 2020 to 2023 were open and safe for swimming 94% of the time over this period. The status of monitored beaches was **Good** in all the lakes other than Lake Erie. Lake Erie beaches in Canada and the U.S. were open and safe for swimming approximately 83% (within the Canadian criteria for Good) and 80% (within the U.S. criteria for **Fair**) of the swimming season, respectively, resulting in a **Fair** to **Good** assessment.

Monitored Canadian Great Lakes beaches are consistently safe for swimming



Sub-indicator supporting the Beaches assessment					
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Beach Advisories	Good & Unchanging to Improving	Good & Improving	Good & Unchanging to Improving	Fair to Good & Unchanging	Good & Unchanging

STATUS

Good **Fair** **Poor** **Undetermined**

FISH CONSUMPTION

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should allow for human consumption of fish and wildlife unrestricted by concerns due to harmful pollutants."

Status: FAIR
Trend: IMPROVING

The Great Lakes support important commercial, recreational and subsistence fisheries; however, some chemicals present in the Great Lakes, including polychlorinated biphenyls (PCBs) and mercury, accumulate in fish tissues at levels that may pose health risks if consumption advisories are not followed.

Fish Consumption

Assessment Highlights

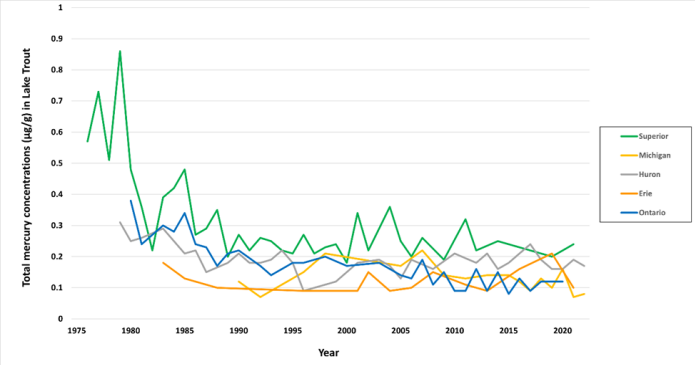
The Fish Consumption indicator is based on the analysis of contaminants in the fillets of five fish species (Chinook Salmon, Coho Salmon, Lake Trout, Walleye and Lake Whitefish) commonly eaten in the Great Lakes. The status of contaminants in the fillets is assessed as **Fair** and the 10-year trend is **Improving**. Many contaminants in fish fillets have declined dramatically in the Great Lakes compared to levels measured 40-50 years ago. After an initial period of rapid decline following bans and phaseouts of certain chemicals, contaminant levels in Great Lakes fish fillets have shown a slower rate of decline over the past 25-30 years. This moderated decline can be attributed to factors such as chemical persistence, reintroduction from historically contaminated sediments, and invasive species-driven changes to the Great Lakes food web. The rate of decline also depends on fish size, age, diet, and lipid content. Additionally, water temperature can influence how contaminants are taken up, stored, and metabolized by fish.

In the Great Lakes, fish consumption advisories primarily result from elevated PCBs and mercury concentrations, with PCBs driving the majority of advisories in both the U.S. and Canada. PCBs in fish fillets have decreased by over 90% for some fish species in some lakes since the 1970s. Mercury levels in fish fillets have generally declined by half over the last 40-50 years. Based on PCB and mercury concentrations, conditions are considered **Good** in lakes Superior, Huron and Erie and **Fair** in lakes Michigan and Ontario. The overall status assessment for this indicator is **Fair**, with signs of improvement in some monitored fish species, resulting in less restrictive fish consumption advice for some areas, in particular in Lake Erie.

Over the past 10 years, PCB concentrations in fish fillets have declined or remained unchanged in all of the lakes. During this same period, mercury concentrations in fish fillets have remained stable or decreased slightly. On this basis, the trend is assessed as **Improving**.

Other contaminants, such as per- and polyfluoroalkyl substances (PFAS) have recently prompted issuance of fish consumption advisories for some areas of the Great Lakes. PFAS are responsible for approximately 10% of the advisories issued in Canadian waters of the Great Lakes.

Mercury concentrations in Lake Trout fillets have declined substantially since the 1970s and 1980s



Sub-indicator supporting the Fish Consumption assessment					
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Contaminants in Fish Fillets	Good & Improving	Fair & Improving	Good & Unchanging to Improving	Good & Improving	Fair & Unchanging to Improving

STATUS

Good | Fair | Poor | Undetermined

TOXIC CHEMICALS

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should be free from pollutants in quantities or concentrations that could be harmful to human health, wildlife, or aquatic organisms through direct exposure or indirect exposure through the food chain."

Status: FAIR
Trend: UNCHANGING TO IMPROVING

Significant progress has been made in reducing toxic chemicals in the Great Lakes, but some chemicals, such as PCBs, still pose a threat to human health and the environment.

Toxic Chemicals

Assessment Highlights

The Toxic Chemicals indicator shows that concentrations of most toxic chemicals in the Great Lakes in water, air, sediment, whole fish, and Herring Gull eggs have decreased over the long term. Overall, the status of Toxic Chemicals is **Fair** and the 10-year trend is **Unchanging** to **Improving**.

Across the Great Lakes, concentrations of many legacy chemicals, including mercury and PCBs, show long-term declines in most monitored media. However, Lake Ontario and Lake Erie have the highest concentrations of hexabromocyclododecane (HBCD), perfluorooctane sulphonate (PFOS), perfluorooctanoic acid (PFOA), and Polycyclic Aromatic Hydrocarbons (PAHs) in sediment, water, and whole fish compared to the other Great Lakes. The presence of large urban centers and industrial areas in the lower lake basins is associated with elevated chemical concentrations in multiple media typically due to increased emissions from sources such as industry, or releases from wastewater.

The status of sub-indicators in the Toxic Chemicals indicator range from **Fair** to **Good**. Over the past 10 years, trends range from **Unchanging** to **Improving** to **No Trend**. Some lake assessments are reported as **No Trend** due to high temporal variability in the data or differing trend directions for contaminants within a monitored media.

ASSESSING TOXIC CHEMICALS

The Toxic Chemicals sub-indicator assessments include several binationally designated Chemicals of Mutual Concern (CMCs) and help track progress on reducing the release of these substances into the Great Lakes. Among the CMCs are PFOS, PFOA and long-chain perfluorocarboxylic acids (LC-PFCAs), which are part of a large complex group of chemicals known as Per- and Polyfluoroalkyl Substances (PFAS). PFAS have a wide variety of applications due to their water-, grease- and heat- resistant properties and are often referred to as “forever chemicals” because of their extreme persistence in the environment.

Sub-indicators supporting the Toxic Chemicals assessment

Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Toxic Chemicals in Sediment	Good & Unchanging	Fair & Unchanging	Good & Unchanging	Fair & Improving	Fair & Improving
Toxic Chemicals in Water	Good & Undetermined	Undetermined & Undetermined	Fair & Improving	Fair & No Trend	Fair & No Trend
Toxic Chemicals in Whole Fish	Fair & No Trend	Fair & No Trend	Fair & No Trend	Good & Improving	Fair & No Trend
Toxic Chemicals in Herring Gull Eggs	Good & Unchanging	Good & Unchanging	Good & Unchanging	Good & Unchanging	Good & Unchanging
Toxic Chemicals in the Atmosphere	Great Lakes Basin Assessment is Fair & Improving				

STATUS

Good **Fair** **Poor** **Undetermined**

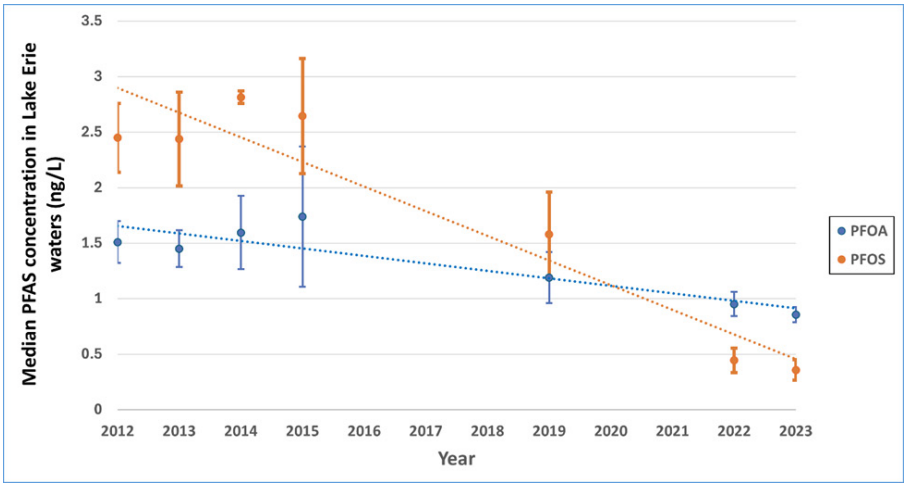
monitored media.

Toxic Chemicals

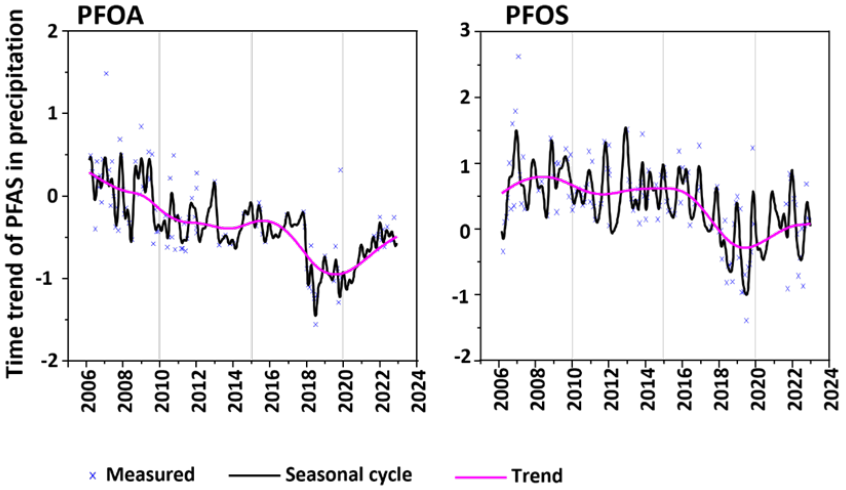
Decreasing trends in PFOS and PFOA concentrations in many monitored media are likely due to phase-outs in both the U.S. and Canada, as well as restrictions in the U.S. and regulatory action in Canada. PFOS and PFOA concentrations are generally higher in locations closer to urban and industrial areas when compared to less developed watersheds.

In whole fish, long-term concentrations of PFOS have significantly declined in lakes Ontario and Huron, but levels still exceed guidelines or targets. Among the contaminants monitored in Herring Gull eggs, the PFAS class of chemicals has shown the most notable short-term decline. PFOS and PFOA concentrations in precipitation are declining at most monitored sites.

PFOA and PFOS concentrations in surface waters have declined in Lake Erie from 2012 to 2023



PFOA and PFOS have declined in precipitation at Point Petre, Lake Ontario



HABITAT AND SPECIES

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should support healthy and productive wetlands and other habitats to sustain resilient populations of native species."

Status: FAIR
Trend: UNCHANGING

The Great Lakes are ecologically diverse ecosystems, supporting rare and unique species and habitats not found anywhere else in the world. Great Lakes coastal wetlands capture, store, and process excess nutrients originating from upland habitats, protect shorelines, and provide critical habitat for many species. The Great Lakes aquatic food web supports ecologically and culturally important fish populations that in turn support commercial, recreational, and subsistence fisheries valued at over $5 billion annually. Watershed development, pollution, invasive species, and other factors can impair Great Lakes habitat quality and native species populations.

Habitat and Species

Assessment Highlights

The Habitat and Species indicator includes assessments of Great Lakes coastal wetlands, habitat connectivity, and species that are part of the aquatic food web. Coastal wetland and aquatic food web health are variable across the basin, ranging from **Good** to **Poor** and **Improving** to **Deteriorating**, depending on the lake, habitat, and species of interest. Overall, the Habitat and Species indicator is assessed as **Fair** and the 10-year trend is **Unchanging**.

Restoration and protection efforts have improved habitat conditions at many coastal wetlands. Wetlands are important to restore and protect as they provide ecological, economic and cultural benefits. Lake Superior wetlands and those along the northern shorelines of lakes Michigan and Huron are generally in better condition than wetlands in lakes Erie and Ontario. For example, most of the wetlands in lakes Erie and Ontario have degraded plant communities as a result of nutrient enrichment, sedimentation, invasive species, or combinations of these factors. These stressors can allow invasive plants such as Cattails, European Frog-bit, *Phragmites* (sometimes called Common Reed), and Water Chestnut to thrive, reducing biodiversity and habitat quality for native flora and fauna.

Amphibian, bird, and fish communities in coastal wetlands tend to be healthiest where the footprint of human activity is the lowest. Coastal wetland amphibian and bird community health in each of the lakes are considered **Fair** with no trend towards improvement or deterioration. Coastal Wetland Fish communities are assessed as **Good** in Lake Superior, **Poor** in Lake Erie and **Fair** in the other three lakes. Coastal wetland fish are in **Poor** condition in Lake

Sub-indicators supporting the Habitat and Species assessment – Coastal Wetlands and Aquatic Habitat Connectivity					
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Coastal Wetland Invertebrates	Fair & No Trend	Fair & No Trend	Fair & No Trend	Undetermined & Undetermined	Undetermined & Undetermined
Coastal Wetland Fish	Good & Improving	Fair & No Trend	Fair & No Trend	Poor & No Trend	Fair & No Trend
Coastal Wetland Amphibians	Fair & No Trend	Fair & No Trend	Fair & Deteriorating	Fair & No Trend	Fair & No Trend
Coastal Wetland Birds	Fair & No Trend	Fair & No Trend	Fair & No Trend	Fair & No Trend	Fair & Unchanging
Coastal Wetland Plants	Good & Unchanging	Fair & Unchanging	Good & Unchanging	Poor & Unchanging	Poor & Unchanging
Coastal Wetland Extent & Composition	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Not Assessed
Aquatic Habitat Connectivity	Fair & Improving	Poor & Improving	Fair & Improving	Fair & Improving	Fair & Improving

STATUS

Good Fair Poor Undetermined

Habitat and Species

Erie due in part, to the abundance of non-native fish in the lake, which compete with native fish for resources, and can degrade habitat. The Canada Water Agency has updated estimates of Canadian coastal wetland extent. Estimates range from approximately 17,000 hectares in Lake Ontario to over 27,500 hectares in Lake Erie. Work is underway to update basin-wide estimates of coastal wetland extent, inclusive of wetlands in the U.S. Great Lakes basin.

Aquatic habitat connectivity assesses the percentage of tributary lengths that remain free of dams or other barriers impacting the connection between the headwaters and the Great Lakes. The connectivity of tributaries is critical for migratory fish to reach spawning habitat and to maintain other ecological processes such as natural sediment transport. Tributary connectivity was reduced in each lake basin during the past century but is currently assessed as **Fair** and is **Improving** in the basin as a result of barrier removal and fish passage projects. These restoration efforts must also consider the potential risks of allowing non-native species to access the Great Lakes, or creating spawning habitat for species like Sea Lamprey.

The Great Lakes aquatic food web contains many interacting species, from tiny algae (Phytoplankton) and animals (Zooplankton) to large fish. Changing

Sub-indicators supporting the Habitat and Species assessment – Aquatic Food Web

Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Phytoplankton	Good & Deteriorating	Fair & Unchanging	Fair & Unchanging	Poor & Deteriorating	Good & Unchanging
Zooplankton	Good & Unchanging	Good & No Trend	Fair & Unchanging	Good & No Trend	Fair & No Trend
Benthos	Good & Unchanging	Good & Unchanging	Good & Unchanging	Poor & Unchanging	Fair & Unchanging
Diporeia	Good & Unchanging	Poor & Deteriorating	Poor & Deteriorating	Poor & Unchanging	Poor & Unchanging
Mysis	Good & Unchanging	Poor & Deteriorating	Good & Unchanging	Good & Undetermined	Good & Unchanging
Lake Sturgeon	Poor & Improving	Poor & Improving	Poor & Improving	Poor & Improving	Poor & Improving
Native Prey Fish Diversity	Fair & Unchanging	Fair & Unchanging	Fair & Unchanging	Poor & Unchanging	Poor & Unchanging
Lake Trout	Good & Improving	Fair & Improving	Fair & Unchanging	Fair & Improving	Fair & Improving
Walleye	Fair & Improving	Good & Unchanging	Fair & Improving	Good & Improving	Good & Unchanging
Fish-Eating & Colonial Nesting Waterbirds	Poor & Deteriorating	Not Assessed	Poor & Deteriorating	Fair & Unchanging	Fair & Deteriorating

STATUS

Good **Fair** **Poor** **Undetermined**

Habitat and Species

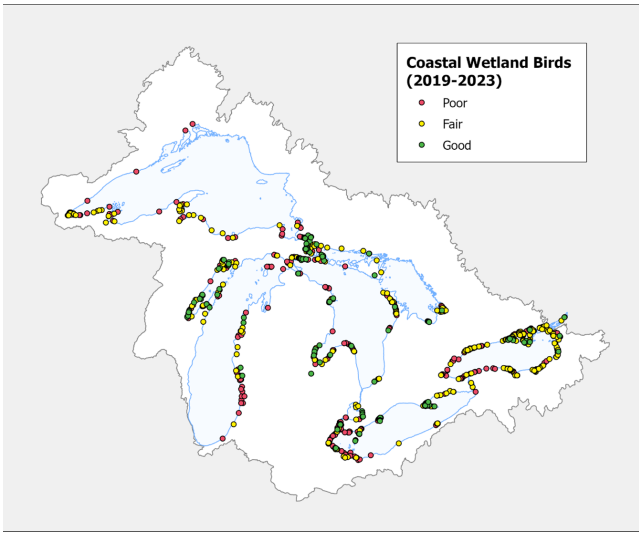
nutrient conditions combined with the impacts of invasive species, especially Dreissenid Mussels (Zebra and Quagga mussels), are some of the most immediate stressors to the Great Lakes food web. Dreissenid Mussels filter phytoplankton from the water column and alter the way nutrients are cycled through the lakes, resulting in reduced food for Zooplankton, which impacts higher components of the aquatic food web, including fish.

Across the Great Lakes, Phytoplankton trends are variable while Zooplankton trends are largely **Unchanging**. Lake Superior has maintained Phytoplankton and Zooplankton communities reflecting oligotrophic (low nutrient) conditions and is assessed as **Good** for Phytoplankton and Zooplankton, but gradual community shifts toward Phytoplankton groups that thrive in warmer conditions may be occurring in response to increasing surface water temperatures, resulting in a **Deteriorating** trend. In lakes Huron and Michigan, declines in spring Phytoplankton biovolume resulted in decreased Zooplankton biomass in past decades, but Phytoplankton biovolumes have generally stabilized in recent years. Phytoplankton is assessed as **Fair** in lakes Huron and Michigan, while Zooplankton is assessed as **Good** in Lake Michigan and **Fair** in Lake Huron. In Lake Erie, Phytoplankton is assessed as **Poor** and **Deteriorating** due to increases in the abundance of cyanobacteria, but Zooplankton communities are in **Good** condition due to high lake productivity.

Diporeia, a small benthic (bottom-dwelling) invertebrate and an important food source for fish, severely declined in the 1990s and are in **Poor** status in all lakes except Lake Superior. The mechanisms causing these declines are complex and are still being studied to better understand the full impacts. Dreissenid Mussels have likely contributed to these trends by altering benthic habitat and reducing the amount of available food for other benthic organisms, including *Diporeia*. In Lake Superior, *Diporeia* remain the dominant benthic organism, resulting in a **Good** status. The decline in *Diporeia* in the Great Lakes has likely increased the importance of *Mysis*, another lipid-rich prey, in the food web. Current *Mysis* densities in all lakes, except Lake Michigan, are assessed as **Good**. Conditions in Lake Michigan are **Poor** and **Deteriorating** due to declines in *Mysis* density and primary productivity.

Phytoplankton, Zooplankton, and benthic communities are important sources of food for prey fish and young sport fish and are essential to sustaining a healthy food web. The diversity of prey fish communities across the Great Lakes continues to change, although the direction and magnitude of those changes vary. The prey fish community is considered **Fair** overall based on the diversity and the proportion of native prey fish species in the Great Lakes. There have been fluctuations in the overall abundances of prey fish, which are influenced by both food availability and the number

Coastal wetland birds are in Fair condition overall in the Great Lakes

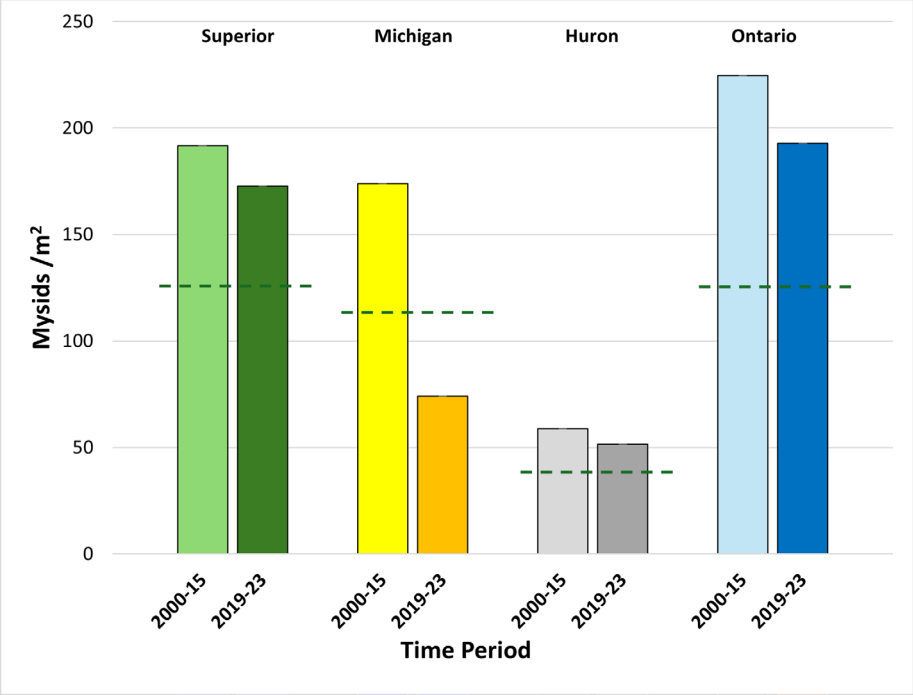


Habitat and Species

of top predator fish such as Lake Trout, Salmon, and Walleye. A balance between the number of predator fish and the available prey fish in the lakes is important for a sustainable Great Lakes Fishery Commission.

Sustainable fishery management, ongoing Sea Lamprey control, improving water quality, population rehabilitation stocking, and restoration of spawning habitat have contributed to **Improving** Lake Sturgeon, Walleye and Lake Trout populations, including increased reproductive success for Lake Trout. Populations of Lake Trout have also improved due to declines in Alewives, an invasive prey fish that causes thiamine deficiency in Lake Trout. In the mid-1900s, Lake Trout populations declined to extremely low levels in Lake Superior due to extensive overfishing and the impacts from the invasive, predatory Sea Lamprey. However, the Great Lakes Fisheries Commission announced in the fall of 2024 that Lake Trout populations are considered fully recovered in most of Lake Superior. There is also evidence of increased natural reproduction of Lake Sturgeon in tributaries throughout the Great Lakes basin, due in part to habitat improvements, dam removals, and stocking efforts. However, changes in Lake Sturgeon status will take a long time to manifest due to the long lifespan of the species. A key highlight for Walleye in Lake Huron is that the population has increased substantially, resulting in an **Improving** trend.

Mysis population density is in Good condition in lakes Huron, Ontario and Superior



Green dashed lines represent lake-specific thresholds for Good Mysid densities. Mysis in Lake Erie are limited to the deep portions of the eastern basin. Available data are insufficient for trend analysis and are not included in this figure.

NUTRIENTS AND ALGAE

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should be free from nutrients that directly or indirectly enter the water as a result of human activity, in amounts that promote growth of algae and cyanobacteria that interfere with aquatic ecosystem health, or human use of the ecosystem."

Status: POOR TO FAIR
Trend: UNCHANGING

Algae occur naturally in freshwater systems and are essential to a healthy aquatic ecosystem. Phosphorus and nitrogen are key nutrients for the growth of algae and other primary producers, which form the base of the aquatic food web. In the Great Lakes, too much phosphorus can lead to harmful algal blooms and nuisance algae which can be detrimental to the environment, the economy and human health. Conversely, too little phosphorus can result in not enough algae to support healthy Great Lakes food webs and can threaten the sustainability of higher trophic level organisms, like fish.

Nutrients and Algae

Assessment Highlights

In the 1980s and early 1990s, basin-wide reductions in nutrient loads were successful in decreasing high concentrations of nutrients that were contributing to the formation of algal blooms, nuisance algae, and hypoxic (low dissolved oxygen) areas in the Great Lakes. There has been a resurgence of nutrient-related impairments resulting from impacts of invasive species, land use changes, rising surface water temperatures, phosphorus levels, and other factors. Although nutrients and algal conditions for Lake Superior are generally **Good**, conditions remain **Poor** in Lake Erie and are **Fair** in lakes Michigan, Huron and Ontario. Overall, the Nutrients and Algae indicator is assessed as **Poor** to **Fair** and the 10-year trend is **Unchanging**.

Only Lake Superior's offshore phosphorus concentrations are considered **Good**. The offshore waters of lakes Michigan, Huron and Ontario continue to have phosphorus concentrations below objectives. Phosphorus concentrations remain above objectives in Lake Erie's western and central basins and are elevated in some nearshore regions and embayments of each of the other lakes.

Elevated nutrient concentrations can lead to algal blooms. Cyanobacteria algal blooms can produce toxins such as microcystin. These toxins can impact drinking water safety and are harmful to people, wildlife and pets when present at high levels. Decomposition of large amounts of algae from blooms can lead to the formation of hypoxic zones (such as in the central basin of Lake Erie), which can suffocate aquatic organisms and degrade habitat.

CONCERNS AND EMERGING THREATS

Nutrients and algae levels are influenced by the timing and magnitude of nutrient inputs, effects of invasive species on nutrient cycling, extreme storm events and warming water temperatures. Changes to one or more of these factors can impact areas of the Great Lakes experiencing nuisance algal growth, algal blooms, and hypoxia. Actions are being taken to address excess inputs of nutrients and to prevent further introductions and spread of invasive species. Warming water temperatures and increased frequency of extreme storm events have the potential to impact algal bloom and nuisance algae dynamics, and these conditions and their impacts are being actively investigated by scientists.

Sub-indicators supporting the Nutrients and Algae Assessment

Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Nutrients in Lakes	Good & Unchanging	Fair & Unchanging	Fair & Unchanging	Poor & No Trend	Fair & Unchanging
Algal Bloom Extent	Undetermined & Undetermined	Fair & Unchanging	Fair & No Trend	Poor & Unchanging	Good & Unchanging
Cladophora	Good & Unchanging	Poor & No Trend	Fair & Undetermined	Poor & No Trend	Poor & No Trend

STATUS

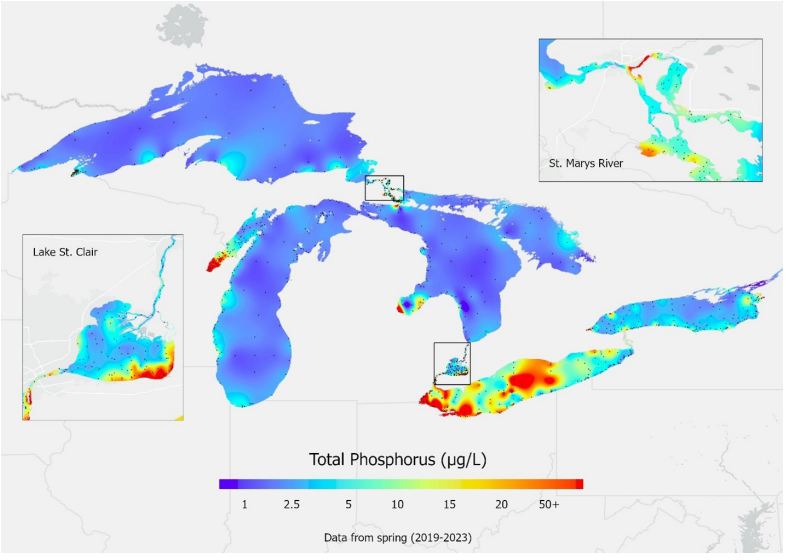
Good | Fair | Poor | Undetermined

Nutrients and Algae

The western basin of Lake Erie experiences the most frequent and largest extent of cyanobacteria algal blooms in the Great Lakes with the bloom extent being highly variable from year-to-year. The percentage of the Lake Erie shallow-water area experiencing cyanobacteria algal blooms has not changed significantly from 2012 to 2023. In other areas of the Great Lakes, such as Green Bay (Lake Michigan), Saginaw Bay (Lake Huron), Lake St. Clair, and in embayments such as Hamilton Harbour and the Bay of Quinte in Lake Ontario, cyanobacteria algal blooms have also adversely impacted ecosystem health and recreational activities. The extent of those blooms has not changed in the past decade. Localized, short-lived blooms have also been reported in Lake Superior in recent years. These blooms tend to be isolated events not typically observable via the remote sensing method used for this assessment. Based on the spatial extent of algal blooms, conditions are considered **Poor** for Lake Erie, **Fair** in lakes Michigan and Huron, and **Good** in Lake Ontario. Status and trends in Lake Superior are **Undetermined** due to current limitations of the remote sensing method used to estimate bloom extent in the lake.

Cladophora is a native benthic alga that provides food and shelter for invertebrates and small fish but that sometimes reaches nuisance levels over broad areas in the nearshore regions of lakes Erie, Ontario, and Michigan. Conditions in those lakes are assessed as **Poor**. Excessive *Cladophora* poses problems including beach and shoreline fouling, clogging of municipal water intakes, and can also impact tourism and recreational fishing. *Cladophora* buildup on shorelines may also harbor pathogens and create an environment conducive to the development of botulism outbreaks, which pose a risk mainly for fish and birds. The introduction of invasive Dreissenid Mussels has promoted nutrient retention in the nearshore and has contributed to increased water clarity in many areas of the Great Lakes, promoting increased *Cladophora* growth. Additionally, large mats of *Cladophora* can persist in areas with low nutrient concentrations in the surrounding water, which is further complicating the management of *Cladophora*.

Total phosphorus concentrations are highest in Lake Erie and other nearshore and embayment areas of the Great Lakes



INVASIVE SPECIES

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should be free from the introduction and spread of aquatic invasive species and free from the introduction and spread of terrestrial invasive species that adversely impact the quality of the Waters of the Great Lakes."

Prevention (Rate of New Aquatic Nonindigenous Species Establishment)

Status: GOOD
Trend: NO TREND

Impacts of Aquatic Invasive Species

Status: POOR
Trend: NO TREND

The number of new invasive species entering the Great Lakes has been significantly reduced; however, some invasive species already in the Great Lakes, such as Sea Lamprey, Zebra and Quagga Mussels, and *Phragmites*, continue to cause substantial ecological and economic impacts.

Invasive Species

Assessment Highlights

The assessment for this indicator is based on two components: Prevention, measured as Rate of New Aquatic Nonindigenous Species (also known as non-native species) Establishment into the Great Lakes (assessed as **Good** with a 10-year trend of **No Trend**), and Impacts of Aquatic Invasive Species (AIS) (assessed as **Poor** with a 10-year trend of **No Trend**). These assessments highlight that there has been success in preventing the establishment of aquatic non-native species (species that are not native to the Great Lakes basin that may or may not have known negative environmental and/or socioeconomic impacts); however, some established AIS (species that have known negative environmental and/or socioeconomic impacts) continue to expand their ranges. As of 2023, 190 aquatic non-native species have been reported as established in the Great Lakes, of which 78 are considered invasive.

Historically, ballast water from transoceanic ships served as the primary vector for the introduction of non-native species into the Great Lakes. There has been success in reducing establishments from outside of the Great Lakes in recent decades. This reduction is largely due to the implementation of regulations on ballast water and mandatory mid-ocean flushing of ballast tanks of all transoceanic ships as well as implementation of inspection programs to confirm that these ships are managing ballast water. No new aquatic non-native species suspected to have been introduced through ballast water have become established in the Great Lakes since 2006. Further, regulations regarding treatment systems for ballast water introduced by the Canadian government in 2021 (phasing in by 2030) aim to reduce the spread of aquatic non-native species within the Great Lakes basin.

Sub-indicators supporting the Invasive Species assessment					
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Rate of New Aquatic Nonindigenous Species Establishment into the Great Lakes Basin	Great Lakes Basin assessment is Good & No Trend				
Impacts of Aquatic Invasive Species	Poor & No Trend	Poor & No Trend	Poor & No Trend	Poor and Deteriorating	Poor & No Trend

STATUS

Good Fair Poor Undetermined

Invasive Species

From 2014 to 2023, four new non-native species of Zooplankton, all of which were suspected to be introduced through means other than ballast water, established overwintering and reproducing populations in the Great Lakes (*Thermocyclops crassus*, *Mesocyclops pehpeiensis*, *Salmincola californiensis*, and *Diaphanosoma fluviatile*). Despite the establishment of these four species, there has been a significant slowdown in establishments of aquatic non-native species compared with the rate from two decades ago, prior to the implementation of ballast regulations.

Preventing the establishment and spread of invasive species is essential for protecting Great Lakes native species and habitats. AIS can spread within and between the lakes, including by hitching rides on boats, trailers, and gear used by anglers, boaters, and other recreationists.

Since 1950, the cumulative impact of AIS on the Great Lakes has more than doubled. This cumulative impact takes into account the increase in the number of AIS, their spread between lake basins, and the magnitude and range of their individual impacts.

The Sea Lamprey is a prominent AIS and a lethal parasite of many Great Lakes fish species, such as Lake Trout. Annual control activities in the Great Lakes have successfully suppressed Sea Lamprey

Sub-indicators provided for background information, but not included in the Invasive Species assessment					
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Rate of New Aquatic Nonindigenous Species Establishment into Each Lake Basin	Poor & Improving	Fair & No Trend	Poor & Improving	Fair & Improving	Poor & No Trend
Sea Lamprey	Poor & No Trend	Good & No Trend	Poor & No Trend	Fair & Improving	Poor & Deteriorating
Dreissenid Mussels	Good & Unchanging	Poor & Deteriorating	Poor & No Trend	Fair & No Trend	Poor & Deteriorating
Terrestrial Invasive Species	The methodology used to assess this sub-indicator is being updated. This sub-indicator is currently assessed as Undetermined.				

STATUS

Good **Fair** **Poor** **Undetermined**

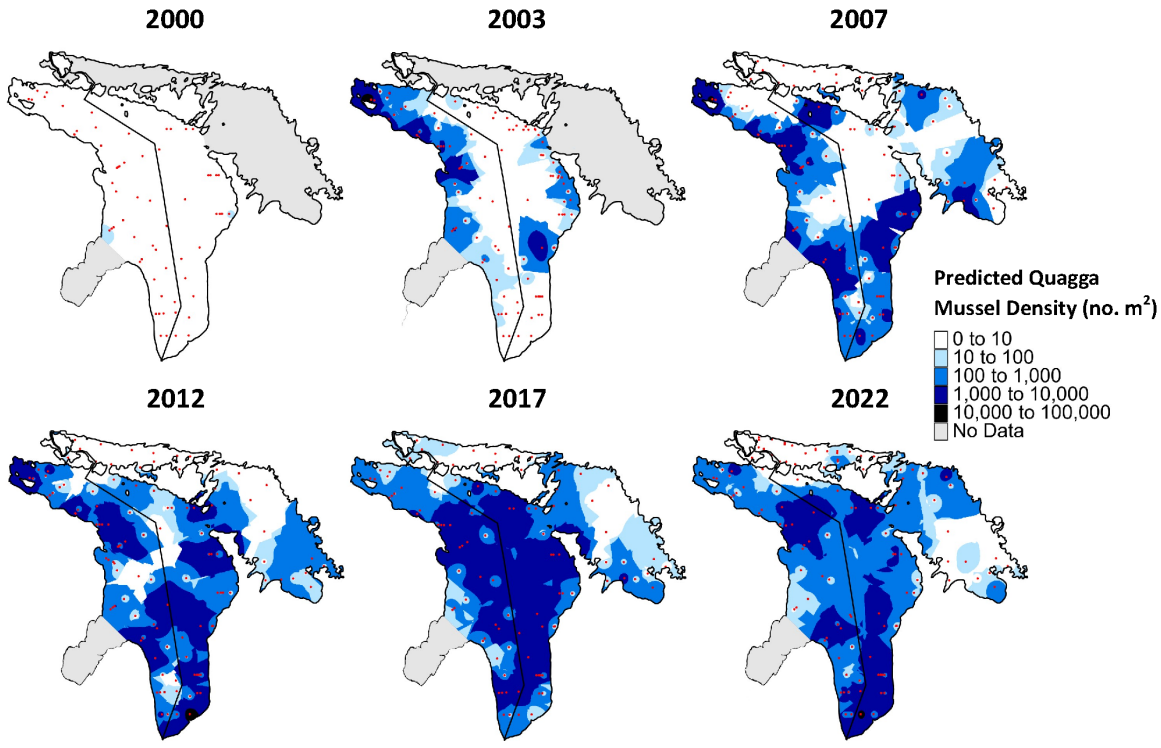
The overall assessment for the Rate of New Aquatic Nonindigenous Species Establishment in the Great Lakes sub-indicator is solely based on new establishments in the Great Lakes; the lake-to-lake spread component provides additional information about the movement of non-native species between the lakes. Sea Lamprey and Dreissenid Mussels are among the species already included in the Rate and Impacts sub-indicator assessments. The Sea Lamprey, Dreissenid Mussels, and Terrestrial Invasive Species sub-indicator reports provide more detailed, supplementary information.

Invasive Species

populations by approximately 90% since pre-control efforts. However, travel restrictions and unfavorable weather conditions in 2020-2021 led to decreased Sea Lamprey control activities, resulting in increases in their recent 3-year average populations, which now exceed target levels in four of the five Great Lakes.

Dreissenid Mussels (Zebra and Quagga Mussels) are AIS that have significantly impacted the Great Lakes ecosystem. They alter nutrient cycling, increase water clarity, and modify Phytoplankton and Zooplankton communities. Quagga Mussels have largely displaced Zebra Mussels in the Great Lakes due to a combination of factors including their ability to colonize deeper, softer substrates, survive in environments with lower food availability, and tolerate colder water temperatures. These advantages allow Quagga Mussels to outcompete Zebra Mussels in a wider range of habitats within the Great Lakes ecosystem.

Increases in Quagga Mussel density and changes in population distribution in Lake Huron

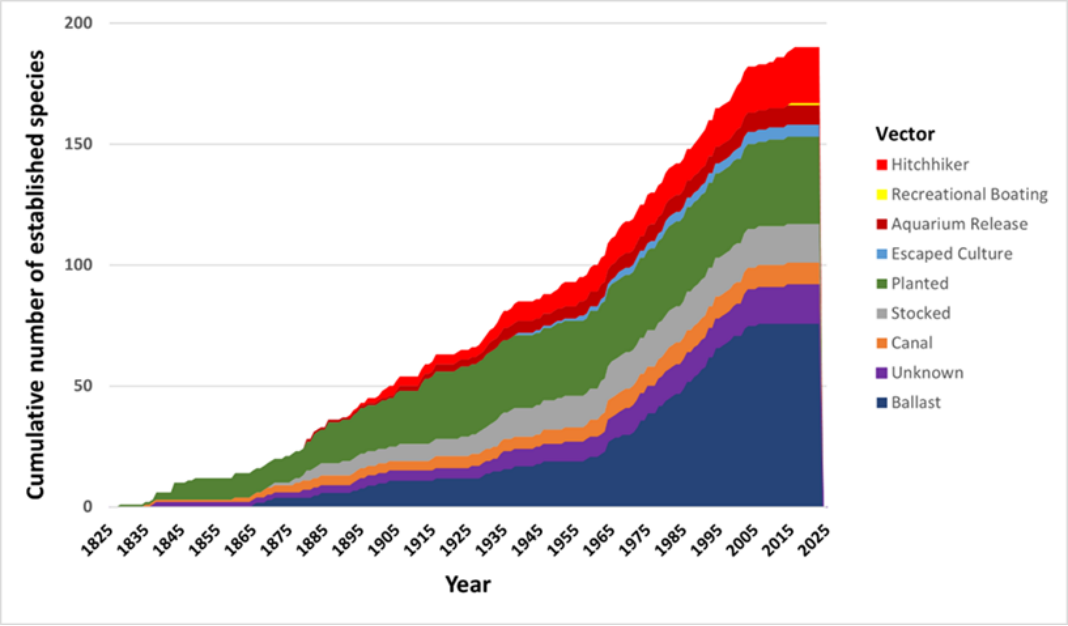


Invasive Species

In lakes Michigan, Huron and Ontario, Dreissenid Mussel populations in the shallow and mid-depth regions (less than 90 meters) are stable or declining. In areas deeper than 90 meters in Lake Michigan, populations continue to increase. In Lake Huron, densities increased to an all-time high in 2017 but have declined since then. In Lake Erie, overall lakewide Dreissenid Mussel densities are approximately four times lower than the peak levels of the 1990s; however, decreases in density vary between the western, central, and eastern basins of the lake. Lake Superior Dreissenid Mussel populations remain low, with some recent localized occurrences in coastal areas.

Terrestrial invasive species such as Emerald Ash Borer, Mute Swan, and Garlic Mustard are widely distributed in the Great Lakes basin and have detrimental impacts on the ecosystem. Community-based science data collection efforts are valuable sources of information for terrestrial invasive species distribution and are used to inform the sub-indicator.

Cumulative discovery of established aquatic non-native species in the Great Lakes basin for all known vector pathways has stabilized in recent decades



GROUNDWATER

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should be free from the harmful impact of contaminated groundwater."

Status: GOOD
Trend: UNDETERMINED

Groundwater can improve the surface water quality of lakes and rivers.
Groundwater can also transmit contaminants and nutrients to the Great Lakes.

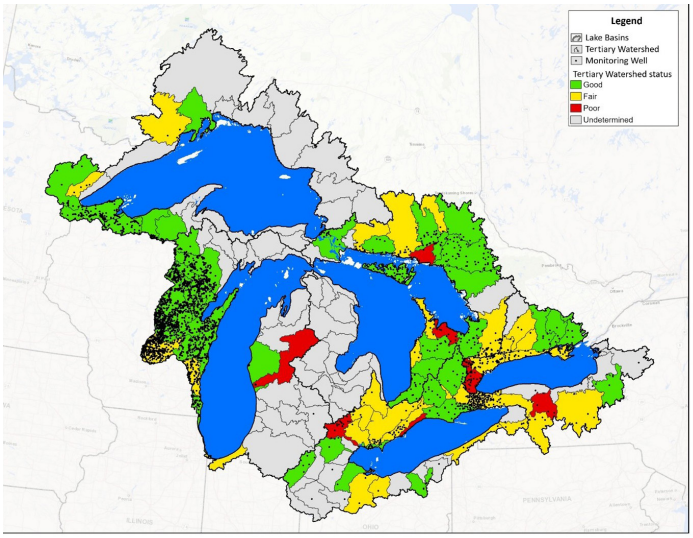
Groundwater

Assessment Highlights

The Groundwater indicator status is assessed as **Good** based on chloride and nitrate concentration data from monitoring wells. The 10-year trend is **Undetermined** due to insufficient spatial coverage of monitoring wells that have enough long-term data to perform a trend analysis. Elevated concentrations of nitrate in groundwater typically result from improper fertilizer and livestock waste management, and/or domestic wastewater (e.g., septic systems, leaky sewers) inputs. Elevated chloride concentrations are commonly observed in developed areas due to the application of deicing (road) salt, but also fertilizer use, domestic wastewater, and landfills.¬ The assessment is based on data from 5,765 wells less than 40 meters deep, situated within the Great Lakes basin. These data were used to determine the status of groundwater quality at the tertiary watershed level. These tertiary watershed-level evaluations informed the assessment for each lake and the Great Lakes overall.

The status of groundwater quality is assessed as **Undetermined** in the Lake Superior and Lake Michigan basins due to limited data coverage required to complete a lake basin assessment. The Lake Erie and Lake Ontario basins are assessed as **Fair**, and the Lake Huron basin is assessed as **Good**. Fifty seven percent of the wells sampled had groundwater quality assessed as **Good**, resulting in the overall Great Lakes basin status assessment of **Good**. Sites with groundwater contamination due to chemicals such as PFAS exist within the Great Lakes basin, and these locations are being actively investigated and/or remediated by environmental agencies.

Groundwater quality varies by watershed, with Good, Fair, Poor, and Undetermined conditions present throughout the Great Lakes basin



Sub-indicator supporting the Groundwater assessment					
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Groundwater Quality	Undetermined & Undetermined	Undetermined & Undetermined	Good & Undetermined	Fair & Undetermined	Fair & Undetermined

STATUS

Good **Fair** **Poor** **Undetermined**

WATERSHED IMPACTS AND CHANGES IN PHYSICAL CONDITIONS IN THE GREAT LAKES

Status: FAIR
Trend: NO TREND

The 2012 Great Lakes Water Quality Agreement states that "the Waters of the Great Lakes should be free from other substances, materials or conditions that may negatively impact the chemical, physical or biological integrity of the Waters of the Great Lakes."

Watershed Impacts and Changes in Physical Conditions in the Great Lakes

Assessment Highlights

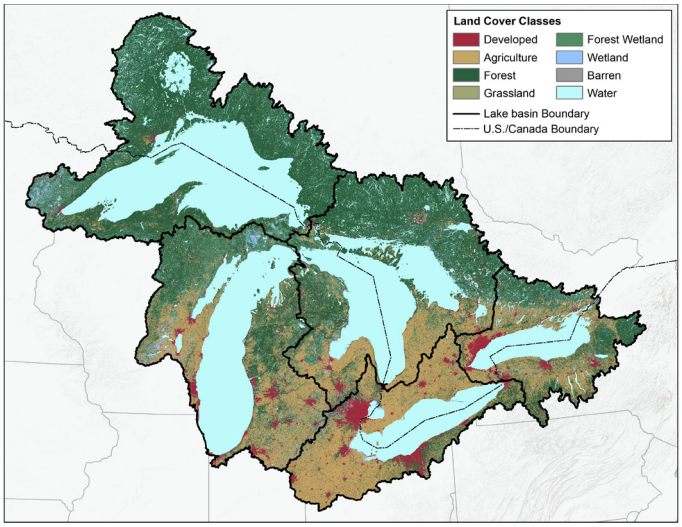
Measures of watershed impacts, including Land Cover, Hardened Shorelines, and Water Quality in Tributaries, which can affect water quality, are assessed as **Fair** with **No Trend** over the reported 10-year period. Status assessments are not prepared for the Changes in Physical Conditions sub-indicators; however, long-term trends are presented.

Watershed Impacts

All lake basins experienced an overall increase in population over the most recent 10-year period for which census data are available (2010-2020 for the U.S. and 2011-2021 for Canada), with the greatest rate of population growth occurring in the Lake Ontario basin. It is expected that the population within the Lake Ontario basin will continue to increase rapidly, particularly in the Greater Toronto Area. Rapid population growth often leads to urban development and loss of natural land cover.

Based on 2020 data, the overall Great Lakes basin land cover is classified as approximately 8% developed, 26% agriculture, and 65% natural. However, there is a high degree of variability in the percentage of land cover type between the lake

Forests, wetlands and other natural land cover that help maintain water quality are more prevalent in the northern regions of the Great Lakes basin



Sub-indicators supporting the Watershed Impacts assessment					
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Land Cover	Good & Unchanging	Fair & Undetermined	Fair & Undetermined	Poor & Undetermined	Fair & Undetermined
Hardened Shorelines	Good & No Trend	Good & Deteriorating	Good & Deteriorating	Poor & Deteriorating	Poor & Deteriorating
Water Quality in Tributaries	Undetermined & Undetermined	Not Assessed	Fair & No Trend	Poor & No Trend	Fair & No Trend
Human Population	Increasing	Increasing	Increasing	Increasing	Increasing

STATUS

Good **Fair** **Poor** **Undetermined**

Watershed Impacts and Changes in Physical Conditions in the Great Lakes

basins. For example, the Lake Superior basin has a large amount of natural lands (97%), compared to the Lake Erie basin (21%). There is a positive relationship between the extent of natural lands and water quality. Runoff from agricultural and developed lands may contribute to degraded water quality and ecological conditions. Riparian zones (i.e., land along the banks of a river or stream) throughout the Great Lakes basin are generally dominated by natural lands (75% overall), much of which is forested (53% overall). However, this varies greatly between lake basins. Forested riparian zones provide essential ecosystem services including decreasing runoff and erosion and regulating water temperatures.

From 2009 to 2020, the amount of shoreline that has been hardened (any placement of material used to armor the shoreline to offer protection from waves and water level changes) increased for the Great Lakes overall. Shoreline hardening can alter habitats and sediment transport, while reducing ecosystem services. Currently, almost one quarter of the assessed Great Lakes shoreline is either moderately or highly hardened.

Tributaries play an important role in transporting surface water to the lakes. Watershed land use and stressors can directly impact water quality in receiving tributaries. Water quality data from 72 Canadian Great Lakes tributaries were evaluated using an index based on concentrations of ammonia, chloride, copper, iron, nitrate, nitrite, phosphorus and zinc. Index scores support an overall **Fair** assessment for the Canadian Great Lakes tributaries. Additionally, long-term trends (1970 to 2019) generally indicate increasing chloride concentrations, no trend in nitrate concentrations, and decreasing phosphorus concentrations. Index scores confirm that overall tributary water quality is influenced by land use, with more urbanized or agricultural watersheds typically having poorer scores.

Long-term Trends in Great Lakes Physical Conditions

Long-term datasets show increases in annual precipitation amounts in most of the Great Lakes basin, increases in summer surface water temperatures in all five lakes, and a reduction in

Sub-indicators supporting the Changes in Physical Conditions assessment

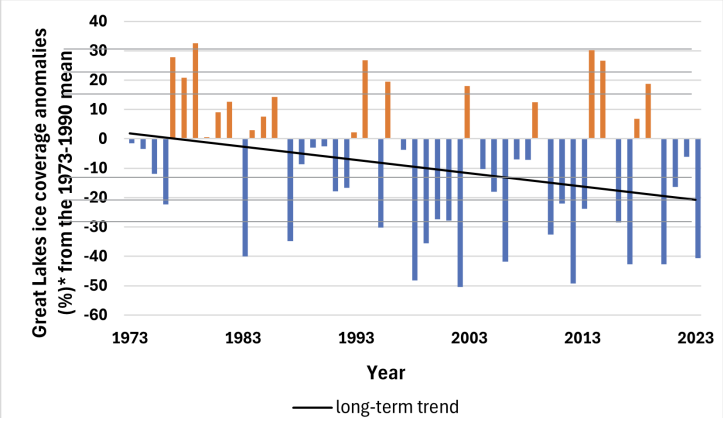
Sub-Indicator	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Precipitation Amounts (1950-2023)	No Trend	Increasing		Increasing	Increasing
Water Levels (1918-2023)	No Trend	No Trend		Increasing	Increasing
Surface Water Temperature (1980-2023)	Increasing	Increasing	Increasing	Increasing	Increasing
Ice Cover (1973-2023)	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing

Watershed Impacts and Changes in Physical Conditions in the Great Lakes

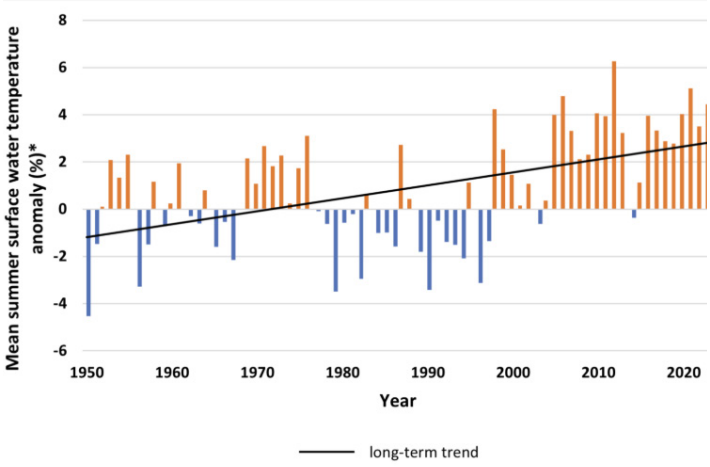
overall Great Lakes annual maximum ice cover. Lake Superior experienced a 34% decrease in maximum ice cover from 1973 to 2023, which is the largest decline in the Great Lakes. Surface water temperatures in lakes Superior, Michigan and Huron have increased at a rate of 0.5 °C per decade since 1980; Lake Erie surface water temperatures have increased 0.2 °C per decade since 1980. In Lake Ontario, surface water temperatures over the past decade are approximately 1 °C higher than the average from the 1960s to the early 1990s. Summer surface water temperatures are driven by both air temperatures and the previous winter ice cover extent. At a 100-year time scale, average lake levels in lakes Superior, Michigan and Huron have not significantly changed, and average lake levels increased in lakes Erie and Ontario. After experiencing historic high lake levels in 2017 –2020, all lakes have returned to levels similar to the average from the 1960s to the early 1990s. Short-term trends for the physical conditions sub-indicators vary annually, leading to a **No Trend** assessment over shorter periods.

Changing water temperatures, ice cover and lake levels can affect Great Lakes habitat quality, including fish spawning areas, as well as other important fish habitats. For example, some fish species rely on the extent and/or duration of ice cover to protect their eggs from turbulence caused by wave action. These physical changes can also contribute to changes in native species range distributions and create conditions that favor the establishment of non-native species.

Annual maximum Great Lakes ice coverage has decreased since 1973



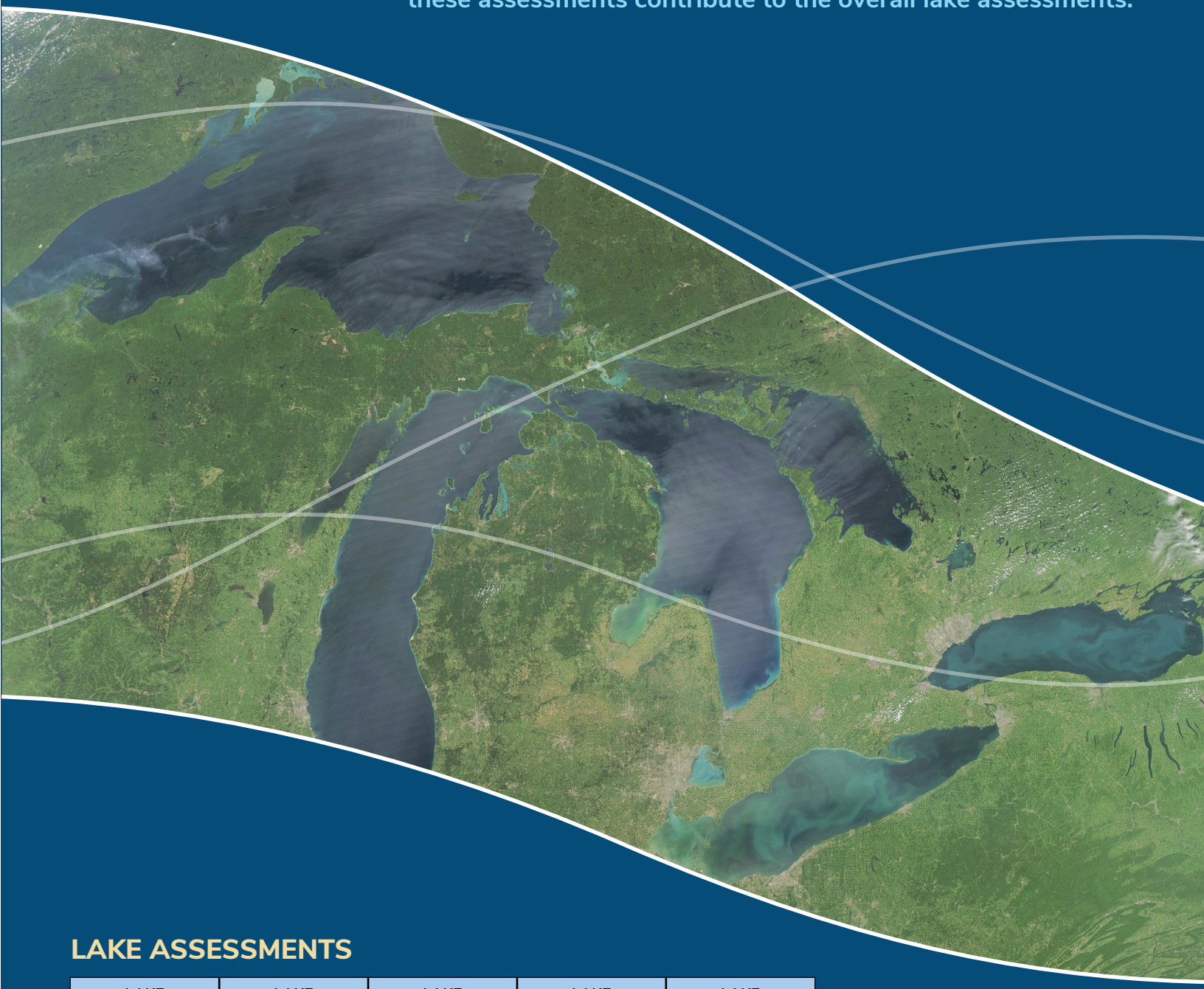
Mean summer surface water temperature in Lake Superior, represented as deviation from the long-term mean, has increased in recent decades



**The anomaly approach compares recent trends to a defined baseline to highlight changes over time. This approach helps put historical data in context with recent ecosystem changes*

LAKE ASSESSMENTS

The suite of indicators and supporting sub-indicators used to assess the overall condition of the Great Lakes is also used to assess each individual lake. Each Great Lake has unique status and trend assessments for each sub-indicator, and these assessments contribute to the overall lake assessments.



LAKE ASSESSMENTS

LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO
Good & Unchanging	Fair & Unchanging	Fair to Good & Unchanging	Poor & No Trend	Fair & Unchanging

Lake Superior

Lake Superior's forested watershed and coastal wetlands help maintain water quality and a healthy aquatic ecosystem.

Lake Superior's treated drinking water is assessed as **Good**. It continues to be a reliable source for producing high quality drinking water. However, the indicator trend calculation is highly influenced by low sample size, with only 2 drinking water systems in Canada and 17 drinking water systems in the U.S. that source from Lake Superior surface waters. The U.S. 10-year trend for treated drinking water is assessed as **Deteriorating** due to violations of health-based standards reported at only two Community Water Systems (CWSs). Nonetheless, over 90% of CWSs met all health-based standards in nine of the last 10 years, underscoring Lake Superior's continued provision of high-quality drinking water. Concentrations of many toxic chemicals monitored in Lake Superior are lower than in the other Great Lakes and long-term trends indicate that concentrations continue to decline. Lake Superior fish remain a nutritious food source; however, fish consumption advisories continue to be in effect for some species due to contaminant levels in fish fillets that exceed benchmarks. Overall, beaches and nearshore waters in Lake Superior provide good opportunities for swimming and recreational use, with only occasional beach closures or advisories posted. Current nutrient levels are considered **Good**, with minimal short-lived, non-toxic blooms of cyanobacteria occurring in localized areas, such as between Duluth Harbor and the Apostle Islands. Coastal wetlands in the Lake Superior basin generally have healthy plant and fish communities and are in **Good** condition. The health of the lake is dependent on the health of the watersheds and the tributaries that connect them. Lack of habitat connectivity has reduced spawning habitat for some native fish species such as Lake Sturgeon, but conditions are **Improving**. Lake Trout are fully recovered in most of the lake and are in **Good** condition, supported by a stable and diverse prey fish population. The lower food web is healthy with Phytoplankton, Zooplankton, and benthic communities in **Good** condition. Lake Superior's prey fish community continues to have the highest proportion of native species of any of the Great Lakes. Populations of invasive Sea Lamprey remain above target levels to maintain fish community objectives and are still a major cause of mortality for native fish such as Lake Trout. Groundwater quality, measured in terms of nitrate and chloride concentrations, has an **Undetermined** status and trend, given that there are limited data in the northern parts of the basin. The Lake Superior basin has a high percentage of natural land cover, which supports healthy habitats and water quality. However, the lake is experiencing changes such as warming surface waters and decreasing ice cover. **Based on the assessments of the nine State of the Great Lakes indicators, the overall status of the Lake Superior ecosystem is Good and the trend is Unchanging.**

BE A SOURCE OF SAFE, HIGH QUALITY DRINKING WATER

ALLOW FOR UNRESTRICTED SWIMMING AND OTHER RECREATIONAL USE

ALLOW FOR UNRESTRICTED HUMAN CONSUMPTION OF THE FISH AND WILDLIFE

BE FREE FROM POLLUTANTS THAT COULD HARM PEOPLE, WILDLIFE OR ORGANISMS

SUPPORT HEALTHY AND PRODUCTIVE HABITATS TO SUSTAIN OUR NATIVE SPECIES

BE FREE FROM NUTRIENTS THAT PROMOTE UNSIGHTLY OR TOXIC BLOOMS

BE FREE FROM AQUATIC AND TERRESTRIAL INVASIVE SPECIES

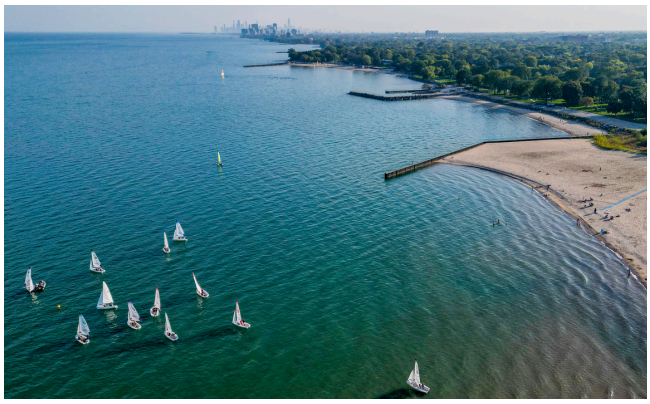
BE FREE FROM THE HARMFUL IMPACTS OF CONTAMINATED GROUNDWATER

BE FREE FROM OTHER SUBSTANCES, MATERIALS, OR CONDITIONS THAT MAY NEGATIVELY AFFECT THE GREAT LAKES

Good **Fair** **Poor**

Lake Michigan

Lake Michigan's habitats support a diverse array of plant and animal species and its waters provide opportunities for swimming and recreational use. However, invasive species and other stressors affect water quality and the lake's food web.



Lake Michigan continues to be a good source for producing high-quality drinking water and provides good opportunities for swimming and recreation. Concentrations of many toxic chemicals continue to decline in monitored media; however, fish consumption advisories due to contaminant levels in fish fillets that exceed benchmarks continue to be issued. Lake Michigan has both healthy wetlands with some of the highest amphibian and bird species richness observed in the Great Lakes as well as wetlands with degraded plant and animal communities. Lake Michigan wetlands are generally in **Fair** condition. In some nearshore areas, there is excessive growth of the nuisance alga *Cladophora*, and toxic blooms of cyanobacteria regularly occur in Green Bay. Aquatic habitat connectivity is considered **Poor** with over 80% of tributary habitat no longer accessible to migratory fish; however, projects implemented over the past decade to remove barriers or improve fish passage have increased connectivity, resulting in more tributary habitat accessible to native fish like Lake Sturgeon. Offshore, invasive filter-feeding Quagga Mussels have contributed to low phosphorus levels and reduced Phytoplankton biomass. Significant declines in Zooplankton biomass in the mid-2000s have now stabilized to levels half of what they were observed in 1997-2002; current observed biomass and community structure are consistent with expected levels for oligotrophic deep lakes and the species assemblage is in **Good** condition. Conversely, *Diporeia* populations are in **Poor** condition and continue to decline. Despite these challenges, increased natural reproduction of Lake Trout is evident, due in part to the successful control of invasive Sea Lamprey. Lake Trout is an important species that contributes to Lake Michigan's $1.7 billion sport fishery. Populations of other important fish species in Lake Michigan, such as Walleye, remain in **Good** condition. Groundwater quality, measured in terms of nitrate and chloride concentrations, is assessed as **Undetermined** due to limited data availability. Agricultural and urban development and increased shoreline hardening threaten water quality in Lake Michigan. Lake Michigan has experienced long-term increases in surface water temperature and decreases in winter ice cover. **Based on the assessments of the nine State of the Great Lakes indicators, the overall status of the Lake Michigan ecosystem is Fair and the trend is Unchanging.**

BE A SOURCE OF SAFE, HIGH QUALITY DRINKING WATER

ALLOW FOR UNRESTRICTED SWIMMING AND OTHER RECREATIONAL USE

ALLOW FOR UNRESTRICTED HUMAN CONSUMPTION OF THE FISH AND WILDLIFE

BE FREE FROM POLLUTANTS THAT COULD HARM PEOPLE, WILDLIFE OR ORGANISMS

SUPPORT HEALTHY AND PRODUCTIVE HABITATS TO SUSTAIN OUR NATIVE SPECIES

BE FREE FROM NUTRIENTS THAT PROMOTE UNSIGHTLY OR TOXIC BLOOMS

BE FREE FROM AQUATIC AND TERRESTRIAL INVASIVE SPECIES

BE FREE FROM THE HARMFUL IMPACTS OF CONTAMINATED GROUNDWATER

BE FREE FROM OTHER SUBSTANCES, MATERIALS, OR CONDITIONS THAT MAY NEGATIVELY AFFECT THE GREAT LAKES

Good **Fair** **Poor**

Lake Huron

Lake Huron provides opportunities for swimming and recreational use. It remains healthy despite nearshore algal blooms.

Lake Huron continues to be a good source for producing high-quality drinking water. Toxic chemicals monitored in Lake Huron are assessed as **Fair** and long-term trends indicate that concentrations are declining in monitored media. Lake Huron fish continue to be a nutritious food source, although restrictions on the consumption of certain species of fish continue to be advised due to contaminant levels in fish fillets that exceed benchmarks. Lake Huron's beaches and nearshore waters provide good opportunities for swimming and other recreational uses. Offshore phosphorus concentrations declined significantly in the 1990s and 2000s but have since stabilized and are considered to be **Fair** with an **Unchanging** trend. *Cladophora* levels are generally low in Lake Huron, although some areas of the lake such as the southern end of Georgian Bay and Saginaw Bay are prone to nuisance algal growth. The current status of algal bloom extent in Lake Huron is **Fair** with **No Trend**, with most impairments occurring in Saginaw Bay. Lake Huron coastal wetlands account for approximately 30% of the total wetland area for all five Great Lakes. Coastal wetland conditions range from **Fair** to **Good**, with generally better conditions in the northern regions. Agricultural and land use stressors, such as runoff, are more common in the southern part of the basin and contribute to coastal wetland degradation. Fish-eating and colonial-nesting waterbirds are assessed as **Poor** due to lower than desired populations of most monitored species and populations. Walleye and Lake Trout populations are assessed as **Fair** and their trends are **Improving** and **Unchanging**, respectively. The Lake Huron assessment for the Impacts of Invasive Species sub-indicator is **Poor**. This status is due in large part to the impact of filter-feeding Quagga Mussels which are the primary cause of lower productivity in offshore waters and localized nuisance algae growth in nearshore waters. Between-lake spread of aquatic non-native species is also increasing, as the range of new non-native species has expanded into Lake Huron from other Great Lakes over the last decade. Groundwater quality is assessed as **Good** based on nitrate and chloride concentration data. Shoreline hardening continues to increase in Lake Huron. As in the other lakes, surface water temperatures are increasing while winter ice cover is decreasing. **Based on the assessments of the nine State of the Great Lakes indicators, the overall status of the Lake Huron ecosystem is Fair to Good and the trend is Unchanging.**

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Good Fair Poor

Lake Erie

Successful Walleye hatches from previous years continue to support excellent recreational and commercial fisheries. However, elevated nutrient concentrations and algal blooms are persistent problems.

Lake Erie continues to be a good source for producing high-quality drinking water. Toxic chemicals monitored in Lake Erie are assessed as **Fair**, but conditions are considered **Improving** with reduced contaminant concentrations in sediment and whole fish. Lake Erie fish continue to be a nutritious food source, and consumption advisories for certain species of fish are less restrictive, supporting an **Improving** trend. Lake Erie's beaches and nearshore waters provide **Fair** to **Good** opportunities for swimming and other recreational uses for the majority of the swimming season. Nutrients and algae continue to be assessed as **Poor**. Cyanobacteria algal blooms driven by high concentrations of nutrients occur regularly in the western basin of Lake Erie during the summer months. These blooms can produce toxins harmful to humans and wildlife. Excessive growth of *Cladophora* in the eastern basin of the lake can foul beaches and shorelines, clog municipal water intakes, and impact tourism and recreational fishing. Coastal wetland conditions range from **Poor** to **Fair** due to several factors, including the impacts of invasive species like *Phragmites* and Hybrid Cattail. Some components of the lower food web, including Phytoplankton and benthic organisms, are in **Poor** condition. However, Zooplankton are in **Good** condition, helping to support abundant prey and predator fish populations. Prey fish diversity in Lake Erie is the highest among the Great Lakes, but is dominated by non-native prey fish species. Lake Erie's Walleye population is at its highest level since the 1970s, and Lake Trout abundance has increased due in part to stocking efforts and declines in Sea Lamprey populations. Self-sustaining populations of Lake Sturgeon are found in the St. Clair River, the Detroit River and the Upper Niagara River. Increased aquatic habitat connectivity due to dam removal and habitat restoration projects is further supporting the increasing predator and prey fish populations in the lake. Among the Great Lakes, Lake Erie has the highest number of aquatic non-native species, as the warmer, highly productive waters provide a favorable environment for these species. Sea Lamprey populations in Lake Erie dropped precipitously after 2018, but adult Sea Lamprey populations have slightly exceeded targets set to reach critical fish community objectives in recent years. Dreissenid Mussels continue to impact nutrient cycling by retaining and recycling nutrients in nearshore and bottom areas of the lake. Groundwater quality is assessed as **Fair** based on nitrate and chloride concentrations. Land use and shoreline hardening continue to pose threats to Lake Erie ecosystem health. Long-term trends such as earlier onset of thermal stratification and decreasing ice cover may also have ecosystem implications. **Based on the assessments of the nine State of the Great Lakes indicators, the overall status of the Lake Erie ecosystem is Poor, and there is No Trend overall due to high variability in ecological conditions in recent years.**

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Good **Fair** **Poor**

Lake Ontario

Lake Ontario shows improvements in Lake Trout and Lake Sturgeon populations, but nuisance algae like Cladophora is distributed across broad regions of the lake's nearshore zones.

Lake Ontario continues to be a good source for producing high-quality drinking water. Toxic chemicals in Lake Ontario are assessed as **Fair** and long-term trends indicate that concentrations are declining in many monitored media. Lake Ontario fish continue to be a nutritious food source. While consumption advisories for certain species of fish remain in effect, some advisories have recently become less restrictive. Lake Ontario beaches and nearshore waters provide good opportunities for swimming and other recreational uses. Excessive growth of *Cladophora* in localized nearshore areas, due in part to nutrient loading and increased water clarity caused by the filtering effects of invasive Dreissenid Mussels, can degrade habitats and foul beaches. The status of algal bloom extent in Lake Ontario is **Good** with an **Unchanging** trend, although there are localized blooms in some embayments. Nutrient concentrations are considered to be **Fair** as offshore phosphorus concentrations remain below established objectives. Coastal wetland amphibian and birds are in **Fair** condition. However, shoreline development and invasive species like *Phragmites* are ongoing stressors for coastal wetland health. Habitat connectivity between the tributaries and the lake is **Fair** and the trend is **Improving**. Lake Trout populations are **Improving**, due in part to successful Sea Lamprey control. Prey fish communities are dominated by non-native species and are in **Poor** condition; but some native prey fish, such as Deepwater Sculpin, are recovering naturally and restoration efforts for populations of other native prey fish are proving successful. Lake Sturgeon populations are showing some signs of recovery with stocking programs leading to successful spawning in tributaries, including the Genessee River. Zooplankton and Phytoplankton communities are assessed as **Fair** and **Good**, respectively. However, *Diporeia*, an important food source for prey fish, is now rarely found during regular sampling. Invasive species, including Sea Lamprey, Zebra and Quagga mussels and *Phragmites*, have significantly altered the Lake Ontario food web and habitat for native species. Groundwater quality is assessed as **Fair** based on chloride and nitrate concentrations. Over the past 50 years, the population in the Lake Ontario basin has grown by more than 60%, with rapid urban expansion particularly evident in the western Canadian portion of the basin. This ongoing growth is placing increasing pressure on local watersheds and nearshore ecosystems. Long-term increases in surface water temperatures and decreasing winter ice cover are occurring. **Based on the assessments of the nine State of the Great Lakes indicators, the overall status of the Lake Ontario ecosystem is Fair and the trend is Unchanging.**

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Good **Fair** **Poor**

Participating Organizations

Many partners assisted with the development of the *State of the Great Lakes 2025 Report*. Thank you to the authors and task team members from the organizations listed below for their hard work and continued support.

Agriculture and Agri-Food Canada

Birds Canada

Canada Water Agency

Central Michigan University

Conservation Ontario

Cornell University

Environment and Climate Change Canada

Essex Region Conservation Authority

Fisheries and Oceans Canada

General Dynamics Information Technology

Great Lakes Fishery Commission

Great Lakes Indian Fish & Wildlife Commission

Health Canada

Indiana Department of Environmental Management

Indiana University

International Joint Commission

LimnoTech

Little Traverse Bay Bands of Odawa Indians

Michigan Department of Environment, Great Lakes, and Energy

Michigan Department of Natural Resources

Michigan Technological Research Institute

National Oceanic and Atmospheric Administration

Natural Resources Canada

Ohio Lake Erie Commission

Ontario Ministry of Natural Resources

Ontario Ministry of the Environment, Conservation and Parks

Oregon State University

Pennsylvania Fish and Boat Commission

SUNY Brockport

SUNY Buffalo State

U.S. Army Corps of Engineers

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

U.S. Geological Survey

University of Minnesota - Natural Resources Research Institute

University of Wisconsin, Green Bay

University of Wisconsin, Milwaukee

University of Wisconsin, Superior

Definitions

Status* terms are generally defined as:

Good: Most or all ecosystem components are in acceptable condition.

Fair: Some ecosystem components are in acceptable condition.

Poor: Very few or no ecosystem components are in acceptable condition.

Undetermined: Data are not available or are insufficient to assess the condition of the ecosystem components.

Trend* terms are generally defined as:

Improving: Metrics show a change toward more acceptable conditions.

Unchanging: Metrics generally show no overall change in condition.

No Trend: Data are available, but the trend is not statistically improving or deteriorating due to high variability in the data, or multiple measured parameters are changing in different directions. No Trend is different from Unchanging (which is used when the trend is not statistically significant and has low variability (i.e., stable)) and Undetermined (which should be reserved for cases where data availability is limited).

Deteriorating: Metrics show a change away from acceptable conditions.

Undetermined: A sufficient amount of data are not available to report on a trend.

*see individual sub-indicator reports for more detail on Status and Trend definitions.

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The information contained within this *State of the Great Lakes 2025 Report* is a summary of science-based information from 42 sub-indicators. These sub-indicator reports can be found in their entirety in the *State of the Great Lakes 2025 Technical Report*.

For more information about State of the Great Lakes reporting, visit the following websites:
www.binational.net
www.canada.ca/great-lakes-protection
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