INDICATOR: STATUS OF GREAT LAKES ECOSYSTEMS

STRATEGIC DIRECTION: Enhance Resilience

TARGET: N/A

THEME: State of Ecosystems and Species

Background Information:

The Great Lakes – Erie, Huron, Michigan, Ontario and Superior - and their surrounding watershed make up a rich and diverse system that supports a wide variety of aquatic and terrestrial life. The Great Lakes contain nearly 20 per cent of the fresh surface water on the planet and there are over 4,000 species of plants, fish and wildlife that call this area their home. The Lakes also provide food and recreational opportunities, as well as supply the province with numerous economic advantages (Environment Canada and the US Environmental Protection Agency 2014).

The Great Lakes ecosystem has undergone significant and sometimes rapid ecological change associated with a long history of intensive human use. During the 1970s it became clear that pollution and other pressures were taking their toll on the Lakes. In response, several successful protection and restoration efforts were initiated, including cleaning up several highly polluted harbours, bays and waterfronts; dramatically reducing emissions of many toxic chemicals that were harming fish and wildlife; and reducing Lake Erie algae problems by banning phosphate detergents, upgrading sewage treatment and enhancing adoption of environmental farm practices, to reduce nutrients entering the lake (Government of Ontario 2012).

Despite these successes, the cumulative impacts of many pressures continue to threaten the Great Lakes. Toxic contaminants, invasive species, excessive amounts of nutrients, shoreline and land use changes, and hydrologic modifications are all impacting the Great Lakes ecosystem (Environment Canada and the US Environmental Protection Agency 2014). An understanding of ecosystem conditions and whether they are getting better or worse is necessary to address these problems. This indicator provides a lake-by-lake summary of the state of the Great Lakes based on information provided in the State of the Great Lakes Report 2011.

Data Analysis:

Information for this indicator was assembled from data provided in the State of the Great Lakes 2011 Report (EC and USEPA 2014), which provides science-based trend information on the state of the health of the Great Lakes Basin. The State of the Great Lakes Report 2011 was developed with the involvement of more than 125 scientists and experts from the Great Lakes community within Canada and the United States. The data are based on indicator reports and presentations from the State of the Lakes Ecosystem Conference. Some indicator reports have also been augmented with more recent information. More information about Great Lakes indicators and the State of the Lakes Ecosystem Conference can be found at: http://www.epa.gov/solec/ or https://www.ec.gc.ca/grandslacs-greatlakes/.

Reporting on a suite of Great Lakes indicators provides a big picture perspective of the complex Great Lakes ecosystem. The State of the Great Lakes 2011 technical report contains indicator reports that

assess trends in water quality, aquatic-dependent life and landscapes and natural processes. The state of 44 indicators is also assessed on a Lake-by-Lake basis. The framework for the status assessment is defined in Table 1.

Table 1. Indicator assessment criteria in the State of the Great Lakes Report 2011.

Status	Description
Good	Meeting Great Lakes Water Quality Agreement or other ecosystem objectives or otherwise in acceptable condition.
Fair	Exhibiting minimally acceptable conditions, but not meeting established GLWQA or other ecosystem objectives.
Poor	Severely negatively impacted and not displaying even minimally acceptable conditions.
Undetermined	Data are not available or are insufficient to assess the status of ecosystem components.

To understand the overall state of each Great Lake, the percentage of indicators that were assessed as good, fair, poor or undetermined are presented (Fig. 1). As well, a narrative describing the state of each Great Lake, including ongoing and emerging stressors is included. While Lake Michigan is located entirely within the Unites States, it is included in this analysis as these waters are part of a larger shared system and the state of the Lake has impacts on the entire Great Lakes Basin, including Ontario.

Results:

Trend: Mixed **Data Confidence:** High **Geographic Extent:** Great Lakes

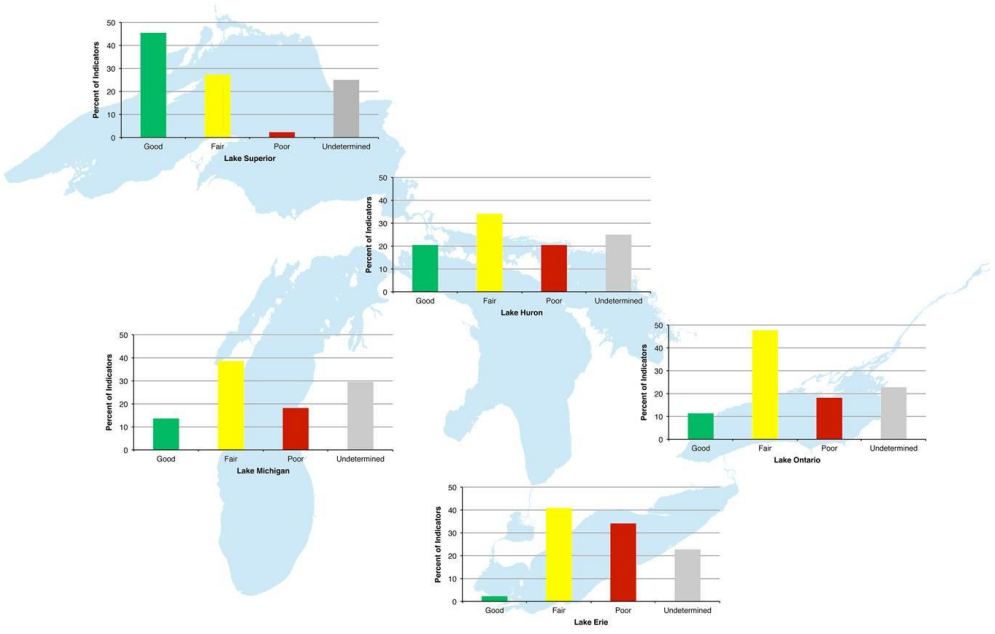

Figure 1. Percentage of indicators that were classified as good, fair, poor or undetermined for each of the Great Lakes in the State of the Great Lakes Report 2011 (*n* = 44).

Status:

- Lake Superior is in generally good condition, with almost half of indicators assessed as good (46%) and only one (aquatic non-native species) considered poor.
- The largest proportion of indicators for Lake Michigan (39%), Lake Huron (34%) and Lake Ontario (48%) were assessed as fair.
- While the largest proportion of indicators for Lake Erie were also assessed as fair (41%), this Lake also had the highest number of indicators assessed as poor (34%) and only one (drinking water quality) assessed as good.

Lake Superior

Lake Superior is in generally good condition due to its larger size and relatively low development pressure. The fisheries are healthy, the lower food web is strong and toxic chemicals are largely decreasing or remaining stable. Ongoing and emerging stressors include fluctuating water levels and increasing concentrations of contaminants in whole fish. Water levels in Lake Superior have been below average since the 1990s and there are concerns that climate change will cause greater fluctuations and possibly lower water levels. From an ecological perspective, short and long-term lake level fluctuations are critical to maintain healthy coastal habitats, especially wetlands. However, dramatic or sustained long-term changes can degrade these important habitats. Concentrations of PCBs and pentaBDEs are also above guidelines in Lake Trout. Total mercury concentrations, although still below the target, have returned to levels observed in the 1980s and appear to be increasing.

Lake Michigan

Lake Michigan is located entirely within the Unites States; however, these waters are part of a larger shared system and the state of the Lake has impacts on the entire Great Lakes Basin, including Ontario. In general, Lake Michigan is in a state of change with both positive and negative trends. The removal of dams, restoration of wetland habitat and riverine spawning habitat, and continued decline of contaminants such as PCBs in fish have resulted in improvements. However, the aquatic food web is under stress because *Diporeia*, a small crustacean that is an important food for many fish species, has almost disappeared. Several invasive species such as Sea Lampreys, Round Goby, Zebra Mussel and Quagga Mussel continue to cause significant changes in water clarity and fertility, resulting in major changes to Lake Michigan's ecosystem. This includes dense, widespread algal growth which is suspected of playing a role in Type E Botulism outbreaks that have caused the death of large numbers of fish eating birds. Viral Hemorrhagic Septicemia (VHS) has also recently become established in this Lake and has caused significant fish die-offs.

Lake Huron

Lake Huron has been called “the lake in the middle” both geographically and in terms of its environmental quality. In general, Lake Huron has good water quality with low concentrations of toxic chemicals in offshore waters and a decreased concentration of some legacy chemicals, such as PCBs and DDT, in fish. However, development, dams, non-point source pollution, invasive species and climate change are major stressors on the ecosystem and are resulting in habitat degradation and loss. In particular, Lake Huron has suffered due to the recent invasion of Zebra Mussel and Quagga Mussel and the disappearance of *Diporeia*, which impact on the Lake’s nutrient cycling and food web dynamics. Prey fish populations have dramatically decreased since 2003 and predator fish species, such as Salmon, have

also decreased in number and total biomass. In contrast, near shore nutrient concentrations have increased and populations of Walleye, Yellow Perch and Smallmouth Bass seem to be rebounding.

Lake Erie

Despite early successes in reducing phosphorus loads to the Lakes after the 1972 Great Lakes Water Quality Agreement was implemented, Lake Erie continues to be threatened by excessive nutrient inputs from non-point sources such as urban and rural run-off. Algal blooms have become a regular occurrence throughout the western basin during summer months and *Cladophora* growth has once again become a problem in near shore areas. Compounding this problem, in-lake nutrient cycling has changed due to the spread of invasive Zebra Mussel and Quagga Mussel that became established in the 1980s. This alteration of nutrient flow is contributing to greater nuisance algal growth in the near shore regions, while deeper offshore waters are deprived of oxygen causing "dead zones" for aquatic life. Other changes contributing to the resurgence of algae include the loss of wetlands and riparian vegetation that once trapped nutrients. Shifting communities of phytoplankton, increased water clarity and climate issues such as warmer waters and extreme precipitation events also play a role. As result of these ecological changes the fish community in Lake Erie has also suffered. Some fish species have been extirpated (e.g., Blue Pike, Shortnose Cisco), while others such as Walleye have much smaller populations than they have had in the past.

Lake Ontario

Although Lake Ontario is the smallest of the Great Lakes, its drainage basin is the most densely populated and provides ecosystem services to over 10 million people. Past and current pressures on this ecosystem have led to drastic changes in nutrient dynamics, altered hydrology, loss of coastal habitats, and the introduction of invasive species, all with serious consequences to native species, food webs, and quality of life. Many of these changes have occurred rapidly and the Lake continues to respond in unpredictable ways. Progress has been made to reduce these stressors including decreasing the amount of nutrients and toxic chemicals entering the lake and restoration of degraded habitats. These improvements have led to the return of Osprey and Bald Eagle to the shores of Lake Ontario, and have supported initiatives to restore native Lake Trout and Atlantic Salmon to the region. In contrast, a number of fish, bird and wildlife populations have declined in Lake Ontario, due in part, to destruction of habitat, overfishing, the introduction of invasive species and toxic contaminants. In particular, the invasion of Zebra Mussel and Quagga Mussel and the disappearance of *Diporeia* continue to impact the Lake's nutrient cycling and food web dynamics.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

State of the Great Lakes 2011 Technical Report http://binational.net/wp-content/uploads/2014/11/sogl-2011-technical-report-en.pdf

State of the Great Lakes 2011 Highlights http://www.ec.gc.ca/grandslacs-greatlakes/DEA99937-E0B6-4F10-8F0A-993661A2F9CC/Highlights%20Report%20E%20130827%20FINAL.pdf

State of the Great Lakes Ecosystem Conference http://www.epa.gov/solec/

Ontario's Great Lakes Strategy https://dr6j45jk9xcmk.cloudfront.net/documents/896/5-1-5-great-lakes-strategy-en.pdf

Great Lakes Biodiversity Conservation Strategies https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/wholesystems/greatlakes/basin/biodiversity/Pages/default.aspx

References:

Environment Canada and the U.S. Environmental Protection Agency. 2014. State of the Great Lakes 2011. Cat No. En161-3/1-2011E-PDF. EPA 950-R-13-002. [Available at: http://binational.net]

Government of Ontario. 2012. Ontario's Great Lakes Strategy. Queen's Printer for Ontario. Toronto, ON. [Available at: https://www.ontario.ca/environment-and-energy/ontarios-great-lakes-strategy]

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Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].