INDICATOR: Changes in Ice Cover on the Great Lakes

Startegic Direction: Reduce Threats

Target: N/A

Theme: Pressures on Ontario's Biodiversity — Climate Change

Previous version:
- Changes in ice cover on the Great Lakes - 2016
- Changes in ice cover on the Great Lakes - 2021

Background Information

Lake ecosystems are vital resources for both wildlife and humans. Any change in their quality can have wide-ranging ecological and societal implications. The increasing accumulation of greenhouse gases in the atmosphere as a result of human activities has begun to affect the structure, functioning, and stability of lake ecosystems throughout the world, and much greater impacts are likely in the future (Goldman et al. 2013). Climate change impacts are widely studied and include decreases in seasonal ice cover, increased water temperatures and lengthened periods between turnover of dissolved oxygen and nutrients (Douglas and Pearson, 2022). These changes affect the functioning of aquatic ecosystems.

Globally, some inland lakes appear to be freezing up at later dates and breaking-up earlier than the historical average, based on a study of 150 years of data (Magnuson et al. 2000). The maximum extent of ice cover on the Great Lakes has undergone a downward trend since the 1970's, due to a combination of natural climate influences as well as influences from anthropogenic climate change (Wang et al. 2018). These trends add to the evidence that the earth has been in a period of global warming for at least the last 150 years (EC and USEPA 2014).

Changes in the ice cover that forms on the Great Lakes each year affects biodiversity in coastal wetlands and nearshore aquatic and inland environments. For example, changes in freeze-up and break-up times can affect the food supply for aquatic life, alter the timing of fish spawning and cause birds to change their migration patterns (Hellmann et al. 2010). Reductions in ice cover can also increase the severity of wave action and lead to shoreline erosion with impacts to coastal habitats. Changes in the extent and duration of ice cover can affect fall and winter spawning species of fish (e.g., lake whitefish) which are dependent on ice cover to stabilize spawning habitats and protect their eggs from wave action during powerful winter storms (Assel 1999). Less ice cover on the Great Lakes also allows more water to evaporate, creating more snow which can negatively affect animals living in the Great Lakes basin (Hellmann et al. 2010; Groenwold et al. 2013). It has been suggested that increased evaporation driven by declines in the spatial and temporal coverage of lake ice may also lead to lower lake levels (Hanrahan et al. 2010).

Recent studies have looked at climate change and coastal vulnerability and found that integrating coastal hazard management across Ontario is needed.

This indicator provides an assessment of the potential impacts of climate change on biodiversity by examining trends in ice cover on the Great Lakes.

Data Analysis

Observed changes in seasonal maximum ice cover data are available from the National Oceanic and Atmospheric Administration (NOAA) NOAA/Great Lakes Environmental Research Laboratory (GLERL), which has been monitoring and documenting Great Lakes ice cover since the early 1970s using the ice products developed by the U.S. National Ice Center and the Canadian Ice Service. This database includes annual maximum ice cover average over all of the Great Lakes as well as for each individual lake.

Maximum seasonal ice cover data for each of the Great Lakes for the years 1973-2023 are plotted in Figures 1-5. Mean decadal maximum ice coverage was calculated for each lake over a series of 10-year periods(note: the average for the first time period only includes data starting from the 1972/73 season — the year it was first available). Percent change in mean decadal maximum ice coverage 1973-2020 was also calculated for each lake and are presented in Figure 6.

Results

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

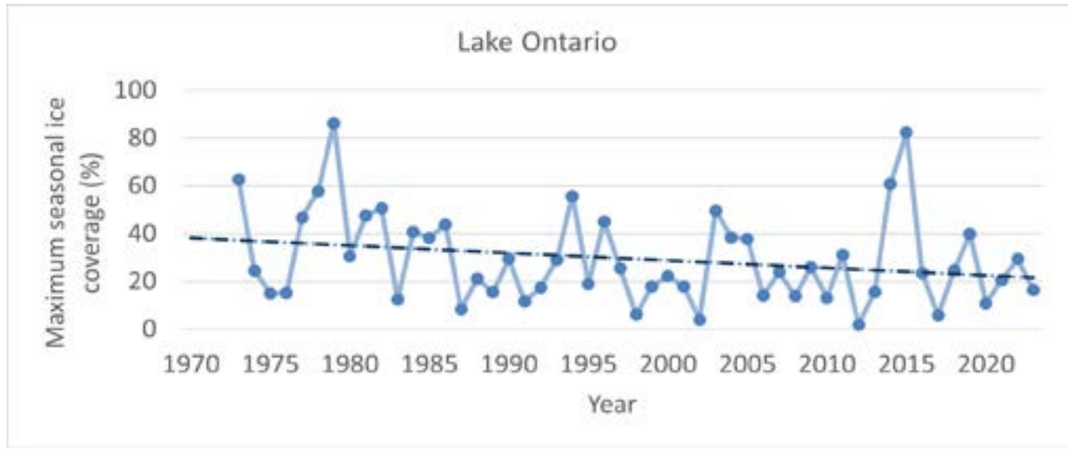

Figure 1. Maximum seasonal ice cover (% cover) on Lake Ontario from 1973 –2023. The dots indicate maximum ice cover of each year, the dashed line is the linear regression trendline for the same period (Source: National Oceanic and Atmospheric Administration (NOAA) NOAA/Great Lakes Environmental Research Laboratory (GLERL)).

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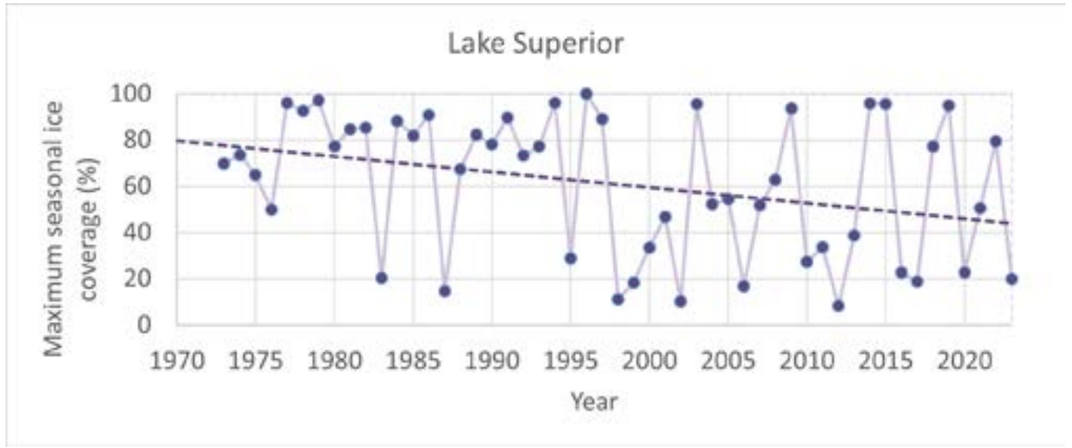

Figure 2. Maximum seasonal ice cover (% cover) on Lake Superior from 1973 –2023. The dots indicate maximum ice cover of each year, the dashed line is the linear regression trendline for the same period (Source: National Oceanic and Atmospheric Administration (NOAA) NOAA/Great Lakes Environmental Research Laboratory (GLERL)).

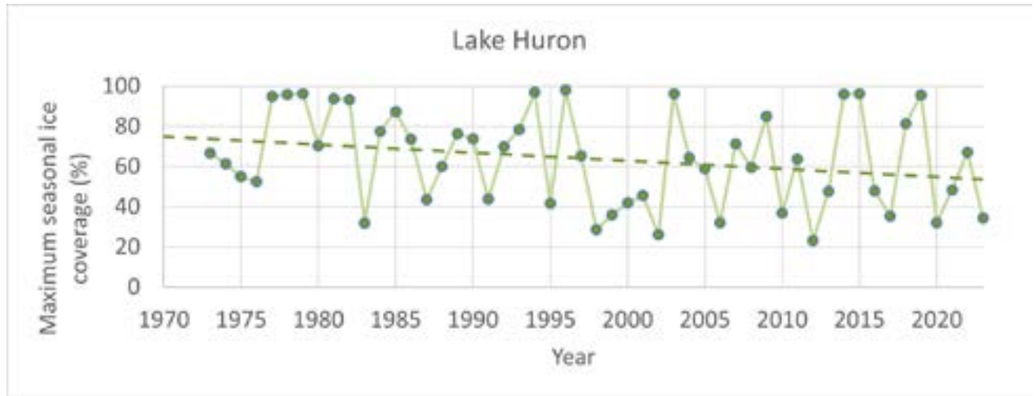

Figure 3. Maximum seasonal ice cover (% cover) on Lake Huron from 1973 –2023. The dots indicate maximum ice cover of each year, the dashed line is the linear regression trendline for the same period (Source: National Oceanic and Atmospheric Administration (NOAA) NOAA/Great Lakes Environmental Research Laboratory (GLERL)).

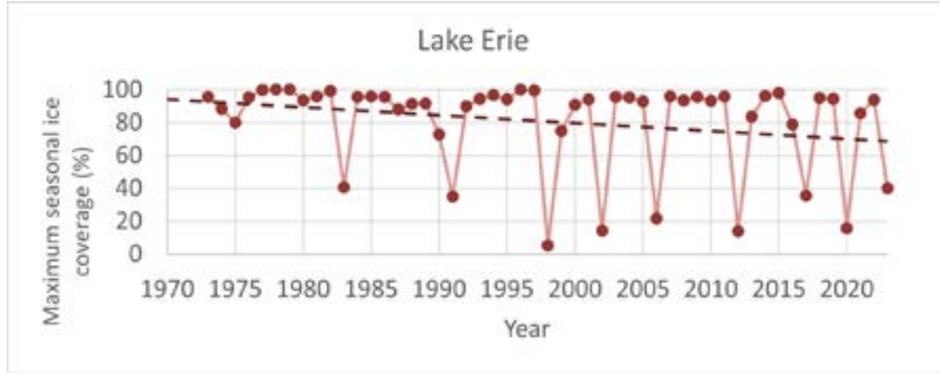

Figure 4. Maximum seasonal ice cover (% cover) on Lake Erie from 1973 –2023. The dots indicate maximum ice cover of each year, the dashed line is the linear regression trendline for the same period (Source: National Oceanic and Atmospheric Administration (NOAA)NOAA/Great Lakes Environmental Research Laboratory (GLERL)).

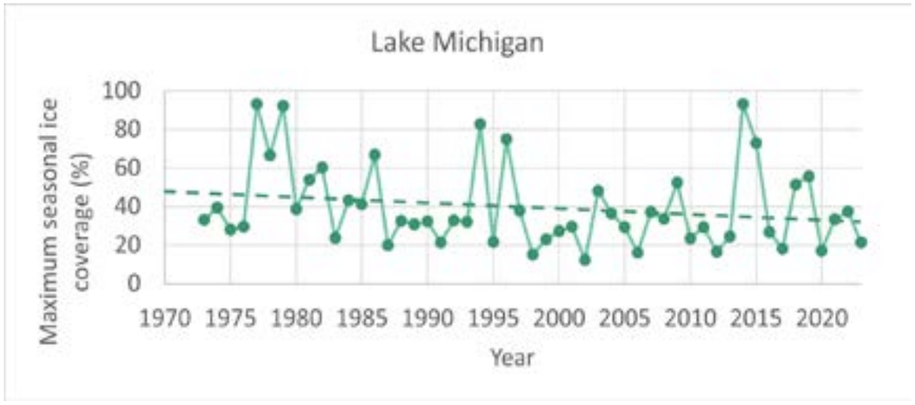

Figure 5. Maximum seasonal ice cover (% cover) on Lake Michigan from 1973 –2023. The dots indicate maximum ice cover of each year, the dashed line is the linear regression trendline for the same period (Source: National Oceanic and Atmospheric Administration (NOAA) NOAA/Great Lakes Environmental Research Laboratory (GLERL)).

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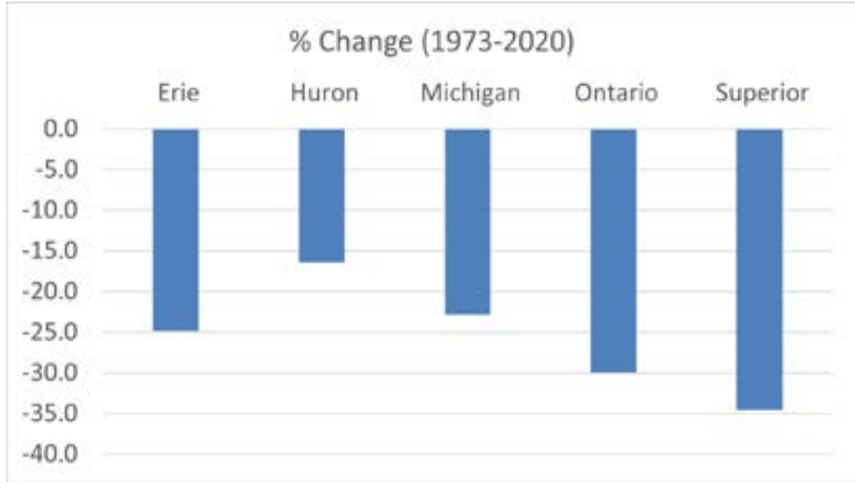

Figure 6: Mean decadal maximum ice coverage change from 1973-2020. Note: the average for the first decadal time period only includes data starting from the 1972/73 season—the year it was first available. Source: National Oceanic and Atmospheric Administration (NOAA) NOAA/Great Lakes Environmental Research Laboratory (GLERL).

Status

- Despite inter-annual variation, the maximum seasonal extent of Great Lakes ice cover shows a long-term declining trend between 1973-2023.
- Over the same time period, mean decadal maximum ice cover has also declined by varying extents for all five of the Great Lakes.
- Between 1973-2020, mean decadal maximum ice coverage declined the most on lakes Superior and Ontario (34% and 30%, respectively) followed by lakes Erie (25%), Michigan (23%), and Huron (16%).

Links

Related Targets

Target 6. By 2030, the release of ecologically damaging pollutants is reduced to a level that is not harmful to biodiversity and ecosystem services.

Target 7. By 2030, the impacts of climate change on biodiversity are minimized and biodiversity is enhanced to support climate mitigation and adaptation.

Related Themes: N/A

Web links

NOAA – Great Lakes Environmental Research Laboratory - Great Lakes Ice Cover https://www.glerl.noaa.gov/data/ice/

Canadian Ice Service https://www.canada.ca/en/environment-climate-change/services/ice-forecasts-observations/about-ice-service.html

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