INDICATOR: CHANGES IN ICE COVER ON THE GREAT LAKES

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Climate Change

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).

Changes in the duration of ice cover on northern hemisphere lakes are a strong signal of climate change (Rosenzweig 2007). 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). On Lake Superior, ice cover may have decreased by almost 50% over the last century (Austin and Coleman 2008). 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). 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).

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 and the Canadian Ice Service (Figure 1). Ice cover data for individual Great Lakes (Table 1) were obtained from the State of the Great Lakes Report 2009, with the exception of the years 2000-2015, which were obtained from the Canadian Ice Service Seasonal Summaries. Mean maximum ice coverage for each ten year period between 1970 and 2015 was calculated (note: accounting for the current decade is incomplete). Percent change in mean maximum ice coverage 1970-2015 was also calculated for each lake.

Results:

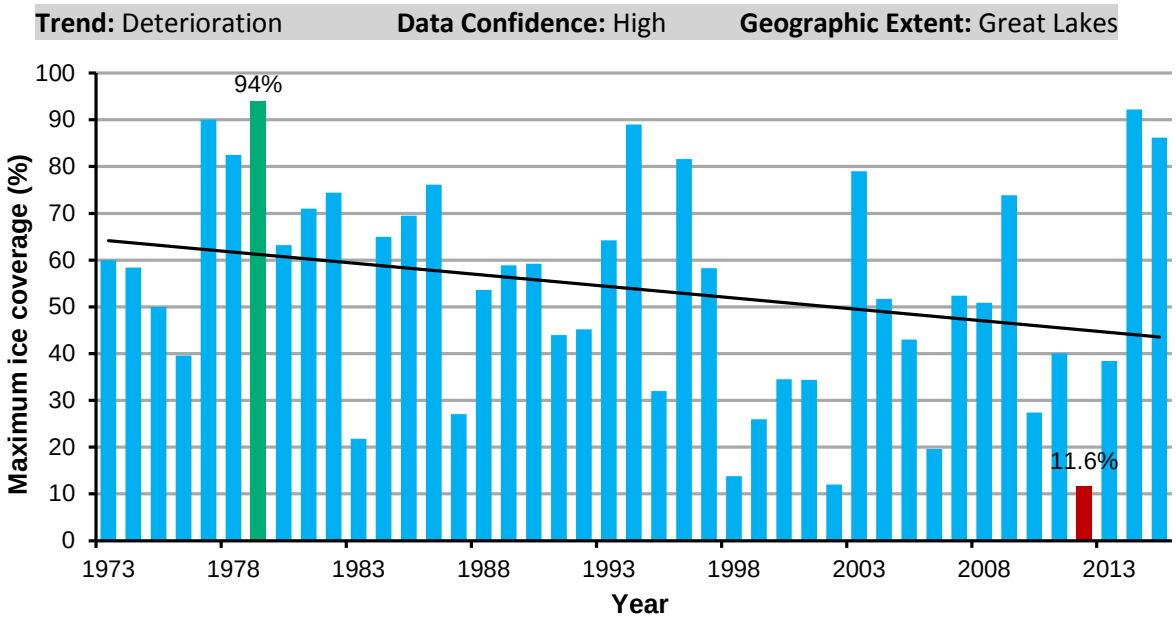

Figure 1. Seasonal maximum ice cover on the Great Lakes 1973-2015 (Source: National Oceanic and Atmospheric Administration and the Canadian Ice Service).

Table 1. Mean maximum ice coverage on the Great Lakes, in percent, during the corresponding decade and percent change 1970-2015.

Lake	1970-1979	1980-1989	1990-1999	2000-2009	2010-2015	% Change (1970-2015)
Erie	94.5	90.8	77.3	80.3	76.8	-18.8
Huron	71.3	71.7	61.3	56.4	66.2	-7.1
Michigan	50.2	45.6	32.4	29.2	42.8	-14.7
Ontario	39.8	29.7	28.1	23.0	30.9	-22.3
Superior	74.5	73.9	62.0	49.0	54.5	-26.9

Source: Updated from State of the Great Lakes Report 2009 using data from the Canadian Ice Services Seasonal Summaries for the Great Lakes (2000-2015).

Status:

- Between 1973 and 2015, ice coverage for all the Great Lakes declined, despite some variability.
- Between 1970 and 2015, mean maximum ice cover declined most on Lake Superior (27%), followed by lakes Ontario (22%), Erie (19%), Michigan (15%) and Huron (7%).

Links:

Related Targets: 6. By 2015, plans for climate change mitigation are developed and implemented and contribute to Ontario's target to reduce greenhouse gas emissions by 6 per cent below 1990 levels.

Related Themes: N/A

Web Links:

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

Canadian Ice Service http://www.ec.gc.ca/glaces-ice/

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

References:

Austin, J., and S. Colman. 2008. A century of temperature variability in Lake Superior. Limnology and Oceanography 53:2724-2730.

Environment Canada (EC) and the U.S. Environmental Protection Agency (USEPA). 2014. State of the Great Lakes 2011. Cat No. En161-3/1-2011E-PDF. EPA 950-R-13-002. [Available at: http://binational.net /wp-content/uploads/2014/11/sogl-2011-technical-report-en.pdf]

Environment Canada (EC) and the U.S. Environmental Protection Agency (USEPA). 2009. State of the Great Lakes 2009. Cat No. En161-3/1-2009E-PDF. EPA 905-R-09-031. [Available at: http://binational.net/wp-content/uploads/2014/11/En161-3-1-2009E.pdf]

Goldman, C.R., M. Kumagai, and R.D. Robarts. (eds). 2013. Climatic change and global warming of inland waters: impacts and mitigation for ecosystems and societies. John Wiley & Sons, Ltd, Chichester, U.K.

Groenwold, A.D., V. Fortin, B. Lofgren, A. Clites, C.A. Stow, and F. Quinn. 2013. Coasts, water levels and climate change: A Great Lakes perspective. Climate Change 120:697-711.

Hellmann, J.J., K.J. Nadelhoffer, L.R. Iverson, L.H. Ziska, S.N. Matthews, P. Myers, A.M. Prasad, and M.P. Peters. 2010. Climate change impacts on terrestrial ecosystems in metropolitan Chicago and its surrounding, multi-state region. Journal of Great Lakes Research 36:74-85.

Magnuson, J. J., D. M. Robertson, B. J. Benson, R. H. Wynne, D. M. Livingstone, T. Arai, R. A. Assel, R. G. Barry, V. Card, E. Kuusisto, N. G. Granin, T. D. Prowse, K. M. Stewart, and V. S. Vuglinski. 2000. Historical trends in lake and river ice cover in the Northern Hemisphere. Science 289: 1743-1746 and Errata 2001 Science 291:254.

National Oceanic and Atmospheric Administration (NOAA). 2014. State of climate - Great Lakes Ice. March 2014. [Available at: https://www.ncdc.noaa.gov/sotc/national/2014/3/supplemental/page-4/ (Accessed July 18, 2014)]

Rosenzweig C. 2007. Assessment of observed changes and responses in natural and managed systems. pp. 79–131 *In* Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, C.E. Hanson, and others (eds). Climate change 2007—impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, U.K.

Citation
Ontario Biodiversity Council. 2016. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. Available **http://ontariobiodiversitycouncil.ca/sobr**. [Date Accessed: May 24, 2016].