Effect of Water Level Fluctuations

Indicator #4861

This indicator report was last updated in 2002.

Overall Assessment

Status:	**Mixed**
Trend:	**Not Assessed**

Lake-by-Lake Assessment

Separate lake assessments were not included in the last update of this report, but data are available for water level fluctuations for all Lakes. A comparison of wetland vegetation along regulated Lake Ontario to vegetation along unregulated Lakes Michigan and Huron provides insight into the impacts of water level regulation.

Purpose

- To examine the historic water levels in all the Great Lakes, and compare these levels and their effects on wetlands with post-regulated levels in Lakes Superior and Ontario, where water levels have been regulated since about 1914 and 1959, respectively
- To examine water level fluctuation effects on wetland vegetation communities over time as well as aiding in the interpretation of estimates of coastal wetland area, especially in those Great Lakes for which water levels are not regulated

Ecosystem Objective

The ecosystem objective is to maintain the diverse array of Great Lakes coastal wetlands by allowing, as closely as is possible, the natural seasonal and long-term fluctuations of Great Lakes water levels.

State of the Ecosystem

Background

Naturally fluctuating water levels are known to be essential for maintaining the ecological health of Great Lakes shoreline ecosystems, especially coastal wetlands. Thus, comparing the hydrology of the Lakes serves as an indicator of degradation caused by the artificial alteration of the naturally fluctuating hydrological cycle.

Great Lakes shoreline ecosystems are dependent upon natural disturbance processes, such as water level fluctuations, if they are to function as dynamic systems. Naturally fluctuating water levels create ever-changing conditions along the Great Lakes shoreline, and the biological communities that populate these coastal wetlands have responded to these dynamic changes with rich and diverse assemblages of species.

Status of Great Lakes Water Level Fluctuations

Water levels in the Great Lakes have been measured since 1860, but 140 years is a relatively short period of time when assessing the hydrological history of the Lakes. Sediment investigations conducted by Baedke and Thompson (2000) on the Lake Michigan-Huron system indicate quasi-periodic lake level fluctuations (Figure 1), both in period and

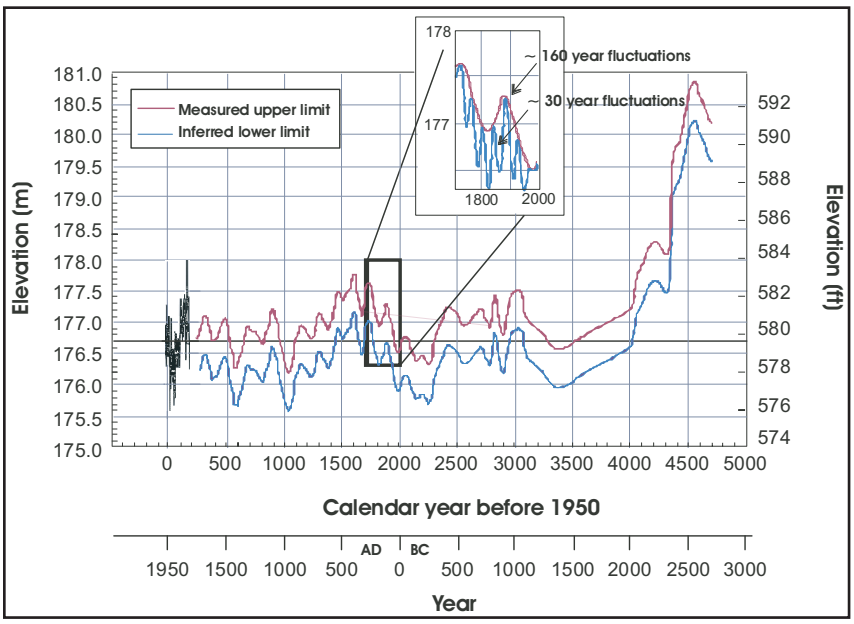

Figure 1. Sediment investigations on the Lake Michigan-Huron system indicate quasi-periodic lake level fluctuations.

Source: National Oceanic and Atmospheric Administration (1992 and updates)

amplitude, on an average of about 160 years, but ranging from 120 to 200 years. Within this 160-year period, there also appear to be sub-fluctuations of approximately 33 years. Therefore, to assess water level fluctuations, it is necessary to consider long-term data. Because Lake Superior is at the upper end of the watershed, the fluctuations have less amplitude than the other lakes. Lake Ontario (Figure 2), at the lower end of the watershed, more clearly shows these quasi-periodic fluctuations and the almost complete elimination of the high and low levels since the lake level began to be regulated in 1959, and more rigorously since 1976. For example, the 1986 high level that was observed in the other lakes was eliminated from Lake Ontario. The level in Lake Ontario after 1959 contrasts with that of the Lake Michigan- Huron system (Figure 3), which shows the more characteristic high and low water levels.

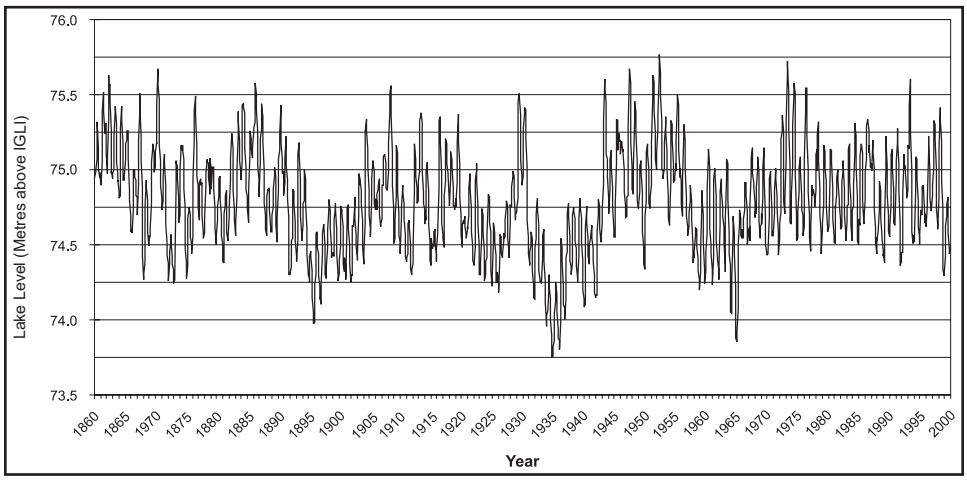

Figure 2. Actual water levels for Lake Ontario.
IGLD=International Great Lakes Datum. Zero for IGLD is Rimouski, Quebec, at the mouth of the St. Lawrence River. Water level elevations in the Great Lakes/St. Lawrence River system are measured above water level at this site.
Source: National Oceanic and Atmospheric Administration (1992 and updates)

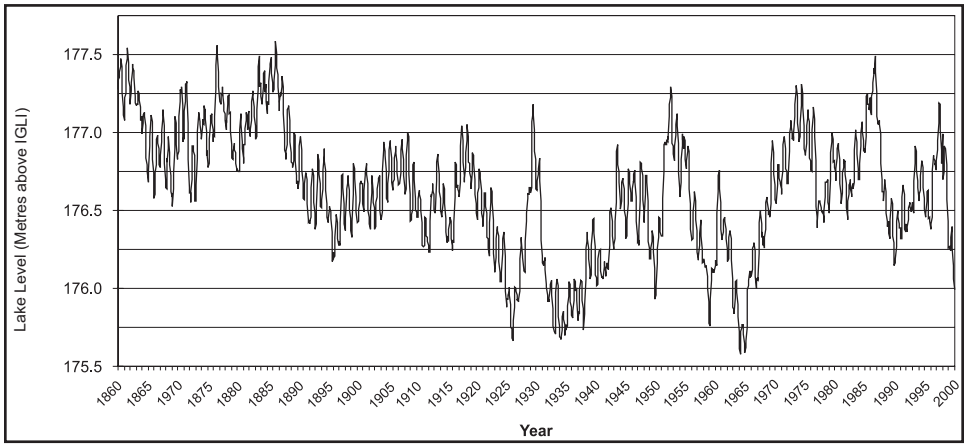

Figure 3. Actual water levels for Lakes Huron and Michigan.
IGLD=International Great Lakes Datum. Zero for IGLD is Rimouski, Quebec, at the mouth of the St. Lawrence River. Water level elevations in the Great Lakes/St. Lawrence River system are measured above water level at this site.
Source: National Oceanic and Atmospheric Administration (1992 and updates)

The significance of seasonal and long-term water level fluctuations on coastal wetlands is perhaps best explained in terms of the vegetation, which, in addition to its own diverse composition, provides the substrate, food, cover, and habitat for many other species dependent on coastal wetlands.

Seasonal water level fluctuations result in higher summer water levels and lower winter levels. Additionally, the often unstable summer water levels ensure a varied hydrology for the diverse plant species inhabiting coastal wetlands. Without the seasonal variation, the wetland zone would be much narrower and less diverse. Even very short-term fluctuations resulting from changes in wind direction and barometric pressure can substantially alter the area inundated, and thus, alter the coastal wetland community.

Long-term water level fluctuations, of course, have an impact over a longer period of time. During periods of high water, there is a die-off of shrubs, cattails, and other woody or emergent species that cannot tolerate long periods of increased depth of inundation. At the same time, there is an expansion of aquatic communities, notably submergents, into the newly inundated area. As the water levels recede, seeds buried in the sediments germinate and vegetate this newly exposed zone, while the aquatic communities recede out-ward back into the lake. During periods of low water, woody plants and emergents expand again to reclaim their former area as aquatic communities establish themselves further outward into the lake. The long-term high-low fluctuation puts natural stress on coastal wetlands, but is vital in maintaining wetland diversity. It is the mid-zone of coastal wetlands that harbors the greatest biodiversity. Under more stable water levels, coastal wetlands occupy narrower zones along the lakes and are considerably

less diverse, as the more dominant species, such as cattails, take over to the detriment of those less able to compete under a stable water regime. This is characteristic of many of the coastal wetlands of Lake Ontario, where water levels are regulated.

Pressures
Future pressures on the ecosystem include additional withdrawals or diversions of water from the Lakes, or additional regulation of the high and low water levels. These potential future pressures will require direct human intervention to implement, and thus, with proper consideration of the impacts, can be prevented. The more insidious impact could be caused by global climate change. The quasi-periodic fluctuations of water levels are the result of climatic effects, and global warming has the potential to greatly alter the water levels in the Lakes.

Management Implications
The Lake Ontario-St. Lawrence River Study Board is undertaking a comprehensive 5-year study (2000-2005) for the International Joint Commission (IJC) to assess the current criteria used for regulating water levels on Lake Ontario and in the St. Lawrence River.

The overall goals of Environment/Wetlands Working Group of the IJC study are (1) to ensure that all types of native habitats (floodplain, forested and shrubby swamps, wet meadows, shallow and deep marshes, submerged vegetation, mud flats, open water, and fast flowing water) and shoreline features (barrier beaches, sand bars/dunes, gravel/cobble shores, and islands) are represented in an abundance that allows for the maintenance of ecosystem resilience and integrity over all seasons, and (2) to maintain hydraulic and spatial connectivity of habitats to ensure that fauna have access, temporally and spatially, to a sufficient surface of all the types of habitats they need to complete their life cycles.

The environment/wetlands component of the IJC study provides a major opportunity to improve the understanding of past water regulation impacts on coastal wetlands. The new knowledge will be used to develop and recommend water level regulation criteria with the specific objective of maintaining coastal wetland diversity and health. Also, continued monitoring of water levels in all of the Great Lakes is vital to understanding coastal wetland dynamics and the ability to assess wetland health on a large scale. Fluctuations in water levels are the driving force behind coastal wetland biodiversity and overall wetland health. Their effects on wetland ecosystems must be recognized and monitored throughout the Great Lakes basin in both regulated and unregulated lakes.

Comments from the author(s)
Human-induced global climate change could be a major cause of lowered water levels in the Lakes in future years. Further study is needed on the impacts of water level fluctuations on other nearshore terrestrial communities. Also, an educated public is critical to ensuring wise decisions about the stewardship of the Great Lakes basin ecosystem are made, and better platforms to getting understandable information to the public are needed.

Acknowledgments
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Much of the information and discussion presented in this summary is based on work conducted by the following:
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Sources
Baedke, S.J., and Thompson, T.A. 2000. A 4,700-year record of lake level and isostasy for Lake Michigan. *J. Great Lakes Res.* 26(4):416-426.

International Joint Commission. Great Lakes Regional Office, Windsor, ON and Detroit, MI.

International Lake Ontario-St. Lawrence River Study Board, Technical Working Group on Environment/Wetlands. http://www.ijc.org.

Maynard, L., and Wilcox, D. 1997. *Coastal wetlands of the Great Lakes*. State of the Lakes Ecosystem Conference 1996 Background

Paper. Environment Canada and U.S. Environmental Protection Agency.

National Oceanic and Atmospheric Administration (NOAA). 1992 (and updates). *Great Lakes water levels, 1860-1990.* National Ocean Service, Rockville, MD.

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