

"The Great Lakes are not a big bathtub of water that was put here for us to use."
Julie O'Leary, Minnesota Environmental Partnership

The Effects of Climate Change on the Great Lakes

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This poster was developed as a 2007 class assignment for Honors 295 **Population, Environment, and Sustainability—Ethics for Living into the Future.**
 References can be obtained by contacting the author.

Abstract

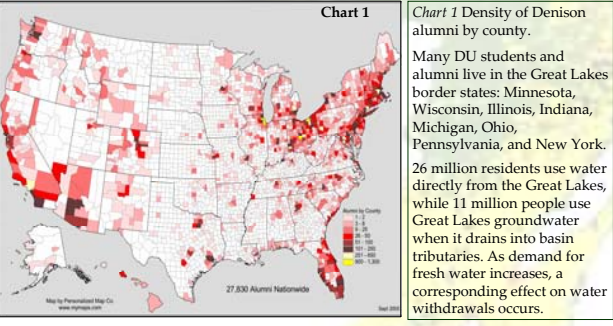
If we treat the Great Lakes as a big bathtub that can be used for drinking water, thermoelectric cooling, commercial shipping, and various other human needs, rather than treating the Great Lakes as a resource which provides important ecosystem services to humans, animals, and the environment, then serious consequences are inevitable. The Great Lakes already suffer from stresses caused by agricultural runoff, wastewater overflows, invasive species, and developmental sprawl. Global climate change is likely to compound current pressures by altering temperature, precipitation, and evaporation patterns. Water levels in some lakes are approaching historic lows and the projected increase in temperature over the coming century is likely to outweigh projected increases in precipitation, resulting in further decreases in water levels. Therefore, global climate change could have devastating consequences for ecosystems, native species, human industries, and overall water quality and availability within the Great Lakes. Combating the effects of climate change must involve a rethinking of how we treat the Great Lakes and why we value their resources.

Why should we care?

The Great Lakes collectively compose the largest body of surface freshwater in the world, representing 20% of the Earth's surface freshwater. Covering over 94,000 square miles and containing approximately 6 quadrillion gallons of water, the Lakes supply water to eight states as well as Ontario and Quebec.

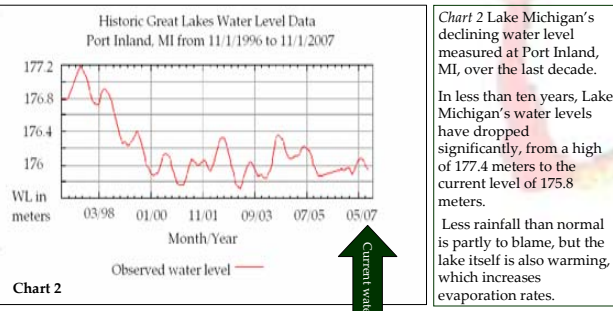
The Great Lakes provide much more than drinking water, supporting diverse habitats and species, producing hydroelectric power, and sustaining commercial shipping. Although the Great Lakes contain 95% of the United States' surface freshwater, less than one percent of this water is renewed annually through precipitation, run-off, and infiltration.

Nearly 157 billion gallons of water, more than 4,000 gallons per resident, are permanently lost through the Great Lakes drainage basin each year. As water availability decreases, water quality also decreases due to airborne pollution from coal power plants, water pollution from agricultural pesticides and urban sewage, and the introduction of over 160 invasive species.



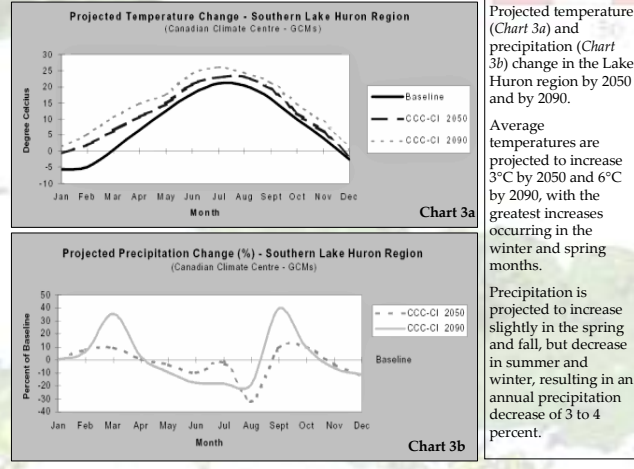
What should we know?

Over the past decade, water levels have gone from unusually high to unusually low. From 1997 to 2001, Lakes Michigan (Chart 2) and Huron dropped by 3.4 feet, and Lake Erie dropped by 3.1 feet. At the end of October, Lake Ontario was 3 inches below its level at the beginning of the month, 5 inches below September's monthly average, and a foot below last year's average. Lake Superior's water level is approaching the record low, currently standing at 18 inches below normal and a foot lower than last year. Projected reductions in water levels range from .8 to 8 feet depending on the lake and the projection model. However, all models suggest that future levels may be much lower than levels during the past 150 years.



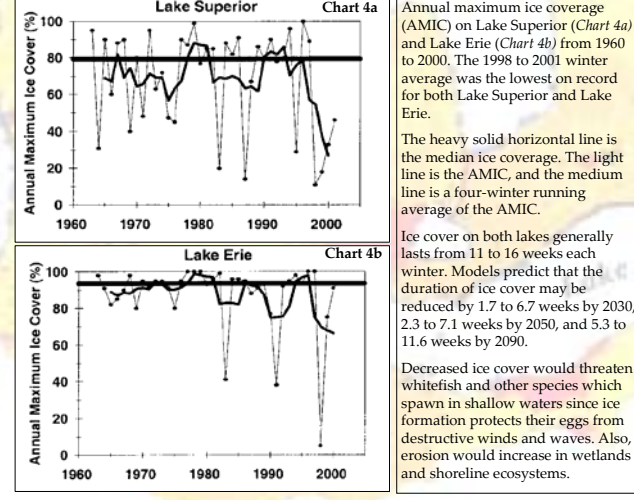
What is predicted for the future?

Present low water levels have resulted from a combination of lower than normal precipitation rates and higher than normal evaporation rates and air temperature. Although long-term climate change may increase precipitation levels during some seasons (Chart 3b), the projected temperature increase of 2 to 4°C (Chart 3a) would increase rates of evaporation. Therefore, temperature increases are expected to outweigh precipitation increases, resulting in lower water levels, especially in the summer and fall. Warmer temperatures cause more water to evaporate from the Lakes' surfaces and they also increase the percentage of precipitation which falls as rain, rather than as snow, resulting in less accumulated snowpack during winter months and therefore decreased snowmelt and water storage later in the year.



Why is ice cover so important?

A report from the University of Minnesota-Duluth's Large Lakes Observatory indicates that Lake Superior's water temperatures are warming twice as fast as air temperatures, resulting in the "largest change in temperature of any natural system that's been observed over the last 25 years". Average surface temperatures have increased more than 4°F, largely due to declining ice cover (Chart 4a); when ice cover decreases, less sunlight is reflected back into space and the lake absorbs more heat. The other Great Lakes are showing similar changes in ice patterns. For example, Grand Traverse Bay in Lake Michigan has not frozen over for the past five winters, marking the longest consecutive stretch without a freeze-up in 150 years. In an average year, ice covers nearly half of Lake Michigan's surface, but, in 1998, ice covered only 15 percent of the surface. Similarly, in 1998, Lake Erie was nearly ice free (Chart 4b).



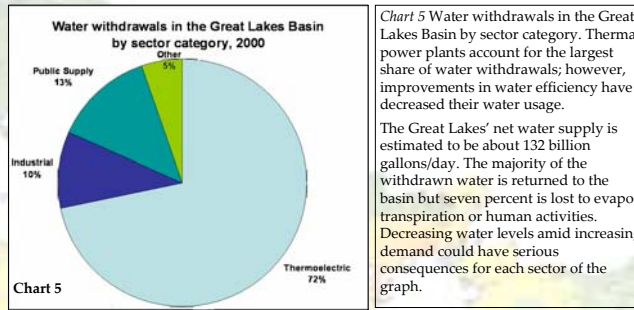
If projections are correct, what will be affected?

Algal growth: Because the interaction between water temperature, sunlight, and nutrient availability is complex, disagreement exists regarding climate change's potential effect on algal growth. In Lakes Huron, Michigan, and Superior, warmer water temperatures are predicted to decrease algal growth. During the winter, "overturning" occurs as oxygen-rich surface waters sink, replenishing oxygen supplies and mixing algae in the top layer with sediments and nutrients in the bottom layer. Algal growth occurs during the spring when sunlight penetrates the nutrient-rich layers. When the water warms to 39°F, thermal stratification inhibits further mixing and algal growth ceases. If temperatures warm and the thermal stratification threshold is reached earlier in the season, then the period of algal growth would shorten. This would deplete algal populations and cause repercussions for species higher on the food chain.

Streamflow and species composition: Rivers in the northern Great Lakes are primarily fed by snow-melt. Peak flows in these rivers will likely occur earlier in the year because of increased winter runoff. Stream water temperatures, which are primarily determined by air temperature, will also increase. Warmer waters could reduce habitats for brook, rainbow, cutthroat, and brown trout as well as whitefish and other cold water fish. MI, WI, MN, NY, and PA might lose half of their cold water stream habitats, while OH and IN could lose all of the cold water habitats as warmer temperature zones move northward.

Coastal wetlands: Declining water levels could reduce coastal wetlands which provide breeding habitats and food for fish and waterfowl. With only 50 percent of the original Great Lakes wetlands remaining, and many of the wetlands already stressed by pollution and development, further declines in coastal wetlands could have serious consequences for the 32 fish species which rely on wetland habitats for reproduction. Climate change could also affect food availability for waterfowl which rely on the Great Lakes for migration resting stops.

Commercial shipping: Over 240 million tons of cargo travel across the Great Lakes annually. For every inch of water that the lakes drop, cargo ships must lighten their load by 270 tons (540,000 pounds). The co-director of the University of Wisconsin-Superior's Transportation and Logistics Research Center explained the economic implications: "When a ship leaves a dock, and it's not filled to capacity, it's the same as a plane leaving an airport with empty seats: It cuts into their earning capacity." The resulting price increases affect everyone from car manufacturers to biodiesel plants to electricity suppliers.



Conclusion

Recognizing and mitigating the effects of climate change on the Great Lakes is imperative because the potential repercussions of falling water levels and rising water temperatures could be devastating not only for Great Lakes ecosystems, including the associated plants, fish, and animals, but also for hundreds of Denison students, 37 million basin residents, and potentially all of America and Canada. The Great Lakes are a gift from the last ice age, and they cannot easily be replaced. Pollution and developmental sprawl continue to stress the Great Lakes' coping ability, and climate change will compound these problems. However, researchers and institutions are studying the overall health of the Great Lakes in order to observe changes and preserve resources. A wealth of online information allows individuals to research and understand the Great Lakes' many benefits as well as climate change's potential effects.

- The Great Lakes Environmental Research Laboratory, funded by the National Oceanic and Atmospheric Administration, studies ecological statistics and projections: www.glerl.noaa.gov/.
- The U.S. Environmental Protection Agency provides comprehensive information about climate change and its effects on the Great Lakes: www.epa.gov/climatechange/.
- Michigan State University's Great Lakes Regional Assessment describes possible changes to Great Lakes' agriculture, climate, land ecology, and water resources: www.geo.msu.edu/glra/.
- The Great Lakes Forever Campaign, a public education initiative, provides information about what individuals can do to protect the Great Lakes: www.greatlakesforever.org/.

If each of us curbs our own water usage, pressures local industries to do the same, and demands that governments institute ecologically sound guidelines, we may finally move beyond exploiting the Great Lakes as a giant bathtub and rather begin viewing the Lakes as a valuable natural endowment. Only then can we hope to ensure their sustainability for generations to come.