

Lake Superior's Vulnerability to Global Environmental Problems



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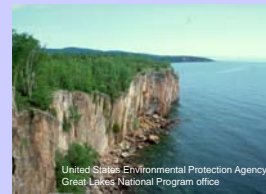
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Background

Lake Superior is the largest Great Lake (Fig 1) with 20% and 95% of world and US fresh surface water. The lake volume is 3rd largest globally, but only 0.5% is replenished yearly, slowing cycling out toxins.



Two countries, 3 states (Minnesota, Wisconsin, and Michigan), 1 province, multiple tribal nations, and 100s of public agencies and NGOs are involved in its management. The watershed is primarily rural (population density = 5 people/km²), but contains a few small cities and a high-traffic shipping port in Duluth, Minnesota.

Governance Structure

The two primary agencies dealing with lake protection are the United States Environmental Protection Agency and the Ontario Ministry of Environment, each with its own environmental policies for issues ranging from water quality to invasive species (Annin 2006; Dempsey 2001; Visser 2007). However, international agreements do govern lake protection. The International Joint Commission advises the U.S. and Ontario in lake protection efforts. The Great Lakes Water Quality Agreement sets timetables for achievement of environmental protection goals. The citizen-based Binational Forum helps implement programs to meet these goals.



Figure 1: Schematic illustration of Lake Superior, its watershed, and external stressors

Vulnerabilities

Although past resource extraction activities impacted the watershed, it is currently relatively undeveloped, which tends to magnify the significance of external stressors. The combination of legacy and current, external stressors creates complex and often poorly understood effects.

Climate Change: The lake's winter ice cover is 50% smaller than in the 1900's. Summer surface water has warmed almost twice as fast as air temperature (see Figure 2). Wind speeds have risen 25% leading to higher evaporation rates (Austin and Colman 2007). 2007 lake levels were at their lowest in 81 years with significant ecological, economic and recreational impacts.

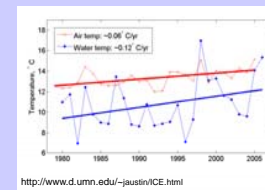


Figure 2: Lake, atmospheric temperature trends

Aquatic Invasive Species (AIS) are non-native plants and animals that thrive in a new environment causing ecosystem damage. Shipping and recreational activities, like fishing, bring AIS to Lake Superior. The lake's cold temperatures and low nutrient levels currently suppress AIS introductions. However, climate change-related precipitation shifts and increased water temperature could increase invasive species' success (USEPA, 2007).



Persistent Organic Pollutants (POPs): Lake Superior's 82,100 km² of cold water surface is vulnerable to legacy POPs, such as PCBs, Dieldrin, toxaphene and DDT that circulate in the air and are deposited in the lake (Visser 2007). POPs were banned in North America, but continuing use in the developing world keeps lake concentrations high. Bioaccumulation continues to result in fish advisories and wildlife reproductive problems. Climate change is expected to worsen problems associated with POPs.

Regional Climate Change Survey

In 2007-08 we conducted a survey of 1500 residents of the 3 states bordering the lake (Minnesota, Wisconsin, and Michigan). Questions covered understandings of climate change causes, solutions, and likelihood of being a significant problem. They also assessed respondents' support for climate change solutions. The response rate was 52%. Demographics of respondents versus the population, responses of early versus late respondents, and responses of respondents versus non-respondents who responded to a shortened phone survey were compared to determine how representative respondents were of the population and to correct for respondent bias.

Climate Change Survey Results^a

Variable	Question	Response (%)			Total N
		Agree (%)	Neither Agree nor Disagree (%)	Disagree (%)	
Familiarity	I hear a lot about climate change in many places, such as on TV	91.2	3.3	5.0	738
	I don't know a lot about global warming or climate change	35.9	14.3	47.4	736
Knowledge	Burning fossil fuels is one of the primary causes of climate change	51.0	21.0	15.2	727
	Saving energy is a way to stop climate change	65.1	15.9	11.2	737
Impacts	Climate change will cause problems for people	74.6	12.0	10.5	732
	Climate change will cause weather pattern changes such as droughts	75.9	4.4	9.3	731
	Climate change will cause the loss of wildlife species	69.8	5.5	10.5	731
Concern	Climate change is <i>not</i> likely to be a serious problem	18.7	11.8	64.4	741
	I worry about global climate change	54.1	18.7	25.6	743
Willingness to take action	I would be willing to pay 40 cents more per gallon if the money was used to stop climate change	32.5	17.2	46.0	738
	I would be willing to drive a smaller, less powerful car if it used less gasoline and helped stop climate change	62.7	12.9	23.0	738

^a Excluding "don't know" responses.

Respondents are hearing a lot about climate change, and many feel they know something about it. However, only about 1/2 know it is primarily caused by burning fossil fuels, although about 65% know saving energy is a good way to stop it. Most respondents recognize that it will have a number of serious impacts. About 1/2 actively worry about it, although more disagree with the statement that it won't be a serious problem (non-response analysis suggests only about 58% disagree in the general population). However, while about 2/3 are willing to drive a smaller, more fuel efficient car, only about 1/3 are willing to pay a \$0.40 pg energy tax to stop climate change.

Conclusions

- As was found by Kempton et al. (1995), respondents were more positive about energy conservation than an "energy tax". Although only 1/2 understand fossil fuel emissions are causing climate change, most would drive a more energy efficient car to stop it.
- Lake Superior suffers from a number of global problems that climate change will exacerbate (Annin 2006; Dempsey 2004). Regional residents generally believe climate change will be a problem with serious impacts, but have mixed responses to solutions.
- Future research should assess whether these residents are aware of these vulnerabilities, including climate change. Increasing awareness of this link could increase effective solution support.

References available by request.