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The Great Lakes Futures Project: Principles and policy recommendations for making the lakes great ☆

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ABSTRACT

The Great Lakes Futures Project (GLFP) created a space for dialogue among stakeholders regarding the basin's past, present, and future. The GLFP used scenario analysis to paint alternate futures and engage stakeholders in a discourse on how to move away from an undesirable future and toward a desired one. Here, we (1) synthesize the results of a process that helped stakeholders collectively understand challenges and identify barriers to more effective policy; (2) provide a set of principles as tools to help overcome these challenges and shape strategic policy formulation; and (3) recommend broad policy directions, using the principles as a guide, to move the basin toward one that thrives ecologically, socially, and economically.

Introduction

The Great Lakes Futures Project (GLFP) was designed as a trans-disciplinary, binational and multi-sector initiative to examine alternative futures for the Great Lakes-St. Lawrence River Basin through scenario analysis. It created a space to convene stakeholders; brainstorm, select, and assess drivers; create critical axes of change; envision alternative scenarios for the basin given a high degree of uncertainty; and develop robust strategies for moving the basin toward a desired state. It engaged participants in a dialogue on understanding the current state of the basin, and then challenged them to critique the status quo, explore gaps in understanding, and think through alternative paths to the future. In doing so, the aim was to provide decision makers with a vision and pathway to a desired future. Here, we synthesize the results of this process first by identifying the challenges and barriers to more effective policy. Next, we provide a set of principles that can help overcome these challenges and shape strategic policy formulation. Finally, we recommend broad policy directions, using the principles as a guide, to move the basin toward one that thrives socially, economically, and ecologically.

Where are we now?

Although attention on the Great Lakes Basin has a rich history, current policies can be traced to the severe environmental challenges of the 1960s and 1970s, including events such as the Cuyahoga River catching on fire (CPD, 1969; Scott, 2009) and the declaration that Lake Erie was "dead" (Sweeney, 1993). During this period of environmental crisis, the Canadian and US governments each established policies and programs to enhance the overall health of the basin. The Great Lakes Basin Compact, signed in 1968 and negotiated among Great Lakes States, with participation by Ontario and Québec, was an early attempt by subnational entities to assist with management of the Great Lakes. In 1970, Canada promulgated the Canada Water Act, which banned phosphates in detergents and authorized federal–provincial agreements to address water quality and resource management priorities (EC, 2013; GC, 1985) followed by the negotiations of the first Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA), which was signed in 1971 (OMoE, 2010). The US closely followed with the

☆ The Great Lakes Futures Project brought together graduate students and expert mentors from universities and institutions in Canada and the United States. Each paper required collaboration between a number of authors with many of them sharing co-leadership that we denote using a †.

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signing of the Clean Water Act of 1972 (USFG, 2002). In that same year both countries signed the Great Lakes Water Quality Agreement (GLWQA), which committed the parties to restoring and maintaining the chemical, physical, and biological integrity of the "Great Lakes Basin Ecosystem" and reaffirmed the rights and obligations of each nation to the Boundary Water Treaty of 1909 (IJC, 2012).

More than a generation later, these governments continued to strengthen policies and programs for the basin. In 2008, the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact; USFG, 2008) came into force to address water diversion threats. One year later, the US promulgated the Great Lakes Restoration Initiative (GLRI), which built upon the Great Lakes Regional Collaboration Strategy (USFG, 2010) and, with a $1 billion funding commitment, represents the largest current investment to protect and restore the integrity of the lakes. Most recently, the governments of Canada and the US negotiated the GLWQA 2012 Protocol, representing an updated blueprint for binational cooperation to restore and protect the lakes (IJC, 2012).

Despite historical and more recent efforts, the health of the basin's ecosystem remains in jeopardy (Bails et al., 2005; IJC, 2006; McLaughlin and Krantzberg, 2012). Although many advances in basin water quality, conservation and remediation have occurred, Great Lakes region scientists indicate that the ecological health of the basin is at significant risk, and may be fast approaching its threshold, or tipping point (Bails et al., 2005; Krantzberg, 2012). Recent research illustrates the accumulation of stressors within the lakes that threaten the ecological services that each provides (Allan et al., 2013). As outlined in the Millennium Ecosystem Assessment, ecological services are related to a variety of diverse drivers in a system and play an important role in human health (Corvalan et al., 2005). Therefore, it is urgent to understand and mitigate the effects of these stressors on the environment, with the Great Lakes Basin being one such example. Succinctly stated, the basin may be facing a point of no return. As a result, the impacts of these stressors on the system and the necessary policy reforms and research strategies to mitigate their effects are important to understand.

The changes in ecological and human systems are profound (Table 1). Ecological pressures deeply shape basin conditions — past, present, and future. These past and present pressures, or "stressors," are detected in each of the five Great Lakes; however, Lakes Erie and Ontario, Saginaw and Green Bays, and Lake Michigan's shoreline are the sub-regions experiencing the most cumulative stress (Allan et al., 2013). One such prominent stressor is invasion of non-native species within the basin, accrediting it as the greatest invaded freshwater system in the world; over 187 non-native species have invaded the system over the past two centuries that have altered the basin's productivity and biodiversity (Ricciardi, 2006; USGS, 2012). According to Pagnucco et al. (2015) research indicates that trends in invasions will continue and be promoted by the live trade industry. Furthermore, emerging and re-emerging biological and chemical contaminants continue to pose serious human, animal, and ecosystem health risks within the basin (Cornwell et al., 2015). Chemical contaminants have been detected in the basin food webs, and in a study that explored the presence of 22,263 potential commercial chemicals, 610 were found in the basin that are considered persistent and bio-accumulative chemicals (Howard and Muir, 2010). In addition, chemicals of emerging concern (IJC, 2011), such as pharmaceuticals, have the potential to disrupt the ecological health of the basin by promoting antibiotic resistance among strains of bacteria (Scott et al., 2012) and acting as endocrine disruptors causing the feminization of male fishes (Kidd et al., 2007).

Table 1
Drivers of change impacting the Great Lakes-St. Lawrence River Basin.

Driver	Article in this issue
Economy	Campbell et al. (2015)
Energy	Kelly et al. (2015)
Geopolitics and governance	Jetoo et al. (2015)
Demographics and societal values	Méthot et al. (2015)
Water quantity	Maghrebi et al. (2015)
Climate change	Bartolai et al. (2015)
Invasive species	Pagnucco et al. (2015)
Biological and chemical contaminants	Cornwell et al. (2015)

When considered independently, the ecological pressures on the basin are immense. However, when considered with regard to climate change, the consequences of these impacts are substantially magnified, increasingly uncertain, and terribly daunting (Bartolai et al., 2015). The basin is experiencing an increase in the total magnitude of annual precipitation and runoff (Hodgkins et al., 2007), as well as the frequency of extreme precipitation events (Andresen et al., 2012). In addition, there has been a 0.7 °C (1.26 °F) overall increase in temperature since 1985 (Hall et al., 2007; Mortsch et al., 2003). Climate change can also play an important role in water quantity within the basin (Bartolai et al., 2015; Maghrebi et al., 2015). While historical trends in climate can be associated with increases in temperature (Mortsch et al., 2000; Mortsch et al., 2003), precipitation and runoff (Hodgkins et al., 2007), and evaporative loss (Fortin and Gronewold, 2012), no consistent trend can be seen with water quantity (IUGLS, 2009), making future projections for lake level fluctuations within the basin difficult.

Economic pressures, too, are paramount within the Great Lakes Basin (Campbell et al., 2015). Rooted in manufacturing, the economy of the basin is in transition forced to diversify by globalization. Traditional energy-intensive industries face increasing global competition and insufficient domestic demand. This is causing concern as to whether the basin will be able to unlock its latent economic potential (Austin et al., 2008) and become a leading innovative economic engine for North America.

Compounding these pressures are dramatic but unequal demographic trends occurring in Canada (population explosion, especially along the Canadian coast of Lake Ontario in the Greater Golden Horseshoe) and the US (population stagnation, with actual decline in many cities throughout the basin) (Méthot et al., 2015). In Canada, population growth has occurred largely due to immigration (SC, 2006). This growth has the potential to impact the region's societal values, which are shaped in part by the cultural make up of a society (Lawrence, 2004). In the US, population decline is coupled with urban sprawl that actually outpaces population growth in many post-legacy cities such as Detroit, Cleveland, and Milwaukee, among others (GLRC, 2005). The result of this mismatch in growth and urban sprawl could result in a "hollowing out" of cities characterized by abandoned core urban areas.

Governance also is a concern, with challenges expected to contribute to basin-wide stress (Jetoo et al., 2015). These governance challenges include institutional fragmentation, the changing relationship between federal and sub-national scales of government in Canada and the US, a lack of capacity to implement the decisions made within a governance regime, and the effects of geopolitics on governance of the basin (Jetoo et al., 2015). These four challenges suggest that, while the governance structure of the basin was once touted as the best practice by some to the world, marked by the hallmark in international cooperation in water management that is the Boundary Water Treaty of 1909 and the formation of the IJC (Krantzberg and Manno, 2011), it must be reformed in order for the basin to thrive.

When the breadth of environmental, economic, social/cultural and political stressors of change are considered, the human capacity for change and a balanced environment and economy emerge as two main forces that drive the system (Laurent et al., 2015) and frame four alternate and contrasting futures for the basin (Comer et al., 2015; Kalafatis et al., 2015; Orr et al., 2015; Steenberg et al., 2015). These four futures differ dramatically in portraying potential realities for the basin in 2063. Notably, stark differences exist between the two extreme scenarios. On the one hand, the "Thriving and Prosperous" scenario is characterized by a system where trade-offs are recognized, environmental and economic considerations are made before every decision, and a balanced top-down/bottom up governance