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

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., in this issue). 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., in this issue; Maghrebi et al., in this issue). 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., in this issue). 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., in this issue). 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., in this issue). 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., in this issue). 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., in this issue) and frame four alternate and contrasting futures for the basin (Comer et al., in this issue; Kalafatis et al., in this issue; Orr et al., in this issue; Steenberg et al., in this issue). 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 system

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allows a long-sighted and cooperative Great Lakes region community to be stewards for the basin (Comer et al., in this issue). On the other hand, the "Out of Control" scenario is characterized by a system where the economy trumps the environment, or vice versa, and an unbalanced governing system exists alongside a short-sighted Great Lakes region community with no attachment to the basin (Kalafatis et al., in this issue).

Clearly, we want to live, work, and play in a Thriving and Prosperous basin. But where are we actually heading? The next section examines where we are heading, synthesizing workshop inquiry that focused on where current policies are leading us into the 21st Century.

Where are we heading?

During the GLFP workshops, stakeholder participants engaged in dialogue on the present state and future course of the basin. These stakeholders were drawn from Great Lakes Basin networks, as well as from lists of attendees at Great Lakes events, and were representative of each environmental policy sector (public, private, NGO, academic) and scale (binational, federal, provincial, state, and local), as well as multiple academic disciplines including the natural sciences, social sciences, engineering, planning, and law (Williams, in this issue). Academic institutions represented in the GLFP are listed in Table 2. Five workshops were held throughout the two-year project period. Approximately 135 stakeholders participated in the GLFP over the two-year period (Williams, in this issue). A core of 25 stakeholders consistently contributed to the workshops; approximately 30 to 80 others participated in only one or two workshops (Williams, in this issue). All workshops were organized and facilitated by GLFP leadership, except for the final workshop held at the University at Buffalo in fall 2013 which used a trained public participation facilitator and TurningPoint Polling Software to draw out responses and tabulate results.

Using the protocol developed by Maack (2001), workshop stakeholders identified critical forces of change (Laurent et al., in this issue) in the basin that resulted in four distinct, alternative futures (Fig. 1): Thriving and Prosperous (Comer et al., in this issue); Living on the Edge (Steenberg et al., in this issue); Trying Hard to Adapt (Orr et al., in this issue); and Out of Control (Kalafatis et al., in this issue). Binational faculty–graduate student research teams further refined these scenarios and developed narratives for each future (Laurent et al., in this issue). Scenario narratives were prepared in the form of "future histories" for each quadrant, where each story was told as a history as if the writer was situated in 2063 and revealed developments that occurred since 2013 (Laurent et al., in this issue). While we are currently at the "origin" of the two axes that define the four quadrants, consensus emerged during our workshop dialogue that we are heading toward the "Out of Control" scenario, a future earmarked by the failure of humans to enact change and a striking imbalance between the environment and the economy. We are witnessing: reactive government responses combined with a decline in financial resources to implement programs and monitor their compliance and effectiveness in meeting policy objectives; a shift in research priorities and funding away from discovery-based research; and a breakdown in education that places us in a position where innovative solutions are unlikely (Kalafatis et al., in this issue). From an environment perspective, globalization pressures, invasive species, the fact that we live in a region inundated with biological and chemical contaminants, and climate change impacts that bring a high degree of uncertainty, place the region in peril. Additionally, from an economic perspective, the Great Lakes region is not moving aggressively toward an innovation economy, leveraging synergies between academia and industry. Participating stakeholders agreed that we are witnessing a breakdown in the policy regime governing the Great Lakes Basin.

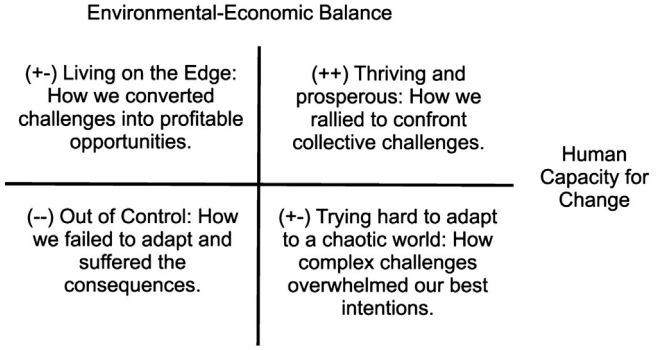

Fig. 1. The alternative future scenarios for the Great Lakes-St. Lawrence River Basin as defined by the intersection of the chosen critical forces for the Great Lakes Futures Project (Laurent et al., in this issue).

Table 2
Academic institutions represented in the Great Lakes Futures Project.

Canadian universities	American universities
Université de Montréal	Cornell University
McGill University	Michigan State University
McMaster University	University at Buffalo (SUNY)
Queen's University	University of Michigan
Ryerson University	University of Minnesota
Trent University	University of Notre Dame
University of Guelph	University at Plattsburgh (SUNY)
University of Ottawa	University at Syracuse (SUNY ESF)
University of Waterloo	University of Wisconsin-Milwaukee
University of Windsor	Wayne State University
Western University	
York University	

Current gaps and barriers to effective policy

The question then becomes: What is driving us toward an Out of Control future? Over the course of the GLFP, stakeholders engaged in a dialogue to provide insight on the most significant policy gaps and barriers that affect the management and resilience of the basin — that is, the gaps and barriers that currently are in place that are leading us toward this undesirable future. The following six emerged as the most significant:

1. Great Lakes policies are fragmented vertically and horizontally across scale and jurisdiction.

In terms of vertical fragmentation, stakeholders suggested that Great Lakes Basin policies currently encompass different mandates for federal, state, provincial, and municipal governments, many of which do not align to produce a cohesive approach to the basin. There is no policy space to accommodate both top-down and bottom-up perspectives. This policy space is critical, as it would provide for "in the trenches" community/municipal support and buy-in of policies established by federal, state, and provincial governments. In addition, global challenges usually are not considered in basin policy formulation. Although global economic competitiveness is a recognized driver behind the Canada–US Beyond the Border and Regulatory Cooperation Council initiatives, other large-scale processes such as global carbon and water footprints have tremendous implications for the Great Lakes Basin, yet are absent in current policy discussions.

With regard to horizontal fragmentation, several barriers are at play. Although binational agreements exist, these do not adequately address current issues and challenges confronting the basin. According to stakeholder participants, current binational agreements like the GLWQA are "reactive" and although the 2012 Annex is a welcome update, it lacks critical emphasis, for example, on ecosystem services. Also, although many of the risks to the basin are identified in the Annex, it does not address management of these risks. Stakeholder participants also cited further challenges around funding inequities between Canada and the US for Great Lakes region protection. Although the US committed

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more than $1 billion to the GLRI, this has not been met by a proportionately equal commitment on the Canadian side. Some argue that the Canadian federal government's recent retrenching on critical legislation that directly impacts the basin, such as the Fisheries Act, the Canadian Environmental Assessment Act, and the Navigable Waters Act (CCPA, 2013), are further harbingers of the divergence in funding between the two nations, although the science and policy analysis to understand the implications of these policy changes on the Basin has not yet been assessed.

2. Great Lakes region policies are fragmented substantively, and lack a holistic approach.

Current policies are fragmented substantively in several ways. First, policies impacting the basin are not linked in a coherent fashion. Policies specific to the Great Lakes region are contained in individual instruments with different policy goals. There are four well-recognized instruments — the COA (1971, revised most recently in 2007), GLWQA (1972) and related 2012 GLWQA Protocol (2012), Compact (2008), and GLRI (2009). However, these policies do not operate in a vacuum. There are other policies, such as the US Transportation Bill, US Immigration Bill, and the US Farm Bill that impact the basin in significant ways, yet these are not incorporated into Great Lakes policy discussion and strategy.

Second, in some circumstances, there exists a dearth of policy to address critical issues facing the basin. For example, both Canada and the US lack a comprehensive energy policy at a time when complex global energy demands drive domestic debate regarding environmental and economic issues.

Third, there exists a lack of linking of the environment and economy within policies. When economic and environmental aspects are mentioned in a singular policy, there is little effort to integrate and link these into holistic goals, objectives, and actions. For example, stakeholder participants pointed to Canada's Economic Action Plan (GC, 2013), where there is brief mention of the Great Lakes Basin but no direct funding allocated. The absence of a holistic approach also is seen in water agreements. Little mention of the economy is found in the four primary Great Lakes region agreements referenced above. This deficit is supported by an empirical analysis of the content of these four policies. When analyzed using a descriptive text statistics methodology and software (Textanalyser, 2004) for key economic terms, such as “economic”, “economy”, “technology”, and “innovation”, none of these Great Lakes region agreements contain the economic terms at a frequency greater that 0.13% (Table 3). Furthermore, when the sum of these terms are tallied and divided by the total term count, none of the policies reach over 0.15% (Fig. 2). Interestingly, the most recent policy amended for the basin, the 2012 GLWQA, has the fewest references to the economy, while the Compact and COA contain more references (Fig. 2).

Fourth, there is a failure of current policy that reflects green or blue economy thinking. Stakeholder participants suggested that policies need to go beyond environmental science and engineering and account for factors such as “green” economics, innovation, and entrepreneurship. A key gap in the four policies is a lack of attention to the emerging green or blue economy as a lever toward a more sustainable system. This is curious, given that a proactive stance on sustainability is becoming a competitive necessity (Matthews, 2012). Finally, there is a lack of sustainability incentives in current policy. For example, in Canada, existing tax policy and business incentives for sustainability are under-utilized, such as efficient pricing (i.e. pricing that accounts for all associated costs), permits, or trading (SP, 2011). The under-utilization of these instruments, especially in Canada, is disappointing in light of the known improvements that these have on regulating water demand, increasing water use efficiency, improving water quality, and providing funds for water infrastructure costs (SP, 2011).

Table 3
Descriptive text statistics of the four pillar policies, agreements and initiatives governing the Great Lakes-St. Lawrence River Basin. The text of the 2012 Great Lakes Water Quality Agreement, the 2009 Great Lakes Restoration Initiative, the 2007 Canada Ontario Agreement Respecting the Great Lakes Ecosystem and the 2005 Great Lakes-St. Lawrence River Basin Water Resources Compact was analyzed for total word counts by removing numbers and word less than three characters. Through the transformation of the text to upper case characters, the removal of numbers and words less than 3 characters in length using Textanalyser (2004), followed by the tallying of the words in question (for example economy) using Microsoft Word (Microsoft, 2007) and Adobe Acrobat Pro (Adobe Systems Incorporated and its licensors, 1984–2011), specific words were searched within each document and the percentage of their occurrence determined relative to the total number of words in the document.

Total number of words: 8447		
Word	Occurrence	Relative occurrence (%)
2012 Great Lakes Water Quality Agreement		
Economy	0	0.00
Economics	0	0.00
Innovation	1	0.01
Technology	5	0.06
Economically	1	0.01
Economic	5	0.06
Total number of words: 8447		
Word	Occurrence	Relative occurrence (%)
2008 Great Lakes Restoration Initiative		
Economy	2	0.02
Economics	0	0.00
Innovation	1	0.01
Technology	5	0.04
Economically	1	0.01
Economic	6	0.05
Total number of words: 8447		
Word	Occurrence	Relative occurrence (%)
2007 Canada-Ontario Agreement Respecting the Great Lakes		
Economy	1	0.01
Economics	0	0.00
Innovation	1	0.01
Technology	5	0.05
Economically	1	0.01
Economic	12	0.12
Total number of words: 8447		
Word	Occurrence	Relative occurrence (%)
2005 Great Lakes-St. Lawrence River Compact		
Economy	2	0.03
Economics	0	0.00
Innovation	0	0.00
Technology	0	0.00
Economically	5	0.08
Economic	3	0.05

3. Policy implementation is hindered by inadequate capacity, accountability, and enforcement.

Some stakeholder participants suggested that Great Lakes region policies sometimes act as “legal shields,” that is, policies exist on paper, but these lack capacity (resources and staff) and enforcement mechanisms (“teeth”), which inhibit the ability of current policy to effectuate true change. Even good policies fail when they lack resources (capacity) to monitor compliance and effectiveness. For example, stakeholder participants noted that the Lakewide Management Plan program – touted as an innovative mechanism for tackling open lake pollutants when established pursuant to GLWQA amendments in 1987 – is neither well-funded nor enforced. With regard to enforcement and accountability measures, the GLWQA includes many implementation organizations, from government

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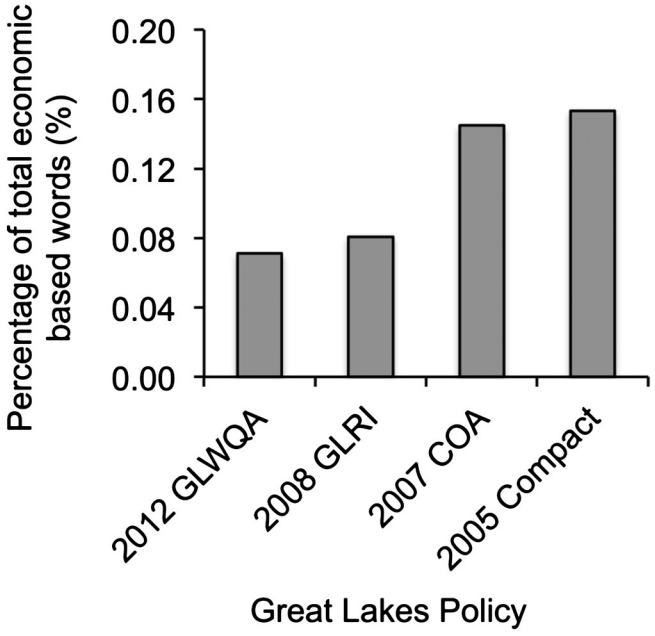

Fig. 2. Percentage of total economic terms occurring within each of the four pillar policies governing the Great Lakes-St. Lawrence River Basin against total policy word count (%). The policies analyzed include the 2012 Great Lakes Water Quality Agreement (2012 GLWQA), the 2009 Great Lakes Restoration Initiative (2009 GLRI) the 2007 Canada Ontario Agreement Respecting the Great Lakes Ecosystem (2007 COA) and the 2005 Great Lakes-St. Lawrence River Basin Water Resources Compact (2005 Compact).

agencies to private institutions, but these organizations do not hold a formal commitment under the Agreement (ARC, 2007).

4. Adaptive management remains elusive.

Adaptive management, although sound in theory, is difficult to implement for several reasons. First, adaptive management is a widely misconceived and frequently misapplied approach to resource management (Gregory et al., 2006; Murray and Marmorek, 2004). Despite the intuitive appeal of "learning by doing," scientists often fail to appreciate the broader array of management priorities faced by resource managers and fail to recognize the need to provide information that can be directly used by decision makers. At the same time, management agencies, often overlapping, frequently fail to fully and clearly define their responsibilities for implementing adaptive management. Perhaps most significant, implementers often lack an appreciation for the variability in system responses to interventions, and continue along command-and-control top-down based management that is ineffective. Second, as with any policy or program, lack of monitoring and assessment is a key barrier to adaptation. Adaptive management requires tools and resources to assess the impacts of actions, but there is a serious gap within current programs to support those efforts. Third, incorporating adaptive management into Great Lakes region policies is difficult because it involves a high degree of experimentation and risk, two aspects that are resisted at a political level because the outcomes require changing policies and programs, which can be misconstrued as originally ill conceived. Finally, a lack of funding for policy assessment is a foundational barrier to effective adaptive management policy.

5. There is a collapse of Canadian support for investment in Great Lakes research and education.

Although the US government recently invested a large sum in the Great Lakes Basin, overall there is a need for more resources and attention. This barrier is particularly acute in Canada, reflecting a current government strategy to promote funding that supports research applicable to industry and job generation (Mancini, 2013). As a result, according to the Professional Institute of Public Service Canada, the Department of Fisheries and Oceans experienced cuts of $79.3 million and Environment Canada experienced cuts by $53.8 million in 2012, after cuts of $200 million in 2011 (Nelson, 2013). Funding cuts resulted in the discontinuation of Department of Fisheries and Oceans programs and laboratories such as the Species-at-Risk Program and the Experimental Lakes Area, and a "slashing" of funds to Environment Canada programs such as Environmental Protection Operations, Compliance Promotion Program, the Action Plan on Clean Water, Sustainable Water Management Division, Environmental Effects Monitoring Program, Contaminated Sites Action Plan, Chemicals Management Plan, and the Canadian Centre for Inland Waters (Nelson, 2013). Reductions have also been made in other government funding agencies, with the National Research Council experiencing a $35 million reduction in 2009 and a $113 million reduction in funding toward the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council and the Social Sciences and Humanities Research Council (PSAC, 2012).

6. The Great Lakes-St. Lawrence River Basin lacks a shared vision for the future.

The basin does not have an inspirational shared vision that integrates the social–economic–environmental aspects on a large scale to use as a policy tool to ground management regimes and guide associated actions. Krantzberg (2009) suggested that the lack of a binational macro-scale vision reflects a malaise in improving implementation of the basin's environmental agenda. Although many separate visions exist, these exercises remain in silos and lack the buy-in of all interests — critical for moving the basin ahead with a unified, regional voice. Embedded in this notion is the idea that a better understanding of diverse stakeholder trade-offs is required. Also, a common vision cannot be imposed on communities. It will require community outreach to ensure that it truly is a collective enterprise.

Common principles to guide future policy decisions

An awareness of these gaps and barriers present the opportunity to reframe thought on the basin as a guide for policy action. The following meta-principle and five supporting principles set forth a guide to stakeholder thinking, understanding, investment, and action in the basin. These principles are synthesized from detailed notes of GLFP dialogue recorded at each workshop. These principles are unique to the basin and build on the foundation of myriad past efforts. Adopting these principles will lead not only to a sustainable basin, but one that thrives.

> Meta-principle: Stakeholders should leverage the fact that the Great Lakes Basin is a policy system characterized by shared power, many actors, ambiguity, complexity, and flexibility.

Although the Great Lakes Basin serves as a unifying idea for advocacy, it is in fact a highly decentralized system, allowing for myriad actors to reach policy goals through many means. Within the policy system, policy redundancy can serve as a means to counteract failures in implementation or lack of political will at various scales. Leaders should leverage the system's fluidity and multiplicity of actors (many of whom change frequently) to allow for nimble strategic action. In other words, analogous to entities like the Internet, the absence of singular leadership or formal structure and organization are significant assets that can make the Great Lakes Basin more resilient (Brafman and Beckstrom, 2008).

The following five principles flow from and reinforce this meta-principle, calling for a multi-dimensional approach to Great Lakes Basin policies and coordinating solutions across boundaries.

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Principle 1: Think creatively about leveraging policies that are place-based and incorporate top-down and bottom-up governance to encourage stewardship.

A place-based approach – that is, multi-scale governance structures developed around the specific reality of individual regions and communities (Bradford and Wolfe, 2010) – should leverage binational, federal, state, provincial, and municipal levers as appropriate. Stakeholders should also think creatively about "middle out" approaches that leverage sub-national (state, provincial, regional and local) scales to promote, encourage, and implement action within the basin. The Nearshore Framework called for in the GLWQA 2012 Protocol adopts this principle, though the mechanisms for cooperative management remain undefined. The fundamental requisite for shared responsibilities is to connect people to place. Citizens who relate to their local watershed, tributary, or waterfront are more likely to appreciate the assets encouraging stewardship initiatives that result in sustainable prosperity.

Principle 2: Tackle basin challenges holistically and explicitly recognize that a thriving environment will lead to a prosperous economy and society.

Stakeholders should recognize that they are not dealing with separate issues when engaged in policy advocacy, formulation, and implementation. A thriving environment is foundational to both a prosperous economy and society. Concepts such as the "green economy" or "blue economy" should figure prominently in policy, a promising example being Ontario's proposed Bill 6: An Act to Protect and Restore the Great Lakes-St. Lawrence River Basin (OMoE, 2013). Also, policy approaches should target not only policies specifically focused on the Great Lakes Basin but also other national policies such as those concerning energy, agriculture, transportation, and immigration — each of which touches upon the basin environmentally, economically, and socially.

Principle 3: Strengthen resource, compliance, and accountability capacity.

In a diffuse policy system that encompasses both top-down and bottom-up approaches, monetary resources, compliance, and accountability are critical for building capacity. When appropriate, basin policies should contain language ("shall") that mandates compliance by parties. In addition, policies should, when appropriate, require measurements such as cost–benefit analysis, economic outputs, and ecosystem services valuation. Finally, monitoring and assessment of policy outcomes should be required and funded. Examples of this approach include the European Union Water Framework Directive, which contains enforcement language for its Member States, i.e. they must "bring into force the laws, regulations and administrative provisions necessary to comply with this directive" (EP, 2000).

Principle 4: Strengthen connections among all relevant sectors – business, science, policy, education, and outreach – to encourage stewardship and improve outcomes.

Stakeholders can no longer work in silos and should develop strategies that are open, adaptive, and flexible to deal with evolving ecological situations and opportunities. Building stronger connections between basin citizens and researchers at academic institutions should be pursued. Academic institutions that focus on issues relevant to their region have traditionally strong ties to their communities, which are important to foster a knowledgeable community that cares about its environment and is passionate about its protection. These academic–community connections, in turn, can lead to innovative strategies for research and innovation that are unrealized by experts, enhancing the impact of the benefits of innovation (Charron, 2012; STEPS, 2010) and leading to better business practices. Through partnerships and education programs, academic intuitions around the basin have great potential to change the future.

Principle 5: Create and empower a Great Lakes "identity" and place-based visions of the basin at appropriate scales that reflect the voice of all constituents.

Place-based visions – and the process for creating them – will create stewardship and motivate our communities to care about the Great Lakes Basin. These visions could lead to a future where residents and incoming immigrants take a "Great Lakes Oath" and the basin is viewed as a "Great Lakes Necklace," — in effect, an interconnected system of jewels. These visions could also lead to a future where residents recognize that the entire Great Lakes Basin is their home, fostering a "Great Lakes identity", and protective and environmentally compassionate behaviors.

Policy recommendations to move toward the desired future

These principles are recommended to guide us into a future that has a balanced economy and environment, as well as a strong human capacity for change. In this future, the Great Lakes Basin is adaptive and resilient. It is inhabited by a far-sighted community that is collective, inclusive, proactive, and has a positive vision and strong respect for the basin in which they live. This respect reflects the belief that the environment and the economy should be viewed holistically, resulting in a strong balance between the two. A "green–blue" economy is prevalent and matched by appropriate economic incentives and legislation that protect the basin while also sustaining the economy. Its governing system consists of an effective hierarchical mix with collective decision-making, thereby restoring the basin's reputation as a leader in binational natural resource governance (Comer et al., in this issue).

There is no single optimal policy space for achieving a prosperous and thriving future. Using the meta-principle allows stakeholders to leverage myriad opportunities while remaining nimble. We, however, are aware that juxtaposed against this meta-principle as well as the other guideposts, our current approach to the basin is leading us in a very different direction. Time is of the essence to change course to a desired future direction. Thus, both old and new policies are required – current policies could be retrofitted, while new policies created. Combining principles with the following policy recommendations, we offer a strategic roadmap for moving us toward a Thriving and Prosperous basin.

Recommendation: Seek out opportunities to develop strategies, mechanisms and practices that are place-based and require shared responsibility for the Great Lakes-St. Lawrence River Basin.

The development of these polices can occur at the federal scale. However, the development should include actions at the state, provincial, regional, local, and First Nations scales to pull stakeholders together to brainstorm creative policy considerations for action that may not involve the federal government. The approach to the basin should be one of the multi-jurisdictional co-responsibility-, where appropriate, rather than turf wars and jurisdictional "ownership". Harmonizing policy guidelines could certainly take place between the various departments in each respective federal government; however, nothing precludes a similar dialogue from occurring among the Great Lakes states and provinces. For example, the US Farm Bill could focus conservation dollars on states and counties where the money will make the most difference, and move from paying for conservation practices to environmental outcomes (Carey, 2012). Federal and state or provincial transportation and infrastructure funding could be approached in a new way (e.g. public–private partnerships) to incentivize green infrastructure at the regional and local scales. Strengthening agreements like the Compact, as well as implementing a cap and trade for carbon policy among the Great Lakes states and provinces also could be considered. Finally, Great Lakes states where populations are in decline could lead the way in promoting immigration as an economic development strategy, recruiting immigrants to the region through tax-based

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incentives, as a way to move post-legacy Great Lakes cities toward an innovation economy. These actions, individually and collectively, allow for place-based policies to flourish, and reflect a holistic approach that lends flexibility and resiliency to the system.

Recommendation: Create, and build upon existing, mechanisms that embody ecosystem health as a foundation that leads to innovation and societal well-being.

These mechanisms could include full cost accounting, take into account externalities, and value natural capital and ecological services. The public sector could incentivize the academy and industry to collaborate on green or blue economy innovations, such as providing seed money for research or tax breaks for companies that adopt sustainable solutions. Additionally, university researchers could collaborate with stakeholders to devise ways to measure and analyze how private sector behavior and spending benefits the natural ecosystem and social well-being outside of the regulatory environment. These mechanisms would work across multiple boundaries – universities, public and private sectors, social and cultural values, and the environment – ultimately strengthening the science–policy interface, research and education, and the society–economy–environment nexus.

Recommendation: Develop and monitor indicators of comprehensive basin health.

The IJC (2014) identifies research, indicator development, and monitoring as a top governance need in the basin. The State of the Lake Ecosystems Conferences, hosted by the US Environmental Protection Agency and Environment Canada, currently engages staff to develop and measure indicators of ecosystem and human health (EC and USEPA, 2005). These could be taken one step further to integrate indicators into adaptive management practices at the appropriate scale, and to develop governance, social, and economic indicators as well, taking into account the idea that in order for the basin to thrive, a sound social–economic–ecological system is essential. In this approach, it is essential to: collect baseline indicator data; develop measurable and achievable indicators and standards; monitor the indicators; and take the necessary adaptive steps to meet or try to achieve the set indicator standards. Additionally, the indicators could be aligned with citizen science programs to create constituent political support for protection, restoration, and reclamation. These indicators would promote both enforcement and accountability, as well as be used as a tool for strategic funding and investment.

Recommendation: Strengthen existing and create new Great Lakes experiential programs.

These programs would provide hands-on experience to real-world problems facing the basin. Basin stakeholders could create or improve education and community capacity building through place-based education at all educational levels. Social media is a prime tool that could be used tie citizens to the basin. For example, a GLFP workshop participant proposed a mobile application that ties farmers directly to the lakes that could inform them of days when not to apply pesticides, days that will affect stream water quality/aquatic life due to pesticide drift. Finally, the Great Lakes Basin could be twinned with other global great lakes such as Lake Baikal and the African Rift Valley lakes as part of the educational enterprise. The efficacy of information uptake in these place-based experiential learning programs should be measured and monitored to provide impetus for secure and strong future funding. These kinds of policies and programs not only strengthen research-education links, but also strengthen the science–policy interface and help to create a community of stewards.

Recommendation: Develop stakeholder-driven planning and visioning that is legitimized by political leadership both before and after planning occurs to nurture a Great Lakes "citizenship" or "identity."

A basin-wide "citizenship" or "identity" would benefit policy and program development and coordination. Place-based visioning at various scales could play an important role in the development of this basin identity. The process of developing these visions requires input from both top-down and bottom-up processes, and needs to involve current and potential implementers including Tribes and First Nations, academia, federal, provincial and state, and municipal governments, industry and community groups. Specific stakeholder-led vision-driven planning exercises could include enhancing public water access utilizing municipal, state, and/or provincial frameworks to link policies. There is much to be learned from stakeholders within the basin. In reality, a single vision may never be reached, but the exercise of creating a vision, or multiple visions, is a powerful tool for developing strategies, establishing goals and objectives, and fostering an overall basin identity. These visions could lead to establishing criteria that are most significant to basin constituents that can be tracked by key indicators to inform if we deviate from the path toward our vision.

Conclusions

Through the adoption of the collectively developed principles and consideration of the recommendations presented in this paper, basin stakeholders possess the tools necessary to shift the current trajectory of the Great Lakes Basin from "Out of Control" to "Thriving and Prosperous." The space created by the GLFP encouraged collective learning, collaboration, creativity, and innovation in formulating steps necessary to reach a basin that thrives. Determining who does what, prioritizing next steps, and creating an action plan are now required to move the basin toward this desirable direction.

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