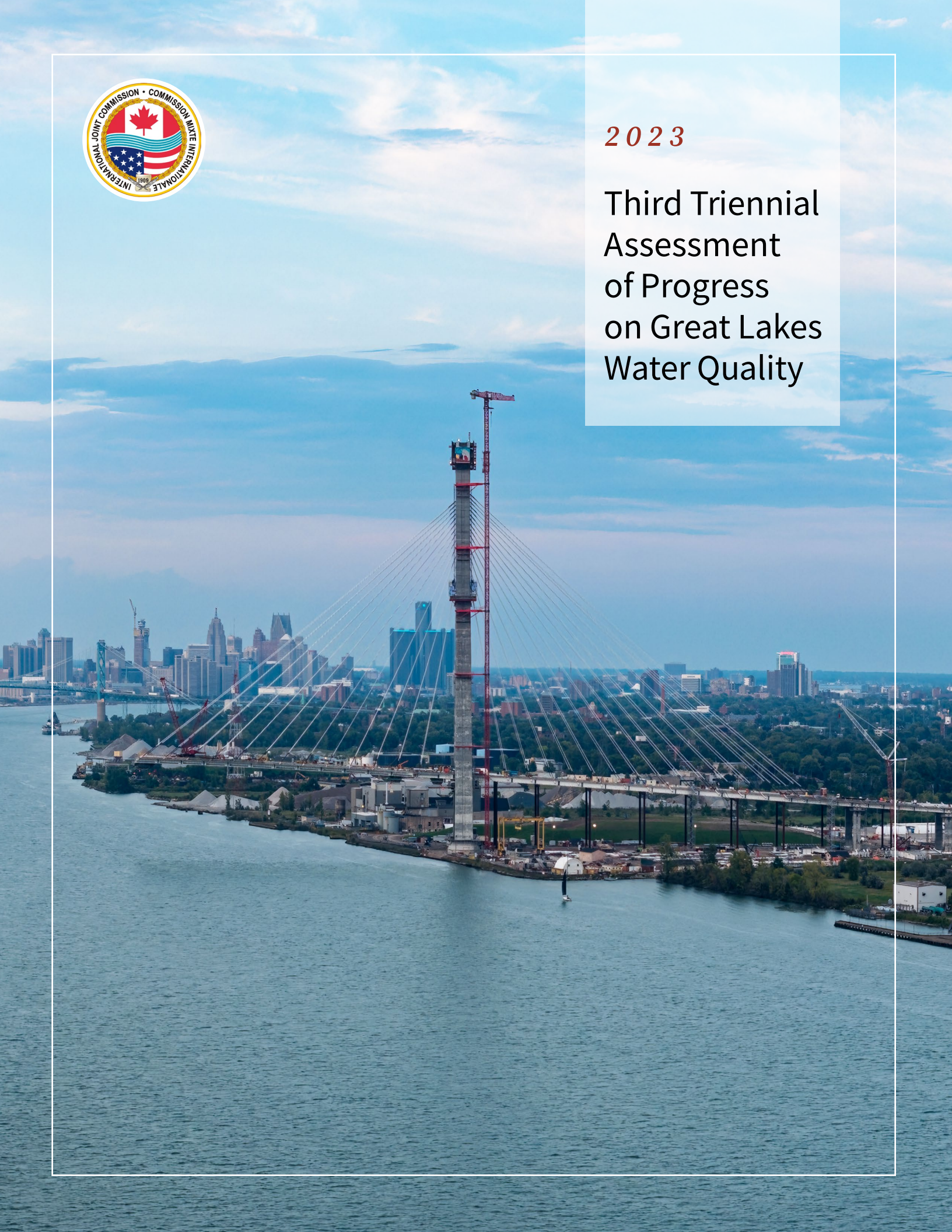
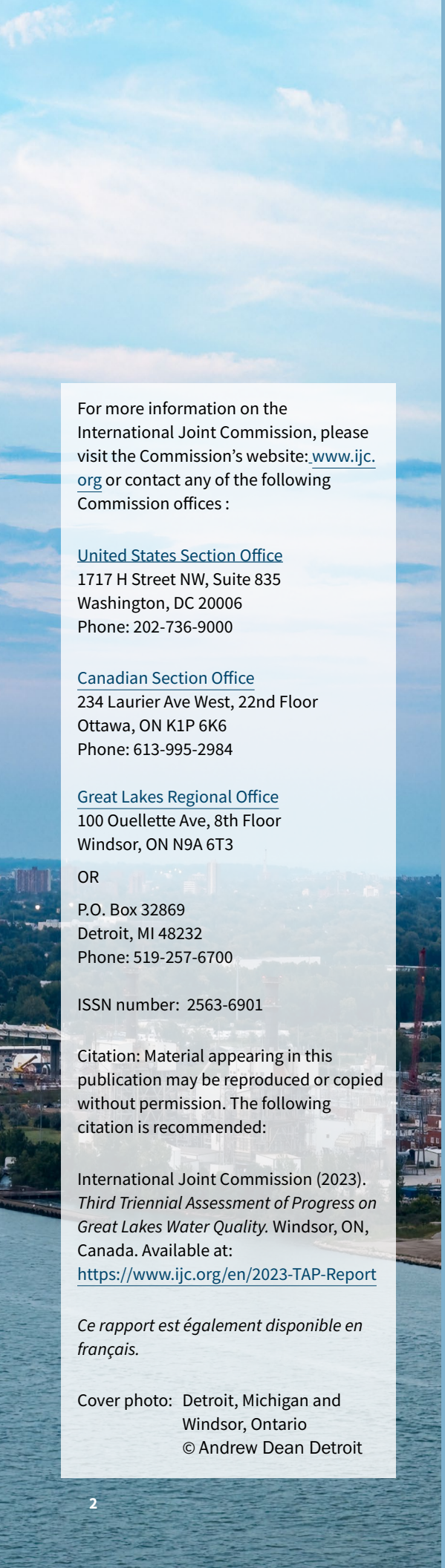
2023

Third Triennial Assessment of Progress on Great Lakes Water Quality





For more information on the International Joint Commission, please visit the Commission's website: www.ijc.org or contact any of the following Commission offices :

United States Section Office
1717 H Street NW, Suite 835
Washington, DC 20006
Phone: 202-736-9000

Canadian Section Office
234 Laurier Ave West, 22nd Floor
Ottawa, ON K1P 6K6
Phone: 613-995-2984

Great Lakes Regional Office
100 Ouellette Ave, 8th Floor
Windsor, ON N9A 6T3

OR

P.O. Box 32869
Detroit, MI 48232
Phone: 519-257-6700

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PREFACE

Message from the International Joint Commission

Special anniversaries are a time for commemoration. 2022 marked the jubilee year of the Great Lakes Water Quality Agreement (the Agreement), first signed by the Canadian and US governments in 1972. Considering this 50th anniversary milestone, the International Joint Commission (the Commission) presents this 2023 "Third Triennial Assessment of Progress" report in the spirit of celebration and reflection.

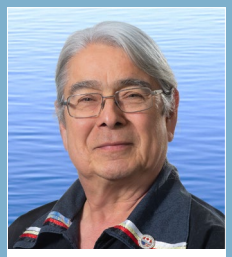
The evolution of the Agreement over time through amendments and protocols illustrates a paradigm shift in the mindset of the governments and communities responsible for stewarding the lakes. The Agreement itself was a landmark inflection point. It radically changed management of the Great Lakes, moving beyond their use as industrial sewers to repairing their ecosystems and, in the process, restoring people's relationships to these waters. Ideas that were radical for their time—the ecosystem approach, adaptive management, the precautionary principle, zero discharge—are now central to the Agreement.

While five decades of binational cooperation to protect the Great Lakes is a testament to the strength and relevance of the Agreement, 50 years is only a small part of the seven-generations timeframe used by the Indigenous Peoples with whom we share the privilege of stewarding the lakes. This report also presents key priority areas where the Commission is looking ahead at the next era of Great Lakes management. As future generations take the lead to protect the lakes, particularly given the urgent and compounding climate-change emergency, the Agreement must continue to evolve and incorporate new ways of knowing and protecting the Great Lakes.

As this report is the Commission's third triennial assessment, the Commission anticipates that the report may be useful to governments as they undertake their Article 5 Agreement review process. Specifically, Article 5.5 of the Great Lakes Water Quality Agreement (as amended in 2012) outlines that the governments of Canada and the United States are to "review the operation and effectiveness of this Agreement" following the publication of "every third triennial Assessment of Progress Report of the Commission." In the view of the Commission, this review process is an important opportunity to continue ensuring that the Agreement is responsive to contemporary and future needs of the lakes and all basin communities.

In presenting this 2023 "Third Triennial Assessment of Progress" report, and keeping the Agreement's anniversary in mind, the Commission places a particular emphasis on what is working well to achieve the Agreement's objectives. The Commission's three recommendations provide the Canadian and US governments with strategic opportunities to address the process and priorities of implementing the Agreement so it remains responsive to the current and future challenges of protecting the Great Lakes.

Pierre Béland
Canadian Co-chair



Henry Lickers
Canadian Commissioner

Merrell-Ann Phare
Canadian Commissioner

Gerald Acker
US Co-chair

Lance Yohe
US Commissioner

Robert Sisson
US Commissioner

Duluth, Minnesota

Indigenous Greeting

Greetings, friends. I hope this greeting finds you and your families in good health and spirits. I am a Haudenosaunee citizen of the Seneca Nation, Turtle Clan. I have spent my life in the Great Lakes-St. Lawrence region, working for the health of these waters and all they sustain. In 2019, I was also the first Indigenous person to be appointed Commissioner to the International Joint Commission.

It is with this unique perspective that I reflect upon the accomplishments enabled by the Great Lakes Water Quality Agreement, not only since the Commission's 2020 "Second Triennial Assessment of Progress," but since the Agreement was first signed half a century ago. I recognize with gratitude the generations of dedicated individuals who have come together across borders—geographic, political, cultural and economic—to better understand these waters and the problems they face, and to restore them to health. Indeed, there are many who have not lived to see the lakes as clean as they are today, and their accomplishments continue to inspire future generations to carry on their work.

The Haudenosaunee say that with a little respect, equity and empowerment we can build joyful relationships that endure over time. Certainly, this Agreement is a testament to the relationship Canada and the United States have built to safeguard and protect our shared waters for present and future generations. Notably, the Agreement and its implementation have also evolved over time to respect and include voices from the Nations that predate Canada and the United States. Indigenous Peoples are the original and ongoing caretakers of these waters, and Indigenous science, knowledge and world views continue to play a critical role in their health and sustainability. Knowledge is powerful only if it is shared, and in my experience Western and Indigenous approaches to science need each other to be a whole knowledge system. By continuing to empower and include Indigenous Peoples in the shaping and implementation of the Agreement over its next 50 years, we all stand to benefit.

Of course, in any respectful relationship, both praise and constructive criticism work together to make it stronger. This report recognizes many of the successes achieved to date and identifies areas where new and additional efforts promise results. It is my hope that we all accept our responsibilities to continue caring, together, for these remarkable lakes, empowering our collective selves to do even more. We are all water people: if we take care of the water, it will take care of us.

Skén:nen, in Peace,

Henry Lickers
Seneca
Commissioner, International Joint Commission, Canadian Section

Executive Summary

Under the Great Lakes Water Quality Agreement (the Agreement), the International Joint Commission (the Commission) is responsible for providing the Canadian and US governments (the Parties) with a report that assesses progress toward achieving the Agreement's objectives. This is the Commission's 2023 "Third Triennial Assessment of Progress" report, and the material presented here fulfills its requirements under Article 7.1(k) of the Agreement.

As in previous reports, the Commission assesses progress toward the Agreement's objectives and offers its findings, conclusions and recommendations to the Parties. During this 2020-2022 assessment cycle, the Agreement also reached its 50th anniversary. This occasion provided an opportunity to reflect more deeply on the Agreement's history and successes while identifying opportunities and challenges in the Great Lakes' future.

Overall, the Commission finds there are many efforts by the Parties to commend. Both governments continue to contribute to achieving the Agreement's general objectives. For example, in the past 50 years some chemicals of mutual concern have decreased significantly, and considerable effort has been made to address water quality and algal blooms in western Lake Erie.

During this assessment period, the Parties made progress in several areas. The Parties conducted activities to help remediate and restore Great Lakes toxic hotspots, including improving the ecosystem at dozens of Areas of Concern and completing cleanup ("delisting") at two sites. In terms of reporting on progress, the Parties improved their indicator reporting for many objectives and made progress with their collaborative communication of the effects of climate change on the basin. The Parties also reported notable efforts to increase First Nation, Métis and Tribal government outreach, representation and engagement. Funding from the US Environmental Protection Agency and federal partners through the Great Lakes Restoration Initiative continues to accelerate progress in five priority areas. Recently, the Canadian government announced a historic new investment of CDN$420 million over 10 years toward Great Lakes protection and restoration, building on Great Lakes Protection Initiative efforts.

At the same time, there are significant current and future challenges for the lakes. Water quality continues to be stressed by the legacies of persistent contaminants, nutrient issues and the increasing presence of contaminants of emerging concern. Climate change also amplifies these and other ecological stresses, threatening health, economies and cultures across the basin. Moreover, there are opportunities to improve and increase harmonization of monitoring and surveillance through enhanced binational collaboration to address gaps in the indicators used to assess progress toward several Agreement objectives.

Public input gathered by the Commission similarly reflects an appreciation of governments' efforts to make progress. The public identified governments' progress under Annex 1 (Areas of Concern) and Annex 4 (Nutrients) as top achievements by the Parties for this assessment period. At the same time, the public reported that greater progress is needed under those same annexes and also under Annex 3 (Chemicals of Mutual Concern). Feedback also showed that the public wants to address gaps in water quality monitoring and expand opportunities for partnership and engagement, particularly with First Nations, Métis and Tribal governments.

Through this assessment, the Commission highlights opportunities for the Parties to deliver on their existing commitments under the Agreement by improving Indigenous engagement, integrating diverse knowledge systems into Agreement activities, advancing climate-change adaptation and resilience actions, addressing nutrients and contaminants of emerging concern, and advancing proactive, comprehensive science and monitoring efforts to enhance future progress assessments.

Throughout this report, the Commission presents *findings* from its assessment that identify key achievements, gaps and opportunities, while *conclusions* provide an interpretation of the findings and the Commission's view on what the Parties might consider for the future. Three *recommendations* strive to identify priority actions for the Parties.

RECOMMENDATIONS

Based on the assessment, findings and conclusions of this report, the Commission offers the Parties three recommendations:

1

The Commission recommends that the Parties collaborate with First Nations, Métis and Tribal governments as active partners in the Parties' Agreement review process and in any subsequent processes to change or amend the Agreement.

2

The Commission recommends that the Parties, in collaboration with all levels of governments, regional watershed authorities and others as appropriate, develop common, basinwide and scalable climate resiliency goals with transparent and accountable performance metrics and assessment processes, to be included in each of the Annex 2 Lakewide Action and Management Plans as they are developed.

3

The Commission recommends the Parties support and actively participate in the Great Lakes Science Advisory Board's collaborative process to develop a 10-year Great Lakes Science Plan.

In submitting this report and recommendations to the Parties, the Commission encourages further strengthening of the collaborative approach already successfully in use for the last 50 years. As always, the Commission does not ask the Parties to take on any initiative alone. Rather, the goal remains to continue expanding engagement with partners and people in the basin and to continue supporting their work under the Agreement.

The Commission sincerely appreciates the time, thoughts and experiences of each person who contributed to the completion of this report. It is the Commission's hope that this assessment adds to critical conversations driving progress under the Agreement, as part of our shared responsibility to protect this vital social, cultural and natural resource.

Sleeping Giant Provincial Park, Pass Lake, Ontario
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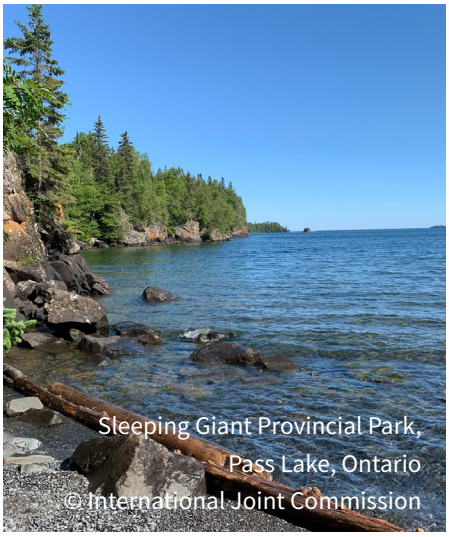
Table of Contents



Sleeping Giant Provincial Park, Pass Lake, Ontario
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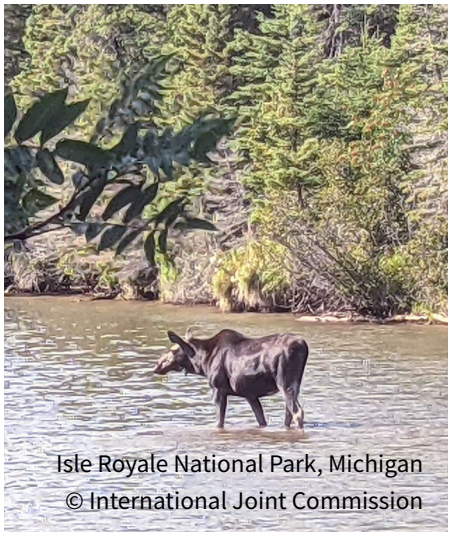

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Detroit River, Michigan and Ontario
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Niagara Falls, New York and Ontario
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1. Introduction

Twenty thousand years ago, receding glaciers began to form the Great Lakes, the **largest freshwater ecosystem on Earth**. These lakes are a vital resource for drinking water, fishing and recreation for millions of people throughout the region, sustaining and shaping cultures, customs and ways of life. The region also supports **billions of dollars in economic activity** and provides essential habitat for thousands of plant and animal species, many of them rare and unique in the world.

The Great Lakes are beautiful, vast and diverse. They are also vulnerable to biological, chemical and physical threats, including stressors caused by human activities. Protection of this valuable shared resource remains a priority.

The Great Lakes Water Quality Agreement (the Agreement) commits the governments of Canada and the United States to work together to restore and maintain the water quality and health of the Great Lakes basin. The lakes, their connecting channels and the upper St. Lawrence River (to the international boundary) are all considered part of "Waters of the Great Lakes" under the Agreement.

The governments of Canada and the United States created the International Joint Commission (the Commission) as an independent binational organization through the Boundary Waters Treaty of 1909. Through the Agreement, the Commission is responsible for assisting the Parties with the Agreement's implementation in finding solutions for protecting the Great Lakes. The Agreement also requires the Commission to submit an assessment of progress report to the Parties every three years. The Commission published two previous "Triennial Assessment of Progress" reports (2017 and 2020) as well as 16 biennial progress reports under its previous reporting responsibilities under earlier versions of the Agreement.

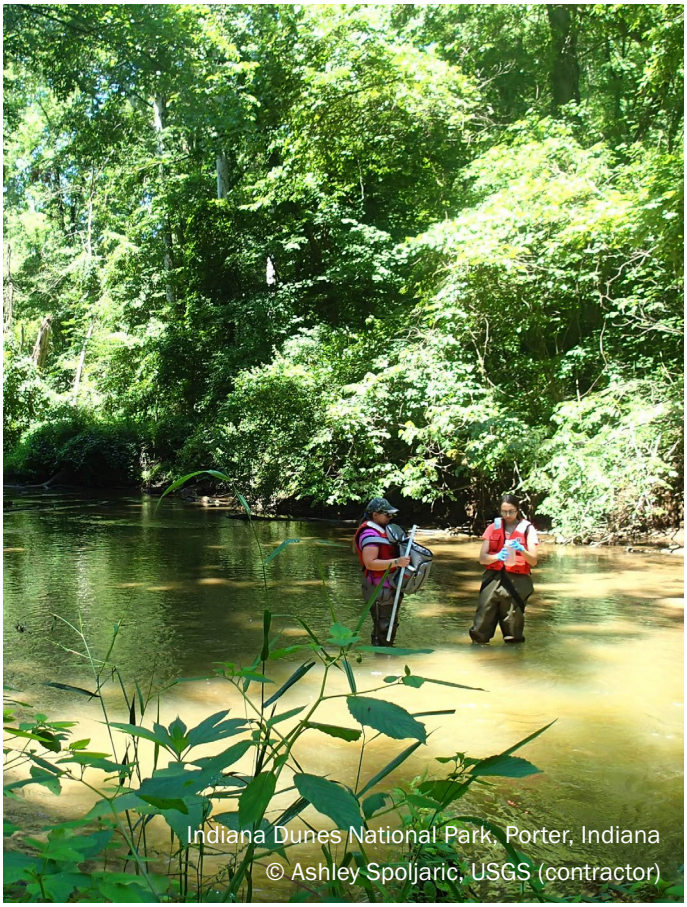
April 2022 marked the 50th anniversary of the Agreement, providing a unique opportunity to reflect on its history and successes and take stock of the region's challenges. As a high-level collaborative framework between Canada and the United States (the Parties), the Agreement is responsible for much success. The Parties amended the Agreement several times since the first iteration was signed in 1972, addressing new priorities while remaining committed to its core objective for binational collaboration. As a result, the Agreement evolved toward a more holistic approach to managing the interconnected Great Lakes ecosystem, from addressing the link between nutrients and algal blooms to assessing and responding to the ways climate change impacts all measures of environmental health.

At the same time, water quality issues such as microplastics, toxic "forever chemicals" and pharmaceuticals continue to challenge current and future management of the lakes while persistent algal blooms underscore the ongoing need for adaptive, watershed-scale management plans. The evolving scientific understanding of the Great Lakes' dynamic, complex ecosystem continues to drive research, monitoring and management decisions. These new and ongoing issues underscore the need to expand and better coordinate science and surveillance efforts across the basin.

The Agreement's anniversary also provides an opportunity to think about how to best work together to ensure a healthy future for the Great Lakes. The Agreement calls upon the Parties to engage with the people who live, work and play in the basin to help achieve its goals. Notably, the involvement of First Nations, Métis and Tribal governments in Agreement activities changed a great deal in five decades, with increasing attention to and opportunities for more direct and empowered participation. There is also more frequent and meaningful integration of community science and Indigenous ways of knowing in Great Lakes science, policy and decision-making. Enhancing the role of communities and First Nations, Métis and Tribal governments under the Agreement and its activities continues to be an increasingly significant part of Great Lakes management and engagement efforts now and into the future.

In this report, which covers the three-year period from 2020 to 2022, the Commission fulfills its responsibilities under Article 7.1(k) of the Agreement. The following sections accomplish these requirements by:

- highlighting past accomplishments under the Agreement (section 2)
- considering the current status and trends of the Great Lakes by reviewing the Parties' "2022 Progress Report of the Parties" and their "State of the Great Lakes 2022 Report" (section 3)
- summarizing public input received on the "2022 Progress Report of the Parties" (section 3.4)
- offering advice and recommendations to the Parties (section 4.5)



Indiana Dunes National Park, Porter, Indiana
© Ashley Spoljaric, USGS (contractor)

The Commission presents its assessment of the Parties' progress toward achieving the Agreement's goals and objectives. The advice and recommendations found in this report may also be useful to multiple levels of government, First Nations, Métis and Tribal governments, academia, nongovernmental organizations, the private sector and the public.

Following the release of this 2023 "Third Triennial Assessment of Progress" report, the Parties are required to review the Agreement's operation and effectiveness, per Article 5.5. The review offers a timely opportunity for the Parties to implement the Commission's three recommendations from this report, leveraging the workflow and timing of processes and projects already in place.

IJC'S TRIENNIAL ASSESSMENT OF PROGRESS

Comment on status and trends

Review, and gather and summarize public input

Assess how governments' programs and measures are achieving Agreement objectives

IJC Triennial Assessment of Progress Report

Every three years the Parties author two reports. The "State of the Great Lakes Report" uses ecosystem indicators to measure and report on the status and trends of the health of the lakes. The "Progress Report of the Parties" details what programs, practices and activities the Parties completed in the past three years. The Commission considers the "State of the Great Lakes Report," reviews the "Progress Report of the Parties" and gathers and summarizes input on it, conducts its own assessment of governments' progress to achieve the Agreement's general and specific objectives, and publishes findings in the "Triennial Assessment of Progress" report.

As always, when developing recommendations for the Parties, the Commission bases its independent, objective advice on the best available science. These recommendations consider the Parties' latest reports and information, advice from the Commission's expert boards, and thoughtful reflection on input received through engagement with other governments, organizations and the public. In reflecting on the Agreement's past, present and future, this report also highlights the Parties' achievements and the opportunities to improve government programs, measures and activities.

As First Nations, Métis and Tribes across the region have long recognized, the inherent value of the Great Lakes must be maintained through a relationship founded on respect and care. For example, the Haudenosaunee and Anishinaabeg of the region share the "dish with one spoon," which describes how the lakes can be preserved for the mutual benefit of all who live here. As the "spoon," the people living in the basin region and using its resources must work together to ensure that the "dish," the Great Lakes themselves, provides enough for all who rely on them. As we collectively look ahead to the next 50 years, this spirit of collaboration and inclusive engagement with all who depend on the Great Lakes remains central to achieving the Agreement's objectives.

Presque Isle State Park, Erie, Pennsylvania

2. The Past: Looking Back Over 50 Years

> "The purpose of this Agreement is to restore and maintain the chemical, physical, and biological integrity of the Waters of the Great Lakes.
>
> To achieve this purpose, the Parties agree to maximize their efforts to: cooperate and collaborate; develop programs, practices and technology necessary for a better understanding of the Great Lakes Basin Ecosystem; and eliminate or reduce, to the maximum extent practicable, environmental threats to the Waters of the Great Lakes."
>
> *Great Lakes Water Quality Agreement 2012 Protocol, Article 2.1*

Throughout the 20th century, human settlement and industrial expansion put great strain on the Great Lakes ecosystem. The Commission investigated Great Lakes water quality issues in the 1910s, 1940s and 1960s, making recommendations to the governments of Canada and the United States to conduct joint, binational efforts to set and achieve water quality objectives. Acknowledging the need for coordination, the Parties signed the Great Lakes Water Quality Agreement in 1972, which was later superseded by the Great Lakes Water Quality Agreement of 1978. As a framework for binational coordination, the Agreement meant both countries committed in good faith to enact their own domestic laws and regulations for restoring the lakes.

Initially, the 1972 Agreement established general and specific water quality objectives for substances such as phosphorus and toxic chemicals. The 1978 Agreement adopted principles including the ecosystem management approach, zero discharge and the virtual elimination of persistent toxic chemicals. This version also first assigned the Commission the responsibility to report every two years on progress toward Agreement objectives. The 1983 Amendment incorporated strategies for reducing land-based phosphorus loading and committed the Parties to further monitoring. The 1987 Protocol addressed airborne toxic substances, groundwater and lake sediment contamination, added Lakewide Action and Management Plans for each lake, and created new commitments for community engagement, coordination and reporting through the Remedial Action Plan process for Areas of Concern.

The 2012 Agreement Protocol made significant changes that focused on implementing ecosystem management programs to address topics including invasive species, habitat degradation, nearshore assessment, cooperative science and climate change. As amended, the 2012 Agreement also addresses the roles of key institutions and their accountability, public engagement and methods of ensuring shared responsibility for the Great Lakes. The 2012 Agreement also changed the Commission's required reporting cycle to every three years.

THE GREAT LAKES WATER QUALITY AGREEMENT FROM 1972 TO TODAY

1972
Reducing nutrients (phosphorus) to reduce algae; reducing visible pollution

1978
Tackling persistent toxic chemicals; adding an ecosystem-wide approach to management

1983
Updating phosphorus reduction strategies

1987
Adding Lakewide Management Plans and Remedial Action Plans processes for Areas of Concern

2012
Modernizing and enhancing governance; new and expanded issue annexes

The Agreement's 50th anniversary presents an occasion to highlight key achievements and opportunities to protect the Great Lakes into the future.

As a framework for binational coordination, the Agreement is globally recognized as a significant commitment between two countries. The Agreement catalyzed federal funding to support its domestic implementation in each respective country, with significant investments in the past decade including the US Great Lakes Restoration Initiative, and several mechanisms in Canada including the Canada Nature Fund, Great Lakes Protection Initiative, the Canada-Ontario Agreement on the Great Lakes Water Quality and Ecosystem Health, and the Canadian federal government's recent announcement of CDN$420 million in new Great Lakes funding.

As a commitment between two countries, the efforts of both federal governments to implement the Agreement expanded over time to include a wide range of partners. The 1987 Amendment added public engagement mechanisms that enabled popular, creative meetings and forums through which Great Lakes community members could provide governments with direct feedback on core regional issues. First Nations, Métis and Tribal governments are not party to the Agreement, but under the 2012 Protocol the Parties explicitly recognized their important role. The Parties increased opportunities for First Nations, Métis and Tribal governments' inclusion in implementation of the Agreement's binational framework through governance.

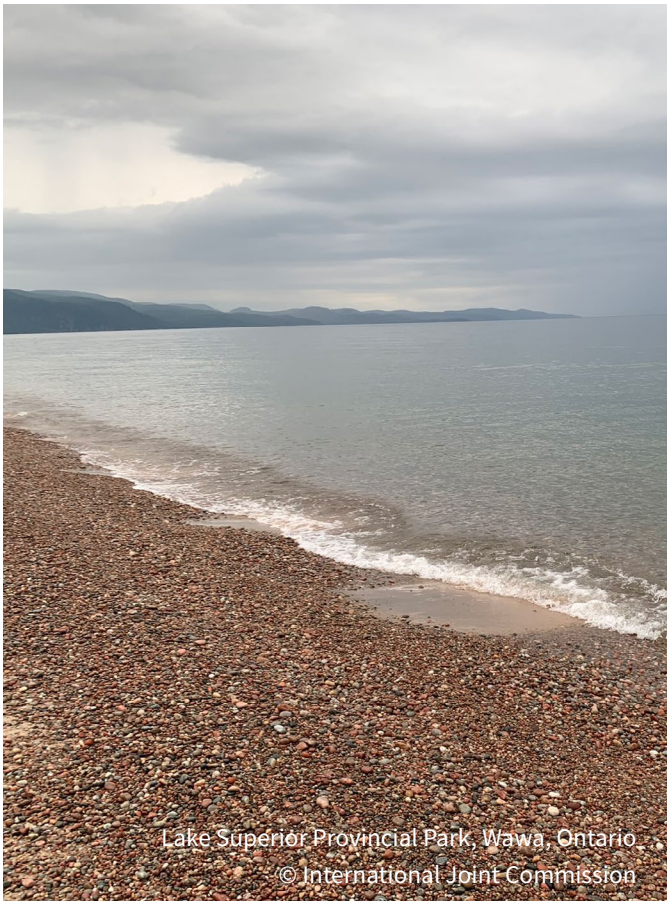
Agreement activities are now supported by many federal departments and agencies, state, provincial and municipal governments, First Nations, Métis and Tribal governments, watershed management agencies, local public agencies, industry, nongovernmental organizations and the public.

The Agreement enabled many successes improving Great Lakes water quality problems, particularly where issues are localized or where the cause and effect are clear. Through coordinated efforts and dedicated funding for Areas of Concern, activities to clean up severe environmental degradation at 43 identified toxic hotspots led to restoring approximately 170 beneficial use impairments and the full environmental recovery of nine Areas of Concern. Targeted actions to control some legacy chemicals of mutual concern, such as polychlorinated biphenyls (PCBs), also led to significant declines in their concentrations in the environment since the 1970s. Between 1970 and 2000, reduction measures introduced on both sides of the border to regulate point sources of phosphorus (those coming from a single, identifiable source) dramatically curbed algal blooms, particularly in Lake Erie.

Another key achievement was the incorporation of new principles and approaches into the Agreement. These include the call for zero discharge and virtual elimination of chemicals of mutual concern, the precautionary principle, adaptive management and taking an ecosystem approach to management. The ecosystem approach means that individual threats to the lakes are not tackled in isolation,

providing a holistic, coordinated focus for research and planning. There has been limited progress to date in implementing these overarching principles and approaches. Applying the ecosystem approach in practice, for example, means overcoming challenges such as a lack of infrastructure and institutions that support such a broad view of the lakes, the long timeframes needed for data collection and the limited documentation of human health parameters in Agreement research and management activities.

Making even greater progress toward the Agreement's objectives will therefore require prioritizing solutions to the more complex, basinwide issues, such as agricultural runoff, land use practices, climate change and invasive species, which complicate the persistence of algal blooms in the lakes. While the levels of some toxic chemicals, like PCBs, in edible fish portions have improved since the 1970s, advisories for consuming some Great Lakes fish are still necessary and toxic chemicals continue to threaten ecosystem and human health. Applying the ecosystem approach to address climate change, a threat that amplifies the impacts of other water quality stressors, requires even greater coordination across the Agreement's science, monitoring and annex implementation activities.



Lake Superior Provincial Park, Wawa, Ontario
© International Joint Commission

Milwaukee, Wisconsin

3. The Present: Current State of the Great Lakes

By some measures, the present is hopeful for the Great Lakes basin. In their science-based "State of the Great Lakes 2022 Report," published every three years, the Parties assessed the overall condition of the Great Lakes as ***fair*** and *unchanging*.

According to the Parties, Great Lakes indicators tell us the following:

- The lakes are a source of high-quality drinking water when treated.
- The water quality of the lakes generally supports a safe environment for recreation, allowing for activities such as swimming, boating and fishing.
- Fish are safe to eat, some in limited quantities.
- Healthy coastal wetlands exist in each lake though, overall, Great Lakes coastal wetlands vary in quality.
- Fish populations, including lake trout and lake sturgeon, have rebounded in several areas.

The Parties' report also provides a lake-by-lake overview that tells us the status of each lake in terms of restoring and maintaining the physical, chemical and biological integrity of the Great Lakes ecosystem:

- Lake Superior is good and unchanging. Lake Superior's forested watershed and coastal wetlands help maintain water quality and a healthy aquatic ecosystem.

- Lake Michigan is fair and unchanging. Lake Michigan supports a diverse array of plant and animal species, and its waters allow for swimming and recreational use, but invasive species and other stressors continue to affect its water quality and food webs.

- Lake Huron is good and unchanging. Lake Huron remains healthy despite nearshore algal blooms and a reduction in offshore nutrients from invasive filter-feeding mussels.

- Lake Erie is poor and unchanging. Lake Erie supports a productive walleye fishery, but elevated nutrient concentrations and algal blooms are persistent problems.

- Lake Ontario is fair and unchanging to improving. Lake Ontario shows improvements with fewer beach closings and declines in contaminant concentrations in fish.

The assessment of the Great Lakes ecosystem conducted by the Parties and presented in the "State of the Great Lakes 2022 Report" reflects the conclusions of many scientists, experts and resource managers. Understanding the extent to which the perceptions of residents within the basin may or may not mirror the outcomes of management actions and scientific assessments is also important. To that end, the Commission gathered public input on the "2022 Progress Report of the Parties" (section 3.4) and the Commission's Great Lakes Water Quality Board conducts a "Great Lakes Regional Poll" every three years to broadly gauge residents' beliefs, attitudes and understanding of Great Lakes environmental health and water quality issues.

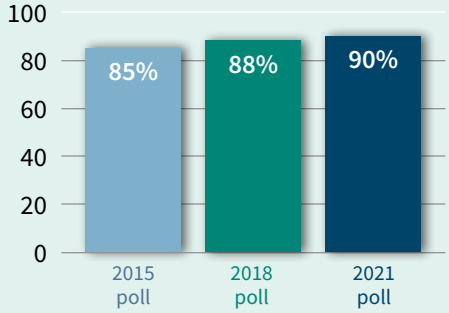
Kichi Gammi Park, Duluth, Minnesota
© International Joint Commission

The board's 2015, 2018 and 2021 polls, each of which surveyed 4,000 or more randomly selected respondents, reflected several notable long-term trends in residents' perceptions of the water quality of the Great Lakes, even considering that these polls are a snapshot of public sentiments at a given moment. The board's poll results over the years showed there is much work to do in making sure Great Lakes residents understand the Parties' efforts that are already in place, while also leaving little doubt that residents care about the lakes' future. For example, the board's 2021 poll found that only 17 percent of residents are aware of the Agreement. At the same time, an overwhelming majority believes it is important to protect the health and water quality of the Great Lakes, a sentiment that increased over time, from 85 percent in 2015 to 90 percent in 2021. Of the 500 respondents to the board's 2021 poll who identified as First Nations, Métis or Tribal members, 99 percent say it is important to protect the Great Lakes.

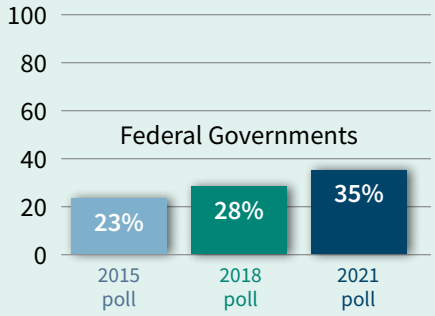
The board's 2021 poll results also showed that the public's top concerns are pollution in general and invasive species, and the majority of the public believes climate change has a negative or very negative impact on the lakes' health and water quality (76 percent of 2021 poll respondents, up from 72 percent of 2018 poll respondents).

2015 POLL, 2018 POLL, 2021 POLL

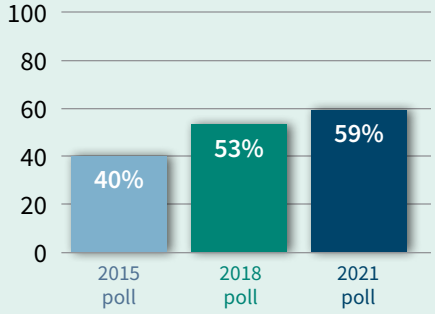
90% of residents said it is **important to protect Great Lakes** health and water quality



Who should be responsible for protecting the Great Lakes Basin?



59% of residents feel there are too few policies and regulations in place to protect the Great Lakes



Comparison of select results from the 2015, 2018 and 2021 Great Lakes Regional Poll conducted by the International Joint Commission's Great Lakes Water Quality Board.

The poll results also suggested that the public looks to their federal governments to protect the Great Lakes. In 2015, 23 percent of respondents said the federal governments should be responsible for protecting the lakes, and this increases to 35 percent of respondents in the 2021 poll. Similarly, in 2015, only 18 percent of respondents said the federal governments are currently responsible for protecting the lakes, while in 2021 the proportion is 29 percent. Residents are also increasingly critical that there are not enough safeguards protecting the lakes. In the 2015 poll, 46 percent of respondents said there are too few policies, regulations, programs and actions in place to protect the Great Lakes. In the 2021 poll, 59 percent of respondents say they agree with that statement.

At the same time, few members of the region's public are aware of specific policies, regulations, programs or actions to protect the lakes, with results showing 10 percent awareness in 2015 and 11 percent in 2021. People are also in favor of action, with 80 percent of 2021 poll respondents believing that actions should be taken now to protect the Great Lakes for future generations, and of respondents who identified as First Nations, Métis or Tribal members, more than 95 percent agree.

As part of this triennial assessment, the Commission takes into consideration the Parties' scientific assessment presented in their "State of the Great Lakes 2022 Report" along with other information and perspectives provided by the Parties, other government and scientific reports, the Commission's advisory boards and input on the "2022 Progress Report of the Parties."

In the following sections, the Commission presents *findings* from its assessment that identify key achievements, gaps and opportunities, while *conclusions* provide an interpretation of the findings and the Commission's view on what the Parties might consider for the future. In section 4.5 three *recommendations* strive to identify priority actions for the Parties.

Milwaukee, Wisconsin
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3.1 HOW THE CHANGING CLIMATE AFFECTS THE GREAT LAKES REGION

Climate change exacerbates impacts on the Great Lakes, influencing and interacting with all the ecosystem indicators of their health. There is ample credible science on the current and growing impacts of climate change in the region, including the United States "National Climate Assessment," "Canada's Changing Climate" report and the "Canada in a Changing Climate: National Issues Report." The basinwide, long-term trends in climate indicators used in the "State of the Great Lakes 2022 Technical Report" show rising surface water temperatures, declining ice cover, increasing precipitation and extreme weather events.

Warming temperatures, lake heatwaves and extended periods of lake stratification (distinct layers of different temperatures of water) are expected to increase the risk of invasion of nonnative species, pose significant implications for coastal wetlands, and lead to the loss of some fish species that will impact fisheries. The persistence of nuisance and harmful algal blooms and hypoxic (low oxygen) waters are expected to increase with warmer lake temperatures. The Parties' "State of the Great Lakes 2022 Technical Report" shows that loss of winter ice cover affects all lakes, with the northern region being most affected: Lake Michigan's deep waters are warming and Lake Superior is one of the fastest warming large lakes in the world. Lake Superior also has the greatest long-term decline in ice cover in the Great Lakes, with a 35 percent decrease in maximum ice cover between 1973 and 2020.

More intense rain and snowstorms can also increase soil erosion, pollution, and sewage and sediment loads, posing risks to ecosystems and human health, including outbreaks of waterborne illness. Climate change is also expected to shift patterns in extreme high and low water levels, which, in combination with increased ice-free duration due to warming winters, can increasingly subject coasts and coastal wetlands to winter storms and erosion.

3.1.1 INDIGENOUS PEOPLES IN A CHANGING CLIMATE

Climate change significantly and distinctly affects First Nations, Métis and Tribal communities. According to the United Nations, on a global scale, climate change exacerbates other related difficulties faced by Indigenous communities, including "political and economic marginalization, loss of land and resources, human rights violations, discrimination and unemployment." For example, impacts on plant and animal habitats may affect how communities use and access their cultural, language, economic and food-based resources.

The Agreement includes numerous commitments to engage directly with Indigenous Peoples, including under Annex 9 (Climate Change Impacts). Indigenous governments and communities are responding directly to the growing threat of climate change and climate impacts through developing and implementing community-level climate resilience plans and tools. Examples include the Great Lakes Indian Fish and Wildlife Commission "Tribal Climate Adaptation Menu" and their climate change vulnerability assessment "Aanji bimaadiziimagak o'ow aki," the Rising Voices Center for Indigenous and Earth Sciences, the Canadian Indigenous Climate Hub, and related research to assess progress under Annex 9.

3.1.2 BINATIONAL CLIMATE INITIATIVES AND COORDINATION

Under the Agreement, the purpose of Annex 9 (Climate Change Impacts) is "to identify, quantify, understand, and predict the climate change impacts on the quality of the Waters of the Great Lakes." Through Annex 9 activities, the Parties published comprehensive annual and quarterly climate trends, impacts and outlook reports and convened a workshop exploring the state of Great Lakes climate modeling to fulfill their priorities for science and action during the 2020-2022 cycle.

The Parties take a bilateral approach to addressing domestic climate change adaptation and resilience strategies applicable to, but not always specific to, the Great Lakes region. In the United States, instead of Great Lakes regional or national strategies for climate change adaptation, federal agencies each develop adaptation strategies (for example, the Environmental Protection Agency's "Climate Adaptation Plan"). The recent Inflation Reduction Act and Infrastructure Investment and Jobs Act will allocate tens of billions of dollars for individual federal climate resiliency programs. Canada's new "National Adaptation Strategy and National Adaptation Action Plan" includes climate resiliency actions that align with Agreement objectives, to be supported by planned ongoing Canadian federal investments such as through the Disaster Mitigation and Adaptation Fund. At the subnational level, several state and provincial governments have initiated or completed climate assessments.

Coordination is a crucial need to respond to the urgent challenges of climate change. Between 2012 and 2019, the Parties made significant progress in sharing information, building networks and building capacity for more effective measurement, monitoring and analysis of climate change impacts in the Great Lakes basin. The Commission's Great Lakes Water Quality Board 2019 report on climate adaptation and resilience recommends that the Parties develop, in cooperation with other governments and organizations across the basin, a binational approach to climate change adaptation and resilience in the Great Lakes. The Commission reiterated the board's recommendation in its 2020 "Second Triennial Assessment of Progress" report. In 2022, the Commission began working toward a "Climate Resiliency Strategy" to identify and prioritize climate-resiliency-related activities that the Commission and its boards may pursue. The Commission also identifies the ongoing and significant need for improved coordination between multiple levels of government, community decision-makers and others in order to meaningfully respond to the impacts and threats of the climate emergency.

3.2 THE IMPORTANCE OF INDIGENOUS ENGAGEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Generations of Métis and approximately 120 First Nations and Tribal Nations have occupied the Great Lakes basin over the course of history and about 30 have recorded treaty rights. Indigenous Peoples past and present rely on and protect the Great Lakes, living in kindred relation with the waters for generations. Today, the Commission works with First Nations, Métis and Tribal governments and organizations as part of its efforts for greater outreach, representation and engagement with Indigenous governments, communities and organizations under the Agreement. There are currently several First Nations, Métis and Tribal governments and organizations listed as members on several annex committees, according to the "2022 Progress Report of the Parties."

Niagara, Ontario
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The Parties acknowledge the importance of engaging and including Indigenous governments in protecting the Great Lakes and are committing more support for Indigenous-led programs addressing Great Lakes water quality. Canada's Indigenous Guardians Funding provides support for First Nations and Métis to protect and conserve ecosystems, including the Great Lakes basin. Since 2021, the US Distinct Tribal Program Framework leverages the Great Lakes Restoration Initiative to directly fund Tribal governments' capacity to participate and provide substantial input in Great Lakes initiatives.

Throughout the basin, there are widespread efforts and attention toward making management decisions that are more informed, meaningful, supportive and lasting by bridging non-Indigenous and Indigenous knowledge systems, including Traditional Ecological Knowledge. Traditional Ecological Knowledge is a term that describes one component of Indigenous ways of knowing and broadly encompasses environmental, social, economic and cultural elements of the overall knowledge and ways of being held by Indigenous Peoples and within Indigenous communities.

As part of these efforts, there is growing dialogue and recognition of the fundamental differences between Western and Indigenous ways of understanding environmental realities. For many Indigenous Peoples, their way of knowing is based on their relationship and responsibility toward ecosystems, including water, whereas Western approaches place emphasis on management. Making room for both these perspectives to coexist in policy and action under the Agreement is essential to current and future work across the basin.

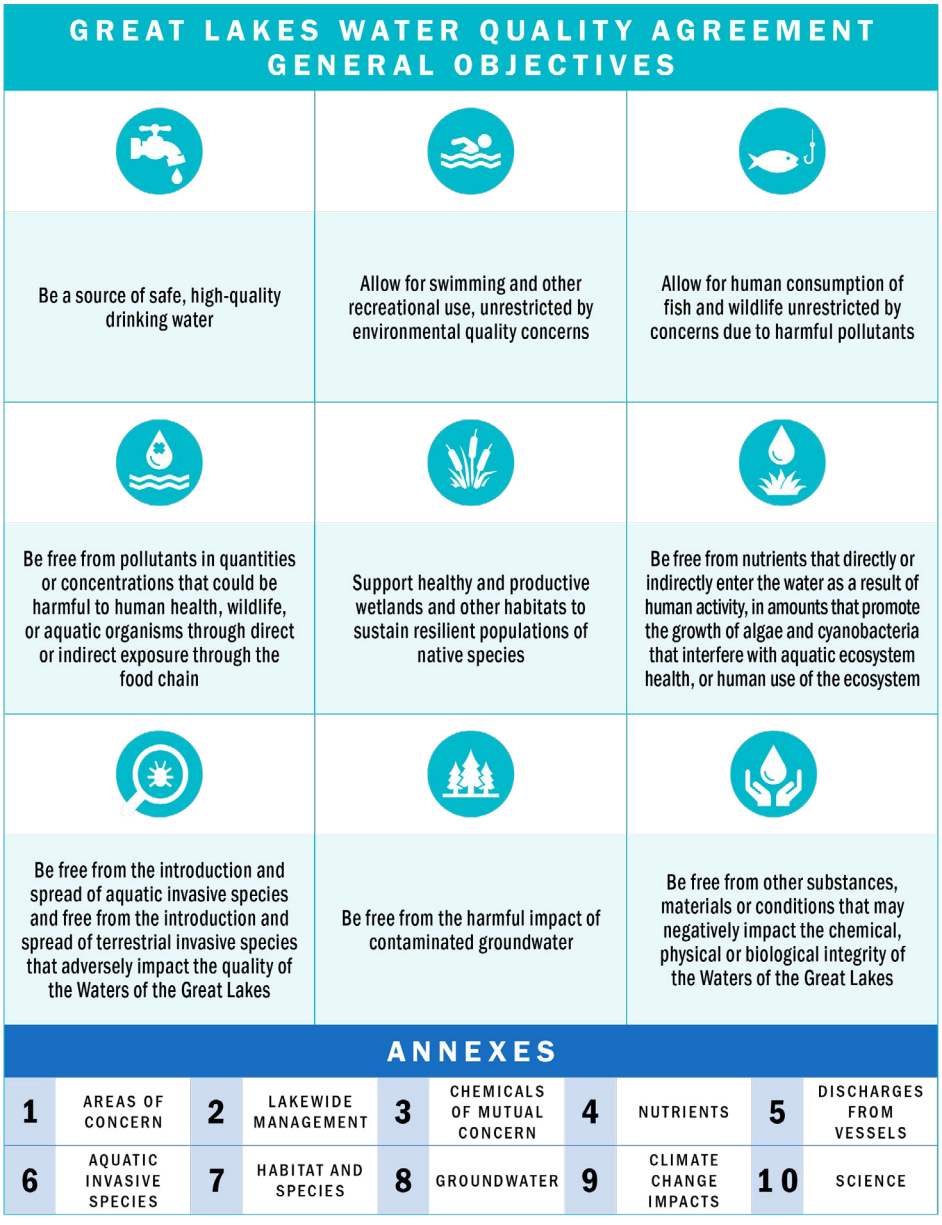
The "2022 Progress Report of the Parties" includes many examples of the Parties' efforts to integrate Indigenous practices and ways of knowing into their Agreement activities. For example, under Annex 10 (Science), the US Caucus of the Traditional Ecological Knowledge Task Team published a guidance document as a "starting point for understanding how Traditional Ecological Knowledge can be appropriately supported and engaged to contribute to the achievement of the objectives of the Agreement." The Commission finds that the Parties' efforts and progress to include Indigenous voices and perspectives are essential to ensuring that the Agreement and its principles remain relevant to all basin residents. The Commission encourages continued involvement and expanded collaboration with First Nations, Métis and Tribal governments to further build capacity and support for having their ways of knowing meaningfully influence Agreement activities and decision-making through collaboration and partnership.

The Commission and its boards also have efforts underway that prioritize relationships with Indigenous nations and their governments, organizations and communities' members. The Commission's Science Advisory Board is currently designing an outreach and engagement plan to inform a framework for incorporating both Traditional Ecological Knowledge and Western science in Commission undertakings. The Commission also held an Indigenous Knowledge Gathering in April 2021 to gather insight and advice on how the Commission and Indigenous Peoples can collaborate more effectively, including embracing the philosophy of Two-Eyed Seeing in the future work of the Commission. Moving forward, the Commission will also continue to examine the distinct impacts of climate change and changes in water quality to communities in the Great Lakes basin.

3.3 PROGRESS UPDATE: ACHIEVING THE AGREEMENT'S WATER QUALITY OBJECTIVES

The "State of the Great Lakes Report" and the "Progress Report of the Parties," both authored by Canada and the United States, provide a lens through which the Commission and the public can assess the Parties' progress to achieve the Agreement's nine general objectives and 10 annexes.

Following the advice of the Commission, the Parties' "State of the Great Lakes Report" uses nine broad indicators of ecosystem health for each of the Agreement's general objectives, supported by 40 sub-indicators, to assess the status of each lake (*good*, *fair* or *poor*) and the 10-year trend (*improving*, *unchanging* or *deteriorating*). The "Progress Report of the Parties" highlights government-led or government-funded domestic and binational programs and activities under each of the Agreement's annexes.



3.3.1 SOURCE OF SAFE, HIGH-QUALITY DRINKING WATER

GENERAL OBJECTIVE 1:

The Waters of the Great Lakes should be a source of safe, high-quality drinking water.

The Agreement's objective is for the "Waters of the Great Lakes" to be a *source* of high-quality drinking water. The Parties' indicators, however, assess the quality of *treated* drinking water. Source waters require treatment to make them safe to drink; some violations of drinking water standards (such as infrastructure issues like lead pipes) are not necessarily a result of adverse source water. While it is important to demonstrate that treated drinking water is of high quality overall, it is difficult to assess progress measuring the quality of treated drinking water against the objective for source water quality. This is particularly important given that drinking water treatment processes may not remove all contaminants of concern, and in several situations, many contaminants may not be monitored. Therefore, the assessment of the quality of treated drinking water, given that it is only assessing the things that are monitored, may not present a complete picture of the state of that quality.

The opportunity remains to better address protection of *source* water quality, use existing source water quality data, expand monitoring to a broader range of the contaminants found in source water, and enhance programs that improve source water quality indicators (as described in the Commission's Health Professionals Advisory Board 2014 report on human health indicators and reiterated in the Commission's Science Advisory Board 2016 "Future Improvements to Great Lakes Indicators" report).

Waterloo, Ontario
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STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 1:
Source of Drinking Water

Indicator: Drinking water for the overall Great Lakes basin.
Sub-indicator: Treated drinking water across the basin.

The Canadian and US governments' "State of the Great Lakes 2022 Report" assesses the overall status of Great Lakes treated drinking water as *good* with a trend of *unchanging* (trend based on Ontario data only). Ontario uses data based on the percentage of treated drinking water samples that met drinking water quality standards. The United States uses the percentage of the population for which treated drinking water meets all applicable health-based standards. The data used to assess lake-by-lake status also differs between countries: Ontario uses *source* water data while the United States uses *treated* drinking water data. While the overall assessment of drinking water is *good*, the Parties note that localized exceedances of drinking water standards sometimes occur, which can be a result of adverse source water quality, failure to treat properly, or inadequate water treatment and distribution infrastructure.

While the overall Great Lakes assessment is reported differently between Canada and the United States, indicator reporting has improved over the previous assessment cycles including a lake-by-lake status assessment, use of Ontario source water data for lake assessment reporting, and the use of US data for drinking water sourced directly from the Great Lakes and connecting channels (now excluding groundwater or inland sources). These changes to the Parties' indicators allow for a more accurate assessment of the state of the "Waters of the Great Lakes."

The "State of the Great Lakes 2022 Technical Report" recognizes that an assessment of a harmonized set of *source* water quality indicators is ideal. However, the Parties note there are barriers limiting requirements for source water sampling and coordinated data accessibility (on the US side) that would require increased collaboration with other agencies and organizations (particularly water treatment utilities) to increase sampling and reporting on US source water data.

PROGRESS REPORT OF THE PARTIES

The Parties' actions and activities through various annexes collectively contribute to progress to protect the Great Lakes as a source of safe drinking water. Nearshore assessment activities in Canada and the United States pursuant to Annex 2 (Lakewide Management) identify Great Lakes coastal waters that are in *good*, *fair* and *poor* condition for water quality and ecological health and identify sources of stress. Under Annex 1 (Areas of Concern), restrictions were lifted for drinking water consumption or taste and odor problems for toxic hotspots in the Bay of Quinte in 2020 and recommended for removal in the St. Clair River in 2020. Binationally coordinated activities to protect the lakes as a source of drinking water include efforts under Annex 3 (Chemicals of Mutual Concern) to manage eight designated chemicals. Nutrients and algal blooms also impact source water protections, and in Lake Erie the National Oceanic and Atmospheric Administration's weekly water quality sampling and monitoring of harmful algal blooms provides key data that informs decision-support tools for researchers and drinking water managers.

There are also state and provincial efforts to protect source water: the integration of Michigan's Healthy Climate Plan into Michigan's Clean Water Plan; investments in nutrient-reduction projects for source water protection in New York; and an Ontario project that will monitor select landfills and leachate for perfluoroalkyl and polyfluoroalkyl substances (PFAS) and potential impacts to groundwater and drinking water wells.

THE CASE FOR FOCUSING ON SOURCE WATER PROTECTION AND ASSESSMENT

Source water protection can reduce the risk of contaminants reaching consumers' taps and lower water treatment costs. Monitoring and reporting are also important to mitigate and understand the risks to those that rely on the Great Lakes for treated water. Natural landscapes and healthy watersheds can protect source water, reduce capital costs of distribution and wastewater treatment, and increase the climate resiliency of communities, which may offset the future costs of infrastructure to manage water-related climate effects (for example, new infrastructure to manage and treat more stormwater and drinking water).

Facilities are required to treat raw water and safely distribute it to people, but deteriorating water infrastructure and unmet investment needs are exacerbated by stressors including combined and sanitary sewer overflows, emerging contaminants, invasive species (for example, dreissenid mussels clogging water intakes) and loss of green space and wetlands. Extreme weather driven by climate change will bring more nutrient runoff, sediment contaminants and sewage overflows into the coastal zones near drinking water intakes, which can compromise source water quality because of toxins produced by harmful algal blooms or pathogens like *Cryptosporidium* or *Giardia,* and some viruses. Lake water quality management goals and water treatment technologies are also challenged by new and emerging threats such as the evolving quantity and types of cyanotoxins and the presence of nanoplastics and microplastics in the Great Lakes.

Threats to source water quality can also lead to temporary shutdowns of drinking water facilities and increased treatment costs. The Alliance for the Great Lakes estimates that monitoring, treatment and residual disposal for harmful algal blooms in the western Lake Erie basin of Ohio costs almost US$306,000 per year. Costs are often passed to the customers through increased water rates, placing a disproportionate financial burden on marginalized communities.

Furthermore, the environmental effects of climate change are likely to diversify and intensify impacts to source water quality, such as by impacting cyanotoxins, increased sewage overflows and runoff containing pathogens and contaminants, creating challenges to drinking water treatment infrastructure.

The Commission's Health Professionals Advisory Board previously demonstrated the need for enhanced monitoring and assessment of Great Lakes source water quality. Given evidence of increased microbial threats related to climate change, the Health Professionals Advisory Board 2021 report called for binational monitoring of relationships between source water quality and meteorological conditions with acute gastrointestinal illness incidence. Such binational monitoring, combining environmental and health data, can help identify and address potential vulnerabilities in drinking water systems and their link to climate change. The board's report also highlighted the importance of source water quality monitoring, recommending that a clearinghouse for binational drinking water source quality be established for communities that obtain their water from the Great Lakes. The board also underscored the importance of modernizing the types of source water data monitored in their 2021 "Great Lakes Water Quality Centennial Study" report, noting that more detailed data using newer technologies can provide better insights into pollution sources.

KEY FINDINGS

The Parties and their partners undertake many activities and programs that contribute to the protection of source water. However, the "Progress Report of the Parties" is not structured in a way to highlight annex activities that are specific to this objective for ensuring safe drinking water sources, and there is not a harmonized indicator for source water.

The Commission finds that, while the Parties have improved their indicator reporting for the drinking water objective as part of their "State of the Great Lakes Report," it is challenging to assess progress toward the lakes serving as a source of safe, high-quality drinking water. Source water monitoring and reporting are important in understanding both source water quality trends as well as the risks to those that rely on the Great Lakes for their treated drinking water.

The Commission also finds that the Parties have yet to report source water data at drinking water facilities for both Ontario and the United States, in addition to reporting treated drinking water data as part of the "State of the Great Lakes Report" and as recommended in the 2017 "First Triennial Assessment of Progress." The Commission acknowledges the challenges of attaining such data and commends the Parties' efforts to include Ontario source water data and explore opportunities to include US source water data in future reporting cycles. The Commission will continue to exercise its convening capacity to examine science needs in this area, including the extent to which drinking water sources are monitored for contaminants of concern.

On Lake Huron
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3.3.2 RECREATIONAL USE

GENERAL OBJECTIVE 2:

The Waters of the Great Lakes should allow for swimming and other recreational use, unrestricted by environmental quality concerns.

Millions of people in Canada and the United States choose the Great Lakes for swimming, boating, beach use and other recreational activities that support their quality of life and boost economic and restoration activities. The Agreement's objective is for nearshore water quality to not interfere with recreational uses of the lakes. Beach advisories and closures are the only measure reported for assessing this objective and indicate the extent that beach managers have monitored, and acted upon, known biological or chemical contamination. Opportunities for a more comprehensive assessment of progress toward this objective include expanding monitoring and use of advanced microbial source tracking technology that can better pinpoint causes of contamination and help managers prevent pollution at the source.

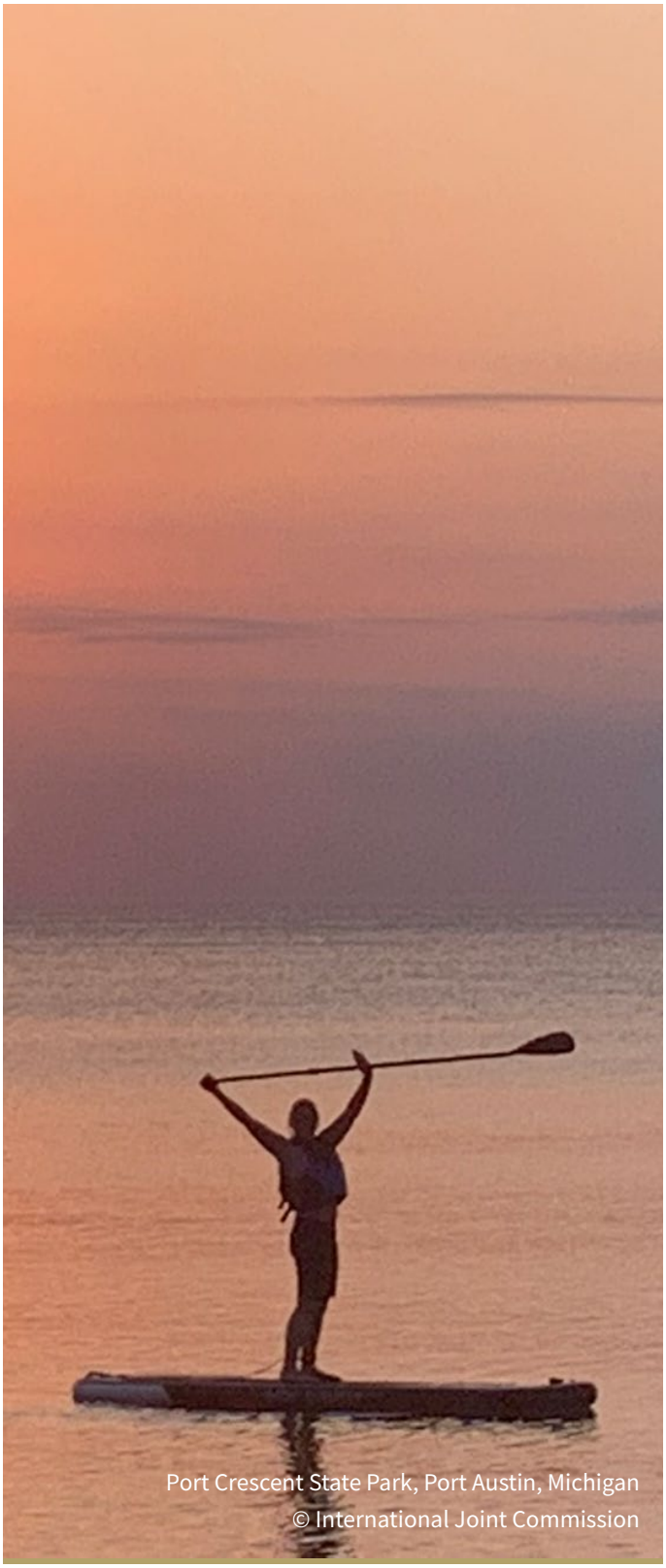
STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 2:
Recreational Use

Indicator: Beaches for the overall Great Lakes basin.
Sub-indicator: Beach advisories and closures.

The Parties' "State of the Great Lakes 2022 Report" assesses the overall status of Great Lakes beaches as *good* with a trend of *unchanging to improving*. Reporting for Ontario beach closings changed in 2022, and all future reports will use *E. coli* thresholds as outlined in the Ontario "Operational Approaches for Recreational Water Quality Guideline." The Canadian data were reanalyzed with the new threshold metric for the "State of the Great Lakes 2022 Report" but only include data going back to 2010; according to the Parties, determining a trend based on data farther back than 2010 would be inconsistent and inaccurate. Additionally, the Parties note that while the quality of Canadian and US data is comparable, monitoring protocols and the posting criteria for beach advisories are not comparable between Canada and the United States.

The individual lake assessments show that Lake Erie's beach conditions improved to *fair and unchanging* from its *poor* status in 2017, and Lake Ontario's beach status is *good and improving* compared to its *fair* status in 2017. The broad lake-by-lake assessments, however, generalize beach closings *across* each lake, which does not account for differences in the number and extent of local beach closings *within* each lake. This approach risks hiding the positive impacts of local improvements and minimizing any negative impacts of compromised local water quality.



Port Crescent State Park, Port Austin, Michigan
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PROGRESS REPORT OF THE PARTIES

Numerous activities under several Agreement annexes focused on monitoring, while source water protection activities (outlined in section 3.3.1) also benefit recreational uses of the Great Lakes. Beach closures remain a problem for 16 Areas of Concern under Annex 1, while the Thunder Bay and Niagara River Areas of Concern engaged with First Nations and Tribes to monitor and assess beach closings. Development of Lakewide Action and Management Plans under Annex 2 includes standards for recreational water quality, and Annex 10 (Science) supports monitoring, including human health-oriented metrics, to support triennial indicator reporting.

States, provinces and environmental nongovernment organizations also led monitoring efforts. The new Visual Assessment Survey Tool maps community beach monitoring data along the Lake Erie beaches in Ontario's Niagara Region. Swim Drink Fish Canada's community science pilot program engages communities, including three First Nations, to collect, analyze and publish water quality samples and data. Indiana's BeachAlert app allows users to check if their favorite beaches are under a contamination advisory or closure due to water safety concerns.

THE CASE FOR IMPROVED MONITORING AND REPORTING

There are many causes and sources of contamination that impede safe and healthy recreational use of the Great Lakes: pathogens from sewage, runoff and animal sources, toxic chemicals and other emerging contaminants like pharmaceuticals, antimicrobial-resistant microorganisms and microplastics, and harmful and nuisance algal blooms.

In 2019, the Commission's Health Professionals Advisory Board "Great Lakes Water Quality Centennial Study" noted the impacts to water quality by historical changes to the basin due to population increases, deforestation and

increased impervious surfaces, along with agricultural and urban runoff. The report also notes that nonpoint sources of runoff have become a greater threat to water quality as sewer, stormwater and septic systems have been extended to support the growth of suburbs and outlying areas. The high failure rates of sanitary sewers, stormwater systems and septic systems, as well as a greater incidence of combined sewer overflows, are major sources of fecal pollution transport to lakes and watersheds. According to the report, aging wastewater treatment facilities will be further challenged by the increased intensity of regional precipitation due to climate change.

Advances in technologies like microbial source tracking make it possible to better protect the public's health during recreational use of the Great Lakes by better identifying sources of fecal pollution and helping target remedial actions for cleanup. Microbial source tracking advances have been particularly useful in improving the ability to detect human sewage contamination. Increased monitoring with modern tools can provide better support for successful restoration efforts made by federal, state, provincial and local governments in recreational areas (including the Areas of Concern). For example, in its forthcoming "Large Basin Microbial Water Quality Study," the Commission's Health Professionals Advisory Board reports that sufficient molecular and genomic tools, and sufficient laboratory capacity to support them, are already developed.

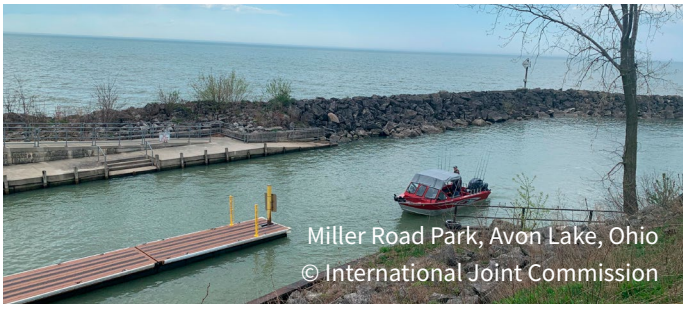
Wastewater is also viewed as a source of contaminants to surface waters. Wastewater treatment is an essential public health service and wastewater monitoring is an increasingly crucial aspect of public health monitoring, including for recreational use of the Great Lakes. Researchers are monitoring SARS-CoV-2, the root cause of COVID-19, in wastewater to examine the disease prevalence in communities and provide an early warning for medical professionals. The experience of monitoring SARS-CoV-2 in wastewater could be applied to other microbes that impact recreational water quality, such as enteric viruses and *E. coli* in fecal pollution, helping to mitigate the associated health hazards. The Commission's Health Professionals Advisory Board 2014 report recommended reporting on measured *E. coli* levels in Great Lakes water as a time- and resource-efficient indicator to compare microbiological hazards at beaches throughout the Great Lakes.

KEY FINDINGS

Water quality is a fundamental determinant of human health and well-being, and the Commission commends the Parties for continued monitoring of human health risks associated with recreational use of water. As identified by the Commission's Great Lakes Science Advisory Board 2016 "Future Improvements to Great Lakes Indicators" report, the use of beach advisories to assess status and trends may not be adequate for assessing progress toward achieving the Agreement objective because monitoring protocols and the criteria to establish beach advisories have not been standardized among Great Lakes jurisdictions.

Both countries' regulations for recreational water quality call for municipalities to monitor indicator organisms including E. coli at beaches. In their "State of the Great Lakes 2022 Technical Report" the Parties note that improved technologies and tools provide opportunities for rapid assessment of E. coli and its sources. A quantitative approach to measuring human health hazards in recreational waters represents an improvement over current reported indicators, and qualitative information on the source of E. coli measured at beaches would be similarly valuable for understanding progress on the health of recreational waters.

The Commission reiterates the advice of its Health Professionals Advisory Board from their 2014 report on recommended human health indicators that adding a specific measure of human health hazards, such as reporting on measured bacteria levels such as *E. coli*, would efficiently allow for comparison of trends.



Miller Road Park, Avon Lake, Ohio
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3.3.3 FISH AND WILDLIFE CONSUMPTION

GENERAL OBJECTIVE 3:

The Waters of the Great Lakes should allow for human consumption of fish and wildlife unrestricted by concerns due to harmful pollutants.

The Agreement's objective is for unrestricted consumption of fish and wildlife; however, the Parties' indicators do not measure wildlife consumption and only assess contaminants in edible portions of fish, utilizing methods that lack standardization across jurisdictions. Commercial, subsistence and recreational fishing and wildlife harvesting in the Great Lakes contribute an estimated US$7 billion annually to the regional economy. There are also local recreational and subsistence activities supported by moose, mussel, bird and turtle populations, especially snapping turtles, that do not support commercial harvesting. There are both benefits and risks to recreational and subsistence consumption of Great Lakes fish and wildlife: they are a healthy source of omega fatty acids and proteins, but they can also be a significant pathway for exposure to contaminants that may pose health risks to consumers, particularly to children and people of childbearing age. In establishing these consumption advisories, policymakers face the ongoing challenge of measuring and communicating risks and benefits to eating fish and wildlife, while consumers must decide how, or if, they follow the information and advice provided.

STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 3:
Fish and Wildlife Consumption

Indicator: Fish consumption for the overall Great Lakes basin.
Sub-indicator: Contaminants in edible fish.

For the current triennial assessment cycle, the Parties assessed the overall status of Great Lakes fish consumption as *fair* with a trend of *improving*. The Parties maintain long-standing programs to monitor levels of chemicals in fish in the Great Lakes, supplemented by contaminant concentration data from the Great Lakes Consortium of Fish Consumption Advisories, which includes input from Tribal members. The Parties improved their indicator reporting, assessing trend data for two contaminants, polychlorinated biphenyls (PCBs) and mercury, and five fish species, lake trout and walleye (used in previous reporting) and adding Chinook salmon, coho salmon and lake whitefish.

The Parties report on toxic chemicals in whole fish as a sub-indicator to support their toxic chemical assessment. The assessment shows that some contaminants in whole fish have decreased since the 1960s. The Parties also show a similar trend for the edible fish sub-indicator for the fish consumption objective. Mercury contamination is currently lower than most health advisory levels. Levels of PCBs plateaued in the 1990s and have remained stable in recent years. Chinook and coho salmon, lake trout and lake whitefish have levels at or higher than advisory guidelines. Walleye have consistently had PCB levels under the health advisory limits in certain lakes since 2002, while PCBs and mercury in Lake Michigan walleye may be increasing.

Individual lake trends show mixed results, with the trend *improving* for Lakes Erie, Michigan, Huron and Ontario or *unchanging* for Lake Superior. The "State of the Great Lakes 2022 Technical Report" used data from the province of Ontario to assess status and trends for Lakes Superior,

Huron, Erie and Ontario. The Parties used data from the US Environmental Protection Agency, Michigan, Wisconsin, Illinois and Indiana to assess Lake Michigan. Indigenous communities also collect their own information on contaminants in local edible fish. The observed trends of lake-specific contaminants reflect the influence of a variety of competing factors, including fish community composition and habitat use, physiochemical characteristics of contaminants and water quality.

PROGRESS REPORT OF THE PARTIES

Various Agreement annex activities factor health considerations into their implementation and contribute to the achievement of the objective as it relates to fish consumption. As reported in the "2022 Progress Report of the Parties," monitoring and assessments concluded that management actions in the Rochester Embayment, Buffalo River and Lower Green Bay/Fox River Areas of Concern under Annex 1 successfully restored impairments to fish and wildlife consumption or tainted flavor, while 32 of the other toxic hotspots continue to deal with fish and wildlife consumption or tainting problems. Canada and the United States use multiple approaches to monitor contaminants in fish and wildlife, such as through the US Geological Survey Mercury Research Laboratory efforts in the St. Louis River Estuary in Minnesota and Wisconsin.

First Nations, Métis and Tribal governments conduct activities to monitor contaminants in fish both on their own and in partnership with the Parties. For example, the Chippewa Ottawa Resource Authority collects data on contaminants in edible fish from Lakes Superior, Michigan and Huron. Several Tribes in the United States conducted numerous programs related to mercury, PCBs, and perfluoroalkyl and polyfluoroalkyl substances (PFAS) contamination in fish. The 2021 Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health includes new commitments to engage with interested First Nations and Métis to ensure Great Lakes fish consumption advisories are appropriate for the protection of their communities.

THE CASE FOR IMPROVING CONTAMINANT INDICATORS AND ADVISORIES

The risks of wildlife consumption, and any corresponding need to set consumption limits, cannot be assessed unless there is consistent monitoring of contaminant levels and consumption levels. It is important to address the need for consistent monitoring given the Parties' commitment in the Fish and Wildlife Consumption Objective.

It is likely that consumption limits for fish will need to remain in place for the foreseeable future. While some contaminants have declined to levels within acceptable consumption ranges, a number of other species are designated wholly unsafe for human consumption in response to a recent monitoring report. Chemicals not currently included in the objective sub-indicator, particularly perfluorooctane sulfonate (PFOS), are causing an increase in fish consumption advisories in the Great Lakes basin. For example, in 2022, a "Do Not Eat" advisory was issued for bluegill and sunfish caught in certain branches of the Rouge River that empty into Lake Erie. There is a growing body of research and scientific literature working to characterize the impacts of other contaminants of emerging concern, such as nanoplastics and microplastics, which are not currently part of the sub-indicators for this objective.

The human health risks associated with fish consumption are effectively tracked through robust monitoring programs, but the parameters for consumption advisories vary across state and provincial jurisdictions. Furthermore, recent advisories restricting local fish consumption do consider the health benefits to people from the omega fatty acids found in fish. The Parties also note, however, that this approach is challenging because scientific understanding is "limited due to the difference in the benefits of various nutrients and health risks from different contaminants."

The public health outcomes from consumption advisories are a function of the extent to which individuals use them to inform their fish and wildlife consumption choices. A wide range of ethnic, cultural and socioeconomic factors affect fishing practices, consumption patterns and compliance with fish advisories. Consumption advisories can impact some

populations disproportionately, particularly those that are high consumers of fish such as Indigenous communities, anglers and those living near Areas of Concern or other contaminated sites. First Nations, Métis and Tribal citizens in the basin may experience unintended social, cultural and health consequences from restrictions on their traditional foods, as well as economic impacts to their commercial and subsistence fish production.

Previous work by the Commission's Health Professionals Advisory Board found that many jurisdictional fish advisories do not routinely account for site-specific data, cultural and socioeconomic factors, and consumer perceptions. Subsequently, there have been efforts to develop community-specific messaging and advisories. The Commission's Health Professionals Advisory Board is currently partnering with the Mohawk Council of Akwesasne to tailor fish consumption advice to support community health and resource management and to effectively communicate the benefits and risks of fish consumption in the national section of the St. Lawrence River. This work, which will address the concerns of First Nations, Tribes and other fishers, will develop frameworks for fish consumption advisories that account for essential nutrients and the effects of chemical mixtures. It will serve as a case study for the development of consistent, harmonized fish consumption advisories between jurisdictions in Canada and the United States for the wider Great Lakes region.

The Commission also notes that the Parties' species list emphasizes top predator and sports fish. Top predator fatty fish, such as lake trout and salmon species, represent a reasonable worst-case scenario for fish consumption advisories. Top predators accumulate larger amounts of chemicals during their life span, and advisories are typically driven by organic and toxic chemicals that can accumulate preferentially in fatty tissue (such as PCBs). The use of commonly consumed fish species in the Great Lakes region as recommended by the Commission's Health Professionals Advisory Board (yellow perch and smallmouth bass) broadens the emphasis of reporting beyond sports fish to include fish at different trophic levels in the ecosystem caught by a broader population of fishers.

KEY FINDINGS

The Commission finds that standardization of all the programs for data collection and reporting for this indicator remains an ongoing challenge, as the parameters for fish consumption advisories vary across jurisdictions. There are chemicals, such as PFOS, for which governments have issued consumption advisories, and other contaminants of emerging concern, such as nanoplastics and microplastics, which are not currently included in the sub-indicator associated with this objective.

The Agreement's objective sets the goal for unrestricted consumption of fish and wildlife, but the Commission finds that the Parties' indicators and activities focus on fish and do not connect human health risks to the consumption of other Great Lakes wildlife such as moose, mussels, birds or turtles. Information regarding the widespread consumption of Great Lakes wildlife is limited at the binational scale but remains important and informative for communities. The Parties may consider obtaining this data directly from First Nations, Métis and Tribal government agencies and organizations for future program activities, monitoring and reporting.

Presque Isle, Michigan
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3.3.4 POLLUTANTS

GENERAL OBJECTIVE 4:

The Waters of the Great Lakes should be free from pollutants in quantities or concentrations that could be harmful to human health, wildlife, or aquatic organisms, through direct exposure or indirect exposure through the food chain.

In accordance with the Agreement's foundational principles of pollution prevention, zero discharge and the precautionary principle, the Parties are tasked with achieving the objective of keeping the Great Lakes waters free from harmful pollutants. The governments coordinate their efforts to remediate legacy contamination through Annex 1 (Areas of Concern) and undertake binational strategies to mitigate and prevent pollution from a list of eight persistent toxic chemicals through Annex 3 (Chemicals of Mutual Concern) activities. The Parties also dedicate resources (under the Agreement and domestically) to contaminants of emerging concern that otherwise fall outside the purview of annex activities and that are given consideration in section 3.4.2. The Commission lauds the Parties' commitment to sustain and enhance existing pollution control programs, recognizing the need to address gaps in detection and analytical processes to keep up with more than 350,000 chemicals and mixtures of chemicals registered for production and use globally.

STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 4:
Pollutants

Indicator: Toxic chemicals for the overall Great Lakes basin.
Sub-indicators: Toxic Chemicals in Herring Gull Eggs; Toxic Chemicals in Water; Toxic Chemicals in the Atmosphere; Toxic Chemicals in Sediment; and Toxic Chemicals in Whole Fish.

The Canadian and US governments' assessment from the "State of the Great Lakes 2022 Report" of the overall status of pollution (toxic chemicals) is listed as *fair* with the trend *unchanging to improving*. However, the COVID-19 pandemic impacted collection and assessment of data for several sub-indicators, which instead reflect the status and trends reported in 2019. These data gaps should not pose a problem given that the sub-indicators assess trends over 10 years or longer. The "State of the Great Lakes 2022 Report" shows that many legacy pollutants, including mercury and polychlorinated biphenyls (PCBs), have decreased significantly since the 1970s, and the 10-year trend is *unchanging* or *improving* for the sub-indicators for toxic chemicals in sediment, open water, whole fish, herring gull eggs and in the atmosphere. The Commission acknowledges the Parties' improved statistical rigor and methods to characterize sub-indicators' datasets on the nature and extent of chemicals of mutual concern.

CHEMICALS OF MUTUAL CONCERN

Eight chemicals of mutual concern have been designated under the Agreement:

- hexabromocyclododecane (HBCD)
- long-chain perfluorinated carboxylic acids (LC-PFCAs)
- mercury
- perfluorooctanoic acid (PFOA)
- perfluorooctane sulfonate (PFOS)
- polybrominated diphenyl ethers (PBDEs)
- polychlorinated biphenyls (PCBs)
- short-chain chlorinated paraffins (SCCPs)

Oscoda, Michigan
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The "State of the Great Lakes 2022 Technical Report" also flags instances where chemicals of mutual concern are found in water, lake sediment, fish and herring gull eggs at levels exceeding the Agreement's ecosystem health goals. Some chemicals show increasing concentration trends, such as polybrominated diphenyl ethers (PBDEs) in Lake Huron, while others, like polycyclic aromatic hydrocarbons (PAHs), which is not currently designated as a chemical of mutual concern, are at higher concentrations in Lakes Erie and Ontario compared to the other lakes.

The Parties' technical report acknowledges that trends remain undetermined for some chemicals of mutual concern. Surveillance for polyfluoroalkyl compounds (PFCs) such as perfluorooctane sulfonate (PFOS) and perfluoroalkyl and polyfluoroalkyl substances (PFAS) in Great Lakes waters only began in 2008. Long-term monitoring and assessment of these chemicals that are widely used as surfactants, repellants and flame retardants will take a concerted effort in coming years before the data can establish clear trends.

PROGRESS REPORT OF THE PARTIES

The purpose of Annex 3 is to "contribute to the achievement of the General and Specific Objectives of this Agreement through cooperative and coordinated measures to reduce the anthropogenic release of chemicals of mutual concern" into the Great Lakes. In the past reporting cycle, the Parties documented several binational achievements under Annex 3. The Parties completed their "Binational Strategy for Short-Chain Chlorinated Paraffins." In addition to the Parties' completing the "Binational Strategy for Mercury Risk Management," the Great Lakes Indian Fish and Wildlife Commission continued monitoring through their Mercury Program. The Parties also finalized their "Binational Screening Criteria" for designating new chemicals of mutual concern and are currently evaluating the nomination packages for lead, sulphates, PAHs and radionuclides. At the 2022 Great Lakes Public Forum, the Parties reported that a decision on the nomination could be expected in 2024.

The Parties also completed domestic actions to mitigate and prevent pollution from chemicals of mutual concern. The US Environmental Protection Agency issued their final rule on PBDEs and now prohibit all manufacture, import, processing and distribution of products containing those chemicals. To address PFAS, Canada developed their Great Lakes "Strategy for perfluorooctane sulfonate, perfluorooctanoic acid and long-chain perfluorocarboxylic acids." The United States is taking a national approach through the Environmental Protection Agency's "PFAS Strategic Roadmap," while Tribal governments such as the Little Traverse Bay Bands of Odawa Indians also conduct PFAS monitoring.

While Agreement activities to achieve the pollution objective emphasize Annex 3 activities, the "2022 Progress Report of the Parties" also mentions a US federal multi-agency program to survey and assess Great Lakes tributaries for contaminants of emerging concern (contaminants currently in use but that lack understanding of exposure and potential impacts to ecosystem and human health). The program found that the contaminant types and concentration varied with land use, that more than 20 were at or close to toxic levels, and that the contaminants found were unlikely to amplify ecosystem harm (for example, changes in gene expression that were observed did not cause reproductive failure or mortality). The program provides new tools, approaches and data meant to inform and support the management of contaminants of emerging concern in the Great Lakes region. The information exchange through this project, along with the Government of Canada Open Data portal, will be important tools for coordinated monitoring and surveillance activities.

THE CASE FOR FILLING DATA GAPS TO ASSESS TRENDS

For both the existing list of chemicals of mutual concern and for the numerous contaminants of emerging concern, the Parties acknowledge gaps in their capacity to collect and analyze data at the requisite scale and frequency needed to establish trends. In their "State of the Great Lakes 2022 Technical Report" the Parties acknowledge that due to the geographic and temporal scale of data required for the Great Lakes basin there are gaps in data for both water and atmospheric sub-indicators. The report recognizes that atmospheric sources from outside the Great Lakes basin impact the environmental quality of the basin and acknowledges that PAH emissions related to forest fires may increase in the future due to climate change.

The "State of the Great Lakes 2022 Technical Report" identifies the need to further study chemicals of mutual concern to determine acceptable limits, including the long-term time scale necessary to monitor flame retardants and PFCs to establish trends. Similarly, assessment processes themselves can be time-consuming. For example, measuring atmospheric deposition can mean collecting and analyzing up to 180 different organic chemicals in each sample. There are also gaps stemming from a level of complexity currently outside the scope of sub-indicator analyses but that affects their trends. For example, there are links between climate change and contaminant levels in aquatic plants and animals that would require scientists to include changing food webs and energy cycling in the sub-indicator analysis. This also includes gaps in understanding the cumulative effects of multiple chemical exposure. The Commission's Great Lakes Science Advisory Board 2020 report evaluating stressor interactions further emphasizes the need to fill gaps in our understanding of the interaction of multiple stressors, including toxic chemicals, through monitoring and research efforts that consider complex spatial, temporal and contextual information to inform management.

There is also room for improvement in the understanding of compliance with regulations as measured by the approximate loads of chemicals entering the ecosystem. The Parties' "State of the Great Lakes 2022 Report" identifies the need to improve methods and access to production data for estimating and interpreting industrial source loads, emphasizing the importance of industry promptly sharing their most recent, best available science with risk assessment and risk management agencies. The Parties are also enhancing their regulatory efforts to prevent new contaminants from entering the Great Lakes in the first place. Under the Canadian Chemicals Management Plan, the federal government assesses new substances before they are marketed to implement early and appropriate controls. In the United States, the Toxic Substances Control Act New Chemicals Review Program serves as a gatekeeper for new chemicals (those not already on their inventory) by imposing conditions on manufacturers before the substances enter the market. This would apply premanufacture and prior to approval of significant changes in chemical uses. Sections of domestic regulations are also updated nearly every year to address emerging or newly recognized pollution problems such as microplastics.

However, as identified by the Commission in its 2017 "First Triennial Assessment of Progress" report, both of these approaches could be complemented by a greater commitment to the principles of extended producer responsibility, according to which a producer's responsibility for a new product extends to the post-consumer stage of its lifecycle. The Parties indicated in response that they would consider extended producer responsibility programs as a potential management option in the development of the binational strategies for management of chemicals of mutual concern. The Commission notes that this would complement the commitments in the Agreement to the precautionary principle and the polluter pays principle. The Commission looks forward to learning more from the Parties about their progress advancing that work.

KEY FINDINGS

The Commission finds that the available evidence supports the Parties' assessment that the eight chemicals of mutual concern, while fairly prevalent in the Great Lakes ecosystem, are generally declining. The Parties are making incremental progress toward the objective to keep the lakes free of those eight chemicals of mutual concern that have been identified, but much more work is required to make progress on the general objective that "The Waters of the Great Lakes should be free from pollutants in quantities or concentrations that could be harmful …"

The Commission notes the Parties' own acknowledgement that their progress reporting and assessment is constrained by gaps in the available scope, scale and complexity of data on chemicals of mutual concern. Indicator reporting and progress assessment would benefit from prioritizing resources dedicated to ensuring continuity in existing monitoring and long time series measurements as well as enhancing science capacity to expand geographic coverage, spatial resolution and complexity of monitoring activities. The Commission is exercising its convening capacity to explore science needs in in this area and assist the Parties in advancing chemicals management.

Allenford, Ontario
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3.3.5 WETLANDS AND OTHER HABITATS

GENERAL OBJECTIVE 5:

The Waters of the Great Lakes should support healthy and productive wetlands and other habitats to sustain resilient populations of native species.

The diverse flora and fauna in the Great Lakes' coastal wetlands, tributaries and shoreline habitats rely on the ecosystem's health and water quality, and vice versa: healthy habitats and species provide essential functions that maintain and protect the lakes' water quality. Since settlement of the Great Lakes region, lakewide water level regulation and stresses such as development in urban areas resulted in the estimated loss of more than 50 percent of the basin's wetlands. The Parties' work to achieve the wetlands and other habitats objective is implemented primarily through their domestic programs and supported by Annex 7 (Habitat and Species). The Parties' improvements to sub-indicator reporting demonstrates their commitment to address coastal assessments. Disparities between data collection methods in Canada and the United States for some monitoring programs should be addressed to ensure that wetland and habitat assessments and reporting are as consistent and comparable as possible.

STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 5:
Habitat and Species

Indicator: Habitats and species for the overall Great Lakes basin.
Sub-indicators: Coastal wetlands species and aquatic habitat connectivity including invertebrates, fish, amphibians, birds and plants; aquatic food web including phytoplankton, zooplankton, benthos, Diporeia, lake sturgeon, native prey fish diversity, lake trout and walleye.

The Parties' "State of the Great Lakes 2022 Report" assesses the overall status of habitats and species as *fair* and *unchanging,* the same as reported by the Parties in 2017 and 2019. The objective's indicator and 14 sub-indicators assess Great Lakes coastal wetlands, tributaries and components of the aquatic food web with an emphasis on native species. Since the last assessment, the Parties improved their data collection methods and refined many of the sub-indicators using this data and through a variety of methods including improved modeling. For the 2022 assessment, this indicator did not include the fish-eating and colonial nesting waterbirds sub-indicator as part of the aquatic habitat connectivity assessment. The coastal wetlands extent and composition sub-indicator was not included in the coastal wetlands species assessment. Both are expected to be included in the 2025 State of the Great Lakes report.

The US Great Lakes Coastal Wetland Monitoring Program involves American and Canadian partners and collects data from wetlands in both countries that is used to inform five of the coastal wetlands sub-indicators. Aquatic food web sub-indicators data are primarily collected through long-standing monitoring programs including the binational Cooperative Science and Monitoring Initiative, which is coordinated through Annex 10 (Science), and the Great Lakes Biology Monitoring Program.

The coastal wetlands and aquatic food web sub-indicator conditions vary across the Great Lakes basin and range from *good* to *poor* and *improving* to *deteriorating*. As noted in the "State of the Great Lakes 2022 Technical Report," the Parties' assessment of data quality shows that Canadian and US data may not be comparable for many of the aquatic food web sub-indicators. This represents an opportunity for both Parties to improve their assessment by standardizing data collection methodologies and then harmonizing monitoring and data collection between both countries. Several sub-indicator assessments in the Parties' technical report that fall under this objective acknowledged Traditional Ecological Knowledge, community science and other ways of knowing, but these metrics have not yet been incorporated into sub-indicator assessments.

PROGRESS REPORT OF THE PARTIES

Annex 7 is the mechanism used by the Parties to contribute to the achievement of this objective by conserving, protecting, maintaining, restoring and enhancing the resilience of native species and their habitats. The Parties, in cooperation with partners, implement this annex domestically through programs and measures used to achieve their binational priorities for science and action.

In the 2020-2022 reporting cycle, the US Great Lakes Restoration Initiative supplemented existing US domestic programs to assess nearshore aquatic habitat, while Canada conducted the Canadian Great Lakes Baseline Coastal Habitat Survey for the Canadian portions of Lakes Erie, Ontario and Huron. Canada also completed an "Assessment of the Resilience of Great Lakes Coastal Wetlands to a Changing Climate" report to guide management decisions and develop priorities for action to improve coastal wetland health, function and resilience in response to threats such as human development and high water levels.

In coordination with Annex 2 (Lakewide Management), the Parties continued work that contributes to lakewide habitat and species protection and restoration conservation strategies, including projects on both sides of the border led by First Nations and Tribal government agencies. This work

also incorporated Traditional Ecological Knowledge in the restoration, protection and management of culturally and traditionally important flora and fauna, such as the stream habitat of eastern brook trout and manoomin (wild rice). The "2022 Progress Report of the Parties" lists a variety of domestic achievements that address commitments to reduce species and habitat loss, recover populations of species at risk, and increase awareness of the need and means to enhance habitat and species resilience.

THE CASE FOR ENHANCING MONITORING CAPACITY AND COLLABORATION

Annex 7 programs and other measures emphasize "binational collaborative actions" to achieve the Agreement's objective for healthy and resilient habitats and species. However, the Parties' approach to this annex continues to emphasize a bilateral, domestic implementation approach to monitoring and reporting on wetland species and habitat indicators. Domestically, the Parties have committed significant resources and achieved progress on their shared priorities for science and action related to habitat and species. Canadian and US domestic monitoring and assessment efforts that provide data for aquatic food web sub-indicators are supported by long-standing monitoring programs. However, monitoring efforts supporting the coastal wetlands sub-indicators rely on funding initiatives that are not permanent, leaving them vulnerable to possible change or discontinuation. Further, while aquatic food web sub-indicators are supported by long-standing monitoring programs, the Parties acknowledge that these separate Canadian and US efforts generate data that are often not consistent or comparable.

The "2022 Progress Report of the Parties" does not provide details on the Parties' progress under Annex 7 to assess gaps in current binational and domestic programs and initiatives "toward the development of a binational framework for prioritizing activities." The Parties do note that the US-based Great Lakes Coastal Assembly led efforts to develop the binational "Great Lakes Coastal Framework" in 2021. The Commission's Great Lakes Water Quality Board 2019 work on wetlands served as a catalyst for the Great Lakes Coastal Assembly's efforts to advance binational collaboration in setting coastal wetland priorities for restoration and protection. The "Great Lakes Coastal Framework" emphasizes the need to bring together Canadian and US efforts for coastal wetlands monitoring and assessment.

Point Pelee National Park, Leamington, Ontario
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KEY FINDINGS

While the Commission commends the Parties' efforts to commit significant resources and achieve progress domestically on their shared priorities, programs and measures under Annex 7, the Commission finds there is a need to enhance capacity for long-term monitoring efforts for all sub-indicators and enhance binational collaboration in monitoring efforts. Pursuing standardized data collection methodologies and harmonizing monitoring and data collection between both countries can further improve indicator reporting and progress assessment. The Commission further finds, given the significant loss of wetlands and other habitats, that much greater progress is needed in order to achieve the substantive goal of the general objective, which is that "The Waters of the Great Lakes should support healthy and productive wetlands and other habitats …"

Due to the traditional and cultural significance of wetlands and native species to First Nations, Métis and Tribal communities in the Great Lakes basin such as harvesting manoomin (wild rice), medicinal plants and various fish and wildlife, the Commission

finds that the Parties are increasingly exploring ways in which Traditional Ecological Knowledge can be better incorporated into the implementation of the Agreement. The Commission encourages continued efforts toward collaboration across national and disciplinary boundaries to systematically and meaningfully incorporate Traditional Ecological Knowledge and Indigenous ways of knowing into monitoring and assessment efforts for habitats and species programs.

3.3.6 NUTRIENTS

Brule River State Forest, Maple, Wisconsin
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GENERAL OBJECTIVE 6:

The Waters of the Great Lakes should be free from nutrients that directly or indirectly enter the water as a result of human activity, in amounts that promote growth of algae and cyanobacteria that interfere with aquatic ecosystem health, or human use of the ecosystem.

Nutrients, including phosphorus and nitrogen, are elemental building blocks that support the lakes' food web. But today's lakes face a dilemma: too many nutrients in the nearshore, such as in Lake Erie, fuel harmful and nuisance algal blooms, while Lakes Superior, Huron, Michigan and Ontario have too few nutrients in the offshore, impacting fishery productivity.

The Agreement's objective is to ensure each lake's nutrient diet is limited so that algal blooms do not impact ecosystem health, drinking water supplies, recreation and tourism, property values and more.

The Agreement also sets specific substance objectives to address phosphorus concentration and load targets for all the lakes and commits the Parties to coordinate and implement domestic action plans to achieve these objectives. Due to the persistence and magnitude of harmful algal bloom occurrence in Lake Erie in particular, the Parties set multiple targets to reduce various aspects of phosphorus loading to parts of Lake Erie by 40 percent of 2008 levels. However, recent trends on phosphorus loads from various tributaries to Lake Erie show variable progress toward achieving these set targets. The Parties report that their voluntary agricultural conservation practices are garnering highly variable progress toward declining trends in nutrient loads to the Lake Erie basin. To achieve the nutrient objectives for each lake, the Parties have an opportunity to address lakewide factors in each lake's unique nutrient balance.

STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 6:
Nutrients

Indicator: Nutrients and algae for the overall Great Lakes basin.
Sub-indicators: Nutrients in lakes; *Cladophora* (green algae); harmful algal blooms; and water quality in tributaries.

The "State of the Great Lakes 2022 Report" describes the overall status of the Nutrients objective as *fair* with a trend of *unchanging*. On a lake-by-lake basis, Lake Superior is assessed as *good*, Lakes Michigan, Huron, and Ontario as *fair*, and Lake Erie as *poor*.

Lake Erie Metropark, Brownstown, Michigan
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The Parties' sub-indicators assess progress toward the Agreement's objective by measuring stressors (the nutrient loads and resulting nutrient concentrations in the water) and outcomes (the occurrence of algal blooms, including nuisance *Cladophora* and harmful, toxic algal blooms). The Parties' assessment of stressors relies on measurements of nutrient concentrations observed in both the nearshore and offshore regions of the lakes. While data on recent phosphorus loads are available for Lake Erie, recent phosphorus loading data are not available for much of the Great Lakes basin, which the Parties' technical report acknowledges is a "major shortcoming that needs to be addressed." The Parties' assessment of nutrient concentrations provides evidence of the concerns flagged by the Commission's Great Lakes Science Advisory Board 2020 report: nearshore nutrient concentrations exceed recommended levels while offshore nutrient targets are below targets and historical trends in Lakes Superior, Huron, Michigan and Ontario. In Lake Erie, nearshore and offshore nutrient concentrations exceed recommended levels and targets respectively throughout the lake's western, central and eastern basins. The Parties' "State of the Great Lakes 2022 Technical Report" shows that the status of the nutrient and algae sub-indicator for this objective is fair with a 10-year trend of *unchanging* but a long-term trend (since 1970) of *deteriorating*.

The Parties' measures of harmful algal blooms only assess extent and frequency of current harmful algal blooms. While they do not *directly* measure the level of toxicity or duration of blooms while they occur, satellite-based imaging measures accurately detected the presence of cyanobacteria blooms (during early summer and late fall) in more than 20 percent of assessed nearshore areas of the Great Lakes, geographically concentrated in western Lake Erie, Saginaw Bay in Lake Huron and Green Bay in Lake Michigan. Similarly, the Parties measure the extent of *Cladophora*, a type of green algae, but there is no definitive threshold for what constitutes "nuisance" levels. The Parties indicate that up to 40 percent of the Great Lakes' nearshore lake bottoms are covered by *Cladophora* and other nuisance aquatic vegetation, mostly in Lakes Michigan, Huron, Erie and Ontario. Opportunities for refining the *Cladophora* sub-indicator include adding region-specific biomass targets against which nutrient targets and management actions could be established and assessed for progress.

PROGRESS REPORT OF THE PARTIES

The Parties coordinate their actions to achieve the Agreement's nutrient objectives primarily through Annex 4 (Nutrients). The Parties' most urgent focus is on their respective Lake Erie domestic action plans. The "2022 Progress Report of the Parties" describes a multitude of projects implemented by Canadian and US federal, state, provincial and local governments aimed at reducing Lake Erie nutrient loads. Canada's notable achievements from this triennial reporting period include the 4R Nutrient Stewardship certification program for farmers, the Canadian Agricultural Partnership and Lake Erie Agricultural Demonstrating Sustainability initiative, Ontario's Wetlands Conservation Partner Program with Ducks Unlimited, and the Great Lakes Protection Initiative. Achievements on the US side of the Lake Erie basin include numerous investments from the Great Lakes Restoration Initiative to support Lake Erie nutrient reduction actions, NOAA's "Lake Erie Harmful Algal Bloom Forecast," US Department of Agriculture's federal cost-share programs for farmers to adopt nutrient management practices, Ohio's H2Ohio Initiative to create, enhance or restore wetlands, Ohio's development of a regulatory tool for the Maumee River that would allocate phosphorus loads for both point and nonpoint sources in their portion of the river's drainage basin, and record-high

cover crop planting, among other agricultural management initiatives.

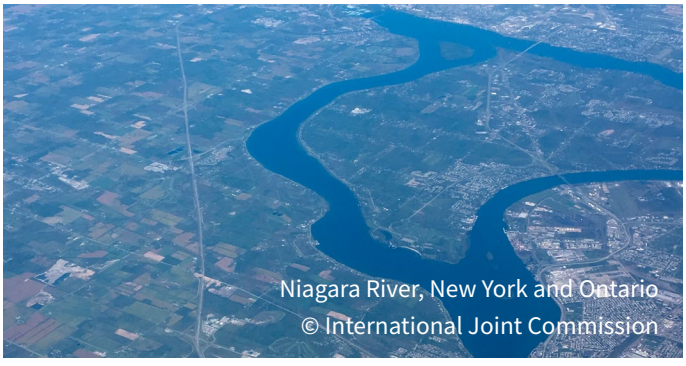
Annex 4 facilitates binational research and monitoring efforts that underpin the Parties' implementation of activities to achieve the Agreement's nutrient objectives for all the Great Lakes. This triennial reporting cycle culminated in achievements under this annex including a draft Binational Adaptive Management Framework for Lake Erie and the coordination of research studies, monitoring, analytical methods and modeling of *Cladophora,* and key factors driving algal bloom toxicity, inter-lake nutrient transport, and ecosystem responses to changes in nutrient loads. In addition to their focus on Lake Erie, the Parties initiated a review of the Agreement's interim phosphorus concentration and load targets, starting with Lake Ontario. Environment and Climate Change Canada's 2021 study suggests that nutrient inputs to Lake Ontario from Lake Erie by way of the Niagara River are higher than previously reported. The Parties' review of Lake Ontario objectives presents an opportunity to further examine the influence of these Lake Erie inputs on algal bloom toxicity.

THE CASE FOR SHORING UP NONPOINT SOURCE REGULATION, PROGRESS REPORTING AND HOLISTIC MANAGEMENT

Reports from the Commission and its Agreement advisory boards continue to provide evidence that the major challenge to achieving Lake Erie nutrient reduction targets is the Parties' voluntary, nonregulatory approach to manage nutrient loads from numerous, diffuse, nonpoint sources. As the "2022 Progress Report of the Parties" indicates, nonpoint sources dominate phosphorus loads to western and central Lake Erie. The Commission's 2014 "Lake Erie Ecosystem Priority" report affirmed that agricultural nonpoint sources, such as runoff of commercial fertilizer and manure, are the main contributor of nutrient loadings to Lake Erie. The Commission's 2017 "First Triennial Assessment of Progress" recommended implementation of enforceable standards governing the application of agricultural fertilizer and animal waste and to ensure that domestic action plans include details and quantifiable performance metrics to support accountability in implementation. The Commission's Great Lakes Water Quality Board published their 2019 report further advising a coordinated, strengthened regulatory framework governing manure management for large and medium livestock operations.

In their 2023 report the Commission's Science Advisory Board and Water Quality Board jointly evaluated the implementation of domestic action plans, with a focus on Lake Erie. The report found significant regulation of point source nutrient loads, such as from wastewater treatment plants. By contrast, nonpoint agricultural sources of nutrient loads are not well regulated in that both countries rely on voluntary nutrient reduction programs. To achieve their nutrient reduction targets, the Parties note that modelling suggests conservation practices must be implemented on *at least half* of both countries' agricultural landscapes in the Lake Erie basin.

While the Parties reported that the implementation of their respective domestic action plans reduced annual nutrient loads into Lake Erie in the last triennial reporting period, they acknowledge that "there is no evidence of a declining trend in phosphorus loads" to the lake. Furthermore, their reports lack specific details linking their actions to outcomes that clearly state their overall progress toward achieving their 40 percent reduction target commitment. The "2022 Progress Report of the Parties" does not report the current status of phosphorus load reductions of each country in comparable terms and timeframes relative to their respective targets: Canada reports a 20-tonne (44,092-pound) annual reduction in phosphorus loads since 2020, while the United States reports an annual reduction in phosphorus loads of over 3 million pounds (1,361 tonnes) between 2015 and 2020.



Niagara River, New York and Ontario
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In addition, the current status of phosphorus load reductions as reported by the Parties may be misleading. According to the "2022 Progress Report of the Parties," the reductions in phosphorus loads "indicate that current actions are on the right track, but significant additional work is needed to meet targets." While the Commission agrees that significant additional work is needed to meet the targets, the Commission disagrees with the characterization of progress as "on the right track." Phosphorus load reductions continue to be well below the annual load reduction targets of 212 tonnes for Canada and 3,316 tonnes for the United States.

The Commission shares the Parties' priority to achieve the Agreement's nutrient objectives in all the Great Lakes; findings from the Commission's recent board reports demonstrate the compelling need for holistic, lakewide assessment and management of nutrients. The Water Quality Board's 2017 Watershed Management of Nutrients in Lake Erie report recommends implementation of effective watershed management as one tool for reducing nutrient loads to Lake Erie. The Commission's 2020 "Second Triennial Assessment of Progress" report highlighted the concern of climate change impacts contributing to the proliferation of algal blooms in the western arm of Lake Superior. The Parties responded to the Commission's report by noting that their priorities remain focused on eutrophic (high in nutrients) basins, including western Lake Erie, as opposed to naturally oligotrophic (low in nutrients) basins like Lake Superior. Notably, the "2022 Progress Report of the Parties" documents that the Parties undertook preliminary efforts to examine the phenomenon of algal blooms in Lake Superior. The Commission's Science Advisory Board 2020 report evaluating stressor interactions shows that climate change is not the only threat multiplier for nutrients and algal blooms; habitat loss and invasive species further exacerbate nutrient and algal blooms impacts on the lakes' ecosystem health. Furthermore, the Commission's 2020 Science Advisory Board report underscored the role of invasive dreissenid mussels and climate change in interrupting the lakes' nutrient dynamics, causing the *feast or famine* dichotomy of nearshore algal blooms and declining fishery productivity in the offshore. The Parties' progress reports only nominally acknowledge the influence of climate change impacts on nutrient loading and algal blooms.

KEY FINDINGS

The Commission echoes the Parties' acknowledgement that "significant additional work is needed to meet targets" to achieve nutrient reductions in Lake Erie. While the Parties provide updated progress indicator information through the ErieStat website, their progress reporting does not include quantifiable performance metrics that links their actions to expected deliverables and load reduction outcomes. To provide transparency on the Parties' progress to reach the nutrient reduction goals, the Commission highlights the need for subsequent "Progress Report of the Parties" and "State of the Great Lakes Report" documents to clearly and plainly communicate progress, including details on quantifiable performance indicators that link actions targeting nutrient load reductions to explicit, quantifiable outcomes. The Commission encourages the Parties' future progress reporting to demonstrate the extent to which their programs and other measures will contribute to ensuring at least half of each country's agricultural lands will have conservation practices in place by 2025.

The Commission finds that the Parties' regulatory approach to managing nutrients from mid- and large-sized livestock operations lacks a common framework. The Commission encourages the Parties to pursue collaborative efforts with state, provincial, First Nations, Métis and Tribal governments, and nongovernment stakeholders to unify and strengthen regulations to curb nutrient loads to the western basin of Lake Erie watershed, as advised by the Commission's Great Lakes Water Quality Board in their forthcoming Manure Nutrient Management Collaborative report.

The Commission also finds that the Parties have yet to implement the recommendations of the Great Lakes Science Advisory Board's 2020 report on the declining productivity in the offshore regions of the Great Lakes. The Commission remains committed to working with the Parties, the Great Lakes Fisheries Commission and others to improve coordination of water quality and fisheries managers in integrated nutrient management for all the lakes. Enhanced capacity for science infrastructure can better connect the efforts of water quality and fishery managers, contribute to more sophisticated modeling that links upper and lower food

webs, and provide more comprehensive monitoring data to enable our understanding of, and reporting on, stressor interactions.

Onota Township, Michigan
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3.3.7 INVASIVE SPECIES

GENERAL OBJECTIVE 7:

The Waters of the Great Lakes should be free from the introduction and spread of aquatic invasive species and free from the introduction and spread of terrestrial invasive species that adversely impact the quality of the Waters of the Great Lakes.

The functioning and health of the Great Lakes ecosystem depends on the ability of its native flora and fauna to flourish. To date, more than 180 aquatic nonnative species have been reported as established in the Great Lakes, of which 64 are considered invasive. An invasive species is defined as a species whose presence in the environment causes economic or environmental harm or harm to human health. The Agreement's objective is to prevent new invasive species from entering, reproducing in and spreading throughout the lakes. Invasive species cost the Great Lakes region's economy more than US$100 million annually (CDN$132 million), underscoring the long-term return on investment for funding prevention efforts. However, knowledge gaps and data compatibility issues hinder the Parties' ability to comprehensively assess the environmental impacts of aquatic invasive species.

STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 7:
Invasive Species

Indicator: Invasive species for the overall Great Lakes basin.
Sub-indicators: Impacts of aquatic invasive species; dreissenid mussels; sea lamprey; and terrestrial invasive species.

In 2019, the Parties improved their reporting to evaluate progress toward this Agreement objective and established two separate indicator categories: *prevention* (assessing the rate that aquatic invasive species establish reproducing populations) and the effects of aquatic invasive species *impacts* (measuring species population extent and their ecological and socioeconomic impacts). In their "State of the Great Lakes 2022 Report," the Parties assess the status of *prevention* in the overall Great Lakes basin as *good* with a trend of *unchanging* but assess the status of *impacts* as *poor* with a trend of *unchanging*. The Parties' "State of the Great Lakes 2022 Technical Report" supports their assessment that prevention efforts are successful at slowing the rate of species establishment: only four new aquatic nonnative species established overwintering and reproducing populations in the Great Lakes since 2011, with no new species established since 2016. The Parties also report on a lake-by-lake basis that 11 invasive or non-indigenous species have now spread between lakes in the last decade.

The Parties' Cumulative Impact Index measures sub-indicators for the overall basin and each of the Great Lakes, considering the magnitude and range of types of impacts of several species. Although the index reflects continued basinwide increases in impacts over time, fewer new impacts are added to the total each year. Some factors indicating more negative overall impacts of aquatic invasive species include the spread of established aquatic invasive species between the lakes. The Parties' report acknowledges the importance of measuring the environmental impact of aquatic invasive species, but gaps in knowledge limit the accuracy of this indicator. The cumulative impact index weights the contribution of each species by its impact factor, but scores are only assigned where data are available to make an assessment. The Parties' technical report notes that climate change impacts can make the lakes more hospitable for invasive species, with warming water temperatures and habitat changes facilitating their ability to outcompete native species and thrive in new parts of the lakes. Data is lacking, however, to assess the role of climate change impacts on potential range expansion of native and nonnative species alike.

Gaps in the sub-indicator metrics include how the index reflects scale and context. The impact index only reflects watershed-scale species eradication, which does not capture progress toward reducing population density that falls short of wholesale eradication. Similarly, the index neither shows the governments' success with invasive species population suppression where eradication is not a realistic target, nor includes the environmental and socioeconomic benefits from sea lamprey control and purple loosestrife biocontrol programs.

PROGRESS REPORT OF THE PARTIES

Over the course of the last triennial cycle, the Parties documented successful collaborative efforts to prevent the spread and mitigate the impacts of aquatic invasive species through their coordinated efforts under Annex 6 (Aquatic Invasive Species) and Annex 5 (Discharges from Vessels). The Parties' approach to preventing the introduction of new invasive species focuses on the pathways that organisms can gain entry to the ecosystem.

The Annex 5 subcommittee facilitates activities to further align the compatibility of Canadian and US monitoring, methods and enforcement to prevent the introduction of invasive species by vessels' ballast water. The "2022 Progress Report of the Parties" notes that both Parties made progress to amend their ballast water regulations, including Canada's 2021 ballast water regulations and the US Environmental Protection Agency's 2020 "Vessel Incidental Discharge National Standards of Performance." Collaborative activities supported by Annex 6 continue to prevent the introduction of invasive, nonnative silver carp, bighead carp and black carp, including coordinated efforts to implement the Invasive Carp Regional Coordination Committee's annual Action Plans. The Parties commit significant resources to contribute to invasive carp suppression, early detection, prevention and control projects, including notable investments in designing and testing control technology at the Brandon Road Interbasin Project in the Des Plaines River near Joliet, Illinois.

Although no established invasive species has been eradicated, the successful control of invasive species such as sea lamprey, purple loosestrife and alewife shows that it is possible to reduce populations of aquatic invasive species to less harmful numbers. The Parties' approach to preventing the spread of established invasive species focuses on species-specific rapid response actions, as exemplified by the resources and coordination committed to successfully controlling invasive sea lamprey, achieving a 90 percent population reduction to date. The "2022 Progress Report of the Parties" also documents the Parties' binational efforts led by the Great Lakes Hydrilla Collaborative, the Great Lakes Phragmites Collaborative, the Invasive Mussel Collaborative and the "Lake Erie Grass Carp Adaptive Response Strategy 2019-2023," as well as other government-led activities targeting other aquatic invasive species like red swamp crayfish. Other actions under Annex 6 related to rapid response, control projects, risk assessment and screening, and adaptive management frameworks consider climate change as a factor in risk assessment and potential range expansion.

THE CASE FOR FURTHER INVESTMENT IN PREVENTION AND SCIENCE TO INFORM SUB-INDICATORS

The Parties' improved sub-indicator reporting approach delineates the results of their efforts to prevent the introduction of new species from efforts to control the spread of established invasive species. This approach shows that investments in prevention efforts are resulting in progress, whereas efforts to control the spread and mitigate the negative impacts of species that are broadly entrenched in the Great Lakes ecosystem is proving to be a larger and more expensive endeavor. The Commission lauds the Canadian and US governments' commitment of significant resources toward their shared priorities for science and action related to aquatic invasive species.

For example, substantial funding for technology testing at the Brandon Road project may benefit aquatic species prevention measures in other regions, underscoring the positive return on governments' investment. While rapid response controls for established invasive species are increasingly effective, the millions of dollars spent annually on these programs, for example to control sea lamprey populations or for water treatment plant maintenance associated with invasive mussels, demonstrates the long-term cost-effectiveness of investing in prevention. Resources for control measures are not without value; the success of species-based collaborative control efforts, such as those established for *Hydrilla*, invasive mussels and invasive *Phragmites*, also demonstrates the compelling need to continue investments into processes that promote communication, coordination and learning between jurisdictions and organizations.

A variety of information sources contribute to the aquatic invasive species objective sub-indicators, and diversifying ways of knowing can help fill the data gaps that limit the accuracy and comprehensiveness of the Parties' assessment. The "State of the Great Lakes 2022 Technical Report" acknowledges the existing data limitations and notes the need to improve the comparability of Canadian and US data. The need for additional research about the environmental impact of aquatic invasive species is underscored by a 2020 updated report on the impact assessment of all nonnative aquatic species in the Great Lakes. At least 35 percent (previously 32 percent) of the nonnative species found in the Great Lakes have significant (moderate to high) environmental impact. This number will be closer to 50 percent if the 81 species for which the state of scientific knowledge is insufficient to complete the assessment of environmental impact follow the trends of the assessed species.

While their progress reports highlight achievements of pilot projects such as the Invasive Species Centre's IsampleON program to engage the public in data collection, the Parties do not address leveraging community science to improve coverage for priorities such as early detection and monitoring. Similarly, the "2022 Progress Report of the Parties" does not reflect the significant role and contributions of First Nations, Métis and Tribal government managers in the Great Lakes, including the several Tribal governments and organizations that serve on the Annex 6 subcommittee. The Progress Report of the Parties would be enhanced by addressing efforts to engage these resources.

KEY FINDINGS

The Commission finds that there are knowledge gaps related to the Great Lakes Cumulative Impact Index. The Commission highlights the benefit of prioritizing resources to fill these gaps to improve risk assessment in support of the Parties' Annex 6 2023-2025 binational priorities for science and

action. The Commission also finds that, in addition to programs that fund control activities, funding for implementation of programs that support prevention and detection are critical for current and future progress toward this objective.

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3.3.8 GROUNDWATER

GENERAL OBJECTIVE 8:

The Waters of the Great Lakes should be free from the harmful impact of contaminated groundwater.

With an estimated volume equal to Lake Huron lending to its moniker as the sixth Great Lake, the basin's groundwater supplies are a critical resource to ecosystems, providing water flow to streams, lakes and wetlands, and are an important resource for drinking water and irrigation for farming. Under the Agreement, the Parties are tasked with the objective to ensure the surface waters of the Great Lakes are not adversely impacted by contaminated groundwater. The governments coordinate their science and management actions to achieve this objective under Annex 8 (Groundwater). While the Parties' priorities for science and action continue to improve indicator reporting for this objective, further collaboration to develop models that advance understanding of groundwater-surface water interactions are necessary to assist managers address climate change stressors.

STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 8:
Groundwater

Indicator: Groundwater quality for the overall Great Lakes basin.

The Canadian and US governments' assessment from the "State of the Great Lakes 2022 Report" of the overall status of groundwater quality is listed as *good,* but the trend is *undetermined* due to a lack of ongoing and consistent monitoring data. The indicator uses chloride and nitrate concentration data, representing sources of urban contaminants (road salt) and rural contaminants (agricultural practices). The Parties base their status assessment on the lowest guideline concentrations of nitrate and chloride for the protection of aquatic life.

The overall status of groundwater quality has changed from *fair* in 2019 to *good* in 2022, attributed to the integration of additional groundwater monitoring data to fill previously identified spatial data gaps. The Parties also made efforts to develop trend assessments for this indicator by exploring methods that may be appropriate to determine trends of chloride and nitrate. The Commission commends the Parties for continuing to refine the groundwater quality indicator to improve spatial reporting and status assessments and for their efforts toward future reporting of long-term trends, and looks forward to the long-term trend being presented in the next "State of the Great Lakes Report." The Parties acknowledge, however, the importance of better understanding the concentrations of contaminants in groundwater (nitrate, chloride and other contaminants) discharging to surface waters and their impacts on the ecosystem through continued monitoring.

PROGRESS REPORT OF THE PARTIES

One of the Parties' commitments under Annex 8 is the production of a binational groundwater report that is to be updated at least every six years. This established commitment was also selected as the only priority for action in the last triennial reporting cycle. Progress toward this commitment was reported in the "2022 Progress Report of the Parties," with an update of their 2016 groundwater report expected to be released by 2022 year-end, but the report is not yet published as of November 2023. When available, the updated report will include valuable information for managers, including an assessment of the geographic distribution of known and potential sources of groundwater contaminants and identification of new science needs. The report would also serve as a useful tool for the Parties to help identify priorities for science and action under the annex, as well as potential linkages with other annexes such as Annexes 3 (Chemicals of Mutual Concern), 4 (Nutrients), 7 (Habitat and Species) and 9 (Climate Change Impacts).

There are notable differences in the focus areas of Canada and US domestic activities and achievements under Annex 8 as reported in the "2022 Progress Report of the Parties." Several Canadian activities were undertaken to understand climate impacts on groundwater and groundwater contaminant impacts on ecosystem health, such as the Ontario Ministry of Environment, Conservation and Parks' support in the development of fully integrated climate, groundwater-surface water models, Natural Resources Canada's assessment of projected climate change impacts, and support for research on contaminants including chloride, nutrients and emerging contaminants. US state agencies lead domestic efforts, supported by the US Geological Survey, including routine monitoring and mapping, and contaminant research. Collectively, these efforts support groundwater annex commitments across a breadth of issues, leading to a better understanding of the interactions between Great Lakes groundwater and surface water, the sources of contaminants and contaminant movement within groundwater.

THE CASE FOR DEVELOPING A BASINWIDE NUMERICAL GROUNDWATER-SURFACE WATER MODEL

Groundwater quality can be adversely affected by several activities, such as urban development, agriculture, landfills and failing septic systems, resulting in a range of contaminants that can enter groundwater through the soil such as nutrients, de-icing compounds, pathogens and persistent organic pollutants. Groundwater, and any contaminants it may contain, can ultimately be discharged directly to the lakes through the lakebeds and shorelines or indirectly by tributaries that ultimately flow to the lakes.

In addition, the role of climate change on the Great Lakes basin's groundwater-surface water system is largely unknown, and understanding its role is an evolving area of research. Climate change poses a threat to groundwater based on changes in the amount and distribution of rain and snow, leading to changes in the water cycle. The relationship between groundwater and climate change is more complex than that of surface waters. Limited studies have been done to determine the impacts of climate change on groundwater systems in the Great Lakes region, including impacts to groundwater quality or impacts to surface waters and groundwater dependent ecosystems. However, impacts are expected from anticipated changes to hydrological processes such as recharge, storage and discharge, as well as water temperature variations and changing anthropogenic practices (for example, new or varied contaminants, or increased groundwater withdrawal). Changes to groundwater recharge rates and soil temperatures could also affect the transport of contaminants.

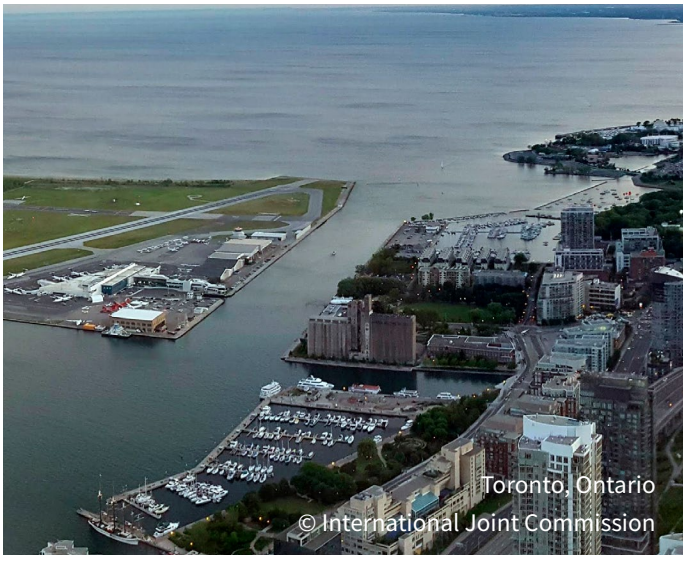
The Commission's 2022 Science Advisory Board report on developing an integrated groundwater-surface water conceptual framework for the Great Lakes identifies the significant knowledge gap in understanding the role and influence of climate change in groundwater-surface water interactions. The board's report notes that the tools and processes for understanding the influence of climate change

on groundwater systems are not keeping pace with management needs. An integrated groundwater-surface water conceptual framework can also help ensure that groundwater indicator data are collected at the most appropriate locations for informing lake water quality.

KEY FINDINGS

The Commission finds that a more broadly based approach to assessing groundwater quality that is directly linked to commitments under the Agreement is warranted with additional research action informed by the binational groundwater science report.

Of note, understanding the role of climate change on Great Lakes groundwater systems is an evolving area of research. The Commission agrees with the finding of its Great Lakes Science Advisory Board's 2022 report that Canadian and US research managers need to collaborate and develop a basinwide groundwater-surface water model as a foundation to evaluate stressors like climate change, inform indicator data collection for the Agreement's objectives and address management questions. Increased connection between groundwater and climate change impacts annexes, through collaborative projects, can help to address gaps in knowledge and understanding of climate change impacts on groundwater.



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3.3.9 OTHER SUBSTANCES, MATERIALS AND CONDITIONS

GENERAL OBJECTIVE 9:

The Waters of the Great Lakes should be free from other substances, materials or conditions that may negatively impact the chemical, physical or biological integrity of the Waters of the Great Lakes.

The Agreement's objective is to protect the lakes from any factors that impair their chemical, physical or biological integrity. The Parties measure their progress to achieve this objective by assessing watershed impacts and climate trends. For this objective, the "State of the Great Lakes 2022 Report" presents five sub-indicators related to watershed impacts, and four sub-indicators related to changing climate.

STATE OF THE GREAT LAKES REPORT

GENERAL OBJECTIVE 9:
Other Substances, Materials and Conditions

This objective does not have a single indicator for watershed impact, but includes several sub-indicators: forest cover, land cover, hardened shorelines, tributary water quality, and human population.

The Parties also consider climate sub-indicators that assess trends in, but not status of: precipitation amounts, water levels, surface water temperature, and ice cover.

In the "State of the Great Lakes 2022 Report," the Parties assess the status of watershed impacts and climate trends as fair with a trend of unchanging. The Parties' technical report acknowledges interdependencies of the watershed impacts sub-indicators; the quality of tributary waters

flowing into the Great Lakes is influenced by increasing human populations driving changes in land use, with land development diminishing forest cover and subsequently altering the hydrology of urban and agricultural watercourses alike. The Parties' assessment indicates that this cascade of impacts driven by population and development is increasing in all watersheds except those in the Lake Superior basin. However, indicator data on tributary water quality only includes Canadian data from Ontario's Provincial Water Quality Monitoring Program and does not include any US data. Natural shorelines support the lakes' aquatic habitats and reduce coastal erosion, but limited available data show that more of the lakes' natural shorelines underwent modification and "hardening" (such as with sheet piling, rip rap and other protection structures) at an alarming rate, resulting in impairments to essential coastal processes and ecosystem services.

The Parties' sub-indicators for climate impacts report trends in 10-year, 30-year and long-term increments, while the long-term trend data for each sub-indicator span different time periods through 2020, constraining comparisons between sub-indicators. Further, the Parties' assessment of climate trends does not include sub-indicator metrics that directly measure climate impacts on ecosystem conditions or functions. Summer surface water temperature is increasing, and winter ice cover is decreasing in every Great Lake. Lake Superior is one of the fastest warming large lakes in the world and also has the greatest long-term decline in ice cover of the Great Lakes. Based on the available data, the overall Great Lakes basin is experiencing increases in precipitation; 2011-2020 had the most precipitation of any decade since 1950. This precipitation trend is consistent with the 10-year trend of increasing water levels on all lakes; the Parties note that variability of short-term trends and complex influences on the lakes' long-term variability make it difficult to determine with certainty if this trend of increasing water levels will persist into the future.

PROGRESS REPORT OF THE PARTIES

While this objective is not directly supported by a single annex, various Agreement annex activities indirectly address watershed impacts through their implementation activities and contribute to progress toward this objective. Holistic watershed restoration and shoreline protection activities are implemented under Annex 2 (Lakewide Management), in conjunction with efforts coordinated under Annex 7 (Habitat and Species). The "2022 Progress Report of the Parties" highlights the achievements of many of Ontario's regional conservation authorities to protect and conserve natural shorelines and conservation areas that protect forest cover and natural habitats in tributary watersheds.

Annex 9 (Climate Change Impacts) coordinates the Parties' efforts to find, quantify, understand and predict how climate change affects Great Lakes water quality, contributing key data to this objective's climate impacts trend sub-indicators. The majority of activities reported in the "2022 Progress Report of the Parties" under this annex focus on knowledge exchange, such as providing climate change impact information on a quarterly and annual basis, contributing to data portals, toolkits and modeling efforts related to climate change impacts, and providing support for assessments of shorelines and coastal resilience.

THE CASE FOR INVESTMENTS IN WATERSHED RESTORATION AND CLIMATE CHANGE RESILIENCE

The observed trend of climate change increasing precipitation in the Great Lakes region underscores the increasing importance of preserving wetlands, forest cover, natural shorelines and climate-resilient land uses (such as green infrastructure or nature-based solutions in urban areas and vegetated agricultural stream banks) to mitigate flood events, diminish sediment erosion and runoff, and reduce nutrient loads and other nonpoint source pollution. The Parties have limited influence to directly affect watershed impacts because strategies and decisions for land use and development (and land conservation) are the domain of state, provincial and local governments and their planning

agencies. However, annex activities can advance watershed restoration in coastal areas (for example, Annex 7) and upstream areas (for example, Annex 2 and Annex 4 [Nutrients]).

The Parties' commitments of technical and financial assistance provide critical support for subnational government jurisdictions to achieve local and regional goals for watershed restoration and climate change resilience. For example, the US Army Corps of Engineers' Great Lakes Coastal Resiliency Study is a collaborative effort that will assess US coastal areas that are vulnerable to flooding, erosion and sediment accretion, provide design parameters to inform sustainable coastal projects, and establish a risk-informed decision framework to help federal, state and local governments identify and prioritize where to invest in coastal resilience. The Parties' continued support is critical for further development of urgently needed tools and programs that advance climate change adaptation and resilience solutions implemented at the local, regional, state and provincial levels across the basin.

KEY FINDINGS

The Commission finds that the absence of US data as part of the tributary water quality sub-indicator is a gap that, when addressed, can improve future progress reporting and assessment of the lakes' watershed conditions. The Commission also finds that the Agreement currently focuses on understanding climate change trends. Future progress reporting would benefit from including information measuring the cross-cutting effects of climate impacts on other indicators of the Agreement's objectives. The Commission will continue to examine opportunities for improved reporting under this objective, related to, for example, tributary water quality data and the cross-cutting effects of climate change.

The Commission commends the Parties for their support for subnational government jurisdictions' watershed restoration and coastal resilience projects. Continued and enhanced support is critical to advance efforts that better address climate change adaptation and resilience.

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3.4 PUBLIC INPUT ON THE PROGRESS REPORT OF THE PARTIES

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As part of its duties under the Agreement, the Commission must gather and summarize public input on the "2022 Progress Report of the Parties" as well as participants' perceptions of progress to restore and protect the Great Lakes. The lakes, their connecting channels and the upper St. Lawrence River (to the international boundary) are all considered part of the "Waters of the Great Lakes" under the Agreement.

Between September 2022 and January 2023, the Commission gathered public input on the Canadian and US governments' "2022 Progress Report of the Parties" through in-person and virtual meetings and workshops, an online questionnaire and written or emailed submissions. The input summarized here is from a wide range of individuals who volunteered their input but is neither a random nor representative sample of the overall Great Lakes region's population. In addition to activities open to all interested individuals, the Commission hosted virtual meetings to gather specific feedback on issues and priorities from target audiences. These audiences included the private sector, mayors and municipal leaders, government officials and staff of First Nations and Tribes, and leaders and staff of the Métis Nation of Ontario. Overall, the Commission engaged with more than 1,000 people and received comments from nearly 500 individuals.

For each of the in-person and virtual meetings, a professional facilitator guided the discussions using a series of nine questions touching on three overarching themes:

- understanding the current reality
- gathering knowledge and building strengths
- opportunities looking forward

The following sections summarize the major themes of the input received from participants. As always, the Commission appreciates the public's engagement and participation and the generous work of many volunteers to gather this valuable input. Public involvement and input are essential to helping the Commission assess progress on the programs, practices and activities of the Parties, and ultimately to achieving the objectives of the Agreement.

3.4.1 MAJOR THEMES

Overall, public input indicated that the **Areas of Concern program** under Annex 1 is widely recognized as governments' top achievement. Examples of progress include legacy contamination cleanup and ecosystem restoration that reduced toxic contamination, improving the quality, safety and frequency of recreational water uses, and waterfront revitalization (also characterized by some participants as gentrification). However, the majority of respondents also reported a broad desire for greater progress and improvements to the Areas of Concern program, citing concerns about rushing the delisting process, the need for monitoring and maintenance after delisting, and calls for resources and time to ensure equitable outcomes of management actions.

Input also indicated that the public recognizes the progress of programs to address **nutrients and harmful algal blooms** under Annex 4. Examples of progress provided include the agriculture sector implementing best management practices to reduce nutrient runoff, as well as studies to generate knowledge, data and technical innovations that, in turn, addressed algal blooms, enhanced ecosystem functioning

and improved water quality for drinking and recreation. Input also reflected the view that there is substantial room for improvement in programs that address nutrient loads, with top concerns including the need for more stringent regulation of concentrated animal feeding operations in the United States and new strategies to enhance adoption of best management practices in the agriculture sector, particularly in the Lake Erie basin.

Comments identified that the public views **Chemicals of Mutual Concern** under Annex 3 as the top program in need of change or improvement. Encouraging comments were those that recognize that regulations, monitoring and "boots on the ground" to manage identified chemicals are contributing to reductions in discharges. However, input also reflected views that the current list does not encompass other known and emerging contaminants, that the process for nominating and developing binational strategies is slow, and that a more holistic approach to contaminants should also encompass proactive policy and regulations that require proof of the safety of new or substitute chemicals. Also of note in relation to contaminants, the Commission heard concerns from the public related to threats posed by the Enbridge Line 5 oil pipeline.

The Commission's questionnaire asked respondents about the "2022 Progress Report of the Parties." The majority of those who responded are aware of or are familiar with the report, and awareness is higher among Indigenous and younger respondents. Of those familiar with the report, responses are broadly positive with most people reporting they find the report relevant, coherently written, easily accessible online and released in a timely manner.

Overall, input indicated that the public thinks the Parties' 2022 report is a comprehensive document that clearly outlines accomplishments for each annex program. Other comments received affirm the Commission's 2020 "Second Triennial Assessment of Progress" recommendation that it would be more impactful to track the Parties' progress by linking for the public the programs and activities listed in the "Progress Report of the Parties" to the corresponding indicators and outcomes as reported in the "State of the Great Lakes Report."

3.4.2 SUMMARY OF INPUT FROM SPECIFIC AUDIENCES

3.4.2.1 Private sector

For the first time in its triennial public engagement efforts under the Agreement, the Commission specifically sought input from private sector representatives to understand their unique perspectives on governments' progress. The Commission met with individuals representing sectors including mining, shipping and port authorities, architecture, environmental and water resource engineering, and retail. Overall, participants from the private sector expressed a desire for governments to increase collaboration with them, in partnership with all stakeholders, to find solutions. The private sector reported that their current reality is that they are already working on their own or with nongovernment partners to address issues like plastic pollution.

At the same time, the private sector also reported facing critical knowledge gaps and a lack of reliable data available to better inform their business resource planning decisions. Areas of interest for private sector partnerships include innovations in manufacturing to address industrial sources of contaminants and partnerships with agricultural suppliers to adopt voluntary programs or adopt and track performance indicators as solutions to minimize nutrient loadings.

Furthermore, the private sector identified future opportunities for governments that would help ensure consistent guidelines for industries to adhere to on both sides of the border, such as government approval of new chemicals on the market. Other Great Lakes issues relevant to their business operations include impacts of climate change on groundwater and governments' implementation of green infrastructure upon which private sector business operations rely.

3.4.2.2 Mayors and municipal leaders

Commissioners met with municipal representatives from large and small communities across the Great Lakes basin who reported their current reality is dealing with the challenge of maintaining aging infrastructure in the face of growing demands. Mayors and municipal leaders expressed

concerns about the pressures of climate change and extreme weather on these systems, sewage overflows and the ability to keep beaches safe for recreation, as well as the challenge of ensuring drinking water treatment plants keep up with emerging contaminants like microplastics, microfibers and new chemicals. Local governments also noted that they must balance the need to expand infrastructure to accommodate economic development and population shifts with the need for environmental protections. Mayors expressed concern about the implications of population shifts for planned growth and pressures on infrastructure, as well as how the possibility that the region will become a climate refuge may underestimate the impacts of climate change on the region and its toll on cities' infrastructure.

Local governments reported that they face gaps in information that the Parties could fill. For example, participants suggested the governments could assist cities with continuous versus periodic monitoring to better inform their residents about the status of their local water quality at the source. Local governments also identified challenges to get relevant industries to come to the table to tackle solutions to water quality problems.

An opportunity that municipal representatives identified for the future is to enhance interjurisdictional cooperation between Great Lakes local governments and across all levels of government and nongovernment stakeholders. Water is a uniting priority for Great Lakes municipalities, as many water quality issues affect all cities, regardless of size. Other reported issues include the need for more comprehensive federal government policy for issues such as eliminating plastics from the Great Lakes, and Canadians' input reflected a lack of provincial leadership from Ontario to prioritize environmental protections.

3.4.2.3 First Nations and Tribes

Engagement with First Nations and Tribes is a top priority of the Commission. The Commission hosted listening sessions at the Native American Fish and Wildlife Symposium, with the Mohawk Council of Akwesasne, St. Regis Mohawk Tribe and Mohawk Nation Council of Chiefs, as well as a virtual session to receive input from participants from 13 First Nations and nine Tribes across the basin. The Commission appreciates the participation of First Nations and Tribal government leaders, as well as staff and representatives of Indigenous organizations, in the various in-person and virtual listening sessions.

First Nations and Tribes highlighted their relationship to water and that they recognize water has its own spirit that must be honored. As such, First Nations and Tribes reported that all topics that impact water quality are of paramount importance to their relationship to water and its spirit. Input indicated that countless impairments of Great Lakes water quality inhibit First Nations and Tribes from exercising their treaty rights, conducting ceremonial activities, and undertaking traditional uses of culturally important flora and fauna like manoomin (wild rice) and many native fish and wildlife. Further comments highlighted crude oil transportation as a threat to treaty rights, both in the siting, routing and permitting of pipelines on First Nations and Tribal lands without consent and as a possible source of contaminants in the waters and watersheds that First Nations and Tribes rely upon. Input gathered noted that under the Agreement and beyond, First Nations' and Tribes' sovereign governments do not have leadership roles equal to the federal governments and are not yet involved early or often in processes that materially impact policy decisions.

Input indicated that building strength under the Agreement would look like increased collaborative efforts by the Parties that empower First Nations and Tribes to provide leadership and the incorporation of Indigenous Traditional Ecological Knowledge into efforts that prioritize action and repair relationships to water. Gaps in knowledge were reported to include lack of coordination for sharing information and resources. For example, data collection efforts, such as hydrogeological assessments that inform government decisions, have excluded First Nations and Tribes.

In their feedback, First Nations and Tribes identified future opportunities as including how governments' resources can be used to prioritize better sharing of water quality, drinking water and fish consumption information. Comments suggested that funding for First Nations and Tribes should also be a priority for the governments, as it presents the opportunity to support better long-term planning for conservation and monitoring programs and supports actions at the local level. Many other important issues were raised by participating First Nations and Tribal government officials and staff, notably the need for more stringent regulation and enforcement on activities such as mining, agriculture, development, loss of coastal wetlands and the spread of invasive species as well as the critical role of the US Great Lakes Restoration Initiative to support Tribes' activities.

3.4.2.4 Métis Nation of Ontario

The Commission also hosted a separate virtual listening session with the Métis Nation of Ontario Regions 2 through 9 (those within the Great Lakes basin) to learn about their views and priorities as important and distinct voices in the region. Overall, it was reported that the current reality *for* Métis in the Great Lakes basin is that there are many threats to their connection to the lakes and their contemporary ability to interact with the lakes and its living creatures per their historical traditional customs. These threats include climate change impacts, pollution, invasive species, inadequate municipal sewage treatment (for emerging threats such as microplastics and outcomes such as overflows), responsible watercraft operations and impediments to access to shoreline.

During this session, the Métis Nation of Ontario's Great Lakes Advisory Group presented to Commissioners the key knowledge gap that their ongoing efforts are trying to address: "If we continue to eat our catch of fish for subsistence as our ancestors did, would it kill us?" To fill this knowledge gap, the Métis Nation of Ontario conducted their own survey, developed their own handheld pocket guide to fish consumption advisories and are participating in the Métis Guardians program.

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Feedback indicated there are future opportunities for empowering Métis communities to lead studies incorporating their Traditional Ecological Knowledge as a complement to studies using Western science methodologies. Participants suggested that resources should also be prioritized to address point and nonpoint pollution sources upstream in Great Lakes tributaries and on the shoreline, with special emphasis on correcting the causes of fish consumption advisories. Another identified desired future outcome for Métis communities in the Great Lakes basin is to ensure that shoreline lands remain accessible to them to conduct cultural and spiritual activities for generations to come.

3.4.3 LAKE-BY-LAKE HIGHLIGHTS

The Commission also received feedback from the public on what the top priorities should be for water quality for each of the Great Lakes and the upper St. Lawrence River. These summaries reflect comments received through webinars, the online questionnaire and other targeted engagement avenues to provide a broad overview of what basin residents consider important topics for each lake.

3.4.3.1 Lake Superior

Input on Lake Superior is consistent with the governments' "State of the Great Lakes 2022 Report" that evaluates Lake Superior's water quality status as *good* and its trend *unchanging*. Public input emphasized the need to proactively protect Lake Superior's high-quality water by improving prevention-focused activities, especially to address the threats of climate change, future population growth and shifts, and related development and pollution. Feedback reflects positively on governments' progress under the Areas of Concern program to clean up legacy pollution, though remediation progress is viewed as being slower in Canada. There are concerns about contaminants from upstream land use and economic development priorities such as mines, underscoring the need for comprehensive cumulative impact assessments to ensure the protection of downstream investments such as Areas of Concern restoration achievements.

While participants identified governments' measures to control vessel ballast discharge, which can minimize the introduction and spread of invasive species, as another top achievement, the "State of the Great Lakes 2022 Report" assessed indicators for invasive species as *poor.* Other areas where input identified that change or improvements are needed are programs to address chemicals of mutual concern, nutrient pollution and harmful algal blooms, climate change impacts, and drinking source water protection activities, including suggestions like reviving the Lake Superior Zero Discharge demonstration project. There were also calls from participants for more collaborative watershed planning involving local government and meaningful Indigenous decision-making.

3.4.3.2 Lake Michigan

Public input that Lake Michigan's water quality status is *fair* is consistent with the Parties' assessment, while reasons given for why the public says the lake is *deteriorating* include lack of regulatory enforcement, public apathy and lack of education. The main theme of input on Lake Michigan is the need to support forward-looking programs. More than other lake basins, input about Lake Michigan focused on the Areas of Concern program as both a top government achievement and a priority area for improvement. There is favorable, widespread recognition from the public of the importance of US federal investments for implementing management actions as well as supporting coordination of federal, state and local partnerships to ensure delisting outcomes reflect community priorities and socioeconomic equity. However, input also identified priorities for change including the need for extra resources for restoring more complex Areas of Concern and protecting those investments with sustained partnerships to maintain long-term monitoring for "life after delisting."

Lakewide Action and Management Plans are reportedly both a top achievement and a top area for improvement or change. Many public comments called for improved public communication and education to empower community stewardship and facilitate greater stakeholder coordination and learning across the basin. The public also called for improvements to the Chemicals of Mutual Concern program, along with more proactive, nimble programs and policies that monitor and address emerging issues, namely microplastics, to protect significant investments cleaning up legacy contaminants.

3.4.3.3 Lake Huron

Public input on the status and trend of Lake Huron's water quality is more pessimistic than the Parties' assessment. Views on the lake's status are *good* but trending to *fair*, while public perceptions that swimming is *good* but trending to *fair* and fishing is *poor* departs from the Parties' assessment that those indicators' statuses are *good*. While the public says Lake Huron is *deteriorating*, most respondents are unsure of

their reasoning for assessing the lake's trend. Other input cited lack of regulatory enforcement and climate change as the causes of degradation.

The public's overarching desire is for government programs to better connect and engage regional and local governments and community organizations with the data, monitoring and studies that are part of Agreement programs in Lake Huron. More than any other lake, input about Lake Huron indicated that the public recognizes that drafting and implementing Lakewide Action and Management Plans are a top government achievement for promoting coordination and yet also a top area for governments to improve or change.

Similar public input discussed the Areas of Concern program as a top government achievement to address legacy contamination but noted that better coordination with local institutions could help improve the program. From Georgian Bay to Saginaw Bay, input underscored concerns about nutrient loading from agriculture, septic and municipal wastewater sources and consequent sediment loading, the health of coastal wetlands and proliferation of invasive species. The public also expressed both positive and negative sentiments about water level fluctuations and their impact on Lake Huron's water quality.

3.4.3.4 Lake Erie

Nutrient runoff and harmful algal blooms are the dominant focus of public input on Lake Erie. The public says that lack of regulatory enforcement for agricultural and other nutrient runoff and resulting harmful algal blooms are why they perceive Lake Erie's water quality status as *fair* but trending to *poor* and over the longer-term that it is *unchanging* but trending to *deteriorating*. These public views generally align with the governments' report that the lake is *poor* and *unchanging*.

The public input gathered is not all negative: responses received recognize governments' funding and implementing programs to reduce nutrient runoff and curb harmful algal blooms as a top achievement, acknowledging that, while voluntary, efforts for best management practices are contributing to load reductions. However, there is strong public agreement that a top priority should be to change governments' nutrient programs. In particular, comments identified public concerns about inadequate regulations addressing nutrient inputs from the growing livestock sector in the US, while other sources such as combined and sanitary sewer overflows and septic systems also need greater focus. Similarly, responses showed that the public recognizes the Areas of Concern program as both a top achievement and priority area for governments to improve. Comments received suggest that greater communication and collaboration with local stakeholders could improve the program, and focus should intensify to complete remediation in highly complex or large-scale Areas of Concern.

Another key theme of public input is the need for source water protection for drinking water. There are concerns about the ability of treatment facilities to address many types of pollution, including emerging contaminants, and suggestions that better programs are needed to address point and nonpoint sources, ranging from green infrastructure for stormwater management to regulations and enforcement of industry. Feedback also identified that the public sees the governments' Chemicals of Mutual Concern program as a top area in need of change and improvement. Other comments expressed concern about constructing and operating offshore wind turbines in the lake and their potential cumulative environmental impacts.

Niles Beach, Ohio
© Ben Yair Raanan, Monterey Bay Aquarium Research Institute

3.4.3.5 Lake Ontario

The public's views on the status and trend of Lake Ontario's water quality are mixed. Public perception that the status of the lake is *fair* is consistent with governments' assessment, yet reasons given reflect sentiments that water level fluctuations have both a positive and negative impact, while others cite nutrient inputs and contamination as causes for concern. The public's perception that the lake's trend is *deteriorating* is less favorable than governments' assessment that Lake Ontario is *unchanging to improving*, yet reasons given for Lake Ontario's perceived decline are mixed. While some cite regulatory enforcement as reasons for improvement, others say lack of enforcement is cause for deterioration, alongside negative perceptions of the impacts of water levels and pollution from runoff.

Public input on Lake Ontario focused on achievements of, and improvements to, programs addressing legacy and emerging contamination as they impact biodiversity in the face of invasive species. Input reflected awareness and appreciation of progress made under the Areas of Concern program as governments' top achievement, with many noting the importance of remediation and habitat restoration projects contributing to enhanced biodiversity. Yet, feedback also acknowledged that most Areas of Concern in Lake Ontario have a long way to go to delisting and that the program needs to improve, with suggested changes focusing on enhancing public education and stewardship, as well as prioritizing management actions that would improve fish populations and address underlying causes for widespread consumption advisories.

Feedback also reflected the view that governments' top priority for improvements or changes should be for their Chemicals of Mutual Concern programs, including concerns about emerging contaminants and suggestions, to strengthen regulatory regimes to create more proactive policy solutions aligned with the Agreement's zero discharge principle.

3.4.3.6 St. Lawrence River

The Agreement also covers the upper portion of the St. Lawrence River to the international boundary. For the first time, the Commission solicited public input specifically about the upper St. Lawrence River as part of its public input activities. The public participating in the Commission's meetings and questionnaire expressed mixed views, but overall sentiments are that the river's condition is *poor* and *deteriorating*. However, the Parties' assessment combines their indicator assessments for Lake Ontario and the upper St. Lawrence River, making it infeasible to compare public perceptions to governments' assessment. As with Lakes Huron and Ontario, the public has both positive and negative notions of the impacts of water level fluctuations on the river's status. While most are unsure of the causes of the river's deterioration, some cite better regulations as reason for improvement, while others say deterioration is driven by ecosystem collapse, poor land use decisions or lack of public education.

Public input received recognizes the great strides made under the Areas of Concern program as governments' top achievement, while simultaneously acknowledging that the program is a top area for improvement to implement management actions on both sides of the border. Comments highlighted watershed-level efforts including the River Strategy and River Rapport that leveraged partnerships between research institutions, citizens, Indigenous governments and state and provincial governments, but that these efforts could benefit from greater federal government support.

Input also showed the public has an interest in improving data gathering and sharing and a need to expand funding for systematic research in the river basin for water quality as well as water levels and related topics like shoreline erosion. Another focus of public feedback is invasive species, with input reflecting a top priority to improve governments' programs to prevent and control aquatic invasive species, while also recognizing the achievements of governments' measures to regulate vessel ballast discharge. Contamination is a top issue for the public as well, with pervasive concerns and criticism of fish consumption advisories complicating traditional Indigenous relationships to the rivers' fish and aquatic species.

3.5 SUMMARY OF FINDINGS AND CONCLUSIONS ON THE CURRENT STATE OF THE GREAT LAKES

Chicago, Illinois
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Overall, the Commission finds reason to commend and further encourage the Parties on their progress toward achievement of the Agreement's objectives. Both the science and the input gathered from the public tell us that by many measures, progress has been made to restore and protect the Great Lakes, while also highlighting the gaps that need to be addressed to ensure a healthy future for this shared, vital resource and all who call this region home.

3.5.1 CLIMATE CHANGE

The Commission finds that the Parties have made significant progress toward evaluating the multiplying effects of climate change impacts in the basin through information-sharing, network-building, capacity-building, monitoring and analysis. A basinwide transnational framework to apply this understanding to action that supports climate change adaptation and resilience across the region is still needed.

As the Agreement currently lacks adequate emphasis on enabling local-level actions to address climate change adaptation and resilience, many basin communities, including Indigenous governments and communities, are already implementing their own local climate resilience plans and tools. The Parties' continued investment and resource commitments are critically important to develop and apply tools and programs to support coordination between multiple levels of government toward climate resilience and adaptation. For example, investments in local resources that proactively advance watershed restoration and coastal resilience from extreme water level fluctuations due to changing climate are critical.

The Commission concludes that the Agreement's existing binational collaboration and governance structure can be used to advance the Parties' shared knowledge and goals into common climate resiliency strategies and actions that are scalable from binational to regional/watershed to local/subwatershed scales across the Great Lakes basin.

3.5.2 INDIGENOUS ENGAGEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The Commission finds there are many examples of the Parties' efforts to prioritize First Nation, Métis and Tribal government outreach and representation and to respectfully integrate Indigenous practices and ways of knowing into existing approaches and Agreement activities. First Nations, Métis and Tribal government members are now on many of the Agreement's annex committees, and the Parties are providing more support to elevate the importance of Indigenous-led programs addressing Great Lakes water quality. The Commission shares this priority. For example, the Commission's Health Professionals Advisory Board has a project in partnership with the Mohawk Council of Akwesasne to create tailored fish consumption advice to support Indigenous community health and resource management.

The Commission concludes there are opportunities under the Agreement for the Parties to expand beyond engagement efforts and pursue direct and empowered collaboration so that Indigenous Peoples, and their Traditional Ecological Knowledge and ways of knowing, have meaningful roles in Agreement implementation, decision-making and reporting activities.

The Commission further concludes that the Parties' efforts to expand their development of more culturally relevant policies and programs under the Agreement should be reflected in the Parties' Agreement review process following the publication of this 2023 "Third Triennial Assessment of Progress" report.

3.5.3 REPORTED PROGRESS TOWARD ACHIEVING AGREEMENT OBJECTIVES

While the Commission acknowledges the Parties' ongoing efforts to improve indicators and reporting for the drinking water, fish and wildlife consumption, pollutants, and groundwater objectives, the Commission finds that its suggestions for improvement (presented below) are pivotal to meaningfully assessing progress in achieving the general objectives of the Agreement. Increased focus on achieving the general objectives is critical.

While the Parties activities to improve indicators are important, the Commission also finds there are persistent and considerable differences between Canada and US domestic approaches to monitoring, surveillance, data collection programs and analytical methods. Consequently, domestic data between the two countries are not comparable for some indicators and sub-indicators for fish and wildlife consumption, habitat and species, aquatic invasive species, drinking water, and other conditions objectives. These differences have led to information gaps that preclude complete or comprehensive analysis and progress reporting.

The Commission suggests that the Parties address several of these gaps in monitoring and reporting on indicators for Agreement objectives to improve future progress reporting in the next "Progress Report of the Parties" and "State of the Great Lakes Report" and inform the Commission's subsequent progress assessments. The Commission encourages the Parties to:

- Standardize sampling, analysis and data interpretation methods and approaches to address issues of gaps in available, comparable Canadian and US data that are preventing interoperability and harmonization of data to inform indicator or sub-indicator reporting and assessment, particularly for fish and wildlife consumption, habitat and species, aquatic invasive species, groundwater, and other conditions objectives.

- Fill gaps in the data gathered and utilized in the Parties' routine monitoring used to inform objective indicator reporting. Priority areas should:
  - Improve the consistency of the data available, expand the data collected to encompass a broader list of toxic chemicals and increase accessibility for reporting on the quality of source water for drinking water by establishing a repository of source water quality data, through increased partnerships and collaborations with national, state, provincial and municipal entities, and other existing organizations, as recommended by the Commission's Health Professionals Advisory Board 2021 report.
  - Obtain data relevant to public health, such as through the systematic application of molecular and genomics tools to advance microbial water quality assessments, to contribute to the development and reporting of a quantitative metric for understanding progress on the health of recreational waters, as recommended by the Commission's Health Professionals Advisory Board 2021 report.
- Communicate the linkages between the Parties' Agreement implementation actions to their respective outcomes, as measured by indicator reporting, to achieve more transparent evaluation of the effectiveness of work undertaken to achieve the Agreement's objectives. Reporting which demonstrates how the Parties' actions are influencing lake conditions can enhance evaluation of progress toward wetlands and other habitats, nutrients, groundwater, and other conditions objectives. Priority areas should:
  - Focus on Annex 4 (Nutrients) efforts to achieve nutrient reduction targets for Lake Erie. The Commission encourages the Parties to communicate progress in subsequent reports using quantifiable performance indicators that link voluntary and non-voluntary actions to progress toward achieving nutrient reduction load targets. To this end, the Parties may consider expanding edge-of-field studies that evaluate best management practices and measure nutrient export at the field level, and facilitate new research that links nutrient concentrations and other water quality measures with best management practice adoption, as recommended by the Commission's Great Lakes Science Advisory Board and Water Quality Board 2023 report.
- Expand the scope of knowledge applied to indicator assessments to include economics, social sciences, Traditional Ecological Knowledge, community science and other ways of knowing. Priority areas should:
  - Include fish portion contamination data, and data on other wildlife consumption and contamination data, including samples collected by First Nations, Métis and Tribes, guided by the ongoing efforts of the Commission's Health Professionals Advisory Board to develop a framework for the collaborative development of culturally relevant, accessible, transparent and protective fish consumption advisories.
  - Advance a transdisciplinary approach to understanding of the economic, social and other dimensions affecting implementation of best management practices and identifying barriers to achieving nutrient load reductions, as advised by the Commission's Great Lakes Science Advisory Board and Water Quality Board's 2023 report.

3.5.4 PUBLIC INPUT

The Commission commends the Parties for their efforts under the annexes and activities that have garnered public attention and appreciation of progress, including for Areas of Concern, nutrients, Lakewide Action and Management Plans, chemicals of mutual concern and aquatic invasive species. For the most part, perspectives heard through public feedback echo the Commission's assessment that more preventive and anticipatory actions need to be taken to protect achievements and investments made to date. Inadequate protection from emerging issues and impact-multiplying stressors like climate change also threaten these achievements.

The Commission finds that across the board, from the private sector to mayors to Indigenous governments to environmental organizations, the public's input identified gaps in the available data collected on the Great Lakes ecosystem, as well as gaps in how findings from research and monitoring efforts are communicated to the public. The

Commission finds the public is interested in partnering with the Parties to help address these gaps in data, including through private sector partnerships, partnerships to enhance understanding and integration of Traditional Ecological Knowledge and partnerships to support community science efforts. Indigenous and non-Indigenous participants alike emphasized the need for First Nations, Métis and Tribal governments in particular to have a more substantial role in Agreement implementation.

The Commission finds that the Parties' support for the participation of First Nations, Métis and Tribal governments in Agreement activities yields mutual value. The Commission encourages the Parties to further emphasize these efforts in their future communications and reporting. The Commission also finds that the Parties' efforts to raise public awareness and support inclusive opportunities for individuals and communities to get involved in Agreement programs builds their continued support for protecting the Great Lakes.

Thousand Islands, Ontario

Aguasabon Falls and Gorge, Terrace Bay, Ontario
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4. The Future: Next Steps for Great Lakes Planning and Action

Human activities and climate change are the key stressors driving rapid changes across the Great Lakes basin. The Parties must remain alert to emerging threats and keep up with the pace of change to advance progress toward achieving the Agreement's objectives. The Parties' focus for Agreement implementation should enhance collaboration with First Nations, Métis and Tribes in Agreement governance processes, document actions that address Agreement commitments and in particular cross-cutting objectives, advance scalable climate resilience goals, and implement proactive, comprehensive science and monitoring to inform management decisions.

4.1 CLOSING GAPS WITH PROACTIVE, COMPREHENSIVE SCIENCE AND MONITORING

The Parties' science and monitoring efforts at present are focused on gathering data on indicators and sub-indicators to generate knowledge about the status and trends of the Agreement's objectives. These efforts are made possible by significant binational and domestic science and monitoring initiatives. The Parties lead this substantial undertaking to "enhance the coordination, integration, synthesis, and assessment of science activities" through their monitoring, surveillance, observation, research and modeling efforts primarily coordinated through Annex 10 (Science). The Parties' ongoing science and monitoring efforts are essential not only to advancing indicator and progress reporting but also to enable the Commission to fulfill its progress assessment responsibilities under the Agreement. The Commission commends the Parties for their commitment of expert personnel and program resources to support the fundamental science, research and monitoring activities that advance understanding of the status and trends of the Great Lakes ecosystem and inform management and policy decisions.

As identified throughout section 3, even as the Parties accomplish incremental changes and improvements, gaps in indicator monitoring and reporting efforts persist. Section 3.5.3 encourages the Parties to consider advice from recent Commission Great Lakes advisory board reports that identify opportunities to address priority gaps in indicator reporting to improve subsequent indicator reporting, progress assessment and Agreement implementation management decisions.

The status quo, piecemeal approach to filling individual indicator reporting gaps, however, does not necessarily ensure sufficient context or ensure that the complexity of data is available to adequately inform an assessment of progress. This is true for cross-cutting issues, such as groundwater, pollutants, and other conditions objectives, and particularly for those that relate to human health including drinking water, recreational use, and fish and wildlife consumption objectives. Addressing information and knowledge gaps at the individual objective or indicator basis does not effectively inform management decisions for interdependent and dynamic stressors and threats, rapid rates of change or issues of emerging concern. Furthermore, enhanced binational coordination is necessary to resolve indicator reporting and progress assessment issues of data

interoperability and harmonization, standardization of sampling approaches, analytical methods and data interpretation.

In the interest of achieving a more comprehensive and proactive understanding of the complexity, rate of changes and risks facing the Great Lakes to improve progress assessment and inform future management decisions, the Commission's Science Advisory Board conducted a basinwide assessment of the Great Lakes' science capacity needs. The board's "Great Lakes Science Strategy for the Next Decade" report summarizes the science gaps and related resource needs identified by hundreds of knowledge-holders in Canada and the United States, including federal agencies, state and provincial agencies, academic researchers and Indigenous government representatives. The board's Science Strategy delineates preliminary priorities to be incorporated in a subsequent collaborative process toward the development of a detailed, actionable 10-year Great Lakes Science Plan.

Strategic, coordinated efforts to expand the Great Lakes science and monitoring capacity can contribute to the Parties' indicators for assessment and reporting of Agreement objectives and better inform management decisions. While the Great Lakes are highly variable systems, present monitoring efforts capture limited time frames. For example, the Cooperative Science and Monitoring Initiative conducts "field year" sampling on each lake once every five years and does not include any data points from the winter months. Yet winter conditions, such as changing water temperature and precipitation patterns, are among the most sensitive to alteration by climate change and are projected to greatly impact the entire system during all seasons. As the Commission's Science Advisory Board notes in its "Great Lakes Science Strategy for the Next Decade," a basinwide plan for coordinating science efforts that prioritizes expanded monitoring, including collecting winter data, can help capture long-term trends and also inform our understanding and management of other critical ecosystem dynamics.

Further, prioritizing monitoring and long time series measurements can inform the development of powerful predictive tools. For example, physical-biogeochemical-ecosystem models can project conditions under future scenarios to inform management that protects health and economic vitality. More comprehensive science efforts that expand the information and knowledge base to include economics, social sciences, Traditional Ecological Knowledge, community science and other ways of knowing can further contribute to improvements in the Parties' indicator reporting, progress assessment and management decisions.

The Commission concludes that the Parties' existing science and monitoring efforts focused on indicator reporting for assessing progress toward Agreement objectives can benefit from complementary efforts toward the development of a Great Lakes Science Plan focused on improving basinwide coordination of science and monitoring.

Milwaukee, Wisconsin
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4.2 THE ROLE OF FIRST NATIONS, MÉTIS AND TRIBAL GOVERNMENTS IN THE AGREEMENT'S GOVERNANCE

Ah-Nab-Awen Park, Grand Rapids, Michigan
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For generations, Indigenous Peoples stewarded the Great Lakes ecosystem through international, regional and local relations, including treaties, confederacies and clans. Many such systems remain today. However, the Agreement is fundamentally binational; as a commitment between the governments of Canada and the United States, today's sovereign Indigenous nations are not signatory Parties to the Agreement.

Changes to the Agreement over time have made it more inclusive of Indigenous nations and their governments and organizations. While Tribal representatives have been members since 1999, the Parties made First Nations and Métis representatives Great Lakes Executive Committee members in 2012. The Parties explicitly recognized that the involvement and participation of First Nations, Métis and Tribes is essential to achieve the Agreement's objectives. In recent years, the Parties increased their project and capacity support to Indigenous governments and organizations in the Great Lakes through programs like the Great Lakes Restoration Initiative and the Distinct Tribal Program in the United States.

The Agreement's binational governance structure does not address the role of sovereign Indigenous governments as equals to the Canadian and US governments. Indigenous Peoples are "engaged" through various Agreement implementation activities, but Indigenous governments have inappropriately been regarded as stakeholders rather than sovereign nations with governments. For example, while the Parties are increasing opportunities for First Nations, Métis and Tribal governments and organizations to engage in Agreement implementation activities, participation is often dependent on the availability of resources to support their valuable participation and contributions.

The Commission concludes that the past changes to the Agreement that elevated the role of First Nations, Métis and Tribal nations in the Agreement's governance and implementation were essential to improving the Agreement's effectiveness and relevance for them, and that future progress in achieving benefits of common concern is possible. There may be opportunities to further advance the roles of Indigenous nations with respect to the Agreement and achieve deeper collaboration with First Nations, Métis and Tribal governments in Agreement implementation.

4.3 PUBLIC ENGAGEMENT AND EDUCATION

In addition to recognizing Indigenous governments, the Parties also identify the essential need for the involvement and participation of all stakeholders, including the public, in the 2012 Agreement. The Parties also commit to cooperate and consult with all groups to accomplish the tasks, programs and goals of the Agreement. As discussed in section 3.5.4, with current public engagement mechanisms in place under the Agreement, stakeholder groups and the informed public continue to express their sincere interest for more engaged dialogue and opportunities to participate and contribute to binational efforts.

The Commission's 2020 "Second Triennial Assessment of Progress" found that public engagement and participation are essential for successful ecosystem management. The report included recommendations to improve engagement under Annex 2 (Lakewide Management) particularly as it relates to Lakewide Action and Management Plans. The Commission finds that there is an opportunity to increase coordination through an improved basinwide stakeholder and public engagement model under each Lakewide Action and Management Plan's Lake Partnership and their associated Outreach and Engagement Committee. Ensuring that community interests are represented in engagement mechanisms for Lakewide Action and Management Plans can generate benefits throughout the region and provide the Parties with the community-level support and cooperation that is essential to achieve progress under the Agreement. The Commission encourages the Parties to increase the detail and frequency of their reporting on the public engagement processes and activities under the Lakewide Action and Management Plans.

Greater integration of community voices, inclusive of Indigenous and under-represented groups, into public engagement processes can generate benefits throughout the region and provide the Parties with the community-level support and cooperation that is essential to achieve progress under the Agreement.

4.4 GOVERNANCE AND ACCOUNTABILITY MECHANISMS

Measuring progress under the Agreement is challenging because most annexes, and their respective binational priorities for science and action, do not include specific governance and accountability mechanisms such as measurable targets, goals and clearly assigned roles and responsibilities for implementation. Moreover, while the Agreement's structure effectively addresses individual priorities and challenges identified through the annexes, the annex approach does not effectively address comprehensive and multi-jurisdictional issues. Ecosystem management, a watershed approach and protecting human health need to be addressed across the basin. And in particular, there is an urgent need to take actions in response to the cross-cutting impacts of climate change on all dimensions of Great Lakes water quality.

The Commission encourages the Parties to consider mechanisms, such as detailed work plans, that include specifics on roles and responsibilities, leadership, expectations of partners (including organizations that do not formally serve on annex subcommittees), performance metrics, allocation of resources and timelines for action. Such accountability mechanisms could create beneficial outcomes, including holding relevant entities accountable for fulfilling their commitments under the Agreement. For example, the Commission finds that Annex 4 (Nutrients) lacks performance metrics that link actions targeting nutrient load reductions to quantifiable deliverables that make the outcomes and progress to date explicit. One example of successfully incorporating accountability mechanisms is the "Lake Superior 2020-2024 Lakewide Action and Management Plan."

It identifies priority restoration and protection actions for Agreement objectives and also specifies the corollary contributing Lake Superior partnership agencies responsible for tracking and reporting on implementation of the actions throughout the five-year cycle.

Furthermore, the Commission finds that the mechanisms of the Agreement's current annex approach do not compel an adequate consideration of cross-cutting issues and their interactions across the basin. For example, climate change considerations are not systematically integrated into every indicator and sub-indicator assessment or into annex priorities for science and action. Similarly, mechanisms to measure and assess progress on the human health dimensions of the "swimmable, drinkable, fishable" Agreement objectives are lacking. Accountability mechanisms can be useful tools to delineate a clear pathway for how to best make (and subsequently measure) progress on cross-cutting topics under the Agreement's implementation.

The Commission concludes that the Parties should identify accountability mechanisms that, in particular, increase transparency of assessment within each annex, and also focus on coordinating actions across annexes starting with the urgent, cross-cutting issue of climate change.

Little Marais, Minnesota
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4.5 RECOMMENDATIONS

This third assessment of progress finds many notable accomplishments by the Parties and other governments toward the goals and objectives of the 2012 Agreement. The Commission commends the Parties for their continued and meaningful binational efforts to restore and protect the Great Lakes.

Giving consideration to the findings and conclusions from this report, the Commission makes **three recommendations** to the Parties. In developing these recommendations, the Commission considered the workflow and timelines of government and other Agreement activities planned or underway, in order to support achievable progress by the Parties within the next assessment cycle. The Commission considers these recommendations to be of equal importance, with equivalent potential to assist the Parties in strengthening their collaborative efforts under the Agreement.

1

The Commission recommends that the Parties collaborate with First Nations, Métis and Tribal governments as active partners in the Parties' Agreement review process and in any subsequent processes to change or amend the Agreement.

- The Parties should document how they collaborate with First Nations, Métis and Tribal governments through a mutually agreed-upon process to include Indigenous governments as partners in the Agreement review process.

Under Article 5.5, the Agreement tasks the Parties with reviewing the operation and effectiveness of the Agreement following every third "Triennial Assessment of Progress." This 2023 "Third Triennial Assessment of Progress" report is the first such report to trigger the Agreement review process. The Agreement states "the Parties shall determine the scope and nature of the review" of the Agreement, "taking into account the views of" state, provincial, municipal, First Nations, Métis and Tribal governments, watershed management agencies, other local public agencies, downstream jurisdictions and the public.

Reflecting the Commission's assessment of the Parties' progress toward achieving the objectives of the Agreement, and as discussed in sections 3.5.2 and 4.2, it is clear that engaging First Nations, Métis and Tribal governments is key to the effectiveness of the Agreement. Deliberate collaboration is required with First Nations, Métis and Tribal governments as active partners in the review process and any subsequent processes to change or amend the Agreement, and in a transparent and mutually agreed-upon manner. Collaboration is critical to ensuring Indigenous voices are involved on their own preferred terms and in a process beyond the Agreement's established expectation that the Parties "take into account the views" of First Nations, Métis and Tribal governments.

The Commission commends the Parties for their efforts over the past triennial cycle to further engage First Nations, Métis and Tribal governments and organizations

in their Agreement implementation activities and programs. First Nations, Métis and Tribal government members are on many Agreement annex committees, and the Parties are providing more funding and financial support to elevate the importance of Indigenous-led programs addressing Great Lakes water quality. As the Agreement's binational framework does not grant decision-making authority to First Nations, Métis and Tribal governments, there is value in taking deliberate steps to include Indigenous governments earlier and more often in Agreement processes and activities.

The Parties' collaborative efforts to incorporate Traditional Ecological Knowledge and Indigenous ways of knowing into Agreement implementation and reporting activities are also commendable and should continue. There are opportunities for the Parties to expand their efforts to support the development of more culturally relevant policies and programs under the Agreement, including in the Parties' Agreement review process following the publication of this "Third Triennial Assessment of Progress" report.

Enhancing Indigenous collaboration and engagement in these ways would further empower First Nations, Métis and Tribes to provide leadership in incorporating Indigenous Traditional Ecological Knowledge to help fill knowledge gaps in analysis and progress reporting and assessment of the Agreement's objectives. More inclusive and early engagement would also facilitate more effective sharing of governments' water quality, drinking water and fish consumption information, an opportunity identified as a priority by Indigenous communities across the basin. It also presents opportunities to support better long-term planning for Indigenous conservation and monitoring programs as well as climate adaptation at the local level to meet the needs of distinct Nations and Tribes.

The Commission concludes that federal leadership in both countries can support Indigenous efforts and communities in culturally relevant ways. Continuing to invite and make space for Indigenous voices and ways of knowing in Agreement-related decision-making is widely viewed by both the Commission and the public as the most appropriate and effective means to advance inclusive, equitable progress for everyone in the Great Lakes basin.

The Commission recommends that the Parties, in collaboration with all levels of governments, regional watershed authorities and others as appropriate, develop common, basinwide and scalable climate resiliency goals with transparent and accountable performance metrics and assessment processes, to be included in each of the Annex 2 Lakewide Action and Management Plans as they are developed.

- On a rolling basis through the five-year Lakewide Action and Management Plans development cycle, the next version of updated Plans should articulate climate resiliency goals that reflect shared basinwide themes and that are scalable and achievable for multiple levels of government. Updated plans should also include accountability mechanisms, such as performance metrics, work plans or other tactics, that specify how each goal will be achieved through coordinating and implementing actions across jurisdictions, other annexes and existing climate resilience activities underway.

As the Commission writes this "Third Triennial Assessment of Progress" report, the Intergovernmental Panel on Climate Change published its latest synthesis report that "underscores the urgency of taking more ambitious action" to mitigate and adapt to climate change, and that "the solution lies in climate resilient development." The Commission offers this recommendation in the interest of enabling local and regional entities to prepare and implement climate resiliency measures.

As discussed in sections 3.1, 3.3.9, and 3.5.1, the Commission finds that, consistent with their responsibilities outlined in the Agreement, the Parties have continued to identify, quantify, understand and predict climate change impacts on Great Lakes water quality. Across the Agreement's objectives, increased information-sharing, network-building, capacity-building, monitoring and analysis have all contributed to significant progress in evaluating climate change impacts. Furthermore, the Commission is encouraged by recent and substantial efforts by both federal governments in a diversity of climate mitigation and adaptation activities. Although many of the Parties' ongoing watershed restoration, protection and coastal resilience programs address climate change impacts and improve resilience, a more deliberate focus on adaptation is needed. The Commission concludes that increased and sustained efforts are needed by both federal governments in their diversity of climate mitigation and adaptation activities.

DEFINING CLIMATE RESILIENCE AND ADAPTATION

The Commission uses the Intergovernmental Panel on Climate Change definition of climate resilience:

> "the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions."

Climate adaptation is defined by the panel as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities."

The Commission finds that watershed-based planning and activities for monitoring and restoring watersheds and implementing coastal resilience are limited through

annex activities and are primarily the domain of state, provincial and local governments. At the same time, the Parties' commitments of technical and financial assistance are critically important to support subnational governments' watershed restoration and coastal resilience activities. The majority of public infrastructure that affects and relies on water (for example, stormwater drainage for road networks and properties, wastewater treatment facilities and water treatment plants) is the responsibility of municipalities. Climate resiliency, therefore, necessarily relies on activities by local and regional entities. More can be done by federal governments to emphasize coordination of climate adaptation and resilience in the basin that empowers actions at the subnational scale.

The Commission recognizes that there are legislative and policy differences between Canada and the United States. This can make binational coordination and support for local and regional adaptation action challenging. Renewed efforts toward coordination are needed, however, to inform multiple levels of government, communities, decision-makers and others as part of building support and resources for coordinated activities for climate resiliency.

Since publishing the 2020 "Second Triennial Assessment of Progress" report, the Commission began working toward an internal "Climate Resiliency Strategy" that aims to identify and prioritize climate resiliency-related activities that the Commission is actively pursuing, as well as activities that it (or others) can pursue or support. As part of developing the strategy, the Commission held two workshops with a diverse group of participants. One theme that emerged from the workshops was the need for improved mechanisms that incorporate and align local and regional actions into common, basinwide goals and outcomes and that also increase the engagement and commitment of actors at all jurisdictional scales to achieve such basinwide climate resilience goals.

The Commission advises that these goals and outcomes should also include accountability mechanisms to specify how each goal will be achieved, considering existing jurisdictional authorities and the multitude of resiliency-related activities already underway in the basin. As discussed in section 4.4, accountability mechanisms can help improve coordination across annexes to address urgent and cross-cutting issues such as taking action on climate change resilience. Details of mechanisms (such as work plans or other tactics) to achieve the goals should also consider coordinated action through multiple annex subcommittees and align with innovative local and regional actions for large-scale engagement, protection and restoration of the entire Great Lakes ecosystem.



The Commission recommends the Parties support and actively participate in the Great Lakes Science Advisory Board's collaborative process to develop a 10-year Great Lakes Science Plan.

- To advance the Commission's Great Lakes Science Advisory Board's ongoing efforts toward the development of a detailed, actionable 10-year Great Lakes Science Plan, the Parties, alongside other participating levels of government, First Nations, Métis and Tribal governments, academia and nongovernment organizations, can support the collaborative process that will define the details for managing, funding, governing and implementing a coordinated and comprehensive binational system of science, monitoring, data management and interpretation, knowledge sharing and forecasting.

The Commission's suggestions in section 3.5.3 outlines actions the Parties may consider to address immediate needs for filling indicator reporting gaps. As discussed in section 4.1, however, these efforts are necessary but independently insufficient to adequately inform progress assessment and management decisions under the Agreement, particularly for urgent and cross-cutting issues. Therefore, it is in the interest of improving progress assessment and management decisions to also pursue complementary efforts toward the development of a plan to conduct holistic and proactive science activities that advance our ability to forecast and proactively manage the Great Lakes for the future.

Following extensive input from the Great Lakes science community, the Commission's Great Lakes Science Advisory Board published its "Great Lakes Science Strategy for the Next Decade" report in 2022. The board's Science Strategy identifies the need to support science activities that advance knowledge about how the Great Lakes system functions and how it will respond to change and interventions, in the interest of advancing proactive management, protection and prevention goals. The board's Science Strategy report suggests six interrelated priority areas to address science gaps and better forecast and anticipate the Great Lakes' future management needs. These priority areas are basic process research, monitoring and long time series measurements, enhanced models and forecasting systems, human capital and workforce development, research infrastructure and Centers of Excellence, and inclusion of broad socioeconomic and cultural perspectives. Finally, it identifies the priorities and resources for creating an integrated, detailed and actionable Science Plan for coordinating activities across the Great Lakes basin.

The board's Science Strategy report estimated the total annual investment, as of 2019, in Great Lakes research, monitoring and program administration at US$250 million, reflecting investments of Canadian and US federal and state/provincial governments, First Nations, Métis and Tribal governments, communities and other organizations. The report also estimated that an additional combined US$1 billion over 10 years is needed to fully realize the Science Strategy's six priority areas. A detailed and actionable plan, and resources, for implementation are now required to achieve these priorities.

In 2023, the Commission's Great Lakes Science Advisory Board began convening all levels of Canadian and US governments, First Nations, Métis and Tribal governments, academia, and nongovernment organizations and others, toward the development of a detailed and actionable Great Lakes Science Plan for the next era. Participants in this collaborative process are beginning efforts to define the specific management, funding and governance mechanisms required to implement this kind of bold, forward-looking plan.

The Parties' support for and active participation in the collaborative process of developing the Science Plan are essential to ensure that the plan's details for action are feasible to implement. In recognition of collaborative science as an underpinning of the Agreement, the Commission views the Parties' support for and participation in developing and advancing the Great Lakes Science Plan as an important indication of binational cooperation to achieve a shared and clear direction for all future work to protect the lakes.

Detroit River, Michigan and Ontario
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4.6 NEXT ASSESSMENT CYCLES: COMMISSION PRIORITIES FOR 2023-2029

One of the Commission's roles is to help ensure that the Agreement and its related activities continually evolve to address future issues facing the lakes. In addition to providing recommendations requiring immediate action (section 4.5), the Commission is also committed to prioritizing its work to be responsive to emerging issues and to supporting and strengthening the Parties' achievement of the Agreement's objectives into the future.

To this end, the Commission developed a Triennial Assessment of Progress Framework to guide how it will continue to meet its obligations in future reporting cycles under the Agreement. This framework includes conducting a focused and detailed assessment of selected Agreement objectives, a general review of all other Agreement objectives, a review of the "Progress Report of the Parties" and summary of public input, consideration of the "State of the Great Lakes Report," a collaboration process and a government communications process.

To select the priority objectives for future "Triennial Assessment of Progress" reports, it is expected that Commissioners would consider recommendations from advisory boards and Great Lakes water quality issues identified through public consultations during the previous reporting cycles. Once Commissioners finalize the next report's objectives, the boards and staff conduct a deeper analysis of each topic. The Commission's assessment reports will follow the Agreement as specified under Article 7.1(k).

Over the next triennial cycles through 2029, and as informed by the work of its advisory boards, the Commission's next several "Triennial Assessment of Progress" reports plan to focus on three topic areas: contaminants of emerging concern, nutrients in the western Lake Erie basin, and climate change adaptation and resilience.

The following sections offer a brief overview and the rationale for their selection. As always, the Commission and its advisory boards strive to contribute to assessing the effectiveness of the Agreement, engaging the public and reporting on progress in protecting the Great Lakes.

4.6.1 CONTAMINANTS OF EMERGING CONCERN

Contaminants of emerging concern include those not previously, or only recently, detected and that have poorly understood ecological and human health impacts, and those that may remain unregulated. Contaminants of emerging concern include pharmaceuticals, ingredients used in personal care products, pesticides, various chemicals and, more recently, nanoplastics and microplastics.

Contaminants of emerging concern are a growing issue because of the hundreds of thousands of new and established contaminants, which are not regulated and have unknown or unproven risks to environmental or human health. Many of these contaminants are endocrine disruptors, meaning they can alter the normal functioning of hormones, potentially causing a range of effects on aquatic species. More information is needed on sources, the health effects of exposure to contaminants on ecosystems and populations, the effects of contaminant mixtures, and how these contaminants interact with other stressors such as climate change.

Contaminants of emerging concern are widely present in the Great Lakes environment, and their pathways into the ecosystem are diffuse and largely unregulated. The widespread presence of these contaminants and their continual release into the environment present several challenges to fully understand the risk of their presence and to inform their prioritization for management. Several factors could impact the types and amounts of contaminants of emerging concern entering the Great Lakes.

For example, trends in the purchase and use of pharmaceuticals will increase as the basin population increases and ages, resulting in higher contaminant loads in wastewater and water resources. Similarly, as the region's industrial base changes over time, the manufacturing, use and disposal processes for new low-carbon technologies will be accompanied by new contaminants for which little is known about their potential release and fate in the environment. Present wastewater treatment infrastructure is also not designed to specifically remove the large variety of emerging contaminants. Failing septic systems are inefficient at removing such contaminants, which could release larger quantities of contaminants of emerging concern into the environment, and the full impact of this risk is not well understood.

Policy and regulatory responses to contamination often occur after environmental or public health issues arise. A reactionary approach cannot keep up with challenges that are rapidly evolving. There is a need to simplify the identification and prioritization of contaminants and improve the pace of risk assessments. Management needs include the implementation of water quality standards, extended producer responsibility, green chemistry and green pharmacy, wastewater treatment upgrades and public education campaigns. Effectively preventing the introduction of contaminants into the environment can save Canadian and US governments money on potential cleanup costs, mitigation actions and liability. The effective, proactive management of emerging contaminants requires transboundary coordination across sectors between policy, science and government to develop integrated policies and avoid fragmented strategies.

The Agreement does not fully address the vast array of contaminants of emerging concern. Under Annex 3 (Chemicals of Mutual Concern) of the Agreement, the Parties work cooperatively to *identify and address chemicals of mutual concern* that may threaten human health or the environment. Since the 2012 Agreement was signed, eight chemicals have been designated as chemicals of mutual concern and relevant binational strategies developed to address them. The evaluation, prioritization and management of contaminants is the responsibility of different federal, state, provincial and binational programs. At times, the fragmentation of managing these contaminants, such as perfluoroalkyl and polyfluoroalkyl substances (PFAS), between different levels of government in both countries causes a lack of consistency in water quality standards and the Agreement's implementation. Research, monitoring and data collection are crucial to understand these chemicals and to inform decision-making.

Therefore, the Commission's advisory boards will prioritize work that helps fill in pieces of the contaminant management puzzle to help inform future progress assessments. This body of work already includes the "Great Lakes Early Warning System" report, which identifies a framework to evaluate, identify and alert for action any potential threats to the Great Lakes, including chemicals. Another study underway is a board project to develop a coordinated framework for monitoring and ecological risk assessment of microplastic pollution in the Great Lakes, as well as provide recommendations on the use of plastics as a sub-indicator for reporting under the Agreement. Such ongoing and future work will provide a foundation of science-based advice for the Parties on how their activities and progress under the Agreement can address the urgent problem of contaminants of emerging concern.

4.6.2 CLIMATE CHANGE ADAPTATION AND RESILIENCE

The Commission emphasizes the urgency of climate change action in this 2023 "Third Triennial Assessment of Progress" report and will continue this focus into the future. The Commission's Water Quality Board will continue its project focused on identifying best practices that can help Great Lakes communities to better understand, adapt to and increase resilience to the impacts of climate change.

Since the late 1980s, the Commission and its advisory boards have been considering the implications of climate change and the need for basinwide climate adaptation and resilience. The Water Quality Board's 2003 "Climate Change and Water Quality in the Great Lakes Basin Report" and the

2017 "Climate Change Guidance Framework" built a foundation for this work and many related activities. Following its 2020 "Second Triennial Assessment of Progress," the Commission initiated a project to assist the Parties by further exploring essential elements of a binational climate adaptation and resilience strategy. To that end, the board began efforts that will culminate in its forthcoming report "Climate Change Adaptation for Community Resilience Across the Great Lakes Region." The outcomes of the board's project are intended to help provide more details around the necessary elements of a Great Lakes basinwide binational strategy for climate change adaptation and resilience. The board is collaborating with municipalities and other organizations across the Great Lakes basin to identify and address related community needs around building climate change adaptation and resilience.

When complete, the project outcomes may lend support to the Parties' Annex 9 (Climate Change Impacts) commitments. The board's project could create a comprehensive suite of climate change adaptation and resilience strategies relevant to small- and medium-sized communities that could benefit from additional technical support and access to shared tools, networks and guidance. Some of these communities have resiliency plans but require access to case studies, lessons learned and opportunities to build on other successes. Beyond emergency response capacity, most communities do not have a long-term emergency prevention strategy, and there are limited resources or regulatory incentives to compel precautionary planning. Few communities in the Great Lakes region have the staffing or technical resources to rapidly scale up climate adaptation strategies such as green infrastructure, wetland protection and restoration, relocation of flood-prone homes or businesses, among other elements. The board's project will provide a necessary and unique perspective encompassing and highlighting the totality of these issues in a way that targets pragmatic outcomes useful to Great Lakes communities.

There are other projects underway or recently completed that may also contribute to future assessment reports focused on understanding progress to address climate change and adaptation. In a new project, the Commission's Health Professionals Advisory Board will identify trackable human health indicators, such as nearshore drinking water and recreational water quality, related to climate-driven environmental changes in the Great Lakes basin. Project outcomes may highlight the relationship of international water management with health resilience in the face of climate change. The indicators could supplement current monitoring and tracking systems to improve the health effects of community mitigation or adaptation response. There is also an effort underway to modernize water quality monitoring that will transform assessments and protection of human health in the future.

The Water Quality Board will complete a Great Lakes Horizons project to build conversations around future scenarios for the Great Lakes and is also currently planning to conduct its fourth Great Lakes Regional Poll to gain insights into the public's views on climate change among other Great Lakes priorities. The outcomes of the collaborative process to develop a detailed Great Lakes Science Plan may also contribute to the Commission's future "Triennial Assessment of Progress" reports as the Science Plan relates to forecasting and proactively managing climate change impacts.

The Commission's future work to identify opportunities for changes to the Parties' assessments can also improve their relevance to Great Lakes communities seeking to protect human and environmental health under current and future conditions of climate change. As climate change impacts continue to dynamically shape the Great Lakes landscape, the tools used to understand and respond to these shifts must also remain dynamic.

The Great Lakes region benefits from the Parties' regular assessments of progress made toward Agreement objectives, and a holistic focus that includes community climate resilience and adaptation is imperative to include in future assessments. The work of the Commission's advisory boards previously contributed to indicator recommendations for the Parties' assessments. By incorporating both Western science and other ways of knowing, such as Traditional Ecological Knowledge and community science, these assessments can inform more integrated, regional approaches to mitigate, and

enhance resiliency to, the environmental and human health impacts of climate change.

4.6.3 NUTRIENT LOAD REDUCTION PERFORMANCE IN THE WESTERN LAKE ERIE BASIN

The Commission's future assessments may also focus on the persistent priority issue of addressing nutrient loads and nearshore algal blooms, particularly in the western Lake Erie basin. The Parties established the goal of a 40 percent reduction of nutrient loads (from 2008 levels). The Commission anticipates that as part of the Parties' 2025 reporting cycle they will specifically identify how close, or far, their efforts came to achieving the goal of 40 percent reduction, and what Annex 4 (Nutrients) programs and activities contributed to that progress. The Commission reaffirms its agreement with the Parties' assessment that "significant additional work is needed to meet targets" in Lake Erie.

The Commission recognizes and appreciates that the Parties are leading efforts to implement policies and programs to reach western Lake Erie's ambitious nutrient reduction goal. The Commission and its boards look forward to continued communication and collaboration with the Parties and other agencies and jurisdictions to help achieve the shared goal of establishing a healthy nutrient diet for Lake Erie.

Future assessment reports may consider findings and recommendations from the Commission's Great Lakes Science Advisory Board's 2023 report evaluating the implementation of the Lake Erie adaptive management framework , the joint Science Advisory Board and Water Quality Board 2023 report to evaluate the implementation of Lake Erie domestic action plans, and outcomes of the Water Quality Board's forthcoming Manure Nutrient Management Collaborative report to specifically address regulation and management of nutrient sources from livestock feeding operations.

In the spirit of this shared vision, the Commission offers its assistance to the Parties to further accelerate progress toward the nutrient goal and commits to conducting a fair and unbiased, evidence-based assessment of the Parties' efforts to inform and support their approach as part of its next assessment report.

4.6.4 MAKING PROGRESS IN PROTECTING THE DISH WITH ONE SPOON

As always, the Commission is grateful for the time and input of all contributors to this report. The Commission offers its assessments, advice and recommendations in the spirit of cooperation, so that everyone connected to our shared Great Lakes may benefit. The Commission's next "Triennial Assessment of Progress" report is scheduled for release in 2026. The Commission anticipates many positive outcomes from the collective efforts of the Parties and all partners and stakeholders as we continue to seek new and successful ways to fulfill the Agreement's principles.

The Agreement has been, since its inception, viewed as a significant and successful framework for collaboration. By implementing these recommendations across science, engagement and proactive planning, and with the continued support of the Commission's assessment responsibilities under the Agreement, the Parties can continue to champion uniting the efforts of the "spoon," the many levels of governments, communities, industry and individuals, to protect, restore and enhance "the dish," our precious, shared Great Lakes.

2023

Third Triennial Assessment of Progress on Great Lakes Water Quality