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Harmful Algal Blooms in the Great Lakes St. Lawrence River Basin: Is It Time fro a Binational Sub-Federal Approach?

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HARMFUL ALGAL BLOOMS IN THE GREAT LAKES ST. LAWRENCE RIVER BASIN: IS IT TIME FOR A BINATIONAL SUB-FEDERAL APPROACH?

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Harmful Algal Blooms (HABs) are a significant threat to ecosystem viability and citizen health in the binational Great Lakes St. Lawrence River Basin. Despite policies and management strategies to reduce the risk of HABs, outbreaks continue to rise in frequency, magnitude, and duration. A consensus is emerging among Great Lakes stakeholders that, although science and technology are crucial to inform policy and practice in this area, these tools are not enough. We need effective binational governance to tackle HABs in the Basin. Legal instruments are an important component of governance, and although the 2012 Great Lakes Water Quality Agreement Protocol provides a foundation, negotiating and funding a strengthened binational regime at the federal scale is unlikely into the near future. Given this reality, this article examines the possibilities and challenges associated with a binational sub-federal approach to addressing the HABs challenge.

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I. INTRODUCTION

For some time now stakeholders have recognized that Harmful Algal Blooms (HABs) are a significant threat to ecosystem viability and citizen health in the binational Great Lakes St. Lawrence River Basin ("Binational Great Lakes Basin").[1] HABs are prevalent in all five lakes and on both sides of the Canada-U.S. border, including Saginaw Bay; Green Bay; Sleeping Bear Dunes National Lakeshore; Maumee River Estuary; Sandusky Bay; Presque Isle Bay; Sodus Bay; Little Sodus Bay; Oswego River Estuary; Rochester Embayment; Bay of Quinte; Hamilton Harbour; Halton; and East Bay.[2] Furthermore, nutrient loading practices in Canada and the U.S. collectively contribute to massive HABs outbreaks in the western basin of Lake Erie. Despite policies and management strategies to reduce the risk of HABs, outbreaks continue to rise in frequency, magnitude, and duration.[3]

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[1] *See, e.g.*, John Hartig, *Great Lakes Moment: Harmful Algal Blooms Negatively Impact the Lake Erie Economy*, GREATLAKESNOW (Nov. 4, 2019), https://www.greatlakesnow.org/2019/11/harmful-algal-blooms-cost-economic-impact; Richard H. Becker et al., *Unmanned Aerial System Based Spectroradiometere for Monitoring Harmful Algal Blooms: A New Paradigm in Water Quality Monitoring*, 45 J. GREAT LAKES RSCH. 444, (2019); S.F. Colborne et al., *Water and Sediment as Sources of Phosphate in Aquatic Ecosystems: The Detroit River and its Role in the Laurentian Great Lakes*, 647 SCI. TOTAL ENV'T 1594 (2019).

[2] *See* Julianne Dyble et al., *Microcystin Concentrations and Genetic Diversity of Microcystis in the Lower Great Lakes*, 23 ENV'T TOXICOLOGY 507 (2008); *Harmful Algal Blooms*, MICH. SEA GRANT, https://www.michiganseagrant.org/topics/coastal-hazards-and-safety/harmful-algal-blooms (last visited Dec. 15, 2020); Keith Schneider, *Algae Blooms*, *A New Visitor, Ruin Sleeping Bar Dunes Shoreline*, CIRCLE OF BLUE (Jan. 29, 2014), https://www.circleofblue.org/cpx/great-lakes-algae/algae-blooms-a-new-visitor-ruin-sleeping-bear-dunes-shoreline; Christine Billau, *UToledo Researchers Tracking Algal Bloom on Maumee River, Lake Erie*, U. TOLEDO (July 8, 2020) https://news.utoledo.edu/index.php/07_08_2020/utoledo-researchers-tracking-algal-bloom-on-maumee-river-lake-erie; Christina Dierkes, *What Triggers Algal Blooms in Sandusky Bay,* OHIO SEA GRANT (Sept. 25, 2014, 12:00PM), https://ohioseagrant.osu.edu/news/2014/t8zho/what-triggers-algal-blooms-in-sandusky-bay; *Harmful Algal Blooms*, PENN. SEA GRANT, https://seagrant.psu.edu/topics/water-quality/harmful-algal-blooms (last visited Dec. 15, 2020); Katherine A. Perri et al., *Harmful Algal Blooms in Sodus Bay, Lake Ontario: A Comparison of Nutrients, Marina Presence, and Cyanobacterial Toxins*, 41 J. GREAT LAKES RSCH. 326 (2015); Kevin Bunch, *Outside of Erie: What About Harmful Algal Blooms in Lake Ontario?*, INT'L JOINT COMM'N (Aug. 5, 2016), https://www.ijc.org/en/outside-erie-what-about-harmful-algal-blooms-lake-ontario; *Harmful Algal Blooms*, SUFFOLK CNTY. GOV'T., https://www.suffolkcountyny.gov/Departments/Health-Services/Environmental-Quality/Ecology/Harmful-Algal-Blooms (last visited Dec. 15, 2020); Susan B. Watson et al., *Taste and Odour and Cyanobacterial Toxins: Impairment, Predication, and Management in the Great Lakes*, 65 CAN. J. FISHERIES AND AQUATIC SCI. 1779 (2008); W.D. McIlveen, *Return of the Phosphorus: Algae Issue*, HALTON NORTH PEEL NATURALIST CLUB (Mar. 9, 2014) https://hnpnc.com/site/the-return-of-the-phosphorus-algae-issue; INFOSUPERIOR, https://infosuperior.com (last visited Sept. 14, 2020).

[3] *See, e.g.*, C.E. Binding et al., *The Impact of Phytoplankton Composition on Optical Properties and Satellite Observations of the 2017 Western Lake Erie Algal Bloom*, 45 J. GREAT LAKES RSCH. 573 (2019); Soren Brothers et al., *A Decline in Benthic Algal Production May Explain Recent Hypoxic Events in Lake Erie's Central Basin*, 43 J. GREAT LAKES RSCH. 73 (2017); Isabella Bertani et al., *Probabilistically Assessing the Role of Nutrient Loading in*

A consensus is emerging among Great Lakes stakeholders that, although science and technology are crucial to inform policy and practice in this area, these tools are not enough.[4] Many are of the view that effective governance is essential to tackling the HABs challenge—and that this challenge should be undertaken collaboratively by stakeholders on both sides of the border.[5] A critical component of effective governance is a robust legal framework[6] that can handle current and future challenges.[7] The 2012 Great Lakes Water Quality Agreement (GLWQA) Protocol[8] provides a foundation; however, negotiating and funding a strengthened binational approach at the federal scale is unlikely into the near future. Given this reality, Creed and Friedman (2020)[9] urged policymakers to strengthen Great Lakes governance as it relates to HABs at the sub-federal scale through a compact, agreement, accord, or other binational mechanism.

This article[10] explores the contours of a binational sub-federal framework for addressing HABs in the Binational Great Lakes Basin. It suggests key elements for establishing such a framework, including possible legal and coordinating mechanisms, guiding legal principles, scientifically-based management measures, and the necessity of process, accountability, and enforcement. This article also discusses the very real challenges to creating such a framework. Part II provides an overview of the HABs challenge in the Binational Great Lakes Basin from a science perspective. Part III provides an overview of current binational mechanisms at the federal and sub-federal scales that address HABs. Part IV proposes the contours of a binational sub-federal framework and challenges; and

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Harmful Algal Bloom Formation in Western Lake Erie, 42 J. GREAT LAKES RSCH. 1184 (2016); Lorraine C. Backer et al., *Cyanobacteria and Algal Blooms: Review of Health and Environmental Data from the Harmful Algal Bloom-Related Illness Surveillance Systems (HABISS) 2007-2011*, 7 TOXINS 1048 (2015).

[4] *See* Irena F. Creed & Kathryn Bryk Friedman, *Enhanced Transboundary Governance Capacity Needed to Achieve Policy Goals for Harmful Algal Blooms, in* 101 THE HANDBOOK OF ENV'T CHEMISTRY 1-15 (Springer 2020); Irena F. Creed et al., *Formal Integration of Science and Management Systems Needed to Achieve Thriving and Prosperous Great Lakes*, 66 BIOSCIENCE 408 (2016); Debora VanNijnatten & Carolyn Johns, *Assessing the Proximity to the Desired End State in Complex Water Systems: Comparing the Great Lakes and Rio Grande Transboundary Basins*, 114 ENV'T SCI. & POL'Y 194 (2020).

[5] *See* Creed & Friedman, *supra* note 4; Kathryn B. Friedman et al., *The Great Lakes Futures Project: Principles and Policy Recommendations for Making the Lakes Great*, 41 J. GREAT LAKES RSCH. 171 (2015).

[6] *See* Creed et al., *supra* note 4; Debora L. VanNijnatten et al., *Assessing Adaptive Transboundary Governance Capacity in the Great Lakes Basin: The Role of Institutions and Networks*, 4 INT'L J. GOVERNANCE 7 (2016).

[7] *See generally* Katherine Hanson, *The Great Lakes Compact and Transboundary Water Agreements*, 34 WIS. INT'L L. J. 668 (2016).

[8] Great Lakes Water Quality Protocol of 2012, Can.-U.S., Sept. 7, 2012, T.I.A.S. No. 13-212 [hereinafter 2012 GLWQA Protocol].

[9] *See* Creed & Friedman, *supra* note 4.

[10] This article was prepared for a Symposium, *A State-Provincial Approach to Harmful Algal Blooms in the Great Lakes Basin: Possibilities and Pitfalls*, held on October 15, 2020 at the Canada-U.S. Law Institute at Case Western University School of Law and benefited from the thoughtful critique, commentary, and feedback of participants [hereinafter October 15, 2020 Symposium].

Part V sets forth conclusions drawn from discussion at the October 15, 2020 Symposium.

II. A SCIENTIFIC OVERVIEW OF THE HABS CHALLENGE IN THE BINATIONAL GREAT LAKES BASIN

HABs have tainted freshwaters for centuries. However, it has only been within the past several decades that we have gained a better understanding of HABs. This is because of science. Science has, *inter alia*, categorized the diversity of species in a HAB event,[11] as well as whether HABs are native or invasive bloom-forming species.[12] Science also has led to the discovery that one group of HAB species in particular dominates contemporary blooms—cyanobacteria.

Cyanobacteria are small, usually single-cells or small chains of prokaryotic (i.e., bacteria-like), photosynthetic (i.e., plant-like) species. These are natural inhabitants of waters and have the ability to capture nutrients effectively and therefore outcompete other algae.[13] When cyanobacteria bloom, the cells create an adverse physiological condition for their competitors at the base of aquatic food webs, altering energy or nutrient transfer into competing organisms and diverting energy through an alternative food web.[14]

Cyanobacteria may also produce toxins (i.e., microcystins, nodularins, saxitoxins, anatoxins, and cylindrospermopsin)[15] which are released into the water and contaminate the water we drink, the air we breathe, and the food we eat. For example, some cyanobacteria toxins that are released into the water and consumed through drinking water may cause liver damage, liver cancers, or general neurotoxicity.[16] Although direct drinking of bloom-filled waters is a rare event, there are concerns that in filtering out or destroying cyanobacteria by heat/ultraviolet light disinfection, the toxins are released into the waters that become our drinking waters.[17]

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[11] *See* Andrew J. Reid et al., *Emerging Threats and Persistent Conservation Challenges for Freshwater Biodiversity*, 94 BIOLOGICAL REV. 849 (2019); Michele A. Burford et al., *Understanding the Winning Strategies Used by the Bloom-Forming Cyanobacterium Cylindrospermopsis Raciborskii*, 54 HARMFUL ALGAE 44 (2016).

[12] Bryan W. Brooks et al., *Are Harmful Algal Blooms Becoming the Greatest Inland Water Quality Threat to Public Health and Aquatic Ecosystems?*, 35 ENV'T TOXICOLOGY & CHEMISTRY 6 (2015).

[13] *See* Hans W. Paerl et al., *Harmful Freshwater Algal Blooms, with an Emphasis on Cyanobacteria*, 1 SCI. WORLD J. 76 (2001); Jef Huisman et al., *Cyanobacterial Blooms*, 16 NATURE REVS. MICROBIOLOGY 471 (2018).

[14] *See* Sylvain Merel et al., *State of Knowledge and Concerns on Cyanobacterial Blooms and Cyanotoxins*, 59 ENV'T INT'L 303 (2013); S.J. Taipale et al., *Lake Eutrophication and Brownification Downgrade Availability and Transfer of Essential Fatty Acids for Human Consumption*, 96 ENV'T INT'L 156 (2016).

[15] Kaarina Sivonen, *Cyanobacterial Toxins and Toxin Production*, 35 PHYCOLOGIA 12 (2019).

[16] Bettina C. Hitzfield et al., *Cyanobacterial Toxins: Removal During Drinking Water Treatment, and Human Risk Assessment*, 108 ENV'T TOXICOLOGY 113 (2000).

[17] *Id.*

Toxins in water can be transported in droplets by breaking waves to form aerosols that can then be inhaled, an exposure pathway of growing concern.[18] Recent concerns of aerosolized algal toxin exposure are associated with higher incidences of neurogenerative ailments; for example, clusters of amyotrophic lateral sclerosis associated in lakes with cyanobacteria blooms have implicated inhalation of the aerosolized neuro toxin beta-N-methylamino-L-alanine.[19] Unfortunately, reports of algal toxin aerosolization in freshwaters are largely anecdotal and epidemiological studies are lacking.

Furthermore, toxins can contaminate food webs. For example, the trophic transfer of the cyanobacterial toxins into secondary and tertiary consumers in aquatic food webs[20] leads to physiological and behavioral impairments[21] and the contamination of food webs.[22] In a more clandestine manner, the presence of the cyanobacteria also may diminish the quality of the food chain in lakes by reducing the trophic transfer of essential fatty acids, which likely provide lower quality resources to primary consumers and propagate up the food web to impacting fish populations.[23] The risks to humans are a bit more uncertain, but certainly present.[24]

Over the past several decades, there has been an increase in the likelihood and magnitude of cyanobacteria HABs worldwide,[25] including all five lakes in the Binational Great Lakes Basin.[26] These blooms have been—and continue to be—

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[18] *See* Nicole E. Olsen et al., *Harmful Algal Bloom Toxins in Aerosol Generated from Inland Lake Water*, 54 ENV'T SCI. & TECH. 4769 (2020).

[19] *See* Trace A. Caller, *A Cluster of Amyotrophic Lateral Sclerosis in New Hampshire: A Possible Role for Toxic Cyanobacteria Blooms*, 10 AMYOTROPH LATERAL SCHLEROSIS 101 (2009).

[20] *See* Aloysio da S. Ferrão-Filho & Betina Kozlowsky-Suzuki, *Cyanotoxins: Bioaccumulation and Effects on Aquatic Animals*, 9 MARINE DRUGS 2729 (2011).

[21] *See* Bas W. Ibelings & Karl E. Havens, *Cyanobacterial Toxins: A Qualitative Meta-Analysis of Concentrations, Dosage and Effects in Freshwater Estuarine and Marine Biota, in* ADVANCES IN EXPERIMENTAL MED. & BIOLOGY 675 (H. Kenneth Hudnell ed., 2008).

[22] *See* Betina Koazlowsky-Suzuki, *Biomagnification or Biodilution of Microcystins in Aquatic Foodwebs? Meta-analyses of Laboratory and Field Studies*, 18 HARMFUL ALGAE 47 (2012).

[23] *See* Stephanie M. Hixson & Michael T. Arts, *Climate Warming is Predicted to Reduce Omega-3 Long-Chain Polyunsaturated Fatty Acid Production in Phytoplankton*, 22 GLOB. CHANGE BIOLOGY 2744 (2016); Trevor A. Gearhart et al., *Alternation of Essential Fatty Acids in Secondary Consumers Across a Gradient of Cyanobacteria*, 784 HYDROBIOLOGIA 155 (2017); Oscar E. Senar et al., *Browning Reduces the Availability—But Not the Transfer—Of Essential Fatty Acids in Temperate Lakes*, 64 FRESHWATER BIOLOGY 2107 (2019).

[24] *See* Justine R. Schmidt, *The Fate of Microcystins in the Environment and Challenges for Monitoring*, 6 TOXINS 3354 (2014).

[25] *See* J.M. O'Neil et al., *The Rise of Harmful Cyanobacteria Blooms: The Potential Roles of Eutrophication and Climate Change*, 14 HARMFUL ALGAE 313 (2012); Jeff C. Ho et al., *Widespread Global Increase in Intense Lake Phytoplankton Blooms Since the 1980s*, 574 NATURE 667 (2019).

[26] *See, e.g.,* Jack Nissen, *New Blue Green Algae Blooms in Lake Superior*, GREAT LAKES NOW (Sept. 27, 2018), https://www.greatlakesnow.org/2018/09/new-blue-green-algae-blooms-in-lake-superior; National Oceanic and Atmospheric Administration, U.S. Department of Commerce, *Great Lakes: Harmful Algal Blooms*, NAT'L OCEAN SERV., https://oceanservice.noaa.gov/hazards/hab/great-lakes.html (last visited Dec. 15, 2020) (discussing HABs in Lakes Michigan, Erie, and Huron); Barbara A. Branca, *To HAB and to*

most prevalent in the western basin of Lake Erie. This is due in part to the fact that Lake Erie is the smallest (by volume) and shallowest of the Great Lakes, which means that nutrient-rich waters that enter the lake basin or are resuspended from the lake sediments are more available at the lake's surface where cyanobacteria thrive.

The presence of cyanobacteria in Lake Erie dates back to the nineteenth century, when Euro-American settlement altered the physical structure of the Lake Erie catchment. Settlers cut down forests and drained swamps and marshes, removing nutrient scavenging area and enabling excessive nutrients to enter the lake and a rise in algal biomass. During the first half of the twentieth century, algal biomass increased dramatically, including nearshore cyanobacteria blooms, with the introduction of phosphate detergents, commercial fertilizers, and a growing population.[27] The blooms were so extensive and long-lasting that by the late 1960s, Lake Erie was pronounced "dead,"[28] as lifeless fish began washing up on shores. These cyanobacteria blooms were traced primarily to point source pollution (i.e., phosphorus runoff from identifiable sources of discharged pollutants) such as sewage treatment plants and factories.

As discussed in Part III, Canada and the United States were generally successful in controlling phosphorus discharged from point source pollution. This was due in large part to science demonstrating that management efforts focused on phosphorus control would reduce the risk of HABs.[29] Lake Erie's "rapid and profound ecological response"[30] was considered "one of humankind's greatest environmental success stories."[31]

Yet by the 1990s, HABs reemerged in the western basin of Lake Erie,[32] and are now expanding to and intensifying in other Great Lakes.[33] With regard to Lake Erie, which is the most scientifically studied Great Lake, the 2008 cyanobacteria bloom was the second largest algal bloom in the history of the lake, only to be succeeded by even larger blooms.[34] The repeated HABs events—ten events since 2008—occurred in years when the total phosphorus load to the lake fell below

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HAB Not: Harmful Algae are Blooming in New York's Waters, 36(2) NYSAC NEWS 49 (Spring/Summer 2015) (noting HABs in Lake Ontario).

27 *See* Lisa E. Allinger & Euan D. Reavie, *The Ecological History of Lake Erie as Recorded by the Phytoplankton Community*, 39 J. GREAT LAKES RSCH. 365 (2013).

28 Alan Edmonds, *Death of a Great Lake*, MACLEAN'S, Nov. 1, 1965, at 28.

29 *See* James P. Bruce, *Dr. Richard Vollenweider and the Great Lakes*, 14 AQUATIC ECOSYSTEM HEALTH & MGMT. 186 (2011).

30 Anna M. Michalak et al., *Record-Setting Algal Bloom in Lake Erie Caused by Agricultural and Meteorological Trends Consistent with Expected Future Condition*, 110 PROC. OF THE NAT'L ACAD. OF SCI. 6448 (2013).

31 Gerald Matisoff & Jan J.H. Ciborowski, *Lake Erie Trophic Status Collaborative Study*, 31 J. GREAT LAKES RSCH. 1 (2005).

32 *See* D.B. Baker et al., *Phosphorus Loading to Lake Erie from the Maumee, Sandusky and Cuyahoga Rivers: The Importance of Bioavailability*, 40 J. GREAT LAKES RSCH. 502 (2014); Donald Scavia, *Assessing and Addressing the Re-eutrophication of Lake Erie: Central Basin Hypoxia*, 40 J. GREAT LAKES RSCH. 226 (2014).

33 *See* Allinger & Reavie, *supra* note 27.

34 INT'L JOINT COMM'N, A BALANCED DIET FOR LAKE ERIE: REDUCING PHOSPHORUS LOADINGS AND HARMFUL ALGAL BLOOMS—A REPORT ON LAKE ERIE ECOSYSTEM PRIORITY (2014).

total phosphorus (TP) load objectives (< 11,000 metric tons) set forth in the legal and regulatory framework, suggesting that something had fundamentally changed in the Lake Erie ecosystem.[35]

This unforeseen new ecosystem state was the result of new sources of phosphorus that were either not accounted for or not considered significant. First, the TP load from surrounding watersheds may not have changed, but there was a significant increase in the proportion of the phosphorus load to Lake Erie that is in dissolved (and reactive), as opposed to particulate, form in these loads. Scientists concluded that soil conservation strategies designed to reduce TP may have inadvertently led to a shift from particulate to dissolved reactive phosphorus in the load.[36] This was due to the fact that dissolved reactive phosphorus is more easily taken up by algae—especially cyanobacteria that have high affinity phosphorus uptake mechanisms,[37] therefore contributing to increased algal growth.[38] Furthermore, this increased algal growth was exacerbated by changing climate conditions including climate warming (i.e., increasing temperatures in recent years are creating longer growing seasons for algae and contributing conditions that lead to increased algal growth)[39] and hydrologic intensification[40] (i.e., more frequent high-intensity spring storms that result in more nutrients being washed off of urban and agricultural lands, and more nutrients bypassing and overflowing from sewage treatment facilities).[41]

Second, science suggests that one unaccounted source of phosphorus in Lake Erie may be atmospheric phosphorus deposition. Atmospheric phosphorus loads are believed to be low, but not negligible in Lake Erie.[42] Current mechanisms of analysis may not be suitable for studying atmospheric phosphorus loads because the relative proportions of dry and wet phosphorus deposition are poorly

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35 *See* David M. Dolan & Steven C. Chapra, *Great Lakes Total Phosphorus Revisited: 1. Loading Analysis and Update (1994-2008)*, 38 J. GREAT LAKES RSCH. 730 (2012).

36 *See* J.M Laflen & M.A. Tabatabai, *Nitrogen and Phosphorus Losses from Corn-Soybean Rotations as Affected by Tillage Practices*, 27 TRANSACTIONS OF THE AM. SOC'Y OF AGRIC. ENG'RS 58, (1984); J.D. Gaynor & W.I. Findlay, *Soil and Phosphorus Loss from Conversation and Conventional Tillage in Corn Production*, 24 J. ENV'T QUALITY 734, (1995); Lula Gherbremichael & Mary Watzin, *An Environmental Accounting System to Track Nonpoint Source Phosphorus Pollution in the Lake Champlain Basin*, LAKE CHAMPLAIN BASIN PROGRAM (2010); Douglas R. Smith et al., *Phosphorus Losses from Monitored Fields with Conservation Practices in Lake Erie Basin, USA*, 44 AMBIO 319, (2015); R.J. Dodd & A.N. Sharpley, *Conservation Practice Effectiveness and Adoption Unintended Consequences and Implications for Sustainable Phosphorus Management*, 104 NUTRIENT CYCLING AGROECOSYSTEMS 373 (2015).

37 *See* Sonya T. Dyhrman, *Nutrients and their Acquisition: Phosphorus Physiology in Microalgae, in* THE PHYSIOLOGY OF MICROALGAE 155 (Michael A. Borowitzka & Éva Loerinczi eds., 2016).

38 *See* Luis Aubriot & Sylvia Bonilla, *Regulation of Phosphorus Uptake Reveals Cyanobacteria Bloom Resilience to Shifting N:P Rations*, 63 FRESHWATER BIOLOGY 318 (2018).

39 *See* Hans W. Paerl & Jeff Huisman, *Blooms Like It Hot*, 320 SCI. 57 (2008).

40 *See* Thomas G. Huntington, *Evidence for Intensification of the Global Water Cycle: Review and Synthesis*, 319 J. HYDROLOGY 83 (2006).

41 *See, e.g.*, Dodd & Sharpley *supra* note 36; *see* James E. Post & Barbara W. Altma, *Managing the Environmental Change Process: Barriers and Opportunities*, 7 J. ORG. CHANGE MGMT. 64 (1994).

42 *See* A BALANCED DIET FOR LAKE ERIE, *supra* note 34.

characterized. Nonetheless, both pools demonstrate appreciable contributions of dissolved reactive phosphorus to lakes. At this stage, the contribution of atmospheric phosphorus loads to the formation of HABs in Lake Erie cannot be ruled out. This is especially true given that intense storm events, coupled with effects of human activity, have the potential to increase atmospheric phosphorus loads to lakes.[43]

Third, another unaccounted source of phosphorus may be the phosphorus stored in sediments. Environmental conditions associated with new climate changes may have "reactivated" or "resupplied" phosphorus to the upper layer of water in a stratified lake (i.e., the epilimnion). Legacy effects of phosphorus buried in the watershed from past agricultural activities is continuously released and contributing to present phosphorus loads.[44] An alternative theory is that the alteration of the redox of the lower layer of water in a stratified lake (i.e., the hypolimnion) or sediments may release phosphorus previously bound to iron hydroxides.[45]

In addition to new sources of phosphorus, the invasive zebra and quagga mussels increase the cycling of phosphorus and therefore contribute to HABs. The mussels inhabit the rocky nearshore, consuming phosphorus-laden particles exported from the land and filter-feeding phosphorus-rich organisms from the open water. These two processes result in phosphorus being recycled in light-rich nearshore waters, where cyanobacteria ingested by the mussels are excreted undamaged and continue to grow. This benthic cycling of phosphorus results in a cyanobacteria-dominant algal community.[46]

III. THE CURRENT LEGAL FRAMEWORK GOVERNING HABS IN THE BINATIONAL GREAT LAKES BASIN

There are hundreds of laws, policies, and regulations in place in both Canada and the United States to help manage varying aspects of HABs.[47] This legal terrain is extremely complex, with a mix of bilateral, federal, state, provincial, and local regulations, laws, and programs in place.[48] There are hundreds of Best

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[43] *See* Sarah Hutchinson, Assessing the Atmospheric Deposition of Phosphorus to the Great Lakes, (January 6, 2019) (unpublished paper) (on file with author).

[44] *See* M.L. Ostrofsky & R.M. Marbach, *Predicting Internal Phosphorus Loading in Stratified Lakes*, 81 AQUATIC SCI. 18 (2019).

[45] *See* L.A. Molot et al., *A Novel Model for Cyanobacteria Bloom Formation: The Critical Role of Anoxia and Ferrous Iron*, 59 FRESHWATER BIOLOGY 1323 (2014).

[46] *See* R.E. Hecky et al., *The Nearshore Phosphorus Shunt: A Consequence of Ecosystem Engineering by Dreissenids in the Laurentian Great Lakes*, 61 CAN. J. FISHERIES & AQUATIC SCIS. 1285 (2004).

[47] *See* Creed & Friedman, *supra* note 4; *See also* Creed et al., *supra* note 4.

[48] At the federal scale, *see, e.g.*, Clean Water Act, 33 U.S.C. § 1342 (2012); Safe Drinking Water Act, 42 U.S.C. § 300f (1974); Agricultural Improvement Act of 2018, Pub. L. No. 115-334, 132 Stat. 4490 (2018). At the state scale, *see, e.g.*, OHIO REV. CODE. ANN. § 905.326 (LexisNexis 2020); MINN. STAT. § 7052.0015 (2017); IND. CODE § 14-25-1-11 (2011); MICH. COMP. LAWS § 324.3901 (1995); N.Y. ENV'T CONSERV. LAW § 35-0105 (Consol. 2020); 510 ILL. COMP. STAT. 77/20 (2001). At the local scale, *see* ANN ARBOR, MICH. § 6:405 (2020); YPSILANTI, MICH. § 110-74 (2018); MICHIGAN CITY, IND., INDIANA MUNICIPAL CODE § 50-505. In addition to this complex web of regulation, in the United States there is also Public Trust Doctrine,

Management Practices (BMPs) in the mix as well.[49] This Part focuses on bilateral sources of law and legal instruments at the federal and sub-federal scales that comprise the management framework for addressing HABs.

The Federal Scale: Treaties

There are two binational legal instruments at the federal scale that address HABs. First, there are treaties that govern the bilateral management of the Great Lakes. A treaty is "an international agreement concluded between States in written form and governed by international law, whether embodied in a single instrument or in two or more related instruments and whatever its particular designation."[50] Treaties spell out how the parties will jointly exercise their sovereignty in a manner designed to be mutually beneficial.[51] The main treaty governing the Binational Great Lakes Basin is the Boundary Waters Treaty of 1909.[52] The Boundary Waters Treaty is hailed as a model in transboundary water law and governance.[53] It grants Canada and the United States exclusive jurisdiction to resolve disputes and protect the quality and quantity of the surface waters of the Great Lakes and connecting waterways.[54] Article IV of the Boundary Waters Treaty provides, "the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property of the other." This underlying legal principle—that one country's pollution should not harm another country—is a foundational legal principle of Canada-United States international environmental law.[55] This principle was reinforced in the *Trail Smelter* case.[56]

groundwater law, and riparian law. For an excellent summary of legal tools for controlling key Ohio sources of phosphorus entering Lake Erie and its tributaries, *see* Kenneth Kilbert et al., *Legal Tools for Reducing Harmful Algal Blooms in Lake Erie*, 44 U. TOL. L. REV. 69, (2012).

[49] *See, e.g.,* IND. CONSERVATION P'SHIP, http://icp.iaswcd.org (last visited Oct. 6, 2020); MICH. AGRIC. ENV'T ASSURANCE PROGRAM, https://maeap.org (last visited Oct. 6, 2020); OHIO LIVESTOCK ENV'T ASSURANCE PROGRAM, https://ohleap.org (last visited Oct. 6, 2020).

[50] Vienna Convention on the Law of Treaties, May 23, 1969, 1155 U.N.T.S. 331.

[51] *See* Mike Piskur, *Management of the Great Lakes-St. Lawrence Maritime Transportation Systems*, 42 CAN.-U.S. L. J. 228 (2018).

[52] Treaty Between the United States and Great Britain Relating to Boundary Waters between the United States and Canada, U.K.-U.S., Jan. 11, 1909, 36 Stat. 2448, T.S. 548 [hereinafter Boundary Waters Treaty].

[53] *See* Paul Muldoon, *Governance in the Great Lakes, A Regime in Transition, in* GREAT LAKES: LESSONS IN PARTICIPATORY GOVERNANCE 44-66 (Velma I. Grover & Gail Krantzberg eds., 2012); Savitri Jetoo et al., *Governance and Geopolitics as Drivers of Change in the Great Lakes—St. Lawrence Basin*, 41 J. GREAT LAKES RSCH. 108 (2015).

[54] *See* James M. Olson, *Navigating the Great Lakes Compact: Water, Public Trust, and International Trade Agreements*, 1103 MICH. ST. L. REV. 1104, 1109-1120 (2006).

[55] *See* Noah D. Hall, *Transboundary Pollution: Harmonizing International and Domestic Law*, 40 U. MICH. J. L. REFORM 681, (2007); Jamie Linton & Noah Hall, *The Great Lakes: A Model of Transboundary Cooperation, in* WATER WITHOUT BORDERS? CAN., U.S., & SHARED WATERS 221 (Emma S. Norman et al., eds. 2013).

[56] *See* U.S. v. Can., 3 R.I.A.A. 1911 (1938), further proceedings 3 R.I.A.A. (1941) [hereinafter *Trail Smelter*]. *Trail Smelter* resulted in a well-established rule of public international law: No nation may use or permit the use of its sovereign territory in such a manner as would cause injury to neighboring nations or to properties or persons therein. *See* Keith R.

The Boundary Waters Treaty established the International Joint Commission (IJC), which comprises six members. The President of the United States appoints three members, with the advice and approval of the Senate, and the Governor in Council of Canada appoints three members, on the advice of the Prime Minister. The principle of impartiality is at the core of the work of the IJC. Commissioners must act impartially in reviewing problems and deciding issues, rather than representing the views of their respective governments.[57]

The IJC primarily engages in aggregating data and analysis,[58] publishing reports on the quality of individual lakes, and convening stakeholders from around the Basin. In 2017, in its First Triennial Assessment of Progress under the GLWQA, the IJC called on Canada and the United States to set specific timelines and targets for, *inter alia*, reducing nutrient runoff.[59] It recommended that federal, state, and provincial governments include the following in their action plans: details on timelines; responsibilities for action; expected deliverables, outcomes and quantifiable performance metrics to ensure accountability; enforceable standards for applying agricultural fertilizer and annual waste; better linkages between agricultural subsidies and conservation practices; and a designation by Ohio of the western basin of Lake Erie as impaired under the Clean Water Act.[60]

The Federal Scale: Agreements

Another legal instrument employed to govern the Binational Great Lakes Basin is an executive agreement. In the United States, executive agreements do not need Senate advice and consent to become binding, which makes these instruments easier to negotiate and execute. The most significant bilateral agreement to govern water quality—and hence, HABs— in the Great Lakes is the GLWQA.[61] The GLWQA was executed by Canada and the United States in 1972 and serves as a binational framework for action on water quality issues, with joint interests superseding national interests.[62] The priority of the GLWQA was to eliminate point source pollution from industrial sources and sewage treatment plants. It implemented an 11,000 metric tons per annum (MTA) total phosphorus load objective that was achieved in the 1980s by regulating phosphorus detergents and industry, wastewater treatment facility upgrades, as well as implementing agricultural soil conservation and nutrient management practices.[63] The GLWQA

Fisher, *Foreword: The Great Lakes-St. Lawrence River Basin Compact and Agreement: International Law & Policy Crossroads*, 1085 MICH. ST. L. REV. 1089, (2006).

[57] Boundary Waters Treaty, *supra* note 52, art. VII; *see also* Jetoo et al., *supra* note 53.

[58] *See* Hanson, *supra* note 7.

[59] INT'L JOINT COMM'N, FIRST TRIENNIAL ASSESSMENT OF PROGRESS ON GREAT LAKES WATER QUALITY (2017); *See also IJC Calls on Government to Set Specific Targets to Accelerate Great Lakes Restoration, Protect Drinking Water and Eliminate Releases of Untreated Sewage*, INT'L JOINT COMMISSION (Nov. 28, 2017), https://www.ijc.org /en/ijc-calls-governments-set-specific-targets-accelerate-great-lakes-restoration-protect-drinking.

[60] *Id.*

[61] Great Lakes Water Quality Agreement of 1972, Can.-U.S., Apr. 15, 1972, 23 U.S.T. 301.

[62] *See* Jetoo et al., *supra* note 53.

[63] *See* R. Peter Richards & David B Baker, *Trends in Water Quality in LEASEQ Rivers and Streams (Northwestern Ohio), 1975-1995. Lake Erie Agriculture Systems for Environmental Quality*, 31 J. ENV'T QUALITY 90 (2002); Andrew Sharpley et al., *Phosphorus Legacy:*

is generally viewed as having been successful in addressing point source pollution.[64]

The GLWQA has been amended no less than four times by Canada and the United States. In 1978, the concept of "ecosystem management" was introduced.[65] In 1983, Canada and the United States supplemented the GLWQA to further limit phosphorus discharges and committed to prepare and implement plans for reducing phosphorus.[66] In 1987, Canada and the United States substantially revised the GLWQA by adopting a Protocol ("1987 GLWQA Protocol")[67] that, *inter alia*, introduced the concepts of Lake-Wide Management Plans and Remedial Action Plans. These steps enhanced community participation. The 1987 GLWQA Protocol also created a Binational Executive Committee (BEC) that took over reporting on the state of the lakes and allowed for Environment Canada and the United States Environmental Protection Agency to consult directly and semiannually without involvement of the IJC. This reorientation away from the IJC as the binational mechanism for governing water quality issues in the Great Lakes was a game changer in terms of governance, as the leadership role and budget of the IJC became severely restricted.[68] The BEC, in turn, was ultimately viewed as entrenched in administrative institutions with no authority or accountability, serving merely as an information exchange forum with no ability to set binational programming.[69]

Due in part to the increased presence of HABs in the Great Lakes Basin, on June 13, 2009, the Canadian Foreign Minister and the U.S. Secretary of State announced that negotiations would begin on the review of the 1987 GLWQA Protocol.[70] The 2012 GLWQA Protocol was signed on September 7, 2012 and, following an exchange of diplomatic notes, entered into force on February 12, 2014.[71] The 2012 GLWQA Protocol reaffirmed a commitment to, *inter alia*, not pollute boundary waters. It outlined sixteen governing principles, including accountability ("establishing clear objectives, regular reporting made available to the Public on progress, and transparently evaluating the effectiveness of work

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Overcoming the Effects of Past Management Practices to Mitigate Future Water Quality Impairment, 42 J. ENV'T QUALITY 1308, (2013).

[64] *See generally* LEE BOTTS & PAUL MULDOON, EVOLUTION OF THE GREAT LAKES WATER QUALITY AGREEMENT, (Mich. State Univ. Press, 2005) as cited in Creed & Friedman, *supra* note 4. Botts and Muldoon also pointed to other successful attributes, including the binational nature of the GLWQA as reflected in its parity in structure and obligations, and joint fact-finding and research; focus on community participation; accountability and openness in information exchange; and flexibility and adaptability to changing circumstances.

[65] Great Lakes Water Quality Agreement of 1978, Can.-U.S., Nov. 22, 1978, 30 U.S.T. 1383. The following summary of updates to the GLWQA was taken from Creed & Friedman, *supra* note 4; *see also* Jetoo et al., *supra* note 53.

[66] Great Lakes Water Quality Agreement of 1983, Can.-U.S., Oct. 16, 1983, 35 U.S.T. 2370; *see also* Creed & Friedman, *supra* note 4.

[67] Great Lakes Water Quality Agreement of 1987, Can.-U.S., Nov. 18, 1987, T.I.A.S. 11551.

[68] GAIL KRANTZBERG ET AL., GREAT LAKES ST. LAWRENCE RIVER GOVERNANCE: REPORT ON THE EXPERT WORKSHOP (McMaster University, 2007).

[69] *Id.*

[70] *See* Creed & Friedman, *supra* note 4.

[71] 2012 GLWQA Protocol, *supra* note 8.

undertaken to achieve the objectives of this Agreement"); adaptive management ("implementing a systematic process by which the Parties assess effectiveness of actions and adjust future actions to achieve the objectives of this Agreement, as outcomes and ecosystem processes become better understood"); coordination ("developing and implementing coordinated planning processes and best management practices by the Parties, as well as among State and Provincial Governments, Tribal Governments, First Nations, Métis, Municipal Governments, watershed management agencies, and local public agencies"); and adherence to an ecosystem approach ("taking management actions that integrate the interacting components of air, land, water, and living organisms, including humans"). The BEC morphed into the Great Lakes Executive Committee (GLEC) under the 2012 GLWQA Protocol. In keeping with the more siloed approach of the BEC (as compared to the binational mechanism of the IJC), the GLEC was charged to coordinate and implement programs undertaken to achieve the purpose of the GLWQA. GLEC membership, however, was more broad-based than that of the BEC. GLEC comprises senior-level representatives from Canadian and United States federal entities responsible for implementation of the GLWQA, as well as state and provincial governments, tribal governments, municipal governments, Indigenous communities, watershed management agencies, and other local public agencies. In addition, the Great Lakes Commission, the IJC, and the Great Lakes Fishery Commission are represented at GLEC meetings. It was envisioned that these new representatives would help Canada and the United States achieve their water quality goals.

Specifically with regard to nutrients, the 2012 GLWQA Protocol listed as one of its main objectives that the waters of the Great Lakes should "[b]e 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."[72] Canada and the United States committed to update phosphorus loading targets and develop strategies and Domestic Action Plans (DAPs) to achieve specific ecosystem objectives—starting with Lake Erie.[73]

Through the 2012 GLWQA Protocol Annex 4 (Nutrients), binational phosphorus reduction targets were adopted for the western and central basins of Lake Erie to address HABs and hypoxia. The new targets included: "a 40 percent reduction (from 2008 levels) in spring loads of TP and soluble reactive phosphorus for the Maumee River to minimize HABs in the western basin; a 40 percent reduction (from 2008 levels) in phosphorus loadings to the central basin, with a new binational loading target of 6,000 tons per year of TP; and a 40 percent reduction (from 2008 levels) in spring loads of TP and soluble reactive phosphorus for priority tributaries to minimize HABs in nearshore areas."[74] Progress on Annex

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[72] *Id.*

[73] ENV'T AND CLIMATE CHANGE CAN. & ONT. MINISTRY OF THE ENV'T AND CLIMATE CHANGE, CANADA-ONTARIO LAKE ERIE ACTION PLAN: PARTNERING ON ACHIEVING PHOSPHORUS LOADING REDUCTIONS TO LAKE ERIE FROM CANADIAN SOURCES (2018).

[74] *Id.*

4 objectives is reported every six months at the GLEC meetings. Accomplishments are described in the Progress Report of the Parties every three years.

The Sub-federal Scale: Interstate Compacts and Declarations

States have used interstate compacts as a legal instrument to address water quality issues in the Binational Great Lakes Basin. An interstate compact is an agreement between two or more states of the United States that is approved by those states' respective legislatures.[75] All interstate compacts require Congressional consent in order to achieve full force and effect.[76] In the context of Great Lakes water quality issues, one compact bears mentioning. On December 12, 1955, five states (Illinois, Indiana, Michigan, Minnesota, and Wisconsin) ratified the Great Lakes Basin Compact ("1955 Compact"), which established the Great Lakes Commission. Pennsylvania ratified the 1955 Compact in 1956; New York in 1960; and Ohio in 1963. The U.S. Congress granted consent on July 24, 1968.[77] In order to formally partner with Ontario and Québec, the governors of these eight Great Lakes states executed a Declaration of Partnership[78] and granted these provinces Associate Member status on the Great Lakes Commission.

The Great Lakes Commission plays an important role in addressing Great Lakes water quality issues. It fosters dialogue, develops consensus, and facilitates collaboration among its member states.[79] Specifically with regard to HABs, the Great Lakes Commission gathers data, develops tools, and shares information that advance solutions.[80] Like the IJC, however, Commission recommendations have no binding effect.

The Sub-federal Scale: Agreements[81]

In addition to the 1955 Compact, states and provinces have entered into agreements regarding the mitigation of HABs. In the transboundary context, on June 13, 2015 at the Québec City Conference of Great Lakes and St. Lawrence Governors and Premiers ("Governors and Premiers Council"), the Governors of Michigan and Ohio and the Premier of Ontario (the "State-Provincial Parties") signed the Western Basin of Lake Erie Collaborative Agreement ("2015

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75 Library of Congress, *Interstate Compacts in the United States*, (2018) https://www.loc.gov/law/help/interstate-compacts/us-interstate-compacts.pdf.

76 U.S. CONST. art 1, § 10, cl. 3.

77 Great Lakes Basin Compact, Pub. L. No. 90-419, 82 Stat. 414 (1968).

78 GREAT LAKES COMM'N, DECLARATION OF PARTNERSHIP WITH ONTARIO AND QUÉBEC (1999).

79 GREAT LAKES COMM'N, STRATEGIC PLAN FOR THE GREAT LAKES COMMISSION (2017).

80 For example, in 2015, the Great Lakes Commission, in partnership with the U.S. Geological Survey-Great Lakes Science Center, established the HABs Collaborative, a "collective laboratory" that seeks to improve communication among scientists and between scientists and decision-makers on issues related to HABs. The HABs Collaborative is establishing a common knowledge base of current science, future science needs, and how the region can work collaboratively to prevent and manage HABs. *See* Great Lakes Comm'n, *HABs Collaborative: Linking Science and Management to Reduce Harmful Algal Blooms*, https://www.glc.org/work/habs.

81 The following summary is taken directly from Creed & Friedman, *supra* note 4.

Collaborative Agreement").[82] The 2015 Collaborative Agreement focuses on the western basin watersheds of the Maumee, Portage, and Toussaint rivers and the Sandusky River, and is intended to meet the nutrient reduction targets proposed by the Nutrient Annex of the 2012 GLWQA Protocol. The State-Provincial Parties collectively pledged to work to achieve a recommended 40 percent total load reduction in the amount of total and dissolved reactive phosphorus entering Lake Erie's western basin by the year 2025 through an adaptive management process. They included an aspirational interim goal of a 20 percent reduction by 2020. Similar to the 2012 GLWQA Protocol, the 2015 Collaborative Agreement further stated that the State-Provincial Parties would use phosphorus loading data from 2008 to the Western Lake Erie Basin as the basis from which progress would be measured.

Three points are important to note with respect to the 2015 Collaborative Agreement. First, Michigan, Ohio, and Ontario reaffirmed that the restoration of the western basin "cannot be achieved solely by the Parties in isolation, but rather, it is dependent upon the collaboration between the Parties to address the water quality of the Western Basin of Lake Erie." Second, the State-Provincial Parties concluded that the "best means" to improve the water quality of Lake Erie is "through a collaborative initiative between the Parties that has a defined goal, establishes specific implementation plans with timetables and is measured against expected results." Third, the Agreement stated that, with respect to implementation, "each state and province commits to developing, in collaboration with stakeholder involvement, a plan outlining their proposed actions and timelines toward achieving the phosphorus reduction goal."[83]

The states and province have taken steps to reach the 2025 reduction goal. In February 2017, Ohio published its *Western Lake Erie Basin Collaborative Implementation Framework*.[84] The *Framework* was developed with adaptive management at the forefront with input through meetings and conversations with stakeholders and state agencies. No less than fifteen state agencies and domestic partners are listed in the framework, with three leading the pack: the Ohio Department of Agriculture is responsible for agricultural nonpoint source pollution; the Ohio EPA is responsible for point source and water quality monitoring; and the Ohio Department of Health is responsible for monitoring household and small flow sewage treatment systems. Additionally, the *Framework* mentions that "there is involvement and coordination from time-to-time on specific issues, such as monitoring and research by [. . .] international agencies, such as Environment and Climate Change Canada and the Ontario Ministry of the Environment and Climate Change and Ontario Ministry of Agriculture-Agri-Food."[85]

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[82] GREAT LAKES ST. LAWRENCE GOVERNORS & PREMIERS, WESTERN BASIN OF LAKE ERIE COLLABORATIVE AGREEMENT (2015).

[83] *Id*.

[84] STATE OF OHIO, WESTERN LAKE ERIE BASIN COLLABORATIVE IMPLEMENTATION FRAMEWORK (2017).

[85] *Id.*

In February 2018, the Ontario Government and the Government of Canada developed the *Canada-Ontario Lake Erie Action Plan*[86] to reduce algal blooms and phosphorus loads in Lake Erie. This plan met Ontario's commitments under a number of agreements, including the 2015 Collaborative Agreement. The Canada-Ontario action plan is led by five federal and provincial government agencies and has more than 120 actions to help reduce phosphorus loading into Lake Erie.

Also, in February 2018, Michigan adopted its DAP, a guiding document toward achieving a healthier Lake Erie ecosystem.[87] The DAP affirms actions towards two objectives: fulfilling commitments under the 2015 Collaborative Agreement and meeting the targeted phosphorus reductions and nutrient-related ecosystem goals for Lake Erie under Annex 4 of the 2012 GLWQA Protocol. The DAP also outlines strategies for Michigan to reach these objectives in collaboration with local municipalities, non-governmental organizations, other stakeholders, the states of Ohio, Indiana, Pennsylvania, and New York, the province of Ontario, and the United States and Canada.

In an executive order dated June 20, 2019,[88] Michigan Governor Gretchen Whitmer ordered additional steps. Importantly, acting under Sections 1 and 8 of Article 5 of the Michigan Constitution of 1963, she directed that the directors of the Michigan Department of Agriculture and Rural Development, Michigan Department of Environment, Great Lakes, and Energy, and Michigan Department of Natural Resources "shall work in collaboration to adopt policies, procedures, and actions as soon as possible to ensure full implementation of the DAP and its objectives, including the objective of reducing the nutrient loadings from certain tributaries and priority watersheds by 40 percent by 2025."[89] She also ordered that certain state departments disseminate the adopted policies and procedures to other state departments and autonomous agencies. She ordered that the same departments must report to the governor on their progress annually. These reports must include, to the greatest extent practicable, quantifiable measures of progress toward the DAP objectives, including nutrient loading reduction targets.

In June 2019, at the meeting of the Governors and Premiers Council, Governor Whitmer, Ohio Governor Mike DeWine, and Ontario's Minister of the Environment, Conservation and Parks Rod Phillips, representing Ontario's Premier Doug Ford, pledged their commitment to the goals of the 2015 Collaboration Agreement and their intention to reduce phosphorus inputs into the Western Lake Erie Basin by 40 percent by 2025.[90]

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[86] CANADA-ONTARIO LAKE ERIE ACTION PLAN, *supra* note 73.

[87] Mich. Exec. Order No. 2019-14 (June 20, 2019).

[88] Letter from Gretchen Whitmer, Governor, Michigan to Department Director and Autonomous Agency Heads, (Jan. 2, 2019) (on file with the Office of Governor Gretchen Whitmer).

[89] *Id.*

[90] WESTERN BASIN OF LAKE ERIE COLLABORATIVE AGREEMENT, *supra* note 82.

IV. THE CONTOURS OF A BINATIONAL SUB-FEDERAL FRAMEWORK FOR HABS

Despite these treaties, compacts, and agreements, HABs outbreaks in the Binational Great Lakes Basin continue. Some have explicitly argued that the GLWQA is not enough.[91] Although at first blush it seems as if binational action at the federal scale is most appropriate, this is not likely for three reasons.[92] First, the influence of the IJC has waned over the years. Second, the Trump Administration has gutted programs at the Environmental Protection Agency—including those addressing water quality challenges.[93] Third, there is quite simply a lack of political will among federal officials on both sides of the border to strengthen the binational framework. The Trump Administration's "transactional" approach to allies such as Canada reflects a lack of interest in collaborating to solve the HABs problem. Even with the election of the Biden-Harris Administration, the COVID-19 pandemic and economic recovery make it highly unlikely that HABs would be a priority. This is also true in Canada, where the Trudeau Government remains steadfast in its focus on public health and the COVID-19 pandemic.

Sub-federal actors, on the other hand, are becoming more common in the environmental space.[94] A sub-federal approach would coincide with the persistent trend of decentralization (i.e., the movement of power from the federal to sub-national governments) that has occurred over the past several decades.[95] In addition, a sub-federal approach would demonstrate leadership at a time when the federal government—at least in the U.S.—is withdrawing from water and environmental policy. Finally, there is a sense that a binational, sub-federal approach may deal with HABs more effectively and efficiently.

Thus, a basin-wide legal instrument at the binational sub-federal scale could add value. It would allow U.S. and Canadian stakeholders to work on shared objectives, bringing further stability and resiliency to the binational relationship. Nonetheless, based on feedback provided at the October 15, 2020 Symposium, there seems to be little interest or political will to create a new legal instrument to address HABs at the binational sub-federal scale. An interstate compact coupled with a concomitant agreement with Ontario and Québec was discussed as an

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91 Danielle Kaeding, *Report Recommends Rewrite of Great Lakes Water Quality Agreement*, WIS. PUBLIC RADIO (December 10, 2019, 1:30PM) https://www.wpr.org/report-recommends-rewrite-great-lakes-water-quality-agreement; *see* Creed & Friedman *supra* note 4.

92 *See* Creed & Friedman, *supra* note 4.

93 Most recently, President Trump's proposed budget for fiscal year 2021 called for a 26 percent cut to the EPA. *See* Rebecca Beitsch & Rachel Frazin, *Trump Budget Slashes EPA Funding, Environmental Programs*, THE HILL (Feb. 10, 2020, 2:18PM), https://thehill.com/policy/energy-environment/482352-trump-budget-slashes-funding-for-epa-environmental-programs.

94 *See* Noah D. Hall, *Toward A New Horizontal Federalism Interstate Water Management in the Great Lakes Region*, 77 U. COLO. L. REV. 405, (2020); *see also* Thomas Hale, *The Role of Sub-state and Non-state Actors in International Climate Processes*, (2018), https://www.chathamhouse.org/sites/default/files/publications/research/ 2018-11-28-non-state-sctors-climate-synthesis-hale-final.pdf.

95 *See generally* BOTTS & MULDOON, *supra* note 64; Jetoo et al., *supra* note 53.

option; however, the process to achieving this outcome is long and complex,[96] and there currently is no political champion of such a path.

Alternatively, the 2015 Collaborative Agreement could be expanded to include all eight Great Lakes states and the province of Québec. Stakeholders at the October 15, 2020 Symposium suggested, however, that this agreement be strengthened prior to expansion, and recommended specific action steps for doing so.

First, stakeholders suggested that accountability and enforcement—which require leadership and resources[97]—are critical to strengthening the 2015 Collaborative Agreement. One of the major critiques of the current legal and regulatory framework is that there are few real accountability and enforcement measures.[98] Accountability measures should include metrics of success.[99] Rather than measure progress or accomplishments like the Annex 4 review process, stakeholders strongly urged that Michigan, Ohio, and Ontario build scientifically-based status assessment into the 2015 Collaborative Agreement. This would include a regular accounting of Total Maximum Daily Loads (TMDLs), analysis of trends, and consideration of performance alongside volume and flow, as well as extenuating circumstances that exist (i.e., lack of implementation, enforcement, extreme weather, and climate change). Michigan, Ohio, and Ontario would also need to manage and adapt using predictive models of future climate change scenarios. Moreover, compliance would need to be strengthened, perhaps incorporating both upstream and downstream economics into compliance measures.

Second, bringing the marketplace to the table to help problem-solve was also suggested to strengthen the 2015 Collaborative Agreement. Stakeholders pointed out that although many regulatory elements exist, these regulations are not working optimally to reduce the risk of HABs. With the idea that we need to "go to where the fertilizer is" (i.e., the power), stakeholders recommended that the agriculture (e.g., concentrated animal feeding operations) and energy sectors be brought to the table to be part of the solution.

Third, deepening the culture among Michigan, Ohio, and Ontario stakeholders is required. A binational, basin-wide approach would require a coalition that is

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[96] For example, the Great Lakes-St. Lawrence River Basin Water Resources Compact, Pub. L. No. 110-342, 122 Stat. 3739 (2008) ("2005 Compact") and accompanying non-binding Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement, Dec. 13, 2005, https://www.gsgp.org/media/nvzkrpyv/great_lakes-st_lawrence_river_basin_sustainable_water_resources_ agreement.pdf., which incorporates Québec and Ontario, took more than five years of negotiations among the states, provinces, native tribes, environmental groups, municipalities, water managers, scientists, and the public. In addition, each Great Lakes state legislature ratified the 2005 Compact, and Congress provided its consent. It is an understatement to suggest that this process would be a lot to coordinate and manage.

[97] *See* Savitri Jetoo, *Multi-Level Governance Innovation of the Baltic Sea and the North American Great Lakes: New Actors and Their Roles in Building Adaptive Capacity for Eutrophication Governance*, 98 MARINE POL'Y 237 (2018).

[98] Alejandro E. Camacho, *Climate Change and Regulatory Fragmentation in the Great Lakes Basin*, 17 MICH. STATE J. INT'L L. 140 (2008).

[99] *Id.*

inclusive of diverse interests and knowledge, including Indigenous peoples, Indian Tribes, and First Nations. A coalition also requires building a common culture with respect for science, shared goals, leadership, and budgetary resources. Stakeholders suggested that deepening these elements in the western basin of Lake Erie could yield important "soft power" elements necessary to form a broader, basin-wide effort.

Fourth, a clearinghouse that serves as a centralized repository for sharing information and best practice is an important element to strengthen the 2015 Collaborative Agreement. Currently, no such mechanism exists. Having a centralized repository would not only add efficiencies, but also allow for flexibility for stakeholders to adopt localized strategies to deal with diverse causal pathways of HABs outbreaks. They also noted that a clearinghouse of regulatory approaches in these jurisdictions would add value. This repository could then serve as a model for a basin-wide program.

Fifth, stakeholders emphasized that in order for policy to be innovative and agile, it should reflect cutting-edge scientific discovery and advances. Incentive programs should be put in place that support these evidence-based policies and allow for on-the-ground action. Novel science-based tools should be tested in the context of the 2015 Collaborative Agreement, which could then be expanded basin-wide, as appropriate. Stakeholders strongly urged that Michigan, Ohio, and Ontario consider climate change and invasive species in their approach to HABs. They also noted the need for convergent approaches to understand causal pathways, integrating evolving data and models into regulatory actions. Nonetheless, stakeholders recognized that the causal pathways may differ, and that a one-size fits all approach will not work; therefore, we need to identify HAB priority "areas of concern" and design place-based strategies to control factors that lead to the formation of HABs.

Stakeholders further noted that the Great Lakes community currently does not have predictive tools that could be used to communicate risk and build the political will necessary for a basin-wide approach to HABs. For example, one novel public health tool would be to create surveillance systems that monitor the extent of HABs and the incidence of illnesses associated with HABs,[100] particularly given the many different classes of toxins that exist (i.e., hepatotoxins, neurotoxins, cytotoxins, dermatotoxins, and irritant toxins).[101] In addition to avoidance and prevention measures,[102] mitigation measures that could serve as tools include

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[100] *See* Backer et al., *supra* note 3.

[101] *See* Rajesh P. Rastogi et al., *Bloom Dynamics of Cyanobacteria and Their Toxins: Environmental Health Impacts and Mitigation Strategies*, 6 FRONTIERS IN MICROBIOLOGY 1 (2015).

[102] For example, well-established preventative measures that reduce the risk of formation of blooms include physical controls, i.e., those that reduce nutrient loads from surrounding lands to surface waters (*see* Paerl & Huisman., *supra* note 39) or those that reduce nutrient loads from lake sediments. The latter approach involves physically removing sediments (*see* Paerl & Huisman, *supra* note 39); capping sediments with clay or sand (Jasper M. Stroom & W. Edwin A. Kardinaal, *How to Combat Cyanobacterial Blooms: Strategy Toward Preventive Lake Restoration and Reactive Control Measures*, 50 AQUATIC ECOLOGY 541 [2016]); aerating sediments to generate conditions unsuitable for phosphorus release (E. E. Prepas et al., *Introduction to the Amisk Lake Project: Oxygenation of a Deep Eutrophic Lake*, 54 CAN. J.

physical controls (e.g., increasing flows to reduce water residence time and remove cyanobacteria);[103] chemical controls such as algicides or flocculants;[104] or biological controls (e.g., introducing organisms that consume HAB species).[105] Uncertainty estimates in the performance of these measures should be considered as well.[106]

Finally, although the governing principles of the 2015 Collaborative Agreement emphasize binational collaboration, the doctrine of interstate nuisance could be incorporated into this agreement. This doctrine addresses harms to natural resources that cross state boundaries, and recognizes the need to balance competing sovereign interests in utilizing and preserving these resources.[107] This doctrine would be appropriate in this context, as it seems to be a sub-federal variation of the principles enshrined in the Boundary Waters Treaty and set forth in the *Trail Smelter* case (i.e., no nation may use or permit the use of its sovereign territory in such a manner as would cause injury to neighboring nations or to properties or persons therein).

V. CONCLUSION

We recognize that the aforementioned recommendations for strengthening binational, sub-federal engagement on HABs are a tall order. We nonetheless conclude that this approach offers promise at a time when the federal governments in both the United States and Canada have neither the political will nor the necessary bandwidth for adequately dealing with this wicked problem. Viewed as ambitious and intentional, these recommendations, if implemented, could ensure the success of the 2015 Collaborative Agreement and set the stage for a basin-wide binational sub-federal agenda for mitigating HABs. We urge policymakers on both

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FISHERIES & AQUATIC SCIS. 2105 [1997]); chemically treating sediments to suppress internal loading, e.g., adding aluminum or polyaluminum sulphate, where aluminum hydroxide is not redox sensitive and will bind phosphorus under anoxic sediments, and sulphate would increase formation of ferrous sulphides and therefore lower internal iron loading (Molot et al., *supra* note 45); or the use of phosphate chelators such as alum or commercially-available Phoslock™, compounds which form chemical bonds with P making it biologically unavailable (*see* Eugene B. Welch & Dennis Cooke, *Internal Phosphorus Loading in Shallow Lakes: Importance and Control*, 21 LAKE & RESERVOIR MGMT. 209 (2005); Miquel Lürling & Frank van Oosterhout, *Controlling Eutrophication by Combined Bloom Precipitation and Sediment Phosphorus Inactivation*, 47 WATER RSCH. 6527 [2013]).

[103] *See* Marten Scheffer & Egbert H. van Nes, *Shallow Lakes Theory Revisited: Various Alternative Regimes Driven by Climate, Nutrients, Depth and Lake Size*, 584 HYDROBIOLOGIA 455 (2007); Stroom & Kardinaal, *supra* note 102.

[104] *See* Daniel Jančula & Blahoslav Maršálek, *Critical Review of Actually Available Chemical Compounds for Prevention and Management of Cyanobacterial Blooms*, 85 CHEMOSPHERE 1415 (2011).

[105] *See* Rastogi et al., *supra* note 101.

[106] *See* Roland Cormier et al., *The Science-Policy Interface of Risk based Freshwater and Marine Management Systems: From Concepts to Practical Tools*, 226 J. ENV'T MGMT. 340 (2018); Jason D. Igras & Irena F. Creed, *Uncertainty Analysis of the Performance of a Management System for Achieving Phosphorus Load Reduction to Surface Waters*, 276 J. ENV'T MGMT. 111217 (2020).

[107] *See* Noah D. Hall & Joseph Regalia, *Interstate Groundwater Law Revisited: Mississippi v Tennessee*, 34 VIR. INT'L ENV'T L. J. 152 (2016).

sides of the border to consider adopting these recommendations, thus positioning stakeholders in the Binational Great Lakes Basin as leaders with innovative solutions to the HABs challenge.