Solving the Phosphorus Paradox: Five States' Approaches to Restoring Nutrient Impaired Surface Water Quality

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The "phosphorus paradox" is a phrase coined to call attention to a challenge of scarcity pitted against overabundance, a story of necessity for a naturally scarce critical element that unfolds into a world of excess and degradation. We depend on phosphorus to feed the world and yet do not treat it as precious nor manage it as finite. Decades of overapplying fertilizer to farmland has created a legacy pollution problem that impairs our surface waters, harms aquatic life, reduces recreational opportunities, and poses a threat to public health.

In the United States, the federal government, states, and Tribes share the responsibility of managing water pollution and protecting water quality through a cooperative federalism framework. This paper explores how the regulatory framework applies to the management of both point and nonpoint sources of phosphorus. We analyze and compare the regulatory approaches of five states in the nation with the strictest nutrient criteria, emphasizing Wisconsin's approach, as it is considered a leader amongst these states.

The article concludes that nutrient regulation through numeric criteria is more effective than narrative standards and is necessary for measurable reductions in phosphorus pollution in water. However, the legacy effects of phosphorus pollution coupled with more voluntary than mandatory approaches to nonpoint

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source management and exacerbated by climate change leave surface waters nutrient impaired. Solving the phosphorus paradox requires transformative and innovative solutions beyond the current legal framework for regulating this nutrient pollution.

INTRODUCTION

Nutrient pollution poses a significant threat to the health and stability of the nation's aquatic ecosystems. It is considered among the most widespread and costly water problems.[3] A 2017 survey of lakes in the United States revealed 45% were in "poor condition" due to elevated phosphorus levels.[4] Rivers and streams were similarly assessed in 2018 to 2019 to find almost 42% in "poor condition" because of excess phosphorus.[5] Coastal waters and estuaries are also vulnerable to nutrient impairment. The United States Environmental Protection Agency's

[3] *Nutrient Pollution: The Problem*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrientpollution/problem (last updated Feb. 20, 2023).

[4] *National Lakes Assessment*, U.S. ENV'T PROT. AGENCY (2017), https://nationallakesassessment.epa.gov/webreport/.

[5] *U.S. EPA National Rivers & Streams Assessment 2018-19*, U.S. ENV'T PROT. AGENCY (2022), https://riverstreamassessment.epa.gov/dashboard/?&view=indicator&studypop=rs&subpop=national&label=none&condition=poor&diff=2v3.

("EPA") 2022 nutrient pollution reduction memorandum identifies "two-thirds of the nation's coastal areas and more than one-third of the nation's estuaries" as nutrient impaired.[6]

Excess nutrients in surface waters produce an ecological imbalance that leads to nuisance or harmful algal blooms ("HABs") and impaired waterways.[7] Algae grow when carbon, nitrogen, and phosphorus are present in a certain ratio. When one of these necessary nutrients is in short supply, it limits algal growth.[8] Phosphorus is considered the primary limiting nutrient for algal blooms in freshwater systems because its available concentration directly controls the rate of algal growth.[9] Removing excess phosphorus is therefore key to abating nuisance algae and HABs. Excess phosphorus and resulting algal blooms impair waterbodies, threaten public health, reduce recreational use, and decrease property values.[10]

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6 Memorandum from Radhika Fox, Assistant Adm'r, U.S. EPA, to State Env't Sec'ys, Comm'rs, and Dirs.; State Agric. Sec'ys, Comm'rs, and Dirs.; Tribal Env't and Nat. Res. Dirs. (Apr. 5, 2022) [hereinafter Fox Memo]. https://www.epa.gov/system/files/documents/2022-04/accelerating-nutrient-reductions-4-2022.pdf; *see also Where This Occurs: Coasts and Bays*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrientpollution/where-occurs-coasts-and-bays (last updated Mar. 30, 2023).

7 *Nutrients and Eutrophication*, U.S. GEOLOGICAL SURVEY (Mar. 3, 2019), https://www.usgs.gov/mission-areas/water-resources/science/nutrients-and-eutrophication.

8 *Understanding Phosphorus and Its Connection to Algal Blooms*, CLEAN LAKES ALLIANCE, https://www.cleanlakesalliance.org/phosphorus/ (last accessed Dec. 1, 2022).

9 *Indicators: Phosphorus*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/national-aquatic-resource-surveys/indicators-phosphorus (last updated June 9, 2023).

10 *See, e.g.*, *Nutrient Pollution*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrientpollution (last updated Nov. 29, 2023) ("Excess algae can reduce or deplete dissolved oxygen available to aquatic life and, in many instances, produce toxins that can harm people, animals, and aquatic life."); Nat'l Ctrs. for Coastal Ocean Sci., *Assessing Environmental and Economic Impacts*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., https://coastalscience.noaa.gov/science-areas/habs/assessing-environmental-and-economic-impacts/ (last accessed Feb. 12, 2024) ("The average annual economic impact of HABs in the U.S. is estimated at $10-100 million and costs from a single major HAB event can reach tens of millions of dollars. The social and cultural impacts from HABs are harder to quantify and severely challenge individuals and communities."); *Algal Blooms*, NAT'L INST. OF ENV'T HEALTH SCI., https://www.niehs.nih.gov/health/topics/agents/algal-blooms/index.cfm (last reviewed Oct. 16, 2023) ("HABs that occur in freshwater, like the Great Lakes and other drinking water sources, are dominated by the cyanobacteria Microcystis. This organism produces a liver toxin that can cause gastrointestinal illness as well as liver damage."); *Harmful Algae: Ecosystems*, U.S. NAT'L OFFICE FOR HARMFUL ALGAL BLOOMS, https://hab.whoi.edu/impacts/impacts-ecosystems/ (last accessed Feb. 12, 2024) ("Non-toxic species can cause impacts including loss of shellfish, loss of habitat, seagrass die-backs, hypoxia, and altered food web interactions that decrease preferred higher trophic level species."); *Harmful Algae: Socioeconomic*, U.S. NAT'L OFFICE FOR HARMFUL ALGAL BLOOMS, https://hab.whoi.edu/impacts/impacts-socioeconomic/#:~:text=Massive%20fish%20mortalities%20that%20result,accumulate%20and%20decompose%20on%20beaches (last accessed Feb. 12, 2024) ("Public health is the largest component, representing nearly $20 million annually, or about 42% of the nationwide average cost. The effect on commercial fisheries averages $18 million annually, followed by $7 million for recreation and tourism effects, and $2 million for monitoring and management."). *See also* John Manuel, *Nutrient Pollution: A Persistent Threat to Waterways*, 122 ENV'T HEALTH PERSPECTIVES A304, A305-06 (2014) (discussing ecological and

Under the Clean Water Act ("CWA") there are two source categories for excess phosphorus pollution: point and nonpoint source. Point source phosphorus pollution enters waterways from direct, identifiable sources, such as municipal wastewater treatment plants.[11] Nonpoint source phosphorus pollution runs off into waterways from diffuse locations, commonly from agricultural land after heavy rainfall or with snow melt.[12] Unlike point source pollution, the discharge of which is prohibited into any water of the United States without a National Pollutant Discharge Elimination System ("NPDES") permit,[13] nonpoint pollution is not federally regulated with permits under the CWA.

Federal, state, and Tribal agencies manage point and nonpoint sources of phosphorus. Within the cooperative federalism framework of the CWA, the EPA delegates authority to approved states and tribes[14] to set water quality standards,[15] administer pollution discharge permit programs,[16] and manage nonpoint pollution.[17] As of 2023, there are twenty-four states that have established numeric nutrient criteria for nitrogen or phosphorus for at least some surface waters as part of state water quality standards, but only five states that have established these criteria for two or more watertypes (i.e., lakes and rivers or estuaries), and no states that have a complete set of criteria for all waterbodies.[18] As of 2024, nineteen of the tribes that the EPA has authorized for treatment as a state ("TAS") have adopted numeric criteria for phosphorus for at least one type of waterbody.[19]

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human health impacts of HABs).

11 Point source pollution includes "any discernible, confined and discrete conveyance," but does not include "agricultural stormwater discharges and return flows from irrigated agriculture." 33 U.S.C. § 1362(14) (2023).

12 NPS is defined as "any source of water pollution that does not meet the legal definition of 'point source' in section 502(14) of the Clean Water Act." *Basic Information about Nonpoint Source (NPS) Pollution*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution (last updated Dec. 4, 2023).

13 The NPDES permit program was created in 1972 by the Clean Water Act to address water pollution by regulating point sources that discharge pollutants to waters of the United States. 33 U.S.C. § 1311 (2023).

14 33 U.S.C. § 1377(a), (e) (2023).

15 33 U.S.C. § 1313 (2023).

16 33 U.S.C. § 1342(a)(5), (b) (2023).

17 33 U.S.C. § 1329 (2023).

18 The five states are Florida, Hawaii, Minnesota, New Jersey, and Wisconsin. *State Progress Toward Developing Numeric Nutrient Water Quality Criteria for Nitrogen and Phosphorus*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrient-policy-data/state-progress-toward-developing-numeric-nutrient-water-quality-criteria (last updated Jan. 23, 2024) [hereinafter *N/P Criteria Progress Map*].

19 The nineteen tribes are: Fond Du Lac Band of Lake Superior Chippewa, Hoopa Valley Tribe, Hopi Tribe, Lummi Tribe, Makah Indian Tribe, Miccosukee Tribe, Navajo Nation, Port Gamble S'Klallam Tribe, Pueblo of Acoma, Pueblo of Nambe, Pueblo of Picuris, Pueblo of Sandia, Pueblo of Santa Ana, Pueblo of Santa Clara, Pueblo of Tesuque, Pyramid Lake Paiute Tribe, Spokane Tribe, White Mountain Apache Tribe, Twenty-Nine Palms Band of Mission Indians. *State-Specific Water Quality Standards Effective under the Clean Water Act*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/wqs-tech/state-specific-water-quality-standards-effective-under-clean-water-

This article analyzes and compares the five states with the most comprehensive nutrient criteria to evaluate phosphorus management schemes. The article emphasizes Wisconsin's approach, as it is considered a leader in the nation. The article proceeds in four parts. First, it provides an overarching scientific understanding of the legacy phosphorus problem which requires targeted pollution management and comprehensive regulation. Next, the article offers regulatory context by discussing the EPA's role in phosphorus management under the CWA. The EPA has thus far refused to set national technology-based nutrient effluent limitations for municipal wastewater treatment and all the top ten industrial sources of phosphorus in wastewater. Because the EPA has left management of this significant pollutant to states and tribes with delegated programs, the article considers the five states that have the most comprehensive approaches. In the third section, the article analyzes Wisconsin's approach, which includes an effluent limit for municipal wastewater and numeric water quality criteria for phosphorus for lakes and rivers. Wisconsin implements this model with market-based compliance options that incentivize point to nonpoint source trades and watershed-level adaptive management. This section also surveys Wisconsin's regulations, overviews literature assessing a decade of implementing this approach, and evaluates whether there has been a measurable impact to water quality. In its fourth section, the article assesses regulatory schemes and nutrient management programs in Florida, Hawaii, Minnesota, and New Jersey. Here, the paper examines commonalities among the five leading states, identifies divergent approaches, and highlights lessons learned. Finally, the article concludes that despite early and stringent numeric phosphorus criteria across all five states, there are widespread delays in water quality improvement. Reasons for this delay include climate change (warmer, wetter conditions are ripe for nutrient loading and water quality impairment), the challenge of phosphorus as a legacy pollutant, and the largely voluntary approach to nonpoint source phosphorus management, which is the leading contributor to nutrient impaired waters.

I. PHOSPHORUS'S WICKED LEGACY

Phosphorus contained in manure and fertilizer travels from agricultural land through soil into waterways, contributing to HABs, fish kills, and human illness.[20]

act-cwa (last updated Oct. 26, 2023). Four of these Tribes have adopted numeric phosphorus criteria that apply, with exceptions, to streams and lakes/reservoirs. The Hopi Tribe, Pueblo of Acoma, Pueblo of Santa Ana, and Pueblo of Sandia all establish phosphorus limits of 100 ug/L in streams and 50 ug/L in lakes/reservoirs. HOPI TRIBE WATER RESOURCES PROGRAM, HOPI WATER QUALITY STANDARDS 9 (revised Nov. 10, 2010); PUEBLO OF ACOMA, WATER QUALITY STANDARDS 11-12 (revised Dev. 2005); PUEBLO OF SANTA ANA, WATER QUALITY STANDARDS 7 (effective Sept. 28, 2021); PUEBLO OF SANDIA, WATER QUALITY STANDARDS 9-10 (effective Mar. 9, 2010).

20 Tracy A. Campbell et al., *Agricultural Landscape Transformation Needed to Meet Water Quality Goals in the Yahara River Watershed of Southern Wisconsin*, 25 ECOSYSTEMS 507, 508 (2022).

According to Helen P. Jarvie and colleagues, roughly 20−30% of phosphorus applied to agricultural lands escapes a watershed via soil runoff or removal in grain and animal produce.[21] "The remaining 70−80% of applied [phosphorus is absorbed and stored] in soil, river sediments, groundwater, wetlands, riparian floodplains, lakes, and estuaries."[22] This type of stored phosphorus is known as "legacy phosphorus" because it is released years or even decades after it enters the waterway.[23] This section provides a scientific foundation for understanding phosphorus's legacy problem, explores what it means for water quality improvement, and discusses strategies to address it.

The presence of legacy phosphorus in a watershed can diminish the efficacy of nutrient management and reduction programs. Researchers have found delays in water quality improvement from land management plans implemented to reduce nutrient runoff. Meals and Dressing, who studied lag time in water quality response to land treatment, found a significant delay in response time of runoff phosphorus to nutrient management.[24] While nutrient management programs have successfully reduced phosphorus runoff at the "edge-of-field,"[25] downstream water quality improvement lags due to the ongoing release of legacy phosphorus.[26] In areas where legacy phosphorus levels are high, it could take years or decades after implementation of a nutrient management plan ("NMP") before total phosphorus levels are effectively reduced and downstream water quality improved.[27]

The Fox River watershed of eastern Wisconsin provides a useful case study to understand the troubling effect of legacy phosphorus on water quality. Kreiling et al. studied this watershed and found land use management strategies and best management practices ("BMPs") had little effect on sediment phosphorus, which remains high throughout the watershed.[28] Kreiling and team concluded that ecological improvements from land use management programs and BMPs in the Fox River watershed were masked by the slow release of legacy phosphorus from river sediment.[29]

A similar pattern was discovered in St. Albans Bay in Lake Champlain,

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21 Helen P. Jarvie et al., *Water Quality Remediation Faces Unprecedented Challenges from "Legacy Phosphorus"*, 47 ENV'T SCI. & TECH. 8997 (2013).

22 *Id.*

23 *Id.*; *see also* Andrew Sharpley et al., *Phosphorus Legacy: Overcoming the Effects of Past Management Practices to Mitigate Future Water Quality Impairment*, 42 J. ENV'T QUALITY 1308 (2013); Rebecca M. Kreiling et al., *Complex Response of Sediment Phosphorus to Land Use and Management Within a River Network*, 124 J. GEOPHYSICAL RES.: BIOGEOSCIENCES 1764 (2019).

24 Donald W. Meals and Steven A. Dressing, *Lag Time in Water Quality Response to Land Treatment*, 4 TECH NOTES 1, 3-4 (2008).

25 Meaning runoff from a given field into an adjacent waterway.

26 Jarvie et al., *supra* note 21.

27 Meals and Dressing, *supra* note 24, at 4.

28 Kreiling et al., *supra* note 23, at 30.

29 *Id.* at 1777.

Vermont, from 1980 to 1991, when the Rural Clean Water Program completed wastewater treatment upgrades and implemented various BMPs for managing dairy waste surrounding the eutrophic bay.[30] Despite a notable reduction of phosphorus loads to the bay, water quality did not significantly improve, and phosphorus levels contained in the sediment did not decline as much as expected.[31] For these and other watersheds, legacy phosphorus becomes an additional source of nutrient pollution that releases slowly over time, contributing to chronic algal blooms and long-term waterbody impairment.

Researchers have found many land use management programs designed to reduce phosphorus pollution do not adequately address and mitigate legacy phosphorus. A team of researchers from the University of Wisconsin-Madison studied phosphorus pollution in the Yahara River watershed in southern Wisconsin, evaluating the potential for agricultural land use scenarios to reduce nutrient pollution, taking into account legacy phosphorus.[32] Examples of these transformative land use practices include transitioning to perennial grassland for grazing, maintaining vegetated buffer strips, and reducing livestock densities.[33] Utilizing the Agro-IBIS agroecosystem model, the team examined a variety of scenarios up to the year 2070, including alternative climate trajectories.[34] Results of the study indicate that, across all climate scenarios, immediate and dramatic changes in land use are required to ensure that water quality improvement goals are met.[35] Researchers state that achieving these goals would require halving animal units while converting half of the land from annual row crops to perennial grassland.[36] The researchers concluded that to effectively combat the impact of legacy phosphorus, transformative land use changes need to be implemented without delay, especially in the face of a rapidly warming climate.[37]

Fortunately, given the persistence of legacy phosphorus and demonstrated need for changes in land use to improve overall water quality, promising strategies do exist. Long term, small-scale, targeted strategies for reducing phosphorus pollution within a single watershed have led to improvements in water quality.[38] Carvin and team tested a targeted strategy for reducing phosphorus in sediment and streams that focused conservation practices on high-contributing fields within

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30 Meals and Dressing, *supra* note 24, at 7.

31 *Id.*

32 Campbell et al., *supra* note 20, at 507.

33 *Id*.

34 *Id*.

35 *Id*. at 512.

36 *Id*. at 516-17.

37 *Id.* at 520.

38 Rebecca Carvin et al., *Testing a Two-Scale Focused Conservation Strategy for Reducing Phosphorus and Sediment Load from Agricultural Watersheds*, 73 J. SOIL & WATER CONSERVATION 298 (2018).

a small watershed located in the hilly Driftless Area of south central Wisconsin.[39] The team's research objective was to test whether their targeted land conservation strategy could achieve quantifiable reductions in sediment phosphorus loads within the treatment watershed.[40] Dane County Land Conservation Division partnered with farmers in the treatment watershed to implement field-scale conservation practices over a decade (2006 to 2016) to reduce phosphorus runoff, including no-till row crop farming, fencing, continuous vegetative cover, and streambank stabilization.[41] Researchers found significant reduction in phosphorus loading in the treatment watershed compared to the similarly sized and situated control watershed.[42] This study's results suggest that targeted land conservation practices can effectively improve water quality in a small-scale watershed.

Green Bay, Wisconsin is one area severely affected by phosphorus pollution and HABs that researchers believe would respond favorably to targeted land conservation and nutrient management practices. Toxic algal blooms resulting from excess nutrient loads were reported in Green Bay as early as 1938, and studies from the early 1990s revealed rural nonpoint source pollution as the source for 74% of phosphorus and 91% of total suspended solid loads to the bay.[43] Achieving the total maximum daily load ("TMDL")[44] for phosphorus in Green Bay will require a 40% reduction in phosphorus, with agricultural phosphorus as the primary reduction target.[45] According to Klump and team, this 40% reduction goal is achievable if phosphorus in soil is reduced to 1970s levels by implementing conservation management practices like cover cropping and reduced and no-till farming.[46]

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39 *Id.*

40 *Id.* at 299.

41 *Id.* at 300.

42 *Id.* at 306.

43 Hallett J. Harris et al., *The Green Bay Saga: Environmental Change, Scientific Investigation, and*

Watershed Management, 44 J. GREAT LAKES RSCH. 829-30, 832 (2018).

44 "A TMDL is the calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant." *Impaired Waters and TMDLs: Overview of Listing Impaired Waters under CWA Section 303(d)*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/tmdl/overview-total-maximum-daily-loads-tmdls#1 (last updated Nov. 14, 2023).

45 J. Val Klump, former Dean and Professor Emeritus, Sch. of Freshwater Sci. at Univ. of Wis.-Milwaukee, Conf. Panel Presentation at Phosphorus: Lessons from 10+ Years of Numeric Standards for Wisconsin's Waters (Feb. 7, 2023) in UW-MILWAUKEE CENTER FOR WATER POLICY, 2023 PHOSPHORUS CONFERENCE REPORT (May 2023), https://pconference.files.wordpress.com/2023/05/2023-p-conference-report-4.pdf at 11; Univ. of Wis.-Milwaukee Ctr. for Water Pol'y, *Panel 2: Land Use, Phosphorus Run-off, and Understanding the Physical System*, YOUTUBE (Feb. 7, 2023 at 6:30), https://www.youtube.com/watch?v=bQ-twWV8o7s&list=PLAyMzPFzDwiLXp4-Talfpv1PI-OzHiVAz&index=3.

46 J. Val Klump, former Dean and Professor Emeritus, Sch. of Freshwater Sci. at Univ. of Wis.-Milwaukee, Conf. Panel Presentation at Phosphorus: Lessons from 10+ Years of Numeric Standards for Wisconsin's Waters (Feb. 7, 2023) in UW-MILWAUKEE CENTER FOR WATER POLICY, 2023

The most effective nutrient reduction strategy is one designed to target "hot spots," or areas within a watershed with high phosphorus yields.[47] For instance, Klump and team's research indicates Green Bay will be responsive to such strategies, where significant reduction in nutrient loading is expected to directly translate to water quality improvement.[48] However, successful implementation of nutrient reduction plans will require collaboration between local watershed communities, scientific researchers, resource agencies, producers, and additional stakeholders. Furthermore, regulators must be mindful of on-the-ground dynamics described above that scientists have revealed about legacy phosphorus when crafting and adapting phosphorus management strategies and regulatory schemes.

II. THE CWA'S FRAMEWORK FOR REGULATING PHOSPHORUS

Congress's primary goal in passing the CWA was to restore and preserve the nation's waters to a fishable and swimmable quality[49] by prohibiting unauthorized discharges of pollution into navigable waters of the United States.[50] Congress charged the EPA with administering the CWA in cooperation with delegated states and tribes.[51] This section explains: (A) the CWA's cooperative federalism framework for regulating phosphorus pollution with federal, state, and Tribal participation; (B) section 402 NPDES permit system; (C) section 304 federal pollution control guidelines; (D) section 303 state and Tribal water quality standards; and (E) section 319 nonpoint source management program.

A. CWA's Cooperative Federalism Framework: the EPA, States, and Tribes

The CWA authorizes the EPA to delegate regulatory authority to states and tribes to set water quality standards[52] and manage point and nonpoint source pollution[53] with EPA guidance and approval. Unless expressly prohibited, states and tribes are permitted to adopt pollution control standards that are more stringent than those established in the CWA.[54] Once approved, the EPA oversees

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PHOSPHORUS CONFERENCE REPORT (May 2023), https://pconference.files.wordpress.com/2023/05/2023-p-conference-report-4.pdf at 11 (implementing 50% reduced till and 40% no-till, relative to the baseline of 90% conventional till farming, in the Green Bay watershed with added cover cropping would reduce phosphorus loads to the bay by 43.4%.).

47 *Id.* at 12.

48 J. Val Klump et al., *Evidence of Persistent, Recurring Summertime Hypoxia in Green Bay, Lake Michigan*, 44 J. GREAT LAKES RSCH. 841, 848 (2018).

49 33 U.S.C. § 1251(a) (2023).

50 33 U.S.C. § 1311(a) (2023).

51 33 U.S.C. §§ 1251(b), (d), (g), 1377(e) (2023).

52 33 U.S.C. §§ 1313, 1377(a), (e) (2023).

53 33 U.S.C. §§ 1342(a)(5), (b), 1329, 1377(e) (2023).

54 33 U.S.C. § 1370 (2023); Albuquerque v. Browner, 97 F.3d 415, 423 (10th Cir. 1996) ("tribes

and partially funds state and tribal regulatory programs with money appropriated by Congress.[55] Through this structure of shared management, Congress recognizes states' and tribes' primary roles in protecting and restoring waters within their jurisdiction.[56]

First, for the EPA to delegate authority to a state, the state must adopt water quality standards and submit them to the EPA for approval.[57] The EPA will approve a state's water quality standards if they are determined to be consistent with applicable requirements of the CWA.[58] If found inconsistent, a state has the opportunity to make changes to its water quality standards to meet applicable requirements.[59] If a state fails to adopt and submit or make changes to water quality standards within the allotted time, the EPA will prepare and publish proposed regulations setting forth water quality standards for a state in accordance with CWA requirements.[60] Federally promulgated water quality standards that are supplemental to state water quality standards are applicable in four out of the five states included in this article's comparative analysis.[61]

The EPA may also authorize a state to administer NPDES permit programs for point source discharges into navigable waters within a state's jurisdiction if the state is deemed capable of administering such a program.[62] NPDES or state equivalent permits set limits for point source discharges, require monitoring and reporting, and contain other provisions to ensure discharges do not unduly impair water quality or public health.[63] A state desiring to administer its own NPDES permit program may submit to the EPA a "full and complete description of the program it proposes to establish and administer under State law or under an interstate compact."[64] In addition, the state must include a statement from "the attorney general (or the attorney for those State water pollution control agencies which have independent legal counsel), or from the chief legal officer in the case

may establish water quality standards that are more stringent than those imposed by the federal government . . . because it is in accord with powers inherent in Indian Tribal sovereignty.").

55 33 U.S.C. §§ 1256, 1377(e) (2023).

56 33 U.S.C. §§ 1251(b), (g), 1377(a) (2023).

57 33 U.S.C. § 1313 (2023).

58 *Id.*

59 *Id.*

60 *Id.*

61 Federally promulgated water quality criteria for the Great Lakes system apply to Wisconsin and Minnesota. 40 C.F.R. § 132.6 (1995); *Water Quality Standards Regulations: Minnesota*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/wqs-tech/water-quality-standards-regulations-minnesota (last updated Nov. 9, 2023). Federally promulgated water quality criteria for specific pollutants also apply to Florida (toxics criteria) and Hawaii (bacteriological criteria). 40 C.F.R. §§ 131.36, 41, 44 (1983).

62 33 U.S.C. § 1342(a)(5) (2023).

63 *NPDES Permit Basics*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/npdes/npdes-permit-basics (last updated Dec. 11, 2023).

64 33 U.S.C. § 1342(b) (2023).

of an interstate agency," that the laws of the state or interstate compact provide adequate authority to carry out the described program.[65] The EPA shall approve a state's proposed NPDES permit program unless the state fails to show adequate authority exists.[66] Forty-seven states have EPA-approved NPDES programs.[67]

While CWA sections 303 and 402 authorize the EPA to delegate this authority to states, CWA section 518 authorizes the EPA to treat qualified tribes in a similar manner as a state ("TAS") with authority over water within Tribal jurisdiction.[68] Tribes that are eligible for TAS have a governing body that carries out substantial governmental duties and powers, seek to manage and protect water resources within their jurisdictions, and are reasonably expected to be capable of carrying out the management and protection of water resources in a manner consistent with the CWA.[69] Tribes may receive TAS authority for, among other actions, establishing water quality standards, listing impaired waters, administering NPDES permits, and managing nonpoint management programs.[70] Out of 574 federally recognized tribes,[71] the EPA has authorized eighty-four for TAS under the CWA for establishing water quality standards.[72] Forty-nine of those delegated tribes have EPA-approved water quality standards programs[73] and nineteen have adopted numeric criteria for phosphorus for at least one type of waterbody.[74]

B. CWA Section 402 NPDES Permit System

The EPA has not set technology standards to control phosphorus pollution from the most significant point sources (top industries, CAFOs, and municipal sewage) and has left it up to states and tribes with delegated programs. Under CWA section 402, the EPA or any state or tribe with an approved NPDES program administers

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65 *Id.*

66 *Id.*

67 *NPDES State Program Authority*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/npdes/npdes-state-program-authority (last updated Feb. 26, 2024).

68 33 U.S.C. § 1377(a), (e) (2023).

69 33 U.S.C. § 1377(e) (2023).

70 33 U.S.C. § 1377(e), (f) (2023).

71 *Tribal Leaders Directory*, U.S. DEP'T OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS (Jan. 8, 2024), https://www.bia.gov/service/tribal-leaders-directory#:~:text=p.-,There%20are%20currently%20574%20Federally%20Recognized%20Tribes%20as%20of%2001,on%20the%20federal%20acknowledgment%20process.

72 *Tribes Approved for Treatment as a State (TAS)*, U.S. ENV'T PROT. AGENCY (Apr. 2023), https://www.epa.gov/tribal/tribes-approved-treatment-state-tas.

73 *EPA Actions on Tribal Water Quality Standards and Contacts*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/wqs-tech/epa-actions-tribal-water-quality-standards-and-contacts (last updated Apr. 12, 2024).

74 *State-Specific Water Quality Standards Effective Under the Clean Water Act (CWA)*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/wqs-tech/state-specific-water-quality-standards-effective-under-clean-water-act-cwa (last updated May 3, 2023).

permits for point source discharges to navigable waters.[75] Only three states, Massachusetts, New Hampshire, and New Mexico, do not have authorized state NPDES permit programs.[76] As of 2024, no tribes have received authorization to administer NPDES permit programs.[77] NPDES permit programs control phosphorus and other point source discharges through effluent limits that are either technology-based or water quality-based.[78] Water quality-based effluent limits are set according to state and Tribal water quality standards; these are discussed below in Section D.

The CWA's goal is to have point sources use technology to eliminate all pollution discharged to navigable waters.[79] However, while significant advances have been made in the past fifty years, in some situations, technologies are still insufficiently advanced to attain this goal.[80] In practice, the EPA reviews available technology for a specific industry and establishes national technology-based effluent limits as performance standards.[81] These effluent limits represent the minimum level of pollution control required in NPDES permits.[82] Absent a national industry-based standard, technology-based effluent limits can be set by a permit writer, using their best professional judgment, on a case-by-case basis.[83]

Meanwhile, it is estimated that industrial facilities discharged more than 153 million pounds of total phosphorous to surface waters of the United States in 2018.[84] The top three dischargers were the meat and poultry products industry (i.e., slaughterhouses) (27%), hospitals (16%), and iron and steel manufacturing (13%).[85] See Figure 1 below for a point source category industry breakdown of phosphorus discharge in 2018. Despite their status as leading phosphorus dischargers, the EPA has not set effluent phosphorus limits for any of these three

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75 33 U.S.C. § 1342(a)(5), (b) (2023).

76 *NPDES State Program Authority*, *supra* note 67.

77 *Clean and Safe Water in Indian Country Key Program Areas for Developing Tribal Clean Water Programs,* U.S. ENV'T PROT. AGENCY, https://www.epa.gov/tribalwater/key-program-areas-developing-tribal-clean-water-programs (last updated Jan. 29, 2024).

78 33 U.S.C. § 1311(b)(1) (2023).

79 33 U.S.C. §§ 1251(a)(1), (6), 1311(a), (b)(1)(A) (2023).

80 *Technology-based Effluent Limitations for Publicly Owned Treatment Works (POTWs)*, U.S. ENV'T PROT. AGENCY, Slide 3, https://www3.epa.gov/npdes/pwtraining/potws/story.html (last accessed Aug. 13, 2023) (water quality-based effluent limitations are used where technology-based effluent limits are not adequate to meet water quality standards).

81 33 U.S.C. § 1314(b) (2023); *see also National Pollutant Discharge Elimination System (NPDES): Permit Limits–TBELs and WQBELs*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/fnpdes/permit-limits-tbels-and-wqbels (last updated Oct. 3, 2022).

82 40 C.F.R. § 125.3(a) (1979).

83 *NPDES: Permit Limits–TBELs and WQBELs*, *supra* note 81.

84 This figure is based on industries' discharge monitoring report data and the EPA's Nutrient Estimation Tool, which identifies and estimates nutrient discharges for industries whose nutrient discharges may be underrepresented in the discharge monitoring report dataset. OFFICE OF WATER, U.S. ENV'T PROT. AGENCY, EFFLUENT GUIDELINES PROGRAM PLAN 14, at 5-4 (Jan. 2021).

85 *Id.* at 5-5.

industries.[86] Instead, the EPA has only published phosphorus effluent limitation guidelines for five point source categories, none of which are identified as leading phosphorus dischargers:[87] fertilizer manufacturing, phosphate manufacturing, glass manufacturing, pharmaceutical manufacturing, and coil coating.[88] In December 2023, however, the EPA proposed a new regulation to revise wastewater discharge standards for the meat and poultry products industry, and conducted public hearings on the proposed revision in January 2024.[89]

The EPA also published nutrient effluent limitation guidelines for Concentrated Animal Feeding Operations ("CAFOs") that regulate a CAFO's "production area" (i.e., animal confinement and manure storage area) and "land application area" (i.e., area where manure and process wastewater is applied).[90] Discharge of manure, litter, or process wastewater pollutants into waters of the United States is generally prohibited from the production area.[91] While the EPA has not established numeric phosphorus effluent limits for CAFO discharges from the land application area, it instead requires CAFOs to follow BMPs when spreading manure and process wastewater.[92] CAFOs must develop and implement NMPs that estimate the potential for nitrogen and phosphorus runoff to surface waters on a field-specific basis.[93] In 2023, the EPA announced its intent to initiate a comprehensive study of CAFOs to determine whether to revise effluent limitation

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86 *Effluent Limitations Guidelines and Standards (ELG) Database*, U.S. ENV'T PROT. AGENCY, https://owapps.epa.gov/elg/ (last accessed Aug. 13, 2023).

87 According to Figure 1, which provides an industry breakdown of the top ten dischargers of phosphorus from 2018. OFFICE OF WATER, U.S. ENV'T PROT. AGENCY, *supra* note 84, at 5-5.

88 *ELG Database*, *supra* note 86.

89 *Meat and Poultry Products Effluent Guidelines – 2024 Proposed Rule*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/eg/meat-and-poultry-products-effluent-guidelines-2024-proposed-rule (last updated Dec. 15, 2023).

90 U.S. ENV'T OFFICE OF WATER, PROT. AGENCY, EFFLUENT GUIDELINES PROGRAM PLAN 15, at 6-2 (Jan. 2023).

91 40 C.F.R. § 412.31(a) (2003).

92 *See id.* § 412.31(b).

93 *Id.* § 412.4(c)(1).

guidelines for this point source category.[94]

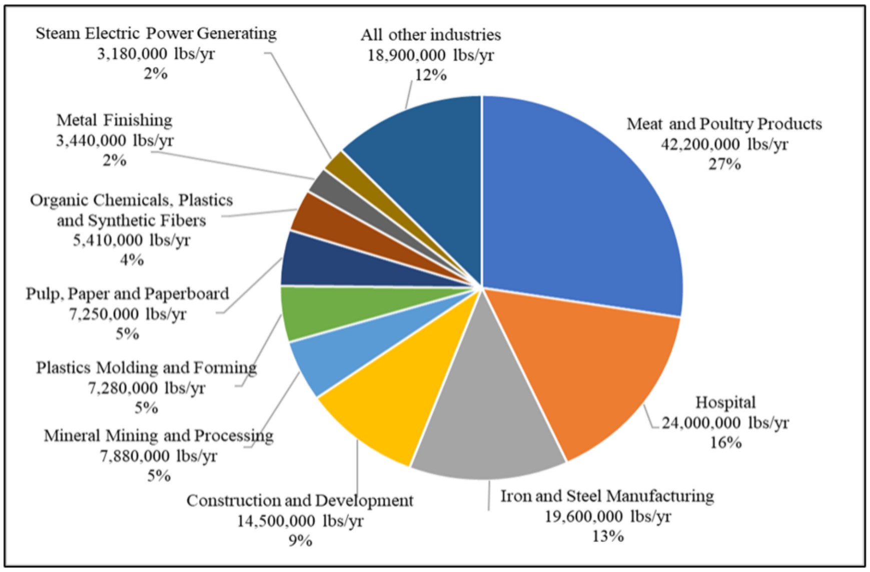

Figure 1. Top Ten Point Source Categories Discharging Total Phosphorus in 2018[95]

Another significant source of phosphorus is wastewater treated by publicly owned treatment works ("POTWs"), which collect and treat human sewage (and stormwater if the community uses combined sewers) before discharging the effluent. Although EPA created secondary treatment standards for POTWs with numeric effluent limits for biological oxygen demand and total suspended solids (30-day average of 30 mg/L and 7-day average of 45 mg/L) and pH (maintain a pH range between 6 to 9 standard units),[96] the EPA has not set secondary treatment standards for phosphorus.[97] One region of the United States is exceptional in this regard due to an international agreement. The Great Lakes Water Quality Agreement between the United States and Canada contains numeric nutrient effluent limits for municipal wastewater treatment facilities within Great Lakes basins that discharge 1 million liquid gallons or more per day.[98] For POTWs in the basins of Lake Superior, Lake Michigan, and Lake Huron, the maximum effluent total phosphorus limit is 1 mg/L, while for POTWs

94 OFFICE OF WATER, U.S. ENV'T PROT. AGENCY, *supra* note 90, at 1-1, 6-3, A-1 to A-3.

95 OFFICE OF WATER, U.S. ENV'T PROT. AGENCY, *supra* note 84, at 5-5.

96 40 C.F.R. § 133.102 (1984); 40 C.F.R. § 122.44(a) (1983); 40 C.F.R. § 125.3 (1979) (requiring NPDES permits for POTWs to include technology-based effluent limits based on secondary treatment); *see also Technology-based Effluent Limitations for POTWs*, *supra* note 80.

97 40 C.F.R. § 133.102 (1984).

98 The Great Lakes Water Quality Agreement, U.S.-Can., Annex 3(2)(a), Nov. 22, 1978, 1153 U.N.T.S. 1979.

in the basins of Lake Ontario and Lake Erie, the maximum effluent total phosphorus limit is 0.5 mg/L.[99]

Additionally, Great Lakes basin states may exercise their authority under CWA section 510 (a savings clause preserving state authority to regulate pollution discharges and protect water quality) to set supplemental standards for POTWs within their jurisdictions, including nutrient effluent limits.[100] For instance, POTWs in Wisconsin discharging more than 150 pounds of total phosphorus per month must meet a monthly average effluent limit of 1 mg/L (1,000 ug/L) of total phosphorus.[101] Since the EPA refuses to regulate phosphorus discharges from POTWs on a national scale, any NPDES permit program containing nutrient effluent limitations for POTWs outside the Great Lakes basin are based exclusively on state and Tribal water quality standards or performance standards. State and Tribal water quality standards and effluent limits are discussed in further detail in Section D.

Dissatisfied with this patchwork of regulations, in 2007, the Natural Resources Defense Council along with ten other organizations petitioned the EPA to establish new technology-based nutrient limits as part of the secondary treatment standards for POTWs.[102] In 2012, the EPA denied this request, stating "a uniform set of nationally applicable, technology-based nutrient limits is not warranted at this time" due to cost and feasibility constraints.[103] As of December 2022, there were no national technology-based nutrient effluent limitations for POTWs.[104] However, the EPA undertook a national survey of POTWs from 2019 to 2021 to evaluate nutrient removal.[105] "Survey results to date show more than 1,000 POTWs with different biological treatment types (including both conventional and advanced treatment technologies) can achieve effluent total nitrogen of 8 mg/L and total phosphorus of 1 mg/L."[106] Figure 2 provides a national breakdown of large POTWs (with a population served of at least 750 individuals and a design capacity flow of at least 1 million gallons per day) reporting effluent nutrient totals

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99 *Id.*

100 *Technology-based Effluent Limitations for POTWs*, *supra* note 80; 40 C.F.R. § 122.44(a) (1983) (requiring NPDES permits to contain technology-based effluent limitations and standards); 40 C.F.R. § 125.3(a)(1) (1979) (requiring NPDES permits for POTWs to include technology-based effluent limits based on secondary treatment); 40 C.F.R. § 133 (1984) (secondary treatment regulation).

101 WIS. ADMIN. CODE NR § 217.04(1) (2022).

102 Letter from Michael H. Shapiro, Deputy Assistant Adm'r, U.S. EPA Office of Water, to Ann Alexander, Att'y, Nat. Res. Def. Council (Dec. 14, 2012) (on file with the U.S. EPA Office of Water).

103 *Id.*

104 *Overview of Effluent Limitations for Nutrients*, U.S. ENV'T PROT. AGENCY, https://www3.epa.gov/npdes/nutrientpwtraining/intro-part2/story.html (last accessed Aug. 13, 2023).

105 *National Study of Nutrient Removal and Secondary Technologies*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/eg/national-study-nutrient-removal-and-secondary-technologies#accomplished (last updated Oct. 20, 2022).

106 *Id.*

discharged for total nitrogen and total phosphorus from 2019 to 2021.

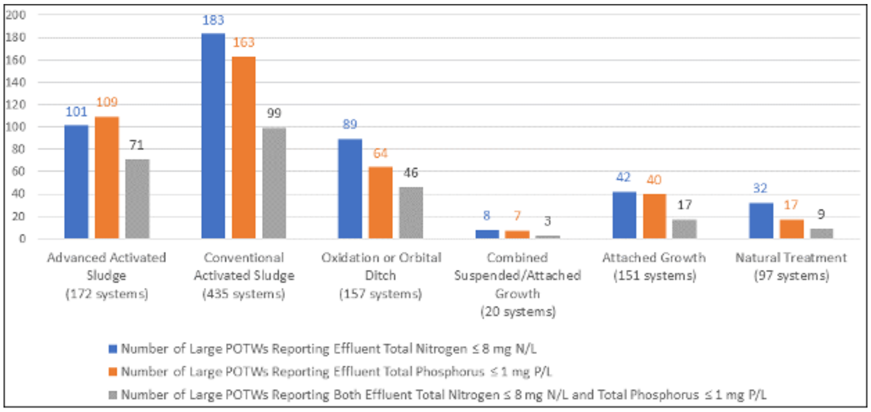

Figure 2. Number of Large POTWs Reporting Effluent Total Nitrogen ≤ 8 mg/L and Total Phosphorus ≤ 1mg/L[107]

The data reported show that technology exists to meet these nutrient limits, suggesting EPA should move forward with setting them as secondary treatment standards for POTWs. In the meantime, delegated states and tribes are the primary regulators, should they choose to exercise their authority.

C. CWA Section 304 Federal Pollution Control Guidelines

While states and tribes with delegated authority to set water quality standards under CWA section 303 take the lead in establishing phosphorus limits for different watertypes, the EPA guides and reviews their work. CWA Section 304 directs the EPA to develop and publish criteria for protection of water quality and human health,[108] and pursuant to this mandate, the EPA published its final Ambient Water Quality Criteria to Address Nutrient Pollution in Lakes and Reservoirs in 2021.[109] The EPA recommends numeric nutrient criteria for phosphorus and nitrogen to limit nutrient concentrations in fresh water and maintain and protect water quality.[110] The EPA provides various criterion models to assist delegated states and tribes in identifying numeric nutrient criteria for total phosphorus and nitrogen.[111] The criterion models are based on an ecological and health risk assessment evaluating the link between nutrient concentrations and the protection of three designated uses: aquatic life, recreation, and drinking water

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107 *Id.*
108 33 U.S.C. § 1314 (2023).
109 OFFICES OF SCI. & TECH. AND WATER, U.S. ENV'T PROT. AGENCY, AMBIENT WATER QUALITY CRITERIA TO ADDRESS NUTRIENT POLLUTION IN LAKES AND RESERVOIRS (Aug. 2021).
110 *Id.* at viii.
111 *Id.*

supply.[112]

For rivers and streams, the EPA published nutrient criteria for fourteen distinct ecoregions.[113] Wisconsin, for instance, is covered by ecoregions seven (Mostly Glaciated Dairy Region) and eight (Nutrient-Poor, Largely Glaciated Upper Midwest and Northeast).[114] When developing ecoregion specific numeric criteria, the EPA considers, among other factors, the region's historical and recent nutrient information, data from reference sites (areas least disturbed by anthropogenic causes), and likely downstream effects of the criteria.[115] The total phosphorus numeric criteria range from 10 to 128 ug/L.[116] The EPA publishes these ambient water quality standards as nonbinding recommendations delegated states and tribes may adopt when creating their water quality standards and nonpoint management programs.[117]

D. CWA Section 303 State and Tribal Water Quality Standards

Regulating phosphorus pollution through water quality-based effluent limits and TMDLs is not possible without promulgation of water quality criteria. CWA section 303 directs each state and authorized tribe to adopt and submit for approval to the EPA water quality standards to protect public health and enhance surface water quality.[118] There are three central components of water quality standards. First, a state or tribe establishes the designated use(s) for the navigable waterbody.[119] Next, the state or tribe sets the water quality criteria required to support the designated use(s).[120] Third, once a designated use has been attained and the water quality standard achieved, the state or tribe must maintain the water quality in accordance with the CWA's antidegradation policy.[121] Delegated states

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112 *Id.* at viii-ix.

113 *Ecoregional Nutrient Criteria for Rivers and Streams*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrient-policy-data/ecoregional-nutrient-criteria-rivers-and-streams (last updated Nov. 30, 2023).

114 *Id.*

115 OFFICES OF WATER AND SCI. & TECH., U.S. ENV'T PROT. AGENCY, AMBIENT WATER QUALITY CRITERIA RECOMMENDATIONS: RIVERS AND STREAMS IN NUTRIENT ECOREGION VIII 2 (Dec. 2021).

116 Regarding the upper value of 128 ug/L: "This value appears inordinately high and may either be a statistical anomaly or reflects a unique condition. In any case, further regional investigation is indicated to determine the sources, i.e., measurement error, notational error, statistical anomaly, natural enriched conditions, or cultural impacts." *Summary Table for the Rivers & Streams Ecoregional Nutrient Criteria Documents*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/system/files/documents/2021-07/ecoregion-table-rivers-streams.pdf (last accessed Aug. 8, 2023).

117 OFFICES OF SCI. & TECH. AND WATER, U.S. ENV'T PROT. AGENCY, *supra* note 109; *Ecoregional Nutrient Criteria for Rivers and Streams*, *supra* note 113.

118 33 U.S.C. §§ 1313(a), (c), 1377(e) (2023).

119 *Id.* § 1313(c)(2)(A).

120 *Id.* § 1313(c)(2)(B).

121 *Id.* § 1313(d)(4)(B); 40 C.F.R. § 131.12 (2024) (when states exercise their delegated authority to establish water quality standards, they are required to incorporate antidegradation policies and

and tribes that administer EPA-approved water quality standards programs must review and make necessary revisions to their water quality standards at least once every three years; the review and any revisions must be submitted to the EPA.[122]

Examples of designated uses of waterbodies include recreation (e.g., swimming and boating), fishing (e.g., coldwater fisheries), and public drinking water supply.[123] Water quality criteria set to protect designated uses can be narrative or numeric. Narrative criteria often describe desired conditions of a waterbody being "free from" certain materials or substances.[124] While permit writers can translate these narrative standards into water quality-based effluent limits in NPDES permits, numeric criteria for total nitrogen and total phosphorus are key to attaining and preserving a waterbody's designated uses.

States that have adopted numeric nutrient criteria do so by waterbody type (river/streams, lakes/reservoirs, and estuaries).[125] Numeric nutrient criteria become the basis for water quality-based nutrient effluent limits contained in NPDES permits. Water quality-based effluent limitations are driven by the CWA's goal to attain fishable, swimmable waters[126] and apply to waterbodies where technology-based limits are inadequate to achieve water quality standards.[127] Water quality models are used to assess the impact a pollutant discharge has on a receiving waterbody and establish appropriate discharge limits to maintain water quality.[128]

Once adopted and approved by the EPA, states' and tribes' numeric nutrient criteria enable effective monitoring for impairment due to phosphorus and provide the basis for more stringent effluent limitations. Delegated states and tribes are required under section 303(d) to develop lists of impaired waters, cataloging waterbodies that either do not meet the jurisdiction's water quality standards or are in danger of becoming so impaired.[129] Delegated states and tribes must submit

implementation methods consistent with three tiers of protection: (1) maintain water quality to protect existing uses; (2) maintain high-quality waters that exceed fishable/swimmable quality unless degradation is necessary to accommodate important economic or social development in the area; and (3) protect and maintain high-quality Outstanding National Resource Waters without exception).

122 33 U.S.C. § 1313(c).

123 *What are Water Quality Standards?*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/standards-water-body-health/what-are-water-quality-standards (last updated Oct. 30, 2023).

124 *Id.;* WIS. ADMIN. CODE NR § 102.04(1)(b) (2022). (E.g., "Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state.").

125 *Progress Towards Adopting Total Nitrogen and Total Phosphorus Numeric Water Quality Standards*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrient-policy-data/progress-towards-adopting-total-nitrogen-and-total-phosphorus-numeric-water (last updated Nov. 30, 2023).

126 *Technology-based Effluent Limitations for POTWs*, *supra* note 80.

127 *NPDES: Permit Limits–TBELs and WQBELs*, *supra* note 81.

128 OFFICE OF WATER, U.S. ENV'T PROT. AGENCY, COMPENDIUM OF STATE AND REGIONAL NPDES NUTRIENT PERMITTING APPROACHES 1 (July 2022).

129 33 U.S.C. § 1313(d) (2023).

their lists of impaired waters to the EPA for approval every two years.[130] Within their 303(d) lists, delegated states and tribes identify which pollutants are causing impairment and establish a priority ranking system for waterbody restoration based on the severity of pollution and the waterbody's designated use.[131] Once a waterbody is placed on a 303(d) list, the regulator should set water quality-based effluent limitations according to TMDLs, which are calculated as maximum pollutant levels allowable while still achieving applicable water quality standards.[132]

Despite tribes' delegated authority to set water quality standards, for a variety of reasons, many have not yet done so. The EPA estimates approximately 76,000 miles of rivers and streams and 1.9 million acres of lakes, reservoirs, and open surface waters within Tribal reservations are lacking EPA-approved water quality standards under the CWA.[133] In an attempt to fill this regulatory gap, the EPA proposed a rule in May 2023 to establish federal baseline water quality standards for Tribal reservation waters to which water quality criteria do not already apply.[134] Still, this proposed rule does not set a numeric phosphorus limit outright.[135] Instead, the EPA proposed narrative criteria covering nonconventional pollutants (including phosphorus)[136] with proposed options for numeric translation of narrative criteria.[137] Regional administrators would thus be required to translate narrative criteria to numeric limits "as necessary" for specific water bodies "as needed" for all purposes under the CWA.[138] The EPA's baseline water quality standards would only remain in effect until a delegated tribe adopted their own.[139]

E. CWA Section 319 Nonpoint Source Management Program

Much of the nation's phosphorus water pollution originates from nonpoint

130 *Statute and Regulations Addressing Impaired Waters and TMDLs*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/tmdl/statute-and-regulations-addressing-impaired-waters-and-tmdls (last updated Aug. 11, 2023).

131 *Id.*

132 Federal Baseline Water Quality Standards for Indian Reservations, 88 Fed. Reg. 29,496, 29,499 (May 5, 2023) (to be codified at 40 C.F.R. pts. 131, 230, 233); 33 U.S.C § 1313(d)(1)(C).

133 *Id.*

134 The proposed rule's public comment period closed on August 3, 2023. 88 F.R. 29496 (2023).

135 *Id.*

136 88 Fed. Reg. 29496(V)(B)(2).

137 88 Fed. Reg. 29496, 29506 (proposed May 5, 2023); see section (V)(B)(3)(A) (options range from using EPA's national recommended water quality criteria, site-specific analyses, numeric criteria developed by the tribe but not yet EPA-approved, numeric limits in effect for adjacent states or tribes, and water quality criteria for the Great Lakes system where applicable).

138 *Id.* at 29496(V)(B)(3).

139 *Promulgation of Tribal Baseline Water Quality Standards Under the Clean Water Act*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/wqs-tech/promulgation-tribal-baseline-water-quality-standards-under-clean-water-act (last updated Oct. 26, 2023).

sources. Diffuse runoff of nutrients and sediment (mainly from agriculture that is categorized as a nonpoint source) is the single largest threat to water quality in the United States.[140] In a 2016 report on the national nonpoint source program, states reported that agricultural nonpoint pollution was the leading cause of water quality impairment for rivers and lakes.[141]

In 1987, Congress amended the CWA to include section 319 on nonpoint source management programs, addressing the need for nationwide nonpoint source management and reduction.[142] Section 319 compels each state and authorized tribe to prepare and submit to the EPA for approval an assessment report and a nonpoint source management program.[143] Each nonpoint assessment report shall: (a) identify navigable waters within the state or Tribal reservation which "cannot reasonably be expected to attain or maintain applicable water quality standards" without additional action to control and reduce nonpoint pollution; (b) identify types and amounts of nonpoint pollution found in those navigable waters; (c) establish BMPs and measures to control and reduce nonpoint pollution to the "maximum extent practicable"; and (d) describe state, Tribal, and local programs for controlling nonpoint pollution.[144] A nonpoint source management program contains the regulator's proposal for controlling nonpoint pollution and improving water quality for the navigable waters within the jurisdiction,[145] and also includes an assessment of financial needs and a projected schedule for implementation.[146]

The EPA is authorized under section 319 to award grants to delegated states and tribes to assist with the implementation of approved nonpoint source management programs.[147] In federal fiscal year 2022, the EPA awarded $178 million in section 319 grants[148] that funded 531 projects nationally.[149] Roughly half of those 531 projects addressed agricultural pollution, with 163 out of 274 projects (60%) resulting in agricultural pollutant load reductions.[150]

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140 Melissa K. Scanlan, *Adaptive Trading: Experimenting with Unlikely Partners*, 62 KAN. L. REV. 971, 972 (2014).

141 U.S. ENV'T PROT. AGENCY, NATIONAL NONPOINT SOURCE PROGRAM 10 (Oct. 2016), https://www.epa.gov/sites/default/files/2016-10/documents/nps_program_highlights_report-508.pdf.

142 *319 Grant Program for States and Territories*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nps/319-grant-program-states-and-territories (last updated July 17, 2023) [hereinafter *319 Grant Program for States and Territories*].

143 33 U.S.C. §§ 1329, 1377(e) (2023).

144 *Id.* § 1329(a).

145 *Id.* § 1329(b).

146 *Id.*

147 33 U.S.C. § 145(h).

148 *319 Grant Program for States and Territories*, *supra* note 142.

149 *Nonpoint Source (NPS) Watershed Projects: Interactive Map and Reporting*, U.S. ENV'T PROT. AGENCY, https://ordspub.epa.gov/ords/grts/f?p=109:940:21436810052157::::P940_WIDGET:N (last accessed June 1, 2023).

150 *Id.*

States that receive section 319 grants for agricultural and other nonpoint source pollution control must comply with EPA's Nonpoint Source Program and Grants Guidelines ("Guidelines").[151] The Guidelines were revised in 2013 to require a set-aside of at least 50% of a state's section 319 award for watershed-based plans that address nonpoint source pollution in impaired watersheds.[152] The remaining allocation is directed toward nonpoint source program planning, assessment, and management.[153]

Tribes must meet four conditions to be eligible to receive section 319 grants: (1) be federally recognized; (2) have an approved nonpoint source assessment report; (3) have an approved nonpoint source management program; and (4) be approved for TAS.[154] From 2013 to 2018, seventy-one out of 160 projects (44%) funded by competitive section 319 grants to tribes addressed nutrient pollution.[155] For example, the Oneida Nation's strategy for controlling nutrient pollution includes agricultural BMPs such as riparian buffers and converting more than 600 acres of cropland into pasture for rotational grazing.[156]

While the CWA provides for federal regulation of point source discharges of phosphorus into waters of the United States, the EPA has not used its power to establish national standards, which shifts the burden to states and tribes. For nonpoint pollution, it is up to delegated states and tribes to manage these diffuse sources of phosphorus dominating water pollution nationwide. This type of regulation requires cooperation between state and/or Tribal agency partners, local watershed planners, and nonpoint source producers.

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151 These guidelines are not directed to Tribal NPS management programs; the EPA implements separate NPS guidelines for tribes. U.S. ENV'T PROT. AGENCY, NONPOINT SOURCE PROGRAM AND GRANTS GUIDELINES FOR STATES AND TERRITORIES 1 (Apr. 12, 2013); U.S. ENV'T PROT. AGENCY, OFFICE OF WATER, HANDBOOK FOR DEVELOPING AND MANAGING TRIBAL NONPOINT SOURCE POLLUTION PROGRAMS UNDER SECTION 319 OF THE CLEAN WATER ACT (Feb. 2010).

152 U.S. ENV'T PROT. AGENCY, NONPOINT SOURCE PROGRAM AND GRANTS GUIDELINES, *supra* note 151, at 23.

153 *Id.* at 23-24.

154 *Tribal Nonpoint Source Program*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nps/tribal-nonpoint-source-program#elig (last updated Jan. 3, 2024) (as of 2024, there are 214 federally recognized tribes that have EPA-approved nonpoint source management programs under section 319).

155 U.S. ENV'T PROT. AGENCY, TRIBAL NONPOINT SOURCE PROGRAMS 3 (Aug. 2019); *Tribal Nonpoint Source Programs, a Report on Highlights of the § 319 Program*, U.S. ENV'T PROT. AGENCY, 3, Aug. 2019, https://www.epa.gov/sites/default/files/2019-09/documents/tribalnpshighlights_aug19_final.pdf (under section 319, the EPA awards to eligible tribes both base grants to support the administration of Tribal nonpoint source programs and competitive grants to support projects that will directly protect or restore water quality. From 2015 to 2019, tribes received an annual average of $8.2 million of section 319 funding, which comprises approximately 5% of the national section 319 budget allocation).

156 *Tribal Nonpoint Source Programs, a Report on Highlights of the § 319* Program, U.S. ENV'T PROT. AGENCY, at 6.

III. Wisconsin's Approach to Phosphorus Management

Wisconsin is recognized as a leader in the nation for its cooperative agency approach to and financial investment in controlling phosphorus from nonpoint sources, as well as its innovative market-based techniques for regulatory compliance. In 2010, Wisconsin exercised its delegated authority to establish some of the nation's most comprehensive numeric water quality criteria for phosphorus. These standards are found in several parts of Wisconsin's Administrative Code: NR 102, NR 217, and revisions to NR 151.[157] Additionally, in October 2022, Wisconsin adopted NR 119, which created protocols for developing site-specific phosphorus criteria that are more or less stringent than applicable statewide standards.[158] Wisconsin also introduced market-based compliance options to engage point and nonpoint sources to improve water quality throughout a given watershed.[159]

This section reviews the major features of Wisconsin's phosphorus rules and compliance programs and discusses their impact, as evaluated by academic literature. This article offers an original analysis of a time series of data on Wisconsin's 303(d) impaired waters to examine whether the existence of numeric phosphorus criteria, along with the market-like mechanisms, has had any impact on listing waters impaired by phosphorus. We also assess data from the Wisconsin Department of Natural Resources ("WDNR") long-term trends monitoring program, which tracks phosphorus concentrations in the state's major river basins.

A. Wisconsin's Phosphorus Rules and Compliance Programs

Wisconsin began to voluntarily assess the need for and justify the development of numeric phosphorus standards earlier than most states. The EPA's 1998 strategy report[160] directing states to adopt and implement numeric nutrient criteria by December 2003 motivated the WDNR to conduct research with the United States Geological Survey on numeric phosphorus limits. They published papers in 2006[161] and 2008[162] that defined appropriate levels of phosphorus in Wisconsin's waters, providing a scientific basis for Wisconsin's numeric

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157 Wis. Admin. Code NR §§ 102 (2024), 151 (2023), 217 (2022).

158 Wis. Admin. Code NR § 119 (2022).

159 *See Wisconsin's Phosphorus Rule: Implementation*, Wis. Dep't Nat. Res., https://dnr.wisconsin.gov/topic/Wastewater/Phosphorus (last accessed Feb. 13, 2024) [hereinafter *Wisconsin's Phosphorus Rule: Implementation*].

160 *See* discussion *infra* Section IV.

161 Dale M. Robertson et al., U.S.G.S., Nutrient Concentrations and Their Relations to the Biotic Integrity of Wadeable Streams in Wisconsin, Professional Paper 1722 (2006).

162 Dale M. Robertson, Brian M. Weigel, and David J. Graczyk, U.S.G.S., Nutrient Concentrations and Their Relations to the Biotic Integrity of Nonwadeable Rivers in Wisconsin, Professional Paper 1754 (2008).

standards.[163] This research directly informed the numeric criteria the state adopted.[164]

Despite this work, a group of concerned environmental organizations pressured the WDNR to move faster in proposing numeric standards.[165] In 2009, environmental groups[166] gave notice to the EPA of their intent to sue under the CWA for the agency's failure to perform its nondiscretionary duty to promulgate numeric nutrient criteria for Wisconsin.[167] The letter cites to problems associated with algae in Wisconsin's waters ranging from economic loss, to public health dangers, and points to the EPA's clear determination that numeric nutrient standards are required to satisfy CWA provisions.[168] Meanwhile, in an attempt to compel the EPA to pressure the state to issue numeric standards, WDNR staff threatened to cease attempting to enforce the unenforceable – narrative nutrient criteria – in open violation of the CWA.[169] The combined pressure by environmental groups and WDNR staff was successful; in April 2010, the EPA issued a warning that it would promulgate federal standards if Wisconsin did not establish its own numeric phosphorus criteria by the end of the year.[170] The state was able to meet the EPA's short deadline.

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163 *Id.* at 2 (the USGS and WDNR used break point analyses to identify thresholds, or "breakpoints," where a "small change in nutrient concentrations corresponded to a relatively large change in [a waterbody's] biotic communities," thus reflecting its overall ecological integrity).

164 WIS. DEP'T NAT. RES., JUSTIFICATION FOR USE OF MONTHLY, GROWING SEASON, AND ANNUAL AVERAGING PERIODS FOR EXPRESSION OF WPDES PERMIT LIMITS FOR PHOSPHORUS IN WISCONSIN 6 (Apr. 30, 2012); *see also* WIS. DEP'T NAT. RES., GUIDANCE FOR IMPLEMENTING WISCONSIN'S PHOSPHORUS WATER QUALITY STANDARDS FOR POINT SOURCE DISCHARGES 60 (Feb. 8, 2017); Matthew Claucherty, Phosphorus Implementation Coordinator, Water Quality Bureau, WDNR, Conf. Panel Presentation at Phosphorus: Lessons from 10+ Years of Numeric Standards for Wisconsin's Waters (Feb. 7, 2023) in UW-MILWAUKEE CENTER FOR WATER POLICY, 2023 PHOSPHORUS CONFERENCE REPORT (May 2023), https://pconference.files.wordpress.com/2023/05/2023-p-conference-report-4.pdf at 7; Univ. of Wis.-Milwaukee Ctr. for Water Pol'y, *Panel 1: Setting the Stage – Wisconsin's Phosphorus Management Framework and Compliance Programs*, YOUTUBE (Feb. 7, 2023 at 10:30), https://www.youtube.com/watch?v=HHZZkg-U8XA&list=PLAyMzPFzDwiLXp4-Talfpv1PI-OzHiVAz&index=2.

165 *Phosphorus Water Quality Standards in Wisconsin*, MIDWEST ENV'T ADVOCATES, https://midwestadvocates.org/issues-actions/actions/phosphorus-water-quality-standards-in-wisconsin (last accessed Aug. 13, 2023).

166 Clean Water Action Council of Northeastern Wisconsin, Gulf Restoration Network, Milwaukee Riverkeeper, Prairie Rivers Network, River Alliance of Wisconsin, Sierra Club, and Wisconsin Wildlife Federation.

167 Letter from Elizabeth Lawton, Acting Exec. Dir. and Staff Att'y, Midwest Env't Advocates, and Albert Ettinger, Att'y, Env't Law & Pol'y Ctr., to Lisa Jackson, Adm'r, U.S. Env't Prot. Agency (Nov. 23, 2009) (on file with Midwest Env't Advocates).

168 *Id.* at 2, 4-5.

169 Telephone interview with Todd Ambs, Chair, Great Lakes Comm'n (Aug. 9, 2023) (on file with author).

170 *Phosphorus Water Quality Standards in Wisconsin*, *supra* note 165.

1. NR 102: Wisconsin's Phosphorus Rule Establishes Numeric Water Quality Criteria for Most of Wisconsin's Waters

Wisconsin adopted science-based numeric phosphorus criteria in 2010. NR 102 of Wisconsin's Administrative Code establishes specific numeric water quality criteria in the form of a total maximum phosphorus concentration.[171] Wisconsin's phosphorus criteria vary relative to the type of waterbody (e.g. lakes, rivers, streams, etc.) and whether the waters generally exhibit unidirectional flow.[172] The ranges of numeric criteria, measured by micrograms per liter (ug/L), are as follows: 75 – 100 ug/L for rivers and streams, 15 – 40 ug/L for reservoirs and lakes, 7 ug/L for Lake Michigan, and 5 ug/L for Lake Superior.[173] Notably, wetlands, lakes smaller than five acres, and "ephemeral streams" are excluded from these water quality criteria,[174] a regulatory gap that is ostensibly due to a shortage of agency resources and staff.[175] The state may also implement site-specific standards in circumstances where doing so is determined to be protective of the waterbody's designated use.[176]

2. NR 217: Wisconsin's Phosphorus Rule Empowers WDNR to Translate Water Quality Criteria into WPDES Permit Limits for Point Sources

The EPA authorized the WDNR to administer permits for the discharge of point source pollutants into waters of the state through the Wisconsin Pollution Discharge Elimination System ("WPDES") program.[177] Pursuant to this authority, the WDNR may include water quality-based phosphorus effluent limitations in permits where discharge from a point source "will cause, has the reasonable potential to cause or contribute to an exceedance of" the aforementioned water quality criteria.[178] Water quality-based phosphorus effluent limitations are established at the point of discharge and are calculated based on applicable numeric criteria for total phosphorus set in NR 102.[179]

The WDNR sets permit limits for phosphorus based on seasonal or annual average phosphorus concentrations as appropriate for different waterbodies.[180] Despite average annual phosphorus limits potentially obscuring a pollution

171 WIS. ADMIN. CODE NR § 102.06 (2022).

172 *Id.*

173 *Id.* § 102.06(3-5).

174 *Id.* § 102.06(6); *Id.* § 102.06(2) (regulations define ephemeral streams as those that only carry water "for a few days during and after a rainfall or snow event.").

175 WIS. DEP'T NAT. RES., WISCONSIN'S NONPOINT SOURCE PROGRAM MANAGEMENT PLAN FFY 2021-2025 10 (Apr. 8, 2021).

176 *Id.* § 102.06(7).

177 WIS. STAT. § 283.31 (2023).

178 WIS. ADMIN. CODE NR § 217.12(1) (2022).

179 *Id.*

180 WIS. DEP'T NAT. RES., JUSTIFICATION FOR USE, *supra* note 164.

problem, the WDNR determined that average limits calculated over shorter periods (e.g., a week) are impracticable given the seasonal variation in agricultural runoff that introduces nutrient contaminants like phosphorus.[181]

3. NR 151: Wisconsin's Phosphorus Rule Sets Performance Standards for Phosphorus Runoff Using a Phosphorus Index, and Requires Crop and Livestock Producers to Develop NMPs that Incorporate the Phosphorus Index

NR 151 of Wisconsin's Administrative Code sets performance standards and requirements for crop and livestock producers. All crop and livestock producers who apply manure or nutrients to agricultural fields, whether directly or via contract, must develop an NMP, with some caveats.[182] "Crop producers" are defined as "owners and operators of an operation" engaging in "crop-related agricultural practices" that are identified by statute.[183] These practices include maintaining orchards as well as raising grain, grass, fruit, nuts, berries, and vegetables.[184] "Livestock producers" are defined as owners and operators of feedlots, facilities, or pastures where animals are fed, confined, maintained, or stabled.[185]

Phosphorus performance standards are set utilizing the 2011 Wisconsin Phosphorus Index ("WI P Index"), a tool that estimates the amount of phosphorus runoff delivered to surface waters expressed as pounds per acre per year.[186] The WI P Index is calculated on a field-by-field basis using multiple factors, including phosphorus balance in soil, tillage practices, proximity to surface water, manuring or phosphorus fertilization practices, and long-term precipitation patterns.[187] Crop and livestock producers must ensure that croplands, pastures, and winter grazing areas maintain a certain balance of phosphorus as expressed through the WI P Index.[188] These areas must average an index value of six or less without exceeding a value of twelve in any single year during the accounting period,[189] which begins

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181 *Id.*

182 WIS. ADMIN. CODE NR § 151.07(1-3) (2023).

183 *Id.* § 151.015(4).

184 WIS. STAT. § 281.16(1)(b) (2022).

185 WIS. ADMIN. CODE NR § 151.015(10-11) (2023); *Id.* § 281.16(1)(c).

186 Univ. of Wis.–Madison, *Tillage and Manure Timing Effects on P Index Loads*, WIS. PHOSPHORUS INDEX, https://wpindex.soils.wisc.edu/managing-runoff-p/soilgraphs/ (last accessed Aug. 13, 2023).

187 Univ. of Wis.–Madison, *Overview*, WIS. PHOSPHORUS INDEX, https://wpindex.soils.wisc.edu/about/overview/ (last accessed Aug. 13, 2023).

188 WIS. ADMIN. CODE NR § 151.04 (2023).

189 WIS. ADMIN. CODE NR § 151.04(2)(a); *Id.* § 151.015(1) (WDNR defines this accounting period to "consist of the current year . . . [extending] back the previous seven years moving forward each consecutive year creating a rolling time period not to exceed eight years.").

once a crop or livestock producer completes an NMP.[190]

After a decade of implementation, academic researchers studying Wisconsin's phosphorus rules and their impact on water quality have found the WI P Index target value of six to be insufficient to meet water quality standards in many watersheds.[191] This is especially true for watersheds where baseline total phosphorus loss is already below six pounds per acre per year, but waterbodies are still impaired, TMDLs surpassed, and water quality goals unmet.[192] Further research and water quality monitoring could help determine WI P Index target values that are adequate for meeting water quality criteria on a watershed-specific basis. Until this regulatory gap is closed, crop and livestock producers shall calculate average phosphorus index values over an accounting period using the 2011 version of the WI P Index.[193]

Wisconsin's Department of Agriculture, Trade, and Consumer Protection ("DATCP") promulgates rules outlining the technical standards and conservation practices available to implement the WDNR's performance standards and prohibitions for agricultural nonpoint sources, such as NMPs.[194] These plans detail strategies to ensure the amount of phosphorus entering a watershed as a consequence of agricultural activities complies with state water quality and groundwater standards.[195] NMPs must be prepared in compliance with the Wisconsin NRCS 590 Nutrient Management Standard and written by a nutrient management planner possessing certain qualifications such as knowledge of soil testing and calculating nutrient needs. Farmers may also write NMPs for their farms if they possess the requisite knowledge and skills.[196] Meanwhile, Certified Crop Advisors are presumptively qualified, though DATCP may provide written notice disqualifying an individual as a nutrient management planner should they lack qualifications or fail to prepare an NMP in compliance with regulations.[197]

In addition to NMPs, the regulations require adherence to additional crop management practices intended to reduce the impact of crop production on surface

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190 WIS. ADMIN. CODE NR § 151.04(2)(c)(1).

191 Adena Rissman, Professor, Dep't of Forest and Wildlife Ecology, Univ. of Wis-Madison, Conf. Panel Presentation at Phosphorus: Lessons from 10+ Years of Numeric Standards for Wisconsin's Waters (Feb. 7, 2023) in UW-MILWAUKEE CENTER FOR WATER POLICY, 2023 PHOSPHORUS CONFERENCE REPORT (May 2023), https://pconference.files.wordpress.com/2023/05/2023-p-conference-report-4.pdf at 21; Univ. of Wis.-Milwaukee Ctr. for Water Pol'y, *Panel 3: Wisconsin Phosphorus Policy Implementation*, YOUTUBE (Feb. 7, 2023 at 42:40), https://www.youtube.com/watch?v=bQ-twWV8o7s&list=PLAyMzPFzDwiLXp4-Talfpv1PI-OzHiVAz&index=3. *See also* Klump, *supra* note 45 (briefly mentions how phosphorus loss at 6 pounds per acre per year would be off the charts and surpass TMDLs in Green Bay).

192 Rissman, *supra* note 191.

193 WIS. ADMIN. CODE NR § 151.04(2)(b).

194 *See* WIS. STAT. § 281.16(3) (2022).

195 WIS. ADMIN. CODE NR § 151.07(3).

196 WIS. ADMIN. CODE ATCP §§ 50.04(3), 50.48(1) (2018).

197 WIS. ADMIN. CODE ATCP § 50.48(2), (4).

water. For instance, crop producers must keep a tillage setback of five to twenty feet from surface water; this is intended to protect streambank stability and provide a vegetated treatment area for surface runoff.[198] Crop producers must also maintain the setback area such that at least 70% of it is covered by "adequate sod or self-sustaining vegetative cover," defined as sufficient vegetation to preserve the "physical integrity of the streambank or lakeshore" (e.g. grasses or layers of woody debris).[199] DATCP regulations also allow local entities (e.g., counties) to adopt ordinances that establish specific requirements or standards related to nonpoint source pollution, such as those related to manure storage, shoreland management, or livestock operations.[200]

4. Wisconsin's Phosphorus Rule Establishes Water Quality Trading and Adaptive Management Programs to Incentivize Point Source Polluters to Reduce Nonpoint Source Pollution

Wisconsin's phosphorus rule establishes compliance options to encourage reductions in phosphorus pollution, including: (1) a water quality trading program ("trading"); and (2) an adaptive management program ("adaptive management").[201] Both programs allow point source polluters to come into compliance with water quality-based effluent limitations by arranging for a reduction in phosphorus pollution from nonpoint sources elsewhere in the watershed.[202] The primary difference between the two programs is that trading involves generating pollution credits to offset discharges exceeding a permit effluent limitation, while adaptive management allows a point source to discharge in excess of a permit effluent limitation if it supports the implementation of BMPs elsewhere in the watershed, such that phosphorus loads are reduced and criteria for receiving waters are satisfied.[203] Other differences include the programs' implementation area, timing, monitoring requirements, and eligibility requirements.[204]

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198 WIS. ADMIN. CODE NR § 151.03 (no direct deposit of soil into surface waters is allowed).

199 WIS. ADMIN. CODE NR §§ 151.03(3), 151.002(1).

200 WIS. ADMIN. CODE ATCP §§ 50.54, 50.56, 50.58, 50.60 (2018).

201 *Wisconsin's Phosphorus Rule: Implementation*, *supra* note 159.

202 *Id.*

203 *See* WIS. DEP'T NAT. RES., GUIDANCE FOR IMPLEMENTING WATER QUALITY TRADING IN WPDES PERMITS 2 (Jun. 1, 2020).

204 *Adaptive Management*, WIS. DEP'T NAT. RES., https://dnr.wisconsin.gov/sites/default/files/topic/Wastewater/AM_Factsheet_382013.pdf (last accessed May 17, 2022) [hereinafter *Adaptive Management*] (adaptive management programs encompass reduction strategies throughout an entire watershed, whereas water quality trading programs typically restrict reduction strategies to upstream of the point source. Unlike water quality trading credits, which must be generated prior to permit issuance, adaptive management programs allow permittees to reduce effluent phosphorus over time. Adaptive management has stricter monitoring and reporting requirements than water quality trading).

a. Water Quality Trading

The Water Quality Trading program allows point sources to come into compliance with a permit's effluent discharge limit by purchasing "pollutant credits" that equate to pollution reduction elsewhere in the watershed.[205] Point source dischargers can generate credits by accepting and complying with WPDES permit discharge limits below any applicable water quality-based effluent limits.[206] Nonpoint sources can generate credits by adopting management practices which result in a reduction in future pollution load; changes in pollution load are calculated using specific models identified by the WDNR.[207] The "credit threshold," or amount of pollutant loading below which reductions must be made to generate credits, differs based on the type of nonpoint source.[208] For agricultural nonpoint sources discharging to an area without an approved TMDL, the threshold is the current pollutant load, regardless of whether this amount is below the statewide performance standards set by NR 151.[209] For urban nonpoint sources discharging to areas without an approved TMDL, the threshold is set at the load at the time of the trade agreement.[210] For both urban and agricultural nonpoint sources discharging to areas covered by an approved TMDL, the threshold is set equal to the load allocation identified in the TMDL.[211]

Though similar to adaptive management, the trading program is distinguished by its participants, timing, and aforementioned methods of calculating pollutant reduction for credits.[212] Potential participants involved in water quality trading include credit users, generators, brokers, and exchanges.[213] Users are point source dischargers who seek to offset their pollutant discharge by purchasing credits.[214] Generators are entities that have reduced their pollutant load such that a credit is generated.[215] Brokers connect users and generators for potential trades based on their "location, pollutant type, [discharge] amount, and timing."[216] Lastly, exchanges are entities that accumulate credits produced by generators to then sell to users.[217]

The use of water quality trading to offset discharges is limited by location; the

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205 WIS. DEP'T NAT. RES., *supra* note 203, at 3.
206 *Id.* at 15.
207 *Id.* at 16-17.
208 *Id.* at 20-22.
209 *Id.* at 20.
210 *Id.* at 22.
211 *Id.* at 20-22.
212 WIS. DEP'T NAT. RES., ADAPTIVE MANAGEMENT TECHNICAL HANDBOOK: A GUIDANCE DOCUMENT FOR STAKEHOLDERS 10 (Jun. 1, 2020).
213 WIS. DEP'T NAT. RES., *supra* note 203, at 3-4.
214 *Id.* at 4.
215 *Id.*
216 *Id.*
217 *Id.*

discharge and reduction of pollutants must "occur within the same basin or portion of a basin" as determined by the WDNR.[218] In general, this means that a credit is free to be traded with dischargers if the credit was generated in the same drainage area of the impaired segment which is the focus of the discharger's water quality-based effluent limits.[219] Additionally, a trade must "involve the same pollutant or the same water quality standard" to be authorized.[220]

In contrast to adaptive management, a point source discharger participating in a water quality trading program may not comply with a permit effluent limit by arranging for credits to be generated during the permit term.[221] In other words, credits must be generated before issuance of a WPDES discharge permit.[222] Once a pollution reduction credit is traded, the credit will generally remain available so long as the user and generator's trading agreement stands, the pollution reduction measure is maintained, and the WDNR continues to approve of the trade.[223]

In March 2023, the state of Wisconsin contracted with a subsidiary of Resource Environmental Solutions (RES) to establish the nation's first market-based water quality trading clearinghouse[224] pursuant to Wisconsin Statute section 283.84.[225] The clearinghouse is a private, online marketplace connecting sellers of pollutant credits (i.e., landowners and agricultural producers) with buyers (i.e., municipal wastewater treatment facilities and private industries) to meet phosphorus discharge limits and reduce overall phosphorus loads to a watershed.[226] Clearinghouse staff act as trade brokers, matching point source facilities seeking to purchase pollutant credits with farmers and landowners who are selling them.[227] The end product is a three-party agreement between the clearinghouse, the buyer, and the seller, which defines the terms of the trade (i.e., length of years, price, and practices).[228] The clearinghouse is funded through fees collected from participants;[229] RES then receives a percentage of each transaction to fund its

218 WIS. STAT. § 283.84(1m)(d) (2023).

219 WIS. DEP'T NAT. RES., *supra* note 203, at 11-12.

220 WIS. STAT. § 283.84(1m)(b).

221 WIS. DEP'T NAT. RES., *supra* note 203, at 31.

222 *Id*.

223 *Id*. at 33-34.

224 *Water Quality Trading Clearinghouse Contract Established in Wisconsin*, WIS. DEP'T NAT. RES. (Mar. 29, 2023), https://dnr.wisconsin.gov/newsroom/release/70636.

225 WIS. STAT. § 283.84(1).

226 *Simplifying Water Quality Trading in Wisconsin*, WIS. WATER QUALITY TRADING CLEARINGHOUSE, https://wiclearinghouse.org (last accessed Aug. 13, 2023).

227 Telephone interview with Chris Murphy, Nutrient Trading Manager, Wis. Water Quality Trading Clearinghouse, Resource Environmental Solutions (Aug. 9, 2023) [hereinafter Telephone interview with Chris Murphy].

228 *Id.*

229 E-mail from Matthew Claucherty, Phosphorus Implementation Coordinator, Water Quality Bureau, WDNR, to author (Aug. 8, 2023) (on file with author) [hereinafter E-mail from Matthew Claucherty]; Telephone interview with Chris Murphy, *supra* note 227; *see also* Madeline Heim, *Wisconsin just launched the first marketplace for trading water quality credits. What is that, and how*

operation costs.[230]

The WDNR was involved in developing the statutory language that authorized this clearinghouse.[231] The authorizing statute requires the production and purchase of credits to take place in the same hydrologic area to ensure compliance with applicable water quality standards and improve water quality.[232] The law also requires WDNR verification of trade credits based pertinent information such as location of and technology used for water pollution reduction activities.[233] According to a WDNR Phosphorus Implementation Coordinator, these statutory provisions help prevent abuse by producers of the trading system (such as overvaluing nonpoint reductions, creating local "hot spots" where discharged pollution is not compensated for, and failing to maintain reductions long-term).[234]

However, there is a concern that the WDNR lacks funding for enough staff capacity to oversee this system if the number of trades in one permit cycle surges.[235] In its beginning stages, the rate of projects coming through the clearinghouse has not been significantly greater than the volume the WDNR has previously handled.[236] According to WDNR, as of 2023, the agency achieves a goal of on-the-ground verification of 10% of the water quality trading projects, however it may be difficult to maintain even 10% verification if the clearinghouse increases trading volume.[237] Nevertheless, the clearinghouse holds promise for reducing agricultural phosphorus pollution by increasing funding for land conservation practices such as cover crops, buffer strips, and managed grazing, all of which reduce nutrient runoff and improve water quality.[238] The WDNR verified the clearinghouse's first credit-generating project on August 4, 2023.[239]

b. Adaptive Management

Wisconsin's adaptive management program operates in a similar manner as water quality trading. It allows point source polluters to satisfy their permit effluent limitations, or receive less stringent, interim effluent limits, when they

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will it cut pollution?, MILWAUKEE J. SENTINEL (Apr. 7, 2023), https://www.jsonline.com/story/news/2023/04/07/wisconsin-dnr-creates-clearinghouse-for-trading-water-quality-credits/70065261007/.

230 *Id.*; Telephone interview with Chris Murphy, *supra* note 227.

231 Wis. 2019 S.B. 91, now 2019 Wis. Act 151.

232 WIS. STAT. § 283.84(1m)(e) (2024).

233 WIS. STAT. §§ 16.9685(3)(g), 283.84(g).

234 *Id.*

235 Heim, *supra* note 229.

236 E-mail from Matthew Claucherty, *supra* note 229.

237 *Id.* (Wisconsin has about sixty ongoing water quality trades; with full use of the clearinghouse, the number of trades could surpass 200).

238 Danielle Kaeding, *Industrial and wastewater facilities may soon find it easier to work with farms to reduce water pollution*, WIS. PUB. RADIO (Mar. 23, 2023), https://www.wpr.org/wisconsin-industrial-wastewater-facilities-partnership-farms-reduce-water-pollution-phosphorus.

239 E-mail from Matthew Claucherty, *supra* note 229.

take steps to reduce nonpoint source pollution elsewhere in the watershed to meet overall numeric phosphorus criteria.[240] This program provides an alternative to complying with water quality-based effluent limits through the adoption of potentially costly technological improvements.[241] This approach is available to point sources located in watersheds where nonpoint sources contribute at least 50% of the pollutant load, where a point source would otherwise be required to utilize "filtration or other equivalent treatment technology" to achieve compliance, or where compliance with phosphorus water quality criteria would be impossible without reduction from nonpoint sources.[242]

Unlike trading, adaptive management allows participants to work with landowners in the watershed to implement BMPs to reduce phosphorus in the watershed throughout the permit term.[243] However, permittees must submit an adaptive management plan for approval before participating in the program.[244] This plan must include an analysis of the phosphorus levels in the permittee's effluent, significant loads to the watershed, metrics for determining the plan's efficacy, identification of anticipated partners, and a demonstration that the permittee is able to fund and implement the plan.[245] An additional requirement may include arranging for long-term monitoring of phosphorus levels in the watershed to measure the success of the adaptive management initiative.[246] Examples of practices that may be implemented as part of an adaptive management strategy include the installation of porous pavement, grass swales, wetland construction, and wetland restoration.[247]

5. The WDNR Implements a Multi-discharger Phosphorus Variance to Further Aid Certain Point Sources in Complying with Phosphorus Effluent Limitations

An area of potential backsliding on reducing phosphorus emerged when the EPA approved the WDNR's request to implement a multi-discharger phosphorus variance through 2027, allowing certain point sources to extend the timeline for compliance with phosphorus effluent limits in exchange for support with implementing watershed projects to reduce phosphorus loads.[248] The purpose of

240 WIS. ADMIN. CODE NR § 217.18 (2022).

241 *Adaptive Management*, *supra* note 204.

242 WIS. ADMIN. CODE NR § 217.18(2)(b), (c) (2022).

243 WIS. DEP'T NAT. RES., *supra* note 212, at 8-9.

244 WIS. ADMIN. CODE NR § 217.18(2)(d) (2022).

245 *Id.*

246 WIS. DEP'T NAT. RES., *supra* note 212, at 19.

247 *Adaptive Management*, *supra* note 204.

248 *Multi-discharger Phosphorus Variance*, WIS. DEP'T NAT. RES., https://dnr.wisconsin.gov/sites/default/files/topic/Wastewater/MDVFactsheet.pdf (last accessed May 17, 2022) (under Wis. State. 283.16 (2), the legislature directed the Department of Administration to conduct an analysis of statewide compliance and determine whether it is infeasible for point sources to achieve compliance

variances is to allow for flexibility where a facility can demonstrate that compliance with phosphorus limits would result in significant financial hardships.[249]

There are several eligibility requirements to qualify for a multi-discharger variance. By statute, only "existing sources" are eligible for this variance, defined as "a point source that was covered by a permit on December 1, 2010."[250] Additionally, permittees must certify that compliance with applicable phosphorus limits would necessitate a "major facility upgrade," defined as "the addition of new treatment equipment and a new treatment process."[251] The WDNR has generated a list of areas where a discharger may potentially be eligible for the multi-discharger phosphorus variance, listed by county and category (e.g. municipal, cheese, food, etc.).[252] Dischargers must also satisfy specific economic eligibility criteria outlined by the DNR based on factors such as type of discharger or estimated per-customer cost of compliance compared to county median household income.[253] In addition to these requirements, dischargers must provide payments to their county, the WDNR, or a third-party broker approved by the WDNR to implement measures to reduce phosphorus in their watershed.[254] By statute, these payments were initially set at fifty dollars per pound of phosphorus discharged annually, to be adjusted based on the Consumer Price Index.[255]

If a discharger is deemed eligible for the multi-discharger variance, the WDNR may issue permits with interim effluent limitations for phosphorus.[256] These permits are issued in a series with a stepwise decrease in the concentration of phosphorus allowed in effluent, culminating in a final permit with a standard water quality-based effluent limitation.[257] The EPA approved the multi-discharger variance until February 6, 2027, and any permit terms or conditions reflecting the variance may not extend beyond this date without additional EPA approval.[258]

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without major facility upgrades that would cause "substantial" and "widespread" adverse social and economic impacts statewide. Once the DOA made that determination, the WDNR sought approval from the EPA for the statewide variance).

249 *Program Policy for Implementing Wisconsin's Multi-Discharger Variance for Phosphorus* 7-8, WIS. DEP'T NAT. RES., https://dnr.wisconsin.gov/topic/Wastewater/phosphorus/StatewideVariance.html (last accessed Apr. 22, 2024) (follow "Program Policy for Implementing Wisconsin's Multi-Discharger Variance" hyperlink).

250 WIS. STAT. §§ 283.16(4)(a)(1), 283.16(1)(d) (2023).

251 WIS. STAT. §§ 283.16(4)(a)(2), 283.16(1)(e).

252 *Program Policy for Implementing Wisconsin's Multi-Discharger Variance for Phosphorus*, *supra* note 249, at 99-101.

253 *Id.* at 20, 78, 96.

254 WIS. STAT. § 283.16(6)(b) (2023).

255 *Id.* § 283.16(8)(a)(2).

256 *Id.* § 283.16(6)(a).

257 *Id.* § 283.16(6).

258 *Program Policy for Implementing Wisconsin's Multi-Discharger Variance for Phosphorus*, *supra* note 249, at 10.

Pursuant to statutory authority,[259] Wisconsin Department of Administration is partnering with WDNR to reevaluate the initial determination made in 2015 that phosphorus water quality standards would cause "substantial and widespread adverse social and economic impacts" to industrial dischargers such as municipal wastewater treatment facilities.[260] The agencies published an Initial Stakeholder Outreach Document in October, 2023, and following a public comment period, will determine whether the 2015 determination remains accurate.[261] If so, WDNR will once again seek EPA approval for a time extension on the variance.[262]

6. NR 119: Wisconsin's Phosphorus Rule Allows WDNR to Set Site-Specific Criteria for Phosphorus

In 2022, Wisconsin added Administrative Code NR 119 to allow the WDNR to adopt site-specific phosphorus criteria that are more or less stringent than statewide criteria where appropriate to protect a waterbody's designated uses.[263] Site-specific evaluation of a waterbody's designated use depends on an ecosystem's phosphorus response indicators[264] and the waterbody's overall biotic integrity.[265] A site-specific criterion may be requested and developed by any person and submitted to the WDNR for review, or may be developed by the WDNR's own rulemaking process.[266] Minimum requirements for a site-specific criterion submitted by an applicant or developed by the WDNR include: (a) identification of all waterbodies contained within the site-specific criterion study area; (b) the designated uses and existing numeric phosphorus criteria for each identified waterbody; (c) biometric data and analysis for the study area; and (d) supporting materials for the proposed site-specific criterion.[267] Because adoption of a new site-specific criterion would revise existing water quality standards, the EPA must approve any new criterion before its promulgation.[268]

As of 2023, the EPA has approved site-specific phosphorus criteria for three Wisconsin waterbodies: two in which the standards were relaxed, and one where

259 WIS. STAT. § 283.16(3)(a).

260 *Statewide Phosphorus Multi-Discharger Variance*, WIS. DEP'T ADMIN., https://doa.wi.gov/Pages/StatewideMDV.aspx (last accessed Jan. 5, 2024); WIS. DEP'T NAT. RES., SUBSTANTIAL AND WIDESPREAD ADVERSE SOCIAL AND ECONOMIC IMPACTS OF WISCONSIN'S PHOSPHORUS REGULATIONS 73 (Dec. 29, 2015).

261 WIS. DEP'T ADMIN. & WIS. DEP'T NAT. RES., REAUTHORIZATION OF WISCONSIN'S MULTI-DISCHARGER PHOSPHORUS VARIANCE (Oct. 10, 2023).

262 *Id.*

263 WIS. ADMIN. CODE NR § 119.01 (2022).

264 *Id.* at § 119.02(7) (indicators that "characterize the condition or abundance of aquatic organisms that are responsive to phosphorus.")

265 WIS. ADMIN. CODE NR § 119.01 (2022).

266 *Id.* § 119.06.

267 *Id.*

268 WIS. ADMIN. CODE NR § 119.07(1), (2) (2022).

they were strengthened. Instead of the statewide criteria of 15 – 40 ug/L, Castle Rock Lake need only meet a total phosphorus criterion of 55 ug/L and Petenwell Lake a total phosphorus criterion of 53 ug/L.[269] The rule notes that "reservoirs, two-story fishery lakes [i.e., deep stratified lakes capable of supporting both warm and coldwater fish species] and water bodies with high natural background phosphorus concentrations are the most appropriate water bodies for site-specific criteria."[270] The EPA approved more relaxed site-specific criteria for these reservoirs based on a 2010 to 2013 water quality monitoring analysis showing lower sensitivity to total phosphorus in Petenwell and Castle Rock reservoirs.[271]

Conversely, the EPA approved a more stringent criterion for Lake Wisconsin, which is classified as an impounded flowing water.[272] Normally, numeric phosphorus criteria for impounded flowing waters are the same criteria that applies to the primary stream or river entering the impounded water (in this case 100 ug/L).[273] However, WDNR has set a total phosphorus criterion of 47 ug/L for Lake Wisconsin.[274] The same 2010 to 2013 water quality monitoring analysis used for Petenwell and Castle Rock reservoirs showed high total phosphorus concentrations in Lake Wisconsin with "frequent and severe algal blooms," indicating that the 100 ug/L criterion is insufficient to maintain water quality.[275]

Due to ecological concerns for Lac Courte Oreilles in northern Wisconsin, the WDNR established a site site-specific criterion of 10 ug/L for the lake, effective February 1, 2024.[276] Lac Courte Oreilles is situated on the boundary between state land and the Lac Courte Oreilles Tribal reservation. Lac Courte Oreilles is one of few two-story fishery lakes in Wisconsin that supports a coldwater fish community.[277] The statewide phosphorus criterion for stratified, two-story fishery

[269] WIS. ADMIN. CODE NR § 102.06(7)(b)(1)-(2) (2022); *see also Wisconsin River TMDL: A Framework for Water Quality Improvement*, WIS. DEP'T NAT. RES., https://dnr.wisconsin.gov/topic/TMDLs/WisconsinRiver/index.html (last accessed Aug. 13, 2023) [hereinafter *Wisconsin River TMDL*]; Pam Jahnke, *EPA Approves Site-Specific Phosphorus Criteria For Multiple Wisconsin Lakes*, MID-WEST FARM REPORT (July 19, 2020), https://www.midwestfarmreport.com/2020/07/19/epa-approves-site-specific-phosphorus-criteria-for-multiple-wisconsin-lakes/.

[270] WIS. ADMIN. CODE NR § 102.06(7)(b) (2022).

[271] *Appendix C: Site Specific Criteria Analysis, Development of Site-Specific Total Phosphorus Criteria for Petenwell Flowage, Castle Rock Flowage, and Lake Wisconsin*, WIS. DEP'T NAT. RES., https://dnr.wisconsin.gov/topic/TMDLs/WisconsinRiver/index.html (last accessed Mar. 18. 2024) (under "Appendices", follow hyperlink "Appendix C – Site-Specific Criteria Analysis").

[272] *Id.* at 1.

[273] WIS. ADMIN. CODE NR §§ 102.06(3)(a)(44), (c) (2022).

[274] WIS. ADMIN. CODE NR § 102.06(7)(b)(3); *see also Wisconsin River TMDL*, *supra* note 269; Jahnke, *supra* note 269.

[275] *Appendix C: Site Specific Criteria Analysis*, *supra* note 271, at 1.

[276] WIS. ADMIN. CODE NR § 102.06(7)(b)(4).

[277] WIS. DEP'T NAT. RES., ORDER OF THE STATE OF WISCONSIN NATURAL RESOURCES BOARD CREATING RULES: WY-21-20 (2022); *see also* WIS. DEP'T NAT. RES., LAC COURTE OREILLES, SAWYER COUNTY PHOSPHORUS SITE-SPECIFIC CRITERIA ANALYSIS, WDNR TECHNICAL SUPPORT

lakes of this kind is 15 ug/L.[278] The DNR analyzed the lake's site-specific characteristics and concluded a phosphorus limit of 15 ug/L was too high to protect the sensitive whitefish habitat, thereby requiring a proposal of the more stringent phosphorus criterion.[279]

Still, the push for this site-specific phosphorus criterion was lengthy and is still pending approval by the EPA.[280] The Lac Courte Oreilles Tribe first proposed the more stringent 10 ug/L criterion in 2014, but the WDNR declined to make a determination until after it completed the site-specific phosphorus rulemaking process for NR 119.[281] When the WDNR denied the Tribe's 2016 petition for the same proposed criterion, the Tribe sought judicial review, resulting in a court-approved settlement wherein the WDNR agreed to develop a scope statement to evaluate a potential site-specific criterion for Lac Courte Oreilles.[282] The WDNR's initial findings in 2018 indicated phosphorus concentrations in the lake were not the main driver impacting its two-story fishery habitat, and therefore a more stringent site-specific criterion was inappropriate.[283] The next year, however, the WDNR issued an addendum to address comments received by the public and the EPA; after further analysis, the WDNR reversed its decision from the 2018 scope statement with an official proposal of a 10 ug/L site-specific criterion for Lac Courte Oreilles.[284]

B. Research Evaluating Wisconsin's Implementation of its Phosphorus Rules

Several studies have explored the policy implications of various programs and requirements established by Wisconsin's phosphorus rules. This section

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DOCUMENT (2022) [hereinafter *2022 Technical Support Document*]. WIS. DEP'T NAT. RES., *Natural Resources Board Meeting – June 28, 2023*, YOUTUBE (June 28, 2023), https://www.youtube.com/watch?v=UfFCdgkUgHA (even as a two-story fishery lake, this body of water is rare, as it is one of nine out of the state's 15,000 lakes that is home to both cisco and whitefish. Its unique coldwater fish community makes it a particularly good candidate for site-specific regulation).

278 WIS. ADMIN. CODE NR § 102.06(4)(b)(1) (2022).

279 *2022 Technical Support Document*, *supra* note 277, at 5 (analyzing the lake's low dissolved oxygen impairment, of which phosphorus is a contributing factor and observing that lowering the lake's total phosphorus concentration will improve its oxygen levels to better support the coldwater aquatic habitat).

280 *See Tribal Consultation: Site-specific Phosphorus Criterion for Lake Lac Courte Oreilles, Wisconsin*, U.S. ENV'T PROT. AGENCY, https://tcots.epa.gov/ords/tcotspub/f?p=106:5::1934:::: (consultation period ends Apr. 24, 2024).

281 WIS. DEP'T NAT. RES., LAC COURTE OREILLES, SAWYER COUNTY PHOSPHORUS SITE-SPECIFIC CRITERIA ANALYSIS, 2018 TECHNICAL SUPPORT DOCUMENT 12 (2018) [hereinafter *2018 Technical Support Document*].

282 *Id.* at 12-13.

283 *Id.* at 9, 13.

284 WIS. DEP'T NAT. RES., 2019 ADDENDUM TO LAC COURTE OREILLES, SAWYER COUNTY PHOSPHORUS SITE-SPECIFIC CRITERIA ANALYSIS, 2018 TECHNICAL SUPPORT DOCUMENT 2 (2019) [hereinafter *2019 Addendum*].

summarizes research findings on Wisconsin's phosphorus policy implementation with an emphasis on phosphorus management through the state's market-based mechanisms, the economic impact of Wisconsin's phosphorus rules on sewer utility consumers, and the effectiveness of local manure ordinances on nonpoint source pollution reduction.

Point sources have a novel choice in Wisconsin: the option to comply with phosphorus effluent limits by participating in advanced market-based mechanisms. Zhixuan Wu's 2021 research weighed key factors in regulated point source entities' decisions to participate in Wisconsin's phosphorus credit markets.[285] At the time of the study, more than 140 point sources had chosen one of the state's market-based compliance options (i.e., adaptive management, water quality trading) for meeting stringent phosphorus standards.[286] Wu identified three central environmental factors, among others, that drive point source entities to trade or fund adaptive management projects: (1) the location of a nonpoint source relative to the point source within a shared watershed; (2) the pollution reduction potential of the nonpoint source, and (3) a nonpoint source's willingness to trade.[287] Wu also found that point source facilities in relatively poor condition were more likely to pay for facility upgrades to meet phosphorus discharge limits rather than participate in water quality trading or adaptive management projects.[288] Another key factor was the length of time between the passage of Wisconsin's phosphorus rules in 2010 and the time of compliance; facilities with more time to plan for trading or adaptive management opted for compliance via markets.[289] Lastly, if there was a TMDL in place instead of a water quality-based effluent limit, the regulated entity was less likely to choose trading or adaptive management.[290]

Agricultural phosphorus is the primary target for pollution reduction and water quality improvement in Wisconsin. Agricultural producer behavior and decision drivers are therefore critical factors for Wisconsin phosphorus policy implementation. While further research would be helpful to inform what influences farmer behavior and drives farmers' decisions, researchers have shed light on risks and opportunities for stakeholders involved in adaptive management projects.

From 2012 to 2018, Wardropper and team conducted a case study exploring the risks and opportunities for stakeholders involved in Wisconsin's first adaptive

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[285] Zhixuan Wu, Key Elements of Nutrient Credit Markets: An Empirical Investigation of Wisconsin's Market-Like Phosphorus Control Policy (2021) (Ph.D. dissertation, Univ. of Wis.-Madison) (on file with the Libraries, Univ. of Wis.-Madison).

[286] *Id.* at 25, 29.

[287] *Id.* at 21.

[288] *Id.* at 50.

[289] *Id.* at 51.

[290] *Id.* at 56.

management program in the Yahara Watershed of southern Wisconsin.[291] This project, called Yahara WINS, was the result of a partnership between nonpoint sources including dairy, corn, and soybean farmers, and the major regional point source of phosphorus, the Madison Metropolitan Sewerage District.[292] For the sewage district, it was an advantageous economic opportunity, as the adaptive management project's estimated cost was $100 million over twenty years compared to technological plant upgrades estimated to cost sewerage district ratepayers up to $270 million immediately.[293] The $100 million would fund conservation practices for farmers and other nonpoint sources to reduce nutrient pollution and improve water quality.[294]

Wardropper revealed that some stakeholders identify regulatory enforcement as a potential risk of adaptive management: there could be penalties if stakeholders fail to meet phosphorus reduction goals, and there is uncertainty associated with monitoring and modeling program outcomes.[295] Additionally, due to the nature of the relationship between phosphorus loading and subsequent concentration in a watershed, regulated entities may be concerned that achieving compliance with numeric water quality will take longer than initially contemplated.[296] Despite the risk, Yahara WINS has shown how to build and strengthen stakeholder partnerships and implement phosphorus reduction policies and programs.

Meyer and Raff explored the impacts of Wisconsin's phosphorus market compliance options with an economic focus on residential sewer utility billing rates. Their objective was to estimate the effect of Wisconsin's phosphorus rules on consumers by providing the first empirical estimate of phosphorus regulation on utility billing rates.[297] The researchers found that complying with Wisconsin's phosphorus rules increased average sewer utility billing rates by 7-12%, as compared to municipal utilities that have not yet encountered stringent phosphorus standards.[298] Calculations suggest "total annual compliance costs of approximately $65.8 million that are borne by end users."[299] These pass-through consumer costs are lower, however, when utilities choose to comply with the phosphorus rules via water quality trading (6.4% increased billing rates)

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291 Chloe Wardropper et al., *Innovation in Outcomes-Based Water Quality Policy: A Case Study from the Yahara Watershed, Wisconsin, USA*, 2 CASE STUD. ENV'T 1, 3 (2018).

292 *Id.*

293 *Id.*

294 *Id.*

295 *Id.* at 4-5.

296 *Id.*

297 Andrew Meyer & Zach Raff, *The Effect of Water Pollution Regulation on Prices: Evidence from Wisconsin's Phosphorus Rule and Sewer Utility Bills* (Nov. 1, 2023), https://ssrn.com/abstract=4390794.

298 *Id.* at 9.

299 *Id.*

compared to utilities that comply with the rules through facility upgrades (14.6% increased billing rates).[300] The research highlights the opportunity for Wisconsin's water quality trading program to lessen the phosphorus compliance costs for point source facilities and ratepayers.[301]

In addition to individual stakeholders' opportunities, risks, and economic impacts associated with participation in Wisconsin's phosphorus credit market, local counties also play a role in phosphorus policy development and implementation. For instance, Skidmore and team researched the impacts of local manure management regulations on surface water quality in Wisconsin.[302] To analyze the relationship between local regulations and water quality, the researchers compiled and classified ordinance data for all of Wisconsin's counties from 2008 to 2020.[303] Water quality was measured utilizing the monthly average ammonia and phosphorous concentration at a water monitoring station.[304] The study found that, while many county-level standards did not significantly affect water quality, the requirement for farms to register a nutrient management plan or certificate of use correlated with improved water quality in the short term.[305] Two main challenges this study identified were legacy phosphorus and the related limitation of studying short-term regulatory impacts on water quality. The next section provides an in-depth analysis of how effective Wisconsin's phosphorus rules are for improving water quality.

C. Impact of Wisconsin's Phosphorus Rules for Water Quality

Wisconsin's phosphorus rules have been in effect for more than a decade. Our preliminary findings suggest the rules' efficacy has resulted in measurable improvements in rivers; however, the number of phosphorus-impaired waters has grown between 2012 to 2022 and improvements have fallen short of restoring waters and removing them from the impaired waters lists. This section offers our original research to evaluate whether a correlation exists between implementation of Wisconsin's phosphorus rules and water quality improvement. Two datasets are used to assess this inquiry: (1) the EPA's geospatial datasets for CWA section 303(d) impaired waters lists and (2) data from the WDNR's long-term trends monitoring program for Wisconsin rivers.

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300 UW-MILWAUKEE CENTER FOR WATER POLICY, 2023 PHOSPHORUS CONFERENCE REPORT (May 2023), https://pconference.files.wordpress.com/2023/05/2023-p-conference-report-4.pdf at 20.

301 *Id.*

302 Marin Skidmore et al., *Effectiveness of Local Regulations on Non-point Source Pollution: Evidence from Wisconsin Dairy Farms,* AM. J. AGRIC. ECON. 1 (2023).

303 *Id.* at 7.

304 *Id.* at 3 (stating that researchers obtained data through the Wisconsin Water Quality Portal).

305 *Id.* at 20.

1. CWA Section 303(d) Impaired Waters Lists

The CWA section 303(d) directs delegated states and tribes to develop and submit lists of impaired waters to the EPA for approval every two years.[306] The EPA then compiles geospatial datasets that identify all surface waterbodies that do not meet water quality criteria and are thus listed as impaired. Using that data, Wisconsin's 303(d) impaired waters lists show an increase in phosphorus-impaired waterways from the baseline dataset submitted in 2002 to the current dataset submitted in 2022.[307] As previously discussed, Wisconsin adopted numeric criteria for phosphorus in 2010. The designation of impairment due to phosphorus grew from 117 miles of Wisconsin rivers and streams in 2002, to 597 miles in 2012, and surged to 7,169 miles in 2022.[308] Similarly, the 1.7 square miles of lakes that were phosphorus-impaired in 2002 increased to 343 square miles in 2012, and 549 square miles in 2022.[309] The maps below in Figures 3 – 5 present a visual of these data.

Figure 3. 2002 Phosphorus-Impaired Waters[310]

[306] 33 U.S.C. §§ 1313(d), 1377(e) (2023); *Impaired Waters and TMDLs*, *supra* note 44.

[307] Patrick Gilvary ET AL., *Trends in Phosphorus Levels and Impairment Designations in Wisconsin Waterways*, Univ. of Wis.–Milwaukee Sch. of Freshwater Sci., Ctr. for Water Pol'y (2023), On File With Author.

[308] *Id.*

[309] *Id.*

[310] U.S. ENV'T PROT. AGENCY OFF. OF WATER PROGRAMS, *Legacy ATTAINS Reach Indexed Datasets Archive: 2002 Impaired Waters Baseline Reach Indexed Dataset Archive*, https://www.epa.gov/waterdata/waters-geospatial-data-downloads (extracted February 7, 2014).

Figure 4. 2012 Phosphorus-Impaired Waters[311]

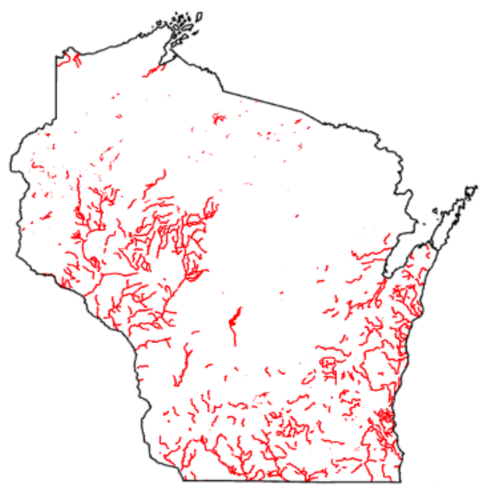

Figure 5. 2022 Phosphorus-Impaired Waters[312]

311 U.S. ENV'T PROT. AGENCY OFF. OF WATER PROGRAMS, *Legacy ATTAINS Reach Indexed Datasets Archive: Pre-2015 303(d) Listed Impaired Waters Reach Indexed Dataset Archive*, https://www.epa.gov/waterdata/waters-geospatial-data-downloads (extracted May 1, 2015).

312 U.S. ENV'T PROT. AGENCY OFF. OF WATER PROGRAMS, *Current ATTAINS Program Data: ATTAINS Water Quality Assessment GIS Dataset*, https://www.epa.gov/waterdata/waters-geospatial-data-downloads (follow OGC "GeoPackage" hyperlink) (last accessed August 9, 2022).

In 2022, the total number of waterbody segments listed as impaired by phosphorus in Wisconsin exceeded 1,100 compared to 1,049 water body segments in 2020, 921 in 2018, and 721 in 2016.[313]

Why would Wisconsin experience an increase in 303(d) impairments following adoption of numeric phosphorus criteria? This increase in phosphorus-impaired waterways corresponds to changes in monitoring programs and impairment designation policies. Wisconsin's phosphorus rules in 2010 led the WDNR to monitor specifically for phosphorus and apply the newly established numeric criteria to more clearly determine when and where total phosphorus exceeded water quality standards. This accounts for the steep increase in impairments in 2012 compared to 2002. Phosphorus-impaired waterways continued to rise between 2012 and 2022. A partial explanation for this increase is legacy phosphorus from decades of overapplying fertilizer to Wisconsin farmland. This excess phosphorus is captured and stored in sediment and released over time, years or even decades later. The slow release of legacy phosphorus means there will be a substantial lag time between changes on land and reductions in phosphorus levels in water. Continued monitoring is needed over the next decade while more land use changes are implemented to determine when we will start to see a decline in legacy phosphorus sufficient to restore waters and move them off the 303(d) list.

2. DNR's Long-Term Trends Monitoring Program for Wisconsin Rivers

While the 303(d) list datasets showcase the significant rise of phosphorus impairment in Wisconsin's waterways since adopting numeric criteria, the WDNR's data from their long-term trends monitoring program for Wisconsin rivers show total phosphorus in river basins shifted from an increasing trend in the northern region prior to the rules to a decreasing trend statewide after the rules. WDNR's long-term trends monitoring program is informed by data from forty-three field sites with at least one site in each major river basin.[314] From 2000 to 2010, rivers in the northern region of the state showed increases in total phosphorus, most commonly at a rate of 1% to 2% per year.[315] Within the same time frame, rivers in the southern region of the state showed decreases, most commonly by around 2% per year.[316] Then from 2010 to 2020 (the last year of data), rivers statewide showed decreases in total phosphorus at all forty-three sites except the Peshtigo, Kewaunee, and Fox Rivers.[317] Phosphorus concentrations in

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313 WIS. DEP'T NAT. RES., *Surface Water Impairments and Pollutants*, https://dnr.wisconsin.gov/topic/SurfaceWater/Impairments.html (last accessed Aug. 13, 2023).

314 WIS. DEP'T NAT. RES., *Long-Term River Water Quality Trends in Wisconsin*, https://wisconsindnr.shinyapps.io/riverwq/ (last accessed Feb. 1, 2023).

315 Gilvary ET AL., *supra* note 307.

316 *Id.*

317 *Id.*

most of these sites have decreased by 2% to 4% per year.[318] See Figures 6 and 7 below.

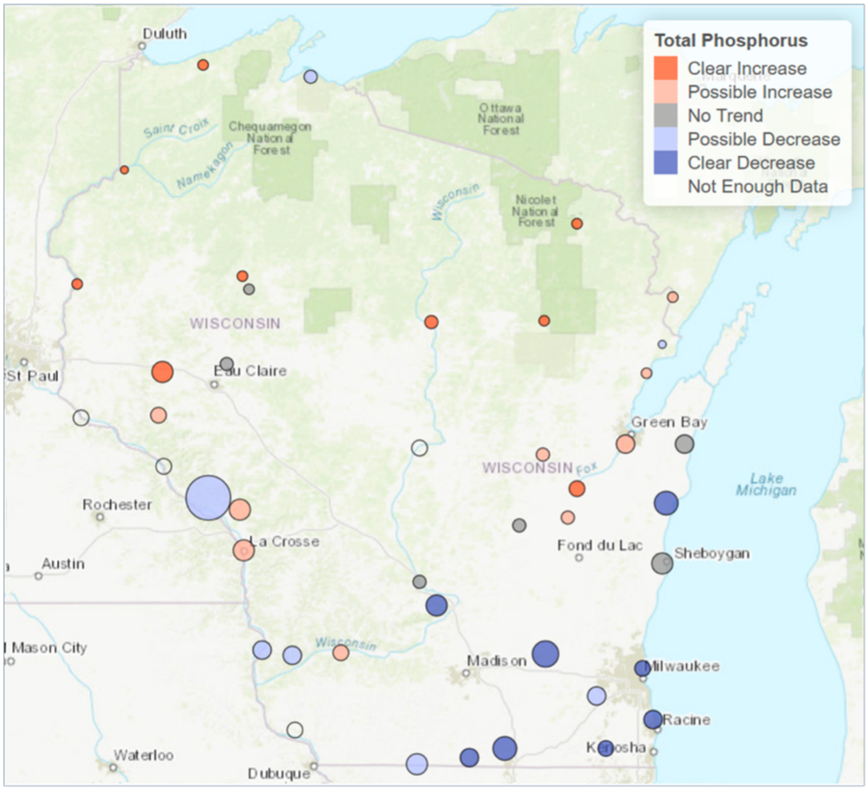

Figure 6. Change in Total Phosphorus (2000 to 2010)[319]

[318] *Id.*

[319] WIS. DEP'T NAT. RES., *supra* note 314.

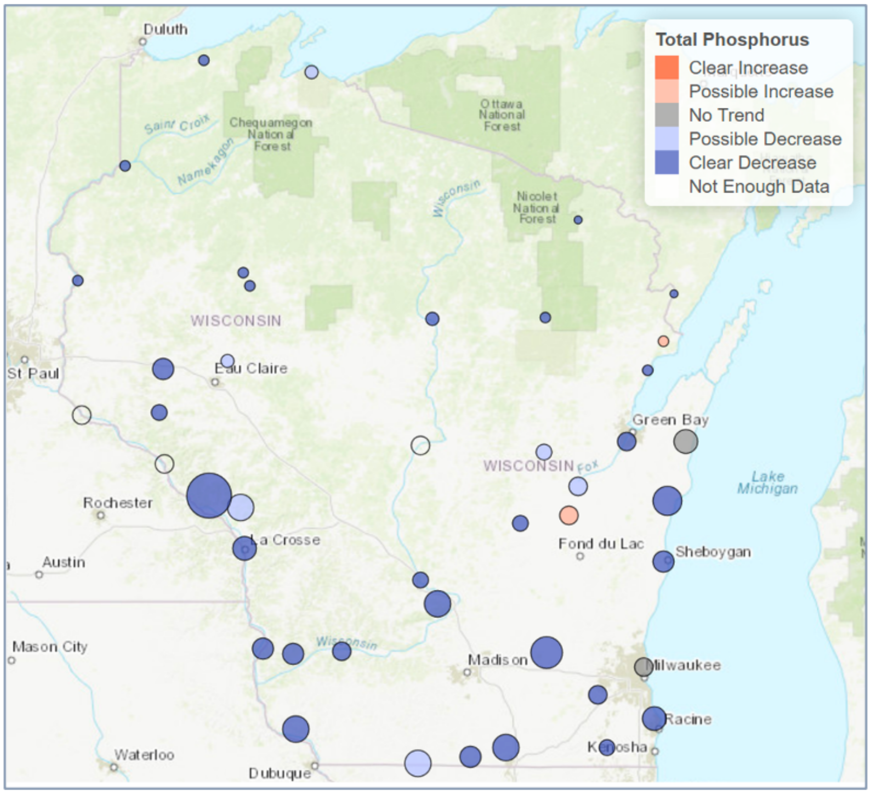

Figure 7. Change in Total Phosphorus (2010 to 2020)[320]

As our analyses show, over the past two decades, waters listed as impaired on the 303(d) list have increased due to monitoring and applying specific numeric criteria for phosphorus. Simultaneously, river monitoring statewide is showing decreases in total phosphorus levels. River monitoring suggests total phosphorus is trending in the right direction; however, it may take many years before those reductions are substantial enough to remove waterbodies from the impaired waters lists.

The delay between implementing numeric phosphorus criteria and restoring phosphorus-impaired water quality is not a trend unique to Wisconsin, rather we found it a common thread in three out of the five states in our comparative analysis.[321] Our research indicates that numeric nutrient criteria offer specificity the agencies need to accurately identify impaired waters and start prioritizing

[320] WIS. DEP'T NAT. RES., *supra* note 314.

[321] *See* discussion *infra* Section IV.A.3., (for a discussion on Florida's legacy phosphorus problem); *see also* discussion *infra* Section IV.C.1., (for a discussion of this issue in Minnesota).

clean-up and restoration activities. Wisconsin's combination of rules implementing phosphorus criteria on a watershed basis using market approaches in addition to existing phosphorus effluent limits on POTWs has gained traction. The long-term river monitoring indicates a trend of improvement in water quality statewide since the rules have been implemented. To accelerate improvements, research shows that transformative change from converting row crops to perennial grasslands needs to be a focused part of the management approach.[322]

IV. COMPARATIVE STATE ANALYSIS: FLORIDA, HAWAII, MINNESOTA, NEW JERSEY

The EPA tracks states' progress towards adopting numeric nutrient water quality criteria, designating a state's level of progress depending on how complete its criteria are for some or all watertypes.[323] As of 2023, no state holds the highest level five status, which would require a complete set of numeric nutrient criteria for all watertypes.[324] States that have set numeric nutrient criteria for two or more watertypes receive level four designation; as of 2023, only five states have achieved this status: Florida, Hawaii, Minnesota, New Jersey, and Wisconsin.[325] We have analyzed Wisconsin, and now turn to a comparative study of the other four states.

As discussed, the cooperative federalism framework positions states and designated tribes as primary regulators of water quality with EPA guidance and support. The EPA turned its focus to nutrient pollution control when it established its 1993 Nutrient Task Force and hosted a National Nutrient Assessment Workshop in 1995.[326] In 1998, the EPA's "National Strategy for the Development of Regional Nutrient Criteria" report recognized excessive nutrients as major pollutants impairing the nation's waters.[327] At the time the report was issued, several states had narrative nutrient standards that the EPA deemed insufficient to address nutrient pollution.[328] The EPA's strategy report notified states of the agency's expectation that all states would adopt and implement numeric nutrient criteria by December 2003.[329]

322 *See, e.g.*, Campbell et al., *supra* note 20.

323 *N/P Criteria Progress Map*, *supra* note 18 (stating that the EPA recognizes three watertypes: (1) lakes/reservoirs; (2) rivers/streams; and (3) estuaries. The EPA tracks the progress of states and United States territories but does not include tribes in this assessment.

324 *Id.*

325 *Id.*

326 U.S. ENV'T PROT. AGENCY, *Programmatic Information on Numeric Nutrient Water Quality Criteria*, https://www.epa.gov/nutrient-policy-data/programmatic-information-numeric-nutrient-water-quality-criteria (last updated Nov. 30, 2023).

327 U.S. ENV'T PROT. AGENCY OFF. OF WATER, NATIONAL STRATEGY FOR THE DEVELOPMENT OF REGIONAL NUTRIENT CRITERIA (1998).

328 *Id.*

329 *Id.*

The EPA's approach to working with states and tribes to adopt nutrient criteria was to first develop waterbody-type technical guidance and region-specific nutrient criteria by 2000 and then assist states and designated tribes in adopting numeric nutrient criteria into water quality standards by 2003.[330] At the time EPA published this strategy in 1998, only a handful of states had numeric nutrient criteria.[331] States largely ignored EPA's 2003 deadline for action. The number of states with partial numeric criteria for some waters increased from seven in 1998 to thirteen by 2008 and sixteen by 2023.[332]

Hawaii and New Jersey were two of the first states to adopt numeric phosphorus standards for some waters, with at least one form of numeric criteria since 1994.[333] In 1998, Hawaii and New Jersey were the first and only two states to attain level four designation, with statewide phosphorus criteria for two watertypes.[334] By 1998, Minnesota had achieved level three status with numeric phosphorus criteria for lakes/reservoirs, but did not rise to level four with numeric phosphorus criteria for rivers/streams until 2015.[335] By 2013, the EPA assigned both Florida and Wisconsin level four status, with statewide phosphorus criteria for two or more watertypes.[336]

We compare the phosphorus management approaches of these five states that have the most stringent criteria and the longest history of numeric nutrient regulation. The table below identifies in alphabetical order each state's numeric phosphorus criteria by watertype. The fifth column presents criteria for specific waterbodies regulated by the state that do not fall within one of the watertype criteria.

330 *Id.*

331 *N/P Criteria Progress Map*, *supra* note 18 (stating that two states had numeric nutrient criteria for two watertypes; two states had numeric phosphorus criteria for one watertype; and seven states had partial numeric criteria for some waters).

332 *Id.*

333 U.S. ENV'T PROT. AGENCY, *supra* note 327, at 34-36 (stating that Hawaii had numeric limits for ambient phosphorus based on watertype as well as site-specific numeric values for ambient nutrient levels; that New Jersey had also established numeric limits for ambient phosphorus based on watertype; and that the 1994 report shows Minnesota and Wisconsin had neither numeric nor narrative criteria for managing phosphorus).

334 *N/P Criteria Progress Map*, *supra* note 18 (stating that Hawaii had statewide phosphorus criteria for rivers/streams and estuaries, and New Jersey for lakes/reservoirs and rivers/streams).

335 *Id.*

336 *Id.*

Table 1. States' Numeric Phosphorus Criteria for Two or More Watertypes

State	Lakes/ Reservoirs	Rivers/ Streams	Estuaries	Other
Florida, FLA. ADMIN. CODE ANN. r. 62-302.531-532 (2016), 62-302.540 (2017)	10 – 160 ug/L	60 – 490 ug/L[337]	6 – 860 ug/L[338]	Everglades Protection Area 10 ug/L[339]
Hawaii, HAW. CODE R. §§ 11-54-	No P criteria	30 – 150 ug/L[340]	25 – 75 ug/L[341]	Embayments 20 – 75 ug/L[342]

337 This regionally based range of stream nutrient thresholds is used in combination with biological information to interpret the narrative nutrient criteria where a more stringent site-specific criteria (e.g., TMDL) has not been established. The nutrient threshold range includes the Panhandle West, Panhandle East, North Central Peninsular, and West Central regions. Numeric thresholds in this table have been converted from mg/L to ug/L for consistency. Narrative nutrient criteria apply for the region of South Florida where no numeric nutrient threshold has been set. FLA. ADMIN. CODE ANN. r. 62-302.531(2)(c)(2).

338 Florida sets site-specific numeric phosphorus criteria for each estuary. Numeric thresholds in this table have been converted from mg/L to ug/L for consistency. Eight estuaries' numeric phosphorus criteria are set as tons/million cubic meters of water representing annual totals not to be exceeded more than once in a three-year period. Two estuaries are assigned numeric phosphorus criteria expressed as "salinity dependent equations." Two more have limits measured in kg/year and one estuary's numeric phosphorus criteria are listed as a water quality-based effluent limit as lbs/day. FLA. ADMIN. CODE ANN. r. 62-302.532.

339 MICCOSUKEE TRIBE OF INDIANS OF FLORIDA, WATER QUALITY STANDARDS 3 (Mar. 3, 2021) (stating that before FDEP set Everglades-specific numeric phosphorus criteria, the Miccosukee Tribe adopted, and the EPA approved, Tribal water quality standards including a numeric phosphorus limit of 10 ppb (equivalent to 10 ug/L) for "the most upstream reaches of the Tribal waters.").

340 HAW. CODE R. § 11-54-5.2(b)(1) (2021) (stating that average stream phosphorus concentrations shall not exceed 50 ug/L during the wet season and 30 ug/L during the dry season. In the wet season, stream phosphorus concentrations shall not exceed 100 ug/L more than 10% of the time nor 150 ug/L more than 2% of the time. In the dry season, those values drop to no more than 60 ug/L 10% of the time and 80 ug/L 2% of the time. The wet season for stream water quality criteria runs November 1 through April 30, with stream water quality criteria for the dry season valid from May 1 through October 31).

341 *Id.* § 11-54-5.2(d)(1)-(2) (2021) (stating that average phosphorus concentrations in estuaries shall not exceed 25 ug/L, shall not exceed 50 ug/L more than 10% of the time, and shall not exceed 75 ug/L more than 2% of the time This criteria range applies to all estuaries except Pearl Harbor, which has a numeric phosphorus criteria range of 60 – 200 ug/L).

342 HAW. CODE R. § 11-54-6(a)(3) (2021) (stating that "Wet" embayment criteria apply when the average freshwater inflow from the land equals or exceeds 1% of the embayment volume per day and "dry" criteria apply when the average freshwater inflow from the land is less than 1% of the embayment volume per day. When wet criteria apply, average embayment phosphorus concentrations are not to exceed 25 ug/L and shall not exceed 50 ug/L more than 10% of the time nor 75 ug/L more than 2% of the time. Dry embayment criteria limit average phosphorus concentrations to 20 ug/L with a 40 ug/L cap 10% of the time and a 60 ug/L cap 2% of the time).

5.2(b)(1), (d)(1), 11-54-6(a)(3), (b)(3), (c)(3) (2021)				Open Coastal Waters 16 – 60 ug/L[343] Oceanic Waters 10 – 25 ug/L[344]
Minnesota, MINN. R. 7050.0220 (2021), 7050.0222 (2023)	12 – 90 ug/L	50 – 150 ug/L	Not Applicable	Site-specific criteria for individual lakes 50 – 105 ug/L[345] Lake Pepin 100 ug/L[346] Mississippi River segments and tributaries 70 – 125 ug/L[347]
New Jersey, N.J. ADMIN. CODE § 7:9B-1.14(d)(4)(ii),	50 ug/L	100 ug/L[348]	No P criteria	Site-specific criteria for 5 individual lakes/ponds

343 *Id.* (stating that for open coastal waters, "wet" criteria apply when the open coastal waters receive more than 3 million gallons per day of freshwater discharge per shoreline mile and "dry" criteria apply when the open coastal waters receive less than 3 million gallons per day of freshwater discharge per shoreline mile. Wet phosphorus criterion is set at 20 ug/L with a 40 ug/L limit 10% of the time and a 60 ug/L 2% of the time. When dry criterion is applicable, phosphorus levels must not exceed 16 ug/L on average, 30 ug/L more than 10% of the time, and 45 ug/L more than 2% of the time).

344 *Id.* (stating that numeric phosphorus criteria are lowest for oceanic waters with an average limit of just 10 ug/L. Phosphorus limits in oceanic waters shall not exceed 18 ug/L more than 10% of the time nor 25 ug/L more than 2% of the time).

345 MINN. R. 7050.0220(7) (2021); 7050.0222(4) (2023) (stating that EPA approved site-specific standards for nine waterbodies); *see also Water Quality Standards Regulations: Minnesota*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/wqs-tech/water-quality-standards-regulations-minnesota (last updated Nov. 9, 2023).

346 MINN. R. 7050.0220(7)(D)(1) (2021).

347 MINN. R. 7050.0220(4) (2021); *see also* MINN. R. 7050.0220(3); 7050.0220(3)(B) (2021).

348 N.J. ADMIN. CODE § 7:9B-1.14(d)(4)(ii), (g)(3)(i) (2023) (stating that this applies to non-tidal streams unless watershed-specific translators (i.e., TMDLs) are established. The statewide criteria are not applicable to twenty-seven rivers/streams where site-specific phosphorus criteria have been assigned).

(g)(2), (3)(B)(i) (2023)				40 – 59 ug/L[349] Delaware River Basin[350]
Wisconsin, WIS. ADMIN. CODE NR § 102.06(3-5) (2022)	15 – 40 ug/L	75 – 100 ug/L	Not Applicable	Lake Michigan 7 ug/L Lake Superior 5 ug/L

This comparative state analysis includes two ocean coastal states and one island state that regulate both inland and marine waters, as well as two inland states that are uniquely positioned to regulate two out of the five North American Great Lakes. Hawaii prioritizes regulating marine waters over inland waters, giving special attention to embayments, coastal, and oceanic waters. Florida stands out as the only state in this analysis that has established numeric phosphorus criteria for all three watertypes recognized by the EPA. As will be explained in the next section, Florida is also unique as the only state the EPA has ever promulgated numeric nutrient water quality standards for, although they have since been rescinded and replaced with state criteria.

Wisconsin, Minnesota, and New Jersey do not have numeric nutrient criteria for estuaries, whereas Hawaii and Florida do. New Jersey applies narrative nutrient criteria to its estuarine waters; their ongoing efforts to develop numeric nutrient criteria that would apply to estuaries have not yet led to statewide adoption.[351]

The following sections describe how each state manages point and nonpoint source phosphorus pollution with numeric water quality criteria applicable to the various watertypes. The case studies are presented and compared below, proceeding in alphabetical order.

A. Florida's Approach to Phosphorus Management

This section explores the federal-state tension underlying Florida's approach to

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349 *Id.* § 7:9B-1.14(g)(2) (stating that the site-specific criteria represent annual averages that apply to two lakes and three ponds).

350 *Id.* § 7:9B-1.14(h) (stating that statewide numeric and narrative phosphorus criteria apply to waters within the basin that are not governed by criteria established by the Delaware River Basin Commission Water Quality Regulations).

351 N.J. DEP'T ENV'T PROT., NEW JERSEY NUTRIENT CRITERIA ENHANCEMENT PLAN at 13, 16 (2018) https://dep.nj.gov/wp-content/uploads/bears/documents/ncep-web-links-checked-epa-r2-comments-incorporated-15-oct-2018_2.pdf.

phosphorus management as compared to Wisconsin's with an overview of the state's numeric nutrient criteria, an analysis of litigation surrounding their development, and a review of the state's nutrient reduction strategies and management plans for restoring water quality. Florida is the only state where the EPA imposed numeric nutrient criteria in response to litigation over chronic and extensive pollution problems.

1. EPA Imposition and Oversight of Numeric Nutrient Criteria

State development of numeric nutrient standards requires cooperation and coordination with the EPA. The state-federal relationship during this process in Florida was contentious, whereas Wisconsin's relationship with EPA Region 5 was more collegial. The EPA and WDNR engaged in extensive dialogue with a shared goal for approval of Wisconsin's phosphorus regulatory scheme. In contrast, the evolution of Florida's numeric nutrient criteria development was fraught with tension between federal versus state control over water quality standards. Both Wisconsin and Florida also faced pressure mounted by environmental groups to take regulatory action or risk federal promulgation of numeric nutrient criteria.

In January 2009, the EPA issued a CWA section 303(c)(4)(B)[352] determination that Florida required water quality standards in the form of numeric nutrient criteria to meet necessary CWA requirements.[353] The EPA rarely makes necessity determinations of this nature; such decisions disrupt the usual cooperative federalism structure that positions states as primary actors in establishing and implementing water quality standards. The EPA considered the following factors when making its determination: (1) Florida's unique and endangered ecosystems; (2) the high number of impaired waters due to existing nutrient pollution; and (3) the challenge associated with growing nutrient pollution resulting from expanding urbanization, continued agricultural development, and a significantly increasing population that is expected to grow 75% between 2000 to 2030.[354]

In this situation, the EPA's action was spurred by a CWA citizen suit[355] filed in 2008 alleging the EPA failed to perform its non-discretionary duty to set

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352 33 U.S.C. § 1313(c)(4)(B) (authorizing the EPA to set state water quality standards after a determination that such standards are necessary to meet the requirements of the CWA).

353 *Numeric Nutrient Criteria for the State of Florida: Withdrawing the Federal Actions*, U.S. ENV'T PROT. AGENCY (2014), https://www.epa.gov/sites/default/files/2015-07/documents/factsheet-withdrawl-2014.pdf.

354 Water Quality Standards for the State of Florida's Lakes and Flowing Waters, 75 FR 4174 (Jan. 26, 2010) (to be codified at 40 C.F.R. 131), https://www.federalregister.gov/documents/2010/01/26/2010-1220/water-quality-standards-for-the-state-of-floridas-lakes-and-flowing-waters.

355 33 U.S.C. § 1365(a)(2) (stating that "any citizen may commence a civil action on his own behalf…against the Administrator where there is alleged a failure of the Administrator to perform any act or duty under this chapter which is not discretionary with the Administrator.").

numeric nutrient criteria for Florida pursuant to CWA section 303(c)(4)(B).[356] At the time of the necessity determination, Florida still had not adopted or even proposed numeric nutrient standards despite extensive water pollution from excess nutrients resulting in nuisance and HABs.[357] In its 2008 Integrated Water Quality Assessment, the Florida Department of Environmental Protection (FDEP) reported approximately 1,000 miles of rivers and streams, 350,000 acres of lakes, and 900 square miles of estuaries as impaired by nutrients.[358] Environmental organizations' frustration with Florida's inaction and the EPA's leniency prompted their 2008 CWA citizen suit and led to the EPA's necessity determination. Environmental groups in Wisconsin gave notice of intent to file a similar suit against the EPA one year later, however, the state passed numeric nutrient standards without federal intervention.[359]

In December 2009, the EPA entered into a consent decree with the Florida plaintiffs that established a schedule for the EPA to propose and promulgate numeric nutrient criteria for the state's surface waters if Florida failed to do so by the scheduled deadlines.[360] The first deadline required numeric nutrient criteria for lakes and flowing waters (i.e. streams) by 2010.[361] When Florida failed to take action by that initial deadline, the EPA in an unprecedented move published a rule finalizing numeric nutrient criteria for the state's inland surface waters.[362]

In 2011, Florida petitioned the EPA to: (1) withdraw its 303(c)(4)(B) determination that numeric nutrient criteria are necessary in Florida; (2) repeal the 2010 federal rule establishing numeric nutrient criteria; and (3) discontinue proposing or promulgating any further numeric nutrient criteria in Florida.[363] In its petition, Florida called out a discrepancy between a 2011 EPA memo detailing necessary elements for effective state nutrient reduction programs, elements which Florida claimed to have in its own nutrient reduction framework, and the 303(c)(4)(B) necessity determination that singled out Florida.[364]

In an initial response to the FDEP, the EPA gave support for Florida's continued focus on reducing nutrient pollution and reaffirmed the state's primary

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356 Consent Decree at 2, Fla. Wildlife Fed'n v. Jackson, Case No. 4:08-cv-00324-RH-WCS (N. D. Fla. 2009) [hereinafter Fla. Wildlife Fed'n Consent Decree].

357 *N/P Criteria Progress Map*, *supra* note 18.

358 FLA. DEP'T ENV'T PROT., INTEGRATED WATER QUALITY ASSESSMENT FOR FLORIDA 67 (2008).

359 *See* discussion *supra* Section III.A.

360 Fla. Wildlife Fed'n Consent Decree at 4-6, *supra* note 356.

361 Water Quality Standards for the State of Florida's Lakes and Flowing Waters, s*upra* note 354.

362 *Id.*

363 Pet. from Thomas M. Beason, Gen. Couns. & Kenneth B. Hayman, Sr. Assistant Gen. Couns., Fla. Dep't Env't Prot., to Lisa P. Jackson, Adm'r, U.S. Env't Prot. Agency at 1 (Apr. 22, 2011) https://www.epa.gov/sites/default/files/2015-07/documents/fdep-petition-withdrawal-2011.pdf.

364 *Id.* at 30.

role in establishing and implementing water quality standards.[365] The EPA reminded Florida of the state's authorization under the CWA to adopt numeric nutrient water quality criteria before and after the EPA's 2009 necessity determination.[366] The EPA in fact stated a preference for state adoption of numeric nutrient criteria over federal promulgation and committed to repealing the federally promulgated standards if the FDEP adopted and the EPA approved sufficient numeric nutrient criteria.[367]

In addition to its petition to the EPA, Florida along with several regulated entities[368] sued the EPA challenging its federally promulgated numeric nutrient criteria, alleging the 2009 determination was arbitrary or capricious and thus should be set aside under the Administrative Procedure Act .[369] These lawsuits were consolidated with suits brought by environmental organizations[370] against the EPA challenging the same rule but arguing it was not protective enough.[371] When issuing the 2009 necessity determination, the EPA had to consider whether a revised or new standard, specifically a numeric nutrient standard, was necessary to meet the CWA's requirements.[372] The EPA answered in the affirmative and issued the determination. The federal district court held the EPA's determination was not "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law."[373] However, when Florida developed and the EPA approved numeric nutrient criteria in 2012 and 2013, the EPA withdrew the promulgated federal criteria and declined to finalize related proposed rules.[374]

In the end, the state-issued numeric criteria closely aligned with the federally promulgated standards. This may be in part because the EPA worked closely with FDEP staff in its analysis and proposal of numeric criteria as interpreted from the state's narrative criteria. The EPA, in consultation with FDEP staff, developed the current classification scheme for lakes using color and alkalinity; both play an important role in the degree to which nutrient concentrations result in a biological response to indicators such as chlorophyll *a*.[375] The state's current criteria for

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365 Letter from Nancy K. Stoner, Acting Assistant Adm'r, to Herschel T. Vinyard Jr., Sec'y, Fla. Dep't Env't Prot. (June 13, 2011) (on file with U.S. EPA, a copy of this letter is also available at page 220 of https://www.govinfo.gov/content/pkg/CHRG-112hhrg81389/pdf/CHRG-112hhrg81389.pdf).

366 *Id.*

367 *Id.*

368 Fla. Wildlife Fed'n, Inc. v. Jackson, 853 F. Supp. 2d 1138 (N.D. Fla. 2012) (stating that the Florida Water Environmental Association Utility Council, the Florida Electric Power Coordinating Group, the Fertilizer Institute, and the Florida Cattlemen's Association were among the plaintiffs).

369 *Id.* at 1154.

370 *Id.* (stating the Fla. Wildlife Fed'n and Gulf Restoration Network as plaintiffs).

371 *Id.* at 1153-54.

372 *Id.* at 1155.

373 *Id.* at 1143.

374 *Numeric Nutrient Criteria for the State of Florida*, *supra* note 353.

375 Water Quality Standards for the State of Florida's Lakes and Flowing Waters, *supra* note 354.

lakes are nearly identical to the EPA's rule.[376] The state's current criteria for streams is similar in that it retained the EPA's original concept of regionally-defined nutrient thresholds but contains a list with differently defined nutrient watershed regions.[377]

A decade after Florida resolved its regulatory conflict over phosphorus, it finds itself in a renewed state-federal battle, this time over regulating toxins. In 2022, the EPA issued another 303(c)(4)(B) determination that new and revised water quality standards in Florida were necessary to satisfy the requirements of the CWA.[378] The fact that the EPA issued a second necessity determination for the state of Florida is seemingly indicative of the state's repeated failure to timely adopt its own water quality standards pursuant to the CWA.

2. Florida's Numeric Phosphorus Criteria

Public pressure and litigation from environmental organizations propelled Florida to adopt and implement numeric nutrient criteria. By 2013, Florida had statewide phosphorus criteria for lakes/reservoirs and estuaries with partial phosphorus criteria for rivers/streams.[379] Similar to Wisconsin's approach, Florida's nutrient standards are numerical interpretations of the state's previously adopted narrative nutrient criteria.[380] Unlike Wisconsin, where numeric criteria are set by watertype with exceptional site-specific criteria, Florida favors site-specific analyses over more broadly applicable numeric interpretations.[381] For instance, Wisconsin established one numeric phosphorus standard applicable to forty-six waterbodies that fall into the rivers/streams category, with other standards broadly applicable to subcategories of lakes/reservoirs (e.g., stratified versus not stratified).[382] Site-specific phosphorus standards for Wisconsin's waters are only used when necessary to protect the waterbody's designated use, a finding that must be supported by scientifically defensible methods and sound scientific rationale.[383] As of 2024, Wisconsin's phosphorus rules established site-

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376 *Compare* 75 F.R. 4174 with FLA. ADMIN. CODE ANN. r. 62-302.531(2)(b)(1) (2016) (proposed EPA rule and adopted Florida rule had nearly identical standards).

377 *Compare* 75 F.R. 4174 with FLA. ADMIN. CODE ANN. r. 62-302.531(2)(c)(2) (2016).

378 Letter from Radhika Fox, Assistant Adm'r, U.S. Env't Prot. Agency, to Shawn Hamilton, Sec'y, Fla. Dep't Env't Prot. (Dec. 1, 2022) (on file with U.S. Env't Prot. Agency) (stating that the EPA determined new and revised human health criteria were needed to protect against adverse health effects from toxins polluting Florida's surface water); *see also* Letter from David A. Ludder, Att'y, Env't Def. Alliance & Jen Lomberk, Att'y, Waterkeepers Fla., to Michael S. Regan, Adm'r, U.S. Env't Prot. Agency (Jan. 19., 2022) (stating that in January 2022, Waterkeepers Florida in partnership with Environmental Defense Alliance petitioned the EPA urging the agency to make this determination).

379 *N/P Criteria Progress Map*, *supra* note 18.

380 FLA. DEP'T ENV'T PROT., IMPLEMENTATION OF FLORIDA'S NUMERIC NUTRIENT STANDARDS (Apr. 2013).

381 *Id.*

382 WIS. ADMIN. CODE NR § 102.06 (2022).

383 WIS. ADMIN. CODE NR § 102.06(7) (2022).

specific numeric phosphorus criteria for just four waterbodies, with one pending EPA approval.[384]

This is different from Florida's approach, where unique site-specific criteria are considered superior to standards determined by watertype due to the varying degree of natural factors affecting nutrient loading and water quality on a given waterbody.[385] Each lake in Florida is assessed for its long-term geometric mean color, alkalinity, and chlorophyll *a* concentration,[386] the results of which determine the lake's corresponding nutrient criteria.[387] Florida sets numeric nutrient criteria for streams based in part on regionally defined nutrient thresholds[388] that are more site-specific than Wisconsin's broadly applicable criteria for all rivers and streams that generally exhibit unidirectional flow.[389] Florida's estuaries have the most detailed numeric nutrient criteria; there are almost 200 estuary segments, each with a specific standard.[390]

Both states have specially designated numeric phosphorus standards for individual waterbodies located in or adjacent to the state. In Wisconsin, Lakes Superior and Michigan have specific phosphorus limits that are significantly lower than other lakes' criteria.[391] Florida separately regulates water quality standards for phosphorus in the Everglades Protection Area.[392]

3. Controlling Point and Nonpoint Source Nutrient Pollution

Florida has invested millions in studying and analyzing the relationship between nutrient pollution and ecosystem health.[393] Researchers have found a legacy phosphorus problem in Florida similar to Wisconsin's. The nutrient's legacy impacts are especially concerning in Lake Okeechobee, one of the nation's largest freshwater lakes.[394] Elevated phosphorus levels in soils around Lake

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384 *Id.*

385 FLA. DEP'T ENV'T PROT., *supra* note 380.

386 *Indicators: Chlorophyll a*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/national-aquatic-resource-surveys/indicators-chlorophyll (last updated May 26, 2023) (stating that chlorophyll *a* is a nutrient response variable used to measure the amount of algae growing in a waterbody; high concentrations of chlorophyll *a* indicate excess levels of nutrients).

387 FLA. ADMIN. CODE ANN. r. 62-302.531(2)(b)(1) (2016).

388 FLA. ADMIN. CODE ANN. r. 62-302.531(2)(c)(2) (2016).

389 WIS. ADMIN. CODE NR § 102.06(3) (2022).

390 FLA. ADMIN. CODE ANN. r. 62-302.532 (2016).

391 WIS. ADMIN. CODE NR § 102.06(5) (2022).

392 FLA. ADMIN. CODE ANN. r. 62-302.540 (2017).

393 Water Quality Standards for the State of Florida's Lakes and Flowing Waters, *supra* note 354; *see also* Adam Weiss, Fe*deral Numeric Nutrient Criteria in Florida: When Cooperative Federalism Goes Rogue*, 30 PACE ENV'T L. REV. 299, 302 (2012).

394 Thomas M. Missimer et al., *Legacy Phosphorus in Lake Okeechobee (Florida, USA) Sediments: A Review and New Perspective*, 13 WATER 39 (2020) (stated "Despite major efforts to control external nutrient loading into the lake, the high frequency of algal blooms will continue until the muds bearing legacy nutrients are removed from the lake.").

Okeechobee are attributed to high concentration of dairy farms from the late 1950s to 1970s, as well as naturally occurring phosphorus that is routinely mined in the area.[395] Numeric standards and implementation programs that address legacy phosphorus are key to mitigating the nutrient pollution.

In response to litigation and EPA involvement, Florida developed a statewide regulatory framework for point and nonpoint nutrient reduction.[396] Unlike Wisconsin, Florida does not impose a technology-based effluent limit for phosphorus on its POTWs. However, both Wisconsin and Florida regulate point sources through state run NPDES permit systems to limit discharges in compliance with the states' numeric nutrient criteria.[397] The FDEP implements nutrient TMDLs[398] and water quality-based effluent limitations[399] for waterbodies where necessary to achieve water quality criteria. Florida's nonpoint source management program utilizes BMPs to target nutrient pollution from urban stormwater and agricultural runoff.[400]

For agricultural phosphorus pollution specifically, Florida, like Wisconsin, administers NMPs and a phosphorus index for nutrient management and runoff reduction.[401] Florida's NMPs are similar to Wisconsin's; they account for land application of manure and nutrient loadings to surface waters and contain strategies for compliance with state water quality standards.[402] Florida's phosphorus index differs from Wisconsin's both in how it is used and how it measures the nutrient. Florida's phosphorus index was developed as a site-specific, qualitative vulnerability assessment tool that assigns risk values for phosphorus loss as "low, medium, high, or very high."[403] Higher vulnerability ratings correlate to greater potential for phosphorus runoff and higher likelihood that phosphorus will impair surrounding waterbodies.[404] The phosphorus index categorizes risk based on factors relating to site, transport, source, and management.[405] This is a different approach from Wisconsin's, where its phosphorus index is reported as a whole number expressed as pounds of

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395 Katrina Elsken, *What is 'legacy' phosphorus*, LAKE OKEECHOBEE NEWS (Mar. 22, 2021), https://www.southcentralfloridalife.com/stories/what-is-legacy-phosphorus,17331.

396 *Numeric Nutrient Criteria for the State of Florida*, *supra* note 353.

397 *Florida NPDES Permits*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/npdes-permits/florida-npdes-permits (last updated Mar. 8, 2024).

398 FLA. STAT. § 403.067 (2023) (stating that TMDLs are set for waters that have been identified as impaired on the state's 303(d) list of impaired waterbodies).

399 *Id.* (water quality-based effluent limitations determine appropriate levels of nutrient discharge that attain nutrient criteria).

400 FLA. DEP'T ENV'T PROT., NONPOINT SOURCE PROGRAM UPDATE at 10 (Oct. 2021).

401 FLA. ADMIN. CODE ANN. r. 62-640.500 (2021); *see also The Florida Phosphorus Index*, UNIV. OF FLA., https://nutrients.ifas.ufl.edu/PIndices/pifinal.pdf (last accessed Aug. 13, 2023).

402 FLA. ADMIN. CODE ANN. r. 62-640.500 (2021).

403 *The Florida Phosphorus Index*, *supra* note 401.

404 *Id.*

405 *Id.*

phosphorus per acre per year. Unlike Florida, where its phosphorus index is not intended to be an evaluation tool to determine compliance of water quality standards by any regulatory agency,[406] Wisconsin uses it to target and assess water quality projects.

Florida implements several watershed-based approaches with restoration plans covering both point and nonpoint sources. These watershed plans include legally enforceable basin management action plans,[407] Surface Water Improvement and Management plans,[408] and legislatively mandated restoration efforts directed at sensitive watersheds like the Everglades and Lake Okeechobee.[409] In the Everglades, for instance, Florida is constructing wetlands, or "Stormwater Treatment Areas," to remove excess phosphorus.[410]

Additionally, water quality trading is an available market-based compliance option for point and nonpoint sources in both states. Wisconsin's water quality trading program is older and more refined than Florida's. Wisconsin established its water quality trading program and the nation's first adaptive management program in 2010, at the same time and through companion legislation to the state's numeric nutrient criteria. Florida authorized statewide water quality trading in basin management action plan areas in 2013, shortly after adopting numeric nutrient standards in 2012.[411] Before extending statewide authorization, water

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406 *Id.*

407 FLA. STAT. § 403.067(7)(a)(5) (2023). *Basin Management Action Plans (BMAPs)*, FLA. DEP'T ENV'T PROT., https://floridadep.gov/dear/water-quality-restoration/content/basin-management-action-plans-bmaps (last modified July 6, 2023) (stating that a basin management action plan is a framework for water quality restoration reliant upon local and state commitments to complete pollutant reduction projects and strategies (e.g., permit limits on wastewater facilities, urban and agricultural best management practices, land conservation programs) designed to achieve TMDL reduction targets, As of June 2023, Florida has adopted basin management action plans for more than thirty waterbodies; *see also* Douglas H. MacLaughlin, *Will Basin Management Action Plans Restore Florida's Impaired Waters?*, 89 ENV'T & LAND USE L. 31 (2015) (stating that an early assessment of Florida's basin management action plan framework impact on water quality).

408 *About SWIM*, SOUTHWEST FLA. WATER MGMT. DIST., https://www.swfwmd.state.fl.us/projects/swim (last accessed Aug. 13, 2023) (stating that the Florida Legislature's 1987 SWIM Act addresses surface water issues by authorizing the state's water management districts to implement water quality improvement plans, including through reducing excess nutrients affecting water quality in stormwater runoff.); *see also* JOHN W. TURCOTTE, OFF. OF PROGRAM POL'Y ANALYSIS & GOV'T ACCOUNTABILITY, FLA. LEGISLATURE, FOLLOW-UP REPORT ON THE SURFACE WATER IMPROVEMENT AND MANAGEMENT PROGRAM, REP. NO. 97-58 (1999) (stating that SWIM plans receive federal, state, and local funds.)

409 *Permitting*, FLA. DEP'T ENV'T PROT., https://floridadep.gov/eco-pro/eco-pro/content/permitting (last modified Sept. 20, 2022) (*e.g.,* the 2007 Northern Everglades and Estuaries Protection Program, which expanded the Lake Okeechobee Protection Act with an intent to protect and restore surface water resources and maintain compliance with water quality standards through a comprehensive and innovative protection program).

410 *Restoration of the Florida Everglades*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/everglades (last updated June 14, 2023).

411 H.B. 713, 2013 Leg. (Fla. 2013); *see also* Tara Wade and Tatiana Borisova, *Water Quality Credit Trading: General Principles*, UNIV. OF FLA. (Feb. 21, 2022), https://edis.ifas.ufl.edu/

quality trading actually began in Florida with a pilot program in 2008 limited to the Lower St. Johns River Basin.[412]

As of February 2023, Wisconsin has overseen water quality trades for fifty-five permittees[413] while Florida has only had four.[414] Of the four trades in Florida, only one involved phosphorus reduction.[415] In Florida, as of February 2023, there were no available credits for trading.[416] Meanwhile, in March 2023, Wisconsin established the nation's first market-based water quality trading clearinghouse, a centralized platform where water quality trades between point and nonpoint sources are brokered for overall nutrient pollution reduction.[417]

There are at least three potential impediments to nutrient trading in Florida that may be hindering the state's program growth. Not unlike the stakeholder risk of regulatory penalties Wardropper revealed in Wisconsin's adaptive management program, point and nonpoint sources in Florida face the same risk, as the FDEP would seek to hold trading parties accountable if TMDL or other water quality-based limits are not met.[418] There also exists a considerable level of uncertainty regarding future pollution reduction potential from a point to nonpoint trade. Florida's approach to accounting for this uncertainty is to establish "default uncertainty factors of 2:1 for urban stormwater best management practices and 3:1 for agricultural best management practices."[419] Florida would also allow credit generators to document more accurate site-specific factors to equalize varying cost and effectiveness of point to nonpoint trades.[420] The underlying uncertainty and burden of defining accounting factors may deter entities from engaging in trades. Finally, Florida's trading program would allow public access to trade

publication/FE824.

412 *Pilot Water Quality Credit Trading Program for the Lower St. Johns River*, FLA. DEP'T ENV'T PROT., https://archives.waterinstitute.ufl.edu/symposium2012/downloads/presentations/JoynerD_Room228_WI_SYMP_2012.pdf (last accessed Aug. 13, 2023).

413 Ken Genskow, Professor, Env't Plan. & Pol'y, Univ. of Wis.-Madison, Conf. Panel Presentation at Phosphorus: Lessons from 10+ Years of Numeric Standards for Wisconsin's Waters (Feb. 7, 2023) in UW-MILWAUKEE CENTER FOR WATER POLICY, 2023 PHOSPHORUS CONFERENCE REPORT (May 2023), https://pconference.files.wordpress.com/2023/05/2023-p-conference-report-4.pdf at 18-19; Univ. of Wis.-Milwaukee Ctr. for Water Pol'y, *Panel 3: Wisconsin Phosphorus Policy Implementation*, YOUTUBE (Feb. 7, 2023 at 13:15), https://www.youtube.com/watch?v=5l3l7C5Wy4k&t=764s.

414 *Florida Water Quality Credit Trading Registry*, FLA. DEP'T ENV'T PROT., https://floridadep.gov/dear/water-quality-restoration/content/florida-water-quality-credit-trading-registry (last visited Feb. 21, 2023).

415 *Id.*

416 *Id.*

417 *Water Quality Trading Clearinghouse Contract Established in Wisconsin*, *supra* note 224; *see also Simplifying Water Quality Trading in Wisconsin*, *supra* note 226.

418 F. Joseph Ullo, Jr., *Water Quality Credit Trading – A Practitioner's Perspective*, 81 FLA. BAR J. 60 (2007).

419 FLA. DEP'T ENV'T PROT., WATER QUALITY CREDIT TRADING: A REPORT TO THE GOVERNOR AND LEGISLATURE at 17 (Dec. 2006).

420 Ullo, *supra* note 418.

information through its credit registry database;[421] it is possible entities will be hesitant to subject themselves to public scrutiny by participating in trades.[422]

The remaining phosphorus reduction approaches discussed in this section are unique to Florida. Two pieces of legislation established additional strategies for nutrient reduction and water quality improvement. First, in 2020, Florida passed Senate Bill 712, the "Clean Waterways Act," which encompasses a wide range of water quality protection provisions to minimize impacts from point and nonpoint nutrient pollution sources.[423] The law targets, among other sources, wastewater treatment facilities and agricultural producers. The law directs local governments to create wastewater treatment plans for certain basin management action plans, supported by a wastewater grant program.[424] The law also requires that "[a]t least every 2 years, the Department of Agriculture and Consumer Services shall perform onsite inspections of each agricultural producer that enrolls in a best management practiceFalse"[425] The bill authorizes legislative budget requests to fund BMPs like conservation easements and dispersed water management (i.e., where private property owners retain water on their land rather than drain it).[426]

Another law that went into effect in 2020 was House Bill 1091, "Environmental Accountability," which made notable changes to penalties for violating Florida's environmental laws.[427] FDEP may now impose up to $50,000 in administrative penalties in a notice of violation, a considerable increase from the previous maximum penalty amount of $10,000.[428] This law also charges each day of unauthorized discharge of domestic wastewater as a separate offense until the violation is resolved.[429]

In addition to the laws passed creating water quality protection provisions and steeper penalties for environmental law violations, Florida has also appropriated significant sums of money to fund HABs mitigation. In fiscal year 2019-20, $10 million were appropriated specifically for technologies to combat and clean up HABs.[430] The FDEP is also providing financial assistance for local governments

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421 FLA. DEP'T ENV'T PROT., *supra* note 419.

422 Ullo, *supra* note 418.

423 S.B. 712, 2020 Leg. (Fla. 2020).

424 *Id.*

425 S.B. 712, 2020 Leg. (Fla. 2020); *see also Agricultural Best Management Practices*, FLA. DEP'T AGRIC. & CONSUMER SERV., https://www.fdacs.gov/Agriculture-Industry/Water/Agricultural-Best-Management-Practices (last accessed Aug. 13, 2023) (stating that when FDEP sets TMDLs, they also set BMAPs in order to implement the TMDL, and that Agricultural producers in a plan area must enroll in the BMP program.).

426 S.B. 712, 2020 Leg. (Fla. 2020).

427 H.B. 1091, 2020 Leg. (Fla. 2020).

428 *Id.*

429 *Id.*

430 Press Release, Fla. Dep't Env't Prot., Governor Ron DeSantis Announces Preparation for Algal Bloom Mitigation Following Announcement by Corps of Releases from Lake O (Oct. 14, 2020), available at https://content.govdelivery.com/accounts/FLDEP/bulletins/2a57376; *see also* Press

to address the red tide bloom, has increased monitoring efforts (including use of robotic technology), and has partnered with county health departments and local governments to distribute advisory community outreach.[431]

In early 2019, then-newly elected Florida Governor Ron DeSantis signed Executive Order 19-12, "Achieving More Now For Florida's Environment," where he identified algae blooms as a threat to the environment, public health, recreation, and the economy and made a pledge to protect the state's water resources.[432] Governor DeSantis directed the FDEP to establish a Blue-Green Algae Task Force to reduce adverse impacts of toxic algal blooms in Lake Okeechobee and other key waterbodies.[433] DeSantis also directed the FDEP to Participate in Florida Fish and Wildlife Conservation Commission's pre-existing Harmful Algal Bloom Task Force charged with researching, monitoring, controlling, and mitigating red tide[434] and other HABs in Florida's waters.[435]

In 2022, Surfrider led a coalition of environmental organizations to review and report on the status of the Blue-Green Algae Task Force. They found that only four of the task force's thirty-one specific and measurable recommendations had been implemented by legislative and state agencies.[436] Surfrider called out Florida's failure to protect public health when the state neglects to test waters for HABs and give public notice when beaches are unsafe for recreating.[437] Governor DeSantis, however, renewed his pledge to prioritize and fund water quality and natural resources protection and restoration in a January 10, 2023 executive order, "Achieving *Even More* Now for Florida's Environment."[438]

Release, Ron DeSantis 46th Gov. of Fla., Governor Ron DeSantis Signs the Fiscal Year 2020-2021 Budget (June 29, 2020), available at https://www.flgov.com/2020/06/29/governor-ron-desantis-signs-the-fiscal-year-2020-2021-budget/ (stating that another 10 million were invested in these projects the following year.)

431 Press Release, Ron DeSantis 46th Gov. of Fla., Governor Ron DeSantis Surveys Impacts and Provides Updates on State's Response to Red Tide Bloom in Tampa Bay Area (July 21, 2021), available at https://www.flgov.com/2021/07/21/governor-ron-desantis-surveys-impacts-and-provides-updates-on-states-response-to-red-tide-bloom-in-tampa-bay-area/.

432 Fla. Exec. Order No. 19-12 (Jan. 10, 2019), https://protectingfloridatogether.gov/sites/default/files/documents/EO_19-12_0.pdf.

433 *Id.* (stating that Lake Okeechobee faced a HABs crisis when two-thirds of the 730-square-mile freshwater body was contaminated by cyanobacteria; also called blue-green algae, these are microorganisms that can produce HABs); *see also* ENV'T INTEGRITY PROJ., THE CLEAN WATER ACT AT 50: PROMISES HALF KEPT AT THE HALF-CENTURY MARK 28 (Mar. 17. 2022).

434 *What is a red tide?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://oceanservice.noaa.gov/facts/redtide.html (last accessed Aug. 13, 2023) (stating that red tide is a harmful algal bloom caused by microscopic algae that produce toxins that lead to fish kills, red-colored tides, and poor air quality).

435 *Fla. Exec. Order No*. 19-12(J).) (Jan. 10, 2019), https://protectingfloridatogether.gov/sites/default/files/documents/EO_19-12_0.pdf.

436 Emma Haydocy, *The Results Are In: Florida Falling Short to Protect Public from Toxic Algal Blooms*, FLA. SURFRIDER (Aug. 8, 2022), https://florida.surfrider.org/the-results-are-in-florida-falling-short-to-protect-public-from-toxic-algal-blooms/.

437 *Id.*

438 Fla. Exec. Order No. 23-06 (Jan. 10, 2023), https://www.flgov.com/wp-content/uploads/

Similar to Wisconsin's experience in the first decade of applying numeric nutrient criteria, Florida has identified more phosphorus-impaired waters. This is to be expected, as the numeric criteria allows for more precise evaluation. Florida's 2016 Integrated Water Quality Assessment Report was the first of these reports to assess state waters according to numeric nutrient criteria.[439] In 2016, 180 rivers/streams, one lake, 106 estuary segments, and 2 coastal segments were identified as nutrient impaired.[440] Four years later, FDEP began reporting total phosphorus as a cause of impairment and identified 151 streams, 158 lakes, 43 estuary segments, and one coastal segment as specifically phosphorus-impaired.[441] In 2022, the number of phosphorus-impaired waterbodies rose to 155 stream segments (1,495 miles), 182 lake segments (728,664 acres), and 54 estuary segments (289,932 square miles).[442]

Unlike our analysis of Wisconsin's positive trend of statewide reductions in total phosphorus in rivers, we do not have access to long-term monitoring trends for Florida's rivers. This is an area needed for additional research to better assess whether Florida's regulations are producing positive results in water quality. However, it appears that nutrient induced nuisance and HABs have become annual events plaguing Florida's waterways, and agricultural and urban phosphorus runoff causes frequent toxic algal blooms in the Everglades.[443]

B. Hawaii's Approach to Phosphorus Management

Hawaii is the only state in the nation besides New Jersey that has been implementing numeric phosphorus criteria for two inland watertypes (rivers/streams and estuaries) since 1998.[444] Hawaii also sets numeric phosphorus criteria for marine waterbodies, categorized as embayments, open coastal waters, and oceanic waters.[445] Nutrient pollution management and reduction are crucial

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2023/01/SKM_C750i23011011240.pdf (stating that the governor's renewed pledge was timely considering the Environmental Integrity Project ranked Florida first in the country for total acres of lakes classified as impaired for swimming and aquatic life (873,340 acres) and second for most impaired estuaries (2,533 square miles) in its 2022 report assessing states' water quality); ENV'T INTEGRITY PROJ., *supra* note 433.

439 FLA. DEP'T ENV'T PROT., INTEGRATED WATER QUALITY ASSESSMENT FOR FLORIDA (2016).

440 *Id.* at 190-92 (noting that although only one lake is identified as nutrient impaired, 224 are listed as impaired by "trophic status," which relates to a lake's nutrient concentration (from oligotrophic lakes that are nutrient-poor to eutrophic lakes with excess nutrients), total phosphorus was not yet evaluated as an identified cause of impairment).

441 FLA. DEP'T ENV'T PROT., 2020 INTEGRATED WATER QUALITY ASSESSMENT FOR FLORIDA 72 (2020).

442 FLA. DEP'T ENV'T PROT., 2022 INTEGRATED WATER QUALITY ASSESSMENT FOR FLORIDA 59-61 (2022).

443 ENV'T INTEGRITY PROJ., *supra* note 433.

444 U.S. ENV'T PROT. AGENCY, STATE ADOPTION OF NUMERIC NUTRIENT STANDARDS (1998-2008) A-17 (2008).

445 HAW. STATE DEP'T OF HEALTH, CLEAN WATER BRANCH, 2022 STATE OF HAWAII WATER

for mitigating nuisance and harmful algal blooms on Hawaii's beaches.

In addition to numeric criteria for phosphorus in inland and marine waters, Hawaii's approach to phosphorus management involves the state administered NPDES permit program for point source management,[446] the state's nonpoint source management plan,[447] and the coastal nonpoint pollution control program.[448]

1. Numeric Phosphorus Criteria for Inland and Marine Waters

Hawaii's water quality standards categorize the state's surface waters as inland or marine. Numeric phosphorus criteria for both inland and marine waters vary for the "wet" versus "dry" seasons, with stricter limits in the dry season. Numeric standards for inland waters cover streams and estuaries.[449] Numeric phosphorus criteria apply year-round to all estuaries except Pearl Harbor, where site-specific criteria allow for higher phosphorus levels.[450] As of 2023, Hawaii applies only narrative nutrient criteria to lakes and reservoirs.[451]

Marine water quality standards apply to embayments, coastal, and oceanic waters.[452] Embayments are marine waters that are "land-confined and physically-protected" with restricted openings to open coastal waters.[453] Oceanic waters encompass "all other marine waters" that fall outside of the open coastal waters' designation and have the lowest phosphorus criteria of all Hawaii's watertypes.[454] Specific numeric water quality criteria set by watertype form the basis for determining whether a waterbody is impaired or is meeting its designated uses. See Table 1 above for a breakdown of Hawaii's numeric phosphorus criteria for the state's inland and marine waters.

QUALITY MONITORING AND ASSESSMENT REPORT ES1 (2022).

446 HAW. CODE R. § 11-55 (2022).

447 HAW. STATE DEP'T OF HEALTH, HAWAII NONPOINT SOURCE MANAGEMENT PLAN 2021 – 2025 (2021).

448 HAW. COASTAL ZONE MGMT. PROGRAM, "HAWAII'S COASTAL NONPOINT POLLUTION CONTROL PROGRAM (1996).

449 HAW. CODE R. § 11-54-5 (2021).

450 HAW. CODE R. § 11-54-5.2(d)(1)-(2) (2021); HAW. STATE DEP'T OF HEALTH, HAWAII'S IMPLEMENTATION PLAN FOR POLLUTED RUNOFF CONTROL, APPENDIX F – DETAILED DESCRIPTIONS OF HAWAII'S 18 WATER QUALITY LIMITED SEGMENTS F-8-F-9 (2013) (stating that Pearl Harbor is the largest estuary in Hawaii; It is also surrounded by federal military installations, including a naval shipyard, a maintenance supply center, a public works center, and an ammunition depot. Shipping, navigation, and industry dominate Pearl Harbor's designated uses and are likely factors weighing in favor of the estuary's relatively higher numeric phosphorus criteria).

451 HAW. CODE R. §§ 11-54-4, 11-54-5.2(a) (2021).

452 *Id.* § 11-54-6 (2021).

453 *Id.* § 11-54-6(a)(1) (2021).

454 *Id.* § 11-54-6(c)(1) (2021).

2. Point Source Nutrient Pollution Management

In pursuit of achieving its numeric nutrient criteria, Hawaii administers its NPDES permit program for authorized point source discharges to surface waters. Permitted point source discharges must comply with either technology-based or water quality-based effluent limits or more stringent TMDLs.[455] Wastewater treatment plants are one entity regulated under Hawaii's NPDES permit program, but in 2012, a group of environmental organizations led by Hawaii Wildlife Fund sued the County of Maui for unlawfully discharging wastewater to navigable waters without an NPDES permit.[456] The County operates a POTW that pumps 4 million gallons daily of partially treated wastewater through underground wells that travel to the Pacific Ocean.[457] Maui claimed its activity was not a point source discharge to surface water due to the groundwater delivery and therefore an NPDES permit was not required.[458]

In 2020, in *County of Maui v. Hawaii Wildlife Fund,* the Supreme Court vacated the Ninth Circuit's "fairly traceable" interpretation of point source regulation under the CWA.[459] The Court instead held that an NPDES permit is required if a point source discharge "reach[es] navigable waters after traveling through groundwater if that discharge is the *functional equivalent* of a direct discharge from the point source into navigable waters."[460] Seven factors are considered in the "functional equivalent" test: (1) the time it takes the pollutant to travel; (2) the distance from the point source to the navigable waterway; (3) the nature of the material through which the pollutant travels; (4) the extent to which the pollutant is diluted or chemically altered; (5) the amount of pollutant entering the navigable waterway compared to the amount of pollutant that was discharged; (6) how the pollutant enters a navigable waterway; and (7) the degree to which the pollutant has maintained its specific identity.[461]

The *Maui* decision had notable implications for point source nutrient management in Hawaii as it closed a regulatory loophole for unpermitted wastewater discharge to groundwater that reaches the Pacific Ocean when the seven factors are met. Maui's wastewater facility treated sewage for viral and bacterial pathogens but not for nutrients.[462] As a result, the discharge through

455 *Id.* §§ 11-55-04 to 11-55-23 (2023); *see also NPDES Permits and How to Apply*, HAW. STATE DEP'T OF HEALTH, https://health.hawaii.gov/cwb/npdes-permits-and-how-to-apply/#:~:text=The%20Hawaii%20NPDES%20permitting%20program,human%20health%20and%20the%20environment (last accessed Aug. 13, 2023).

456 County of Maui v. Hawaii Wildlife Fund, 140 S. Ct. 1462, 1469 (2020).

457 *Id.* at 1469.

458 *Id.*

459 *Id.* at 1478.

460 *Id.* at 1456-77 (emphasis added).

461 *Id*.

462 Lurline Wailana McGregor, *How Clean Is Clean?*, SEA GRANT, UNIV. OF HAW. (2022), https://seagrant.soest.hawaii.edu/how-clean-is-clean/.

groundwater from this particular facility was causing elevated nutrient loads and was in fact the primary polluter of phosphorus to the affected coastal waters.[463] Local residents reported algal blooms and destruction of sensitive coral reef ecosystems in the surrounding waters.[464] Now that this and other similarly situated point source facilities are required to obtain NPDES permits before discharging, they should be regulated to comply with applicable technology-based and water quality-based effluent limits or more stringent TMDLs for phosphorus.[465]

3. Nonpoint Source Nutrient Pollution Management

Hawaii had numeric nutrient criteria for over twenty years before it created administrative rules or a comprehensive program for managing nonpoint source pollution in 2021.[466] The Department of Health (DOH) leads the nonpoint program, which applies to publicly- or privately-owned entities involved in agriculture, forestry, or marinas and recreational boating, as well as individuals who are found to cause or contribute to nonpoint source pollution.[467] Parties subject to the rules must develop, submit, and implement Water Pollution Prevention Plans to control nonpoint pollution, complete with monitoring strategies and reporting requirements.[468] Regulated parties are required to "minimize negative impacts on water quality to the maximum extent practicable."[469] However, when determining whether a party complies with the maximum extent practicable standard, the DOH considers a water's designated use, the pollutant's impact on water quality, and financial impact to the regulated party, but does not consider the waterbody's numeric water quality criteria.[470] This omission is problematic, as it allows nonpoint sources to openly exceed a waterbody's numeric phosphorus criteria.

In addition to its nonpoint program, Hawaii also published a Nonpoint Source Management Plan for 2021 to 2025 containing goals, objectives, strategies, and milestones for statewide nonpoint source prevention and reduction.[471] The state's Nonpoint Source Management Plan identifies and proposes strategies to reduce urban and agricultural sources of total phosphorus pollution, including sewage,

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463 CRAIG R. GLENN ET AL., UNIV. OF HAW. AT MANOA, LAHAINA GROUNDWATER TRACER STUDY ES-4-ES-5 (2013).

464 McGregor, *supra* note 462.

465 HAW. CODE R. § 11-55-19, 20 (2023); *see also* McGregor, *supra* note 462 (stating that the Earthjustice attorney who took the *Maui* case to the Supreme Court has vowed to bring similar lawsuits across the state to curb the unpermitted discharge of partially treated wastewater to coastal waters).

466 HAW. STATE DEP'T OF HEALTH, RATIONALE FOR HAWAII ADMINISTRATIVE RULES at 2 (2021).

467 HAW. CODE R. § 11-56-3 (2021).

468 *Id.* § 11-56-6 and 11-56-7 (2021).

469 *Id.* § 11-56-9 (2021).

470 *Id.*

471 HAW. STATE DEP'T OF HEALTH, *supra* note 447.

fertilizer, and animal waste.[472] The management plan also calls attention to onsite disposal systems such as cesspools and septic systems,[473] an issue of particular concern in Hawaii.[474] The cesspools discharge more than 53 million gallons of untreated sewage (with nearly 6,000 pounds of phosphorus[475]) into the ground each day, which contributes to nutrient pollution impairing coastal waters.[476] In 2016, Hawaii banned the construction of new cesspools and passed a law the following year to rid the state of cesspools by 2050.[477]

As an island state with a federally approved coastal zone management program,[478] Hawaii also submitted its coastal nonpoint pollution control program, considered an expansion of the nonpoint source management plan, for full federal approval anticipated by 2024.[479] DOH's Surface Water Protection Branch is working toward formalizing and consolidating voluntary and regulatory nonpoint source management programs that will advance and achieve the nonpoint source management plan goals and objectives.[480] However, the failure to tie the program to numeric phosphorus criteria will limit its ability to achieve water quality improvements.

The EPA administers approximately $1.2 million annually to Hawaii to assist with implementation of the state's nonpoint source management plan through various nonpoint source pollution control projects.[481] The state's Clean Water Branch mitigates nonpoint source pollution through the Polluted Runoff Control (PRC) Program, which administers section 319 grant money.[482] The $1.2 million is split evenly between watershed project funds for restoring and protecting waters through watershed-based plans (e.g., nonpoint source pollution control projects, education and outreach, water quality monitoring, and technical assistance for BMP implementation) and nonpoint source program funds for developing these watershed-based plans.[483] The PRC Program coordinates with state and county

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472 *Id.* at 25.

473 *Id.*

474 Audrey McAvoy, *83,000 Hawaii homes dispose of sewage in cesspools. Rising sea levels will make them more of a mess*, AP NEWS (July 5, 2023), https://apnews.com/article/hawaii-cesspools-rising-sea-levels-climate-change-61b72be5dcae1aff25945d17117cc873# (stating that Hawaii has 83,000 cesspools, which is more than any other state. Roughly 20% are less than 1 kilometer from shore).

475 HAW. STATE DEP'T OF HEALTH, *supra* note 447, at 19.

476 HAW. STATE DEP'T OF HEALTH, FINANCING CESSPOOL CONVERSIONS IN HAWAII at 1 (2019).

477 *Id.*

478 *Coastal Zone Management Programs*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., https://coast.noaa.gov/czm/mystate/#hawaii (last accessed Aug. 13, 2023) (note that NOAA approved Hawaii's coastal zone management program in 1978).

479 HAW. STATE DEP'T OF HEALTH, *supra* note 447, at 7-8.

480 *Id.* at 4.

481 *Id.* at 24.

482 *Id.*

483 *Id.* at 25.

agencies to finance and implement nonpoint source pollution control projects such as streambank restoration and agricultural BMPs.[484] As of 2023, there are twenty-four ongoing projects in Hawaii funded by section 319 grant money,[485] six of which are achieving phosphorus load reductions.[486] Hawaii's phosphorus load reductions are attributed to wetland restoration (natural filtration systems for nutrient runoff) and agricultural BMPs (like controlled and rotational grazing, riparian restoration and buffers, and reduced fertilizer applications).[487]

4. Impact of Hawaii's Nutrient Reduction Strategy

Despite two decades of implementing phosphorus criteria, excess nutrient induced algal blooms still impair water quality and negatively impact the island state's billion-dollar tourism industry.[488] Algal blooms on Hawaii beaches lead to losses of real estate value, hotel and rental income, and are costly to cleanup.[489] A study from 2002 out of the University of Hawaii estimated annual algal blooms on Maui reduce real estate value by $9.4 million and decrease hotel and rental income by $10.8 million.[490] Condominium owners in Maui pay between $55,000 and $200,000 annually for algal removal in beach cleanup operations.[491] Researchers conducting a case study on Maui found that investments for reducing nutrient discharges and mitigating algal blooms could result in a nearly $30 million economic benefit to Hawaii's tourism industry.[492]

The eutrophic condition of waterbodies impaired by excess nutrients also poses a significant threat to Hawaii's coral reefs and fisheries.[493] The state depends on

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484 *Id.* at 25-26.

485 *Nonpoint Source (NPS) Watershed Projects: Interactive Map and Reporting*, U.S. ENVTL. PROT. AGENCY, https://ordspub.epa.gov/ords/grts/f?p=109:940:21436810052157::::P940_WIDGET:N (last accessed Apr. 21, 2024).

486 HAW. STATE DEP'T OF HEALTH, *supra* note 447, at 99-102.

487 *Id.* at 7-8; 99-101.

488 *See* HAW. DEP'T OF BUS., ECON. DEV. & TOURISM, PLANNING FOR SUSTAINABLE TOURISM: SUMMARY REPORT 61-62 (2006) (stating that algal blooms significantly impact the overall quality of Hawaii's beaches and near shore regions, particularly on Oahu and Maui. The algae create foul smells along the beach and decrease water visibility, which is a particularly prominent issue for tourists and recreators who snorkel and dive).

489 *See* Pieter J. H. van Beukering & Herman S. J. Cesar, *Ecological Economic Modeling of Coral Reefs: Evaluating Tourist Overuse at Hanauma Bay and Algae Blooms at the Kihei Coast, Hawai'i*, 58 PACIFIC SCI. 243, 257 (2004).

490 *Economic Value of Hawaii's Nearshore Reefs*, UNIV. OF HAW. AT MANOA, https://www.hawaii.edu/ssri/cron/files/econ_brochure.pdf (last visited Aug. 13, 2023).

491 *Id. See also* van Beukering, *supra* note 489; *Hitting Us Where It Hurts: The Untold Story of Harmful Algal Blooms*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.fisheries.noaa.gov/west-coast/science-data/hitting-us-where-it-hurts-untold-story-harmful-algal-blooms (last visited Oct. 7, 2021).

492 van Beukering, *supra* note 489, at 257 (this figure is based primarily on economic benefits of coral reefs on recreational and amenity values).

493 HAW. STATE DEP'T OF HEALTH, *supra* note 447, at 19.

healthy coral reefs for food security, tourism, infrastructure protection, and resiliency from major storms; damage to and loss of coral reefs have widespread ecological and economic consequences.[494] Excess nutrient triggered algal blooms threaten the estimated $10 billion value the state's coral reefs provide.[495]

Hawaii monitors the status of its water quality and prepares a biannual integrated water quality monitoring and assessment report. As an island state, monitoring marine as opposed to inland water quality is a higher priority, thus marine waterbodies comprise the majority of waters assessed for impairment.[496] For instance, Hawaii's 2022 integrated report surveyed 170 of 565 marine waterbodies (30%) and only twelve inland waterbodies.[497] Excess nutrient pollution was the second leading cause of impairment for marine waters, with 43 out of 66 (65%) of marine assessments failing to meet water quality standards for one or more nutrients.[498] That same year, Hawaii had a total of 303 marine waterbodies and 119 inland waterbodies listed as impaired on its 303(d) list.[499] The cause of impairment for 16% of listed marine waters and 43% of inland waters was total phosphorus.[500]

Hawaii was one of the first states in the nation to establish numeric nutrient criteria. They acted a decade before Wisconsin, but they were late in adopting regulations and programs for nonpoint source pollution management through which they could implement the criteria and they have not squarely addressed major point sources such as the POTW in Maui County or residential septic (allowing cesspools until recently). Even when Hawaii adopted a nonpoint program in 2021, they disconnected it from their numeric criteria for phosphorus. Hawaii does not offer a watershed-focused trading or adaptive management program to link point and nonpoint sources. By contrast, Wisconsin adopted numeric nutrient criteria about a decade later, but already had technology-based effluent limits for POTWs and established parallel regulations and programs for addressing point and nonpoint sources of nutrient pollution.

C. Minnesota's Approach to Phosphorus Management

Minnesota's phosphorus pollution story is a familiar one; excess nutrient loads from point and nonpoint sources impair surface waters causing nuisance HABs, threatening public health, and harming aquatic ecosystems. In 2004, phosphorus

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494 Michael Mezzacapo et al., *Hawaii's Cesspool Problem: Review and Recommendations for Water Resources and Human Health*, 170 J. WATER RES. & EDUC. 35, 38 (2020) https://ucowr.org/wp-content/uploads/2020/11/170_Mezzacapo_et_al.pdf.

495 *Id.*

496 HAW. STATE DEP'T OF HEALTH, *supra* note 447, at 13.

497 HAW. STATE DEP'T OF HEALTH, *supra* note 445, at ES2.

498 *Id.*

499 HAW. STATE DEP'T OF HEALTH, *supra* note 447, at 15.

500 *Id.*

was identified as the primary nutrient polluting Minnesota's surface waters.[501] In 2008, the Minnesota Pollution Control Agency (MPCA) began a ten-year cycle to monitor and assess select watersheds each year on a rotational basis to identify impaired versus unimpaired waters.[502] In 2014, Minnesota listed nutrient/eutrophication as the second leading cause of impairment with 573 out of 4,114 (14%) total number of impairments.[503] In 2022, Minnesota listed nutrient/eutrophication as the fourth leading cause of impairment with 744 out of 6,167 (12%) total number of impairments.[504] While nutrients dropped in the cause ranking, the total number of impairments rose.

Like in Wisconsin, the nutrient impaired status of many Minnesota waterbodies does not tell the full story. Minnesota has a long history of phosphorus pollution reduction. This section presents an overview of Minnesota's point source nutrient reduction strategies, current numeric nutrient criteria, and ongoing efforts to curb nonpoint source phosphorus loads.

1. Minnesota's History of Point Source Nutrient Pollution Reduction

Minnesota began controlling point source phosphorus discharges with effluent limits in the early 1970s.[505] In 2000, Minnesota revamped its point source nutrient pollution reduction strategy by setting phosphorus effluent limits in NPDES permits on a watershed basis.[506] The state legislature passed a law in 2003 aimed at reducing phosphorus concentrations in wastewater, especially POTWs.[507] Around the same time, Minnesota led the nation in banning phosphorus in lawn

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501 JOHN HELLAND, MINN. HOUSE OF REPRESENTATIVES RSCH. DEP'T, THE CONTINUING CONCERN OVER PHOSPHORUS at 1 (2004) https://www.house.mn.gov/hrd/pubs/phosph.pdf.

502 MINN. POLLUTION CONTROL AGENCY & MINN. DEP'T OF AGRIC., APPENDIX A: FIVE-YEAR ASSESSMENT OF WATER QUALITY TRENDS AND PREVENTION EFFORTS at 27 (2015).

503 *Id.*; *see also* MINN. POLLUTION CONTROL AGENCY, APPENDIX A: FIVE-YEAR ASSESSMENT OF WATER QUALITY TRENDS AND PREVENTION EFFORTS 31 (Sept. 2020) (stating that in 2020, Minnesota still listed nutrient/eutrophication as the second leading cause of impairment with 746 out of 5,774 (13%) total number of impairments).

504 MINN. POLLUTION CONTROL AGENCY, 2022 IMPAIRED WATERS LIST (Apr. 29, 2022) (note that Minnesota does not differentiate between phosphorus versus nitrogen impairment on its impaired water list).

505 Steve Weiss, *Phosphorus in Wastewater*, MINN. POLLUTION CONTROL AGENCY, https://www.pca.state.mn.us/business-with-us/phosphorus-in-wastewater (last accessed Jul. 13, 2023).

506 *Id.* (stating that this nutrient reduction strategy sets phosphorus effluent limits for all wastewater facilities within a watershed at one time, rather than one-by-one as permits come up for reissuance). The EPA retains authority to issue NPDES permits for all Tribal lands located within the state boundary. As of 2023, the EPA had issued twenty-four and proposed one NPDES permits on Tribal lands within Minnesota. *Minnesota NPDES Permits*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/npdes-permits/minnesota-npdes-permits (last updated Mar. 29, 2023).

507 MINN. STAT. § 115.425 (2022) (stating that the law set a state goal to reduce phosphorus from "noningested sources" entering municipal wastewater treatment systems by at least 50% from a set timetable).

fertilizer.[508]

In 2008 and 2015, Minnesota approved new numeric phosphorus limits for lakes and rivers, respectively, with the intention of protecting aquatic life from harmful impacts of excess algae.[509] The phosphorus limits are numerical interpretations of the state's narrative nutrient criteria as shown in Table 1 above and discussed in more detail in the following section. The new standards for rivers resulted in changes to regulated entities' water quality-based effluent limits; overall, thirteen point source wastewater treatment facilities received new phosphorus limits in their NPDES permits following the state's rule update.[510] Like in Wisconsin, NPDES permittees in Minnesota may receive variances from discharge effluent limits or treatment requirements for a specified pollutant if they meet certain conditions.[511] Unlike in Wisconsin, where the state passed a phosphorus specific variance for point source dischargers, none of Minnesota's four proposed or ten active variances are for phosphorus pollution.[512] According to Minnesota's 2022 water quality report to Congress, 99% of permitted municipal and industrial facilities were already meeting their phosphorus effluent limits.[513] As a result, by 2022 phosphorus loads from wastewater treatment plants have decreased by 55% since 2006.[514]

Minnesotans voted their support for phosphorus reduction and water quality improvement in passing the Clean Water, Land and Legacy Amendment, a 2008 ballot initiative that annually funds around $100 million of additional water quality work for twenty-five years through a sales tax increase.[515] Minnesota's phosphorus reduction strategies have been effective in achieving lower phosphorus loads from point source wastewater discharges. The rule requires "removal of nutrients from all wastes. . .to the *fullest practicable extent*."[516] As of

508 *Phosphorus Lawn Fertilizer Law*, MINN. DEP'T OF AGRIC., https://www.mda.state.mn.us/phosphorus-lawn-fertilizer-law (last accessed Jul. 14, 2023).

509 Weiss, *supra* note 506 (note that Minnesota refers to its numeric phosphorus criteria as "eutrophication standards;" for consistency throughout this article, they are simply referred to as numeric criteria).

510 MINN. POLLUTION CONTROL AGENCY, NAT'L POLLUTANT DISCHARGE SYSTEM / STATE DISPOSAL SYS. PERMITS, ELIMINATION SYSTEM / STATE DISPOSAL WATER QUALITY STANDARDS, AND SYS. PERMITS, WATER QUALITY MUN. STANDARDS, AND MUNICIPALITIES at 1-2 (Jan. 2017).

511 MINN. R. 7053.0195 (2016).

512 MINN. POLLUTION CONTROL AGENCY, *Water quality variances*, https://www.pca.state.mn.us/business-with-us/water-quality-variances (last accessed Aug. 13, 2023).

513 MINN. POLLUTION CONTROL AGENCY, 2022 MINNESOTA WATER QUALITY: REPORT TO CONGRESS 10 (2021).

514 *Id.*

515 Margaret Wagner, *Clean Water Land and Legacy Amendment*, MINN. POLLUTION CONTROL AGENCY, https://www.mda.state.mn.us/clean-water-land-legacy-amendment#:~:text=On%20November%204th%202008,2009%20and%20continuing%20through%202034 (last accessed Jul. 17, 2023; *see also* Robert Hearne, *Cooperative Federalism and the Clean Water Act: Implementation in Minnesota and North Dakota*, 10 J. NAT. RESOURCES POL'Y RES. (2020).

516 MINN. R. 7053.0255(3)(B) (2021) (emphasis added).

2023, the phosphorus effluent limit for point source discharges of sewage, industrial, and other wastes is 1,000 ug/L.[517] The state's 2000-2001 baseline point source phosphorus load was 1,855,000 kilograms per year.[518] The state was able to reduce that load by 54% between 2000 and 2009, with an average point source phosphorus load of 729,000 kilograms between 2011 and 2012 and a total point source phosphorus load of 605,000 kilograms in 2014.[519]

The MPCA conducted a five-year review of its 2014 Nutrient Reduction Strategy in which it published river monitoring trends for nutrient concentrations.[520] This time span includes two years after the 2015 establishment of numeric phosphorus criteria for rivers. Out of fifty rivers monitored, twenty-four (48%) showed phosphorus reductions between the 2008 to 2017 monitoring period.[521] Minnesota has also reduced phosphorus loads to the Mississippi River, with a 33% reduction between 2000 and 2014.[522] Point source wastewater discharges accounted for largest (24%) of these phosphorus load reductions to the Mississippi.[523] Reducing nonpoint sources is the next major task for Minnesota. Similar to other states with a large agricultural base, legacy pollution from over-application of phosphorus fertilizer means there will be substantial lag time between implementing controls on nonpoint pollution and measurable water quality improvement in Minnesota.[524] The state's strategy for nonpoint source

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517 MINN. R. 7053.0255(3)(A) (2021); *see also* WIS. ADMIN. CODE NR § 217.04 (2022) (note that this is the same limit Wisconsin sets for POTWs discharging more than 150 pounds of total phosphorus per month).

518 Weiss, *supra* note 506.

519 *Id.*

520 MINN. POLLUTION CONTROL AGENCY, 5-YEAR PROGRESS REPORT ON MINNESOTA'S NUTRIENT REDUCTION STRATEGY 16 (Aug. 2020).

521 *Id.* at 19; *See also* Dan Gunderson, Elizabeth Dunbar & Jiwon Choi, *A look at Minnesota farming in 7 charts*, MPR NEWS (Apr. 2019), https://www.mprnews.org/story/2019/04/11/ag-census-2017-minnsota-snapshot# (note that the majority of rivers showing phosphorus reduction were located in the eastern part of the state, where rivers in the agriculturally dominated western region showed non-significant trends).

522 MINN. POLLUTION CONTROL AGENCY, MINNESOTA NUTRIENT REDUCTION STRATEGY at 422 (2014) https://www.pca.state.mn.us/sites/default/files/wq-s1-80.pdf.

523 *Id.* at 6.

524 *Id.* at 7-9; *see also* MINN. POLLUTION CONTROL AGENCY, *supra* note 521 at 16, 25 (stating that the release of legacy phosphorus in the Mississippi River and other waterbodies is masking downstream effects of phosphorus load reductions; "Improvements made on the land can sometimes take a significant amount of time—in some instances, decades or more—before these changes become observable water quality changes in rivers."); *see also Lake Ida Targeted Phosphorus Reduction Project*, MINN. LEGACY (2023), https://www.legacy.mn.gov/projects/lake-ida-targeted-phosphorus-reduction-project (stating that researchers found legacy phosphorus leaching into the lake to be a major contributor to the phosphorus load); *see also Phosphorus remains the main cause of poor water quality within Lake Winona*, MINN. POLLUTION CONTROL AGENCY (2021), https://www.pca.state.mn.us/news-and-stories/phosphorus-remains-the-main-cause-of-poor-water-quality-within-lake-winona#:~:text=This%20legacy%20phosphorus%20can%20be,areas%20that%20surround%20the%20lake ("Consistently high levels of phosphorus in this shallow lake cause excessive algae growth that frequently affects swimming, fishing, and other recreation." Legacy phosphorus is the primary source

nutrient reduction is discussed in section 3. The following section offers comparisons between Wisconsin and Minnesota's approach to numeric nutrient regulation.

2. Minnesota's Numeric Phosphorus Criteria

In 2015, Minnesota became the fifth state in the nation and only second in EPA Region 5 to adopt statewide numeric phosphorus criteria for two or more watertypes.[525] The state developed numeric phosphorus criteria based on "eutrophication standards" to curb excess nutrient loading, prevent water quality degradation, and restore beneficial uses.[526] In Minnesota, numeric limits apply to lakes/reservoirs and rivers/streams and vary by ecoregion (i.e., central hardwoods forest region allows more phosphorus in lakes than northern forest region).[527] The state also sets site-specific standards for individual lakes, flowage lakes, or lake segments[528] and segments of the Mississippi River.[529] This approach diverges from Wisconsin's as Minnesota's ecoregion-based criteria reflect the regional diversity of lake conditions,[530] whereas Wisconsin assigns criteria based not on regional characteristics but rather on lake/reservoir characteristics (i.e., stratification and drainage versus seepage).

Minnesota and Wisconsin are the only two Great Lakes states in this comparative analysis; both possess jurisdiction over waters within the drainage basins of Lake Superior. Despite their shared jurisdiction over Lake Superior, Minnesota has not set numeric phosphorus limits for open and nearshore waters of the great lake, whereas Wisconsin set a strict numeric phosphorus standard of 5 ug/L for open and nearshore waters of Lake Superior.[531] Minnesota instead

contributing to the lake's impairment).

525 *N/P Criteria Progress Map*, *supra* note 18.

526 MINN. R. 7050.0150(4)(L); (M) 7050.0150(5) (2023) (stating that the standards are based on biological response indicators like chlorophyll *a*, water transparency, and oxygen levels).

527 MINN. R. 7050.0222(2), (3) (2023) (noting that Class 2A lakes/reservoirs are categorized as lake trout lakes (12 ug/L phosphorus) or non-lake trout lakes (20 ug/L phosphorus) for all ecoregions; Class 2Bd lakes/reservoirs are divided by Northern Lakes and Forest Ecoregion (30 ug/L total phosphorus), North Central Hardwood Forest Ecoregion (40-60 ug/L total phosphorus), and Western Corn Belt Plains and Northern Glaciated Plains Ecoregions (65-90 ug/L total phosphorus); All rivers/streams are divided into North River Nutrient Region (50 ug/L total phosphorus), Central River Nutrient Region (100 ug/L total phosphorus), and South River Nutrient Region (150 ug/L total phosphorus).

528 *Water Quality Standards Regulations: Minnesota*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/wqs-tech/water-quality-standards-regulations-minnesota (last updated May 18, 2023) (stating that Lake Pepin's site-specific phosphorus standard is 100 ug/L. pursuant to MINN. R. 7050.0220(7)(D)(1); EPA approved site-specific standards pursuant to MINN. R. 7050.0220(7) (2021), 7050.0222(4) (2023)).

529 MINN. R. 7050.0222(4) (2021).

530 Steven Heiskary & Bruce Wilson, *Minnesota's approach to lake nutrient criteria development*, 24 LAKE & RESERVOIR MGMT at 282 (2009).

531 WIS. ADMIN. CODE NR § 102.06(5)(a) (2022).

applies a numeric phosphorus criteria of 1,000 ug/L to point source discharges of sewage, industrial, and other waste to intrastate waters draining into Lake Superior.[532] Wisconsin's numeric phosphorus limit for Lake Superior conforms with the Great Lakes Water Quality Agreement's interim loading target of 5 ug/L for open waters of Lake Superior, whereas Minnesota fails to regulate accordingly.[533]

Like in Wisconsin and Florida, public pressure and litigation over regulating phosphorus also corresponded with Minnesota's adoption of numeric criteria. In 2008, environmental groups petitioned the EPA to issue the same CWA section 303(c)(4)(B) necessity determination and impose numeric nutrient criteria for Mississippi basin states (including Minnesota).[534] The petition was motivated by concern over hypoxia in the Gulf of Mexico and states' lack of action in adopting numeric criteria to address the pollution.[535] The EPA was unresponsive for three years until petitioners sent a letter demanding the EPA reply or face litigation.[536] In 2011, around the same time that EPA was actively engaged in Florida litigation, the EPA issued a denial letter to the Mississippi River petitioners, stating "comprehensive use of federal rulemaking authority is [not] the most effective or practical means of addressing these concerns at this time."[537] In the denial letter, the EPA recognized the nuisance and harmful effects of nutrient pollution, particularly in the Mississippi River basin, and affirmed its support for reducing nutrient pollution.[538] The agency also highlighted its 2011 memo on a federal-state-Tribal cooperative framework for reducing nutrient pollution.[539] Ultimately, unlike in Florida's case where the EPA did impose federally-promulgated state criteria, the EPA was not willing to exercise its authority to establish federal numeric nutrient criteria in place of state standards for a multi-state river basin.[540]

Petitioners were unsatisfied by the EPA's response and sued in 2012 to challenge the agency's denial.[541] This was two years after Wisconsin had

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532 MINN. R. 7053.0255(5)(A) (2021).

533 The Great Lakes Water Quality Agreement, *supra* note 98.

534 Letter from Michael H. Shapiro, Deputy Assistant Adm'r, U.S. EPA Office of Water, to Kevin Reuther, Legal Dir., Minn. Ctr. Env't Advocacy, & Albert Ettinger, Att'y, Chicago, IL (2011) (on file with U.S. Env't Prot. Agency) [hereinafter EPA Denial Letter]; *see also* Hearne, *supra* note 516 at 6.

535 EPA Denial Letter, *supra* note 535 at 1; *see also* Laura Kerr, *Compelling A Nutrient Pollution Solution: How Nutrient Pollution Litigation Is Redefining Cooperative Federalism Under the Clean Water Act*, 44 ENV'T L. 1219, 1240 (2014) ("excess nutrients that are discharged into the Gulf of Mexico have resulted in the seasonal growth of large algae blooms that have created the largest hypoxic zone in the United States…").

536 Kerr, *supra* note 536, at 1243 n. 212.

537 EPA Denial Letter, *supra* note 535, at 1.

538 *Id.* at 2.

539 *Id.*

540 *Id.* at 4.

541 *Gulf Restoration Network v. Jackson*, No. 12-677, 2013 WL 5328547, at 3 (E.D. La. 2013); *see also* Kerr, *supra* note 536, at 1244.

established phosphorus rules so it along with Minnesota declined to intervene, while thirteen other states intervened in opposition to federal numeric nutrient criteria.[542] The EPA was eventually granted summary judgment in favor of its denial to set federal numeric nutrient standards for states in the river basin.[543] However, while this litigation was pending, Minnesota was focused on targeting nonpoint pollution by promoting voluntary agricultural BMPs, publishing a nutrient reduction strategy, and finalizing its river eutrophication numeric criteria to protect aquatic life from excess phosphorus pollution. As of 2023, Minnesota and Wisconsin are the only two Mississippi River basin states with statewide numeric phosphorus criteria for two or more watertypes, although five other basin states have developed partial phosphorus criteria for some waters.[544]

3. Controlling Nonpoint Source Phosphorus Discharges

Despite progress in addressing point sources, most phosphorus loading in Minnesota comes from nonpoint sources such as stormwater runoff or stream bank erosion.[545] To target nonpoint pollution, Minnesota created the Minnesota Agriculture Water Quality Certification Program in 2012 to promote adoption of voluntary agricultural BMPs.[546] The state also published a nutrient reduction strategy in 2014.[547] Pursuant to CWA section 319, Minnesota developed a nonpoint source management plan, wherein the state sets forth its collaborative interagency approach to nonpoint source pollution reduction through a watershed-or-basin-scale water quality framework.[548] For example, the Lake St. Croix Implementation Plan is a basin-scale plan developed by the MPCA in cooperation with the WDNR (as the basin is located in both states) to address nutrient impairment.[549] The basin implementation plan provides strategies for phosphorus reduction to meet the applicable TMDL and numeric phosphorus standard.[550]

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542 Kerr, *supra* note 536, at 1244 n. 229.

543 *Gulf Restoration Network v. Jackson*, 224 F. Supp. 3d 470 (E.D. La. 2016).

544 *N/P Criteria Progress Map*, *supra* note 18.

545 Weiss, *supra* note 506.

546 MINN. POLLUTION CONTROL AGENCY, *Minnesota Agricultural Water Quality Certification Program*, https://www.mda.state.mn.us/environment-sustainability/minnesota-agricultural-water-quality-certification-program (last accessed Jul. 17, 2023); *see also* Hearne, *supra* note 516.

547 MINN. POLLUTION CONTROL AGENCY, *supra* note 523.

548 MINN. POLLUTION CONTROL AGENCY, MINNESOTA'S NONPOINT SOURCE MANAGEMENT PLAN – 2019-2029 at 5 (2021) https://www.pca.state.mn.us/sites/default/files/wq-cwp8-26.pdf ("Minnesota Water Quality Framework is for 'cleaner water via comprehensive watershed management; ensure that groundwater is protected and managed sustainably.'").

549 *Id.* at 32 ("The implementation plan provides strategies for point and NPS pollution control, water resource education, and targeting critical source areas.").

550 *Id.* ("The water quality standards for Lake St. Croix are 40 ug/l TP and 14 ug/l chlorophyll-a as summer averages. The Lake St. Croix Nutrient TMDL determined that the phosphorus loading could not exceed 360 metric tons of total phosphorus per year to meet the total phosphorus water quality criteria of 40 ug/L. A load reduction of about 123 metric tons per year would be needed to

Like Wisconsin and Florida, Minnesota also utilizes a phosphorus index as an assessment tool to calculate the risk of phosphorus loss. The phosphorus indices in all three states are used as management decision-making tools for farm-level conservation practices and watershed planning strategies. While Wisconsin's phosphorus index reports risk of phosphorus loss as a whole number expressed as pounds of phosphorus per acre per year, Florida's and Minnesota's express risk qualitatively as low, medium, or high.[551] Farmers, conservationists, and watershed planners use Minnesota's phosphorus index to identify and refine site-specific methods for reducing phosphorus runoff by evaluating risk factors such as landscape characteristics, cropping and tillage practices, and fertilization application methods.[552] Like Wisconsin, Minnesota's phosphorus index measures phosphorus loss on a field scale, but in Minnesota, the tool's risk assessment is scaled up for watershed level land management.[553]

Section 319 grant money funds the state's nonpoint source management such as developing TMDLs for nonpoint sources, providing watershed restoration and protection strategies, and implementing agricultural BMPs.[554] Agricultural BMPs in Minnesota are similar to Wisconsin's and include cover crops, perennial coverage (such as conservation easements and conservation crop rotation), and field erosion control (such as no-till farming).[555]

Minnesota, like Wisconsin, also has a water quality trading program that was first used in 1999.[556] Water quality trading in Minnesota was renewed in 2021 when state agencies developed a water quality trading pilot program between point and nonpoint sources in the North Fork Crow River watershed.[557] Trading between point and nonpoint sources is only viable when it is more expensive for a point source to achieve an effluent limit through technological upgrades than it is for the point source to pay for nonpoint source reductions. There is a Minnesota River basin-specific trading option carved out in state law for these types of

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achieve this goal.")

551 *The Minnesota Phosphorus Index: Assessing risk of phosphorus loss from cropland*, UNIV. OF MINN. EXTENSION, https://extension.umn.edu/phosphorus-and-potassium/minnesota-phosphorus-index-assessing-risk-phosphorus-loss-cropland#when-to-use-the-index-616110.

552 *Id.*

553 *Id.*

554 MINN. POLLUTION CONTROL AGENCY, *supra* note 549, at 35.

555 MINN. POLLUTION CONTROL AGENCY, *supra* note 521, at 55, 61.

556 HELLAND, *supra* note 502, at 3. (stating that the MPCA approved water quality trading for the Southern Minnesota Beet Sugar Cooperative plant in 1999 so the point source facility could increase its wastewater discharge as long as it obtained offsetting phosphorus reductions from nonpoint sources within the shared Minnesota River basin; the MPCA reported phosphorus reductions due to agricultural BMPs).

557 MINN. POLLUTION CONTROL AGENCY, WATER QUALITY TRADING PILOT PROJECT NORTH FORK CROW RIVER WATERSHED (2021) https://www.pca.state.mn.us/sites/default/files/wq-wwprm1-37.pdf.

trades.[558] As of 2023, however, trading was not being used extensively in Minnesota; there are only five ongoing point-to-nonpoint trades.[559] This may be because Minnesota's aggressive control of point sources for more than twenty years has most of the existing point sources already controlling phosphorus pollution. Further, Minnesota's sales tax to fund water programs provides a ready funding source for nonpoint controls that the other states in these case studies lack.

D. New Jersey's Approach to Phosphorus Management

New Jersey was the earliest state to adopt numeric phosphorus criteria. In 1975, the EPA approved a numeric phosphorus criterion of 50 ug/L for lakes and reservoirs.[560] Unlike most states in 1981, New Jersey already had statewide water quality standards that included narrative and numeric phosphorus criteria for freshwater statewide.[561] In 1998, the EPA designated New Jersey as level 4 status, with statewide numeric phosphorus criteria for two watertypes (lakes/reservoirs and rivers/streams).[562]

Despite being an early adopter of phosphorus criteria, excess phosphorus remains the primary cause of over-enrichment of New Jersey's freshwaters[563] and the leading known cause of impairment for aquatic life.[564] The New Jersey case study shows nuisance algae will remain a problem if a state establishes numeric criteria for phosphorus without companion management strategies to implement it through strict point and nonpoint programs.

In 1996, the New Jersey Department of Environmental Protection (NJDEP) evaluated 126 lakes (11,172 acres) and found all were either threatened with eutrophication or considered eutrophic.[565] NJDEP also reported a majority of New

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558 MINN. POLLUTION CONTROL AGENCY, *Water quality trades in Minnesota*, https://www.pca.state.mn.us/business-with-us/water-quality-trades-in-minnesota (last accessed Jul. 17, 2023) (stating that permittees under the Minnesota River Basin General Phosphorus permit have the option of buying or selling phosphorus credits in accordance with the terms of the permit).

559 *Id.* (stating that the pollutant of concern for five out of six point-to-nonpoint trades was phosphorus. For both of the point-to-point source trades, the pollutant of concern was phosphorus).

560 The Hopi-Navajo Land Settlement Interagency Committee, 40 FR 1497 (1975); *see also* Debra Hammond, *Category One Waters*, N.J. DEP'T OF ENV'T PROT. (June 11, 2008), https://www.nj.gov/dep/wms/download/NJDEP%20-%20antideg-process.pdf.

561 N.J. DEP'T ENV'T PROT., NEW JERSEY NUTRIENT CRITERIA ENHANCEMENT PLAN at 3 (Apr. 2009) https://www.nj.gov/dep/wms/bears/docs/Nutrient_Criteria_Enhancement_Plan.Final.pdf.

562 *N/P Criteria Progress Map*, *supra* note 18.

563 N.J. DEP'T ENV'T PROT. DIV. OF WATER MONITORING STANDARDS, *Surface Water Quality Standards*, https://www.state.nj.us/dep/wms/bears/swqs-overview.htm (last updated Oct. 19, 2023) [hereinafter *Surface Water Quality Standards*].

564 *Id.; see also* N.J. DEP'T ENV'T PROT., *2018/2020 New Jersey Integrated Water Quality Assessment Report, Statewide Water Quality, Surface Water Quality – Parameters*, https://www.state.nj.us/dep/wms/bears/assessment-report20182020.html (last accessed Sept. 1, 2022).

565 N.J. DEP'T ENV'T PROT., N.J. 1996 STATE WATER QUALITY INVENTORY REPORT I-21 (1996).

Jersey's monitored freshwater streams contained elevated nutrients.[566] Almost twenty years later, phosphorus pollution was still an issue; in 2014, the NJDEP reported 31% of freshwater statewide was not attaining aquatic life uses due to total phosphorus concentrations.[567] By this time, TMDLs had been established for 48 lakes in New Jersey where phosphorus levels exceeded the numeric criteria.[568] As of March 2023, the EPA identified phosphorus as the most common impairment of New Jersey's surface waters.[569]

Ongoing nutrient impairment in New Jersey's surface waters harms aquatic life with fish kills and hypoxic "dead zones," reduces recreational value with nuisance and HABs, and requires increased use of chemical disinfectants in drinking water supplies.[570] This section explores New Jersey's approach to managing phosphorus pollution and restoring beneficial uses in surface waters, including an overview of the state's numeric phosphorus criteria and strategies for controlling point and nonpoint sources of phosphorus.

1. New Jersey's Numeric Phosphorus Criteria

New Jersey fulfills its CWA section 303 obligation by setting and periodically revising water quality standards for surface waters.[571] The state assigns water quality criteria, including numeric phosphorus limits, to surface waters classified according to their designated uses.[572] As of 2023, the state applies phosphorus limits of 50 ug/L to lakes and 100 ug/L to non-tidal streams (unless a site-specific numeric phosphorus criterion has been developed or the NJDEP determines phosphorus concentrations do not render a waterbody unsuitable in accordance with the state's narrative nutrient criteria). [573] The state does not have numeric

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566 *Id.*

567 N.J. DEP'T ENV'T PROT., 2014 NEW JERSEY INTEGRATED WATER QUALITY ASSESSMENT REPORT 18 (May 2017) https://dspace.njstatelib.org/handle/10929/68748.

568 N.J. DEP'T ENV'T PROT., *supra* note 562, at 10.

569 U.S. ENV'T PROT. AGENCY, REGION 2 NPDES PROGRAM AND PERMIT QUALITY REVIEW NEW JERSEY at 17 (Mar. 2023) https://www.epa.gov/system/files/documents/2023-04/New%20Jersey%20%282021%29.pdf.

570 N.J. DEP'T ENV'T PROT., *supra* note 562, at 8-9.

571 N.J. ADMIN. CODE § 7:9B (2023).

572 N.J. ADMIN. CODE §§ 7:9B-1.4(b)(2)(ii), (c), 1.14(d)(4)(ii), 1.14(g)(2), 1.14(g)(3)(B)(i) (2023); *See also Surface Water Quality Standards*, *supra* note 564 (Note that New Jersey applies numeric phosphorus criteria to waters classified as "general surface water" (FW2) and for freshwater portions of Pinelands Waters, located within the boundaries of the Pinelands Area (PL). The state applies narrative nutrient criteria to saline portions of PL, saline waters of estuaries (SE), and coastal saline waters (SC). The state has also set site-specific numeric phosphorus criteria for two lakes, three ponds, and twenty-seven rivers/streams).

573 N.J. ADMIN. CODE § 7:9B-1.14(d)(4)(ii) (2023); N.J. ADMIN. CODE § 7:9B-1.4 (d)4ii (amended 2009) (note that New Jersey restricts the application of numeric phosphorus criteria to non-tidal streams because the EPA recommended this criterion for flowing freshwater streams, not waters that are tidally influenced).

phosphorus limits for estuaries or coastal waters.[574] This approach contrasts with Florida and Hawaii's, the two other ocean coastal states in this comparative analysis that do apply numeric phosphorus criteria to estuarine waters. In 2009, however, New Jersey developed a Nutrient Criteria Enhancement Plan, later updated in 2018, to refine its current nutrient criteria and develop new criteria where numeric limits were lacking, such as coastal waters.[575] The 2018 update reported progress in creating a nutrient response database for freshwater lakes, wadable streams, and coastal waters to support the NJDEP's efforts to develop additional numeric criteria development.[576] As of 2023, New Jersey still lacks numeric phosphorus criteria for coastal and estuarine waters.[577]

Reviewing New Jersey's 303(d) list of impaired waters will not provide a clear gauge on which waters exceed the phosphorus criteria. This is due to a 2009 amendment where New Jersey revised its surface water quality nutrient policies and criteria by adopting a nutrient assessment methodology that uses site-specific biological response indicators (such as chlorophyll *a* and dissolved oxygen or pH levels) instead of total phosphorus concentration to evaluate whether phosphorus is the pollutant causing a beneficial use impairment.[578] New Jersey now uses these biological indicators as proxy for phosphorus impairment.[579] According to the NJDEP, a single, statewide numeric criteria "may not be appropriate for all waterbodies," whereas narrative criteria are a "better way to determine where nutrients cause impairment."[580] If the NJDEP concludes phosphorus is impairing a waterbody and narrative nutrient criteria are unsatisfied, it will use numeric phosphorus criteria to set state-administered NPDES permit limits and TMDLs.[581] But if a waterbody achieves narrative nutrient criteria, even if phosphorus concentrations exceed a waterbody's numeric limit, phosphorus will not be listed as a cause of impairment on the state's 303(d) list.[582]

New Jersey's reliance on narrative water quality when it has numeric criteria stands in contrast to the other case studies. When New Jersey abandoned its long-established approach of regulating nutrient pollution through numeric phosphorus

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574 N.J. ADMIN. CODE § 7:9B-1.14 (2023); *see also N/P Criteria Progress Map*, *supra* note 18.

575 N.J. DEP'T ENV'T PROT., *supra* note 562 at 1; N.J. DEP'T ENV'T PROT., *supra* note 351, at 6.

576 N.J. DEP'T ENV'T PROT., *supra* note 351, at 9.

577 *N/P Criteria Progress Map*, *supra* note 18.

578 N.J. ADMIN. CODE § 7:9B-1.5(g) (amended 2009) (note that the state takes a "weight of evidence" approach using a waterbody's dissolved oxygen concentration, diurnal fluctuation, and biological metrics).

579 *Id.* (identifying impaired waters when the dissolved oxygen criteria is not met and biological metric is impaired).

580 *Id.*; *see also* N.J. ADMIN. CODE § 7:9B-1.14(d)(4)(i) (2023) ("Except as due to natural conditions, nutrients shall not be allowed in concentrations that render the waters unsuitable for the existing or designated uses due to [indicators of nutrient impairment such as nuisance or HABs].").

581 N.J. ADMIN. CODE § 7:9B-1.5(g) (2023).

582 *Id.*

limits in 2009, a group of environmental organizations[583] sent a comment letter voicing concerns about NJDEP's administrative maneuvering.[584] They considered the state's prioritization of narrative nutrient criteria over numeric phosphorus a move that would relax restrictions on nutrient polluters.[585] The state responded within the same year to "eliminate this concern and clarify the Department's intention. . .that the applicable numeric criterion applies *until* the Department determines that the phosphorus concentration in the waterbody does not cause undesirable conditions described in the narrative criterion for nutrients."[586] NJDEP's response to the environmental groups' concerns mirrors the surface water quality standards for nutrients (current as of 2023): numeric phosphorus limits apply unless the NJDEP "determines [phosphorus] concentrations do not render the waters unsuitable in accordance with [narrative nutrient criteria]."[587]

The plain language of the rule reveals New Jersey's favor for narrative standards by not obliging adherence to numeric phosphorus standards unless there are nuisance algae problems, low oxygen levels, etc. Despite its divergence in this respect, New Jersey regulates point sources and manages nonpoint sources of nutrient pollution in a similar manner to Wisconsin.

2. Controlling Point and Nonpoint Source Discharges

Since 2002, the NJDEP has set TMDLs and imposed water quality-based effluent limits based on numeric phosphorus criteria when issuing NJPDES permits.[588] New Jersey does not apply statewide technology-based effluent limits on phosphorus discharges from POTWs[589] despite the fact that POTWs are a significant source of phosphorus discharged to surface waters. The state's failure to regulate these point sources of phosphorus will limit its ability to make measurable improvements to water quality.

As a party to the Delaware River Basin Compact, New Jersey also participates in regulating point source discharges to surface waters within the Delaware River

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583 Letter from Maya K. van Rossum, Del. Riverkeeper, William Sheehan, Hackensack Riverkeeper, & Deborah Mans, NY/NJ Baykeeper, to Gary J. Brower, Att'y, N.J. Dep't Env't Prot. (June 19, 2009) (mentioning Delaware Riverkeeper Network, NY/NJ Baykeeper, and Hackensack Riverkeeper).

584 *Id.*

585 *Id.*

586 Summary of Proposed Amendments N.J.A.C. 7:9B-1.4, 1.5(g) and 1.14(d) to N.J. Surface Water Quality Standards, adopted as N.J. ADMIN. CODE §§ 7:9B-1.4; 1.5(g); 1.14(a)-(e) (2023).

587 *Id.*

588 N.J. DEP'T ENV'T PROT., *supra* note 562, at 4-5 (ensuring discharge to not cause further violation of surface water quality standards).

589 N.J. ADMIN. CODE §§ 7:14A-12.2; 13.3 (2023) (stating that the state follows federal guidance and regulates direct discharges to surface water from POTWs with effluent limits on biological oxygen demand and total suspended solids and required pH levels).

Basin.[590] A point source must obtain Delaware River Basin Commission approval and a NJPDES permit before discharging pollutants to these regulated surface waters.[591] New Jersey's numeric and narrative phosphorus criteria apply to waters within the Delaware River Basin that are not governed by the Delaware River Basin Commission water quality regulations.[592] However, for waters under the Commission's regulations, wastewater treatment discharges have a phosphorus limit of 2,000 ug/L (thirty-day average effluent criteria treated with best demonstrable technology) (double Minnesota's effluent limit), and various site-specific criteria range from 40 to 29,000 ug/L.

New Jersey's nonregulatory means of managing nonpoint source pollution are to use agricultural best management practices and riparian restoration.[593] New Jersey has also approved the use of "watershed-based plans" as an "effective alternative" to the TMDL process; these plans advocate for watershed restoration through nonregulatory "restoration and stewardship-building actions."[594] EPA section 319 grants have funded both TMDL development and watershed-based plan implementation in New Jersey.[595]

Agricultural nutrient reduction is an important component of New Jersey's nonpoint source pollution control strategy. One key program that advances this goal is the Environmental Quality Incentive Program, which provide technical, financial, and educational support to agricultural producers in implementing conservation practices.[596] New Jersey also has a specific HAB initiative, which entails a multipronged approach to addressing nonpoint source pollution, the primary cause of nuisance and HABs in the nation's waters.[597]

Unlike Wisconsin, New Jersey does not have an established water quality trading program or other market-like options for complying with water quality standards. In 2008, the EPA awarded a grant to Rutgers University to develop a water quality trading pilot program to target phosphorus impairments in the Passaic River basin in northern New Jersey.[598] In 2013, the NJDEP evaluated the

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590 U.S. ENV'T PROT. AGENCY, *supra* note 570 at 27.

591 *Id.*

592 N.J. ADMIN. CODE § 7:9B-1.14 (2023).

593 N.J. DEP'T ENV'T PROT., NEW JERSEY NONPOINT SOURCE MANAGEMENT PROGRAM PLAN (2020-2025) https://www.nj.gov/dep/wms/bears/docs/NJFinalNPSProgramPlan2020-2025.pdf.

594 *Id.* at 8-9.

595 *Id.* at 9-10.

596 *Id.* at 11.

597 N.J. DEP'T ENV'T PROT., 2021 CYANOBACTERIAL HARMFUL ALGAL BLOOM (HAB) FRESHWATER RECREATIONAL RESPONSE STRATEGY, 6 (2022), https://www.nj.gov/dep/hab/download/HAB2021StrategyFinal.pdf ("Harmful Algal Blooms (HABs) Initiative…has three main components: to reduce and prevent future harmful algal blooms; to enhance HAB science, and build monitoring, testing and data management response capacity; and to improve communication, including HAB website enhancements and interactive mapping and reporting.").

598 N.J. DEP'T ENV'T PROT., EVALUATION OF THE WATER QUALITY TRADING PROGRAM AS PRESENTED IN THE FINAL RUTGERS UNIVERSITY REPORT ENTITLED 'DEVELOPMENT AND WATER

pilot program and found several deficiencies ranging from concerns over the legality and enforceability of trades between buyers and sellers to confusion over how to implement the trading program through the NJPDES permit program.[599] The NJDEP was dissuaded by its evaluation and decided the water quality trading program was neither viable nor approvable.[600] The NJDEP remained open to considering water quality trades on a case-by-case and facility-specific basis, but only if a set of permittees were to propose a specific trading arrangement complete with a plan for implementation, enforceability, and accountability.[601] This piecemeal approach stands in contrast to Wisconsin's program with fifty-five trades within the first decade and newly established clearinghouse in 2023 to facilitate trades for nutrient reduction.

New Jersey's approach to phosphorus management showcases how a well-established history of water quality regulation through numeric nutrient limits does not guarantee improvement to surface water quality. Despite early adoption of numeric phosphorus limits, the state has not been able to show meaningful improvements to water quality impaired by phosphorus. This may be especially true going forward since New Jersey reverted its approach to assessing water quality back to narrative criteria, which have been deemed inadequate for water quality protection when compared with numeric standards.

E. Lessons Learned from Leading State Efforts to Curb Nutrient Pollution

As we demonstrate above, states with the most robust framework for regulating point sources of phosphorus are more likely to see reductions in phosphorus pollution and improvements to water quality (even if delayed). Minnesota has been exceptionally successful at reducing point source discharges of phosphorus as a result of its long history of regulating point sources with effluent limits. One of the common themes uniting Minnesota and Wisconsin is the application of statewide technology-based effluent limits on phosphorus discharges from POTWs. Notably, both states are Great Lakes Basin states that are governed by The Great Lakes Water Quality Agreement's numeric nutrient effluent limits for POTWs within the basin. Neither Florida nor New Jersey's water quality standards contain phosphorus effluent limits applicable to POTWs, and until 2020 when the Supreme Court held otherwise in *County of Maui*, Hawaii had been allowing POTWs to discharge partially treated wastewater into navigable waters without any NPDES permit.

QUALITY MODEL VALIDATION OF A PHOSPHORUS TRADING PROGRAM FOR THE NON-TIDAL PASSAIC RIVER BASIN,'" at 2 (May 24, 2013), https://www.nj.gov/dep/wms/bears/docs/(2013-05-24)%20Whitepaper%20-Evaluation%20of%20Rutgers%20Proposal.pdf

599 *Id.* at 3-5.

600 *Id.* at 8-9.

601 *Id.* at 9.

When it comes to nonpoint source management, Florida and Wisconsin stand out. As compared to the other states, Florida's approach to nonpoint source management is more mandatory than voluntary, with legally enforceable watershed basin management plans and legislatively mandated watershed restoration efforts. Florida should consider focusing on bolstering its nutrient trading options for shared point and nonpoint phosphorus reduction. Wisconsin is the one state in this analysis that has an advanced system nutrient trading, with the nation's first centralized, online clearinghouse to facilitate trades, and the nation's first adaptive management program; both compliance options offer opportunity to reduce high-polluting nonpoint sources of phosphorus.

Minnesota's nonpoint source management program is not unlike Wisconsin's, in that the state utilizes a phosphorus index and has a system for water quality trading. Despite that, Minnesota has overseen a fraction of Wisconsin's trades; Minnesota should consider using Wisconsin's new trading clearinghouse as a model to strengthen its own program. Hawaii's nonpoint management program is the least robust of the five states. The language contained within Hawaii's nonpoint management program is flawed and ineffective for reducing phosphorus pollution. It requires applicable entities to "minimize" negative impacts on water quality to the "maximum extent practicable," but the Hawaii DOH does not even consider a waterbody's numeric phosphorus limit when evaluating the lenient standard. Hawaii also has a cesspool dilemma, where millions of gallons of untreated sewage containing thousands of pounds of phosphorus are contributing to nutrient impaired coastal waters; the state made an effort to address this issue with a ban on new development and removal of all cesspools by 2050.

The future of nonpoint source management of phosphorus lies with market-based trades and shared point to nonpoint reduction efforts. Neither Hawaii nor New Jersey have established nutrient trading programs. All four states that are lacking in this area should pay attention to Wisconsin's leading efforts to systematize innovative trade options to model and strengthen their own programs for trade.

CONCLUSION

In 1998, the EPA's "National Strategy for the Development of Regional Nutrient Criteria" report recognized excessive nutrients as major pollutants impairing the nation's waters.[602] The EPA notified states of the agency's expectation that all states would adopt and implement numeric nutrient criteria by December 2003.[603] Most states failed to meet this expectation. By 2023, there are only five states with numeric phosphorus standards for two or more waterbody types. This article has compared the numeric criteria and management strategies

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[602] U.S. ENV'T PROT. AGENCY, *supra* note 327.

[603] *Id.*

employed to improve water quality in the five states: Wisconsin, Florida, Hawaii, Minnesota, and New Jersey. These case studies are essential for the remaining majority of states and tribes that have yet to move forward on comprehensive nutrient management.

Given the lack of phosphorus limits on water discharges and runoff around the country, it is unsurprising that the EPA continues to identify nutrient pollution as a growing challenge with severe implications to the nation's water quality, public health, and economy.[604] As is true for most natural resource management, climate change is exacerbating nutrient-impaired waters due to rising water temperatures and more frequent and intense rain events causing runoff.

In 2022, the EPA issued a memo: "Accelerating Nutrient Pollution Reductions in the Nation's Waters," where the agency outlined principles and strategies to work with states, tribes, and local partners in a targeted effort to reduce nutrient pollution.[605] The five states included in this article's comparative analysis are already implementing numeric criteria. As we highlighted in section E above, some, like Wisconsin, offer examples of programs that should be replicated, while others, like New Jersey's shift from numeric to narrative interpretation of phosphorus impairment and Hawaii's lacking nonpoint management plan, present cautionary tales. One of the common themes that emerged for at least three out of the five states was mounting public pressure and actual or threatened legal action over water quality impairment that motivated development of numeric standards to regulate nutrient pollution. In this regard, Florida is an exceptional case due to its litigious history with environmental groups and industry leaders and regulatory battle with the EPA, where the EPA issued numeric water quality criteria for phosphorus when Florida initially refused. This demonstrates the critical importance of environmental NGOs in pushing for implementation of the CWA.

When it comes to applying numeric nutrient criteria and gauging water quality impairment, two distinct patterns emerged. First, Florida and Minnesota both demonstrate preference for more site-specific application of numeric criteria that serves ecological diversity in different regions of each state. This approach contrasts with Wisconsin's where numeric criteria are applied to more broadly defined waterbody categories. Additionally, New Jersey is the only state in this analysis that exhibited a shift away from numeric interpretation of phosphorus impairment toward a narrative approach to gauging water quality with other biological indicators serving as a proxy for phosphorus impairment.[606]

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[604] Fox Memo, *supra* note 6.

[605] *Id.*

[606] Amanda Eggert, *Montana to Become 1st State to Strike Numeric Standards for Nitrogen, Phosphorus*, MISSOULA CURRENT (May 7, 2021), https://missoulacurrent.com/montana-numeric-standards/ (stating that Montana has become the first state to repeal numeric nutrient criteria altogether and replace it with subjective, unenforceable narrative standards; This is a concerning trend to watch for as other states decide how to move forward with regulating nutrient pollution).

One area where Wisconsin emerged as a clear leader is the use of market-based mechanisms for reducing phosphorus loads to watersheds. Three out of the five states (Wisconsin, Minnesota, and Florida) have statewide water quality trading programs. Minnesota has only five ongoing trades and Florida only four, with no available credits for new trades. Wisconsin, on the other hand, oversees fifty-five active trades and in 2023 created the nation's first clearinghouse for brokering trades statewide. Only a few months in existence, the clearinghouse already verified its first credit-generating project in August 2023 and is already evaluating a new trade, as well as performing public education and outreach. Not only is Wisconsin leading in water quality trading, but it also runs the nation's first adaptive management program that focuses on achieving stringent numeric phosphorus criteria through nonpoint source pollution reduction projects funded by point sources in shared watersheds. Wisconsin has registered measurable improvement trends in total phosphorus levels in rivers statewide in 2022 compared to 2010.

Despite the five states' numeric criteria for phosphorus, the nutrient is still causing problems in waters of all five jurisdictions. Each year these states struggle to control nuisance and HABs that choke their waterways. In 2022, Hawaii identified excess nutrient pollution as the second leading cause of water impairment, which plague its world-renowned beaches. Algae blooms that are becoming larger and more toxic are on the rise in some of Minnesota and Wisconsin's most pristine waters.[607] And despite being the earliest adopter of nutrient criteria, New Jersey stopped regulating excess phosphorus in a meaningful way with numeric criteria, which has caused phosphorus to remain the primary source of over-enrichment of New Jersey's freshwaters and the leading known impairment of aquatic life.

While numeric standards are critical for achieving phosphorus load reductions, particularly for point sources, the measurable delay in water quality improvement reveals both academic research and regulatory gaps that should be addressed to better understand and regulate this issue. Additionally, this trend showcases the need for creative methods that can effectively target and reduce nonpoint source phosphorus loads, the primary contributor of nutrient impairment. Transformative and innovative changes to managing phosphorus pollution is required nationwide to meet water quality criteria and achieve the shared goal of restoring water quality.

[607] Dan Kraker, *Boundary Waters algae blooms spark questions, concern*, MPR NEWS (Oct. 17, 2022), https://www.mprnews.org/story/2022/10/17/boundary-waters-algae-blooms-spark-questions-concern.