STEMMING THE "RED TIDE": LEGISLATIVE APPROACHES TO ADDRESSING THE CONTRIBUTION OF AGRICULTURAL NUTRIENT POLLUTION TO THE DEVELOPMENT AND CONSEQUENCES OF HARMFUL ALGAL BLOOMS

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INTRODUCTION

We forget that the water cycle and the life cycle are one.
- Jacques Yves Cousteau[1]

The numerous, varied, and long-term challenges associated with harmful algal blooms (HABs) have become widely recognized in recent years.[2] While some may generally refer to all HABs as "red tides," HABs actually result from blooms of various algal species in both marine and freshwater bodies.[3] Not all algal blooms are harmful; however, a rapid, uncontrolled bloom expansion can cause: lethal oxygen depletion in an aquatic ecosystem, poisoned aquatic plant and animal life, human health effects, degraded aquatic uses, contaminated public water supplies, and economically impacted businesses dependent on those uses and on the aquatic environment.[4]

Various factors, including temperature, light, pH levels, and water circulation, are associated with the occurrence and effects of marine and freshwater HABs.[5] While the impact of climate change and these factors play a role in the problem, "[n]utrient enrichment is widely recognized as one of the key causes of HAB formation."[6] High concentrations of nutrients—particularly nitrogen and phosphorus—in a water body also significantly contribute to HAB occurrence and consequences.[7] Sources contributing nutrients to waterbodies include discharges from industrial and wastewater

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1. BrainyQuotes, https://www.brainyquote.com/search_results?x=0&y=0&q=Jacques+Yves+Cousteau (last accessed Aug. 12, 2022).

2. LAURA GATZ, CONG. RSCH. SERV., R44871, FRESHWATER HARMFUL ALGAL BLOOMS: CAUSES, CHALLENGES, AND POLICY CONSIDERATIONS (2002); *see, e.g.,* Dep't of Health & Human Services Donald Anderson, *HABs in a Changing World: A Perspective on Harmful Algal Blooms, Their Impacts, and Research and Management in a Dynamic Era of Climactic and Environmental Change*, HARMFUL ALGAE (2012); *see also Recent Trends: National Changes*, U.S. NAT'L OFF. FOR HARMFUL ALGAL BLOOMS, https://hab.whoi.edu/maps/regions-us-distribution/regions-us-recent-trends/ (last accessed Aug. 12, 2022) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4667985/pdf/nihms691284.pdf; *see also Recent Trends: National Changes*, U.S. NAT'L OFF. FOR HARMFUL ALGAL BLOOMS, https://hab.whoi.edu/maps/regions-us-distribution/regions-us-recent-trends/ (last accessed Aug. 12, 2022).

3. *Harmful Algal Blooms*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrientpollution/harmful-algal-blooms (last accessed Aug. 12, 2022).

4. *Id.*

5. CONG. RSCH. SERV., *Freshwater Harmful Algal Blooms: An Overview*, (2020).

6. *Id.*; *Climate Change Indicators: Oceans*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/climate-indicators/oceans (last accessed Aug. 19, 2022); *Climate Change Indicators: Ecosystems*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/climate-indicators/ecosystems (last accessed Aug. 19, 2022).

7. *Nutrient Pollution—The Issue*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrientpollution/issue (last accessed Aug. 12, 2022).

facilities, animal feeding operations, stormwater runoff, septic systems, and emissions from fossil fuels.[8]

This Article focuses on one source of nutrient pollution—agricultural operations—and addresses the contribution of agricultural nutrient pollution to HAB occurrences. This Article also considers whether existing water quality and HAB-related laws are sufficient to eliminate, reduce, and respond to the water quality effects of agricultural nutrient pollution and its impacts on HAB proliferation. According to a 2017 United Nations Food and Agriculture Organization report, nitrate from agricultural operations "is now the most common chemical contaminant in the world's groundwater aquifers." [9] The report states that agriculture "is responsible almost exclusively for groundwater pollution by nitrogen" in China and also is a significant concern for waterbodies in the European Union.[10] For the United States, the report identified agriculture as "the main source of pollution in rivers and streams" and a major source in lakes and wetlands.[11]

This Article discusses the existing legal framework related to nutrient pollution (excess nitrogen and phosphorus) for agricultural operations and its effect on HAB occurrences. This Article also evaluates whether existing laws effectively regulate agricultural nutrient pollution and considers whether alternative approaches would be more effective in reducing HAB events and their consequences.

Part I of this Article explains the nature and causes of HABs, their associated impacts, and the relationship between HABs and nutrients used in agricultural operations. Part II and Part III describe existing federal and select regional legal frameworks related to HAB prevention and response and to management, control, reduction, or elimination of agricultural nutrient pollution. Part IV evaluates the efficacy of efforts to combat HABs and manage agricultural nutrient pollution through existing legal frameworks. Additionally, this section proposes alternative approaches that may better address agricultural nutrient pollution's contribution to HABs and perhaps

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8. LAURA GATZ, CONG. RSCH. SERV., IF10690, FRESHWATER HARMFUL ALGAL BLOOMS: AN OVERVIEW (2020), https://www.everycrsreport.com/files/2020-07-08_IF10690_dd40b27d3857b0c45f24f72dc4b721b39ffa4fb0.pdf.

9. *Land & Water*, FOOD & AGRIC. ORG. OF THE UNITED NATIONS, https://www.fao.org/land-water/news-archive/news-detail/en/c/1032702/ (last accessed Aug. 12, 2022); FOOD & AGRIC. ORG. OF THE UNITED NATIONS, *Water Pollution from Agriculture: A Global Review – Executive Summary* (2017), https://www.fao.org/3/i7754e/i7754e.pdf.

10. *Id.* (according to the report's executive summary, "38 percent of water bodies in the European Union are under pressure from agricultural pollution"; the report notes various concerns regarding the impacts of chemical fertilizers, pesticides, livestock operations, and aquaculture on water quality).

11. FOOD & AGRIC. ORG. OF THE UNITED NATIONS *supra* note 9; JAVIER MATEO-SAGASTA ET AL., WATER POLLUTION FROM AGRICULTURE: A GLOBAL REVIEW – EXECUTIVE SUMMARY, FOOD & AGRIC. ORG. OF THE UNITED NATIONS 3 (2017), https://www.fao.org/3/i7754e/i7754e.pdf.

more effectively promote reduction and prevention of HAB events in the future.

I. HABS AND AGRICULTURAL OPERATIONS

Water and air, the two essential fluids on which all life depends, have become global garbage cans.
- Jacques Yves Cousteau[12]

A. HABs–Background

Algae are simple photosynthetic organisms that live in both marine water and freshwater; the term includes a range of organisms from "microscopic, single-celled organisms to large seaweeds . . . that form the base of food webs."[13] Common types of algae related to freshwater and marine HABs include cyanobacteria (blue-green algae) and *Karenia brevis* (K. brevis).[14] Algal blooms occur when algae in a particular water body expand to higher than normal levels and then proliferate ("bloom") in that aquatic system.[15] Algal blooms become harmful when their "rapid and uncontrolled expansion" results in the release of toxins, or their growth and decomposition cause depletion of oxygen in the waterbody.[16] A HAB can "produce toxins that can kill fish, mammals and birds, and may cause human illness or even death in extreme cases."[17] Even blooms from nontoxic algae create impacts, including: loss of oxygen in the aquatic system and injury to fish, corals, and aquatic vegetation from their decomposition.[18] Nontoxic blooms can also "discolor water, form huge, smelly piles on beaches or contaminate drinking water."[19]

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12. Brainy Quotes, *supra* note 1.

13. *What is a Harmful Algal Bloom?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.noaa.gov/what-is-harmful-algal-bloom (April 27, 2016); HARMFUL ALGAL BLOOM RSCH. INITIATIVE, *Project Update 2021*, https://www.utoledo.edu/commissions/water-task-force/docs/HABRI%20Year%203%20and%204.pdf.

14. *Harmful Algal Blooms*, *supra* note 3; *What is a Harmful Algal Bloom?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., (April 27, 2016) (while this bloom is named for its distinctive red color, K. brevis is not connected to tides and is not always colored red).

15. *Harmful Algal Blooms—Tiny Organisms with a Toxic Punch*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., NAT'L OCEAN SERV., https://oceanservice.noaa.gov/hazards/hab/ (last accessed Aug. 12, 2022); *What is a Harmful Algal Bloom?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., (April 27, 2016).

16. *What is a Harmful Algal Bloom?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., (April 27, 2016).

17. *Id.*

18. For example, the decomposition of nontoxic algal blooms can "clog the gills of fish and invertebrates, or smother corals and submerged aquatic vegetation." *Id.*

19. *Id.*

Not all algal blooms harm the aquatic environment; indeed, some blooms may have environmental benefits.[20] An algal bloom becomes harmful when the bloom has "the potential to harm human health or aquatic ecosystems."[21] Sunlight and nutrients in the water stimulate the growth of algae, which can lead to an algal bloom under the right conditions.[22] The algal bloom may cause oxygen depletion and/or release toxins into the water body, resulting in the death of aquatic plants and animals.[23] These impacts can have catastrophic aquatic and economic effects.[24] For example, a 2013 Florida red tide was associated with the deaths of 277 West Indian manatees, a protected species under federal and state law; furthermore, a 2015 toxic bloom affecting California, Oregon, and Washington resulted in losses of $97 million to the crab fishery and $40 million to tourism industries in those states.[25]

The increased scope and frequency of national and global HAB events, indicated by scientific research, has stimulated legislative interest and concern.[26] A variety of factors associated with climate change are also factors in the development of marine and freshwater HABs, including increased water temperatures, increased evaporation rates, salinity changes, acidification, oxygen depletion, and water level increases.[27] Recognizing the importance of these factors, the existence of high levels of nutrients (particularly nitrogen and phosphorus) in an aquatic environment is recognized as a significant causal factor in the occurrence and effects of

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20. NAT'L OCEANIC AND ATMOSPHERIC ADMIN, *Are all Algal Blooms Harmful?*, NAT'L OCEAN SERV., https://oceanservice.noaa.gov/facts/habharm.html (Jan. 20, 2023).

21. *Cyanobacterial Harmful Algal Blooms (CyanoHABs) in Water Bodies*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/cyanohabs (April 26, 2022).

22. *Harmful Algal Blooms*, *supra* note 3.

23. *What is a Harmful Algal Bloom?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.noaa.gov/what-is-harmful-algal-bloom (April 27, 2016).

24. *Hitting Us Where It Hurts: The Untold Story of Harmful Algal Blooms*, NATI'L OCEANIC AND ATMOSPHERIC ADMIN FISHERIES, https://www.fisheries.noaa.gov/west-coast/science-data/hitting-us-where-it-hurts-untold-story-harmful-algal-blooms# (Oct. 07, 2021).

25. *Id.*; *see* 16 U.S.C. § 1531 (1973) (explaining that the West Indian manatee is listed as a threatened species under the Endangered Species Act and Marine Mammal Protection Act); *see also* 16 U.S.C. §§1361-1362 (codifying that the West Indian manatee, also known as the Florida manatee, is also protected by statute and through a species management plan under Florida law. F.S. 379.2431); FLA. FISH & WILDLIFE CONSERVATION COMM'N, *Florida Manatee Program*, https://myfwc.com/wildlifehabitats/wildlife/manatee/ (last accessed Aug. 18, 2022).

26. *What is a Harmful Algal Bloom?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., (April 27, 2016); LAURA GATZ, CONG. RSCH. SERV., R44871, FRESHWATER HARMFUL ALGAL BLOOMS: CAUSES, CHALLENGES, & POL'Y CONSIDERATIONS 1 (2020) https://crsreports.congress.gov/product/pdf/R/R44871.

27. *Climate Change Indicators: Oceans*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/climate-indicators/oceans (Aug. 19, 2022); *Climate Change Indicators: Ecosystems*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/climate-indicators/ecosystems (March 02, 2023).

HABs.[28] This type of "nutrient pollution" results from various sources, including: fertilizer application on agricultural, commercial, and residential lands; animal waste (commercial, livestock, and domestic); stormwater runoff from various sources; fossil fuel emissions from power generation, transportation, and agricultural operations; and discharges from sewage treatment facilities.[29]

HABs are a national and international problem. A recent large-scale global study of HAB events determined that potentially toxic algal species occur in each region of the world.[30] In the United States, "HABs occur in all U.S. waters" and are a "major environmental problem in all 50 states."[31] HABs can occur in fresh and salt waterbodies, including rivers, lakes, estuaries, and oceans.[32] HABs can result from various types of algae, including cyanobacteria (blue-green algae), a common source of lake blooms, and *Karenia brevis* (*K. brevis*).[33] Blooms caused by some freshwater cyanobacteria produce "highly potent" cyanotoxins; *K. brevis* causes a type of HAB known as "red tide," which is not connected to tides and is not always red.[34]

Cyanobacteria and red tide events in Ohio, Florida, and other states during the past 20 years have increased public awareness of the significant water quality, health, and economic impacts of HABs and generated interest in addressing problems related to HABs.[35] For example, Lake Erie's 2011 cyanobacteria bloom "broke the record" for this lake in terms of size and concentration:

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28. *Nutrient Pollution—The Issue*, *supra* note 7; Catherine Janasie, *Harmful Algal Blooms and Water Quality*, NAT'L SEA GRANT L. CTR. (Jun. 2, 2018), http://nsglc.olemiss.edu/projects/ag-food-law/files/harmful-algal-blooms-and-water-quality.pdf.

29. *Nutrient Pollution: Sources and Solutions*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrientpollution/sources-and-solutions (Aug. 11. 2022); Catherine Janasie, *President Trump Signs New Legislation Concerning Harmful Algal Blooms*, NAT'L SEA GRANT L. CTR. (Jan. 18, 2019), https://nsglc.olemiss.edu/blog/2019/jan/18/index.html.; *Harmful Algal Blooms and Water Quality*, NAT'L SEA GRANT L. CTR., (June 2018).

30. INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION, *Global Harmful Algal Bloom: Status Report 2021* at 4 (2021), https://unesdoc.unesco.org/ark:/48223/pf0000378691?locale=en.(The study, based on 9,503 harmful algal bloom events, noted the widespread nature of potentially toxic species but specified that "they do not cause harmful events everywhere, nor with the same intensity at different places").

31. *Harmful Algal Blooms—Tiny Organisms with a Toxic Punch*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., NAT'L OCEAN SERV., https://oceanservice.noaa.gov/hazards/hab/ (last accessed Aug. 12, 2022); U.S. GOV'T ACCOUNTABILITY OFF., GAO-22-104449, WATER QUALITY: AGENCIES SHOULD TAKE MORE ACTIONS TO MANAGE RISKS FROM HARMFUL ALGAL BLOOMS AND HYPOXIA 1 (June 2022), https://www.gao.gov/assets/gao-22-104449.pdf.

32. *What is a Harmful Algal Bloom?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.noaa.gov/what-is-harmful-algal-bloom (April 27, 2016); *Harmful Algal Blooms*, *supra* note 3.

33. *Id*. (discussing that while this bloom is named for its distinctive red color, K. brevis is not connected to tides and is not always colored red.).

34. *Id.*

35. *Hitting Us Where It Hurts: The Untold Story of Harmful Algal Blooms*, *supra* note 24.

> In the summer and fall of 2011, a green tide of blue-green algae enshrouded 230 square miles of Lake Erie's western basin. This algae "bloom" poisoned the water with toxins, suffocating the aquatic life of oxygen, burdening the city of Toledo, Ohio's water treatment plant and threatening a $11.5 billion tourism industry in Ohio.[36]

The 2011 bloom was not an isolated incident; federal and state agencies have collaborated to forecast or record HAB events in the western portion of Lake Erie every year since 2002.[37]

In addition to the temporary effects of the seasonal blooms, HABs can have significant long-term consequences on affected waterbodies. HABs can create a hypoxic (low oxygen) or anoxic (no oxygen) area "that can kill fish and marine life . . . [and] may persist and remain incapable of sustaining aquatic life."[38] While these "dead zones" have occurred widely throughout the world for many years, "the frequency of their occurrences in shallow coastal and estuarine areas worldwide is increasing, largely attributed to anthropogenic nutrient pollution."[39] The northern Gulf of Mexico hypoxic area is "the largest zone of oxygen-depleted coastal waters in the United States, and the second largest for the world's coastal oceans."[40] According to data recorded since 1985, the Gulf of Mexico dead zone has ranged in size from approximately 2,000 square miles in 2000 to 8,776 square miles in 2017; the average size during this period was 5,380 square miles.[41] In 2021,

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36. Tiffany Stecker, *Algal Blooms May Become the Norm in Lake Erie*, SCIENTIFIC AMERICAN (Apr. 2, 2013), https://www.scientificamerican.com/article/algal-blooms-may-become-the-norm-in-lake-erie/?gclid=EAIaIQobChMImeHBjtPG-QIVyCZMCh3odQxDEAMYASAAEgIQaPD_BwE.

37. *Below-average Harmful Algal Bloom Forecast for Western Lake Erie,* NAT'L OCEANIC & ATMOSPHERIC ADMIN., (June 30, 2022), https://www.noaa.gov/news-release/below-average-harmful-algal-bloom-predicted-for-western-lake-erie#:~:text=Below%2Daverage%20harmful%20algal%20bloom%20predicted%20for%20western%20Lake%20Erie,-Focus%20areas%3A&text=NOAA%20and%20its%20research%20partners,in%20the%20lake%20in%202020.

38. *Larger-than-average Gulf of Mexico 'Dead Zone' Measured*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.noaa.gov/news-release/larger-than-average-gulf-of-mexico-dead-zone-measured#:~:text=Today%2C%20NOAA%2Dsupported%20scientists%20announced,to%20fish%20and%20bottom%20species (Aug. 3, 2021); *NCCOS-Supported Research Provides Foundation for Management of the "Dead Zone" in the Northern Gulf of Mexico*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., NAT'L CTRS. for COASTAL OCEAN SCIS., https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/habhrca/dead-zone/ (last accessed Aug. 14, 2022).

39. *NCCOS-Supported Research Provides Foundation for Management of the 'Dead Zone' in the Northern Gulf of Mexico*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., NAT'L CTRS. for COASTAL OCEAN SCIS., https://coastalscience.noaa.gov/science-areas/habs/habhrca/dead-zone/ (last accessed Aug. 14, 2022).

40. *Id.*

41. *Larger-than-average Gulf of Mexico 'Dead Zone' Measured*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., (Aug. 3, 2021).

this "dead zone" was "approximately 6,334 square miles, or equivalent to more than four million acres of habitat potentially unavailable to fish and bottom species."[42]

The impacts of HAB events are diverse and substantial. HABs can damage the environment by depleting oxygen in water bodies, creating hypoxic areas, impacting air quality, and reducing water quality in the affected water bodies. HABs can also result in injury or death to humans and to the aquatic and non-aquatic wildlife that they affect. In addition, HABs can: disrupt drinking water supplies; preclude recreational uses of coastal areas' water bodies; create economic losses for aquaculture, fisheries, and tourism industries; and impact operations of water-dependent and water-adjacent commercial uses.[43] The following are some examples of those effects.

***Water supply*:** Public water utilities face disruption from HAB events. The HAB's effect on water quality can cause public drinking water utilities to issue public health advisories or suspend service. HAB events may also require water utilities to incur costs to treat algal toxins and address the health, taste, and odor issues related to these toxins.[44]

HABs impact both rural areas and large cities. For example, Lake Erie has been affected by cyanobacterial toxins for more than 20 years, and HAB events have caused a variety of impacts, including substantial disruption in the public water supply.[45] Within the region, approximately 11 million people rely on Lake Erie for drinking water.[46] Additionally, the Lake plays an essential role in supporting tourism, commercial and recreational fishing, agriculture, and manufacturing industries in surrounding states and provinces. However, recurrent HABs and dead zones in Lake Erie have impaired drinking water, threatened public health, and hurt the regional economy. In August 2014, more than 500,000 Toledo, Ohio residents were subject to a "do not drink" order for their water service because of a Lake Erie HAB event.[47] The total economic impact of this HAB event was

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42. *Id.*

43. *Nutrient Pollution: The Effects*, ENV'T PROT. AGENCY, (Aug. 11, 2022), https://www.epa.gov/nutrientpollution/effects.

44. *Id.*

45. *Lake Erie's Toxic Algae Blooms: Why is the Water Turing Green?,* NAT'L SCI. FOUND. (Apr. 8, 2019), https://beta.nsf.gov/news/lake-eries-toxic-algae-blooms-why-water-turning-green.

46. Blue Acct., *Measuring What Matters: Shared Goal for Lake Erie Phosphorus*, GREAT LAKES COMM'N DES GRANDS LACS, https://www.blueaccounting.org/issue/eriestat/ (last visited Sept. 11, 2022).

47. LAURA GATZ, CONG. RSCH. SERV., R44871, FRESHWATER HARMFUL ALGAL BLOOMS: CAUSES, CHALLENGES, & POL'Y CONSIDERATIONS 1 (2020), https://crsreports.congress.gov/product/pdf/R/R44871.

estimated at $65 million.[48] Since that time, HABs have become an almost annual occurrence in this area of the lake.[49] Those recurring HABs continue to create the potential for economic, health, and aesthetic effects for: the wildlife; residents; recreational users; commercial users; and fisheries, tourism, commercial, and recreational industries reliant on the lake.[50]

As another example, the May 2018 discovery of "dangerous levels" of cyanotoxins in Detroit Lake, a water supply source for Salem, Oregon, led the city to issue a "do not drink" water advisory that lasted for weeks.[51] This HAB event prompted the Oregon Health Authority to temporarily require specified large drinking water systems to test their water supplies for cyanotoxins on a regular basis.[52] To protect the city's drinking water, Salem invested heavily in HAB protection, including the construction of a $48 million drinking water treatment facility.[53]

***Economic effects*:** HABs can have significant impacts on the economy. Water-dependent businesses and property owners can incur significant economic losses when a HAB event impacts how businesses and people use the aquatic resources associated with them. The economic impacts of HAB events include: commercial and recreational fisheries impacts from fish kills; revenue losses for aquatic sporting and commercial businesses; financial impacts from reservation cancelations; and reduced traffic for waterfront hotels, restaurants, and other service businesses.[54]

HABs also can seriously impact use and enjoyment of aquatic environments.[55] Negative impacts on both commercial and recreational aquatic uses from nutrient-polluted waters and HABs can result in significant losses in "tourism, property values, and business revenues."[56] Further, the businesses dependent on aquatic resources, uses, or environments suffer from

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48. M. BINGHAM ET AL., ECONOMIC BENEFITS OF REDUCING HARMFUL ALGAL BLOOMS IN LAKE ERIE 1, 3 (Env't Consulting & Tech., 2015), https://legacyfiles.ijc.org/tinymce/uploaded/Publications/Economic-Benefits-Due-to-Reduction-in-HABs-October-2015.pdf.

49. Experimental Lake Erie Harmful Algal Bloom (HAB) Tracker, NAT'L OCEANIC ATMOSPHERIC ADMIN-GREAT LAKES ENV'T RSCH. LAB'Y, https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html; Great Lakes Harmful Algal Blooms (HABs) and Hypoxia, NOAA-Great Lakes Env't Rsch. Lab'y, https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/ (last accessed Sept. 20, 2022).

50. Blue Acct., *Measuring What Matters: Shared Goal for Lake Erie Phosphorus*, GREAT LAKES COMM'N DES GRANDS LACS, https://www.blueaccounting.org/issue/eriestat/ (accessed Sept. 11, 2022).

51. U.S. GOV'T ACCOUNTABILITY OFF., GAO-22-104449, WATER QUALITY: AGENCIES SHOULD TAKE MORE ACTIONS TO MANAGE RISKS FROM HARMFUL ALGAL BLOOMS AND HYPOXIA 1, 1, 9 (June 2022), https://www.gao.gov/assets/gao-22-104449.pdf.

52. *Id.*

53. *Id.*

54. *Id.* at 1, 60-61 (citing *The Effects: Economy,* U.S. ENV'T PROT. AGENCY (Aug. 27, 2022), https://www.epa.gov/nutrientpollution/effects-economy).

55. *Id.* at 1.

56. *Id.* at 9.

the effects of a HAB.[57] The following examples demonstrate some of the significant economic impacts of HABs:

- During May–July 2016, a large HAB occurred on Florida's Lake Okeechobee, the largest freshwater lake in the state. Because of high water levels in the lake at the time the HAB occurred, some HAB-impacted water was transported through canals and rivers to coastal areas. As a result, the Lake Okeechobee HAB affected agriculture, caused tourism losses, required beach closures, and impacted aquatic life.[58]
- Freshwater HABs were the basis for at least 281 public health notices (e.g., "cautions, warnings, public health advisories, and public health warnings") reported by states during an approximately two-month period in 2017.[59]
- Another Florida red tide event in 2018, which lasted for months, caused "beach closures and fish kills [that] plagued the state's coasts."[60] Florida declared a state of emergency because of the effects of this HAB.[61]

***Health effects*:** In addition to the impacts on water quality and aquatic life, HABs can affect human health. Human health impacts include serious respiratory problems, neurological effects, and skin rashes and burns.[62] Toxins in saltwater HABs of red and brown algae can cause human illness, paralytic shellfish poisoning, respiratory issues, "[g]astrointestinal illness, muscle cramps, seizures, paralysis," and death.[63] Freshwater HAB toxins can

57. *Id.* at 9 (citing *The Effects: Economy*, U.S. ENV'T PROT. AGENCY (Aug. 27, 2022), https://www.epa.gov/nutrientpollution/effects-economy).

58. Env't Health Program, *Cyanobacteria from 2016 Lake Okeechobee Harmful Algal Bloom Photo-Documented*, U.S. GEOLOGICAL SURV. (June 14, 2017), https://www.usgs.gov/programs/environmental-health-program/science/cyanobacteria-2016-lake-okeechobee-harmful-algal.; LAURA GATZ, CONG. RSCH. SERV., R44871, FRESHWATER HARMFUL ALGAL BLOOMS: CAUSES, CHALLENGES, & POL'Y CONSIDERATIONS 1 (2020), https://crsreports.congress.gov/product/pdf/R/R44871.

59. LAURA GATZ, CONG. RSCH. SERV., R44871, FRESHWATER HARMFUL ALGAL BLOOMS: CAUSES, CHALLENGES, & POL'Y CONSIDERATIONS 1 (2020), https://crsreports.congress.gov/product/pdf/R/R44871.

60. Catherine Janasie, *President Trump Signs New Legislation Concerning Harmful Algal Bloom*, SEA GRANT L. CTR. (Jan. 19, 2019), https://nsglc.olemiss.edu/blog/2019/jan/18/index.html.

61. *Id.*

62. LAURA GATZ, CONG. RSCH. SERV., R44871, FRESHWATER HARMFUL ALGAL BLOOMS: CAUSES, CHALLENGES, & POL'Y CONSIDERATIONS 1, 3 (2020), https://crsreports.congress.gov/product/pdf/R/R44871.

63. *Algal Blooms*, NAT'L INST. ENV'T HEALTH SCIS., https://www.niehs.nih.gov/health/topics/agents/algal-blooms/index.cfm (Sep. 08, 2021).

cause liver damage and gastrointestinal illness.[64] Toxins can spread to humans from contact with the water, fish, or shellfish, and from the airborne form of the toxins when walking near affected waterbodies.[65]

HABs can also adversely affect animal health. Animal impacts from HAB exposure may be similar to those experienced by humans. For example, HAB-related symptoms include: "skin, ear, eye, nose, or throat irritation; respiratory issues; lethargy, paralysis, tremors or seizures; abdominal pain, diarrhea, or vomiting."[66] In addition, the hypoxia and toxins associated with HAB events can be lethal for fish and other aquatic life; indirect health impacts can occur when aquatic animals (e.g., sea lions, turtles, birds, and manatees) and domestic animals (e.g., dogs) consume toxin-affected fish and shellfish.[67]

B. Agricultural Operations' Contribution to HABs

According to the United States Department of Agriculture (USDA), 53% of the land in the United States was used for agricultural purposes in 2012.[68] Of those acres, 392 million were used for agricultural crop land.[69] For this estimate, the USDA definition of cropland includes land actively used for harvesting crops and cropland not currently being used for that purpose (i.e., fallow land, cropland used for pasture or range, and cropland idled in connection with federal conservation or acreage-reduction programs).[70] The acreage of cropland used for crop production accounted for 87% of the total acreage.[71]

The Environmental Protection Agency (EPA) has identified agricultural production as "the largest single contributor to water quality impairment for rivers and lakes."[72] The nitrogen and phosphorus used in agricultural

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64. *Id.*

65. *Nutrient Pollution—The Effects: Environment*, ENV'T PROT. AGENCY, (April 19, 2022), https://www.epa.gov/nutrientpollution/effects-environment.

66. MONT. DEP'T OF PUBLIC HEALTH AND HUMAN SERVICES, *Public Health & Safety: Harmful Algal Blooms*, MONTANA.GOV, https://dphhs.mt.gov/publichealth/epidemiology/hab/ (last accessed Sept. 9, 2022).

67. *Id.; Nutrient Pollution—The Effects: Environment*, *supra* note 65.

68. Daniel Hellerstein et al., *Agricultural Resources and Environmental Indicators,* U.S. DEP'T AGRIC. 1 (May 2019), https://www.ers.usda.gov/webdocs/publications/93026/eib-208.pdf?v=5766.

69. *Id.*

70. *Id.*; Econ. Rsch. Serv., Major Land Uses, U.S. Dep't of Agric. https://www.ers.usda.gov/data-products/major-land-uses/ (last accessed Aug. 29, 2022) (the USDA estimates are published every five years).

71. Daniel P. Bigelow, Allison Borchers, *Major Uses of Land in the United States, 2012* US DEP'T OF AGRIC. 1, 14 (Aug. 2017), https://www.ers.usda.gov/webdocs/publications/84880/eib-178.pdf?v=9914.4.

72. Nat'l Inst. of Food & Agric., *Manure and Nutrient Management Programs*, U.S. DEP'T OF AGRIC., https://www.nifa.usda.gov/grants/programs/manure-nutrient-management-programs (last accessed Oct. 1, 2022).

operations contribute to the nutrient pollution facilitating the proliferation of HABs.[73] According to the USDA, "[m]ost of the cropping systems in the world are naturally deficient in nitrogen, making nitrogen inputs necessary to produce the crop yields needed to support human populations."[74] For crop production, the nitrogen and phosphorus in chemical fertilizers and manure stimulate plant development and production of crop plants.[75] If these nutrients are not fully used for that purpose, they can be indirectly introduced into the air and water in various ways.[76] For example, the excess nutrients can leach into groundwater from the soil or be carried to waterbodies from agricultural field runoff from storm events and snow melt.[77] Nutrients can also be introduced directly through animal waste discharges from livestock using waterbodies on agricultural lands.[78] Introduction of large amounts of these nutrients can result in nutrient pollution and eutrophication conditions associated with HAB events.[79]

The contribution of nitrogen and phosphorus from agricultural operations to nutrient pollution has been recognized for a long time. In 2011 the USDA recognized agriculture as the "single largest source of nitrogen compounds entering the environment" in the United States.[80] Noting these compounds "can change form and move easily between air, land, and water," the Agency in 2011 identified agriculture as the source of "73 percent of nitrous oxide emissions, 84 percent of ammonia emissions, and 54 percent of nitrate emissions in recent years."[81]

A 2019 report by the USDA describes the significant contribution of agriculture to water quality impairment.[82] The report discussed United States waters that had been assessed in 2016.[83] The data showed impaired water quality occurred in: "55 percent of assessed rivers and streams; 71 percent of lakes; and 84 percent of bays and estuaries."[84] The number of impaired water

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73. *Id.*

74. Marc Ribaudo et al., *Nitrogen in Agricultural Systems: Implications for Conservation Policy* U.S. DEP'T OF AGRIC. 1 (2006), https://www.ers.usda.gov/webdocs/publications/44918/6767_err127.pdf?v=5279.

75. *The Sources and Solutions: Agriculture*, U.S. ENV'T PROT. AGENCY, (Oct. 28, 2022), https://www.epa.gov/nutrientpollution/sources-and-solutions-agriculture.

76. *Id.*

77. *Id.*

78. *Id.*

79. *Id; see also Eutrophication*, Bitannica (2023) (defining Eutrophication as "the gradual increase in the concentration of phosphorus, nitrogen, and other plants nutrients in an aging aquatic ecosystem").

80. Marc Ribaudo, *Reducing Agriculture's Nitrogen Footprint: Are New Policy Approaches Needed?* U.S. DEP'T OF AGRIC. (Sept. 1, 2011), https://www.ers.usda.gov/amber-waves/2011/september/nitrogen-footprint/?source=post_page.

81. *Id.*

82. Hellersetein, *supra* note 68 at V-VI.

83. *Id.* at 90 (the USDA report noted that the 2016 data included "32 percent of rivers and streams, 44 percent of lakes, and 64 percent of bays and estuaries . . . assessed for water quality.").

84. *Id.* at VI.

bodies unable to "support their designated uses (e.g., fishing, recreation, and/or drinking water)" increased approximately 40% between 2005 and 2016. This significant percentage increase incorporates the additional water body assessments completed during the period indicated. The report identifies "sediments, nutrients, and pathogens" as the "largest causes of impairments in rivers and streams."[85] The impacts of nutrient pollution are not limited to the water bodies directly associated with lands on which agricultural activities occur; rather, nutrient pollution issues can occur "hundreds of miles from these sources."[86] For example, excess nitrogen contribution from fertilizer use "in the Mississippi and Missouri river basins is thought to be the major cause of the hypoxia problem in the Gulf of Mexico."[87] Recognizing that these pollutants may originate from other sources, the USDA report identified agriculture as "the largest source of impairments in rivers and streams and the second-largest source in lakes and ponds."[88]

Fertilizer use on croplands contributes to nutrient pollution of aquatic systems.[89] Commercial fertilizers include three primary nutrients: nitrogen, phosphorus, and potassium.[90] Nitrogen is required for the protein formation that is essential for plant development; nitrogen is also the element most absorbed by plants.[91] Phosphorus is necessary for plant growth, development, and use and storage of energy. Potassium is essential for improving plants' disease resistance, improving crop quality, increasing crop quality, and improving root system strength and crop yields.[92]

One way to mitigate nitrogen loss from commercial fertilizer is fertilizer composition and efficiency. Nitrogen emissions from fertilizers can be reduced by using "enhanced-efficiency nitrogen fertilizers"—without sacrificing crop yield.[93] However, most fertilizers used by United States agricultural operations are not produced in the United States, and currently

85. *Id.* at 90.

86. *Manure and Nutrient Management Programs, supra* note 72.

87 *Id.*

88. *Agricultural Resources and Environmental Indicators, 2019*, *supra* note 68, at 90.

89. While this issue is beyond the scope of this article, fertilizer use on residential and other commercial lands also affects water quality through introduction of nutrients. *See Nutrients*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/caddis-vol2/nutrients (last accessed March. 20, 2023).

90. *Fertilizer 101: The Big 3 - Nitrogen, Phosphorus and Potassium*, FERTILIZER INST. (May 7, 2014), https://www.tfi.org/the-feed/fertilizer-101-big-3-nitrogen-phosphorus-and-potassium.

91. *Id.*

92. *Id.*

93. Allen G. Good & Perrin H. Beatty, *Fertilizing Nature: A Tragedy of Excess in the Commons*, NAT'L CTR. FOR BIOTECHNOLOGY INFO. (Aug. 16, 2011), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3156687/.

there are no federal laws requiring the use of enhanced fertilizer.[94] China, Russia, Canada, and Morocco are major producers of fertilizer's main components. The United States is the "second or third top importer" of these components.[95]

Another way to reduce nitrogen and phosphorus loss from fertilizer application is through agricultural management practices. Since agricultural crops have varying rates for required nitrogen application amount, uptake, and "return in residue," the addition of more nitrogen than needed for crop production can contribute to nutrient pollution.[96] Further, excess phosphorus contributes to nutrient pollution through runoff and soil erosion when fertilizer is applied.[97] Thus, excess application of fertilizer to crops can lead to the nutrient loading in water bodies that can promote HAB growth and hypoxia events.[98]

Choice of fertilizer application practices can positively affect water quality. For example, application methods that consider the timing, amount, and method of fertilizer application can help control the amount of excess nitrogen that results from application practices.[99] Other management practices can decrease the amount of nitrogen lost from crop production.[100] For example, the use of cover crops during periods when production crops are not in the agricultural fields can absorb nitrogen from the soil and significantly reduce nitrogen loss from erosion, surface runoff, and leaching.[101]

Animal manure is used as a fertilizer for agricultural operations because manure is considered an excellent source of plant nutrients and a soil builder because of manure's contributions to improving soil quality. According to the USDA, using properly applied manure for crop fertilization may result in

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94. *USDA Announce Plans for $250 Million Investment to Support Innovative American-made Fertilizer to give US Farmers More Choices in the Marketplace*, U.S. DEP'T AGRIC. (Mar. 11, 2022), https://www.usda.gov/media/press-releases/2022/03/11/usda-announces-plans-250-million-investment-support-innovative.

95. *Id.*

96. INST. OF MED. & NAT'L RSCH. COUNCIL, A FRAMEWORK FOR ASSESSING EFFECTS OF THE FOOD SYS. 344 (Malden C. Nesheim et al. eds., 2015) (ebook) (discussing the effects of nutrients in the agriculture system).

97. Id. at 132.

98. Allen G. Good & Perrin H. Beatty, *Fertilizing Nature*; *A Tragedy of Excess in the Commons*, NAT'L CTR. FOR BIOTECHNOLOGY INFO. (Aug. 16, 2011), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3156687/; Comm. on a Framework for Assessing the Health, Env't, & Soc. Effects of the Food Sys. Et al., *A Framework for Assessing Effects of the Food System*, NAT'L CTR. FOR BIOTECHNOLOGY INFO. (June 17, 2015).

99. Good & Beatty, *supra* note 98; *see also* NITROGEN IN AGRICULTURE SYSTEMS: IMPLICATIONS FOR CONSERVATION POLICY, iii, 1 17, U.S. DEP'T AGRIC., https://www.ers.usda.gov/webdocs/publications/44918/6767_err127.pdf?v=3907.7 (discussing that "corn is the most intensive user of nitrogen" and "improvements in rate, timing, and/or application method are needed on 70 percent of corn acres" to improve nitrogen use efficiency).

100. *Id.*

101. INST. OF MED. & NAT'L RSCH. COUNCIL, *supra* note 96, at 138.

less nitrate loss through leaching, soil erosion, and runoff than from use of commercial fertilizers.[102] Manure provides an organic source of nitrogen, phosphorus, and other nutrients. Nitrogen in manure is a more stable form of nitrogen and is more slowly released than the nitrogen from commercial fertilizers. The release timing is a factor in the amount of nitrate leaching that occurs from fertilizer application.[103]

Animal manure, however, significantly contributes to the nutrient pollution problem when used as a fertilizer in agricultural operations. Despite the USDA's indication that manure may result in less nutrient leaching, EPA research indicates that nutrient losses from equivalent rates of nutrients from commercial fertilizer and manure are similar.[104] The efficiency of manure application for fertilization can be affected by nutrient imbalances and difficulty in estimating available nutrients from this source.[105] The form of manure used as a fertilizer may also be a factor; manure compost may be a more efficient form than fresh manure because of its comparable nutrient composition and the ability to apply it more evenly and with more control.[106] Like use of commercial fertilizers, timing of application may also be a factor.[107] Similarly, nutrient loss from manure application may occur from management practices that result in overapplication of nutrients for crop production.[108] In addition, nitrate loss may occur in different forms (e.g., ammonia from stored manure) and at greater rates than commercial fertilizer with direct manure application to fields.[109]

Manure also directly contributes to nutrients in water bodies through animal agriculture. According to the EPA, "[a]nimal agriculture manure is a primary source of nitrogen and phosphorus to surface and groundwater."[110]

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102. Nat'l Inst. of Food & Agric., *Manure and Nutrient Management Programs*, U.S. DEP'T AGRIC., https://www.nifa.usda.gov/grants/programs/manure-nutrient-management-programs (last visited Oct. 1, 2022).

103. *Id*.

104. JOHN A. LORY ET AL., USING MANURE AS A FERTILIZER FOR CROP PRODUCTION, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/sites/default/files/2015-07/documents/2006_8_25_msbasin_symposia_ia_session8.pdf (last visited Oct. 1, 2022).

105. *Id*.

106. *Animal Feeding Operations—Uses of Manure*, U.S. DEP'T AGRIC., https://www.epa.gov/npdes/animal-feeding-operations-uses-manure#:~:text=1%20Nutrients.%20Farmers%2C%20gardeners%2C%20landscapers% 2C%20and%20others%20commonly,based%20on%20the%20fiber%20content%20of%20the%20manure (last visited Oct. 1, 2022).

107. ELIZABETH GRAHAM ET AL., *Manure Effects on Soil Organisms and Soil Quality*, MICH. STATE UNIV. EXTENSION 1, 4, https://www.canr.msu.edu/uploads/files/AABI/Manure%20effects%20on%20soil%20organisms.pdf (last visited February 13, 2023).

108. LORY ET AL., *supra* note 104.

109. *Id*.

110. *Estimated Animal Agriculture Nitrogen and Phosphorus from Manure*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nutrient-policy-data/estimated-animal-agriculture-nitrogen-and-phosphorus-manure (last visited Oct. 1, 2022) (noting the amount of nitrogen and phosphorus produced from animal manure based on data from 2007).

Animal manure negatively impacts quality of surface and ground water sources through contribution of excess nutrients—including nitrogen and phosphorus—and through pathogens and other contaminants and pollutants from this organic matter.[111]

A measure of the amount of excess nutrients is the "recovery rate," which reflects "the ratio of the amount of nutrient in the harvested crop to the amount of nutrient applied."[112] The 2019 USDA report reflected data from 2015, which stated that approximately 22 million short tons of commercial fertilizer was used in that year and reported that nitrogen recovery rates from corn, winter wheat, and cotton crops were approximately 70%, while phosphate recovery rates were 60%.[113] Using data from 2011, the 2019 USDA report stated that the percentages of livestock operations with nutrient management plans to manage animal manure were 66%, 54%, and 41% for broiler, hog, and dairy operations respectively.[114]

Agricultural irrigation practices play a role in facilitating nutrient pollution. The USDA tracks irrigation use across "six regions with significant concentrations of irrigated farmland" in the United States.[115] During the past seven decades, the extent of irrigated cropland has changed within these regions.[116] While the acreage of irrigated agriculture has decreased by 30% in the Mountain and Pacific regions, the Mississippi Delta and Northern Plains regions experienced an increase of more than 25%. Factors related to the increase in irrigation for the latter regions include availability of surface water and the combination of humidity and drought, respectively.[117]

Subject to these conditions, agricultural producers "are more likely to practice supplemental irrigation to replenish soil moisture deficits during critical crop growth stages."[118] Within the Mississippi Delta region, the Mississippi River Valley is the area of increased expansion. Other areas that were "historically dominated by rain-fed agriculture" but have increased use of irrigated agriculture include Chesapeake Bay's eastern region, "north-central Corn Belt region," and the "southeastern Atlantic Coastal Plain."[119]

Further, technology use in agricultural operations may facilitate improvements in nutrient retention and reduce nutrient pollution. Precision

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111. Nat'l Inst. of Food & Agric., *supra* note 102.

112. Econ. Rsch. Serv., *Nutrient Management*, U.S. DEP'T AGRIC., (April 28, 2020).

113. Hellerstein ET AL., *supra* note 68, at 45.

114. *Id.*

115. R. Aaron Hrozencik & Marcel Aillery, U.S. DEP'T AGRIC., *Trends in U.S. Irrigated Agriculture: Increasing Resilience Under Water Supply Scarcity*, 1, 10 (Dec. 2021) (specifying that the six regions are Mississippi Delta, Mountain, Northern Plains, Southern Plains, Southeast, and Pacific).

116. *Id.*

117. *Id.*

118. *Id.*

119. *Id.* at 12.

agriculture technologies include "guidance systems and variable-rate technology."[120] These technologies may assist in reducing agricultural nutrient pollution from irrigation systems that result in nutrient-laden runoff, infiltration, and irrigation return flows.[121]

II. FEDERAL LAW APPROACHES TO ADDRESSING HABS

If we pollute the air, water and soil that keep us alive and well, and destroy the biodiversity that allows natural systems to function, no amount of money will save us.

– David Suzuki.[122]

Various federal and state laws and regional legal frameworks relate to the problem of HAB detection, response, mitigation, and prevention. Some of these laws were enacted specifically to address problems associated with HABs. Other laws relate to nutrient pollution activities which contribute to bloom events and impacts. For example, federal and state water quality laws, including the federal Clean Water Act and state counterparts, establish water quality requirements, prohibitions, and programs. Various federal and state agencies have regulatory, research, planning, and other responsibilities concerning agricultural operations and issues associated with HABs.[123]

Some federal and state laws and regional legal frameworks provide for coordination of efforts concerning water quality issues, including nutrient pollution and HABs. Jurisdiction for addressing HABs and coordinating efforts among agencies or within regional partnerships may depend on whether the bloom occurs in marine and coastal waters or in freshwater bodies. For example, under federal law the National Oceanic and Atmospheric Administration (NOAA) generally has jurisdiction over marine and coastal waters, and the EPA has authority over freshwater bodies.[124]

Some federal, regional, and state initiatives respond to HABs by creating commissions and establishing research, monitoring, and management programs. Other initiatives target nutrient pollution more directly by

120. HELLERSTEIN ET AL., *supra* note 68, at V.

121. PHILLIP R. MCLOUD ET AL., PRECISION AGRICULTURE: NRCS SUPPORT FOR EMERGING TECHNOLOGIES 7 (U.S. DEP'T AGRIC, 2007); *See e.g. Nonpoint Source: Agric.*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nps/nonpoint-source-agriculture (last visited July 11, 2022) (explain nonpoint source pollution); *see e.g. also Nat'l Mgmt Measures to Control Nonpoint Pollution from Agric*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nps/national-management-measures-control-nonpoint-source-pollution-agriculture (last visited March 20, 2023) (explaining that taking measures to improve fertilizer would help to limit runoff).

122. BrainyQuotes, https://www.brainyquote.com/search_results?x=0&y=0&q=David+suzuki (last visited Aug. 12, 2022).

123. 33 U.S.C. §§ 1251, 4001.

124. 33 U.S.C. §§ 1251, 4001.

prescribing requirements for fertilizer application and nutrient management and for onsite sewage treatment operations (e.g., septic tanks). Still others involve land use restrictions on the type or timing of fertilizer applications and on the use or conversion of septic systems.[125]

The various federal and state laws related to addressing the problem of HABs generally do not provide specific regulatory or enforcement mechanisms concerning nutrient pollution from agricultural operations. Rather, these federal laws focus on research, coordination, and planning to understand the nature of HABs and to develop mechanisms to detect, monitor, and mitigate their occurrences and impacts.

A. Harmful Algal Bloom Hypoxia Research and Control Act

More than 20 years ago, Congress recognized the need for action to address the significant problem of HABs in the United States by enacting the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA).[126] A "harmful algal bloom" is defined in HABHCRA as:

> . . . marine and freshwater phytoplankton that proliferate to high concentrations, resulting in nuisance conditions or harmful impacts on marine and aquatic ecosystems, coastal communities, and human health through the production of toxic compounds or other biological, chemical, and physical impacts of the algae outbreak.[127]

"Hypoxia" is defined as "a condition where low dissolved oxygen in aquatic systems causes stress or death to resident organisms."[128]

As enacted in 1998, HABHRCA included specific legislative findings concerning the causes and effects of HABs.[129] Congress recognized the significance of recent HAB occurrences, including: "red tides in the Gulf of Mexico and the Southeast; brown tides in New York and Texas; ciguatera fish poisoning in Hawaii, Florida, Puerto Rico, and the United States Virgin Islands; and shellfish poisonings in the Gulf of Maine, the Pacific Northwest, and the Gulf of Alaska."[130] Congress also noted concerns regarding the increasing frequency and intensity of HABs and their impacts on human and animal health, such as "fish kills, the deaths of numerous endangered West

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125. *Id.* § 1251, §§ 4001–4009.

126. Harmful Algal Bloom and Hypoxia Research and Control Act of 1998, Pub. L. 105-383, 112 Stat. 3447.

127. Harmful Algal Bloom and Hypoxia Research and Control Act of 2014, Pub. L. 113-124 § 608, § 10(a)(3), 128 Stat. 1379, 1385-86 (2014).

128. *Id.*

129. Harmful Algal Bloom and Hypoxia Research and Control Act, Pub. L. 105-383, § 602 (1998).

130. *Id*. § 602(1)–602(3).

Indian manatees, beach and shellfish bed closures, threats to public health and safety, and concern among the public about the safety of seafood."[131] The HABHRCA findings also specified that both "HABs and blooms of non-toxic algal species may lead to other damaging marine conditions such as hypoxia (reduced oxygen concentrations), which are harmful or fatal to fish, shellfish, and benthic organisms."[132] In addition, Congress noted that at the time the legislation was enacted, "53 percent of United States estuaries experience[d] hypoxia for at least part of the year and a 7,000 square mile area in the Gulf of Mexico off Louisiana and Texas suffer[ed] from hypoxia."[133] Finally, Congress recognized the financial impact of harmful algal bloom events, finding that "HABs may have been responsible for an estimated $1 billion in economic losses" during the ten years preceding this legislation.[134]

In the 1998 legislation enacting HABHCRA, Congress specifically recognized scientific support for determining nutrient pollution to be a causal factor in HAB and hypoxia events.[135] Congress found that the "factors causing or contributing to HABs may include excessive nutrients in coastal waters" and that "a factor believed to cause hypoxia is excessive nutrient loading into coastal waters."[136] Further, Congress found that "a need [exists] to identify more workable and effective actions to reduce nutrient loadings to coastal waters."[137] HABHCRA defines "United States coastal waters" to include the Great Lakes.[138]

Task Force: Through the 1998 HABHRCA legislation and later amendments, Congress established a specific statutory program to develop mechanisms to address the problem of HABs.[139] A foundational component of HABHRCA was the creation of the Inter-Agency Task Force on Harmful Algal Booms and Hypoxia (Task Force).[140] The Task Force was directed to

131. *Id.* § 602(1)–602(3).
132. *Id.* § 602(6).
133. *Id.* § 602(7).
134. *Id.* § 602(5).
135. *Id.* §§ 602(4), 602(8).
136. *Id.*
137. *Id.* § 602(9).
138. Harmful Algal Bloom and Hypoxia Amendments of 2014, Pub. L. 113-124, §10(a)(9), 128 Stat. at 1385-86 (2014).
139. 33 U.S.C. § 4001.
140. *Id.; See also* Harmful Algal Bloom and Hypoxia Amendments of 2014, Pub. L. 113-124, §10(a)(7), 128 Stat. at 1385–86 (2014) (explaining the initial legislation and subsequent amendments to the Task Force composition resulted in a membership including representatives from each of the following agencies and from other agencies as determined by the President: the Department of Commerce, Environmental Protection Agency, Department of Agriculture, Department of the Interior, Department of the Navy, Department of Health and Human Services, National Science Foundation, National Aeronautics and Space Administration, Food and Drug Administration, Office of Science and Technology Policy, Council on Environmental Quality, Centers for Disease Control and Prevention, and Army Corps of Engineers.).

study the "ecological and economic consequences of hypoxia in United States coastal waters, alternatives for reducing, mitigating, and controlling hypoxia, and the social and economic costs and benefits of such alternatives." [141] As initially established, the Task Force included representatives from the following agencies: Department of Commerce; EPA; Departments of Agriculture, Interior, Navy, and Health and Human Services; Food and Drug Administration; National Science Foundation; National Aeronautics and Space Administration; Office of Science and Technology Policy; Council on Environmental Quality; and "other Federal agencies as the President considers appropriate."[142] The 2014 HABHCRA amendments added the Centers for Disease Control and Prevention to the Task Force.[143] The 2019 HABHCRA amendments added the United States Army Corps of Engineers to the Task Force.[144] While the initial legislation authorized the President to "disestablish the Task Force" after submission of a required plan,[145] the 2004 amendment eliminated this authority.[146]

Assessments: HABHCRA provides a statutory framework for researching and assessing the various impacts associated with HABs and potential options for prevention, response, and mitigation. This framework does not create mechanisms for regulating activities or actions that contribute to HABs or modify existing statutory or regulatory water quality programs that may impact the occurrence and impacts of HABs. Rather, HABHCRA is focused on planning, assessment, research, and recommendations rather than regulatory and permitting programs.[147]

HABHRCA requires the Task Force to conduct assessments concerning both HABs and hypoxia. Further, HABHCRA required the first national HAB and hypoxia assessments by HABHCRA for United States waters to be conducted within 12 months of the legislation's enactment.[148] For the HAB assessment, the statute required the Task Force to submit "an assessment which examines the ecological and economic consequences of [HABs], alternatives for reducing, mitigating, and controlling [HABs], and the social

141. 33 U.S.C. § 4001.

142. Harmful Algal Bloom and Hypoxia Research and Control Act of 1998, § 603(a)(1)–(12).

143. Harmful Algal Bloom and Hypoxia Amendments of 2014, Pub. L. 113-124, § 3, 128 Stat. at 1379 (2014).

144. 33 U.S.C. § 4001; s*ee, e.g.,* Water Resources Development Act of 2020, H.R. 7575, 116th Cong. (2020); *see also* GOV'T ACCOUNTABILITY OFF., GAO-22-104449, *Water Quality: Agencies Should Take More Actions to Manage Risks from Harmful Algal Blooms and Hypoxia* 1 (June 2022), https://www.gao.gov/assets/gao-22-104449.pdf (noticing that while HABHCRA provides a broad interagency framework for coordination and activities, other federal laws include provisions directing action concerning HABs and hypoxia).

145. Harmful Algal Bloom and Hypoxia Research and Control Act of 1998, § 603(a)(1)-(12).

146. Harmful Algal Bloom and Hypoxia Amendments of 2004, Pub. L. 108-456, § 102, 118 Stat. 3630, 3630.

147. *Id.*

148. Harmful Algal Bloom and Hypoxia Research Control Act, Pub. L. 105–383, § 603(b)-(c).

and economic benefits of such alternatives."[149] To assess bloom effects, response, mitigation, and prevention, the Task Force was required to include "alternatives for preventing unnecessary [federal agency] duplication of effort" and provisions for "[f]ederal cooperation and coordination with and assistance to the Coastal states, Indian tribes, and local governments."[150]

For the initial hypoxia assessment, the Task Force was required to examine "the ecological and economic consequences of hypoxia in United States coastal waters, alternatives for reducing, mitigating, and controlling hypoxia, and the social and economic costs and benefits of such alternatives."[151] In addition, the Task Force was required to include in this assessment: the "needs, priorities, and guidelines for a peer-reviewed, inter-agency research program on the causes, characteristics, and impacts of hypoxia."[152] For both assessments, the Task Force was required to examine "the social and economic costs and benefits of such alternatives" and to "identify alternatives for preventing unnecessary duplication of effort among Federal agencies and departments."[153] In conducting both initial assessments, the Task Force was required to cooperate with: state, tribal, and local governments; academic institutions and non-governmental organizations with relevant expertise; and "industry"; the directive included specific reference to cooperation with agricultural organizations.[154] This statute also requires periodic assessments of the ecological and economic impacts of hypoxia and "benefits of possible policy and management actions for preventing, controlling, and mitigating hypoxia."[155]

Later amendments to HABHCRA increased the Task Force's assessment and reporting requirements. The 2004 HABHCRA amendments directed the Task Force to evaluate HAB prediction and response measures.[156] This amendment required the Task Force to: review current techniques' "accuracy and utility in protecting environmental and public health"; "identify innovative research and development methods for the prevention, control, and mitigation of HABs and provisions for their development"; and "identify incentive-based partnership approaches . . . where practicable."[157] Congress amended the requirement in the 1998 legislation to "cooperate" with specified governmental, nongovernmental, and academic entities, and also

149. *Id.* § 603(b)(1) (1998).
150. *Id.* § 603(b)(2) (1998).
151. *Id.* § 603(c)(1) (1998).
152. *Id.* § 603(c)(2)(A) (1998).
153. *Id.* § 603(b)(2)(A), 603(c)(2)(B) (1998).
154. *Id.* § 603(b)(1), (c)(1) (1998).
155. 33 U.S.C. § 4001(f).
156. Harmful Algal Bloom and Hypoxia Research Control Act of 2004, Pub. L. 108-456, § 103(d)(1) (requiring the Task Force to complete and submit this report within twelve months of the enactment of the 2004 amendments).
157. *Id.* § 103(d)(2)(B); 33 U.S.C. § 4001(d)(2).

with industry to instead require the Task Force to "consult" with these entities and add fisheries and fertilizer to the identified industries.[158]

In the 2014 HABHCRA amendments, Congress created a new research and action strategy. The amendments required the Task Force to "develop . . . a comprehensive research plan and action strategy to address marine and freshwater HABs and hypoxia" (Action Strategy).[159] In addition to providing for activities and assignment of Task Force members' roles, this legislation provided for research and activities for regional focus areas to identify priorities, research needs, and methods "to reduce the duration and intensity" and "address human health dimensions of HABs and hypoxia."[160] In developing the Action Strategy, the Task Force was required to: "coordinate with" affected state and tribal government officials and agencies; and to "consult with public health [and] emergency management officials," individuals and institutions with relevant expertise, and "industries and businesses affected by marine and freshwater [HABs] and hypoxia."[161] Congress also required the Task Force to submit a report describing the activities related to the Action Strategy and progress on its implementation within two years of submitting it.[162] Among other revisions, the 2019 HABHCRA amendments added national program responsibilities, including: duties for NOAA to implement grant funding to "accelerate the utilization of effective methods of intervention and mitigation to reduce the frequency, severity, and impacts of harmful algal bloom and hypoxia events"; "use cost effective methods" in implementing the program; and "develop contingency plans for the long-term monitoring of hypoxia."[163]

In 2014, Congress also directed the Task Force to "maintain and enhance a national harmful algal bloom and hypoxia program" for marine and freshwater bodies, including: program objectives, a comprehensive research plan, and an action strategy.[164] Program objectives include "detecting, predicting, controlling, mitigating, and responding" to bloom and hypoxia events and implementing the research and action strategy established in the

158. Harmful Algal Bloom and Hypoxia Amendments of 2004, § 102, 118 Stat. at 3630.

159. Harmful Algal Bloom and Hypoxia Research and Control Act of 2014, Pub. L. 113-124 § 603B, § 5, 128 Stat. 1379, 1382 (2014). The deadline for submission of the Action Strategy was June 30, 2014. 33 U.S.C. § 4003(a).

160. Harmful Algal Bloom and Hypoxia Research and Control Act of 2014, Pub. L. No. 113-124. § 603B(b), § 5 (2014); 33 U.S.C § 4003(b).

161. Harmful Algal Bloom and Hypoxia Research and Control Act of 2014, Pub. L. No. 113-124. § 603B(b), § 5 (2014); 33 U.S.C § 4003(b).

162. Harmful Algal Bloom and Hypoxia Research and Control Act of 2014, Pub. L. No. 113-124. § 603B(b), § 5 (2014); 33 U.S.C § 4003(b).

163. Pub. L. 115-423 § 9(e)(1)(D), (2)(7)–(8); 33 U.S.C. § 4002(e)(3)(D), (2)(7)–(8).

164. Harmful Algal Bloom and Hypoxia Research and Control Act of 2014, § 603A, § 3; 33 U.S.C.A. § 4002.

2014 amendments.[165] Task Force responsibilities include: establishing interagency working groups; coordinating interagency review of program objectives; and support for the action strategy's implementation, new technology development, and program funding distribution.[166]

NOAA was designated as the lead agency for program implementation; EPA was delegated authority for the freshwater aspects of the program.[167] As with previous HABHCRA legislation, the 2014 amendments provided for coordination within federal agencies and with governmental and other stakeholders and for avoiding duplication of effort concerning research and development programs.[168]

Finally, in the 2019 amendments, Congress established authority to designate a marine, coastal, or freshwater hypoxia or HAB an "event of national significance."[169] For purposes of the designation, a "hypoxia or harmful algal bloom event" is defined as "the occurrence of hypoxia or a harmful algal bloom as a result of a natural, anthropogenic, or underdetermined cause."[170] The statute defines "event of national significance" as "a hypoxia or harmful algal bloom event that has had or will likely have a significant detrimental environmental, economic, subsistence use, or public health impact on an affected State."[171] Considerations for designating an event of national significance include:

> the toxicity of the harmful algal bloom, the severity of the hypoxia, its potential to spread, the economic impact, the relative size in relation to the past 5 occurrences of HABs or hypoxia events that occur on a recurrent or annual basis, and the geographic scope, including the potential to affect several municipalities, to affect more than 1 State, or to cross an international boundary.[172]

After NOAA (marine or coastal) or the EPA (freshwater) designates an event of national significance, the agency can "ma[k]e available to the affected State or local government" funding up to 50% of the cost of authorized activities.[173] Activities that may be funded include "assessing and mitigating the detrimental, environmental, economic, subsistence use, and public health effects of the event of national significance."[174]

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165. *Id*. §§ 603A(a), 4; 33 U.S.C. § 4002(a).
166. *Id*. § 4002(c).
167. *Id*. § 4002(d), (h).
168. *Id*. § 4002(f)–(h).
169. *Id*. § 4010(2)(A).
170. *Id*. § 4010(3)(C).
171. *Id*. § 4010(3)(B).
172. *Id*. § 4010(2)(B).
173. *Id*. § 4010(1)(A), (2)(B).
174. *Id*. § 4010(1)(A).

HABHCRA created specific provisions for scientific assessments concerning HABs and hypoxia. In 2004, Congress required the Task Force to "provide for local and regional scientific assessments of hypoxia and [HABs], as requested by States, Indian tribes, and local governments," or identified "affected areas."[175] Subsequent HABHCRA amendments also required an initial and periodic five-year scientific assessments of marine and freshwater HABs and hypoxia.[176] The purpose and reporting requirements for the scientific assessments reflect those of other HABHCRA-required assessments, including: identifying progress made on "causes, characteristics, and impacts" of HABs and hypoxia; assessing their causes, ecological and economic consequences and costs; options for "preventing, controlling, and mitigating" blooms and hypoxia; and "ways to improve coordination and to prevent unnecessary duplication of effort" regarding agency research efforts.[177] Finally, the 2004 amendments required the Task Force to submit a "comprehensive and coordinated national research program" focusing on "prevention, control, and mitigation methods to reduce impacts . . . on coastal ecosystems (including the Great Lakes), public health, and the economy."[178]

In addition to the comprehensive HAB and hypoxia assessments, HABHCRA requires assessments to address specific water body concerns. The 1998 enacting legislation created the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force and required the Nutrient Task Force to complete "an integrated assessment of hypoxia in the northern Gulf of Mexico."[179] The legislation specified that this assessment must examine hypoxia "distribution, dynamics, and causes" and "ecological and economic consequences."[180] Notably, Congress expressly directed the Task Force to consider nutrient pollution in the Gulf of Mexico, specifying the assessment would include: "sources and loads of nutrients transported by the Mississippi River to the Gulf of Mexico; effects of reducing nutrient loads; methods for reducing nutrient loads; and the social and economic costs and benefits of such methods."[181] Congress directed the Nutrient Task Force to submit a plan based on this assessment "for reducing, mitigating, and controlling hypoxia

175. *Id*. § 4001(e)(1).

176. *Id*. § 4001(f)–(h) (requiring the initial assessment to be submitted within twenty-four months of enactment of the 2004 amendments).

177. *Id*.

178. *Id*. § 4001(h)(1), (h)(2) (requiring priorities and guidelines "for a competitive, peer-reviewed, merit based interagency research, development, demonstration, and technology transfer program" incorporating agency coordination, "prevent[ing] unnecessary duplication" and including "diverse institutions").

179. Coast Guard Authorization Act of 1998, Pub. L. 105-383, § 604(a), 112 Stat. 3412, 3449.

180. *Id*. (requiring the Task Force to complete the assessment by May 30, 1999).

181. *Id.*

in the northern Gulf of Mexico."[182] The 2014 HABHCRA amendments required biennial progress reports on goals established in the Gulf Hypoxia Action Plan 2008.[183] This requirement includes evaluation of "progress made toward nutrient load reductions" as well as hypoxic zone response, water quality, and "economic and social effects." Congress later created specific provisions to assess hypoxia and HAB events for the Great Lakes region and for south Florida.[184]

Plans and Programs: HABHCRA includes requirements for developing a strategy to address HABs. The statute requires the Task Force to submit to Congress by the end of 2005 "a plan providing for a comprehensive and coordinated national research program to develop and demonstrate prevention, control, and mitigation methods to reduce the impacts of HABs on coastal ecosystems (including the Great Lakes), public health, and the economy."[185] The statute requires the Task Force, when "developing the [required] assessments, reports, and plans," to consult with various governmental, academic, and commercial stakeholders, including notably agriculture and fertilizer.[186]

Amendments to HABHCRA required the Task Force to: create a "national harmful algal bloom and hypoxia program"; include "a statement of objectives, including understanding, detecting, predicting, controlling, mitigating, and responding to marine and freshwater harmful algal bloom and hypoxia events"; and develop a "comprehensive research plan and action strategy." [187] Among other requirements, the developed strategy must include: a regional focus on HABs and hypoxia; research; and actions "needed to develop and advance technologies and techniques for minimizing the occurrence of [HABs] and hypoxia[;] and improving capabilities to detect, predict, monitor, control, mitigate, respond to, and remediate [HABs] and hypoxia."[188]

Leadership: NOAA and the EPA share leadership responsibility for implementing HABHCRA. The 1998 legislation directed the Department of Commerce, which includes NOAA, to chair the Task Force. [189] The congressional findings in that legislation specifically recognized NOAA's expertise, stating the agency "possesses a full range of capabilities necessary

182. *Id.* § 604(b) (requiring the Task Force to submit the plan by March 30, 2000).

183. Harmful Algal Bloom and Hypoxia Research and Control Act of 1998, 2014 Amendments, Pub. L. No. 113-124, § 604(a), 128 Stat. 1379, 1384 (amended 2014). *See also* Harmful Algal Bloom and Hypoxia Research and Control Act of 2014, 33 U.S.C. § 4004 (requiring submission of the first progress report by June 30, 2014, and biennial reports after the initial report).

184. *Id*. § 4004(a)–(4005).

185. *Id.* § 4001(h)(1).

186. *Id.* § 4001(a).

187. *Id.* §§ 4002(a), 4003(a).

188. *Id.* § 4003(b)(1)–(2).

189. Coast Guard Authorization Act of 1998, Pub. L. 105-383, § 603(a)(1), 112 Stat. 3412, 3449.

to support a near and long-term comprehensive effort to prevent, reduce, and control HABs and hypoxia."[190] The 2014 HABHCRA amendments identified a shared responsibility between NOAA and the EPA for administering the National Harmful Algal Bloom and Hypoxia Program established in that legislation.[191] NOAA is identified as the lead federal agency and has the primary responsibility for program administration.[192] Specific duties assigned to NOAA include: responding to "marine and Great Lakes harmful algal bloom and hypoxia events"; creating and improving "critical observations, monitoring, modeling, data management, information, and operational forecasts" concerning these events; and "enhanc[ing] communication and coordination among Federal agencies carrying out marine and freshwater harmful algal bloom and hypoxia activities and research."[193]

The amendments also charge NOAA with "work[ing] cooperatively and avoid[ing] duplication of effort" with other Task Force agencies and with "States, tribes, and nongovernmental organizations concerned with marine and freshwater issues" related to HAB and hypoxia "activities and research."[194] While significant responsibility for HABHCRA administration is delegated to NOAA, the amendments delegate EPA the authority for "the freshwater aspects of the [National Harmful Algal Bloom and Hypoxia] Program" not specifically delegated to NOAA.[195] EPA responsibilities for freshwater HABs include "research on the[ir] ecology and impacts" and "forecasting and monitoring of and event response to freshwater [HABs] in lakes, rivers, estuaries (including their tributaries), and reservoirs."[196] The amendments specifically direct the EPA to "focus on new approaches to addressing freshwater [HABs]" and to avoid duplication "of existing research and development programs."[197]

Limitation on Authority: HABHCRA does not create or expand federal regulatory authority, and the Act also precludes limitation of state regulatory authority granted or delegated to states through federal water quality law.[198] The enacting legislation specified that "[n]othing in this title shall be interpreted to adversely affect existing State regulatory or enforcement power which has been granted to any State through the Clean Water Act or Coastal Zone Management Act of 1972."[199] This legislation also prohibited

190. *Id.* § 602(10).
191. *Id.* § 4, 128 Stat. at 1379–82.
192. *Id.* § 4(d), at 1380.
193. *Id.* § 4(f), at 1381.
194. *Id.* § 4(g), at 1381.
195. *Id.* § 4(h), at 1381–82.
196. *Id.* § 4(h)(1), at 1382.
197. *Id.* § 4(h)(2), at 1382.
198. Coast Guard Authorization Act of 1998, Pub. L. 105-383, § 606, 112 Stat. 3412, 3450.
199. *Id.* § 606(a).

interpreting HABHCRA "to expand the regulatory or enforcement power of the Federal government which has been delegated to any State through" those statutes.[200] In 2014, Congress amended HABHCRA to specify that the statute may not "be construed as establishing new regulatory authority for any agency" and does not "supersede[] or limit[] the authority of any agency or carry out its responsibilities and missions under other laws."[201]

Funding Provisions: As initially enacted and through subsequent amendments, HABHCRA has provided significant funding for implementing its provisions. The 1998 enacting legislation appropriated more than $35 million for research, education, and monitoring during fiscal years 1999–2001.[202] In 2004, Congress appropriated $74 million for fiscal years 2005–2008 and approximately $102.5 million for fiscal years 2014–2018, in HABHCRA amendments enacted in 2014.[203] In the most recent amendments, Congress authorized annual appropriations of $20.5 million for the period 2019–2023.[204] In this appropriation, Congress included funding for up to half of the costs to respond to hypoxia or HAB events of national significance.[205]

B. The Clean Water Act

Goals: The federal Clean Water Act provides the foundational legal framework for water quality protection in the United States. The Clean Water Act was enacted in 1972 as amendments to the Federal Water Pollution Control Act.[206] Through this statutory amendment, Congress declared its overall goal "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[207] One "national goal" Congress identified in the Clean Water Act was to eliminate "the discharge of pollutants into the navigable waters . . . by 1985."[208] The "navigable waters" within the jurisdiction of the Clean Water Act are defined as "the waters of the United States, including the territorial seas."[209]

Pollution: For purposes of the Clean Water Act, "[t]he term 'pollution' means the man-made or man-induced alteration of the chemical, physical,

200. *Id.* § 606(b).
201. *Id.* § 9, 128 Stat. at 1385.
202. Coast Guard Authorization Act of 1998 § 605.
203. Harmful Algal Bloom and Hypoxia Amendments of 2004, Pub. L. 108-456, § 105, 118 Stat. 3630, 3633–34; § 609, 128 Stat. 1386–87; Janasie, *supra* note 28.
204. National Integrated Drought Information System Reauthorization Act of 2018, Pub. Law 115-423, § 9(h), 132 Stat. 5454, 5464 (2019); Janasie, *supra* note 28.
205. National Integrated Drought Information System Reauthorization Act of 2018, § 9(h); Janasie, *supra* note 28.
206. Federal Water Pollution Control Act Amendment, P.L. 92-500, 86 Stat. 816 (1972); 33 U.S.C. § 1251 et seq.
207. *Id.* § 1251(a).
208. *Id.* § 1251(a)(1).
209. *Id.* § 1362(7).

biological, and radiological integrity of water."[210] A "pollutant" includes various substances and materials that may be discharged into water through construction, industrial processes, commercial and human activities, and other methods.[211] Specifically, the term "means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water." [212] A "toxic pollutant" is a pollutant—alone or in combination with other pollutants—that "after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly . . . or indirectly, will . . . cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations in . . . organisms or their offspring."[213]

Pollutant Discharges: The Clean Water Act specifies the types of pollutant discharges that are within its scope. A "discharge of a pollutant" is defined as "any addition of any pollutant to navigable waters from any point source" or to "waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft."[214] A "point source" is "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged."[215] This statutory point source definition expressly excludes "agricultural stormwater discharges and return flows from irrigated agriculture." [216] The term "nonpoint source" is not specifically defined in the Clean Water Act; however, the EPA describes a nonpoint source as "any source of water pollution that does not meet the legal definition of 'point source' in the statute."[217]

Research and Technology: In addition to establishing the national goal of eliminating pollutant discharges within 13 years of enactment, the Clean Water Act specifies national goals concerning research, technology, and

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210. *Id.* § 1362(19).

211. *Id.* § 1362(6).

212. *Id.* § 1362(6) (clarifying that the statutory "pollutant" definition includes some exceptions, including certain discharges from vessels, military operations, and oil and gas production.).

213. *Id.* § 1362(13).

214. *Id.* § 1362(12)(A)–(B) (italics added).

215. *Id.* § 1362(14).

216. *Id.* (return flows result from runoff occurring on agricultural lands irrigated through natural precipitation or irrigation systems).

217. *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 accessed Feb. 9, 2023).

funding to achieve the statutory goal of restoring and maintaining water quality.[218] Congress specified policies to control pollutant discharges through prohibition of "discharge of toxic pollutants in toxic amounts" and initiation of a "major research and demonstration effort . . . to develop technology necessary to eliminate the discharge of pollutants into the navigable waters, waters of the contiguous zone, and the oceans."[219] Further, the Clean Water Act's national policies provide for federal construction funding for "publicly owned waste treatment works" and "development and implementation" of "areawide waste treatment management planning processes . . . to assure adequate control of sources of pollutants."[220] Importantly, Congress also included a national policy for development and implementation of "programs for the control of nonpoint sources . . . in an expeditious manner so as to enable the goals of this chapter to be met through the control of both point and nonpoint sources of pollution."[221]

Effluent Limitations: The Clean Water Act directs the EPA to develop and periodically revise "regulations, providing guidelines for effluent limitations" for point sources of pollution.[222] The regulations must specify "the degree of effluent reduction attainable through the application of the best practicable control technology currently available for [point source] classes and categories" and the relevant factors for "determining the control measures and practices" to apply to point sources of pollution.[223] For assessing the factors related to "best practicable control technology," the EPA must compare the: technology application cost to the resulting "effluent reduction benefits"; "age of equipment and facilities"; process technology's engineering aspects; process as a whole; and "non-water quality environmental impact."[224] The Agency must address similar considerations for assessment of best available control measures, "including treatment techniques, process and procedure innovations, operating methods, and other alternatives" for point sources.[225] In addition, the Agency must, with consideration of costs, "identify control measures and practices available to eliminate the discharge of [categories and classes of] pollutants."[226] Under the Clean Water Act, pollutant discharges must comply with these adopted effluent limits.[227]

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218. *Id.* § 1251.
219. *Id.* § 1251(a)(3), (6).
220. *Id.* § 1251(a)(4)–(5).
221. *Id.* § 1251(a)(7) (italics added).
222. *Id.* § 1314(b).
223. *Id.* § 1314(b)(1)(A).
224. *Id.* § 1314(b)(B).
225. *Id.* § 1314(b)(2)(A).
226. *Id.* § 1314(b)(3).
227. *Id.* § 1311(a).

Further, the EPA must determine "the degree of effluent reduction attainable through the application of the best conventional pollutant control technology.[228] Factors the agency must consider in evaluating the best conventional pollutant control technology include a cost-benefit analysis of achieving effluent reduction, relationship between cost and benefit level, facility and equipment age, process, engineering aspects of control techniques, and non-water quality environmental impact.[229] The statute also requires the agency to provide information and technical assistance to states regarding "the processes, procedures, or operating methods" that eliminate or reduce pollutant discharge.[230] The EPA is also authorized to promulgate supplemental effluent limitation regulations for toxic or hazardous pollutants to address industrial best management practices that would be incorporated into a point source permit.[231]

Point Source Permitting: The Clean Water Act's regulatory provisions include limitation and permitting of pollutant discharges. The "discharge of any pollutant by any person" is prohibited, except as authorized by, and when in compliance with, specified Clean Water Act provisions.[232] When enacted, the Clean Water Act imposed a five-year deadline for industries to incorporate best practical control technology and publicly owned treatment plants to provide for secondary treatment. The Clean Water Act also required the use of "best available technology" for point source discharges.[233] The statute requires establishment of effluent limitations, which are defined as "any restriction[s] . . . on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources."[234] Effluent limitations for point sources include compliance schedules and are based on "the application of the best practicable control technology" and established according to the need "to meet water quality standards, treatment standards, or schedules of compliance, . . . or any other Federal law or regulation."[235]

The Clean Water Act also establishes a permitting program, the National Pollutant Discharge Elimination System (NPDES), for wastewater

228. *Id.* § 1314(b)(4)(A).

229. *Id.* § 1314(b).

230. *Id.* § 1314(c).

231. *Id.* § 1314(e).

232. *Id.* § 1331(a) (listing the authorization and compliance exceptions include: the effluent limitation provisions in § 1331(a); and the water quality-based limits in § 1312; the national standards of performance in § 1316; toxic and pretreatment effluent standards in § 1317; aquaculture permitting in § 1328; and pollutant and dredge and fill discharge permitting provisions in §§ 1342 and 1344); *see generally id.* §§ 1342, 1344 (outlining respective permitting statutory provisions).

233. *Id.* § 1331(b)(2)(A).

234. *Id.* § 1362(11).

235. *Id.* §§ 1311(b)(1)(A)–(C), 1317 (explaining that for publicly owned treatment plants existing on July 1, 1977, the Clean Water Act specified effluent limitations based on secondary treatment and compliance with the toxic and pretreatment effluent standards).

discharges to surface waters and for discharges that have a "significant potential to impact surface waters."[236] In 1987, the Clean Water Act was amended to include certain municipal, industrial, and construction stormwater discharges.[237] Concentrated animal feeding operations also are subject to NPDES permitting.[238]

NPDES permits are issued as individual permits for site-specific facilities and activities (such as commercial or industrial operations) that result in point source pollutant discharges. Individual NPDES permit conditions consider the best available technology for effluent treatment and water-quality-based limits based on the receiving water body's designated uses.[239] Under the Clean Water Act, general NPDES permits also are issued; these permits prescribe conditions to cover a category of similar discharges from activities such as construction and industrial operations. Rather than specific, technology-based conditions, general NPDES permit conditions are based on best management practices.[240]

The foundation of the Clean Water Act's regulatory framework is a cooperative federal-state relationship. The Clean Water Act specifies a congressional policy "to recognize, preserve, and protect the primary responsibilities and rights of States to prevent, reduce, and eliminate pollution." [241] Congress delegated authority for Clean Water Act administration, permitting, and enforcement to the EPA. [242] However, Congress also provided for the EPA to delegate authority to states to implement the Clean Water Act's NPDES and dredge and fill permit programs in their jurisdictions. [243] As of 2016, "more than 65,000 conventional industrial and municipal dischargers" and "more than 150,000 industrial and municipal sources of stormwater dischargers" were required to obtain NPDES permits from either the EPA or states with federally delegated permit authority.[244]

Water Quality Standards: The Clean Water Act provides for adoption of state water quality standards as a means to assess and regulate water

236. *Id.* § 1362(a).

237. *See generally id.* § 1342 (outlining municipal, industrial, and construction stormwater discharges); *and* 40 CFR § 122 (2013) (discussing the purpose of the NPDES system).

238. 33 U.S.C. § 1362(14).

239. *Id*. § 1342(s)(5)(A).

240. *Id*. § 1342(p)(3)(B)(iii).

241. *Id.* § 1251(b).

242. *Id*. §§ 1251(d), 1361 (outlining EPA's authority under the Clean Water Act).

243. *Id.* § 1251(b) (stating the United States Army Corps of Engineers administers the dredge and fill permits authorized under the Clean Water Act).

244. Claudia Copeland, Congressional Research Service, CRS Report RL 30030, *Clean Water Act: A Summary of the Law* (October 18, 2016), https://crsreports.congress.gov/product/pdf/RL/RL30030.

bodies.[245] Designed to protect both public health and water quality, these standards "serve the dual purposes of establishing the water quality goals for [all or part of] a specific water body and serve as the regulatory basis for the establishment of water-quality-based treatment controls and strategies . . . ."[246] The standards define these goals "by designating the use or uses to be made of the water and by setting criteria that protect the designated uses."[247] Under the Clean Water Act, water quality standards should address water quality considerations by: "wherever attainable, provid[ing] water quality for the protection and propagation of fish, shellfish and wildlife and for recreation in and on the water."[248] The standards should also consider "agricultural, industrial, and other purposes including navigation."[249]

State water quality standards identify desired conditions or protection for water bodies within the respective state jurisdictions and for the basis of public health advisories or notifications concerning water quality issues for recreational waters.[250] Once adopted, the state water quality standards "serve as the regulatory basis for the establishment of water-quality-based treatment controls and strategies beyond the technology-based levels of treatment required" under the Clean Water Act.[251] The water quality criteria in the standards includes both narrative and numeric criteria.

The Clean Water Act directs the EPA to develop its recommended water quality criteria.[252] The agency's criteria must "[reflect] the latest scientific knowledge" for state and tribal governments to adopt or use as guidance when "determining when water has become unsafe for people and wildlife."[253] The statute specifies that the criteria must address: the "kind and extent of all identifiable effects on health and welfare . . . which may be expected from the presence of pollutants in any body of water"; the "concentration and dispersal of pollutants, or their byproducts, through biological, physical, and chemical processes"; and the "effects of pollutants on biological community diversity, productivity, and stability, including

245. *See* 40 C.F.R. § 131.3(j) (2021) (defining "State" to mean "[t]he 50 States, the District of Columbia, Guam, the Commonwealth of Puerto Rico, Virgin Islands, American Samoa, the Commonwealth of the Northern Mariana Islands, and Indian Tribes that EPA determines to be eligible for purposes of the water quality standards program.").

246. *Id.* § 131.2.

247. 40 C.F.R. § 131.2.

248. *Id*.; 33 U.S.C. §§ 1251(a)(2), 1313(c).

249. *Id.*

250. Laura Gatz, Cong. Rsch. Serv., R44871, Freshwater Harmful Algal Blooms: Causes, Challenges, & Pol'y Considerations (2020).

251. 40 C.F.R. § 131.3(b); 33 U.S.C. § 1311(b), § 1316.

252. 33 U.S.C. § 1314(a)(1)–(3) (the recommended criteria must be published, "issued to [s]tates," and "otherwise made available to the public").

253. *Basic Information on Water Quality Criteria*, ENV'T PROT. AGENCY, https://www.epa.gov/wqc/basic-information-water-quality-criteria (last visited Feb. 8, 2023).

information on the factors affecting rates of eutrophication and rates of organic and inorganic sedimentation for varying types of receiving waters."[254] The agency is also required to develop and publish information identifying the factors needed to: "restore and maintain the chemical, physical, and biological integrity" of covered waters; protect aquatic life, wildlife, and recreational uses; measure and classify water quality; and identify "pollutants suitable for [total] maximum daily load measurement."[255] States may consider water quality criteria when developing their water quality standards, which describe the desired condition or level of protection of a water body and what is needed for protection. States may also use these values as the basis of swimming advisories for public notification purposes at recreational waters.[256]

States are also required by the Clean Water Act to develop a list of impaired waters, identified as waters that do not meet the state's adopted water quality standards.[257] States must create a priority list of the impaired waters and adopt a total maximum daily load (TMDL) (i.e., a pollution "budget") for each pollutant of concern. The TMDL must address "the maximum amount of a particular pollutant that the listed waterbody can receive while meeting water quality standards."[258]

The EPA published final water quality criteria in 2019 for two algal toxins in waters used for recreational purposes.[259] Most states have identified nutrient pollution as a water quality priority in some way. Some states have developed algal toxin guidelines for public health advisories, while others have listed waters as impaired (i.e., not meeting water quality standards) or developed TMDLs based on either algal blooms or toxins. States have also used federal funding for nonpoint source pollution programs.[260]

Nonpoint source pollution: Water quality issues associated with nonpoint source pollution are addressed by the Clean Water Act through a separate process. The Clean Water Act requires the EPA to issue and update information including: "(1) guidelines for identifying and evaluating the nature and extent of nonpoint sources of pollutants, and (2) processes, procedures, and methods to control pollution."[261] Among other nonpoint

254. 33 U.S.C. §1314(a)(1).

255. *Id.* § 1314(a)(2).

256. Laura Gatz, Cong. Rsch. Serv., R44871, Freshwater Harmful Algal Blooms: Causes, Challenges, & Pol'y Considerations (2020).

257. 33 U.S.C. § 1313(d).

258. *Id.*

259. U.S. Env't Prot. Agency, *Implementing the 2019 National Clean Water Act Section 304(a) Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin* 1 (July 2022), https://www.epa.gov/system/files/documents/2021-08/final-tsd-implement-2019-rwqc.pdf.pdf.

260. *Id.* at 14.

261. 33 U.S.C. § 1314(f).

pollution sources, "pollution resulting from . . . agricultural and silvicultural activities, including runoff from fields and crop and forest lands" are identified for purposes of this statutory requirement.[262] The Clean Water Act also directs the EPA to enter into an agreement with the Department of Agriculture "to provide for the maximum utilization of other Federal laws and programs for the purpose of achieving and maintaining water quality" concerning "nonpoint pollution management programs" related to agricultural operations.[263]

In addition to permitting, states have a role in establishing water quality standards and in certifying whether projects comply with those standards. The Clean Water Act provides for states to adopt water quality standards to specify the standards that will apply in their jurisdictions.[264] Water quality standards include criteria for total nitrogen and total phosphorus in three water-types: lakes/reservoirs, rivers/streams, and estuaries. According to the EPA, more than half of the states currently have no approved total nitrogen and/or total phosphorus criteria.[265] The EPA has categorized state progress according to five different compliance levels:

- Level 5: "Complete set of" nitrogen and/or phosphorus criteria for all watertypes" (no states at this level, but there is compliance by American Samoa, Commonwealth of Northern Marianas, Guam, and the United States Virgin Islands);[266]
- Level 4: "[Two] or more watertypes with" nitrogen and/or phosphorus criteria (five states and Puerto Rico);[267]
- Level 3: "[One] watertype with" nitrogen and/or phosphorus criteria (three states);[268]
- Level 2: "Some waters with" nitrogen and/or phosphorus criteria (sixteen states);[269] and
- Level 1: No nitrogen and/or phosphorus criteria (26 states and the District of Columbia).[270]

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262. *Id.* § 1314(f)(1)(A).
263. *Id.* § 1314(k)(1).
264. *Id.* § 1313.
265. *State Progress Toward Adopting Numeric Nutrient Water Quality Criteria for Nitrogen and Phosphorus,* Env't Prot. Agency, https://www.epa.gov/nutrient-policy-data/state-progress-toward-developing-numeric-nutrient-water-quality-criteria#tb1 (last accessed Feb. 11, 2023).
266. *Id*.
267. *Id*.
268. *Id*.
269. *Id*.
270. *Id*..

The EPA also tracks adoption of water quality criteria for chlorophyll-a, an important indicator for whether waters are impaired due to nitrogen and phosphorus pollution. Progress in adoption of criteria for chlorophyll-a is worse than for state's efforts to adopt nutrient and phosphorus criteria. Current data indicates that 26 states have no criteria, and 19 states have some waters with criteria. Only the District of Columbia and American Samoa have adopted criteria for one water type, and only three states have adopted either criteria for at least two water types.[271]

As explained above, the scope of EPA's ability to regulate agriculture's contribution to nutrient pollution under the Clean Water Act is limited by statute. Congress, however, authorized EPA to issue permits for concentrated animal feeding operations under the Clean Water Act. Animal feeding operations are non-aquatic facilities or lots dedicated to livestock production where "[a]nimals . . . are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period."[272] Animal feeding operations meeting the EPA's concentrated animal feeding operation definition are regulated as point sources under the Clean Water Act's NPDES permitting program. [273] The concentrated animal feeding operations permitting program is based on development of nutrient management plans which, among other provisions, include best management practices to address discharges of manure, wastewater, and stormwater runoff from these operations.[274]

The Clean Water Act authorizes the EPA to delegate authority to states and territories to administer and enforce the statute's NPDES permitting programs. Most states are fully authorized to administer the program. Further, all but a few states have at least partial delegated authority for permitting. [275] Therefore, much of the administration of this important permitting program is conducted by state governments rather than federal authorities.

Nonpoint source regulation: Other than provisions for water quality standards and concentrated animal feeding operations permitting, the Clean Water Act largely relies on nonpoint source programs to address agricultural nutrient pollution's water quality impacts. Although agriculture lands constitute nearly half of the nation's land base, the actions taken to reduce and mitigate the water quality impacts of agricultural operations are based in

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271. *Id*.

272. 40 C.F.R. § 122.23(b)(1)(i).

273. ENVIRONMENTAL PROTECTION AGENCY, *Animal Feeding Operations (AFOs)*, https://www.epa.gov/npdes/animal-feeding-operations-afos (accessed August 30, 2022).

274. 40 C.F.R. § 122.23.

275. ENVIRONMENTAL PROTECTION AGENCY, *NPDES Authorized States, 2021*, https://www.epa.gov/sites/default/files/2021-02/documents/authorized_states_2021.pdf (accessed February 21, 2023).

large part on voluntary and incentive-based efforts.[276] Significant aspects of nonpoint source pollution are exempt from both NPDES permitting and from dredge and fill permitting under § 404 of the Clean Water Act. Activities exempted for the latter permits include: "[e]stablished (ongoing) farming, ranching, and silviculture activities"; drainage ditch maintenance; irrigation ditch and farm or stock pond construction and maintenance; farm and forest road construction and maintenance when conducted according to "best management practices"; and dam, dike, and levee maintenance.[277]

The Clean Water Act includes provisions for states to adopt nonpoint source management programs.[278] States are directed to identify waters requiring control of nonpoint pollution sources to achieve established water quality standards or water quality goals. States must also identify the nonpoint sources adding "significant pollution" and the amounts of contributions affecting water quality standards.[279] Further, states must develop processes and programs for implementation of "best management practices and measures to control" nonpoint sources and "reduce, to the maximum extent practicable, the level of pollution resulting from" these sources.[280] The Clean Water Act identifies required components for state management programs, including: best management practices to reduce pollutant loads; "nonregulatory or regulatory" programs to provide assistance, education, training, and enforcement of the best management practices; and a schedule for completion of program implementation and milestones for achieving the program's objectives. Further, the state must certify either that state laws provide "adequate authority" for management plan implementation or, if not, identify needed state authority to make that certification.[281]

C. Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) is a federal management framework for the nation's coastal areas.[282] Originally enacted in 1972, the CZMA recognizes that "present state and local institutional arrangements for planning and regulating land and water uses in such areas are inadequate" and the "competing demands and the urgent need to protect and to give high

276. ENVIRONMENTAL PROTECTION AGENCY, *Nonpoint Source: Agriculture*, https://www.epa.gov/nps/nonpoint-source-agriculture (accessed September 1, 2022).

277. 33 U.S.C. § 1344(f)(1)(E).

278. *Id.* § 1329.

279. *Id.*

280. *Id.*

281. *Id.*

282. Coastal Zone Management Act, 16 U.S.C. § 1451 (1972); NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, COASTAL ZONE MANAGEMENT ACT (last accessed Aug. 21, 2022). https://coast.noaa.gov/czm/act/ (last accessed Aug. 21, 2022).

priority to natural systems in the coastal zone."[283] In addition, the statute notes the impacts coastal zone land uses have on water quality and finds that "efforts to control coastal water pollution from land use activities must be improved."[284] The statute also identifies as the "key" to a more effective program for coastal use and protection "is to encourage the states to exercise their full authority over" coastal areas, with federal and local cooperation and assistance, and to have states "develop[] land and water use programs for the coastal zone, including unified policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance."[285]

The CZMA defines coastal zone as: coastal waters, lands, and the adjacent shorelands "strongly influenced by each other and in proximity to the shorelines of the several coastal states," including the Great Lakes coastal areas. [286] The statute authorizes federal grants for state coastal zone management plan development, implementation, and enhancement activities, and it prescribes some requirements for states concerning plan development.[287]

Like CZMA's other provisions, the approach to addressing nonpoint pollution is through the cooperative federal-state framework. When HABHCRA was initially enacted in 1998, and until the 2014 statutory amendments, HABHCRA was enacted as notes to CZMA's statutory sections.[288] The CZMA's nonpoint pollution provisions, enacted in 1990, required NOAA and EPA to publish guidance to coastal zone states concerning management methods, measures, or practices to control nonpoint pollution.[289] The conference committee report concerning these amendments indicates Congress's expectation that the guidance would "concentrate on the large nonpoint sources that are widely recognized as major contributors of water pollution and on which there is broad consensus on the appropriate management measures that must be developed and implemented." [290] Examples in this report included "use of buffer strips, setbacks, techniques

283. 16 U.S.C. § 1451(h).

284. *Id.* § 1451(k).

285. *Id*. § 1451(i).

286. *Id.* § 1453(1) (the statute defines "coastal state" as a state "in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes. 16 U.S.C. § 1453(4). This definition "also includes Puerto Rico, the Virgin Islands, Guam, the Commonwealth of the Northern Mariana Islands, and the Trust Territories of the Pacific Islands, and American Samoa.").

287. *Id.* §§ 1454, 1455(a)–(b).

288. Harmful Algal Bloom and Hypoxia Research and Control Act of 1998, Pub. L. No. 105-383, 112 Stat. 3447 (1998); Harmful Algal Bloom and Hypoxia Research and Control Act of 2014, Pub. L. No. 113-124, 128 Stat. 1379 (2014).

289. 16 U.S.C. §§ 1455b(g)(1), 1455b(g)(2)(A).

290. U.S. GOV'T ACCOUNTABILITY OFF., CONGRESSIONAL RECORD, 101ST CONGRESS, EXTENSION OF REMARKS, H.R. 5835, at E3725 (1990).

for identifying and protecting critical coastal areas and habitats, soil erosion and sedimentation controls, and siting and design criteria for water-related uses such as marinas."[291] As enacted, the statutory amendments specified that the guidance must include:

> (C) an identification of the individual pollutants or categories or classes of pollutants that may be controlled by the measures and the water quality effects of the measures; (D) quantitative estimates of the pollution reduction effects and costs of the measures; (E) a description of the factors which should be taken into account in adapting the measures to specific sites or locations; and (F) any necessary monitoring techniques to accompany the measures to assess over time the success of the measures in reducing pollution loads and improving water quality.[292]

For purposes of the nonpoint pollution guidance, "management measures" is defined as "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution."[293] The statutory definition specifies these measures must "reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives."[294]

The CZMA amendments required states with federally-approved management plans to adopt a nonpoint pollution control plan.[295] These state plans were to be submitted to NOAA for approval after the publication of the federal guidance.[296] The CZMA authorizes NOAA to withhold grant funds from states that fail to submit or implement the nonpoint pollution control plan.[297]

Rather than being a separate regulatory framework for coastal protection and management, the CZMA structure is based on federal assistance and cooperation for state and local action. The CZMA provides for NOAA approval of the management plans that are developed by the coastal states and territories.[298] NOAA is directed to cooperate with other federal agencies concerning coastal zone management activities and to ensure consistency

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291. *Id.*
292. 16 U.S.C. § 1455b(g)(2)(C)–(F).
293. *Id.* § 1455b(g)(5).
294. *Id.*
295. *Id.* § 1455b(a)(1).
296. *Id.*
297. *Id.* § 1455b(c)(3).
298. *Id.* § 1455b(c)(1).

with these state management plans.[299] The CZMA specifies that this statute does not "diminish either Federal or state jurisdiction, responsibility, or rights in the field of planning, development, or control of water resources" or "affect any requirement (1) established by the [Clean Water Act] . . . or (2) established by the Federal Government or by any state or local government pursuant to" the Clean Water Act.[300] The statute also specifies these requirements will be incorporated as requirements into any CZMA program.[301]

D. Safe Drinking Water Act

The impact of HABs on the delivery and safety of public water supplies has been the subject of attention and concern for a long time. The long saga of HAB events in Lake Erie—where cyanobacteria HABs have occurred since the 1990s—demonstrates the magnitude of disruption that can occur from a HAB event.[302] For example, public water supply impacts from the 2014 Lake Erie HAB included illness for 100 people, a loss of water supply for 500,000 people for several days, and $65 million in lost benefits.[303] In recent years, Lake Erie HABs have become an annual occurrence.[304] Water supply systems in Oregon have also experienced HABs caused by cyanotoxins that required the utilities to issue health advisories and water restrictions.[305]

The federal Safe Drinking Water Act (SDWA) protects drinking water quality for groundwater and surface water sources that are or may be used for public drinking water supply.[306] With certain statutory exceptions, the SDWA's "national primary drinking water regulations . . . apply to each public water system in each State."[307] The definition of primary drinking

299. *Id.* § 1456.
300. *Id.* § 1456(e)–(f).
301. *Id.* § 1456(f).
302. LARA GATZ, CONG. RSCH. SERV., R44871, FRESHWATER HARMFUL ALGAL BLOOMS: CAUSES, CHALLENGES, AND POLICY CONSIDERATIONS 1 (updated June 8, 2020), https://crsreports.congress.gov/product/pdf/R/R44871.
303. *Lake Erie's toxic algae blooms: Why is the water turning green?*, NAT'L SCIENCE FOUND., https://beta.nsf.gov/news/lake-eries-toxic-algae-blooms-why-water-turning-green (last accessed Aug. 20, 2022).
304. *Id.*
305. *Id.*
306. 42 U.S.C. §300f–g; United States Environmental Protection Agency, *Summary of the Safe Drinking Water Act*, https://www.epa.gov/laws-regulations/summary-safe-drinking-water-act (last accessed Aug.19, 2022).
307. 42 U.S.C. § 300g.

water regulation includes public water system rules that,[308] among other requirements, "specif[y] contaminants which . . . may have any adverse effect on" human health.[309] For any specified contaminant, these regulations must include a maximum contaminant level.[310] The SDWA defines the term maximum containment level as "the maximum permissible level of a contaminant in water which is delivered to any user of a public water system."[311] A maximum contaminant level is one that "is economically and technologically feasible to ascertain the level of such contaminant"; if not feasible, the regulations must include "each [known] treatment technique . . . which leads to a [sufficient] reduction in the level of such contaminant."[312]

In identifying a contaminant for which a maximum level should be specified, the EPA must consider whether it may adversely affect human health, whether the contaminant is either known or substantially likely to "occur in public water systems with a frequency and at levels of public health concern," and whether the contaminant's "regulation . . . presents a meaningful opportunity for [human] health risk reduction."[313] In addition, the SDWA regulations must provide for procedures and criteria to assure compliance with the promulgated maximum contaminant levels.[314]

The 2015 amendments to the SDWA provided for consideration of the risk of algal toxins to public water systems. These amendments, adopted in the Water Infrastructure Improvements for the Nation Act, were enacted in response to the large Lake Erie HAB impacting the Toledo, Ohio water supply.[315] Among other provisions, this legislation provided for coordination of projects and actions related to HABs in the Great Lakes.[316]

These amendments required the EPA to create a strategic plan concerning algal toxins in public water supplies.[317] In developing the plan, the EPA was required to analyze and assess risks to human health from algal toxins in public water systems and to create a list of algal toxins with potential human health risks.[318] For listed algal toxins, the statute requires the plan to include: their "known adverse human health effects"; factors

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308. "Public water system" is defined in the SDWA as "a system for the provision to the public of water for human consumption through pipes or other constructed conveyances" that has a minimum of "fifteen service connections or regularly serves at least twenty-five individuals." 42 U.S.C. § 300f(1)(D)(4)(A).

309. *Id.* § 300f(1)(B).

310. *Id.* § 300f(1)(C).

311. *Id.* § 300f(3).

312. *Id.* § 300f(1)(C)(i)–(ii).

313. *Id.* § 300g-1(b)(1)(A)(i)–(ii).

314. *Id.* § 300f(1)(D).

315. P.L. 114-45; Congressional Research Service, *Freshwater Harmful Algal Blooms: An Overview*, p. 1 (July 8, 2020, update), https://crsreports.congress.gov/product/pdf/IF/IF10690.

316. *Id.*

317. 42 U.S.C. § 300j-19(a)(1).

318. *Id*. § 300j-19(a)(1)(A)–(B).

associated with bloom growth and toxin release; need for public health advisories; guidance concerning quantifying and monitoring toxins in public water supplies; recommendations for feasible treatment options; mitigation of adverse public health effects; consideration of cooperative agreements; and technical assistance coordination with states and public water systems for risk management related to listed algal toxins.[319]

For purposes of identifying maximum contaminant levels for listed toxins and for listing algal toxins, the term "feasible" is defined as "feasible with the use of the best technology, treatment techniques and other means which . . . after examination for efficacy under field conditions and not solely under laboratory conditions, are available (taking cost into consideration)."[320] Both statutory processes also expressly provide for the use of science and reliable data in making decisions regarding contaminant levels and algal toxin listings.[321]

The SDWA directs the EPA to issue health advisories concerning contaminants posing threats to public health, and EPA has done so for some algal toxins.[322] The SDWA also directs the EPA to act through a three-step process to assess and identify contaminants not previously regulated under the SDWA that may require regulation in the future.[323] First, EPA issues Contaminant Candidate Lists (CCLs) every five years for contaminants that are not currently subject to federal drinking water regulations but "are known or anticipated to occur in public water systems."[324] Second, EPA must provide for monitoring of the CCL-listed contaminants by enacting an unregulated contaminant monitoring rule.[325] Third, the EPA is required to determine whether to regulate CCL-listed contaminants.[326] The determination, which must be made every five years (for at least five unregulated contaminants), is based on consideration of whether: the contaminant may adversely affect human health; the contaminant is known

319. *Id*. § 300j-19(a)(1)(C)(i)–(iii).

320. *Id*. §§ 300g-1(b)(4)(D), 300j-19(d) (the harmful algal bloom statute specifies that "feasible" for the harmful algal bloom provisions has the same meaning as in the general maximum contaminant level statute).

321. *Id*. § 300g-1(b)(3)(A)(i)–(ii).

322. Environmental Protection Agency, *EPA Drinking Water Health Advisories for Cyanotoxins*, https://www.epa.gov/cyanohabs/epa-drinking-water-health-advisories-cyanotoxins (last accessed Aug. 22, 2022) (for example, EPA issued health advisories for cyanotoxins, cylindrospermopsin, and microcystins in 2015).

323. Env't Prot. Agency, *Basic Information on the CCL and Regulatory Determination,* https://www.epa.gov/ccl/basic-information-ccl-and-regulatory-determination (last accessed Aug. 20, 2022).

324. *Id.*

325. *See, e.g.*, Environmental Protection Agency, *Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 5) for Public Water Systems and Announcement of Public Meetings*, 86 Fed. Reg. 73131 (December 27, 2021); 40 C.F.R. §141.35 (2022); 40 C.F.R. §141.40 (2022).

326. *Id.* at 73136.

or substantially likely to occur in public water systems at the "frequency and at levels of public health concern"; and contaminant regulation "presents a meaningful opportunity for health risk reduction" for water system users.[327] The EPA then documents its determinations and announces its intent to propose national primary drinking water regulations for unregulated contaminants satisfying these criteria.[328]

Even before the 2015 SDWA amendments added specific algal toxin requirements to the statute, the EPA identified some algal toxins as contaminants of concern for drinking water.[329] EPA's first CCL (CCL1), which was issued in 1998, included "[c]yanobacteria (blue-green algae), other freshwater algae, and their toxins" on the unregulated microbiological contaminants list.[330] The CCL1 accorded priority to these algal toxins concerning their occurrence and for health, analytical methods, and treatment research.[331]

In adding these algal toxins to the CCL1, the EPA noted its opinion that "algal control was best handled through good watershed management practices."[332] However, as one reason for the toxins' addition to the list, the EPA cited the agency's recognition that "some data suggest that current treatment techniques may be particularly inadequate in controlling algal toxins."[333] The EPA also specified the listing would make these algal toxins "a priority for research to determine what triggers toxic algal growth in source water and the effectiveness of water treatment practices."[334] The EPA included cyanotoxins, individually or as a group, in CCL2, CCL3, and CCL4—which were issued in 2005, 2009, and 2016 respectively.[335]

As directed in the 2015 SDWA amendments, the EPA released an assessment and management strategic plan concerning algal toxins.[336]

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327. *Id.*

328. *See, e.g.,* Environmental Protection Agency, *Announcement of Final Regulatory Determinations for Contaminants on the Fourth Drinking Water Contaminant Candidate List*, 86 Fed. Reg. 12272 (March 3, 2021) (this 2021 announcement is based on CCL4, which was published in 2016. Environmental Protection Agency, *Drinking Water Contaminant Candidate List 4—Final*, 81 Fed. Reg. 81099, 81107, 81112 (Nov. 17, 2016) [CCL4]).

329. Announcement of the Drinking Water Contaminant Candidate List, 63 Fed. Reg. 10274 (Mar. 2, 1998).

330. *Id.* at 10275.

331. *Id.* at 10286 (these toxins were listed second in the priorities lists for health and analytical research and third in the priorities lists for treatment research and occurrence considerations).

332. *Id.* at 10281.

333. Environmental Protection Agency, *Announcement of the Drinking Water Contaminant Candidate List; Notice*, 63 Fed. Reg. 10274, 10281 (Mar. 2, 1998).

334. *Id.*

335. Drinking Water Contaminant Candidate List 3-Final, 74 Fed. Reg. 51850, 51852, 51860 (Oct. 8, 2009); Drinking Water Contaminant Candidate List 4-Final, 81 Fed. Reg. 81099, 81107, 81112 (Nov. 17, 2016).

336. U.S. Env't Prot. Agency, 810R04003, Algal Toxin Risk Assessment and Management Strategic Plan for Drinking Water (2015).

Among other considerations, this assessment addressed the existing "information gaps" concerning cyanotoxins and HABs:

> The relationship among factors that promote algal bloom and subsequent toxin production are not well understood. Those factors include both environmental conditions such as water clarity, meteorological conditions, alteration of water flow, vertical mixing, temperature and water quality conditions such as pH changes, nutrient loading (principally in various forms of nitrogen and phosphorus) and trace metals. . . . More information is also needed to better understand how climate change will affect the geospatial and temporal distribution of HABs. For example, studies have shown that increases in temperature, altered rainfall patterns, and anthropogenic nutrient loading may lead to an increase in bloom frequency, intensity, duration and geographic distribution [citation omitted] . . . . Given the potential increase in cyanobacterial blooms due to both the direct and indirect effects of climate change, understanding the effects at a regional scale can help water systems prepare for potential blooms that could occur due to changes in regional climate.
>
> A better understanding of risk communication in the context of risk management is also needed for cyanotoxins and HABs. . . . Although systems have been dealing with algal blooms for some time, additional training is needed regarding the cyanotoxin-producing blooms, on preventing the toxins from reaching finished water as well as training on how to handle communication situations as described above once cyanotoxins occur in finished water. PWS training can also help systems understand the impacts of the management cost consequences to the PWS for preparation and response measures to cyanotoxin occurrence.[337]

The draft 2021 CCL5 references this assessment and proposes to continue listing the cyanotoxin group as unregulated chemical contaminants.[338]

E. Agricultural Laws

The Soil and Water Resources Conservation Act (RCA) is a federal law that delegates to the USDA "broad natural resource strategic assessment and

337. *Id.*

338. Drinking Water Contaminant Candidate List 5-Draft, 86 Fed. Reg. 37948, 37953, 37962 (July 19, 2021).

planning authority."[339] As enacted in 1977 and through subsequent amendments, the RCA provides for "a coordinated appraisal and program framework" for the nation's soil and water resources.[340] The statutory findings address: the "growing [present and future] demand on the soil, water, and related resources"; the USDA's ability to assist land owners regarding "conservation and use" of these resources; the need for appraisal, assessment, inventory, and evaluation of these resources and of resource conservation; and consideration of "alternative approaches" to natural resource conservation programs.[341]

The RCA is not a water quality regulatory statute. In delegating authority for implementation of the RCA's provisions, Congress directed the USDA to: develop and update "a program for furthering the conservation, protection, and enhancement of the soil, water, and related resources" in the United States; conduct continuing appraisals of these resources as part of the RCA program; and establish "cooperative arrangements" with state, tribal, and local governments "to the fullest extent practicable."[342] The RCA program framework, therefore, is largely based on research, reporting, and technical assistance.

The statute's requirements for USDA appraisals focus on data development on resource quantities and on their "capability and limitations . . . for meeting current and projected demands on the resource base."[343] The RCA directs the agency to include its appraisal data on the following: status and conditions changes for these resources; costs and benefits of alternative soil and water conservation practices; costs and benefits of alternative irrigation practices; and "conservation plans, conservation practices planned or implemented, environmental outcomes, economic costs, and related matters" for USDA-administered conservation programs.[344] In developing these five-year appraisals, the USDA must provide for public participation; cooperate with state, tribal, and local resource conservation agencies; and "solicit and evaluate recommendations for improving the appraisal."[345] In addition, the USDA must use available information and data from these agencies as well as private organizations.[346] The USDA must also coordinate

339. U.S.D.A., *RCA Appraisal: Soil and Water Resources Conservation Act*, vi, https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044939.pdf (September 10, 2022); 16 U.S.C. § 2001.

340. 16 U.S.C. § 2001(4).

341. *Id.* § 2001(1)–(3).

342. *Id.* § 2003(a)–(c).

343. *Id.* § 2004(a)(2).

344. *Id.* § 2004(a).

345. *Id.* §§ 2004(c)-(d), 2004(e), 2006 (the current version of the statute requires the USDA to complete these periodic appraisals by December 31st of 2010, 2015, and 2022; the statute requires submission of these appraisals to Congress).

346. 16 U.S.C. § 2008.

actions with other federal agencies in an effort to "avoid unnecessary duplication and overlap of planning efforts."[347]

Similar to the requirements for resource assessment, the USDA program development provisions require the USDA to continue to evaluate and improve its conservation programs in cooperation with federal, state, tribal, and local agencies.[348] The long-term effect of the RCA's program implementation and appraisal provisions are apparently quite limited, as they are currently scheduled to sunset on December 31, 2023.[349] In soliciting comments for its program, the USDA recognizes the nonregulatory nature of its statutory mandates.[350]

While the RCA does not directly address agricultural nutrient pollution, some agricultural activities affecting water quality through nutrient pollution are regulated under federal water quality law. For example, the federal Clean Water Act requires NPDES permits for certain aquacultural facilities and concentrated animal feeding operations to address discharges from these facilities.[351] Under the Clean Water Act, the EPA has also issued a general NPDES discharge permit for pesticide use and application.[352] In addition, the CZMA addresses nonpoint source runoff (including nutrient pollution) by requiring coastal states with approved CZMA management programs to reduce polluted runoff via specific land-based measures.[353]

Another federal law with regulatory implications for agricultural operations is the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which governs pesticide registration, sale, distribution, and use in the United States and delegates regulatory authority to the EPA.[354] Not limited to agricultural pesticide use, FIFRA statutory and regulatory provisions include requirements related to: pesticide registration and

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347. *Id.*

348. *Id.* § 2005(a)–(c) (the program deadlines in the current version of the statute are a year after the assessment deadlines (i.e., December 31 of 2011, 2016, and 2023)).

349. *Id.* § 2009.

350. *See, e.g.*, Notices: Soil, Water, and Related Resources, 53 Fed. Reg. 10135, 10135 (U.S.D.A. Mar. 29, 1988) (quoting: "Although the national program does not propose or direct any specific Federal actions that would affect the human environment so as to require an analysis under section 102(2)(c) of the National Environmental Policy Act, 42 U.S.C. 4332(2)(c), an environmental assessment was conducted by the Department of Agriculture in the development of the program").

351. 33 U.S.C. § 1362(14); 40 C.F.R. § 122.23 (Concentrated Animal Feeding Operations); 40 C.F.R. § 122.24 (Concentrated Aquatic Animal Production Facilities).

352. 33 U.S.C. § 1342.

353. *See id.* § 1451–1466 (other CZMA sections address nonpoint source pollution in non-mandatory ways). *See also* Eva Lipiec, CONG. RSCH. SERV., R45460, COASTAL ZONE MANAGEMENT ACT (CZMA): OVERVIEW AND ISSUES FOR CONGRESS 3 fn. 7 (2019) https://crsreports.congress.gov/product/pdf/R/R45460#:~:text=Reauthorization%20Amendments%20Act%20(%C2%A76127,through%20specific%20land%2Dbased%20measures (acknowledging the lack of mandatory sections).

354. 7 U.S.C. § 136(a)–(w), (FIFRA regulation provides for pesticide regulation in a broad array of uses and is not limited to agricultural pesticide use).

labeling; worker protection standards; use of restricted pesticides or pesticides covered by experimental use permits; pesticide applicators; and pesticide storage, disposal, transportation, and recall.[355] FIFRA provides for federal-state cooperation.[356] The statute also authorizes EPA administrative actions and enforcement through criminal and civil penalties for FIFRA violations.[357]

FIFRA includes specific provisions concerning agricultural pesticide use. The statute authorizes "minor use programs" within both EPA and USDA and authorizes grants to support research concerning minor use pesticides.[358] FIFRA also includes an exemption for some agricultural pesticide use under an experimental use permit. The law includes a process for issuing experimental use permits for pesticides not otherwise authorized for use under the statute. The statute specifies an experimental use permit for a pesticide may be issued "only if the [EPA] Administrator determines that the applicant needs such permit in order to accumulate information necessary to register a pesticide"; further, the authorized pesticide use must be under EPA supervision and subject to the permit's time limit, terms, and conditions.[359] In addition, this type of permit may be revoked if its "terms or conditions are being violated[] or . . . are inadequate to avoid unreasonable adverse effects on the environment."[360] FIFRA, however, has an exemption allowing issuance of experimental use permits, "[n]otwithstanding the foregoing provisions of" this permitting statute, to "any public or private agricultural research agency or educational institution which applies for such permit."[361] These permits are limited to a one-year term and other permit conditions, and they are authorized only "for purposes of experimentation."[362]

Other than the laws mentioned above, much of the federal approach to controlling agricultural nutrient pollution is based on policy and voluntary efforts. While other environmental laws include regulatory and enforcement authority concerning agricultural practices and operations, USDA's role concerning nutrient pollution is based largely on policy, guidance, assistance, and voluntary, incentive-based actions rather than regulation and enforcement.[363] The USDA describes its categories of policy-based

355. *Id.* §§ 136(a), 136(c), 136(i), 136(j), 136(l), 136(q).
356. *Id.* §§ 136(v), 136(w), 136(w)(1).
357. *Id.* § 136(c)–(d).
358. *Id.* § 136(II).
359. *Id.* § 136c(a).
360. *Id.* § 136c(e).
361. *Id.* § 136c(g).
362. *Id.*
363. *Landscape Conservation Initiatives*, U.S. DEP'T OF AGRIC., NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/programs-initiatives/landscape-conservation-initiatives (last visited Feb. 27, 2023).

environmental programs as: "involuntary measures that are, to varying degrees, coercive; voluntary measures providing varying amounts of financial incentive; and facilitative measures that rely primarily on information."[364]

The USDA Natural Resources Conservation Service (NRCS) defines nutrient management as: "[m]anaging the right amount, right source, right placement, and right timing of the application of nutrients and soil amendments to ensure adequate soil fertility for plant production and to minimize the potential for environmental degradation, particularly air and water quality impairment."[365] The USDAs approach to addressing nutrient pollution thus focuses on these "4Rs of Nutrient Management" (i.e., right rate, source, placement, and timing).[366]

NRCS develops and publishes Field Office Technical Guides to provide "technical information about the conservation of soil, water, air, and related plant and animal resources" with scientific information, criteria, and recommended practices.[367] These guides are a compilation of NRCS publications providing conservation practice standards, information sheets, physical effects worksheets, and job sheets.[368] Conservation practice standards, as described by the NRCS, are guidelines for "planning, designing, installing, operating and maintaining conservation practices."[369] These standards identify minimum criteria that may be less restrictive than those adopted by states.[370]

The NRCS's conservation practice standard for nutrient management, based on the 4Rs, provides guidance to achieve effective nutrient management for stated purposes. One of those purposes is "minimiz[ing] agricultural nonpoint source pollution of surface and groundwater

364. *Policy Instruments for Protecting Environmental Quality*, U.S. DEP'T OF AGRIC., ECON. RSCH. SERV., https://www.ers.usda.gov/topics/natural-resources-environment/environmental-quality/policy-instruments-for-protecting-environmental-quality/ (last visited Sept. 10, 2022).

365. U.S. DEP'T OF AGRIC., NAT. RES. CONSERVATION SERV., *National Nutrient Management Policy,* Title 190 of General Manual, Part 402, 402.1(3) (January 2012).

366. *Id.*

367. *Field Office Technical Guide*, U.S. DEP'T OF AGRIC., NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/resources/guides-and-instructions/field-office-technical-guides (last visited Feb. 27, 2023).

368. *Conservation Practice Standards Information*, U.S. DEP'T OF AGRIC., NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/getting-assistance/conservation-practices (last visited Feb. 28, 2023).

369. *Field Office Technical Guide*, U.S. DEP'T OF AGRIC., NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/resources/guides-and-instructions/field-office-technical-guides (last visited Feb. 27, 2023).

370. *Conservation Practice Standards*, U.S. DEP'T OF AGRIC., NAT. RES. CONSERVATION SERV., https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-standards (last visited Feb. 28, 2023).

resources."[371] Other purposes include proper use of "manure, municipal and industrial biosolids, and other organic by-products as plant nutrient sources" and maintenance or improvement of "the physical, chemical, and biological condition of soil." [372] This standard's general criteria provide for development of a "nutrient management plan for nitrogen, phosphorus, and potassium that considers the crop requirements and all potential sources of nutrients," including both commercial fertilizer and animal manure.[373]

Some of the specific considerations related to nutrient sources, application, timing, and placement to address the impacts of agricultural nutrient pollution are described below:

- Select nutrient sources "compatible with the application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to minimize risk to the environment";
- Determine the nutrient application, timing and placement "to correspond as closely as practical with nutrient uptake" and to "consider nutrient source, cropping system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment results";[374]
- Coordinate conservation practices to minimize nutrient transport "[w]hen there is a high risk of transport of nutrients . . . to avoid, control, or trap manure and nutrients before they can leave the field by surface or subsurface drainage";
- Avoid surface nitrogen application during periods of soil saturation to avoid leaching before crop uptake;
- Use conservation practices with cover crops to test management options and assess nitrogen availability and impact on water quality;[375]
- Consider slow-release and controlled release fertilizers;

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371. U.S. DEP'T OF AGRIC., NAT. RES. CONSERVATION SERV., *Conservation Practice Standard: Nutrient Management,* Code 590, 1 (Jan. 2012), https://www.cayugacounty.us/DocumentCenter/View/1512/Natural-Resources-Conservation-Service-Conservation-Practice-Standard-Nutrient-Management-Code-PDF (defining "nutrient management" as "[m]anaging the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments").

372. *Id.*

373. *Id.*

374. *Id.* at 3.

375. *Id.* at 4–5.

- Monitor fields with manure applications to identify excess phosphorus;
- Manage crop sequence and rotation to minimize the need for additional nitrogen; and
- Establish filter strips between agricultural crop land and sensitive areas (e.g., waterbodies or direct conduits to waterbodies).[376]

This standard is supplemented by the NRCS National Nutrient Management Policy and its "National Instruction" for policy interpretation, which are incorporated into the agency's technical assistance and other efforts concerning nutrient management.[377]

The USDA's conservation programs, as updated in the Agricultural Improvement Act of 2018, provide funding and technical assistance for conservation activities on natural resource lands related to water quality, soil health, and other environmental objectives.[378] The agency administers numerous assistance programs, some of which are summarized below:

- The Conservation Reserve Program (CRP) provides for allocation among states of rental payments to landowners "who maintain cropland, marginal pasture, or grassland in grass or tree cover for 10–15 years." The 2018 legislation increased the maximum acreage for this program to 27 million acres in fiscal year 2023 and incorporated the Conservation Reserve Enhancement Program (CREP) by statute. Additional CRP incentive payments may be available for "continuous signup" of lands into the program.[379]
- Payments to farmers are available under the Soil Health and Income Protection Pilot Program (SHIPP) for "establish[ing]

376. *Id.* at 3.

377. U.S. DEP'T OF AGRIC., NAT. RES. CONSERVATION SERV., *National Nutrient Management Policy,* Title 190 of General Manual, Part 402 (Jan. 2012).

378. *Agriculture Improvement Act of 2018: Highlights and Implications, Conservation*, U.S. DEP'T OF AGRIC., ECON. RSCH. SERV., https://www.ers.usda.gov/agriculture-improvement-act-of-2018-highlights-and-implications/conservation/ (last updated Aug. 20, 2019); *Agriculture Improvement Act of 2018: Highlights and Implications*, U.S. DEP'T OF AGRIC., ECON. RSCH. SERV., https://www.ers.usda.gov/agriculture-improvement-act-of-2018-highlights-and-implications/ (last updated July 12, 2022).

379. *Agriculture Improvement Act of 2018: Highlights and Implications, Conservation*, U.S. DEP'T OF AGRIC., ECON. RSCH. SERV., https://www.ers.usda.gov/agriculture-improvement-act-of-2018-highlights-and-implications/conservation/ (last updated Aug. 20, 2019).

grass cover on less productive cropland for a period of 3–5 years."[380]

- Under the Conservation Stewardship Program (CSP), agricultural producers may receive financial assistance for achieving specified "stewardship requirements on agricultural and forest lands" up to mandatory funding levels for different fiscal years. The 2018 legislation added a Grassland Conservation Initiative to provide assistance with protection of grazing and wildlife grasslands.[381]
- The Environmental Quality Incentives Program (EQIP) is a financial assistance program to promote conservation practices' implementation and maintenance on agricultural and forest lands. The 2018 legislation increased incentive payments for "highly beneficial practices," created Conservation Incentive Contracts for annual and cost-sharing payments for "practices with broad resource benefits (e.g., cover crops, transition to resource conserving crop rotations)," and funding for Conservation Innovation grants to fund on-farm trials.[382]
- The Agricultural Conservation Easement Program (ACEP) funds long-term easements for wetlands restoration and protection on farmlands and protection against conversion of agricultural lands to other uses.
- The Regional Conservation Partnership Program (RCPP) provides financial assistance for funding problem solving "on a regional or watershed scale." Under the 2018 Act, the USDA is required to "provide guidance on quantifying natural resource outcomes for projects" and allocates funding for "state and multistate projects" and for "projects centered on critical conservation areas."[383]

As explained above, the USDA manages a variety of programs providing guidance, assistance, and funding to state agricultural programs and agricultural producers to promote the implementation of the standards,

380. *Id.*
381. *Id.*
382. *Id.*
383. *Id.*

criteria, and considerations in federal plans and programs. The National Agricultural Law Center tracks state legal approaches with three broad categories of regulated activities: nutrient management plans, application restrictions, and applicator certification.[384] For purposes of identifying relevant state laws, the categories are described as follows:

> The first category of "nutrient management plans" encompasses laws and regulations that mandate the development of written plans that manage the amount, source, placement and timing of plant nutrients and soil amendments. "Application restrictions" comprise the second category, which includes laws and regulations that place limitations on the physical application of agricultural nutrients to land. Our third category of "applicator certification" contains laws and regulations that establish minimum knowledge standards for the individuals who apply agricultural nutrients to land.[385]

Data current as of June 2020 shows that 48 states have adopted requirements for nutrient management plans, 16 states require certified fertilizer applicators for agricultural lands, and 33 states impose restrictions on fertilizer application.[386] This data includes only 11 states that have adopted laws in all three categories, and 14 states had laws in two of those categories.[387] The 16 states with laws in one category adopted nutrient management plan requirements rather than the fertilizer application laws or regulations.[388]

To address nutrient pollution from agricultural lands, states have also imposed these and other mandatory restrictions on agricultural operations as well as voluntary, incentive-based conservation measures.[389] The approach to specific conservation measures may vary. For example, nutrient management plans have been used as both voluntary and mandatory measures.[390] Other voluntary approaches include technical expertise, informational assistance, and economic incentives.[391] For example, some

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384. Peggy Kirk Hall & Ellen Essman, *State Legal Approaches to Reducing Water Quality Impacts from the Use of Agricultural Nutrients on Farmland,* NAT'L AGRIC. L. CTR. 5 (May 2019), https://nationallawcenter.org/wp-content/uploads//assets/articles/agnutrient_report.pdf.

385. *Id.* at 4.

386. *Mandatory Legal Approaches to Agricultural Nutrient Management*, NAT'L AGRIC. L. CTR., https://nationalaglawcenter.org/state-compilations/nutrientmanagement/ (last visited Sept. 10, 2022).

387. *Id.*

388. *Id.*

389. Peggy Kirk Hall & Ellen Essman, *State Legal Approaches to Reducing Water Quality Impacts from the Use of Agricultural Nutrients on Farmland,* NAT'L AGRIC. L. CTR. 21 (May 2019), https://nationalaglawcenter.org/wp-content/uploads/assets/articles/agnutrient_report.pdf

390. *Id.*

391. *Id.* at 4, 21.

states may provide financial incentives to encourage voluntary agricultural practices reducing agricultural nutrient pollution through land use buffers, conservation easements, ground cover on fertilized lands, and fertilizer (commercial and manure) application and timing.[392]

Some states have addressed nutrient pollution through laws concerning fertilizer composition and application. Most agricultural fertilizers include the primary nutrient components of nitrogen, phosphorus, and potassium.[393] Excess fertilizer application can result in leaching or runoff of these components to ground and surface water bodies.[394] Some states, like Michigan, that impose restrictions on phosphorus fertilizer application for other uses, exempt use of fertilizers on agricultural lands.[395] States may also impose requirements for timing of fertilizer applications, cautions on fertilizer use, and land use restrictions, such as setbacks between agricultural lands where fertilizer may be applied near water bodies adjacent to those lands.[396] For example, Minnesota restricts commercial nitrogen fertilizer (non-manure) applications during the fall and on frozen lands in areas that are vulnerable to groundwater contamination from nutrient pollution.[397] Another approach is to adopt best practices for fertilizer or a model fertilizer ordinance prescribing requirements for fertilizer use or application. Pennsylvania law establishes fertilizer "best practices" for promoting effective fertilizer use and minimizing harm to water bodies from fertilizer use.[398] As another example, Florida has implemented the model ordinance approach in state law.[399]

State laws may also require certification of fertilizer applicators. These laws may establish educational standards for persons authorized to apply nutrients to agricultural lands. For example, Ohio law requires certified applicators for fertilizer applications on more than 50 acres of agricultural

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392. The National Agricultural Law Center, *Mandatory Legal Approaches to Agricultural Nutrient Management*, https://nationalaglawcenter.org/state-compilations/nutrient (last accessed Sept. 10, 2022) (italics added).

393 . U.S. EPA, Agriculture Nutrient Management and Fertilizer, https://www.epa.gov/agriculture/agriculture-nutrient-management-and-fertilizer, (last accessed Feb. 14, 2023).

394. *Id.*

395. Michigan Department of Agriculture & Rural Development, *Use Phosphorous Free Fertilizer*, https://www.michigan.gov/-/media/Project/Websites/mdard/documents/pesticide-plant-pest/feedsafetyandfertilizer/phosphorus_flyer.pdf?rev=d41337e25cb440efb26351d36d5453fc; Kristen L. Miller, *State Laws Banning Phosphorous Fertilizer Use*, (Feb. 1, 2012) https://www.cga.ct.gov/2012/rpt/2012-r-0076.htm.

396. Kristen L. Miller, *State Laws Banning Phosphorous Fertilizer Use*, CGA (Feb. 1, 2012), https://www.cga.ct.gov/2012/rpt/2012-r-0076.htm.

397. Matthew Wilde, *Nitrogen Restrictions in Effect*, PROGRESSIVE FARMER (Jan. 1, 2021), https://www.dtnpf.com/agriculture/web/ag/news/article/2021/01/01/regulations-nitrogen-restrictions.

398. S.B. 915, 2019-2020 Leg., Reg. Sess. (Pa. 2019).

399. Kristen L. Miller, *State Laws Banning Phosphorous Fertilizer Use*, CGA (Feb. 1, 2012), https://www.cga.ct.gov/2012/rpt/2012-r-0076.htm.

lands. The certification process includes training and testing for applicators (other than those previously certified) as certified crop advisers or certified livestock managers.[400]

Finally, states may establish program requirements or incentives concerning land use conservation practices and use restrictions to prevent or mitigate nutrient pollution from entering water bodies associated with agricultural lands. For example, Minnesota law includes nitrogen fertilizer restrictions and provides for buffer strips on agricultural lands.[401] Minnesota imposes, on average, 50 foot buffers for streams, lakes, and rivers on agricultural croplands and 16.5 foot buffers on agricultural ditches.[402] In addition, the Vermont Required Agricultural Practices rule imposes a buffer on ditches and surface water of 10 feet and 25 feet, respectively.[403] The Vermont rule restricts fertilizer use to establishment and maintenance and bans the use of "manure or other agricultural waste" in these buffers, but the rule does allow harvesting within the buffers.[404] Further, the Vermont's Grassed Waterway and Filter Strip Program provides financing for up to 90% of implementation costs for filter strips (buffers) and an incentive payment for increasing buffer width.[405]

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400. *Id*; Nina Gage, *Don't Forget Your Buffers*, State of Vermont, https://agriculture.vermont.gov/don%E2%80%99t-forget-your-buffers (last visited Feb. 14, 2023); Ohio Department of Agriculture, *Fertilizer*: *Agricultural Fertilizer Application Certificate*, https://agri.ohio.gov/divisions/plant-health/licenses/fertilizer-licenses (last visited Sept. 11, 2022); *A Summary of the Required Agricultural Practices*, Vt. Agency of Ag., Food & Markets (effective date Dec. 5, 2016).

401. *A Summary of the Required Agricultural Practices*, Vt. Agency of Ag., Food & Markets (effective date Dec. 5, 2016); Matthew Wilde, *Nitrogen Restrictions in Effect*, PROGRESSIVE FARMER (Jan. 1, 2021), https://www.dtnpf.com/agriculture/web/ag/news/article/2021/01/01/regulations-nitrogen-restrictions.

402. U.S. EPA, *Facts and Figures About the Great Lakes*, https://www.epa.gov/greatlakes/facts-and-figures-about-great-lakes (last visited Feb. 14, 2022).

403. Nina Gage, *Don't Forget Your Buffers*, State of Vermont, https://agriculture.vermont.gov/don%E2%80%99t-forget-your-buffers, (last visited Feb. 14, 2023); *A Summary of the Required Agricultural Practices,* Vt. Agency of Ag., Food & Markets (effective date Dec. 5, 2016); *Required Agricultural Practices Rule for the Agricultural Nonpoint Source Pollution Control Program*, Vt. Agency of Ag., Food & Markets (effective date Nov. 23, 2018), https://agriculture.vermont.gov/sites/agriculture/files/documents/RAPFINALRULE12-21-2018_WEB.pdf.

404. *Id.*

405. Nina Gage, *Don't Forget Your Buffers*, State of Vermont, https://agriculture.vermont.gov/don%E2%80%99t-forget-your-buffers (last visited Feb. 14, 2023; *A Summary of the Required Agricultural Practices,* Vt. Agency of Ag., Food & Markets (effective date Dec. 5, 2016); *Required Agricultural Practices Rule for the Agricultural Nonpoint Source Pollution Control Program*, Vt. Agency of Ag., Food & Markets (effective date Nov. 23, 2018), https://agriculture.vermont.gov/sites/agriculture/files/documents/RAPFINALRULE12-21-2018_WEB.pdf.

III. REGIONAL APPROACHES TO ADDRESSING HABS

There are several regional frameworks for initiatives and actions related to addressing the problem of HABs. States bordering, or with relation to, the Great Lakes, Chesapeake Bay, and Mississippi River have joined in cooperative efforts regarding actions to respond and work to mitigate and prevent HAB occurrences. Among other issues, the member states in these three regional networks are addressing the impacts of agricultural nutrient pollution on HAB proliferation and consequences. Similar to federal efforts, regional initiatives concerning HABs, and the contribution of agricultural nutrient pollution on HABs, are focused primarily on voluntary, incentive-based approaches rather than regulatory actions.

A. Great Lakes

The Great Lakes region is "one of the world's largest surface freshwater ecosystems."[406] This region includes fresh surface water resources covering more than 750 miles and reflecting 84% of the continent's supply and approximately 21% of the world's supply.[407] This region is home to more than 30 million people in the United States and Canada, reflecting 10% of the United States population and 30% of the Canadian population.[408] Further, the Great Lakes region includes a substantial amount of agricultural production lands for both countries: approximately 25% for Canada and 7% for the United States.[409]

Water quality in the Great Lakes region has been a focus for national and international cooperation for nearly 70 years. In 1972, the United States and Canada executed a cooperative agreement to promote restoration, management, and protection of water quality for the Great Lakes (Superior, Michigan, Huron, Erie, and Ontario).[410] As amended several times since initial enactment, the 2012 Canada–United States Great Lakes Water Quality Agreement (GLWQA) includes provisions concerning water quality in two Canadian provinces and eight states with shoreline in the Great Lakes

406. *Facts and Figures about the Great Lakes*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/greatlakes/facts-and-figures-about-great-lakes (last accessed Sept. 11, 2022); *see also Great Lakes Protection Overview*, Government of Canada (Jan. 27, 2022), https://www.canada.ca/en/environment-climate-change/services/great-lakes-protection/overview.html.

407. *Facts and Figures about the Great Lakes*, U.S. ENV'T PROT. AGENCY, *supra* note 406.

408. *Id.*

409. *Id.*

410. *Id.*; Great Lakes Water Quality Agreement, Canada-U.S., art. 3 (b), Feb. 12, 2023; *see also Great Lakes Protection Overview*, Government of Canada (Jan. 27, 2022), https://www.canada.ca/en/environment-climate-change/services/great-lakes-protection/overview.html.

region.[411] The GLWQA establishes a framework for cooperation in addressing priority water quality areas, including lake-wide management, chemicals, aquatic invasive species, vessel discharge, groundwater, habitat and species, and nutrient pollution.[412]

As originally enacted, the GLWQA created a structure for efforts to restore and manage water quality in the Great Lakes.[413] The GLWQA identifies priorities and assesses progress on a regular basis. Article 5, § 2(c) of the GLWQA requires development of "binational priorities" for both science and action on a biennial basis to address present and future water quality threats in the Great Lakes.[414] In 2016, the United States and Canada agreed to an "annual load target" for total phosphorus in Lake Erie's western and central basins in an effort to reduce phosphorus loads by 40% from the countries' 2008 contribution levels. Recognizing phosphorus as a "major driver of the algae bloom in the western basin of Lake Erie," the countries established target annual reductions for Lake Erie phosphorus loads of 212 tons and 3,316 tons for Canada and the United States, respectively.[415] The GLWQA 2020–22 action priorities identified for nutrients reflect the continuing need for action and progress; the report listed the following priority actions:

- Implement phosphorus reduction initiatives through the established binational and domestic strategies and plans;
- Monitor phosphorus concentrations in Lake Erie and report progress on achieving established phosphorus reduction targets; and
- Evaluate research to determine the feasibility of establishing Lake Erie targets for reducing phosphorus load.[416]

411. Great Lakes Water Quality Agreement, Canada-U.S., annex 2 B. 7, Feb. 12, 2013; Pennsylvania Department of Environmental Protection, *Great Lakes Water Quality Agreement*, https://www.dep.pa.gov/Business/Water/Compacts%20and%20Commissions/Great%20Lakes%20Program/Pages/Great-Lakes-Water-Quality-Agreement.aspx (last accessed September 7, 2022).

412. *Id.*

413. Pennsylvania Department of Environmental Protection, *Great Lakes Water Quality Agreement*, https://www.dep.pa.gov/Business/Water/Compacts%20and%20Commissions/Great%20Lakes%20Program/Pages/Great-Lakes-Water-Quality-Agreement.aspx (last accessed September 7, 2022).

414. 2022 Progress Report of the Parties Pursuant to the 2012 Canada-U.S. Great Lakes Water Quality Agreement, ix, ix ISSN 2816-7783, EPA 905R22003.

415. *Id.* at 39.

416. *The Governments of Canada and the United States agree on 2020–2022 Great Lakes Binational Priorities for Science and Action*, BINATIONAL.NET, (Mar. 2, 2021) https://binational.net/2021/03/02/bpsa-pbas-2020-2022/.

The corresponding science priorities for nutrients during this period include: future climate impacts on Lake Erie's nutrient conditions, nitrogen and other factors affecting toxicity of HABs, phosphorus sources and inter-lake phosphorus transport, and research and monitoring to assess interim phosphorus concentration and loading targets.[417]

The 2022 GLWQA progress report recognized improvements made but concluded that more work on phosphorus loading in Lake Erie was needed.[418] This report identified factors impeding the countries' ability to achieve the agreed 40% reduction target. The factors identified include: extended algae growing seasons promoted by temperature increases, increased intensity and duration of summer blooms facilitated through phosphorus contributions from "more frequent high intensity precipitation during the spring," and increases in fall fertilizer application and other land management changes impacting phosphorus loading.[419] Despite some success, the report concluded that the countries were not able to achieve the phosphorus target.

> Since 2018, Canada and the U.S., along with their partners, have enhanced their support for on-the-ground actions to reduce sources of phosphorus to Lake Erie as identified in their respective Domestic Action Plans. These actions are slowing phosphorus inputs that cause algae blooms in the lake. Since 2015, the U.S. has reduced phosphorus loading from agricultural and municipal sources to the watershed by over 3 million pounds (1,361 tons) per year. In Canada, edge-of-field studies indicate a 20-tonne annual reduction in phosphorus loads since 2020. These reductions are early indications that *actions being taken by the U.S. and Canada are on the right track, but the Parties are still a long way from meeting the 40% reduction target*.
>
> Modeling suggests that at least 50% of the agricultural landscape in Canada and the U.S. will need to have conservation practices implemented to achieve the targets and reduce harmful algal blooms and hypoxia in Lake Erie. To date, *there is no evidence of a declining trend in phosphorus loads*, as shown in the figure below. Across the basin, progress has been highly variable with some tributaries showing improvement and yet others remain stable or are degrading.[420]

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417. *Id.*

418. 2022 Progress Report of the Parties Pursuant to the 2012 Canada-U.S. Great Lakes Water Quality Agreement, *supra* note 414 at 39.

419. *Id.*

420. *Id.* (emphasis added).

While a major initiative to address water quality in the Great Lakes, the GLWQA was not the first multi-governmental effort to respond to the water quality problems in this region. The GLWQA was preceded by a multi-state Great Lakes effort initiated nearly 20 years earlier, when the Great Lakes Basin Compact was approved.[421] The Great Lakes Commission, which originated from the GLWQA, currently includes Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin.[422] The 2017 Strategic Plan for the Great Lakes Commission identified rural and urban water quality as challenges and specified "strategic actions," including: water quality projects to "reduce sediment and nutrient loads"; funding to address "sediment and nutrient runoff"; and action on "innovative approaches to manage sediment and nutrient loading" in priority watersheds.[423] This plan included other strategic actions, such as creation of the HABs Collaborative and participation in GLWQA priority actions. Further, this plan identified a need for advocacy "for refinements to U.S. federal policy and legislation to protect and improve water quality, including the U.S. Clean Water Act, the U.S. Safe Drinking Water Act, the U.S. Water Resources Development Act, and the U.S. Farm Bill."[424]

The Great Lakes Commission established the HABs Collaborative in 2015 to facilitate HAB science, policy, and information communications. The goal was to create a "common knowledge basis of current science and science needs, strategies for transmitting key science to managers, and opportunities [for] getting management feedback on science-based decision support needs."[425] Further, the Great Lakes Commission manages the Great Lakes Sediment and Nutrient Reduction Program, a federal-state partnership established in 1988, to provide grant funding for sediment and nutrient erosion and control projects implemented within the Great Lakes region by state and local governments and by nonprofit organizations. The Great Lakes Commission reported that this program has addressed nutrient pollution by helping to "prevent millions of pounds of phosphorus and tons of sediment

421. Great Lakes Commission des Grands Lacs, *Governing Documents*, https://www.glc.org/about/documents (last visited Feb. 14, 2023).

422. *Id.* (New York, Ohio, and Pennsylvania signed the Great Lakes Basin Compact after the initial five signatories. *Id.* After the states' ratifications, Congress granted consent to the Great Lakes Basin Compact in 1968).

423. Great Lakes Commission des Grands Lacs, *Strategic Plan for the Great Lakes Commission 2017-2022*, 4 (adopted Jan. 2017), https://www.glc.org/wp-content/uploads/2013/07/GLC-strategic-plan_Final_Adopted-Jan-13-2017.pdf; Great Lakes Commission des Grands Lacs, *About the HABs Collaborative*, https://www.glc.org/work/habs (last visited Sep. 11, 2022) (priority watersheds were identified as Lower Fox/Green Bay, Saginaw River/Bay, and Maumee river/Western Lake Erie Basin).

424. *Strategic Plan for the Great Lakes Commission 2017-2022*, *supra* note 423 at 4.

425. Great Lakes Commission des Grands Lacs, *About the HABs Collaborative*, https://www.glc.org/work/habs (last visited Sep. 11, 2022).

from reaching the Great Lakes by funding innovative practices to address these issues."[426]

The Great Lakes Commission also created a mechanism for member states to report water quality actions and results. The "Blue Accounting" information service "tracks the region's efforts to tackle critical issues facing the Great Lakes."[427] Nutrients contributing to Lake Erie HABs are one of the issues tracked by Blue Accounting. States' efforts are considered from the perspective of agreements within the scope of the GLWQA.[428]

B. Chesapeake Bay

The Chesapeake Bay is the largest estuary in the United States and, like the Great Lakes region, is a water body that has been plagued with water quality issues for many years. The Chesapeake Bay is a 64,000-square-mile watershed that includes "more than 18 million people and 3,000 species of plants and animals" in six states and the District of Columbia.[429] In 2009, President Obama formally recognized the need for a "renewed effort to restore and protect" this "national treasure" in the Chesapeake Bay Protection and Restoration Executive Order.[430] The Executive Order described the state of water quality in the Chesapeake Bay at that time:

> Despite significant efforts by Federal, State, and local governments and other interested parties, water pollution in the Chesapeake Bay prevents the attainment of existing State water quality standards and the "fishable and swimmable" goals of the Clean Water Act. At the current level and scope of pollution control within the Chesapeake Bay's watershed, restoration of the Chesapeake Bay is not expected for many years. *The pollutants that are largely responsible for pollution of the Chesapeake Bay are nutrients, in the form of nitrogen and phosphorus, and sediment*. These pollutants come from many sources, including sewage treatment plants, city streets, development sites, agricultural operations, and deposition from the

426. *Id.*

427. Great Lakes Commission des Grands Lacs, *About Blue Accounting*, https://www.blueaccounting.org/about/ (last visited Sep. 11, 2022). Other issues tracked by Blue Accounting aquatic invasive species and drinking water quality.

428. *Id.*

429. Chesapeake Bay Foundation, *Our Mission: Saving a National Treasure*, https://www.cbf.org/about-cbf/our-mission/ (last visited Sep. 11, 2022).

430. Exec. Order No. 13508, *Chesapeake Bay Protection and Restoration*, Preamble (2009), https://obamawhitehouse.archives.gov/realitycheck/the_press_office/Executive-Order-Chesapeake-Bay-Protection-and-Restoration.

> air onto the waters of the Chesapeake Bay and the lands of the watershed.[431]

The Executive Order established a federal, multi-agency committee "to oversee the development and coordination of programs and activities" for "protection and restoration of the Chesapeake Bay."[432] In addition, the Executive Order required the committee to develop a strategy to define environmental goals and progress milestones concerning: environmental conditions; environmental changes; "specific programs and strategies to be implemented"; mechanisms assuring coordinating and effectiveness of activities; and an implementation process for "adaptive management principles" toward goal attainment.[433] Further, the Executive Order required the federal agencies to coordinate their programs and activities with the Chesapeake Bay states.[434]

States created their own organizations to address water quality issues in the Chesapeake Bay. The Chesapeake Bay Foundation was created in 1996 with a mission to provide "education, advocacy, litigation, and restoration to turn the tide and leave a legacy of clean water" in this region.[435] The region includes parts of Maryland, Delaware, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia.[436]

The Chesapeake Bay Foundation has focused on various sources of water quality challenges in the Chesapeake Bay region. Some of the areas of focus and measures to address them are runoff pollution, climate change, aquatic dead zones, fisheries, land use, and habitat loss.[437] Despite the stated benefits from agricultural lands, the Foundation recognizes that "agricultural lands also contribute nitrogen, phosphorus, and sediment pollution to our rivers and streams."[438] The Foundation also identifies largely voluntary, incentive-based approaches to resolving nutrient pollution from agricultural operations.[439] For example, the Foundation supports "programs and policies that slow the loss of farmland and prevent sprawl" to preserve the natural

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431. *Id.* (italics added).

432. *Id.* at § 201 (member agencies included the EPA, the Departments of Agriculture, Commerce, Defense, Homeland Security, the Interior, Transportation, and "such other agencies as determined by the Committee").

433. *Id.*

434. *Id.*

435. Chesapeake Bay Foundation, *Our Mission: Saving a National Treasure*, https://www.cbf.org/about-cbf/our-mission/ (last visited Sep. 11, 2022).

436. *Id.*

437. Chesapeake Bay Foundation, *The Issues*, https://www.cbf.org/issues/ (last viewed Sep.11, 2022).

438. Chesapeake Bay Foundation, *Agriculture—Farmers Play a Critical Role in Keeping Our Waters Clean*, https://www.cbf.org/issues/agriculture/ (last visited Sep. 11, 2022).

439. *Id.*

water filters provided by farmland and open space.[440] The Foundation also advocates "for conservation programs and projects "that limit polluting runoff: stream buffers, cover crops, rotational grazing, and other best management practices."[441] Those best management practices include:

- Streamside forest buffers and/or fencing;
- Conservation tillage (continuing no-till practice);
- Conservation crop rotation (planned crop rotation sequence);
- Rotational grazing practices;
- Planting of trees on grazing land (silvopasture);
- Conversion of cropland to pasture;
- Use of cover crops; and
- Implementation of nutrient management plans.[442]

The Foundation's support notes that "widespread use of these practices on Bay region farms could reduce the amount of nitrogen pollution flowing into the Bay from nonpoint sources by as much as 60 percent."[443] The Foundation also notes that, through implementation of these best management practices, the Chesapeake Bay region "could achieve almost two-thirds of the nitrogen and phosphorus reductions necessary to restore the Chesapeake Bay, at only 13 percent of the total cost of Bay restoration."[444]

The Chesapeake Bay Clean Water Blueprint governs plans and targets to achieve, by 2025, the identified pollution limits specified in the 2010 Chesapeake Bay total maximum daily load (TMDL). This Blueprint and the TMDL, which resulted from a 2010 settlement of litigation brought by the EPA, required the six states and the District of Columbia (with membership in the Chesapeake Bay Foundation) to develop individual plans to achieve specified water quality milestones.[445] Those individual plans and milestones collectively created the Chesapeake Bay Clean Water Blueprint.[446]

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440. *Id.*

441. *Id.*

442. Chesapeake Bay Foundation, *Regenerative Agriculture's Top Eight Conservation Practices*, https://www.cbf.org/issues/agriculture/eight-key-conservation-practices-used-in-regenerative-agriculture.html (last visited Sep. 11, 2022).

443. Chesapeake Bay Foundation, *Agriculture—Farmers Play a Critical Role in Keeping Our Waters Clean*, *supra* note 443.

444. *Id.*

445. Chesapeake Bay Foundation, *What is the Chesapeake Clean Water Blueprint?*, https://www.cbf.org/how-we-save-the-bay/chesapeake-clean-water-blueprint/what-is-the-chesapeake-clean-water-blueprint.html (last accessed Sep. 11, 2022).

446. *Id.*

How well have efforts by those states worked to achieve their plan goals and milestones? The 2021 State of the Blueprint report's description of the progress of three Chesapeake Bay Foundation states (Pennsylvania, Maryland, and Virginia) provides some results.[447] The report identifies the status of these states' efforts based on three levels of achievement of projected load targets: (1) on track ("less than 10% off target"); (2) in danger of being off track ("within 10–25% of target"); and (3) off track ("more than 25% off target or pollution is increasing").[448] The results in the 2021 report demonstrate that the efforts of these three states to achieve their agricultural nutrient pollution targets had not been successful to that point.

***Pennsylvania*:** According to the report, agriculture is the means by which Pennsylvania plans "to achieve more than 90 percent of its remaining nitrogen-pollution reductions."[449] This plan is based on significant estimated nutrient pollution reductions (more than two million pounds) from agricultural conservation practices. The report reflects that, as of 2021, the state "remains significantly behind, and a major acceleration of financial and technical assistance is essential to help farmers establish the conservation practices needed to reach Pennsylvania's commitment."[450]

The report concluded Pennsylvania was "off track" in achieving two of its agricultural objectives. First, assisting farmers with implementation of "crop- and soil-management practices [e.g., nutrient management plan implementation and conservation practices] that improve long-term soil health." Second, establishing a "comprehensive communication/outreach strategy to engage farmers/landowners in planting and maintaining riparian forest buffers and technical assistance and funding sources to achieve 95,000 acres of forested buffers by 2025."[451] The report also noted Pennsylvania was "in danger of being off track" in developing a strategy for compliance and enforcement for farm inspections and verification of nutrient pollution reduction plans.[452]

The report noted that some steps in achieving objectives had been taken. These steps included: state funding for riparian forest buffers through existing grant programs to build capacity for tree planting and care; a cost-share program for developing nutrient pollution reduction plans; plan verification for more than 11,000 farms during the period 2016–20; and

447. Chesapeake Bay Foundation, *2021 Chesapeake Bay State of the Blueprint: Pennsylvania, Maryland, and Virginia*, https://www.cbf.org/document-library/cbf-reports/2021-state-of-the-blueprint-report.pdf.

448. *Id.*

449. *Id*.

450. *Id.*

451. *Id*.

452. *Id.*

establishment of approximately 25% of the buffers projected by 2021.[453] Based on these findings, the report identified "steps needed" to achieve plan objectives, including: completion of inspections for more than half of the state's farms; legislation to create a program and funding for agricultural conservation assistance to implement the necessary conservation practices; financial and technical assistance to farmers for implementation of the plans' practices; legislation to create a "dedicated, stable, state agricultural cost-share program" for investments in conservation practices; and funding and technical assistance to complete the remaining 75% of the buffers planned by 2021.[454]

***Maryland*:** According to the report, as of 2021, Maryland was on track for achieving its objective to fully "implement Maryland's phosphorus management program" and in danger of being off track for increasing "natural filters and healthy soil cover on agricultural land."[455] Despite progress in agricultural conservation practices, including voluntary actions to manage phosphorus from fertilizers, as well as in technical assistance and funding for filters and soil cover, the report concluded the state's "broad strategies alone are not enough to put Maryland on pace to meet its targets for agriculture by the Blueprint's 2025 deadline."[456] Necessary steps indicated in the report include: best practices for phosphorus management; "timely reporting" of soil phosphorus levels and farm practices to reduce excess phosphorus; increasing targets and improving timing for implementation of natural filters; prioritizing enhanced incentives for "diverse, year-round crop or pasture cover"; maximizing enrollment in the federal Conservation Reserve Enhancement Program (CREP); and standardizing natural filter restoration for conservation easement lands.[457]

***Virginia*:** As of 2021, Virginia was in danger of being off track for implementing its nitrogen and phosphorus goals for agriculture related to: (1) "changes in cost-share practices to increase incentives for forested buffer implantation";[458] and (2) "legislation to track and require livestock exclusion and nutrient management."[459] The report noted that substantial work remained for the agricultural objectives, concluding that "[a]griculture represents nearly 70 percent of the remaining pollution reductions Virginia must make to meet its Blueprint targets."[460] Further, the report stated that "without finding ways to massively accelerate the adoption of conservation

453. *Id.*
454. *Id*.
455. *Id.* at 8.
456. *Id.*
457. *Id.*
458. *Id.* at 11.
459. *Id.*
460. *Id.*

practices on farms, [Virginia] will not meet its targets for agriculture by the 2025 deadline."[461]

For the first objective—cost-share practices—the report described the technical committee's recommendation to create a cost-share program for streamside forested buffers during the first three years of creation and the need for state agency approval of the program. [462] Virginia reported 257 acres of forested buffers were planted in 2020. The report also identified the need for annual planting of "more than 6,000 acres of buffers" [463] to achieve the 48,000 acres projected for 2025. Regarding legislation for tracking and requiring livestock exclusion and nutrient management, the report described 2020 legislation concerning cattle fencing for streams by 2026 if agricultural nutrient reduction targets could not be achieved within the Blueprint timeline. The report also noted Virginia conducted pilot studies that "evaluate[d] progress and established an approach to evaluate the remaining work."[464] Finally, the report identified the need for "[l]ivestock exclusion and nutrient management" in the state's watershed plan and funding for the cost-share program.[465]

IV. ANALYSIS OF CURRENT APPROACHES AND PROPOSALS FOR FUTURE ACTION

"You cannot escape the responsibility of tomorrow by evading it today."
- Abraham Lincoln[466]

The time for action is now on the agricultural problem of nutrient pollution and its effect on the growth and proliferation of HABs. The causes and significant damaging impacts of HABs have been well known for a long time. The current strategies to address this national and international problem have been the subject of working groups, task forces, and research. A substantial body of studies, research, reports, and recommendations have been produced through these initiatives. Legislation, policy recommendations, incentives, funding, and technical assistance have produced scientific research, information, and recommendations about methods to detect and mitigate the effect of HABs and actions to prevent or

461. *Id*.
462. *Id.* at 11.
463. *Id.*
464. *Id.* at 12.
465. *Id.*
466. BRAINY, ABRAHAM LINCOLN, https://www.brainyquote.com/search_results?q=Abraham+Lincoln (last visited Aug. 12, 2022).

deter their occurrence. These efforts have also identified ways to reduce the impact of agricultural operations' contribution to the HAB problem.

The products of the long period of studying agricultural nutrient pollution's impact on HABs have not, however, led to real action. Despite the time, effort, and funds spent to study, assess, and make recommendations regarding the problem, there has been little in the way of legislation, regulation, policy, or other actions to actually effect change. Instead, federal and regional initiatives have largely taken a voluntary, incentive-based approach to agricultural nutrient pollution instead of a regulatory framework to mitigate and control the problem. Given the extensive knowledge of this issue as well as some potential solutions, legislators and regulators now need to take action to implement methods to reduce, mitigate, and prevent further impacts from agricultural nutrient pollution.

A. Federal

HABHCRA: The Harmful Algal Bloom and Hypoxia Research and Control Act (HABHCRA) was enacted more than 20 years ago. HABHCRA's provisions have initiated an extensive body of research, assessment, and recommendations for effectively addressing nutrient pollution from agricultural operations. The significant resources, planning, and funding dedicated to development of this knowledge base have not been effectively utilized and should be applied now as the basis for action to implement solutions to the agricultural nutrient pollution problem. This need has already been identified by the Government Accountability Office (GAO), and recommendations to address this deficiency already have been presented to Congress.[467]

The GAO recently issued a report that evaluated the status of HABHCRA actions and issued findings regarding needed action and recommendations for managing HAB risks under federal law. Importantly, the GAO found the HABHCRA Task Force (i.e., the Interagency Working Group) failed to implement the national HAB and hypoxia program as required by the statute.[468] The GAO finding states in relevant part:

> We found that the working group has taken some actions to fulfill its responsibilities called for by the [A]ct, such as developing required plans and reports, but the group has not yet implemented a national HAB and hypoxia program under the act. The [A]ct calls for NOAA

467. GOVERNMENTAL ACCOUNTABILITY OFFICE, GAO-22-104449, WATER QUALITY, AGENCIES SHOULD TAKE MORE ACTIONS TO MANAGE RISKS FROM HARMFUL ALGAL BLOOMS AND HYPOXIA (2022).

468. *Id.*at 12.

> and EPA, acting through the working group, to maintain and enhance a national HAB and hypoxia program, which is to include a statement of objectives, including to understand, detect, predict, control, mitigate, and respond to marine and freshwater HAB and hypoxia events. As part of this program, the [A]ct called for the development of a comprehensive research plan and action strategy to address marine and freshwater HABs and hypoxia.[469]

The report notes actions the working group has completed, including: a comprehensive research plan and action strategy in 2016; a 2018 progress report on implementation of the 2016 plan and action strategy; a Great Lakes regional plan for HAB reduction, mitigation, and control; and a 2021 coordination planning document to identify agencies' roles and duties.[470] While noting these efforts, the GAO emphasized that the working group had not achieved the required program implementation:

> The working group has not implemented a national HAB and hypoxia program under the [A]ct, according to the NOAA and EPA co-chairs. The co-chairs told [the GAO] that they have had conversations about the potential staffing and resources that would be required to run a national HAB and hypoxia program, but the working group has not formally defined what such a program would look like or identified a preferred approach.
>
> According to the NOAA and EPA co-chairs, the working group has not implemented a national HAB and hypoxia program because of resource constraints and because the group has focused on other responsibilities, such as developing statutorily mandated reports. The [A]ct calls for the working group to, among other things, support the development of institutional mechanisms and financial instruments to further the objectives and activities of a national HAB and hypoxia program. However, the officials raised the concern that neither NOAA nor EPA has received funding specific to implementing such a program, and they stated that the agencies would need resources for additional staff to expand upon the existing coordination role of the working group. According to the officials, neither NOAA nor EPA, as co-chairs of the working group, has the resources or staff needed to implement a national program to address marine and freshwater HABs and hypoxia.[471]

469. *Id.*
470. *Id.*
471. *Id.* at 14–15.

The GAO further reported that the working group has failed to "develop performance measures that would allow it to assess the results of federal efforts to manage the risks of HABs and hypoxia."[472] A primary area of concern is the failure to "assess[] progress toward achieving the recommended goals" from the working group's 2016 plan and strategy.[473] The GAO cautioned that "failing to use performance measures and performance information to track progress toward outcomes can increase the risks of interagency efforts not achieving their outcomes."[474] Absent identified performance measures, the GAO concluded the working group's co-chairs "cannot assess the results of federal agencies' efforts to manage the risks of HABs and hypoxia, including the extent to which the [2016 plan and strategy's] recommended goals . . . have been achieved."[475]

An obvious immediate action, therefore, would be implementation of the national program called for by HABHCRA. After all the time and process that has occurred since HABHCRA's enactment, the working group co-chairs' admission that the group has not yet defined the national program's parameters or the implementation approach is very concerning. Determining the components of the national program and the approach for program implementation must be identified as a priority and an urgent action item.

As part of that effort, Congress and the federal agencies should assess the time, legislative and regulatory requirements, and human and financial resources needed to effectively implement the national program. Various federal laws may be appropriate mechanisms to implement the new program's requirements. For example, HABHCRA could be amended to provide new, substantive authorities for HAB and hypoxia management and control. Amendments to existing statutory programs such as the Clean Water Act, Safe Drinking Water Act, Coastal Zone Management Act, and National Environmental Policy Act, could create new requirements, permitting programs, and enforcement provisions to assure effective and accountable water quality actions to address HABs and hypoxia. Because of these statutory programs' significance to both HABs and hypoxia, these legislative amendments should include specific provisions to reduce agricultural nutrients from polluting waterbodies and mitigate the effects of agricultural nutrient pollution.

***Clean Water Act Regulation and Enforcement*:** As the nation's primary legal framework for water quality, the Clean Water Act would seemingly be the natural choice as the vehicle for specific, direct regulation of nutrient pollution. Congress could reconsider the exemptions from pollutant and point

472. *Id.* at 16.
473. *Id.*
474. *Id.*
475. *Id.* at 18.

source definitions to include agricultural activities that contribute to nutrient pollution. Even if the exemptions were maintained, the Clean Water Act could be amended to include specific requirements for reducing agricultural nutrient discharges.

The failure to regulate agricultural nutrient discharges as a pollutant is a significant obstacle to effectively addressing nutrient pollution from agricultural operations.[476] Agricultural activities could be directly regulated as point sources with specified criteria and permit conditions. Given the information known about the nature of agricultural discharges, the NPDES permitting approach could regulate agricultural nutrient discharges as either a point source or nonpoint source.[477] If nonpoint, the program could be developed in a manner similar to the concentrated animal feeding operation permit program.

Nutrient discharges could be regulated through permitting of commercial fertilizer use, manure applications, or both. For these applications, NPDES permit conditions might be based on quantitative limits for specific nutrients or qualitative conditions based on best management practices. Even if the NPDES permit conditions are not based on specific numeric conditions, providing for permitting of nutrient discharges would provide some basis for restrictions on nutrient discharges.[478] NPDES permit conditions would also assist planning and review of nutrient discharges impacts on water quality in agricultural areas.

Of course, significant change in the scope of the Clean Water Act's regulated activities, permitting requirements, and enforcement regarding nutrient discharges would require the political will to act and the initiative and resources to increase compliance. Environmental laws in general can be controversial topics for legislative action, and considering changes to the Clean Water Act would no doubt be a substantial challenge. The history of the Clean Water Act and its implementing regulations show that statutory changes to incorporate a robust regulatory structure for agricultural nutrient pollution could be very difficult to achieve.[479]

However, there is another option within the existing Clean Water Act framework to act on agricultural nutrient pollution. Compliance with numeric nutrient standards for total nitrogen and total phosphorus in state water quality standards is already within the scope of the statute and implementing regulations.[480] Increased federal enforcement of states' compliance with development of these standards would increase focus on this problem. Under

476. *See infra* text accompanying notes 236–244.
477. *Id.*
478. *Id.*
479. *See infra* Part II(B).
480. *Id.*

the Clean Water Act, the EPA is responsible for ensuring compliance with the statute's water quality standards directives and is authorized to develop criteria and standards for states that fail to do so.[481]

Although the EPA has demonstrated reluctance to do so in the past, and has even been compelled by litigation to take action,[482] public attention and/or legislative direction may prompt an EPA response to the need for action. To date, no states have adopted a complete set of nitrogen and phosphorus criteria for all water types.[483] Only eight states have adopted both nitrogen and phosphorus criteria for one or more water types; further, half of the states have failed to adopt any nitrogen, phosphorus, or chlorophyll-a criteria.[484] Based on this poor record of compliance and the demonstrated lack of real progress, action by the EPA to enforce compliance—or to adopt criteria for noncompliant states—would create a real benefit.

***Conservation Programs*:** The USDA has a variety of programs and policies to address agriculture's environmental impacts. Several voluntary programs (e.g., Conservation Reserve Program, Conservation Stewardship Program, and Environmental Quality Incentives Program) provide payments and incentives to promote conservation actions, best management practices, and conservation measures on agricultural lands.[485] While not limited to actions that promote reduction of nutrient pollution, these programs and other USDA conservation programs can induce positive change by increasing use of conservation practices known to mitigate nutrient pollution, such as buffers, filter strips, cover crops, and crop rotation.[486]

Given the substantial funding provided for land conservation and conservation practices on natural resources programs, evaluation and accountability for results is appropriate. For example, in 2017, approximately $6 billion in federal funding was allocated to the five major programs for land retirement and conservation practices.[487] Like the recommendations for HABHCRA, establishing performance measures and accountability for achieving those measures would allow the USDA and federal agencies to assess the value of the programs in addressing agricultural nutrient pollution. The data would be beneficial for determining the efficacy of established practices and priorities for funding.

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481. *Id.*

482. *Id.*

483. *State Progress Toward Adopting Numeric Nutrient Water Quality Criteria for Nitrogen and Phosphorus,* Env't Prot. Agency, https://www.epa.gov/nutrient-policy-data/state-progress-toward-developing-numeric-nutrient-water-quality-criteria#tb1 (last accessed Feb. 11, 2023).

484. *Id.*

485. *See infra* text accompanying notes 378–383.

486. *Id.*

487. UNITED STATES DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESOURCES AND ENVIRONMENTAL INDICATORS 2 (2019).

***Federal Fertilizer Regulations*:** The federal approach to fertilizer application on agricultural lands is focused on the 4Rs: right amount, right source, right placement, and right timing. Research has shown that attention to the 4Rs can reduce the nutrient runoff or leaching that may occur from commercial fertilizer or manure application.[488] The USDA has expressed its support for management practices that specifically address fertilizer application rate, timing, or method in their standards.[489] Without a regulatory structure for the 4Rs, however, compliance with this approach is based on voluntary cooperation or incentives.

Regulation of fertilizer composition and application practices could promote reduction of agricultural nutrient pollution. Use of products and technologies that facilitate efficient fertilizer use (e.g., slow-release fertilizer and precision application technology) could be regulated under federal water quality or agricultural laws. Fertilizer composition could also be regulated under federal law to promote use of products that minimize impacts from nutrient leaching and runoff. Further, conditions requiring efficient fertilizers and best management practices to minimize nutrient pollution could be incorporated into any federal permitting or funding authorizations for agricultural lands. Additionally, federal law could require states receiving federal funding or exercising federally delegated permitting authority (e.g., Clean Water Act permits) to require use of agricultural best management practices, fertilizer composition and application restrictions and conditions, and conservation land use practices.

B. Regional

The Great Lakes Commission and Chesapeake Bay Foundation demonstrate an approach to information sharing and collaboration that may serve as a model for other states to follow, pertinent to agricultural nutrient pollution. The research and assessment initiatives and information exchange facilitated by those groups can leverage members' resources in seeking solutions to HAB-related problems.[490] For areas in which research and data is not current or adequate, the collaborative nature of these groups may provide a great benefit.

As demonstrated by the experiences of the Great Lakes and Chesapeake Bay groups, however, these are not perfect models. Similar to the HABHCRA working group, the Great Lakes Commission and Chesapeake Bay Foundation have developed research, assessments, and reporting during

488. *See infra* text accompanying notes 365–377.

489. UNITED STATES DEPARTMENT OF AGRICULTURE, ERR-127, NITROGEN IN AGRICULTURAL SYSTEMS: IMPLICATIONS FOR CONSERVATION POLICY, 27 (2011).

490. *See infra* Part III(B)

the many years in which they have existed.[491] Unlike HABCRA, there has been some effort at the regional level to define benchmarks for progress. The progress reports issued by the Chesapeake Bay Foundation, for example, document member states' progress in achieving those benchmarks and actions needed to improve performance in meeting the benchmarks.[492]

These regional groups do not have authority to mandate that member states enact specific legislation concerning agricultural nutrient pollution.[493] However, they could collaborate on legislative proposals and commit to proposing legislation to accomplish their agreed objectives. Examples of legislative proposals that may be considered include: fertilizer composition and application restrictions; certified fertilizer applicator certifications; land use practices (e.g., buffers and use of cover crops) to reduce agricultural nutrient discharges; and conditions on state permitting or funding to promote agricultural nutrient best management practices and minimization of discharges. Similarly, federal funding for these regional groups could include conditions incorporating these legislative proposals as well as other actions to promote reduction of agricultural nutrient discharges.

CONCLUSION

"When we forget that we are embedded in the natural world, we also forget that what we do to our surroundings we are doing to ourselves."
- David Suzuki[494]

The issues and options associated with agricultural nutrient pollution have been known for many years. Significant research conducted at the federal, regional, and state levels has provided extensive information about the causes, impacts, and methods to combat agricultural nutrient discharges. Research on agricultural nutrient pollution as well as assessments, planning, and reporting have demonstrated the needed understanding that this problem exists. However, the motivation—or political will—to act and implement specific, concrete steps to address the problem does not appear to exist. A sense of urgency is needed to motivate legislators, policymakers, and the public to prioritize the HAB problem generally and to address the impacts of agricultural nutrient pollution specifically. Given what we know about the problem and the consequences of delay, failure to act is not an option.

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491. *Id.*
492. *Id.*
493. *Id.*
494. DAVID SUZUKI FOUNDATION ONE NATURE, DAVID SUZUKI, https://davidsuzuki.org/expert/david-suzuki/ (last visited Aug. 12, 2022).