Nutrient Loss Reduction in the Mississippi/Atchafalaya River Basin


By Reagen Tibbs and Maria A. Boerngen

Reagen Tibbs is a Graduate Research Assistant in the Department of Agriculture at Illinois State University. Maria A. Boerngen is an Associate Professor of Agribusiness in the Department of Agriculture at Illinois State University.

Acknowledgment

The authors are grateful for support from the USDA NRCS Conservation Innovation Grant, On-Farm Trials Program, Award No. NR213A7500013G021, "Improving the Economic and Ecological Sustainability of U.S. Crop Production Through On-Farm Experimentation."

Abstract

The United States Environmental Protection Agency's Hypoxia Task Force was established to address the hypoxic zone in the Gulf of Mexico caused by excess nutrient loading and to coordinate efforts between the 12 states in the Mississippi/Atchafalaya River Basin to reduce their nutrient runoff. This case study focuses on the Illinois Nutrient Loss Reduction Strategy (NLRS) and compares it to the strategies implemented by the other Basin states. In the years ahead, farm operators, landowners, and farm managers will be challenged to voluntarily meet nutrient loss goals while balancing the costs of implementing best management practices recommended to reduce the size of the Gulf hypoxic zone.

INTRODUCTION

In 1972, the U.S. Congress passed, among other environmental legislation, the Clean Water Act and established the Environmental Protection Agency (EPA). The EPA is charged with both regulating and protecting the environment (US EPA, 2022). In 1997, the EPA established the Hypoxia Task Force with the goal of "understand[ing] the causes and effects of eutrophication in the Gulf of Mexico; coordinat[ing] activities to reduce the size, severity, and duration of the hypoxic zone; and ameliorat[ing] the effects of hypoxia" (US EPA, 1998). Under the Hypoxia Task Force's charter, the relationship and roles of various federal, tribal, state, and local agencies were defined, and several committees were formed to perform specific tasks. The Hypoxia Task Force also set forth nutrient reduction goals and strategy guidelines for the several states in the Mississippi/Atchafalaya River Basin based on priority watersheds identified by the task force, with 12 states containing priority watersheds. Each state that contains a priority watershed is tasked with creating goals that align with the overall goals of the Hypoxia Task Force and developing tailored strategies that can be implemented in that state to meet its respective goals. In 2015, the State of Illinois, through the Illinois Department of Agriculture, Illinois EPA, and other agencies, released the final strategy for nutrient loss reduction in Illinois following the EPA Gulf Hypoxia Action Plan.

This case study aims to analyze the Illinois Nutrient Loss Reduction Strategy (NLRS), focusing on its goals and strategies and the progress made to reach those goals, with particular attention paid to agricultural non-point sources of runoff. In addition, nutrient loss efforts in the 11 other states under the jurisdiction of the Hypoxia Task Force are analyzed and compared to Illinois. The primary evidence and literature for this case study are the original nutrient loss reduction strategies from the 12 states and federal agencies.

HYPOXIA TASK FORCE ACTION PLANS OF 2001 AND 2008

Although nitrogen and phosphorus are essential nutrients that aquatic ecosystems need to thrive, an excess of these nutrients can cause many different adverse reactions in a local ecosystem. Excess nitrogen in the northern Gulf of Mexico has driven excessive algae growth. It deprives underwater life of the oxygen it needs, causing aquatic life to die and the underwater habitat to be lost (US EPA, 2001). Water quality in the Mississippi and Atchafalaya River Basins is also affected by excessive nutrients, particularly phosphorus, from many different sources, such as storm runoff, wastewater treatment plants, and nutrient loss from farmland. The Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 required that the Hypoxia Task Force submit action plans to address nutrient runoff in the Gulf. In 2001, the Hypoxia Task Force released its first action plan, entitled "Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico," with the purpose of "describ[ing] an adaptive approach, based on implementation, monitoring, and research to address known problems, clarify scientific uncertainties, and evaluate the effectiveness of efforts to reduce hypoxia" (US EPA, 2001). The Hypoxia Task Force developed this plan with input from several officials and citizens concerned about hypoxia in the Gulf of Mexico. Eleven priority actions and recommendations were proposed in the 2001 Action Plan, with adjustments made as data and results became available. The plan cites that 90% of the nitrate load in the Gulf comes from non-point sources,[1] with 56% coming from the Mississippi River Basin above the Ohio River and 34% added from the Ohio River—with the states that add the highest amounts of nitrate load being Iowa, Illinois, Indiana, Ohio, and southern Minnesota (US EPA, 2001). The primary goals to reduce hypoxia outlined in the plan were to (1) reduce nitrogen loads into the basins and (2) enhance denitrification in Louisiana along the northern shore of the Gulf, with the overall goal being to reduce nitrate loads in the hypoxic zone by 40% compared to the average between 1955 and 1970. Eleven short-term actions were outlined in the plan to achieve the long-term goals of the task force and are summarized in Table 1.

Following the 2001 Action Plan, the Hypoxia Task Force submitted a 2008 Action Plan that "reflect[ed] the Task Force's efforts to track progress, update[d] the science, and adapt[ed] actions to improve the effectiveness of the efforts throughout the Basin," and "la[id] out specific steps that need[ed] to be accomplished to reach the goals. It also reiterate[d] the long-term goals and continue[d] the Task Force's commitment to an adaptive management approach to reduce the size and impact of the Gulf hypoxic zone and improve water quality in the Basin" (US EPA, 2008). Three primary goals were reiterated from the 2001 Action Plan and followed the same guiding principles, including "encourag[ing] actions that are voluntary, incentive-based, practical, and cost-effective; [and] identify[ing] opportunities for, and potential barriers to, innovative and market-based solutions" (US EPA, 2008). The 2008 Action Plan provided updates to the science of the 2001 Action Plan and analyzed the progress made toward reaching the 2001 Action Plan's goals. The 2001 Action Plan established a goal of reducing the size of the hypoxic zone to less than 5,000 square kilometers (approximately 1,900 square miles). The average size of the zone between 2003 and 2007 was 14,644 square kilometers (5,600 square miles), and in 2007 the size of the zone was 20,500 square kilometers (7,900 square miles) (US EPA, 2008). Data also showed that 80% of the nitrogen load and 64% of the phosphorus load in the Gulf came from either the Upper Mississippi or Ohio/Tennessee sub-Basins. Between 2001 and 2005 there was a 21% decrease in nitrogen load and a 12% increase in phosphorus load. However, most of the reduction in the nitrogen load was from nitrogen forms other than nitrate, the leading cause of hypoxic activity (US EPA, 2008). Of the 11 short-term actions in the 2001 Action Plan, actions 2, 3, and parts of 4, 5, 6, 9, 10, and 11 had been completed by 2008. Action 1; a portion of actions 4, 5, and 6; and actions 7 and 8 had not been completed (US EPA, 2008). To reduce the amount of nitrogen and phosphorus that runs off into the sub-basins and Gulf, the 2008 Action Plan provided recommendations to landowners and managers as well as guidance to state, federal, tribal, and local leaders to help in the fight to reduce nitrogen and phosphorus loads. One such recommendation was for states within the Mississippi/Atchafalaya Basin to create nutrient loss reduction strategies no later than 2013. These strategies "should target those watersheds with significant contributions of nitrogen and phosphorus to the surface waters of the Mississippi/Atchafalaya River Basin and ultimately to the Gulf of Mexico" (US EPA, 2008). In addition to state strategies, federal programs for nutrient reduction and utilizing existing state programs for cost-effective nutrient reduction were also recommended actions to meet the 2001 Action Plan (US EPA, 2008). From the 2008 Action Plan, the 12 states with priority watersheds, including Illinois, adopted nutrient loss reduction strategies.

2015 ILLINOIS NUTRIENT LOSS REDUCTION STRATEGY

In addition to the 2008 Action Plan's call for the 12 Mississippi/Atchafalaya River Basin states to create strategies to reduce nitrogen and phosphorus loads, the EPA released "Recommended Elements of a State Nutrients Framework" (Stoner, 2011). Its recommendations included "set[ting] watershed load reduction goals based upon best available information . . . targeting adoption of the most effective agricultural practices . . . [and establishing] accountability and verification measures" (Stoner, 2011, 5–6). Based on these recommendations, a Policy Working Group was established by the Illinois EPA and Illinois Department of Agriculture that was tasked with advising the two agencies on several matters, including "strategies for point source reductions in watersheds with high contributions of nutrients to the Mississippi River . . . [,] accountability and verification measures, specifically for non-point sources . . . [, and] strategies for promoting identified Best Management Practices (BMPs) to maximize widespread implementation throughout a priority watershed" (Illinois EPA, 2015). The Policy Working Group comprises members from various groups and entities, ranging from water treatment agencies and university personnel to industry associations and non-governmental organizations (NGOs). Under the Policy Working Group, three subcommittees were created to address specific portions of the plan. The Point Source, Agricultural Non-Point Source, and Urban Non-Point Source subcommittees provided guidance and advice to the writing teams drafting the central parts of the strategy. The strategy outlines the legal and regulatory framework that allows the U.S. EPA, Illinois EPA, and Illinois Department of Agriculture to set the goals and recommendations outlined, among which are the Clean Water Act (33 USC 1313(c)), the Illinois Environmental Protection Act (415 ILCS 5), and the regulatory power of the agencies.

Following the 2008 Action Plan, the main goals of the Illinois NLRS are to reduce the annual loading of nitrate-nitrogen and phosphorus to the Mississippi River, with "phase 1 milestones" of 15% reduction in nitrate-nitrogen and 25% reduction in phosphorous by 2025 and a final target goal of 45% reduction of both compared to the loading average of nitrate-nitrogen and phosphorus between 1980 and 1996 (Illinois EPA, 2015). Data in the NLRS from 2015 indicate that agricultural non-point sources are responsible for 80% of nitrate-nitrogen load and 48% of phosphorus load in the Mississippi River, with 45% of reductions amounting to a decrease of 150.61 million pounds per year of nitrate-nitrogen and 8.97 million pounds per year of phosphorus from agricultural non-point sources (Illinois EPA, 2015). It is important to note that the NLRS does not explicitly state a deadline for achieving the 45% goal. For agricultural non-point sources, the NLRS outlines best management practices for farmers to voluntarily implement to meet the strategy's goals of reducing nitrate-nitrogen and phosphorus loss. The NLRS predicted that implementing best management practices will increase as education and outreach efforts, as well as incentives for adoption, become more available for farmers. Recommended in-field practices for nitrate-nitrogen loss reduction include reducing nitrogen application to the rate recommended by the Maximum Return to Nitrogen (MRTN) calculation (possible removal of 2.3 million pounds per year), changing the time of the year when fertilizer is applied (reduction estimated between 13 and 26 million pounds per year), and the use of cover crops (reduction of 84 million pounds annually) (Illinois EPA, 2015). Three edge-of-field practices are recommended in the NLRS: bioreactors, wetlands, and buffers. Bioreactors are "trenches filled with wood chips located at the edge of fields and intercept tile flow" (Illinois EPA, 2015, 3–33). The NLRS estimates that bioreactors in Illinois could reduce nitrate-nitrogen loads by 35 million pounds per year (Illinois EPA, 2015). Constructed wetlands at the end of tile lines are usually between 0.5 and 2 acres in size, and they are projected to reduce nitrate-nitrogen runoff by 49 million pounds per year. Buffers along streams and ditches in non-tiled fields can effectively reduce streams' losses while increasing plant uptake and denitrification in water that flows through buffers. If buffers are installed along agricultural streams that currently do not have them, the NLRS estimates that nitrate-nitrogen runoff could be reduced by 36 million pounds annually (Illinois EPA, 2015). Overall, if these recommendations and practices are implemented across the state, the estimated reduction of nitrate-nitrogen into the Mississippi River would be approximately 357.6 million pounds per year, well above the target 45% goal of 150.61 million pounds per year. Removing this nitrate-nitrogen load would cost approximately $3.30 per pound (Illinois EPA, 2015).

In addition to the recommendations for nitrate-nitrogen loss reduction, the NLRS suggests practices to reduce phosphorus runoff. The strategy attributes the loss of phosphorus to surface water runoff and soil erosion because phosphorus clings to soil particles. Because soil erosion is a significant factor in phosphorus loss, the best management practices recommended for reducing phosphorus loss are also recommendations to reduce soil erosion rates. One recommended practice is the establishment of buffers along streams. When the NLRS was published, approximately 64% of Illinois stream miles did not have a buffer. Introducing buffers to as many miles as possible may reduce 4.8 million pounds annually (Illinois EPA, 2015). The NLRS recommends the use of riparian buffers, which are "vegetative buffer-strip[s] near a stream, which helps to shade and partially protect the stream from the impact of adjacent urban, industrial, or agricultural land use" (Burden, 2015). The buffers should be 35 feet wide, but the strategy cautions against using aquatic buffers due to a lack of scientific studies proving their effectiveness in reducing phosphorus runoff compared to nitrate-nitrogen runoff. In addition to riparian buffers along streams, other recommendations in the report include terraces, strip cropping, and sediment control basins. Implementing the recommended practices could result in a significant non-point source reduction of 8.3 million pounds, or 22% of the goal, per year, with an estimated cost of $13.71 per pound removed (Illinois EPA, 2015).

COMPARISON OF THE ILLINOIS NLRS TO OTHER STATE STRATEGIES

Each of the 12 states in the Mississippi/Atchafalaya Basin plays an essential and integral role in reducing nitrate-nitrogen and phosphorus runoff to the hypoxic zone. Like Illinois, each state has a nutrient loss reduction strategy that explicitly addresses nitrate-nitrogen and phosphorus loading and practices to reduce loading. There is much similarity among the states' approaches. Table 2 illustrates which entity was responsible for creating each state's nutrient loss reduction goals, the composition of that entity, and the specific reduction goals established in each state. Most state strategies rely on groups and task forces led by government officials at either a department of agriculture, a state EPA, or a department of conservation/natural resources. However, Mississippi took a different approach. Each sub-group that developed its initial 2009 strategy included a representative of a group called Delta Farmers Advocating Resource Management (F.A.R.M.). This group was formed in 1997 to "facilitate environmental improvements on the farm and help the region address growing natural resource concerns" (Delta F.A.R.M., n.d.). With the help of industry sponsors such as Syngenta, support from the Mississippi State University Extension, and governmental bodies such as the U.S. Army Corps of Engineers, the USDA Economic Research Service, and the U.S. Geological Survey, the group has played a vital role in advocating for nutrient and resource management and was instrumental in the creation of the 2009 Mississippi strategy.

Another unique situation arose in Ohio, whose nutrient loss reduction efforts include the Mississippi River Basin and Lake Erie. Before the Hypoxia Task Force, Ohio had started working on a specific strategy for Lake Erie due to increased phosphorus loads in that body of water, particularly in the summer months (Ohio EPA, 2013). This resulted in the United States and Canada entering into a water quality agreement to address water quality in shared waters, including Lake Erie, in the Great Lakes Water Quality Agreement (GLWQA), first signed in 1972 and amended numerous times since then (Government of Canada and Government of the United States of America, 2012). Therefore, when it came time to draft Ohio's state strategy in 2011, the Lake Erie Phosphorus Task Force was one of the major entities responsible for establishing its goals. It should be further noted that some state strategies do not contain specific nutrient reduction goals, opting to either set goals for priority watersheds in their state (e.g., Kentucky) or to simply state that a goal is to monitor nutrient loading into priority watersheds to get a better understanding of the scenario in that state (e.g., Mississippi and Louisiana).

Table 3 compares the best management practices recommended by the Illinois NLRS and the other 11 state strategies to reduce nitrogen and phosphorus loss from agricultural non-point sources. While some state strategies outline specific practices targeted at either nitrogen or phosphorus loss, others have blanket approaches that can be used for nitrogen and phosphorus. There is little difference in the recommended best management practices among most of the 12 states, except for Mississippi, whose strategy includes a goal of determining appropriate best management practices. At the time of this case study, there is no further information on progress toward that goal.

PROGRESS TOWARD MEETING GOALS IN ILLINOIS AND NEXT STEPS

The ultimate objective of the Illinois NLRS, as with each of the 12 states in the Mississippi/Atchafalaya River Basin, is to reduce nutrient loading to acceptable levels with voluntary measures. The first benchmark date (2025) is rapidly approaching, and the 2021 Biennial Report (Illinois EPA, 2021) notes advancements and successes in reducing the state's impact on the hypoxic zone and hypoxia in the Gulf of Mexico but also notes further work that needs to be done for the state to fully meet the goals.

The report also provides updates on the progress made by several working groups in monitoring and implementing the strategic objectives. The report includes a science assessment update from the 2015 strategy, which notes that the statewide loads of nitrate-nitrogen and phosphorus are correlated with increased water yield, defined as the difference between the amount of precipitation that falls in a watershed and evapotranspiration.[2] Water yield is further connected with precipitation. Between 2015 and 2019, the statewide average for nitrate-nitrogen load was 448 million pounds per year, whereas the statewide average for phosphorus load in the same period was 46 million pounds per year (Illinois EPA, 2021). Those totals are 13% and 35% greater than the 1980–1996 baseline averages, which are the foundation of the 2015 goals. The report attributes the 2015–2019 averages to the unusually high precipitation and river flows in 2019. The largest nitrate-nitrogen and phosphorus loads were found in the Illinois River, which the report partially attributes to the fact that the river drains the largest area of rivers in the state, in addition to runoff from tiled cropland in central Illinois and wastewater treatment from Chicago and Decatur (Illinois EPA, 2021). The largest overall increase in nitrate-nitrogen loads came in the Rock River between Rockton and Joslin, which saw an increase of 135% over the 1980–1996 averages. This increase in nitrate-nitrogen loads is most likely attributed to heavy rainfall and flow through groundwater aquifers. The Vermilion and Kaskaskia Rivers saw decreases of 17% and 28%, perhaps caused by increased efficiency of nitrogen fertilizer use. The Kaskaskia, in addition to the Little Wabash River, had the greatest percent increase in phosphorus loads (86% and 77%) (Illinois EPA, 2021). In the Kaskaskia, legacy phosphorus sediment loads may have played a factor in the increase, whereas greater surface runoff is the likely cause for increases in the Little Wabash.

The 2021 Biennial Report also discusses current programs and projects devoted to reducing agricultural non-point sources of nutrient loss. Resources for this effort include 132 full-time equivalent positions in several different agencies and organizations in 2020 that were engaged in outreach, implementation, or research for the agricultural sector under the NLRS (this figure does not include private sector employees or farmers). Private and public funds made available by agricultural sector partners in 2020 totaled $13,982,060, an increase of approximately $1 million from 2019 (Illinois EPA, 2021). The report also discusses the challenges presented by the COVID-19 pandemic related to outreach and education events.

Before the pandemic, hundreds of events were held across the state to share research and data on topics ranging from cover crops, effective nutrient management, and edge-of-field practices sponsored by various agricultural organizations and commodity groups (Illinois EPA, 2021). The pandemic made holding events more difficult due to stay-at-home orders and attendance limits for certain events. Nevertheless, just over 1,000 events were held between 2019 and 2020, with more than 72,000 people in attendance. This figure is slightly lower than the 84,000 attendees between 2017 and 2018.

The 2021 Biennial Report also discusses progress in implementing conservation practices recommended in the 2015 Illinois NLRS with assistance from state and federal conservation programs. The USDA Farm Service Agency (FSA) administers a Conservation Reserve Program in Illinois, which provides resources and assistance to farmers to establish and maintain wetlands and other practices. In 2020, there were 57,867 acres enrolled as wetlands under the program, whereas 250,784 acres were in buffer zones (Illinois EPA, 2021). The FSA also reports the number of acres that had cover crops planted and harvested, regardless of financial assistance from government conservation programs. In 2020, 131,757 acres were reported in cover crops by producers, which was drastically lower than the 2019 figure of 427,410 acres (Illinois EPA, 2021). This is likely attributed to the number of acres in prevent plant following widespread flooding. Other programs at the federal level include the Environmental Quality Incentives Program, the Conservation Stewardship Program, the Mississippi River Basin Healthy Watersheds Initiative, and the National Water Quality Initiative. In addition, there are various programs and projects supported by state agencies, including the Conservation Reserve Enhancement Program, the Illinois Department of Natural Resources Contaminant Assessment Section, and the Streambank Stabilization and Restoration Program. The 2021 Biennial Report also outlines efforts by NGOs such as the Illinois Sustainable Ag Partnership, Nutrient Research and Education Council, and Illinois Farm Bureau (Illinois EPA, 2021). The report also summarizes the findings of the NLRS survey, administered by the National Agricultural Statistics Service (NASS) in 2019 and 2020. The survey results showed that most farmers know more about cover crops and nitrogen fertilizer rates. At the same time, they are less knowledgeable about edge-of-field practices such as wetlands and bioreactors (Illinois EPA, 2021).

CONCLUSION

In response to the U.S. EPA Gulf Hypoxia Task Force, the state of Illinois released the Illinois NLRS that established nutrient load reduction goals and recommended best management practices to reduce nutrient loads into the Mississippi/Atchafalaya River Basin. Eleven other states in that basin produced similar strategies. This case study analyzed the Illinois NLRS and compared it to the strategies of the other 11 states. As discussed in the 2021 interim report, Illinois may not be making adequate progress toward meeting its interim 2025 goals, which begs the question: What if voluntary adoption of best management practices is insufficient? State and federal agencies could use their broad administrative and rule-making powers to implement specific programs and practices to reduce nutrient loss, similar to the maximum daily load limits established in the Chesapeake Bay watershed (Chesapeake Bay Program, 2004). A survey of Illinois corn growers revealed that over 88% of respondents are concerned about implementing regulations to address nutrient loss concerns (Hoselton and Boerngen, 2021), which would significantly impact on-farm decision-making. As states in the Mississippi/Atchafalaya River Basin work toward achieving their nutrient loss reduction targets, farm operators, landowners, and farm managers will continue balancing the benefits of working to achieve the greater goals with the cost of implementing the best management practices that contribute to meeting those goals.

FOOTNOTES

1. The U.S. National Oceanic and Atmospheric Administration (NOAA) and U.S. EPA define "non-point source" pollution as runoff from various sources. Examples may include oil from a car parking lot being washed into a stream due to rainfall. "Point source" pollution is "any single identifiable source of pollution from which pollutants are discharged." An example of point source pollution is a factory's smokestack putting pollutants into the atmosphere (NOAA, n.d.).
2. Evapotranspiration is "loss of water from the soil both by evaporation from the soil surface and by transpiration from the leaves of the plants growing on it" (Encyclopedia Britannica, 2022).

REFERENCES

Arkansas Department of Agriculture. 2014. *State of Arkansas Nutrient Reduction Strategy.* Little Rock, AR: Arkansas Department of Agriculture, Natural Resources Division. http://arkansaswaterplan.org/references/ar_nutrient_reduction_strategy101014.pdf.

Burden, D. 2015. "What is a Riparian Buffer?" Iowa State University Extension and Outreach. Accessed August 1, 2022. https://www.extension.iastate.edu/smallfarms/what-riparian-buffer.

Chesapeake Bay Program. 2004. *The State of the Chesapeake Bay and Its Watershed: A Report to the Citizens of the Bay Region (2004).* Annapolis, MD: U.S. Environmental Protection Agency.

Delta F.A.R.M. n.d. "Our History." Accessed July 24, 2022. https://www.deltafarm.org/about-us.html.

Encyclopedia Britannica. 2022. "Evapotranspiration." https://www.britannica.com/science/evapotranspiration.

Government of Canada and Government of the United States of America. 2012. *Great Lakes Water Quality Agreement.* https://binational.net/wp-content/uploads/2014/05/1094_Canada-USA-GLWQA-_e.pdf.

Hoselton, G.S.W., and M.A. Boerngen. 2021. "Awareness of nutrient loss among Illinois corn farmers." *Journal of Soil and Water Conservation* 76 (5): 387–391.

Illinois EPA. 2015. *Illinois Nutrient Loss Reduction Strategy.* Springfield, IL: Illinois Environmental Protection Agency and Illinois Department of Agriculture. https://epa.illinois.gov/content/dam/soi/en/web/epa/documents/water-quality/watershed-management/nlrs/nlrs-final-revised-083115.pdf.

Illinois EPA. 2021. *Illinois Nutrient Loss Reduction Strategy Biennial Report 2021*. Springfield, IL: Illinois Environmental Protection Agency and Illinois Department of Agriculture. https://epa.illinois.gov/content/dam/soi/en/web/epa/topics/water-quality/watershed-management/excess-nutrients/documents/nlrs-biennial-report-2021_FINAL.pdf.

Indiana State Department of Agriculture and Indiana Department of Environmental Management. 2021. *Indiana's State Nutrient Reduction Strategy.* https://www.in.gov/isda/files/Indiana-State-Nutrient-Reduction-Strategy_final-Version-6_small.pdf.

Iowa Department of Agriculture and Land Stewardship, Iowa Department of Natural Resources, and Iowa State University College of Agriculture and Life Sciences. 2017. *Iowa Nutrient Reduction Strategy.* https://www.nutrientstrategy.iastate.edu/sites/default/files/documents/2017%20INRS%20Complete_Revised%202017_12_11.pdf.

Kentucky Energy and Environment Cabinet, Division of Water. 2014. *Kentucky Nutrient Reduction Strategy.* https://eec.ky.gov/Environmental-Protection/Water/Protection/Documents/2014%20Draft%20Kentucky%20Nutrient%20Reduction%20Strategy.pdf.

Louisiana Department of Environmental Quality. 2019. *Louisiana Nutrient Reduction and Management Strategy.* https://edms.deq.louisiana.gov/app/doc/view?doc=11972009.

Minnesota Pollution Control Agency, Minnesota Department of Agriculture, and Minnesota Department of Natural Resources. 2014. *The Minnesota Nutrient Reduction Strategy.* https://www.pca.state.mn.us/sites/default/files/wq-s1-80.pdf.

Mississippi Department of Environmental Quality and Delta F.A.R.M. 2009. *Mississippi Delta Nutrient Reduction Strategies*. https://www.mdeq.ms.gov/wp-content/uploads/2017/06/Delta-Nutrient-Reduction-Strategy_12-15-2009.pdf.

Missouri Department of Natural Resources. 2014. *Missouri's Nutrient Loss Reduction Strategy*. https://dnr.mo.gov/document-search/missouri-nutrient-loss-reduction-strategy.

NOAA. n.d. "Nonpoint Source Pollution." Accessed September 10, 2022. https://oceanservice.noaa.gov/education/tutorial_pollution/welcome.html.

Ohio EPA. 2013. *Ohio Nutrient Reduction Strategy.* https://epa.ohio.gov/static/Portals/35/wqs/ONRS_final_jun13.pdf.

Stoner, N.K. 2011. "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions." Official memorandum. Washington, DC: US EPA. https://www.epa.gov/sites/default/files/documents/memo_nitrogen_framework.pdf.

Tennessee Department of Environment and Conservation, Division of Water Resources. 2015. *Tennessee Nutrient Reduction Framework*. https://www.tn.gov/content/dam/tn/environment/water/tmdl-program/wr-ws_tennessee-draft-nutrient-reduction-framework_030315.pdf.

US EPA. 1998. *Charter of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force*. Washington, DC: Watershed Nutrient Task Force, US EPA. https://www.epa.gov/sites/default/files/2015-03/documents/2008_9_10_msbasin_tfcharter_revised.pdf.

US EPA. 2001. *Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico.* Washington, DC: Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, US EPA. https://www.epa.gov/sites/default/files/2015-03/documents/2001_04_04_msbasin_actionplan2001.pdf.

US EPA. 2008. *Gulf Hypoxia Action Plan 2008.* Washington, DC: Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, US EPA. https://www.epa.gov/sites/default/files/2015-03/documents/2008_8_28_msbasin_ghap2008_update082608.pdf.

US EPA. 2022. "Our Mission and What We Do." https://www.epa.gov/aboutepa/our-mission-and-what-we-do.

Wisconsin Department of Natural Resources and University of Wisconsin Extension. 2013. *Wisconsin's Nutrient Reduction Strategy.* https://dnr.wi.gov/water/wsSWIMSDocument.ashx?documentSeqNo=163205586.

Table 1. Short-Term Action Plans Established by the Gulf Hypoxia Task Force		
Recommendation	**Time Frame for Achievement**	**Responsible Party**
#1: Comprehensive budget proposals to support the action plan	By December 2000	Hypoxia Task Force, with input from states and tribes in the Mississippi/Atchafalaya Basin
#2: Establish sub-basin committees	By summer 2001	States and tribes in the Basin, along with the Hypoxia Task Force
#3: Develop an integrated Gulf of Mexico Hypoxia Research Strategy	By fall 2001	Hypoxia Task Force
#4: Expansion of long-term monitoring programs for the hypoxic zone	By spring 2002	Coastal states, tribes, and relevant federal agencies
#5: Expansion of the existing monitoring programs within the Basin	By spring 2002	States, tribes, and federal agencies within the Mississippi/Atchafalaya Basin
#6: Develop strategies for more significant nutrient reduction	By fall 2002	States, tribes, and federal agencies within the Mississippi/Atchafalaya Basin
#7: Complete a reconnaissance-level study of potential nutrient reduction strategies	By December 2002	Army Corps of Engineers, Congress, states, tribes, and other federal agencies
#8: Identify point-source dischargers	By January 2003	Sub-Basin committees and other Clean Water Act authorities
#9: Increase assistance to landowners for voluntary actions	By spring 2003	Sub-Basin committees, states, tribes, and federal agencies
#10: Increase assistance to agricultural producers to implement best management practices	By spring 2003	Sub-Basin committees, states, tribes, and other federal agencies
#11: Assess nutrient load reductions and changes in the hypoxic zone	By December 2005 and every five years after	Hypoxia Task Force

Source: EPA, 2001.

Table 2. Comparison of the Illinois NLRS to Other State Strategies			
State	**Body/Entity Responsible for Creating State Strategy**	**Composition of the Body/Entity**	**Nutrient Reduction Goals for the State**
Illinois	Policy Working Group	Members include representatives from the Illinois EPA, Department of Agriculture, academia, NGOs, and industry	By 2025, a 15% reduction in nitrate-nitrogen and a 25% reduction in phosphorus with a long-term goal of 45% reduction of both
Arkansas	Nutrient Reduction Strategy Coordination Team	Members include representatives from state agencies, academia, and extension	40% reduction of the baseline goal in the Illinois River watershed
Indiana	Indiana Department of Environmental Management and Department of Agriculture	Department of Agriculture and Department of Environmental Management, along with other state organizations and Purdue Extension	Nutrient benchmark goals for phosphorus loads are not to exceed 0.3 mg/L and nitrate-nitrite not to exceed 10 mg/L
Iowa	Iowa Department of Agriculture and Department of Natural Resources	In addition to the Department of Agriculture, Department of Natural Resources, Iowa State University Extension, and other state and federal agency partners	45% reduction of nitrogen and phosphorus losses
Kentucky	Kentucky Division of Water and other partners	Kentucky Center of Excellence for Watershed Management, academia, and other state agencies	No overall goals for the state; goals are set for each specific priority watershed
Louisiana	Louisiana Nutrient Reduction and Management Strategy Interagency Team	Various state and federal agencies and LSU Extension	No specific goals are listed
Minnesota	Interagency Coordination Team	Various state and federal agencies, academia, and local government bodies	45% reduction from average 1980–1996 conditions for nitrogen and phosphorus by 2040, with a 2025 milestone of 20% reduction for nitrogen and 45% for phosphorus
Mississippi	Planning Team	Various state and federal agencies, farmer advocacy organizations, and water management districts	No specific goals are listed
Missouri	Missouri Department of Natural Resources	In addition to the Department of Natural Resources, other state and federal agencies, community, and farmers groups were consulted	No specific goals are listed
Ohio	Ohio Department of Agriculture, Department of Natural Resources, Ohio EPA	Various state agencies, U.S. EPA Region V, Point Source, and Urban Nutrient Workgroup	In the Ohio River Basin, maximum phosphorus permit limits of 1.0 mg/L
Tennessee	Tennessee Department of Environment and Conservation, Division of Water Resources, and Tennessee Nutrient Strategy Taskforce	Various state and federal agencies, agricultural industry representation, NGOs, and other advocacy groups	Short-term goal of reducing nitrogen and phosphorus by 20%; long-term goal of reducing nitrogen and phosphorus by 40%
Wisconsin	Wisconsin Department of Natural Resources, Targeting Workgroup, Tracking & Reporting Workgroup, and Monitoring Workgroup	Department of Natural Resources, along with University of Wisconsin Extension, Wisconsin Department of Agriculture, Trade & Consumer Protection, and the U.S. Geological Survey	45% reduction of phosphorus to the Mississippi River; no specific goal for nitrate-nitrogen reduction

Sources: Individual states' nutrient reduction strategies.

Table 3. Comparison of Best Management Practices Recommended by Each State Strategy for Agricultural Sources		
State	**Nitrogen Practices**	**Phosphorus Practices**
Illinois	Reduce the application of nitrogen to the MRTN recommendations; change the timing of fertilizer application; use cover crops, bioreactors, wetlands, and riparian buffers	Riparian buffers, water and sediment control basins, strip cropping, terraces
Arkansas	Riparian buffer zones and functional wetland areas; improved grazing, pasture management, and use of nutrient-inhibiting substances	Same as Nitrogen Practices
Indiana	No fall application of nitrogen; apply sulfur to make nitrogen more available to plants and use nitrogen stabilizers	Same as Nitrogen Practices
Iowa	Timing of nitrogen application, cover crops, living mulches, bioreactors, extended rotations, planting perennials	Erosion control, tillage, crop change, wetlands, buffers, and sediment control
Kentucky	Contour farming, grass/legume rotation, mulching, strip cropping, and cover crops	Same as Nitrogen Practices
Louisiana	Cover crops, contour farming, grassed waterway, riparian buffers, wetland creation	Same as Nitrogen Practices
Minnesota	Cover crops, prescribed grazing, contour farming, strip cropping, terracing, and vegetative barriers	Same as Nitrogen Practices
Mississippi	[Do not list any practices, just the goal of recommending practices]	
Missouri	Manage manure, 4R nutrient management, cover crops, and gully erosion control	Same as Nitrogen Practices
Ohio	Implementing whole farm conservation practices, grass waterways, cover crops, reduced tillage, applying manure/fertilizer to meet the needs of the plants, retiring highly vulnerable land	Same as Nitrogen Practices
Tennessee	4R nutrient management, cover crops, vegetative waterways, conservation tillage	Same as Nitrogen Practices
Wisconsin	Manage manure systems, riparian buffers, prescribed grazing, sediment basins, strip cropping	Same as Nitrogen Practices

Sources: Individual states' nutrient reduction strategies.