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Policy process and problem framing for state Nutrient Reduction Strategies in the US Upper Mississippi River Basin

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Abstract: To address the hypoxic zone in the Gulf of Mexico, US Mississippi River Basin (MRB) states have developed Nutrient Reduction Strategies (NRSs) following a framework outlined by a US Environmental Protection Agency (USEPA) memo in 2011. In this study, we documented the process of NRS formulation and implementation by states based on qualitative interviews with 34 policy actors involved with NRS development in seven Upper MRB states a decade after the NRS framework was introduced. Our objectives were to (1) describe and compare stakeholder perceptions of each state's NRS policy stages; (2) identify common challenges, accomplishments, and innovations resulting from the NRSs; and (3) explore the role of the 2011 USEPA memo as a catalyst for nutrient reduction action. We found that the USEPA policy memo was generally acknowledged as a catalyst for initial planning, but most interviewees framed the policy problem primarily around concern for local waterways compared to the Gulf of Mexico as a motivation for sustained policy development and implementation. Multistakeholder forums were a commonly cited success of the NRS development processes. Implementation challenges included the voluntary nature of most options to address nonpoint source pollution and the scale of practice implementation needed to achieve goals. There were differences both within and among states with respect to the importance and effectiveness of one USEPA framework element—establishing numeric nutrient criteria.

Key words: nonpoint source pollution—planning—policy—qualitative social science—water

Nutrient and sediment pollution affects lakes, rivers, and coastal oceans around the world (Steffen et al. 2015). In the United States, federal and state agencies have coordinated for decades to reduce hypoxia (depleted oxygen [O] levels) in the Gulf of Mexico caused largely by nitrogen (N) pollution from the Mississippi River Basin (MRB). These entities have funded numerous programs that largely promote voluntary reductions in pollution sources, from agricultural best management practices (BMPs) like cover crops or manure management, to urban stormwater management practices like rain gardens (Ribaudo and Shortle 2019). Yet each year, Gulf hypoxia has resulted in enormous "dead zones," averaging more than 5,300 m^2 over the past five years (USEPA 2021a). Established in 1997, the Mississippi River/Gulf of Mexico Hypoxia Task Force is comprised of representatives from federal and state agencies throughout the MRB and is charged with coordinating efforts to reduce excess nutrients to the Gulf and address negative water quality effects. The task force released an action plan in 2008 with a goal of reducing 20% of the nutrient pollution into the Gulf by the year 2025 and reducing the areal extent of the resulting hypoxic zone to less than 5,000 km^2 by 2035 (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2008).

Consistent with goals established in the 2008 Action Plan, Nancy Stoner, then acting assistant administrator for the US Environmental Protection Agency (USEPA) Office of Water (and task force member), released a memorandum in 2011 exhorting MRB states to "make greater progress in accelerating the reduction of nitrogen and phosphorus loadings" (Stoner 2011). This memorandum (hereafter the "Stoner Memo") outlined a framework of eight "recommended elements" for state nutrient reduction strategies, as follows: (1) prioritize watersheds within the state based on available data; (2) set pollution load reduction goals; (3) ensure point source permit effectiveness in priority areas; (4) develop watershed-scale plans in partnership with governmental and nongovernmental stakeholders to address agricultural pollution; (5) address pollution from community stormwater and septic systems; (6) assess and demonstrate progress by setting a baseline of existing pollution loads and BMPs and monitoring pollution load change; (7) report implementation activities annually and report load reductions biannually; and (8) develop a work plan to develop numeric water quality criteria (as opposed to narrative criteria). All 12 states in the core MRB have adopted and begun implement-

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ing Nutrient Reduction Strategies (NRSs) that include most or all these elements.

The scope of the framework outlined in the Stoner Memo is comprehensive for assessing nutrient sources and reducing excess loads to waterways, and the immense scale involved in responding to the Stoner Memo requires engagement from a broad cross section of stakeholders. Agriculture is an important industry in the MRB. Corn (*Zea mays* L.) and soybeans (*Glycine max* L.) account for almost half of US cash crop sales (USDA ERS 2021), and most of that is produced in the MRB. Additionally, agriculture contributes most of the N pollution entering the Gulf of Mexico (Rabalais and Turner 2019). Municipal, industrial, and urban stormwater elements are also reflected in the NRS framework, and many environmental groups engage in the issues, from local and regional watershed coalitions to multinational organizations. Perhaps not surprisingly, given the large geographic scale and variability in state efforts, critics have questioned whether the NRSs are achieving progress and whether MRB states are on track to meet water quality goals (Iowa Environmental Council 2019; Secchi and McDonald 2019). We suggest that while water quality improvement is the ultimate goal, an exclusive focus on measuring water quality to assess progress may mask important deliberations and innovations within each of the MRB states through the process initiated by the Stoner Memo and NRS framework. In this study, we sought to document NRS development and implementation to better understand advances and setbacks across states, and to explore whether the 2011 Stoner Memo was a catalyst for water quality management in the MRB (Prokopy et al. 2014).

We draw upon concepts of policy development stages to structure our analysis. Public policy writing and implementation can be characterized as a set of interconnected stages or arenas through which multiple actors, including governmental and nongovernmental stakeholders, deliberate over a particular issue or problem, assess potential options, and act (Ostrom 2005). Although policymaking rarely follows a specific progression (Jann and Wegrich 2007), policy scholars commonly divide the process into multiple stages that encompass agenda setting, policy formulation, decision-making, policy implementation, and policy evaluation (Howlett and Cashore 2014). In this context, agenda setting is the process of how issues become important as policy problems; policy formulation is the creation of options for government action; decision-making is the process of choosing a particular option; policy implementation is how policies are rolled out on the ground; and policy evaluation is the assessment of results attributed to policies by governments and stakeholders, which may lead to further refinements. The policy stages have been critiqued as overly linear and noncausal (Jenkins-Smith and Sabatier 1993); more recent applications use the concept of policy arenas to accommodate complex nonlinear effects across multiple streams of activity in policy, politics, and science (Kingdon 1984; Keller 2009). For instance, agenda setting generally happens at the beginning of a policy process, but the agenda may be reset and refined as issues shift and new actors join the conversation and move into new roles over time. When comparing across policy environments, the starting points in agenda setting and policy formulation stages are also different, and the concept of path dependence suggests that the array of feasible options and resources for priority setting are influenced by past governance decisions (each with its own historical process) (Pierson 2000). At different points in the policy process, "windows of opportunity" may open—in which attention to the problem, a solution, and motivated "policy entrepreneurs" all converge—to allow new policies or other changes to occur (Kingdon 1984).

We further draw on literature on policy problem framing to understand the extent to which concern about hypoxic conditions in the Gulf of Mexico drove this federalist planning and implementation effort. Policy agendas are driven by the problems that stakeholders frame as worthy of attention. Thus, problem framing has received the most attention in the agenda-setting stage of the policy process, but "debates about the nature and significance of a problem actually recur through all phases of the policy process" (Head 2019). Iterative rhetorical framing allows for making sense of, creating plans for, creating coalitions around, and acting on a policy problem (Peters 2005). Framing often changes based on the institutional level of debate or action (Brown 2012), where local government actors are likely to frame a problem differently than national-level actors to gain support (Harrison 2012). Problem framing can motivate policy entrepreneurs and influence the creation of policy windows (Mintrom and Luetjens 2017).

In this paper, we analyze state-level NRS development in the MRB across multiple policy stages, drawing on participant interviews and public NRS documents (table 1). The overall policy directive for MRB states emerged through sustained national-level attention to MRB nutrient pollution, the 2008 Action Plan, and the Stoner Memo in 2011 that outlined an organizing framework and exhorted states to move forward with individual NRSs. Several recent studies have examined various initial outcomes associated with state NRSs. Secchi and McDonald (2019) focused on whether watershed prioritization and BMP choices in NRSs were based on science, transparency and consistency of reporting, and alignment of funding with certain priorities. They found little science was used in decisions and many states failed to provide updates on progress. Christianson et al. (2018) found several common aspects across NRSs that proved effective for nutrient reduction, despite the pronounced variability between states. NRS commonalities included layering of multiple practices in one place ("stackability"), the ability to track implementation within the state ("trackability"), and some suggestions for transformative changes in agricultural production. The authors concluded the most effective NRSs were highly trackable, made significant changes to state agricultural production systems, and incorporated stackable practices to increase cost-effectiveness (Christianson et al. 2018). Finally, Salk et al. (2020) assessed NRS content and implementation by comparing nitrate (NO_3^-) concentrations from monitoring data with details found in NRSs. They found high variability between state NRS documents with respect to word counts and how each incorporated the eight Stoner Memo elements. Importantly, states with the most consistent improvements in NO_3^- levels from 2000 to 2015 also had the most comprehensive policies in their NRSs (Salk et al. 2020).

The development of NRSs by each MRB state provides an opportunity to learn about how the policy process evolved across states and how different actors in policy deliberations—including federal and state employees and representatives of agricultural and environmental nongovernmental interests—perceive the successes and failures of the process. While studies described above

Table 1
Policy stages, with definitions adapted from Howlett and Cashore (2014), described in the Mississippi River Basin (MRB) Nutrient Reduction Strategies (NRS) context.

Policy stage	Definition	MRB NRS context
Agenda setting	The process through which issues become important as policy problems	For each state, stakeholders debate priorities for and contribute to the NRS and its scope and goals
Policy formulation and decisions	The creation of options for government action and the process of choosing specific options	At the state level, developing new legislation, funding or initiatives for nutrient reduction, or reframing existing initiatives, as a result of the NRS
Implementation	How policies are rolled out and put into practice	Carrying out NRS activities to accomplish goals and objectives, such as expanding use of best management practices to reduce nonpoint source pollution
Monitoring and evaluation	Assessment of the results of policies by governments and citizens, which may lead to reformulated policies	Monitoring and assessing water quality change over time, and documenting implementation of NRS activities

represent initial assessments of the NRSs, our qualitative social science approach, 10 years after the Stoner Memo, provides in-depth understanding of this federalist policy planning process. In this study, we conducted qualitative interviews in the seven Upper MRB states (figure 1) with policy actors involved with their state NRS. We focused on the Upper Basin states because these states contribute relatively greater amounts of pollution to the Gulf than Lower Basin states (Robertson and Saad 2021). Our objectives were to (1) describe and compare perceptions of states' NRS policy stages; (2) identify common challenges, accomplishments, and innovations resulting from the NRSs; and (3) explore the role of the 2011 USEPA memo focused on reducing Gulf of Mexico hypoxia as a catalyst for nutrient reduction action.

Materials and Methods

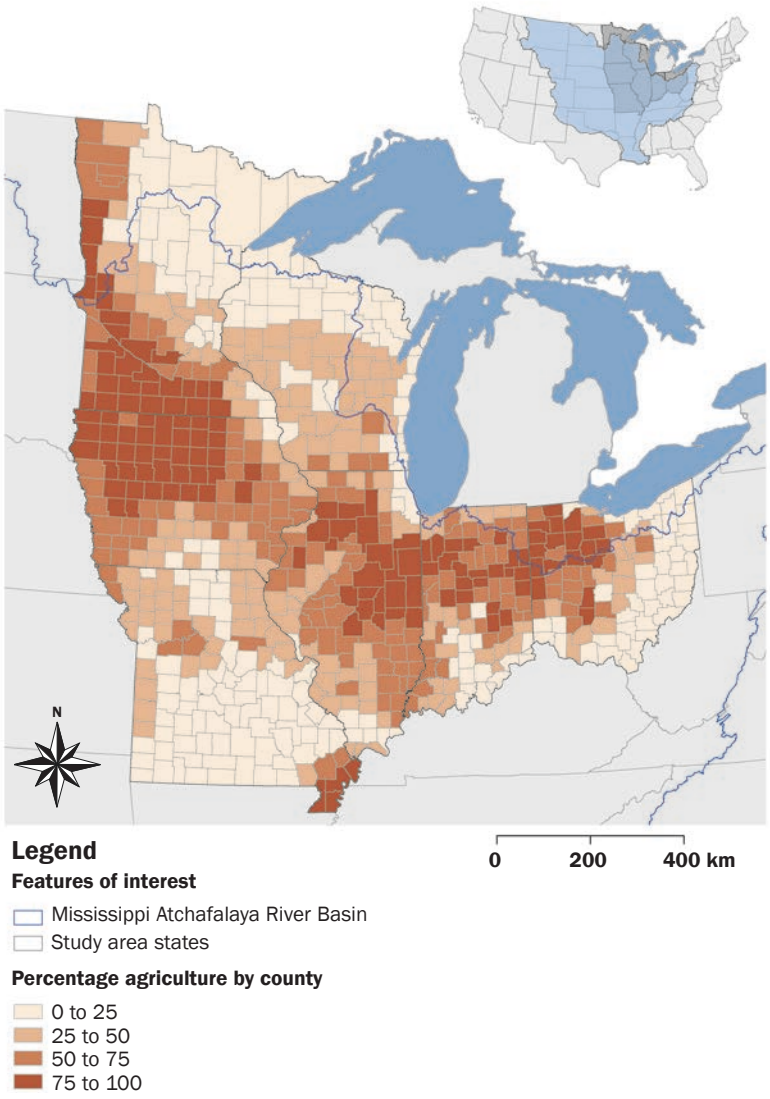
We began our research with document reviews of each state's NRS document and subsequent interim reports to understand context and establish baseline comparisons. We then conducted in-depth semistructured interviews with different policy actors from organizations involved in each state's process across the region, encompassing state agriculture and natural resources agencies, environmental organizations, and farm/commodity groups. The interviews consisted of a set of open-ended questions that would allow respondents to provide nuanced observations of the development and implementation of the NRS and their assessment of the successes and challenges of this process. The interview guide (see supplemental material) was developed based on literature review, the authors' knowledge of the existing NRS context, and the objectives stated above. The interview guide and author discussions were also informed by the involvement in state NRS processes by some of the authors of this paper through their university extension activities.

We interviewed 34 people, with multiple representatives from each of the seven Upper MRB states—Indiana, Illinois, Iowa, Minnesota, Missouri, Ohio, and Wisconsin (table 2). Most interviews were conducted between December of 2019 and January of 2021. Due to the COVID-19 pandemic, we deferred to individual preferences or organizational policies on meetings, so interviews were held in-person, over the phone, or over video conference; several Ohio interviews were conducted (in-person) in 2017 using a slightly different questionnaire. We purposely sampled interviewees to represent key actors involved in the development of NRSs, as well as university scientists and agricultural and conservation organization leaders (if they were not already explicitly included in the NRS process). We attempted to interview people from each state representing the following affiliations: state department of agriculture, state department of natural resources/environment, agricultural industry organization (e.g., commodity group), conservation/environmental organization, and a university. Research subjects were selected based on their familiarity with the NRS process and plan.

We recorded interviews in accordance with Institutional Review Board (IRB) protocols at each institution and transcribed them all. Qualitative data analysis was conducted using NVivo 12 software (QSR International, Doncaster, Australia). We analyzed transcripts through an iterative process beginning with deductive codes based on our assumptions about components of the NRS policy process, while successive rounds of coding allowed for emergent themes to come out of the interviews (Tracy 2019). We focused on perceived successes and challenges as they related to each policy stage. Four team members went back and forth during the coding process to refine the coding framework and ensure intercoder reliability. The coding framework was refined following the process of reflexive iteration as new categories emerged. After refining the coding framework, two coders conducted an intercoder reliability test on a subset of five interviews and achieved a Cohen's kappa of 0.85, indicating adequate consistency between the two coders (Church et al. 2019). In addition to the interviews, we conducted document analysis of each state's NRS and their recent annual reports to provide contextual information about states' plans. NRS update documents were retrieved from each state's nutrient reduction website (most documents were called a "Progress Report," but Indiana instead shared a short update brochure, while Ohio's most recent public document on their website was their 2015 NRS addendum). Analysis of update documents was restricted to the first paragraphs of the introduction section in which the public problem was framed.

We adapted an analytical framework from the policy stages literature. We combined two of the commonly used policy stages (policy formulation and decision-making) into a single stage because we found through initial interviews that many states adapted existing policies and practices to fit the NRS agenda, meaning the policy formulation process was absent from multiple states, or was indistinguishable from policy

Figure 1
Map showing the seven Upper Mississippi River Basin states included in this study. The watershed boundary shows the combined Mississippi River and Atchafalaya River basins. Also displayed by county are percentage agricultural land area, an important economic driver and contributor to nutrient pollution, from the 2011 National Land Cover Dataset (the year the Stoner Memo was written).



choice. Furthermore, we added "monitoring" to the evaluation stage to account for monitoring data that has been collected but not yet used for evaluation. Next, we drew on literature relating to policy problem framing to assess the relative primacy of local water quality concerns versus Gulf of Mexico concerns (the latter being the concern highlighted by the Stoner Memo).

Results and Discussion

Policy Process of the Nutrient Reduction Strategies: Agenda Setting. Each state in the MRB was expected to publish a unique NRS addressing the eight framework elements highlighted in the Stoner Memo. While the memo established an agenda and defined the scope of the policy problem, states had different starting points for engaging stakeholders and establishing priorities, scope, goals, and strategies. States assembled advisory committees to inform NRS development, all of which included stakeholders from multiple state agencies and nongovernmental organizations representing agricultural and environmental interests. Interviewees across states described how agenda setting meetings often created a feeling of a shared vision. The process often brought new people to the discussion or brought together historically adversarial stakeholders. For example, as one agricultural stakeholder noted in Illinois:

> We feel like that's a huge thing—that folks like the Sierra Club are aware of what we're doing, we invite them to our field days, we have discussions of what we think the science is saying, and I feel like we're all learning a little bit more about the perspectives even between agriculture and environmental communities.

In Missouri, the Department of Natural Resources was primarily responsible for convening meetings and brought in a variety of stakeholder groups including the Missouri Farm Bureau, the Missouri corn and soybean associations, Missouri Coalition for the Environment, and university partners. While many were at the table, environmental and university-affiliated interviewees in Missouri perceived the agricultural industry and partners as being in a privileged leadership role.

Stakeholders interviewed across the region attributed much of the initial state activity to the Stoner Memo and framework. In Illinois, one interviewee commented that the NRS process "really energized the [water quality] issue" in the state across interest groups. Wisconsin's approach to develop the Strategy embraced the Stoner Memo's emphasis on partnership and collaboration, and the resulting document reflected a comprehensive compilation of information about needs, priorities, and program initiatives. Interviewees underscored its importance for catalyzing a renewed sense of urgency for statewide conversations about long-term goals across stakeholder groups. As one Iowa participant stated, "One of the bigger things that the memo did is it really spurred all of those different groups and perspectives to come together to have those kinds of discussions… [that we] were really having a tough time trying to generate on our own." The connection was especially clear in Iowa, where stakeholders saw the Hypoxia Task Force and/or the Stoner Memo as a major catalyst for NRS agenda setting. Strong support from

Table 2

Summary of interviewees by state and affiliation. Interviewee IDs throughout the paper are the state abbreviation with group affiliation and a number if more than one interviewee in a state represented one affiliation.

State	Environmental/ Natural Resource Agency (EA)	Agriculture Agency (AA)	Agriculture Industry (AI)	Environmental NGO (EN)	University (U)	Total interviewees
IL	1	1	—	1	1	**4**
IN	2	1	3	—	—	**6**
IA	1	1	1	3	—	**6**
MN	2*	1*	—	—	1	**3**
MO	2	—	—	—	4	**6**
OH†	1	2	2	—	1	**6**
WI	1	1	—	1	—	**3**
Total	**9**	**7**	**6**	**5**	**7**	**34**

*One MN agency interviewee is listed in two categories because they play both agricultural and environmental agency roles.

†The Ohio interviews included one representative from an EN, but the interview recording was corrupted so this interview was not included in the final tally.

state agency leaders was also noted, with one stakeholder saying, "We had all the leadership fully invested like 'We're doing this,' and so… everyone was on board with it. They were all willing to put resources towards it."

Two additional comments from Iowa stakeholders further reinforce the role of the Stoner Memo as a catalyst for agenda-setting conversations in an already charged environment. An agency staff member noted, "I think it surprised the heck out of Nancy Stoner and the EPA that states just like…really grabbed onto it…[the memo] was the thing that was needed as far as giving the states some flexibility to move forward with something that can make meaningful, incremental progress, scientifically, in a practical way." On the other hand, another Iowa interviewee, while recognizing the memo as a conversation driver, suggested the process amounted to little more than cover and appeasement:

> I think the Stoner Memo was a rallying point for the agriculture groups to not do what was in there. I've been to two Gulf Hypoxia Task Force meetings, and the Stoner Memo, in my experience, was not the focus of those discussions…those meetings were…a big cheerleading session for agriculture. All of those things that would have regulated, significantly, nutrient runoff, were minimized.

The Stoner Memo was often cited as a reason advisory boards were brought together and documents written. However, while the Stoner Memo specifically highlighted Gulf hypoxia and multistate environmental concerns, stakeholders across the Upper Basin states were not especially motivated by water quality in the Gulf, and their NRSs primarily address state concerns. We analyze and discuss this phenomenon further in the section below on problem framing.

Policy Formulation and Decisions. In the context for this study, the policy formulation and decision stage involved state-level development of new legislation, funding, or initiatives for nutrient reduction, or reframing existing initiatives, as a result of the NRS. In most states, interviewees thought the NRS provided momentum for ongoing efforts and helped drive partnerships but did not directly change legislation or funding, while in two states, the NRS was directly linked to new programs and policies.

In Ohio, stakeholders expressed that much of the actual NRS document reflected policies and programs that had emerged from previous discussions in a preexisting, multiagency Agricultural Nutrient and Water Quality (ANWQ) working group. In the words of one stakeholder, "We had a draft of our nutrient strategy…When we looked at the framework in the Stoner Memo we customized our content to reflect that." Indeed, a close examination of the Ohio NRS submitted to the USEPA and earlier reports demonstrates that much of the content and recommendations related to nonpoint source reductions were directly derived from these preexisting efforts. In addition, the Ohio NRS integrated goals and action plans developed by a parallel Point Source Urban Work Group that had identified steps to achieve reductions in nutrient loadings from point source facilities (particularly publicly owned water treatment plants). That said, interviewees also felt that the process helped integrate state agency point and nonpoint source reduction work and energized ongoing efforts to get legislative action to expand funding for conservation programs. In the words of one respondent, "I don't think it's direct cause and effect, but I think the…sum total of nutrient issues in the environment and people talking about it, and us writing these strategies, has helped push some of the legislative changes."

Similarly for Wisconsin, the NRS document completed in 2013 described the array of existing federal, state, and local programs for Wisconsin and outlined a need to identify and fill program gaps and enhance coordination around those initiatives. Whereas the NRS did not establish new policies, it provided a framework for understanding how multiple efforts fit together. Consistent with the experiences of neighboring states, reducing nutrients from nonpoint sources remains a significant implementation challenge. Before the Stoner Memo in late 2010, Wisconsin passed new laws establishing stringent numeric ambient water quality standards for phosphorus (P) (Wisconsin Admin. Code NR102), and as the NRS development process began, agency staff were simultaneously creating new implementation options that emphasized a watershed approach with opportunities for point-nonpoint trading arrangements. Convening stakeholders around a full statewide approach to reduce excess nutrients in water helped clarify important connections between programs and actors. Wisconsin interviewees mentioned that the NRS has helped focus statewide as well as subwatershed level priorities (including watershed-specific HUC 10, 12 areas for detailed 9 key element plans).

While Indiana interviewees reported no new policy formation as a result of the NRS, they all agreed that the NRS influenced political coalitions. The NRS gave different groups a shared goal and catalyzed the development of the Indiana Agricultural Nutrient Alliance (IANA). IANA bridged gaps between agency and commodity groups, reached a broad audience, and provided a unified voice to promote the NRS. Multiple interviewees described the development of the IANA as a success of the NRS process:

> The IANA was probably born out of the NRS…it formalized all of those partnerships and efforts. That's how all the partners are sharing around practice adoption, as well as building better opportunities, better research outcomes, and communicating those to farmers along the way.

Stakeholders in two states identified new policies or institutional arrangements that emerged from the NRS. In Illinois, interviewees described a novel cover crop insurance policy program developed through the process (the Cover Crops Premium Discount Program) that resulted from collaboration between the Farm Bureau, Illinois Fertilizer and Chemical Association, and the State Department of Agriculture. One interviewee suggested that although Illinois budget constraints may pose challenges for nutrient reduction work, increasing the budget to support new initiatives like the cover crop insurance program is a priority for state agricultural partners:

> Our financial situation is tight here in Illinois in our state agencies, but the [cover crop insurance program] is a major priority for several stakeholders. Outside groups like the Illinois Farm Bureau committed significant funding toward the effort in the private space and report our efforts to the state annually.

In Minnesota, multiple state-level programs were created or advanced because of the NRS, according to interviewees. For instance, the Minnesota Agricultural Water Quality Certification Program was finalized in 2015 as a voluntary program to support adoption of agricultural BMPs to protect water quality, and hundreds of thousands of acres have been enrolled. Several other programs, such as the Minnesota Department of Agriculture's Nutrient Management Initiative and the University of Minnesota Extension's Nitrogen Smart educational trainings, were also created. The NRS has also provided support for increased state funding for the Forever Green Initiative and work involving continuous living cover vegetation that can help reduce nutrient pollution runoff. One Minnesota stakeholder was optimistic about progress in nonpoint source nutrient reduction practice implementation, but realistic about the challenges associated with the large scale of the problem:

> I think [the NRS] really increased awareness of the needs for nitrogen reduction and with moving forward some of the programs that will ultimately help get us there…the challenge is getting the scale of adoption of the practices up by an order of 10 or 20.

Implementation. Implementation refers to how policies are rolled out in practice, and specifically for the NRS context, the carrying out of activities to accomplish goals and objectives, such as expanding use of BMPs to reduce nonpoint source pollution. With many NRS implementation actions tied to existing state programs or partnership efforts, stakeholder reactions to implementation focused heavily on concerns about whether the NRS would become too reliant on regulation, too reliant on voluntary action, or just too daunting in scale. Some also shared guarded optimism about the potential around collaborative, multiactor approaches for better understanding implementation challenges and for sustaining a long-term focus on the issues.

Concerns about the NRS as a new discursive tool that might be used to strengthen regulation are illustrated by comments from multiple interviewees. Many in the agricultural industry preferred a voluntary approach. However, one Indiana interviewee recognized that a threat of regulation could catalyze voluntary action, since the agricultural community might say: "'Hey, over in Des Moines, Iowa, those farmers are being sued [to reduce nutrient pollution]. Over in the Chesapeake Bay, those farmers are being regulated. And here's what we can do [in Indiana] to stem that.' That threat of regulation…does get some people to listen." Yet few NRS-specific plans actually have statutory authority. This was a concern in some of our interviewees, who feared mission drift over time. For instance, an Illinois interviewee said:

> [The NRS] is not a creature of statute…it's kind of operating now on mutual respect and understanding of the framework, and if you move away from that because of the passage of time…that's something where I worry that we may lose all of these potential environmental benefits.

Several interviewees shared their awareness of concerns that continued reliance on voluntary approaches for NRS implementation would make achieving water quality improvement goals challenging. The critique among environmental advocates was that states avoided implementing a regulatory framework—namely, numeric nutrient criteria for assessing whether waterways meet designated uses—and used the NRS to show symbolic rather than actual progress. From one Iowa interview, "[The NRS] is a straw man, if you will. It's a construct to escape regulation of farm pollution, period. It's been used as window dressing. That's the most important way our state has used it." Two Missouri interviewees suggested that the NRS would increase promotion of voluntary conservation practices on crop fields (like cover crops and the 4Rs of nutrient management—right source, right rate, right time, and right place). However, they also noted that funding for a program called Our Missouri Waters, which had been embedded within the NRS as a mechanism for prioritizing watersheds, had been cut. They perceived a subsequent diminishment of cohesion and focus on the NRS.

The daunting nature of the scope of the nutrient reduction challenge and the scale of implementation given available resources emerged as another theme from interviews. An Iowa interviewee illustrated the concern:

> If we [need] 4,000 wetlands [to meet goals]...If you divide that by 365 days, that's 11 years. If you build a wetland every single day. Imagine a wetland machine going out there and stamping them out—kakoonk, kakoonk, kakoonk—and you'd have to do that one a day for 11 years to get that kind of scale. And knowing you have to get landowner buy-in, you have to design, engineer,

> build, maintain, fund. That just gives an idea of how big the scale is. That's just on the wetlands side.

Similarly, Minnesota agencies have pushed for the voluntary adoption of perennial crops and structural farm practices like controlled drainages and bioreactors to meet NRS goals. Yet voluntary adoption of agricultural conservation practice is a well-documented challenge that was recognized by Minnesota interviewees. Perennial crops and structural practices have not been widely used in recent history. There are few established markets for some perennial crops and structural practices are expensive and may not provide direct economic benefits for the farmer or landowner.

In Wisconsin, the NRS emphasizes the importance of agricultural nutrient management plans, adoption of management practices to minimize nutrient loss, and engagement with various programs and farmer peer networks. Programs have coordinated to target funding and cost-share assistance in priority areas. Even so, interviewees reflected that existing cost-share incentives are insufficient for farmer adoption of BMPs at the desired scale and suggested the need for better understanding of the social-behavioral changes to support broader acceptance of practices. They also recognized that there may be a lack of trust between farmers and agencies that may create barriers to disseminating information, technical, and financial support. Continuing concerns tied to excess NO_3^- in groundwater across Wisconsin have added to stakeholder conflict around these issues, though groundwater is not an explicit goal of the Hypoxia Task Force.

Implementation conversations with some interviewees uncovered a guarded optimism about the attention generated by the NRS and potential for sustained interest and support over time. Notably, a central feature of the NRS documents is the listing of priority watersheds that should receive most attention in future programming and policy. In Ohio, these watersheds reflect a mix of Lake Erie and Ohio River basin drainages. In the years since the NRS was submitted, the Ohio EPA has used this list to target investments of state and federal funding for conservation programs. (However, some of these watersheds drain to Lake Erie and are unlikely to contribute directly to meeting Gulf Hypoxia Task Force goals.) An additional reflection noted in one interview is that no lawsuits had been initiated related to NRS initiatives, which was perceived as a success of the implementation process, as legal legitimacy of the framework has withstood potential challenges thus far.

Monitoring and Evaluation. The monitoring and evaluation policy stage for NRSs involves monitoring and assessing water quality change over time (at multiple scales) and documenting implementation of NRS activities. As with other stages, interview responses reflect a variety of challenges and concerns. In Illinois, while interviewees were pleased with initial monitoring infrastructure, there was concern about continuing momentum for implementing the NRS: "If interim goals aren't getting there fast enough…that's when I think there will be a big shift in how people participate and how they cooperate." These interviewees further emphasized that the scale of the challenge would make the measured demonstration of water quality change very slow: "We're talking about significant management changes involving 72,000 individual farm operations over 23,000,000 ac [9,308,000 ha]. That's what we're dealing with in Illinois, so it's going to take time."

Stakeholders were also aware of the complexities associated with measuring the impact of long-term initiatives such as the NRS while taking a voluntary adoption approach. However, communication to the public has been challenging as captured by an interview in Indiana:

> Trying to communicate [why we are not seeing water quality change] is the biggest challenge…[The public is not aware] that we [may not] see changes in water quality in [a short] time frame. It might take a decade or more… I'd say trying to explain lag time while demonstrating that [we have] a critical mass of folks [voluntarily] working to make a difference is probably the biggest challenge. [We] really embrace the notion of social indicators. We need to look and see—are our farmers and residents changing their behaviors? If yes, that indicates to us that in time we will see those changes.

Other state interviewees noted those challenges and discussed needing to measure improved conservation practice adoption as the primary success of the NRS, specifically related to cover crop adoption. Interviewees acknowledged that adequately measuring contributions from individual farms is a significant challenge that requires information sharing across multiple state and federal programs. One state environmental agency was trying to address data gaps related to social indicators through a partnership with the USDA National Agricultural Statistics Service (NASS) to survey producers about BMPs every two years.

For some states, the NRS has particularly supported the development of tools for modeling impacts of implementation activities. For instance, in Minnesota, the Hydrologic Simulation Program FORTRAN Scenario Application Manager (HSFP SAM) and The Prioritize, Target, and Measure Application (PTMApp) models are used by scientists and practitioners to develop estimates of HUC-12 scale load reduction for local watershed strategies. However, interviewees in Minnesota expressed concern about future challenges with measuring water quality changes when "it's going to be so incremental." These concerns are echoed across the MRB and were further complicated by record-setting rainfall events and other dynamic flow issues noted earlier. Another Minnesota interviewee pointed the need to include private industry in monitoring and modeling efforts as well:

> We are looking at "what are these other kinds of metrics that go beyond the government-funded programs?" recognizing that private industry is really going to be key. If we don't have private industry working with us on these things, I don't think we can really achieve this successfully.

Interviews reflected concerns about drifting policy priorities influencing effectiveness of monitoring and evaluation. For Wisconsin, state monitoring of the NRS has so far involved updates on the existing policies and programs described in the original NRS. The state coordinated across entities for water quality monitoring, but to the extent program monitoring and evaluation have occurred, they have been conducted internally by program staff. For example, the state agriculture department organizes an annual review of nutrient management plans and collects data from each county on the extent of nutrient management adoption; while helpful, there is no statewide mechanism to track ongoing adoption or compliance with NMPs. Multiple Wisconsin stakeholder

groups were exploring ways to establish metrics and generate data around more difficult-to-measure activities such as farmer-led watershed groups "to better understand what their overall impacts are and if they're having a truly beneficial impact on local or larger scale water quality."

The Stoner Memo explicitly calls for states to move toward numeric water quality criteria for N and P, and some interviewees suggested NRSs should be evaluated on this basis. As of early 2022, of the seven Upper MRB states, Minnesota and Wisconsin have numeric criteria for P concentrations in lakes, rivers, and streams, Illinois has partial P criteria for lakes, and Missouri has partial N and P criteria for lakes, while Indiana, Iowa, and Ohio have no numeric criteria (USEPA 2021b), though Indiana is in the process of a science assessment that could inform future numeric criteria for P. Numeric criteria adoption is clearly a contentious issue, and one that will likely continue to be debated. In Iowa, numeric nutrient criteria dominated responses to interview questions about monitoring and evaluation of the NRS, with varied perspectives regarding whether attainment of quantifiable nutrient load reduction should be part of the NRS. Environmental interests in Iowa requested that the state set numeric criteria in both 2013 and 2018, and agencies have declined to move away from narrative criteria. An Iowa interview noted one reason for hesitation: "Everyone saw what was going on in the Chesapeake Bay with lawsuits…people punching each other in the face, hating each other. It wasn't the ideal paradigm. People were so averse to that for the Mississippi River Basin." The perception reflected here was that numeric water quality criteria would create conflict in the state and derail collaborative progress. Missouri stakeholders have had similar disagreements as those in Iowa about whether to set numeric nutrient criteria, contributing to challenges in monitoring and evaluating efforts. As one interviewee put it, "The NRS is really what we use to chart our path. But when you don't have a target and you don't have a numeric goal in the strategy, it does create some difficulty in measuring success."

Water Quality Problem Framing. We asked interviewees, when they talk or hear about nutrient reduction efforts in their state, how much of the focus is on Gulf of Mexico hypoxia and the Stoner Memo versus local water quality issues. Further, we analyzed the introductory text of the most recent NRS update report in each state to assess the problem frame as stated in state-level documents written five or more years after the initial NRS. In the interviews and the textual analysis, we found the water quality problem framed first as a local issue and then as a Gulf issue in every state. As noted by an interviewee in Missouri, water quality concerns are "dominated by local and state issues, and the Gulf's hypoxia issue is in the background. Percentagewise, I would say [attention is] something like 80/20, with the bigger portion of that being state and local issues." An Indiana stakeholder noted while most of Indiana lies within the MRB, a portion of the state is in the Great Lakes basin: "We took more of a comprehensive view in saying, 'If it's good for the Gulf of Mexico, it's good for Morse Reservoir, and it's good for Lake Erie.' So [the NRS focus] is more than just the Gulf." Similar attitudes were reflected among stakeholders in Ohio, Illinois, Wisconsin, and Minnesota, which also have rivers flowing into the Great Lakes.

In several states, the comprehensive framework outlined through the Stoner Memo expanded the scope of priorities from P to include N loss to surface waters. When the Stoner Memo was released, Minnesota had completed a state-wide assessment of P sources to watersheds and was in the process of a N assessment. The Stoner Memo sparked an effort to enhance understanding of NO_3^- movement in surface water, which had previously been isolated to local groundwater concerns. One Minnesota interviewee commented, "[Minnesota] doesn't really have many other drivers for nitrogen reduction other than the NRS." One year before the memo, Wisconsin had established new numeric water quality standards for P, and like Minnesota, the state's main focus for reducing N load was related to groundwater contamination and public health; discussions around the NRS expanded that scope to reemphasize N in surface waters. In Ohio, the NRS came at a time when the state was actively working to organize a response to the harmful algal blooms (HABs) in Lake Erie, primarily linked to P, and engaging with the NRS required an expansion of focus on N.

Table 3 describes the local water quality problems mentioned in interviews for each state, followed by an illustrative quote. It also provides a quote from each state's most recent NRS update documents framing water quality problems. These data demonstrate the relatively low emphasis given to the national concern of Gulf hypoxia by state-level policy stakeholders. At the same time, they demonstrate the water quality priorities of each state as shaped by beloved surface water recreation areas, drinking water sources, primary land uses, and location within the MRB. For instance, in Iowa, a state dominated by agricultural land cover, interviewees mentioned the importance of NO_3^- in drinking water and preventing soil erosion as primary drivers of their water quality work, while Ohio and Minnesota interviewees were concerned about the Great Lakes. The rhetorical shift toward local concerns may be partly due to an inflated perception by these experts of the relative importance of local issues to the average state resident. As one interviewee in Iowa acknowledged, speaking about persuading landowners to adopt nutrient reduction practices, every individual has their own reasons for adopting a practice and messages shift accordingly: "There's all these different benefits for why they do these practices that can speak to a landowner in many different ways: 'I want to take care of the land. I care about water quality. My downstream neighbors. I care about the Gulf.'" Nonetheless, the consistent shift toward local framing points to an important leverage point for promoting and sustaining multilevel planning efforts.

Summary and Conclusions

In 2011, the Stoner Memo laid out clear expectations for MRB states to make and implement plans to address nutrient pollution to the Gulf of Mexico following an eight-point framework. Twelve states subsequently wrote and began implementing NRSs under the USEPA framework. Yet critics have questioned whether the NRSs do too little to significantly affect nutrient pollution (Iowa Environmental Council 2019). We suggest that while water quality improvement is the ultimate goal of the Hypoxia Task Force and NRSs, an exclusive focus on measuring water quality to assess progress may mask important deliberations and innovations within the MRB states. Through qualitative interviews and analysis, we found several commonalities across states with respect to the NRS process. The Gulf Hypoxia issue held little weight as a catalyst for NRS work. Rather, more local or regional water quality concerns were the primary focus for most state discussions, even if the catalyst for NRS meetings was

Table 3

For each state, local water quality concerns mentioned in interviews, an illustrative quote from an interview, and a quote from the introduction to the most recent Nutrient Reduction Strategy update document for the state.

State	Local concerns mentioned in interviews	Illustrative quote	Introductory problem framing of most recent reports
Illinois	Lake Michigan drinking water quality	"At the first meeting, most of the groups in the room were pretty adamant that they didn't want to just do this for Gulf of Mexico reduction, if we were doing it they also wanted to have local water quality goals... I came to learn a part of that was a strategy because when you're doing Gulf of Mexico, you're doing nitrate reduction, you're doing local water quality. So, if you set a local water quality goal, then there was a little more emphasis on phosphorous reduction than the nitrogen reduction." IL-U	"The Illinois Nutrient Loss Reduction Strategy is a statewide collaborative effort to reduce the amount of nutrients, particularly nitrogen and phosphorus, in Illinois' waterways." 2021 Biennial Report*
Indiana	Morse Reservoir, Lake Erie	"We took more of a comprehensive approach in saying, 'If it's good for the Gulf of Mexico, it's good for Morse Reservoir, and it's good for Lake Erie.'" IN-EA	"Though originally developed as a result of the HTF Action Plan for the Gulf of Mexico, Indiana's strategy encompasses all waters of the state that drain to the Mississippi River, including the Wabash, White and Kankakee River systems, as well as to Lake Michigan and Lake Erie. Indiana surface and ground waters are adversely affected by excessive nutrients that come from many different sources." 2020 Nutrient Reduction Framework Brochure†
Iowa	Preventing erosion; nitrates in drinking water	"The driver I think is reduction of nutrients and protecting Iowa's waters... but I look at it based on the practice and when you approach a farmer, it's not about the Gulf, it's as local as possible and how it fits into their operation... So for no-till, it's not about the Gulf, it's about how you save passes on the field." IA-AA	"The Iowa Nutrient Reduction Strategy (NRS) is a science-and technology-based approach to assess and reduce nutrients delivered to Iowa waterways and the Gulf of Mexico." 2018-19 Annual Progress Report‡
Minnesota	Surface water and recreation; groundwater nitrates; multiple downstream concerns	"We have over 12,000 lakes, many of which have eutrophication problems with river eutrophication problems. Then we have nitrate groundwater as well... so we had a lot of in-state concerns... I'd even expand it and say, you know, we have drainage that goes three different directions... Lake Winnipeg's eutrophication problems, and then the Great Lakes [in addition to the Gulf]." MN-EA	"Excessive nutrients can diminish water quality, both within Minnesota and in downstream waters, including Lake Winnipeg, the Gulf of Mexico, and Lake Superior." 2020 5-year Progress Report§
Missouri	Surface drinking water and recreation	"Percentagewise, I would say it's something like 70/30, 80/20, with the bigger portion of that being state and local issues. There's a lot of interests here and especially in the northern half of the state, and nutrient reduction to protect public drinking water supplies because that's where most of our surface water supplies are. And... to protect lakes and streams that are recreational in nature." MO-U	"The NRLS recommends actions aimed to improve Missouri's water quality while also reducing nutrients transported downstream to the Gulf of Mexico." 2020 Update Report#
Ohio	Lake Erie and smaller lakes in-state (Buckeye Lake, Grand Lake, St. Mary's Lake)	"Now I think that Lake Erie, western Lake Erie basin is the primary focus... rarely do we talk about nitrogen in the Gulf. Not that it isn't an issue, it is. I just think there's strong focus on phosphorus and Lake Erie that gets most of the attention." OH-AI	"The Ohio Nutrient Reduction Strategy is an assessment of current efforts to reduce negative impacts on Ohio's water resources." Ohio Nutrient Reduction 2015 Addendum^

Continued

Table 3 continued

State	Local concerns mentioned in interviews	Illustrative quote	Introductory problem framing of most recent reports
Wisconsin	Surface water and recreation; groundwater nitrates affecting drinking water	"I think the ratio is like, 10% about the Gulf anymore to be honest and 90% about local. And that, you know, to some extent, I don't know if it's always a bad thing because, of course, at the local level, you can see the algal blooms and the poor water quality and our recreational lakes. And you can see the groundwater impacts from landscape practices and industries." WI-AA	"Wisconsin, like all states in the Mississippi River basin, had agreed to develop and implement a nutrient reduction strategy to address its contribution to Gulf of Mexico hypoxia… However, Wisconsin's main objective in minimizing nutrient losses to water is to improve lakes, rivers, streams and groundwater within the state." Implementation Progress Report, 2017-2019|

* https://www2.illinois.gov/epa/topics/water-quality/watershed-management/excess-nutrients/Pages/nutrient-loss-reduction-strategy.aspx.

† https://www.in.gov/isda/divisions/soil-conservation/indiana-state-nutrient-reduction-strategy/.

‡ https://store.extension.iastate.edu/Product/15915.

§ https://www.pca.state.mn.us/water/five-year-progress-report.

https://dnr.mo.gov/document-search/2020-update-missouri-nutrient-loss-reduction-strategy.

^ https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/nutrient-pollution-finding-solutions.

\| https://dnr.wisconsin.gov/topic/SurfaceWater/NutrientStrategy.html.

to respond to the Stoner Memo. Many states found energy in the first two policy stages—agenda setting and policy setting—but there was less clear connection to the Stoner Memo framework in the latter stages of implementation and monitoring/evaluation. There were especially positive feelings expressed about collaborative agricultural–environmental discussions during the agenda setting stage. When it came to policy formation and decisions, most Upper MRB states worked to better showcase and reframe existing programs to fit the NRS rather than using the NRS as a catalyst for new programs. Exceptions included cover crop insurance in Illinois and a certification program in Minnesota, suggesting that policy entrepreneurs were occasionally able to use the catalyst of the Stoner Memo to influence decision-making (Cairney 2018). However, we also heard concerns that the response to the memo was often window dressing rather than an open window for policy change (Nash and Steurer 2021). We found that at the level of individual states, the NRS development process lent energy and focus to multistakeholder discussions on how to address this issue. Yet the NRSs as planned and implemented are not meeting their potential as a regional framework (Secchi and McDonald 2019). It was clear from our interviews that as a decentralized process (consistent with US federalism), state planners were able to tailor plans and outreach to local water quality issues more appealing to their constituents. The variability in state responses and priorities lessened the potential impact of the Stoner Memo on collective contributions to nutrient problems in the Gulf of Mexico.

While the Stoner Memo provided a spark for agenda-setting and policy formulation, we found mostly low perceived levels of influence of the issue of hypoxia in the Gulf of Mexico as a driver of action. In Missouri, Ohio, and Wisconsin, interviewees perceived the NRS as bringing together existing policies and programs under one umbrella that was artificially created by USEPA. Water quality concerns were particularly focused on local issues such as drinking water, outdoor recreation, and HABs. Interviewees were most vocal about the dominance of local concerns in Missouri (drinking water and fishing) and Ohio (Lake Erie HABs). Wisconsin interviewees described the Stoner Memo as a clear catalyst of planning, but the state was already far along on nutrient management policy development including numeric criteria, so there were no new programs created because of the NRS in Wisconsin. The rhetorical shift to local concerns can be used to increase support for policy implementation and create windows of opportunity for change in a multilevel context. For instance, in the climate change policy realm, promoters have similarly utilized shifts in problem framing toward local impacts to increase buy-in (Mintrom and Luetjens 2017).

Multistakeholder forums were a commonly cited success of the NRS development processes. Divides between water stakeholders often reflect deep and enduring disagreements over appropriate actions and options (Comito et al. 2012; Church et al. 2020), but in a federalist management context such as this one, the threat of greater federal involvement can motivate local stakeholders to organize and preempt that oversight (Rosenbaum 2016). Yet it was not always clear how much weight some state NRSs gave to different perspectives. For instance, Missouri interviewees perceived outsized influence of the agricultural industry. This may suggest a degree of agency capture, reflected in resistance to further regulation on agriculture, though this position was not unique to Missouri. Furthermore, some interviewees, notably in Iowa and Missouri, were concerned their state NRS merely put a positive spin on voluntary efforts that would likely be insufficient to achieve water quality improvement, particularly in states where numeric nutrient criteria for N and P have not been adopted (as of 2022, Indiana, Iowa, and Ohio have not adopted any numeric criteria for N or P pollution).

Commonly cited implementation challenges included the voluntary nature of most options to address nonpoint source pollution and the scale of practice implementation needed to achieve goals. Much has been written about both the challenges associated with relying solely on voluntary action to address environmental problems in agriculture (Segerson 2013; Ribaudo 2015; Donley 2019) and backlash (or indifference, if regulations are not enforced) that can occur with regulation (Perez 2015; Vos 2017). Indeed, policy scholars generally recommend a combination of both voluntary and regulatory approaches to achieve pollution reduction goals (Ribaudo and Shortle 2019). At the same time, there were also hopeful characterizations of implementation. For instance, interviewees in Indiana and Minnesota expressed excitement about new public-private partnerships.

Monitoring and evaluating progress varied. Some states, like Illinois, cited the need for additional funding to pay for more water quality monitoring equipment. Many interviewees were aware of the lag time between implementation and measurement, and some interviewees, like the Indiana environmental agency interviewee, noted that it can be difficult to communicate slow feedbacks between practice implementation and water quality improvements. Another challenge cited was increasing frequency and severity of storm events. Both monitoring and modeling may also decrease in accuracy with changing weather conditions. Midwestern watersheds have experienced increasing annual precipitation along with more frequent heavy rainfall events (Villarini et al. 2013). These changing weather patterns may not be adequately reflected in models based on older assumptions of precipitation and subsequent nutrient runoff (Rissman and Carpenter 2015). In the bigger picture, the state-level NRS approach embeds forward-looking water quality goals, but no clear strategies for more transformative land use change—such as changes in crops or livelihoods—that might be needed to achieve water quality outcomes in the long-term (Campbell et al. 2021).

There are several limitations of our work that constrained our analyses but point to areas ripe for future investigation. First, it was difficult to make clear comparisons between states. There are multiple reasons for this shortcoming: our qualitative data approach does not lend itself to clear-cut comparisons; the relative flexibility of the NRS framework limits points of comparison across states; and the complexity of the social-ecological problem stymies clear causal associations between political, environmental, and policy variables. More defined comparisons may provide good opportunities for future research. For instance, analyzing why each state has implemented different approaches to assessing pollution concentrations—some states have numeric criteria, while others have narrative criteria—may be a sufficiently narrow question to compare different state contexts in determining these criteria. Second, our interviews were limited to professionals who were highly involved with the NRS process in their state. While this is an important group for understanding the development of the policy process, they could only anecdotally tell us about the desires of the general public in their state. A future survey assessing the views of state residents with respect to NRSs and important drivers of water quality policy would expand this picture.

Research on policymaking and implementation in complex systems has identified approaches that may be important to move the Hypoxia Task Force and state NRSs forward in inclusive and sustainable ways. First is reflexive governance, which rejects the assumption that there is one best way to frame and address a problem. Instead, reflexivity integrates diverse perspectives, acknowledges the multidimensionality of problems, and values learning and adapting across a system (Voß and Bornemann 2011). Reflexiveness will be crucial moving forward in the MRB under changing climate and weather regimes, acknowledging especially that some of the nonpoint source pollution reduction practices put in place may not be as effective as hoped given increased precipitation and runoff. Second and relatedly, prioritizing multistakeholder evaluations of the policy process can increase the legitimacy and success of sustainable policies (Ostrom 2010). Engaging many interests and backgrounds in evaluation can lead to active involvement and oversight of the policy process across scales. Some states in the MRB have been proactive in creating and using "social indicators" of water quality (Prokopy et al. 2009). The social indicator approach might be adopted at a regional scale in the future to better integrate multivocal understandings of progress and success. Third, national- and regional-level planners should acknowledge and adopt our finding that local concerns (e.g., proximate water bodies and drinking water sources) are more motivating for state-level coalitions than more distant problems (e.g., the Gulf of Mexico). Framing the problem first as a local issue and second as a regional issue may be the best rhetorical approach to sustain nutrient reduction over the long term. Finally, although tangible results in the form of measurably improved water quality in the MRB and Gulf of Mexico are lacking, we see value in the Stoner Memo approach of leveraging federal influence to drive policy discussions and engagement on complex environmental management issues across a region. Defining success is challenging; these issues span scales (both geographic and temporal) and shifts in state and federal political and policy environments over time make these types of initiatives difficult to sustain. The Stoner Memo regulatory federalism approach reflects the nature and scale of a problem that currently lacks regulatory solutions and requires leadership for coordinated action across states.

Supplemental Material

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