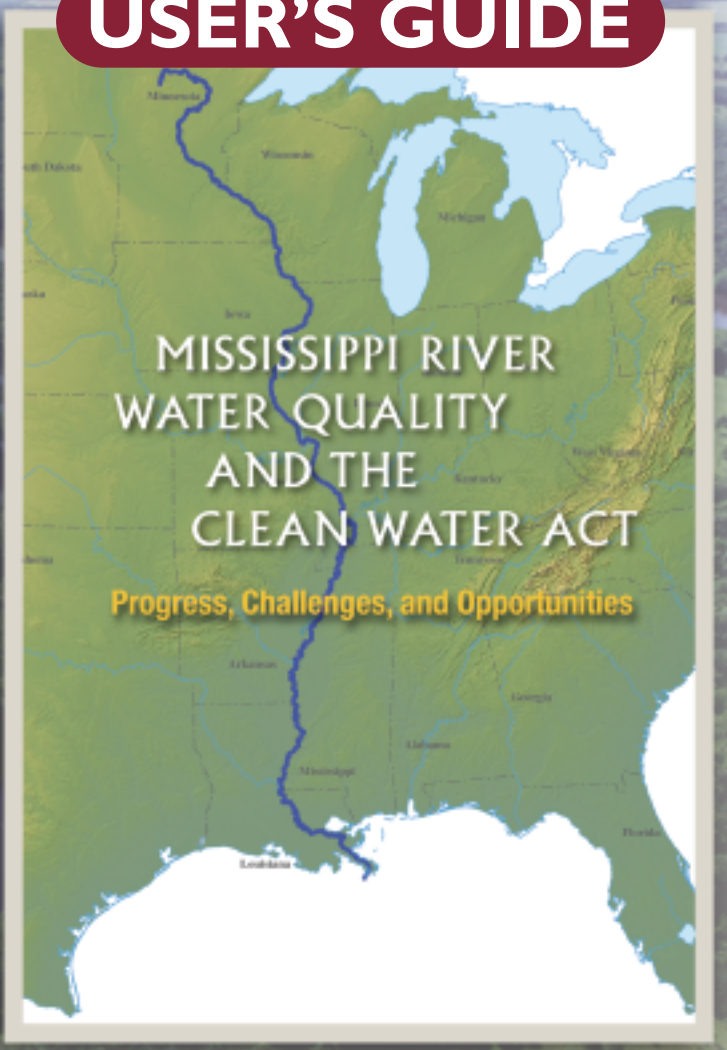
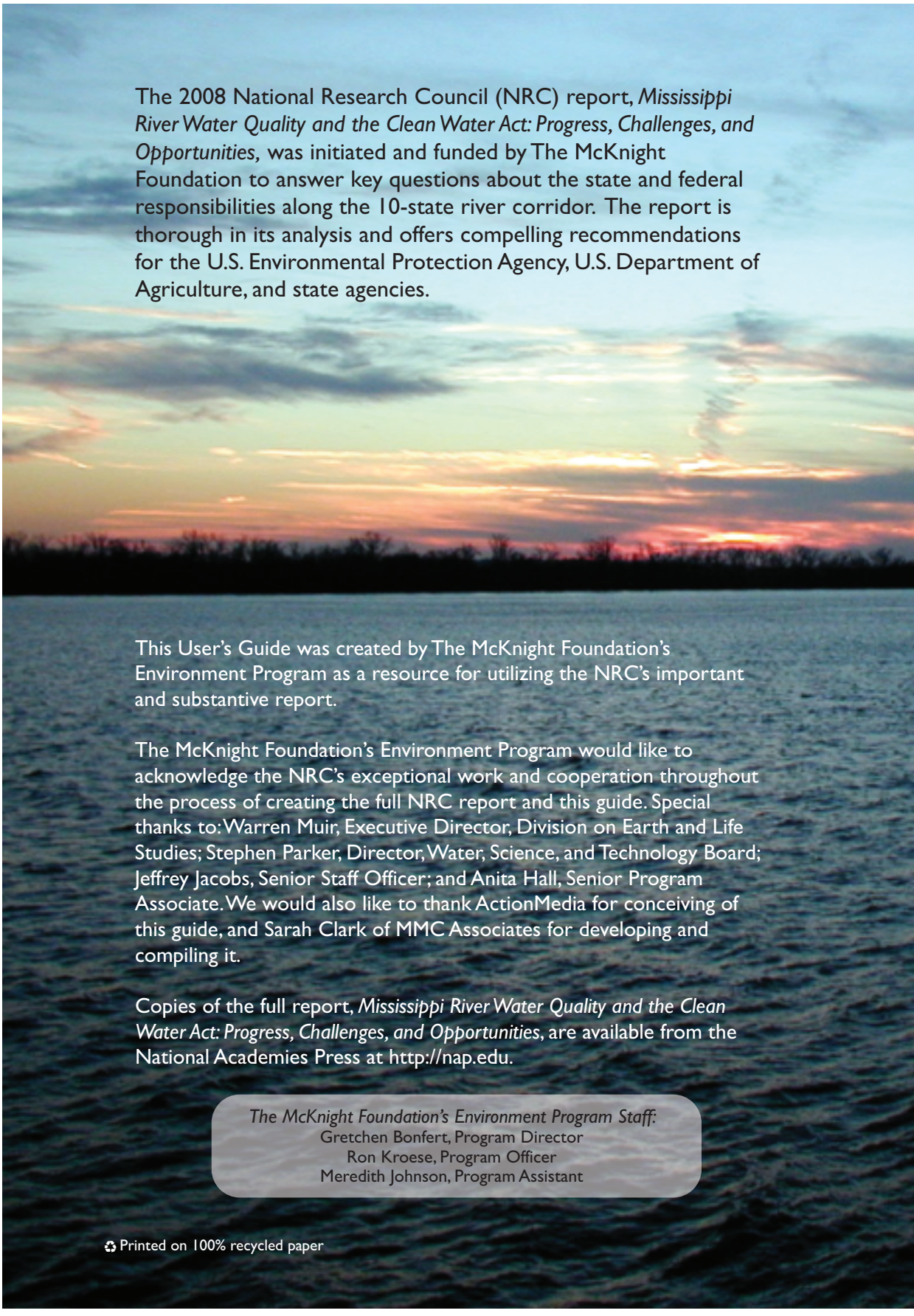
# USER'S GUIDE




**A reference tool from The McKnight Foundation's Environment Program for using the 2008 National Research Council report on Mississippi River Water Quality**



The 2008 National Research Council (NRC) report, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities,* was initiated and funded by The McKnight Foundation to answer key questions about the state and federal responsibilities along the 10-state river corridor. The report is thorough in its analysis and offers compelling recommendations for the U.S. Environmental Protection Agency, U.S. Department of Agriculture, and state agencies.

This User's Guide was created by The McKnight Foundation's Environment Program as a resource for utilizing the NRC's important and substantive report.

The McKnight Foundation's Environment Program would like to acknowledge the NRC's exceptional work and cooperation throughout the process of creating the full NRC report and this guide. Special thanks to: Warren Muir, Executive Director, Division on Earth and Life Studies; Stephen Parker, Director, Water, Science, and Technology Board; Jeffrey Jacobs, Senior Staff Officer; and Anita Hall, Senior Program Associate. We would also like to thank ActionMedia for conceiving of this guide, and Sarah Clark of MMC Associates for developing and compiling it.

Copies of the full report, *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities*, are available from the National Academies Press at http://nap.edu.

*The McKnight Foundation's Environment Program Staff:*
Gretchen Bonfert, Program Director
Ron Kroese, Program Officer
Meredith Johnson, Program Assistant

♻ Printed on 100% recycled paper

# USER'S GUIDE

for

## *Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities*

### A report by the National Research Council of the National Academies



**Note to reader:** The National Research Council uses the term "nutrient" throughout its report to reference nitrogen and phosphorous pollution. As the report notes, nitrogen and phosphorous pollution, along with sediments, are the primary sources of water quality problems in the Mississippi River. Further, nitrogen and phosphorous are the major sources of pollution responsible for the "dead zone" in the Gulf of Mexico.


95°
90°
MINNESOTA
90°
Mississippi R.
45°
Minneapolis
WISCONSIN
45°
La Crosse
Wisconsin R.
Dubuque
IOWA
Quad Cities
River
Illinois
40°
ILLINOIS
40°
95°
Missouri
River
St. Louis
MISSOURI
Ohio
River
KENTUCKY
TENNESSEE
Mississippi River
Memphis
35°
85°
35°
Arkansas River
ARKANSAS
MISSISSIPPI
LOUISIANA
Vicksburg
Baton
Rouge
30°
30°
New Orleans
Atchafalaya R.
90°
GULF OF MEXICO
0 150 300 mi
0 150 300 km

# REPORT IN BRIEF



*The Clean Water Act has reduced much of the pollution in the Mississippi River from "point sources" such as industries and water treatment plants, but problems stemming from urban runoff, agriculture, and other "non-point sources" have proven more difficult to address. Too little coordination among the 10 states along the river has left the Mississippi River an "orphan" from a water quality monitoring and assessment perspective. Stronger leadership from the U.S. Environmental Protection Agency (EPA), along with better interstate coordination, is needed to address these problems. Specifically, the EPA should establish a water quality data-sharing system for the length of the river, and work with the states to establish and achieve water quality standards. For this effort, the EPA and the Mississippi River states should draw upon the lengthy experience of federal-interstate cooperation in managing water quality in the Chesapeake Bay.*

The Mississippi River is, in many ways, the nation's best known and most important river system. It is a source of drinking water for millions of people and supports many recreational and commercial activities. The river's ecosystems provide environmental goods and services that are of great value to communities along the river and to the nation.

Mississippi River water quality is of paramount importance for the sustainability of these values and uses. However, many different human activities across the Mississippi River basin affect water quality. These include manufacturing, urbanization, timber harvesting, and agriculture. Locks, dams, levees, and other hydrologic modifications along the river also affect water quality.

The river has a variety of water quality problems, at different scales. There are some localized problems, such as legacy contaminants like PCBs and DDT, and fecal bacteria from sewage discharges. At a larger scale, excess nutrient loadings from across the basin cause water quality problems within the river. Those loadings also result in nutrient overenrichment further downstream and are the primary cause of the "dead zone" in the Gulf of Mexico. Sediment problems also affect large areas of the river. In the upper river, excess sediments are a problem in many areas. Downstream in Louisiana, by contrast, reduced sediment in river flows, due to retention behind upstream dams, has contributed to losses of coastal wetlands. At the scale of the entire river, nutrients (primarily nitrogen and phosphorus from fertilizers) and sediments are the two primary water quality problems.

Although the Clean Water Act has led to many successes in reducing point source pollution, nonpoint source pollution such as runoff from agricultural land and urban areas, has proven more difficult to manage. One challenge in addressing nonpoint source pollution is that the Clean Water Act does not provide for its direct regulation, in contrast to point source pollution, which is regulated under the act.

Efforts to reduce nonpoint source pollution are hampered by inconsistencies among the 10 Mississippi River corridor states in their water quality standards (consisting of designated uses and water quality criteria) and monitoring programs. State-level water quality monitoring programs along the river have different levels of resources and have not been well coordinated, leaving the river an "orphan" from a water quality monitoring and assessment perspective. The Clean Water Act assigns most interstate water quality coordination authority to the EPA, but EPA has failed to use its mandatory and discretionary authorities to provide adequate oversight of state water quality activities along the river.

## Implementation of the Clean Water Act

The Clean Water Act is the cornerstone of surface water quality protection in the United States. Passed in 1972, along with important subsequent amendments, the act employs regulatory and nonregulatory measures designed to reduce direct pollutant discharges into waterways, finance wastewater treatment facilities, protect wetlands, and manage polluted runoff. Congress designed the act "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The act also called for zero discharges of pollutants into navigable waters by 1985 and "fishable and swimmable" waters by mid-1983. The EPA and the states are jointly responsible for implementing the act.

The Clean Water Act calls upon the states, working in conjunction with the EPA, to establish designated uses for surface waters, and corresponding water quality criteria for specific contaminants in order to protect those uses. The Clean Water Act aims to achieve water quality improvements by requiring technology-based standards for point source discharges. This approach to point source management has had many successes, having reduced, for example, sewage discharges into the Mississippi River.

For waterbodies that remain impaired after application of technology-based (and water quality-based) controls of point source discharges, the Clean Water Act requires development and application of Total Maximum Daily Loads (TMDLs) to achieve water quality standards. TMDLs represent the amount of a pollutant that can be discharged into a waterbody consistent with applicable

water quality standards. Achievement of water quality criteria requires analysis of total contaminant loadings to particular waterbodies and establishment of TMDLs that cannot be exceeded. TMDLs provide the basis for plans to control both point and nonpoint sources of particular contaminants. The TMDL framework is more easily implemented in smaller watersheds within individual states than in multistate waterbodies like the Mississippi River. For TMDLs and water quality standards to be effectively employed in interstate rivers, the effects of interstate pollutant loadings must be fully considered in developing a TMDL.

The Clean Water Act requires the EPA to establish water quality criteria; oversee and approve state water quality standards and TMDLs; set water quality standards and the TMDL process when state efforts are inadequate; and safeguard water quality interests of downstream and cross-stream states. Despite the authorities granted to the EPA within the Clean Water Act to coordinate interstate water quality issues, large-scale water quality problems exist in the Mississippi River due to nutrient loadings and sediment loading and retention. The low-oxygen (hypoxic) "dead zone" in the northern Gulf of Mexico also continues to persist.

Congress did not design the Clean Water Act to address every process that affects Mississippi River water quality, and many structural and physical changes to the Mississippi River predate passage of the act. The Clean Water Act cannot be used as the sole legal vehicle to achieve all water quality objectives along the Mississippi River and into the northern Gulf of Mexico. Nevertheless, the Clean Water Act provides a legal framework that, if comprehensively implemented and rigorously enforced, can effectively address many aspects of intrastate and interstate water pollution, although the emphasis to date has been predominantly on the former.

## Agriculture and Water Quality

Agriculture contributes the major portion of nutrients and sediments delivered to the Mississippi River. Reductions in pollutant loadings, especially nutrients, from agriculture therefore are crucial to improving Mississippi River water quality. The U.S. Department of Agriculture (USDA) administers several incentive-based conservation programs designed to implement Best Management Practices (BMPs) to reduce levels of nutrient and sediment in runoff. Participation in these programs is voluntary but there are financial incentives to implement BMPs.

Effective management of nutrient and sediment inputs and other water quality impacts from agricultural sources will require site-specific, targeted approaches directed at areas of higher nutrient and sediment runoff. Recent increases in biofuels production, and the increased nutrient and sediment pollutant loads this likely will induce, provide an even stronger rationale to target applications

## Differences in Upstream and Downstream Portions of the River

The upper and lower portions of the Mississippi River exhibit many contrasts that affect the nature of water quality problems and the extent of water quality monitoring programs. Much of the upper Mississippi River is a river-floodplain ecosystem that contains navigation pools, braided channels, islands, extensive bottomland forests, and floodplain marshes. In contrast, on the lower river, many natural connections between the river channel and its floodplain have been severed by the construction of large flood protection levees. The lower river has fewer backwater areas and islands than in the upper river. Flows of the lower river are much larger than those in the upper river, and they contain dangerous currents and eddies, making both river-based recreation and water quality monitoring activities more difficult.

In the upper Mississippi River, high rates of sediment input and deposition are important concerns. In the lower Mississippi River, deprivation of sediments—due in large part to the trapping of large amounts of sediments behind dams on the Missouri River—is a significant problem. Sediment deprivation is, for example, a key contributor to losses of coastal wetland systems in southern Louisiana.

Lock and dam on the upper Mississippi River; photo courtesy of the Alexis Park Inn and Suites.

Lower Mississippi River near Vicksburg, MS. Photo courtesy of Jan Hoover.

of USDA conservation programs. The EPA and the USDA also should strengthen their cooperative activities designed to reduce water quality impacts on the Mississippi River and the northern Gulf of Mexico from agriculture.

## State-Level Leadership

The 10 mainstem Mississippi River states have different priorities regarding the river and devote different levels of resources to water quality data collection. Broadly speaking, there is a distinction between priorities and approaches of the upper river states compared to the lower river states. One example is that the five upper river states established the Upper Mississippi River Basin Association (UMRBA) in 1981 to help coordinate their river-related programs and to work with the federal agencies on Mississippi River issues. There is no equivalent organization for the lower river states. The Lower Mississippi River Conservation Committee (LMRCC) is a multistate organization established to discuss river biology and restoration issues, but it does not have representation of gubernatorial appointees or employ full-time staff like the UMRBA.

The Mississippi River states will have to be more proactive and cooperative in their water quality programs for the Mississippi River if marked improvements in water quality of the river are to be realized. The lower Mississippi River states should strive toward creating a cooperative mechanism similar in organization to the UMRBA. The EPA also should facilitate stronger integration of water quality programs of all 10 Mississippi River states.

## EPA Leadership

To help promote a more systematic approach to monitoring, the EPA should take the lead in establishing a water quality data-sharing system for the length of the Mississippi River. Several federal agencies, including the National Oceanic and Atmospheric Administration (NOAA), the Corps of Engineers, and the U.S. Geological Survey (USGS), have collected various water quality data for different stretches of the river and into the gulf. All these programs have merit, but there is no single federal program for water quality monitoring and data collection for the river as a whole.

The EPA should coordinate with the Mississippi River states to ensure the collection of data necessary to develop water quality standards for nutrients in the Mississippi River and the northern Gulf of Mexico. As part of this effort, the EPA should draw upon the considerable expertise and data held by the federal agencies noted. Also, the EPA administrator should ensure coordination and consistency among the four EPA regions along the Mississippi River with regard to water quality issues along the river and in the northern Gulf of Mexico.

The EPA also should develop water quality criteria for nutrients in the Mississippi River and the northern Gulf of Mexico. Further, the EPA should ensure that states in the Mississippi River watershed establish water quality standards (designated uses and water quality criteria) and TMDLs such that they protect water quality in the Mississippi River and the northern Gulf of Mexico from excessive nutrient pollution. In addition, through a process similar to that which has been developed for the Chesapeake Bay watershed, the EPA should develop a federal TMDL, or its functional equivalent, for the Mississippi River and the northern Gulf of Mexico.

## Looking Ahead

The Mississippi River provides immense value to the nation. This report's recommendations will not be easy to implement and will entail a higher degree of collaboration and compromise among interest groups, states, and agencies, than has been the case in the past. Some of the recommendations will require additional levels of resources to realize scientific and programmatic improvements. These challenges will have to be addressed, however, if the purposes of the Clean Water Act are to be realized along the Mississippi River, and the river accorded a level of protection and restoration commensurate with its many values.

**Committee on the Mississippi River and the Clean Water Act:**

David A. Dzombak (Chair), Carnegie Mellon University; H.H. Cheng, University of Minnesota (Emeritus); Robin K. Craig, Florida State University; Otto C. Doering III, Purdue University; William V. Luneburg, Jr., University of Pittsburgh; G. Tracy Mehan III, The Cadmus Group, Inc.; James B. Park, Consultant; Nancy N. Rabalais, Louisiana Universities Marine Consortium; Jerald L. Schnoor, University of Iowa; David M. Soballe, U.S. Army Engineer Research and Development Center; Edward L. Thackston, Vanderbilt University (Emeritus); Stanley W. Trimble, University of California, Los Angeles; Alan H. Vicory, Ohio River Valley Water Sanitation Commission; Jeffrey W. Jacobs (Study Director), National Research Council.

# LIST OF FIGURES, TABLES, AND INFORMATIONAL BOXES

**Tables**

# ANNOTATED TABLE OF CONTENTS

*The McKnight Foundation's Environment Program prepared the following annotated table of contents as a resource guide to the National Research Council (NRC) report,* Mississippi River Water Quality and the Clean Water Act: Progress, Challenges, and Opportunities. *Information is presented in the NRC report in the following fashion: a summary chapter followed by an introductory chapter, and six topical chapters (chapters 2–7). Findings and recommendations from the report's summary chapter are included in the chart below, followed by descriptions of all chapters of the report. (All chapter headings and page numbers refer to the NRC report.)*

## SUMMARY CHAPTER PAGES 1–12

Key findings and recommendations presented in this chapter offer a concise overview of the report results.

### FINDINGS

| | |
|---|---|
| ***Mississippi River Water Quality Problems*** | At the scale of the entire Mississippi River, including its effects that extend into the northern Gulf of Mexico, nutrients and sediment are the two primary water quality problems. Nutrients are causing significant water quality problems within the Mississippi River itself and in the northern Gulf of Mexico. Regarding sediment, many areas of the upper Mississippi River main channel and backwater areas are experiencing excess suspended sediment loads and deposition, while limited sediment replenishment is a crucial problem along the lower Mississippi River and into the northern Gulf of Mexico (4). |
| ***Water Quality Monitoring and Assessment*** | As a result of limited interstate coordination, the Mississippi River is an "orphan" from a water quality monitoring and assessment perspective (5).<br><br>The lack of a centralized Mississippi River water quality information system and data gathering program hinders effective implementation of the Clean Water Act and acts as a barrier to maintaining and improving water quality along the Mississippi River and into the northern Gulf of Mexico (5). |

| | |
|---|---|
| ***Effectiveness of the Clean Water Act*** | Only approximately 10 percent of Mississippi River nitrogen loading is from point sources (6).<br><br>The Clean Water Act has been effective in addressing point sources of water pollutants. Notably, however, the Clean Water Act only addresses nonpoint source pollution in a limited, indirect manner. This is a crucial point given the significance of nonpoint source water pollution throughout the nation and its special importance to Mississippi River and northern Gulf of Mexico water quality (6).<br><br>The Total Maximum Daily Load (TMDL) framework is a key aspect of the Clean Water Act and is designed, in part, to address nonpoint source pollutants and protect and restore water quality. For TMDLs and water quality standards to be effectively employed in managing water quality in interstate rivers like the Mississippi, it is essential that the effects of interstate pollutant loadings be fully considered in developing the TMDL (6).<br><br>The Clean Water Act assigns most interstate water quality coordination authority to the Environmental Protection Agency (EPA). The Clean Water Act also encourages the EPA to stimulate and support interstate cooperation to address larger-scale water quality problems. It provides the EPA with multiple authorities that would allow the EPA to assume a stronger leadership role in addressing Mississippi River and northern Gulf of Mexico water quality (7).<br><br>The EPA has failed to use its mandatory and discretionary authorities under the Clean Water Act to provide adequate interstate coordination and oversight of state water quality activities along the Mississippi River that could help promote and ensure progress toward the act's "fishable and swimmable" and related program goals (7).<br><br>The Clean Water Act cannot be used as the sole legal vehicle to achieve all water quality objectives along the Mississippi River and northern Gulf of Mexico. Nevertheless, the Clean Water Act provides a legal framework that, if comprehensively implemented and rigorously enforced, can effectively address many aspects of intrastate and interstate water pollution, although the emphasis to date has been predominantly on the former (8). |

| | |
|---|---|
| ***Nonpoint Source Pollution and Agriculture*** | As agriculture contributes the major portion of nutrients and sediments delivered to the Mississippi River, reductions in pollutant loadings, especially nutrients, from the agricultural sector, are crucial to improving Mississippi River water quality (8).<br><br>The careful targeting of programs to areas of higher pollutant loadings could enhance the effectiveness of conservation programs designed to reduce nutrient and sediment runoff (8). |

## RECOMMENDATIONS

| | |
|---|---|
| ***Agriculture and Mississippi River Water Quality*** | It is imperative that U.S. Department of Agriculture (USDA) conservation programs be widely and aggressively applied to help achieve water quality improvements in the Mississippi River and its tributaries. Programs aimed at reducing nutrients and sediment inputs should include efforts at targeting areas of higher nutrient and sediment deliveries to surface water. The EPA and USDA should strengthen their cooperative activities designed to reduce impacts from agriculture on the water quality of the Mississippi River and the northern Gulf of Mexico (9). |
| ***State-Level Leadership*** | Better interstate cooperation on lower Mississippi River water quality issues is necessary to achieve water quality improvements. The lower Mississippi River states should strive to create a cooperative mechanism, similar in organization to the Upper Mississippi River Basin Association (UMRBA), in order to promote better interstate collaboration on lower Mississippi River water quality issues (10). |

| | |
|---|---|
| ***EPA Leadership*** | There is a clear need for federal leadership in system-wide monitoring of the Mississippi River. The EPA should take the lead in establishing a water quality data-sharing system for the length of the Mississippi River (11).<br><br>The EPA should act aggressively to ensure improved cooperation regarding water quality standards, nonpoint source management and control, and other related programs under the Clean Water Act (11).<br><br>The EPA administrator should ensure coordination among the four EPA regions along the Mississippi River corridor so that the regional offices act consistently with regard to water quality issues along the Mississippi River and into the northern Gulf of Mexico (11).<br><br>The EPA should encourage and support the efforts of all 10 Mississippi River states to effect regional coordination on water quality monitoring and planning, and should facilitate stronger integration of state-level programs. The EPA has an opportunity to broker better interstate collaboration and thereby improve delivery of Clean Water Act-related programs, such as permitting, monitoring and assessment, and water quality standard development. The EPA should provide a commensurate level of resources to help realize this better coordination (11).<br><br>The EPA should develop water quality criteria for nutrients in the Mississippi River and the northern Gulf of Mexico. Further, the EPA should ensure that states establish water quality standards (designated uses and water quality criteria) and TMDLs such that they protect water quality in the Mississippi River and northern Gulf of Mexico from excessive nutrient pollution. In addition, through a process similar to that which has been applied to the Chesapeake Bay, the EPA should develop a federal TMDL, or its functional equivalent, for the Mississippi River and the northern Gulf of Mexico (12). |

# Chapter 1: Pages 13–20

## INTRODUCTION

*After a brief overview of the Mississippi River and the state and federal entities involved in its protection, this chapter offers a description of the four study areas at the heart of the report: Mississippi River corridor water quality problems; data needs and system monitoring; water quality indicators and standards; and policies and implementation (16–17). The report's scope, structure, and audience are also described (20).*

### Mississippi River Water Quality Issues 17

The many water quality issues facing the Mississippi River are touched upon in this section, including point source pollutants and legacy contaminants. While the authors note that these concerns are important, they identify sediments and nutrients as the factors of primary concern because of the magnitude of their mass loadings into the river, their changes over time, and the scale of associated impacts (18). The authors also note that they conducted their investigations and present their findings within the framework of the existing Clean Water Act, with a focus on assessing whether and how the Clean Water Act can be used to address water quality problems more effectively in the future (19).

> *"Despite the value and importance of the Mississippi River, there is no clearly defined, river-wide framework for adequately monitoring and ensuring protection of its water quality — a theme that runs through this report."*
>
> —Page 19

### Report Organization and Audience 20

Chapters are listed here and the authors note that their target audiences are federal and state elected officials; federal and state resource managers and scientists; experts in river and water quality science and policy issues; nongovernmental organizations with interests in Mississippi River and northern Gulf of Mexico water quality; and individual citizens along the river, across the basin, and along the Gulf Coast (20). Environmental protection and agricultural agencies for states in the basin and the U.S. EPA, USDA, and U.S. Geological Survey are considered special audiences (20).

# Chapter 2: Pages 21 – 64

## CHARACTERISTICS OF THE MISSISSIPPI RIVER SYSTEM

*The Mississippi River flows approximately 2,300 miles through 10 states and its drainage basin covers more than 1.8 million square miles. This chapter describes the Mississippi River's large and varied watershed and the factors that affect water quality, including natural processes and human influences over the decades.*

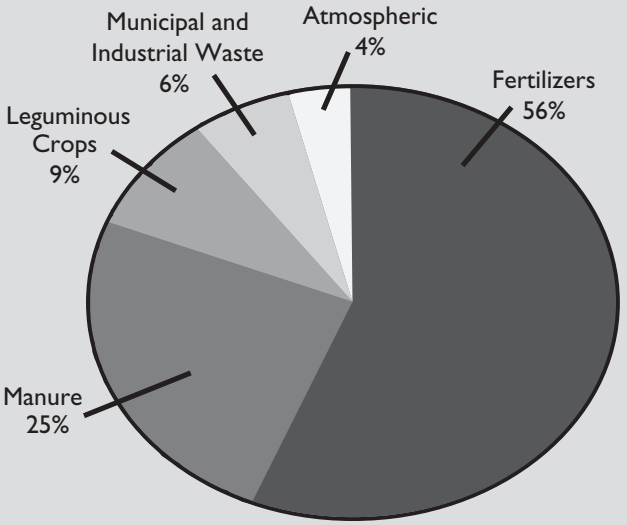



Figure 2-2. Relative proportions of point and nonpoint sources of nitrogen to the Mississippi River from the Mississippi River basin. Based on Antweiler et al. (1995) and Goolsby et al. (24).

### Mississippi River Water Quality 35

Nutrients (nitrogen and phosphorous) and sediments are the primary water quality problems in the river and unlike other pollutants they are not readily addressed by the existing mechanisms (36). Both phosphorous and nitrogen pollution are explained in detail and illustrated with numerous maps and charts in this section. Specific topics include phytoplankton growth (37), nutrient quantities (37), nutrient sources (40), and nutrient uptake and transformation (42). The authors describe the causes of excess sediment loads in many areas of the upper river and the problem of limited sediment replenishment along the lower river (45–49). Metals (50), PCBs (51), pesticides and herbicides (53), fecal bacteria (54), and emerging contaminates (56) are also explored.

### Water Quality Impacts in the Gulf of Mexico 56

This section describes the large zone of oxygen-depleted coastal waters in the northern Gulf of Mexico, known as the "dead zone." Causes and impacts of this hypoxia are explored and the EPA's Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico — which includes sub-basin efforts working toward a 30 percent nitrogen load reduction — is described (61). The authors conclude that, despite the plan and the activities initiated in connection with it, little change has been implemented within the watershed, and the size and persistence of the hypoxia area continue unabated (62).

## Chapter 2 Summary 64

- At the scale of the entire Mississippi River, including its effects that extend into the Gulf of Mexico, nutrients and sediment are the two primary water quality problems. Nutrients are causing significant water quality problems within the Mississippi River itself and in the northern Gulf of Mexico. With regard to sediment, many areas of the upper Mississippi River main channel and backwater areas are experiencing excess sediment loads and deposition, while limited sediment replenishment is a crucial problem along the lower Mississippi River and into the northern Gulf of Mexico (64).
- With respect to nutrients (nitrogen and phosphorous) and sediments (and some toxic substances), water quality in the lower Mississippi River is largely determined by inputs in the upper Mississippi River basin, with different portions of the upper river basin having a dominant influence for particular constituents. For example, sediment loads are determined largely by the Missouri River contributions, and nutrient contributions are primarily from the upper Mississippi River (64).
- Whereas the Clean Water Act has been successful in reducing many point source pollution problems along the Mississippi River, it has not been as successful in reducing nonpoint source pollutants. Both the source and the scale of the Mississippi River and Gulf of Mexico nonpoint source water quality problems pose significant Clean Water Act-related management challenges (64).

# Chapter 3: Pages 65 – 98

## THE CLEAN WATER ACT

*This chapter reviews the Clean Water Act, from its origins in 1948 and key 1972 amendments to today. The authors focus on the sections of the act, and the federal and state authorities and responsibilities, that are most applicable to the Mississippi River. They conclude that, if rigorously implemented and enforced, the Clean Water Act can address many aspects of intrastate and interstate water pollution (95), and that it provides the EPA with multiple authorities that would allow the agency to assume a stronger leadership role (96). Progress in reducing point source pollution is described and the legal intersection of point and nonpoint pollution is explored. Total Maximum Daily Load (TMDL) provisions, which require regulators to look comprehensively at all sources of water pollution — point source, nonpoint source, and background — are highlighted. The authors indicate that TMDLs are becoming and are likely to remain key provisions of the Clean Water Act in achieving the goal of the Mississippi River and all of the nation's water being at least fishable and swimmable (95).*

### Origins of the Clean Water Act 66

This section describes early water-related policies and their limits. Two key acts are explored: the Refuse Act, created in 1899 and upheld to punish polluters of navigable waters throughout the 1960s (66); and the Federal Water Pollution Control Act of 1948, which encouraged states to improve water quality largely through federal grants for publicly owned sewage treatment works (POTWs) and was amended through the 1950s and 1960s to slowly expand the federal government's abatement authority (67).

*"...the Clean Water Act's regulatory program extends 200 nautical miles out to sea."*

—Page 74

### Federal Water Pollution Control Act Amendments of 1972 68

The 1972 amendments enacted the contemporary version of the Clean Water Act, which set goals to eliminate discharge of pollutants into navigable waters by 1985 and achieve "fishable and swimmable" waters (68). The amendments shifted emphasis in water quality regulation from state-level water quality standards to a federal permitting scheme based primarily on technology-based and water quality-based effluent limits for individual dischargers (65). Topics explored include federal funding for sewage treatment plants, with a description

of sewage pollution problems and sewage treatment under the Clean Water Act (69–72); federal permit programs for point sources, including the act's extension to oceans, which necessitates state and federal cooperation on hypoxia in the Gulf of Mexico (72–74); Section 404 "Dredge and Fill" permit program, which features largely federal permitting of discharge or dredged or fill materials into navigable waters (75); the Section 402 National Pollutant Discharge Elimination System (NPDES) permit program, which governs most point source discharges of pollutants and can establish "water quality based" effluent limitations (76); and agricultural exemptions, including implicit elimination of nonpoint source pollution from the act's regulatory scheme and explicit exclusion of "agricultural stormwater discharges and return flows from irrigated agriculture" from its definition of "point source" (77). The authors note that "concentrated animal feeding operations (CAFOs)" are included in the point source definition and are generally regulated through NPDES permits (77).

### State-Level Authority in Protecting Water Quality 78

Under the 1972 amendments, states retained their authority to set water quality standards for waters within their borders, including designated use of the navigable water and water quality criteria (79). The authors note that while states set the standards, the EPA can significantly influence the standards through its federal reference water quality criteria (80). The EPA bacteria water quality criteria are presented to demonstrate that the EPA can impose a federal layer of water quality regulation while retaining flexibility and consistency among states in interstate waters (81). On the topic of nonpoint source pollution programs, the authors identify that while nonpoint source pollution is not subject to the act's two permitting programs, 1987 amendments require each state to identify waters that cannot achieve applicable water quality standards without nonpoint source controls, and identify Best Management Practices (BMPs) and measures to control those sources (82). The authors highlight that when a waterbody is deemed impaired as a result of nonpoint source pollution, TMDLs can be a means for encouraging states to address both point and nonpoint sources, noting that EPA regulations regarding TMDLs expressly recognize that both point source loadings and nonpoint source loadings are components of the total TMDL (84).

### Interstate Water Quality Protection 85

This section details the provisions for both state and federal authorities and responsibilities with regard to interstate water quality issues. State actions authorized through interstate compacts and interstate considerations in state NPDES permitting are described (86). Numerous federal interstate authorities and responsibilities are detailed, including the EPA's: general authority and duty to coordinate transboundary pollution regulation (86); role in addressing federally licensed or permitted sources of interstate pollution (87); oversight

of NPDES permitting (88); authority to convene interstate nonpoint source management conferences (88); and authority to convene interstate management conferences for the National Estuary Program (89). Interstate implications of EPA-set TMDLs are explored, with the EPA-set Louisiana Coast/Gulf of Mexico Mercury TMDL as an example of the EPA assuming authority to impose a load allocation on the entire upstream Mississippi River basin (90–93).

## Chapter 3 Summary 94

- The Clean Water Act has been effective in addressing point sources of water pollutants (94).
- Notably, however, the Clean Water Act only addresses nonpoint source pollution in a limited, indirect manner. This is a crucial point given the significance of nonpoint source water pollution throughout the nation and its special importance to Mississippi River and northern Gulf of Mexico water quality (94).
- The Clean Water Act cannot be the sole legal vehicle used to achieve water quality objectives along the Mississippi River and into the northern Gulf of Mexico. Nevertheless, the Clean Water Act provides a legal framework that, if comprehensively implemented and rigorously enforced, can effectively address many aspects of intrastate and interstate water pollution, although the emphasis to date has been predominantly on the former (95).
- For TMDLs and water quality standards to be employed effectively to manage water quality in interstate rivers such as the Mississippi, it is essential that the effects of interstate pollutant loadings be considered fully in developing the TMDL (95).
- The Clean Water Act assigns most interstate water quality coordination authority to the EPA (95).
- The Clean Water Act also encourages the EPA to stimulate and support interstate cooperation to address larger-scale water quality problems. The act provides the EPA with multiple authorities that would allow it to assume a stronger leadership role in addressing Mississippi River and northern Gulf of Mexico water quality (96).

# Chapter 4: Pages 97–137

## IMPLEMENTING THE CLEAN WATER ACT ALONG THE MISSISSIPPI RIVER

*The Clean Water Act has successfully reduced pollution from many point sources on the Mississippi River. However, it has not been very effective in addressing large-scale, nonpoint source pollution problems — namely nitrogen and phosphorous pollution and sediments (135). This chapter describes the challenges involved in using the Clean Water Act to address these concerns and underscores the need for interstate coordination and strong leadership from the EPA.*

### The NPDES Program and Point Source Control on the Mississippi River 98

National Pollutant Discharge and Elimination System (NPDES) permits have been issued to thousands of industrial, municipal and other point sources on the river, and have resulted in substantial reductions in pollution inputs (98). This section explores NPDES program implementation under the Clean Water Act and provides examples of Clean Water Act-related progress on the Mississippi River due to improvements at publicly owned sewage treatment facilities (POTWs) (100). Discharges from combined sewer overflows (CSOs) are described as a problem that varies considerably on different stretches of river. For example, Minneapolis has been working since 1922 to separate sewers from storm drains, and today only eight outfalls discharge water from CSOs in the city. In contrast, St. Louis has 208 CSO outfalls, many of which discharge directly into the Mississippi (103).

### Mississippi River Water Quality Standards 104

It is currently up to individual states to designate stretches of river for specific uses and develop water quality standards. The many inconsistencies among state-based approaches are described in this section, with maps and charts that show the range of applicable water quality criteria from state to state and examples of states establishing conflicting standards for the same stretches of river (104–112). The authors identify the failure of the EPA to use its mandatory and discretionary authorities under the Clean Water Act to provide adequate interstate coordination and federal oversight of water quality activities. A description of a 2003 Sierra Club petition to the EPA on this topic provides additional detail (113).

### Water Quality Data and Assessment for the Mississippi River 114

This section explains that the Mississippi River has become an "orphan" from a water quality monitoring and assessment perspective due to lack of interstate coordination and the limited allocation of funds by states for Mississippi water quality monitoring (136). Insufficient data prevents effective utilization of the Clean Water Act along the river (116). The authors explore differences in the reliable data from the lower and upper river, and reasons for the dearth of reliable lower river data (116). They also provide charts that show water quality assessments to date and compare impaired waters listings from different states along the same stretches of river (117–121).

### The Status of TMDL Development Along the Mississippi River 122

Total Maximum Daily Loads (TMDLs) are required for stretches of the river that fail to meet the relevant states' water quality standards. Imposing this water quality improvement mechanism on a river bordered by 10 different states is described as difficult (122). This section shows how lack of testing, inconsistency between state standards, and limited coordination add to the challenge (123–124). The authors assert that despite these challenges, this Clean Water Act mechanism for addressing water quality impairments can be implemented effectively and that the EPA is well positioned to provide the needed coordination (125).

### Nutrient Criteria and TMDLs for the Mississippi River 126

None of the 10 Mississippi River mainstem states currently have numerical criteria for nitrogen or phosphorous pollution applicable to the river (126). This section makes the case that, without such standards, there is little prospect of significantly reducing or eliminating hypoxia in the Gulf of Mexico (126). The authors point out that in lieu of adequate state action, the EPA has the legal authority to intervene and adopt necessary numerical nutrient goals for the terminus of the Mississippi River and the northern Gulf of Mexico, requiring each state in the watershed to create a TMDL for appropriate waters within its boundaries (127).

> *"The Mississippi River would seem clearly to qualify for special treatment, being the nation's only waterbody with congressional recognition as 'a nationally significant ecosystem and a nationally significant commercial navigation system.'"*
>
> —Page 127

## Federal-State Cooperation in the Chesapeake Bay 128

A description of the Chesapeake Bay Program is presented as a model for multi-state, science-based cooperative effort. The program includes basinwide coordinated monitoring programs, an agreement on designated uses for shared tidal waters, consistent water quality standards agreed to by upstream states, major tributary basin cap load allocations, and a basinwide permitting strategy that addresses 467 facilities (130). The value of this type of federal-state and interstate collaboration is strongly emphasized, especially in regard to adopting and implementing necessary water quality criteria (134).

## Chapter 4 Summary 135

- Use of the Clean Water Act to address nonpoint source pollution issues for a large interstate river like the Mississippi River presents significant challenges. Nonetheless, many key Clean Water Act water quality provisions and methods have been under- or poorly utilized in the mainstem Mississippi River. This reflects the river's interstate nature, the expensive and complex task of comprehensively addressing the water quality of the river as an integrated whole, and the inclination of states to divert limited water quality resources to internal waters. Further progress in improving the Mississippi River water quality will require improved interstate coordination and cooperation with regard to water quality standards, water quality assessments, TMDLs, and nonpoint source management (135).
- As a result of limited interstate coordination, the Mississippi River is an "orphan" from a water quality monitoring and assessment perspective (136)
- The EPA has failed to use its mandatory and discretionary authorities under the Clean Water Act to provide adequate interstate coordination and federal oversight of state water quality activities along the Mississippi River that could help promote and ensure progress toward the act's fishable and swimmable and related goals (137).
- The EPA should act aggressively to ensure improved cooperation regarding water quality standards, nonpoint source management and control, and other related programs under the Clean Water Act (137).
- The EPA should develop water quality criteria for nutrients in the Mississippi River and the northern Gulf of Mexico. Further, the EPA should ensure that states establish water quality standards (designated uses and water quality criteria) and TMDLs such that they protect water quality in the Mississippi River and the northern Gulf of Mexico from excessive nutrient pollution. In addition, through a process similar to that applied to the Chesapeake Bay, the EPA should develop a federal TMDL, or its functional equivalent, for the Mississippi River and the northern Gulf of Mexico (137).

# Chapter 5: Pages 138–164

## EVALUATING MISSISSIPPI RIVER WATER QUALITY

*Accurate evaluation of Mississippi River water quality is essential for identifying problems and measuring the effectiveness of remediation strategies (138). This chapter examines the differences between the upper and lower river in hydrology and monitoring activities and reviews past and existing monitoring programs. The importance of monitoring in achieving Clean Water Act goals is explored, and the authors offer recommendations for enhanced state and federal efforts to improve monitoring efficiency, reduce data gaps, and strengthen implementation of the Clean Water Act.*

### Mississippi River Basin Structure, Hydrology, and Monitoring 139

Differences in hydrology, sediment load, and other features that influence monitoring are discussed in this section, particularly the contrasts between the upper and lower Mississippi River. As the river doubles its discharge below the confluence of the Missouri and Ohio rivers in Cairo, Illinois, it becomes deeper, wider, and more turbulent — making monitoring difficult (139). These logistical issues, the fact that lower river water quality primarily is a function of upstream inputs, and possible perceptions that lower river water quality is "beyond the control" of lower river states are identified as contributors to federal and state monitoring differences between the upper and lower river (140).

### Federal and Regional Mississippi River Evaluations 141

Mississippi River monitoring efforts have been conducted by different federal and state agencies and scientists, at differing spatial scales and time intervals, with differing objectives, and with varied and changing budgets. The sum of these efforts is a complex and fragmented picture of river water quality (141). Large-scale federal monitoring programs overseen by the Army Corps of Engineers and U.S. Geological Survey (USGS) are described in this section, including the Long Term Resource Monitoring Program (LTRMP) (141) and National Stream Quality Accounting Network (NASQAN) (143). Charts and tables illustrate the number and locations of study areas through these programs. Two widely cited regional-scale comprehensive Mississippi River assessments, conducted in 1995 and 1999, are also described (145). The authors note that while valuable, federal and regional studies have generated more upper river than lower river data, have not been systematic and sustained, have been affected by declining funding, and have not been directed toward Clean Water Act objectives (146).

## Monitoring Associated with Clean Water Act Objectives 146

Under the Clean Water Act, states are responsible for monitoring, and several court decisions involving Total Maximum Daily Load (TMDL) development have expressly refused to require the EPA to conduct water quality monitoring (146). The EPA does compile assessments from each state, which are required under Section 503(b) of the Clean Water Act, into a national synthesis (147). However, there is recognition that this compilation cannot provide a thorough, science-based assessment of the nation's waters. The authors indicate that the 305(b) framework merely creates a patchwork of impaired and unimpaired sections, with many areas of overlap and contradiction (149). Several figures are presented showing differing impairment designations on opposite sides of the same stretch of river (150–151). In discussing state monitoring programs, the authors report that efforts typically have been directed to specific issues or crises, for example, maintenance and updating of fish consumption advisories (153–154). Further, lower Mississippi River states consider Mississippi River water quality to be the responsibility of others and give it lower priority for monitoring funds (155).

> *"There is no consistency in the amount and quality of water quality data available for the length of the mainstem Mississippi River."*
>
> —Page 163

## Status of and Prospects for Mississippi River Monitoring 155

This section emphasizes the value and importance of monitoring — and the need for better coordination and a shared sense of purpose among mainstem river states (157). The authors point out that today's water quality problems consist primarily of nonpoint pollution loads from agricultural, urban, and suburban activities, which is a marked difference from the early 1970s when the Clean Water Act was enacted (157). They further identify that to address these current pollution sources requires a science- and data-intensive approach to understanding the linkages between activities that generate pollutant loads and their ultimate impacts on waterbodies (158). Emerging monitoring issues are described, including new techniques that focus on biomonitoring, such as Rapid Bioassessment Protocols (160), and challenges related to sediment transport and deposition (161).

## Chapter 5 Summary 163

- The lack of a centralized Mississippi River water quality information system and data gathering program hinders effective application of the Clean Water Act and acts as a barrier to maintaining and improving water quality along the Mississippi River and into the northern Gulf of Mexico (164).
- There is a clear need for federal leadership in systemwide monitoring of the Mississippi River. The EPA should take the lead in establishing a water quality data-sharing system for the length of the Mississippi River (164).

# Chapter 6: Pages 165–189

## AGRICULTURAL PRACTICES AND MISSISSIPPI RIVER WATER QUALITY

*Runoff from agricultural land is the primary nonpoint source of nutrients (nitrogen and phosphorous) and sediments that enter the Mississippi River (187). Most runoff from farmland is exempt from the Clean Water Act. However, the United States Department of Agriculture (USDA) has instituted conservation programs to reduce agriculture's water quality impacts, generally using voluntary control measures through economic incentives (184, 188). This chapter discusses how production incentives affect farmers' participation in conservation programs and explains specific strategies for reducing nutrient and sediment inputs. Recommendations focus on the need to aggressively apply USDA conservation programs, target areas with higher nutrient and sediment deliveries to surface water, and strengthen cooperation between the USDA, the EPA, and states in reducing water quality impacts from agriculture (188). Expanded biofuel production adds urgency to this need (185).*

### Tensions Between Agriculture Production and Water Quality 166

Since 1933, Farm Bills and other agricultural programs have had a tremendous influence on Mississippi River basin land uses, crop types, farmer attitudes and preferences, and the structure of the agricultural sector; in turn, they have greatly affected runoff patterns and water quality across the basin and in the Mississippi River and Gulf of Mexico (167). This section explores the impacts of the Farm Bill and agricultural commodity programs that have led farmers to focus on row crops that require intensive fertilizer application and soil tillage. The ways in which production incentives may work against efforts to engage farmers in voluntary land and water conservation programs are also explored (167).

### Federal Agriculture Programs for Resource Conservation 168

Key USDA programs providing incentives for land and water quality conservation are described in this section, including the Conservation Reserve Program (CRP)(168), which traditionally focused on retiring environmentally sensitive lands from production but has recently expanded in scope; the

> *"Current application of the USDA environmental protection programs is not well targeted to the most significant of sources land degradation and water pollution, but targeting could be much improved through interagency coordination."*
>
> —Page 188

Environmental Quality Incentive Program (EQIP)(169), the main USDA program for protection of environmental quality on working land; and the Conservation Security Program (CSP)(169), designed to assist farmers in implementing conservation practices on a whole farm basis. State Conservation Reserve Enhancement Programs (170) and specific Best Management Practices (BMPs) are described (171). Improved cooperation between the USDA, the EPA, and other stakeholders is recommended, and the Conservation Effects Assessment Project is described as a cooperative effort that could be expanded to achieve better-targeted expenditures and programs (172).

**Key Pollutants and Strategies for Reducing Their Impacts** **172**

This section explains how the nutrients nitrogen (173) and phosphorous (175) and sediments (175) affect Mississippi River water quality and describes the specific activities that increase or reduce inputs. For nutrients, recommendations focus on balancing the nutrient requirements for crop production with reductions of nutrient loss to surrounding watersheds. Sediment inputs are described as complex, and work to evaluate sediment loadings on the Minnesota River is used as a case in point (177). Recommendations include targeting USDA conservation programs to encourage farmers to implement BMPs on lands that are the primary sources of nonpoint pollutants (176).

**Approaches for Reducing Nonpoint Source Inputs from Agricultural Lands** **177**

A targeted approach that focuses on the most significant sources of land degradation and water pollution is needed, but current applications of USDA programs are not well targeted (178). This section explores the pressures that limit targeted efforts and describes commonly attempted market-based approaches and regulation, including water quality trading (179), performance-based trading (182), and design-based trading (182), as well as auction-based contracting (183). The Pennsylvania Nutrient Trading Program for the Susquehanna River is described as a good example of a working nutrient trading program and model for collaboration between state and federal water quality regulators, the USDA, and conservation districts (181). Conservation compliance is also described, and authors note that high commodity prices dull the effectiveness of conservation programs that are tied to price support payments (183).

**Motivating Nonpoint Source Control in Agriculture** **184**

Farmers and ranchers are motivated to take part in conservation programs by a combination of institutional and economic considerations. Market-based approaches can become operative only if some enforceable regulatory standard provides an incentive to which market forces can respond, and the institution

providing the incentives must have the appropriate geographic reach and enforcement authority (184). This section emphasizes that the suite of USDA conservation programs aimed at farmers and ranchers must be more effectively applied to realize additional water quality benefits and that there must be improved coordination between the USDA, the EPA, and states on this issue (185).

### Potential Impacts of Biofuels Production 185

Expanded production of biofuels, particularly ethanol, is encouraging producers to extend and intensify crop production across the basin — and much of this expanded production is in corn, which entails high rates of fertilizer application and intensive soil tillage (188). This section emphasizes that biofuel production increases provide an even stronger rationale to implement with urgency the targeted application of USDA conservation programs, to improve and expand EPA-USDA coordination for nonpoint pollution control programs, and to devise and implement other initiatives to mitigate the adverse effects of nutrients and sediments on the Mississippi River and Gulf of Mexico (189).

### Chapter 6 Summary 187

- Runoff from agricultural lands is the primary nonpoint source of nutrients and sediments to the Mississippi River and the Gulf of Mexico (187).
- It is imperative that USDA conservation programs be widely and aggressively applied to help achieve water quality improvement in the Mississippi River and its tributaries (188).
- Programs aimed at reducing nutrient and sediment inputs should include efforts at targeting areas of higher nutrient and sediment deliveries to surface water (188).
- The EPA and the USDA should strengthen their cooperative activities designed to reduce water quality impacts on the Mississippi River and the northern Gulf of Mexico from agriculture (188).

# Chapter 7

**Pages 190–211**

## COLLABORATION FOR WATER QUALITY IMPROVEMENT ALONG THE MISSISSIPPI RIVER CORRIDOR

*Clean Water Act implementation along the Mississippi River poses a substantial scientific and public administration challenge because it requires some degree of coordination among the 31 basin states, particularly the 10 mainstem states, as well as four regions of the EPA and other federal agencies (190). This chapter examines programs under the Clean Water Act that require better coordination; reviews existing and potential collaborations among states, EPA regions, and other federal agencies (191); and calls on the EPA to exercise a stronger role in coordination and management guidance (209).*

### Clean Water Act Coordination Needs on an Interstate River — 191

This section explains how coordination among states along the Mississippi River is important for implementation of the pillars of the Clean Water Act: National Pollutant Discharge Elimination System (NPDES) point source permitting programs; water quality standards comprising designated uses and water quality criteria; adequate monitoring to ensure protection of water quality and achievement of water quality standards; assessment to evaluate water quality status; and restoration programs, including those based on Total Maximum Daily Loads (TMDLs), to improve waters with impaired water quality relative to designated use (191).

### Cooperation on Interstate Rivers — 192

Clean Water Act activities, including permitting, standards development, and TMDLs, offer enforceable mechanisms for states to interact on major decisions of joint interest — but they are rarely used by mainstem Mississippi River states (192). This section reviews six examples along other interstate river systems where states are coordinating activities for river management through interstate compacts that receive funding under Section 106 of the Clean Water Act (192–197). All of the Section 106 commissions were established prior to the Clean Water Act (192) and the authors point out that while an interstate compact can be an effective approach to water quality management, compacts can be difficult to establish today because of the complexities involved in creating an agreeable compact, resistance to ceding state authority to an interstate entry, and difficulty securing long-term funding (198). A box on Principles of Interstate Cooperation for Water Quality Management provides details on the benefits of interstate frameworks (199).

## Cooperative Efforts Along the Mississippi River 198

This section illustrates non-compact cooperative mechanisms undertaken on the Mississippi River since the passage of the Clean Water Act. Early initiatives focused on navigation and flood control (198). The 1965 Water Resources Planning Act authorized federal-state basin commissions, and while a 1981 executive order dismantled these commissions, several were maintained in other forms (200). Multiple examples of Mississippi River-based cooperation outside of compacts are reviewed, including: Upper Mississippi River Basin Association (UMRBA) (200); Upper Mississippi River Water Suppliers Coalition (201); Upper Mississippi River Sub-basin Hypoxia Nutrient Committee (202); Upper Mississippi River Conservation Committee (202); Lower Mississippi River Conservation Committee (202); Lower Mississippi River Sub-basin Committee on Gulf Hypoxia (203); and nongovernmental organizations and efforts including the Mississippi River Water Quality Collaborative sponsored by The McKnight Foundation (203).

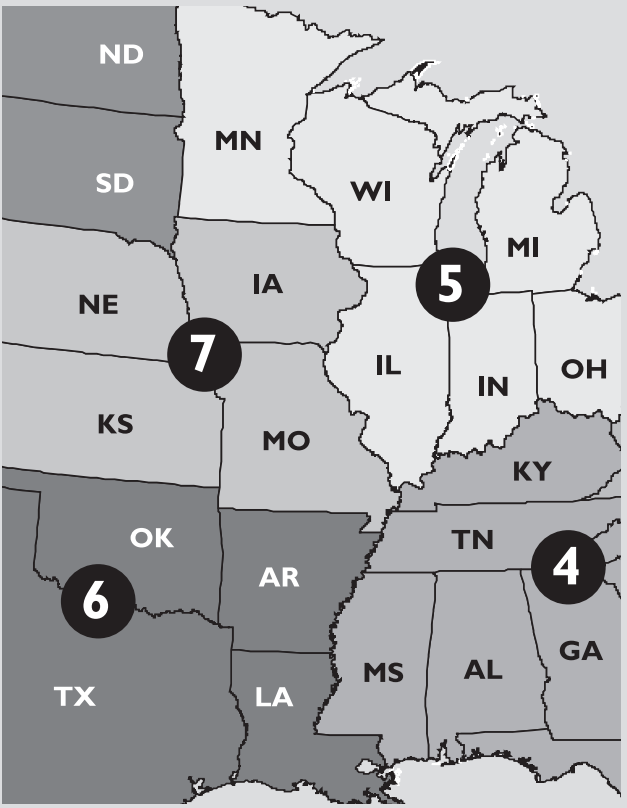



Figure 7-1. EPA regions with responsibility for the mainstem Mississippi River. Source: Adapted from USEPA (2007e) (205).

## EPA Collaboration on the Mississippi River 204

There are four EPA regions along the Mississippi River corridor and seven regions within the watershed. Each region has been delegated considerable discretion in carrying out NPDES, TMDL and other key Clean Water Act programs and the authors identify inconsistency among regional offices as a persistent problem (204). While some collaborative efforts are taking place — for example EPA Regions 5 and 7 are working with UMRBA to improve coordination on water quality management — there has been limited interagency coordination on the river (206). The authors call for stronger leadership by the EPA in promoting interstate and interregion cooperation along the Mississippi River and assert that this strategy complements the "watershed approach" that has been vigorously promoted by EPA since the early 1990s (206–207).

## Cooperation Among Federal Agencies on the Mississippi River 207

This section reviews the many federal agencies with jurisdiction over activities that influence Mississippi River Water quality, including the EPA; U.S. Army Corps of Engineers, with its authorizations related to water resource management for navigation and flood control; the U.S. Department of Agriculture (USDA), with its activities under the Farm Bill to minimize the impacts of agricultural practices on water quality; the U.S. Fish and Wildlife Service, with its authorities on the Endangered Species Act; the U.S. Geological Survey, with its streamflow and water quality monitoring activities throughout the Mississippi River basin; and the National Oceanic and Atmospheric Administration with its monitoring responsibilities in the Gulf of Mexico (207–208). The authors conclude that with the authority created by the Clean Water Act and the continuing mission expansion of other federal agencies such as the Corps of Engineers and the USDA to encompass water quality, the EPA is well positioned to lead cooperative efforts among federal agencies (209).

## Chapter 7 Summary 210

- Better interstate cooperation on lower Mississippi River water quality issues is necessary to achieve water quality improvements. The lower Mississippi River states should strive to create a cooperative mechanism, similar in organization to the UMRBA, in order to promote better interstate collaboration on lower Mississippi River water quality issues (210).
- The EPA should encourage and support the efforts of all 10 Mississippi River states to effect regional coordination on water quality monitoring and planning and should facilitate stronger integration of state-level programs. The EPA has an opportunity to broker better interstate collaboration and thereby improve delivery of Clean Water Act-related programs, such as permitting, monitoring and assessment, and water quality standards development. The EPA should provide a commensurate level of resources to help realize this better coordination (211).
- The EPA administrator should ensure coordination among the four EPA regions along the Mississippi River corridor so that the regional offices act consistently with regard to water quality issues along the Mississippi River and in the northern Gulf of Mexico (211).

# INDEX

*Italicized page numbers refer to boxes, figures, and tables.*

Aerial photo on cover: © Garth Fuller courtesy of The Nature Conservancy

All other photos and figures provided by the National Research Council