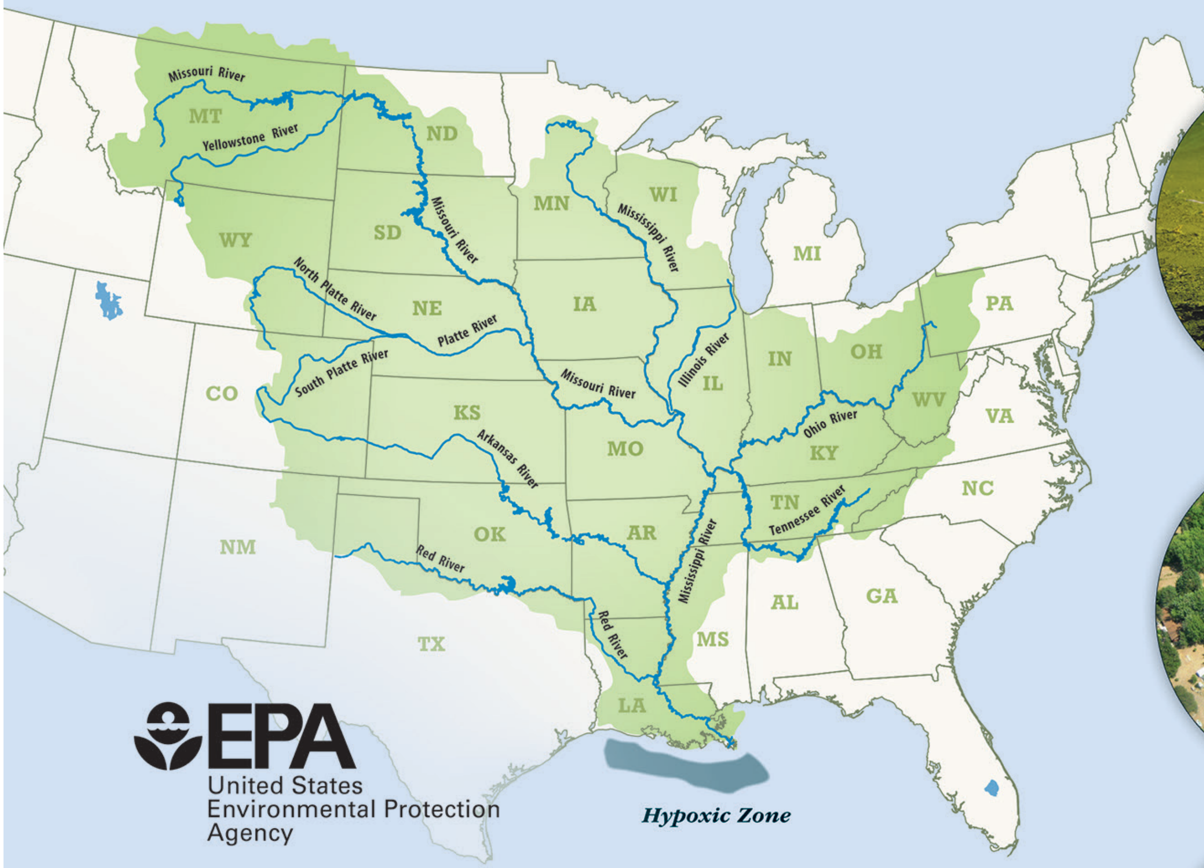

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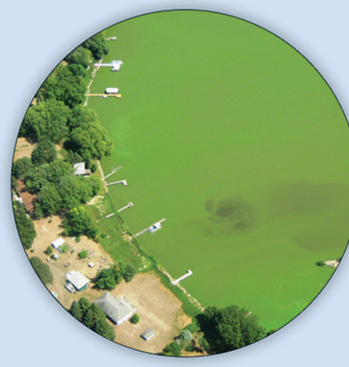


Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

2015 Report to Congress

Biennial Report

2015

Acknowledgments

Special thanks go to the many federal, regional, and state representatives and their staff who support the efforts of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, also known as the Hypoxia Task Force (HTF). Their diverse knowledge and expertise contributed to the successful collaboration and consensus building needed to produce this report to Congress. The U.S. Environmental Protection Agency (EPA) appreciates the input provided by the HTF members:

State Agencies

Arkansas Natural Resources Commission – Randy Young

Illinois Department of Agriculture – Philip Nelson

Indiana State Department of Agriculture – Ted McKinney

Iowa Department of Agriculture and Land Stewardship – Bill Northey, State Co-Chair

Kentucky Department for Environmental Protection – Larry Taylor

Louisiana Governor's Office of Coastal Activities – Kyle R. "Chip" Kline, Jr.

Minnesota Pollution Control Agency – Rebecca Flood

Mississippi Department of Environmental Quality – Gary Rikard

Missouri Department of Natural Resources – Joe Engeln

Ohio Environmental Protection Agency – Karl Gebhardt

Tennessee Department of Agriculture – Jai Templeton

Wisconsin Department of Natural Resources – Russell Rasmussen

Federal Agencies

U.S. Army Corps of Engineers – Major General Michael C. Wehr

U.S. Department of Agriculture: Natural Resources and Environment – Ann Mills

U.S. Department of Agriculture: Research, Education and Economics – Ann Bartuska

U.S. Department of Commerce: National Oceanic and Atmospheric Administration – Rear Admiral Gerd Glang

U.S. Department of the Interior: U.S. Geological Survey – Lori Caramanian

U.S. Environmental Protection Agency – Ellen Gilinsky, Federal Co-Chair

Tribes

National Tribal Water Council – Michael Bolt

Additional Entities Participating on the HTF's Coordinating Committee:

Lower Mississippi River Sub-basin Committee – Doug Daigle

Ohio River Valley Water Sanitation Commission – Greg Youngstrom

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

2015 Report to Congress

August 2015

First Biennial Report

Contents

Executive Summary

The states and federal agencies that comprise the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Hypoxia Task Force or HTF) continue to work collaboratively to implement the *Gulf Hypoxia Action Plan 2008* (2008 Action Plan). Since the release of the plan, each HTF state has developed a nutrient reduction strategy through stakeholder participation that serves as a road map for implementing nutrient reductions in its state; these strategies serve as the cornerstone for reaching the HTF goals. The federal members of the HTF issued a unified federal strategy in September 2013 to guide assistance to states and continued science support. (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2013b). In furtherance of its goals, the HTF is also expanding partnerships with organizations with similar goals. In May 2014, the HTF entered into an agreement with 12 land grant universities (LGUs) to reduce gaps in research and outreach/extension needs in the Mississippi/Atchafalaya River Basin (MARB).

Although achieving measureable water quality improvements takes time and extreme weather events pose challenges, the report highlights specific examples of progress achieved by the HTF and its members. The report also discusses strategies for meeting the HTF's goals and key lessons the HTF has learned, which include the importance of: planning and targeting at a watershed scale; identifying the critical pollutants, their sources, and means of transport; using appropriate models to plan and evaluate implementation; using appropriate monitoring designs to evaluate conservation outcomes; understanding farmers' attitudes toward conservation practices and working with them through appropriate messengers to offer financial and technical assistance; and sustaining engagement with the agricultural community following adoption of conservation systems. The report describes significant actions that will allow the HTF to move towards accomplishing its goals.

As new research and information have become available and systems of conservation practices are implemented on vulnerable lands across this large basin, the HTF has gained a better understanding of the complexities of this large-scale problem and the efforts and time that will be needed to achieve its goals. In February 2015, the HTF announced that it would retain its goal of reducing the areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 km^2, but that it will take until 2035 to do so. The HTF agreed on an interim target of a 20 percent nutrient load reduction by the year 2025 as a milestone toward achieving the final goal in 2035. The Task Force also agreed to adopt quantitative measures to track progress in reducing point and nonpoint source inputs. To accelerate the reduction of nutrient pollution, the Task Force will:

- Target vulnerable lands and quantify nutrient load reductions achieved from federal programs such as the USDA RCPP, USDA MRBI, USFWS Mississippi River Habitat Initiative and Landscape Conservation Cooperatives, and EPA Water Pollution Control Program Grants and the Nonpoint Source Management Program.
- Implement state nutrient reduction strategies, including targeting vulnerable lands and quantifying nutrient reductions.
- Expand and build new partnerships and alliances with universities, agriculture, cities and communities, and others.

The Hypoxia Task Force looks forward to using its Biennial Reports to Congress to report on continued progress toward reducing nutrient loads to the northern Gulf of Mexico, summarize lessons learned in implementing nutrient reduction strategies, and describe any adjustments to its strategies for reducing Gulf hypoxia.

Part 1: Introduction

This report describes the progress made through activities directed by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Hypoxia Task Force or HTF) and carried out or funded by the U.S. Environmental Protection Agency (EPA) and other state and federal partners toward attainment of the goals of the *Gulf Hypoxia Action Plan 2008* (2008 Action Plan). The report is organized into the following sections in accordance with the Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014 (HABHRCA):

- **Environmental, economic, and social impacts:** Part 1 discusses the environmental, economic, and social impacts of Gulf of Mexico hypoxia and harmful algal blooms (HABs).
- **Assessment of the progress made toward nutrient load reductions, the response of the hypoxic zone, and water quality throughout the Mississippi/Atchafalaya River Basin (MARB)**: Part 2 provides information about the size of the hypoxic zone (also referred to as the "dead zone") since 1985 and sources of nutrient loading in the MARB. Part 3 describes the progress of state nutrient reduction strategy development and implementation and highlights successful state projects. Part 3 also describes federal agency programs that support state implementation of nutrient reduction strategies.
- **Evaluation of lessons learned**: Part 4 covers lessons learned by presenting broader HTF successes.
- **Recommendations of appropriate actions to continue to implement or, if necessary, revise the strategy set forth in the *Gulf Hypoxia Action Plan 2008*:** Part 5 focuses on recent HTF efforts to track the environmental results of state strategy implementation as the HTF continues to implement the 2008 Action Plan.

1.1 2014 HABHRCA Amendments

HABHRCA 2014 directs the EPA Administrator, through the HTF, to submit a progress report beginning no later than 12 months after the law's enactment, and biennially thereafter, to the appropriate congressional committees and the President (see the excerpt of HABHRCA below). This document is the HTF's initial report to Congress.

HABHRCA 2014: LANGUAGE REGARDING THE HTF

PUBLIC LAW 113–124—JUNE 30, 2014

Public Law 113–124
113th Congress
An Act
To amend the Harmful Algal Blooms and Hypoxia Research and Control Act of 1998, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014."

SEC. 7. NORTHERN GULF OF MEXICO HYPOXIA.

Section 604 is amended to read as follows:

''SEC. 604. NORTHERN GULF OF MEXICO HYPOXIA.

''(a) INITIAL PROGRESS REPORTS.—Beginning not later than 12 months after the date of enactment of the Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014, and biennially thereafter, the Administrator, through the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, shall submit a progress report to the appropriate congressional committees and the President that describes the progress made by activities directed by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force and carried out or funded by the Environmental Protection Agency and other State and Federal partners toward attainment of the goals of the Gulf Hypoxia Action Plan 2008.

"(b) CONTENTS.—Each report required under this section shall—

"(1) assess the progress made toward nutrient load reductions, the response of the hypoxic zone and water quality throughout the Mississippi/Atchafalaya River Basin, and the economic and social effects;

"(2) evaluate lessons learned; and

"(3) recommend appropriate actions to continue to implement or, if necessary, revise the strategy set forth in the Gulf Hypoxia Action Plan 2008."

1.2 The Nature of the Hypoxia Problem: Environmental, Economic, and Social Impacts

Hypoxia is a term used to describe waters that have very low dissolved oxygen and thus are stressful to habitats and living resources in lakes, estuaries, and coastal waters. Hypoxic waters have dissolved oxygen concentrations of less than 2-3 ppm. Hypoxia can be caused by a variety of factors, including excess nutrients, primarily nitrogen and phosphorus, and waterbody stratification due to saline or temperature gradients.

Eutrophication occurs when waterbodies are over-enriched with nutrients beyond natural levels, causing significant increases in primary production, or growth of algae. In the same way that nitrogen and phosphorus fertilize crops, they also fertilize plants in the aquatic systems. The spring delivery of nutrients initiates a seasonal progression of biological processes that ultimately leads to the depletion of oxygen in the bottom water. (Gulfhypoxia.net)

Every summer, a large hypoxic zone forms in the Gulf of Mexico. This zone, where the amount of dissolved oxygen is too low for many aquatic species to survive, is fueled primarily by excess nutrients (nitrogen and phosphorus) from the MARB and is also affected by temperature and salinity stratification (layering) of waters in the Gulf that prevents mixing. Human activities are the leading cause of increased amounts of nutrients delivered to the Gulf. These activities include (1) historical landscape changes in the drainage basin, consisting primarily of loss of freshwater wetlands caused by artificial drainage to convert wetlands into productive agricultural lands, which diminishes the capacity of the river basin to remove nutrients; (2) channelization and impoundment of the Mississippi River throughout the basin and the delta and the loss of coastal wetlands; and (3) changes in the hydrologic regime of the Mississippi and Atchafalaya Rivers and the timing of fresh water inputs that are critical to stratification, which can cause hypoxia under the right conditions (e.g., excess nutrients). The diversion of a large amount of fresh water from the Mississippi River through the Atchafalaya River has profoundly modified the spatial distribution of freshwater inputs, nutrient loadings, and stratification on the Louisiana-Texas continental shelf (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2008).

Fresh water from the MARB is warmer and less dense than the ocean water and contributes to the formation of an upper, less saline surface layer. This stratification of the water column restricts the mixing of oxygen-rich surface water with oxygen-poor deep water. Furthermore, the excessive nutrient loads trigger an overgrowth of algae that rapidly consumes oxygen as it decomposes. This decomposition in bottom waters, coupled with water column stratification, results in hypoxia. The nitrogen and phosphorus loads come mainly from sources upstream of the Gulf. Sources of nitrogen include agriculture (both row crop agriculture and animal feeding operations), atmospheric deposition, urban runoff, and point sources such as wastewater treatment plants. Sources of phosphorus include agriculture, urban runoff, wastewater treatment plants, stream channel erosion, and natural soil deposits.

Low dissolved oxygen in the Gulf is a serious environmental concern that can affect valuable fisheries and disrupt sensitive ecosystems. Mobile animals, such as adult fish, can typically survive hypoxic events by moving to areas of higher oxygen, but this displacement pushes them into less optimal habitats, often along the edge of the hypoxic zone (Craig 2012; Craig and Bosman 2012). One study estimates that the hypoxic zone has resulted in about a 25 percent habitat loss for brown shrimp along the Louisiana coast, west of the Mississippi delta (Craig et al. 2005). Exposure to hypoxia can cause severe health effects to aquatic life, such as reduced growth and reproduction. Atlantic croaker, a species considered hypoxia-tolerant, exhibits sublethal physiological symptoms, including reproductive impairment, when exposed to low oxygen. Studies have isolated and established a biomarker that appears in Atlantic croaker when exposed to hypoxia. The biomarker has been seen in other species (e.g., shrimp) as well, indicating that the sublethal physiological impacts of hypoxia are likely not limited to fish (Thomas et al. 2007; Murphy et al. 2009; Thomas and Rahman 2009, 2010; Kodama et al. 2012a, 2012b). Additional information regarding the environmental impacts of the hypoxic zone in the Gulf of Mexico can be found under Action 5 of the HTF 2013 Reassessment (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2013a).

In addition to hypoxia, nutrient pollution has other impacts. High levels of nutrients in drinking water—nitrate in particular—and elevated levels of by-products from the reaction of disinfection agents with organic material (e.g., algae from nutrient excess) have been linked with increased disease risks, illnesses, and even death (State-EPA Nutrient Innovations Task Group 2009). The economic costs of treating nutrient-enriched drinking water are considerable; one USDA study estimates that the cost to all public and private sources of removing nitrate from U.S. drinking water supplies—not just drinking water supplies in HTF states—is over $4.8 billion per year (Ribaudo et al. 2011). Efforts to control Gulf Hypoxia can have the corollary benefit of reducing drinking water concerns and other more localized impacts of nutrient excess in communities located in the MARB.

In Ohio, Grand Lake St. Marys, which feeds the Wabash River and flows to the Ohio River before joining the Mississippi River, is a striking example of the environmental and economic impacts of nitrogen and phosphorus pollution. Grand Lake St. Marys covers more than 13,000 acres and is Ohio's largest inland waterbody. In 2009, nutrient loading from farm runoff, failing septic systems, and lawn fertilizers triggered unprecedented blooms of toxic algae, leading to the death of fish, birds, and dogs, as well as illnesses in at least seven people (State-EPA Nutrient Innovations Task Group 2009). Since then, Grand Lake St. Marys State Park revenues have declined by more than $250,000 a year. Water-based recreation has shrunk to a small percentage of what it once was. Several marinas and boat dealers have closed and other small businesses around the lake have either closed or experienced substantial reduction in revenues estimated at $35–45 million in 2010 (Davenport and Drake 2011). Resources from local, state, and federal agencies including EPA and USDA have been marshalled to restore the lake, but costs are steep. In the past four years, nearly 40 projects totaling over $25 million have funded a variety of management actions, including monitoring, alum treatment, dredging, aeration, wetland treatment systems, habitat improvement, and agricultural conservation practices. These investments have produced documentable results such as decreased sediment loadings and improved dissolved oxygen and water circulation (Ohio EPA 2013). The city of Celina, which draws its drinking water from Grand Lake St. Marys, has spent $7.2 million in capital costs for a new granular activated carbon (GAC) facility and spends $340,000 per year on GAC filter media to address trihalomethanes (THMs) and algae concerns (Michael Eggert, Ohio EPA, personal communication, November 9, 2012).

Much work remains to be done to better quantify the socioeconomic costs and benefits of nutrient reduction at the MARB scale. Anderson et al. (2000) estimated the potential annual impacts of HABs nationally on public health, fisheries, recreation and tourism, and monitoring and management. The authors note that their results are underestimates due to additional unquantified categories of impacts, but estimated that:

- Shellfish and ciguatera fish poisoning resulted in $33.9–81.6 million in public health expenditures.
- Wild harvest and aquaculture losses associated with shellfish poisoning, ciguatera, and brown tides resulted in $18.5–24.9 million in commercial fishing losses.
- Tourism industries in North Carolina, Oregon, and Washington lost up to $29.3 million.
- Monitoring and management programs (such as routine shellfish toxin monitoring) in just 12 states cost $2.0–2.1 million.

Dodds et al. (2009) also developed national-level estimates of the impacts of nutrient pollution. They compared nutrient concentrations for EPA ecoregions to reference conditions to identify areas potentially impacted by nutrient pollution, then estimated annual impacts to recreation, real estate, spending on threatened and endangered species recovery, and drinking water. The results for each sector were:

- $189–589 million in fishing expenditure losses and $182–567 million in boating expenditure losses (based on lake area closures and expenditures).
- $0.3–2.8 billion in property value losses (depending on the assumed land availability).
- $44 million in spending to develop conservation plans for 60 species impacted by eutrophication.
- $813 million in expenditures on bottled water due to taste and odor issues in public water supplies attributable to eutrophication.

Estimates of the costs of controlling hypoxia vary. One recent study published by the National Academy of Sciences indicates that if agricultural conservation investments could be targeted to the most cost-effective locations, a combined federal, state, local and private investment of $2.7 billion per year could effectively reduce the size of the hypoxic zone (Rabotyagov et al. 2014). A number of qualifications apply to this estimate. Notably, it only considers conservation practices installed on agricultural lands in production, specifically overland flow practices, edge-of-field practices, and improvements in irrigation efficiency. It does not consider innovative approaches to preventing nutrient runoff that have the potential to further reduce costs, such as agricultural drainage water management and bioreactors, saturated buffers, cover crops, use of easements for wetlands restoration/creation, streambank conservation, and/or advances in technologies such a urease inhibitors or slow release fertilizers.

Once loading reductions are achieved, the reduction in the hypoxic zone would likely take at least another five years to fully respond depending on the timing of the reductions and the natural interannual variability (Greene et al. 2009). These lag times occur for a number of reasons. Phosphorus often attaches to sediment or is incorporated into organic particulate matter. Sediment and attached pollutants can take years to move downstream as particles are repeatedly deposited, resuspended, and redeposited within the drainage network by episodic high flow storm events. Thus, substantial lag times could occur between reductions of sediment and P delivery into the streams and measurement of those reductions at the watershed outlet. Upland conservation actions that reduce phosphorus within or at the edge of a field may be masked by streambank or bed erosion of phosphorus laden sediment for years to come (Tomer and Locke 2011). For phosphorous that is dissolved in solution in the water, hydraulic residence time (the length of time it takes for water to flush through the lake or reservoir) has a great impact on how long it takes to measure an improvement. Eutrophic state and "internal loading" (or cycling of phosphorous stored in aquatic sediments by biological organisms) can also influence lag time. Internal loading from legacy pollutants can become a significant source of phosphorus, one that is not addressed by management measures on the land.

Nitrogen typically travels in dissolved form and, because of this fact, may infiltrate along with water into subsurface drainage or groundwater systems. In many places, water moving through subsurface drainage or groundwater aquifers eventually rejoins surface water, either through tile outlets or as base flow in a stream. These water flows can carry nitrogen from the fields to the stream, but there is a time lag for nitrogen to reach the water body. Groundwater flows much more slowly than surface water—perhaps 10,000 times or more slowly in some cases—so nitrogen in groundwater may move only a few hundred feet per year (Tomer and Burkart 2003).

Members of the Hypoxia Task Force

- Arkansas Natural Resources Commission
- Illinois Department of Agriculture
- Indiana State Department of Agriculture
- Iowa Department of Agriculture and Land Stewardship
- Kentucky Department for Environmental Protection
- Louisiana Governor's Office of Coastal Activities
- Minnesota Pollution Control Agency
- Mississippi Department of Environmental Quality
- Missouri Department of Natural Resources
- Ohio Environmental Protection Agency
- Tennessee Department of Agriculture
- Wisconsin Department of Natural Resources
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture: Natural Resources and Environment
- U.S. Department of Agriculture: Research, Education, and Economics
- U.S. Department of Commerce: National Oceanic and Atmospheric Administration
- U.S. Department of the Interior: U.S. Geological Survey
- U.S. Environmental Protection Agency
- National Tribal Water Council

Additional Entities Participating on the HTF's Coordinating Committee:

- Ohio River Valley Water Sanitation Commission (ORSANCO)
- Lower Mississippi River Sub-Basin Committee

1.3 The Hypoxia Task Force

The HTF is a federal/state partnership established in 1997 to work collaboratively on reducing excess nitrogen and phosphorus in the MARB and to reduce the size of the hypoxic zone in the Gulf of Mexico. Members of the HTF include five federal agencies and 12 states bordering the Mississippi and Ohio rivers. The National Tribal Water Council represents tribal interests on the HTF. EPA is the HTF federal co-chair; the position of state co-chair, established in 2010, rotates among the state members. Iowa is the current state co-chair. Senior staff, who meet as the Coordinating Committee, support HTF members.

Each HTF member state is represented by an official from its agriculture, pollution control, or natural resources agency and is encouraged to work with all relevant state agencies to achieve HTF goals. The membership structure enables the HTF to provide a forum for state water quality, natural resources, and agricultural agencies; tribes; and federal agencies to partner on local, state, and regional nutrient reduction efforts, encouraging a holistic approach that takes into account both upstream sources and downstream impacts.

1.3.1 2001 Action Plan

In 2001, the HTF delivered an action plan to Congress. That plan, entitled *Action Plan for Reducing and Controlling Hypoxia in the Northern Gulf of Mexico* (2001 Action Plan), described a national strategy to reduce the frequency, duration, size, and degree of the oxygen depletion of the hypoxic zone in the northern Gulf of Mexico (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2001). Key aspects of the strategy were: (1) a goal to reduce the areal extent of the dead zone to less than 5,000 km^2 by 2015; and (2) a commitment to reduce nitrogen discharges to the Gulf, with multistate sub-basin committees responsible for developing nutrient reduction strategies. Interestingly, phosphorus was not viewed as a cause of hypoxia at that time.

1.3.2 2006-2007 Science Advisory Board Evaluation

In 2006, EPA asked its Science Advisory Board (SAB) to evaluate the most recent science on the Gulf hypoxic zone, as well as potential options for reducing the size of the zone. The SAB's report (USEPA 2007) reaffirmed that the hypoxic area in the Gulf is caused primarily by nutrient loads from the MARB, and indicated that significant reductions in both nitrogen and phosphorus are needed. The report states that in order to achieve the coastal goal for the size of the hypoxic zone and improve water quality in the MARB, a dual nutrient strategy targeting at least a 45 percent reduction in both riverine total nitrogen load and in riverine total phosphorus load is needed.

1.3.3 2008 Action Plan

After a reassessment of the 2001 Action Plan, the HTF released the 2008 Action Plan. The revised plan calls for each state to develop reduction strategies that address both nitrogen and phosphorus. Key action items include: (1) promoting effective conservation practices to manage rural runoff; (2) using existing regulatory controls to reduce point source discharges of nitrogen and phosphorus; (3) tracking progress; (4) reducing existing scientific uncertainties; and (5) promoting effective communication to increase awareness of Gulf hypoxia. The 2008 Action Plan also reaffirms the 2001 Action Plan quantitative coastal goal (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2008):

> "Subject to the availability of additional resources, we strive to reduce or make significant progress toward reducing the five-year running average areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 square kilometers by the year 2015."

1.3.4 2013 Reassessment

The 2008 Action Plan calls for a reassessment, in five years, of the HTF approach to addressing excess nitrogen and phosphorus loads in the MARB and reducing the size of the Gulf hypoxic zone. The 2013 Reassessment reaffirms the HTF's commitment to implementing the 2008 Action Plan and provides a snapshot of progress to date (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2013a).

1.3.5 2015 Revised Goal Framework

In February 2015, the HTF announced that it would retain the original goal of reducing the areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 km^2 and extend the time of attainment from 2015 to 2035. The HTF also for the first time agreed on an interim target of a 20 percent nutrient load reduction by the year 2025 as a milestone toward reducing the hypoxic zone to less than 5,000 km^2 by the year 2035. Given the size of the MARB and the Gulf, the many actions that need to be funded and implemented, the reservoir of excess nutrients in soils and groundwater, and the impacts of climate change (e.g., more intense and frequent rain storms leading to more nutrient runoff and warmer waters which are not able to hold as much dissolved oxygen), the HTF recognized that it will take additional time to meet the water quality goals in those large bodies of water. The HTF committed to accelerated and new actions including concerted state efforts to implement their nutrient reduction strategies, targeting vulnerable lands and quantifying the nutrient load reductions from federal programs such as the USDA RCPP, USDA MRBI, USFWS Mississippi River Habitat Initiative and Landscape Conservation Cooperatives, and EPA Water Pollution Control Program Grants and Nonpoint Source Management Program, adopting quantitative measures to track interim progress, strengthening water quality monitoring efforts, and expanding and building new HTF partnerships and alliances. The revised goal statement reads as follows:

> "We strive to reduce the five-year running average areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 square kilometers by the year 2035. Reaching this final goal will require a significant commitment of resources to greatly accelerate implementation of actions to reduce nutrient loading from all major sources of nitrogen and phosphorus in the Mississippi/Atchafalaya River Basin (MARB). An Interim Target of a 20% reduction of nitrogen and phosphorus loading by 2025 (relative to the 1980-1996 average MARB loading to the Gulf) is a milestone for immediate planning and implementation actions, while continuing to develop future action strategies to achieve the final goal through 2035. Federal agencies, States, Tribes and other partners will work collaboratively to plan and implement specific, practical and cost-effective actions to achieve both the Interim Target and the updated Coastal Goal."

Part 2: Understanding the Hypoxic Zone and Sources of Nutrients in the MARB

2.1 Understanding the Extent and Nature of the Hypoxic Zone

The areal extent of the hypoxic zone in the Gulf of Mexico is measured every summer. Monitoring supported by the National Oceanic and Atmospheric Administration (NOAA) and EPA, and conducted by Drs. Nancy Rabalais (Louisiana Universities Marine Consortium - http://www.lumcon.edu/) and Eugene Turner (Louisiana State University), documented that the midsummer areal extent of the 2014 hypoxic zone was 13,080 km^2 (NOAA 2014), or about the size of Connecticut. That size is close to the long-term average (13,751 km^2) as well as the average over the last five years (14,353 km^2). It is still much larger than the HTF coastal goal of 5,000 km^2, indicating that nutrients from the Mississippi River watershed are continuing to affect the nation's coastal resources and habitats in the Gulf. The observed dead zone area fell within the predicted June forecast range of 12,000 to 14,785 km^2 (NOAA and USGS 2014), confirming the accuracy of NOAA-sponsored forecast models. Figure 1 shows the size of the hypoxic zone from 1985 to 2014.

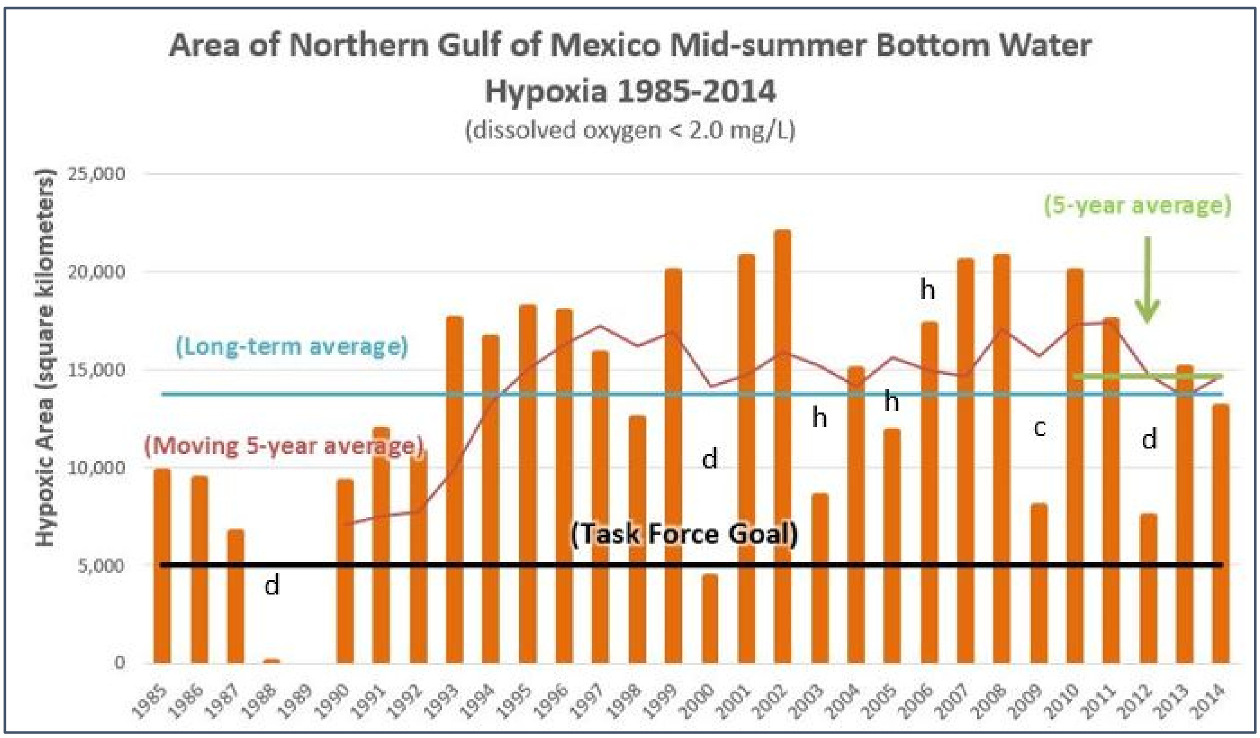


Figure 1. Size of the hypoxic zone from 1985 through 2014. Droughts (d) occurred in 1988, 2000, and 2012, resulting in less fresh water and fewer nutrients reaching the Gulf. Years when hypoxia area was lower than expected from nutrient loading levels included 2003, 2005, and 2006, when hurricanes (h) occurred just prior to the cruises that mapped oxygen conditions, and in 2009, when strong southwesterly wind-driven circulation (c) changes reduced hypoxia areal extent by pushing water masses to the east.

An important factor driving the NOAA hypoxic zone forecast model predictions is the U.S. Geological Survey (USGS) May nutrient load data from the Mississippi/Atchafalaya River basin. NOAA-supported researchers use the USGS May nutrient loads to estimate the size of the Gulf dead zone (USGS 2014b). The 2011-2014 five year moving average of May nitrate flux is similar to the 1980-1996 baseline period (see Figure 2).

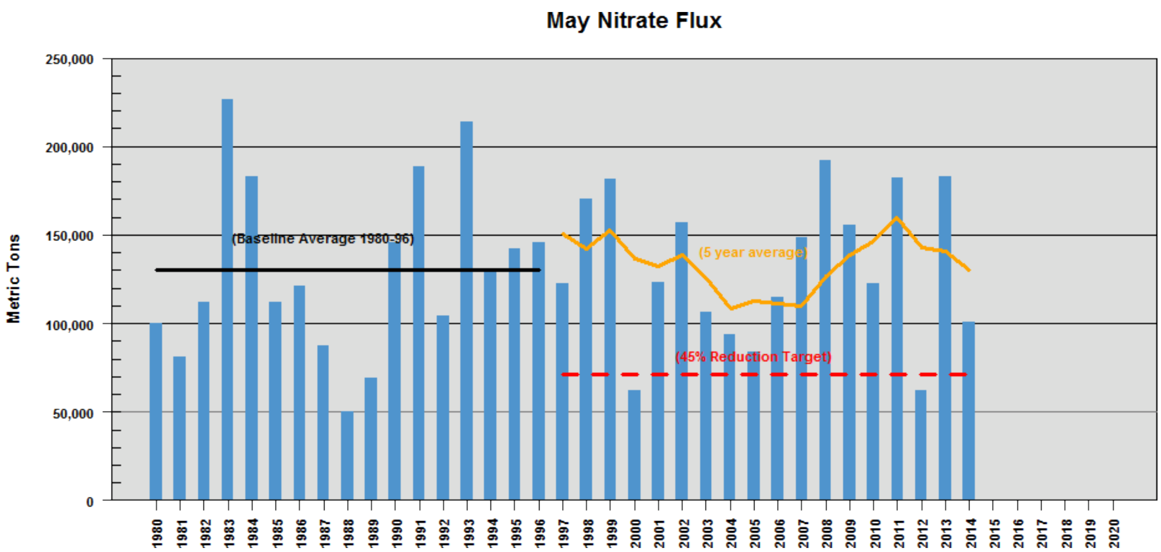


Figure 2. The amount of nitrate transported to the Gulf from the Mississippi/Atchafalaya River in May is used by NOAA supported researchers to estimate the size of the hypoxic zone. The 2011-2014 five year moving average is similar to the 1980-1996 baseline period.

The HABHRCA-authorized Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program (NGOMEX) has supported development of the forecast models used in these multi-model ensembles (three models in 2014 and four models planned for the 2015 forecast). The models are used to quantify the link between MARB nutrients and the size of the hypoxic zone and provide guidance to the Task Force on nutrient reduction levels required to meet the coastal goal. NGOMEX has also supported Dr. Rabalais' mapping of the dead zone since the HABHRCA program started in 2000, extending the long-term monitoring data set to 30 years (from 1985 to 2014).

NOAA has invested more than $38 million to sponsor research advancing science to support management of the dead zone, spanning from the Nutrient Enhanced Coastal Ocean Productivity (NECOP) program (1990-1999) to the HABHRCA-mandated NGOMEX program (2000 to the present) and the more recent Coastal and Ocean Modeling Testbed Program. These investments have developed the scientific foundation for long-term monitoring, and modeling of the causes and impacts of hypoxia.

2.1.1 Assessing the Dead Zone

NOAA's hypoxia and nutrient pollution research provides monitoring capabilities, biogeochemical processing results, and predictive modeling tools that enable coastal resource managers to make informed, proactive, and scientifically-based decisions to mitigate the impact of hypoxia on aquatic ecosystems. Conducted under HABHRCA and in response to needs identified by the HTF, NOAA's efforts are leading to the development of an operational hypoxia monitoring and forecasting system for the Gulf of Mexico and providing an annual measurement of the size of the dead zone—a key metric of the HTF—each summer. Over the past five years, NOAA, in partnership with the Northern Gulf Institute (NGI) and EPA, has convened annual Gulf hypoxia research coordination workshops to advance monitoring and modeling needs critical to managing hypoxia.

NOAA Accomplishments

NOAA has been instrumental in fostering knowledge about the hypoxic zone and continuing to advance the science to improve that understanding. Examples of NOAA's hypoxia-related accomplishments include the following:

- Conducting annual monitoring of the size of the hypoxic zone, which allows the HTF to track the metric that determines whether the HTF is making progress toward meeting its goal of reducing the size of the zone.
- Working to improve monitoring and understanding through the use of new technologies such as gliders.
- Developing modeling approaches to better support the HTF's management needs.

2.1.2 Operational Hypoxia Monitoring

One of the outputs from the 2013 NOAA/NGI Hypoxia Coordination Workshop was the Glider Implementation Plan for Hypoxia Monitoring in the Gulf of Mexico (Howden et al. 2014). The plan supports the dispatch of autonomous underwater vehicles for enhanced monitoring of seasonal hypoxia in the northern Gulf of Mexico. The HTF has repeatedly emphasized the need for improved hypoxic zone monitoring to better characterize the spatial and temporal relationship to Mississippi River nutrient loading. The plan is tiered according to available funds with three priorities: (1) four hypoxia glider cross-shelf transects that extend both east and west of the Mississippi River Delta; (2) expanded coverage spatially and temporally; and (3) sensors for determining the effects of hypoxia on living marine resources.

NOAA and the U.S. Integrated Ocean Observing System have recently announced a fiscal year (FY) 2015 NGOMEX federal funding opportunity (FFO) that is a HABHRCA-authorized program to support pilot research to test the application of gliders to Gulf hypoxic zone monitoring for integration into an operational monitoring program. Note that glider monitoring of the dead zone is intended to augment, not replace, the midsummer ship-based survey that provides the long-term HTF metric (areal extent) used to assess progress toward mitigating hypoxia. Operational shipboard monitoring of the hypoxic zone remains a critical requirement along with fixed, continuously recording sensors, since gliders can be expected only to supplement the full range of measurements that are possible at this time only from a vessel with a scientific crew.

2.1.3 Operational Hypoxia Scenario Forecast Modeling.

Another output from the 2013 NOAA/NGI workshop is a white paper, Modeling Approaches for Scenario Forecasts of Gulf of Mexico Hypoxia (Aikman et al. 2014), which assesses the state of scenario forecast models that target hypoxic zone dynamics and evaluate modeling approaches that most effectively meet the HTF management directive to mitigate hypoxia. The paper was written by a technical expert panel whose objective was to assess existing models based on their (1) ability to address key management questions; (2) infrastructure, data, and remaining research needs; and (3) readiness for transition to operation.

The models discussed in the paper include both empirical and deterministic models. The panel concluded that several empirically-based models were ready for transition to operational use for informing living resource and water quality managers of the nutrient reduction goals needed to mitigate hypoxia. The panel also found that the deterministic modeling efforts were not fully ready to be considered for use in an operational environment. They emphasized the need for continued refinement of the deterministic modeling efforts, with the ultimate goal of developing an ensemble (multiple-model) modeling approach. This approach would be used to inform the HTF of required nutrient reduction goals, both in the short term and under longer climate change scenarios. The paper also provides detailed information on the model types (Aikman et al. 2014). NOAA's Coastal and Ocean Modeling Testbed Program is continuing to provide considerable support to transition these complex models to an operational status under NOAA's Ecological Forecast Roadmap Initiative.

2.1.4 Ecological Modeling of the Impacts of Hypoxia.

The Fifth Annual NOAA/NGI Hypoxia Research Coordination Workshop continued its tradition of advancing the science that informs fisheries and resource managers about the ecological and socioeconomic effects of Gulf hypoxia. The workshop also provided a forum to assess and predict the potential effects of large-scale Mississippi River diversions. Large-scale ecosystem restoration efforts, such as river diversions and hypoxia mitigation, affect fisheries and their habitat. The ability to assess and predict those effects is important in ensuring that restoration management is informed by the best available science and that decision makers have the latest information on advances in understanding ecosystem responses (i.e., adaptive management). The workshop gave federal, state, nongovernmental organization (NGO), and academic managers and researchers an opportunity to chart a course for adaptive management in the Gulf: http://www.ncddc.noaa.gov/activities/healthy-oceans/gulf-hypoxia-stakeholders/workshop-2014/. Attendees emphasized the need to include the human element in assessing ecosystem effects by integrating social and economic sciences into ecosystem modeling. A white paper from the workshop proceedings will provide guidance for adaptive management of fisheries responses to hypoxia and diversions.

2.2 Monitoring and Modeling Water Quality and Nutrient Loading in the Mississippi/Atchafalaya River Basin

2.2.1 Nutrient Monitoring and Trends

The hypoxic zone in the northern Gulf of Mexico is one of the largest in the world and its size is related to the flux of nutrients from the Mississippi River Basin (Turner et al. 2006). Nutrient flux from the Mississippi River Basin is strongly influenced by changes in streamflow, which in turn is influenced by changes in precipitation and runoff (Donner et al. 2007, Goolsby et al. 2001, McIsaac et al. 2001). USGS tracks annual nutrient loads at about 40 stations throughout the MARB, which can be viewed at: http://toxics.usgs.gov/hypoxia/mississippi/flux_ests/index.html (USGS 2014c). Many of the large river sites have been monitored for more than 30 years, providing a long-term measurement of how nutrient loads are changing over time in response to climate, land-use changes, and nutrient-reduction actions.

USGS Accomplishments

USGS has made significant contributions to monitoring and modeling in the MARB. Examples of hypoxia-related accomplishments include the following:

- Real-time monitoring of nitrate levels in over 40 small streams and large rivers to reduce uncertainty in nutrient load estimates.
- Developing models (e.g., SPARROW) to determine the sources and areas contributing the largest amounts of nutrients to the Gulf of Mexico.

The 2007 Mississippi River Basin Science Advisory Board Panel recommended a dual nutrient reduction strategy targeting a 45 percent reduction in total nitrogen and total phosphorus loads flowing into the Gulf of Mexico to reduce the hypoxic zone to a five year running average of 5,000 km^2. The baseline period for the load comparison is 1980-1996. The total nitrogen five year moving average for 2011-2014 was about 18 percent below the baseline period (Figure 3).The total phosphorus five year moving average for 2011-2014 was about 15 percent above the baseline period (Figure 4).

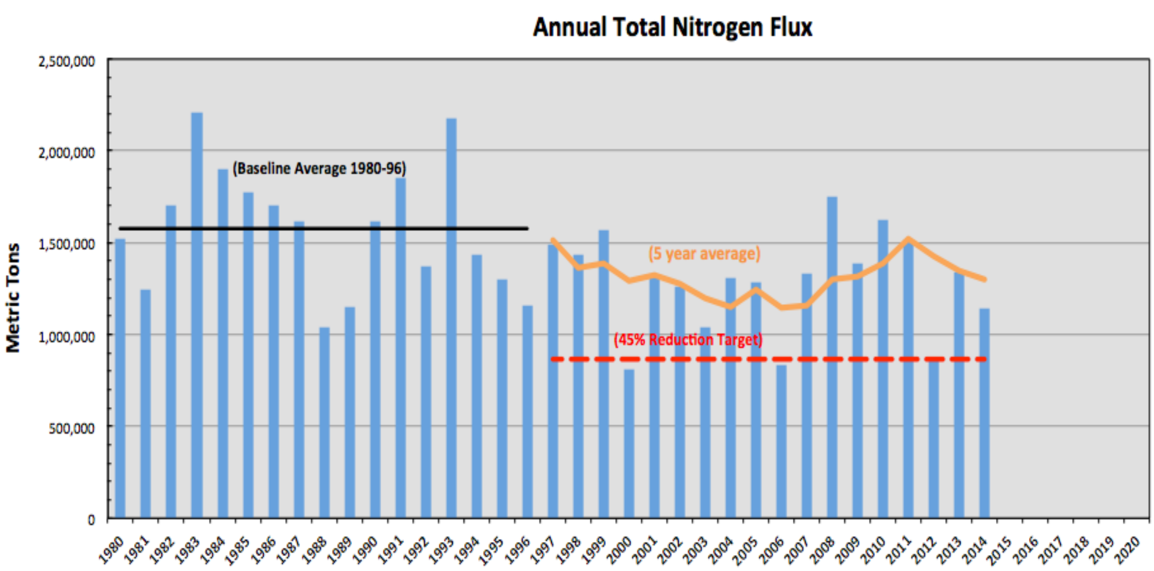


Figure 3. Annual total nitrogen loads in the Mississippi/Atchafalaya River basin transported to the Gulf of Mexico from 1980-2014.

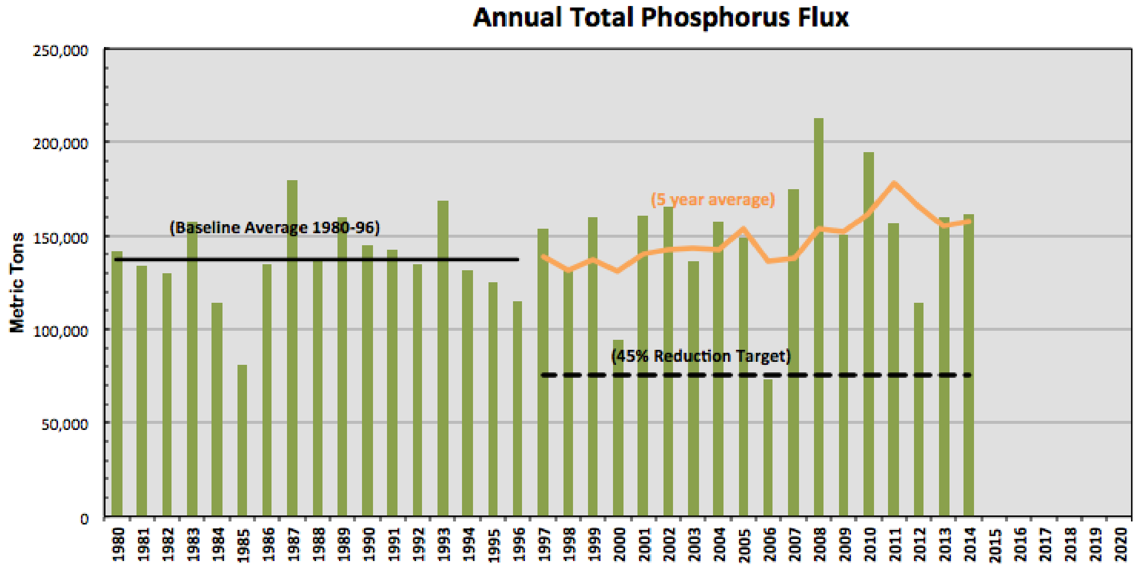


Figure 4. Annual total phosphorus loads in the Mississippi/Atchafalaya River basin transported to the Gulf of Mexico from 1980-2014

USGS is using advanced optical sensor technology to accurately track nitrate levels in real-time at more than 40 small streams and rivers throughout the Mississippi River Basin (USGS 2014a). Hourly information on nitrate levels improves the accuracy of, and reduces the uncertainty in, estimating nitrate loads to the Gulf of Mexico, especially during drought and flood years. Those data can also be used to detect changes in nitrate levels related to nutrient reduction actions. Figure 5 provides an example of real-time data. Nitrate levels at the Mississippi River Baton Rouge site peaked close to 2.0 mg/L in 2012, but were near or exceeded 3.0 mg/L in 2013 and 2014.

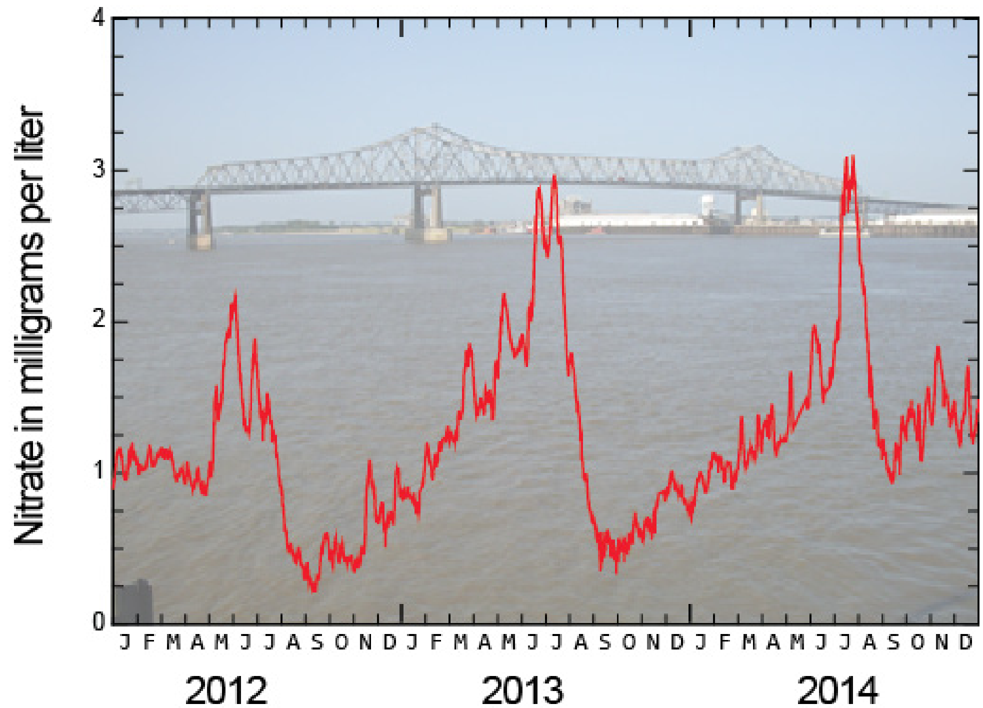


Figure 5. Real-time USGS nitrate data provides new insights into the seasonal patterns and peak concentrations. The data shown here from the Mississippi River at Baton Rouge can be found at this link: http://waterdata.usgs.gov/nwis/uv?site_no=07374000. There are currently over 40 real-time nitrate sensors located in the Mississippi River Basin. (link: http://waterwatch.usgs.gov/wqwatch/?pcode=00630)

Nitrate trends were determined at eight long-term USGS monitoring sites in the Mississippi River Basin—including four major tributaries (i.e., the Iowa, Illinois, Ohio, and Missouri rivers) and four locations along the Mississippi River—using a methodology that adjusts for year-to-year variability in streamflow conditions (Murphy et al. 2013). Flow-normalized nitrate concentrations at the Mississippi River outlet to the Gulf of Mexico increased 12 percent from 2000 to 2010.

Consistent increases in flow-normalized nitrate concentrations occurred between 2000 and 2010 in the Upper Mississippi River (29 percent) and the Missouri River (43 percent). Nitrate concentrations in the Ohio River are the lowest among the eight Mississippi River Basin sites and have remained relatively stable over the past 30 years.

Nitrate levels in the Illinois River decreased by 21 percent between 2000 and 2010, marking the first time substantial, multiyear decreases in nitrate had been observed in the Mississippi River Basin since 1980. Nitrate levels during the same period decreased by about 10 percent in the Iowa River. Reliable information on trends in contributing factors (e.g., fertilizer use, livestock waste, agricultural management practices, urban inputs, wastewater treatment improvements) is needed to better understand the correlation of those factors, independently and collectively, to increases or decreases in nitrate levels in streams and rivers throughout the Mississippi River Basin.

2.2.2 Sources of Nutrients

2.2.2.1 MARB-Scale Assessment of Nutrient Sources

The USGS spatially referenced regression on watershed attributes (SPARROW) model (Robertson and Saad 2013) provides a consistent basinwide approach to understanding how rivers receive and transport nutrients from urban, agricultural, and natural sources to the Gulf of Mexico. Figure 6 provides a graphic showing estimated sources of total nitrogen and total phosphorus to the Gulf of Mexico. At the basin scale, agricultural inputs (i.e., manure, fertilizer, and legume crops) were the largest total nitrogen source (60 percent of the total), with farm fertilizers contributing 41 percent of that amount. Atmospheric deposition, which may include volatilized losses from natural, urban, and agricultural sources, contributed 26 percent; urban sources contributed about 14 percent (7 percent from urban areas and 7 percent from wastewater treatment plants).

Agricultural inputs (manure and fertilizers) were also the largest total phosphorus source: 49 percent of the total, with 27 percent from chemical fertilizers and 22 percent from manure. Urban sources contributed 29 percent: 16 percent from urban areas and 13 percent from wastewater treatment plants. Background sources of phosphorus included erosion of channels and banks of large streams where phosphorus was previously deposited from other upstream sources (14 percent), deeply weathered loess soils (5 percent), and forests (3 percent).

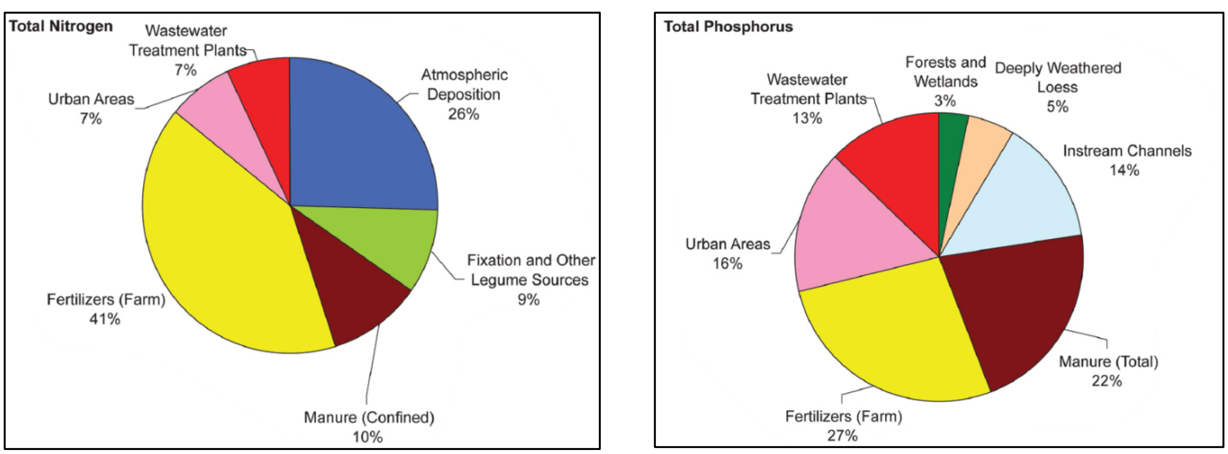
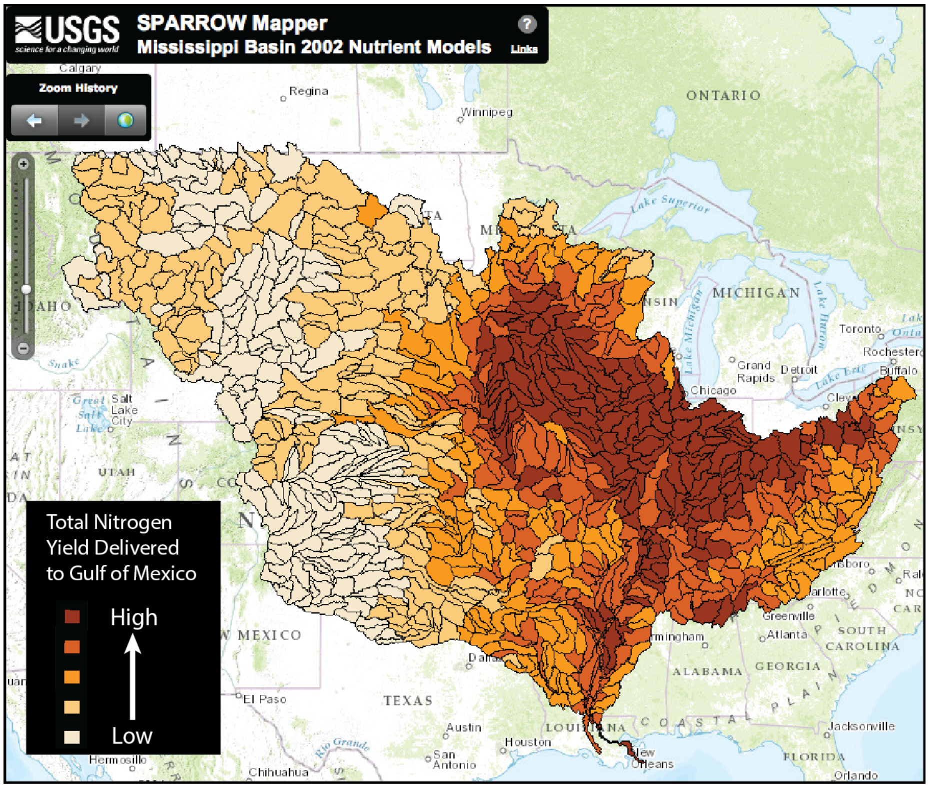


Figure 6. USGS SPARROW model estimates of sources of total nitrogen and total phosphorus transported from Mississippi River Basin to Gulf of Mexico (Robertson and Saad 2013)

The sources of nutrients transported to local water bodies in each of the 12 HTF states draining to the Mississippi River can vary significantly. The nutrient reduction strategies developed by each of the HTF states provide comprehensive assessments of nutrient sources at the state scale and describe suites of actions to be taken to reduce nutrients (see “State-Scale Assessment of Nutrient Sources” in next section).

Maps of nitrogen and phosphorus yields, loads, and watershed rankings with nutrient source information for a state, a large river basin, or the entire Mississippi River Basin can be accessed using the USGS SPARROW mapper:

http://wim.usgs.gov/sparrowMARB/sparrowMARBmapper.html (USGS 2002a). The USGS SPARROW decision support system (http://cida.usgs.gov/sparrow/map.jsp?model=37) provides similar types of maps, but it can also be used to simulate nutrient reduction scenarios basinwide or to target multiple-nutrient reductions in selected areas of the watershed and evaluate the effect the reductions would have on nutrient inputs at the outlet of the Mississippi River (USGS 2002b). Figure 7 shows which watersheds are delivering the highest nutrient yields to the Gulf of Mexico, based on USGS SPARROW model estimates.



USGS SPARROW MAPPER

Figure 7. The online SPARROW mapper can map nutrient yields, loads, and sources for a state, large river basin, or the entire Mississippi River watershed

2.2.2.2 State-Scale Assessment of Nutrient Sources

State assessments of nutrient sources in the nutrient-reduction strategies provide a finer scale resolution of information identifying the major sources of nutrients to streams, rivers, lakes, and reservoirs. The state assessments contain multiple innovative approaches to enhance the understanding of how nutrients are transported to streams, rivers, lakes, and reservoirs. State assessments may differ from basinwide assessment estimates because they may use different input data and modeling assumptions.

2.2.2.3 Examples of State Assessments of Nutrient Sources

Illinois

In Illinois, extensive analyses conducted by researchers at the University of Illinois estimated that point sources and agricultural nonpoint sources each contributed 48 percent of the total phosphorus reaching the Mississippi River from that state. Agriculture was the source of 80 percent of the nitrate-nitrogen; point sources contributed about 18 percent. Urban runoff contributed 4 percent of the total phosphorus and 2 percent of the nitrate-nitrogen. The tile-drained areas of central and northern Illinois are the largest source of nitrate. Sloping, erosive soils in western and southern Illinois are the largest contributor of nonpoint total phosphorus.

Iowa

The Iowa Department of Agriculture and Land Stewardship (IDALS), Iowa Department of Natural Resources (Iowa DNR), and Iowa State University (ISU) developed a science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico (Iowa State University 2015). On an annual basis, the largest percentage of nutrient loads in Iowa come from nonpoint sources (See Table 1). Wastewater treatment facilities contribute a relatively small percentage of the total annual nutrient load to Iowa rivers and streams when compared to nonpoint sources. However, the impacts of nutrient discharges by wastewater treatment facilities on water quality in small streams during low streamflow conditions can be significant. Artificial drainage (tile drains) and natural subsurface drainage facilitate the vast majority of nitrogen transport to streams in Iowa. In tile-drained landscapes, an estimated 17 percent nitrate yield was from surface runoff and 83 percent was from subsurface flow. The sources of phosphorus include agricultural nonpoint source runoff and streambank erosion.

Table 1. Estimated Sources of Nutrient Loads to Streams in Iowa

Source of Nutrient Loads	Nitrogen (Percent)	Phosphorus (Percent)
Point sources	7	21
Nonpoint sources	93	79

Minnesota

As part of Minnesota's nutrient reduction strategy, the state conducted a comprehensive science assessment that incorporated nutrient conditions, trends, sources, and pathways. The nutrient source assessment was based on multiple Minnesota Pollution Control Agency (MPCA) studies and engaged numerous local, state, and federal partners. During an average precipitation year, cropland sources contribute an estimated 78 percent of the nitrogen load to the Mississippi River in Minnesota. Cropland nitrogen reaches surface waters through two dominant pathways: tile-line transport; and leaching to groundwater and subsequent flow to surface waters. The primary sources of phosphorus transported to streams are cropland runoff, permitted wastewater, and stream bank erosion (Minnesota Pollution Control Agency 2014b). Figure 8 provides more information about nutrient sources from Minnesota to the Mississippi River (Minnesota Pollution Control Agency 2014b).

Nutrient source	Mississippi River	
	P	N
Cropland runoff	35%	5%
Atmospheric [b]	8%	6%
NPDES permitted wastewater discharges [c]	18%	9%
Streambank erosion	17%	--
Urban runoff	7%	1%
Nonagricultural rural runoff [d]	4%	--
Individual sewage treatment systems	5%	2%
Agricultural tile drainage	3%	43%
Feedlot runoff	2%	0%
Roadway deicing	1%	--
Cropland groundwater [e]	--	31%
Forest	--	4%

Notes: P = phosphorus; N = nitrogen

a. Source percentages do not represent what is delivered to the basin outlets.

b. Atmospheric deposition is to lakes and rivers.

c. Nutrient loads in the Lake Superior Basin are lower than other basins in the state and therefore wastewater is a larger portion of the overall sources. Western Lake Superior Sanitary District (Duluth area) accounts for more than 50 percent of the wastewater phosphorus load in the basin.

d. Includes natural land cover types (forests, grasslands, and shrublands) and developed land uses that are outside the boundaries of incorporated urban areas.

e. Refers to nitrogen leaching into groundwater from cropland land uses.

Scale: Low — High

Figure 8. Sources of phosphorus and nitrogen in Minnesota that contribute to nutrient loading in Mississippi River Basin (Minnesota Pollution Control Agency 2014b).

2.2.3 Mississippi River Basin Monitoring Collaborative

Numerous reports have highlighted the challenges of identifying the water quality benefits of conservation practices on private land. They also stress the need for continued efforts to integrate monitoring and modeling studies to move conservation science and policy forward in cooperation and partnership with interested landowners and other stakeholders. Expanded stream monitoring and improved accounting of nutrient inputs and management actions are essential to tracking progress in reducing nutrient pollution in the Mississippi River Basin and informing future water-quality models.

In 2012, the HTF established the Mississippi River Basin Monitoring Collaborative to identify streams with long-term monitoring and streamflow records that can be used to evaluate progress toward reducing the amounts of nutrients transported to local streams and ultimately to the Gulf of Mexico. This long-term monitoring network, which USGS helps lead, provides a foundation for evaluating the effectiveness of conservation practices and other nutrient reduction efforts included in the HTF states' nutrient reduction strategies. The Task Force Monitoring Collaborative has compiled more than 670,000 nutrient data records collected by 48 agencies throughout the HTF area states since 2000. Initial assessments of the data have focused on sites with both long-term water quality and streamflow monitoring. There are 134 sites with more than 20 years of monthly water quality data and approximately 240 sites with 10 to 19 years of monitoring data. Bimonthly and quarterly monitoring frequencies are also being assessed.

The Water Quality Portal is a cooperative service sponsored by USGS, EPA, and the National Water Quality Monitoring Council that integrates publicly available water quality data from the USGS National Water Information System (NWIS), the EPA STOrage and RETrieval (STORET) Data Warehouse, and the USDA Agricultural Research Service (ARS) Sustaining The Earth's Watersheds - Agricultural Research Database System (STEWARDS). It includes data collected by over 400 state, federal, tribal, and local agencies. Incorporating long term monitoring data into the portal will increase the visibility of this critical network, which is needed to assist in assessing the progress being made in reducing nutrients to local waters, the MARB, and ultimately, the Gulf of Mexico. Water quality data collected by numerous states and agencies on the Task Force are currently available through the Water Quality Portal, but not all water quality information being collected is currently available in the Portal. Once the long term monitoring network is identified, the goal will be to have all the water quality information for these sites available through the Water Quality Portal (NWQMC 2015). The portal can be accessed by going to http://www.waterqualitydata.us.

2.2.4 EPA Water Quality Monitoring

EPA conducts National Aquatic Resource Surveys (NARS) that provide statistically based estimates of the condition of water resources at national and broad ecoregion scales. NARS is currently assessing the nation's waterbodies on a five year rotating basis, with one of four waterbody types (rivers and streams, lakes, wetlands, and coastal waters) assessed each year. The national surveys are a stratified probability-based design that randomly selects sample locations so that condition estimates can be extrapolated beyond the sample locations. As a result, these surveys can be used to track trends in the condition of the nation's waters, including water quality and biological condition, over time. These assessments are conducted in partnership between the EPA and the states, along with other federal partners, and utilize standard methods across the nation to ensure data compatibility.

In 2008-2009, NARS conducted the nation's first National Rivers and Streams Assessment (USEPA 2009). EPA and its partners sampled a total of 1,925 sites during the assessment, 945 of which are located within the Mississippi River Basin. The sites selected for future national rivers and streams surveys will be a mixture of newly identified random sites, along with a subset of probabilistic repeat sites to increase the power of the trend analysis over time. Due to the great number of sites located within the Mississippi River Basin, an assessment of condition can be made at both the basin and sub-basin scales. Below are some results for nutrient concentration at both scales.

Nutrient concentrations at the basin scale ranged widely throughout the basin, with phosphorus and nitrogen ranging from 0.7 to 11,654 µg/L and 1 to 48,016 µg/L, respectively. Approximately 55 percent of stream miles in the Mississippi River Basin had phosphorus concentrations between 10 to 100 µg/L, while 35 percent of river and stream miles had phosphorus concentrations between 100 to 1,000 µg/L (Figure 9). Approximately 50 percent of river and stream miles in the basin had nitrogen concentrations ranging from 100 to 1,000 µg/L, while approximately 38 percent had nitrogen concentrations between 1,000 to 10,000 µg/L (Figure 9).

Phosphorus concentrations within the sub-basins varied greatly, with the Upper and Lower Mississippi Sub-basins having a great amount of river and stream miles with phosphorus concentrations in the range of 100 to 1,000 µg/L (Figure 10). These two sub-basins also had the greatest percentage of river and stream miles greater than 1000 µg/L, compared to the other three sub-basins. The Missouri Sub-basin had similar percentages of rivers and streams in both the 10 to 100 µg/L and 100 to 1000 µg/L concentration ranges, whereas the Ohio-Tennessee and the Arkansas-White-Red Sub-basins had the greatest percentage of rivers and streams within the 10 to 100 µg/L concentration range.

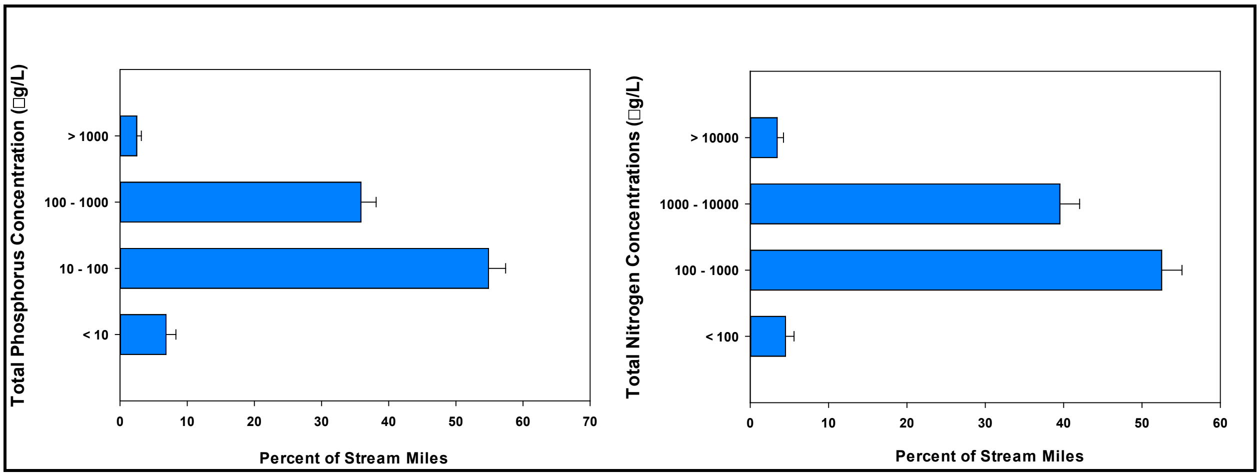


Figure 9. Nutrient Concentration Categories as Percent River and Stream Miles within the Mississippi Basin

As with phosphorus concentrations, nitrogen concentrations varied within the sub-basins, with the Upper Mississippi Sub-basin having the greatest percentage of river and stream miles within the range of 1000 to 10000 µg/L (Figure 11). The other four sub-basins had the greatest percentage of river and stream miles within the 100 to 1000 µg/L range; however, the Missouri Sub-basin had very similar percentages of river and stream miles in the 100 to 1000 µg/L and 1000 to 10000 µg/L nitrogen concentration ranges.

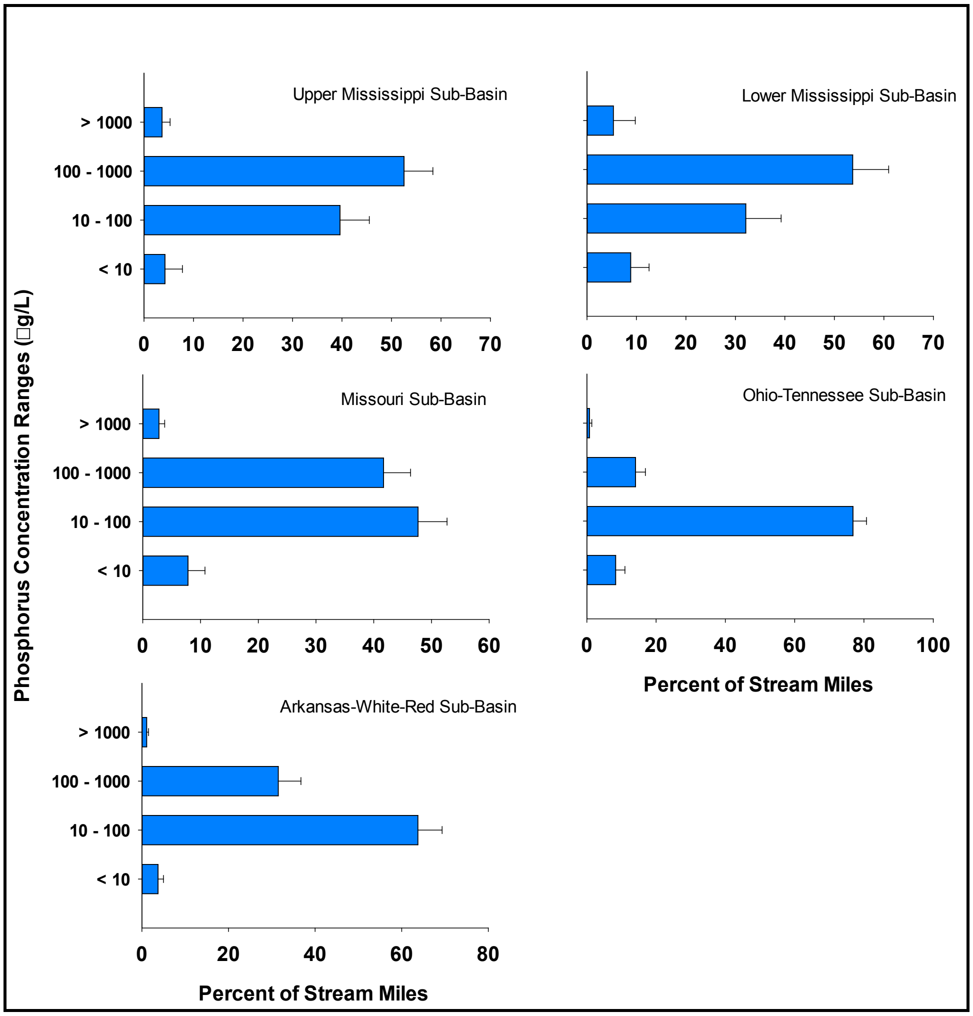


Figure 10. Phosphorus Concentration Categories as Percent River and Stream Miles within the Mississippi Sub-Basins

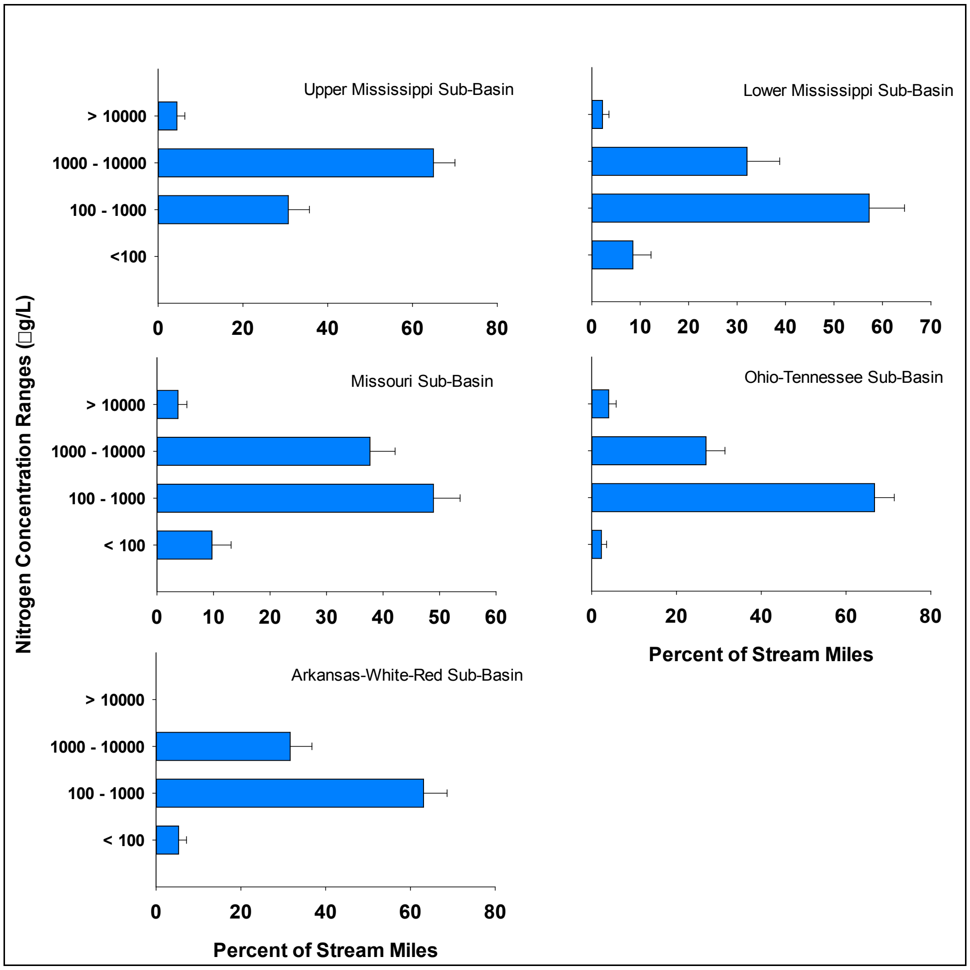


Figure 11. Nitrogen Concentration Categories as Percent River and Stream Miles within the Mississippi Sub-Basins

Data collected during the national surveys create a baseline from which trends can be assessed. These surveys are a useful tool to help assess changes in water quality and biological condition due to changes in land use practices throughout the Mississippi River Basin. Additionally, in conjunction with targeted monitoring, these surveys can help increase our ability to measure change at both local and regional scales throughout the basin. In addition to the data presented in this document, the national surveys are collecting a wide range of data that includes additional water quality parameters, physical habitat measures, and biological indicators. These surveys are a valuable piece in the larger effort to monitor condition and change throughout the Basin.

2.2.5 Conservation Effects Assessment Project

2.2.5.1 Cropland Assessments

Since 2003, USDA has worked cooperatively through the Conservation Effects Assessment Project (CEAP) to better understand watershed dynamics and the effectiveness of conservation systems on agricultural land in the MARB. CEAP is a multiagency effort to measure the environmental effects of conservation practices and programs and to develop the science base for managing the agricultural landscape for environmental quality (Duriancik et al. 2008, Maresch et al. 2008). Project findings help guide USDA conservation policy and program development and help conservationists, farmers, and ranchers make more informed conservation decisions.

> **USDA Tools to Better Target Conservation**
>
> - Since 2010, CEAP Cropland Assessments have been completed for all five sub-basins of the MARB. These assessments estimate the environmental effects of conservation programs and provide valuable information for policymakers and conservation planners to more effectively allocate conservation dollars and assistance. For details, see http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=nrcs143.
> - CEAP watershed studies provide insights into the tools necessary to improve water quality at the watershed scale. Key findings of 10 years of these studies were published in the September 2014 issue of *Journal of Soil and Water* and are being used to implement water quality-focused conservation initiatives.

USDA CEAP cropland assessments of the five major basins in the Mississippi River drainage combined the USDA Agricultural Policy/Environmental eXtender (APEX) field-scale model with the Hydrologic Unit Model for the U.S. and the Soil and Water Assessment Tool (HUMUS/SWAT) watershed models to estimate the basinwide environmental impacts of conservation practices. The model scenarios demonstrate the benefits of current conservation practices and estimate the nutrient and sediment loss reductions that could be achieved if appropriate additional conservation practices were applied to undertreated acres (Arnold et al. 1998; Neitsch et al. 2002; Williams et al. 2008; USDA 2011, 2012a, 2012b, 2013a, 2013b;). CEAP researchers from the USDA ARS and academic institutions estimate that the conservation practices on cropland, as reported in the 2003–2006 CEAP surveys, have reduced nitrogen and phosphorus loading to the Gulf of Mexico by 18 percent and 20 percent, respectively, compared to a no-practice scenario. CEAP cropland assessments have also shown that certain areas within the Mississippi River Basin contribute more nutrient loading to both the Gulf of Mexico and local waters, underscoring the importance of targeting conservation practice implementation to provide the greatest environmental benefit per U.S. dollar spent (White et al. 2014).

In 2014, USDA and USGS entered into a memorandum of understanding regarding the sharing of data sets from the USDA Natural Resources Conservation Service (NRCS). Per the agreement, NRCS will share CEAP survey data and model estimates and assist with aggregate treatment potential and associated cost estimates at the same level of aggregation and statistical reliability that NRCS has used in its published basinwide reports. This will allow USGS to incorporate Natural Resources Inventory (NRI)/CEAP modeling data and estimate the impacts of conservation practice implementation data collected through the CEAP croplands effort into its surface water quality modeling (SPARROW). The results of that effort, which includes an initial pilot project in the Upper Mississippi River Basin, will allow USDA and other agencies to more accurately target conservation systems to address local and regional nutrient loading.

2.2.5.2 Watershed Assessments

As part of the CEAP studies, NRCS has partnered with USDA's Agricultural Research Service (ARS), the National Institute of Food and Agriculture (NIFA), and universities across the country to fund a network of small watershed assessment studies. Collectively, the CEAP Watershed Assessment studies evaluate the effects of cropland and pastureland conservation practices on spatial and temporal trends in water quality using water quality monitoring and complementary modeling. Although a variety of conservation practices can and have been shown to improve water quality (cf., The Conservation Effects Assessment Project Special Issue (2008) Journal of Soil and Water Conservation 63(6); Osmond et al. 2012; Lizotte et al. 2014), responses in stream or river water quality to the implementation of conservation practices can be difficult to demonstrate for several reasons (Tomer and Locke 2011; Osmond et al. 2012). Even watershed projects with well-designed, fully implemented conservation practices and effective water quality monitoring efforts might not be able to measure change if the monitoring period and sampling frequency are not sufficient to address the lag time between treatment and response (Meals et al. 2010).

Factors that can combine to obscure the effects of conservation on water quality include historical ("legacy") loads in the natural systems, shifts in climate, changes in land use, lags in water quality responses, and lack of monitoring information (Tomer and Locke 2011; Tomer et al. 2014). For example, phosphorus, which readily attaches to sediment, can be controlled by multiple conservation practices that prevent erosion of sediment from agricultural fields. Unfortunately, sediment and phosphorus that have previously been eroded from fields without conservation might already have been deposited along downstream streams and rivers. Kuhnle et al. (2008) found that 78 percent of the total sediment load in the Goodwin Creek Experimental Watershed in Mississippi originated from channel sources. Simon and Klimetz (2008) noted that the source of sediment erosion has shifted from fields to uplands in CEAP watersheds in Iowa, New York, and Oklahoma in addition to Mississippi. Where this legacy accumulation occurs, it can add substantial phosphorus load to a river system (Brooks et al. 2010). While current upland conservation practices helped reduce present-day phosphorus loads and limit additional contributions, in some cases, large reductions in in-stream loads due to legacy sources remain to be addressed with in-stream and restoration strategies (Wilson et al. 2014).

Results from both ARS (Richardson et al. 2008 plus accompanying special issue papers; Tomer and Locke 2011; Tomer et al. 2014) and NIFA (Osmond et al. 2012) CEAP watershed studies have identified a number of lessons learned, which USDA is working to integrate into its watershed-based programming and landscape conservation initiatives. These lessons include: the importance of planning at a watershed scale; identifying the critical pollutants, their sources, and means of transport; using appropriate models to plan and evaluate implementation; using appropriate monitoring designs to evaluate conservation outcomes; identifying farmers' attitudes toward conservation practices and working with them by offering appropriate financial and technical assistance; and sustaining assistance and agricultural community engagement after practice adoption. ARS and NRCS continue to collaborate on CEAP Watershed Assessments in the 13 ARS Benchmark Watersheds.

2.2.6 USDA Edge-of-Field Water Quality Monitoring

Since 2008, NRCS has provided assistance for 38 edge-of-field water quality monitoring contracts with private landowners in eight MARB states for evaluating the effectiveness of conservation practices at the field scale. The objectives of edge-of-field monitoring are to: (1) assess the efficacy of selected priority conservation systems; (2) calibrate models used to predict edge-of-field nutrient and sediment reductions; and (3) inform adaptive management decisions. In FY 2013, USDA revised the edge-of-field practice standard, creating two new edge-of-field water quality monitoring conservation activity standards. Using those NRCS technical standards and a rigorous evaluation of landowner applications to participate, only the most promising sites—those that are scientifically sound and include strong partner support—will be selected for funding to implement edge-of-field water quality monitoring.

Of the $13 million available in the NRCS's Environmental Quality Incentives Program (EQIP) in FY 2013 and FY 2014 nationwide to support the targeted implementation of the new water quality monitoring standards, more than $2 million has been targeted for use in the NRCS Mississippi River Basin Healthy Watersheds Initiative's (MRBI) small watersheds (information on MRBI can be found in section 3.2.3).

Part 3: Assessing the Progress Made toward Nutrient Load Reductions and Water Quality throughout the MARB

3.1 Progress and Accomplishments of HTF States and Tribes

As of January 2015, all HTF states have draft or complete nutrient reduction strategies. It is important to note that those strategies are living documents that provide a roadmap for the many actions that stakeholders will need to take to reduce nutrients from point and nonpoint sources in the MARB. The strategies were developed by multiple agencies and stakeholders within each state and have resulted in greater awareness of the need for nutrient reductions in the Mississippi River Basin and, in some cases, development and implementation of new programs. Links to all HTF state nutrient reduction strategies are on the HTF website at http://water.epa.gov/type/watersheds/named/msbasin/nutrient_strategies.cfm.

Also included in this section are examples of Clean Water Act (CWA) section 319 success stories from HTF states, which are posted at http://water.epa.gov/polwaste/nps/success319/. The examples show the types of watershed projects funded with section 319 funds given to the states by EPA to reduce nutrient pollution from nonpoint sources in the MARB. In most of the success stories, project sponsors leverage multiple sources of funding (e.g., EPA CWA section 319 funds, USDA funds, state/local funds, funds from NGOs, and other funds) and landowners share the costs of installing best management practices (BMPs).

In addition to the summaries of progress in this section, MARB-specific success stories from past HTF reports (e.g., annual reports) are available on the HTF's website at http://water.epa.gov/type/watersheds/named/msbasin/success_stories.cfm.

3.1.1 Arkansas

Initiated by the 2014 Arkansas Water Plan update and Arkansas's participation on the HTF, the Arkansas Nutrient Reduction Strategy (ANRS) is a strategic framework that outlines both regulatory and voluntary opportunities to improve overall aquatic health and viability in Arkansas waters for recreational, economic, environmental, and human health benefits (Arkansas Natural Resources Commission 2014). The ANRS is not a regulatory document and does not supersede existing water laws governing water quality issues in Arkansas. Rather, it focuses on outreach and grassroots implementation of nutrient reduction activities. Arkansas has invested significant effort to address point and nonpoint source nutrient loading through state, federal, and private partnerships. Partnerships with local, county, state, and federal agencies as well as nonprofit, academic, and for-profit private sector entities are essential and necessary for (1) mobilization and coordination of available resources; (2) interpretation and implementation of water management policies; (3) long-term support at the national, state, and local levels; and (4) advancement of science-based technologies, methods, and new nutrient reduction techniques. The ANRS can be accessed at: http://arkansaswaterplan.org/state%20nutrient%20reduction%20strategy.html.

The strategic framework promotes iterative and collaborative processes that are adaptive to changing conditions and adhere to the following guiding principles:

- Strengthening existing programs.
- Promoting voluntary, incentive-based, cost-effective nutrient reduction measures.
- Incorporating adaptive management and flexible strategic planning.
- Leveraging available financial and technical resources.
- Pursuing market-based opportunities and solutions.

An integrated approach, as defined in this strategic framework, represents a "sustained multi-discipline, multi-sector effort to reduce point and nonpoint nutrient loading and improve water quality through publicly supported strategies." These efforts require consistent cooperation and communication on the "ground level" and represent a "from the bottom up" versus "from the top down" approach to nutrient reduction. Arkansas's soil and water conservation districts are on the ground level, that is, active in local communities and pioneering the implementation of innovative practices. These grassroots connections are essential to working with private, state, and federal entities to improve water quality through public policy, public outreach and education, research, project implementation, and water quality monitoring in priority watersheds.

Arkansas Highlights

Illinois River Watershed. The Illinois River watershed, located in northwest Arkansas, has been the focus of multi-year efforts to reduce nutrient (phosphorus) loadings from nonpoint and point sources. Coordinated efforts in the Illinois River watershed have consisted of legal, regulatory, and voluntary reduction activities that have proved effective in nutrient reduction and water quality improvement. City, county, state, federal, and private industry partnerships have been formed to address nutrient management issues "on-the-ground" in local communities and have resulted in positive changes to existing policies and legal mechanisms available to support nutrient reduction. A few highlights of reduction efforts in the Illinois River watershed include:

- National Pollutant Discharge Elimination System (NPDES) nutrient limits for wastewater dischargers
- Increased water quality monitoring and reporting
- Registration of all poultry and livestock production operations, on-farm nutrient management planning, certification of nutrient management planners and applicators
- Increased funding for USDA conservation and state nonpoint programs
- Research and study of new nutrient markets and market-based solutions
- Development of watershed phosphorus nutrient index
- Creation of proactive non-profit watershed groups and stakeholder involvement

The Arkansas Natural Resources Commission (ANRC) and its partners successfully addressed surface erosion from agricultural activities through cost-effective targeting of CWA section 319 funds. The 2014 Arkansas Department of Environmental Quality (ADEQ) water quality assessment has shown that exceedances of the turbidity standard for all flows (17 nephelometric turbidity units [NTU]) had declined to 18 percent in the 5-year period leading up to 2014. Therefore, ADEQ removed the turbidity impairment for the 2.5-mile segment of the Illinois River from its 2014 impaired waters list.

St. Francis River Watershed. In 2009 the Cross County Conservation District (CCCD), using CWA section 319 funds provided by the ANRC, began offering financial and technical assistance to help landowners implement water control structure BMPs called drop pipes. The BMPs prevent sediment from leaving agricultural fields by controlling the rate, velocity, and volume of field runoff. Many landowners took advantage of this opportunity; they installed 108 water control structures along with 10,120 feet of water transfer pipeline. In 2004 the CCCD used CWA section 319 funds to purchase a no-till drill that could be used by landowners with small agricultural operations. No-tilling allows for planting seed into the previous year's crop residue without any tillage. The crop residue protects the soil and lessens the opportunity for erosion. From 2004 through 2009, landowners used the drill to reduce erosion on more than 5,400 acres. In 2010 the Poinsett County Conservation District (PCCD) followed CCCD's lead and began providing financial and technical assistance to landowners to help implement water control structure BMPs. The PCCD implementation project, also supported by CWA section 319 funds from the ANRC, resulted in the addition of 287 water control structures on 63 different farms.

As a result of the practices implemented in the watershed, the 2014 ADEQ water quality assessment has shown that exceedances of the turbidity standard for all flows (100 NTU) declined to 23 percent in St. Francis River reaches 008 and 009. Therefore, ADEQ removed both reaches from Arkansas's 2014 CWA section 303(d) list for turbidity impairment.

3.1.2 Illinois

The *Illinois Nutrient Loss Reduction Strategy* is based on an assessment of available science and uses the input of Illinois stakeholders (Illinois EPA 2014). The document was developed in consultation with a nutrient reduction policy workgroup (composed of wastewater agencies, agricultural groups, environmental groups, academia, and government agencies), and it went through a 60-day public comment period. Illinois identified reduction goals to address hypoxia: 45 percent reduction in nitrate-nitrogen and total phosphorus; interim milestones of 15 percent reduction in nitrate-nitrogen, and 25 percent reduction in total phosphorus by 2025. Much of the strategy relies on voluntary action, but regulatory limits on some point sources are also included in the Illinois approach. The state also identified actions to address the impact of nutrients on local water quality, as well as their contribution to Gulf of Mexico hypoxia, for each of the main sources of nutrients—point sources, agricultural nonpoint sources, and urban stormwater. The *Illinois Nutrient Loss Reduction Strategy* can be accessed at: http://www.epa.illinois.gov/topics/water-quality/watershed-management/excess-nutrients/index.

The following excerpts from the *Illinois Nutrient Loss Reduction Strategy* highlight some key activities already being implemented.

3.1.2.1 The Nutrient Research & Education Council

In 2012, a group of agricultural organizations, state agencies, and environmental groups successfully worked with the Illinois General Assembly to enact changes to the Illinois Fertilizer Act (505 ILCS 80) to create the Nutrient Research & Education Council (NREC). NREC is a public-private partnership that ensures a sustainable source of funding for nutrient research and education programs. The council is made up of nine voting members from the agricultural sector and four nonvoting members, including representatives from environmental groups, Illinois EPA, and academia. The partnership between NREC and the Illinois Department of Agriculture ensures that a $0.75/ton assessment on all bulk fertilizer sold in Illinois is allocated to research and educational programs focused on nutrient use and water quality.

NREC funded two water quality research projects in 2013, including an agronomic and environmental assessment of cover crops and phosphorus runoff potential in fields with minimal slope. These ongoing projects have totaled $320,048. In 2014, NREC provided over $2.55 million to 14 projects, including educational and outreach programs as well as several research projects addressing the need to reduce nutrient losses from agricultural sources and evaluating the effectiveness of various nutrient management practices in improving water quality. Details on all NREC projects can be found at: http://www.illinoisNREC.org.

3.1.2.2 Keep It for the Crop

The Council on Best Management Practices established the Keep It for the Crop (KIC) program in January 2012. KIC currently works in eight watersheds designated by Illinois EPA as being impaired due to nitrate-nitrogen, total phosphorus, or both: Lake Springfield, Lake Evergreen, Lake Bloomington, Lake Vermilion, Salt Fork Vermilion River, Vermilion River–Illinois Basin, Lake Decatur, and Lake Mauvaise Terre. KIC engages agricultural retailers and their farmer customers in systematically managing nutrients throughout the growing season rather than as a single-nutrient application. This approach helps to reduce the likelihood of nutrient losses from surface or subsurface movement and can improve yields by keeping nutrients available for crop uptake. KIC uses the following programs and tools to better educate farmers on the nitrogen cycle, nutrient uptake, and optimum nitrate-nitrogen rates for individual fields:

- Nitrogen management systems
- N-WATCH®
- On-farm nitrogen rate trials
- N-Calc (Maximum Return to Nitrogen calculator)

These tools are components of the four R's of nutrient stewardship: right source, right rate, right time, and right place. The 4R program is a nationally recognized nutrient framework developed by the International Plant Nutrition Institute. It can be customized to different cropping systems, soil types, and climatic conditions. KIC also coordinates the on-farm nitrate-nitrogen rate trials, N-WATCH soil samples, and observations of crop response with the University of Illinois's Department of Crop Sciences to ensure proper analysis of the results and dissemination of the findings through the University's extension service publications. KIC receives financial support from NREC for its education, outreach, and research-based components.

3.1.2.3 Point Source NPDES Permit Limits

As a result of state-enacted laws, Illinois Pollution Control Board standards, and other actions, 36 percent of major municipal dischargers in Illinois currently have total phosphorus limits in their NPDES permits. These dischargers represent 70 percent of the regulated discharge statewide from major municipal sources. A smaller number of major municipal dischargers have nitrate-nitrogen goals (10 milligrams per liter [mg/L]).

The implementation of a 1 mg/L total phosphorus limit in the NPDES permits of major municipal dischargers in the highest loading watersheds, which is already in progress, will address the bulk of the point source total phosphorus reductions needed to reach the HTF coastal goal. Loading of total phosphorus will be reduced by 3.1 million pounds (or approximately 33 percent of the point source reduction goal) once the limits have been fully implemented at the state's Calumet, Stickney, and O'Brien wastewater treatment plants.

Major municipal dischargers in the Fox River, Des Plaines River, and DuPage River/Salt Creek watersheds will also achieve significant reductions in total phosphorus loading. The reductions are expected in the next 3–10 years (perhaps longer in the DuPage/Salt Creek watershed). Limiting total phosphorus in the NPDES permits of major municipal dischargers in other watersheds in the Illinois River Basin will complete the reduction needed to meet the point source component of the HTF coastal goal.

Illinois Highlights

Governor Bond Lake. Governor Bond Lake suffered from excessive algal growth and turbidity, causing Illinois to add the lake to its 1998 CWA section 303(d) list of impaired waters. The impairments were caused by suspended solids, nutrients, and other nonpoint source pollutants from within the lake (from legacy bottom sediments) and from the lake's watershed. Project partners implemented BMPs such as stormwater wetland basins and shoreline protection and stabilization practices. As a result, levels of nutrients and suspended solids decreased, allowing Illinois to remove the lake from its 2006 303(d) list of impaired waters for those pollutants. (The waterbody, however, remains impaired by a high concentration of manganese from an unknown source.)

Illinois EPA administered $523,542 in section 319 funding for this project. Conservation 2000 and the Illinois Clean Lakes Program provided $383,339 in matching funds and technical and administrative assistance. The Illinois EPA Nonpoint Source Unit and Clean Lakes Unit and the city of Greenville helped review, develop, and install the completed BMPs. The city of Greenville contracted with several environmental engineering firms to create design specifications and oversee construction.

Dutchman Creek. Uncontrolled runoff from non-irrigated crop production had impaired the aquatic life designated use of Dutchman Creek, causing Illinois EPA to add the creek to the 1998 CWA section 303(d) list of impaired waters for nutrients and siltation. Stakeholders implemented a successful EPA-funded outreach and education program in the Dutchman Creek watershed that promoted no-till agricultural practices and prompted landowners to convert more than 400 acres of environmentally sensitive land back into forest. These changes improved water quality and restored the creek's aquatic life use, allowing Illinois to remove the creek from its 2008 303(d) list of impaired waters.

The Shawnee Resource Conservation and Development Area administered the two Cache River forestation projects. Excluding administration costs, a total of $26,799 in section 319 funds and $28,615 in state and local funds was spent in the Dutchman Creek watershed to implement the 424.6 acres of tree planting. The Johnson County Soil and Water Conservation District administered the county's no-till drill project. Countywide, the project used $13,176 in CWA section 319 funds and $8,784 in state and local funds for education and to purchase a drill for operators' use. The district has continued the program and now has four no-till drills available for producers to rent.

Charleston Side Channel Reservoir. Erosion from agriculture and other land-based activities resulted in elevated levels of manganese, sediment, and phosphorus in the Charleston Side Channel Reservoir (CSCR). The pollutants contributed to excess algal growth. Illinois EPA added the CSCR to the state's CWA section 303(d) list of impaired waters beginning in 1998 for a variety of pollutants, including phosphorus, sediment, and manganese (added in 2004). To reduce erosion and manage nutrients, project partners installed shoreline stabilization structures and other BMPs. Manganese levels dropped, prompting Illinois EPA to remove the reservoir from the 2008 CWA section 303(d) list for manganese. Partners installed BMPs on city property and privately owned land in the two watersheds. All the practices were designed to control erosion and reduce sediment delivery to the lake and river and, in turn, reduce the amount of nutrients being transported by the sediment to the lake.

The BMPs installed in the CSCR watershed reduced the pollutant load by an estimated 1,627 tons of sediment per year, 1,371 pounds of phosphorus per year, and 2,738 pounds of nitrogen per year. EPA provided $194,449 in CWA section 319 funding to Illinois EPA to support implementation of BMPs that reduced sediment and nutrient loads, including streambank and lakeshore stabilization and installation of an in-lake sediment detention basin. The city of Charleston, Coles County Soil and Water Conservation District, Illinois Department of Agriculture, and Eastern Illinois University also used CWA section 319 funding to install BMPs.

3.1.3 Indiana

Indiana's state nutrient reduction strategy was developed under the leadership of the Indiana State Department of Agriculture (ISDA) and Indiana Department of Environmental Management (IDEM), with guidance on watershed prioritization coming from the entire Indiana Conservation Partnership (ICP), a group of eight Indiana agencies and organizations who share a common goal of promoting conservation. Indiana's state nutrient reduction strategy can be accessed at http://www.in.gov/isda/2991.htm and more information on the Indiana Conservation Partnership can be found at http://icp.iaswcd.org/. (Indiana State Department of Agriculture and Indiana Department of Environmental Management 2014). The strategy will serve as a means of:

- Identifying water quality challenges and concerns in Indiana.
- Tracking the impact of conservation across the state.
- Cataloging available funding and programs across the state that stand to improve water quality.
- Reporting and accountability to conservation partners, federal agencies, and the public.
- Prioritizing 8-digit and 12-digit hydrologic unit code (HUC8 and HUC12) watersheds within Indiana.

While watershed ranking and prioritization processes are still under development within the strategy, a major component of prioritization, tracking of reductions and setting goals will hinge on the wide adoption of the EPA's Region 5 Nutrient Load Reduction model, assessing the impact of assisted and voluntary conservation in Indiana. Other factors influencing the selection of priority watersheds within the state nutrient reduction strategy will include, but are not limited to:

- Indiana's major drainage basins (priority watershed[s] in each basin)
- Water use and associated challenges within basins
- Presence of state, local, and federal resources (funding, staff, and conservation programs, and their respective coverage)
- Monitoring programs and data (i.e., IDEM rotating basin assessments and fixed station monitoring, USGS National Water Quality Assessment [NAWQA])

Indiana's nutrient reduction strategy has undergone several review and comment cycles with EPA and will be completed in 2015 with the completion of a watershed prioritization process approved by the ICP.

3.1.3.1 Nonpoint Sources

The ICP is using EPA's Region 5 Nutrient Load Reduction model to determine the impact of voluntary and assisted conservation efforts statewide. The entire partnership, consisting of six state and federal agencies, Indiana Association of Soil and Water Conservation Districts, and Purdue University's extension service, has adopted the model to consolidate and run conservation practice data from several programs including:

- State-level conservation projects, such as those funded by Clean Water Indiana and CWA section 319
- Local conservation efforts by soil and water conservation districts
- Farm Bill practices across the state

Data from the practices, totaling well over 18,000 just for 2013, are run through the Region 5 Nutrient Load Reduction model to estimate annual amounts of nitrogen, phosphorus, and sediment kept from Indiana's waters. Indiana's adoption of the EPA model on such a large scale enables the ICP to comprehensively set reduction goals across the state.

Load reductions estimated by the model for Indiana in 2013 were published in January 2015 with watershed maps (for nitrogen, phosphorus, and sediment) and quarterly updated estimates from the model will be published annually moving forward. The estimates, paired with monitoring by state and federal partner agencies, as well as continued assessment of Indiana's CWA 303(d) list of impaired waters, will inform watershed prioritization and conservation resource management for the ICP's efforts and Indiana's nutrient reduction strategy.

3.1.3.2 Point Sources

IDEM has limited NPDES permits for major municipal dischargers to reducing allowable phosphorus concentrations to 1 part per million (ppm).

IDEM is also partnering with USGS to estimate the total phosphorus loads leaving the State of Indiana from point sources. The assessment will contribute to a better understanding of nutrient sources and loading in Indiana as the state's nutrient reduction strategy is implemented.

Indiana Highlights

School Branch Watershed Monitoring Project. The School Branch watershed covers roughly 8.4 square miles and feeds into Eagle Creek Reservoir, a source of drinking water for Indianapolis. Its land use consists of an agriculture-to-urban development ratio of about 3:2 (about 60 percent row crops and 40 percent suburban residences). The project goal is to measure the impact of good agricultural practices on the landscape, comparing water quality above the participating farm in the watershed with water quality below the farm in the watershed. Conservation practices include riparian and grass buffers, a nutrient-removal bioreactor, a strict no-till tillage system, and use of cover crops. Some monitoring is already underway, but the rest of the project is set to start up in late 2015. Monitoring will include:

- Edge-of-field sensors measuring nitrate-nitrite leaving agricultural tiles on a participating farm (sampling now underway).
- A USGS Sentry Gauge (to be installed summer 2015) monitoring water leaving the farm, measuring nitrate, phosphorus, sediment, and temperature, as well as a gauge at the bottom of the watershed.
- Isotope sampling by USGS to determine sources of nitrogen loading in the watersheds.
- Indiana Geological Survey's monitoring wells for groundwater and soil moisture probes measuring soil moisture and temperature on the farm, to accompany Sentry Gauge (to be installed summer 2015).
- Monthly fixed-station monitoring by IDEM (ongoing).
- Biweekly fixed-station water quality monitoring by Marion County Health Department (ongoing).

Jenkins Ditch. Agricultural activities related to crop cultivation and hydrological modification contributed nonpoint source pollution to Jenkins Ditch, causing the waterbody to fail to support its aquatic life designated use. As a result, in 2006 IDEM added Jenkins Ditch (a 2.13-mile segment) to Indiana's CWA section 303(d) list of impaired waters for poor fish community biological integrity. Stakeholders implemented BMPs in the watershed and conducted education and outreach activities to raise community awareness, resulting in improved water quality. The waterbody now supports its aquatic life designated use. As a result, IDEM removed Jenkins Ditch from Indiana's list of impaired waters in 2012.

Among the many partners involved in these activities were the Clinton, Howard, Tipton, and Tippecanoe County Soil and Water Conservation Districts; the Greater Wabash River Resource Conservation and Development Council; Purdue Cooperative Extension; Hoosier Riverwatch; and NRCS. Partners used $729,000 in CWA section 319 funds to implement restoration projects throughout the watershed. Another $462,000 in CWA section 319 matching funds supported the work of a variety of project partners.

INfield Advantage (formerly Indiana On Farm Network). The Indiana State Department of Agriculture, Division of Soil Conservation received a $450,000 competitive USDA grant in 2010 to establish the On Farm Network (OFN) in Indiana over three years. The grant was matched with checkoff funds and support from the IN Corn Marketing Council and IN Soybean Alliance. The project has exceeded original grant goals. The project's objective was to engage three watersheds within the Indiana portion of the Mississippi River Basin. Each watershed's goal was to enroll 40 to 50 fields with 10 to 15 farmers on average. In 2014, the Indiana On-Farm Network® was more than five times larger than expected and includes 22 groups in 19 watersheds within the Mississippi River Basin. On average, each watershed has 12 or 13 growers engaged and more than 34 fields enrolled. During the project, over 142,000 acres have been evaluated with the On-Farm Network's® tools and 264 growers have been introduced to the participatory learning process. In 2015, Indiana On-Farm Network will be rebranded as INfield Advantage.

3.1.4 Iowa

3.1.4.1 Iowa Nutrient Reduction Strategy

The Iowa nutrient reduction strategy is a science- and technology-based approach to assess and reduce nutrients delivered to Iowa waterways and the Gulf of Mexico (Iowa State University 2015). The strategy outlines primarily voluntary efforts to reduce nutrients in surface water from both point sources (e.g., wastewater treatment plants and industrial facilities) and nonpoint sources (e.g., farm fields and urban areas) in a scientific, reasonable, and cost-effective manner. As a part of the point source efforts, which are described in more detail below, all major municipal and industrial facilities, and minor industrial facilities that treat process wastewater using biological treatment will be required to evaluate the economic and technical feasibility for reducing nutrient discharges.

The development of the strategy reflects more than two years of work led by Iowa Department of Agriculture and Land Stewardship (IDALS), Iowa Department of Natural Resources (DNR), and Iowa State University (ISU). The scientific assessment to evaluate and model the effects of practices was developed through the efforts of 23 individuals representing five agencies or organizations, including scientists from IDALS, Iowa DNR, ISU, USDA ARS, and USDA NRCS. The Iowa nutrient reduction strategy can be accessed at http://www.nutrientstrategy.iastate.edu/.

Iowa has devoted significant resources to addressing Gulf hypoxia, which are reflected both by their leadership role on the HTF as the State co-chair (served by Iowa Secretary of Agriculture Bill Northey) and by their efforts to effectively target limited resources to advance water quality and soil conservation efforts in the state. In developing its strategy, Iowa has followed the recommended framework provided by EPA in 2011 and was the second state to complete a statewide nutrient reduction strategy.

The strategy is just the beginning. Operational plans are being developed and work is underway. It is a dynamic document that will evolve over time and is a key step towards improving Iowa’s water quality.

3.1.4.2 Nonpoint Sources

The Iowa nutrient reduction strategy was completed in spring 2013 and, thanks to strong support from the Iowa governor and legislature, IDALS received $22.4 million targeted to implementation efforts around the nonpoint source section of the strategy. This effort, called the Water Quality Initiative (WQI), is administered through IDALS, the coauthor and nonpoint source lead of the Iowa nutrient reduction strategy. The four main components of Iowa’s WQI are outreach/education, statewide practice implementation, targeted demonstration watershed projects, and tracking/accountability. The WQI seeks to harness the collective ability of both private and public resources and organizations to rally around the nutrient reduction strategy and deliver a clear and consistent message to the agricultural community to reduce nutrient loss and improve water quality. In the WQI’s first year, IDALS partnered with Iowa farmers on a dollar-for-dollar match and implemented over 95,000 acres of cover crops. This effort prevented the loss of over 800,000 pounds of nitrate and 22,500 pounds of phosphorus from Iowa waters.

IDALS also established 13 targeted demonstration watershed projects through the WQI. The projects are locally led initiatives located in individual or small groups of HUC12s within priority HUC8 watersheds as designated by the Water Resources Coordinating Council (WRCC). The collection of these projects are coordinating activities with over 70 individual partners to leverage resources and expand the audience of the Iowa nutrient reduction strategy. The projects represent over $6 million in IDALS funding combined with an additional $10.3 million in partner and landowner contributions. This effort will promote increased awareness and adoption of available practices and technologies. Successful projects will serve as local and regional hubs for demonstrating practices and providing practice information to farmers, peer networks, and local communities.

The WQI is also coordinating tracking and accountability measures of the Iowa nutrient reduction strategy. Through the Measures subcommittee of the WRCC, the development of a logic model type framework will be employed to collect and report on progress made through the strategy. The logic model looks at a variety of parameters to assess a reasonable chronological order that can be applied to cumulative efforts being conducted throughout the state involving multiple groups and individuals. The subcommittee will assess the pertinent information currently available and make suggestions for areas that need to be augmented or possibly created if they do not exist. When completed, the logic model will act as a dashboard for advancing the strategy and will allow more responsiveness and feedback in investing resources and programming. The subcommittee continues to work on developing recommendations on the information to be collected as part of the logic model, where to access the information from existing resources, and what resources are not yet available and should be developed.

In addition to the projects detailed in this report, IDALS has put into motion new initiatives that will leverage partner resources and increase the adoption of conservation practices in the state. The initiatives include a focus on edge-of-field practices, streamside and in-field buffers, and demonstrating urban nonpoint source practices. The funding requested for the WQI would allow the department to continue and expand its work to address the quality of Iowa's streams and water resources in a scientific, reasonable, and cost-effective manner.

3.1.4.3 Point Sources

One of the goals of the point source component was to issue, within the first year of the strategy, 20 NPDES permits that included a feasibility study requirement and weekly influent and effluent monitoring for facilities listed in the nutrient reduction strategy. As of May 31, 2014, 21 permits had been issued with the feasibility study requirement included. There are currently 147 facilities included in the strategy. The intent is to reissue approximately 20 permits per year that include the feasibility study requirement; the expectation is that after seven years all major facilities' permits will have been reissued with the feasibility study requirement included.

3.1.4.4 Targeted Implementation Efforts

In addition to the WQI, the Iowa Conservation Reserve Enhancement Program (CREP) was developed specifically in response to water quality efforts related to Gulf of Mexico hypoxia and the Iowa nutrient reduction strategy.

The Iowa CREP was initiated in 2001 and developed based on wetlands research conducted at ISU that showed tremendous potential for targeted wetland restoration to remove large amounts of nitrates via natural denitrification processes that occur in wetlands. Building off of this research, the program was designed to target wetland restoration at the locations in the landscape where they can remove the largest amounts of nitrate. Targeted landscapes in Iowa include areas of heavy agricultural intensity coupled with the existence of artificial drainage tile that serves to facilitate transport of nitrates to the wetland restoration where they can be removed. This targeting ensures that the wetlands are positioned to provide maximum effectiveness, which equates to a 40–70 percent removal rate for nitrates delivered to the wetlands. CREP wetlands are an integral component of the Iowa nutrient reduction strategy as an edge-of-field practice with the capacity to provide large reductions in the amount of nitrogen exported to surface waters. To date, 72 wetland areas have been completed with another 24 under development. The wetlands completed to date provide an annual nitrogen reduction capacity of over 1 million lbs at a cost of just $0.26/lb of nitrogen removed, highlighting both the capacity and cost-effectiveness of the wetlands.

Iowa Highlights

Clear Creek. Runoff from agricultural areas and waste from leaking septic systems sent pollution to Clear Creek, preventing the stream from meeting several of Iowa's water quality standards. As a result, the Iowa DNR added a 7-mile segment of Clear Creek to the state's CWA section 303(d) list of impaired waters in 2004. Watershed partners implemented agricultural BMPs and coordinated construction of a wastewater treatment facility to replace leaking septic systems. The DNR estimates that landowners reduced phosphorus delivery by 10,081 pounds per year. In 2009, DNR staff conducted a field check, finding that Clear Creek showed improved water quality conditions with no evidence of untreated or poorly treated wastewater in the stream. The DNR determined that Clear Creek no longer exceeds Iowa's narrative water quality standards and now fully supports its general uses. As a result, DNR removed the 7-mile segment of Clear Creek from the state's list of impaired waters in 2010.

Several funding sources supported the installation of practices to control soil erosion and phosphorus delivery: the EPA CWA section 319 program ($250,000), IDALS–Division of Soil Conservation's Water Protection Fund ($196,560), NRCS EQIP ($166,775), USDA Conservation Reserve Program ($60,940), and Iowa Financial Incentive Program ($75,000). Landowners contributed another $182,460 toward implementation of practices in the project.

Iowa CREP Wetlands. The Iowa CREP is a joint effort of IDALS and USDA's Farm Service Agency, in cooperation with local soil and water conservation districts (SWCDs). The goal of the program is to reduce nitrogen loads and the movement of other agricultural chemicals from croplands to streams and rivers by targeting wetland restorations to "sweet spots" on the landscape that provide the greatest water quality benefits. CREP wetlands are positioned to receive tile drainage by gravity flow, which enables natural wetland processes to remove nitrates and herbicides from the water before it enters streams and rivers.

Research and monitoring has demonstrated that these strategically sited and designed CREP wetlands remove 40 to 70 percent of nitrates and over 90 percent of herbicides from cropland drainage waters. The highly targeted nature of this program has led to 72 wetlands currently restored and another 24 under development. During their lifetimes, the wetlands are expected to remove more than 100,000 tons of nitrogen from 121,650 acres of cropland. In 2013, the number of restored wetlands reached an annual capacity of removing over 1 million lbs of nitrogen. The 96 targeted restorations total more than 888 acres of wetlands and 3,100 acres of surrounding buffers planted to native prairie vegetation.

Even with the impressive results so far, Iowa continues to explore and develop new technologies to optimize wetland performance by incorporating additional considerations for habitat, hydraulic efficiency, and temporary flood storage benefits. CREP wetlands are already providing high-quality wildlife habitat and recreational opportunities in addition to water quality benefits. The high-quality buffers, in conjunction with the shallow wetland habitats, have proven to be a tremendous boon to a multitude of wildlife species commonly found in these areas. The areas have shown that targeting wetland restoration for water quality benefits does not come at the expense of mutual habitat and recreational benefits.

3.1.5 Kentucky

Kentucky continues to work with stakeholders to develop and implement the state's nutrient reduction strategy. The Kentucky Division of Water (KDOW) is working to finalize the draft strategy, which can be accessed at http://water.ky.gov/Documents/NRS%20draft%203-20.pdf (Kentucky Division of Water 2014). Other pertinent information is available on the Kentucky Nutrient Reduction Strategy Web page at http://water.ky.gov/pages/nutrientstrategy.aspx.The strategy has been developed in conjunction with input from stakeholders representing a broad perspective of interests: agriculture, industry, environmental advocacy, municipalities, conservation organizations, and federal and state partners. The strategy encompasses reduction from both point and nonpoint sources, as well as a variety of regulatory and cooperative approaches.

In 2014, the KDOW formed a Wastewater Advisory Council in cooperation with the Kentucky-Tennessee Water Environment Association to provide a forum for discussing the various issues related to wastewater, including infrastructure funding and regulatory impacts. The Wastewater Advisory Council is working with KDOW to develop a modern approach to reducing nutrient loads in wastewater effluent by identifying new, affordable technologies available to reduce nutrient levels during treatment and by providing enhanced technical assistance to wastewater treatment plants to implement nutrient reduction operational strategies. In light of the evolving technical landscape for removing nutrients in wastewater, KDOW is revisiting its approach to permitting nutrient effluent limits at wastewater treatment plants. The agency is also working with stakeholder groups formed for drinking water and municipal separate storm sewer system (MS4) concerns.

The Kentucky Department for Environmental Protection also worked with partner agencies to monitor and issue advisories of HABs and to develop fact sheets for the public and drinking water facilities about how HABs form, their potential recreational impacts, and ways to prevent them. KDOW is working with the U.S. Army Corps of Engineers (Corps), the University of Cincinnati, and other federal and state agency partners to develop an improved predictive model using remote sensing satellite data. This model will refine current models used to predict the trophic state of waters and the occurrence of HABs. KDOW is also using other remote sensing techniques, including purchasing a drone, to remotely collect data that can be used to assess waters for HABs and trophic state.

KDOW is beginning efforts to develop numeric nutrient criteria for lakes and reservoirs, in addition to similar efforts for wadeable streams. The division is working with EPA and Tetra Tech, Inc., to evaluate its historic lakes data by conducting a gap analysis regarding data necessary to advance this effort. The division will use feedback from this analysis to help guide its monitoring strategy this year and in years to come.

Kentucky continues to work with the Kentucky Agriculture Water Quality Authority to implement practices on agricultural lands. In the past few years, this legislatively assembled group has developed and revised numerous nutrient reduction practices, including adopting the NRCS Standard Practice Code 590 as a BMP, as well as developing and adopting a Kentucky-specific nutrient management planning practice for farms. The Kentucky Nutrient Management Planning tool was developed by the University of Kentucky College of Agriculture, Food and Environment (CAFE) and enables producers to develop a nutrient management plan for their own farm by stepping through a variety of worksheets. Information on the program is available at http://www2.ca.uky.edu/agc/pubs/ID/ID211/ID211.pdf. The tool also has an Excel workbook available so many of the calculations are done automatically. Education and outreach about the existing Agriculture Water Quality Act and the new nutrient management requirements continue throughout the state, including targeted training and outreach to dairy and beef operations. The training for producers and county extension agents was conducted by the University of Kentucky CAFE.

The USDA-NRCS State Conservationist for Kentucky also recently announced that the Kentucky Department of Natural Resources, Division of Conservation and the University of Kentucky CAFE have been awarded a Regional Conservation Partnership Program grant to improve Kentucky's water quality. The funds will be used to help educate producers and implement BMPs on their farms that reduce runoff and protect water quality.

Kentucky Highlights

Fleming Creek. Pollutants in agricultural runoff impaired water quality in Kentucky's Fleming Creek and many of its tributaries. The KDOW added numerous watershed segments to Kentucky's CWA section 303(d) list of impaired waters in 1994 because of pathogens or nutrients and organic enrichment/low dissolved oxygen. Using approximately $3.6 million in state and federal financial support, watershed partners implemented numerous restoration activities, including targeted agricultural BMPs. Although much of the watershed still does not fully support its primary contact recreation use, habitat and biological monitoring indicate that a 4.8-mile segment of Fleming Creek now fully supports its designated use of warm water aquatic habitat. As a result, KDOW removed the segment from Kentucky's 2006 CWA section 303(d) list of impaired waters.

Project partners include agricultural producers, Fleming County Conservation District Board of Supervisors, Fleming County Conservation District, Kentucky Division of Conservation, KDOW, Redwing Ecological Services, Inc., the University of Kentucky's Cooperative Extensive Service and Department of Agronomy, and the Community Farm Alliance.

Federal financial assistance provided through CWA section 319 supported targeted BMP efforts in the watershed. Between 1991 and 2007, watershed partners spent more than $1.6 million and contributed more than $970,000 in nonfederal match contributions. The Kentucky Soil Erosion and Water Quality Cost Share Program provided cost-share assistance to landowners to install agricultural BMPs worth $2,134,884 in the watershed. The state cost-share program provided $1,408,288; landowners provided another $726,595 in cash payments or in-kind labor.

Several USDA programs, including the Agricultural Conservation Program, Water Quality Special Project, EQIP, and Conservation Reserve Program supported landowners' efforts to install agricultural BMPs. Since 1992, more than $1.2 million in federal financial support from USDA has been targeted to the Fleming Creek watershed for implementing agricultural BMPs.

3.1.6 Louisiana

The Coastal Protection and Restoration Authority of Louisiana (CPRA), Louisiana Department of Agriculture and Forestry (LDAF), Louisiana Department of Environmental Quality (LDEQ), and Louisiana Department of Natural Resources (LDNR) have collaboratively developed the Louisiana nutrient management strategy for the purpose of managing nitrogen and phosphorus to protect, improve, and restore water quality in Louisiana's inland and coastal waters (Louisiana DEQ 2015). Implementation of the strategy focuses on six key areas: (1) river diversions, (2) nonpoint source management, (3) point source management, (4) incentives, (5) leveraging opportunities, and (6) new science-based technologies/applications. This interagency committee continues to work collaboratively to implement and monitor the progress of the nutrient strategy. The Louisiana nutrient management strategy can be accessed at http://www.deq.louisiana.gov/portal/DIVISIONS/WaterPermits/WaterQualityStandardsAssessment/NutrientManagementStrategy.aspx.

Watershed implementation plans (WIPs) have been developed and implemented for more than 50 sub-segments in Louisiana. An analysis of nutrient data collected through LDEQ's Ambient Water Quality Monitoring Network indicates that water quality is improving in many of the watersheds where a WIP has been developed and implemented through the CWA section 319 program. In 15 sub-segments in the Ouachita River Basin in northeast Louisiana, with WIPs developed and implemented, 11 sub-segments (73 percent) show decreasing nitrate-nitrite trends, 13 sub-segments (87 percent) show decreasing total Kjeldahl nitrogen trends, and 12 sub-segments (80 percent) show decreasing total phosphorus trends. These water quality improvements suggest that nutrient management measures at the sub-segment scale have been effective at reducing nutrient levels in local waterways.

The LDAF created the Louisiana Agriculture and Forestry Nutrient Management Task Force in 2012 to study topics related to agricultural nutrient issues and evaluate the impact of the issues on the state's agricultural industries. The task force is an excellent example of producers, industry, universities, and state government working together to address nutrient concerns, and it will continue to do so in a manner that is consistent with sound science and practical application.

LDEQ is implementing ongoing nutrient management activities related to point sources through the Louisiana Pollutant Discharge Elimination System (LDPES) permit program. LDEQ has made progress in implementation of nitrogen and phosphorus monitoring in some permits based on Total Maximum Daily Load (TMDL) determination and in wetland assimilation projects. Nutrient monitoring is being implemented in new and renewed individual and general sanitary discharge permits in the Lake Pontchartrain Basin as indicated by recent TMDLs. Ongoing nutrient monitoring also occurs at point source wetland assimilation projects in Louisiana. Further, LDEQ's Compliance Monitoring Strategy performs routine inspections as well as targeted watershed based inspections to identify unpermitted dischargers to be added to the LPDES program. LDEQ is working to enhance approaches for managing nutrients in point sources in Louisiana that will further the progress of addressing nutrients through direct support of implementation of the Louisiana nutrient management strategy.

LDEQ also administers the Louisiana Environmental Leadership Program (ELP), which provides the point source community an opportunity for voluntary stewardship. While the ELP promotes and supports stewardship for many aspects of pollution prevention and reduction, voluntary efforts related to nutrient management have received special attention in recent years. Industries such as BASF, ExxonMobil, Marathon, Mosaic, and Nalco have been recipients of ELP awards for their voluntary nutrient management and reduction efforts. Louisiana cities including Carencro, Denham Springs, and Ruston have also received leadership awards for nutrient management efforts. These Louisiana companies and cities serve as leaders in their respective groups and models for ways to achieve voluntary nutrient reductions.

The Louisiana Water Synergy Project, managed by the U.S. Business Council for Sustainable Development, provides a forum for business leaders with infrastructure investments in southern Louisiana, state and local leaders, academic institutions, and NGOs to take collective actions to help protect wetlands and improve water quality in the region. The project has been underway since May 2012. The 21 participating companies represent a wide range of industrial sectors, including oil and gas, chemicals, manufacturing, beverages, and services. The Water Synergy Project funded an inventory of nutrient releases to the Mississippi River by point sources within the Mississippi River Industrial Corridor (MRIC) in Louisiana, which was an update to a report issued under the ELP in 2000. Results of the 2014 inventory further support results from the 2000 report that nutrient releases from industrial and municipal point sources to the MRIC continue to have minimal, or essentially no, impact on nutrient levels in the river as indicated by ambient water quality data collected by LDEQ (Knecht 2000; Providence Engineering and Environmental Group LLC. 2014). Nutrient levels entering the MRIC at St. Francisville, Louisiana, the northern border of the MRIC, are essentially the same as the levels at Belle Chasse, Louisiana, south of New Orleans. As substantiated by the data and information compiled and evaluated for the inventory, point source dischargers in the Louisiana MRIC continue to contribute a negligible percentage of the overall nutrient load to the Mississippi River. During the period 2008–2013, there was considerable industrial expansion in Louisiana based on capital expenditure data from the manufacturing sector. Inventory data shows that industry has continued to control nitrogen releases to the river during this period.

Water Synergy Project members are planning to develop a Water Quality Trading (WQT) program as a market-based, voluntary approach for improving water quality in Louisiana. An effective WQT program could lead to greater nutrient reductions in the Lower Mississippi River Basin and the Gulf of Mexico more quickly and at a lower overall cost than a traditional regulatory approach. In addition, water quality trading could also provide some point sources and agriculture businesses with the opportunity to generate revenues, and offer local regulators more policy options for improving water quality. The desired outcome of the project is to implement a WQT program and demonstrate that water quality trading is a cost-effective approach to reducing nutrients and improving water quality. Project participants are now identifying funding sources for a WQT program feasibility study/market analysis that will include review of tools and templates and lessons learned from WQT programs in other states; proposed program design, implementation strategies, and key performance indicators; establishing iterative feedback loops with LDEQ and EPA Region 6; and conducting initial outreach to stakeholders (e.g., communities, industry, agriculture, environmental groups).

The CPRA continues to work with The Water Institute of the Gulf, the U.S. Army Corps of Engineers, and NOAA on improving the science surrounding river diversions and nutrient assimilation. In addition to the development of Delft3D models to predict the receiving basin response to diversions, CPRA is also designing and implementing a new System Wide Assessment and Monitoring Program (SWAMP) to ensure that relevant water quality data are collected both prior to and following the construction and operation of new river diversion projects. Louisiana’s strategy continues to be informed by ongoing work from Louisiana’s Coastal Master Plan to model the effects of river-borne nutrients on coastal wetlands that receive diverted Mississippi River water.

Louisiana Highlights

Lake St. Joseph Special Project. Lake St. Joseph is a 1,580-acre oxbow lake located in the Ouachita Basin in Louisiana and is located in a region that is largely agricultural. A CWA section 319 project approved for the Tensas-Concordia Soil and Water Conservation District aims to improve water quality in the lake with a suite of incentive-based BMPs focused on the lake's impairments. Ninety-three percent (or 14 out of 15) of the agricultural producers in the 17,835-acre watershed are now implementing one or more of those practices. The Louisiana State University AgCenter, a cooperating agency in the project, is responsible for monitoring the lake and analyzing the data collected in the project. At this time, one year of data has been collected post-initial implementation of the BMPs.

Nonpoint Source Pollutant Reduction in Tensas River Watershed Using a Vegetative Filter Strip-Retention Pond System. The goal of this project was to determine whether a vegetated filter strip-retention pond system would reduce nutrient runoff to the Tensas River watershed as part of an effort to restore the waterbody to the point at which it would support its CWA designated uses. The data suggest that the filter strips are capturing the sediment, to which the phosphorus binds; however, the filter strips have not affected any of the nitrogen parameters.

The project demonstrates the effectiveness of filter strips for sediment trapping in northeast Louisiana. In terms of nutrient reduction, the strips are best suited for nutrients that are attached to soil particles or the colloidal organic fraction.

Winter Wheat Filter Strip for In-field Ditches to Reduce Nutrient and Sediment Runoff— A New Best Management Practice. This USDA Conservation Innovation Grant (CIG) project aims to demonstrate the performance and effectiveness of conservation buffers (e.g., filter strips, vegetative barriers, contour buffer strips) by assessing the situational effectiveness of the component practice and design parameters (including appropriate width and plant materials).

In fall 2014, three treatments were being demonstrated: (1) no planted filter strip; (2) a 40-foot wheat filter strip, planted directly over the center of the in-field ditch; and (3) an Elbon rye filter strip planted directly over the in-field drainage ditch. The treatments are in three blocks, according to a randomized complete block design, across the field for a total of nine ditches. Water sampling will begin at the Feekes 2 growth stage and continue until the wheat is chemically burned down 3–4 weeks before planting in the spring of 2015. Nine ISCO water samplers will be placed in the middle of the in-field ditches to collect water from runoff events to evaluate the nutrient and sediment loss reduction attributable to this new BMP.

3.1.7 Minnesota

The Minnesota nutrient reduction strategy is accessible at http://www.pca.state.mn.us/nutrientreduction. This collaboratively developed strategy was established on a strong foundation of extensive scientific data and analysis. A study of nitrogen sources and pathways is available at http://www.pca.state.mn.us/d9r86k9; for phosphorus sources, see http://www.pca.state.mn.us/jsrifaa. Development of the state's nutrient reduction strategy was supported by a year-long public conversation regarding the problems of and solutions for nutrient loss into waters of the state. Mindful of Minnesota's critical strategic location as the headwaters for three different continental basins, the strategy sets goals and action targets for the nitrogen and phosphorus reduction needed to provide a path to healthy waters in Minnesota, as well as to meet the state's fair share of the loading reductions needed for downstream waters. Those waters include Lake Winnipeg and the Gulf of Mexico. In the case of nitrogen loss to waters, the strategy includes a milestone target and schedule pegged to the level of progress needed to stay on track to meet Minnesota's reduction goals. A companion nutrient planning portal provides rapid nutrient assessment information and planning tools for each of Minnesota's HUC8 watersheds; it is available at http://mrbdc.mnsu.edu/mnnutrients/.

Nutrient-related water quality and drinking water standards are an important part of the water quality policy framework in Minnesota and nationally (Minnesota Pollution Control Agency 2015). Both lake and river eutrophication standards in Minnesota include phosphorus, but they do not include nitrogen. Eutrophication standards were promulgated for lakes in 2008, and the river eutrophication standards were approved by USEPA in January 2015. Nitrate standards to protect aquatic life in Minnesota surface waters are anticipated in the next few years. Phosphorus loading is often directly related to total suspended solids in rivers, especially during moderate-to-high flow events. Minnesota's turbidity standard was replaced with a total suspended solids (TSS) standard in January 2015.

An evaluation of monitoring data indicates that meeting in-state lake and river eutrophication standards will likely result in meeting the major basin goals for phosphorus reduction. For example, Lake Pepin, a riverine lake on the Mississippi River, requires a greater phosphorus load reduction, at this point in time, than reductions needed to meet the Gulf of Mexico hypoxia goal. Downstream nitrogen load reductions need to address Minnesota's share of nitrogen to the Gulf of Mexico and Lake Winnipeg, which exceeds the cumulative nitrogen reductions needed for meeting current drinking water standards in Minnesota. Future nitrate standards to protect aquatic life will also necessitate nitrate reductions in some waters of the state, but the effect of those standards on downstream loading will not be known until they are established.

One of the most encouraging aspects of the state's efforts is the documented reduction of phosphorus loading. Minnesota has been able to show a reduction of 33 percent of phosphorus loading as compared to loads prior to 2000 in the Mississippi River just below the Twin Cities of Minneapolis and St. Paul. Municipal wastewater facilities in particular have led the way on this milestone reduction by reducing 64 percent of their loading over that period. Total phosphorus loads discharged by the 588 NPDES-permitted wastewater sources in Minnesota's portion of the Lake Pepin watershed have decreased from 1,591 metric tons per year in 2000 to 353 metric tons per year in 2013—an overall reduction of 1,239 metric tons per year or 78 percent from all point sources (see Figure 12). Over the last decade (2004–2013), effluent total phosphorus loads have been reduced by 538 metric tons per year, or 60 percent. Documentation has improved as well during the period. The percentage of observed loads (i.e., monitored effluent loads) to estimated loads (i.e., loads calculated from monitored flows and estimated effluent concentrations) has increased from 82 percent observed/18 percent estimated in 2000 to 92 percent observed/8 percent estimated in 2013. In addition, Minnesota is phasing in a permit requirement that all wastewater treatment facilities monitor their discharges of nitrogen so that the need for future effluent limits can be accurately determined.

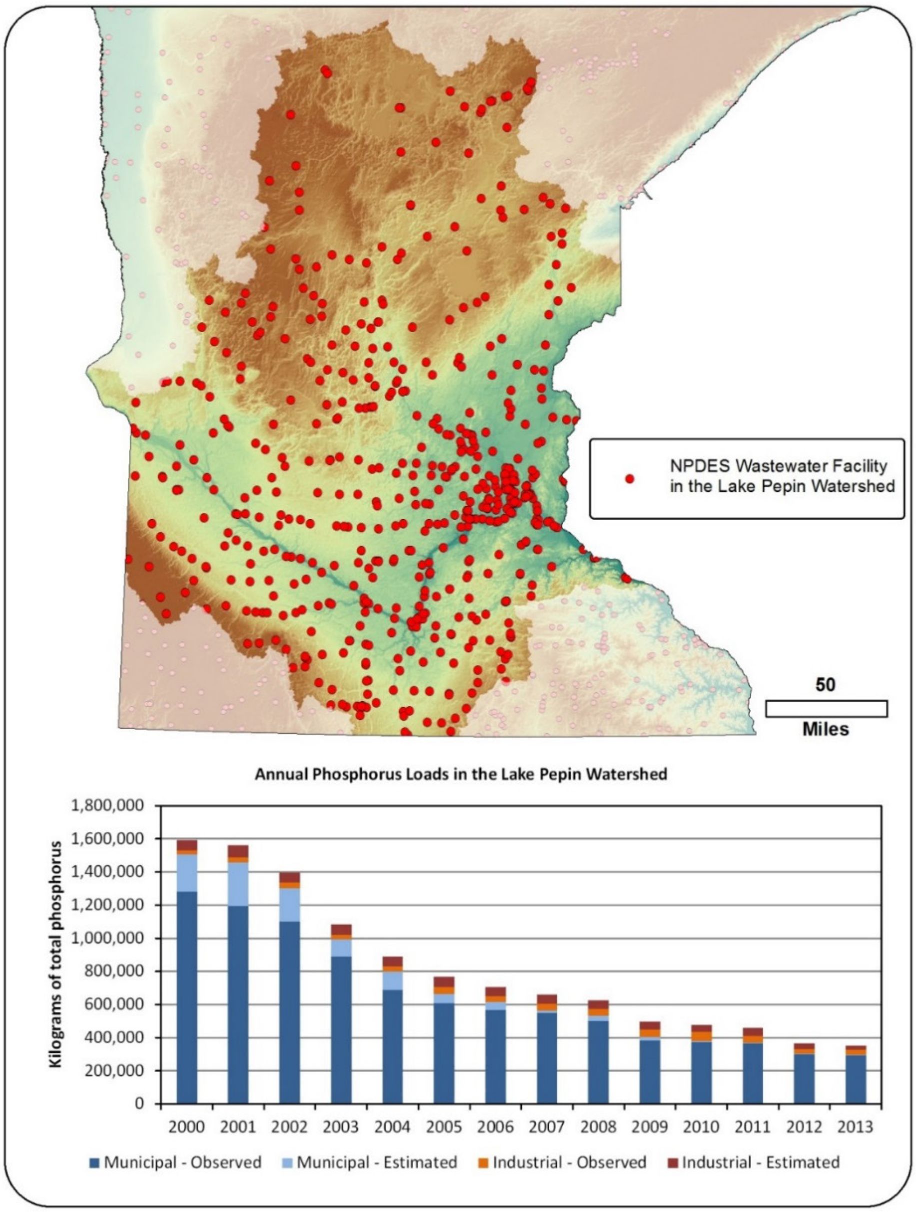


Figure 12. Geographic Distribution and TP Loads Discharged by Wastewater Point Sources in the Mississippi River Watershed tributary to Lake Pepin. (Minnesota Pollution Control Agency 2014a)

Continuing to make progress meeting the significant reduction levels needed will require a federal-state-private partnership. Minnesota citizens bring a 25-year Clean Water Legacy funding commitment to the table to fulfill the state's role in that partnership. For the fiscal years 2016–2017, the funding is expected to provide the following resources for clean water efforts:

FY 2016-2017 by Category	
Monitoring and Assessment	$ 24,680,000
Watershed Restoration/Protection Strategies	$ 25,080,000
Groundwater/Drinking Water	$ 34,020,000
Nonpoint Source Implementation	$109,018,000
Applied Research and Tool Development	$ 8,400,000
Point Source Implementation	$ 20,400,000
Total State Agency Clean Water Fund Budget	$221,598,000

Minnesota has initiated a statewide comprehensive water quality monitoring and watershed assessment program, along with locally led planning and implementation programs to create the capacity to support a significant watershed restoration and protection program in the 81 HUC8 watersheds in Minnesota. Through this watershed-based organizational infrastructure and stable resource base, with strategic direction and prioritization provided in Minnesota's nutrient reduction strategy, the state is well positioned to partner with federal agencies, local units of government, and NGOs to rapidly transition to implementing nutrient loss reduction.

Minnesota Highlights

Sauk River Chain of Lakes. The Sauk River Chain of Lakes is an interconnected system of 14 bay-like lakes fed by the Sauk River in Central Minnesota. The Sauk River Chain of Lakes is impaired by phosphorus and total suspended solids due to row cropping and livestock operations, as well as discharges from on-site septic systems. Agricultural BMPs, stormwater BMPs, shore land BMPs and upgrades to septic systems and municipal wastewater treatment facilities throughout the Sauk River Chain of Lakes watershed have reduced total phosphorus concentrations to 176 micrograms per liter (µg/L), nearly achieving the regional goal of 100–150 µg/L and representing a 48 percent decrease in total phosphorus loading.

Project costs since 1999 are estimated at $30.2 million. CWA section 319 provided $1,200,000 in funding to assist farmers with installing agricultural BMPs, erosion control measures, municipal stormwater BMPs, shore land BMPs and to provide a septic system maintenance education program. Other funding sources included NRCS' EQIP/MRBI ($18,482,624), the Minnesota state cost-share program ($267,717), MPCA Clean Water Partnership funds ($1,034,250), DNR Habitat ($334,403) BWSR CWF (427,412), CRP ($5,762,400) and the CWA State Revolving Fund ($3.9 million in loans).

Minneapolis Chain of Lakes. The Minneapolis Chain of Lakes, located 2.5 miles southwest of downtown Minneapolis, Minnesota, receives urban runoff delivering high levels of phosphorus and sediment from its fully developed 7,000-acre watershed. By implementing a widespread public education campaign, sediment control measures, and other practices throughout the watershed, the Minneapolis Chain of Lakes Clean Water Partnership achieved significant in-stream reductions in sediment and phosphorus, which has helped to keep most of the lakes off the state's CWA 303(d) list and has also brought a listed stream close to meeting water quality standards.

Most of the initiative was locally funded by the Minneapolis Park Recreation Board ($1.5 million), Minnehaha Creek Watershed District ($6.1 million), City of Minneapolis ($2.6 million), City of St. Louis Park ($663,000), and Hennepin County. MPCA provided critical diagnostic and seed money ($1.2 million). CWA section 319 funds totaled $255,000 and were used to fund kickoff efforts for the education campaign, a demonstration project on Lake Calhoun showing the effects of alum treatments, and research on the interaction between alum and milfoil (an invasive species).

Heron Lake Watershed. Runoff from agricultural and urban areas contributed phosphorus and sediment to water bodies in Minnesota's Heron Lake watershed. Because three of the watershed lakes failed to meet Minnesota's water quality standards, MPCA added them to the CWA section 303(d) list of impaired waters—North Heron and South Heron lakes in 2002 and Fulda Lake in 2008. Implementing BMPs and conducting public outreach in the watershed have led to significant water quality improvements.

From 2007 to 2011, the Heron Lake Watershed District provided cost-share to encourage landowners in the Fulda Lakes subwatershed to implement conservation tillage, critical area plantings, and shoreline restoration projects to reduce water pollution. Landowners implemented conservation tillage on 5,828.5 acres. Watershed partners completed three shoreline restoration projects, ranging from a simple filter strip to a complex restoration involving a complete bank stabilization using all bioengineered practices. The district held a walking tour to showcase the shoreline restorations. According to the Minnesota Board of Water and Soil Resources' eLINK system, implementing these practices prevented 1,251 pounds per year of phosphorus and 1,312 tons per year of sediment from leaving the land surface.

Restoration work in the Heron Lake watershed was supported by $114,043 in CWA section 319 funding. The district served as the project sponsor and lead agency, providing $59,880 in cash match and $37,325 through in-kind match.

3.1.8 Mississippi

As an active member of the HTF, the Mississippi Department of Environmental Quality (MDEQ) initiated a proactive, collaborative approach in 2009 to reduce nutrient loadings to Mississippi's surface waters, the Mississippi River, and the Gulf of Mexico. This multiprogram, multiagency, and multi-stakeholder approach has created significant leveraging opportunities. Mississippi has developed nutrient reduction strategies, first for the delta (2009) and subsequently for the upland (2011) and coastal (2011) regions. Those three regional strategies have been integrated into a statewide strategy, *Mississippi's Strategies to Reduce Nutrients and Associated Pollutants* (Mississippi Department of Environmental Quality 2012). This integration allows consistent, compatible, and coordinated watershed management plans to be developed and implemented across the state while addressing the distinct regional differences that exist for nutrient sources. The strategy establishes a road map to reduce nutrient loadings from nonpoint and point sources, whether in a predominantly agricultural environment, areas of higher municipal and industrial uses, or coastal environments. Information on Mississippi's nutrient reduction activities and strategies can be accessed on the MDEQ website: http://www.deq.state.ms.us/mdeq.nsf/page/WMB_Basin_Management_Approach?OpenDocument.

As the first HTF state to attempt a regional nutrient reduction strategy, MDEQ's delta nutrient reduction strategy development process was primarily based on the interactions of three different teams: a visioning team, a planning team, and individual strategy work groups. The strategies will be implemented through watershed implementation teams. The strategy development process began with a visioning exercise including key partners and stakeholders to ensure a consistent approach, promote leveraging of resources, and foster stakeholder buy-in. A planning team, composed of multiple governmental agencies, nonprofit organizations, members of academia, and agricultural producers, provided the direction for this effort. Eleven work groups formulated the details for 11 strategic elements: (1) stakeholder awareness, outreach, and education; (2) watershed characterization; (3) current status and historical trends; (4) analytical tools; (5) water management; (6) input management; (7) best management practices; (8) point source treatment; (9) monitoring; (10) economic incentives and funding sources; and (11) information management. The same overall process was applied to develop nutrient reduction strategies for both the uplands region and the coastal region of the state.

To combat the problem of nutrient pollution, Mississippi is implementing a collaborative, leveraged approach to reduce nutrients. The approach involves increased coordination of MDEQ programs including Basin Management, Nonpoint Source, TMDLs, Water Quality Monitoring, Water Quality Assessment, Water Quality Standards, and NPDES Permitting. The focus of the collaborative, leveraged approach will be on the development of numeric nutrient criteria, improvement of nutrient TMDLs, and development and implementation of nutrient reduction strategies across the state. This approach leverages resources and outputs from over two dozen state and federal agencies, NGOs, and academic institutions to ensure the highest level of technical input and broadest range of support possible.

Mississippi Highlights

Leveraging Resources to Implement Nutrient Reduction Strategies. Implementation of nutrient reduction strategies in the Mississippi Delta is an example of the state's leveraging approach. To date, MDEQ has applied $7.07 million in 319 funds towards reducing nutrients as part of the nonpoint source projects listed below. The CWA section 319 funds have led to over $100 million in other federal, state, and private funds, which have been applied towards implementation of these projects. Some partners contributing towards these efforts include NRCS, EPA, the Corps, USGS, Mississippi Department of Marine Resources, Mississippi Soil and Water Commission, farmers, and private corporations.

Reducing Nutrients from Nonpoint Sources in the Delta. MDEQ is currently implementing components of the Mississippi Delta Nutrient Reduction Strategies in multiple watersheds within the delta region including Harris Bayou, Porter Bayou, Coldwater River, and Bee Lake. To date, numerous BMPs have been installed in the treatment areas within those watersheds. Installed BMPs include tail-water recovery systems; on-farm storage reservoirs; land-formed, low-grade weirs; water control structures; two-stage ditches; grass waterways; and cover crops. Nutrient data collection is ongoing for these projects and include both "pre-BMP" and "post-BMP" data. The data will help MDEQ document the water quality improvements obtained through conservation measures.

Reducing Nutrients from Point Sources. To date, Mississippi has developed over 300 TMDLs for nutrients across the state. Many of them call for significant reductions in nitrogen and phosphorus. Nonpoint sources will be addressed through projects similar to those discussed above. In many cases, TMDL studies indicate that a reduction in point source loading is also necessary to achieve the goals of the TMDL. Through combined efforts of the MDEQ TMDL and NPDES programs, over 280 NPDES facilities are now required to monitor for total nitrogen and total phosphorus. Of this number, over 120 of the facilities have received permit limits requiring total phosphorus and/or total nitrogen reductions.

Nutrient Reduction Strategy and Data Compendium. During the process of developing the Mississippi Delta Nutrient Reduction Strategies, MDEQ and its partners identified the need for a data compendium. Consequently, MDEQ, in partnership with USGS and the Corps, developed a geographic information system (GIS)-based data compendium to improve interagency communication and coordination concerning water quality/quantity data collection. A GIS toolkit provides access to the existing water quality and quantity data collected by the three agencies. A user can choose sites for inquiry, query databases, generate reports complete with maps, and much more. The mapping application allows users to obtain map-based information concerning water quality and quantity. The compendium helps to (1) foster increased access and use of the existing data; (2) identify gaps and/or overlaps in data collection; (3) promote collaboration and coordination of monitoring activities; and (4) improve water resource management.

The Mississippi Water Resources Data Compendium is available on the MDEQ website at http://www.deq.state.ms.us/mdeq.nsf/page/WMB_MississippiWaterResourcesDataCompendium?OpenDocument.

3.1.9 Missouri

Missouri's nutrient reduction strategy was developed through the Missouri Department of Natural Resources' (MDNRs) existing partnerships with a broad array of interested agricultural, community, environmental, and educational entities as well as with state and federal agency counterparts (Missouri DNR 2014). Experts were engaged throughout the development of the strategy, including subject matter experts from agricultural, industrial, and water quality groups. Past successes on nutrient-related issues were used to guide development of the individual actions while additional actions were included for development and implementation over the first five year period of this strategy. The strategy uses the most reliable scientific data available as a guide. Data from USGS, USDA, and MDNR provide the basis for determining past and current loadings and for framing discussions at the watershed level. The Missouri nutrient reduction strategy can be accessed at http://www.dnr.mo.gov/env/wpp/mnrsc/index.htm.

Missouri's parks, soils, and water sales tax has been in place for 30 years. One-half of the tax is used to address nonpoint source pollution from agricultural sources. As a result of the funding, $635 million has been put into structural and management-based soil and water conservation practices. This work has resulted in 175 million tons of soil kept on the fields for productive use—a 48 percent reduction in soil loss with an attendant reduction in phosphorus loading to Missouri streams. The program recently expanded its list of practices to more fully address water quality improvement, and it expects to widen its monitoring of practices to determine the efficacy of the new practices. The Nutrient Tracking Tool (NTT) is a new Web-based program using the USDA APEX model; it will be used to measure success in reducing nutrient and sediment loads from farm fields where conservation practices have been implemented. The NRCS MRBI projects in Missouri feature edge-of-field monitoring, and they are obtaining valuable information about the effectiveness of NRCS conservation practices in reducing nutrient- and sediment-laden runoff.

In 2010, MDNR established new stream water quality monitoring stations in six priority HUC12 watersheds in the Lower Grand Basin of north-central Missouri through a contract with USGS. Mean total nitrogen and total phosphorus concentrations and watershed loading rates collected during the project at existing long-term stream water quality monitoring stations will be compared with the long-term mean total nitrogen and total phosphorus concentrations and watershed loading rates calculated from 1990 to 2011. Similar historical assessments will also be completed for all available sediment and nutrient parameters, and the data will be compared with other water quality monitoring data to evaluate changes in stream water quality after conservation practices have been implemented.

Missouri Highlight

Fellows Lake. Point source and nonpoint source pollution from agricultural and suburban land sources affected water quality in Fellows Lake, prompting MDNR to add the lake to Missouri's 1994 CWA section 303(d) list of impaired waters for mercury and nutrients. The Watershed Committee of the Ozarks (WCO) launched outreach and education activities, worked with landowners to implement BMPs, and conducted water quality monitoring. Water quality improved, and MDNR removed Fellows Lake from the state's 2004/2006 CWA section 303(d) list of impaired waters.

The WCO has managed several CWA section 319-funded projects in the watershed and surrounding areas, including one for $276,500 that supported the main project responsible for restoring Fellows Lake. It has received technical assistance through partnerships with NRCS, soil and water conservation districts, and the Missouri Department of Conservation Professionals. It continues to work to improve water quality in the watershed and reduce nonpoint source pollution.

3.1.10 Ohio

3.1.10.1 Nutrient Management Initiatives

Ohio is aggressively tackling water quality issues, particularly HABs. A multifaceted, multiyear approach to reduce discharges and runoff of nutrients is vital to protect public health, the environment, and valuable water resources. Ohio's approach uses both broad and targeted projects and partnerships at the local, state, national, and international levels.

The Ohio Environmental Protection Agency (Ohio EPA), coordinating with the Ohio Department of Agriculture (ODA) and Ohio Department of Natural Resources (ODNR), developed the Ohio Nutrient Reduction Strategy, a comprehensive plan to manage point and nonpoint sources of nutrients and reduce their impact on Ohio's surface waters (Ohio EPA 2015). The strategy recommends regulatory initiatives and voluntary practices that can reduce nutrients throughout the state. The state developed the strategy with input from more than 100 research scientists, agribusiness leaders, and environmentalists on how Ohio can partner with the agricultural community to promote nutrient stewardship statewide. The Ohio nutrient reduction strategy can be accessed at http://epa.ohio.gov/dsw/wqs/NutrientReduction.aspx.

3.1.10.2 On-the-Ground Practices

ODNR, ODA, and Ohio EPA have worked collaboratively to improve the health of Grand Lake St. Marys and its watershed. With the assistance of numerous local, state, and federal partners, Ohio has implemented multiple practices, including constructed wetland and treatment train installation, improved aeration efforts, alum treatments, and the installation of more than 700 conservation practices in the watershed.

3.1.10.3 Strategies, Research, Partnerships, and Legislative Updates

- In 2013, Ohio EPA asked for public comments from various stakeholder groups regarding the development of nutrient water quality standards. A nutrient technical advisory group was formed and is advising Ohio EPA as it moves forward with the next steps in drafting administrative rules. The rules will describe methods to identify waters impaired by nutrients and then take restorative actions, including TMDLs.
- In 2014, Governor John Kasich signed into law Senate Bill 150, an update of Ohio's regulatory structure specifically geared to improving water quality. The bill requires fertilizer applicators to undergo education and certification by ODA, encourages producers to adopt nutrient management plans, allows ODA to better track the sales and distribution of fertilizer throughout the state, and provides ODNR the authority to repurpose existing funding for additional BMP installation.
- Ohio EPA has offered $150 million in no-interest loans for improvements to local drinking water and wastewater treatment facilities, and $1 million for local water systems for testing equipment and training, and testing support from Ohio EPA's lab for any system that requests it. In addition, Ohio EPA received $1,548,800 in Great Lakes Restoration Initiative funding to help improve water quality in the western basin of Lake Erie and combat HABs by expanding Maumee River tributary monitoring to measure the success of agricultural conservation practices.

3.1.10.4 Monitoring

Ohio EPA, ODNR, and the Ohio Department of Health have developed protocols for monitoring public waters where HABs exist or are suspected. Ohio is one of the first states to establish protocols for issuing advisories when algal toxins are present at or above threshold levels, including finished drinking water. Ohio EPA is working closely with EPA to revise the thresholds before the 2015 HAB season. For more information, visit http://www.ohioalgaeinfo.com.

Ohio Highlights

Olentangy River. Lowhead dam structures, failing home septic systems, and increased agricultural and urban stormwater runoff had degraded water quality in Ohio's Olentangy River. Failing home sewage treatment system units contributed nutrients to the river, and high-volume stormwater flows contributed silt and sediment. As a result, in 2002, Ohio EPA added a watershed-based unit of the river to the state's CWA section 303(d) list of impaired waters for failure to meet the water quality standards associated with the unit's designated warm-water habitat aquatic life use. Because of work completed through the Olentangy River Restoration Project, approximately three miles of the Olentangy River now fully attain the designated warmwater habitat aquatic life use. Although additional monitoring is required, Ohio EPA expects to remove flow alteration as a cause of impairment in the watershed-based unit of the Olentangy River on the state's 2014 list of impaired waters.

Key partners included the City of Delaware; Delaware County General Health District; Preservation Parks; Ohio's Scenic Rivers; Ohio Department of Transportation (ODOT); ODNR, Division of Soil and Water Resources; and Ohio EPA. EPA, Ohio EPA, the City of Delaware, and ODOT provided project funding. The city received a $105,000 CWA section 104(b)(3) grant to help support dam removals. Approximately $6.3 million was provided through Ohio EPA's Water Resources Restoration Program for land and conservation easement acquisition. The health district received approximately $110,000 in CWA section 319 funding to support home sewage treatment system inspections and replacements. In addition, $70,000 in Ohio EPA Surface Water Improvement funds was awarded to the city of Delaware for additional dam removal work. All monitoring was completed by staff from Ohio EPA's Ecological Assessment Unit.

4R Nutrient Stewardship Certification. The 4R Nutrient Stewardship Certification program is a voluntary program launched in March 2014 to encourage agricultural retailers, service providers, and other certified professionals to adopt proven best practices through the 4Rs. The program is governed and guided by the Nutrient Stewardship Council, a diverse set of stakeholders from business, government, university, and nongovernmental sectors with a common goal of maintaining agricultural productivity while also improving water quality. The program is administered by the Ohio AgriBusiness Association (http://4rcertified.org/). To date, the program's focus has been in northern Ohio due to concerns about deteriorating water quality in Lake Erie and Grand Lake St. Marys. There are currently 64 retailers signed up for the program, including several with retail locations in Michigan, Indiana, and the Ohio River Basin. Participating retailers must comply with up to 43 specific business and operational performance criteria established by the Nutrient Stewardship Council and audited by an independent third party. Three retailers involved with piloting the program have achieved certified status. The interest and enthusiasm generated by the 4R Nutrient Stewardship Certification in its first year is very positive and sustaining the program should promote long-term improvements in soil health and water quality.

3.1.11 Tennessee

Tennessee has a draft nutrient framework and is working with EPA Region 4 to refine it. The draft framework can be accessed at http://www.tn.gov/assets/entities/environment/attachments/tennessee-draft-nutrient-reduction-framework_01-21-2015.pdf.

Supported in part by a grant from EPA, Tennessee will be scheduling meetings to solicit feedback from point and nonpoint source stakeholders in 2015 and intends to revise its framework using stakeholder input. With the EPA grant support, Tennessee is also funding watershed modeling, using SWAT to determine the effects of installing conservation practices in a watershed in terms of nutrient flux. Tennessee believes the most effective means to address agricultural nutrient management is through a farmer-led approach. Tennessee's framework will be posted on the Tennessee Department of Environment and Conservation website, to coincide with its posting on the HTF website.

Tennessee has local and state programs that provide staff and cost-share grants to incentivize the installation of conservation practices that affect nutrient impacts. These programs, along with partnerships with federal agencies, have resulted in documented success stories of water quality improvement (Osmond et al. 2012).

Reducing nutrient flux is a challenge that the agricultural community has been addressing for many years. In 2012, based on USDA National Agricultural Statistics Service data, 75 percent of major commodity crops raised in Tennessee were grown using no-till and another 15 percent were grown using another form of conservation tillage, meaning that nearly 90 percent of major commodity crops raised in Tennessee are in a system designed to conserve soil and, thereby, reduce nutrient losses.

Tennessee Highlights

Blue Spring Creek. Runoff from livestock operations and unrestricted grazing was contributing high levels of sediment and nutrients to Blue Spring Creek in Coffee County, Tennessee. Education and the introduction of BMPs, including fencing, water facilities for cattle, and waste management systems, have helped to eliminate existing water quality problems, allowing the creek to be removed from Tennessee's CWA section 303(d) list of impaired waters.

This project received support from NRCS and the Coffee County Soil Conservation District, which designed and approved the animal waste management systems. The project costs totaled $110,219, including funding through the Agricultural Resources Conservation Fund (ARCF) and $8,733 of CWA section 319 funding, which was used to cover the costs of exclusion fencing, alternative water facilities, and pasture seeding.

Fall Creek. Polluted runoff from pasture grazing caused nutrients and sediment to enter into Fall Creek, which led to the listing of an 11.4-mile segment of the creek as impaired in 2002 and 2004. Using CWA section 319 funding, the Bedford County Soil Conservation District installed two major waste management systems on tributaries to Fall Creek in 1999. This action resulted in water quality improvements of the Fall Creek segment and its removal from the 2006 CWA 303(d) list of impaired waters.

Fall Creek has benefited from a total of $13,861 provided through cost-share from CWA section 319 grant pool projects. In addition, $94,747 was provided by a Tennessee state ARCF grant and local match.

West Sandy Creek. High nutrient concentrations from agricultural runoff, loss of biological integrity as a result of siltation, and habitat loss from streamside alteration caused Tennessee to put a 15-mile segment of West Sandy Creek on its CWA section 303(d) list of impaired waters in 2002 and 2004. Nutrient sources included agriculture use, bank and shoreline modification, and runoff from urbanized areas. To help address the problems, the Henry County Soil Conservation District implemented 10 BMPs, including grade-stabilization structures, water/sediment control basins, terrace construction, and hay and pasture plantings. The BMPs improved the water quality in the 15-mile segment, which was removed from the 2006 CWA section 303(d) list of impaired waters.

The Henry County Soil Conservation District implemented the BMPs with $24,817 provided by the Tennessee state ARCF through cost-share from CWA section 319 grant pool projects. In addition, local matching funds contributed $13,170.

3.1.12 Wisconsin

In December 2013, Wisconsin completed and submitted to EPA the *Wisconsin Nutrient Reduction Strategy*. The strategy emphasizes the need to implement ongoing point source and nonpoint source programs in targeted watersheds to most effectively build on the strategy-estimated 23 percent phosphorus load reduction to date. Particular emphasis was placed throughout the development process on strengthening coordination between federal, state, and local agencies and the Wisconsin LGU system to maximize results for phosphorus control and move ahead on nitrogen management. The strategy document and all annual updates are available at http://dnr.wi.gov/topic/SurfaceWater/nutrientstrategy.html.

3.1.12.1 Phosphorus Water Quality Standards Criteria

In 2010, Wisconsin adopted phosphorus numeric water quality standards for rivers, streams, lakes, reservoirs, and state portions of the Great Lakes. The water quality standards are a major driver of nonpoint source and point source implementation projects statewide. They serve as one of the water quality targets for watershed management projects and TMDL analyses and are the basis for phosphorus water quality-based effluent limits for point sources.

3.1.12.2 Agricultural Nonpoint Source and Urban Stormwater Management Projects

Wisconsin's water quality improvement projects include the following:

- State and CWA section 319 funding was used in 45 agricultural watershed and critical site projects in the Mississippi River Basin. Grant funding allocated in 2014 for agricultural nonpoint source management totaled $9.1 million, with $8.2 million from state agency grants. Additional grant information is available at http://datcp.wi.gov/uploads/Environment/pdf/JointAllocationPlanFinal2015.pdf.
- An additional $9.1 million was allocated in 2014 statewide to county-level staff support, with $9 million from state agency grants.
- Urban stormwater grants statewide included $1.2 million for construction activities and $1.4 million for stormwater management planning.
- NRCS, in cooperation with state and local partners, implemented a variety of projects, including the MRBI project in the Sixmile Creek watershed, the National Water Quality Initiative (NWQI) Horse Creek–Horse Lake project, and the Driftless Area Landscape Conservation Initiative in southwestern Wisconsin. In addition, NRCS offered a special EQIP signup for cover crops.
- Progress also continued to be made in implementing the state's nonpoint source "quasi-enforceable" performance standards and prohibitions, including the cropland phosphorus index. Performance standards and prohibitions represent a uniform level of management statewide and have been adopted for agricultural, urban, construction, and highway sources. Greater levels of management may be needed to meet the management needs identified in EPA-approved TMDL analyses or in watershed projects. For agricultural sources, the performance standards and prohibitions are enforceable if state cost-sharing is provided. Additional information is available at http://dnr.wi.gov/topic/nonpoint/AgPerformanceStandards.html.

3.1.12.3 Point and Nonpoint Sources

With the development of state water quality trading and watershed adaptive management project guidance, trades are being developed to comply with new phosphorus effluent limits for municipal and industrial wastewater treatment facilities. A number of watershed plans are also being developed jointly between point source and nonpoint source partners. Legislation has been passed to provide additional opportunities for point source compliance through nonpoint source implementation projects.

3.1.12.4 University of Wisconsin Nitrogen Science Summit

The University of Wisconsin hosted the Nitrogen Science Summit in March 2014 to kick off an increased emphasis on nitrogen management to complement phosphorus management already in place. Research on nitrogen management practices will be a high priority in 2015 on university research farms.

Wisconsin Highlights

Eagle and Joos Valley Creeks Projects. Erosion from stream banks, pasturelands, and wooded grazing lands had contributed to excess sediment and degraded habitat in Wisconsin's Waumandee Creek watershed. As a result, segments of Eagle Creek and Joos Valley Creek (8.5 and 7.4 miles, respectively) were added to the state's 1998 CWA section 303(d) list of impaired waters. Beginning in the mid-1990s, project partners implemented agricultural BMPs to limit soil erosion and nutrient loading. Partners also stabilized streambanks and waterways to restore fisheries habitat. Monitoring data showed that water quality improved in Eagle and Joos Valley creeks as a result of these efforts, and the Wisconsin Department of Natural Resources (WDNR) removed both water bodies from the state's list of impaired waters in 2012.

The success of this project is the result of coordination between multiple nongovernmental and local, state, and federal government partners. WDNR led watershed planning efforts prior to implementation, committed $392,044 in state Priority Watershed Program funds for BMP implementation, and supported monitoring and data evaluation in the watershed. Other funding for BMP implementation included $52,313 in EPA CWA section 319 funds (supporting the installation of riprap and barnyard runoff control systems) and grant funding from the U.S. Fish and Wildlife Service (USFWS). The Buffalo County Land Conservation Department played a key role in coordinating with local farmers to promote BMP implementation. The Fountain City and Alma Rod and Gun clubs helped with fundraising to meet farmer cost-sharing requirements; they also helped to install in-stream habitat structures and other stream restoration practices. USGS provided monitoring and data evaluation support during the 17-year Waumandee Creek watershed study. USDA offered technical assistance for BMP implementation and provided Conservation Reserve Enhancement Program funds to promote voluntary land retirement, which helps agricultural producers to protect natural resources. The Wisconsin Department of Agriculture provided technical assistance, and the University of Wisconsin extension service led local education and outreach efforts throughout the watershed.

Pleasant Valley Watershed. Since 2009, farmers, conservation groups, and staff from a number of federal, state, and local agencies, including LGUs, have been working on a research and demonstration project in the Pleasant Valley Watershed in the Mississippi River Basin. The goal of the project is to test whether it is possible to use science to target implementation efforts to improve water quality at the lowest cost. For three years, implementation was targeted to a small number of farms representing less than one-third of the watershed that were contributing the largest amount of sediment and phosphorus. Conservation staff worked with the farms to identify and implement applicable management practices.

The first year of post-implementation water quality monitoring found a 37 percent reduction in phosphorus loading during storm events in comparison to baseline information and monitoring in a paired watershed. With streambank stabilization, silt and muck on the stream beds were reduced and cobble and stone beds were exposed. Biological assessments found improved conditions for fish and aquatic insects. If these positive results continue, the streams in Pleasant Valley will be proposed for removal from Wisconsin's impaired waters list. More information on this project can be found at http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/wisconsin/howwework/wi-pecatonica-results-fact-sheet.pdf.

3.1.13 Tribes

The National Tribal Water Council (NTWC) has actively supported tribal representation on the HTF since 2008. Through an interagency task force composed of representatives from EPA, USDA, and USGS, the NTWC has taken the lead on providing a broad-based tribal nutrient strategy. The primary goal of the tribal nutrient strategy is to provide a road map of technical assistance options open to tribes that wish to reduce nutrient loadings to their waters.

The NTWC representative to the HTF is from the Eastern Band of Cherokee Indians (EBCI), whose lands are in the Little Tennessee River Basin, which is part of the Ohio River Basin in western North Carolina. The EBCI has applied to EPA for Treatment in a Similar Manner as a State for its surface water quality jurisdiction. Simultaneously, the EBCI has been developing water quality standards, which will commit the EBCI to a plan of action for numeric nutrient criteria development. The criteria would be adopted as nutrient standards in EBCI’s first Triennial Water Quality Standards Review, which would help guide nutrient reduction to Mississippi River waters.

In September 2014, the EBCI contracted with USGS to install and operate a gauging station on the lower Oconaluftee River in North Carolina to collect a full suite of water quality monitoring parameters. The data collected from the station will be incorporated into the MRBI to facilitate water quality modeling by USGS.

3.2 Federal Assistance to HTF States and Tribes

3.2.1 EPA Grants and Programs

EPA is working cooperatively with states, tribes, and other partners to reduce nitrogen and phosphorus pollution, including protecting and restoring surface waters already degraded by nutrient pollution. This section details some key EPA programs that reduce nutrient pollution:

- **Nutrient Reduction Strategies—**EPA is working with states nationwide to help them develop and implement strategies, frameworks, and programs to reduce nutrient pollution. In 2012, EPA invested approximately $1.1 million to help HTF states develop their nutrient reduction strategies and implement demonstration projects in priority watersheds. All 12 HTF states now have draft or complete strategies in place and are taking action to reduce nutrient pollution.

EPA Accomplishments

EPA has provided continued assistance and funding to HTF states and tribes to address nutrient pollution. Examples of hypoxia-related accomplishments include the following:

- Providing technical assistance for developing state nutrient reduction strategies.
- Providing training opportunities and discussion forums for experts in the field, such as NPDES permit writer training and workshops with states to discuss innovative approaches to water quality standards for nutrients.
- Providing funding, such as CWA section 319 grants, to support efforts to reduce nonpoint source pollution.

- **CWA Section 106 Grants for State Water Quality Management Programs** - Section 106 of the CWA authorizes EPA to provide federal assistance to states (including territories, the

District of Columbia, and Indian Tribes) and interstate agencies to establish and implement water pollution control programs. Prevention and control measures supported by EPA include permitting, developing water quality standards and TMDLs, ambient water quality monitoring, compliance assistance, advice and assistance to local agencies, and providing training and public information. From 2009–2013, EPA provided $254 million in section 106 grant funding to HTF states to support their efforts to reduce nutrients and other types of water pollution. See Table 2 below.

- **Clean Water State Revolving Fund (CWSRF) Capitalization Grants** - Since its inception, EPA's CWSRF program has served as the largest water quality financing source, helping communities across the country meet the goals of the CWA by improving water quality, protecting aquatic wildlife, protecting and restoring drinking water sources, and preserving our nation's waters for recreational use. In recent years, the CWSRF programs provided, on average, more than $5 billion annually to fund water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management. Over the last two and half decades, the CWSRF grants have provided over $100 billion, funding more than 33,320 low-interest loans. States can choose to use the assistance to help communities reduce nutrient pollution. From 2009–2013, EPA provided $1.9 billion in CWSRF allotments to HTF states to support their efforts to reduce water pollution, including nutrients. See Table 2 below.
- **NPDES Permits for Municipal and Industrial Wastewater Discharges** - Publicly owned treatment works (POTWs) and industrial facilities in the MARB contribute nitrogen and phosphorus pollution (see Figure 3 in section 2.2.2.1 for their estimated contributions). These facilities are regulated by NPDES permits under the CWA that are generally issued by states, with EPA oversight. The permits require compliance with national, technology-based discharge standards or, where needed, more stringent limitations to meet state water quality standards. As discussed in the state progress summaries, a number of HTF states are issuing permits with specific numeric nutrient permit limits or monitoring requirements, or requiring feasibility studies prior to treatment upgrades or trading programs. Although not all permits may need numeric phosphorus and/or nitrogen limits, there is the potential for greater use of permit limits to reduce nutrient pollution. EPA conducts training and workshops for NPDES permit writers on controlling nutrient pollution.
- **NPDES Permits for Stormwater Controls -** Polluted stormwater discharges, a major cause of water quality impairments, are regulated under the CWA section 402(p) National Stormwater Protection Program. The program's focus is on discharges from municipal separate storm sewer systems (MS4s), construction site stormwater discharges from sites of one acre or larger, and 29 industrial sectors that discharge stormwater to an MS4 or to surface water. The national stormwater program applies to medium and large MS4s that serve incorporated communities in urbanized areas with populations of over 100,000, as well as other "small" MS4s in urbanized areas and other small MS4s that have been specifically designated by the NPDES permitting authority. MS4s are required to implement stormwater management programs to eliminate nonstormwater discharges from MS4s, reduce pollutants in MS4 discharges to the "maximum extent practicable", and comply with any water quality or other pollutant control requirements in the permit.

- **Concentrated Animal Feeding Operations (CAFO) Regulations** - NPDES permits are required for CAFOs that discharge to waters of the United States. Some states regulate a larger universe of animal confinement facilities under state law and may require that those facilities develop and implement nutrient management plans and/or regulate the transport of manure to limit nutrient runoff.
- **Water Quality Criteria and Standards -** Under the CWA, states adopt water quality criteria and standards that define the water quality goals for a waterbody. "Narrative" criteria (e.g., waters must be free from objectionable scums or deposits) or "response" criteria (e.g., dissolved oxygen) are widely used, but are not easily applied to reduce nutrient pollution. Numeric nutrient criteria generally better provide the basis for assessment of impaired water quality and help NPDES permit writers to more easily derive, as necessary, numeric limits for point source dischargers. EPA continues to assist states with the development of numeric nutrient criteria and has recently conducted technical workshops across the country to communicate the state of the science and to help states, including HTF states, share best practices and approaches they are using to develop numeric nutrient criteria.
- **CWA Section 303(d) Listings and TMDLs** - States monitor and assess their waters and every two years, under section 303(d) of the CWA, develop lists of waters that do not meet state water quality standards. Nationwide, states have listed more than 12,000 waters as impaired by nutrient-related causes under CWA section 303(d). This number includes waters listed for nutrients specifically as well as for nutrient indicator parameters of organic enrichment, oxygen depletion, and algal growth (USEPA 2015). Under section 303(d), once states list waters as impaired, they develop "pollution budgets" known as Total Maximum Daily Loads, or TMDLs. A TMDL identifies the pollutant reductions needed from point and nonpoint sources to meet water quality standards. Once approved, TMDL allocations are generally implemented through NPDES permits for point sources and BMPs for nonpoint sources. To date, more than 8,000 nutrient-related TMDLs, for more than 5,000 waters, have been developed nationwide. Of those nutrient-related TMDLs, more than 2,100, for more than 1,400 waters, have been developed in the HTF states, helping to guide HTF state efforts to reduce nutrient pollution in their waters.
- **Water Quality Trading -** EPA supports states interested in using water quality trading, sometimes referred to as "nutrient credit trading", as a means to achieve cost-effective reductions in nutrient loading within a watershed. This approach often, but not always, relies on a target load from a TMDL or water quality standard to serve as a baseline to generate "credits" and identify how many pounds are available for trading in a particular watershed. Water quality trading is often implemented through an NPDES permit to one or more of the trading partners. All HTF states have expressed interest in water quality trading programs and some states are already implementing trading projects. For example, Kentucky, Indiana, and Ohio are participating in the Ohio River Valley Water Sanitation Commission (ORSANCO)-Electric Power Research Institute Pilot Trading Project, which facilitates pollution credit trading between farmers and industrial facilities to reduce fertilizer runoff and nutrient point source discharges. More information on this project is available at http://wqt.epri.com/pdf/3002001739_WQT-Program-Summary_2014-03.pdf.

- **CWA Section 319 Nonpoint Source Program -** EPA provides grants to states to implement nonpoint source management programs under section 319 of the CWA. Recently, almost all HTF states updated their nonpoint source management programs. Section 319 grant monies support a wide variety of activities, including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects. The program relies on watershed plans as a primary tool to ensure grant monies are used as effectively as possible to achieve water quality goals. The previous section highlighted nonpoint source success stories in HTF states. From 2009 to 2013, EPA provided $255 million in section 319 grant funding to HTF states to support their efforts to reduce water pollution, including nutrients. See Table 2 below.

Table 2: EPA Financial Assistance to HTF States by Program (2009–2013)

Program	2009	2010	2011	2012	2013	Total
CWSRF	$182,898,500	$547,635,000	$396,894,000	$379,869,000	$358,843,000	**$1,866,139,500**
319 Grants	$57,275,000	$57,275,000	$49,750,000	$46,479,000	$44,055,000	**$254,834,000**
106 Grants	$47,333,300	$50,406,800	$52,299,800	$52,332,100	$49,634,600	**$252,006,600**
Total	**$287,508,809**	**$655,318,810**	**$498,945,811**	**$478,682,112**	**$452,534,613**	**$2,372,980,100**

Please note that these resources support a broad range of state activities to reduce nonpoint source pollution, including but not limited to nutrients.

- **National Aquatic Resource Surveys (NARS)** - EPA, states, tribes, and other partners are conducting a series of surveys of the nation's aquatic resources. Often referred to as "probability-based surveys", these studies provide nationally consistent and scientifically defensible assessments of our nation's waters and can be used to track changes in condition over time. Each survey uses standardized field and lab methods and is designed to yield unbiased estimates of the condition of the whole water resource being studied (i.e., rivers and streams, lakes, wetlands, or coastal waters) at a national scale and across broad, ecologically similar regions. Some states supplement the surveys or conduct their own assessments at a state scale. Section 2.2.4 describes findings from surveys on the extent of nutrient concentrations in rivers and streams (2008 - 2009) in the Mississippi basin, including sub-basins that are within the MARB.

  Other NARS reports include data on nutrient concentrations and effects in the MARB, including the 2004 survey of streams; the 2007 survey of lakes and reservoirs; the 2012 survey of lakes and reservoirs (report scheduled for release in 2015); and a 2013/14 survey of rivers and streams (scheduled for release in 2015), which includes a specific focus on the Mississippi River, and a first estimate of changes in the condition of streams since the 2004 streams surveys.

- **Continued Commitment to Science -**
  - Between 2005 and 2008, EPA invested $500,000 towards USGS enhancements to the SPARROW model that allow load estimates to be allocated to HUC8 watersheds based on 1992 data and, more recently, 2002 data.

- In 2005–2008, EPA invested $1.5 million to reassess the scientific basis for Gulf hypoxia, which included four science symposia held throughout the basin and an EPA SAB panel and report.
- EPA Office of Research and Development (ORD) conducts research that supports state and federal efforts to reduce Gulf hypoxia including:
  - Working with scientists from academia and other federal agencies in NOAA's Coastal and Ocean Modeling Testbed to develop an ensemble hypoxia model forecasting and scenario system for the northern Gulf of Mexico (see http://testbed.sura.org/).
  - Developing a coupled Mississippi River Basin and northern Gulf of Mexico coastal ocean ecosystem modeling framework for predicting how nutrient management decisions and future climate scenarios will impact the size, frequency, and duration of the hypoxic area.
  - Conducting research and modeling to resolve quantitatively the extent of hypoxia that may occur naturally in northern Gulf estuaries versus that which results from anthropogenic nutrient loading.
  - Working to quantitatively understand the effects of hypoxia on aquatic life, particularly when exposure to hypoxia is variable. EPA ORD research in this area aims to improve estimates of the total exposure of fauna to low oxygen conditions and community and population level effects.
  - Conducting research to examine the nexus between land-based nutrients and ocean acidification. The interaction of hypoxia and low pH impacts aquatic life—including the aquaculture industry.
- EPA is promoting innovation toward cost-effective and practical solutions through initiatives such as the nutrient sensor challenge (http://www.act-us.info/nutrients-challenge/). The nutrient sensor challenge is a cooperative effort between federal agencies, the Alliance for Coastal Technologies, and other partners to develop affordable, accurate, and reliable nutrient sensors.
- Additionally, EPA ORD recently approved funding, through its Science to Achieve Results (STAR) grants program, for research that uses a "systems view" of nutrient management to study new, sustainable ways to improve U.S. water quality. A systems view relies on social, technical, and economic considerations to determine the success of nutrient management strategies. The funded projects address three urgent research needs:
  - New science to achieve sustainable and cost-effective public health and environmental solutions in water management.
  - Demonstration projects to support water management strategies with and beyond current technology, including information at appropriate scales.
  - Community involvement in the design, acceptance, and use of nutrient management systems.

  EPA awarded STAR grants totaling nearly $9 million (more than $12 million with nonfederal cost-share funds included) to four universities across the country. These funds will benefit HTF efforts to reduce nutrient pollution.

3.2.2 EPA and USDA Collaboration

EPA and state water quality agencies are coordinating with USDA's NRCS to implement the National Water Quality Initiative (NWQI) with landowners in many small watersheds across the country, including watersheds in HTF states. State agencies, supported by EPA's CWA section 319 grant funds, coordinate in voluntary, private land conservation investments and technical assistance to landowners, and support state-led water quality monitoring. EPA and NRCS initiated the NWQI in FY 2012, initially targeting 154 small (HUC12) watersheds in all 50 states and Puerto Rico to improve water quality, particularly in waterbodies that are on the CWA section 303(d) lists of impaired waters. Through NWQI, NRCS and its partners help producers implement systems of conservation practices to reduce nutrient and sediment losses from their farms, as well as address pathogens related to agricultural production. The systems include practices to optimize nutrient inputs and to control and trap nutrient and manure runoff. Within the 12 HTF states, about 50 NWQI projects have resulted in $27.7 million obligated for conservation systems related to addressing nutrient and sediment runoff. State programs are using EPA CWA section 319 or other funds to conduct water quality monitoring in selected NWQI priority watersheds.

3.2.3 USDA Programs

USDA has been the lead federal agency on developing, promoting, and evaluating voluntary nutrient conservation practices on agricultural lands in the MARB. The department has made progress through a variety of actions, such as creating several water quality-related landscape conservation initiatives in the MARB to target and implement conservation systems that avoid, control, and trap nutrients. Other USDA actions include quantifying the effectiveness of conservation practices and using models to predict impacts of those practices, as described in previous sections of this report, as well as delivering technical support to farmers and ranchers in the MARB.

USDA's Conservation Investments Improve Water Quality

Since 2010, USDA NRCS has funded 124 watershed-based projects in the MARB in areas that have been high contributors of nitrogen and phosphorus, more than doubling the investment in water quality-related conservation in the majority of those areas. According to CEAP models, this targeted approach to investing in conservation has enhanced the per-acre benefit by 1.7 times for sediment losses, 1.3 times for nitrogen losses, and 1.4 times for phosphorus losses.

3.2.3.1 Conservation Programs through NRCS

From FY 2009 to FY 2013, NRCS invested nearly $5 billion in voluntary conservation programs in HTF states (Table 3). This investment includes Conservation Technical Assistance, which provides technical assistance to farmers, communities, and tribes to develop and voluntarily implement resource management plans that conserve, maintain, and improve natural resources.

Table 3. Total NRCS Financial Assistance and Technical Assistance to HTF States by Program (2009–2013)

Program	2009	2010	2011	2012	2013	Total
Conservation Technical Assistance (CTA)	$163,463,163	$170,288,870	$169,381,847	$151,518,609	$168,218,417	**$822,870,906**
Farmland Protection Program (FRPP)	$13,842,812	$10,966,260	$16,528,779	$20,590,143	$13,310,032	**$75,238,026**
Wildlife Habitat Incentives Program (WHIP)	$13,408,098	$22,017,569	$12,422,474	$13,829,360	$10,360,671	**$72,038,172**
Environmental Quality Incentives Program (EQIP)	$240,988,094	$279,239,683	$303,997,478	$367,939,054	$402,000,615	**$1,594,164,924**
Wetlands Reserve Program (WRP)	$147,287,357	$203,186,503	$228,785,962	$255,910,523	$174,572,020	**$1,009,742,365**
Conservation Security Program (CSP)	$114,787,843	$92,865,866	$83,273,380	$81,134,906	-	**$372,061,995**
Grasslands Reserve Program (GRP)	$730,925	$1,086,301	$1,600,238	$1,028,324	$677,092	**$5,122,880**
Conservation Stewardship Program (CSpT)	$3,616,175	$134,488,502	$196,746,426	$263,245,727	$316,915,610	**$915,012,440**
Agri Water Enhancement Program (AWEP)	$4,385,680	$5,901,159	$8,036,105	$7,372,859	$8,427,986	**$34,123,789**
Healthy Forests Reserve Program (HFRP)	$1,321,405	$2,440,651	$3,317,797	$2,863,197	$2,142,882	**$12,085,932**
Total	**$703,831,552**	**$922,481,364**	**$1,024,090,486**	**$1,165,432,702**	**$1,096,625,325**	**$4,912,461,429**

3.2.3.2 Landscape Conservation Initiatives

Beginning in the 2008 Farm Bill, NRCS developed several landscape conservation initiatives that target voluntary conservation program funding to areas with critical natural resource concerns (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/initiatives/). The initiatives, which include three water quality-related initiatives that intersect with MARB, cross geopolitical boundaries, take a science-based approach to addressing resource concerns on a landscape scale, and rely on strong partnerships to enhance conservation system implementation.

The Mississippi River Basin Healthy Watersheds Initiative (MRBI), begun in 2009, targets financial and technical assistance for conservation in high-priority, small watersheds in 13 states, including the 12 HTF states. MRBI emphasizes a cost-effective conservation systems approach with a focus on suites of conservation practices that optimize use of nutrients, control nutrient runoff, and trap or filter nutrients before they run into surface water or leach into groundwater. MRBI accelerates voluntary conservation efforts by overlaying targeted conservation assistance on top of what is generally available through Farm Bill conservation programs. Compared to general program funding, targeted investments in MRBI have more than doubled the adoption of critical water quality conservation practices, such as cover crops and nutrient management, in the majority of MRBI project areas. Over its first five years, MRBI invested more than $380 million in technical and financial assistance across 124 projects. In FY 2013, the demand for EQIP financial assistance under MRBI was more than double the available funding at $123 million across almost 3,500 farmer applications, and that demand continued to grow in FY 2014.

The effectiveness of MRBI's small watershed targeting and conservation systems approach was modeled under NRCS CEAP in April 2013. For conservation systems under contract with farmers through MRBI between FYs 2010 and 2012, when fully applied, it is projected that the per-acre benefits of these systems will be 1.7 times greater for sediment reduction, 1.4 times greater for phosphorus reduction, and 1.3 times greater for nitrogen reduction compared to a non-targeted approach. MRBI has also shown the effectiveness of targeted landscape initiatives in attracting strong partnerships. An average of five active partners, including conservation districts, NGOs, other federal and state agencies, industry groups, and universities, supported each of the 124 MRBI projects.

The targeted investment of NRCS program funding through the Wetlands Reserve Program (WRP) resulted in the permanent protection and restoration of 30,000 acres of wetlands and associated habitats throughout the MRBI area. Through WRP, NRCS purchases perpetual easements from private landowners and restores wetlands that have been converted or degraded for agricultural use. The agricultural lands on the former wetland areas continue to be subject to frequent flooding or prolonged inundation and, as a result, are often marginal agricultural lands. The restoration of the historic hydrology, native vegetative communities, and full suite of wetland functions and values on these lands is highly successful and improves water quality, along with wildlife habitat, in the targeted MRBI areas.

Other water quality initiatives in the MARB include the NWQI, which is described above, and the Gulf of Mexico Initiative (GoMI). Through GoMI, NRCS and its partners work with agricultural producers to improve ecosystem health and water quality, relieve overuse of water resources, and prevent saltwater from entering the habitats of many threatened and endangered species. The GoMI project area includes selected watersheds in the five Gulf States: Alabama, Florida, Louisiana, Mississippi, and Texas. From FY 2012 through FY 2014, nearly $7 million was obligated in voluntary contracts to provide agricultural producers with assistance in accelerating the implementation of conservation systems.

3.2.3.3 Regional Conservation Partnership Program

The 2014 Agricultural Act (Farm Bill) expanded opportunities to leverage USDA resources with those of key partners through the Regional Conservation Partnership Program (RCPP) (see http://www.nrcs.usda.gov/wps/portal/nrcs/ main/national/programs/farmbill/rcpp/). The RCPP asks partners to submit project proposals to address local and regional resource concerns. A portion of the MARB—the same 13 states that comprise NRCS' MRBI—was selected as one of eight critical conservation areas (CCAs) under the RCPP. CCAs are intended to address regional natural resource concerns that cross geopolitical boundaries, with a particular focus on water quality and quantity. With the first announcement of program funding for RCPP, the MARB CCA received 62 out of 204 CCA project pre-proposals (approximately 30 percent), underscoring the high demand for conservation and the strong partnerships in this area. In FY 2015, five projects were selected in the MARB CCAs, all related to reducing nutrient loading. For example, the Iowa Targeted Demonstration Watersheds Partnership Project brings together more than 70 partners to help implement Iowa's nutrient reduction strategy, with nine focus watersheds that will receive additional conservation funding for practices that are most beneficial in reducing nutrients.

3.2.3.4 Conservation Innovation Grants

Conservation Innovation Grants (CIGs) funded through EQIP can play a role in reducing nitrogen and phosphorus runoff from agricultural production (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/). These grants are intended to stimulate development and adoption of innovative conservation approaches, while leveraging federal investment in environmental enhancement and protection. One such innovation is the ecosystem markets projects, which NRCS has funded through CIG since 2004. In 2012, 12 water quality trading projects were awarded CIG funding, including four in MARB states. Recently, the growing understanding of the beneficial effects of healthy soils on water quality and quantity have led to several CIGs in the MARB focused on the adoption of soil health practices and strengthening farmer networks to boost widespread adoption of these practices.

Environmental Markets Offer Additional Incentives for Water Quality Conservation

The Electric Power Research Institute (EPRI), with partial funding from an NRCS Conservation Innovation Grant, has established the nation's first interstate water quality trading program in the Ohio River Basin, in which farmers can sell nutrient credits to permitted dischargers. EPRI facilitated the program's first pilot trades in March 2014. Thirty farmers generated the credits used in the pilot trades, and the program's first credit auction is scheduled to take place on April 16, 2015.

3.2.3.5 Refinement and Increased Adoption of Key Conservation Systems

Through both general program funding and landscape conservation initiatives, NRCS continues to implement conservation systems and practices that have been updated based on the latest science and research.

3.2.3.6 Soil Health

In 2012, NRCS launched its Unlock the Secrets in the Soil educational campaign, which seeks to increase awareness and adoption of soil health management systems (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/). One of the major benefits of soil health is improved water quality because of associated decreases in overland flow to surface waters, decreases in soil erosion, increased nutrient retention, and a reduced need for nutrient inputs. Other soil health benefits include increased soil carbon storage capacity, increased water retention and drought tolerance, and reduced susceptibility to disease and pests.

2015, The International Year of Soils

As part of the International Year of Soils—declared by the United Nations General Assembly—USDA will partner with the Soil Science Society of America and other organizations to raise awareness of the vital importance of healthy soils to protect natural resources, mitigate against extreme weather events, and increase food security across the world. Healthy soils mean better water quality, and 2015 marks a significant opportunity to protect and improve one of the nation's greatest resources. News, research, and events related to soil health can be found at http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/yos/.

As a result of NRCS' soil health campaign, more than 75 percent of NRCS field staff, as well as 400 conservation partners and 300 farmers, have received soil health training. Resources on the Internet have been widely used: one soil health video has been viewed more than 100,000 times. NRCS played a key role in organizing the first National Conference on Cover Crops and Soil Health, which was held in February 2014 (https://www.youtube.com/watch?v=8HYLCtftSQo). The conference attracted approximately 6,000 participants in the central meeting location and in 220 remote sites across the country.

These educational efforts are resulting in increased adoption of soil health practices. For example, the number of acres with planned or applied cover crops contracted through EQIP nearly doubled in 2013, compared to 2009 (USDA 2014). The National Agricultural Statistics Service (NASS) Census of Agriculture estimates that 10 million acres of cover crops were planted in 2013 alone (with and without federal assistance). New tools, such as a soil testing procedure being developed by USDA's ARS and NRCS that measures the amount of organic nitrogen available to crops, will help producers refine their nutrient management strategies and give them the confidence to adopt soil health management systems.

3.2.3.7 Nutrient Management

In December 2011, NRCS, in collaboration with universities and NGOs, released a revised Conservation Practice Standard (CPS) for Nutrient Management, CPS 590. NRCS created CPS 590 to manage nutrients for plant production, minimize agricultural nonpoint source pollution, protect air quality, and maintain or improve soil conditions. It is an important tool for NRCS staff and others to help agricultural producers apply nutrients using the 4R principles—the right amount, right source, right placement, and right timing. Since 2011, more than 2.3 million acres of nutrient management have been planned or applied in HTF states.

3.2.3.8 Drainage Water Management

The National Ag Water Management (AGWAM) Team assists states in voluntary conservation efforts to reduce nutrients leaving fields in intensively drained farmlands, with a focus on the Upper Mississippi River Basin, as well as the Great Lakes Basin and the Red River Valley of the North. The AGWAM Team, working in collaboration with partners, has a charge to increase the voluntary adoption of agricultural drainage water management and associated practices, such as denitrifying bioreactors and vegetated subsurface drain outlets for conservation benefits. Significant progress is being made, with the acres planned for drainage water management increasing from just over 12,000 acres in FY 2013 to more than 42,000 acres in the first three quarters of FY 2014. Application of drainage water management has increased from just over 4,300 acres in FY 2013 to more than 7,400 in the first three quarters of FY 2014.

3.2.3.9 Conservation Reserve Program

USDA's Farm Service Agency (FSA) administers the Conservation Reserve Program (CRP), which is a voluntary program for agricultural landowners. Landowners participating in CRP convert highly erodible and environmentally sensitive cropland into conservation covers including wetlands, buffers, grass and trees. FSA has quantified the reduction of sediment, nitrogen, and phosphorus resulting from 17.0 to 22.7 million acres of former cropland enrolled in CRP during 2009-2014. Between 2009 and 2014, CRP resulted in over 965 million tons of sediment, over 2,500 million pounds of nitrogen, and over 530 million pounds of phosphorus being retained in fields and not being available to enter waterways within the Mississippi River Basin (see table 4).

CRP is a voluntary program that targets highly erodible and other fragile cropland for conservation. Participants that enter a 10-15 year contract to place eligible cropland into long-term conservation covers such as grass, trees, and wetlands receive annual rental payments, cost share assistance, and in some cases additional incentive payments.

The Conservation Reserve Enhancement Program (CREP) provides for federal - state partnerships. States identify high-priority conservation issues and provide state resources. USDA brings additional resources to supplement the CRP and together FSA and the state target these resources to tackle the conservation concerns. In the MARB most states have entered into at least one CREP agreement. Several of these agreements are featured in the state nutrient management strategies.

Table 4. Environmental Benefits of the Conservation Reserve Program 2013 Mississippi River Basin

		2009	2010	2011	2012	2013	2014
Land Enrolled *	million acres	22.7	21.0	20.7	19.4	17.6	17.0
In Buffers	million acres	1.32	1.40	1.31	1.32	1.32	1.21
In Wetland	million acres	1.22	1.29	1.35	1.32	1.18	1.07
Reductions (not leaving field or intercepted by buffers)**							
Sediment	million tons	164	159	165	163	158	158
Nitrogen	million lbs	431	431	446	439	423	423
Phosphorus	million lbs	89	89	91	90	86	86

* Acres of land enrolled in the Mississippi River Watershed

** The nitrogen, phosphorus and sediment reduction are estimated by FSA using a model developed by the Food and Agricultural Policy Research Institute (FAPRI) at the University of Missouri. The model and results for the initial year are provided in a report (Estimating Water Quality, Air Quality, and Soil Carbon Benefits of the Conservation Reserve Program) available at http://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/EPAS/PDF/606586_hr.pdf.

3.2.3.10 Research and Extension Programs through NIFA

USDA's National Institute of Food and Agriculture (NIFA) provides federal financial assistance to states through competitive grants and capacity grants to work on topics relevant to nutrient issues in the MARB. NIFA's competitive grants are available to universities, state governments, industry, federal research laboratories, and non-governmental organizations. Below are a few NIFA competitive programs that have specific research priorities relevant to HTF goals:

- Agriculture and Food Research Initiative (AFRI) Foundational Program: Bioenergy, Natural Resources, and Environment;
- AFRI Challenge Area, Water for Agriculture;
- National Integrated Water Quality Program;
- Sustainable Agriculture Research and Education;
- Regional Aquaculture Centers;
- Specialty Crop Research Initiative; and
- Small Business Innovation Research.

NIFA also provides financial assistance to our LGU partners through block or capacity grants to work on agricultural issues that are of high priority to their states and regions. State Agricultural Experiment Stations and Cooperative Extension use this funding to maintain research and extension capacity in the agriculturally related sciences. Much of this funding is used in support of locally-led state projects. Currently the states in the MARB use capacity funding to do high priority research and extension related to HTF priorities such as fertilizer recommendations, soil testing, nutrient management, fate and transport of nutrients, basic plant and animal nutrient biology, agroecosystem hydrology, and nutrient use economics. Twenty-five percent of capacity funding is required by law to be used for multistate research and extension projects. Below are a few multistate projects that have been funded with capacity funds that have research and extension objectives that address issues of importance to the HTF:

- Framework for Nutrient Reduction Strategy Collaboration: the Role for Land Grant Universities (SERA-46);
- Organization to Minimize Nutrient Loss from the Landscape (SERA-17);
- Drainage Design and Management Practices to Improve Water Quality (NCERA-217);
- Enhancing Nitrogen Utilization in Corn-Based Cropping systems to Increase Yield (NC-1195);
- Southern Region Integrated Water Resources Coordinating Committee (SERA-43); and
- Catalysts for Water Resources Protection and Restoration: Applied Social Science Research (NC-1190).

3.2.4 U.S. Department of the Interior Programs

3.2.4.1 U.S. Fish and Wildlife Service

Over the past few years, the HTF has started working more closely with the USFWS and its Landscape Conservation Cooperative (LCC) programs. What started as informational exchanges has developed into a more formal partnership. Now a USFWS representative joins a USGS representative as Coordinating Committee members for the U.S. Department of the Interior on the HTF.

In August 2014, seven LCCs convened a workshop in Memphis to develop a structured decision-making process to best allocate wildlife management actions throughout the Mississippi River Basin in a way that reduces the contribution of nutrients to Gulf hypoxia while simultaneously benefiting terrestrial and aquatic wildlife populations and balancing agricultural interests. The Mississippi River Basin/Gulf Hypoxia Landscape Conservation Design Implementation and Model Refinement Workshop (http://www.tallgrassprairielcc.org/ research-projects/mississippi-river-basingulf-hypoxia-structured-decision-making-workshop-2014/), led by the Eastern Tallgrass Prairie and Big Rivers (ETPBR) LCC in partnership with six other LCCs encompassing the Mississippi, Missouri, and Ohio River basins, brought decision makers and on-the-ground technical experts together to assess policy and program-level decisions that could support implementation of strategies that address Gulf hypoxia. This effort was designed to complement the HTF, MRBI, and state nutrient reduction initiatives. There was an added emphasis on considering the ecological and social values of wildlife habitat, establishing corridors for wildlife adaptation to climate change, and enhancing organizational capacity to promote adoption of these practices in the most effective configurations and locations.

USDA, a key partner to USFWS, has provided leadership in developing partnerships with private industry, nonprofit organizations, and state and federal agencies, especially through Landscape Conservation Initiatives and cooperative agreements. Partners often offer financial or in-kind contributions for conservation implementation, allowing USDA's conservation dollars to go further, or they can align conservation opportunities in critical areas. The 2014 Farm Bill institutionalized the importance of partnerships through the RCPP.

3.2.4.2 U.S. Geological Survey

USGS operates over 3,000 stream gages and conducts nutrient and wetland monitoring and modeling assessments throughout the MARB, totaling about $62 million in 2010, through a variety of federal and cooperative programs with numerous local, state, and federal agencies.

HTF states are using the USGS Cooperative Water Program (http://water.usgs.gov/coop/) to increase support and action for mitigating Gulf hypoxia. This program brings together local, state, and tribal water needs and decision making with USGS capabilities, involving partnerships between USGS and more than 1,500 state, tribal, and local agencies. Some of these partnerships focus on real-time monitoring of nitrate, long-term ambient water quality monitoring, and water quality improvements and agricultural BMPs. In addition, the Corps /USGS Long-Term Resource Monitoring Program (www.umesc.usgs.gov/ltrmp.html), under the direction of the Corps Environmental Management Program and in collaboration with USGS, partners with other federal and state agencies in Illinois, Iowa, Minnesota, Missouri, and Wisconsin to support decision makers by providing critical information needed to maintain the Upper Mississippi River System as a viable, multiple-use, large river ecosystem.

The USGS National Wetlands Research Center (www.nwrc.usgs.gov/) engages in robust alliances to develop and disseminate scientific information needed for understanding the ecology and values of wetlands, and for managing or restoring wetlands and coastal habitats. This program potentially yields significant benefits toward nutrient reduction and hypoxia mitigation through its protection of wetlands.

3.2.5 U.S. Army Corps of Engineers Programs

The Corps' primary civil works missions of navigation, flood risk management, and ecosystem restoration provide enormous opportunities for partnership and collaboration with other federal and state agencies, local communities, and NGOs across the MARB. Although not designed to specifically address water quality, many Corps project features can provide significant water quality improvement, particularly when accomplished in partnership with other agencies and organizations at a watershed level.

The Steele Bayou Watershed (SBW) project, located in the Yazoo River Basin in Mississippi, is an example of a successful Corps, federal, state, and private partnership. Streams and rivers in the SBW have been altered through agricultural activities and flood risk management projects. The result has been increases in sediment and nutrient loading. Poor stream health in the SBW has been documented by several short-term studies, citing elevated concentrations of suspended sediment and nutrients. The SBW is listed on the MDEQ's CWA section 303(d) list of impaired waters with identified impairments of pesticides, organic enrichment, low dissolved oxygen, nutrients, and siltation. Since the early 1990s, the Corps has been involved with flood risk management and sediment reduction projects in the SBW. From 1995 to 2000, the Corps installed eight low-head weirs to maintain minimum water depths in the channels and 67 sediment control structures to prevent sediment from filling the channels. In 2005, post-project monitoring results of the sediment control structures indicated a large reduction of in-stream TSS.

Due to the significant reductions in TSS, the Corps identified over 100 additional sites where sediment control and water management practices were needed and worked with MDEQ, Delta Farmers Advocating Resource Management (F.A.R.M.), and local stakeholders to implement the practices. To date, 30 smaller structures and 76 larger structures have been installed in addition to the 67 previously installed. Edge-of-field monitoring on the structures was initiated in 2007 by USGS. Concurrent with this effort, the Mississippi Soil & Water Conservation Commission, NRCS, EPA, and Ducks Unlimited also worked with stakeholders within the watershed to install numerous water management practices that included sediment control structures, land leveling, containment dikes (pads), and overfall pipes. Over $15 million has been spent for sediment structures in the SBW, without including investments by landowners for various conservation practices.

The cumulative results from these efforts have been dramatic. A GIS model was developed by the Corps that correlates incremental changes in water quality with the implementation of sediment control and water management practices. The pre-implementation monitoring data (1995) established baselines for TSS, total nitrogen, and total phosphorus. Baseline land use analysis estimated that 15 percent of the land area in the SBW had conservation practices already installed. By 2010, 50 percent of the watershed was protected by some type of sediment control structure or water management practices. Analysis of post-project monitoring data from the three sub-watersheds within the SBW reveal a 42–60 percent reduction in TSS concentrations over 15 years, an 18–26 percent reduction in total nitrogen concentrations, and an 8–35 percent reduction in total phosphorus concentrations. Correlation of the reductions to the areas of installed sediment control and water management practices shows that for every one percent increase in land area protected by the practices, there was a one percent reduction in TSS, total nitrogen, and total phosphorus concentrations. The model shows that TSS reduction is tied to implementing the practices in a half-mile buffer adjacent to a channel.

Part 4: Keys to Success and Lessons Learned

4.1 Cooperative Development and Implementation of Nutrient Reduction Strategies

State nutrient strategies are a key activity in the *Gulf Hypoxia Action Plan 2008* and are critical to making progress toward reducing Gulf hypoxia. In September 2010, the HTF agreed on the basic elements to be included in each state's nutrient strategy. The first element is stakeholder involvement. Outreach by the 12 HTF states to their stakeholders has significantly increased the awareness of the potential for nitrogen and phosphorus pollution both locally and in the Gulf of Mexico among the agriculture and wastewater sectors and a broad array of government organizations and NGOs. This broad involvement has also led to a widening of support for nutrient reduction efforts. One example is support from the Iowa farm community for additional state funding for conservation practices.

State strategies and other HTF efforts are founded on the best available science. The 2008 Action Plan was built around the 2008 recommendations of EPA's Science Advisory Board. Both federal agencies and states have continued to develop and use science-based tools and approaches. Federal agencies have developed tools for analyzing nutrient sources and cost-effective solutions (see previous CEAP and SPARROW discussions), collected monitoring information, and developed improved models to better analyze progress (e.g., USGS SPARROW model, NOAA Gulf models). The states have used their LGUs to ground their strategies in the best science. Building on the work of individual states with their LGUs, the HTF now has a memorandum of agreement (MOA) with a group of LGUs in all 12 HTF states that will further engage LGU research and extension programs as states implement their strategies.

HTF state strategies use a range of voluntary and regulatory approaches to improve local water quality and reduce hypoxia in the Gulf of Mexico that reflect each state's unique circumstances and needs. For example in Iowa, where artificial drainage (tile drains) and natural subsurface drainage facilitate the vast majority of nitrogen transport to streams, the state has an initiative to demonstrate practices that ameliorate water quality impacts from drainage. Other states have developed programs to educate and certify the workforce that works with farmers on nutrient applications. Illinois passed a Fertilizer Act with a $0.75/ton assessment on all bulk fertilizer sold in the state to support research and education programs on nutrient use and water quality. In Ohio, a state law now requires nutrient applicators to be certified through an educational program on nutrients and water quality and the state agricultural retailer association offers a voluntary educational program for the retailers. Indiana is issuing NPDES permits to its major municipal dischargers with one part per million limits on phosphorus discharges. In Minnesota, municipal wastewater facilities have reduced phosphorus loads by 68 percent since 2000 to comply with the state's regulations for phosphorus discharges. State funding levels and sources also vary. As states implement their strategies with support from federal agencies and in collaboration with partners, and as HTF members track implementation progress and monitor water quality, patterns may emerge regarding effective approaches that inform adaptive management of state strategies and future Reports to Congress.

HTF meetings and other HTF-sponsored fora helped states become familiar with the latest science and learn about voluntary and regulatory approaches being adopted on a state-by-state basis. The meetings also help states learn from each other's approaches to common strategy elements like identifying priorities and adopting measures of progress.

The unified federal strategy has provided focused support for developing, refining, and implementing state nutrient reduction strategies (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2013b). Federal agencies are supporting state efforts with new science, programs, and approaches that states can tailor to their particular needs associated with implementing individual state strategies. The agencies have expanded outreach and education on nutrient pollution issues and solutions, and focused on engaging partners with similar goals. They also have provided technical assistance and funding support to states where possible.

4.2 Forging State and Basinwide Partnerships to Implement Nutrient Reduction Strategies

Important work by the HTF lies ahead in implementing state nutrient reduction strategies, tracking progress, and making adjustments as new information and science become available. Critical to success is expanding partnerships and alliances to help carry out the ecosystem and watershed restoration actions that will reduce nutrient loads. Five key sets of partners are being targeted:

- **Universities.** LGUs in the Mississippi River Basin meet critical research needs and conduct outreach to communities throughout the basin, particularly the agricultural community. LGUs have partnered with individual states to help develop state nutrient strategies that address the diversity of nutrient sources and the geographic, climatic, and hydrologic variability of the MARB. In addition to individual state partnerships, the LGUs now have an MOA with the HTF and are working collaboratively with the HTF to improve the consistency of communications and collectively advance the technologies and knowledge needed to reach HTF goals. The LGUs have received approval to formalize their group as a USDA Southern Extension and Research Activity (SERA) group and receive funding from the USDA's SERA program for their travel.
- **Farmers and Agricultural Organizations.** Farmers are recognized for their long tradition of commitment to soil and water stewardship, and they have been a critical part of developing and implementing state strategies in every state. Farm innovations and the examples set by early adopters help accelerate progress and provide needed demonstration of the effectiveness of systems of conservation practices. The members of the HTF will seek to promote and stimulate markets for farmer-led actions that improve water quality and enhance ecological benefits and services. Actions that reduce the loss of nutrients, while simultaneously providing economic, agronomic, and soil health benefits, are particularly beneficial as they support farm sustainability as well as protect and restore nearby and downstream waters.

- **Businesses.** The ability of business to create products and services to meet the needs of the American people is unprecedented. Many businesses are actively working to reduce their environmental impacts and have lessons to share that will enable other businesses to implement similar actions. Industries that discharge significant amounts of nutrients can provide leadership in identifying and piloting cost-effective process optimization or control technologies. Firms are marketing nitrogen inhibitors and other products that can keep nutrients in the soil and available to plants.
- **Cities and Communities.** Reducing Gulf hypoxia will require reductions from all sources of nutrients and will benefit those who depend on the river for water, recreation, and many other uses. Municipal wastewater agencies and the communities they serve will be relied upon to improve the performance of sewage treatment facilities as a component of state nutrient strategies. Groups like the Mississippi River Cities and Towns Initiative can help build connections with these cities that rely on the river and its tributaries.
- **Other Nongovernmental Organizations.** The HTF will strengthen partnerships with NGOs working on initiatives to improve water quality and reduce nutrients in the MARB. The HTF is now collaborating with the United Nations (UN) Global Compact business partnership, CEO Water Mandate, on the Water Action Hub through the Pacific Institute, the UN's representative partner. The Water Action Hub is the world's first online platform to unite companies, governments, NGOs, and other stakeholders on a range of critical water projects in specific river basins around the world. The HTF will use the Water Action Hub as an online platform to secure corporate and NGO support for projects implementing state nutrient reduction strategies. The HTF has also worked with The Nature Conservancy on a variety of their efforts, including the recent collaborative project, America's Watershed Initiative, which is creating a "report card" to assess the social, economic, and environmental health of key areas in the Mississippi River Basin.

4.3 Lessons Learned from USDA's Conservation Effects Assessment Project (CEAP)

Since 2003, USDA has worked cooperatively through CEAP to better understand watershed dynamics and the effectiveness of conservation systems on agricultural land in the MARB. This multiagency effort and a number of lessons learned are described in detail in section 2.2.5 of this report. For example, CEAP cropland assessments have shown that certain areas within the Mississippi River Basin contribute more nutrient loading to both the Gulf of Mexico and local waters, underscoring the importance of targeting conservation practice implementation to provide the greatest environmental benefit per U.S. dollar spent (White et al. 2014).

Syntheses of results from the CEAP Watershed Assessment studies have identified a number of lessons learned (Richardson et al. 2008; Tomer and Locke 2011; Osmond et al. 2012; Tomer et al. 2014). NRCS is working to integrate these findings into its watershed-based programming and landscape conservation initiatives. The lessons learned include: the importance of planning at a watershed scale; identifying the critical pollutants and their sources and means of transport; using appropriate models to plan and evaluate implementation; using appropriate monitoring designs to evaluate conservation outcomes, determining farmers' attitudes toward conservation practices and working with them by offering appropriate financial and technical assistance; and sustaining assistance and agricultural community engagement after practice adoption. CEAP Watershed Assessments have also demonstrated that even with well-designed fully implemented conservation practices and effective water quality monitoring efforts, if the monitoring period and sampling frequency are not sufficient to address the lag between treatment and response, watershed projects might not be able to measure changes in water quality due to the implementation of conservation practices (e.g., Meals et al. 2010).

Part 5: Recommend Appropriate Actions to Continue to Implement or, if Necessary, Revise the Strategy Set Forth in the Gulf Hypoxia Action Plan 2008

5.1 Continue to Implement the 2008 Action Plan

The 2008 Action Plan called for reassessment of the Action Plan within five years and, in 2013, the HTF published its reassessment. HTF members believe the 2008 Action Plan continues to provide a strong framework for reducing nitrogen and phosphorus in the MARB and reducing the size of the Gulf hypoxic zone. Its most important recommendations remain valid, and HTF members remain committed to its implementation. The most effective approach to moving forward is for the HTF to accelerate implementation of the actions contained in the 2008 Action Plan while refining specific approaches as better science, new tools, and policy innovations become available.

5.2 Revising the Coastal Goal and Committing to Accelerated and New Actions to Reduce Nutrients

As described in Section 1.3.5, in February 2015 the HTF announced that it would retain the original goal of reducing the areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 km^2 and extend the time of attainment from 2015 to 2035.

To meet this updated goal, the HTF will focus on several areas:

- **Implementing** state nutrient reduction strategies to accelerate the reduction of nutrient pollution.
- For the first time, **adopting quantitative measures** to track interim progress. Measures are discussed in Section 5.3.
- Targeting vulnerable lands and quantifying the nutrient load reductions from **federal programs** such as the USDA RCPP, USDA MRBI, USFWS Mississippi River Habitat Initiative and Landscape Conservation Cooperatives, and EPA Water Pollution Control Program Grants and Nonpoint Source Management Program.
- **Expanding and building new partnerships** and alliances with universities, agriculture, cities and communities, and others.

5.3 Tracking Environmental Results

5.3.1 Measuring Progress on Reducing Nutrient Loads

The HTF has agreed to develop and report on several common point source and nonpoint source measures that all HTF states would use to measure progress toward the interim target:

- NPDES Permits—Monitoring: Number and percent of individual non-stormwater permits issued to “major” publicly owned treatment works (POTW) dischargers, with monitoring-only requirements for nitrogen, phosphorus, or both.

- NPDES Permits—Limits: Number and percentage of individual non-stormwater permits issued to major POTW dischargers, with numeric discharge limits for nitrogen, phosphorus, or both.

In addition, the HTF is exploring a potential measure that would track reductions in loads of nitrogen and phosphorus from major POTWs. Some states will also use additional, state-specific measures to track progress on reducing point source loads.

The Nonpoint Source Measures Workgroup continues to review and discuss available and achievable common measures that all HTF states could use to track progress. While not yet finalized, these measures will focus on the success of conservation and best management practices in reducing nutrient loads, including estimates of amounts of nitrogen and phosphorus reduced. Nonpoint source measures such as these are currently employed by several states and by federal programs to track progress toward nutrient reduction goals; these various approaches will be considered for use as a common measure by all HTF states. Some HTF states will also use additional state-specific measures to track progress.

5.3.2 Conducting Long-Term Assessment of Environmental Conditions and Trends

The National Rivers and Streams Assessment (NRSA) is a statistically representative, probability-based monitoring survey undertaken every 5 years by EPA and its state and federal partners. The HTF plans to use data and analysis generated by NRSA surveys to report on the ecological condition of rivers and streams in the MARB and its sub-basins, including nitrogen and phosphorus concentrations. A draft of the first NRSA survey was released in 2013, and it is based on samples collected in 2008 and 2009. In 2016, EPA will report on changes in nitrogen and phosphorus concentrations in MARB streams and rivers at the basin and sub-basin levels, based on data collected in 2013/2014. More information on NRSA and other national aquatic resource surveys is available at this website:
http://water.epa.gov/type/watersheds/monitoring/aquaticsurvey_index.cfm.

The national NRCS/NASS NRI/CEAP cropland farmer survey will be administered for a second time in calendar years 2015 and 2016. The survey is intended to update baseline data on conservation implementation impacts and monitor conservation trends and progress since the initial NRI/CEAP cropland farmer survey was conducted from 2003 to 2006.

5.3.3 Compiling Existing Site-Specific Monitoring from Many Sources

In 2012, the HTF established the Mississippi River Basin Monitoring Collaborative, which USGS helps lead, to identify streams with long-term monitoring and streamflow records that can be used to evaluate progress toward reducing the amounts of nutrients transported to local streams and ultimately to the Gulf of Mexico. This long-term monitoring network provides a foundation for evaluating the effectiveness of conservation practices and other nutrient reduction efforts included in the HTF states' nutrient reduction strategies in the Mississippi River Basin. The long-term monitoring network data will be available through the Water Quality Portal:
http://www.waterqualitydata.us/.

5.4 Conclusion

This first report to Congress required by the 2014 Amendments to HABHRCA describes the history of and progress made by the HTF toward attainment of the goals of the *Gulf Hypoxia Action Plan 2008*. The members of the HTF continue to work collaboratively to implement the 2008 Gulf Hypoxia Action Plan. All HTF states now have draft or complete strategies to reduce nitrogen and phosphorus pollution in the MARB, a key contributor to the dead zone, the large area of low oxygen in the Gulf of Mexico. The HTF is committed to making strong progress on implementation of these strategies and other actions outlined in the 2008 Action Plan. Recognizing the enormity of the work to be done, the HTF has revised the deadline for achieving its goal of reducing the areal extent of the dead zone, while adopting an interim milestone and measures to track progress made to reduce point and nonpoint sources of nitrogen and phosphorus pollution.

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