

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2017 Report to Congress



Biennial Report
2017

Acknowledgments

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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

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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 that state; these strategies serve as the cornerstone for reaching the HTF's goals. The federal members of the HTF issued an updated unified federal strategy in December 2016 to guide assistance to states and continued scientific support (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2016a). In furtherance of its goals, the HTF is also expanding partnerships with organizations with the same or 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). In February 2016, the HTF released its first *Report on Point Source Progress in Hypoxia Task Force States* (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2016b). This report documents the nitrogen and phosphorus monitoring data and discharge limits for major sewage treatment plants within the 12 HTF states.

The Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014 (HABHRCA) directs the U.S. Environmental Protection Agency (EPA) Administrator, through the HTF, to submit a progress report biennially to the appropriate congressional committees and the President. In 2015 EPA submitted the *Mississippi River/Gulf of Mexico Watershed Nutrient Task Force: 2015 Report to Congress*; this report is the second biennial report to Congress (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2015).

This 2017 report highlights specific examples of progress achieved by the HTF and its members. The report also discusses strategies for meeting the HTF's goals, as well as key lessons the HTF has learned, including 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.

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 hypoxia in the Gulf 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 km² by the year 2035. 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 HTF also agreed to adopt quantitative measures to track progress in reducing point and nonpoint source inputs. To accelerate the reduction of nutrient pollution, the HTF will:

- Target vulnerable lands and quantify nutrient load reductions achieved through federal programs, subject to future appropriations.

- Implement state nutrient reduction strategies, including targeting vulnerable lands and quantifying nutrient reductions.
- Expand and build new partnerships and alliances with universities, the agricultural community, cities, and others.
- Track progress towards the interim target and long-term goal, with intent to understand whether the current actions are appropriate to meet the goal.

The Hypoxia Task Force looks forward to continuing to use its biennial reports to Congress to report on 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 or coordinated with 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) (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2008). 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.
- **Tracking outcomes, 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 outcomes and metrics that are in development and in use to track progress towards goals. Part 4 describes the progress of state nutrient reduction strategy development and implementation and highlights successful state projects. Part 4 also describes federal agency programs that support state implementation of nutrient reduction strategies.
- **Evaluation of lessons learned:** Part 5 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 6 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

The Harmful Algal Blooms and Hypoxia Research and Control Amendments Act of 2014 (HABHRCA) 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). In 2015, EPA submitted the *Mississippi River/Gulf of Mexico Watershed Nutrient Task Force: 2015 Report to Congress* (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2015). This report is the second biennial 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

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. 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.

In addition to the human activities listed above that are the leading causes of increased amounts of nutrients delivered to the Gulf, other factors contribute to excess nutrients reaching Gulf waters including (1) historical landscape changes in the drainage basin, including conversion of perennial systems to annual cropping systems; (2) channelization and impoundment of the Mississippi River throughout the basin and the Mississippi 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, and which can cause hypoxia under certain 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).

Hypoxia in the Gulf is a serious environmental concern that can affect valuable fisheries and disrupt sensitive ecosystems by reducing the extent and quality of habitat for a variety of organisms (Diaz and Rosenberg 1995, 2008; Breitburg et al. 2009). Large areas and durations of hypoxia result in substantial changes in fish, benthic, and plankton communities. Impacts to

Hypoxia is a term used to describe waters that have very low dissolved oxygen and thus are stressful to living resources in lakes, estuaries, and coastal waters. Hypoxic waters are often defined as having dissolved oxygen concentrations less than 2 parts per million but chronic impacts to living resources can occur at levels above this concentration. 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 algae 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. For more information, see gulfhypoxia.net.

ecosystems generally include mortality and chronic impairment of growth and reproduction. Reduced fishery production in hypoxic zones has also been documented in the United States and worldwide (Diaz and Rosenberg 2008). 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). Less mobile or more sensitive species fail to survive exposure to low oxygen (Kidwell et al. 2009). Even intermittent hypoxia can cause shifts in benthic communities that favor resistant or tolerant organisms that are less desirable food sources, creating unbalanced benthic communities and cascading trophic level effects to fish communities (Baustian and Rabalais 2009; Breitburg 2002).

Research supported by NOAA's Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program (NGOMEX) has revealed ecological and economic impacts on commercially and recreationally important fisheries. 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). 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).

Another NGOMEX funded project led to the first evidence linking Gulf hypoxia to economic impacts. The study, led by Duke University, has found that the hypoxic zone drives up the price of large shrimp relative to small shrimp, creating an economic impact that directly affects consumers, fishermen and seafood markets (Smith et al. 2017). While the negative effects of these low oxygen waters on marine life are well known, understanding the economic impact and importance has been difficult to achieve due to the dynamic and complex variables that influence fisheries markets. Analysis of monthly trends in the price of Gulf brown shrimp from 1990-2010 showed that the price of large shrimp relative to small ones was high during hypoxic events. Previous efforts likely did not track this type of market impact due to a focus on shrimp quantity over fluctuations in pricing. When the dead zone is present, fishermen catch more small shrimp and fewer large ones, making small shrimp cheaper and larger ones more expensive. The total quantity of shrimp caught could remain the same during hypoxic periods, but a reduction in the highly valued large shrimp would lead to a net economic loss. Other fisheries affected by hypoxia likely undergo similar fluctuations, and further studies are needed to understand how lethal and sub-lethal hypoxia effects (e.g., reduced growth, barriers to spawning pathways, changes to species reproductive success and sex ratios), along with human decisions, can have an important economic impact on fisheries.

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 nationally—not just drinking water supplies in HTF states—is over \$4.8 billion per year (Ribaud 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. From 2009 to 2013, nearly 40 projects totaling over \$25 million 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 and has plans to continue to upgrade at a cost of \$250,000. The utility spends \$460,000 per year to address trihalomethanes (THMs) and algae concerns (A.J. Klei, Ohio EPA, personal communication, October 25, 2016).

Additional work is needed to better quantify the socioeconomic costs and benefits of nutrient reduction at the MARB scale. Dodds et al. (2009) 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 the United States as a whole 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 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 voluntary 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 as urease inhibitors or slow release fertilizers.

Once loading reductions are achieved, the reduction in the hypoxic zone will 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 phosphorus delivery to 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 a waterbody) has a profound 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 alone 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, or groundwater contributions, in a stream. These water flows can carry nitrogen from the fields to a stream, but there is a time lag for this 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).

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 km² by 2015; and (2) a commitment to reduce nitrogen discharges to the Gulf, with multistate sub-basin committees responsible for developing nutrient reduction strategies (phosphorus was not viewed as a cause of hypoxia at that time).

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 Department of Agriculture
- 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

1.3.2 2006-2007 Science Advisory Board Evaluation

In 2006, on behalf of the HTF, 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 stated 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 called 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 reaffirmed the HTF's commitment to implementing the 2008 Action Plan and provided 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 km² 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 km² 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 impact of more intense and frequent rain storms leading to more nutrient runoff and warmer waters which have a lower dissolved oxygen capacity; 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; quantifying the nutrient

load reductions from USDA, EPA and other programs; 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 percent 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.”

EPA included this revised goal in the first biennial progress report on the *Mississippi River/Gulf of Mexico Watershed Nutrient Task Force: 2015 Report to Congress* (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2015).

1.3.6. 2016 Point Source Report

In February 2016, the HTF released its first [Report on Point Source Progress in Hypoxia Task Force States](#) (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2016b). This report documents permitting requirements for nitrogen and phosphorus monitoring and discharge limits for major sewage treatment plants within the 12 HTF states.

1.3.7 2016 Updated Federal Strategy

The federal members of the HTF issued an [updated federal strategy](#) in December 2016 to guide assistance to states and continued scientific support (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2016a).

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 generally measured every summer; annual tracking is a key tool for the Hypoxia Task Force to measure progress towards the long-term goal of reducing the areal extent of the Gulf of Mexico hypoxic zone. Starting in 1985, monitoring supported by the National Oceanic and Atmospheric Administration (NOAA) and EPA, and conducted by Drs. Nancy Rabalais ([Louisiana Universities Marine Consortium](#) or LUMCON) and Eugene Turner (Louisiana State University), has shown that the midsummer areal extent of the hypoxic zone remains much higher than the coastal goal (Figure 1).

In 2015, this monitoring documented that the midsummer areal extent of the 2015 hypoxic zone was 16,768 km² (6,474 mi²) (NOAA 2015). That size is larger than the long-term average (13,751 km²; 5,240 mi²) as well as the average over the last five years (14,024 km²; 5,415 mi²). It is still much larger than the HTF coastal goal of 5,000 km² (1,931 mi²), 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 was larger than the predicted June forecast range of 11,999 km² (4,633 mi²) to 15,501 km² (5,985 mi²) (NOAA and USGS 2015).

Researchers suggest that heavy rains in June and high river discharges in July may provide an explanation for the larger zone measurement.

The mid-summer areal extent of the Gulf hypoxic zone was not measured in 2016 because the monitoring survey was canceled due to ship mechanical failure. In lieu of the full cruise, a more limited sampling effort at two long-term transects (C and F) was completed in August 2016. NOAA and other partners, including the Integrated Ocean Observing System (IOOS) Coastal and Ocean Modeling Testbed ([COMT](#)) program, are using three-dimensional time-variable hypoxia forecast models to hindcast and simulate hypoxia dynamics for the full summer of 2016. The models, developed through NOAA's HABHRCA-authorized Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program (NGOMEX), are using data from the August cruise, glider experiments, recent cruises by Texas A&M at the Flower Garden Banks National Marine Sanctuary, National Marine Fisheries Service (NMFS) Southeast Area Monitoring and Assessment (SEAMAP) data, and satellite chlorophyll data to improve their estimates. The loss of the 2016 mid-summer survey dataset emphasizes the need for a more sustainable and robust monitoring strategy for the hypoxic zone and in September 2016, NOAA and the Northern Gulf Institute (NGI) convened a workshop aimed at achieving this goal ([See Section 2.1.1](#)).

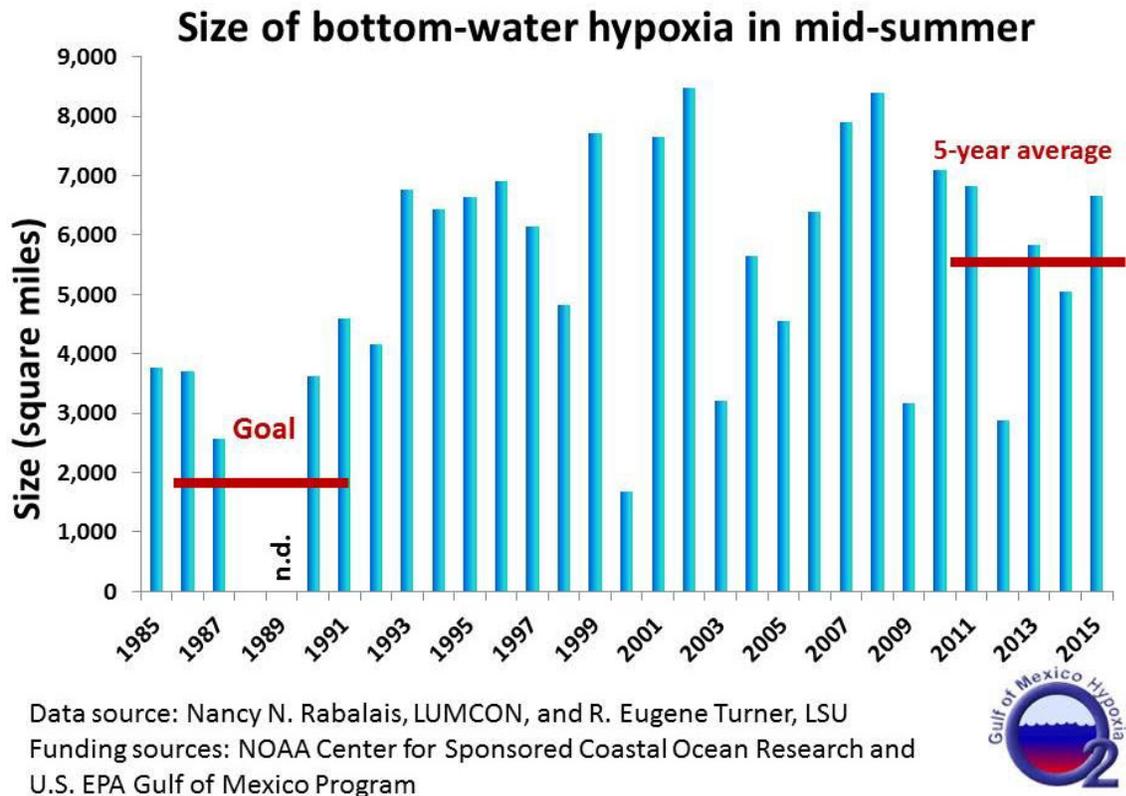


Figure 1. Size of the hypoxic zone from 1985 through 2015. An important factor driving the NOAA hypoxic zone forecast model predictions is the U.S. Geological Survey (USGS) May nutrient load data from the Mississippi/Atchafalaya River basin. NOAA-supported researchers use the USGS May nutrient loads to estimate the size of the Gulf dead zone (USGS 2014a). The 2012-2016 five-year running average of May nitrate flux is similar to the 1980-1996 baseline period (see Figure 2).

Based largely on U.S. Geological Survey (USGS) estimates of springtime nitrogen loading, the Gulf of Mexico was forecasted to experience a hypoxic zone of average size in 2016 compared across the years of measurement (Figure 1) (NOAA 2016). NOAA’s NGOMEX Program has supported development of the forecast models used in these multi-model ensembles (three models in 2014 and four models in 2015 and 2016). NOAA is currently funding a study to explore options for transition of the ensemble forecast to long-term operations. The models are used to quantify the link between MARB nutrients and the size of the hypoxic zone. The model results provide guidance to the HTF on nutrient reduction levels required to meet the coastal goal, and need to be updated and re-calibrated periodically with recent data.

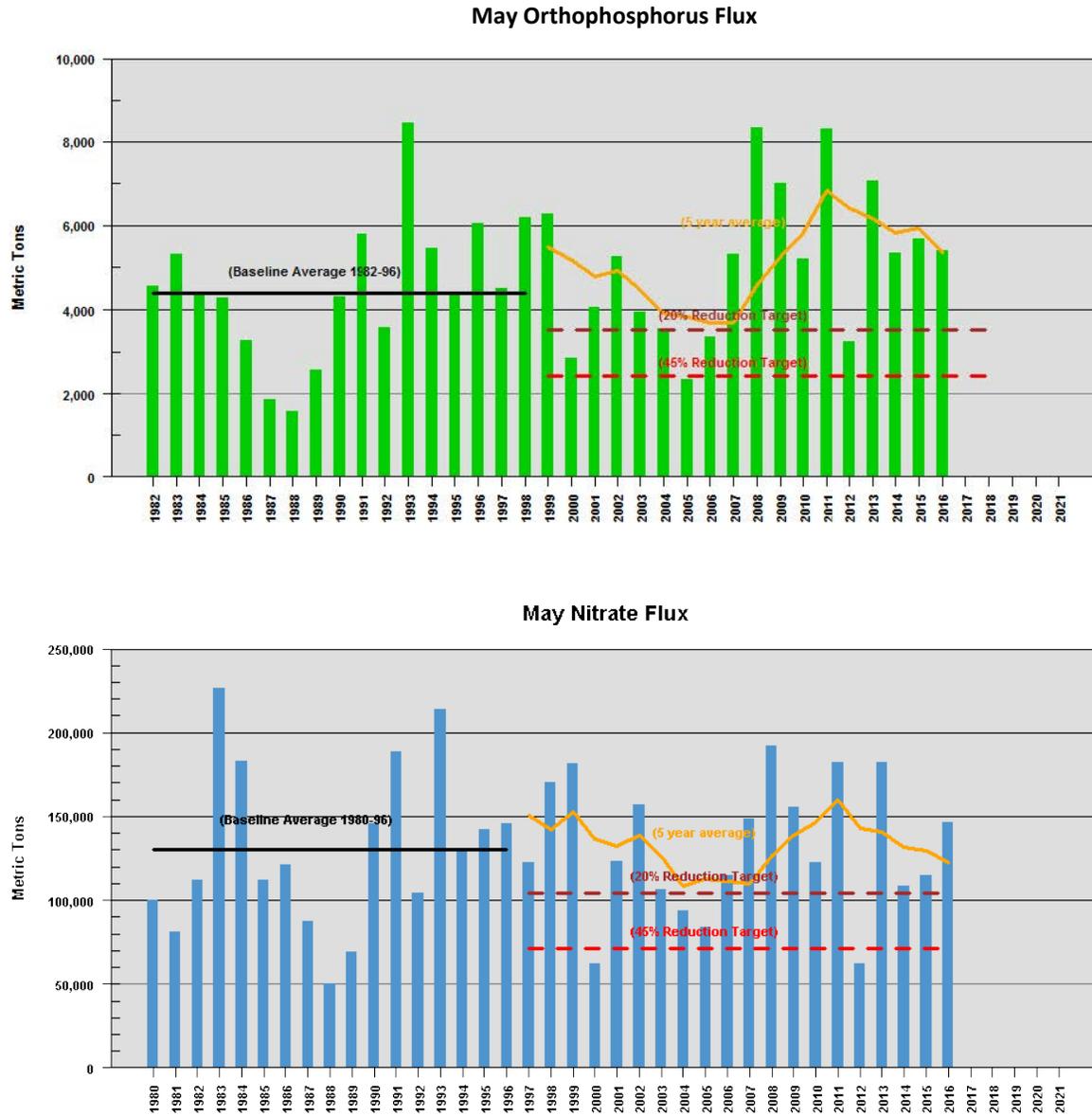


Figure 2. The amount of nitrate transported to the Gulf from the Mississippi/Atchafalaya River in May is used by NOAA supported researchers to estimate the size of the hypoxic zone. The 2012-2016 five-year average is about 10 percent below the 1980-1996 baseline period for nitrate and 22 percent above the baseline period for orthophosphorus (USGS 2014a).

2.1.1 Assessing the Dead Zone

NOAA has invested more than \$44 million to sponsor research advancing science to support management of the dead zone, spanning from the Nutrient Enhanced Coastal Ocean Productivity (NECOP) program (1990 to 1999) to the HABHRCA-mandated NGOMEX program (2000 to 2017) and the more recent SEAMAP Hypoxia Watch program (2001 to 2017) and the Coastal and Ocean Modeling Testbed (COMT) program (2010 to 2017). These investments have provided the scientific foundation for long-term monitoring and modeling of the causes and impacts of hypoxia. NOAA's Center for Operational Oceanographic Products and Services is enhancing the modeling infrastructure for an operational forecast system by extending coverage of its Northern Gulf of Mexico Operational Forecast System (NGOFS) from Brownsville, Texas, up the Mississippi River to Baton Rouge, Louisiana.

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 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 (see 2.1.2).
- Developing modeling approaches to better support the HTF's management needs.

NOAA's multi-faceted hypoxia research provides monitoring capabilities, new understanding of processes, and predictive modeling tools that enable coastal resource managers and planners, the Hypoxia Task Force and partners to make informed, proactive, and science-based decisions to mitigate the impact of hypoxia on the Gulf of Mexico ecosystem. Conducted under the authorization of 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 forecast and measurement of the size of the dead zone—the key metric of the HTF—each summer. Over the past six years, NOAA, in partnership with the NGI and EPA, has also convened annual Gulf hypoxia research coordination workshops to advance monitoring, research, and modeling needs critical to managing hypoxia.

In September 2016, the 6th Annual NOAA/NGI Hypoxia Research Coordination Workshop: *Establishing a Cooperative Hypoxic Zone Monitoring Program* was convened to address the need to: (1) refine the HTF monitoring needs associated with determining the annual maximum areal extent and volume of the Gulf of Mexico hypoxic zone; (2) refine monitoring variables and the spatial and temporal sampling needs to support robust modeling and forecasting capabilities for both empirical and coupled three-dimensional time-variable modeling platforms that are required to meet critical management objectives for hypoxia mitigation and other Gulf ecosystem restoration goals; (3) define needs for long-term data storage and distribution to comply with regulatory requirements and facilitate data access for management applications and dissemination to stakeholders (operational data management, storage, and availability); and (4) identify the agency, interagency, private sector and institutional entities whose missions would be advanced by a robust and sustained Gulf monitoring program and document potential partner roles in establishing a cooperative hypoxia monitoring program. A summary of the September

2016 workshop is available at: <http://www.neddc.noaa.gov/activities/healthy-oceans/gulf-hypoxia-stakeholders/>.

2.1.2 Operational Hypoxia Monitoring

One of the outputs from the 2013 NOAA/NGI Hypoxia Research 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 of hypoxia to Mississippi River nutrient loading. The plan is tiered according to available funds with three priorities: (1) implement four hypoxia glider cross-shelf transects that extend both east and west of the Mississippi River Delta; (2) expand coverage spatially and temporally; and (3) install sensors for determining the effects of hypoxia on living marine resources. NOAA funded a proof of concept glider application study, conducted in 2015, that demonstrated the feasibility of using gliders to monitor the hypoxic zone. The NOAA NGOMEX Program funded a new glider study in 2016 to further refine ways to optimize glider application for dissolved oxygen mapping near the bottom of the Gulf, which would complement ongoing ship surveys and moored observation systems.

The Gulf of Mexico [Hypoxia Watch](#) collaborative project (2001 to 2016) provides scientists with difficult-to-obtain environmental and fishery-independent (data on long-term resource monitoring needs) data to allow them to understand the effects of the physical environment on fish and other marine organisms. Hypoxia Watch disseminates near real-time data and maps of the hypoxic zone online from data collected during the annual [SEAMAP](#) summer groundfish surveys. The annual survey runs from June 22 to July 20 and has operated since 1982. SEAMAP is a cooperative state, federal, and university program that collects, manages, and disseminates fishery-independent data and information in the southeastern United States. The Hypoxia Watch project generates products that form the basis for summertime advisories on anoxic (no oxygen) and hypoxic conditions in the north-central Gulf of Mexico.

In March 2016, the Gulf of Mexico Coastal Ocean Observing System (GCOOS), a Regional Association of the Integrated Ocean Observing System (IOOS) network, launched the Hypoxia-Nutrient Data Portal (<http://nutrients.gcoos.org/>), which was developed in partnership with the Gulf of Mexico Alliance. The portal supports state and regional efforts for seamless data sharing and information dissemination on nutrient inputs and hypoxia impacts to Gulf coastal ecosystems, extending from the inshore waters of estuaries to the continental-shelf break of the five U.S. Gulf states. The new portal allows users to inspect base maps of observations down to the station level (independent measurement point) and is a “one-stop shop” for resource managers that will allow them to pinpoint problems and take action to reduce excess nutrients in our waterways. The Hypoxia-Nutrient Data Portal is an outgrowth of the National Hypoxia Data Portal originally developed by NOAA National Center for Environmental Information as a core requirement of the [Gulf of Mexico Hypoxia Monitoring Implementation Plan](#) (Gulf of Mexico Hypoxia Monitoring Implementation Plan Revision Steering Committee 2009, revised 2012).

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 goal to reduce hypoxia. The paper was written by an expert panel whose charge was to assess existing Gulf hypoxia models based on: the ability to address key management questions, infrastructure, data, and remaining research needs, and readiness for transition to operations. The paper is informing two efforts that are underway to transition to Gulf hypoxia forecast models. One is a study supported by NOAA's National Centers for Coastal Ocean Science, which aims to transition four empirical models to active use, possibly within NOAA, so that the modeling framework for evaluating the effectiveness of watershed nutrient reduction targets can be sustained in a robust manner. The second involves the three-dimensional time-variable deterministic models that present the approximation of the hypoxic zone developed under the NGOMEX Program that are being considered for transition to operational status through the IOOS Coastal and Ocean Modeling Testbed (COMT) program.

NOAA's National Weather Service is developing watershed models that may be used in the near future to enhance the predictive capabilities of the empirical and deterministic hypoxia models. NOAA's National Water Center developed a new National Water Model, released in 2016, which increases the number of water discharge forecast sites from 4,000 to 2.7 million nationwide. While greatly improving flood forecast capabilities for public safety, the model also will be coupled to NOAA's ecological forecasting operations to provide water quality predictions by 2023. See the National Water Center Overview PowerPoint presentation for more background at: http://www.icwp.org/wp-content/uploads/2016/04/National-Water-Center-Overview_Graziano.pdf.

The Runoff Risk Advisory Forecast (RRAF) is another new decision support tool under development that provides guidance to farmers and producers on timing fertilizer and manure application on a fine time scale to prevent excess nutrient runoff. The tool will be tailored to the runoff characteristics of each state, and when used, will reduce the risk that freshly applied nutrients will be transported into nearby waterbodies. The RRAF resulted from collaborative efforts of NOAA's National Weather Service with federal, state, academic, and industry partners. A partnership with Great Lakes Restoration Initiative has resulted in multiple grants to expand and enhance the RRAF tools in additional Great Lakes states in the next year. The RRAF Tool can be found at: <http://www.manureadvisorysystem.wi.gov/app/runoffrisk>.

2.1.4 Ecological Modeling of the Impacts of Hypoxia

The Fifth Annual NOAA/NGI Hypoxia Research Coordination Workshop in 2014 continued its tradition of advancing the science that informs fisheries and resource managers about the ecological and socioeconomic effects of Gulf hypoxia. The workshop brought researchers and managers involved in addressing hypoxia together with analysts assessing and predicting the potential effects of large-scale Mississippi River diversions that are likely to impact the same Gulf area affected by hypoxia. 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. Workshop discussions are captured in a 2015 proceedings paper, Advancing Ecosystem Modeling of Hypoxia and Diversion Effects on Fisheries in the Northern Gulf of Mexico

(<http://service.ncddc.noaa.gov/rdn/www/media/documents/activities/2014-workshop/Adaptive-Management-proceedings-paper-13June.pdf>). The paper is informing ongoing efforts to ensure that adaptive management decisions for diversions are science-driven and that there is a formal process to ensure that restoration goals are most effectively achieved.

In fiscal year (FY) 2016, three projects were awarded from the NGOMEX Program competition, which focused on advancing the HTF's understanding of the impacts of hypoxia on living resources, and the application of advanced knowledge and modeling tools to fisheries management. The lead Principal Investigators (PIs) and titles of the awards are:

1. Kim de Mutsert, George Mason University (Lead PI); Matthew Campbell, NOAA NMFS (Application PI). User-driven tools to predict and assess effects of reduced nutrients and hypoxia on living resources in the Gulf of Mexico;
2. Dan Obenour, North Carolina State University (Lead PI); Kevin Craig, NOAA NMFS (Application PI). Synthesis and integrated modeling of long-term data sets to support fisheries and hypoxia management in the Northern Gulf of Mexico; and
3. Kenny Rose, Louisiana State University (Lead PI); Kevin Craig, NOAA NMFS (Application PI). Using linked models to predict the impacts of hypoxia on Gulf Coast fisheries under scenarios of watershed and river management.

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 is influenced by changes in precipitation and runoff (Donner and Scavia 2007, Goolsby and Battaglin 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_estimates/index.html (USGS 2014c). Many of the large river sites have been monitored for more than 30 years, providing long-term documentation of how nutrient loads are changing over time in response to climate, land-use changes, and nutrient-reduction actions (Sprague et al. 2011, Murphy et al. 2013).

The 2007 Mississippi River Basin Science Advisory Board Panel recommended a dual nutrient reduction strategy consisting of 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 km² (USEPA 2007). The baseline period for the load comparison is 1980 to 1996. The HTF agreed on an interim target of a 20 percent nutrient load reduction by the year 2025 as a milestone toward achieving the 45 percent goal in 2035 (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2015). The total nitrogen (TN) five year running average for 2011-2015 was about 21 percent below the baseline period average (Figure 3). The total phosphorus five year running average for 2011-2015 was about 13 percent above the baseline period (Figure 4). While the five-year total nitrogen average is below the 2025 target, the five-year running average is heavily influenced by low river flow conditions in 2012 and 2014. The 2015 TN loads are above the 2025 target.

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 60 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.

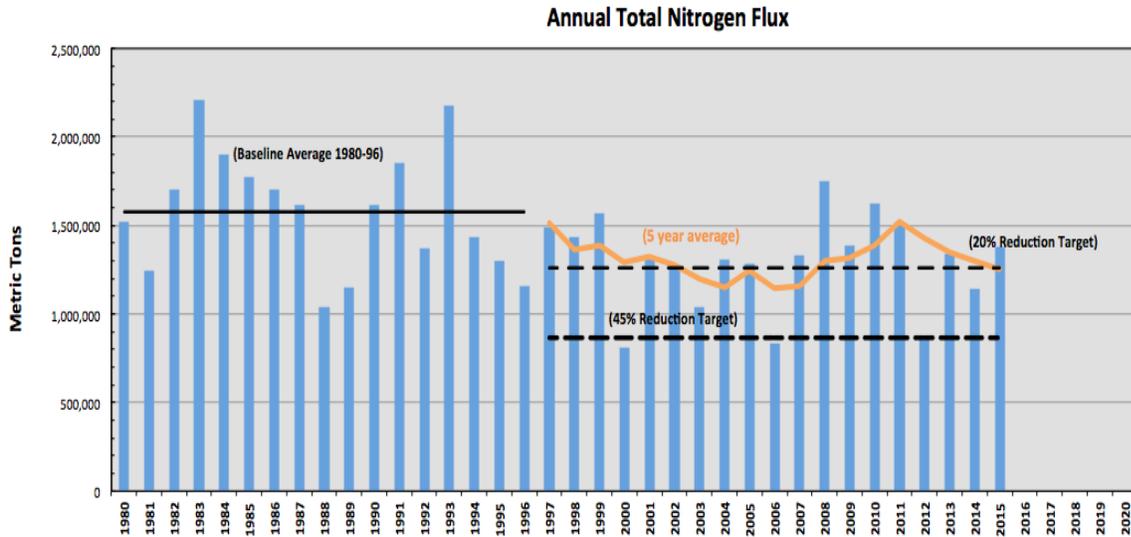


Figure 3. Annual total nitrogen loads in the Mississippi/Atchafalaya River basin transported to the Gulf of Mexico from 1980-2015. (USGS 2017)

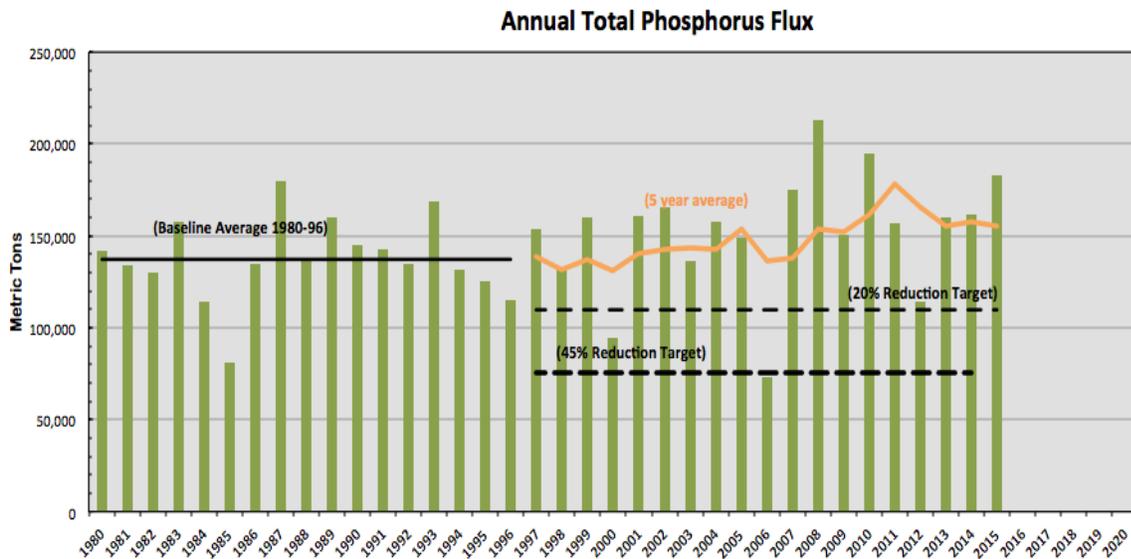


Figure 4. Annual total phosphorus loads in the Mississippi/Atchafalaya River basin transported to the Gulf of Mexico from 1980 to 2015. (USGS 2017)

Using a methodology that adjusts for year-to-year variability in streamflow conditions, the USGS assessed trends in nitrate loads 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 (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 availability 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.

USGS is using advanced optical sensor technology to accurately track nitrate levels in real-time at more than 60 small streams and rivers throughout the Mississippi River Basin (USGS 2014b). Over 20 additional nitrate monitors have been installed over the last two years. 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 milligrams per liter (mg/L) in 2012, and were near or exceeded 3.0 mg/L in 2013 and 2014. Nitrate levels remained below 2 mg/L in 2015 because of higher streamflow in the spring and summer. Nitrate peaks returned to near 3 mg/L in 2016.

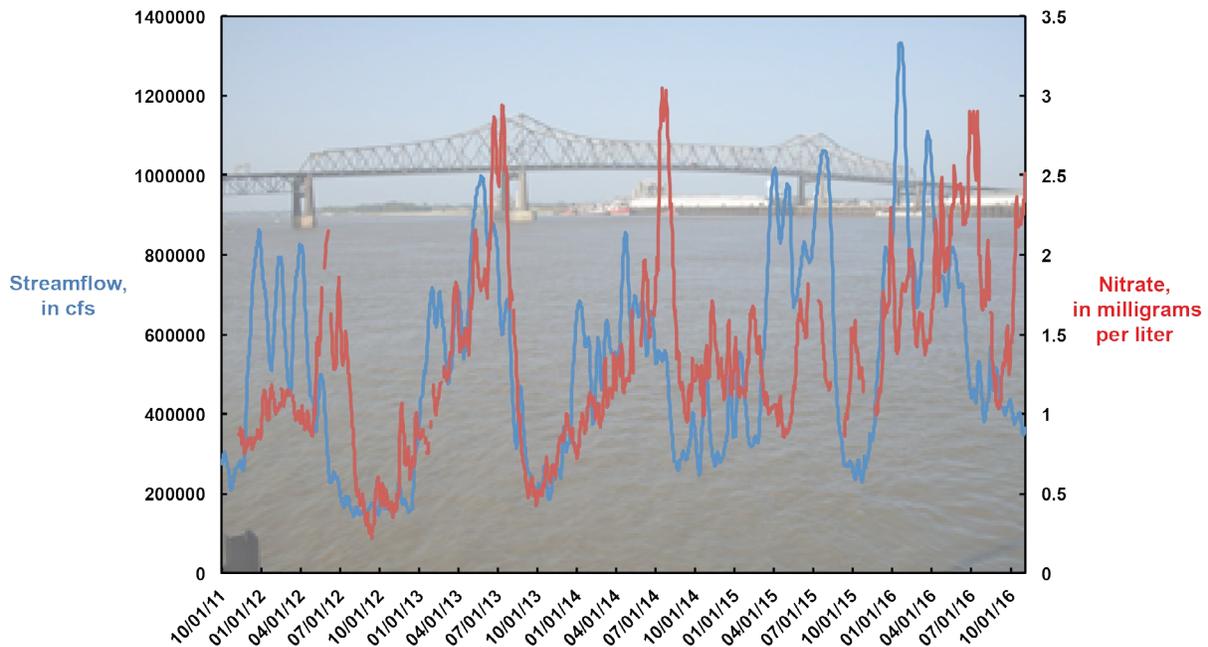


Figure 5. Real-time USGS nitrate data provides new insights into the seasonal patterns and peak concentrations. The data shown here from the Mississippi River at Baton Rouge can be found at this link: http://waterdata.usgs.gov/nwis/uv?site_no=07374000. There are currently over 60 real-time nitrate sensors located in the Mississippi River Basin. (link: <http://waterwatch.usgs.gov/wqwatch/?pcode=00630>)

EPA conducts National Aquatic Resource Surveys (NARS) that provide statistically-based estimates of the condition of water resources at national and 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 (rivers and streams field work is implemented over two years). The national surveys use 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 states and tribes, along with other federal partners, and utilize standard methods across the nation to ensure data compatibility.

In 2008 and 2009, NARS conducted the nation's first National Rivers and Streams Assessment (USEPA 2016). EPA and its partners sampled a total of 1,924 sites during the assessment, 948 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 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 concentrations at both scales.

Nutrient concentrations at the basin scale varied widely, with phosphorus and nitrogen ranging from 0.8 to 11,654 micrograms per liter ($\mu\text{g/L}$) and 1 to 48,016 $\mu\text{g/L}$, respectively. Approximately 55 percent of stream miles in the Mississippi River Basin had phosphorus concentrations between 10 to 100 $\mu\text{g/L}$, while 36 percent of river and stream miles had phosphorus concentrations between 100 to 1,000 $\mu\text{g/L}$ (Figure 6). Approximately 52 percent of river and stream miles in the basin had nitrogen concentrations ranging from 100 to 1,000 $\mu\text{g/L}$, while approximately 39 percent had nitrogen concentrations between 1,000 to 10,000 $\mu\text{g/L}$ (Figure 6).

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 $\mu\text{g/L}$ (Figure 7). These two sub-basins also had the greatest percentage of river and stream miles greater than 1000 $\mu\text{g/L}$, compared to the other three sub-basins. The Missouri Sub-basin had similar percentages of rivers and streams in both the 10 to 100 $\mu\text{g/L}$ and 100 to 1,000 $\mu\text{g/L}$ concentration ranges, whereas the Ohio-Tennessee and the Arkansas-White-Red Sub-basins had the greatest percentage of rivers and streams in the 10 to 100 $\mu\text{g/L}$ concentration range.

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 1,000 to 10,000 $\mu\text{g/L}$ (Figure 8). The other four sub-basins had the greatest percentage of river and stream miles within the 100 to 1,000 $\mu\text{g/L}$ range; however, the Missouri Sub-basin had very similar percentages of river and stream miles in the 100 to 1,000 $\mu\text{g/L}$ and 1,000 to 10,000 $\mu\text{g/L}$ nitrogen concentration ranges.

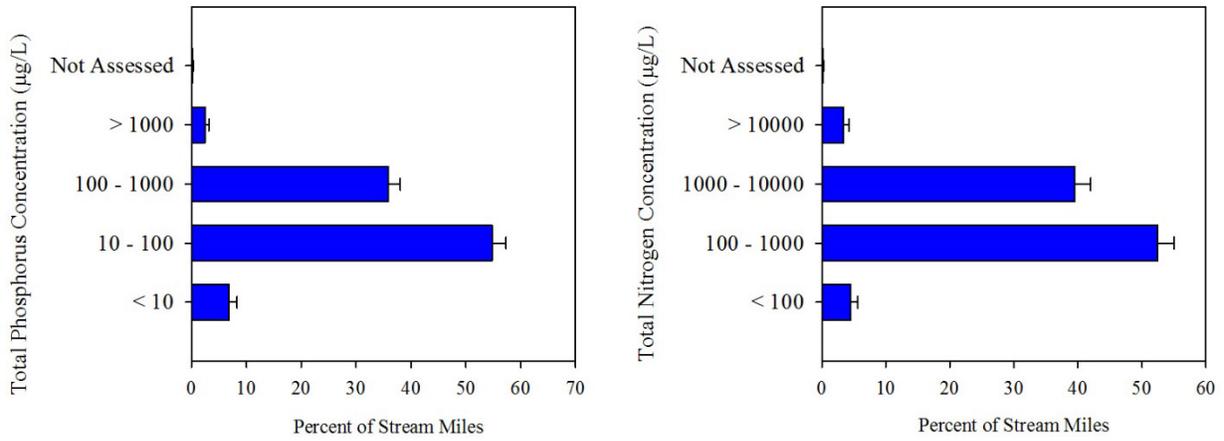


Figure 6. Nutrient concentrations as percent of river and stream miles within the Mississippi Basin (USEPA 2016).

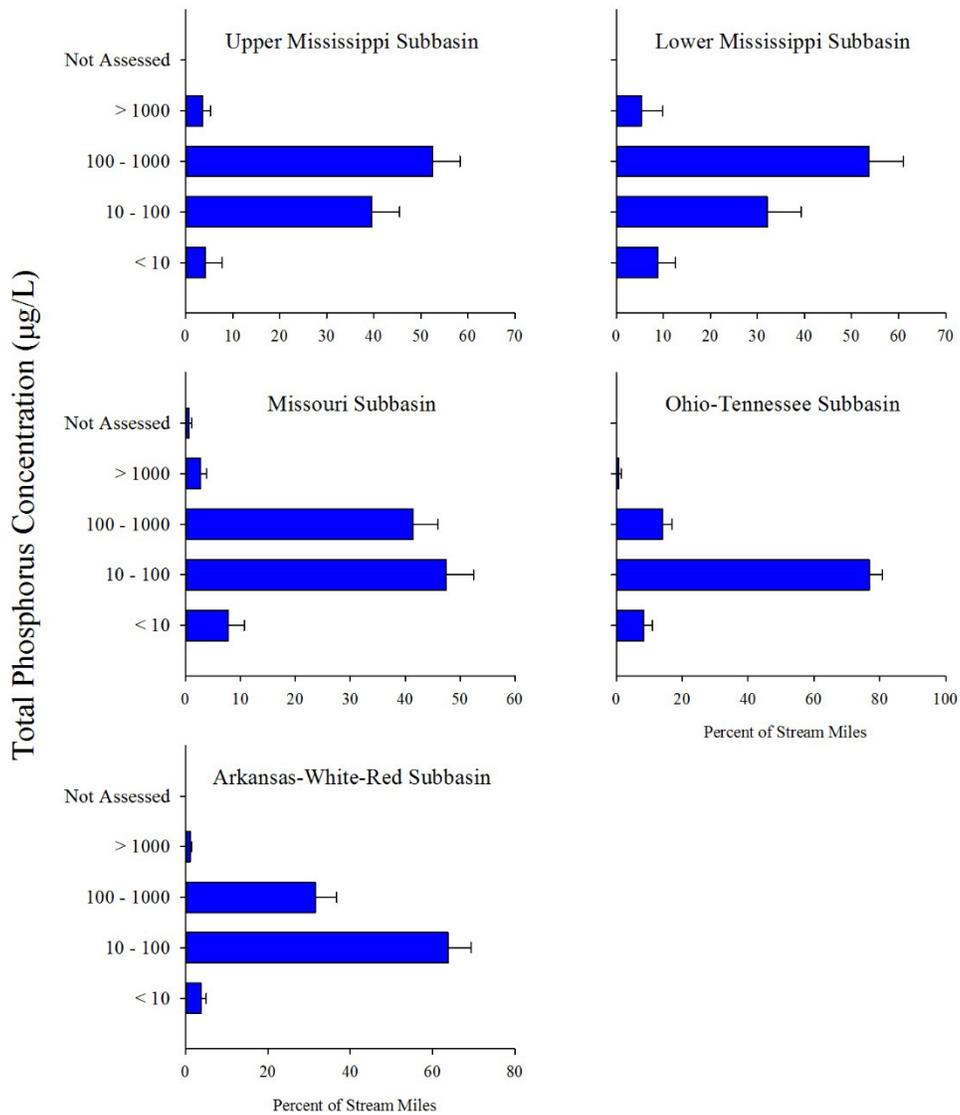


Figure 7. Phosphorus concentration categories as percent river and stream miles within the Mississippi Sub-Basins (USEPA 2016).

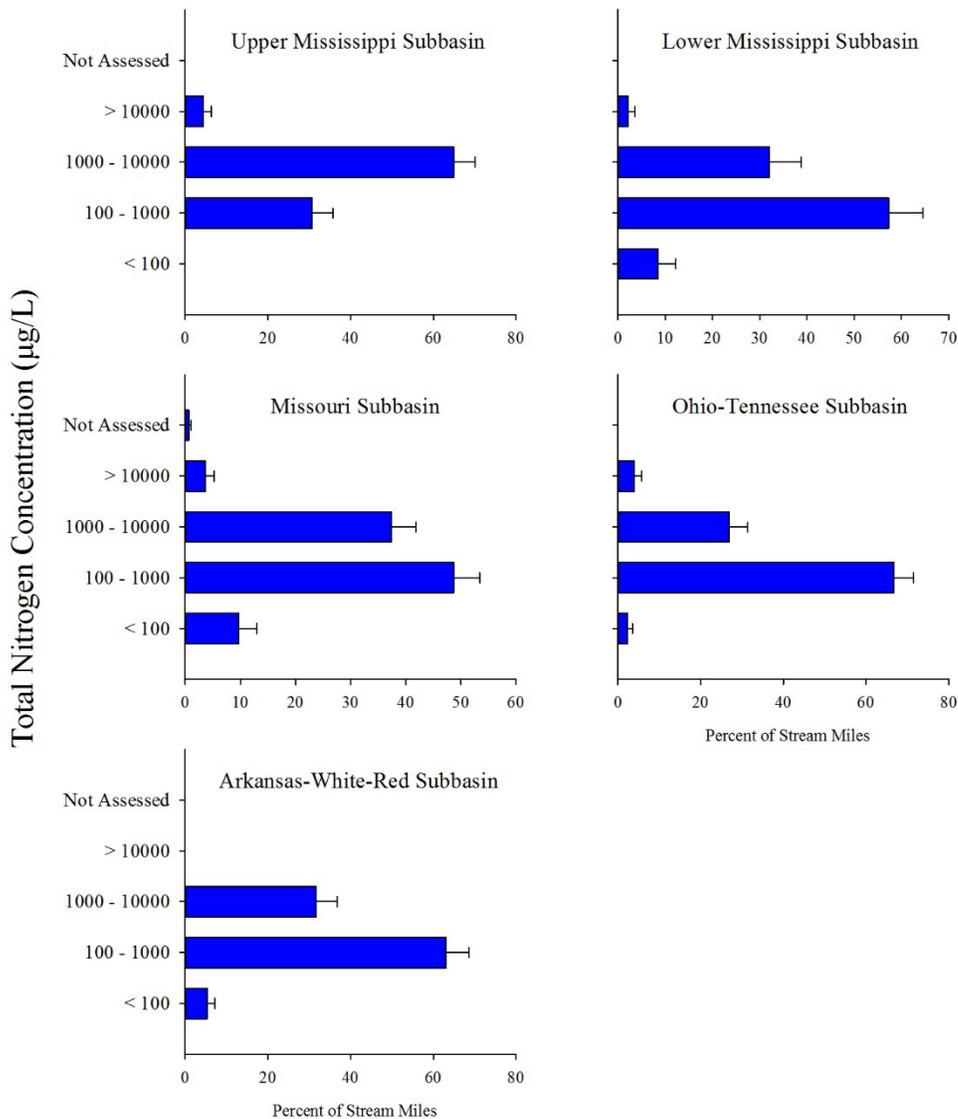


Figure 8. Nitrogen concentration categories as percent river and stream miles within the Mississippi Sub-Basins (USEPA 2016).

Data collected during the national surveys create a baseline from which trends in water quality and biological condition can be assessed. 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. Beyond what is 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.

2.2.2 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 9 provides SPARROW-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).

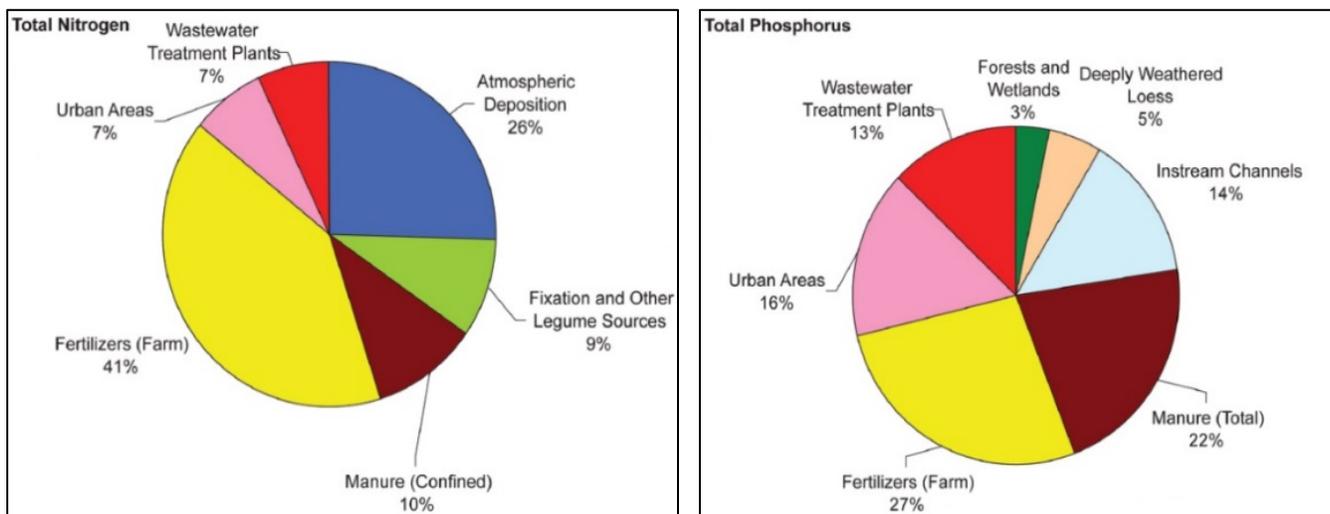


Figure 9. USGS SPARROW model estimates of sources of total nitrogen and total phosphorus transported from Mississippi River Basin to Gulf of Mexico (Robertson and Saad 2013).

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 (Section 2.2.2.2).

Effects Assessment Project (CEAP) Cropland National Assessment to describe the sources and delivery of nutrients to the Gulf of Mexico (White et al. 2014).

Results from the SWAT-CEAP model support the findings of the SPARROW model of the MARB. The dominant source of nitrogen and phosphorous loads to local waters and the Gulf is cultivated land in the Mississippi Basin, however, the contribution from cultivated land varies by regional watershed (Fig 11 & 12). Furthermore, the watersheds that contributed the highest nutrient loads according to the SWAT-CEAP model are the Upper Mississippi, Lower Mississippi and Ohio basins (Fig. 11 & 12).

(a) Nitrogen and (b) phosphorus yields from the landscape (all land uses) delivered to the Gulf of Mexico as predicted by the Conservation Effects Assessment Project modeling framework.

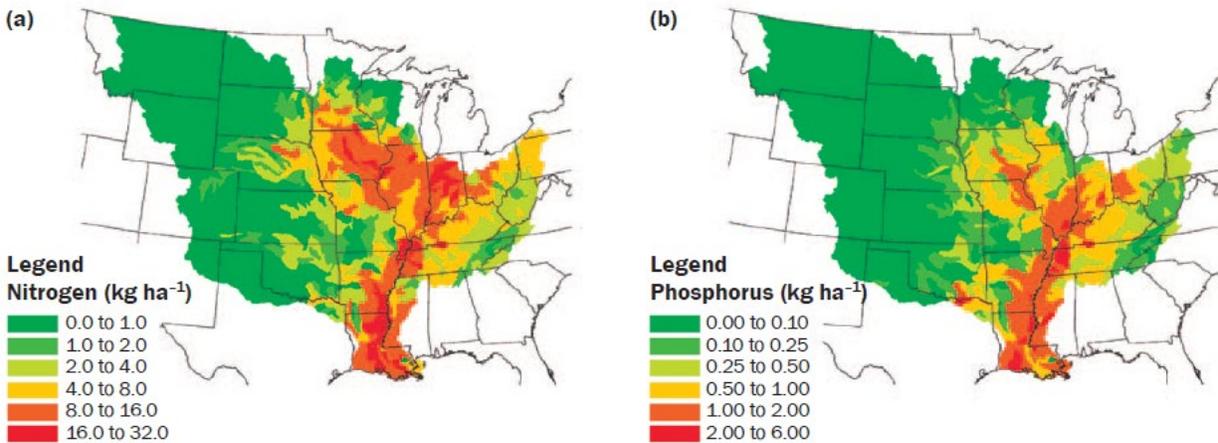


Figure 11: Conservation Effects Assessment Project modeling framework predicted (a) nitrogen and (b) phosphorous delivery to local waters at the hydrologic unit 8 (HUC8) scale (White et al. 2014).

(a and c) Nitrogen and (b and d) phosphorus delivered to the Gulf of Mexico by (a and b) source and (c and d) regional contribution from cultivated agriculture alone as predicted by the Conservation Effects Assessment Project modeling framework.

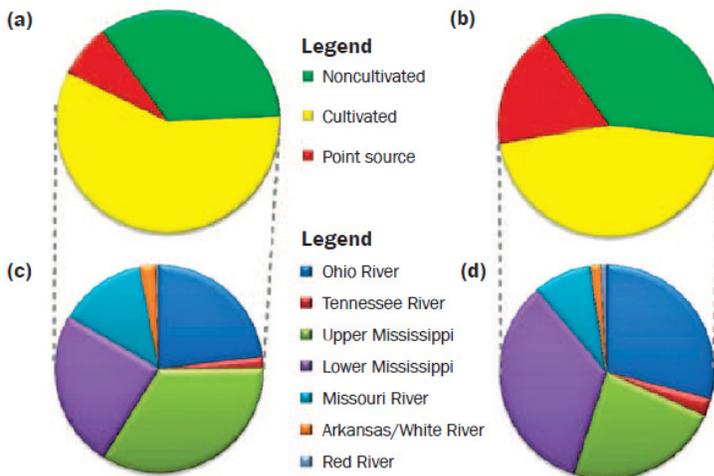


Figure 12: (a) Flow, (b) sediment, (c) total nitrogen, and (d) total phosphorous loads delivered to local waters by source as predicted by the Conservation Effects Assessment Project modeling framework (White et al. 2014).

While SWAT and SPARROW use different techniques – mechanistic vs. statistics – and datasets, both describe a similar story of nutrients in the MARB. Both models are useful in the Hypoxia Task Force’s commitment to track efforts in the basin.

In 2014, USDA and USGS entered into a memorandum of understanding regarding the sharing of data sets from the NRCS. Under the agreement, NRCS shares 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 to 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 SPARROW, its surface water quality model. The results of that effort, which includes an initial pilot project in the Upper Mississippi River Basin, have allowed USDA and other agencies to more accurately target conservation systems to address local and regional nutrient loading. Nutrient reductions attributable to agricultural conservation practices in the Upper Mississippi Basin ranged from 5 to 34 percent for nitrogen and from 1 to 10 percent for total phosphorus, according to the study. Until this study, nutrient reductions have been difficult to detect in streams because changes in multiple sources of nutrients (including non-agricultural sources) and natural processes (e.g., hydrological variability, channel erosion) can have confounding influences that conceal the effects of improved farming practices on downstream water quality. The models used in this study overcame these difficulties to help validate the downstream benefits of farmers’ conservation actions on the land (Garcia et al 2016).

This recent study demonstrates that agricultural conservation practices in the upper Mississippi River watershed can reduce nitrogen inputs to area streams and rivers by as much as 34 percent (Garcia et al. 2016). Nutrient reductions have been difficult to detect in the streams because changes in multiple sources of nutrients (including non-agricultural sources) and natural processes (e.g., hydrological variability, channel erosion) can have confounding influences that conceal the effects of improved farming practices on downstream water quality. The models used in this study overcame these difficulties to help validate the downstream benefits of farmers’ conservation actions on the land. The innovative approach combined information from process-based models from USDA’s Agricultural Research Service (ARS) and the Natural Resources Conservation Service (NRCS) with a USGS hybrid statistical and process-based model to quantify the environmental benefits of agricultural conservation practices at a regional scale. The incorporation of agricultural conservation practice information into watershed models helps in better understanding where water quality conditions are improving and prioritizing where additional conservation actions are needed.

The U.S. Army Corps /USGS Long-Term Resource Monitoring Program examined nutrient cycling in main-channel and backwater areas of the Upper Mississippi River (Houser 2016). The program’s study found that Mississippi River mainstem nitrogen concentrations nearly always exceeded those of backwaters. Maximum phosphorus concentrations generally occurred in backwaters during summer, when backwater phosphorus often exceeded that of the main channel. The flux of phosphorus from sediments may be a substantial source of water-column phosphorus in Upper Mississippi backwaters in the summer.

2.2.2.2 State-Scale Assessment of Nutrient Sources

Assessments of nutrient sources in state nutrient reduction strategies provide information at a finer resolution than basinwide assessments, 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 assessments 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 (Illinois EPA 2014).

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, most 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 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. Annual row crop production, coupled with usually abundant rainfall, facilitates the vast majority of nitrogen transport to streams in Iowa. 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 streambank erosion (Minnesota Pollution Control Agency 2014a). Figure 13 provides more information about nutrient sources from Minnesota to the Mississippi River (Minnesota Pollution Control Agency 2014a).

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

Part 3: Tracking Outcomes and Metrics to Measure Progress

In recent years, the HTF has worked to set and report on metrics to help better track progress towards the reduction goals. This work is key to understanding in the next few years whether the conservation actions that states and others are taking will move us to reach our interim target and goal of a 20% reduction in N and P delivered to the Gulf by 2025.

No one tool can be perfect for measuring our progress because of the wide variety of factors that influence loading. Thus the HTF and partners are working to measure basinwide nutrient reductions at multiple scales through multiple tools (Figure 14), including:

- a decadal look at conservation through the USDA-supported CEAP and USGS-supported SPARROW efforts (Section 2.2.2.1);
- state, regional and basin-scale loading models, including CEAP and SPARROW, that examine nutrients in the basin through source analyses;
- statistical and other trend analyses of nutrient concentrations in the MARB across multiple time-frames using data collected by states, USGS National Water Quality Assessment (NAWQA), EPA National Aquatic Resource Surveys (NARS) (Section 2.2.1), watershed groups, researchers, and those who use the Water Quality Portal for Nutrient Water Quality data (WQX) to house nutrient water quality data;
- biennial reports on point and nonpoint source trend information; and
- the annual NOAA hypoxia zone monitoring cruise (Section 2.1).

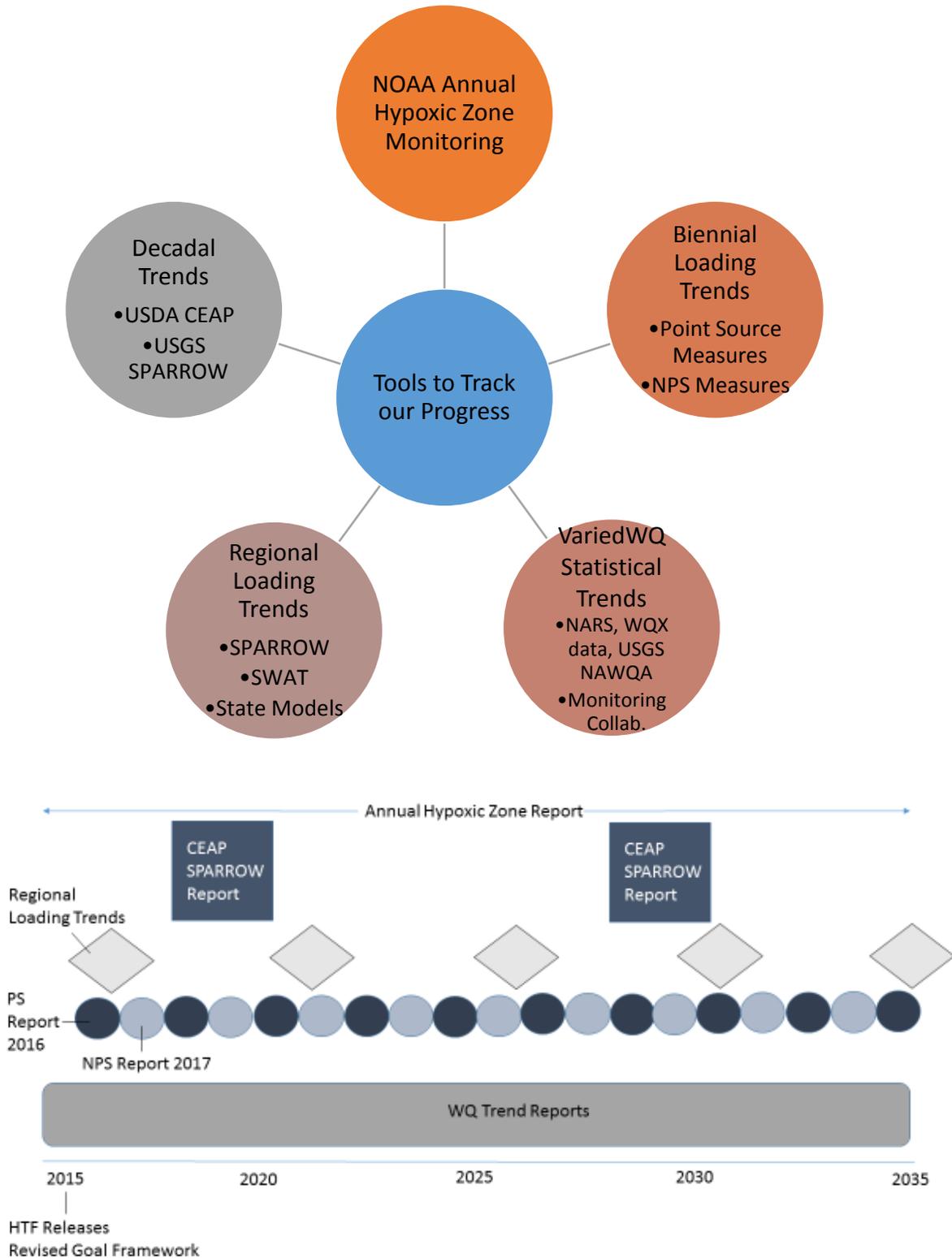


Figure 14. Measuring basinwide nutrient reductions at multiple scales through multiple tools.

3.1 Tracking with Conservation Effects Assessment Project and USDA and Other State, Regional and Basin Scale Loading Models

3.1.1 Cropland Assessments

Since 2003, USDA has worked cooperatively through the 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 CEAP cropland assessments of the five major basins in the Mississippi River drainage combine 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 Agricultural Research Service (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). NRCS is piloting the application of the APEX model at a small watershed scale for the entire Des Moines River watershed in Iowa. This pilot is intended to explore approaches for producing CEAP results at the small watershed level (8- or 12-digit

USDA Tools to Better Target Conservation

- Since 2010, CEAP Cropland Assessments have been completed for all five sub-basins of the MARB using the 2003-2006 data. 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/main/national/technical/nra/ceap/>.
- CEAP watershed studies provide insights into the tools necessary to improve water quality at the watershed scale. These were reviewed, among other key insights, as part of a webinar in the EPA Watershed Academy in 2015 (<https://www.epa.gov/watershedacademy>). A new watershed targeting tool, the Agricultural Conservation Planning Framework, founded on CEAP Watersheds concepts and techniques, was released in 2015 and is being used by watershed planners for selected projects in several MARB states including Iowa, Minnesota, Indiana, Illinois and Wisconsin in conjunction with either MRBI, NWQI or other state nutrient reduction strategy projects (Tomer et al 2013).

hydrologic unit code), with a special emphasis on the Boone and Raccoon River watersheds within the larger Des Moines River. The study of the entire Des Moines River watershed will allow comparison with data collected for the initial CEAP survey, conducted from 2003 to 2006. This information could show substantial changes in agricultural conservation and could provide lessons learned for future agricultural conservation. NRCS is currently conducting a new round of CEAP survey collection. This work will show change in the adoption of conservation practices since the CEAP surveys during 2003 to 2006, and will further address a major priority of the HTF related to evaluating the use and effectiveness of conservation practices.

3.1.2 Watershed Assessments

As part of the CEAP studies, NRCS has partnered with 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 watershed modeling. ARS and NRCS continue to collaborate on CEAP Watershed Assessments in the 14 ARS Benchmark CEAP Watersheds (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/centsc/?cid=nrcs143_014160). In FY 2014, two new CEAP Watershed Assessment Studies were established in Arkansas in partnership with USDA ARS and other local partners, in conjunction with NRCS MRBI Projects. The watersheds added to the network of sites within the Mississippi River Basin are located in the Little River Ditches and the Lower Saint Francis Watersheds.

A variety of conservation practices can and have been shown to improve water quality at the edge-of-fields and in small watersheds through CEAP or similar studies (cf., The Conservation Effects Assessment Project Special Issue (2008) *Journal of Soil and Water Conservation* 63(6); CEAP Special Issue of *Journal of Soil and Water Conservation* (2010) 65(6), Osmond et al. 2012; Lizotte et al. 2014). For example, Lerch et al. (2015) documented nitrogen benefits to surface water quality in Goodwater Creek CEAP Watershed in Missouri associated with shifting fertilizer application from fall to spring. However, improvements in water quality due to the implementation of conservation practices can be difficult to document 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. 2012).

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 appropriate monitoring designs or information (Meals et al. 2010; 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 (Sharpley et al. 2013, Brooks et al. 2010). In addition, based on an assessment of CEAP Watersheds, the source of sediment loads in a majority of watersheds has shifted from uplands to gully or channel sources (Wilson et al. 2014, Kuhnle et al. 2008, Simon and Klimetz 2008). 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 restoration strategies (Wilson et al. 2014).

3.1.3 Other State, Regional and Basin Scale Loading Models

Tracking nutrient reduction at multiple scales is necessary to confirm and validate results, and measure progress. Two main basin models, the USDA-supported SWAT model and USGS supported SPARROW model, are described in Section 2.2.2.

An HTF Modeling Workgroup regularly engages with both SWAT and SPARROW modelers to work toward integrating HTF states' conservation data into regional modeling efforts. Improved basin models will enable the HTF to better track progress towards the long-term goal and help states adaptively manage implementation of their Nutrient Reduction Strategies.

3.1.4 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 practices or 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 (<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/nca/>). 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 \$20 million available in the NRCS's Environmental Quality Incentives Program (EQIP) in FY 2013 through FY 2016 to support the targeted implementation of the new water quality monitoring standards nationwide, more than \$2.5 million has been targeted for use in the NRCS MRBI watersheds (information on MRBI can be found in section 4.2.3.2).

3.2 Nutrient Concentration Statistical and Trend Analyses

Water quality data and nutrient concentrations in the MARB are collected across multiple time-frames by states, USGS (NAWQA), EPA (NARS), Watershed Groups, researchers and others.

3.2.1 Mississippi River Basin Monitoring Collaborative

Numerous reports have highlighted 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 MARB 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. The HTF Monitoring Collaborative, which USGS helps lead, 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 Collaborative will create five-year reports quantifying nutrient and sediment changes throughout the monitoring network.

One goal is to make data collected by members of the HTF Monitoring Collaborative available via the Water Quality Portal. This 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 ARS Sustaining The Earth's Watersheds - Agricultural Research Database System (STEWARDS) (NWQMC 2015). In turn, the STORET database house includes data collected by over 400 state, federal, tribal, and local agencies. Making the Collaborative's long-term monitoring data available via the Portal will assist in assessing the progress being made in reducing nutrients to local waters, the MARB, and ultimately, the Gulf of Mexico. The portal can be accessed at <http://www.waterqualitydata.us>.

3.3 Biennial Tracking of Point and Nonpoint Source Trends

3.3.1 Point Source Trends

As part of the Revised Goal Framework adopted in 2015, the HTF agreed to use the following common point source measures to track progress toward the interim load reduction target: the number and percentage of major sewage treatment plants, including publicly owned treatment works (POTWs), issued National Pollutant Discharge Elimination System (NPDES) permits with: 1) monitoring requirements for nitrogen and/or phosphorus; and 2) numeric discharge limits for nitrogen and/or phosphorus. The HTF chose these measures because data and methodology limitations preclude swift adoption of a common approach for directly measuring load reduction. Monitoring requirements in permits are important because they support direct calculation of nutrient loads and progress on load reduction; monitoring information can also support decisions on where additional permit limits are needed to reduce loads. The status of these two point source measures is documented in the first [Report on Point Source Progress in Hypoxia Task Force States](#). The HTF intends to release a similar progress report every two years (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2016b).

The HTF continues to explore other potential common measures of progress, including load reduction tracking. Load reductions are the most direct measure of progress toward the 2025 interim load reduction target of reducing nutrient loads by 20 percent relative to the average nutrient loads from the Mississippi-Atchafalaya River Basin during the 1980 to 1996 period. However, a number of issues need to be worked through, including identification of a common approach for documenting or estimating baseline loads from point sources (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2016b).

3.3.2 Nonpoint Source Trends

For nonpoint sources, an HTF state NPS workgroup is working with a team of research and extension specialists from the MARB Land Grant Universities to develop a Measurement Framework that MARB states will use to report progress on nonpoint source nutrient reductions individually by state and in aggregate for the MARB. This Framework will include tools that aggregate conservation actions to date and those planned in the future so that the HTF can measure nutrient reductions generated and progress towards the HTF goal and 2025 interim load reduction target. The states will report on federal and state conservation actions, and will work with other organizations supporting conservation actions to attempt to capture the full range of actions that reduce nonpoint source loads. This work will expand on the efforts to date of the NPS state workgroup to aggregate data on conservation activity.

Part 4: Assessing the Progress Made Toward Nutrient Load Reductions and Water Quality Impacts throughout the MARB

4.1 Progress and Accomplishments of HTF States and Tribes

As of January 2017, 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 MARB and, in some cases, development and implementation of new programs. Links to all HTF state nutrient reduction strategies are on the HTF website at <https://www.epa.gov/ms-htf/hypoxia-task-force-nutrient-reduction-strategies>.

Also included in this section are examples of Clean Water Act (CWA) section 319 success stories from HTF states, which are posted at <https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-success-stories>. The examples show the types of watershed projects funded with section 319 funds provided by EPA to the states 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, success stories from past HTF reports (e.g., annual reports) are available on the HTF's website at <https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-success-stories>.

4.1.1 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 urban land use and activities through cost-effective targeting of CWA section 319 funds. In 2014 - 2016 the Illinois River Watershed Partnership (IRWP) implemented Low Impact Development (LID) practices to reduce nutrient and sediment runoff.

Arkansas Highlights, continued.

Projects were designed and implemented to demonstrate LID techniques which included: porous pavers, a vegetated wall, a green roof, rain gardens, and a phosphorous-removal structure. The LID projects were installed at the IRWP Watershed Sanctuary in Cave Springs. This project showcased benefits of LID to overall watershed and community health, as well as providing information on how to implement such features throughout the watershed.

IRWP engaged approximately 10,774 participants for 24,145 hours of education, including low-impact development and watershed conservation topics. Participants visited the IRWP Watershed Sanctuary and Learning Center, were able to see firsthand how these LID elements function in the environment, learn more facts about watershed conservation, low-impact development through educational signage at each LID element outside and the processes demonstrated through educational displays inside the Watershed Learning Center. Programs for school field trips, workshops for all ages, and special events at the Sanctuary and Learning Center highlighted the adoption of LID practices for the Illinois River Watershed.

L'Anguille and Cache River Watersheds. The ANRC and its partners were able to successfully address surface erosion on agricultural lands through CWA section 319 funds. ANRC partnered with the St. Francis County Conservation District to cost share Best Management Practices (BMPs) in the L'Anguille watershed. Through the project, the District was able to offer landowners up to 40% cost share on certain water quality practices. The practices selected were deemed the most economical practices that offered great erosion control services at the same time. Between 2012 and 2015, land owners installed 25,554 feet of irrigation water conveyance, 49 water control structures, and 816 acres of cover crops. These practices are estimated to save around 2,000 tons of sediment annually.

ANRC also partnered with the Greene County Conservation District to do a similar project in the Upper Cache River Watershed. Again, BMPs were cost shared up to 40% to eligible landowners in the Poplar Creek sub-watershed. These practices included nearly 60 acres of tree and erosion control plantings, a grade stabilization structure, 8 sediment retention ponds, a water control structure, and 5,623 feet of water conveyance. These practices are estimated to mitigate at least 230 tons of sediment annually.

EPA 9 Element Watershed Management Plan Development – Between 2014 and 2016, ANRC has been involved with the development of several Watershed Management Plans (WMPs) in the state. The city of Fort Smith initiated WMP's for Lee Creek and Frog Bayou in northwest Arkansas with funding help from ANRC thru CWA section 319 funding. These plans were first initiated by the city to help protect drinking water sources, but ended up becoming an all-encompassing 9 element WMPs. These WMP's were accepted by EPA in 2015.

ANRC also has used state funds during this time period to develop WMPs on three of the state's non-point source priority watersheds (Lower Little River, Cache River, and the Strawberry River). ANRC contracted with FTN and associates to develop these WMP's on the 8-digit hydrologic unit code (HUC8) scale. The main purpose of these 9 element plans is to identify causes and sources of pollution, so that resources can be acquired and targeted in the watershed. All three WMP's were developed and submitted to EPA in 2015-2016. All three WMP's have been accepted by EPA as well.

4.1.2 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 Illinois Nutrient Loss Reduction Strategy (ILNLRs) was released in 2015. It calls for the development of five implementation working groups, which have subsequently formed and have had more than 35 meetings. See website for committee information and meeting notes:

<http://www.epa.illinois.gov/topics/water-quality/watershed-management/excess-nutrients/nutrient-loss-reduction-strategy/index>.

Updates on Nutrient Reduction Strategy Implementation

- **Policy Working Group** – This group, which guides ILNLRs implementation, is planning the release of Illinois’ 2017 biennial report and a workshop at the end of 2017.
- **Point Source Benchmarking Subwork Group** - This group is developing performance benchmarks and baselines for point sources. Currently 47 percent of major municipal dischargers have total phosphorus limits, up from 36 percent (2015). This number represents 81.5 percent of the regulated discharge statewide from major facilities, up from 70 percent as reported in the 2015 HTF Report to Congress (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2015).
- **Nutrient Monitoring Council** – The USGS, which has representation on the council, have installed eight “super gages” throughout Illinois to monitor nutrients leaving the state. The council is working to develop monitoring strategies within the state for local water quality outcomes.
- **Nutrient Science Advisory Committee** – A committee of six experts were selected to guide the Illinois Environmental Protection Agency on the development of numeric nutrient criteria most appropriate for Illinois streams and rivers based on the best available science. Their recommendation is expected at the end of 2017.
- **Agriculture Water Quality Partnership Forum** – Forum member organizations have conducted outreach to thousands of people in the Illinois agriculture industry at more than 200 meetings held throughout the state. This work continues with the focus shifting from awareness to implementation.

- **Urban Stormwater Working Group** – This group is focusing on compiling existing stormwater education for general audiences and professional staff and identifying mechanisms for statewide distribution.

Via these committees, the three sectors (agriculture, point source, and stormwater) are finalizing their respective performance measures to track implementation. **They are gathering this information for a biennial report that will be released in 2017.** Further, the agriculture sector worked with the USDA National Agriculture Statistics Service to survey 1,000 randomly selected Illinois farmers about best management practice implementation. Survey results will also be included in the report.

ILNLRs partners have invested hundreds of thousands of direct and in-kind dollars to support nutrient research and fund wastewater treatment plant upgrades. Initial funding and outreach and implementation programs have focused on 13 watersheds. Across sectors, more than 50 staff members work on nutrient issues.

Illinois Highlights

Blue Creek. Sedimentation from hydromodification and agriculture resulted in degraded habitat for aquatic life in Illinois' Blue Creek. As a result, Illinois added the creek to its Clean Water Act (CWA) section 303(d) list for sedimentation impairment in 1998. In the early 2000s project partners implemented best management practices (BMPs) in the upper watershed that decreased sedimentation. As a result of these efforts, water quality improved and Illinois removed Blue Creek from its section 303(d) list in 2014.

Illinois EPA provided staff hours to administer \$1,439,044 of USEPA CWA section 314(h)/319(h) funding that was provided for BMPs. USDA provided \$32,000 in Farm Bill funding. Illinois DNR/Illinois SWS provided \$459,333 of in-kind funds, and Illinois Department of Agriculture and Pike County SWCD provided \$223,332 in state and local funds. The city of Pittsfield provided \$132,110 in city funds. Lastly, the Farm Bureau of Pike County helped educate producers about BMPs, conducted outreach and evaluated possible participation interests.

Lake Vermilion. Industrial and municipal point sources of pollution, agricultural sources of nonpoint source pollution, and hydrologic and habitat modifications led to low levels of dissolved oxygen (DO) in Illinois' Lake Vermilion and Hoopeston Branch, a tributary to the North Fork Vermilion River. As a result, the state added Lake Vermilion to its Clean Water Act (CWA) section 303(d) list of impaired waters in 2002 and added Hoopeston Branch in 2004. Project partners implemented best management practices (BMPs) throughout the Lake Vermilion watershed, leading to water quality improvements. The two waterbodies now meet water quality standards for DO, prompting the Illinois Environmental Protection Agency (Illinois EPA) to remove them from the state's CWA 303(d) list—Lake Vermilion in 2006 and Hoopeston Branch in 2008.

The Vermilion County Soil and Water Conservation District, Consumers Illinois Water Company, local landowners, and others cooperated to implement nonpoint source control projects in the Lake Vermilion watershed. The U.S. Environmental Protection Agency provided \$730,213 in CWA section 319 funding to implement BMPs in the watershed between 1997 and 2012. Project partners provided \$565,702 in local match funding. All entities combined have invested a total of \$1,295,915 in these projects.

Honey Creek. Sediment and organic matter from eroding streambanks and cropland areas caused low dissolved oxygen conditions in Illinois's Honey Creek. As a result, Honey Creek failed to support its aquatic life designated use, prompting the Illinois Environmental Protection Agency (Illinois EPA) to add a 13-mile-long segment of the creek to the list of impaired waters in the 1992–1993 *Illinois Water Quality Report*. Stakeholders stabilized stream channels and worked with local landowners to implement best management practices (BMPs) to reduce sedimentation/siltation and organic enrichment loading into the creek. Water quality improved, prompting Illinois EPA to remove the creek from the state's list of impaired waters in 2008. Honey Creek now fully supports its designated use for aquatic life.

Contributing a total of \$380,661 of CWA section 319 funds, Illinois EPA partnered with the Pike County Soil and Water Conservation District, Bay Creek River Conservancy District, and local landowners to implement BMPs in the Honey Creek watershed. Local partners provided \$253,774 in matching funds, bringing the total cost for the Honey Creek Watershed Project to \$634,435.

4.1.3 Indiana

Indiana's [State Nutrient Reduction Strategy](#) (Indiana State Department of Agriculture and Indiana Department of Environmental Management 2014) is the product of an inclusive effort of the [Indiana Conservation Partnership \(ICP\)](#) under the leadership of the Indiana State Department of Agriculture (ISDA) and the Indiana Department of Environmental Management (IDEM) to capture statewide, present and future endeavors in Indiana, which positively impact the State's waters, as well as gauge the progress of conservation, water quality improvement and soil health practice adoption in Indiana. The ICP is a group of eight Indiana agencies and organizations who share a common goal of promoting conservation. The mission of the ICP is to provide technical, financial and educational assistance needed to implement economically and environmentally compatible land and water stewardship decisions, practices, and technologies. The ICP provides a roadmap for addressing Indiana's conservation issues, and in so doing, functions collectively to touch many other organizations and individuals.

The strategy serves as a means of:

- Identifying water quality challenges and concerns in Indiana;
- Prioritizing 8-digit and 12-digit hydrologic unit code (HUC8 and HUC12) watersheds within Indiana through watershed characterization of the nine major river basins;
- Discussion of the water quality monitoring taking place throughout Indiana;
- Cataloging available funding and programs across the state that stand to improve water quality;
- Tracking and reporting the impact of conservation across the state through the continued use of Indiana's tillage and cover crop transects, continued use of the EPA Region 5 nutrient load reduction model calculations on "assisted" BMPs, as well as conducting instream water quality monitoring of performance measures to identify watershed improvements and trend analysis of data;
- Working through the milestones and actions items; and
- Educating and providing information to the public on "What you can do to protect water quality in Indiana"

Further watershed prioritization is underway using watershed characterization of the major drainage basins that are monitored probabilistically and assessed statistically by IDEM on a nine-year rotating basin schedule to determine if waters are meeting their water quality standards. Characterization includes, but are not limited to:

- An inventory of land use
- Analysis of fixed station and other water quality monitoring data (i.e., IDEM rotating basin assessments and fixed station monitoring, USGS National Water Quality Assessment [NAWQA])
- Critical areas identified in approved 9-Element Watershed Management Plans (WMPs)
- Current social and environmental indicators
- Watersheds with drinking water reservoirs and surface water intakes are priorities
- Presence of state, local, and federal resources (funding, staff, and conservation programs, and their respective coverage)

4.1.3.1 Nonpoint Sources

The ICP is using EPA's Region 5 Nutrient Load Reduction model (<http://it.tetrattech-ffx.com/steplweb/>) to determine the impact of 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 the Conservation Reserve Enhancement Program (CREP), Clean Water Indiana, the Lake and River Enhancement (LARE) program and CWA section 319
- Local conservation efforts by soil and water conservation districts
- Farm Bill practices across the state

Data from the practices, on an annual basis, 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 provides a valuable perspective when showing the collective reductions of practices. It enables the ICP to comprehensively set reduction goals across the state and helps to establish baselines and measure load reduction trends by watershed for each calendar year, allowing for prioritization of workload and staffing needs, all while serving as a tangible component of the Indiana Nutrient Reduction Strategy.

Load reductions estimated by the model for Indiana each year are published in annual accomplishments reports, which include watershed maps showing the nitrogen, phosphorus, and sediment reductions. These annual reports can be found on ISDA's website at <http://www.in.gov/isda/2991.htm>. 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.

4.1.3.2 Conservation Reserve Enhancement Program (CREP)

One of the initiatives that is part of Indiana's Nutrient Reduction Strategy is the CREP. It is a voluntary federal and state conservation program that aims to improve water quality and address wildlife issues by reducing erosion, sedimentation and nutrients, and enhancing wildlife habitats within specified watersheds in the Wabash River System. This program is designed to help alleviate some of the concerns of high nonpoint source sediment, nutrient, pesticide, and herbicide losses from agricultural lands by restoring grass and riparian buffers and wetlands to improve water quality, as well as to protect land from frequent flooding and excessive erosion by planting hardwood trees in floodplain areas along rivers and streams.

CREP in Indiana was first announced in 2005 across three HUC8 watersheds in the state. The program expanded in 2010 to include eleven HUC8 watersheds in Indiana, covering a total of 65 Indiana counties. To date, over 10,280 acres of buffers have been implemented along bodies of water protecting 596 linear miles of water ways. The ISDA has invested over \$3.6 million in

state funds to implement these conservation practices, and for every state dollar that is invested, \$7-\$10 federal dollars are matched through the Conservation Reserve Program (CRP) incentives available through the Farm Service Agency (FSA).

4.1.3.3 Point Sources

To significantly reduce the discharge of nutrients to surface waters of the state and to protect downstream water uses, IDEM set a practical state treatment standard of 1.0 mg/L total phosphorus (TP) for sanitary wastewater dischargers with design flows of 1 million gallons/day (mgd) or greater. This policy became effective January 1, 2015.

Applying the 1 mg/L TP limit will lead to a nearly 60 percent reduction of TP loads from major sanitary dischargers over the next five years as permits are renewed. TP loads from major sanitary dischargers from across the state have been approximately 229,631 pounds per year whereas with the 1.0 mg/L TP limit, the estimated state-wide load is 93,241 pounds per year (ISDA and IDEM 2014).

Additionally, IDEM will implement Total Maximum Daily Load (TMDL) load reductions as written and approved for total phosphorous upon the renewal of any affected permit, and IDEM will continue to implement phosphorus removal as required by 327 IAC 5-10-2 (ISDA and IDEM 2014).

IDEM, as part of the Indiana Water Monitoring Council, is working to improve the ambient water quality monitoring network throughout the state in order to determine nutrient loads entering and leaving Indiana. A gap analysis is nearly complete and discussions to optimize the network are underway. The assessment will contribute to a better understanding of nutrient sources and loading in the state as Indiana's Nutrient Reduction Strategy is implemented.

Indiana Highlights

Tillage & Cover Crop Transects. The tillage transect is a cropland survey conducted each spring following planting in each county by ICP personnel and Earth Team volunteers. Using a predetermined route, staff look at farm fields in their county collecting data on tillage methods, plant cover, residue, etc., in order to tell the story of conservation efforts in Indiana. The survey uses GPS technology and provides a statistically reliable method for estimating farm management and related annual trends. Transects are usually conducted bi-annually in the spring after crops are planted.

In addition, in the fall of 2014, the first-ever statewide cover crop and fall tillage transect was done in Indiana. This was done as part of a collaborative effort between ISDA, USDA NRCS, Indiana's 92 SWCDs and other members of the Indiana Conservation Partnership (ICP). The 2014 fall transect estimated 1 million acres of living plant cover such as cover crops and winter cereal grains were planted on Indiana farms. The report also shows most Indiana farmers left their tillage equipment in the shed in the fall to protect their fields with harvested crop residues. Results for residues and undisturbed soil on harvested acres during the winter months include: 77% of corn acres, 79% of small grain acres, and 82% of soybean acres.

The fall cover crop and tillage transect occurred again in 2015, and according to the data, over 1.1 million acres of cover crops were planted in 2015, which is an increase of nearly 10 percent compared to the previous year and 225 times more coverage over the past decade. The fall tillage and cover crop transect will be conducted again in late 2016.

Ohio River Basin Water Quality Trading Project. In August 2012, representatives from the states of Indiana, Kentucky, and Ohio signed an agreement to create the Ohio River Basin Water Quality Trading Program (<http://wqt.epri.com/>), a pilot program allowing farmers and industrial facilities to trade pollution credits to reduce fertilizer run-off and nutrient discharges. It is aimed at achieving water quality standards in watersheds along the Ohio River by allowing dischargers to purchase pollution reductions from other sources. The project was conceived by Electric Power Research Institute (EPRI) in conjunction with the states of Indiana, Ohio, Kentucky, the U.S. Department of Agriculture Natural Resources Conservation Service, American Farmland Trust, the Ohio Farm Bureau, and ORSANCO. It was initially funded by a Conservation Innovation Grant (CIG) to the EPRI and is now privately funded and supported by over a dozen organizations and utilities like AEP and Duke Power with technical support from local, state and federal agencies. Indiana counties participating include Wayne, Dearborn, Ripley, Ohio, and Switzerland. The ISDA-DSC District Support Specialist for the region has been serving as an advisor and representative for the project and works with EPRI, American Farmland Trust, DSC Resource Specialists, participating County SWCDs, and USDA-NRCS District Conservationists.

The Electric Power Research Institute's Ohio River Basin Trading Pilot Project is a first-of-its-kind inter-state trading program with participation from Indiana, Ohio and Kentucky. Indiana alone has been contracted to remove 22,000 pounds of total nitrogen and 11,000 pounds of total phosphorus over the five-year period of the pilot. A total of \$100,000 in cost-share monies for each of the three partner states were distributed to farmers for implementation of approved water quality Best Management Practices. In Indiana practices for cover crops, heavy use protection areas for livestock, and cropland to hayland conversion were approved. All practices have been installed for two years and continue to be inspected and verified by DSC staff. This project has not only gained regional interest, but also international attention, and is the largest water quality trading project in the world. In 2014, the project was featured in many newsletters and articles, including the Wall Street Journal. In the fall of 2016, ISDA-DSC entered into another funding contract with EPRI to provide cost share to forestry practices for the entire Ohio River Basin Watershed in Indiana.

4.1.4 Iowa

4.1.4.1 Iowa Nutrient Reduction Strategy

The Iowa Nutrient Reduction Strategy (NRS) is a science- and technology-based approach to assess and reduce nutrients delivered to Iowa waterways and the Gulf of Mexico (Iowa State University 2015). The strategy outlines 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 research-based, reasonable, and cost-effective manner.

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 followed the recommended framework provided by EPA in 2011 and was the second state to complete a statewide nutrient reduction strategy.

The strategy recently wrapped up the third year since its release and has resulted in tremendous progress in key areas of implementation. While there is significant work yet to be done, the progress made to date reflects a significant investment from multiple stakeholders that have rallied support around the Iowa NRS. The examples below provide a sample of these efforts. More comprehensive information related to the Iowa NRS can be found at: <http://www.nutrientstrategy.iastate.edu/documents>.

4.1.4.2 Nonpoint Sources

The Iowa nutrient reduction strategy was completed in spring 2013 and, thanks to strong support from the Iowa governor and legislature, IDALS state appropriations targeted 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 engage the collective ability of both private and public resources and organizations to support the nutrient reduction strategy and deliver a clear and consistent message to the agricultural community to reduce nutrient loss and improve water quality. Since establishment of the WQI, IDALS has partnered with over 9,400 farmers impacting over 930,000 acres of Iowa farmland. IDALS and partners have also been successful in leveraging WQI appropriations to bring in additional federal resources through the

USDA-NRCS Regional Conservation Partnership Program (RCPP). IDALS has been effective in obtaining over \$13 million in additional funding for practices installed on private lands through new and existing partnerships. Partners have also been effective in leveraging WQI funds through RCPP, including the cities of Cedar Rapids (\$2 million additional) and Charles City (\$1.6 million additional) (<http://www.cleanwateriowa.org/>).

Additional key developments since the release of the Iowa NRS include:

Iowa Nutrient Research Center

The Iowa Nutrient Research Center was established in 2013 by the State of Iowa. The center receives funding for research to evaluate the performance of current and emerging nutrient management practices and to make recommendations on the implementation of practices and development of new practices.

The projects address critical needs or gaps in nitrogen and phosphorus research identified in the science assessment that was part of the Iowa Nutrient Reduction Strategy.

More information on the projects and the researchers involved are listed on the center's web site: www.cals.iastate.edu/nutrientcenter/project.

New Partnerships

Iowa Agriculture Water Alliance (IAWA) <http://www.iowaagwateralliance.com/about.php>

Expanding upon Iowa Agriculture's commitment to the Iowa NRS, three commodity groups: Iowa Corn Growers Association, Iowa Soybean Association, and Iowa Pork Producers -- collectively established the Iowa Agriculture Water Alliance. The alliance's purpose is to help increase the pace and scale of implementation of the Iowa NRS. The three groups committed at least \$1 million each over five years. This alliance will be a valuable partner in seeking additional resources to advance implementation of the Strategy, increase the pace and scale of practice adoption and help to improve water quality in Iowa.

Within the first year of existence, IAWA co-led with IDALS the formation and development of the Midwest Agriculture Water Quality Partnership RCPP. The project brings together a diverse set of partners to establish a public-private partnership bringing in additional federal resources to improve water quality in key watersheds. The project was awarded \$9.5 million in 2016, leveraged with over \$38 million in partner, non-federal contributions over the next five years. More information can be found here: <http://www.iowaagwateralliance.com/RCPPPartners.php>.

Iowa Nutrient Research & Education Council (INREC) <http://iowanrec.org/>

INREC was formed in late 2014 to support environmental stewardship efforts under the Iowa NRS through science-based solutions and strategic missions. INREC brings together agricultural businesses, crop advisors, farm and commodity organizations, and the crop production industry

to address nutrient issues. INREC is explicitly focused on three specific missions to increase impact.

1. Environmental Progress, Measurement, & Demonstration
2. Validation of Environmental Products/Practices/Services
3. Enhance Environmental Impact of Ag Retailers & Certified Crop Advisors (CCAs)

Through these efforts, INREC will serve to demonstrate progress, foster innovation of new technologies, and enhance CCA and agriculture retailer roles as “change agents” working with Iowa farmers to achieve goals.

Development of the Logic Model method of tracking and reporting:

IDALS, IDNR and ISU continue to work on development of a robust and qualitative framework through the Measures Subcommittee of the Water Resources Coordinating Council (WRCC). The development of a logic model type framework is being employed to collect and report on progress made through the Iowa NRS. The first annual report using the logic model framework was completed and presented to the WRCC in the summer of 2016.

In 2015, the Nutrient Research Center received funding from the Iowa Legislature to establish a Measurement Coordinator position at ISU. The coordinator is responsible for managing the information collected from agencies and organizations to document progress and ultimately guide implementation of the Iowa NRS.

Reports are available at: nutrientstrategy.iastate.edu/documents

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 vision for the logic model will be to act as a dashboard for advancing the Iowa NRS and will allow more responsiveness and feedback in investing resources and programming. The subcommittee continues to work on developing recommendations on additional 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.

For example, after collecting information from WRCC & WPAC members, it was discovered that over \$200 million in state, federal, and local funding was invested in 2015 and 2016 for soil and water conservation efforts.

This did not include CRP funding for buffer strips, perennial land use, etc., through USDA-FSA, which was \$220 million in 2015 & \$225 million in 2016. This number also doesn't include the investment by farmers and landowners needed to match these programs or their investment for practices installed outside of the purview of government programs.

4.1.4.3 Point Sources

The point source portion of the nutrient reduction strategy established a process to achieve significant reductions in the amounts of nitrogen and phosphorus discharged to Iowa's rivers and streams by the largest industrial and municipal wastewater treatment plants. Major point sources will be required to assess the feasibility and reality of reducing the amounts of nitrogen and phosphorus discharged to Iowa surface waters. Practices determined to be feasible and affordable will be required to be implemented. The process is unique and innovative. In the traditional approach, limits are established in a permit and treatment facilities are constructed to meet those limits. In this approach, nutrient reduction facilities are constructed, sampling is performed and technology-based limits are developed using actual treatment plant performance data.

101 out of ~150 NPDES permits have already been issued with provisions to implement the strategy with intent to issue 20 permits per year.

Several Publicly Owned Treatment Plants (POTWs) and industries have constructed or are presently constructing biological or chemical nutrient reduction facilities. Many others are planning to construct facilities in the coming years.

4.1.4.4 Targeted Implementation Efforts

In addition to the WQI, the Iowa 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 where they can be removed. This targeting ensures that the wetlands are positioned to provide maximum effectiveness, which equates to a 30-70 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, 82 wetland areas have been completed with another 13 under development. The wetlands completed to date provide an annual nitrogen reduction capacity of over 1 million pounds at a cost of just \$0.26 per pound of nitrogen removed, highlighting both the capacity and cost-effectiveness of the wetlands.

Iowa Highlights

Des Moines Water Reclamation Authority (WRA). Des Moines WRA approved funding to install an Ostara phosphorus recovery process (ostara.com). This technology is expected to remove approximately 365 tons of phosphorus per year from their wastewater and instead provide a marketable product that will be sold as fertilizer. Although, the original purpose was to reduce the buildup of struvite, which causes operational and maintenance issues and increases costs, it is expected to significantly reduce the amount of total phosphorus in the wastewater stream. The new facility is planned for completion by 2019.

Iowa SRF Sponsored Projects. Iowa law allows sewer utility revenues to finance a new category of projects, called “water resource restoration sponsored projects.” This includes locally directed, watershed-based projects to address water quality concerns. Prior to 2009, utility revenues could only be used for construction and improvements for the wastewater system itself. Now, wastewater utilities can also finance and pay for projects, within or outside the corporate limits, which cover best management practices for nonpoint sources. The Sponsored Projects program has been implemented through the Clean Water State Revolving Fund (CWSRF), a loan program for construction of water quality facilities and practices. On a typical CWSRF loan, the utility borrows principal and repays principal plus interest and fees. On a CWSRF loan with a sponsored project, the utility borrows for both the wastewater improvement project and the sponsored project. However, through an overall interest rate reduction, the utility’s ratepayers do not pay any more than they would have for just the wastewater improvements. Instead, two water quality projects are completed for the cost of one.

The dollar amount available for a sponsored project equals approximately \$100,000 per \$1 million wastewater loan, or about 10% of the wastewater loan amount. Iowa has set aside a total of \$35 million for sponsored projects through fiscal year 2016. After launching the pilot project with the City of Dubuque, Iowa’s SRF opened the program to other communities during FY 2014. Including the pilot project and the six funding rounds since then, a total of \$45 million has been committed to 57 projects.

Integrated Wetland Landscape Systems Initiative. Building upon the Iowa Conservation Reserve Enhancement Program (CREP), IDALS and multiple stakeholders embarked on a pilot project to demonstrate a market-driven effort to improve water quality while improving crop production through leveraged infrastructure improvements. Wetlands are a capital intensive practice to install and at current funding levels, Iowa is implementing 3-4 targeted, nutrient removal wetlands annually. Also, there are over 3,000 organized drainage districts that oversee and maintain infrastructure to facilitate crop production in primarily central and north central Iowa. This infrastructure was installed 100 years ago and is nearing the end of its useful life. The pilot project looked to work with drainage districts to reinstall their systems integrated with targeted wetlands to couple crop production improvements with WQ improvements through both lower reduced surface runoff, with targeted wetlands for nitrate reduction.

Five pilot projects have been completed protecting over 12,700 acres of cropland, with the capacity to reduce total nitrate loss of over 150,000 lbs/year. This would be the equivalent of taking over 5,000 acres of land out of production. However, this project resulted in just over 98 acres of wetlands restored, plus 320 acres (2.5% of affected watersheds) of additional buffer and wildlife habitat, protected into perpetuity.

More importantly, this project demonstrated a market driven ability to facilitate advancing water quality improvement with significantly reduced dependence on state and/or federal programs, a rarity for this type of practice.

4.1.5 Kentucky

Kentucky continues to work with stakeholders to develop and implement the state's nutrient reduction strategy. The Kentucky Division of Water (DOW) 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 DOW 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 has worked with DOW to develop a scientific approach to interpreting its narrative nutrient water quality standard to determine whether the discharge from individual wastewater facilities may have reasonable potential in accordance with 40 CFR 112.44(d). DOW has used this analysis to developing interim technology-based limits for use in permits as it continues its efforts in developing numeric water quality criteria for nutrients in various waterbody types.

DOW continues its 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, DOW is revisiting its approach to permitting nutrient effluent limits at wastewater treatment plants.

DOW and the Division of Compliance Assistance (DCA) are implementing a pilot program, modeled after similar programs in Tennessee and other EPA Region 4 states. DOW and DCA staff attended workshops for Energy Optimization in Tennessee and met with Grant Weaver about the Nutrient Optimization program. This program is intended to work with wastewater facilities to improve energy efficiency by modifying operational procedures in lieu of investing in large capital projects. Elsewhere, these operational modifications have shown to have significant improvement in effluent quality as it relates to total phosphorus and total nitrogen concentrations. DOW and DCA are pursuing this program with optimism to take the program beyond the pilot stage.

DOW continues to work with partner agencies to monitor and issue advisories of harmful algal blooms (HAB)s and to develop protocols and thresholds for public advisories related to HAB. DOW has developed fact sheets for the public and drinking water facilities about how HABs form, their potential recreational impacts, and approaches to prevent the formation of HABs.

DOW continues to use remote sensing techniques to collect data that can be used to assess waters for HABs and trophic state and alert the agency to developing HABs. DOW and partners continue to conduct water quality sampling and screening where HABs have been identified or suspected. DOW is working with Kentucky Water Watch (a volunteered-based organization that conducts water quality monitoring as education and outreach to citizens) and the river basin water watch efforts to develop a volunteer lakes monitoring program to assess water quality in lakes and reservoirs.

DOW has developed a “HAB viewer” available on its water health portal (<http://watermaps.ky.gov/>). The HAB viewer allows users to quickly identify waters for which HAB advisories have been issued and the status of waters of interest.

DOW has been providing guidance and technical assistance to public water systems that are experiencing HABs in source waters or who rely on HAB-susceptible source waters. These efforts were critical in areas that experienced HABs in 2015, including along the Ohio River.

DOW updated its Nutrient Criteria Development Plan in 2015 and continues to implement this plan, including efforts to develop numeric nutrient criteria for lakes and reservoirs, in addition to similar efforts for wade-able 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 best management practices on agricultural lands, particularly focusing on the prevention of nutrient pollution to waterbodies. These efforts include adopting BMPs that incorporate federal and state nutrient planning standards, conducting education and outreach regarding nutrient management, soil health, animal health, productivity and economics. The focus of outreach and educational efforts has shifted toward the agronomics of smart nutrient management and animal management. This has been particularly effective with livestock management on cattle and dairy facilities.

Kentucky Highlights

From Boot Camp to Jamboree: Successful Partnerships in Kentucky. Kentucky's agricultural landscape is diverse, both in terms of animal and plant production systems. These systems are supported with research-based information from land-grant universities, federal technical agencies, and regulated through state agencies. To ensure accurate and up-to-date information is available for agricultural producers, the KY Division of Compliance Assistance partnered with the University of Kentucky, Kentucky Natural Resources Conservation Service, and the Kentucky Divisions of Conservation and Water to host multiple workshops for each entity's personnel. Ag Boot Camp served as a primer for basic agricultural information related to environmental compliance, and was targeted to agency personnel with limited ag backgrounds. Agricultural Professionals Workshops (Jamborees) were targeted to project partners' regional offices to connect personnel to agency counterparts and clear up confusion regarding who is responsible for which pieces of the agricultural and regulatory information for farmers. More than 200 people attended the workshops that were held across the state. As a result of these workshops, 96% of attendees agreed that they would be able to apply the information that they gained in their jobs. Additionally, more than 50% expressed a desire for additional training on environmental regulations, nutrient management or partner agency interactions. Three of the agencies report increased communications as a result of the workshops. We plan to grow the program in the future by adding other agencies and specific hands-on training as requested by participants.

4.1.6 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.

The Louisiana Nutrient Management Strategy was developed in May 2014, and the interagency committee continues to work collaboratively to implement and monitor the progress of the nutrient management strategy in Louisiana. In addition to USEPA, other collaborative partners include the Louisiana State University Agricultural Research Center (LSU AgCenter); U.S. Business Council for Sustainable Development, Louisiana Water Synergy Group; and the U.S. Department of Agriculture, Natural Resources Conservation Service (USDA NRCS). Annual reports for 2014 and 2015 document the nutrient management implementation activities in Louisiana. The Louisiana nutrient management strategy and annual reports can be accessed at <http://www.deq.louisiana.gov/portal/DIVISIONS/WaterPermits/WaterQualityStandardsAssessment/NutrientManagementStrategy.aspx>.

The LDEQ, in support of a strategic action under the Louisiana Nutrient Management Strategy, examined long-term trends of nitrogen and phosphorus in Louisiana. Nutrients [total Kjeldahl

nitrogen (TKN), nitrite + nitrate (NO_x), and total phosphorus (TP)] collected at 21 long-term monitoring sites in the LDEQ ambient water quality monitoring network from 1978 to 2014 were analyzed for trends. A Mann-Kendall trend test found the majority of nutrient trends (73%) to be decreasing in the state. At the 21 long-term monitoring sites, TKN concentrations had decreased at all sites. Whereas NO_x decreased at 12 sites and TP decreased at 13 sites over the period of record; all other trends were no observable trend over time. An exception was a trend for NO_x in an upstream area of the Lake Pontchartrain Basin, where NO_x was observed increasing in concentration over time. Through this analysis, LDEQ also considered the land use of the watersheds for the long-term monitoring stations along with the median nutrient value in a Kendall tau correlation analysis. Agriculture was found to be significantly correlated with higher concentrations of TKN and TP ($p < 0.01$), while forested lands were found to be significantly correlated with lower concentrations of TKN and TP ($p < 0.05$). Though agriculture was found through this analysis to be associated with higher nutrient concentrations, watersheds with the most agriculture in Louisiana also showed the most improvement in nutrient management as evidenced by decreasing or no observable increasing trends in nutrients (LDEQ 2015).

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 (LPDES) permit program. LDEQ has previously implemented total nitrogen (TN) and TP monitoring in some water discharge permits based on Total Maximum Daily Load (TMDL) determination (such as in the Lake Pontchartrain Basin) and in wetland assimilation projects. The LDEQ Compliance Monitoring Strategy performs routine inspections as well as targeted watershed based inspections to identify unpermitted dischargers to be added to the LPDES permit program. In 2016, LDEQ also began implementation of nutrient monitoring of TN and TP in major and minor sanitary LPDES permits for publicly owned treatment works (POTWs). These point source efforts will further the progress in Louisiana of addressing nutrients through direct support of implementation of the state nutrient management strategy.

Many projects and programs have been highlights of nutrient management in Louisiana. The LDEQ Nonpoint Source Pollution Prevention Program (or 319 Program) in coordination with LDAF, USDA NRCS, and LDNR recently published six success stories: three in 2014 for the Bayou Nezpique in southwestern Louisiana, Lake Arthur and the Lower Mermentau River in southwestern Louisiana, and Little Silver Creek in eastern Louisiana; and three in 2015 for Bayou Plaquemine Brule located in the Vermilion-Teche River Basin in southwestern Louisiana, Joe's Bayou located in the Ouachita River Basin in northeastern Louisiana, and Turkey Creek in the Ouachita River Basin in northeastern Louisiana. These 319 Program success stories focused on water quality improvements in previously impaired water bodies in Louisiana, where agency collaboration on planning and development and implementation of best management practices

resulted in the removal of waterbodies from the 303(d) list of impaired waterbodies (Louisiana Nutrient Management Strategy Interagency Team 2015, 2016; USEPA 2017).

The Louisiana Master Farmer Program (LMFP) is an environmental stewardship educational program aimed at agricultural producers in the state. Louisiana Master Farmer participation increased from 2,718 in 2014 to 3,782 participants in 2015, an increase of 1,064 participants from 2014 to 2015. Further the LMFP added 19 certified Master Farmers in 2015. As of 2015, there are 225 certified Master Farmers in Louisiana representing 50 of the 64 parishes (78% of the parishes in the state) (Louisiana Nutrient Management Strategy Interagency Team 2016).

The LDEQ administers the Louisiana Environmental Leadership Program (ELP) which provides the point source community an opportunity for voluntary stewardship. While the Louisiana 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 Louisiana 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. Participants also include representatives from the Lake Pontchartrain Basin Foundation, The Nature Conservancy, LDEQ, and LDAF. Working Groups are in place to address: Nutrients, Wetlands Restoration and Protection, Sustainable Water Supplies, and Alternative Levee Construction Materials.

As reported in the 2015 Report to Congress, 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, a WQT program could also provide 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).

In 2015, LDEQ, CPRA, and LDAF in conjunction with the Water Synergy Group formed a small workgroup to review options and considerations for the state of Louisiana for water quality credit trading. The workgroup is reviewing the document produced by the National Network on Water Quality Trading in summer of 2015 to evaluate options and considerations for a water quality trading program in Louisiana (National Network on Water Quality Trading 2015). Findings from this review may aid Louisiana in identifying options and considerations that could be helpful in designing and implementing any future water quality trading program for Louisiana.

The CPRA continues to work with The Water Institute of the Gulf, the U.S. Army Corps of Engineers, USGS, and NOAA to improve the science surrounding river diversions and nutrient assimilation. In 2015 and 2016, CPRA commissioned The Water Institute of the Gulf to utilize an unpublished 20-year water quality dataset (from Dr. R. Eugene Turner, LSU) to further calibrate and validate the Delft3D nutrient dynamics model applied to Barataria Basin (one of the coastal basins which will ultimately receive diverted Mississippi River water). This model will be capable of simulating past, present, and future ecological conditions of the Barataria Basin estuary with the goal of examining how the estuary may respond to riverine inflows (through diversions) and under varying salinity regimes resulting from climate change conditions (especially sea level rise). Intercepting nutrients by filtering them through coastal basins before they exit the mouth of the Mississippi River may ultimately reduce the concentrations of nutrients that reach the Gulf. The Delft3D model developed for Barataria Basin closely reproduces nitrogen concentrations (including TN, NH₄, and NO₃), and only slightly overestimates phosphorous (TP, and PO₄; which will require further refinement). Seasonal patterns of chlorophyll were also closely reproduced by the model.

In support of this model and also in support of improving the science surrounding how the Barataria Basin might respond to the influx of nutrients from a future Mississippi River diversion, 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. As a part of SWAMP implementation in Barataria, CPRA initiated water quality data collection in 2015 by

adding 23 discrete stations (measuring nitrogen, phosphorous, turbidity, dissolved oxygen, and chlorophyll) and upgrading 4 existing real-time USGS data collection platforms to include chlorophyll, turbidity, and dissolved oxygen. CPRA is currently working with USGS to construct and instrument 4 additional real-time stations within Barataria Basin to improve spatial and temporal water quality data availability.

Louisiana Highlights

Bayou Chene Ag 319 Project; Mermentau River Basin. One of the suspected sources for dissolved oxygen and fecal impairments in the Bayou Chene watershed is agriculture. Runoff from unmanaged agricultural land can carry excess nutrients, such as nitrogen and phosphorus into streams, lakes, and groundwater supplies. These excess nutrients have the potential to degrade water quality. In Bayou Chene, Nonpoint source pollution was estimated to be 65% of the total pollutant load during the summer and 75% of the total during the winter months. The key to reducing the critical NPS runoff in the watershed is to eliminate the spring discharge of muddy water from the rice fields. The application of BMPs will allow farmers to reduce the muddy discharges that occur during planting season. Instead of mudding in, the rice farmers can utilize precision leveling techniques, and instead of aerial seeding into flooded fields, farmers can drill rice seed into a dry seedbed. Regarding soybean rotation practices, simply eliminating the fall tillage operations and leaving the crop residue on the field causes a significant amount of soil to be retained on the fields over the winter months when the area experiences heavy and frequent rain events. Evaluation of these rice and soybean practices has indicated that sediments and nutrients could be reduced by 50-75% from the traditional practices. These are the types of steps that will be taken by the rice and soybean farmers in the Bayou Chene watershed to reduce the nonpoint source loads entering the bayous.

The Jefferson Davis SWCD assessed the natural resource concerns for the Bayou Chene Watershed. The top natural resource priorities are: improving water quality, enhancing wildlife habitat, and reducing soil erosion. EPA Section 319 funds will address a large proportion of these conservation needs. This project will: 1) integrate efforts presently being implemented by project partners, 2) increase the level of conservation practice implementation within the critical watershed areas, 3) help producers voluntarily implement conservation practices that avoid, control, and trap nutrient runoff, 4) improve wildlife habitat, 5) maintain agricultural productivity and the local economy by providing financial incentives.

Bayou Que de Tortue Ag 319 Project; Mermentau River Basin. The objective of this project is to improve water quality and reduce NPS pollutant loads associated with agricultural activities in the Bayou Queue de Tortue Watershed of the Mermentau River Basin. To reduce NPS pollution and improve water quality, via a reduction in annual loads of sediment, nutrients, pesticides and organic materials entering these water bodies, BMPs such as grade stabilization structures, irrigation land leveling, dry seeding of rice, seasonal residue management, nutrient management, pest management, and other practices are being planned and implemented.

One key component of this project includes school, community, and agricultural education and information outreach programs that will include the use of educational materials such as flyers, brochures and curriculum guides. An agricultural BMP field day will be held within the project watershed to demonstrate the potential for reducing stream loading from agricultural activities through the implementation of BMPs. A special effort will be made to encourage landowners and operators to participate in the environmental education events, and to pursue Louisiana Master Farmer Certifications.

The long-term success will be evaluated based on how well water quality meets state water quality standards within the impacted stream sub-basins in the Mermentau River Basin. The short-term success will be measured by continuous application of new and management of existing BMPs and related conservation practices that reduce sediment, nutrients, pesticides and organic material entering the river basin on an annual basis. All related BMPs and related practices will be monitored at the 12-digit HUC (HUC12) level at predetermined sampling sites.

4.1.7 Minnesota

The Minnesota Nutrient Reduction Strategy (NRS) is accessible at <http://www.pca.state.mn.us/nutrientreduction>. This collaboratively developed state level 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 and has supported several innovative initiatives to reduce nutrient pollution and improve water quality 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 8-digit hydrologic unit code (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 standard in January 2015.

An evaluation of monitoring data indicates that meeting 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 exceed the cumulative nitrogen reductions needed for meeting current drinking water standards in Minnesota. Future nitrate standards to protect aquatic life will necessitate nitrate reductions in some waters of the state, but the cumulative 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 (MPCA 2014). 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 561 NPDES-permitted wastewater sources in

Minnesota’s portion of the Lake Pepin watershed have decreased from 1,536 metric tons per year in 2000 to 292 metric tons per year in 2015—an overall reduction of 1244 metric tons per year or 81 percent from all point sources (see Figure 15). Over the last decade (2004 to 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 (MPCA 2016).

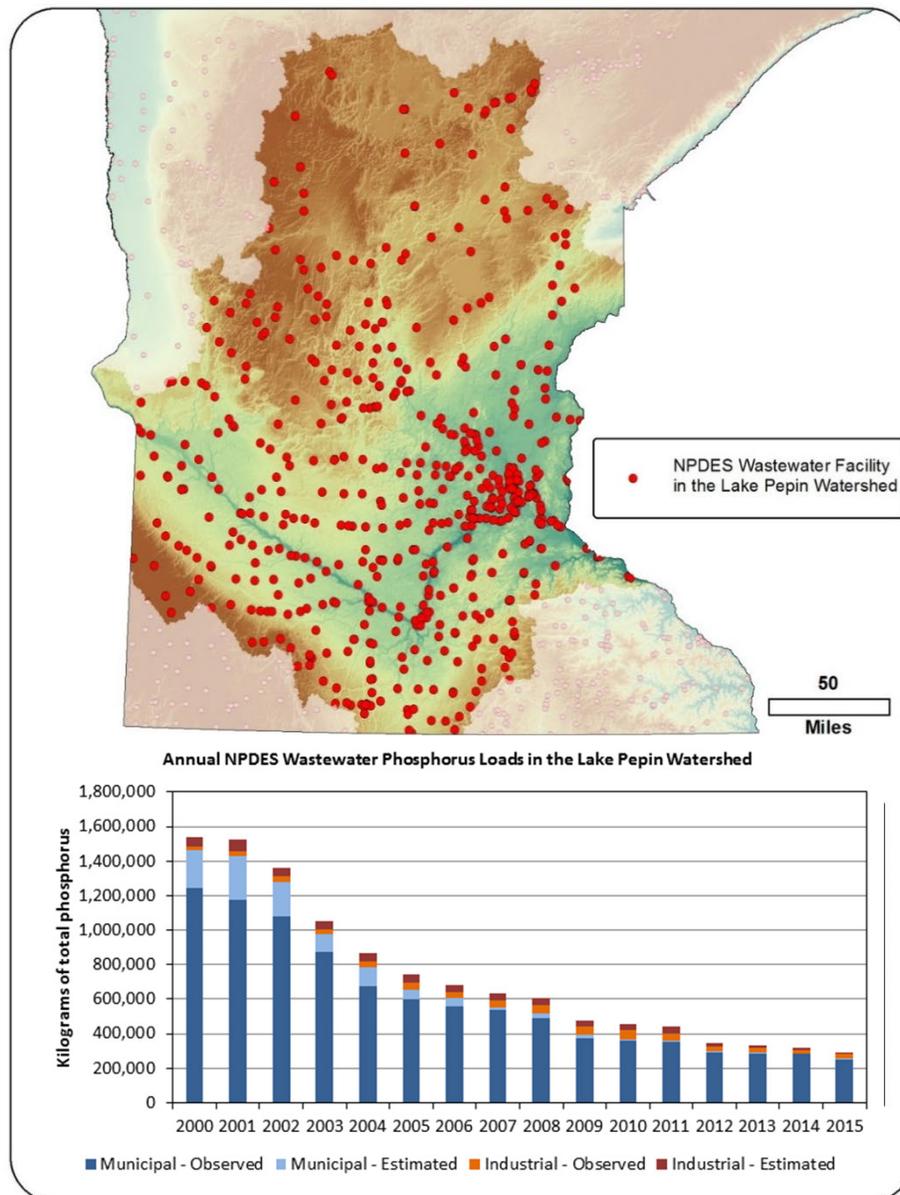


Figure 15. Geographic Distribution and Total Phosphorus Loads Discharged by Wastewater Point Sources in the Mississippi River Watershed tributary to Lake Pepin. (Minnesota Pollution Control Agency 2014a, Minnesota Pollution Control Agency 2016)

Continuing to make progress towards 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 (Minnesota 2017). For the fiscal years 2016–2017, the funding is expected to provide the following resources for additional clean water efforts:

<u>FY 2016-2017 by Category</u>	
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 watershed framework for monitoring and assessment, along with locally led planning and implementation programs to create the capacity to support a significant watershed restoration and protection program in the 80 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 reduction.

Minnesota is reducing nutrients through point source and nonpoint source efforts. The Minnesota NRS laid out a strategy to achieve a 45% reduction in total phosphorus loads to the Mississippi and a 20% milestone reduction of total nitrogen by 2025 with a future goal of 45% reduction of total nitrogen by 2040. Nutrient standards have been established for eutrophication in lakes and streams and permits to control phosphorus discharges are being issued to wastewater facilities. Drinking water standards for nitrogen are in place and have resulted in impaired listings for several streams. In addition, the state is reviewing aquatic life toxicity needs for nitrate in streams and future standards are anticipated. In addition to phosphorus controls, wastewater facility discharges are being monitored and facility planning processes are being made aware of the state nutrient strategy goals for nitrogen reduction.

For nonpoint source nutrients Minnesota has a number of programs identified in the NRS to facilitate the planning and implementation of nutrient management BMPs. In addition to conservation implementation programs that are delivered through USDA NRCS and FSA and the Minnesota Board of Water and Soil Resources, new initiatives since the NRS include:

Laws and Standards

- Mandatory riparian buffer initiative passed by Minnesota Legislature
 - This Governor’s initiative for clean water was passed by the legislature and signed into law in the 2015 legislative session and then passed again with

clarifications in the 2016 session. Deadlines for establishment of buffers on public waters and public ditches are 2017 and 2018 respectively.

- River phosphorus/eutrophication standards established
 - Minnesota has had longstanding phosphorus standards for discharges to lakes. Newly established eutrophication standards are designed to protect flowing water.
- Nitrogen fertilizer rule development for priority groundwater areas – fall fertilizer restrictions and required BMPs
 - Drinking water wells in vulnerable aquifers are being threatened and in many cases impaired for use as drinking water in private and community water supplies. This rule is being developed following updating of the state’s plan for nitrogen fertilizer management and will include monitoring, restrictions on the use of fertilizer and promotion (and in some cases requirements) of BMPs.
- Wastewater nutrient treatment certainty
 - Passed by the Minnesota Legislature and signed into law by Governor Dayton in 2016, Minnesota Statute 115.426 authorizes the Minnesota Pollution Control Agency (MPCA) to hold fixed total phosphorus and nitrogen limits for up to 20 years for wastewater facilities that voluntarily employ treatment options that remove and reduce those parameters according to permit limits from wastewater discharges.

Incentives for BMPs

- Certifying farms for water quality protection (\$9 million + state match); Land O Lakes joins as a partner

Minnesota along with USEPA and USDA initiated this program for providing certainty for farms certified to meet water quality protections (<http://www.mda.state.mn.us/protecting/waterprotection/awqcprogram/programbackground.aspx>). In 2016, Land O Lakes became a partner in promotion of this program through its Cooperative Division, which assists farmers with nutrient management. Recent progress reported at the end of September 2016 shows 350 additional active applicants in process while having certified 264 farms representing 147,957 acres with the following results:

- 487 new Best Management Practices
- 4,516 tons total suspended solids reduced per year
- 6,668 tons soil saved yearly
- 5,654 pounds phosphorus reduced per year
- N loss reduction of up to 49% on acres treated with new practices

- CREP funding is being sought for approximately 100,000 acres (\$800 million in 1:4 state to federal match pending)
 - This project will target 100,000 acres of high priority sediment and nutrient contributing farmland for restoration of perennials including restored wetlands, floodplains and prairies. The total project funding is anticipated to be \$795 million.
- Water storage (and nutrient retention) in the landscape (\$1.5 million).
 - Drainage is a key practice in those areas of Minnesota that are disproportionate contributors of nutrients to downstream waters, causing hypoxia. As that drainage system has been built up, much of the water storage and watershed treatment capacity has been lost. This program will work with farmers voluntarily to identify and implement restoration of water storage and treatment practices.

Watershed planning

- Watershed assessment – chemical & biological
 - Minnesota has established a comprehensive watershed initiative to assess all of the states 80 HUC8 watersheds over an ongoing 10-year cycle. Water quality conditions are being monitored and modeled, and stressors for fish and invertebrates are being identified where biological impairments are noted.
- State strategy integrated into HUC8 Watershed Restoration and Protection Strategies
 - As part of the Watershed Initiative, in addition to water condition assessments, water quality goals and strategies for addressing water quality impairments and threats including nutrient related impairments are being established. These local problem solving strategies are being integrated with goals and strategies established in Minnesota’s state level Nutrient Reduction Strategy.
- Nutrient reduction tracking being established
 - Each watershed is tracking reduction of nitrogen and phosphorus due to BMP installation.
- Wastewater permit nutrient effluent tracking
- Governor Mark Dayton convened a Clean Water Summit in 2016 to further water restoration and protection strategies including strategies aimed at reducing nutrient loading to surface and groundwater and stepping up the pace of progress. One of the themes of the Summit was “increasing living cover on the landscape”.

Improving BMP options

- Research and demonstration of drainage BMPs designed to lower the nutrient loss from drainage practices.
 - Practices that include wetland treatment, saturated buffers, bio-reactors along with improved nutrient use efficiency and the use of cover crops and perennial vegetation are being promoted and studied to help foster adoption.
- Drainage manual revisions – adding BMP chapter
 - Minnesota has had a drainage manual since 1991. As part of the 2016 update to this manual, there is greater emphasis on considerations for water quality impacts of drainage and inclusion of a chapter on Best Management Practices.
- Cover Crop and living cover research – University of Minnesota Forever Green Initiative (Legislature add \$1 million in 2016) is creating an aggressive research base for establishment of new crops and markets for perennial based vegetation.
- Water Education
 - **MPCA, Minnesota Department of Health, Minnesota Humanities Center and the Smithsonian Institution presents a new exhibit - “Water/Ways”**
Water/Ways is a free traveling exhibit sponsored by the Minnesota Humanities Center, the Minnesota Pollution Control Agency, and the Minnesota Department of Health and Smithsonian Institution. It focuses on the relationships between people and water—how water connects story, history, faith, ethics, the arts, and science. *Water/Ways* reveals the central nature of water in our lives. This is done by exploring how Americans use water, how water unites communities, how water affects every element of life, and how Americans care for our water and protect this valuable resource for the future *while seeking active solutions to real water problems*. As part of the *Water/Ways* exhibit, a companion exhibit, *We are Water MN*, has been developed to tell the Minnesota story and will accompany the traveling exhibit. *We are Water MN* is an interactive story-collecting exhibit that focuses on individuals’ relationships with and responsibilities to water. The exhibit raises awareness about the quantity and quality of Minnesota’s water, connecting exhibit-goers to active water solutions. Information on the Exhibit: mnhum.org/waterways

a Success Story . . .

Lake Shaokatan: A prairie lake with improving water quality

Section 319 and Clean Water Partnership grants along with Clean Water Legacy funds were used to help improve water quality in Lake Shaokatan in southwestern Minnesota by addressing feedlot runoff, farming and urban sources of pollutants, and failing septic systems.

Plagued by toxic blue-green algal blooms for several years, the lake is now recording all-time lows of phosphorus (P), the nutrient that causes algae, and showing other signs of improvement.

Typical of many shallow lakes in agricultural watersheds, Lake Shaokatan's condition shows that long-term efforts can make a difference. This 995-acre lake near the town of Ivanhoe in Lincoln County has a maximum depth of ten feet. Excessive nutrient runoff from neighboring farm fields and developed shorelines likely led to extensive algae blooms in the lake. The lake has a history of water quality problems including severe nuisance blue-green blooms, low oxygen levels in summer and winter, and periodic fish kills.

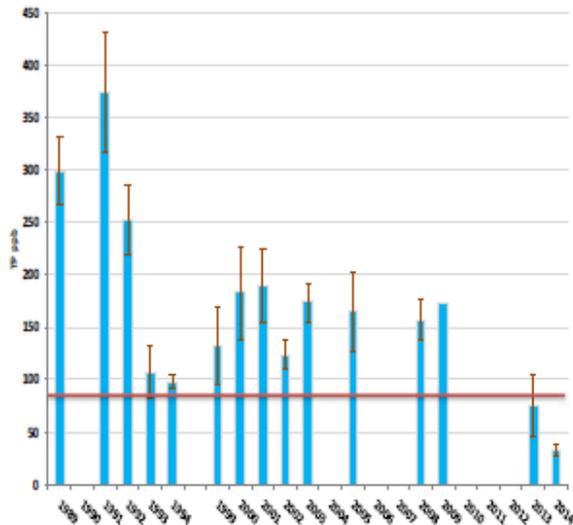
Lake Shaokatan was part of a Clean Water Partnership effort, sponsored by the Yellow Medicine Watershed District, involving the MPCA, state and federal agencies, local groups, and local units of government. A detailed diagnostic study started in 1991 and restoration efforts were underway by 1993.

These efforts included rehabilitation of three animal feedlots, four wetland areas, and shoreline septic systems. The result was a 58% reduction in P loading into the lake. By 1994, P levels in the lake had dropped significantly. This decrease resulted in reductions in the frequency and severity of nuisance algal blooms. In addition, water clarity increased and residents reported that rooted plants – instead of algal plants – were increasing.

The MPCA officially listed the lake as impaired in 2002, requiring a Total Maximum Daily Load (TMDL) study to determine the maximum amount of nutrients the lake can accept and still meet standards. That study led to further restoration efforts that are now paying off.

The level of P in Lake Shaokatan has dropped significantly in recent years, with the blue lines indicating the summer means and the red line showing the water quality standard of 90 parts per billion (ppb) maximum. Additional sampling in future years will show if Lake Shaokatan can be delisted as an impaired water.

Annual Total Phosphorus in Lake Shaokatan
1989 – 2014



Making a difference: Local watershed partners

From an article in the online journal Water Laws

Terry Renken served on the Board of Managers of the Yellow Medicine River Watershed District. His involvement with the Lake Shaokatan project began when he was designated by the Yellow Medicine River Watershed District as the watershed district's project representative.

Terry's ultimate satisfaction with the completion of the project has been in watching the public's excitement about Lake Shaokatan's improvements.

"Lake lots are now developing at a rapid pace. Economic values have increased, as well as the lake's increased recreational value. The Picnic Point County Park rests along the south shore, offering campsites, a new playground, and a newly created beach. A supper club has reopened on the north shore."

According to Terry, "through the Lake Shaokatan Project, new knowledge was gained. As a result, the Yellow Medicine River Watershed District has grown, redeveloping and extending its interests, broadening our horizons."

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, livestock operations, and 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 ($\mu\text{g/L}$), nearly achieving the regional goal of 100 to 150 $\mu\text{g/L}$ 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 Eurasian milfoil (an invasive species).

Heron Lake Watershed. Runoff from agricultural and urban areas contributed phosphorus and sediment to waterbodies 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.

4.1.8 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

Orphan Creek. Agricultural nutrients, cattle with access to the creek or tributaries, and sediment erosion in pasture land contributed nonpoint source pollution to Mississippi's Orphan Creek. Water quality monitoring conducted in 2001 and 2003 indicated that Orphan Creek was not attaining aquatic life designated use support, which is intended to assure that a waterbody is healthy enough to support the propagation of fish and wildlife that use the water. As a result, the Mississippi Department of Environmental Quality (MDEQ) added Orphan Creek to the state's 2006 Clean Water Act (CWA) section 303(d) list for aquatic life use impairment. The Dead Tiger/Orphan Creek Nonpoint Source Project significantly reduced sediment and nutrients entering Orphan Creek through the implementation of best management practices (BMPs). Using the data collected in 2009, Orphan Creek was assessed as attaining aquatic life use support as part of the 2012 CWA section 305(b) statewide assessment process.

Due to the high level of stakeholder interest, the restoration of Orphan Creek was a collective effort between the Mississippi Soil and Water Conservation Commission, the MDEQ, the U.S. Environmental Protection Agency, the NRCS, and the Hancock County Soil and Water Conservation District. The total cost of the overall Dead Tiger/Orphan Creek watershed project was \$206,779, of which \$122,247 was comprised of CWA section 319 funds. Section 319 funds were expended in the following way: \$15,319 for technical assistance; \$3,273 for education and information outreach; and \$103,655 for BMP installation. Participating state and local stakeholders contributed a total of \$84,532 towards the implementation of the watershed project.

Caney Creek. Sedimentation and organic enrichment from silvicultural and agricultural activities impacted water quality in Mississippi's Caney Creek. As a result, the Mississippi Department of Environmental Quality (MDEQ) placed Caney Creek on the state's 2002 Clean Water Act (CWA) section 303(d) list of impaired waters for aquatic life use impairment. Implementing best management practices (BMPs) as part of the Pickwick Reservoir Tributaries Restoration and Protection Project significantly reduced sediment and nutrients entering Caney Creek. As a result, a 4.99-mile segment of Caney Creek was assessed as attaining the aquatic life use in the state's 2014 CWA section 305(b) report.

The restoration of Caney Creek was a collective effort between the Mississippi Soil and Water Conservation Commission, MDEQ, U.S. Environmental Protection Agency, NRCS and the Tishomingo County Soil and Water Conservation District. The total cost of the overall Pickwick Reservoir Tributaries Restoration and Protection Project was \$1,219,228, of which \$720,900 was comprised of CWA section 319 funds. Section 319 funds were expended in the following way: \$139,006 for technical assistance, \$42,417 for education and information outreach, and \$540,477 for BMP installation. Participating state and local stakeholders contributed a total of \$498,328 towards the implementation of the watershed project.

4.1.9 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>.

Nutrient Trading

In response to expressed interest in nutrient trading during the development of the Missouri Nutrient Loss Reduction Strategy, the department established a stakeholder work group in 2015 to examine water quality trading and develop a framework for interested stakeholders. Water quality trading allows point sources that wish to do so to meet their permit conditions through purchasing credits for water quality improvements within their watershed from other point sources or from non-point sources that are implementing water quality improvements. Trading is voluntary and provides another mechanism to help communities and businesses meet their obligations in a cost-effective manner. The work group members also recognize that the framework should support voluntary trading programs that are effective, efficient and equitable for all trading partners. Following a public comment period, the Missouri Clean Water Commission approved the framework in October 2016.

Parks, Soils and Water Sales Tax

In Missouri, the Parks, Soils and Water Sales Tax is a statewide one-tenth-of-one percent sales tax that provides funding for Missouri state parks and historic sites and soil and water conservation efforts.

- The Parks, Soils and Water Sales Tax was first approved by voters in 1984, and has since been reapproved by voters three times. In 1988, 1996 and 2006, the tax was renewed by more than two-thirds majority of Missouri voters.
- Due to the efforts of the Missouri Soil and Water Conservation Program, Missouri has saved more than 177 million tons of soil over the past 30 years (Missouri DNR 2017).
- The Parks, Soils and Water Sales Tax is placed on the ballot every 10 years to reaffirm the voter's support of the park system and soil and water conservation efforts. In the November 2016 election, the Parks, Soils and Water Sales Tax was renewed for another 10 years in Missouri with 80% approval by voters.

Our Missouri Waters

The Our Missouri Waters framework divides Missouri's 66 watersheds into groups and works on a five-year rotating schedule. We are currently in Year 2 of the initial phase of implementation.

The department compiles information about each watershed into a document called the **State of Our Missouri Waters** reports. These documents are shared with local citizens to facilitate a common understanding of watershed characteristics and challenges. Local citizens then share their understanding and set goals and recommend actions through a series of at least six watershed meetings. This information sharing part of the process is known as the Collaborative Watershed Process.

The local watershed citizens deliver their goals and recommendations to the department in a document called the Healthy Watershed Strategy. The Department's Interdisciplinary Collaborative Team then considers the local goals and recommendations and assists the local watershed citizens in building and implementing action plans and measuring progress.

The Our Missouri Waters effort employs several mechanisms to ensure feedback is received and employed so that it can continuously adapt and adjust to remain efficient and effective. Primarily, a statewide Watershed Advisory Committee is convened periodically to review progress and outcomes and offer vision and recommendations on how to continue success of the effort.

Missouri Highlight

North Fork Salt River Watershed. The North Fork Salt River Watershed in northeast Missouri has been one of the first focus watersheds for the department's Our Missouri Waters effort. The streams of this watershed flow downstream to Mark Twain Lake, where this water serves as source water for the Clarence Cannon Wholesale Water Commission's public water system. Their ten million gallon per day treatment plant treats raw water and sends drinking water to its member systems in 14 counties, which together serve over 70,000 people. In 2015, the water commission collaborated with the department and several local partners, including local soil and water conservation districts, University of Missouri Extension, local seed dealers, the Missouri Rural Water Association, and the Missouri Department of Conservation to sponsor a source water protection project, with the goal of increasing awareness about the watershed and promoting soil health (through cover crops) in the watershed. Adding cover crops into a farming operation costs approximately \$20 to \$50 per acre per year, depending on the type of cover crop used and the planting method. However, after using cover crops for several years, the long-term goal is that the cost of using cover crops is offset through a decreased need for herbicides and fertilizers, and an increase in soil productivity and crop yields. For Missouri watersheds, the use of cover crops in row crops fields has the potential to not only improve soil health and the sustainability of our farmland, they also can play a large role in reducing soil erosion, reducing nutrient runoff, increasing infiltration of water into the soil, and decreasing runoff of water from the landscape.

The department's Soil and Water Conservation Program also offers cost-share assistance for landowners wanting to plant cover crops on their farm. In the six counties that make up the North Fork Salt River watershed, local soil and water conservation districts have provided cost-share assistance to farm operators to plant cover crops on over 12,000 acres of farmland, and funding through the USDA Natural Resource Conservation Service has assisted with planting cover crops on an additional 120 acres.

4.1.10 Ohio

4.1.10.1 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>.

4.1.10.2 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 stormwater treatment train installation, improved aeration efforts, alum treatments, and the installation of more than 700 conservation practices in the watershed.

4.1.10.3 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 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.

4.1.10.4 Monitoring

Ohio was 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 back in 2011. Following notable microcystin finished water detections 2013 and 2014, Ohio Senate Bill 1 was passed in July 2015 and directed Ohio EPA to implement actions to protect against cyanobacteria in the western basin on Lake Erie and in public water supplies. This legislation led to creation of Ohio Revised Code 3745.50, authorizing the director to Ohio EPA to serve as the coordinator of harmful algae management and response and implement actions to manage wastewater and limit nutrient loading and develop and implement protocols and actions to protect against cyanobacteria and public water supplies. New and amended rules became effective on June 1, 2016, establishing action levels for microcystins, cyanotoxin monitoring requirements for public water systems, treatment technique requirements, and public notification and reporting requirements. All surface water systems are subject to the new HAB rules and required to conduct routine monitoring for total microcystins from May to October. Weekly monitoring during this time period includes both raw and finished water. Any raw water detections greater than 5 ug/L or any finished water detections can trigger increased monitoring requirements. Some Public Water Systems (PWS) will be eligible for reduced monitoring for microcystins between November and April based on raw water levels. The rules also require biweekly collection of raw water cyanobacteria screening samples. These samples are analyzed at Ohio EPA's laboratory for the presence of toxin-producing genes using the quantitative polymerase chain reaction (or qPCR) method. The cyanobacteria screening samples are collected at the same time as the total microcystins raw water sample. The results of the cyanobacteria screening samples will be used by Ohio EPA to determine if cylindrospermopsin or saxitoxin are potentially present and then Ohio EPA conducts follow up monitoring for the specific cyanotoxins in raw and finished water.

Ohio annually updates the Public Water System HAB Response Strategy and the 2016 version incorporated the new HAB rules and describes the follow up monitoring actions and drinking water advisories if the cyanotoxin thresholds are exceeded in finished water. Ohio EPA is also working directly with public water systems to develop treatment optimization plans for susceptible systems, ensure HAB events are covered under their contingency plans, and maintain a data management/early warning system to provide HABs information to water systems and the public in a timely manner.

To assist and encourage our water systems to conduct proactive source water HAB monitoring, Ohio EPA provided grants for monitoring equipment and training in 2015 and 2016. To date, over \$1.2 million has been awarded for the purchase of ELISA microcystins testing equipment and training, microscopes and training, and multi-parameter datasondes, including phycocyanin sensors. Water systems are currently utilizing the real-time information to better understand conditions for HAB development and identify triggers for treatment optimization. Ohio EPA's Inland Lake Program also provides valuable data on HABs. In 2016 public water supply lakes

were targeted for monitoring, providing important water quality data to the public water systems and lake managers on the occurrence of HABs within their reservoirs and lake dynamics to better inform lake management.

To address HABs in recreational waters, Ohio EPA, ODNR, and the Ohio Department of Health jointly developed and annually update the State's Harmful Algal Bloom Response Strategy for Recreational Waters. The strategy identifies monitoring and advisory posting responsibilities, specifies cyanotoxin numeric thresholds for recreational waters, and provides sampling guidance and recommended language and signage for advisories. Ohio DNR conducts cyanotoxin monitoring at state park beaches and lakes when a bloom is observed. While the State's strategy is primarily focused on publicly owned and managed waters it also offers guidance for response at all surface waters, including privately owned and/or managed. To assist with local monitoring efforts, Ohio EPA recently developed a video on basic sample collections procedures for cyanotoxins at beaches and has worked closely with ODH to provide education and sampling guidance to local health districts and other local partners. This effort was successful and a number of local health districts, metro parks, and private beach managers conducted water quality monitoring for cyanotoxins and posted local advisories in 2016.

For more information and the latest Ohio HAB Response Strategies for both recreational waters and public water systems, visit <http://www.ohioalgaefinfo.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.

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, administered by the Ohio AgriBusiness Association (<http://4rcertified.org/>), currently has 71 participating retail branch locations. Total acreage and clients served has reached 2,700,000 and 5,500, respectively. The program's initial focus was in northern Ohio due to concerns about deteriorating water quality in Lake Erie and Grand Lake St. Marys. In the past two years the program has expanded its coverage within the Ohio River drainage where services have been provided to 1,500 clients covering 800,000 acres. 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.

4.1.11 Tennessee

Tennessee has a draft nutrient framework (Tennessee Department of Environmental Conservation 2015) that 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 has funded watershed modeling, using SWAT to determine the effects of installing conservation practices in a watershed in terms of nutrient flux. The study focused on two watersheds; the Red River, and the South Fork of the Obion River. The results have shown that if a single species cover crop of winter wheat was planted on all row crop fields in these watersheds, the upland loss reductions of total nitrogen would range from 30 to 50 percent, and total phosphorus would range from 12 to 32 percent. A summary of this project can be found at:

<https://ag.tennessee.edu/news/Pages/NR-2016-07-ShrinkDeadZone.aspx>.

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, which can be found here:

<https://www.epa.gov/nps/nonpoint-source-success-stories>.

Tennessee has a distinct focus on soil health through the initiatives of the USDA Natural Resources Conservation Service and the Tennessee Department of Agriculture (TDA). Tennessee is third in the nation, behind Indiana and North Dakota in the number of acres of cover crops being planted. In 2015 alone, NRCS programs provided cost share assistance for cover crops on over 99,000 acres. Since 2013, TDA programs have provided cost share assistance for producers to plant cover crops on over 55,000 acres. Cover crops lessen the risk of nutrient flux, and may dramatically improve the water infiltration capacity of the soils. Many informative video interviews with Tennessee producers regarding soil health and other beneficial conservation practices have been made, and can be accessed here:

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/tn/soils/health/>.

Another informative link to more “Soil Health Heroes” can be found here:

<http://www.tnacd.org/index.php/soil-health/soil-health-heros>.

Reducing nutrient flux is a challenge that the agricultural community has been addressing for many years. In 2016, based on USDA National Agricultural Statistics Service data, 76 percent of major commodity crops raised in Tennessee were grown using no-till and another 19 percent were grown using another form of conservation tillage, meaning that nearly 95 percent of major commodity crops raised in Tennessee are in a system designed to conserve soil and, thereby, reduce nutrient losses (USDA 2016).

Tennessee Highlights

Cloyd Creek. Pasture grazing activities and livestock in the stream along Tennessee's Cloyd Creek contributed to silt runoff and physical substrate habitat alterations that degraded water quality. As a result, the Tennessee Department of Environment and Conservation (TDEC) added the creek to the state's 2002 Clean Water Act (CWA) section 303(d) list of impaired waters due to siltation and physical substrate habitat alterations. Landowners installed numerous agricultural best management practices (BMPs) along Cloyd Creek, including fencing for livestock exclusion, heavy-use areas with watering facilities for livestock, and cropland conversion. Water quality improved, prompting TDEC to remove Cloyd Creek from Tennessee's list of impaired waters for siltation and physical substrate habitat alterations in 2010.

Funding for Cloyd Creek BMPs included \$28,885 in CWA section 319 grant pool funds, with local matching funds of \$13,637. Local landowners contributed \$10,574 to the project. The Agricultural Resources Conservation Fund (a fund created through Tennessee's real estate transfer tax) provided another \$26,994 in cost-share funds to help Tennessee landowners install BMPs. U.S. Department of Agriculture Farm Bill funds also supported installation of practices from 2004 to 2011.

Goose Creek. Land development contributed to increased siltation in Tennessee's Goose Creek and degraded water quality. As a result, the Tennessee Department of Environment and Conservation (TDEC) added the creek to the state's Clean Water Act (CWA) section 303(d) list of impaired waters in 2004. Best management practices (BMPs) implemented in the watershed improved water quality, and Goose Creek was removed from Tennessee's CWA section 303(d) list of impaired waters in 2010.

Funding sources included CWA section 319 grants totaling \$51,971, which were allocated for improvements made along Goose Creek and its tributaries. Stakeholders used \$36,009 from the ARCF.

McKnight Branch. Pasture grazing along Tennessee's McKnight Branch contributed to damaged riparian areas, increased stream siltation, and habitat alteration, prompting the Tennessee Department of Environment and Conservation (TDEC) to add the stream to the state's Clean Water Act (CWA) section 303(d) list of impaired waters in 2000. Project partners implemented agricultural best management practices (BMPs) that reduced siltation and improved water quality. As a result, TDEC removed McKnight Branch from the state's CWA section 303(d) list of impaired waters in 2010.

BMP installation was supported by the state's Agricultural Resources Conservation Fund (created through Tennessee's real estate transfer tax), NRCS Farm Bill funding, and matching funds from landowners.

4.1.12 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 (Wisconsin Department of Natural Resources 2013). The strategy document and all annual updates are available at <http://dnr.wi.gov/topic/SurfaceWater/nutrientstrategy.html>. Implementation of nutrient loss reduction activities is occurring mainly through phosphorus limits in WPDES permits and TMDLs for phosphorus in many watersheds across the state, including all watersheds identified in the Strategy as being the highest priority for phosphorus reduction. The following activities are highlights from the 2015-16 Nutrient Reduction Strategy Progress Report (<http://dnr.wi.gov/topic/surfacewater/nutrientstrategy.html>).

4.1.12.1 Point Sources

Before 2010, most wastewater dischargers had a technology-based phosphorus limit of 1 mg/L. New permit limits (whether a Water Quality Based Effluent Limit or WQBEL, or TMDL load limit) are incorporated as WPDES permits expire and are renewed every 5 years. Wisconsin DNR estimates that about 500/589 (85%) of the surface water discharge permits that have been reissued since January 1, 2011, do include phosphorus WQBELs – either TMDL-based WQBELs, non-TMDL WQBELs, or both.

Although Wisconsin does not currently have a water quality standard for nitrogen, WPDES permits for municipal majors in the Mississippi River Basin issued since November 2012 contain a requirement for quarterly effluent monitoring for total nitrogen.

The DNR Water Quality Bureau has been tracking point source phosphorus loads over the years. Annual load estimates are based on the average daily discharge rate and average daily effluent phosphorus concentration reported over a calendar year by each WPDES permittee required to monitor. The annual loading has been decreasing over the period of record (1995-2015). Of note, the total loadings in the Mississippi basin are estimated at 646.9 thousand pounds in 2013 (646,900 after rounding), 618.8 in 2014, and 573.7 in 2015. Over that time, the annual point source loadings will therefore have decreased by about 11.4% or about 73,200 pounds per year.

Wisconsin permittees have the option of complying with new phosphorus permit limits through improved controls or through adaptive management or water quality trading. Both adaptive management and water quality trading offer the opportunity for point sources and non-point sources within a watershed to work together on actions that improve water quality. The difference between the two options is the measure of success: for adaptive management, the measure is meeting phosphorus water quality standards in the receiving water; for water quality trading, it is finding non-point source phosphorus reductions that more cost-effectively offset the pounds of phosphorus a point source needs to reduce. There are currently 13 permittees using one of these options, with many more exploring their potential use.

4.1.12.2 Agricultural Nonpoint Source and Urban Stormwater Management Projects

Wisconsin DNR and Department of Agriculture, Trade and Consumer Protection (DATCP) continue to implement (in partnership with county land and water conservation departments) the state's **nonpoint source performance standards and prohibitions** found in Chapter NR 151, Wisconsin Administrative Code and Chapter ATCP 50, Wisconsin Administrative Code. These include the cropland phosphorus index and requirements for nutrient management planning. In 2015, Wisconsin farmers made impressive strides toward implementing soil and water conservation through the development of 6708 NMPs on 2,875,779 acres, an 11% increase from 2014, covering 31% of Wisconsin's 9 million cropland acres. 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>.

Watershed plans consistent with EPA's nine key elements provide an important framework for improving water quality in a holistic manner within a geographic watershed, and are a typical pre-cursor to implementation activities to reduce agricultural losses of nutrients to water. The nine elements help assess the contributing causes and sources of nonpoint source pollution, involve key stakeholders and prioritize restoration and protection strategies to address water quality problems. The first three elements characterize and set goals to address pollution sources. The remaining six elements determine specific resources and criteria to implement and evaluate the plan. For agriculture NPS contribution to nutrient impairments, a typical piece of the watershed planning process is to use modeling tools such as SNAP+ or STEPL to assess critical areas within the watershed where phosphorus losses to water are projected to be the highest. These become areas of focus for BMP promotion and implementation under the plan. Having an approved 9 key element watershed plan is a prerequisite to accessing state funding for BMP implementation. In 2016, there are 31 active 9 key element watershed plans covering 6.9 million acres.

Farmer-Led Watershed Councils have emerged as an effective tool to improve water quality by developing farmer leadership and strong partnerships for increased on-farm conservation. The most mature of these Councils are the St. Croix/Red Cedar Council and Yahara Pride Farms that are making measurable progress in reducing phosphorus losses to water. Objectives of these Councils include improving water quality through reduced phosphorus and sediment loading, increasing farmer knowledge of/engagement with water quality issues (including adoption of conservation practices) and to develop water quality leadership among farmers in the watershed for sustained action. In 2015, DATCP began making grants to producer-led groups which go to projects that focus on ways to prevent and reduce runoff from farm fields and that work to increase farm participation in these voluntary efforts. Each application must come from a group of at least 5 farmers in the same watershed, collaborating with conservation agencies, institutions or nonprofit organizations. The maximum grant award per group is \$20,000 and there are currently 14 grantees.

UW Discovery Farms, part of UW-Extension, is working with farmers across Wisconsin on careful phosphorus and nitrogen management. One activity, the [Nitrogen Use Efficiency Project](#) has the potential to improve soil and water resources, while preserving farm productivity and profitability. The project is currently working with 43 farmers on over 100 fields in 11 counties around Wisconsin. The project has five main objectives: (1) evaluate nitrogen use efficiency (NUE) on farms at the field level; (2) train farmers to conduct their own on-farm evaluations of NUE; (3) allow farmers to test their own management practices for improvements in NUE; (4) enhance farmer understanding of the connection between NUE and water quality; (5) develop an online farmer network with NUE results, water quality information, and a forum for information exchange among participants.

Wisconsin Highlights

2015 Yahara Pride Farms Outcomes. A Producer-led Council, Yahara Pride Farms combines a diverse set of partners including the Clean Lakes Alliance, the Madison Metropolitan Sewerage District, the Natural Resource Conservation Service, UW-Extension-Dane County, and over twenty other agribusiness and cooperative organizations. To increase the use of conservation practices in the watershed, Yahara Pride Farms provides a cost-share program. The goal of the cost-share program is to allow farmers the opportunity to test new, innovative technologies at a minimized risk, in hopes that farmers will see the benefits from the technology and incorporate the practice into their standard operations. Across the state, farmers and municipalities alike are taking note of the successes of Yahara Pride Farms and working to replicate aspects of the program.

In 2015, farmers in the program documented the adoption of practices that reduced phosphorus delivery to the Madison chain of lakes and the Yahara River (Rock River Basin) by 8,642 lbs. Since 2012, farmers have documented a total phosphorus delivery reduction of 15,872 lbs. Documented practices include: cover crops, strip tillage, low disturbance manure injection, manure composting and low disturbance deep tillage. New data shows the promise of even greater reductions if practices are combined (known as stacking practices) and when practices are used for several years in a row.

Pecatonica Watershed. The Nature Conservancy/Wisconsin is working with farmers to test a new approach to improving water quality in up Wisconsin's lakes and rivers. The results of a nine-year effort to improve water quality in a tributary of the Pecatonica River in Dane and Green counties in southwest Wisconsin shows that targeting the application of conservation practices agricultural lands with the highest estimated phosphorus runoff to streams, rather than randomly throughout a watershed, will result in cleaner water.

Water quality monitoring data, following a three-year implementation period, show a 55% decrease in phosphorus loading in the test watershed. These results are the result of the conservation practices that farmers put into place. With 95% confidence this result is statistically significant. Similarly, the reduction in phosphorus concentration was also significant. These results were obtained through the use of a paired watershed study using a test and a control watershed. The project focused on 11 farmers with fields and pastures with the highest estimated runoff phosphorus losses during storm events. Farmers who changed their management practices reduced both their estimated phosphorus and sediment losses by about half, keeping an estimated average 4,400 pounds of phosphorus and 1,300 tons of sediment out of the water each year.

Another way to think about the reduction in phosphorus loading is this: "on a warm spring day with steady rainfall, if there would have been 500 pounds of phosphorus run-off without the project, after farmers put conservation practices in place on targeted fields and pastures there would only be 225 pounds."

4.1.13 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 Eastern Band of Cherokee Indians has received Treatment As a State for its water quality program from EPA. The tribe has prepared draft water quality standards to include the most recent recommended parameter criteria, and is planning to present the new standards for federal review later this year.

The USGS, in cooperation with EBCI, maintains a real-time water quality station (nitrate, turbidity, water temperature, specific conductance, pH, and dissolved oxygen) and streamflow gage on the lower Oconaluftee River in North Carolina. (<http://waterwatch.usgs.gov/wqwatch/map?state=nc&pcode=00630>). The data collected from the station will be incorporated into the MRBI to facilitate water quality modeling by USGS.

4.2 Federal Assistance to HTF States and Tribes

4.2.1 EPA Grants and Programs

EPA works 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 help to 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 has provided approximately \$940,000 in contractor support to the HTF states between 2014 and March, 2017 for the development and implementation of their nutrient strategies, lake management plans and training, watershed indicators, and recovery potential screening.
- **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 2009–2016, EPA provided \$397 million in section 106

EPA Accomplishments

Examples of hypoxia-related accomplishments include the following:

- Providing technical assistance for developing state nutrient reduction strategies.
- Providing training opportunities and discussion forums for state NPDES permit writers.
- Providing funding, including CWA section 319 grants, to support efforts to reduce nonpoint source pollution.

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) Program** - Established by the 1987 amendments to the Clean Water Act (CWA), the CWSRF program has served as a significant 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. Under the CWSRF program, EPA provides grants to all 50 states and Puerto Rico to capitalize state loan programs. These programs function like environmental infrastructure banks by providing low interest loans to eligible recipients for water infrastructure projects. Repayments of loan principal and interest earnings are recycled back into individual state programs to finance new projects that allow the funds to revolve at the state level over time. Over the last three decades, EPA has awarded over \$41 billion in capitalization grants. The states have combined these federal dollars with required state matching contributions, loan repayments, and others sources of funding to provide 38,457 low-interest loans that have funded over \$118 billion in high priority projects. In recent years, the state loan programs provided, on average, more than \$6 billion annually to fund water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management. States can choose to use the assistance to help communities reduce nutrient pollution. From 2009–2016, EPA provided almost \$3 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 contribute nitrogen and phosphorus pollution (see Figure 9 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.
 - In February 2016, the HTF released the *Report on Point Source Progress in Hypoxia Task Force States* (<https://www.epa.gov/ms-htf/report-point-source-progress-hypoxia-task-force-states>) (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2016b). This report documents the nitrogen and phosphorus monitoring and discharge limits for major sewage treatment plants within the 12 HTF states.
 - USEPA will continue to work with water quality agencies in HTF states to permit and reduce point source loads through CWA and related state programs. The HTF will continue to track progress on nutrient permit limits and monitoring.

- **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 non-stormwater 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 larger 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 can be difficult to apply to reduce nutrient pollution. Numeric nutrient criteria generally provide clearer metrics 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** - The CWA and its implementing regulations direct states to monitor and assess their waters and every two years, under section 303(d) of the CWA, to develop lists of waters that do not meet state water quality standards and still require additional pollution control measures. 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 are required to 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 8,600 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 2016, EPA provided \$255 million in section 319 grant funding to HTF states to support their efforts to reduce water pollution, including nutrients (Table 2).

Table 2: EPA Financial Assistance to HTF States by Program (2009–2016)

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

Program	CWSRF	319 Grants	106 Grants	Total
2009	\$182,898,500	\$57,275,000	\$47,333,300	\$287,508,809
2010	\$547,635,000	\$57,275,000	\$50,406,800	\$655,318,810
2011	\$396,894,000	\$49,750,000	\$52,299,800	\$498,945,811
2012	\$379,869,000	\$46,479,000	\$52,332,100	\$478,682,112
2013	\$358,843,000	\$44,055,000	\$49,634,600	\$452,534,613
2014	\$376,853,000	\$45,067,000	\$50,000,000	\$471,920,000
2015	\$377,692,000	\$44,604,000	\$46,437,502	\$468,733,502
2016	\$362,489,000	\$46,105,000	\$49,407,000	\$458,001,000
Total	\$2,983,173,500	\$390,610,000	\$397,851,102	\$3,771,634,602

- **National Aquatic Resource Surveys (NARS)** - EPA, states, tribes, and other partners conduct 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 2.2.1 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 2007 survey of lakes and reservoirs; the 2012 survey of lakes and reservoirs released in December 2016; the 2004 survey of streams; and a 2013/14 survey of rivers and streams released in March 2016, 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** – EPA's 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/> and section 2.1 of this report).
 - Developing a coupled Mississippi River Basin and northern Gulf of Mexico coastal ocean ecosystem modeling framework for predicting how nutrient management decisions and changing weather patterns may impact the size, frequency, and duration of the hypoxic area. EPA completed the development and application of Gulf of Mexico hypoxia and Mississippi River Basin multi-media nitrogen models to assess policy scenarios for nitrogen reduction. Manuscripts are in various stages of peer review and are expected to be published in the upcoming year. Additional studies based on the multi-media model are also in development.
 - Conducting research and modeling to quantitatively resolve 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.
 - NOAA, USEPA, USDA, NIST and USGS are part of a partnership of federal agencies and stakeholders that launched the Nutrient Sensor Challenge in December 2014. Continued development of more accurate and affordable sensors for measuring nutrient loads are needed to help reduce the high cost and complexity of collecting data. This Challenge and supporting activities aim to identify next-generation tools that can help monitor and inform decisions pertaining to nutrient pollution and be

commercially available in 2017. The final winners were announced in Spring 2017. A follow-on challenge “Nutrient Sensors in Action” will support pilots to promote the deployment of nutrient sensors and the sharing of sensor data.

- In November 2015, EPA and USDA launched the Nutrient Recycling Challenge in partnership with pork and dairy producers and environmental and scientific experts. The goal of the challenge is to find affordable technologies that can help farmers manage nutrients, create valuable products and protect the environment. EPA announced the winners of Phase I of the Nutrient Recycling Challenge in March 2016.
- 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.

- In response to recommendations from the USEPA Science Advisory Board’s Integrated Nitrogen Committee, USEPA’s Office of Research and Development (ORD) released a cross-agency Nitrogen and Co-pollutant Research Roadmap in October 2015 to foster intra- and inter-agency research collaboration (<https://www.epa.gov/research/research-roadmaps>). The roadmap is a cross-media, integrated, multi-disciplinary approach to sustainably manage reactive nitrogen (Nr) and co-pollutant loadings to air, surface and ground water to reduce adverse impacts on the environment and human health.
- ORD has an Advanced Nutrient Monitoring (<https://www.epa.gov/water-research/advanced-nutrient-monitoring>) project to enhance current monitoring activities, as well as provide cheaper and faster information on nutrients or other pollutants. Through this project, USEPA is studying monitoring technologies that will measure nutrient pollution in the air and water using satellites, portable and ground remote sensors, and measurement or model data. A 2011 study evaluated the use of satellite measurements as a way to analyze water quality in Florida’s coastal waters. Researchers compared 13 years of data from a satellite to measurements from field studies and found that this unique application of satellite data for monitoring water quality is effective and could be applied by other satellites and in other coastal waters (Schaeffer et al. 2012). EPA plans to refine technical tools like this, which could greatly assist agencies in cost effectively monitoring nutrient pollution levels.

4.2.2 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. As of FY 2016, there were 188 NWQI watersheds. 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 animal agriculture production. The systems include practices to optimize nutrient inputs and to control and trap nutrient and manure runoff. Within the 12 HTF states, over 50 NWQI projects have resulted in \$28.9 million obligated for conservation systems related to addressing nutrient and sediment runoff from FY 2012 to FY 2015. State programs are using EPA CWA section 319 or other funds to conduct water quality monitoring in selected NWQI priority watersheds.

USDA and USEPA held a National Workshop on Water Quality Markets in 2015, bringing together water resource professionals, environmental market professionals, representatives from academia, and government representatives from federal, states, and local offices, nonprofits and other agricultural and environmental stakeholders to discuss the state of water quality markets in the U.S. USDA and USEPA announced the release of a new tool during the workshop, the Water Quality Trading Roadmap. This tool is an online resource that provides information on water quality trading in one searchable database (<https://www.oem.usda.gov/welcome-usda-epa-water-quality-trading-roadmap>). The Workshop Report is available online: [https://www.oem.usda.gov/sites/default/files/CLEARED EPA USDA Workshop Report.pdf](https://www.oem.usda.gov/sites/default/files/CLEARED_EPA_USDA_Workshop_Report.pdf).

4.2.3 USDA Programs

USDA has been the lead federal agency on developing, promoting, and evaluating voluntary nutrient conservation practices on private 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 and sediment. 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 conservation plans and providing technical and financial assistance to farmers and ranchers in the MARB.

USDA's Conservation Investments Improve Water Quality

Since 2010, USDA NRCS has funded over 175 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 many 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.

4.2.3.1 Conservation Programs through NRCS

From FY 2009 to FY 2015, NRCS invested \$6.7 billion in voluntary conservation programs in HTF states (Table 3). This investment includes Conservation Technical Assistance (CTA), which provides technical assistance to farmers, communities, and tribes to develop and voluntarily implement conservation plans that conserve, maintain, and improve natural resources.

Conservation planning involves identifying landowner objectives, inventorying resources and resource concerns and conservation practices that address those specific resource concerns and presenting alternative systems of conservation practices to landowners for their decision.

Landowners may then choose to apply for financial assistance or request NRCS to help them implement their conservation plan without financial assistance. NRCS assists with implementation by providing site specific technical design information for conservation practices identified in the conservation plan.

Table 3. Total NRCS Financial Assistance and Technical Assistance to HTF States by Program (2010–2015, Source: Resource Economics Analysis and Policy Division–Dollars Obligated to NRCS Programs)

Program	2009	2010	2011	2012	2013	2014	2015	Total
Conservation Technical Assistance (CTA)	163,463,163	170,288,870	\$169,381,847	\$151,518,609	\$168,218,417	\$127,169,717	\$113,282,127	1,063,322,750
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	\$311,962,548	\$314,712,442	2,220,839,914
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)	114,787,842	92,865,866	\$83,273,380	\$81,134,906	--	--	--	372,061,994
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	\$370,071,366	\$380,319,019	1,665,402,825
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	0	0	12,085,932
Agricultural Conservation Easements Program (ACEP)	--	--	--	--	--	\$97,591,868	\$94,209,390	\$191,801,258
Regional Conservation Partnerships Program (RCPP-EQIP)	--	--	--	--	--	\$44,541	\$1,887,358	\$1,931,899
Total	703,831,552	922,481,364	\$1,024,090,486	\$1,165,432,702	\$1,096,625,325	\$906,840,040	\$904,410,336	6,723,711,805

Note: Change in Programs with the 2014 Farm Bill. Amounts do not include the FA and TA expended to service active contracts in programs that were not continued in the 2014 Farm Bill.

4.2.3.2 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. In FY 2015 and FY 2016, 60 new projects have been added in HTF states, with a commitment of EQIP financial assistance of \$100 million from FY 2015 through FY 2018. These new projects were developed to be aligned with and to support the states' nutrient reduction strategies.

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. Based on CEAP estimates, MRBI projects collectively result in a yearly average of 223,000 tons of sediment, 1.4 million pounds of nitrogen, and 385,000 pounds of phosphorus that are prevented from off-site movement due to conservation practice implementation. 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 MRBI projects.

The targeted investment of NRCS program funding through the Wetlands Reserve Program (WRP, now within the Agricultural Conservation Easement Program – ACEP-WRE) resulted in the permanent protection and restoration of 31,900 acres of wetlands and associated habitats specifically for MRBI, and an additional 200,000 acres of wetland easements throughout the MRBI area from general easement funding or other targeted initiatives (acquired or completed easements FY 2009-2015, source = National Easement Staging Tool database). 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 2015, nearly \$7.3 million was obligated in voluntary contracts to provide agricultural producers with assistance in accelerating the implementation of conservation systems.

In the fall of 2015, this dedicated initiative graduated to a Gulf Strategy led by the Gulf of Mexico Ecosystem Restoration Team. NRCS staff from the Gulf States worked with conservation partners to create a restoration strategy that will serve as a roadmap for the agency's conservation efforts from 2016 to 2018 in the Gulf of Mexico region. This strategy builds on the work of the Gulf of Mexico Initiative and Migratory Bird Habitat Initiative, both launched following the Deepwater Horizon oil spill.

Through the strategy time period (2016-2018), NRCS anticipates investing more than \$328 million through the Farm Bill in this targeted, science-based restoration strategy. These funds will be leveraged by additional support through councils and partnerships. This strategy focuses work on enhancing wildlife habitat and cleaning and conserving water as well as engages in partnerships to maximize effectiveness.

4.2.3.3 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 <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmland/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. In FY 2016, 4 projects were selected for the MARB CCA. Since the start of the RCPP, over 30 additional projects (National and State funding categories) in HTF states have been initiated with a primary focus of water quality improvement.

4.2.3.4 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 2015, five water quality trading projects were awarded National CIG funding, including three in MARB states. The growing understanding of the beneficial effects of healthy soils on water quality and quantity have led to ten CIGs in the MARB from FY 2013 to FY 2015 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, which were expected to reduce phosphorus by 30,000 lbs and nitrogen by 66,000 lbs. An additional CIG grant was awarded to EPRI to develop "credit stacking" of nutrient reductions and other ecosystem services.

4.2.3.5 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.

4.2.3.6 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 partnered 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 marked 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 tens of thousands of conservation partners and farmers, have received soil health training. Resources on the Internet have been widely used: one soil health video has been viewed more than 500,000 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. A new Soil Health Division was established in NRCS in 2015 to improve the delivery of soil health information and training.

These educational efforts are resulting in increased adoption of soil health practices. 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). From FY 2009 through 2015, almost 1.5 million acres of cover crops have been applied across the 12 HTF states with NRCS federal assistance through EQIP (Source: NRCS-NPAD). New tools, such as soil health testing procedures under development by USDA’s ARS and universities are being evaluated for the current best available technologies by NRCS and partners, and will help producers refine their biological, physical, and nutrient management strategies and give them the confidence to adopt soil health management systems.

4.2.3.7 Nutrient Management

In January 2012, NRCS, in collaboration with universities and NGOs, released a revised Conservation Practice Standard (CPS) for Nutrient Management, CPS 590. The purpose of CPS 590 is management of nutrients for plant production, minimizing agricultural nonpoint source pollution, protecting air quality, and maintaining or improving soil conditions. This is an important tool for NRCS staff and partners to help agricultural producers apply nutrients using

the 4R principles—right amount, right source, right placement, and right timing. From FY 2009 to FY 2015, more than 2.8 million acres of nutrient management have been applied in HTF states with NRCS financial assistance through EQIP (Source: NRCS-READ).

4.2.3.8 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.

Application of drainage water management has increased significantly in HTF states. In FY 2009, less than 1,000 acres of drainage water management was applied in the MARB. By FY 2015, over 34,000 acres of drainage water management have been installed in HTF states with EQIP financial assistance (Source: NRCS-READ). Moreover, the AGWAM team finalized the conservation practice standard *Denitrifying Bioreactor and Saturated Buffer* in 2015 to address water quality from agricultural drains.

In 2016, the University of Illinois Extension published *Ten Ways to Reduce Nitrogen Loads from Drained Cropland in the Midwest* (Christianson et al. 2016). This publication describes the complex processes that affect nitrate loads and identifies ten promising and available practices for reducing loads.

4.2.3.9 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 2009-2015. 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 to 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

Item	Item Units	2009	2010	2011	2012	2013	2014	2015
Land Enrolled*	million acres	22.7	21.0	20.7	19.4	17.6	17.0	16.3
In Buffers	million acres	1.32	1.40	1.31	1.32	1.32	1.21	1.25
In Wetland	million acres	1.22	1.29	1.35	1.32	1.18	1.07	1.36
Reductions (not leaving field or intercepted by buffers)**								
Sediment	million tons	164	159	165	163	158	158	150
Nitrogen	million lbs	431	431	446	439	423	423	401
Phosphorus	million lbs	89	89	91	90	86	86	81
* 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 (Food and Agricultural Policy Research Institute 2007) (http://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/EPAS/PDF/606586_hr.pdf).								

4.2.3.10 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).

4.2.4 U.S. Department of the Interior Programs

4.2.4.1 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. A USFWS representative now joins a USGS representative as Coordinating Committee members for the U.S. Department of the Interior on the HTF.

Landscape Conservation Cooperatives (LCCs) are regional collaborations of states, federal agencies and nongovernmental organizations that build connections across their boundaries to tackle large scale and long-term conservation challenges. Through a stakeholder-driven decision support process, the Mississippi River Basin / Gulf Hypoxia Initiative, led by seven LCCs, created an integrated framework consisting of resource management objectives, a tiered set of conservation strategies within five agricultural production systems (corn and soybean, grazing lands, floodplain forest, rice, and cotton), and a Landscape Conservation Design spatial analysis to align work in four ecological systems (headwater fields, upland prairies, mid-sized riparian streams, and mainstem floodplains) in water quality priority zones across the Mississippi Basin. The Gulf Hypoxia Initiative is designed to complement related ongoing efforts including the Gulf of Mexico Hypoxia Task Force, NRCS Mississippi River Basin Initiative, and state nutrient reduction strategies—but with an emphasis on the ecological and social values of wildlife habitat that help upstream communities connect to downstream impacts.

Modifying the design or shifting the location of conservation practices could make program dollars go farther and appeal to more land managers by producing multi-sector benefits for wildlife, water quality, energy and agriculture. The Mississippi River Basin/Gulf Hypoxia Initiative focuses on how to select, design and configure conservation practices in a multi-sector precision targeting approach that allows resource managers and policy makers to implement efficient and effective conservation investment on the landscape. This current version of the Precision Conservation Blueprint online spatial analysis provides over 200 data layers organized

by theme and includes data to guide both basin-level and site-level prioritization of multi-benefit conservation practices. At a local scale (30 meter resolution), the Blueprint considers soil type, field grade, contiguous habitat, cropland value, and other factors to map “green infrastructure” opportunities for prairie, wetland and floodplain habitats in the water quality priority zones of the Midwest and Mississippi Alluvial Valley.

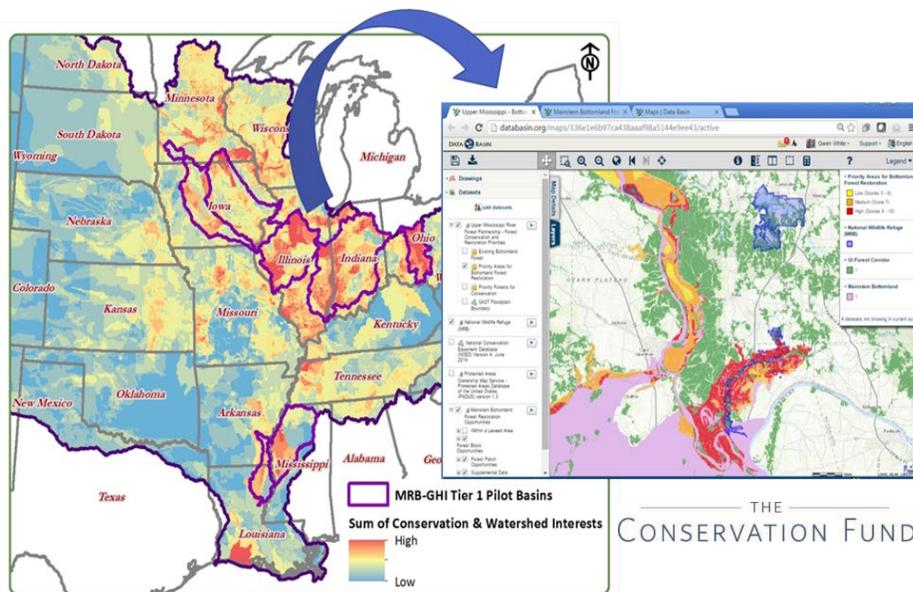


Figure 16. The Mississippi River Basin/ Gulf Hypoxia Initiative, led by seven Landscape Conservation Cooperatives, strives to make every conservation dollar count for wildlife, water quality, and agriculture. The online Precision Conservation Blueprint can be used as a targeting tool to locate areas for connecting and enhancing wetland, forest, riparian and floodplain habitat on marginal lands in key areas throughout the basin.

In a March 2016 workshop, researchers and technical program managers reconvened to guide further development and implementation of these tools. As a result, the LCCs are supporting projects to evaluate the impacts of key practices, gauge climate and other drivers for adoption of these practices, and test and refine application of these tools in the context of local land use planning and management. Pilot training on tool use will be integrated with existing current opportunities, including through extension to support the goals of the Hypoxia Task Force, Transforming Drainage Coalition, and related efforts, along with new and existing LCC-supported pilot projects representing a range of conservation planning conditions from county to regional levels (<https://tallgrassprairielcc.org/issue/gulf-hypoxia>).

The USFWS published the *Vision for a Healthy Gulf of Mexico Watershed* in the summer of 2013 in response to the restoration challenges facing the Gulf following the 2010 Deepwater Horizon oil spill (USFWS 2013). The *Vision* acknowledges the need for a holistic approach – one that spans the entire Gulf watershed and articulates overarching restoration and conservation strategies for sustaining fish and wildlife resources and thriving communities for future generations. It identifies geographically based high-priority focal areas and actions to help align the efforts of the USFWS with its partners and other stakeholders (<https://www.fws.gov/gulfrestoration/vision.html>).

Much has happened in the Gulf in the three years since the publication of the *Vision*. State and federal agencies and other stakeholders have made major investments in Gulf restoration, resulting in progress towards achieving goals. A follow-up document, *Next Steps for a Healthy Gulf of Mexico Watershed*, was released in March 2017 and is intended to refine and put on paper the perspectives, priorities and preferred courses of action held by the USFWS. It is a representation of collective understanding across Service programs and a tool to use with partners for developing, promoting and securing specific restoration across the watershed (<https://www.fws.gov/southeast/gulf-restoration/next-steps/>).

Next Steps highlights specific courses of action for the development and implementation of conservation and restoration initiatives in each of the geographic focal areas, including key areas of the Mississippi River Basin. The approach identifies target species for each focal area and is dedicated to ensuring the protection and management not only of federal trust resources (migratory birds, interjurisdictional fisheries, federally threatened and endangered species and public lands), but also at-risk species and those of concern to other partners. The actions outlined in this document are not the only options for good conservation in the Gulf and its watershed. However, the document is designed to open the door for conversations with present and future partners focused on discovery and the development of desirable collaborations, creative problem solving, and increased transparency and coordination. Most actions in *Next Steps* target objectives that will have the greatest likelihood of success for natural resources and many recommendations resemble or reinforce those from other efforts, initiatives or plans.

4.2.4.2 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. In cooperation with numerous partners, the USGS is tracking nitrate levels at more than 60 sites in the MARB using real-time nitrate sensors. These sensors are providing new insights in how and when nitrate is transported in small and large streams (<http://waterwatch.usgs.gov/wqwatch/?pcode=00630>). Annual and monthly nutrient loads at the Mississippi River mainstem and large tributary sites in the MARB, (http://toxics.usgs.gov/hypoxia/mississippi/flux_estimates/index.html), graphical summaries of nutrient levels (<http://cida.usgs.gov/quality/rivers/mississippi>), and tracking of decadal changes in nutrient levels in shallow groundwater (<http://nawqatrends.wim.usgs.gov/Decadal/>) are available using new USGS online tools.

The USGS National Water-Quality Assessment (NAWQA) project is updating the nitrogen and phosphorus SPARROW models for the Mississippi River Basin with 2012 nutrient inputs. The SPARROW modeling framework can be used to track sources and quantities of nutrients transported to downstream waters, identify which sources and which areas contribute the largest amounts of nutrients downstream, and evaluate alternative nutrient reduction scenarios. The updated models are anticipated to be released in early 2019 (<http://water.usgs.gov/nawqa/sparrow/>). The NAWQA project is assessing long-term nutrient trends in streams and rivers throughout the MARB using water-quality data collected by local, state, and federal agencies

(<http://water.usgs.gov/nawqa/swtrends/>). A new online mapper provides a decadal look at changes in nutrient and pesticide levels (<http://nawqatrends.wim.usgs.gov/Decadal/>).

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 U.S. Army 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.

In addition, 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.

4.2.5 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 67 sediment control structures to prevent sediment from filling the channels. Monitoring results of the sediment control structures indicated a large reduction of in-stream total suspended solids.

Due to the significant reductions in total suspended solids, the Corps identified 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. Through 2015, 30 smaller structures and 115 larger structures have been installed in addition to the 67 previously installed. 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.

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 total suspended solids, total nitrogen, and total phosphorus. 1995 baseline land use analysis estimated that 15 percent of the land area in the SBW had conservation practices already installed. By 2016, approximately 70 percent of the watershed was protected by some type of sediment control structure or water management practices. Monitoring data from within the SBW indicate up to a 60 percent reduction in total suspended solids concentrations, up to a 26 percent reduction in total nitrogen concentrations, and up to a 35 percent reduction in total phosphorus concentrations, depending on location within the basin. 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 total suspended solids, total nitrogen, and total phosphorus concentrations. Based on the success of the work in the SBW, this work has been expanded to the adjacent Big Sunflower River Basin, where 24 sediment control structures have been installed in the past few years (See <https://archive.usgs.gov/archive/sites/ms.water.usgs.gov/projects/319/SteeleBayou.html>).

Another example is the Mississippi Delta Headwaters Project. This project provided a means for the U. S. Army Corps of Engineers and NRCS to work cooperatively and demonstrate various methods to reduce flooding and major sediment and erosion problems in the eastern (hill) section of the Yazoo River Basin in northwest Mississippi. The project consists of 16 watersheds, ranging in size from 220 acres to 423,000 acres and total 1,887,000 acres or approximately 2,950 square miles. The features that control erosion and sedimentation include bank stabilization, grade control structures, and sediment control structures.

Water from the eastern portion of the Yazoo Basin flows into the Mississippi Delta (western portion) carrying sediment and associated chemicals. The sediment control measures used in the Mississippi Delta Headwaters Project have had a dramatic effect on phosphorus retention in the soils of the hill portion of the Yazoo Basin. An analysis of sediment retention in six of the 16 watersheds indicates that approximately 9,600,000 tons of sediment have been retained as a result of the stabilization and erosion control features. Based on phosphorus content levels in the soils in the six watersheds, approximately 1,900 tons of phosphorus were also retained as a result of the completed work (See <http://www.mvk.usace.army.mil/Missions/Civil-Works/>).

4.2.6 National Oceanic and Atmospheric Administration Programs

NOAA's contributions are documented in Section 2.1 of this report.

4.3 Land Grant Universities and Partners

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 respective 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 HTF and 12 HTF state Land Grant Universities formed a partnership through a Non-Funded Cooperative Agreement (<https://www.epa.gov/ms-htf/lgu-htf-non-funded-cooperative-agreement>) to support state-level strategies and actions to curb nutrient loading and Gulf hypoxia. These Land Grant Universities have organized through the Southern Extension Research Activities Committee 46 (SERA-46) Hatch multistate committee (<http://northcentralwater.org/sera-46/>). In 2015, the HTF and SERA-46 released their Priorities for Collaborative Work (<https://www.epa.gov/ms-htf/htf-lgu-priorities-collaborative-work>). The work plan objectives are:

1. Establish and strengthen relationships that can serve the missions of multiple organizations addressing nutrient movement and environmental quality.
2. Expand the knowledge base for discovery of new tools and practices as well as for the continual validation of recommended practices.
3. Improve the coordination and delivery of educational programming and increase the implementation effectiveness of nutrient management strategies that reduce nutrient movement for agricultural and non-agricultural audiences.

Since 2015, SERA-46 has advanced the science and extension knowledge and opportunities in many of the areas identified as Priorities for Collaborative Work. SERA-46 has collaborated with other NIFA-supported committees such as NCERA-217 and released an extension publication, *Ten Ways to Reduce Nitrogen Loads From Drained Cropland in the Midwest* ([Christianson et al 2016](#)). SERA-46 is developing a paper after an initial presentation to the HTF in December 2016 that examines each of the HTF state nutrient reduction strategies. SERA-46 and the American Society of Agronomy CCA's program are collaborating to provide enhanced training and technical expertise and facilitate learning. The Task Force and SERA-46 view their "Priorities for Collaborative Work" as living document and, in response to input from the HTF, SERA-46 is now studying economic factors that influence adoption and maintenance of conservation activity. SERA-46's leadership is integral to the states' desire to biennially report on Nonpoint Source Metrics (Section 3.3.2).

EPA has committed a total of \$550,000 through 2020 to support three identified needs through small grants, the projects and goals are:

1. Using Social and Civic Engagement Indicators to Advance Nutrient Reduction Efforts
 - a. Refining and improving existing social indicators to guide, evaluate, and accelerate implementation of state-level nutrient reduction strategies through a regionally inclusive and consistent expansion of the use of the Social Indicator Planning and Evaluation System (SIPES)/Social Indicator Data Management and Analysis (SIDMA) tools throughout the MARB

- b. Developing civic engagement indicators to assess and encourage non-government stewardship of state-level nutrient reduction strategies
- 2. Building Capacity for Watershed Leadership and Management in Twelve Mississippi River Basin States
 - a. Assessing of existing watershed training programs that include farmers; identify successful methodologies and gaps
 - b. Hosting leadership summits of watershed practitioners, farmers, and farm advisors from MARB states
 - c. Developing training modules based on needs assessment for watershed leadership and nutrient management
- 3. Adding an additional state (Illinois) to a larger project on Transforming Drainage, this project will:
 - a. Strengthen and broaden the network to advance and coordinate research, extension, and implementation of drainage water storage systems
 - b. Determine economic and environmental benefits and costs of storing drainage water at field sites across the region.
 - c. Extend estimates of benefits and costs both temporally, accounting for future climate change, and spatially across the region
 - d. Develop strategies and tools to apply the research findings in decision-making on the farm, in watersheds, and in state and national policy
 - e. Extend the strategies and tools to agricultural producers, the drainage industry, watershed managers, agencies, and policy makers to bring about transformation of drainage strategies

Part 5: Keys to Success and Lessons Learned

5.1 Cooperative Development and Implementation of Nutrient Reduction Strategies

State nutrient strategies 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 (e.g. IAWA) for additional state funding for conservation practices.

State strategies and other HTF efforts are founded on the best available science. The 2008 Action Plan, which included the Task Force's commitment to develop and implement state nutrient reduction strategies, was informed by 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., USDA SWAT model, 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 Non-Funded Cooperative Agreement with a group of LGUs in all 12 HTF states that will further engage LGU research and extension programs as states implement their strategies (see 4.3: Land Grant Partnerships).

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 agricultural 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, 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 updated federal strategy (December 2016) describes the federal agency's focused support for developing, refining, and implementing state nutrient reduction strategies (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2016a). Federal agencies are supporting state efforts with new science, programs, and approaches that states can tailor to their particular needs in implementing individual state strategies. The agencies have expanded outreach and education on nutrient pollution issues and solutions, focused on engaging partners with similar goals, and provided technical assistance and funding support to states where possible.

5.2 Forging State and Basinwide Partnerships to Implement Nutrient Reduction Strategies

Critical to the HTF's success is expanding partnerships and alliances to reduce nutrient loads. Five key sets of partners are being targeted:

- **Universities.** In 2016, USEPA selected three new projects for funding to support key objectives in the HTF and SERA-46's "Priorities for Collaborative Work". The projects are: building capacity for watershed leadership and management; transforming agricultural drainage to reduce nutrient losses through strengthened collaboration; and, using social and civic indicators to guide, evaluate, and accelerate implementation, and encouraging non-government stewardship of state Nutrient Reduction Strategies. SERA-46's critical work with the state NPS measures workgroup to develop a Measurement Framework is possible based on support from the Walton Family Foundation and the leadership of the University of Illinois.
- **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. A good examples of business collaboration is the Midwest Row Crop Collaborative, coalition of agriculture/food industry and environmental organizations focused on supporting and accelerating the use of sustainable agricultural practices in order to protect air, water and soil while still meeting production goals. One of their main goals is reducing nutrient runoff in the Mississippi River Basin. In alignment with the HTF nutrient reduction interim target and long-term goal and are working first on pilot projects in three states: Illinois, Iowa, and Nebraska (<https://www.keystone.org/our-work/agriculture/midwest-row-crop-collaborative/>).
- **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, economic growth 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 has 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. The Nature Conservancy has a robust presence in the basin states and is working now through their America’s Great River initiative, which focuses on the Mississippi River Basin, to better connect their state chapters to coordinate on work. They have also adopted the HTF’s goal of achieving a 20 percent nutrient reduction in the basin by 2025, and are working toward this goal in priority areas with a variety of partners (<http://www.nature.org/ourinitiatives/regions/northamerica/north-america-water-mississippi-river.xml>).

5.3 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 3.1 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). The first

national survey of farmers through CEAP was completed in 2006, a second national survey is ongoing and will complete the farmer interview phase in March 2017. These two surveys, in time, will provide USDA a method to track progress in conservation adoption and highlight areas in which additional conservation will make the largest impact on delivery of sediment and nutrients to the Gulf.

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). The lessons 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. NRCS is working to integrate these findings into its watershed-based programming and landscape conservation initiatives. For example, the NWQI was developed to incorporate the CEAP lessons learned. This initiative uses a small watershed approach to target critical source areas for practice implementation. Watershed level plans should be available for NWQI watersheds across the country. In at least one NWQI watershed in each state, the state water quality agency has established effectiveness monitoring to determine impacts of conservation implementation. An NWQI pilot project will begin in FY 2017 to address watersheds that either do not have a watershed level plan or where planning documents lack the detail needed to inform conservation planning. This pilot project will provide planning resources to help states develop complete watershed assessments at the HUC12 scale and to work with partners to develop outreach strategies. Financial assistance in FY 2018 will be provided to states that complete the pilot.

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

6.1 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.

6.2 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 km² 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 6.3.
- Targeting vulnerable lands and quantifying the nutrient load reductions from **federal programs** such as the USDA RCPP, USDA MRBI, 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.

6.3 Tracking Environmental Results

6.3.1 Measuring Progress on Reducing Nutrient Loads

The HTF has developed, and continues to develop and report on several common point source and nonpoint source measures that all HTF states will 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 continues to explore a potential measure that would track reductions in loads of nitrogen and phosphorus from major POTWs and other industrial sectors. Some states will also use additional, state-specific measures to track progress on reducing point source loads.

For nonpoint sources, there is ongoing work to develop a Measurement Framework that states, with partners, can use to report progress on nonpoint source nutrient reductions by state and in aggregate for the MARB. The HTF states and their partners are working to develop tools that can aggregate conservation actions to date and those conservation actions planned in the future so that the HTF, with partners, can measure nutrient reductions generated and progress towards the HTF 2035 goal and 2025 interim target for nutrient load reductions.

6.3.2 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 five 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. The first NRSA survey was released in 2016, based on samples collected in 2008 and 2009 (USEPA 2016). In Fall, 2017, 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 was 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.

The USGS NAWQA project compiled over 25 million nutrient records from over 488 agencies nationwide to examine how nutrient concentrations and loads are changing over multiple time periods (1972-2012, 1982-2012, 1992-2012, and 2002-2012). These national trends results are planned to be released in late 2017 (<http://water.usgs.gov/nawqa/swtrends/>). The HTF will use the new USGS online tool to track decadal changes in nutrients in groundwater in several aquifers throughout the MARB (<http://nawqatrends.wim.usgs.gov/Decadal/>).

6.3.3 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 continues to provide 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/>.

6.3.5 Assessing the Dead Zone

The Hypoxia Task Force will continue to emphasize the significance of having long-term annual research and results of the dead zone in the Gulf of Mexico. NOAA's multi-faceted hypoxia research provides monitoring capabilities, new understanding of processes, and predictive modeling tools that enable coastal resource managers, the HTF and partners to make informed, proactive, and scientifically-based decisions to mitigate the impact of hypoxia on the Gulf of Mexico ecosystem.

Tracking the size of the dead zone not only allows the HTF to assess its progress towards the long-term goal, but also allows the broader public to witness the outcomes of states' nutrient reduction strategies.

The HTF and its partners will continue to examine the findings of the 2016 Hypoxia Monitoring Workshop and consider ways to implement the recommendations for a consistent long-term assessment of the dead zone.

6.4 Conclusion

This second 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* since the 2015 HTF Report to Congress. The members of the HTF continue to work collaboratively to implement the 2008 Gulf Hypoxia Action Plan. All HTF states have draft or complete strategies to reduce nitrogen and phosphorus pollution in the MARB contributing to the dead zone, the large area of low oxygen in the Gulf of Mexico. The HTF is committed to making strong progress on implementing these strategies and other actions outlined in the 2008 Action Plan. Federal agencies are providing critical funding to support state efforts and advancing the science. The HTF is forging many action-focused partnerships, including collaboration with Land Grant Universities, to develop innovative approaches to tracking conservation activity supported by a broad range of partners. The HTF is committed to tracking progress towards the long-term goal.

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