US Army Corps of Engineers ®

USDA

EPA

USGS science for a changing world

NOAA

NATIONAL TRIBAL WATER COUNCIL

December 2016 Update

Looking Forward

The Strategy of the Federal Members of the Hypoxia Task Force

An update of the September 2013 Federal Strategy

Mississippi River Gulf of Mexico Watershed Nutrient Task Force

Contents

Abbreviations and Acronyms

ACPF	Agricultural Conservation Practice Framework
CEAP	Conservation Effects Assessment Project
CIG	Conservation Innovation Grant
CWA	Clean Water Act
EPRI	Electric Power Research Institute
EQIP	Environmental Quality Incentives Program
FY	fiscal year
GCOOS	Gulf of Mexico Coastal Ocean Observing System
HTF	Hypoxia Task Force
HUC	Hydrologic Unit Code
IOOS	Integrated Ocean Observing System
LCC	Landscape Conservation Cooperative
MARB	Mississippi/Atchafalaya River Basin
MRBI	Mississippi River Basin Healthy Watersheds Initiative
NAS	National Academy of Sciences
NGI	Northern Gulf Institute
NGOMEX	Northern Gulf of Mexico Ecosystems and Hypoxia Assessment
NIFA	National Institute of Food and Agriculture
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWQI	National Water Quality Initiative
ORD	Office of Research and Development
RCPP	Regional Conservation Partnership Program
RESTORE	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies
RPST	Recovery Potential Screening Tool
RRAF	Runoff Risk Advisory Forecast

SPARROW	SPAtially Referenced Regressions On Watershed attributes
STEWARDS	Sustaining The Earth's Watersheds - Agricultural Research Database System
SWAT	Soil and Water Assessment Tool
TMDL	total maximum daily load
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Introduction

The states and federal agencies that comprise the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, or the Hypoxia Task Force (HTF), continue to work collaboratively to implement the Gulf Hypoxia Action Plan 2008 (2008 Action Plan). Since the release of the plan, each HTF state has developed a nutrient reduction strategy through stakeholder participation that serves as a road map for implementing nutrient reductions in its state; these strategies serve as the cornerstone for reaching the HTF goals.

In September 2013, the federal agency members of the HTF — the U.S. Army Corps of Engineers (USACE), U.S. Department of Agriculture (USDA), U.S. Department of the Interior (USDOI), U.S. Environmental Protection Agency (USEPA), and National Oceanic and Atmospheric Administration (NOAA) — issued "Looking Forward: The Strategy of the Federal Members of the Hypoxia Task Force." It highlights technical, financial, and other assistance that the federal members provide to the HTF states for developing and implementing the state strategies.

This 2016 Update continues to focus on seven priority areas of support to the HTF states as they implement their nutrient reduction strategies to reduce nutrient loads in the Mississippi/Atchafalaya River Basin (MARB) that are delivered to the northern Gulf of Mexico: monitoring, decision support tools, modeling; permitting and regulatory program support, outreach, education and partnerships, financial and technical assistance, and other initiatives. The federal HTF members' support contributes to the implementation of the 12 state nutrient reduction strategies. More information on these state strategies is available at https://www.epa.gov/ms-htf/hypoxia-task-force-nutrient-reduction-strategies.

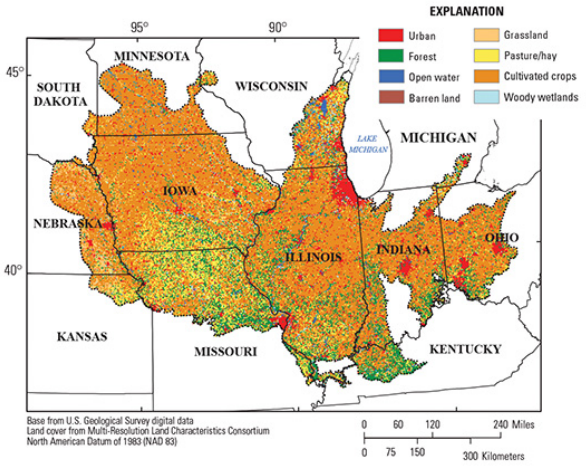
For a more comprehensive description of the HTF and its work, please see the 2015 Report to Congress on the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (2015 Report to Congress): https://www.epa.gov/ms-htf/htf-2015-report-congress.

Monitoring

How will we improve existing monitoring programs to demonstrate water quality improvement?

HTF federal members recognize that water quality monitoring in the MARB and Gulf of Mexico is key to demonstrating progress in reducing nutrient pollution and hypoxia. This information is collected over time to track changes in nutrient loadings and concentrations, water quality, hypoxia zone size, benefits of conservation practices, and more. This information can also be used to establish federal and state-level priorities and identify other opportunities to reduce nutrient pollution and Gulf hypoxia.

Monitoring in the MARB



Midwest Stream Quality Assessment Study Area.

- The **MARB Monitoring Collaborative**, led by the U.S. Geological Survey (USGS) and NOAA, was established in 2012 under the leadership of the HTF. Since then, the Collaborative has gathered existing long-term monitoring information to use in analyzing the changes in nutrients and sediments over time, determine data gaps, and promote a more uniform, accessible collection of monitoring data and information. The Collaborative is working toward creation of a network of existing long-term monitoring sites that can be easily displayed on a map and eventually used to share nutrient and sediment trend information across the MARB. Over the long term, the Collaborative hopes to create five-year reports quantifying nutrient and sediment changes throughout the monitoring network.

- USEPA and USGS started a new partnership called **The Midwest Stream Quality Assessment** in 2013 to assess stream quality across the Midwestern United states. The goal is to characterize water quality stressors (contaminants, nutrients, and sediments) and ecological conditions in streams throughout the Midwest. The assessment will also determine the relative effects of these stressors on aquatic organism in the streams. (http://pubs.usgs.gov/fs/2012/3124/pdf/Midwest_Stream_Quality_Assess_%20fs.pdf).

- USGS collaborated with the ongoing USEPA National Rivers and Streams Assessment to more intensively measure stream quality across the Midwest, including the following HTF states: Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Ohio, and Wisconsin. In the spring and early summer of 2013 streams were tested weekly for important water quality-related variables such as contaminants, nutrients, sediment, toxicity, and reproductive effects and biomarkers of contaminant exposure in fish and amphibians. Data from this

partnership are now available online (txpub.usgs.gov/RSQA/MSQA.aspx). In 2016, USGS published an article in the Journal of Environmental Quality titled, “High Nitrate Concentrations in Some Midwest United States Streams in 2013 after the 2012 Drought” (https://dl.sciencesocieties.org/publications/jeq/abstracts/0/0/jeq2015.12.0591).

- To help benchmark current water quality in the MARB, the **National Water Quality Assessment Program** (http://water.usgs.gov/nawqa/) and **National Stream Quality Accounting Network** (http://water.usgs.gov/nasqan/) have been monitoring water quality at 37 long-term sites in the MARB since 2013. The **Cooperative Water Program** (http://water.usgs.gov/coop/), a partnership between USGS and more than 1,500 state, tribal, and local agencies, also operates a number of water quality sites, some with real-time monitoring, throughout the MARB.

Continuous ultraviolet nitrate sensors and other water quality instruments deployed in the Mississippi River allow for a better understanding of nitrogen dynamics at the rates in which changes occur.

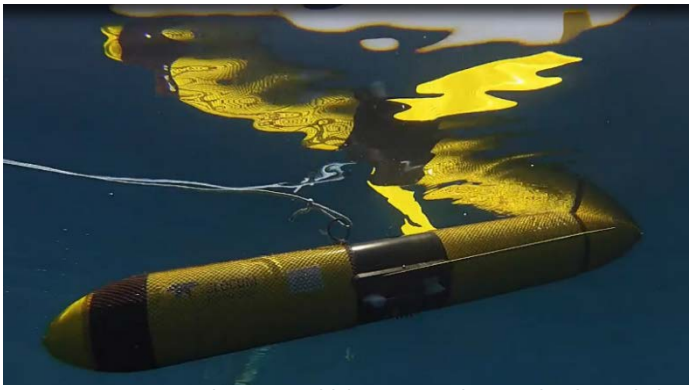
- USDA’s Agricultural Research Service (ARS) in partnership with USDA’s Natural Resources Conservation Service (NRCS) continue to conduct edge-of-field and instream monitoring within nine small watersheds throughout the MARB as part of the Watershed Assessment Studies under the **Conservation Effects Assessment Project (CEAP)**. These long-term projects continue efforts to document watershed and field scale water quality changes as a result of conservation practice implementation. They also help to build the science base for more effective watershed conservation strategies. Two new study locations were added near the Mississippi River in Arkansas in 2014 and many of the lessons learned from the projects have been used to inform the water quality monitoring standards for NRCS, to inform the guidance for the **Mississippi River Basin Healthy Watersheds Initiative (MRBI)** and **Regional Conservation Partnership Program (RCPP)** in NRCS, and to develop and assess innovative conservation practices.

- USDA also provides assistance for edge-of-field 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 Mississippi River Basin Healthy Watersheds Initiative’s (MRBI) small watersheds. With lessons learned from partnership efforts with edge-of-field water quality monitoring since 2010, NRCS has developed and released two new standards that guide edge-of-field monitoring implementation standards for edge-of-field water quality monitoring: “System Installation”: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1097618.pdf and “Data Collection and Evaluation”: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1097617.pdf. The standards

serve three purposes: (1) evaluate performance; (2) validate and calibrate models; and (3) inform on-farm management. Furthermore, they will enable farmers to apply for cost share/financial assistance through EQIP to implement edge-of-field monitoring systems.

Gulf Monitoring

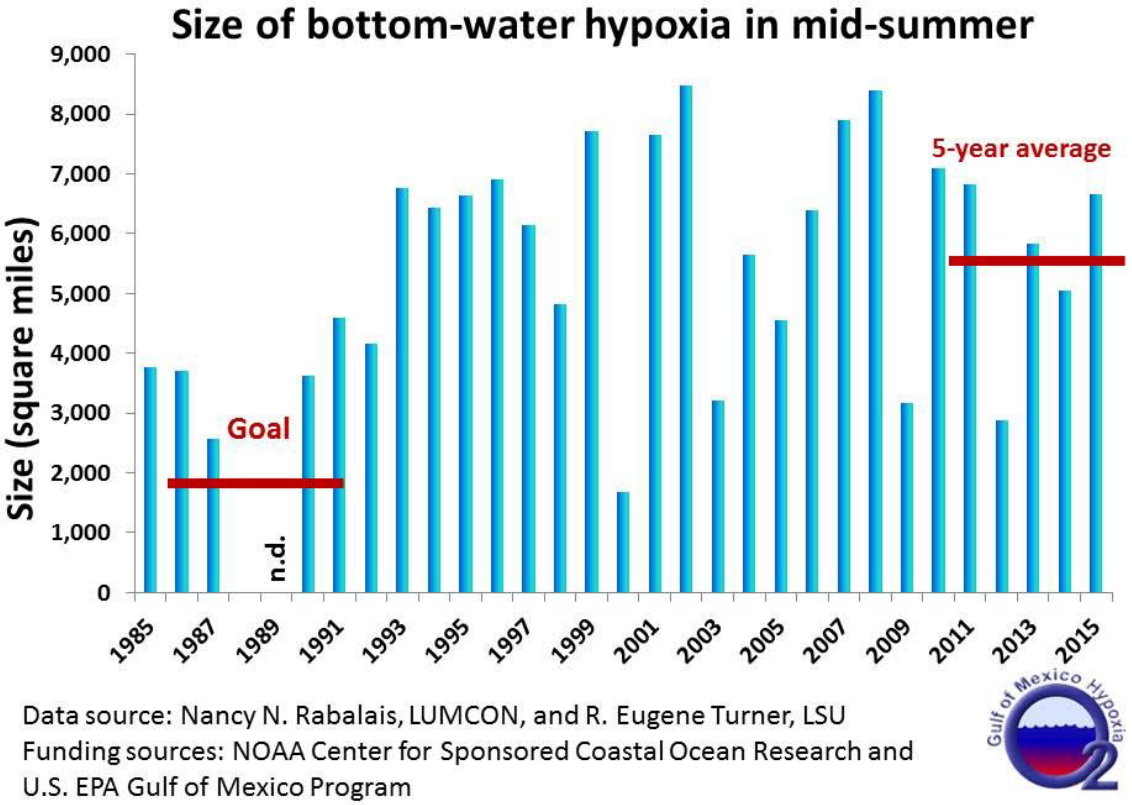
- NOAA leads the Gulf component of the MARB Monitoring Collaborative, with a focus on establishing a robust and sustainable monitoring program to ensure that hypoxic zone responses to reduced nutrients delivered from the MARB are accurately assessed. Ship surveys are the principle sampling tool for measuring the annual maximum size of the hypoxic zone. NOAA and USEPA have supported sampling of the Gulf hypoxic zone for 31 years (1985-2015). There was no ship survey in 2016 due to last-minute vessel engine failure. Instead, NOAA performed a more limited sampling effort in late August. NOAA and partners used 3-D, time-variable hypoxia forecast models for the first time, utilizing the August cruise and several other available data sets, to hindcast and evaluate hypoxia dynamics for the summer of 2016. This effort estimated the hypoxic zone area and volume during the summer of 2016, provided critical data for investigators quantifying living resource impacts, and explored potential impacts of the stratified and warmer conditions of 2016 on hypoxia management.



Autonomous underwater vehicles are used to monitor hypoxia in the Gulf of Mexico. This is just one example of how NOAA is funding hypoxia monitoring and research. Photo by Steve DiMarco, Texas A&M.

- As one element of implementing the ***Gulf of Mexico Hypoxia Monitoring Implementation Plan*** (see http://service.ncddc.noaa.gov/rdn/www/media/documents/activities/2012-workshop/Gulf-Hypoxia-Monitoring-Implementation-Plan-August-2012.pdf), NOAA convened the 6th Annual NOAA/Northern Gulf Institute (NGI) Hypoxia Research Coordination Workshop: *Establishing a Cooperative Hypoxic Zone Monitoring Program* in September 2016. The workshop objectives were to: (1) refine the 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 3-D, time-variable modeling platforms that are needed to meet critical management objectives for hypoxia mitigation and other Gulf ecosystem restoration goals; (3) define needs for long-term 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. One objective of the *Gulf of Mexico Hypoxia Monitoring Implementation Plan* is the deployment of autonomous underwater vehicles (also known as gliders) with dissolved oxygen sensors. Following recommendations from the *Implementation Plan for Glider Application to Hypoxia Monitoring and Modeling* (https://coastalscience.noaa.gov/news/wp-content/uploads/2014/05/Glider-Implementation-Plan-for-Hypoxia-Monitoring-in-the-Gulf-of-Mexico.pdf), NOAA funded and conducted a proof of concept glider application study in 2015, that demonstrated the feasibility of gliders to monitor the hypoxic zone. NOAA initiated a new glider study in 2016 to expand on this preliminary study to further refine ways to optimize glider application for dissolved oxygen mapping near the bottom of the Gulf, to complement ongoing ship surveys and moored observation systems throughout the Gulf.



Area of bottom water hypoxia (< 2mg/l of dissolved oxygen) for mid-summer cruises, 1985-2015. Hypoxia Action Plan goal for reduced size is shown on the histogram along with the 5 year running average.

Decision Support Tools

How do our enhanced monitoring and conservation tools help to improve water quality?

The HTF federal members have consolidated water quality information into accessible web-based portals and will continue to add more data. Efforts like these will provide more useful and consistent information to a wider audience.

- USGS, USEPA, and USDA continue to jointly improve the **Water Quality Portal** (http://www.waterqualitydata.us/). The Water Quality Portal provides a single, user-friendly website showing where water quality information has been or is being collected by federal, state, and tribal partners and stored in USGS, USEPA, and USDA databases. It ensures that data are accessible from a central location in a single format. Data available through the Water Quality Portal include USDA's ARS edge-of-field and instream monitoring data from CEAP small watershed studies which are fed into the Sustaining The Earth's Watersheds - Agricultural Research Database System (STEWARDS) database and then into the USGS Water Quality Portal. The combined data are used to verify and calibrate the **CEAP** simulations of watershed scale nutrient loss (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/ceap/). Recent portal additions include mapping features that enhance data discovery using upstream/downstream navigation. To supplement the Water Quality Portal, USEPA developed the Data Discovery Tool to assist users in identifying data in an area of interest (https://www.epa.gov/waterdata/water-quality-portal-data-discovery-tool).

- 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. This 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 is a "one-stop shop" for resource managers that allows users to inspect base maps of observations at individual monitoring sites 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's National Center for Environmental Information as a core requirement of the *Gulf of Mexico Hypoxia Monitoring Implementation Plan*.

- To increase and broaden efforts on monitoring and assessing MARB water quality, NRCS entered into an agreement to partner with the National Academy of Sciences (NAS) to hold a "**Mississippi River Water Quality Science and Interstate Collaboration**" workshop in November, 2013 in St. Louis, Missouri. Following the workshop, NAS issued a consensus report summarizing scientific challenges and priorities regarding Mississippi River water

quality monitoring and evaluation: http://www.nap.edu/catalog/18797/mississippi-river-water-quality-and-interstate-collaboration-summary-of-a-workshop.

- NRCS is currently piloting the application of the **Agricultural Policy/Environmental Extender (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 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 from the initial CEAP survey, conducted from 2003 to 2006. This information could show substantial changes in agricultural conservation and provide lessons for future agricultural conservation.

- The NOAA **Runoff Risk Advisory Forecast (RRAF)** is a decision support tool developed by NOAA's National Weather Service in collaboration with federal, state, academic, and industry partners that provides guidance to farmers and producers on when to avoid applying fertilizers and manure to their fields in the next ten days. Following the guidance in the RRAF will reduce the risk that freshly applied nutrients will be transported into nearby water bodies. A partnership with USEPA's 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.

- USEPA developed the **Recovery Potential Screening Tool (RPST)** to provide states and other restoration planners with a systematic, flexible tool for comparing watersheds in terms of key environmental and social factors affecting prospects for restoration success (https://www.epa.gov/rps). In 2014, USEPA released statewide RPS tools for each of the lower 48 states. Two HTF member states have worked with USEPA to enhance their state tools:

  - Iowa has been an active partner in using and enhancing the RPST to better target its watersheds for nutrient reduction in the near-term.

  - The Louisiana Department of Environmental Quality (LDEQ) collaborated with USEPA to refine the RPST for Louisiana's nutrient management efforts and is using the RPST to prioritize watersheds under the state's nutrient strategy.

Modeling

How will we use in-basin and Gulf modeling to gain further understanding of nutrient pollution, its effects, and how we can reduce it?

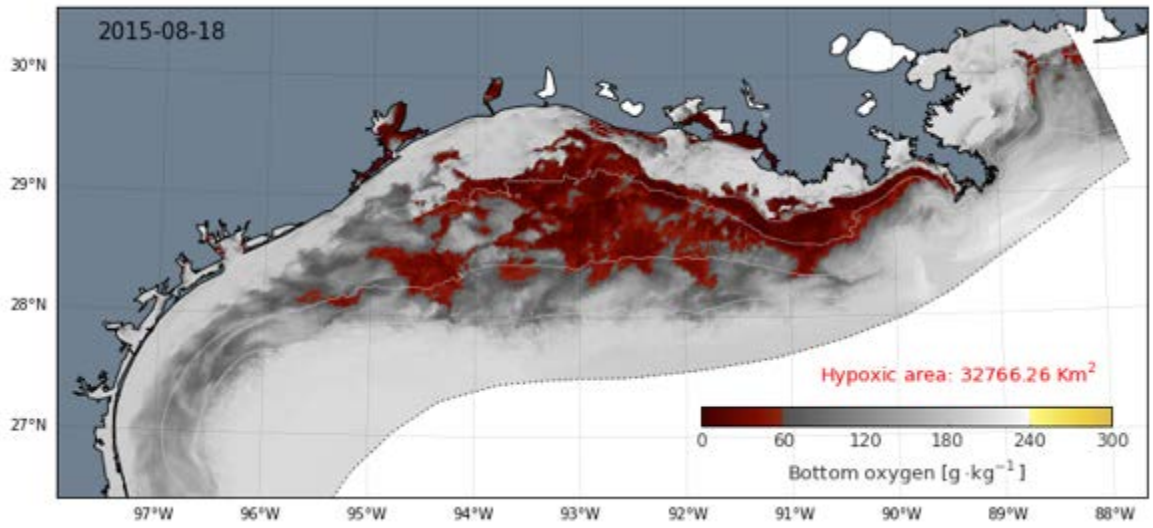
Models are valuable tools that allow resource managers and others to supplement existing water quality data and estimate the effects of changes in conservation practices, climactic conditions and other key factors on water quality, nutrient loadings, and the hypoxic zone size. Federal modeling efforts are listed below.

- In **CEAP**, USDA models the environmental effects of conservation treatment on agricultural lands. Through research, modeling, monitoring, data collection, and outreach, CEAP studies provide HTF states with information to support conservation planning, implementation, and management and prioritization decisions (Arnold et al. 2014, Duriancik et al. 2008).
  - The **Soil and Water Assessment Tool (SWAT)** is a hydrological, or water and land interaction, model widely used in CEAP to quantify the environmental impacts of land use or land management practices. The SWAT model assesses water quality and quantity for small watersheds ranging to large river basins. Developers have added modules to tailor and extend SWAT's core capabilities. ARS has also developed "SWATmf" to assess ground water quality and NRCS uses this tool to conduct both watershed scale and basin-scale analyses of the environmental benefits of conservation practices through CEAP.
  - NRCS is conducting a new round of CEAP survey collections in 2016-17. This work will show change in adoption of conservation practices since the CEAP surveys during 2003-2006 and help evaluate the effectiveness of conservation practices.
- USGS nitrogen and phosphorus **SPAtially Referenced Regressions On Watershed attributes (SPARROW)** (http://water.usgs.gov/nawqa/sparrow/) models for the MARB can be used to explain spatial patterns in monitored stream-water quality data in relation to human activities and natural processes as defined by detailed geospatial information. The online Decision Support System (http://cida.usgs.gov/sparrow/#modelid=37) provides water-resource managers access to the model to map predictions of nutrient sources, track nutrient sources and quantities of nutrients transported to downstream reservoirs and estuaries, identify which sources and which watersheds contribute the largest amounts of nutrients to downstream waters, and evaluate alternative nutrient reduction scenarios. An online mapper (http://wim.usgs.gov/sparrowmarb/sparrowmarbmapper.html) provides easy access to mapping nutrient sources and hotspots throughout the MARB. Water quality data from local, state, and federal agencies was used to calibrate the 2002 MARB SPARROW models. These models are being updated and are currently planned for release in early 2018.

- NOAA administers the **Northern Gulf of Mexico Ecosystems and Hypoxia Assessment (NGOMEX)**, a competitive grant program authorized by the 1998 Harmful Algal Bloom and Hypoxia Research and Control Act and the Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2004. NGOMEX research emphasizes the development and management application of (1) scenario forecast models to predict the extent of the hypoxic zone given varying levels of nutrient inputs and other factors that control hypoxia (to inform HTF goal-setting, monitor progress of HTF nutrient abatement actions, and validate the benefit of conservation practices) and (2) quantitative models to determine the impacts of the hypoxic zone on ecologically and economically important living resources.

- NGOMEX studies have developed an ensemble of four empirical models that use data provided by USGS on May Mississippi/Atchafalaya River nutrient loads to the Gulf to produce an annual forecast of the hypoxic zone size. The forecast is issued via a joint NOAA/USGS press release to heighten public awareness of the importance of the HTF mission. NOAA is funding a study to transition these empirical models to long-term operations.

- NOAA and USEPA have supported the development of 3D, time-variable mechanistic models to advance understanding of hypoxia dynamics and controlling factors, and to predict the effects of alternative management scenarios on future coastal ecosystem states. Models developed under the NGOMEX program and IOOS' Coastal Ocean Modeling Testbed program are in the implementation plan of the NOAA Ecosystem Forecast Roadmap Initiative for eventual transition to an operational framework. 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** from Brownsville, Texas up the Mississippi River to Baton Rouge.



A simulation of bottom oxygen using a simple parameterization of bottom oxygen utilization reveals the complex structure of bottom oxygen. While the area affected by hypoxia stretches nearly 400 km along the shelf, variability on much smaller scales, down to a few kilometers, is also evident. The position of the Mississippi/Atchafalaya river plume, and instabilities present within the plume, determine the extent and structure of the hypoxic bottom waters. Figure by RD Hetland and V Ruiz (TAMU); Colorbar: Thyng et al. (2016) submitted, Oceanography Magazine.

- NOAA's Office of Water Prediction has developed a new **National Water Model**, which increases the number of water level forecast sites from 4000 to 2.7 million nationwide (2016). This greatly improves flood forecast capabilities for public safety and will be coupled to NOAA's ecological forecasting operations to provide water quality predictions by 2023.

- The 5th Annual **NOAA/NGI Gulf Hypoxia Research Coordination Workshop** (July 2014) brought Gulf partners together to examine the interactive effects of Gulf hypoxia and other stressors on coastal ecosystems. Large-scale Mississippi River diversions may have a pronounced effect on Gulf hypoxia, and adaptive management of both river diversions and hypoxia would benefit from improved understanding of their interactive effects on ecosystem resources. These 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 will help to ensure that adaptive management decisions for diversions are science-driven and have a formal process for adjusting management actions to ensure that restoration goals are most effectively achieved.

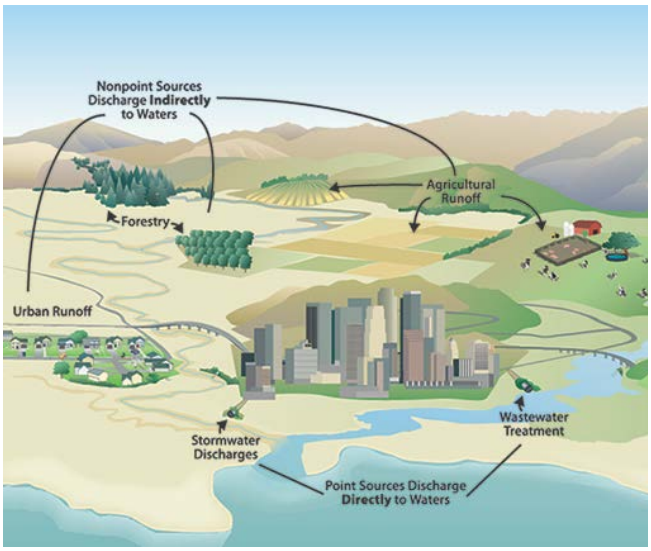
- The FY16 NGOMEX grant competition focused on advancing multidisciplinary ecosystem models and will support projects that quantify the ecosystem impacts of hypoxia. These impacts include an evaluation of the effects of alternative management strategies on ecosystem function and living resource populations. The projects will advance understanding of hypoxia impacts at the population level (e.g. targeting croaker, red

snapper, menhaden, and shrimp) and ecosystem level, including the effects of river diversions. The projects also include integration of nutrient-based models (water quality management) with living resource models (fisheries management), an important action in the NOAA Ecological Forecast Roadmap Implementation Plan.

- USEPA completed the development and application of Gulf of Mexico hypoxia and MARB multi-media nitrogen models to assess policy scenarios for nitrogen reduction, land-use change, and climate change. The 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.

Permitting and Regulatory Programs Support

How are permitting and regulatory programs reducing nitrogen and phosphorus pollution?



Example of point and nonpoint sources of pollution.

Nonpoint source nutrient pollution comes from many diffuse sources, including urban runoff and excess fertilizer from agricultural lands and residential areas. Nonpoint source pollution is generally not regulated at the federal level, however, some states choose to regulate some nonpoint sources of nutrient pollution under state law. Point sources of nutrient pollution, such as from sewage treatment plants, industrial dischargers, many sources of urban and industrial stormwater runoff, and certain concentrated animal feeding operations are regulated under the Clean Water Act's (CWA) National Pollutant Discharge Elimination System (NPDES) permit program. These programs control nutrient pollution discharged to state waters and ultimately to the larger MARB and the Gulf.

- In February 2016, the HTF released its first **Report on Point Source Progress in Hypoxia Task Force States** (https://www.epa.gov/ms-htf/report-point-source-progress-hypoxia-task-force-states). 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 reduce point source loads though the CWA and related state programs. The HTF will continue to track progress on nutrient permit limits and monitoring. USEPA has developed and is refining a **Discharge Monitoring Report Pollutant Loading Tool** (http://cfpub.epa.gov/dmr/) which states and the public can use to track the status of nutrient monitoring requirements and permit limits for facilities with NPDES permits. USEPA is updating the tool to refine its methodology for calculating nutrient loads from facilities that do not yet monitor for nutrients in their effluent. Increased nutrient monitoring and updates to this loading tool will help the HTF track progress on load reductions from point sources.

- Under section 303(d) of the CWA, states, territories, and authorized tribes are required to assess their waters and submit to USEPA, for approval, a list of "impaired" waters that need one or more Total Maximum Daily Loads (TMDLs) for pollutants (e.g., nutrients) exceeding water quality standards every two years. A TMDL identifies the pollutant load reduction needed from all point and nonpoint sources so that a water body attains standards. Permit

limits for point sources must be consistent with these TMDLs and states can pursue a variety of implementation actions to reduce nonpoint source loads. Over the past two decades, states have identified more than 17,000 waters as impaired by nutrient-related pollution and have developed more than 8,600 TMDLs for nutrient-related impairments nationally; many of these TMDLs have been established by HTF states. USEPA continues to provide assistance to states as they identify impaired waters and develop and implement TMDLs. USEPA has released additional program and technical information (https://www.epa.gov/sites/production/files/2015-10/documents/final_2014_memo_document.pdf and https://www.epa.gov/sites/production/files/2015-10/documents/2016-ir-memo-and-cover-memo-8_13_2015.pdf) for identifying waters impaired by nutrients. Financial assistance for this work is provided through USEPA's Clean Water Act Section 106 and Section 319 grants to the States, Territories and Tribes.

Outreach, Education, and Partnerships

How will we use outreach and education programs to promote work that addresses nutrient pollution and hypoxia, as well as enhances partnerships?

Federal agencies continue to generate, synthesize and disseminate state-of-the-art information about nutrient pollution and hypoxia to states, academia, NGOs, industry, farmers, and other key stakeholders. The HTF members are developing key partnerships with many entities with similar goals.

- A key role for the federal agencies is to support HTF collaboration with organizations that have goals similar to those of the HTF. In spring 2013, the HTF invited a panel of representatives from land grant universities to offer their insights on how to mobilize land grant resources to support nutrient- and Gulf hypoxia-related work, as well as to increase engagement between land grant universities and federal and state water quality and agricultural agencies. The HTF and twelve 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. With USDA-NIFA (National Institute of Food and Agriculture) support, these land grant universities have organized through a "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 priorities are to strengthen partnerships and networks of collaborators across states, research and outreach on effective conservation systems, enhance water quality monitoring and analyses, and calibration and validation of water quality models that can be used to track progress towards the HTF goal.

- 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, state, and local offices, nonprofits, and other agricultural and environmental stakeholders to discuss the state of water quality markets. 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 (http://oem.usda.gov/welcome-usda-epa-water-quality-trading-roadmap). The Workshop Report is available online: http://www.oem.usda.gov/sites/default/files/CLEARED EPA USDA Workshop Report.pdf.

- NRCS and the Environmental Defense Fund are partnering through a Conservation Innovation Grant (CIG) to demonstrate a watershed-based planning approach to address resource concerns, including nutrient load reduction. This approach was first discussed at the HTF's September 2012 meeting, held in Des Moines, Iowa. The project is designed to

determine the need for both upland and downstream measures for nutrient removal through hydrology restoration and the means to fund and maintain these measures. ARS's National Laboratory for Agriculture and the Environment developed early versions of the Agricultural Conservation Practice Framework (ACPF) under this NRCS CIG project awarded to the Environmental Defense Fund. The ACPF is based on concepts and assessment techniques developed in CEAP Watershed Assessment Studies. The ACPF has been tested in several watershed projects within the MARB. For example, the Beargrass Creek study in Indiana was part of the CIG grant. The tool now has enhanced capabilities, with datasets available for its use in parts of Minnesota, Iowa, Illinois and Kansas. The ACPF toolbox can be used within the ArcGIS environment to analyze soils, land use, and high-resolution topographic data at the Hydrologic Unit Code HUC-12 level to identify a broad range of opportunities to install conservation practices in fields and in watersheds. These opportunities can then become part of a participatory approach to encourage farmers and landowners to become engaged in local watershed improvement.

- NRCS is seeking to improve and expand technical assistance for agricultural producers through partnerships with the public and private sectors. Through contribution agreements, partnership agreements, and other arrangements with NRCS, agriculture and conservation organizations provide technical or financial resources to help with the delivery of NRCS conservation programs. In addition to national-level agreements, states enter into agreements locally to provide needed technical skills for conservation delivery. For example:

  - NRCS has long-standing agreements (at least 20 years) with the Missouri Department of Conservation for state biologists to provide technical assistance.

  - The NRCS Wetland Reserve Enhancement Partnership program funds agreements with partners to assist with planning restoration and enhancement activities and help with acquisition of easements for wetland protection. This program has an MRBI component as well as a general component.

  - To enhance and expand technical planning assistance and outreach associated with MRBI active projects, NRCS State Offices enter into cooperative agreements with Soil and Water Conservation Districts and other partners to provide assistance to landowners. This assistance may include outreach and education, collection of data, reviewing plans, engineering assistance, applying conservation practices, and coordinating and communicating with customers, for the purpose of installation of conservation practices contracted through EQIP-MRBI. The following are a few examples of active MRBI projects: Pierce County Land Conservation District (Wisconsin); Lonoke County, Prairie County, and Arkansas County Conservation Districts (Arkansas).

- NRCS is developing additional strategies to engage the agricultural industry and increase implementation of nutrient management and improvement of soil health.

  - NRCS' Agricultural Water Management Team, the Agricultural Drainage Water Management Task Force, the Agricultural Drainage Management Coalition, and others are working to accelerate the adoption of drainage water management practices in the Upper MARB.

  - NRCS is working to significantly increase producer adoption of soil health practices through partnerships with public and private groups. Healthy soils that have increased natural nutrient cycling require less nutrient input to produce a crop. Healthy soils have less weed pressure, needing fewer pesticides. Functioning soils increase carbon sequestration, water storage, and water infiltration, and they retain nutrients more effectively. These results have positive impacts on the environment by, for example, reducing nutrient losses from farm fields. They also help farmers become more resilient to natural disasters, such as droughts, and reduce costs for products like fertilizer and pesticides.

- USDA's **RCPP** promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. In FY 2015, five projects were selected in the MARB Critical Conservation Area (CCA), 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 FY16, four projects were selected for the MARB CCA. Over 30 additional projects (National and State funding categories) in HTF states have been initiated with a primary focus of water quality improvement since the start of RCPP (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/rcpp/).

- Through NRCS's MRBI, NRCS and its partners help producers in selected MARB watersheds to voluntarily implement conservation practices and systems that avoid, control, and trap nutrient runoff; improve wildlife habitat; and maintain agricultural productivity.

NRCS is working with partners nationwide to foster the development of regulatory certainty for farmers and ranchers. States are pursuing a range of programs to facilitate the voluntary adoption of systems of conservation practices that improve and protect water quality. Recognizing that states are taking the lead in developing these programs, NRCS is providing assistance to states with their development and implementation of "certainty" and "certification" programs. These programs generally recognize the environmental stewardship of farmers and provide assurance that, for as long as they continue to implement and maintain approved conservation systems, they are meeting a state's expectations for water quality concerns for a defined time period.


Farmer and NRCS employee in a cotton field.

For example, Minnesota developed the statewide voluntary **Agricultural Water Quality Certification Program** (http://www.mda.state.mn.us/protecting/waterprotection/awqcprogram.aspx), designed to accelerate adoption of on-farm conservation practices that protect Minnesota lakes and rivers. Producers who implement and maintain approved farm management practices will be certified and, in turn, assured that their operations meet the state's water quality goals and standards for a period of 10 years. This program is the product of a state-federal partnership that includes multiple Minnesota agencies, as well as USEPA and NRCS.

- USEPA is supporting a pilot effort by AGREN to engage non-operator landowners in Iowa's Raccoon River Basin in working toward sustainable nutrient management practices with their farm operators. Activities are oriented toward sharing tools and techniques with trainers in high-priority watersheds throughout the MARB to assist in their efforts to reach out to the non-operator landowner audience. To date, more than 100 land operators have been trained in conservation farming techniques and those land operators are being matched with Absentee Land Owners.

- USEPA and the National Association of Conservation Districts coordinate the Farmer Hero Campaign, which recognizes farmers who voluntarily implement best management practices to minimize nutrient runoff. Farmer Heroes showcased represent Illinois, New York, Arkansas, Minnesota, and Iowa, and other candidates are being interviewed. Through their stories, they describe voluntary BMP implementation and demonstrate cost-savings and improved yields, reduced nutrient inputs, and enhanced soil quality.

- NOAA, in conjunction with USGS and academic partners, provides an annual hypoxic zone forecast for the Northern Gulf of Mexico, approximately a month before the hypoxic zone size is measured. While these modeling and forecasting tools provide critical information to help set nutrient reduction goals, they also inform stakeholders, politicians, managers and citizens about these damaging "dead zones", what is causing them, and how state-of-the-art forecasts are used to guide management efforts to alleviate this stress on vital ecosystems and economic resources. Following the annual ship survey in late July, a second press release provides the measured zone size and explains why the measured zone size did or did not match the forecast, which provides the public further insight into the factors that influence the dynamic hypoxic zone size. As the forecast and measured sizes are carried each year by national news outlets, the public is better informed about the relationship between activities in the MARB watersheds and downstream impacts on water quality.

Financial and Technical Assistance

How are federal agencies using innovation and leveraging resources to offer financial and technical assistance?

The federal members of the HTF continue to develop and implement programs that provide funds and expertise to stakeholders working to reduce nutrient loads in the MARB and delivered to the Gulf. While demand often exceeds availability for this support, agencies continue to provide assistance in critical areas through a variety of programs. For example, USDA distributes funds through programs like MRBI or RCPP, and NOAA continues to fund the modeling and monitoring of the hypoxic zone to ensure that the zone's response to watershed nutrient reductions is understood and detected. Federal agencies are also increasing technical assistance, such as access to nutrient management and soil specialists, nutrient trading support, and regional or MARB scale nutrient modeling. Improving the availability and quality of this support will help states and federal agencies address nutrient pollution and hypoxia more effectively.

- Although the demand for federal assistance to HTF states exceeds available resources, HTF federal members are devoting significant funds to these efforts where possible. A few examples of this assistance include the following:

  - In FY 2011 USEPA provided $1 million in competitive grant funding for states to develop and implement nutrient reduction strategies through a comprehensive partnership. USEPA has provided approximately $340,000 in contractor support to the HTF states between 2014 and 2016 for the development and implementation of their nutrient strategies, lake management plans and training, and watershed indicators, and recovery potential screening.

  - USEPA selected three new projects for funding to support key objectives in the HTF and SERA-46's "Priorities for Collaborative Work" document, under the Hypoxia and Agricultural Nutrient Outreach and Technical Assistance (National Priority Activity III). 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.

  - **USDA-NIFA** supports research on nutrient cycling through the Nitrogen and Phosphorus Cycling Program Area in the Agriculture and Food Research Initiative (AFRI) Foundational Request for Applications. This program funds projects that evaluate the physical and biogeochemical (including microbial) processes affecting the flow, fate and transport, transformation, movement, and storage of nitrogen and phosphorous. The projects developed improved management/conservation practices that will lead to

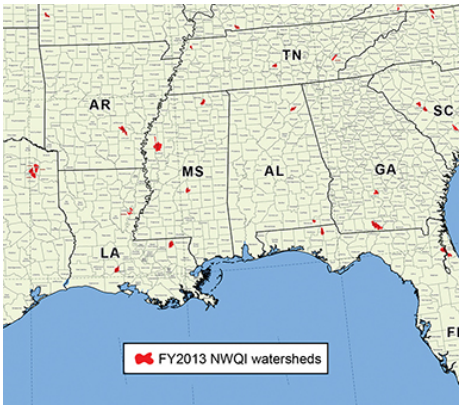
substantial improvements in nutrient use efficiency and development of decision-support tools.

- NIFA supports efforts in the states through financial assistance to LGU partners through 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. NIFA supports several multistate projects that address issues of importance to the HTF. In particular, SERA-46 and SERA-17 are closely engaged with work in the region. SERA-17, Organization to Minimize Nutrient Loss from the Landscape, has produced a wide range of phosphorus best management practices fact sheets for both crop and animal production. They have been very active in assessing phosphorus indices to ensure that each state index is correctly ranking the potential for P delivery to surface water.

- In 2016, USEPA funded a cooperative agreement with the University of Minnesota to provide training for watershed and conservation planning using the ACPF. The ACPF is a tool to help local conservationist precisely site conservation opportunities within small watersheds. This cooperative agreement provides funding for training and support to agricultural advisors in at least three watersheds in the MARB Four priority watersheds within the MARB will receive additional coaching on using the tool after training sessions. In addition, training material will be available online for other agriculture advisors in the MARB.

- NRCS's MRBI invested over $341 million in technical and financial assistance across 123 projects by the end of FY 2013. In 2013, the demand for EQIP financial assistance in FY 2013 under MRBI was more than double the available funding: $123 million across almost 3,500 applications. In 2015, $10 million was invested in 27 new watersheds and 13 existing projects. In 2016, $30 million was invested in 33 new MRBI watersheds and 40 existing MRBI projects. NRCS has committed $30 million to assist MRBI projects in both FY 2017 and FY 2018.

- **NWQI** is a collaboration between NRCS, USEPA and state water quality agencies to improve water quality in small agricultural watersheds. In 2015, NRCS invested ~$25 million in EQIP conservation funds towards the NWQI. 49 of 188 NWQI watersheds are in HTF states; these are high priority agricultural watersheds that receive targeted EQIP conservation funds and many partners are engaged. In FY 2015, $5.7 million was obligated in NWQI watersheds in the HTF states within the MARB. At least one watershed per state is monitored by state water quality agencies to track water quality responses to nutrient, sediment, and pathogen conservation practices. Learn more about NWQI at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/?cid=stelprdb1047761 and https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-national-water-quality-initiative.



NWQI FY 2013 Watersheds.

- NOAA has invested more than $27 million for research and monitoring since 2000, which has improved understanding of the causes and effects of Gulf hypoxia, including the advancement of scenario forecast models to inform nutrient management. These research advances facilitate the HTF's adaptive management approach in refining nutrient reduction targets as needed and assessing measures of success.

o USDA and USEPA are providing financial and technical assistance to support nutrient credit trading as an approach to improving water quality. Nutrient credit trading offers the promise of reducing the cost to entities that must meet water quality standards while maintaining or improving water quality and increasing private-sector funding for voluntary conservation of private lands.

- The **Ohio River Basin Trading Project**, managed by the Electric Power Research Institute (EPRI), is an innovative multistate trading program. This project was initiated in 2009 with funding from USDA-NRCS and USEPA, among others. In 2012, project leaders announced the nation's first multi-state water quality trading compact. During 2014-2015, the first pilot trades were conducted with participation from Ohio, Indiana and Kentucky in 30 conservation projects. Currently, EPRI is focused on scaling up the projects into programs (http://wqt.epri.com/pdf/3002001739_WQT-Program-Summary_2014-03.pdf).

o In response to recommendations from the USEPA Science Advisory Board's Integrated Nitrogen Committee, USEPA's Office of Research and Development (ORD) released a **Nitrogen and Co-pollutant Research Roadmap** in March 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 managing reactive nitrogen (Nr) and co-pollutant loadings to air, surface water, and ground water to reduce adverse impacts on the environment and human health.

- This reactive nitrogen report includes a regionally-focused effort on the nutrient problem in the MARB/Northern Gulf of Mexico (Science Advisory Board 2011). ORD, in collaboration with the Office of Water and Office of Air and Radiation, is developing decision support tools in three areas: (1) models of environmental systems to address the environmental soundness of decisions; (2) models of ecosystem services (humankind benefit) and their response to changes in the environmental system to address the extent of social impact; and (3) frameworks/models to examine the sustainability of alternative futures to address the three components of sustainability. Currently, ORD is in the process of applying these modeling system tools and evaluating their performance. ORD will integrate these results into the Coastal Gulf Ecology Model to support understanding and prediction of hypoxia in the Gulf of Mexico and elsewhere in the U.S. The ORD cross-program research also coordinates with the Gulf Coast Ecosystem Restoration Council, HTF efforts, and USEPA air and water programs to inform these modeling applications, in partnership with USGS, USDA, and NOAA.

- USEPA's 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 and 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. USEPA plans to refine technical tools like this, which could greatly assist agencies in cost effectively monitoring nutrient pollution levels.

- The USACE, in partnership with Delta F.A.R.M. (Delta Farmers Advocating Resource Management), has promoted the following suites of conservation practices in the Mississippi delta to address the broadest range of resource concerns: pads/pipes/winter flooding, on-farm storage, tailwater recovery, edge-of-field/farm treatments, nutrient management, and conservation cover/cover crops. Authorizing legislation from 1983 directs USACE and NRCS to work cooperatively toward the continuation of erosion, flood, and sediment control in the Yazoo Basin Hill Region. New technology will continue to be developed, as will monitoring data, all of which will be made available through the project website

(www.mvk.usace.army.mil/Missions/CivilWorks.aspx) and/or listed points of contact. On the website, scroll down to “Mississippi Delta Headwaters Project” for existing information and updates.

- NOAA, USDA, USEPA and USGS are part of a partnership of federal agencies and stakeholders that launched the **Nutrient Sensor Challenge** in December 2014. 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 solutions and tools that can help monitor and inform decisions pertaining to nutrient pollution and be commercially available by 2017. As of September 2016, sensors are in final evaluation, awards will be made early next year, and a suite of pilots for testing sensors under different conditions will begin next spring. The Challenge also addresses the market and economics of nutrient monitoring. Challenge sponsors are collaborating with states and other organizations on incentives to promote the deployment of nutrient sensors and the sharing of sensor data.

Other Initiatives

What other initiatives are federal agencies involved in that can help address nutrient pollution in the MARB and hypoxia in the Gulf of Mexico?

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 continues to participate along with a USGS representative as Coordinating Committee members for the U.S. Department of the Interior on the HTF.

- All of the HTF federal members also serve on the federal-state governing body established by the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies (RESTORE) Act to manage certain civil penalty monies BP paid following the 2010 Deepwater Horizon oil spill. In addition, most of the HTF federal members are also natural resource damage trustees for the Deepwater Horizon spill and serve with the five Gulf states on a trustee council that coordinates $110 million in funds allocated for controlling nutrient loads to the Gulf. Certain other restoration approaches, including proposals for Mississippi River sediment diversions, may also reduce Gulf nutrient loads. Consistent with their responsibilities and the governance structures for these restoration programs, the HTF federal members coordinate with the five Gulf states on opportunities to reduce nutrient inputs to the Gulf.

- The U.S. Fish and Wildlife Service (USFWS) is organizing projects around a Vision for a Healthy Gulf of Mexico Watershed (Vision) to prioritize landscape-scale restoration. USFWS recognizes the role of the entire Gulf watershed in promoting and protecting the health of the Gulf of Mexico ecosystem.

    - Since releasing the Vision in 2013, the USFWS is engaged with federal, state and NGO partners to address the impacts of the oil spill, in addition to the long-term, system-wide issues of habitat loss, flow diversion, altered hydrology, altered salinity gradients, and nutrient loading. The USFWS's Gulf Restoration Program is finalizing a follow-up document to the Vision that captures specific implementation steps for high priority actions described in the Vision, as well as for additional focal areas and priorities that have emerged. Targeting investments in wildlife habitat not only provides ecosystem services (e.g., pollination, pest control, flood mitigation, climate adaptation) at multiple scales, but also appeals to land managers and complements efforts such as those of the HTF, NRCS' MRBI, and state nutrient reduction strategies. High priority actions are also directed at reversing steep declines in grassland birds and pollinators. If implemented, these actions would also have benefits for water quality throughout the MARB and ultimately the Gulf.

- The geographies that contribute the most nutrients to the Gulf also overlay that of the Eastern Tallgrass Prairie and Big Rivers Landscape Conservation Cooperative (LCC), which joined six other LCCs in the MARB to develop a *Precision Conservation Blueprint v1.0* (https://databasin.org/groups/d52de40d017e4ce98c3914dba1bc4ee7) spatial analysis framework. This framework, or targeting tool, will allow partners across the basin to target and track conservation delivery that has high-impact, multi-sector benefits for habitat restoration, water quality, as well as agricultural resiliency and sustainability.

Summary and Path Forward

This December 2016 Federal Strategy Update provides an overview of projects completed or planned by the HTF federal agencies since release of the first HTF federal strategy in 2013. In summary:

- **Monitoring**: The federal members of the HTF are involved in numerous monitoring programs and projects that help track water quality changes instream, at the edge-of-fields, and in the Gulf hypoxic zone. Through the MARB Monitoring Collaborative, the HTF seeks to institutionalize a long-term monitoring network.

- **Decision Support Tools**: The federal agencies provide access to many of their databases through public online portals, and have created tools that states, farmers, and others can use in making prioritizing and implementing nutrient reduction opportunities.

- **Modeling**: Basin and regional scale models supported by the federal partners, including SWAT and SPARROW, provide a scientific basis for decision making and nutrient reduction tracking.

- **Permitting and Regulatory Programs Support**: USEPA will continue to work with water quality agencies in HTF states to reduce point source loads though CWA and related state programs and will continue to track progress on nutrient permit limits and monitoring.

- **Outreach, Education, and Partnerships**: The HTF is focused on developing partnerships with key stakeholders, such as the HTF state land grant universities. The federal agencies support these HTF partnerships and are working to continue to support partners, such as through RCPP and NWQI.

- **Financial and Technical Assistance**: The federal agencies provide funds and tools that assist the states and their partners as they implement their state nutrient reduction strategies.

The HTF federal agencies will continue to support the HTF in all of these areas, as well as focus on these key priorities for the near future:

- **Support states as they implement state nutrient reduction strategies.**
  - Implementation of the state nutrient reduction strategies to accelerate the reduction of nutrient pollution is key to meeting the HTF goals. The federal agencies will continue to provide tools and assistance as needed to the states for strategy implementation.

- **Work towards the HTF's adoption of quantitative measures to track progress.**
  - The HTF has adopted point source measures to track progress and released the first Report on Point Source Progress in HTF States in February 2016. The federal agencies support the states as they work to track nonpoint source measures with their partners.

- **Develop partnerships with organizations aligned with its goals.**
  - The federal agency members of the HTF continue to identify opportunities to build and support partnerships between the HTF or its individual member agencies and NGOs, industry, universities, communities and cities.

For more information and updates on the work of the federal members of the HTF and the HTF in general, please visit www.epa.gov/ms-htf.

References

Arnold, J.G., Harmel, R.D., Johnson, M.V., Bingner, R., Strickland, T.C., Walbridge, M., Santhi, C., DiLuzio, M., and Wang, X. 2014. *Impact of the Agricultural Research Service Watershed Assessment Studies on the Conservation Effects Assessment Project Cropland National Assessment*. Journal of Soil and Water Conservation 69(5):137A-144A.

Duriancik, L., Bucks, D., Dobrowolski, J., Drewes, T., Eckles, S.D., Jolley, L., Kellogg, R., Lund, D., Makuch, J., O'Neill, M., Rewa, C., Walbridge, M., Parry, R., and M. Weitz. 2008. The first five years of the Conservation Effects Assessment Project. Journal of Soil and Water Conservation. 63 (6): 185A-197A.

Greene, R.M., J.C. Lehrter, and J.D. Hagy III. 2009. *Multiple regression models for hindcasting and forecasting midsummer hypoxia in the Gulf of Mexico*. Ecological Applications 19 (5):1161-1175.

Missssippi River/Gulf of Mexico Watershed Nutrient Task Force. 2008*. Gulf Hypoxia Action Plan 2008 for Reducing, Mititgating, and Controlling Hypoxia in the Northern Gulf of Mexico and Improving Water Quality in the Mississippi River Basin.* U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Mississsippi River/Gulf of Mexico Watershed Nutrient Task Force, Washington, D.C. Accessed August 2016. https://www.epa.gov/sites/production/files/2015-03/documents/2008_8_28_msbasin_ghap2008_update082608.pdf

---------. 2013. *Looking Forward: The Strategy of the Federal Members of the Hypoxia Task Force*. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, Washington, DC. Accessed August 2016. http://water.epa.gov/type/watersheds/named/msbasin/upload/hypoxia_annual_federal_strategy_508.pdf.

---------. 2015. *2015 Report to Congress*. U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Mississsippi River/Gulf of Mexico Watershed Nutrient Task Force, Washington, D.C. Accessed August 2016. https://www.epa.gov/sites/production/files/2015-10/documents/htf_report_to_congress_final_-_10.1.15.pdf

---------. 2016. *Report on Point Source Progress in Hypoxia Task Force States*. U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Mississsippi River/Gulf of Mexico Watershed Nutrient Task Force, Washington, D.C.

Accessed August 2016. https://www.epa.gov/sites/production/files/2016-03/documents/htf_pointsource_progressreport_02-25-16_508.pdf

SAB (Science Advisory Board to the US Environmental Protection Agency). (2011). Reactive Nitrogen in the United States; an analysis of inputs, flows, consequences, and management Options. US Environmental Protection Agency: Washington, DC. EPA-SAB-11-013.