Gulf Hypoxia Action Plan 2008

for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico and Improving Water Quality in the Mississippi River Basin

Mississippi River
Gulf of Mexico
Watershed Nutrient
Task Force

Gulf Hypoxia Action Plan 2008

Sediment loads from the Mississippi and Atchafalaya Rivers empty into the Gulf of Mexico.

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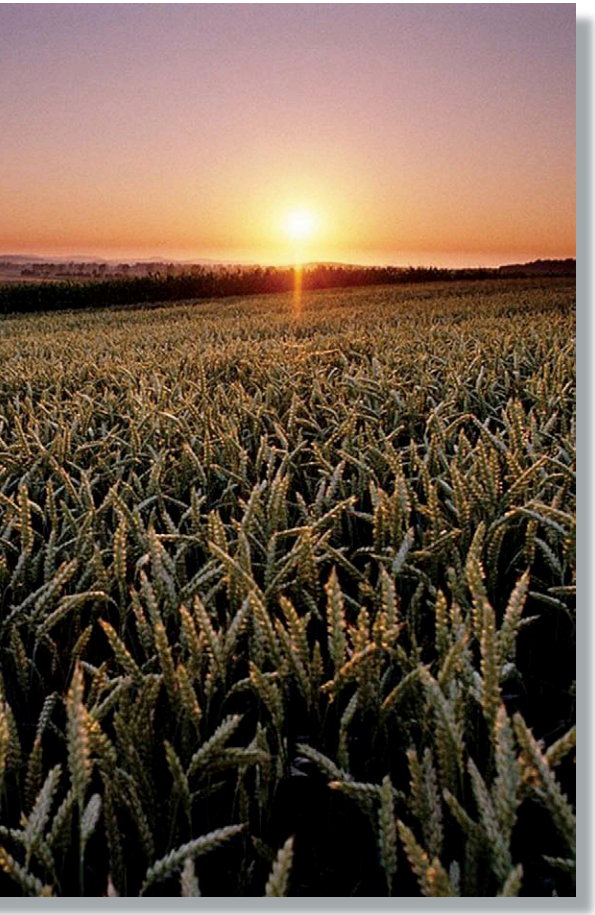
Moving Forward



More than thirty years after the passage of the Clean Water Act, a large area of low oxygen or hypoxia, absent of most marine life and threatening to inexorably change the biology of the region, continues to form in the Gulf of Mexico during periods in the summer off the coasts of Louisiana and Texas. The hypoxia is primarily caused by excess nutrients—originating from the great productivity of Middle American cities, farms, and industries—which cause extensive growths of algae that deplete the oxygen in the water when they die, sink to the bottom, and decompose. The condition is exacerbated by the stratification of the water column—the result of warmer, low salinity surface waters that isolate the organic-rich bottom waters from the surface and prevent oxygen exchange with the atmosphere—which occurs where the Mississippi River meets the Gulf of Mexico.

The watershed of the Mississippi River drains 41 percent of the contiguous United States and includes waters from several major river systems, including the Missouri/Platte River Basin, the Ohio/Tennessee River Basin, and the Arkansas/Red/White River Basin. The Mississippi River Basin includes two functionally distinct zones, each with its own potential to contribute to the reduction of Gulf hypoxia. These zones include the huge Mississippi watershed with its tributary network, and at the lower end of the river system, the deltaic zone that formerly dispersed river water naturally throughout Southeast Louisiana via a distributary (deltaic) network. While the tributaries of the Mississippi River are the sources of nutrient loading to the river trunk, the distributaries within the Mississippi Delta are critical to the final dispersal of nutrients and sediments into the Gulf of Mexico and the salinity of the estuaries and coastal waters.

The distributary zone includes the entire area influenced by river flow south of the Old River Control Structures, where the Atchafalaya River diverges from the lower Mississippi River and

on Gulf Hypoxia

the Red River merges with the Atchafalaya (Figure 1). During the past two centuries the hydrology of the distributary zone was totally modified by the construction of flood levees and closing of key distributaries for flood control and navigation enhancement programs. These structures isolated the river from its delta, causing an ongoing catastrophic collapse in the deltaic landscape, primarily wetlands. The hydrologic changes that have caused such damage to South Louisiana also exacerbate Gulf hypoxia by jetting most nutrient-rich river water and sediments directly into the Gulf of Mexico, bypassing the deltaic wetlands that require the nutrients and sediments.

States and Tribes within the entire Mississippi/Atchafalaya River Basin and Federal agencies are working together to take action to reduce the size of the hypoxic zone, while protecting and restoring the human and natural resources of the Mississippi River Basin. In January 2001, the Mississippi River/Gulf of Mexico Watershed

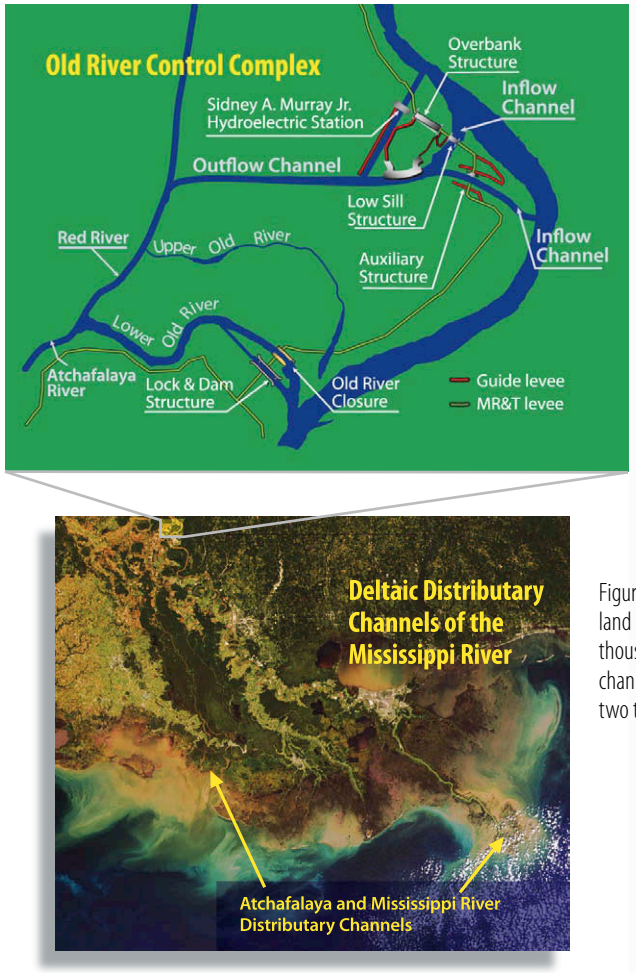


Figure 1. Deltaic plain of Louisiana showing land built, maintained, and nourished over thousands of years by many distributary channels of the Mississippi River, including the two that are currently active.

Nutrient Task Force issued the Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico. The plan was submitted in accordance with the Harmful Algal Bloom and Hypoxia Research Control Act of 1998. The plan stimulated a great deal of collaboration in understanding science and planning; however, much work remains to be done to implement it.

The Task Force has updated the initial plan through a multiple-step reassessment. This *2008 Action Plan* reflects the Task Force's efforts to track progress, update the science, and adapt actions to improve the effectiveness of the efforts throughout the Basin. Building on the *2001 Action Plan,* this plan lays out specific steps that need to be accomplished to reach the goals. It also reiterates the long term goals and continues the Task Force's commitment to an adaptive management approach to reduce the size and impact of the Gulf hypoxic zone and improve water quality in the Basin. This adaptive management approach involves continual feedback between the interpretation of new information and improved management actions and is the key to targeting actions within watersheds where they will be most effective.

Six major policy themes provided direction for the reassessment. These themes address needed improvements to the *2001 Action Plan* within the adaptive management framework and include:

1. Acknowledge the social, political and economic changes and links to emerging issues and policies. The vast drainage basin of the Mississippi/Atchafalaya River Basin and the adaptive management framework of the Action Plan require that the Task Force analyze the broad landscape and policy changes that impact the hypoxic zone and water quality in the Basin. These trends may include wetland trends in both the upper and lower basin, channelization of the Mississippi River and how it affects the hydrology of the Mississippi and Atchafalaya deltas, and the role of energy and agriculture markets on land use in the Mississippi/Atchafalaya River Basin.

2. Ensure greater specificity and accountability and tie to funding strategies. The Task Force must identify the appropriate actions and engage State, Tribal, and Federal agencies and stakeholders to identify the appropriate funding strategies that will be the most effective in ensuring timely

implementation to achieve measurable and effective results.

3. Track program and environmental progress. The Task Force needs to improve communication, better understand the results of its efforts, and improve tracking and integration of results into improved design and targeting of adaptive strategies in future reassessments.

4. Adapt to new scientific findings. The Task Force has been active in soliciting and evaluating the latest scientific findings through a series of symposia on relevant topics and advice from a panel of experts under the United States Environmental Protection Agency's (EPA) Science Advisory Board.

5. Maximize opportunities for stakeholder involvement. Given the cooperative and voluntary nature of the Action Plan, the Task Force must engage a wide range of stakeholders and facilitate broad acceptance of the plan in order to maximize opportunities for stakeholders to pursue the identified actions.

6. Reexamine roles and responsibilities of Task Force partners. A reassessment of the roles and responsibilities assigned to the Federal agencies, the States, Tribes, and the Sub-Basin Committees in achieving the goals of the Action Plan will improve future implementation and action.

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Framework for Action

Bear Creek in Story County, Iowa is a United States Department of Agriculture National Demonstration Area for conservation buffers.

Principles

Throughout the process of the reassessment, the Task Force has reaffirmed these six overarching principles as guidance to reach the three major goals of this plan:

- Encourage actions that are voluntary, incentive-based, practical, and cost-effective;
- Utilize existing programs, including existing state and federal regulatory mechanisms;
- Follow adaptive management;
- Identify additional funding needs and sources during the annual agency budget processes;
- Identify opportunities for, and potential barriers to, innovative and market-based solutions; and
- Provide measurable outcomes as outlined below in the three goals and eleven actions.

Goals

The Task Force has revised and reaffirmed the three goals that conform to these principles and will provide the overall measure of the results of the plan:

1. **Coastal Goal:** 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 through implementation of specific, practical, and cost-effective voluntary actions by all Federal agencies, States, and Tribes, and address all categories of sources and removals within the Mississippi/Atchafalaya River Basin to reduce the annual discharge of nitrogen and phosphorus into the Gulf.*

2. **Within Basin Goal:** To restore and protect the waters of the 31 States and Tribal lands within the Mississippi/Atchafalaya River Basin through implementation of nutrient and sediment reduction actions to protect public health and aquatic life as well as reduce negative impacts of water pollution on the Gulf of Mexico.

3. **Quality of Life Goal:** To improve the communities and economic conditions across the Mississippi/Atchafalaya River Basin, in particular the agriculture, fisheries and recreation sectors, through improved public and private land management and a cooperative, incentive-based approach.

* The Task Force understands the difficulty of meeting the 2015 goal so is therefore including a revision that takes into account the uncertainty of the task but attempts to maintain momentum and progress achieved to date. As such, at this time, the Task Force accepts the advice of EPA's Science Advisory Board on this topic. . . *"The 5,000 km^2 target remains a reasonable endpoint for continued use in an adaptive management context; however, it may no longer be possible to achieve this goal by 2015. . . it is even more important to proceed in a directionally correct fashion to manage factors affecting hypoxia than to wait for greater precision in setting the goal for the size of the zone. Much can be learned by implementing management plans, documenting practices, and measuring their effects with appropriate monitoring programs."* (EPA Science Advisory Board 2008, 2).

Critical Needs

Much planning and implementation is under way at the local level, as well as through federal and state programs, to address scientific and management concerns and to put the conservation practices and management practices and technologies in place to reduce nutrient loads. Progress is being made; however, ongoing programs, rather than new initiatives, are responsible for most of the progress. Furthermore, progress is often the result of collateral benefits resulting from actions States and Federal agencies have taken independently of the hypoxia Action Plan to generally improve the state of the science, restore local water quality, or improve the efficiency of industrial and agricultural activities. The Task Force members are committed to continue, within these existing programs, current activities that contribute to meeting the goals of this plan, while increasing the targeting within this reassessment to fill gaps that are observed within the existing programs.

However, while landowners, States and Federal agencies have undertaken numerous nutrient reduction activities, these activities have not resulted in a reduction of the hypoxic zone. Resources are insufficient to attain the goals of the Action Plan, and the lack of resources is the primary barrier to successful implementation of the plan. Federal, state, and local governments and non-governmental organizations all have a role in the reduction in the size of the hypoxic zone. To achieve results, significant resources must be provided and targeted toward implementing the most effective nutrient reduction actions in Mississippi River Basin states with the greatest loadings of nitrogen and phosphorus to the Gulf. The difference between the results that might be achieved using existing programs and resources and the results that would be realized with additional legislative, regulatory, or financial support is considerable. These specific, critical needs are summarized later in this document and will be defined more precisely in the Annual Operating Plan that accompanies this document. The Annual Operating Plan will also describe the interim steps, funding needs, and associated timeline that will guide implementation of the eleven actions listed in the final section of this Action Plan.

Water Quality Credit Trading Program

The nutrient trading program administered by the Miami Conservancy District for the Great Miami River Watershed in Ohio allows National Pollutant Discharge Elimination System (NPDES) permitted dischargers to purchase credits from best management practices installed by upstream nonpoint sources (i.e., agricultural producers) to offset nutrient loadings. While no Total Maximum Daily Load (TMDL) is in place yet, point sources in the watershed are concerned that upstream nonpoint source loadings will result in a stringent TMDL in future years. The point sources are purchasing reductions upstream in order to improve water quality enough to lessen the stringency of or eliminate the need for a TMDL. The program also employs trade ratios to encourage early investing. The trades are administered in a reverse auction format, where nonpoint sources submit bids for the amount they will accept in order to implement practices. Currently, there are 28 projects and more than 112 tons (244,606 lbs.) of nutrient reduction is targeted over the terms of the projects. Funded best management practices include conservation tillage, conservation crop rotation, conservation cover, milk house/cow lot treatment, pasture seeding/prescribed grazing, sod establishment, hayland, manure storage, grid sampling/variable rate technology, and filter strips.

Bottomland hardwood forests improve water quality by filtering and flushing nutrients and by reducing sediment before it reaches open water.


STEAMER
NEW ORLEANS
LOUISIANA

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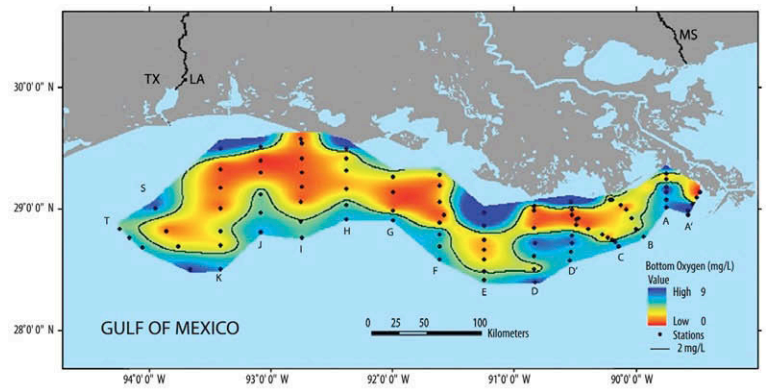
Progress and Reassessment 2001–2007



Areal Extent of 2007 Hypoxic Zone

Data courtesy of N. Rabalais and A. Sapp

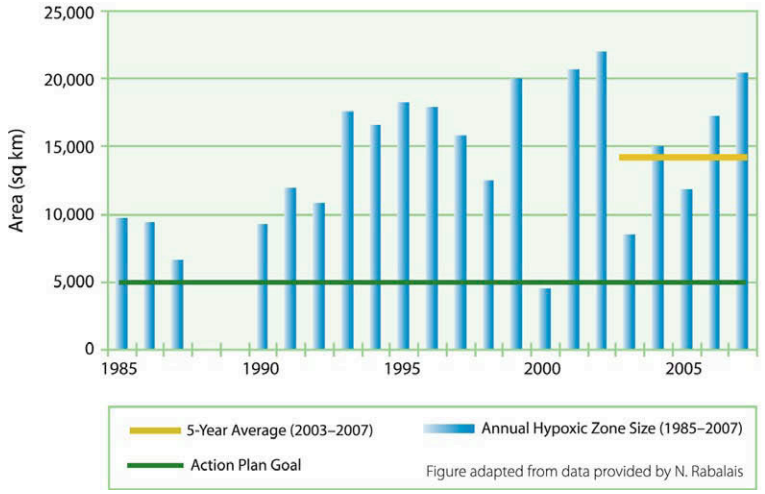


Figure 2. Size of Gulf Hypoxic Zone

Trends in the Size of the Hypoxic Zone

The hypoxic zone in the Northern Gulf of Mexico forms each summer and can extend up to eighty miles offshore and stretch from the mouth of the Mississippi River westward to Texas coastal waters. The size of the hypoxic zone varies considerably each year, depending on natural and anthropogenic factors. In 2007, the measured size of the hypoxic zone was 20,500 square kilometers (7,900 square miles), about the size of the state of Massachusetts, the third largest hypoxic zone since measurements began in 1985 (Figure 2). The goal of this Action Plan is to reduce the five-year running average size of the zone to less than 5,000 square kilometers (about 1,900 square miles). The current five-year average (2003–2007) is 14,644 square kilometers (5,600 square miles), more than twice the size of the goal.

Trends in Nitrogen and Phosphorus in the Basin

With a twenty-year average (1985–2005) annual stream flow of over 20,000 cubic meters per second, the Mississippi River carries large amounts of sediments and nutrients from its watershed, resulting in large nutrient loads* delivered to the Gulf of Mexico at the river terminus. Nutrient loads vary greatly and are positively related to streamflow. According to the United States Geological Survey (USGS), between 1985 and 2005, nutrient loads ranged from lows of 810,000 metric tons of nitrogen and 80,700 metric tons of phosphorus to highs of 2,210,000 and 180,000 metric tons of nitrogen and phosphorus, respectively (Figure 3).

It is especially important to understand the sources of these nutrient loads that flow into the Gulf of Mexico. Analysis of five-year averages, from 2001–2005, of nutrient loads from the various sub-basins indicates that 80% of the nitrogen load delivered to the Gulf of Mexico came from the Ohio/Tennessee and

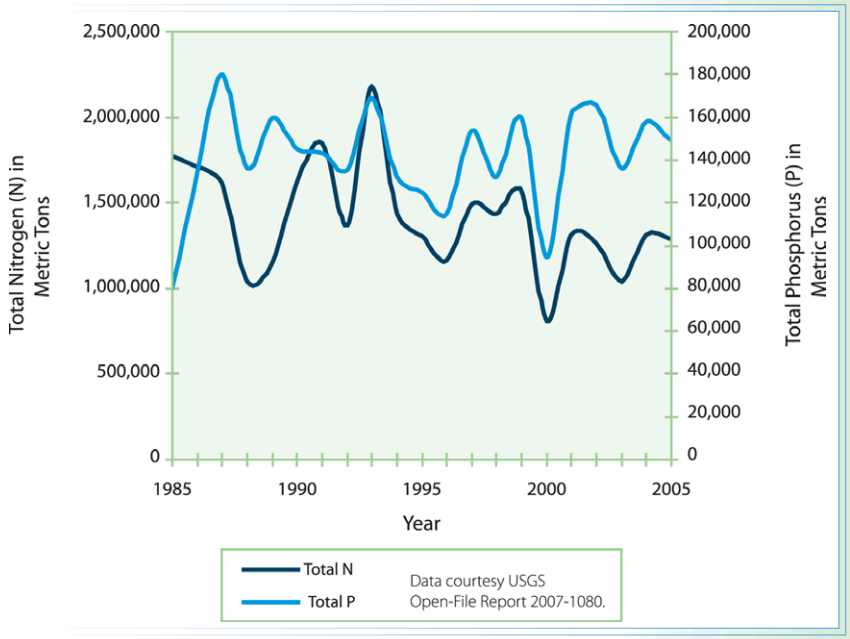


Figure 3. Nutrient Loads in the Mississippi/ Atchafalaya River Basin (1985–2005)

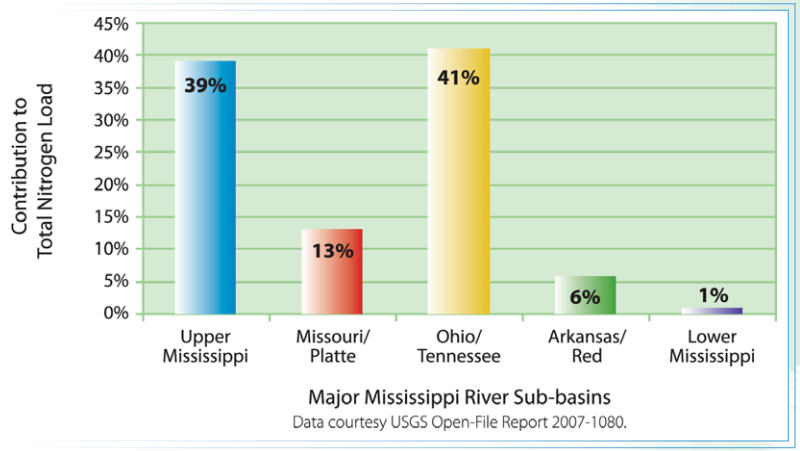


Figure 4. Nitrogen Loads to the Gulf by Sub-basin (2001–2005 average percentage)

*Load (often called flux) is the amount (mass) of a chemical in a river that passes a given point over a given period of time. It is calculated by multiplying the average streamflow (discharge) of the river by the average concentration of that chemical in the river over that time period.

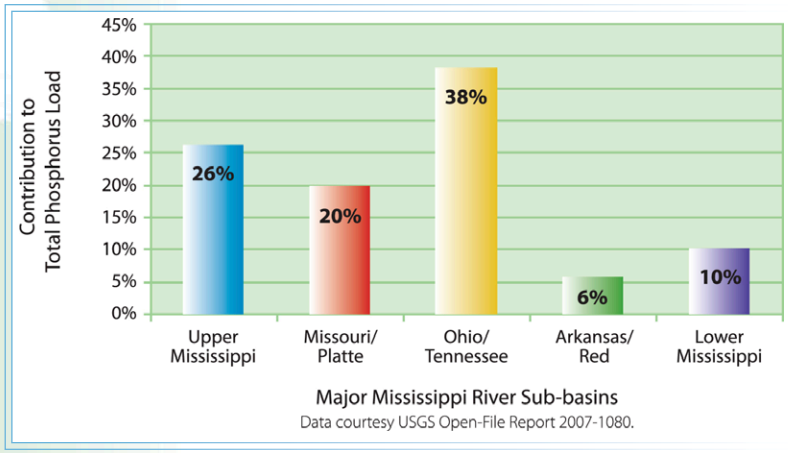


Figure 5. Phosphorus Loads to the Gulf by Sub-basin (2001–2005 average percentage)

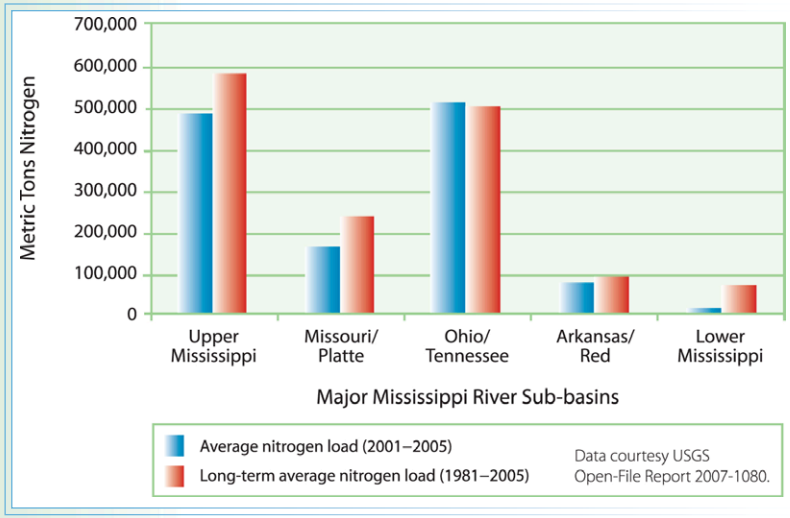


Figure 6. Mississippi River Basin Nitrogen Load by Sub-basin

Upper Mississippi River Sub-basins (Figure 4), which contributed 41% and 39% of the load, respectively. Similar analysis shows that from 2001–2005, the Ohio/Tennessee and Upper Mississippi River Sub-basins were the greatest contributors of phosphorus loads to the Gulf of Mexico as well, contributing 38% and 26%, respectively (Figure 5). The Missouri/ Platte, Lower Mississippi, and Arkansas/Red Sub-basins contributed 20%, 10%, and 6%, respectively.

Figures 6 and 7 show both the long term average and the most recent 5-year average (for which data is available) nitrogen and phosphorus loads for each sub-basin in the Mississippi/Atchafalaya River Basin.

Overall, total annual loads to the Gulf from 2001–2005 show a 21% decline in nitrogen load and a 12% increase in phosphorus load when compared to the average from the 1980–1996 period. However, during the spring period (April, May, and June) most of the reduction in total nitrogen load was from nitrogen forms other than nitrate, an important form fueling the primary production that leads to hypoxia development in the spring.

Progress on Actions in the *2001 Action Plan*

Of the eleven actions identified in the *2001 Action Plan*, several have made significant progress:

- The States established Sub-Basin Committees for the Upper Mississippi Basin, the Ohio Basin and the Lower Mississippi Basin. These committees have worked to coordinate actions in the sub-basin states. The Sub-Basin Committees have opened the discussion to include many stakeholders not represented on the Task Force, including additional basin states, state agencies, and interested parties and organizations. (*Action 2 of 2001 Action Plan*)

- The Task Force issued an integrated monitoring, modeling and research strategy (MMR workgroup report), for the Basin and Gulf to guide the development of the nutrient reduction strategies as well as future scientific research. The MMR workgroup report was a driver for research strategies of the National Oceanic and Atmospheric Administration's (NOAA) Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program, which supported studies advancing understanding of causes and impacts of the hypoxic zone. (*Action 3 of 2001 Action Plan*)

- After detailed planning and building on the recommendations of the MMR workgroup report, NOAA conducted additional monitoring of the hypoxic zone on a seasonal and annual basis, though this has not "greatly expanded" the long-term monitoring program, as many important needs persist (see next section). (*Action 4 of 2001 Action Plan*)

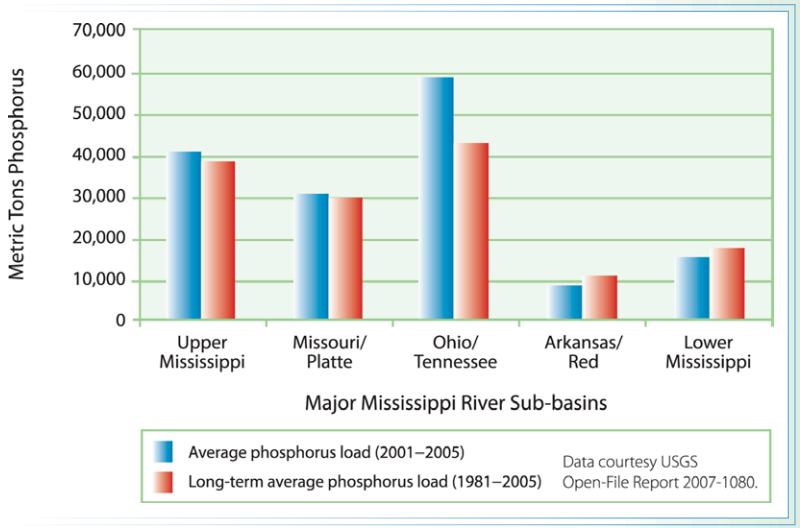


Figure 7. Mississippi River Basin Phosphorus Load by Sub-basin

Millionth CREP Acre Enrolled

In the Fall of 2007, USDA enrolled farmland in Minnesota as the one millionth acre in its nationwide Conservation Reserve Enhancement Program (CREP).

CREP is a community-based, results-oriented effort that focuses on local participation and leadership and addresses high-priority conservation issues of both local and national significance, such as impacts to water supplies, loss of critical habitat for threatened and endangered wildlife species, soil erosion, and reduced habitat for fish populations.

As a component of USDA's Conservation Reserve Program administered by the Farm Service Agency, CREP is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat and safeguard ground and surface water. Partnering with tribal, state and federal governments and private groups, USDA establishes contracts with agricultural producers to retire highly erodible and other sensitive cropland and pastureland. During the 10- to 15-year contract period, participants convert enrolled land to grass, trees, wetlands, wildlife cover and other conservation uses. CREP supports increased conservation practices such as filter strips and forested buffers, which help protect streams, lakes and rivers from sedimentation and agricultural runoff.

Farmers in local communities deserve much of the credit for CREP's overwhelming success. Without their commitment to CREP, this innovative program would not have reached this milestone.

- Higher resolution spatial data were added to large watershed-scale models to help identify smaller watersheds for focused nutrient reduction efforts. (*Action 5 of 2001 Action Plan*)

- The Ohio and the Lower Mississippi Sub-Basins began development of nutrient reduction strategies at the sub-basin level, incorporating specific issues and proposals from the states within those basins. (*Action 6 of 2001 Action Plan*)

- Increased assistance to agricultural producers through U.S. Department of Agriculture (USDA) programs for voluntary actions resulted in an additional 1.4 million acres of wetlands restored, enhanced, or created and an additional 2.3 million acres of conservation buffers installed within in the Basin during fiscal years 2000–2006. (*Action 9 of 2001 Action Plan)*

- Increased assistance to agricultural producers through USDA programs for the voluntary implementation of best management practices, which are effective in addressing loss of nutrients to water bodies, has resulted in conservation tillage/ residue management practices applied to

20.8 million acres and nutrient management applied to 18.3 million acres in the Basin during fiscal years 2000–2006. A total of 42.8 million acres of conservation tillage, nutrient management, wetland, and conservation tillage practices were applied, not counting additional areas impacted by wetland and buffer practices. *(Action 10 of 2001 Action Plan)*

- The Task Force completed a major reassessment of the science and actions to support the Action Plan principle of adaptive management. (*Action 11 of 2001 Action Plan*)

However, some of the actions called for in the 2001 plan have not been initiated, authorized or completed:

- An integrated federal budget that would have supported voluntary actions to reduce nutrient pollution in the Basin and thereby the size of the hypoxic zone in the Gulf was never finalized. (*Action 1 of 2001 Action Plan*)

- The long-term monitoring program for the hypoxic zone has not been "greatly expanded," and uncertainties remain in the ability to characterize the spatial and temporal dynamics of hypoxia and the biological, chemical, and physical properties that contribute to it. *(Action 4 of 2001 Action Plan)*

- Water quality monitoring in the Basin has not significantly increased and in some cases long term stations included in the USGS network have been discontinued. (*Action 5 of 2001 Action Plan*)

- Although some work has begun on the development of nutrient strategies at the sub-basin level, much work still needs to be accomplished. *(Action 6 of 2001 Action Plan)*

- Congress did not authorize and fund a reconnaissance-level study for the U. S. Army Corps of Engineers (USACE) and partners to specifically assess the potential for nutrient reductions in federal (EPA, U.S. Fish and Wildlife Service (FWS), National Resources Conservation Service (NRCS), USACE) river and farmland management, refuge management, and navigation projects. Without specific Congressional language, work could not commence. *(Action 7 of 2001 Action Plan)*

Nutrients reach rivers in the Mississippi/Atchafalaya River Basin through urban stormdrains.

Scientific Basis for Hypoxic Zone Management

With a commitment greater than $12.5 million since 2001, NOAA has continued to provide the scientific foundation on Gulf of Mexico ecosystem dynamics upon which management of the hypoxic zone is based. As part of this commitment, annual monitoring of the hypoxic zone provides the benchmark for which progress on Action Plan goals is measured. Utilizing an ecosystem-based approach, NOAA research studies have led to enhanced predictive models capable of examining a multitude of interacting factors on the size of the hypoxic zone, and provide information on how hypoxia affects commercially and ecologically important species in the region. These models are integrating oceanographic physical data and coastal biogeochemistry to improve quantification of the duration, timing, and extent of the hypoxic zone, and their relationship to causative factors such as nutrients and stratification. These model predictions of complex processes will continue to allow for the comprehensive assessment of alternative management strategies to mitigate hypoxia in the Gulf of Mexico.

- Additional analysis of detailed nutrient pollution contributions from multiple sectors, including point sources and non-agricultural contributions, needs to be undertaken. (*Action 8 of 2001 Action Plan*)

Updating the Science

The Task Force undertook a major reassessment of the state of the science for the causes, effects, and management actions for reducing Gulf hypoxia.

- In the fall of 2006, the Task Force agencies and the Sub-Basin Committees completed a series of four scientific symposia on the science surrounding Gulf hypoxia and nutrient sources, fate, and transport in the Mississippi/Atchafalaya River Basin.

- The Task Force completed a major technical report, *A Science Strategy to Support Management Decisions Related to Hypoxia in the Northern Gulf of Mexico and Excess Nutrients in the Mississippi River Basin* (MMR workgroup report), published in 2004. The report describes a framework for monitoring, modeling, and research activities to support management decisions related to achieving the three major goals of the *2001 Action Plan*. It describes the scientific information needed to support management actions and defines the scope, interrelation, and framework of the activities needed to provide that information. It also describes existing programs and activities, identifies gaps and limitations in those activities, and outlines the actions and resources needed to overcome the gaps and limitations.

- The Task Force completed a second major technical report, *The Management Action Review Team* report, published in 2006. The report is a compilation of information on point sources in the Mississippi River Basin and available programs that assist landowners, municipalities, and others in the Basin to reduce nutrient loadings. It also shows how such programs could more effectively address nutrient reduction if they were aligned and integrated with the Action Plan. The *Management Action Review Team* report represents the first time the Task Force has compiled a snapshot of programmatic information, and thus it can be used as a resource for future reassessments.

- In August 2006, the Task Force asked EPA's Science Advisory Board to provide independent advice on scientific advances since 2000 that might have increased understanding and options in three general areas:

1. ***Characterization of the causes of hypoxia.*** The physical, biological, and chemical processes that affect the development, persistence, and extent of hypoxia in the Northern Gulf of Mexico.

2. ***Characterization of nutrient fate, transport, and sources.*** Nutrient loadings, fate, transport, and sources in the Mississippi River that affect Gulf hypoxia.

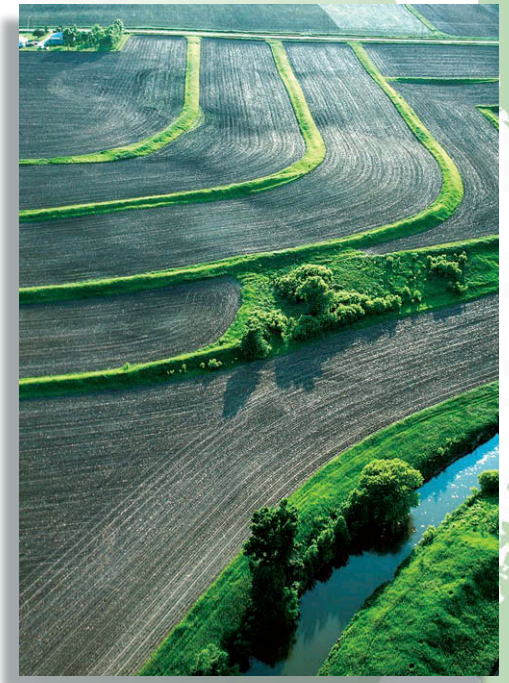
3. ***Scientific basis for goals and management options.*** The scientific basis for, and recommended revisions to, the goals proposed in the *2001 Action Plan*; as well as the scientific basis for the efficacy of recommended management actions to reduce nutrient load from point and nonpoint sources.

Conclusions from the Reassessment

Taken together, the state-of-the-science symposia, MMR workgroup report, *Management Action Review Team* report, and Science Advisory Board findings have advanced our understanding of hypoxia in the Northern Gulf of Mexico, as well as the factors contributing to it. Based on the complete reassessment of the science, the Task Force has agreed on the following main points which inform the actions in this plan:

- It is extremely important to accelerate actions that manage factors affecting hypoxia rather than waiting while science develops greater precision in revising the appropriate size goal for the hypoxic zone.

- The 5,000 square kilometer size of the hypoxic zone, the Coastal Goal set by the *2001 Action Plan,* remains a reasonable goal in an adaptive management context; however, it may not be possible to achieve this goal by 2015. The hypoxic zone, measured in July 2007, was the third largest measured.



Contour farming, conservation tillage, and conservation buffers protect soil and improve water quality on this farm in Woodbury County in northwest Iowa.

- While nutrients from the Mississippi/Atchafalaya River Basin, coupled with temperature- and salinity-induced stratification, are indicated as the primary *causes* of hypoxia in the Northern Gulf of Mexico, other factors contribute to increased amounts of nutrients delivered to the Gulf, including:
  - Historic landscape changes in the drainage basin, primarily losses of freshwater wetlands, and increases in artificially drained areas that diminish the capacity of the river basin to remove nutrients,
  - Channelization and impoundments of the Mississippi River throughout the Basin and the delta and the loss of coastal wetlands, and
  - Changes in the hydrologic regime of the Mississippi and Atchafalaya Rivers and the timing of freshwater inputs that are critical to the stratification which is necessary for hypoxia. The diversion of a large amount of freshwater from the Mississippi River through the Atchafalaya has profoundly modified the spatial distribution of freshwater inputs, nutrient loadings, and stratification on the Louisiana-Texas continental shelf.
- Hypoxia has negative impacts on marine resources. Research on the deleterious effects of hypoxia on living resources in the Gulf suggests the occurrence of long term, ecological changes in species diversity, and possibly a regime shift (a large-scale, often rapid, reorganization of the entire ecosystem's food-web that is difficult and often impossible to reverse).
- Phosphorus also contributes to hypoxia. New information has emerged that more precisely demonstrates the role of phosphorus in determining the size of the hypoxic zone, requiring strategies that address both nitrogen and phosphorus.
- Significant reductions in nitrogen and phosphorus are needed. To achieve the Coastal Goal for the size of the hypoxic zone and improve water quality in the Basin, a dual nutrient strategy targeting at least a 45% reduction in riverine total nitrogen load and in riverine total phosphorus load,

measured against the average load over the 1980–1996 time period, may be necessary.

- Total annual loads to the Gulf from 2001–2005 show a 21% decline in nitrogen load and a 12% increase in phosphorus load when compared to averages from the 1980–1996 period. However, during the spring period (April, May, and June) most of the reduction in total nitrogen load was from nitrogen forms other than nitrate, an important form fueling the primary production that leads to hypoxia development in the spring.

- Considerations of seasonality and nitrogen composition should be emphasized in nutrient reduction strategies. Recent scientific findings have affirmed that spring (April, May, and June) nitrate load from the Mississippi/Atchafalaya River Basin to the Gulf is highly correlated with hypoxic zone size. From 2001–2005, nitrate load to the Gulf during the spring period may not have changed significantly when compared to averages from the 1980–1996 period, despite a 21% decline in total annual nitrogen load and a 12% increase in total annual phosphorus load.

- New estimates of point and nonpoint source contributions are available. Point sources represented 22% of nitrogen and 34% of phosphorus loads, resulting in a higher percentage of the total load to the Gulf from point sources than estimated in 1999. Estimates of the point source load would be at the upper end of the range, as they assume delivery to the Gulf without any in-stream losses. Nonpoint sources, including atmospheric deposition, represented 78% of nitrogen and 66% of phosphorus loads; accordingly, these numbers would be at the lower end of the range.

- Anthropogenic nitrogen and phosphorus contributions have declined. Net anthropogenic nitrogen inputs (NANI) and net phosphorus inputs for the Mississippi/Atchafalaya River Basin have declined in the last decade because of more efficient use of fertilizer (as evidenced by increasing corn harvest and constant or declining fertilizer application rates). From 1999–2005, NANI calculations show 54% of nonpoint nitrogen inputs in the Mississippi/Atchafalaya River Basin were from fertilizer, 37% from fixation, and 9% from atmospheric deposition.

Steamboats are a historical reminder that the Mississippi River is a major artery of the nation's transportation system, sustaining commerce and economic growth.

Industrial Nutrient Discharge Reductions

Recognizing the impacts of nutrient pollution on the hypoxic zone in the Gulf, the Louisiana Department of Environmental Quality (LDEQ) works with industries and municipalities along the Mississippi River to reduce nutrient discharges, consistent with Action 8 of the *2001 Action Plan*. Voluntary programs, like the Louisiana Environmental Leadership Pollution Prevention Program (LaELP) engage professional, environmental, industrial, and municipal associations to improve the quality of the environment through pollution prevention, community environmental outreach, and environmental management.

Since 2000, the LaELP has recognized three industrial businesses for significant nutrient discharge reductions: IMC Phosphates (now Mosaic Industries), BASF Corporation, and ExxonMobil. Both BASF Corporation and IMC Phosphates have been acknowledged with "Special Recognition for Outstanding Nutrient Reductions," a category created to highlight Louisiana's special concern for hypoxia in the Gulf of Mexico and to emphasize the need for nutrient reductions.

Two **IMC-Agrico** plants were recognized for implementing a comprehensive, long range by-product management improvement campaign. This provides inactive phosphogypsum stacks with a synthetic liner and a clay/grass cover, and has resulted in more than an 80% reduction, over 100 million lbs., in average annual phosphorus discharges. While the program was voluntary, IMC-Agrico agreed to place the reductions in permits to ensure long-term compliance.

BASF Corporation was recognized for developing a biological treatment system that converts nitrates in wastewater — that would otherwise have been discharged to the Mississippi River — to atmospheric nitrogen and other non-nutrient parameters. Specifically, a new process was added that completed the denitrification process using "anoxic treatment" and specific bacteria that live in low oxygen environments that break down nitrates. The result has been an annual reduction of over 2.3 million lbs. of nitrates in BASF's permitted discharged wastewater since implementation began in 1999. BASF has transferred ownership of the process to the Water Environment Research Foundation for wider use.

The **ExxonMobil Baton Rouge Refinery**, the second largest petroleum refinery in the nation, was recognized by both the LaELP and the EPA's Gulf Guardian Award for reducing annual nitrate discharges from 4.1 million lbs. in 1999 to 1.5 million lbs. in 2003. ExxonMobil's management team established a nitrate reduction objective and supported it through a five-year effort that included an extensive engineering analysis. As a result of the analysis, process operations were modified to run two ammonia strippers in parallel and the refinery wastewater treatment facility began operating under anoxic conditions. This reduction effort was not only voluntary, but was achieved without capital expenditure.

Recently, the Secretary of LDEQ reaffirmed the Department's commitment to the many objectives of the LaELP and the special nutrient reduction effort in particular. As a result, the LaELP will continue to recognize activities and projects that demonstrate environmental leadership including innovative pollution prevention efforts implemented by its partners to reduce point source nutrient discharges to the Mississippi River.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Contents

Next Steps:

Atchafalaya River Delta.

Getting Results

Actions to Accelerate the Reduction of Nitrogen and Phosphorus

To reduce the size and impacts of the hypoxic zone and improve water quality in the Mississippi/Atchafalaya River Basin, landowners and resource managers must reduce nitrogen and phosphorus in the surface waters of the Mississippi/Atchafalaya River Basin. Although many other natural and seasonal factors contribute to the formation of the hypoxic zone, reducing nutrient loadings from the various sources in the Basin addresses the most critical and controllable cause of hypoxia. No single action or strategy will achieve the necessary reductions. The optimal approach will take advantage of the full range and variety of actions to reduce nutrient loss to waters and increase nutrient retention and removal.

The work of the Task Force will continue to provide a basin-wide context for the continued pursuit of both voluntary, incentive-based efforts for nonpoint sources and existing regulatory controls for point sources. Improved coordination and, in most cases, continued expansion of the outstanding private and government supported efforts to reduce losses of nutrients are central to the success of this strategy. Throughout the Mississippi/Atchafalaya River Basin much work is underway to increase the efficiency of farming

practices, reduce point and nonpoint sources of pollution, and restore wetlands and riparian buffers. Landowners and managers primarily are taking these actions to achieve local water quality goals or implement conservation practices and management practices.

Even though current activities of landowners and managers will contribute to reducing the size of the hypoxic zone and improving basin water quality, they are not sufficient to meet the goals of this plan. Current funding for the necessary actions is insufficient. In addition, emerging issues, such as biofuels, climate change, changes in agricultural practices, and new technologies for monitoring and modeling will have significant effects on the design and implementation of this plan. The Task Force has identified the actions listed below to encourage and advance the continued implementation of cost-effective, voluntary, incentive-based best management practices and conservation practices at the local and regional level—actions to both reduce loss of nutrients into the water and to reduce those loads once they exist. These actions are intended to support and add greater specificity to the actions begun under the *2001 Action Plan*.

Following each action are the reasons for the action, the key players, and the process for implementing the action. Because many of these actions are beyond the scope of existing state and federal water quality and conservation efforts, they will achieve only limited progress without additional financial (and in some cases legislative) support. Therefore, the plan also includes a description of the "critical needs"—additional funding and analyses that are essential to achieve significant reductions in the size of the hypoxic zone. The Task Force is committed to meeting these critical needs, wherever possible, and is publishing a separate, more detailed Operating Plan to guide the implementation of these actions.

Phosphorus Reduction

Phosphorus is the nutrient primarily responsible for the eutrophication of Minnesota's surface waters. An overabundance of phosphorus results in excessive algal production in Minnesota waters. In response to a dissolved oxygen TMDL on the Lower Minnesota River, Minnesota developed the *Statewide Phosphorus Report* which quantifies the phosphorus loading to Minnesota waters from various point and nonpoint sources. In 2005, Minnesota developed a Phosphorus General Permit for forty point sources in the Minnesota River Basin. Under the permit, the point sources have the option of trading to meet their water quality-based effluent limits.

The Metropolitan Council owns and operates eight municipal wastewater treatment plants in the Twin Cities metropolitan area of St. Paul and Minneapolis. Since 1990, the Council has achieved dramatic reduction in phosphorus discharged from its plants to area receiving waters. Since the peak of phosphorus discharge in 1995, the Council has achieved a 78% reduction in phosphorus loads.

To understand the magnitude of such a reduction, it would be as if we went back to before 1900. At that time, the metropolitan area had a population of 500,000 people and it is estimated that 1,860 lbs/day of phosphorus was discharged to area rivers. Today, 2 million more people live in this area, yet discharge only 1,670 lbs/day.

Farmers use a line-transect method of determining the percentage of ground covered by crop residues for soil protection.

Complete and implement comprehensive nitrogen and phosphorus reduction strategies for states within the Mississippi/Atchafalaya River Basin encompassing watersheds with significant contributions of nitrogen and phosphorus to the surface waters of the Mississippi/ Atchafalaya River Basin, and ultimately to the Gulf of Mexico.

WHY DO THIS?

Because the soils, hydrology, land use, and cropping practices as well as the legal, legislative, and administrative framework vary considerably across the 31 states in the Basin, the Task Force recognizes that no single approach to nutrient reduction would be effective in every state. All states already have programs to reduce nutrient losses from both point and nonpoint sources. However, while most states have plans within those programs to reduce their water quality problems, those plans are often focused on local or regional water quality. Existing plans may need to be modified to incorporate nitrogen and phosphorus reduction activities within the state to reduce loadings to the Gulf, while continuing to protect and restore local water quality. These strategies will provide a road map for each state, a more detailed basis for budget development and implementation, and a vehicle for coordination with other states in the Basin. Once the state strategies are developed and adopted by the broad reach of stakeholders throughout each state, and new funding is provided, Federal and State agencies and many involved stakeholders can accelerate their efforts to reduce nutrient impacts on local waters and the Gulf.

WHO WILL TAKE THE LEAD?

Mississippi/Atchafalaya River Basin States, Federal agencies

WHO ELSE WILL HELP?

Sub-basin Committees, local stakeholder groups, and other regional groups

HOW DO WE DO THIS?

State nutrient reduction strategies should be completed as soon as possible but no later than 2013. Strategies should target those watersheds with significant contributions of nitrogen and phosphorus to the surface waters of the Mississippi/Atchafalaya River Basin and ultimately to the Gulf of Mexico. Ongoing nutrient

pollution control efforts should continue, while states, in collaboration with other states in the Basin and Federal agencies, complete the strategies and seek necessary funding. Implementation of the state strategies should be started as soon as practicable, but no later than 2013. The development of state nutrient reduction strategies as prescribed by this plan is to be complementary to, and shall in no way delay or interfere with the progress of any existing or planned nutrient reduction activities, or identification of priority watersheds. To further advance progress, the States should provide a list of activities for incorporation into the Annual Operating Plans, identifying planned nutrient reduction activities and the corresponding availability and needs for funding.

Implementation of the Action Plan will require a significant level of commitment from the Federal agencies and State and local governments, and increased awareness and action by the many varied stakeholders. Existing relationships with key stakeholders should be maintained and additional relationships developed with other stakeholders to develop and implement strategies to reduce nutrient loads to the Gulf of Mexico and to water bodies within the Basin. The States are uniquely qualified to identify the key stakeholders within their states who can influence opinion and support needed changes in practices and programs. State agencies have established relationships with their constituents, whether agricultural producers or regulated entities such as wastewater facilities. This approach will allow Federal and State agencies and stakeholders in each state to focus on activities that will be most effective in their area.

WHAT ARE THE CRITICAL NEEDS?

Federal agencies, working with the States and the Sub-Basin Committees, will need to establish incentives through the 319 program, Farm Bill programs, or other federal funding sources to provide additional resources for the development and implementation of state-level nutrient reduction strategies.

The States and Federal agencies must coordinate efforts across organizations and programs and use adaptive management to modify the strategies as new information and innovative solutions are acquired to identify critical watersheds, assess current conditions, and maximize potential nitrogen and phosphorus reductions with the most cost-effective approaches.

On-Farm Assistance

Since 2005, over $1 million has been provided to landowners in Arkansas for installation of on-farm structures to reduce sediment and nutrient runoff. These projects have been implemented in the Arkansas River and Bayou Bartholomew/Beouf-Tensas basins. Overwhelming public participation and interest has created additional opportunities for implementation of nutrient reduction programs in other Mississippi River tributary watersheds.

Complete and implement comprehensive nitrogen and phosphorus reduction strategies for appropriate basin-wide programs and projects. Target first those programs and projects with significant federal lead or co-implementation responsibilities.

WHY DO THIS?

Federal agencies have significant programs and projects that affect water quality in the Gulf and locally throughout the Basin. In some cases a Federal agency may have direct lead for a specific activity, such as management of water flow and navigation on large, interstate rivers or management of fisheries. In other cases federal programs help to set the parameters of programs that are co-implemented or delegated to states, such as technology standards for wastewater treatment or criteria used as the basis for water quality standards. Broader federal strategies are also needed to establish a context and approach to guide and coordinate the actions of these other partners. These strategies could include programs to identify effective nutrient reduction approaches, including streamlining regulatory requirements, utilizing innovative funding mechanisms, and implementing best management practices. For example, a federal strategy for restoration of the Mississippi/Atchafalaya River Basin's natural assimilative system would facilitate and help coordinate federal and state actions to implement the plan. These federal, basin-level strategies will help set a framework for individual state action and support collaborative efforts for program planning and implementation.

WHO WILL TAKE THE LEAD?

Federal agencies, Mississippi/Atchafalaya River Basin States

WHO ELSE WILL HELP?

Sub-basin Committees, other regional groups

HOW DO WE DO THIS?

Federal strategies for programs and projects with the greatest impact on nutrient levels within the Basin should be identified by June 2008 and completed by 2009. As part of the strategy, Federal agencies will identify opportunities to align existing programs with hypoxia efforts. For example, the USACE should

look for opportunities to reduce nutrient loadings related to Corps projects and programs, ensure that environmental and related documents specifically address the hypoxia impact, and take advantage of environmental projects to create wetlands and reconnect backwater and riparian zone areas to absorb nutrients. Efforts should be made to better engage the research and development expertise in the Corps with regard to reducing nutrient loadings related to Corps civil works projects. Another example is for EPA to provide direct financial and technical support to its state partners in the Mississippi/Atchafalaya River Basin as they develop a scientific basis to assist in the adoption of state numeric nutrient standards. These cooperative efforts not only will serve to assist the states in protecting in-state water quality, but also may result in reduced nutrient loadings to the Gulf. More detail on each agency's effort is documented in the Annual Operating Plan.

WHAT ARE THE CRITICAL NEEDS?

The opportunity may exist through the implementation of the 2007 Farm Bill for additional conservation technical assistance, including rapid watershed assessments to help prioritize use of limited financial assistance for producers, establishing a Regional Water Enhancement Program to provide funding to support development and implementation of water quality plans at the watershed scale, providing funding to support conservation innovation addressing nutrient reductions, and additional funding for working lands (Environmental Quality Incentive Program) and wetland restoration, creation, and enhancement (Conservation Reserve Program/ Wetlands Reserve Program/Conservation Technical Assistance).

Ongoing analysis of the impacts of emerging issues on water quality, such as the increased production of biofuels, will also be critical to ensure that the nitrogen and phosphorus strategies will continue to improve water quality in the Mississippi/Atchafalaya River Basin and ultimately the Gulf of Mexico.

Additionally, an interagency coordination strategy to leverage USDA, EPA, USACE, and other funding mechanisms to eliminate financial barriers for private landowners implementing conservation practices to address nutrient runoff from neighboring properties will aid in the implementation of these federal strategies.

Managing sediment sustains economic activity and can contribute to ecosystem restoration and protection.

While developing comprehensive state and federal nitrogen and phosphorus reduction strategies and continuing current reduction efforts, examine and, where possible, implement opportunities to enhance protection of the Gulf and local water quality through existing federal and state water quality, water management, and conservation programs.

WHY DO THIS?

For programs whose primary intent is not to mitigate hypoxia, such as wildlife habitat enhancement, conservation practices, navigation controls, or wastewater discharge permits, incorporating considerations of additional benefits into implementation decisions can result in the "win-win" outcome of adding increased nutrient retention and capture benefits to these programs, and consequently improving water quality downstream and in the Gulf.

The guiding principle of this plan is that when establishing priorities for watershed restoration, States, Tribes, and Federal agencies within the Mississippi/Atchafalaya River Basin will consider the potential for benefits to the Gulf of Mexico. This principle is especially important in the context of changes in agricultural markets such as the increased demand for corn for ethanol production that could have a substantial effect on nutrients delivered to the Gulf. Many federal, state, and tribal programs offer the opportunity to enhance nutrient reductions, whether large water infrastructure projects or day-to-day decisions on zoning, permitting, and land use planning. However, most state, tribal, and federal projects usually only address local water quality concerns. Support for approaches that protect local water quality, including drinking water sources, can be leveraged to increase support for mitigating Gulf hypoxia. There is frequently strong public support for protecting drinking water sources. Public awareness and support for local water quality benefits can increase support for actions that ultimately reduce Gulf hypoxia. These entities should consider this guiding principle, ensuring that these projects, including land and river management strategies, and flood control and navigation projects throughout the Basin, examine their effect on Gulf hypoxia as well as look for opportunities to increase the ability to reduce nutrients which harm local waters, including drinking water sources, and the Gulf, through design and operation changes.

WHO WILL TAKE THE LEAD?

USACE, U.S. Department of the Interior (DOI), EPA, USDA, Mississippi/Atchafalaya River Basin States

WHO ELSE WILL HELP?

Sub-basin Committees

HOW DO WE DO THIS?

Each Federal agency and State will identify opportunities for implementing cost-effective nutrient reduction through existing programs. Two examples of how to do this are given below, although there are many other programs at each participating Federal agency that will need to be included.

One example of this is the manner in which USDA plans to address concerns about the effect that increased biofuels production will have on nutrient loads to the Gulf. Management of agricultural lands in the Mississippi River Basin is not static, but invariably changes in response to changes in the demand for agricultural commodities. USDA provides technical and financial assistance to farmers and ranchers to help them address environmental concerns associated with agriculture production. The technical foundation for this assistance is the development and application of conservation practice standards through several conservation programs that address a wide variety of environmental issues in addition to water quality. These programs are designed to help maintain the sustainability of agricultural lands regardless of their use. Given the need for further reductions in nutrient loads to the Gulf, in the delivery of its programs within the Mississippi Basin, USDA will place additional emphasis on conservation practices with high potential for reducing nutrient loadings. These conservation practices include nutrient management, cover crops, the siting of wetlands, and on-farm drainage water management. This approach permits agriculture production to adjust to meet the changing needs of the market while maintaining the sustainability of the resource base and minimizing environmental effects.

USDA will encourage the increased use of its nutrient management standard to minimize nutrient loss from fields to help alleviate the impact of increased biofuels production on nutrient loads to the Gulf. The nutrient management standard requires farmers to account for all plant-available nutrient sources immediately available or rendered available throughout the crop production cycle

When heavy rains occur, unprotected farm fields can yield topsoil, as well as farm fertilizers and other potential pollutants.

and to apply only the amount of nutrients needed to maintain nutrient balances. Nutrient applications needed to maintain nutrient balances are based on realistic yield expectations and attempt to maximize profitable production. The use of cellulosic feedstocks, such as crop residues, perennial grasses, and trees for biofuels production will require utilization of different conservation systems and conservation practice standards, such as the one for residue management. USDA will continue to adjust current standards and develop additional standards, where needed, to permit cellulosic feedstocks to be produced and utilized in a sustainable manner.

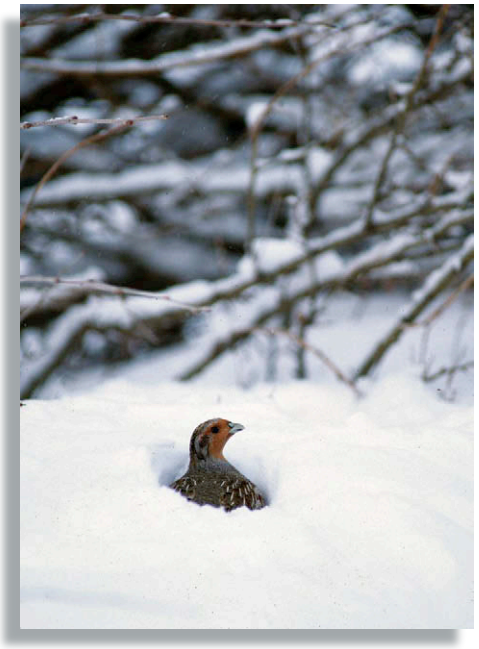
Another example is the massive coastal protection/restoration program being undertaken by the State of Louisiana, the federal government, and various stakeholder groups. The most critical element of this program involves retaining river sediment and river-borne nutrients within the coastal marshes to the greatest degree possible by redistributing river water throughout the delta before it reaches the Gulf of Mexico. Diverting river water into the deltaic system on a large scale could provide an important sink for some of the excess nutrients that

cause hypoxia through plant uptake, bacterial processing, and sedimentation. In addition, increasing the number of outlets for river water could significantly increase mixing in the coastal ocean and reduce salinity stratification and the setup conditions for hypoxia. There is substantial evidence that such a program would save wetlands now in jeopardy and increase productivity and sequestration of both nutrients and carbon.

While this apparent "win-win" strategy is complex and expensive, authorization and funding for Louisiana's critical river diversion program has garnered broad public support. There are, however, serious environmental concerns about releasing huge volumes of nutrient-rich river water into the estuarine zone instead of into the nearshore ocean where it goes today. Thus, river diversions could be postponed until nutrient levels are significantly reduced upstream, although such postponement could undermine the restoration of what has come to be known as "America's Wetland."

WHAT ARE THE CRITICAL NEEDS?

- Identify barriers to aligning existing programs, projects, and initiatives with needs of hypoxia.
- Continue funding as defined by current budget requests for actions identified in the Annual Operating Plan.



A riparian buffer provides shelter and other habitat for wildlife along Bear Creek in central Iowa.

Contents

Actions to Advance the Science, Track Progress and Raise Awareness

The Task Force identified other actions to achieve its goals and improve awareness of the efforts to address hypoxia in the Gulf of Mexico. These actions will improve the effectiveness of nutrient reduction and track and report on the results of the effort. The actions emphasize the crosscutting nature of the problem and recognize the diversity of activities that must be undertaken to achieve the goals and the need to track and respond to progress.

These additional actions advance the adaptive management approach and periodically reassesses the state of the science, keep track of progress of both environmental measures and programmatic actions, and seek to continually engage involved stakeholders in order to maximize results. Since the *2001 Action Plan*, researchers have advanced the understanding of nutrient transport and fate in the Mississippi/Atchafalaya River Basin and the consequences on Mississippi/Atchafalaya

River Basin water quality and the Northern Gulf of Mexico's hypoxic zone. States and Federal agencies will seek to further advance science in the priority needs recommended in the MMR workgroup and Science Advisory Board reports. Furthermore, effective implementation of this Action Plan will require monitoring and tracking progress. Finally, the *2008 Action Plan* is the result of several years of study and discussion by the members of the Task Force and many concerned officials, organizations, and citizens who participated in the deliberations. Given the cooperative and voluntary nature of the *2008 Action Plan*, its implementation will be dependent upon broad acceptance and a willingness to pursue the identified actions. The engagement of stakeholders will continue to be a priority.

The following actions implement the principle of adaptive management for this strategy.

This aerial photo shows the channelization of the Mississippi River and the loss of coastal wetlands.

Develop and promote more efficient and cost-effective conservation practices and management practices for conserving nutrients within the Mississippi/Atchafalaya River Basin watershed and evaluate their effectiveness at all scales beginning with local watersheds and aggregating them up to the scale of the Mississippi/Atchafalaya River Basin.

WHY DO THIS?

Understanding the most efficient and cost-effective conservation practices and management practices to reduce nutrient loads is central to the success of nutrient reduction strategies. Federal and State agencies and other partners need to be able to identify effective management practices and technologies, including conservation practices and wastewater treatment at the local scale, and large scale federal approaches to enhance the biological removal of nutrients. We also need to incorporate changing contexts in conservation practices and management practices and accurately assess the economic costs and benefits of different approaches.

WHO WILL TAKE THE LEAD?

USDA (Agricultural Resource Service, Cooperative State Research, Education, and Extension Service, NRCS, Farm Service Agency), Mississippi/Atchafalaya River Basin States, USACE

WHO ELSE WILL HELP?

EPA, USGS

HOW DO WE DO THIS?

1. Continue to develop field and farm scale management practices that conserve nutrients for the wide range of agricultural production systems within the Mississippi/Atchafalaya River Basin;

2. Quantify the effectiveness of conservation practices within local watersheds that are representative of the wide range of soils, climates, and farming systems within the Mississippi/Atchafalaya River Basin;

3. Review, update, or develop USDA NRCS national and state conservation practice standards for the practices most effective in conserving nutrients;

4 Assist State Extension, USDA personnel and agricultural consultants in delivering nutrient-conserving practices to farmers and ranchers within the Mississippi/Atchafalaya River Basin; and

5 Further analyze nutrient pollution contributions from point sources and non-agricultural sectors, including a full analysis of costs; target cost-effective actions to reduce nutrient loads from point sources as warranted.

WHAT ARE THE CRITICAL NEEDS?

- Obtain resources necessary to quantify at the watershed scale the efficacy of newly evolving nutrient control strategies proven effective at plot and field scales to ensure that these strategies produce equivalent benefits at the landscape scale.

- Obtain resources necessary to use the Conservation Effects Assessment Project (CEAP) Watershed Network to monitor and assess how changes in agricultural practices driven by future market and other forces may affect efforts outlined above to reduce nitrogen and phosphorus inputs to the Gulf of Mexico. Progress toward reducing nutrient loads from agricultural lands could be assessed annually.

- Obtain resources and priority for the development and implementation of strategies to use National Resources Inventory (NRI)/CEAP for monitoring progress in reducing nutrient loads from agricultural land management activities, to provide 5–10 year estimates with trends.

- It will be difficult to achieve the necessary nutrient reductions utilizing current technologies and with current cropping practices in the Corn Belt. New scientific findings and technology development will likely be needed.

Identify and, where possible, quantify the effects of the hypoxic zone on the economic, human and natural resources in the Mississippi/Atchafalaya River Basin and Northern Gulf of Mexico, including the benefits of actions to reduce nitrogen and phosphorus and the costs of alternative management strategies.

WHY DO THIS?

Researchers have greatly expanded our understanding of the effects of hypoxia. However much uncertainty remains, specifically concerning the indirect biological and socioeconomic effects of hypoxia and excess nutrients throughout the Mississippi/Atchafalaya River Basin and on the Gulf.

As State and Federal agencies, and other partners make progress reducing nutrient loads within the Basin, we need to better understand the changes that are occurring, their effects on the ecosystem and its economic resources, the costs and benefits of seeking additional reductions in loads throughout the Basin, and the additional effects that reductions in nitrogen and phosphorus may have on the economic and social welfare of the Mississippi/Atchafalaya River Basin.

Research into the impacts of the hypoxic zone on living resources is authorized through the Harmful Algal Bloom and Hypoxia Research and Control Act. Within the Gulf ecosystem there is evidence that an ecological regime shift, associated with the expansion of hypoxia in the Northern Gulf of Mexico, has occurred. Effects of the hypoxic zone on fisheries and ecologically important species are often likely to be indirect and difficult to measure. Spatially-explicit ecosystem models are needed to quantify these indirect effects and their consequences on fisheries and ecologically important populations. Economic analysis of these impacts will improve resource assessments and help to better quantify the socioeconomic benefits of nutrient reduction achievements in the Mississippi/Atchafalaya River Basin.

WHO WILL TAKE THE LEAD?

USDA, NOAA, USACE, EPA

WHO ELSE WILL HELP?

DOI, Mississippi/Atchafalaya River Basin States

HOW DO WE DO THIS?

1. Conduct an economic assessment of alternative options for reducing nutrient loads;

2. Identify and assess the ancillary environmental effects of the alternative options for reducing nutrient loads;

3. Improve quantification of the indirect effects of hypoxia on living resources, especially those related to interactions with additional stressors (e.g., fishing and climate change), to inform model development and management strategies;

4. Quantify the socioeconomic effects of hypoxia on coastal communities along the Northern Gulf of Mexico, especially impacts to commercial and recreational fisheries;

5. Quantify the socioeconomic effects on basin states from implementation of practices that will be required to meet the nutrient reduction goals of the Action Plan; and

6. Track progress to support future science assessments.

WHAT ARE THE CRITICAL NEEDS?

- Continued resource allocation for a USDA Hypoxia Economic Analysis to assess the socioeconomic and bioeconomic implications of varying nutrient management scenarios.

- Expansion of resources for ecological impact studies on commercially and ecologically important species, such as those funded by NOAA's Northern Gulf of Mexico Ecosystems and Hypoxia Assessment Program, to advance model capabilities that predict the impacts of hypoxia.

- Coordination and expansion of faunal monitoring surveys, such as SEAMAP, with increased resource allocations for fishery-independent data on commercially and ecologically important fish and shellfish species.

- Quantified nutrient loading thresholds and corresponding ecological responses to determine the magnitude of ecological system resiliency (i.e., point of regime change) within the northern Gulf.

Hypoxia is one of many ecological stressors that can affect Gulf fisheries and consequently fishing communities.

Coordinate, consolidate, and improve access to data collected by State and Federal agencies on Gulf Hypoxia and Mississippi/Atchafalaya River Basin program activities and results.

WHY DO THIS?

Currently many agencies are independently collecting, storing, and reporting information on progress and activities. The Task Force has committed to ensure that data collection methodologies are better described to aid reporting and ensure data comparability. In particular, some significant sources are not consistently collected or reported, leading to misunderstandings of their contributions to the total load to the Basin and Gulf.

WHO WILL TAKE THE LEAD?

EPA, USGS, NOAA

WHO ELSE WILL HELP?

USACE, Mississippi/Atchafalaya River Basin States, Sub-basin Committees, Upper Mississippi River Basin Association, Lower Mississippi River Conservation Committee, Ohio River Valley Sanitation Commission, Gulf Alliance

HOW DO WE DO THIS?

1. Define information needs and design a strategy to satisfy those needs in a comprehensive and interdisciplinary manner that brings scientists and resource managers together from a range of disciplines and perspectives, including from Gulf and Basin perspectives;

2. Gather and disseminate needed scientific information in a manner that is cost-effective, takes advantage of all existing activities, and explains the practical value of synergies gained from actions taken to address both local water quality and the quality of receiving waters;

3. Provide information gathered from monitoring, modeling, and research related to Gulf hypoxia, Basin water quality, and social and economic factors in a form and a timeframe that feed directly into complementary scientific

interpretations, management planning, and implementation; and

4 Share, among scientists and managers, all information relevant to improving research and management decision-making, including those decisions that are directed primarily at other issues indirectly related to hypoxia, but also contribute to achieving the goals of the Action Plan.

WHAT ARE THE CRITICAL NEEDS?

Current activities are unlikely to resolve serious inconsistencies or provide additional data from unmonitored sources. Additional work is needed to define processes for acquiring, documenting, storing, and accessing data. Particularly, we need to develop and implement programs to measure nitrogen and phosphorus discharges from non-agricultural sources for which data are not currently collected, such as municipal water treatment systems, and industrial, urban wet-weather, and air deposition sources. We also need to develop and implement strategies for using NRI/CEAP to monitor progress regarding reducing nutrient loads from agricultural land management activities. We need to design and implement a coordinated, ongoing state and federal sustainable monitoring program as recommended in the MMR workgroup report for the hypoxic zone and for the fresh waters of the Mississippi/Atchafalaya River Basin that would allow comprehensive temporal and spatial data acquisition to assess progress.

Track interim progress on the actions to reduce nitrogen and phosphorus by producing an annual report on federal and state program nutrient reduction activities and results.

WHY DO THIS?

There remain serious gaps in our ability to track and evaluate the effectiveness of programs and management efforts and their interactions in reducing the hypoxic zone. More attention should be paid and resources expended on improving the understanding of which efforts are the most effective, and how effective they are, so we can better design and target future actions.

WHO WILL TAKE THE LEAD?

EPA

WHO ELSE WILL HELP?

Mississippi River/Gulf of Mexico Watershed Nutrient Coordinating Committee, USDA (NRCS)

HOW DO WE DO THIS?

1. Identify existing methods that can quantify the results of the existing suite of best management practices and conservation practices, and adapt or modify these methods to quantify best management practices and conservation practices used in the Mississippi/Atchafalaya River Basin that will impact hypoxia;

2. Coordinate with NRCS to collect state and federal implementation data; and

3. Use data to annually evaluate the effectiveness of programs and management efforts.

WHAT ARE THE CRITICAL NEEDS?

- Consistent data that is standardized across programs.
- Authority and staff, financial or in-kind support.

The sediment plume from the Mississippi River is clearly delineated in the Gulf of Mexico.

Continue to reduce existing scientific uncertainties identified in the Science Advisory Board and MMR workgroup reports regarding source, fate, and transport of nitrogen and phosphorus in the surface waters of the Mississippi/ Atchafalaya River Basin to continually improve the accuracy of management tools and efficacy of management strategies for nutrient reduction.

WHY DO THIS?

Gaps still exist in the science surrounding source, fate and transport of nitrogen and phosphorus in the Mississippi/ Atchafalaya River Basin. Eliminating these gaps is essential to the creation and implementation of effective nutrient reduction strategies.

WHO WILL TAKE THE LEAD?

USGS

WHO ELSE WILL HELP?

USDA, EPA, USACE, Mississippi/Atchafalaya River Basin States

HOW DO WE DO THIS?

1. Evaluate and rank the scientific uncertainties and monitoring needs identified in the MMR workgroup report, the Science Advisory Board report, and other information;

2. Develop and implement a long term research and monitoring strategy under the MMR Workgroup of the Coordinating Committee with greater emphasis on the spatial and temporal characteristics of nutrient source, fate, and transport in watersheds throughout the Mississippi/Atchafalaya River Basin;

3. Reduce uncertainties associated with predictive models allowing for improved adaptive management capabilities;

4 Integrate monitoring, modeling, and experimental results to understand the impacts of management actions on the spatial and temporal characteristics of nutrients in watersheds throughout the Mississippi/Atchafalaya River Basin; and

5 Track progress to support future science assessments.

WHAT ARE THE CRITICAL NEEDS?

- Supplement existing monitoring efforts including emphasis for additional monitoring on smaller rivers and streams to enable an understanding of the sources of nutrients, processes that affect nutrient loading, and ways to reduce nutrient loading.

- Further analysis of nutrient pollution contributions from point sources and non-agricultural sectors, including a full analysis of costs.

A USGS employee servicing equipment at a USGS gaging station on the Mississippi River, Baton Rouge, Louisiana.

Continue to reduce uncertainty about the relationship between nitrogen and phosphorus loads and the formation, extent, duration, and severity of the hypoxic zone, to best monitor progress toward, and inform adaptive management of the Coastal Goal.

WHY DO THIS?

Researchers have greatly expanded our understanding of the physical dynamics of the Gulf of Mexico and the causes of hypoxia, providing additional evidence that supports the strategy to reduce the size of the hypoxic zone by reducing nutrient loading to the Gulf. However, improved characterization of nutrient load and hypoxic zone properties is needed to further refine management strategies. As State and Federal agencies and other partners make progress at reducing nutrient loads, improved precision in understanding the effects of a dual nutrient strategy for the hypoxic zone is needed to best inform quantitative load reduction goals that will be required to reach the Coastal Goal. Improvements in hypoxic zone monitoring are needed to better characterize its magnitude and the processes that lead to its development, maintenance, and distribution as well as its impacts. Greater temporal and spatial coverage in monitoring efforts are needed to account for variability and pre-cruise storm events, define boundaries, characterize seasonality, and support modeling efforts. Improvements are needed in the accuracy of models forecasting the quantitative association between biological, chemical, and physical processes, and hypoxia development, magnitude, and extent.

WHO WILL TAKE THE LEAD?

NOAA

WHO ELSE WILL HELP?

EPA

HOW DO WE DO THIS?

1 Evaluate and rank the scientific uncertainties and monitoring needs identified in the MMR workgroup report, the Science Advisory Board report, the *White Paper to Improve Monitoring*

of the Gulf of Mexico Hypoxic Zone in Support of the Hypoxia Task Force's Coastal Goal, and other information;

2. Develop and implement a long term research and monitoring strategy under the MMR workgroup of the Coordinating Committee with greater emphasis on the spatial and temporal extent of the hypoxic zone;

3. Reduce uncertainties associated with predictive models allowing for improved adaptive management capabilities;

4. Integrate monitoring, modeling, and experimental results to understand the impacts of nutrient management actions on the spatial and temporal characteristics of the hypoxic zone; and

5. Track progress to support future science assessments.

WHAT ARE THE CRITICAL NEEDS

- Understanding of nutrient cycling and transformations with emphasis on quantifying the lag time between reductions in nutrient loadings and reductions in the extent of the hypoxic zone.

- A long-term and sustainable hypoxic zone monitoring program, with adequate spatial and temporal coverage. Critical components of this need include:
  - Increasing the number of shelf-wide monitoring surveys beyond the current one per summer with increased number of sampling stations and greater area surveyed;
  - Additional in situ platform-based continuous monitoring devices (observing systems);
  - Mechanism to transition monitoring from a research to an operational framework; and
  - Improved predictive modeling capabilities.

Research vessels support monitoring and assessment of hypoxia in the Gulf of Mexico.

10

Promote effective communications to increase awareness of hypoxia and support the activities of the Task Force.

WHY DO THIS?

There are many stakeholders invested in the effort to reduce hypoxia. While the Task Force has effectively communicated with its member states and agencies, national recognition of the issue and widespread implementation of management practices—two critical aspects to the ultimate resolution of Gulf hypoxia—will require increased cooperation and understanding from other stakeholders throughout the country. Regular, effective, and strategic communications, through public meetings, annual reports, and other communication mechanisms will be important components of outreach efforts to expand public awareness.

WHO WILL TAKE THE LEAD?

EPA

WHO ELSE WILL HELP?

USDA (NRCS), USACE, Mississippi/Atchafalaya River Basin States

HOW DO WE DO THIS?

1. Create and maintain a Web site for accessing current information on Task Force activities, status of actions, and all associated monitoring, modeling, and research plans and products;

2. Identify and promote existing communication tools for outreach and education that are deemed most effective in reducing nutrients; and

3. Develop and distribute annual report for the general public and Task Force describing the condition of the Mississippi/Atchafalaya River Basin and Gulf hypoxic zone, actions accomplished, and objectives for the next year.

WHAT ARE THE CRITICAL NEEDS?

A Strategic Communications Plan that outlines a process and focuses on effective outreach to both the general public and specific stakeholders. The Communications Plan will focus on:

- Creating and maintaining a Web site for accessing current information on Task Force activities, status of actions, and all associated monitoring, modeling, and research plans and products.
- Identifying and promoting existing communication tools for outreach and education that are deemed most effective in reducing nutrients.
- Developing and distributing an annual report for the general public and Task Force describing the condition of the Mississippi/Atchafalaya River Basin, Gulf hypoxic zone, actions accomplished, and objectives for the next year.
- Developing and distributing communications materials for the general public.

The Task Force Communications Plan can be assembled using existing staff resources. Under current levels of funding, communications efforts will remain status quo and relatively limited and will not meet the goal of expanding public awareness of Gulf Hypoxia and the publication of the Action Plan. To reach a broader audience, several activities outlined by the Task Force can be strengthened with a relatively modest increase in funding by engaging communications/media specialists and increasing publication of communications pieces and outreach materials to communicate the ongoing efforts of the Task Force.

An employee of Trees Forever helps students plant a tree that is part of a demonstration riparian buffer in west central Iowa. Trees Forever is helping establish more than 100 such demo sites across Iowa.

11

In five years (2013) reassess nitrogen and phosphorus load reductions, the response of the hypoxic zone, changes in water quality throughout the Mississippi/Atchafalaya River Basin, and the economic and social effects, including changes in land use and management, of the reductions in terms of the goals of this Action Plan. Evaluate how current policies and programs affect the management decisions made by industrial and agricultural producers, evaluate lessons learned, and determine appropriate actions to continue to implement or, if necessary, revise this strategy.

WHY DO THIS?

The Task Force has always been committed to adaptive management as we continue to implement strategies to reduce hypoxia. Because of the tremendous scientific attention drawn by the Gulf and Mississippi/Atchafalaya River Basin, as well as the rapidly changing practices surrounding biofuels, changing climate, and national economics, the Task Force believes that a significant reassessment is necessary every five years.

WHO WILL TAKE THE LEAD?

EPA

HOW DO WE DO THIS?

1. Determine reassessment strategy in FY2009;

2. Identify quantitative measures of in-basin nutrient reductions that exhibit progress toward both the Within Basin and Coastal goals. Measures will be developed at the state level with support as necessary from Federal agencies;

Farmers in Jackson County, Iowa, inspect corn planted no-till into sod.

3 Identify scientific needs and financial and staff resources according to reassessment strategy; and

4 Implement reassessment strategy.

Appendix

Members of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

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Resources

EPA's Mississippi River Basin and Gulf of Mexico Hypoxia Web site: http://www.epa.gov/msbasin

EPA Science Advisory Board. 2008. *Hypoxia in the Northern Gulf of Mexico. An Update by the EPA Science Advisory Board*. Washington, DC. EPA Science Advisory Board. EPA-SAB-08-003. Available on EPA's Science Advisory Board Web site at: http://yosemite.epa.gov/sab/sabproduct.nsf/C3D2F27094E03F90852573B800601D93/$File/EPA-SAB-08-003complete.unsigned.pdf

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