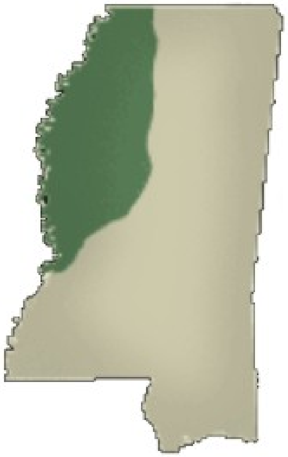
Mississippi Delta Nutrient Reduction Strategies



IMPLEMENTATION DRAFT
DECEMBER 15, 2009

Mississippi Delta
Nutrient Reduction Strategies

Prepared for

Delta F.A.R.M. (Farmers Advocating Resource Management)
and
Mississippi Department of Environmental Quality

Prepared by

FTN Associates, Ltd.

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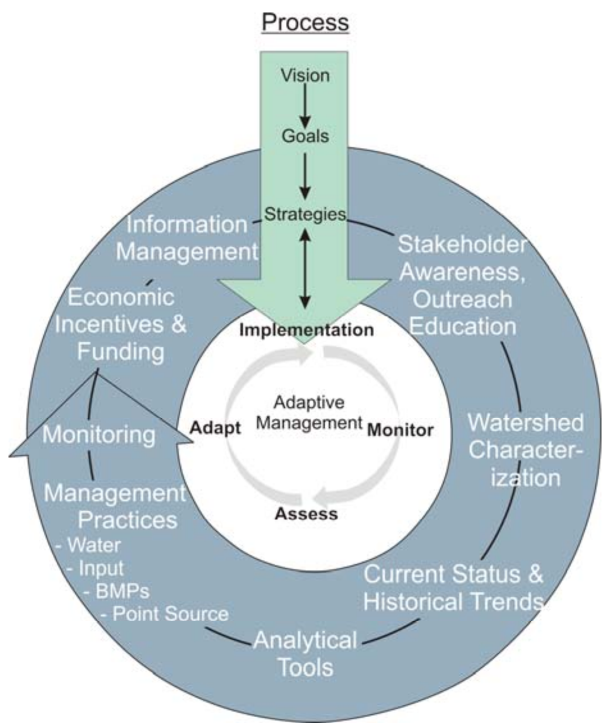
EXECUTIVE SUMMARY

The Mississippi River/Gulf of Mexico Hypoxia Task Force and the Gulf of Mexico Alliance both have Action Plans that call for the reduction of nutrients to the Gulf of Mexico. Mississippi, as a member of both programs, is developing Mississippi Delta Nutrient Reduction Strategies as part of these efforts to reduce nutrients to the Gulf of Mexico. Delta Farmers Advocating Resource Management (F.A.R.M.) and Mississippi Department of Environmental Quality are co-leading this effort to answer four key questions:

1. What nutrient load reductions are achievable?
2. What will these reductions cost?
3. What is the value to each stakeholder from these reductions?
4. What nutrient reductions will protect Delta waterbodies and the Gulf of Mexico?

To provide satisfactory answers to these questions requires more than just deciding on which management practices need to be implemented and where. The approach being taken in Mississippi is to develop an holistic and comprehensive set of nutrient reduction strategies.



The Mississippi Delta nutrient reduction strategy development process began with a visioning exercise with key partners and stakeholders to ensure a consistent approach, promote leveraging of resources, and foster stakeholder buy-in (side figure).

A planning team, composed of multiple governmental agencies, non-profit organizations, academia, and agricultural producers, provided the direction for this effort. Eleven Work Groups formulated the details for 11 strategic elements: 1) Stakeholder awareness, outreach and education; 2) Watershed characterization: 3) Current status and historical trends; 4) Analytical tools; 5) Water management; 6) Input management; 7) Best management practices; 8) Point source treatment; 9) Monitoring; 10) Economic incentives and funding sources; and 11) Information management (Side Figure). Each of these strategic elements is described in this report.

Implementation of these strategies has begun in six watersheds within the Delta, following an adaptive management approach.

Participants, Affiliations

Visioning Team

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Jerry Cain, MDEQ
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Planning Team

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Work Groups

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Economic Incentives and Funding	**Kent Parrish, USACE Vicksburg District** Trey Cooke, Delta F.A.R.M. Richard Ingram, MDEQ Dr. Kent Thornton, FTN Associates, Ltd.
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Figure 1. Map of MARB.

Figure 2. Major river basins of Mississippi.

INTRODUCTION

The Mississippi River/Gulf of Mexico Hypoxia Task Force released the *Gulf Hypoxia Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico and Improving Water Quality in the Mississippi River Basin* in June 2008. The task force is led by the U.S. Environmental Protection Agency (EPA), and includes state environmental and agricultural agencies within the Mississippi/Atchafalaya River Basin (MARB) (Figure 1), as well as federal agencies whose mission deals with agriculture and water quality-related issues. A key component of the Gulf Hypoxia Action Plan is the development and implementation of state nutrient reduction strategies. Mississippi is also a member of the Gulf of Mexico Alliance (GOMA) and leads the Nutrient Priority Issue Team. In June 2009, GOMA released its Governor's Action Plan II for Healthy and Resilient Coasts. A key component of this plan includes a focus on developing and implementing state nutrient reduction strategies.

The Mississippi Department of Environmental Quality (MDEQ) is participating with a task force-facilitated forum, the State Nutrient Reduction Strategy Work Group, to develop a consistent approach among MARB States to reduce nutrient loadings to the Gulf. As a first step, MDEQ is co-leading an effort with Delta Farmers Advocating Resource Management (F.A.R.M) to develop a nutrient reduction strategy for the Delta region of Mississippi, Mississippi's primary row-crop agricultural area.

The Mississippi Delta covers the western half of the Yazoo River Basin (Figure 2), the largest river basin in the state. Designated stream, lake, and reservoir uses currently are not being attained in a number of Delta waterbodies. Under a Federal Consent Decree, MDEQ developed 48 nutrient Total Maximum Daily Load (TMDLs) studies on evaluated non-attaining waters in the Yazoo River Basin during 2008. With limited monitoring data upon which to model assimilative capacities, a mass balance approach was used for most of the TMDLs. This approach did not consider nutrient fate or transport. The TMDLs call for nutrient load reductions of around 80% for nitrogen and over 90% for phosphorus. There is general agreement that the magnitude of these reductions is not feasible. This situation has created the need for focused nutrient reduction watershed projects and studies to answer four questions:

1. What levels of nutrient reductions are achievable?
2. What will they cost?
3. What is the value to each stakeholder from these nutrient reductions?
4. What levels of nutrient reductions will protect Delta waterbodies and benefit the Gulf of Mexico?

GUIDING PRINCIPLES

Guiding Principles

Five principles guide the 2009 GOMA Action Plan II. These five principles are also applicable for guiding the Delta nutrient reduction strategies:

1. Encourage voluntary, incentive-based, practical, cost-effective actions.
2. Use existing programs.
3. Follow adaptive management.
4. Identify additional funds needed and sources.
5. Identify opportunities for innovative, market-based solutions.

Building Blocks

In addition to these five principles, there are five building blocks on which the Delta nutrient reduction strategies are founded.

1. Use collaborative teams of stakeholders, governmental agencies, non-governmental organizations, academia, businesses, and agricultural producers to develop the nutrient reduction strategies.
2. Leverage resources (budgetary, personnel, expertise).
3. Formulate integrated, comprehensive nutrient strategies.
4. Do the best you can with what you have, recognizing that, through adaptive management, improvements will be made over time.
5. Emphasize local watershed nutrient reductions and water quality improvements, which also provide cumulative, regional benefits for downstream waterbodies and the Gulf of Mexico.

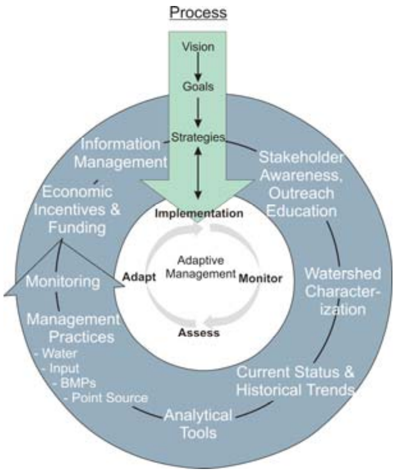

Figure 3. Process of developing and implementing nutrient reduction strategies.

Vision:

Sustained productive, profitable agriculture; attained waterbody designated uses; and improved quality of life for Delta communities as stakeholders collaborate, cooperate, and work together.

APPROACH

The approach used to develop integrated, comprehensive nutrient strategies for the Mississippi Delta reflects these building blocks and guiding principles. The process used to formulate the nutrient reduction strategies is shown on Figure 3 and discussed below. Additional detailed information is included in the Appendices. This process was developed through the interactions of three different teams – a Visioning Team, Planning Team, and individual strategy Work Groups. The strategies will be implemented through Watershed Implementation Teams.

Visioning Team

A Visioning workshop was the first step in the process of developing the nutrient reduction strategies. Participants at this workshop included senior administrators of the primary participating agencies and organizations, and individuals representing prominent stakeholder groups in the Delta. The purpose of the workshop was to elicit a vision, goals, expectations, concerns and path forward for developing nutrient reduction strategies for Delta waterbodies.

The **vision** for the nutrient reduction strategies is: Sustained productive, profitable agriculture; attained waterbody designated uses; and improved quality of life for Delta communities as stakeholders collaborate, cooperate, and work together.

The **goals** for the nutrient reduction strategies are based on the four questions stated in the Introduction:

1. Determine what levels of nutrient reductions are achievable.
2. Determine the costs associated with these nutrient reductions.
3. Quantify the value and benefits to stakeholders from these reductions.
4. Determine what levels of nutrient reductions will protect Delta waterbodies.

The Visioning Team also provided considerations for the strategic planning process and highlighted potential concerns related to nutrient reduction strategies (see

Planning Team:

- ***Inclusive Stakeholder Representation***
- ***Broad Range of Expertise***
- ***Collaborative Interactions***
- ***Comprehensive Approach***

Appendix A). The Visioning Team recommended the formation of a planning team to provide oversight and guide the development of the nutrient reduction strategies. They also provided suggestions for members of the Planning Team.

Planning Team

A planning team, co-led by Delta F.A.R.M. and MDEQ, was formed and included about 30 representatives from the agencies, organizations, and stakeholder groups shown in Table 1. The objective was for the strategy development process to be inclusive and transparent, facilitating collaboration, cooperation, and buy-in of the process. The planning team, therefore, included individuals and organizations with a broad range of expertise including: input nutrient management; best management practices; point source reduction; watershed and water quality modeling; watershed planning; water quality; agricultural production; agricultural extension, outreach, and research; producers; drainage and water management; in-field, edge of field, and in-stream monitoring; socioeconomics; and education.

Table 1. Planning Team Representation.

Delta F.A.R.M.	Producers (farmers)
Mississippi Department of Environmental Quality	Yazoo Water Management District
Farm Bureau	USDA Natural Resources Conservation Service
Delta Drainage Districts	US Environmental Protection Agency Region 4
US Geological Survey	US Army Corps of Engineers
Mississippi State University	MSU Extension Service
Mississippi Soil and Water Conservation Commission	US Department of Agriculture Agricultural Research Service National Sedimentation Lab
US Environmental Protection Agency Gulf of Mexico Program	MSU Geo Resources Institute
Delta Council	The Nature Conservancy

12 Critical Elements

1. **Involve and Engage Stakeholders**
2. **Establish Quantitative Reduction Targets**
3. **Characterize Delta Watersheds and Prioritize Sites**
4. Review Approaches Being Used by Other States
5. Synthesize Current Status and Historical Trends in Delta Systems
6. Document Lessons Learned from Other Studies Within the Delta
7. Evaluate and Select Appropriate Analytical Tools
8. Propose Management Practices Applicable for Delta Watersheds and Receiving Waterbodies
9. Implement Monitoring Programs
10. Create/Identify Economic Incentives and Funding Sources
11. Document and Communicate the Results
12. Practice Adaptive Management; Focus on Sustainability

Twelve critical elements for a Delta nutrient reduction strategy were identified by the Planning Team and are described below.

1. ***Involve and Engage Stakeholders –*** Landowners must be involved and engaged if voluntary management practices are to be implemented. This includes not only stakeholder outreach and education, but also awareness that nutrients are an issue in Delta waterbodies. Stakeholder beliefs, perceptions, and insights need to be identified and incorporated in the outreach and education efforts. While there are costs associated with implementing various management practices, there are also benefits that accrue. This information needs to be provided and presented so these benefits are recognized and understood.

2. ***Establish Quantitative Reduction Targets –*** Mass balance equations were used in the nutrient TMDLs to estimate the reductions needed to attain target nitrogen and phosphorus concentrations in Delta streams. As noted above, however, **there was general agreement that these reductions cannot be achieved. In addition, the vision is to attain designated uses for these waterbodies, not necessarily a specific nutrient target.** Assessing the attainment of these designated uses will include considerations of the biological response of the aquatic ecosystem to nutrients. These nutrient-biological relationships are either currently unknown or are not well understood for Delta streams, and need to be developed. With an understanding of how biological communities respond to nutrients, quantitative nutrient reductions to achieve a desired biological response associated with a designated use can be established so that progress can be tracked over time. Ultimately, a quantitative reduction target is required for adaptive management. However, the interim goal is to determine what quantitative nutrient reductions can be achieved.

3. ***Characterize Delta Watersheds and Prioritize Sites –*** With around 4 million acres in the Delta, where do we start? One strategy for determining where early successes might be achieved and where conditions might be optimal for estimating the percent nutrient

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reductions achieved through different management practices is to determine the characteristics of different watersheds and catchments throughout the Delta. These characteristics might include soil types, land cover/land use, stream and riparian habitat attributes, land ownership, crops and cropping practices, receiving waterbody quality and type, point source contributions, current management practices, and other attributes, such as the nesting of farms within catchments within watersheds. An understanding of the different Delta catchment characteristics, combined with a set of desired management practice criteria, can be used to select an initial set of watersheds for implementation of the strategies. The benefits of different combinations of management practices in reducing nutrient loads, at the edge of field, in receiving waterbodies, and in downstream transport can then be evaluated and documented for these watersheds. This information can also be used to help establish the characteristics of reference watersheds and waterbodies.

4. ***Review Approaches Being Used by Other States –*** Nutrient reduction strategies and approaches have been, and are being, developed by other states and programs (e.g., Chesapeake Bay Program). Reviewing these approaches can provide insight into approaches that might be applicable or tailored for the Mississippi Delta.

5. ***Synthesize Current Status and Historical Trends in Delta Systems –*** To determine what reductions are needed requires an understanding of the current status or condition of these watersheds and receiving waterbodies, and their historical trends. In many cases, historical trends indicate the future direction of water quality changes for the next several years. Aquatic ecosystems exhibit lags in response to changes in sediment and nutrient inputs. Understanding historical trends can provide insight into the magnitude and duration of these lags and contribute to more realistic expectations of how long it might be before a significant response can be observed following the implementation of management practices. Establishing the current water quality status provides a baseline for documenting and quantifying future reductions. There are not many monitoring sites with long-term water quality

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information throughout the Delta. Establishing baseline conditions before implementing management practices, therefore, is a priority.

6. ***Document Lessons Learned from Other Studies Within the Delta –*** There have been a number of studies conducted within the Delta from which lessons can be learned, including Beasley Lake, Bee Lake, Lake Washington, Steele Bayou, and the Management Systems Evaluation Areas program. Case studies such as these can help illustrate how stakeholders were involved; provide nutrient reduction estimates, lag times, system responses, and relative costs; illustrate how management practices might be combined and implemented; and identify remaining issues that need to be resolved. These lessons learned might be extrapolated to other sites or practices within the Delta.

7. ***Evaluate and Select Appropriate Analytical Tools –*** There are a number of tools that are applicable for estimating and assessing potential nutrient reductions associated with implementing different management practices. These include the obvious tools such as empirical (nutrient loading models) and dynamic (AnnAGNPS, WASP, SWAT) models, but also tools such as GIS and LiDAR. A review and recommendation of applicable tools needs to be included as one of the strategies for designing, siting and assessing the potential reductions from multiple management practices implemented within these Delta watersheds.

8. ***Propose Management Practices Applicable for Delta Watersheds and Receiving Waterbodies –*** The Planning Team recommended this strategic element be partitioned into four parts:

   a. *Water Management* – Nutrients are transported to receiving waterbodies either through groundwater or surface water. How water is managed in the Delta plays a major role in nutrient transport. Retaining water on the field can reduce surface water runoff of nutrients, but can also reduce crop production and yield if soils become water-logged. Reuse and recycling of nutrients in irrigation return flow to fields can reduce additional fertilizer

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application, but could reduce summer base flows in streams. Traditional and innovative water management practices need to be reviewed, their advantages and disadvantages identified along with their potential for complementary use with other BMPs, and recommendations provided for different crops, cropping practices, and areas of the Delta.

b. *Input Management* – One way to reduce nutrients running off fields is to reduce nutrients applied to fields. Nutrients don't run off if plants take up or assimilate all the applied nutrients. In addition, there are cost savings to the farmer if nutrient input goes directly into production. Additional information is needed on how to practically implement expanded input management for Delta farms. Developing practical approaches with documented cost-savings and benefits could significantly reduce fertilizer application to Delta farms.

c. *Best Management Practices (BMPs)* – Traditional and innovative best management practices need to be reviewed for specific application to Delta soils, farms, and waterbodies. There are a number of long established BMPs recommended by NRCS and others that are applicable for the Delta and some that have been used in other states that are not applicable for Delta watersheds. In addition, there are a number of innovative management practices that are emerging that might be applicable for Delta watersheds. These practices need to be compiled, their advantages and disadvantages identified along with their potential for complementary use with other BMPs, and recommendations provided for different crops, cropping practices, and areas of the Delta.

d. *Point Source Treatment* – Point sources (primarily municipal wastewater effluent) and septic systems also contribute nutrients to Delta waterbodies. Different types of distributed and conventional treatment systems need to be considered for reducing point source nutrient inputs to Delta streams. Recommendations on these options and

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management practices, including maintenance, need to be provided and integrated with nonpoint source management practices. Economic incentives and funding sources are available and need to be explored by local communities.

9. ***Implement Monitoring Programs –*** Both pre- and post-implementation monitoring needs to occur if percent reductions, lag times, and system responses are to be determined and documented. Monitoring programs need to be designed so that the information collected is applicable and appropriate for multiple objectives such as developing relationships between nutrients and biological responses, assessing the effectiveness of management practices on nutrient reductions and assessing trends over time. In some instances, the appropriate metrics to monitor need to be determined for Delta waterbodies.

10. ***Create/Identify Economic Incentives and Funding Sources –*** Funds are available from multiple agencies, but this information is not necessarily available from one source or in one repository. Matching funding requirements need to be clearly stated, along with possible sources of funds that can be used to meet these matching funding requirements. Leveraging funds from multiple sources is a cornerstone of this element. In addition, other incentives need to be developed to promote the implementation of management practices. This information should be compiled so it can be readily updated as funding authorization and appropriations change and made readily available for stakeholders to consider and use in applying for funding to implement management practices.

11. ***Document and Communicate the Results –*** The results, including quantitative costs and benefits, need to be analyzed and documented for each management practice and watershed. These results need to be analyzed and presented so they convey clear, concise, and understandable messages to stakeholders, regulatory agencies, and participating organizations.

12. ***Practice Adaptive Management; Focus on Sustainability –*** Adaptive management, or learning by

doing, is the recommended approach for implementing nutrient reduction strategies. The process is to implement – monitor – assess – adapt, if necessary – implement – monitor… Monitoring and assessment are critical elements of adaptive management. In addition to adaptive management, there also needs to be an emphasis on sustainability, so that future operation and maintenance costs can be reduced and practices become self-sustaining. Research is considered to be an integral part of each of the strategies listed above, with an eye toward trying new and innovative approaches that will improve everything from the effectiveness of the management practices to stakeholder involvement to presenting the results.

The Planning Team consolidated some of these strategic elements and recommended eleven work groups to formulate a set of integrated comprehensive nutrient reduction strategies.

Work Groups

Eleven work groups were created to develop strategies for each of the strategic elements. The areas of focus for these work groups are listed in the sidebar. Work groups provided the greatest opportunity for involvement of additional stakeholders with a range of expertise and interests. A member of the Planning Team led each of the Work Groups. The entire Planning Team also worked to identify individuals in, or associated with, the Delta who would be interested and/or have expertise in the Work Group areas of focus. While nutrient criteria development is an important strategic element, this activity is inherently the responsibility of MDEQ and does not require a separate Work Group for development. The MDEQ Water Quality Standards Coordinator, responsible for nutrient criteria development, is a member of the Planning Team.

To initiate the process, a series of questions were developed to help guide thinking and formulation of strategies around each element (Appendix B). Through small group meetings, conference calls, email exchanges, and one-on-one conversations, the Work Groups prepared a preliminary set of strategies and presented these to the Planning Team. The preliminary set of strategies contributed to a discussion of

Work Groups:

1. **Stakeholder Awareness, Outreach and Education**
2. **Watershed Characterization**
3. **Current Status & Historical Trends**
4. **Analytical Tools**
5. **Water Management**
6. **Input Management**
7. **Best Management Practices**
8. **Point Sources**
9. **Monitoring**
10. **Economic Incentives & Funding**
11. **Information Management**

performance measures, or measures of success, that can be tracked to document the success of implementing watershed management practices over time (See Appendix C). The preliminary strategies also helped identify and document information gaps that were subsequently considered in revising the strategies.

The Work Groups refined their strategies, based on Planning Team comments, and collaborated with other Work Groups where there were common information needs or where specific information from one Work Group was needed to implement a step proposed by another Work Group. The consolidated Work Group strategies are presented on the following pages, with some examples of work group collaborations indicated in parentheses.

Stakeholder Awareness, Outreach and Education

We see things not as they are, but as we are (H.M. Tomlinson)

Objective:

Identify target audiences and perceptions of the nutrient issue in Delta waterbodies and formulate effective awareness, outreach, and education programs to address these perceptions.

Audiences

1. Identify the appropriate audiences for targeted outreach and education programs:
    a. Producers,
    b. Commodity groups,
    c. Point source dischargers,
    d. Regulators,
    e. Environmental community, and
    f. General public.

Awareness

1. Determine the underlying beliefs of each of the target audiences concerning nutrient issues in Delta waterbodies.
    a. Review policy, value statements of various organizations (i.e., community beliefs) representing these target audiences for initial understanding of awareness and beliefs related to nutrient issues.
    b. Using information from policy statements, formulate questionnaires and conduct surveys to elicit individual beliefs of representatives from each of these target audiences.
    c. Compare individual and community beliefs with current factual understanding of nutrient elements and issues.
2. Document areas where perception is inconsistent with current factual understanding of nutrient issues.

Outreach

1. Develop conceptual maps of social networks among target audiences.
    a. Describe interrelationships among various target audiences using conceptual social network maps.
    b. Document desired behaviors that appeal to the various target audiences.
    c. Determine potential barriers associated with attaining the desired behaviors.
2. Document mediums used by various target audiences to both receive and communicate information.

Education

MSU Agricultural Field Day

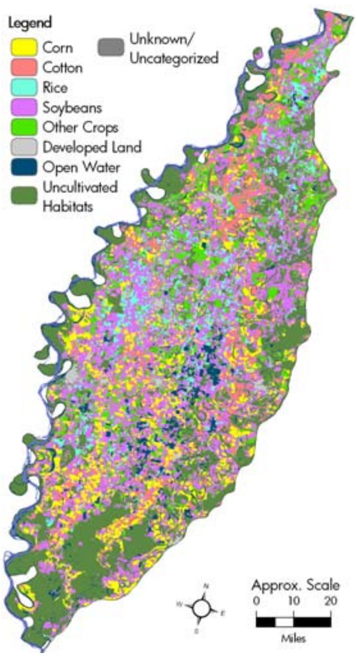
1. Develop educational programs for specific target audiences.
   a. Develop messages that address specific areas where perception and factual understanding are incongruent.
   b. Develop guidelines for reducing barriers associated with the desired behaviors.
   c. Reinforce messages where perceptions are consistent with factual understanding and contribute social, economic, and environmental benefits.
   d. Deliver messages through appropriate mediums and trusted sources, using social marketing approaches.
2. Formulate behavioral economic incentives to encourage acceptance and adoption of desired behaviors. (with Funding WG)
3. Farmer to Farmer Exchange with the state of Iowa procedures.
4. Identify and document economic and social benefits for individual land owners as well as community socioeconomic benefits.
5. Formulate quantitative measures of success for stakeholder awareness, outreach and education and track these over time to document behavioral changes.
   a. Consider social indicators being piloted in the Great Lakes states by the USDA Cooperative Research, Education, and Extension Service as potential measures of success (http://www.joe.org/joe/2009april/a1.php).
   b. Formulate performance measures unique to the Delta that resonate with local shareholders.

Watershed Characterization

Objective:

Characterize, prioritize and target (select) agricultural watersheds in which to implement nutrient management practices.

Characterize Watersheds Within the Delta



2008 Land Use in the Delta

1. Delineate watersheds by Hydrologic Unit Code (HUC) from the finest scale available to 8-digit HUCs.
2. Within each HUC, characterize the watersheds by:
    a. Watershed size;
    b. Geology;
    c. Land use/land cover (including catfish ponds, agricultural crops, and lands in conservation programs);
    d. Soil associations;
    e. Physiography/relief;
    f. Point source dischargers;
    g. Hydrologic types (e.g., ditches, stream order);
    h. Groundwater recharge areas;
    i. Current management practices – opportunistic distribution throughout the watersheds or clustered in contributing areas;
    j. Potential high and low nutrient-loading areas;
    k. Levees, channelization, weirs, dredging, other stream modifications, etc.;
    l. Historical information, including historical land use, if available;
    m. Previous or ongoing studies;
    n. Impaired waterbodies;
    o. Completed TMDLs.
3. Characterize landscape patterns within the basin using the MS Watershed Characterization and Ranking Tool, and develop an Index of Watershed Similarity. Index would assist in paired watershed identification. (with Analytical Tools WG)

Prioritize Watersheds

1. Base prioritization on the following subset of watershed characteristics:
   a. Watershed size;
   b. Availability of historical data (with Monitoring WG, Current Status and Historical Trends WG);
   c. Occurrence of point sources;
   d. Waterbody type(s);
   e. Geographic location;
   f. Watershed nutrient loads/nutrient instream concentrations (with Monitoring WG, Current Status and Historical Trends WG);
   g. Presence of channelization or other stream modifications;
   h. Presence of existing management/restoration projects – in-field, edge of field, instream, downstream;
   i. Impaired waterbody segments;
   j. Completed TMDLs;
   k. Riparian areas and stream stability;
   l. Head cutting/gully forming erosion; and
   m. Likelihood of stakeholder participation.
2. Prioritize using Best Professional Judgment (BPJ) of a team of professionals familiar with the region and watersheds of concern.

Target Watersheds

1. Conduct "on-the-ground" survey to determine:
   a. Stakeholder interest – are people willing to volunteer their time, money, resources to implement and/or maintain nutrient-reducing BMPs?
      i. Stakeholder interest and willingness is critical for selecting watersheds for implementation.
      ii. Interact with the Stakeholder Awareness, Outreach, and Education Work Group to determine stakeholder attitudes and beliefs about nutrient management practices and new technologies/approaches.
   b. Local topography – what types of BMPs will the landscape allow?

c. Soil types – how do the soils contribute to the problem and/or influence what BMPs can be implemented and how?

d. Cropping practices – what types of crops, tillage, fertilization, crop rotation, etc.?

e. Existing drainage – what types of drainage systems, their condition, potential for improvement/expansion?

f. Hydraulic connectivity – how is the watershed connected to downstream systems?

   i. Connected via streams and rivers,

   ii. Connected to local lake/oxbow systems that flow into downstream systems,

   iii. Connected to local lake/oxbow systems that do not connect with downstream systems, or that connect with downstream systems only during high flow events, or

   iv. Connected to an impaired downstream waterbody.

g. Nutrient and other impairments in the waterbody segment – are there also sediment, organic enrichment, bacteria, or other impairments in addition to nutrients?

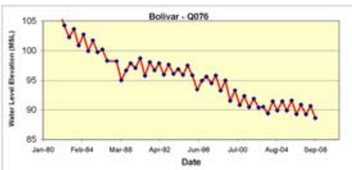
2. Use BPJ to target and select watersheds for implementation of nutrient management practices.
3. Estimate the nutrient budget and contributing sources. (with Analytical Tools WG)
4. Identify opportunities for leveraging resources of multiple groups/agencies. (with Economic Incentive and Funding Sources WG)

Current Status and Historical Trends

Objective:

Document historical trends and establish current baseline of nutrient concentrations and loads in Delta waterbodies.

Historical Trends



Groundwater decline in Bolivar County

1. Query agencies, organizations, and scientists working in the Delta for historical water quality, nutrients, and biological monitoring information or studies.
2. Establish quality assurance and minimum period of record criteria for both assessing current status and historical trends in nutrient concentrations/loads and biological responses to these loads and screening historical information against these criteria.
3. Review historical land use/land cover changes in Delta waterbodies to identify potential "ghosts of land use past" (with Watershed Characterization WG)
4. Establish flow (discharge) – nutrient-loading relationships and seasonal patterns. (with Analytical Tools WG)
5. Determine if there are relationships among biological response metrics/indicators and nutrient concentrations/loads.
6. Assess potential effects of changing analytical methodologies on trend analyses.
7. Evaluate spatial distribution of historical/current monitoring sites and hydrologic waterbody types in establishing historical trends and current status. (with Monitoring WG)

Current Status

1. Determine locations of current monitoring sites and the characteristics of their watersheds, including hydrologic type. (with Watershed Characterization WG, Monitoring WG)
2. Estimate nutrient loads for current locations and rank from lowest to highest.
3. Establish relationships, if any, among land use and nutrient concentrations/loads and among nutrient concentrations/loads and biological responses. (with Watershed Characterization, Analytical Tools WG)
4. Rank locations according to biological condition (e.g., fish, benthic index of biotic integrity, periphyton index) and compare with ranking based on nutrient loads.

Case Studies

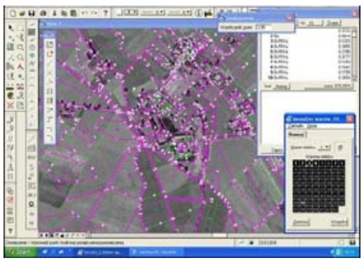
1. Collate and compile studies that have assessed land use, nutrient concentrations/loading, and/or biological condition in Delta waterbodies.
2. Synthesize “lessons learned” from these case studies and provide recommendations for each of the other Work Groups. Document what nutrient reductions have been achieved and the associated costs.

Analytical Tools

Objective:

Guide the application of tools in order to develop the most efficient and effective action plans for the selected watersheds.

Use a Tiered Approach



GIS analysis of agricultural fields

1. Identify which tools are most appropriate at different scales and to answer different questions, such as:
   a. Characterization of watershed (available data, land use, etc.). (from Watershed Characterization WG)
   b. Evaluation of different combinations of BMPs at different locations within selected watershed. (with Best Management Practices WG)
   c. Identification of critical monitoring points within watershed. (with Monitoring WG)
2. Select tools applicable for various types of watershed and waterbodies;
3. Consider two options:
   a. For smaller, well characterized watersheds, use GIS mapping with knowledgeable stakeholders and best professional judgment to locate management practices.
   b. For larger, more diverse watersheds, consider using quantitative models, including the Mississippi Watershed Characterization and Ranking Tools, for targeting the location of management practices in reducing nutrients.

Tool Application – Tool for Specific Nutrient Strategies

4. Use tools to identify current nutrient budget for the watershed.
   a. Consider watershed size in tool selection.
   b. Estimate current loads both for nutrient inputs applied throughout the entire watershed and nutrient exports reaching the mouth of the watershed.
   c. Based on these estimates, identify the most significant nutrient sources and those sources that can be most effectively reduced.
5. Apply tools to enhance the nutrient reduction strategy in the watershed.

a. Determine the desired nutrient reduction target(s). Target could be in terms of the nutrient concentration or an ecological endpoint.

b. Assess the effects of spatial locations on nutrient reduction.

c. Identify potential location and clustering of management practices for collecting monitoring data. (with Monitoring WG)

6. Track the implementation of the BMPs (e.g., use Geographical Information Systems (GIS) to document BMP deployment) and help evaluate BMP effectiveness.

Water Management

Objective:

Integrate sustainable water management practices with nutrient reduction management practices to reduce nutrient loadings and/or increase denitrification to Delta waterbodies.

Water Conservation

1. Identify water management practices that will increase water residence time on watershed soils to increase potential for denitrification without decreasing crop productivity.
2. Recycle nutrients in runoff back onto the fields to reduce nutrient input requirements (with Input Management) and satisfy crop water requirements.
3. Implement conservation practices to reduce groundwater use, which also reduces phosphorus in runoff. (with BMP WG)

Alternative Water Supplies

1. Create additional onsite water storage to increase denitrification, reduce runoff, reduce sediment/phosphorus load, and provide irrigation source water.
   a. Tailwater recovery ponds.
   b. Off-stream storage ponds.
2. Explore intra-basin water transfers to encourage reuse of surface water and associated nutrients for irrigation.

Groundwater Recharge

1. Continue to research natural recharge processes in the watershed and opportunities to protect natural recharge areas. (with Watershed Characterization WG)
2. Implement practices to protect groundwater from nutrient inputs.

Instream Flow/Lake Levels


Low drop elevation weir

1. Investigate achievable minimum instream flows/lake levels, by waterbody type, watershed size, and hydrologic characteristics, to satisfy designated uses. (with Watershed Characterization WG)
2. Use weirs, meanders, and riparian wetlands to increase residence time of water in the channel to promote denitrification.
3. Evaluate potential for increasing contact with stream sediments to promote denitrification.

Input Management

Objective:

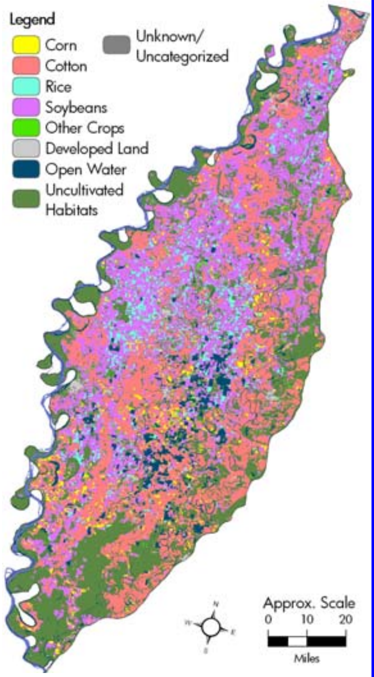
Review and enhance input management to reduce the application of fertilizers to Delta farms.

Categorizing Costs

1. Construct generic budget of costs for producing various crops on Delta farms (e.g., fuel, labor, fertilizer, irrigation, pesticides, seed).
2. Determine which cost categories, if any, are relatively inelastic and/or similar regardless of the crop produced.
3. Identify crop differences, if any, in costs geographically across the Delta.
4. Inquire and document farmers beliefs/concerns/ obstacles in using input management practices/plans to reduce costs or increase yield.

Reducing Costs/ Increasing Revenue

1. Specifically focus on factors that are of concern or create obstacles for adapting and implementing input management.
2. For each cost element, by crop, identify alternative approaches for reducing costs, increasing yield, and/or profit (e.g., variable rate fertilizer application, alternative nitrogen forms).
3. Consider emerging technology to time fertilizer application for maximum uptake or need by plants.
    a. Phenological remote sensing across the Delta.
    b. Canopy reflectance related to leaf nitrogen content.
4. Improve irrigation scheduling for fields to maximize plant uptake and minimize runoff. (with Water Management WG)
    a. Emphasize reuse/recycling of nutrients in irrigation runoff or surface water.
    b. Evaluate soil moisture/plant turgor probes or sensors for scheduling irrigation.
5. Document decreased costs/increased revenue among Delta farmers who have implemented input management practices/plans in production.
6. Interface with work group on economic incentives and funding for alternative funding or revenue sources.



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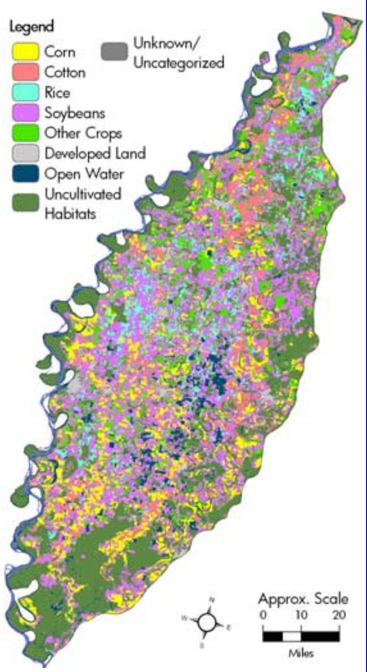

2008

Streamlined management plans to accommodate changing market forces.

7. Determine what information would be needed to change farmers' perception on the benefits of using input management practices/plans to reduce fertilizer application within the Delta.

8. Review emerging markets, genetic modifications, and alternative crops with increased yield and/or reduced production costs appropriate for Delta farms.

9. Develop input management plans streamlined and applicable for large producers. Consider modular nutrient management plans that are reactive to market changes driving crop selection and rotation. Set up farm templates that can be adopted for these changing market forces.

10. Identify specific farmers and farms to pilot input management practices and document benefits.

Best Management Practices

Objective:

Determine which best management practices are most effective and applicable in reducing nutrient concentrations/loads from non-point sources and surface water in the Mississippi Delta region.

BMP Selection & Application

Grassed filter strip

1. Review watershed characteristics (from Watershed Characterization WG), including areas where BMPs are currently in-place, and target sites where BMP implementation could contribute to nutrient reductions.
2. Identify nutrient reduction BMPs that may generate nutrient reductions through proper application and maintenance in the region.
3. Use a spreadsheet or similar analytical tool to prioritize nutrient reduction BMPs based upon performance potential measured by professional knowledge, existing research, literature, and monitoring data as well as added economic and environmental benefits using criteria such as:
   a. BMP category – in-field, edge of field, in-stream;
   b. Constituent of concern – sediment, nutrients, water;
   c. Expected percent reduction;
   d. Production impacts, if any;
   e. Cost to install and maintain;
   f. Time to install;
   g. Acres of land required for implementation;
   h. Compatible/incompatible with other BMPs; and
   i. Direct/indirect benefits to producer.
4. Work with landowners, farm operators, and other land/resource users to develop a watershed nutrient reduction strategy.
5. Apply the watershed nutrient reduction strategy by developing individual nutrient reduction strategies in conjunction and cooperation with individual landowners, farm operators, and other land/resource users. Individual strategies should include:
   - Site Identification for Potential BMPs,
   - Appropriate BMP Selection,

- BMP Installation and Maintenance Instruction,
- Financial Assistance, and
- Continuing Technical Assistance.

Point Source Management

Objective:

Reduce nutrient loadings (nitrogen and phosphorus) from point source discharges into Delta waterbodies.

Evaluate Alternative Technologies

1. Review the range of wastewater treatment technologies currently being used by Delta communities.
2. Review and evaluate alternative treatment technologies for Delta waste water systems, including:
   a. Wastewater to wetlands,
   b. Wastewater to agriculture crop irrigation,
   c. Land application of residual solids generated at wastewater treatment facilities, and
   d. Reuse, recycling opportunities and options.
3. Conduct a wastewater treatment workshop for operators, design engineers, construction contractors, and other appropriate entities on alternative wastewater treatment technologies with potential applicability to Delta systems.

Evaluate Alternative Systems

Sewage lagoon

1. Evaluate the feasibility of alternative treatment systems, such as:
   a. Regional wastewater facilities that combine small municipal systems. Evaluate municipality cost sharing through regional facilities to reduce individual homeowner costs;
   b. Decentralized, onsite treatment systems with zero discharge; and
   c. Integrated onsite/instream treatment systems for some streams where instream structures or characteristics might reduce nitrogen loading through denitrification and sequester phosphorus loads in sediments.
2. Review locations of facility outfalls and evaluate alternative outfall locations that could minimize nutrient effects and/or integrate instream processes for nutrient removal.

Improve Treatment Effectiveness

1. Increase the efficiency and effectiveness of existing wastewater treatment facilities through:
   a. Operational changes in existing facilities, and
   b. Operator training on increased efficiency of operations.

2. Review influent quality and implement approaches that will either reduce nutrient loads in the influent to the treatment system, or modify influent quality to improve treatment effectiveness and/or efficiency.

Establish Numeric NPDES Nitrogen and Phosphorus Limits

1. Establish quantitative nitrogen and phosphorus NPDES limits that are achievable and cost-effective.
2. Monitor nitrogen and phosphorus concentrations and flow in both the effluent discharge and downstream to document nutrient load reductions and associated instream effects.

Reduce Stormwater Nutrient Loads

1. Evaluate nutrient loads from non-agricultural (i.e., urban/suburban, industrial, commercial) sources.
2. Determine what nutrient load reductions are achievable and cost-effective by source type through various BMPs for both water quantity and water quality.
3. Establish nitrogen and phosphorus NPDES stormwater permit limits based on these results.
4. Develop awareness, outreach and education programs on reducing stormwater runoff and nutrient loading from non-agricultural sources.

Monitoring

Objective:

Provide quality assured data to scientifically assess success of nutrient reduction efforts in Mississippi Delta streams, and to plan future nutrient reduction activities.

Determine Appropriate Spatial-Temporal Scales

1. Consider watershed size in determining appropriate spatial-temporal scales for monitoring. (with Watershed Characterization WG)
   a. The size of the watershed that drains to the monitoring station will determine the duration of monitoring. The larger the watersheds, the longer the duration.
   b. Smaller, upstream watersheds have better likelihood of demonstrating early success of management practices in reducing nutrients because of response lag time in large systems.
   c. Evaluate possible relationships between size of the upstream watershed, location of management practices, and distance downstream where effectiveness of nutrient reductions can still be observed.
2. Consider end use of the information in determining appropriate scales for monitoring.
   a. Modeling data sets typically have different spatial-temporal scales than assessment data sets.
   b. Evaluating long-term effectiveness of management practices has different spatial-temporal scales than determining the effectiveness of management practices during individual storm events (e.g., biotic water-quality relationships, annual nutrient loading).

Determine Minimum Baseline Period

1. Assess system dynamics in determining the minimum period needed to establish a baseline.
   a. In general, the longer the better for establishing a baseline.
   b. One year is typically not sufficient to establish a baseline.
   c. Watershed characteristics such as size and land use can affect baseline period. (e.g., watersheds with legacy nitrogen and phosphorus might have considerable lag

times before response to management practices can be observed.)

2. Evaluate hydrologic period of record for various sized watersheds and stream types in the Delta.
   a. Flashy streams can require longer periods of record to establish a statistical baseline compared to streams with long response times.
   b. One of the primary interventions that might disrupt a short baseline period is climatic extremes (i.e., drought or flood years).
   c. Consider interventions in the watershed that can also affect stream responses (e.g., changing land use, weir installation, upstream dams, etc.).
   d. Incorporate existing monitoring information directly, through indexing, or extrapolation to establish baseline conditions.

Identify Management Practices to be Implemented

1. Identify the management practices to be monitored:
   a. Input management – document farm records and practices for different crop types and field locations.
   b. Best management practices – document the maintenance of the BMPs in addition to the time since their installation.
   c. Point source discharge – determine the NPDES limits and changes in these limits over time with permit renewal.
   d. Water management – consider gage location, stage-discharge relationships, maintenance, document groundwater permits and withdrawals.
2. Consider attributes of these management practices in designing the monitoring network.
   a. For example, monitoring of intensive management practices (e.g., slotted board risers, variable fertilizer application, hydrographic-controlled releases, etc.) will require more intensive monitoring than less intensive management practices (e.g., enrollment in conservation programs).
   b. Nutrient management for corn is different than nutrient management for soybeans.

Water quality sampling

c. Monitoring during the growing season will likely be different than during the non-growing season, including the responses of stream biota to nutrient inputs.

Establish Site Locations

1. Consider multiple options for number of sites and their location.
   a. Upstream – downstream sites.
   b. Paired watershed sites.
   c. Before and after sites.
   d. Multiple downstream sites for cumulative assessment.
   e. Probabilistic versus targeted sites.
   f. Phased or rotating sites.
   g. Integrator sites.
2. Integrate information above in determining the number and location of sites.
   a. Above-below sites might be appropriate for point source outfalls.
   b. Paired watersheds might be appropriate for smaller watersheds and those with limited baseline data.
   c. Consider monitoring locations that would strengthen watershed-scale model development by reducing model uncertainty.
   d. Consider locations that are strategic in assessing long-term changes in watershed nutrient loading.
   e. Initiate and complete reconnaissance monitoring, if necessary, to identify watershed stream reaches with higher nutrient concentrations, to better site BMPs and monitoring locations.

Select What Will Be Monitored

1. Match the monitoring parameters with the project objectives and the management practices.
   a. Different nitrogen or phosphorus species might be associated with different management practices (e.g., nonpoint versus point sources).
   b. Physical measurements (e.g., temperature, specific conductivity) can indicate changes in water management practices.

   c. Incorporate variables or parameters of interest or value to stakeholders.
   d. Incorporate data parameters suitable for selected models if a model is to be used to extrapolate results to other similar watersheds.
2. Include biological as well as physicochemical parameters so relationships can be established between the biological or stream response and nutrient management practices.
   a. Biological parameters might include periphyton or stream algae, benthic organisms, fish, or waterfowl.
   b. Chemical parameters should include both nitrogen and phosphorus species.
   c. Physical parameters should include in situ measures of temperature, dissolved oxygen, specific conductance, pH, and turbidity.
3. Consider surrogate parameters that could reduce monitoring costs or resources.

Establish Sampling Frequency

1. Integrate watershed, site, and hydrologic characteristics with desired outcomes from the management strategies.
   a. Evaluating management effectiveness for individual storm events will require intensive sampling during storms.
   b. Modeling data sets typically need both some storm sampling with baseflow sampling.
2. Regardless of watershed or other attributes, ensure monitoring occurs over the annual hydrograph.

Analysis and Assessment

1. Establish an information management system to store information.
2. Consider the analyses to be performed as part of the monitoring program design, rather than after monitoring has been initiated, such as watershed/stream modeling, geomorphic analyses, land use-nutrient loading, biotic-nutrient or other statistical relationships, status and trends analyses, etc.

QA/QC

1. Ensure that all data quality objectives and Quality Assurance Project Plans are prepared and approved prior to initiating monitoring.
2. Conduct quality assurance and quality control protocols as part of field, laboratory, analysis, and modeling activities.

Sustainability

1. Establish feedbacks with other project strategies to refine and improve the monitoring strategies and network as additional information becomes available.
2. Continually update the monitoring network as improved technology becomes available.
3. Integrate basin-wide monitoring networks.

Economic Incentives and Funding Sources

Objective:

Synthesize information on existing monetary sources available to fund the implementation of various elements of nutrient reduction strategies for Delta waterbodies, and investigate alternative economic incentives to promote nutrient reduction.

Funding Sources

NRCS Photo

1. Review and document needed elements to reduce nutrients in Delta waterbodies (e.g., characterization, implementation, monitoring, education).
2. Synthesize information on existing funding sources including but not limited to:
   a. Funding Agency (federal, state agencies, non-governmental, private organizations);
   b. Authorization;
   c. Appropriation;
   d. Description;
   e. Eligibility;
   f. Matching fund requirements, if any;
   g. Application process for funding;
   h. Current status; and
   i. Web links and ancillary information.
3. Provide funding information to appropriate Work Groups and Watershed Implementation Teams for use in submitting funding applications.
4. Investigate alternative funding sources existing in other states, such as:
   a. Conservation Reserve and Enhancement Program (CREP), and
   b. Nutrient trading programs (e.g., Florida, Ohio, Pennsylvania.
5. Investigate modifications to existing state, federal, non-governmental, and private sources to create or enhance nutrient reduction activities in the Delta.
   a. Cluster Environmental Quality Incentives Program(EQIP) projects within watersheds to improve effectiveness of management practices to reduce nutrients.

   b. Joint funding of clustered Farm Services Agency, EQIP projects within watersheds.

6. Leverage project funds within watersheds to integrate in-field, edge of field, and instream management practices.

Incentives

1. Investigate alternative approaches for creating incentives – economic, social, and environmental – to reduce nutrients in Delta waterbodies (also Stakeholder Awareness, Outreach and Education WG) including but not limited to:
   a. Ecosystem services,
   b. Carbon credits,
   c. Nutrient trading (point source/nonpoint source),
   d. Poultry litter transfer (on-going in the Delta),
   e. Tax credits,
   f. Value added products,
   g. Improved perception of agricultural producers.
2. Implement alternative approaches with potential application to Mississippi watersheds or watersheds within the Mississippi River basin.
   a. Farmable wetlands as being proposed through Iowa CREP Initiative (http://www.agriculture.state.ia.us/waterresources/PDF/InformationalBrochure.pdf).
   b. Second crop of trees for riparian habitat, timber harvest, and hunting leases.
   c. Nutrient trading.
   d. Vegetated agricultural drains as an EQIP accepted practice.
   e. Market-based incentives, such as reverse auctions for BMPs.

Information Management

Objective:

Develop a user-friendly, repository for information related to and applicable for reducing nutrients within the Mississippi Delta.

Site Development

1. Identify the desired characteristics for a common access web site and information repository.
2. Establish necessary formats and protocols for adding information to this web site and data repository.
3. Develop an MDEQ webpage with the desired content and characteristics.
4. Include on the MDEQ website an icon for announcing "Newly Released Information" when any information is first uploaded.
5. Interact with participating agencies and organizations to establish links to their websites to help provide multiple points of access for information.

Populating the Site

1. Upload information developed specifically for the Mississippi Delta nutrient reduction strategies and implementation.
2. Develop criteria and protocols specifying what information is appropriate for the site and may be uploaded to the site.
3. Provide links to the websites of participating agencies and organizations for selected information on development and implementation of the Mississippi Delta nutrient reduction strategies.
4. Where possible, provide links to information at other sites rather than add the information to this site. Also, ensure source acknowledgement is provided for all information included in the repository.
5. Provide a search engine for both the MDEQ site and associated links to other websites

Site Maintenance

1. Update an index of information accessible from the site on a weekly basis.
2. Develop desired operation and maintenance procedures for the site, including establishing a web master and responsibilities for site maintenance.

NEXT STEPS: IMPLEMENTATION, EVALUATION, ADAPTATION

The next steps in this project will be to:

1. Implement the nutrient reduction strategy template through the development/revision and implementation of local watershed management plans in selected Mississippi Delta watersheds with developed nutrient TMDLs;

2. Evaluate the nutrient reduction strategies, their effectiveness for local nutrient reduction watershed projects, and its achievability, including the accuracy of the modeled TMDL load reductions; and

3. Refine and adapt the nutrient reduction strategies and implementation practices based on an assessment of what is and is not working in moving toward to the desired vision for the Mississippi Delta.

Implementation

Implementation

The Watershed Characterization, Analytical Tools, and Monitoring Work Groups met to select two watersheds to pilot test the implementation of the nutrient reduction strategies. The 48 Delta watersheds in which nutrient TMDLs were completed during 2008 were initially selected for consideration. The prioritization factors identified as part of the Watershed Characterization strategies were used to narrow the list from 48 to 9 watersheds. Delta F.A.R.M. evaluated these 9 watersheds based on the targeting/selection criteria proposed in the strategy and narrowed the list to 4 watersheds. The combined Work Groups used best professional judgment to select 4 smaller catchments within 2 watersheds to pilot the implementation of the nutrient reduction strategies. One catchment in each watershed is planted primarily in rice, while the second catchment in each watershed is planted in corn and/or cotton.

Watershed Implementation Teams will develop local watershed plans to address nutrient and other water quality issues in these selected pilot watersheds by integrating the nutrient reduction strategy and nutrient TMDL load reductions. There currently are watershed management plans and Watershed Implementation Teams for four watersheds in the Delta. These existing plans focused primarily on sediment reduction. These plans will be revised to also address nutrient reduction. The objectives of the plans will be to implement and evaluate the nutrient reduction.

strategy; implement, monitor, and evaluate the load reductions called for in the TMDLs; estimate expected nutrient load reductions from restoration activities and BMPs using revised and appropriate models/empirical relationships; determine the costs of achieving the load reductions; and assess the socio-economic and environmental values of achieving the load reductions. The plans will incorporate the US Environmental Protection Agency's 9 Elements of Watershed Protection (http://www.epa.gov/owow/nps/watershed_handbook/pdf/ch02.pdf).

Evaluation

Evaluation

Comparison of pre- and post-implementation monitoring data from these local watershed projects, as well as other assessment tools, will be used to provide a better understanding of what nutrient and sediment load reductions are achievable. The quantification of achievable nutrient and sediment load reductions and implementation costs, as well as environmental values using the concept of ecosystem services, will be performed to provide a better understanding of the costs and benefits of these watershed projects, and to calibrate/modify the nutrient reduction strategy, determine the appropriateness of TMDL load reduction targets, and provide useful information for the development of nutrient criteria. Documentation of these results will be an important product of this work, which can provide the information necessary to quantify estimates of potential nutrient reductions, costs, and values to stakeholders on a basin-wide or regional scale.

The Delta Water Quality Research Initiative is a companion program that includes many of the same participants as the Delta Nutrient Reduction Planning Team. Several critical needs that require additional research were identified as the strategies were being developed. For example, some of the BMPS that have been implemented in agricultural areas in other states have not been evaluated in the Delta. The research initiative will investigate not only the individual practices, but also establish experimental areas to evaluate combinations of water, sediment and nutrient management practices to evaluate their effectiveness. This research might also include the modification of watershed models to permit specific placement of BMPs within the watershed for use in evaluating the spatial effects of implementing BMPs within the watershed. Additional research projects will be identified as the nutrient strategies are implemented in other watersheds throughout the Delta.

The nutrient reduction strategies will be evaluated both through review by other states, organizations, producers, academics, and businesses, and during implementation. The strategies will continue to be revised as the process moves forward.

Adaptation

Adaptation

Adaptive management is one of the building blocks of the nutrient reduction strategies. An integrated assessment will be conducted every 5 years to assess the progress and document the lessons learned through the implementation process. Five years is considered adequate for observing near-field changes in water quality from the implementation of various management practices in the watershed. Two assessment periods should permit an assessment of far-field, downstream water quality changes. These analyses will include not only an assessment of what has been effective, but also what modifications are needed to improve the implementation practices and process. With the determination of what reductions are achievable, quantitative reduction targets can be established and future progress evaluated in relation to achieving these targets.

SUMMARY

The process used to develop the Delta nutrient reduction strategy involved:

1. Forming a Visioning Team to elicit a vision for the Delta from stakeholders and establish goals to achieve the vision;
2. Forming a planning team to identify the critical elements needed in a nutrient reduction strategy to satisfy the goals;
3. Forming work groups to develop these strategic elements;
4. Integrating these strategic elements into an holistic, comprehensive strategy for reducing nutrients in Delta waterbodies;
5. Forming Watershed Implementation Teams to implement the nutrient reduction strategies within specific watersheds.
6. Testing the strategies in selected Delta watersheds and refine the strategies based on the lessons learned; and
7. Using adaptive management to implement nutrient reduction practices in the Delta and continuously refine the strategies to move toward attaining the vision for the Delta.

GLOSSARY

Algae: small aquatic plants that occur as single cells, colonies, or filaments. They contain chlorophyll but lack special water-carrying tissues. Through the process of photosynthesis, algae produce most of the food and oxygen in water environments.

Adaptive management: a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices.

Aquatic ecosystems: any watery environment (e.g., wetland, stream, ocean) in which plants and animals interact with the chemical and physical features of that environment.

Aquifer: water-saturated layers of underground rock, sand, or gravel that conduct water easily enough for a well to remove useful quantities.

Aquifer/groundwater recharge: the process by which surface water (from rain and sometimes streams/rivers and lakes) moves downward through soil and rock to groundwater.

Bacteria: a large group of single-cell organisms, generally without chlorophyll. In this document the term refers to those bacteria used as indicators of the potential for health risks due to contamination with human or animal wastes, e.g., fecal coliform bacteria.

Benthic organisms: macroscopic creatures living in and on the bottom sediments of lakes and streams.

Best management practices: systems, activities, or structures that people can employ to prevent nonpoint source pollution.

Best professional judgment: the sound evaluation of, and response to, circumstances according to the technical and ethical principles of your profession.

Biological community: all of the living things in a given habitat/environment.

Biological condition: the ability of a waterbody to support a healthy community of benthic organisms.

Biota (stream biota): plants and animals (stream plants and animal)

Biotic (relationship to nutrients): referring to plants or animals (and their response to nutrients)

Carbon credit: a component of emissions trading programs to reduce greenhouse gas emissions – one credit is equivalent to one ton of emitted carbon.

Catchment: the area drained by a stream or other waterbody

Clean Water Act: the Federal Clean Water Act of 1972 requiring the development of comprehensive programs for preventing, reducing, or eliminating the pollution and improving the condition of the navigable, surface, and groundwater of the US.

CREP: the Natural Resource Conservation Service Conservation Reserve Enhancement Program is an extension of the Conservation Reserve Program. It is a voluntary program that provides incentives and assistance to landowners to address soil, water, and related natural resource concerns on their property in an environmentally beneficial and cost-effective manner. As of September 16, 2009, CREP was not active in Mississippi.

Denitrification: the process of converting nitrates and nitrites to nitrogen-containing gases through the action of bacteria in soils and sediments.

Designated use: defined in the Mississippi water quality criteria, waterbodies must maintain the level of water quality necessary for the designated uses, e.g., fish and wildlife support, secondary contact recreation, primary contact recreation.

Ecological endpoint: an explicit description of the element of the environment to be protected.

Ecosystem services: beneficial processes (e.g., water filtration) and resources (e.g., timber, soil) provided to human society by nature.

Effluent: liquid wastes from sewage treatment, septic systems, or industrial processes that are released to surface water through and NPDES permit.

Erosion: soil loss due to the action of water or wind

EQIP: the Natural Resource Conservation Service Environmental Quality Incentives Program is a voluntary program that supports agricultural production and environmental quality as compatible goals. Through this program farmers can receive financial and technical assistance with manure storage and conservation practices.

Filter strip: vegetated areas located between sources of erosion or nutrients (i.e., cropland, disturbed land) and waterbodies for the purpose of capturing sediment and nutrients in runoff that crosses the filter strip prior to going into the waterbody.

Groundwater: water stored in water-saturated layers of underground rock, sand, or gravel below the water table.

Groundwater recharge area: land area where surface water (from rain and sometimes streams/rivers and lakes) moves downward through soil and rock to groundwater.

Habitat: the physical environment or typical place within which a plant or animal naturally or normally lives and grows.

HUC: Hydrologic Unit Codes that are assigned by US Geological Survey to hydrologic units (i.e., catchments) of the US.

Hydrologic (waterbody) type: two major types in the Delta are standing water (oxbows, reservoirs) and flowing water (streams, rivers).

Indicator: a microbial, chemical, or physical parameter that indicates the potential for harm to biota.

Influent: wastewater that goes to a wastewater treatment system.

Input management: a management system used to optimize fertilizer applications for maximum productivity with minimum nutrient loss to field runoff and groundwater.

Inter-basin transfer: supplementing surface water supplies in one catchment with surface or groundwater from another catchment.

LiDAR: is the Light and Data Ranging system of measuring land elevations remotely (i.e., using a plane) using laser technology.

Management Systems Evaluation Areas program: a national program initiated by the USDA to research the economic viability of alternative farming methods. In the Delta this program is developing alternative and innovative farming methods that improve water quality and ecology.

NPDES: the National Pollutant Discharge Elimination System is a program in which the Mississippi Department of Environmental Quality provides permits for the release of wastewater to state surface waters such that the Clean Water Act and state water quality criteria are supported.

Non-governmental organizations: non-profit, voluntary citizens' groups organized at the local, state, or national level.

Nonpoint source: pollution sources that are not distinct, that are diffuse or distributed over large areas.

Nutrient: nitrogen and phosphorus

Nutrient management practices: management practices that reduce nutrient loads to waterbodies.

Nutrient load/loading: the amount of nitrogen and/or phosphorus entering a waterbody, usually expressed in terms of weight.

Nutrient trading: a management system in which target nutrient load reductions are achieved by allowing some nutrient sources to not reduce, or even increase, their nutrient loads in return for paying other nutrient sources to reduce their nutrient loads enough to offset the first group's load.

Nutrient criteria: numerical values for both causative (phosphorus and nitrogen) and response (chlorophyll a and turbidity) variables associated with the prevention and assessment of eutrophic conditions.

Nutrient assimilation: the conversion or incorporation of plant nutrients into plant cells and tissue.

Nutrient runoff: the flow of water, from rain, snowmelt, or other sources, over the land surface that can pick up soil contaminants such as petroleum, pesticides (in particular herbicides and insecticides), or fertilizers that become discharge or non-point source pollution.

Nutrient enrichment: a water quality problem associated with the lack of agricultural conservation practices, leaking septic systems, and uncontrolled fertilizer application (e.g., golf courses, parkland, home gardens, etc.). Nutrient enriched streams can lead to water quality problems.

Nutrient source: any material (i.e. commercial fertilizer, animal manure, sewage sludge, irrigation water, etc.) that supplies one or more of the elements essential for plant growth.

Organic enrichment: amounts of organic material that exceed a waterway's capacity to maintain high levels of dissolved oxygen. Decaying organic material, such as aquatic plants or organic material in non-point runoff wastewater, depletes oxygen levels in a waterway and sometimes results in impairment or death in aquatic life.

Outfall: the point where water flows from a conduit, stream, or drain.

Performance measure: a quantitative or qualitative characteristic or metric chosen to provide a measure of the degree of progress or success a program/project has had in achieving its stated objectives, goals, and planned program activities.

Percent reduction: starting value minus final value, divided by starting value times 100.

Physiography: the natural features of the earth's surface, especially in its current aspects, including land formation, climate, currents, and distribution of flora and fauna.

Physical measurement: quantitative information on a physical condition, property, or relation.

Periphyton: microscopic underwater plants and animals that are firmly attached to solid surfaces such as rocks, logs, pilings, and other structures.

Point source: pollution discharged into waterbodies from specific, identifiable pipes or points, such as an industrial facility or municipal sewage treatment plant.

Point source treatment: processes used to treat human or industrial waste to a level that satisfies regulatory requirements for discharge into waters of the State.

Pollutant: solid, liquid, or gaseous substance that contaminates the local or general environment.

Pollutant load: the quantity of a pollutant entering or carried by a waterbody. Loads are usually expressed in terms of a weight and a time frame, such as pounds per day (lb/d).

Producers: those who work on, or manage, farms.

QAPP: Quality Assurance Program (or Project) Plan is a written record of methods that will be used to characterize the quality of information developed and/or collected during the program or project.

Quality assurance criteria: specifically defined quality requirements for data or information.

Receiving waterbody: creek, stream, river, lake, estuary, ground-water formation, or other body of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.

Regulatory agency: a public authority or government agency responsible for exercising autonomous authority over some area of human activity in a regulatory or supervisory capacity.

Runoff: that portion of precipitation that flows over the land carrying with it such substances as soil, oil, trash, and other materials until it ultimately reaches streams, rivers, lakes, or other waterbodies.

Riparian: pertaining to or situated on or along the bank of a stream or other body of water.

Sediment: bottom material in a waterbody that has been deposited after the waterbody formation. It includes remains of aquatic organisms, precipitated dissolved minerals, and eroded material from surrounding lands.

Sediment load: total sediment in a sample of water. There are three categories of sediment: suspended load, dissolved load, and bed load.

Septic system: a small-scale, independent process for treating combined liquid and solid wastes from drains and toilets, i.e., sewage.

Socioeconomic: involving social as well as economic factors.

Soil association: group of soils forming a pattern of soil types characteristic of a geographical region.

Soil type: a basic unit for classifying and mapping soils, based primarily on texture of the surface soil to a depth of at least equal to plow depth.

Stakeholders: any individual or organization that has an interest in water management activities. In the broadest sense, everyone is a stakeholder, because water sustains life.

Water resources stakeholders are typically those involved in protecting, supplying, or using water for any purpose, including environmental uses, who have a vested interest in a water-related decision.

Storm event: a storm of a specific duration, intensity, and frequency.

Stormwater permit: a permit that regulates the pollutant levels associated with stormwater discharges for compliance with EPA established water quality standards and/or to specify stormwater control strategies.

Sustainability: ability to provide the best outcomes for the human and natural environments both now and into the indefinite future.

Sustainable water management: to manage our water resources while taking into account the needs of present and future users.

Swale: shallow, man-made ditch to hold water and allow it to soak into the ground.

Tailwater recovery: the process of collecting irrigation water runoff for reuse.

Topography: The physical features of a geographic surface area including relative heights and the positions of natural and man-made features.

Tillage: The mechanical manipulation of soil performed to nurture crops. Tillage can be performed to accomplish a number of tasks including: seedbed preparation, weed control, and crop chemical incorporation.

TMDL: the Total Maximum Daily Load is a pollution "budget" that is used to determine the maximum amount of pollution a waterbody can assimilate without violating water quality standards. A TMDL is composed of pollution from permitted point sources, pollution from non-point and natural background sources, and a margin of safety, which accounts for any uncertainty associated with estimating the load allocations.

Turbidity: a measure of the amount of suspended material in water based on the ability of light to pass through a sample.

Wastewater: water containing waste or contaminated by waste contact, including process-generated and contaminated rainfall runoff.

Wastewater system: public system for the collection and transportation of wastewater to a treatment plant.

Waterbody: any natural or artificial pond, lake, reservoir, or other area that ordinarily or intermittently contains water, and which has a discernible shoreline.

Waterbody type: specific waterbody classes, e.g., stream, river, oxbow, reservoir.

Waterbody segment: waterbodies across the US are subdivided into numbered reaches, or segments, for the purpose of reporting water quality impairments. Information about these reaches is stored in the National Hydrography Dataset.

Water management: practices and activities geared toward controlling water movement over land, and reducing the amount of water used and withdrawn from sources.

Water quality: the biological, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.

Watershed: the drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Wetland: land or area, such as a tidal flat or swamp, that is often or periodically saturated with water. Wetland soils have a high moisture content and support plants that grow well in that condition.