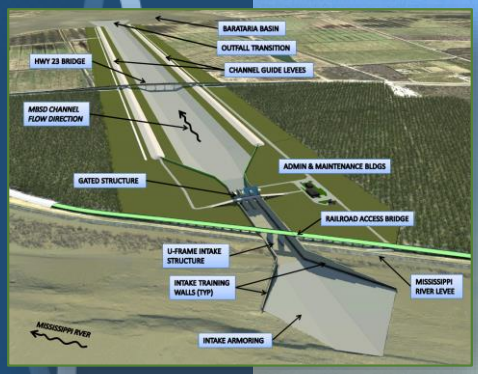
Louisiana Nutrient Management Strategy

Protection, Improvement and Restoration of Water Quality in Louisiana Water Bodies

July 2019

Developed through the joint efforts of the Coastal Protection and Restoration Authority of Louisiana, Louisiana Department of Agriculture and Forestry, Louisiana department of Environmental Quality, and Louisiana Department of Natural Resources



DEQ LOUISIANA

CPRA

Louisiana Department of Agriculture and Forestry

Louisiana Department of Natural Resources

2019 Nutrient Strategy Highlights

- The Nutrient Management Team is now tracking events where stakeholders and the public are engaged in nutrient management discussion
  - 523 outreach activities were held from 2014 to 2018
- 100% Best Management Practice implementation has been achieved for the Lake Providence watershed, with documented improvements in water quality
- Permit reporting and tracking has been made easier and more efficient through online advancements (NetDMR)
- Nutrient monitoring has been implemented for various general and individual permits, with ~3,000 permits holders currently monitoring for nitrogen and/or phosphorus
- The agricultural community continues to be engaged and committed to proper management activities, with 97% parish participation in the Louisiana Master Farmer Program
- The Nonpoint Source program continues to promote nutrient reduction through cooperative efforts with the US Department of Agriculture, LA Department of Forestry, and the US Environmental Protection Agency, identifying high priority watersheds for Best Management Practice implementation
- River Diversion(s) planning and permitting are underway for coastal restoration and other ecological enhancements, and an updated 2017 Coastal Master Plan is in effect
- 16,717 support activities from LDEQ's Small Business/ Small Community Assistance program have occurred from 2014 to 2018
- 900 loggers, foresters, and landowners were trained in Best Management Practices for water quality through the LA Forestry Association in 2018
- In 2018, 422,888 acres were treated to improve water quality, 297,823 acres underwent conservation plans, 72,625 acres improved soil health, 226,648 acres received stewardship, and nearly 100,00 acres had wetland/wildlife habitat improvements in Louisiana from Farm Bill supported programs
- A Water Quality Trading Program has been developed by LDEQ as an inducement to reduce discharges of pollutants into waters of the state, with the regulatory component expected to be complete at the end of 2019

EXECUTIVE SUMMARY

Background

Excess nutrients such as nitrogen and phosphorus are a nationwide concern for water quality. Nutrient water quality concerns for Louisiana originate locally and from upriver as the state is partially located within the large watershed of the Mississippi-Atchafalaya River Basin (MARB), which drains 41% of the contiguous United States and parts of two Canadian Provinces to the Gulf of Mexico (GOM). Nutrients contribute to the formation of the summer hypoxic zone, an area of reduced oxygen content, in coastal shelf waters off Louisiana. However, nutrient contribution from sources within the state have been estimated at only 2% of the total loads entering the GOM. Thus, nutrient solutions to address water quality within the state of Louisiana will be needed from upriver states as well as locally.

State of Louisiana

At the state level, Louisiana state agencies of the Coastal Protection and Restoration Authority of Louisiana (CPRA), Louisiana Department of Agriculture and Forestry (LDAF), Louisiana Department of Environmental Quality (LDEQ), and Louisiana Department of Natural Resources (LDNR), in conjunction with partners, developed this 2019 Louisiana Nutrient Management Strategy as part of the planned 5-year strategy review. Managing nitrogen and phosphorus to protect, improve, and restore water quality in Louisiana's inland and coastal waters is of high priority, and is continued from groundwork laid in the 2014 Louisiana Nutrient Management Strategy. This 2019 strategy document includes information to date on nutrient management in Louisiana; and thus, represents the 2018 Annual Report. Other state and federal agencies as well as stakeholders from the watershed community will continue to play a major role in implementing this strategy. The state of Louisiana must comprehensively evaluate the nutrient management activities that are already occurring within the state to leverage the best use of existing resources and future planned activities regarding nutrients and water quality in Louisiana.

Framework

A ten-component framework for outlining and accomplishing action items was established in the 2014 strategy for nutrient management. This approach was successful and will continue to be employed moving forward. The ten components are: 1) Stakeholder Engagement; 2) Decision Support Tools; 3) Regulations, Policies, and Programs; 4) Management Practices and Restoration Activities; 5) Status and Trends; 6) Watershed Characterization, Source Identification, and Prioritization; 7) Incentives, Funding, and Economic Impact Analyses; 8) Targets and Goals, 9) Monitoring, and 10) Reporting. This framework allows multiple components to be implemented simultaneously and incorporates adaptive management practices as inherent in the process. The strategic action items schedule (Appendix A) outlines a timeframe from 2019 to 2023 for this strategy, after which another assessment of progress to date will be made to allow for newer information to be incorporated into strategic planning and nutrient management activities beyond 2023.

Implementation

Implementation of the Louisiana Nutrient Management Strategy will continue to focus on key areas that include: 1) river diversions, 2) nonpoint source management, 3) point source management, 4) incentives, 5) leveraging opportunities, and 6) new science-based technologies/applications. These focus areas are specific to the state of Louisiana and the implementation measures that the state may employ for water quality improvements.

River Diversions

River diversions constructed for the purposes of rebuilding and sustaining Louisiana's coastal wetlands have the value-added benefit of assimilating and removing nutrients that have already entered the Mississippi river system either from within Louisiana or from upbasin states. CPRA uses numerical models to predict potential nitrogen and phosphorus uptake by wetlands receiving river water input. Assimilation capacity of existing river diversions (Davis Pond, Caernarvon, Naomi, and West Pointe a la Hache) are estimated at 4,381 tons of total nitrogen (TN) and 129 tons of total phosphorus (TP) annually. Models also predict future planned diversions (West Maurepas and the Mid-Barataria) with potential annual removals of 10,187 tons of TN and 124 tons of TP. As long-term plans (5-50 years) for CPRA's 2017 Coastal Master Plan include the implementation of additional river diversion projects, annual removal of TN and TP from the Mississippi and Atchafalaya Rivers is predicted to be higher once projects are constructed and become operational.

Thus, the implementation of all planned diversions constructed and operational as outlined in Louisiana's Coastal Master Plan has the potential to remove thousands of tons of TN and TP. This, in turn, prevents these nutrient loads from reaching the GOM. Extrapolation from USGS watershed modeling estimates (i.e. Louisiana contributes 1.7% of TN and 2.4% of the TP reaching the GOM) suggests that river diversions could remove more than twice of Louisiana's modeled TN input and nearly half of Louisiana's modeled TP input from MARB to GOM. These extrapolations suggest that river diversions in Louisiana could remove more nitrogen than it contributes and a significant portion of phosphorus, thereby mitigating some of the nutrient loads from upbasin states.

Nonpoint Source Management

Nonpoint source management in Louisiana will focus on best management practices (BMPs) and conservation practices (CPs) to address runoff water quality in agriculture, forest, and urban settings; those for individual home sewage systems; and through floodplain reconnection. LDAF, LDEQ, and LDNR all work in collaboration with watershed partners through the Nonpoint Source Pollution Prevention Program through the Clean Water Act (CWA) Section 319 program to address nonpoint sources in select watersheds throughout the state, and develop and implement plans specifying appropriate BMPs and CPs. Several manuals on guidance for BMPs have been developed by LDAF, LDEQ, LDNR and the Louisiana State University Agricultural Center (LSU AgCenter) that are specific to commodities within the state, such as rice, poultry, dairy, sugar cane, and swine and for addressing nonpoint source from urban storm water runoff and individual home sewage systems.

Conservation practices recommended by the U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS) in Louisiana are the backbone for nonpoint source management efforts on the field. These conservation practices are designed to be effective as a systems approach to avoid, control, or trap runoff before it leaves the field. At least 140 conservation practices have been utilized in Louisiana in an effort to improve water quality. Implementation of these conservation practices are largely focused in agricultural and forestry areas in Louisiana. Forestry practices within Louisiana currently boast over a 97% compliance rate in BMP implementation by Louisiana foresters.

Reviews of BMP efficiency indicate their effectiveness in nutrient removal and in limiting water quality degradation. Reviews and papers for the Lower Mississippi Alluvial Valley and/or Mississippi River Basin agriculture found that many BMPs result in fewer nutrients leaving a field, and that environmental, managerial and site-specific variables should be evaluated when establishing BMPs. Further, studies on the effectiveness of forestry BMPs also indicate they are effective in limiting water quality degradation in Louisiana. In addition, more recent literature identifies beliefs and perceptions as important for implementation success across sectors (homeowners to farmers). Continued studies are improving the understanding of BMPs across environmental and sociological sectors.

Lake Providence, in the northeast corner of Louisiana, is an example of BMPs having a profound impact on water quality. In 2015, the Louisiana Legislature created the Lake Providence Watershed Council to address degraded water quality and other local concerns related to sedimentation. The Council named USDA NRCS as a federal partner for agricultural best management practice (BMP) implementation. LDEQ also was named as a partner, and through its Nonpoint Source Pollution Program, water quality has been monitored throughout the lake. One hundred percent BMP participation has been achieved in the watershed through several conservation measures (cover crops, field borders, etc.), and it is anticipated to be removed from impairment in 2020. Practices for sedimentation are often relevant to nutrient reduction, thus extending the effect of these measures in the watershed.

Hydrologically modified water bodies, such as the Mississippi River in Louisiana, are disconnected by levees from their historical floodplain. The natural process of overbank flooding which allowed nutrients and sediment to be removed from the water body channel was discontinued. Reconnecting a river to its floodplain will allow for the natural process of nutrient removal to occur, thereby enhancing water quality. Floodplain reconnection projects within Louisiana such as Mollicy Farms on the Ouachita River in northeast Louisiana are one such effort to reestablish this connection. Small-scale flood plain reconnection projects in non-coastal floodplains such as Mollicy Farms and the larger river diversion projects proposed in coastal Louisiana discussed later in this document play an important role in nutrient removal and improved water quality.

Point Source Management

Louisiana's Water Quality Regulations (LAC 33: Part IX) require permits for the discharge of pollutants from any point source into waters of the state of Louisiana. The Louisiana Pollutant Discharge Elimination System (LPDES) Permit Program is regulated by the LDEQ. There are over 13,000 permitted dischargers within the state. More specific to nutrients entering surface waters of the state, LDEQ discharge water permits address sanitary wastewater; storm water through industrial, construction, or Municipal Separate Storm Sewer Systems (MS4) permits; Concentrated Animal Feeding Operation (CAFO) permits; various industrial wastewater; and biosolids management. These LDEQ regulated activities are permitted through the LPDES and state permitting programs. Based on the Point Source Implementation Strategy for Nutrients, all point source types identified above will be required to monitor for nutrients through the LPDES permit. This monitoring will allow LDEQ to gather data necessary to determine the extent of nutrient contributions from these dischargers to water bodies of Louisiana.

Permitted point source wetland assimilation projects in Louisiana provide an opportunity for wetland restoration and nutrient removal. In Louisiana, wetlands have been experiencing degradation due to reduced supplies of fresh water, which introduce nutrients and sediments needed for plant growth. Through point source wetland assimilation projects, wetlands receive nutrient rich treated municipal/sanitary wastewater that not only act to bring water to a wetland area that needs it, but also introduces nutrients into the wetlands. As wetland plants uptake nutrients, wetland health is promoted and nutrients are removed from the water, thus decreasing the amount of nutrients that would have been discharged into a receiving water body such as a river or lake. There are currently 13 point source wetland assimilation projects permitted in Louisiana and more are proposed. Recent (2011 to 2017) nutrient removal efficiencies calculated by the LDEQ from project reports ranged from 16% to 96% for total nitrogen and no removal to 97% for total phosphorus, with an average of 72% and 29% respectively (averages from positive removal values only). Nutrient removal efficiencies may range up to near 100% for nitrogen and phosphorus compounds in some years, although there is variability among efficiencies; at times, positive fluxes of phosphorus have occurred.

Incentives

Incentive-based programs within the state of Louisiana offer stakeholders the opportunity to participate in environmental stewardship activities. Voluntary stewardship programs exist for both nonpoint and point source community groups thus offering nearly all stakeholders within a watershed community an opportunity to participate in water quality protection, improvement, and restoration.

Nonpoint source stewardship in Louisiana is largely through programs aimed at agriculture and forestry. Through the USDA NRCS Farm Bill programs such as the Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), Agricultural Conservation Easement Program (ACEP), and Regional Conservation Partnership Program (RCPP), total funding averaged just over $100 million annually from 2005 through 2017. These funds were used for implementation of conservation

practices in Louisiana. These programs have allowed for significant acreage averaging nearly one-half million acres per year to receive conservation practices in Louisiana, with a high of nearly 700,000 acres in 2011.

Another nonpoint source-focused voluntary program vital to Louisiana's conservation efforts is the Louisiana Master Farmer Program led by the LSU AgCenter. Over 3,800 farmers within Louisiana are enrolled in the three phase training program that features classroom and field training and development of a farm-specific management plan. Louisiana Master Farmer program participation covers 97% of the parishes in the state with the state's major agricultural and forestry areas demonstrating the most participation. The Louisiana Master Farmer University combines the first two phases of the classroom and field training into a 2-day back-to-back event that aims to recruit additional farmers to its ranks and promote this environmental stewardship opportunity to farmers. Other tracks of the Louisiana Master Programs include the Louisiana Master Logger Program aimed at loggers, and the Louisiana Master Gardner and Louisiana Master Naturalist Program aimed at citizens within Louisiana.

The Louisiana Environmental Leadership Program (ELP) provides an opportunity for voluntary stewardship. While the ELP promotes and supports stewardship for many aspects of pollution prevention and reduction, voluntary efforts related to nutrient management have received special attention. Industries such as BASF, ExxonMobil, Marathon, Mosaic, and Nalco have been recipients of ELP awards for their voluntary nutrient management and reduction efforts. Louisiana cities including Carencro, Denham Springs, Ruston, and the City of West Monroe have also received leadership awards for nutrient management efforts. St. Tammany Parish Government received an Outstanding Achievement Award in 2019 for sewage enhancements in the Bayou Liberty Watershed, which resulted in significant improvement of water quality. These Louisiana companies and cities/parishes serve as leaders in their respective groups and models for ways to achieve voluntary nutrient reductions.

Entities within the state of Louisiana rely upon economic incentives to support water quality projects. Such programs include the LDAF Agriculture Economic Development Assistance Program, Clean Water Act Section 319 Program administered through the LDEQ Nonpoint Pollution Prevention Program, and others specific to the coastal areas of Louisiana through the LDNR Coastal and Estuarine Land Conservation Program (CELCP) and CPRA Coastal Forest Conservation Initiative (CFCI) that provide financial support for conservation that may result in water quality improvement. Additionally, the Clean Water State Revolving Fund Program (CWSRF) supports municipalities in achieving water quality improvement.

Additional incentive avenues are available through water quality credit trading and business forces. Trading is a market-based approach that connects point and nonpoint sources to achieve a cost-effective solution to water quality improvement. Louisiana has progressed in the development of a water quality trading program with stakeholder engagement in 2018, and proposed rulemaking in early 2019. Business forces are also becoming an incentive driver

through committing to do business with other businesses in the supply chain that employ sustainable practices.

Leveraging Opportunities

It is widely acknowledged that leveraging resources and creating opportunities for collaboration are essential to this strategy. Many stakeholders with vested interest in a watershed community are actively developing or implementing projects to protect, improve, or restore the water quality in their watersheds. The ability to leverage with these groups in ongoing projects and to engage them for creating partnerships on new projects is a factor that will result in improved water quality within the state of Louisiana. Over 30 leveraging opportunities have been identified to date and many more are anticipated in the future (Appendix C).

New Science-Based Technologies/Applications

Incorporating the current state of the science and cutting edge technologies and applications will be needed for nutrient management within Louisiana. Areas of focus for Louisiana include agricultural production, wastewater treatment, in-stream assimilation and removal, and river diversion research.

Globally, the human population is currently over 7 billion and has been projected to reach 9.8 billion by 2050. By 2030 as the human population exceeds 8 billion, the demand for food and energy has been projected to rise 50% and the demand for fresh water by 30%. Science-based technologies abound in agriculture as the industry seeks ways to increase production and improve water quality simultaneously to meet future demands.

The USDA NRCS Conservation Effects Assessment Project (CEAP) aims to quantify environmental effects of conservation practices and to develop science-based management for agriculture. CEAP produces regional and watershed based assessment of conservation practices from data gathered in two phases: 2003-2006 (CEAP-1) and 2015-2016 (CEAP-2). Currently available CEAP assessments include cropland, wetlands, grazing land, and wildlife from CEAP-1 data, although reports utilizing data from CEAP-2 are in development. The Lower Mississippi River Basin (LMRB) CEAP Project released in August 2013 estimated that implemented conservation practices resulted in an average reduction of 35% in sediment, 21% in nitrogen, and 52% in phosphorus delivered to rivers and streams from cultivated cropland in the LMRB. Reduction estimates from 2015 to 2016 data are expected in 2019.

Fertilizer application is another technology that aims to optimize nutrient use while at the same time minimizing water quality impacts. The use of the 4R nutrient stewardship philosophy involving the **r**ight timing, **r**ight source, **r**ight rate, and **r**ight place of fertilizer application promotes efficiency in fertilizer use. Enhanced efficiency fertilizers can also reduce nutrient losses while increasing nutrient availability to plants. Application methods such as variable rate technology can ensure that fertilizers are applied to maximize application to areas that need them and minimize application to areas that are already nutrient rich.

Wastewater treatment technologies and advances in this science will aid in nutrient removal from some point source dischargers. These wastewater technologies can aid in reducing the amount of nutrients that enter water bodies in the state. Once nutrients enter a water body, other technologies and applications may aid in assimilation or removal of nutrients from in-stream. Research involving nutrient assimilation and removal through river diversions in coastal Louisiana is a developing science. CPRA has partnered with The Water Institute of the Gulf (TWIG) to identify a research strategy to resolve critical diversion-related uncertainties.

Nutrient Solutions

The state of Louisiana prepared the 2014 Nutrient Management Strategy through collaboration with state and federal agencies and through engagement with stakeholders within Louisiana, and will continue to engage these partners in ongoing efforts. It is evident that nutrient solutions for Louisiana are not a one-size-fits-all approach, as implementation methods will involve coastal restoration, nonpoint source and point source management, incentives, leveraging opportunities, and science-based technologies/applications to varying degrees depending on the specific characteristics such as land use and hydrology and primary suspected nutrient sources within subwatersheds in the state. Further, nutrient solutions employed in upbasin states will be needed and are being implemented in order to address nutrients and water quality in the larger MARB.

Within Louisiana, several state and federal agencies and stakeholder groups are continuing to implement nutrient solutions; unfortunately, this information is typically not stored or reported in a central area. The ability to document, track, and report on existing efforts and share that information within the watershed community underscores the desire for more coordinated and collaborative endeavor under this Louisiana Nutrient Management Strategy.

LOUISIANA NUTRIENT MANAGEMENT STRATEGY INTERAGENCY TEAM

The Louisiana Nutrient Management Strategy was developed by an interagency team from the Coastal Protection and Restoration Authority of Louisiana, the Louisiana Department of Agriculture and Forestry, the Louisiana Department of Environmental Quality, the Louisiana Department of Natural Resources. Additional partners in strategy development include the Louisiana State University Agricultural Center and the U.S. Department of Agriculture, Natural Resources Conservation Service.

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LOUISIANA NUTRIENT MANAGEMENT STRATEGY

Protection, Improvement, and Restoration of Water Quality in Louisiana's Water Bodies

A. PREFACE

A.1 Nutrient Management

Nutrient pollution from excess nitrogen and phosphorus is an issue for many water bodies within the United States, including those that drain to and are within the state of Louisiana. While nutrients are essential components of natural ecological functions, excess nutrients in water bodies may disrupt the balance of these natural processes, disrupting nutrient assimilation and degrading water quality resulting in significant impacts to fish and other aquatic life inhabiting those water bodies.

Nutrients come from various sources including nonpoint sources, such as agriculture and urban runoff, and point sources, such as municipal and industrial discharges, and may be transported far downstream from the original input. Additionally, as the state of Louisiana contains both inland and coastal environments that border the Gulf of Mexico (GOM), non-local nutrient sources affecting offshore waters may encroach upon Louisiana's coastal water bodies and may affect inland waters through upstream sources.

Strategies to manage nutrient pollution in Louisiana waters and in other upstream states are critical to addressing excess nutrients and protecting, improving, and restoring Louisiana's water quality (see Box 1). The 2019 Louisiana Nutrient Management Strategy will continue to guide the development and implementation of nutrient management activities. The Coastal Protection and Restoration Authority of Louisiana (CPRA), Louisiana Department of Agriculture and Forestry (LDAF), Louisiana Department of Environmental Quality (LDEQ), and the Louisiana Department of Natural Resources (LDNR) comprise the interagency team that develops and implements this statewide nutrient management strategy to address nutrient pollution issues influencing water bodies within the state. Through the collaborative and voluntary participation of stakeholders within the Louisiana watershed community, this Louisiana Nutrient Management Strategy continues to build upon existing programs and initiatives to protect, improve, and restore the water quality within the state of Louisiana.

On a national level many entities including the Mississippi River Gulf of Mexico Watershed Nutrient Task Force (Hypoxia Task Force), Gulf of Mexico Alliance (GOMA), U.S. Environmental Protection Agency (USEPA), U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS), and the U.S. Fish and Wildlife Service (USFWS) recognize the need to address excess nutrients within the nation's water bodies and coastal systems. The incidence of hypoxia or low dissolved oxygen in offshore waters such as the GOM has been the focus of nationwide efforts to preserve and restore water quality, habitat, and fisheries. The completion of the 2014 strategy is the result of coordinated efforts between the Hypoxia Task Force and Louisiana agencies in support of the first action item in the 2008 Hypoxia Task Force Action Plan

(Mississippi River/Gulf of Mexico Watershed Nutrient Task Force Hypoxia Task Force [HTF] Plan 2008).

BOX 1: WHY A NUTRIENT MANAGEMENT STRATEGY?

A strategy focused on the nitrogen and phosphorus loads to the Gulf of Mexico (GOM) will determine what improvements are necessary for Louisiana to contribute to nutrient management throughout the Mississippi-Atchafalaya River Basin (MARB). In addition to identifying the appropriate level of nutrients in the MARB, this strategy requires an assessment of the way nutrients are managed at the individual watershed and statewide scales. The management tools to be studied for implementation include, but are not limited to, managing nutrients on the field, at the edge-of-field (USDA NRCS and LDAF OSWC), and intercepting nutrients that have already entered the river system either from Louisiana sources or from sources upriver from Louisiana (CPRA).

Louisiana, situated at the bottom of the largest North American watershed that drains 41% of the contiguous U.S., bears the full brunt of effects from nutrients introduced to the MARB system from upriver states. However, in addition to controlling and capturing our own nutrients through local nonpoint and point source management, Louisiana is uniquely positioned to also contribute to removing nutrients that have entered the system from upriver states. This "intercepting" of nutrients is a key part of **Louisiana's Nutrient Management Strategy** (Figure 1).

With the full implementation of river diversion projects in Louisiana's Coastal Master Plan, Louisiana wetlands will have the potential to remove nearly double the 1.7% nitrogen load and almost half the 2.4% phosphorus load USGS SPARROW models estimate that Louisiana contributes to the system under average Mississippi River conditions. Existing and additional voluntary nonpoint and point source measures could further improve these efforts. The added benefit is that this coastal wetland assimilation process will also help restore and sustain Louisiana's coastal wetlands, which have suffered catastrophic losses during the last century. By reconnecting the Mississippi River to the deltaic wetlands, Louisiana will build and maintain coastal wetlands that will protect and preserve nationally significant ecosystem services (oil and gas production, navigation, fisheries, wildlife habitat), provide storm protection for coastal communities, and achieve improved water quality.

The spatial extent of Louisiana's Nutrient Management Strategy is not limited to just those areas that drain into the MARB. Louisiana is focused on assessing the appropriate nitrogen and phosphorus loads and their impacts on water quality throughout the state. Whether a basin drains into the GOM through the MARB or whether a basin drains directly into coastal bays or lakes, such as Lake Pontchartrain, Louisiana is committed to protecting, improving, and restoring quality in all state waters.

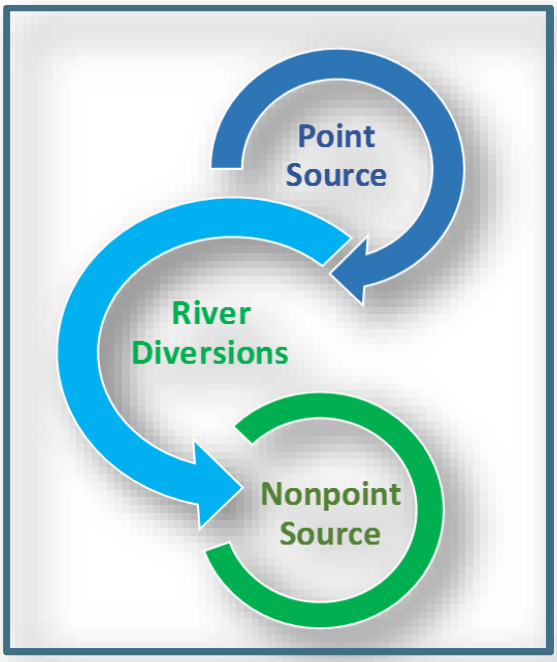


Figure 1. Louisiana's Nutrient Management Strategy focuses statewide on improving the management of nonpoint and point sources of nutrients and also leverages the capacity of river diversions to intercept nutrients that have already entered the river upstream locally from Louisiana or from upbasin sources and preventing those nutrients from reaching the Gulf of Mexico.

A.2 Gulf of Mexico Hypoxia and Impacts

Hypoxia is a condition where sustained dissolved oxygen concentrations in the water decrease to a level that can no longer support living aquatic organisms. Hypoxic areas (also known as "dead zones") can be found in many areas around the world and have increased in duration and frequency since first being noted in the 1970s. In the northern GOM, hypoxia was first documented in 1972 and its severity and extent have been surveyed annually, with two exceptions, since 1985 (Rabalais 2001; Turner et al. 2005; LUMCON 2018; Figure 2).

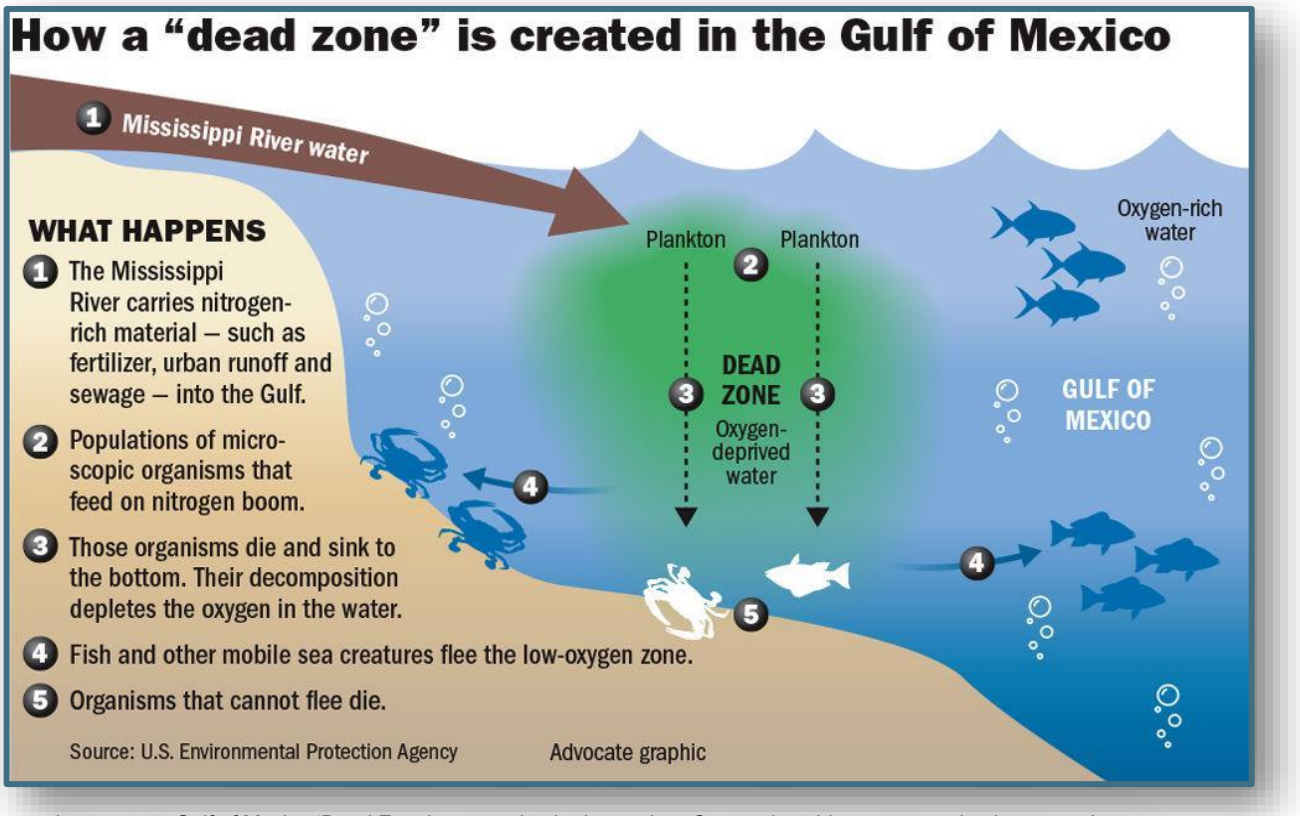
In the northern GOM, hypoxia is a reoccurring condition that generally occurs in bottom waters off the Louisiana and Texas coasts during the summer months of June, July, and August. It occurs primarily as a result of excess nutrients carried in the Mississippi and Atchafalaya Rivers and freshwater stratification (layering) of waters in the GOM (Bianchi et al. 2010; Rabalais et al. 2010; USEPA 2018).

Understanding direct effects of hypoxia on commercial fisheries in the northern Gulf of Mexico is of critical concern. Coastal waters off Louisiana provide essential habitat for nationally important commercial fisheries and effects of hypoxia can include fish kills, which can deplete valuable fish populations and disrupt ecosystems. However, more common effects of hypoxia include population shifts in both spatial distribution and community structure through mortality, immigration/emigration, and aggregation. It has been well documented that bottom-dwelling Gulf species such as the Atlantic croaker and brown shrimp are displaced by hypoxia from physiologically optimal foraging and breeding habitat along the Louisiana shelf (Craig et al. 2001; Craig and Crowder 2005; Craig 2012). The impacts of hypoxia in these instances are likely to be

more indirect with changes in food web structure and sub-lethal reproductive effects. For example, Atlantic croaker, a dominant fish species along the Louisiana shelf generally considered hypoxia-tolerant, exhibit a suite of sub-physiological impacts resulting in endocrine disruption and impaired reproduction when exposed to varying levels of hypoxia (Thomas et al. 2007; Thomas and Rahman 2009, 2012; Rahman and Thomas 2017). Craig (2012), Craig and Bosman (2013), and Briggs et al. (2017) demonstrate that hypoxia effects likely extend to the broader demersal and possibly pelagic fish communities in northern GOM waters.

Recent research into the socioeconomic impacts of hypoxia on Gulf commercial fisheries has focused primarily on the brown shrimp and menhaden fisheries (Smith et al. 2014; Langseth, et al. 2014, 2016; Purcell et al. 2017). Fishing for these economically important species is influenced by hypoxia via shifts in effort and catchability. Smith et al. (2017) provided an economic link from hypoxic conditions to brown shrimp market price (size based), and thus economic loss/gain. The potential impact of hypoxia on northern GOM fisheries is of critical concern because Louisiana's commercial landings are significant and exceeded 1,256 million pounds in 2016 with a dockside value over $427 million, accounting for approximately 31% of the total catch by weight in the lower 48 States (NOAA 2018). Ongoing work through NOAA's National Centers for Coastal Ocean Science includes using models to evaluate and predict hypoxia and its impacts to fisheries in the GOM (NOAA NCCOS 2016, 2016a).

Figure 2. Schematic showing how hypoxia can develop at depth in the water column. Freshwater from rivers such as the Mississippi River carry and deposit nutrients (nitrogen and phosphorus) which promote phytoplankton growth in the surface waters of the Gulf of Mexico. When phytoplankton, which feed on the nutrients, are eaten by zooplankton or die, they sink to the bottom. When the organic material sinks to the bottom, it decomposes, a process which consumes oxygen. Due to natural salinity and temperature stratification, oxygen flux from the surface water to the bottom waters is blocked and oxygen in the bottom waters becomes depleted. As a result, animals that cannot move to waters with higher oxygen levels may die (Graphic from *The Advocate, 2018*).



Hardy, S. 2018. Gulf of Mexico 'Dead Zone' expected to be larger than Connecticut this summer, scientists say. The Advocate.

A.3 Significance to the State of Louisiana

The Mississippi-Atchafalaya River Basin (MARB) drains approximately 41% of the contiguous United States and includes several major river systems (Figure 3). According to modeling studies conducted by the U.S. Geological Survey (USGS), approximately 98% of the nutrient loading into the MARB comes from sources upstream of Louisiana; and of this nutrient loading, approximately 90% is associated with agricultural sources, natural sources, and atmospheric deposition (Alexander et al. 2008). The major source of total nitrogen and phosphorus to the MARB is attributed to crop fertilizers (Alexander et al. 2008; Robertson and Saad 2013). White et al. (2014) further supports that cultivated cropland is the dominant source of nitrogen and phosphorus exported to gulf waters, but not across all water resource regions within the MARB; point sources and urban nonpoint sources contribute to phosphorus loading in some areas.

Within Louisiana, approximately 43% of the land area drains into the MARB (Figure 4) and according to USGS models, contributes 1.7% of the nitrogen and 2.4% of the phosphorus load into these rivers (Alexander et al. 2008; Table 1). The remaining 57% of the state land area drains directly to the GOM through coastal bays and lakes, such as Lake Pontchartrain. Therefore, it is important to address water quality and nutrient management throughout the state. This statewide nutrient management strategy will address all watersheds in Louisiana including those that drain into the GOM through the MARB or those that drain directly into coastal bays or lakes and the GOM.

Figure 3. The Mississippi-Atchafalaya River Basin (MARB) drains approximately 41% of the contiguous United States that includes all or part of 31 states and 2 Canadian provinces.

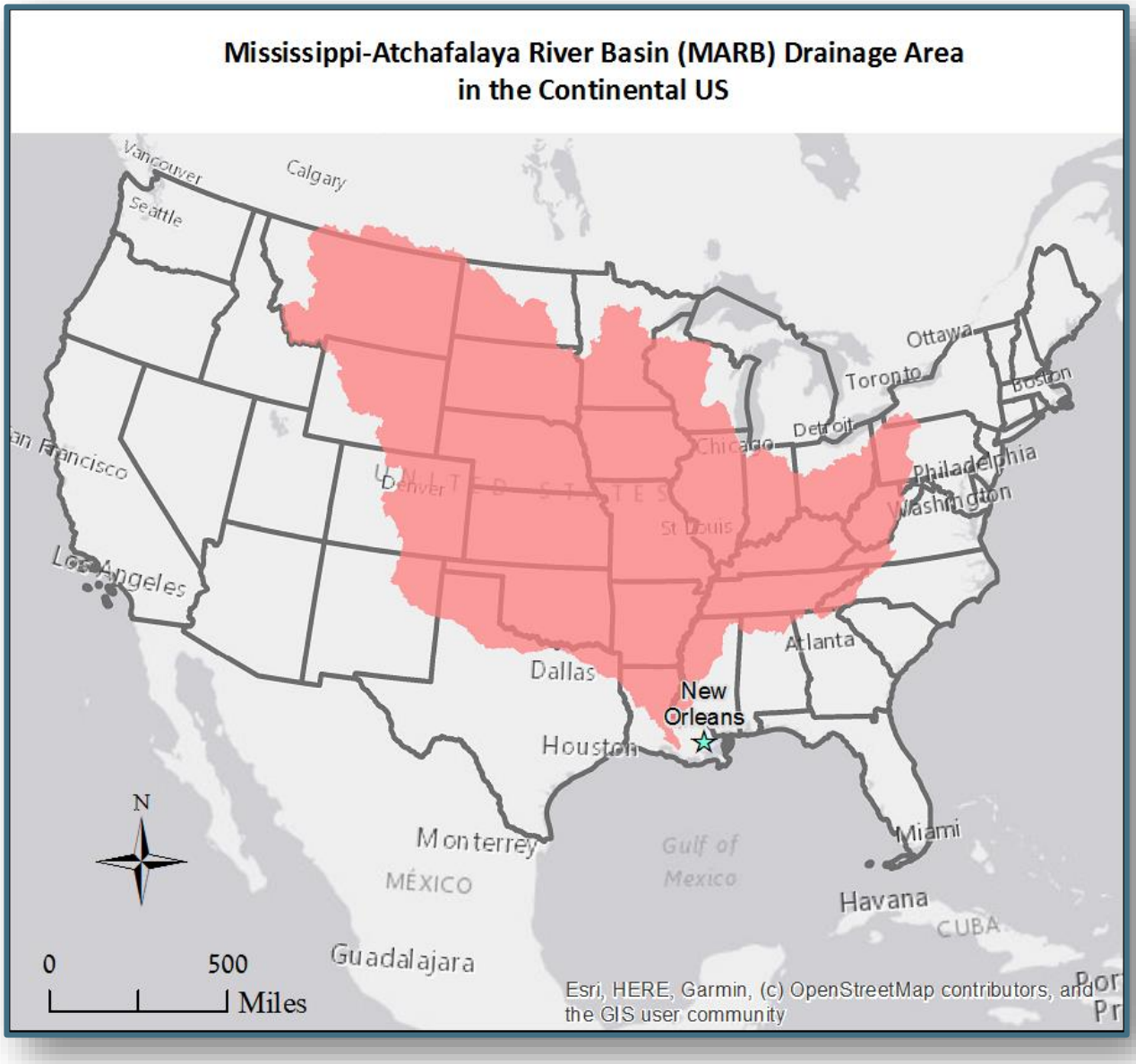


Figure 4. Approximately 43% of Louisiana's land area drains into the Mississippi-Atchafalaya River Basin (MARB) and eventually into the Gulf of Mexico (GOM). According to USGS models, Louisiana contributes 1.7% of the nitrogen and 2.4% of the phosphorus load into these rivers (Alexander et al. 2008).The remaining 57% of the land area in the state drains into the GOM either directly or through coastal bays or lakes.

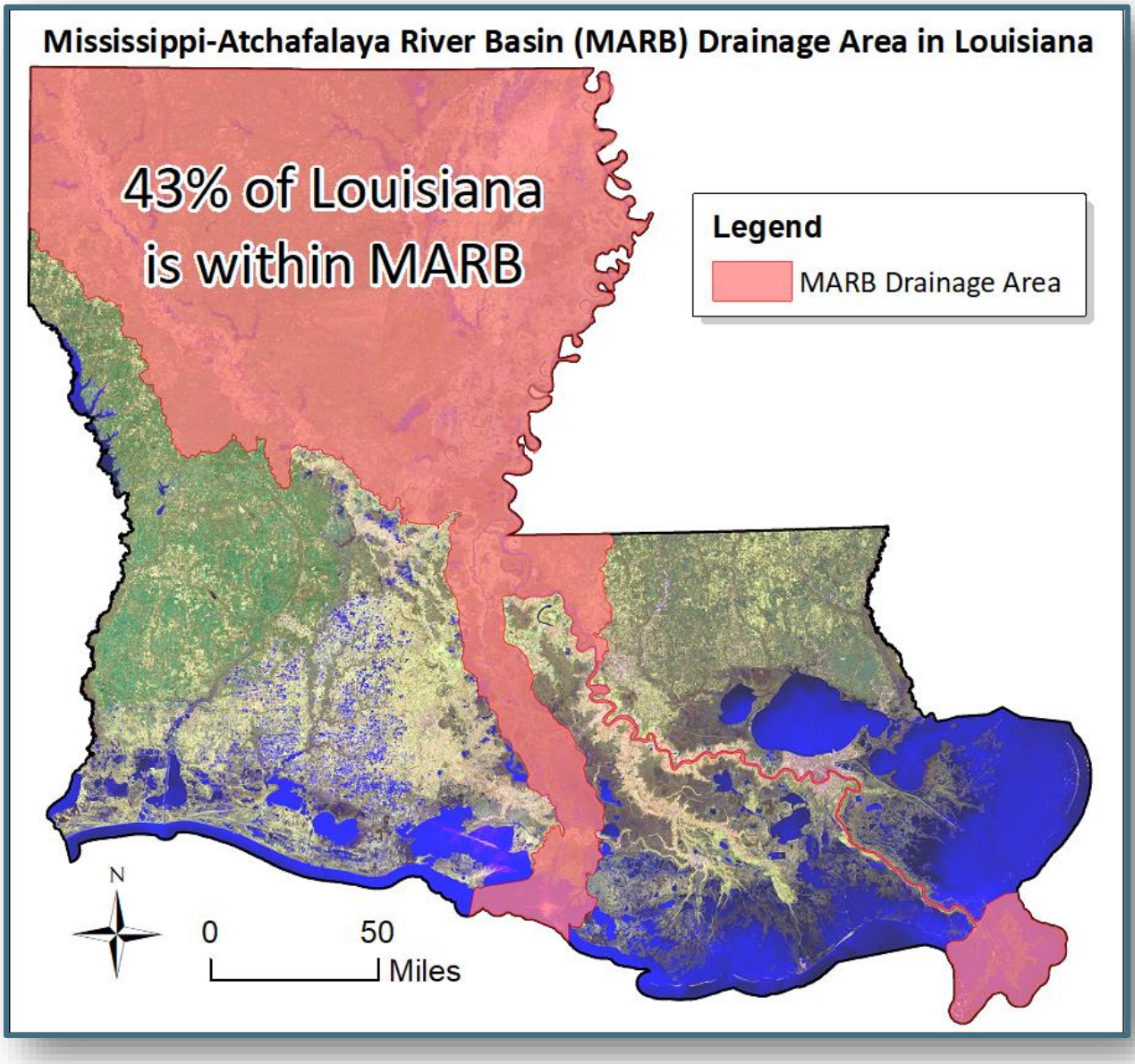


Table 1. Percent share of nutrient flux (mass per time) delivered to the Gulf of Mexico (GOM) from States within the Mississippi-Atchafalaya River Basin (MARB). States which are not members of the Hypoxia Task Force are reported under "other" (reproduced from Alexander et al. 2008).

Total Nitrogen			Total Phosphorus		
State	*Percent of Total Flux*	*Delivered Yield (kg km^2 yr^1)*	*State*	*Percent of Total Flux*	*Delivered Yield (kg km^{2}yr^1)*
Illinois	17	1734.9	**Illinois**	12.9	117.4
Iowa	11	1167.2	**Missouri**	12.1	89.4
Indiana	10	1806.6	**Iowa**	9.8	89.2
Missouri	10	800.5	**Arkansas**	9.6	94.6
Arkansas	7	750.1	**Kentucky**	9	113.4
Kentucky	6	879.5	**Indiana**	8.4	132.3
Tennessee	6	757.7	**Tennessee**	5.3	61.9
Ohio	5.4	1082.3	**Mississippi**	4.4	101.6
Mississippi	3	863.5	**Ohio**	4.1	72.1
Minnesota	3	340.7	**Louisiana**	2.4	67.4
Wisconsin	3	406.8	**Wisconsin**	2.4	31.7
Louisiana	2	513	**Minnesota**	2	20.1
Other	17		**Other**	17.7	
Total	**100**		**Total**	**100**	

Although Louisiana's contribution to the overall nutrients entering the GOM is small, Louisiana is at the terminus of all nutrient impacts resulting from nutrient loads upstream. During the summer, a hypoxic zone has been observed in the northern Gulf of Mexico. Nutrient loading from the Mississippi River has been recognized as a key factor for the development of this northern GOM hypoxic zone. For this reason, Louisiana is committed to protecting and improving

water quality within its inland and coastal waters, and cooperating with upstream states to reduce nutrient loads in the MARB.

Specifically, river diversions built as a part of the 2017 Coastal Master Plan (CPRA 2017) will provide a means of intercepting nutrients from the main stem of the Mississippi River and reducing the amount of nutrients reaching the Gulf of Mexico. In addition to the regulatory requirements under the Clean Water Act (CWA), this comprehensive strategy includes an incentives-based approach for participation of all stakeholders within the watershed community involved in agricultural management practices, wastewater treatment technologies, and coastal programs and restoration activities. A commitment to the development of a Nutrient Management Strategy for Louisiana is a strong indication of the state's continued dedication to protect, improve, and restore water quality of the state's water bodies.

B. VISION

The overarching vision of the Louisiana Nutrient Management Strategy is that through its implementation:

- Nutrient levels in Louisiana's surface waters, both inland and coastal, will be managed to ensure support of healthy aquatic communities, clean water for public, agricultural and industrial use, including but not limited to recreation in and on the water, drinking water supplies, irrigation and livestock watering;
- Stakeholders will be involved in nutrient management at the local level to actively support water quality protection, improvement, and restoration of Louisiana's water bodies and will be encouraged through participation in voluntary, innovative, and incentive-based approaches; and
- Nutrient management for water quality protection, improvement, and restoration at the local level may have a cumulative and positive impact on the health of the receiving water bodies both within the state and within the Gulf of Mexico.

C. PURPOSE

The purpose of the Louisiana Nutrient Management Strategy is to manage nitrogen and phosphorus to protect, improve, and restore the nutrient-related water quality in Louisiana's inland and coastal waters.

D. STAKEHOLDERS AND PARTNERS

All stakeholders within a watershed community will play a role in nutrient management for Louisiana's water bodies. Stakeholders include state and federal agencies, academic institutions, nonprofit, non-governmental organizations (NGOs), private industry, private landowners and members of the watershed community, and parishes and municipalities among others. Participation by and partnerships among these stakeholder entities is necessary for the success of the Louisiana Nutrient Management Strategy for protection, improvement, and restoration of water quality within Louisiana's watershed communities.

E. FRAMEWORK FOR LOUISIANA'S NUTRIENT MANAGEMENT STRATEGY

Strategy features, strategic components, and strategic actions are outlined below that support the vision and purpose of the Louisiana Nutrient Management Strategy.

Strategy features includes those essential elements desired in a nutrient management strategy. Strategic components are the framework for organizing and accomplishing the goal. Strategic actions are those action items to be accomplished through employing the nutrient management methods described therein.

E.1 Strategy Features

The Nutrient Management Strategy for the state of Louisiana will continue to address sources of nutrients including point and nonpoint sources within the water bodies of the state. This implies that all nutrient sources will be considered for management, assimilation, and reduction. Thus, the Nutrient Management Strategy will be **goal oriented** where specific actions are identified along with **measurable environmental outcomes.** The Nutrient Management Strategy utilizes a **watershed approach** where all activities within a watershed, including natural environmental and human activities, are assessed and taken into account. Therefore, it is imperative that **watershed leaders** who are the most familiar with the local conditions and needs within a watershed be the vanguard for these efforts.

Accordingly, efforts will be **broadly collaborative** with watershed partnerships formed among state and federal agencies, academic institutions, private landowners and industry, and other groups to leverage strategies. Watersheds throughout Louisiana will be included in nutrient management activities through the connectivity of water bodies statewide culminating in **comprehensive statewide water quality improvements**.

The Nutrient Management Strategy relies on **strategic planning including macro-, meso-, and micro-watershed approaches** that will allow objectives and measureable outcomes to be scalable from watershed level (micro) to state (meso) and possibly even nationwide (macro). Programs implemented for water quality improvements through this Nutrient Management Strategy will be routinely evaluated and **improvement projects tracked** in order to measure the environmental outcome. Continued and routine **progress monitoring and reporting** will aid in identifying successes as well as identifying programs that may require adjustments or re-evaluation in order to achieve the desired outcome of nutrient management within Louisiana's water bodies. Performance measures and tracking will be a key part to strategy implementation.

All available 'tools in the toolbox' will be identified and used in this nutrient management effort. These decision support tools may include existing data sources, modeling efforts, and mapping applications originating from a wide array of watershed community stakeholders. While current knowledge of the watersheds will be incorporated into this Nutrient Management Strategy, it may also be important to **leverage new technologies** to manage and reduce nutrients.

E.2 Strategic Components

The Louisiana Nutrient Management Strategy is composed of a framework of ten strategic components to support the vision and purpose of the strategy. These ten strategic components (Table 2) represent common themes for nutrient management and illustrate the process taken to develop and implement this Nutrient Management Strategy to protect, improve, and restore the nutrient water quality within water bodies of the state of Louisiana.

Further, the ten strategic components for the Louisiana Nutrient Management Strategy align with common components or elements of a nutrient strategy envisioned by such entities as the Gulf of Mexico Alliance (GOMA 2010, 2016), the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, and USEPA (2011, 2016).

Table 2. Framework of ten strategic components of the Louisiana Nutrient Management Strategy.

Component	Description
1. Stakeholder Engagement	Identify, engage, and involve stakeholders within the watershed community in water quality solutions
2. Decision Support Tools	Identify and evaluate tools that may be utilized in evaluating and assessing nutrients in watersheds
3. Regulations, Policies, & Programs	Examine current regulations, policies, and programs that may guide nutrient management activities
4. Management Practices & Restoration Activities	Identify and document appropriate management practices and restoration activities
5. Status & Trends	Examine status and trends of information related to nutrient management
6. Watershed Characterization, Source Identification & Prioritization	Characterize watersheds and subsegments, identify nutrient sources, and prioritize watersheds for nutrient management efforts
7. Incentives, Funding, & Economic Impact Analyses	Utilize voluntary incentives or funding to promote participation in stewardship activities and evaluate economic impact of nutrient management activities
8. Targets & Goals	Document agency commitments, timelines, and milestones for nutrient management activities
9. Monitoring	Utilize effective monitoring programs to document nutrient levels or other associated data
10. Reporting	Develop reporting mechanisms for communicating with stakeholders and tracking strategy progress

E.3 Strategic Actions

A series of strategic actions guides the implementation of the 2019 Louisiana Nutrient Management Strategy. These strategic actions fall under the framework of the ten strategic components described above. Completing these strategic actions, as well as adapting, modifying, or identifying additional strategic actions, will be part of the strategy implementation process.

E.3.1 Stakeholder Engagement

Stakeholder participation is essential to accomplishing the vision of the Louisiana Nutrient Management Strategy. Stakeholders have a vested interest in the protection, improvement, and restoration of water quality within their watershed community and are the stewards of their local landscapes. Engaging and communicating with stakeholders will be key to the success of the Louisiana Nutrient Management Strategy. Ongoing stakeholder and outreach is a continuing part of the strategy process, with 523 events attended among supporting agencies from 2014 to 2018 (Table 3) concerning nutrient reduction.

Table 3. Stakeholder and outreach events attended by Nutrient Management Strategy supporting agencies (CPRA, LDAF, LDEQ, LDNR, LSU AgCenter, and USDA) from 2014 to 2018.

	Outreach/Stakeholder Event Description									
YEAR	**Meeting**	**Presentation**	**Public Event**	**Workshop /Training**	**School**	**Tour**	**Symposium**	**Press**	**Field Day**	**Grand Total**
2014	20	1		14						35
2015	16	7	4	57			**1**		27	112
2016	16	22	6	36			**1**		26	107
2017	13	13	8	23	2	30	**2**		13	104
2018	32	7	12	59	6	26	**5**	6	12	165
Grand Total	**97**	**50**	**30**	**189**	**8**	**56**	**9**	**6**	**78**	**523**

One of the many benefits of a robust stakeholder engagement process is increased awareness and participation from all sectors within a watershed in activities that are more nutrient-responsible. Working with local watershed and industry leaders, future stakeholder engagement efforts will focus on performing ongoing and additional outreach and education, and identifying and promoting partnerships and leveraging opportunities. Leveraging existing programs will be critical to engage stakeholder communities further as the Louisiana Nutrient Management Strategy is implemented.

The strategic actions for Stakeholder Engagement under the Louisiana Nutrient Management Strategy are to:

- Identify and engage stakeholders for continued strategy development and actions
- Perform outreach/education on strategy activities

- Identify and promote partnerships/leveraging opportunities

Timelines and milestones for these strategic actions are given in Appendix A.

E.3.2 Decision Support Tools

Decision support tools are essential to evaluating and assessing various aspects of nutrient management activities. Numerous tools exist that may be utilized for this purpose. Available tools include water quality data, water quality models, and management actions and assessments.

Web-based data access tools, such as the Louisiana Environmental Assessment Utility (LEAU) Web Portal for water quality data (LDEQ 2018a), are directly applicable to nutrient management. The USEPA Nitrogen and Phosphorus Data Access Tool (USEPA 2018b), and the Water Quality Portal (USGS et al. 2018) may provide access to available information on nutrient levels within the state's water bodies. In addition, the USEPA is currently updating their public interactive web page for impairment information (expected release 2019). This webpage will enable access to water quality impairments (including nutrients) for all states and tribal lands (USEPA 2018d).

Water quality models, such as the USGS Spatially Referenced Regressions On Watershed attributes or SPARROW model (USGS 2018), may provide information on potential sources of nitrogen and phosphorus and nutrient loads in surface waters. Currently, this model is undergoing revision, with update completion of more recent data (2012 vs 2002) anticipated in 2019. Geographic Information Systems (GIS) based tools that allow visualization of watershed features, such as land use and elevation, and identification of potential nutrient sources will be important in supporting decisions on nutrient management activity and aid in watershed prioritization.

Another tool is the Recovery Potential Screening (RPS) spreadsheet tool available from the USEPA to each state that can compare watersheds within the state's waters (USEPA 2018e). This tool performs RPS index calculations, and automatically generates maps, graphs and tables of index values and rank orders from these calculations to help states examine their waters' condition and potential recovery. Another developed tool includes The Nature Conservancy's Freshwater Network, which provides scientific information to support decision making about Louisiana freshwater resources through an online mapping system (TNC 2016).

The strategic action for Decision Support Tools under the Louisiana Nutrient Management Strategy is to:

- Identify, evaluate, and document selected tools

Timelines and milestones for this strategic action is given in Appendix A.

In the development of the 2014 strategy, the Interagency Team conducted a broad review of available decision support tools, and at that time over 200 tools were identified, evaluated, and

their applicability or utility to nutrient management determined. Applicable tools included best management practices, data access portals, mapping applications, modeling tools, and reports. Current relevant tools and associated links to these tools are available through the Louisiana Nutrient Management Strategy website (LDEQ 2018). As the strategy is applied, newly identified tools will continue to be evaluated and documented, as they are useful to the Louisiana Nutrient Management Strategy.

E.3.3 Regulations, Policies, & Programs

Numerous efforts are underway within the state of Louisiana as well as nationally that address a multitude of nutrient management activities such as those aimed toward outreach, monitoring, or agricultural incentives. These programs may assist with nutrient management activities within the state of Louisiana. Agricultural production in Louisiana has benefitted from Farm Bill programs that offer financial incentives and technical assistance with implementation of conservation practices. A list of regulations, policies and programs may be found on the Louisiana Nutrient Management Strategy website (LDEQ 2018).

The strategic actions for Regulations, Policies, & Programs under the Louisiana Nutrient Management Strategy are to:

- Propose or establish new regulations, policies and/or programs pertinent to strategy objectives
- Leverage multiple regulations, policies, and/or programs to most efficiently utilize varying practices in managing nutrients

Timelines and milestones for these strategic actions are given in Appendix A.

Recent Regulations, Policies and Programs of note involve environmental catastrophes that have occurred within Louisiana: the Deepwater Horizon oil spill (2010) and historic flooding in south Louisiana (2016). As part of the settlement of the 2010 Deepwater Horizon oil spill, new projects to reduce nonpoint source pollution were released in 2018 in a document entitled: *Louisiana Trustee Implementation Group Final Restoration Plan and Environmental Assessment #4: Nutrient Reduction (Nonpoint Source) and Recreational Use* (Louisiana Trustee Implementation Group 2018) after public review and comment. The Louisiana Trustee Implementation Group (LA TIG), consisting of several members of the nutrient management strategy group, developed this final restoration document as part of reparations resulting from environmental damage caused by the spill. Up to $9.5 million will be earmarked for nonpoint source nutrient reduction in southern Louisiana, and will focus on dairy farms and cropland/grazing land operations for water quality improvements.

The Louisiana Watershed Initiative, launched in August 2018 by Gov. John Bel Edwards in response to historic flooding events in 2016, is a multiple agency collaborative tasked with the development of new approaches to reducing flood risk throughout Louisiana. As part of this initiative, the *Council on Watershed Management* was also established to develop floodplain management based on watersheds rather than political boundaries. Local jurisdictions and

communities have been empowered through the Council to implement regional, long-term solutions that follow watershed boundaries to reduce flood risk within their communities. This effort may provide opportunities to improve nutrient inputs from point and nonpoint sources as part of flood control improvements across the state.

E.3.4 Management Practices & Restoration Activities

Developing, documenting, and leveraging appropriate management practices, including nonpoint source, point source, and restoration activities for a given watershed, will be essential to the Louisiana's nutrient management efforts. Louisiana's land use is diverse which requires solutions to regional nutrient issues be location-specific. Opportunities to leverage management practices and restoration activities within a selected watershed will allow for a more holistic approach to nutrient management resulting in more informed decision-making with multi-layered beneficial effects.

Currently, management practices which control the sources, transformation, and delivery of nutrients are widely applied in various state and federal programs in Louisiana. Watershed management programs have been effective tools for addressing water quality in Louisiana's water bodies. Some of the most effective application of these includes controlling land use, restoring and maintaining the landscape, and utilizing conservation practices (CPs; Figure 5 shows how to access current practices).

Point source wetland assimilation projects which introduce nutrient-rich wastewater to natural wetlands can achieve tertiary levels of sewage treatment and stimulate wetland productivity. The state has adopted policy guidelines and regulations for utilizing wetlands to assimilate nutrients in municipal effluent (LDEQ 2016a, 2018; LDEQ 2018d).

Many coastal programs within Louisiana are focused on combating land loss and salt water intrusion. However, the 2017 Coastal Master Plan (CPRA 2017) focuses on projects that not only reduce risk from storms and flooding but also restore ecosystems and ecological functions (Figure 6). CPRA evaluated ecosystem services such as nutrient uptake potential in various habitats; the evaluation indicated that the management of existing and proposed Mississippi and Atchafalaya River diversions within the MARB could allow for substantial nutrient removal (Rivera-Monroy et al. 2013).

The strategic actions for Management Practices & Restoration Activities under the Nutrient Management Strategy are to:

- Document current practices related to nutrient management
- Identify areas where practices are being implemented
- Identify case studies/modeling efforts for strategy leveraging
- Integrate science-based nutrient management approaches
- Promote BMP/CP implementation by farm in priority watersheds

Timelines and milestones for these strategic actions are given in Appendix A.

Figure 5. U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS) conservation practices applicable to Louisiana (USDA NRCS 2018c). Currently there are 142 listed conservation practices in Louisiana in Section IV (archived).

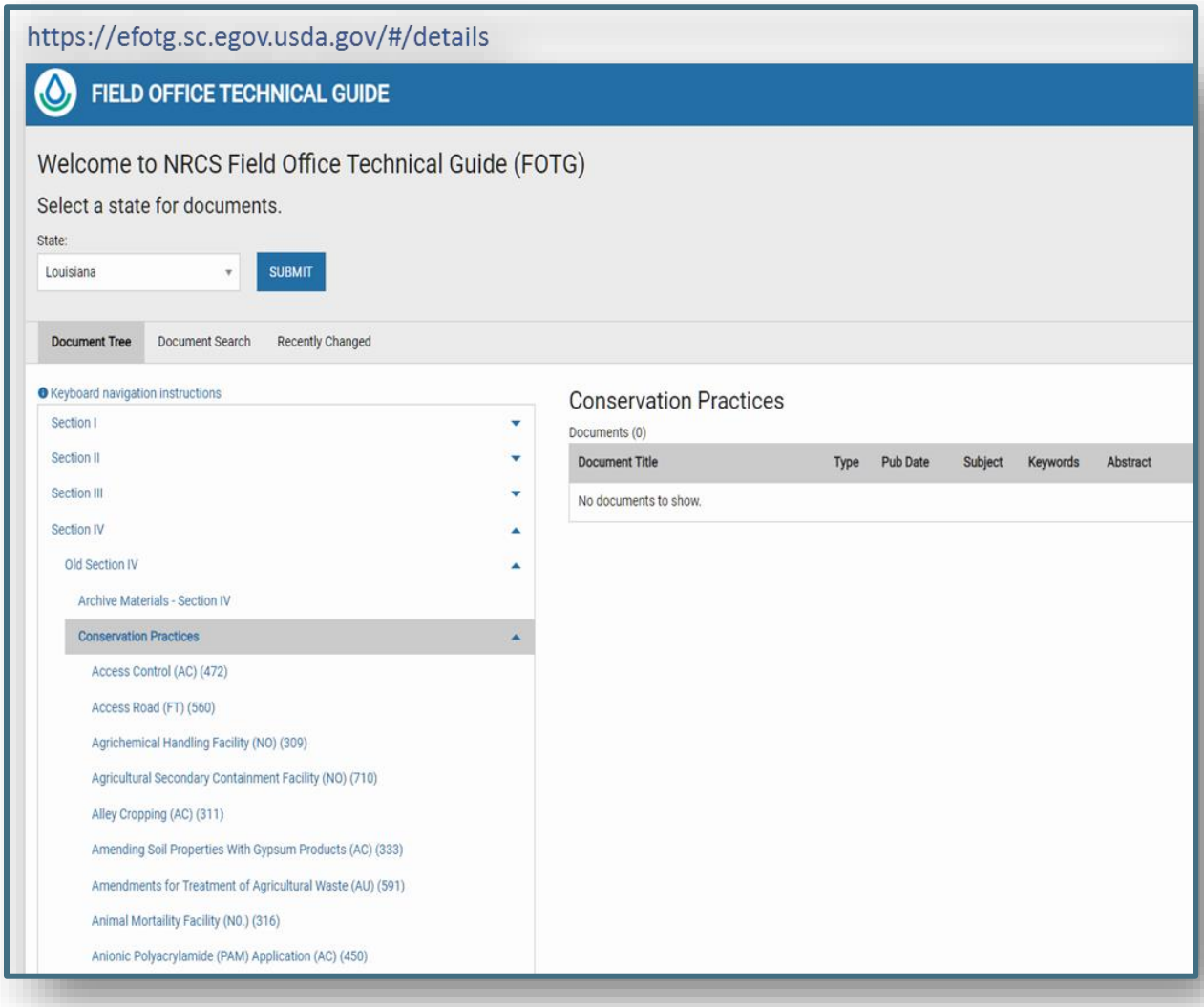
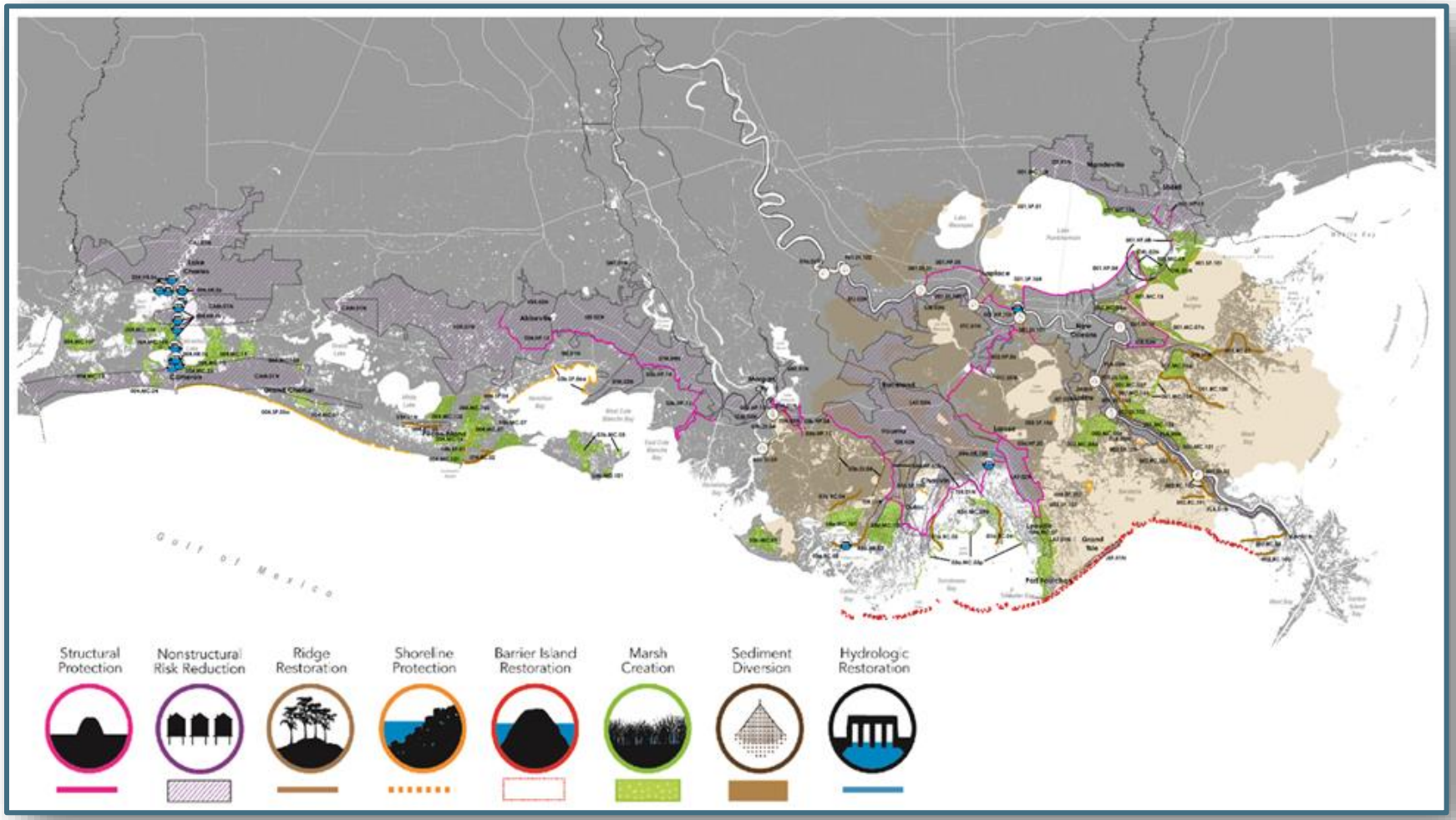


Figure 6. The 2017 Coastal Master Plan by the Coastal Protection Restoration Authority (CPRA; CPRA 2017) includes 124 restoration and protection projects within the state of Louisiana are necessary to build or maintain land and reduce flood risk.



E.3.5 Status & Trends

Documenting the status of nutrients and determining changes over time is a critical part of evaluating the success of nutrient management efforts in Louisiana. Water quality data collected as part of the LDEQ Ambient Water Quality Monitoring Network (AWQMN) provides data on nutrient levels within the state's water bodies (LDEQ 2018a). Information in the coastal zone related to historic land loss, future projected land loss, habitat type, salinity and water level data are routinely collected by CPRA through the Coastwide Reference Monitoring System (CRMS)-*Wetlands* and the Barrier Island Comprehensive Monitoring (BICM) programs (CRMS 2018; BICM 2018), as well as Couvillion, et al. 2017. In addition, CPRA and TWIG collected nutrient-related data in the Barataria and Breton Sound (east of the Mississippi River) basins in 2014 and 2015 to serve as baseline for new diversion projects, as well as provide data for the calibration and validation of models. CPRA continues to develop and implement the System-Wide Assessment and Monitoring Program (SWAMP), which is a comprehensive monitoring program to serve predictive models as well as program assessment (TWIG 2016). These results will be used to investigate and evaluate trends in nutrients as diversion projects move through engineering, design, construction, and operation.

As part of a project to inform management decisions regarding the planned Mid-Barataria Sediment Diversion (MBSD) at Myrtle Grove, Louisiana, NOAA's Gulf of Mexico Integrated Ecosystem Assessment (IEA) program team is currently analyzing a suite of biophysical, ecological, and human dimension indicators to exhibit the status and trends in Barataria Basin. The Barataria Basin Ecosystem Status Report (ESR) will provide the status of water quality monitored in the lower Mississippi River and in Barataria Basin to provide a baseline condition before large-scale ecosystem restoration projects are implemented. Water quality parameters analyzed for status and trends include discharge, gage height, water level, water temperature, salinity, total nitrogen, total phosphorus, turbidity, chlorophyll a, total suspended sediments, and total suspended organics. In addition, modeling outputs (Delft 3D) for the next 50 years from selected locations will be produced (Martin 2019).

Point source discharges into Louisiana waters are managed through the Louisiana Pollutant Discharge Elimination System (LPDES) Permit Program by the LDEQ under Louisiana's Water Quality Regulations (LAC 33: Part IX) (LDEQ 2016a). As part of the management practices of LDEQ, permits are tracked yearly. From 2014 to 2018, the total number of permits averaged around 13,280 (Table 4). Current permits requiring nutrient monitoring are presented in Table 5.

Changes in the permitting reporting process have occurred since the 2014 Nutrient Management Strategy was implemented. The USEPA NPDES Electronic Reporting Rule became effective December 21, 2015 requiring electronic reporting instead of paper-based NPDES reports as was done in the past (USEPA 2018c). The rule has resulted in LDEQ requiring electronic reporting from LPDES permitted dischargers. LDEQ utilizes a web-based tool called NetDMR that allows facilities to electronically sign and submit LPDES discharge monitoring reports (DMRs) to the

LDEQ (LDEQ 2019). Use of NetDMR allows for improved availability and access to DMR results of all parameters that are part of the dischargers permit, including nutrient monitoring results

Watershed Implementation Plans (WIPs) developed through the LDEQ Nonpoint Source Program include an evaluation of the status and trends of historical water quality data for each priority water body that is targeted for partial and/or full restoration. Currently, the LDEQ Nonpoint Source Program has Watershed Implementation Plans (WIPs) for seven watersheds accepted by EPA to receive CWA 319(h) funding for BMP implementation. According to the LDEQ Nonpoint Source Management Plan, the department projects to submit two additional WIPs per year to EPA through 2022 (LDEQ 2012). These plans include suggestions for where and what types of BMPs to implement for each watershed in order to reduce suspected causes of impairments, and thus restore use support for that watershed. To that end, in 2018 the NPS Annual Report estimated the reduction of nitrogen entering state waters by over thirteen tons, and reduction of phosphorus by nearly 3 tons (LDEQ 2018e). LDEQ projects that it will reduce over 50 tons of nitrogen and 12 tons phosphorus by 2022 (LDEQ 2018e). As Louisiana's Nutrient Management Strategy implementation continues, case studies for nutrient management activities will be tracked and evaluated to assist with determining watershed status and trends.

Nonpoint source pollution may be a factor of not only environmental conditions but also individual behavior (Mendoza 2006). Social Indicators provide a means to measure social change and may be an important management tool in understanding effectiveness of management strategies (Genskow and Prokopy 2011). Within Louisiana, the LSU AgCenter has conducted surveys and studies to document Social Indicators associated with implementation of conservation practices and attitudes on water quality for specific agricultural interest groups within the state (e.g., LSU AgCenter 2013). Topical papers and activities concerning LSU AgCenter are discussed below and in Section F.2. Guzman et al. (2017) released a report in 2017 to document social indicator use, determine the importance of indicator use, and advise on the best way to use indicators across MARB states and the GOM. This report breaks down how to use current tools and methods to assess the human implications of nutrient management. Documenting current behavior and determining changes over time may be valuable in guiding nutrient management decisions within a given watershed.

The strategic actions for Status & Trends under the Nutrient Management Strategy are to:

- Model nutrient loading estimated within Louisiana watersheds
- Document and determine trends for in-stream nutrient water quality (long-term)
- Document and determine trends for Social Indicators of nutrient management behavior
- Document and determine trends for Best Management Practice (BMP) and conservation practice (CP) implementation in watersheds
- Document and determine trends for permitted discharger inventories
- Document coastal protection and restoration activities

Timelines and milestones for these strategic actions are given in Appendix A.

The efforts described above, in addition to others identified through the Louisiana Nutrient Management Strategy process, will be evaluated together to give an overall view of the current status and future trend of nutrients. This information can be utilized to inform decision-makers and to guide management efforts within a watershed.

Since the development of the 2014 strategy, the LDEQ and the LSU AgCenter have each completed studies on trends of nutrients in Louisiana. In 2015, the LDEQ determined trends in nutrient water quality concentrations observed at 21 active long-term monitoring stations located in the throughout the state (LDEQ 2015a). This trend analysis examined nitrogen [including TKN and nitrate + nitrite (NO_x)] and phosphorus [as TP] concentrations observed at long-term stations in Louisiana. The results of the Mann-Kendall trend tests for TKN, NO_x, and TP from 1978 to 2014 revealed the majority of trends (73%) to be decreasing. All sites had a decreasing trend for TKN, twelve sites showed a decreasing trend for NO_x, and thirteen sites showed a decreasing trend for TP. Only one trend, NO_X for the Bogue Chitto River, was found to be increasing. The LSU AgCenter also examined nutrient trends over time in Louisiana water bodies, specifically in the Mermentau and Vermilion Rivers (He and Xu 2015), and the results complimented those from the LDEQ analyses. The LSU AgCenter utilized the LDEQ long-term data as well as data from the USGS. In their review of nutrient trends by decade from 1980 to 2010 in the Mermentau and Vermilion Rivers, the researchers observed that there was an overall steady decline of nitrogen and phosphorus concentrations in both rivers, mainly in the 1990s.

In addition, the USGS has completed long-term trend analysis on 40 years of water quality data (1982 to 2012) in the Nation's waterways through the National Water-Quality Assessment (NAWQA) Project (Oelsner et al. 2017). An interactive mapping tool with this information is available (Oelsner et al. 2017a). As part of that effort, trends in annual water quality loads to the GOM were also examined from 1980 to 2017 (USGS 2017). The long-term trends to the GOM were calculated utilizing flow-normalized loads, which represent the amount of yearly load that would have reached the GOM if streamflow was fixed and never changed (at the long-term average); thereby removing effects of river flow (drought/flooding) from analyses. The results from this effort for various water quality parameters are available through an interactive graphing application on the website, and have been integrated into the HTF's evaluation of hypoxia area (USGS 2017; HTF 2015, 2019). Murphy and Sprague (2019) examine the confounding effects of stream flow and watershed management efforts on trends, as well as the effects of parameter choice (load vs. concentration, nutrient, and site), with findings illustrating the necessity of understanding all of these components in reaching water quality goals. Mize et al. (2018) provides information on decreasing suspended sediment trends in the MARB.

Table 4. Number and type of LPDES permits held from 2014 to 2018.

	Permit Type		
Year	Total No. Permits	General and Industrial	Stormwater
2014	13,570	10,417	3,153
2015	12,931	10,639	2,292
2016	13,388	11,052	2,336
2017	13,224	10,943	2,281
2018	13,287	11,098	2,189
Total	13,280	10,830	2,450

Table 5. Nutrient monitoring by permit type as of May 2019. Gen=General Permit, Indiv=Individual Permit.[1]

Permit Type	Nutrient Type				
	Nitrogen, Kjeldahl, Total (as N)	Nitrogen, Nitrate Total (As N)	Nitrogen, Organic Total (as N)	Nitrogen, Total (As N)	Phosphorus, Total (as P)
Gen-LAG48-Light Commercial				25	24
Gen-LAG53-Sanitary Class I				767	768
Gen-LAG54-Sanitary Class II				212	212
Gen-LAG56-Sanitary Class III				16	16
Gen-LAG57-Sanitary Class IV				90	90
Indiv-Major-Industrial[2]				4	2
Indiv-Major-MS4	12			12	12
Indiv-Major-Sanitary				54	54
Indiv-Minor Industrial[2]		2	6	115	125
Indiv-Minor-Sanitary[2]	3	1		199	200
Grand Total	15	3	6	**1494**	1,503

1. Multisector permits not included
2. Totals also include permits requiring nutrient limits (n=12).

E.3.6 Watershed Characterization, Source Identification, & Prioritization

Watershed characterization, source identification, and prioritization involve identifying the natural characteristics of land and water bodies found within watersheds, and identifying the possible suspected sources of nutrients to a given water body. This information on watershed characteristics and suspected sources will allow for prioritization of water bodies for nutrient management activities.

Watershed characterization of such attributes as land use, elevation, and nutrient sources include factors related to the physical, chemical, and biological properties of the water bodies within a watershed. Watershed characterization involves delineating the watershed that will be the focal management unit addressed by the Nutrient Management Strategy and determining the attributes and characteristics of the watersheds that are relevant to nutrient water quality. The LDEQ *Water Quality Management Plan, Volume 4 Basins and Subsegment Boundaries* (LDEQ 2014) describes the delineations of LDEQ water management units Basins/Subsegments and the primary water body types within those units. There are 12 basins within the state that are subdivided into nearly 500 subsegments that fall within these basins. Additionally, the USGS delineates Hydrologic Units (HUCs) that are also subdivided into successively smaller units (Seaber et al. 1987; USGS 2018a). HUCs are another set of water management units that may be utilized in nutrient management activities; within the state of Louisiana there are four HUC2 (regional) watersheds, 12 HUC4 (subregions), 21 HUC6 (basins), 60 HUC8 (subbasins), 277 HUC10 (watersheds), and 1,275 HUC12 (sub-watershed) level watersheds delineated.

The National Land Cover Database (NLCD 2011) geographically categorizes the land use/land cover within the state of Louisiana as well as that of the nation. The land use/land cover statewide in Louisiana is categorized as 27% wetlands, 19% forests, 18% open water, 15% cultivated crops, 6% developed areas, 8% shrub/scrub, and 5% pasture/hay (Table 6). The distribution of these land use/land covers differ among basins and regions of Louisiana (Figure 7). Wetlands occur largely within the coastal area and Mississippi and Atchafalaya River delta regions of the state, whereas forests mainly occur in the central to northwestern portions as well as the eastern part of the state. Crops are mainly located within the northeastern and southwestern part of the state. Developed areas are typically associated with larger cities within Louisiana and occur interspersed throughout the state. Other data sets including Geographic Information Systems (GIS) based data such as hydrology and elevation, and water quality monitoring data will also be useful in characterizing watersheds for nutrient management activities.

Source identification involves identifying suspected sources of pollution within a given water body or watershed. Source identification may be accomplished through desktop analyses or rapid assessment utilizing a multitude of GIS-based and water quality data to look at the land surrounding the water body to help determine potential impacts. Windshield surveys, performed by driving around the watershed of interest, may also help acquire information on potential sources of nutrients. Through LDEQ's Compliance Monitoring Strategy (LDEQ 2018f),

the agency outlines approaches for monitoring permit compliance to aid in addressing potential point source issues. Additionally, LDEQ performs watershed sweeps to identify nonpoint sources and to identify unpermitted point source dischargers within a selected basin or watershed. From 2014 to 2018, watershed sweeps or inspections were performed across the state in over 25 watersheds (Beckstrom 2009, 2011, 2013a, 2013b; Kelly 2007; Mallett 2008, 2009, 2012a, LDEQ 2014a, 2015b, 2016b, 2017, 2017a; Table 7).

Utilizing watershed characterization and source identification information allows for informed prioritization of water bodies for protection, improvement, and restoration of nutrient water quality. The LDEQ Nonpoint Source Program and partners have prioritized water bodies through 2022 for targeting actions to address nonpoint source activities that may be the cause of the impairments (LDEQ 2012; Table 8, Figure 8). Additionally, under LDEQ's TMDL program, prioritization has occurred through the USEPA's Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program ('New Vision'), where LDEQ has incorporated the guidance for prioritization and associated timelines (LDEQ 2015, USEPA 2013). The NPS and TMDL sections of LDEQ have identified additional measures, in conjunction with the New Vison process, to help identify areas within Louisiana that are likely to show the greatest water quality improvement with effort. These measures include such parameters as: (1) the presence/absence of a completed TMDL, (2) restoration potential of the waterbody, (3) water quality parameter trends, (4) parameter criteria of waterbody (5) impairment history, (6) the presence of potential watershed partners, and other factors depending on section, target goals, and other agencies (e.g. USDA NRCS). All prioritization measures were performed in cooperation with USEPA Region 6, and were given final acceptance in 2016 (TMDL) and 2019 (NPS).

NPS priority water bodies are located throughout the state but are largely located in the Mermentau River, Ouachita River, Terrebonne, and Vermilion-Teche River Basins (Table 8, Figure 8). Nutrients are among some of the suspected causes of impairments that also include fecal coliforms, suspended sediment, and turbidity (LDEQ 2012). This prioritization approach summarizes the collaborative effort with the USEPA, although other studies in previous areas of interest may still be ongoing.

Several USDA initiatives within Louisiana have prioritized watersheds within the state for restoration activities associated with conservation practices, and have been highlighted in the Louisiana Nutrient Management Strategy Annual Reports (LDEQ 2018). The Gulf of Mexico Initiative (GoMI; watershed funding active until 2019), National Water Quality Initiative (NWQI), and the Mississippi River Basin Initiative (MRBI) target watersheds across the state for implementation of BMPs to address suspected nonpoint sources through conservation practices (USDA NRCS 2018a; Table 9, Figure 9). Louisiana will receive nearly $1.5 million for northern Louisiana watersheds (Lake Providence, Little Tensas, Lake Bruin, and Van Buren Bayou) for fiscal year 2019 (USDA NRCS Louisiana 2019).

In an effort to best utilize available resources, leveraging with these current programs and initiatives that are working in priority watersheds will be essential under this strategy. In addition, using available watershed characterization and source identification information will allow for the screening and prioritization of watersheds to help select those as priority nutrient management activities.

The strategic actions for Watershed Characterization, Source Identification, & Prioritization under the Nutrient Management Strategy are to:

- Maintain watershed and/or water body characterization through time
- Identify potential pollution sources through Desktop Analysis/Windshield Survey
- Identify unpermitted point sources
- Identify priority watersheds from leveraging programs
- Determine priority watershed & subwatershed basins
- Develop priority watershed scheme for basin subwatersheds
- Develop/leverage Watershed Nutrient Management Projects for priorities

Timelines and milestones for these strategic actions are given in Appendix A.

Table 6. National Land Cover Database land use/land cover (LULC) classifications within watershed basins and statewide for state of Louisiana (NLCD 2011). Statewide, wetlands account for nearly 27%, 19% forests, 18% open water, 15% cultivated crops, 6% developed areas, 8% shrub/scrub, and 5% pasture/hay of the LULC within Louisiana.

		National Land Cover Database (2011) Percent by Basin												
Watershed Basin	Hectares	Open Water	Barren Land	Developed, Open Space	Developed, Low Intensity	Developed, Medium intensity	Developed, High Intensity	Pasture/Hay	Cultivated Crops	Shrub/Scrub	Grassland/ Herbaceous	Forest (Deciduous, Evergreen, Mixed)	Woody Wetland	Emergent Herbaceous Wetlands
Atchafalaya River Basin	575,823	22.2	1.9	1.0	0.9	0.1	0.0	2.3	10.5	0.8	0.4	0.9	52.1	7.0
Barataria Basin	702,135	39.5	0.6	1.0	3.1	0.8	0.5	1.4	7.6	0.1	0.1	0.2	16.9	28.2
Calcasieu River Basin	1,050,845	7.1	0.6	2.2	3.9	0.7	0.3	8.1	6.9	19.8	2.8	27.1	13.8	6.7
Lake Pontchartrain Basin	2,052,781	42.2	0.4	3.3	3.1	1.3	0.6	3.9	2.1	8.9	1.0	8.8	14.5	9.8
Mermentau River Basin	1,009,553	13.1	0.2	1.2	3.5	0.3	0.1	7.7	37.4	2.9	0.9	3.6	8.4	20.8
Mississippi River Basin	536,026	44.4	1.7	1.9	1.0	0.5	0.3	3.1	5.1	3.9	0.8	11.4	18.2	7.8
Ouachita River Basin	2,590,106	2.4	0.1	4.0	1.7	0.3	0.1	1.4	30.5	6.8	1.8	32.6	17.3	1.1
Pearl River Basin	234,858	2.9	1.1	5.0	1.4	0.4	0.1	8.1	3.0	22.9	2.4	18.0	31.1	3.5
Red River Basin	1,993,430	3.9	0.2	3.7	2.7	0.6	0.3	7.8	10.1	9.8	2.9	40.8	16.3	1.1
Sabine River Basin	755,385	12.3	0.9	2.4	1.5	0.2	0.1	4.6	0.8	19.2	4.3	29.4	12.9	11.3
Terrebonne Basin	1,012,555	33.2	0.3	1.4	2.4	0.4	0.3	3.2	10.9	0.3	0.2	0.3	22.2	24.7
Vermilion-Teche River Basin	1,055,275	17.5	0.4	3.0	4.4	0.6	0.3	9.2	27.3	3.4	0.9	6.7	15.9	10.4
State Total:	**13,568,771**	**18.3**	**0.5**	**2.8**	**2.6**	**0.6**	**0.3**	**4.9**	**15.0**	**7.8**	**1.6**	**18.9**	**17.6**	**9.3**

**Percent's may not add up to 100 due to rounding*

Figure 7. Land use/land cover (LULC) plays a major role in watershed characterization in Louisiana, where apparent regional differences exist throughout the state (NLCD 2011). Wetlands occur largely within the coastal area and Mississippi and Atchafalaya River delta regions of the state, whereas forests mainly occur in the central to northwestern portions as well as the eastern part of the state. Crops are mainly located within the northeastern and southwestern part of the state.

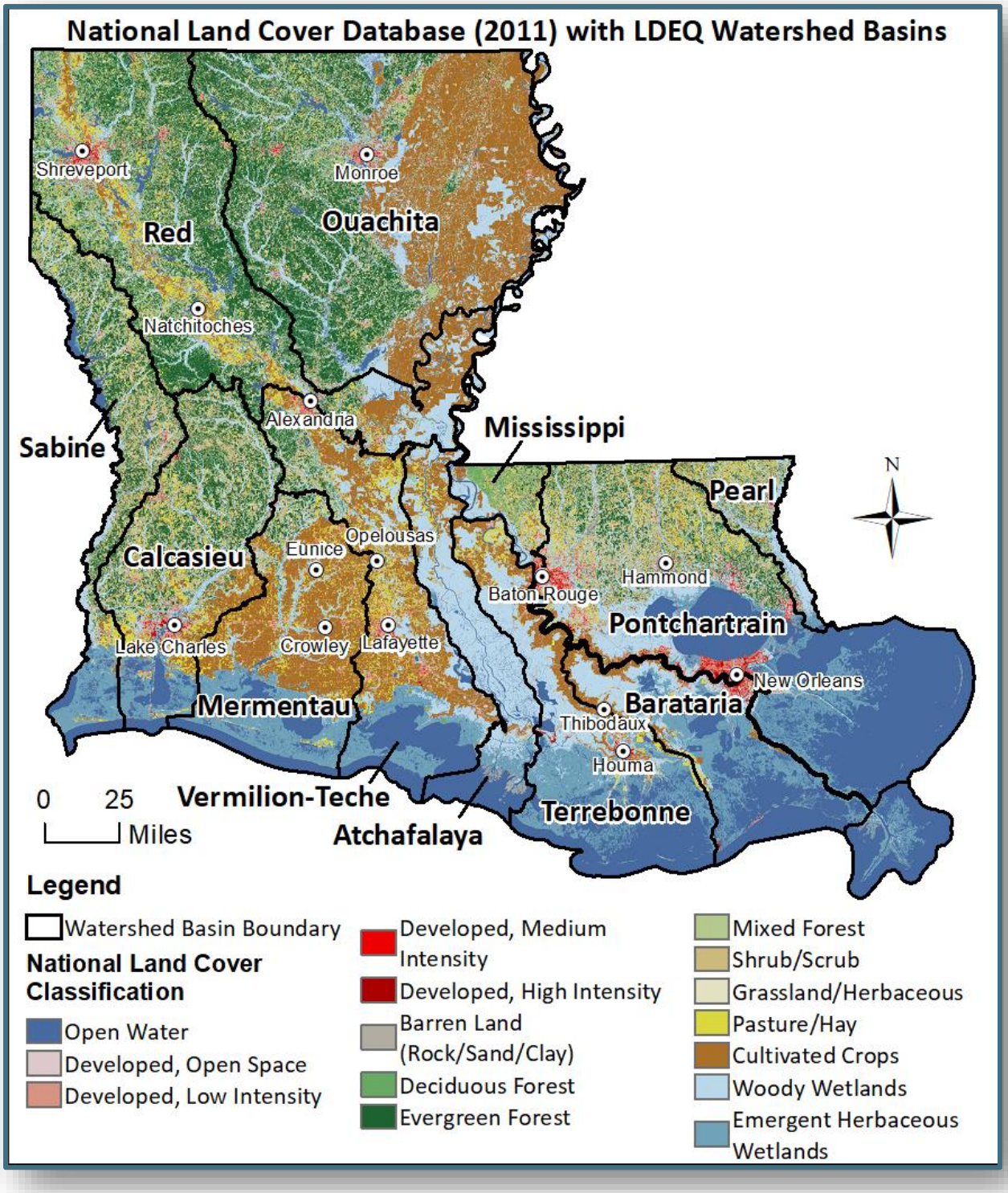


Table 7. LDEQ Watershed sweeps 2014 to 2018.

	Watershed Sweeps			
Location	Subsegment No.	Year	No. Inspections	Notices of Deficiency
Bayou Carron	LA060210	2014	30	13
Bayou Folse - From Headwaters to Company Canal	LA120302	2014	34	11
Bayou Choctaw - From Bayou Poydras to Bayou Gross Tete	LA120103	2014	-	-
West Atchafalaya Basin Floodway - From Simmesport to Butte LaRose Bay and Henderson Lake	LA010301	2015	7	6
Intracoastal Waterway - From Bayou Villars to Mississippi River	LA020601	2015	140	21
Bayou Barataria and Barataria Waterway From lcww to Bayou Rigolettes	LA020802	2015	5	0
Calcasieu River - From Marsh Bayou to saltwater barrier	LA030201	2015	33	32
Calcasieu River and Ship Channel - From saltwater barrier to Moss Lake; includes Ship Channel, Coon Island Loop, Clooney Island Loop	LA030301	2015	4	4
West Fork Calcasieu River - From confluence with Beckwith Creek and Hickory Branch to mainstem of Calcasieu River	LA030801	2015	3	3
Indian Bayou - From headwaters to West Fork Calcasieu River	LA030805	2015	9	9
Chappepeela Creek - From LA-1062 to Tangipahoa River	LA040704	2015	3	2
Intracoastal Waterway - From Inner Harbor Navigation Canal to Chef Menteur Pass	LA041601	2015	5	1
West Atchafalaya Borrow Pit Canal - From Bayou Courtableau to Henderson; includes Bayou Portage	LA060211	2015	19	3
Bayou Teche - From headwaters at Bayou Courtableau to Keystone Locks and Dam	LA060301	2015	8	4
Lake Fausse Point and Dauterive Lake	LA060702	2015	1	0
Bayou Du Portage	LA060703	2015	2	0
Bayou D'Arbonne - From Lake Claiborne to Bayou D'Arbonne Lake	LA080603	2015	1	1

	Watershed Sweeps			
Location	Subsegment No.	Year	No. Inspections	Notices of Deficiency
Dugdemona River - From headwaters to Big Creek	**LA080401**	**2015**	**9**	**9**
Bayou Funny Louis - From headwaters to Little River	LA081611	2015	1	1
Intracoastal Waterway - From Bayou Villars to Mississippi River	LA020601	2016	118	29
Calcasieu River - From Marsh Bayou to saltwater barrier	LA030201	2016	1	1
Turkey Creek - From Turkey Creek Cutoff to Turkey Creek Lake	LA080906	2016	19	19
Bayou Macon - From Arkansas state line to Tensas River	LA081001	2016	26	23
Hemphill Creek - From headwaters to Catahoula Lake; includes Hair Creek	LA081611	2016	1	1
Bayou Cane - From US- 190 to Lake Pontchartrain	LA040904	2017	47	21
Bayou Cane - From US Hwy 190 to CDM Ecoregion Boundary	LA040914	2017	4	0
West Atchafalaya Borrow Pit Canal - From Bayou Courtableau to Henderson	LA060211	2017	1	1
Bayou Tigre - From headwaters to Bayou Petite Anse	LA060903	2017	11	4
Bayou Sara - From Mississippi state line to Mississippi River	LA070501	2017	26	13
Fish Creek - From headwaters to Little River (Scenic)	LA081606	2017	1	0
Latt Lake	LA101302	2017	1	0
Bayou Cane-From CDM Ecoregion boundary to Lake Pontchartrain	LA040914	2018	2	1
Bayou Mallet-From headwaters to Bayou Des Cannes	LA050103	2018	11	0
Bayou Sara-From Mississippi state line to Mississippi River	LA070501	2018	9	4
Bayou Mallet - From headwaters to Bayou Des Cannes	LA050103	2019	15	6
Total			543	219

Table 8. The LDEQ Nonpoint Source Program (LDEQ 2012) identifies priority watersheds through 2022.

SUBSEGMENT	NAME	BASIN	CURRENT ACTIVITY
40503	Natalbany River	PONTCHARTRAIN	New Vision
40504	Little River	CALCASIEU	
50101	Bayou des Cannes	MERMENTAU	Implementation
50103	Bayou Mallet	MERMENTAU	Implementation
50301	Bayou Nezpique	MERMENTAU	
50304	Bayou Blue	MERMENTAU	
50401	Mermentau River	MERMENTAU	
50501	Bayou Queue de Tortue	MERMENTAU	Implementation
50603	Bayou Chene	MERMENTAU	Implementation
60201	Bayou Cocodrie	VERMILION-TECHE	
60202	Bayou Cocodrie	VERMILION-TECHE	
60204	Bayou Courtableau	VERMILION-TECHE	
60208	Bayou Boeuf	VERMILION-TECHE	
60301	Bayou Teche	VERMILION-TECHE	
60703	Bayou du Portage	VERMILION-TECHE	Baseline Monitoring
60801	Vermilion River	VERMILION-TECHE	Baseline Monitoring
60802	Vermilion River	VERMILION-TECHE	
60910	Boston Canal	VERMILION-TECHE	Post-Implementation
70501	Bayou Sara	MISSISSIPPI	New Vision
70505	Tunica Bayou	MISSISSIPPI	New Vision
80202	Bayou Louis	OUACHITA	Post-Implementation
80203	Lake Louis	OUACHITA	Post-Implementation
80401	Bayou Bartholomew	OUACHITA	
80903	Big Creek	OUACHITA	Implementation
80904	Bayou Lafourche	OUACHITA	Implementation
81101	Lake Providence	OUACHITA	USDA - Monitoring
81609	Hemphill Creek	OUACHITA	Implementation
101601	Bayou Cocodrie	RED	
120103	Bayou Choctaw	TERREBONNE	
120104	Bayou Grosse Tete	TERREBONNE	Planning
120110	Bayou Cholpe	TERREBONNE	
120111	Bayou Maringouin	TERREBONNE	Planning
120302	Bayou Folse	TERREBONNE	USDA - Monitoring

Figure 8. Utilizing watershed characterization and source identification information allows for prioritization and leveraging of efforts for protection, improvement, and restoration of nutrient water quality. The LDEQ Nonpoint Source Program (LDEQ 2012) identifies planned activities and priority watersheds for activities through 2022. Previous watersheds of interest where activities have occurred, but are not currently active, are marked as 'No Current Activity'.

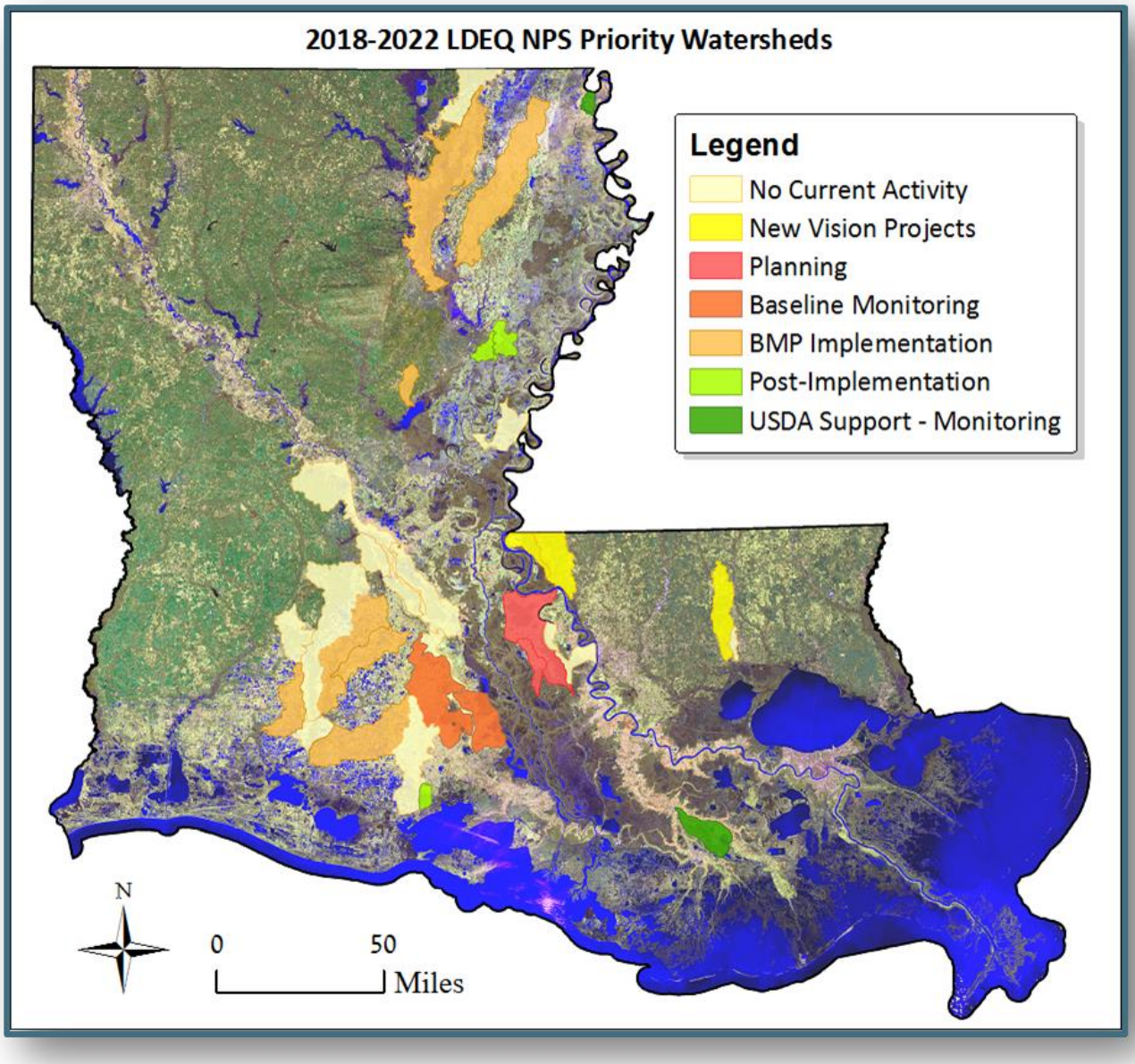
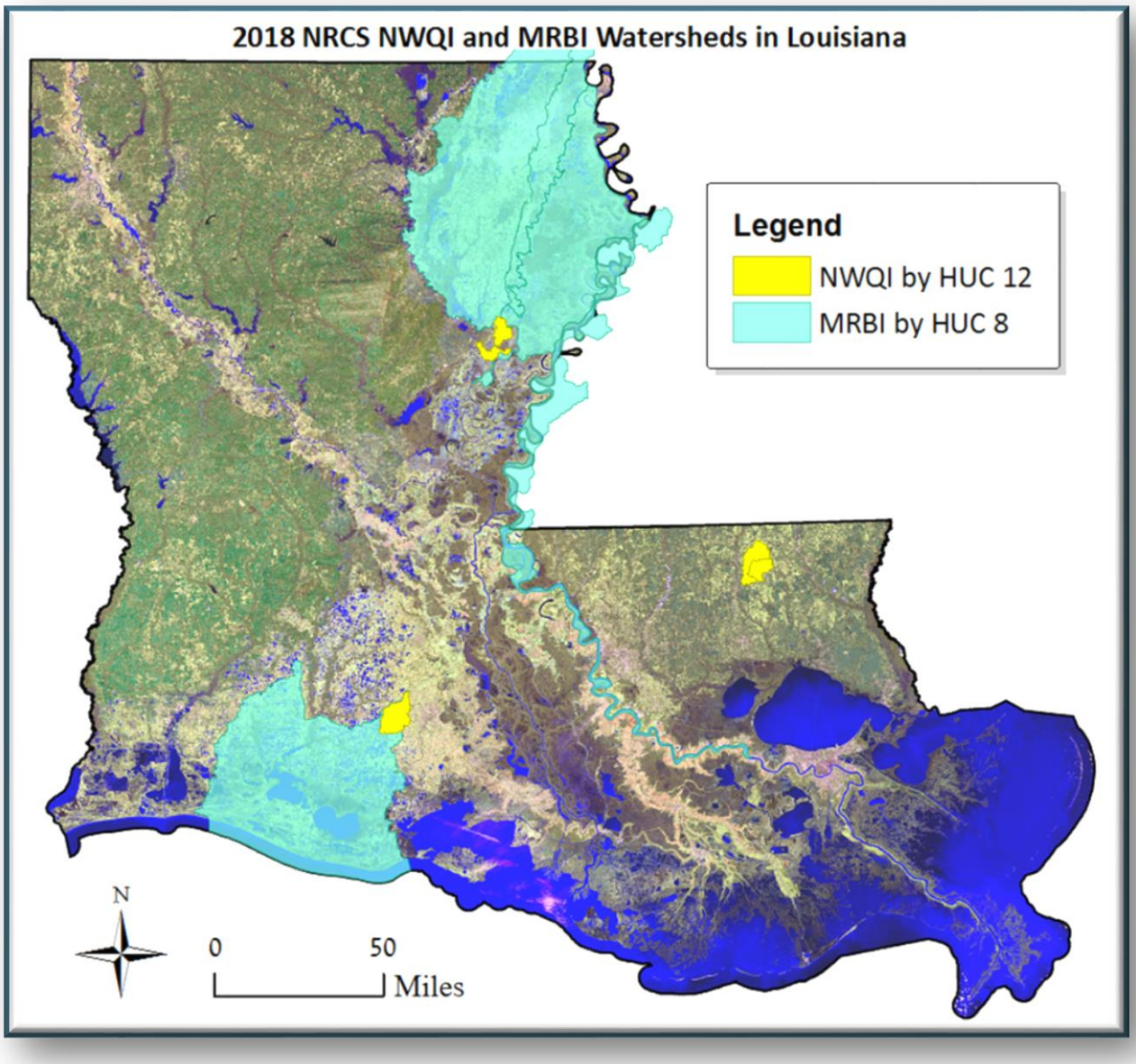


Table 9. Priority watersheds for conservation through USDA initiatives in Louisiana: Mississippi River Basin Health Watersheds Initiative, MRBI and the National Water Quality Initiative, NWQI (USDA NRCS 2018a, 2018b).

USDA Initiative	HUC Level	HUC Name
NWQI	HUC 12	Lake Louis-Bayou Louis
NWQI	HUC 12	East Fork Big Creek
NWQI	HUC 12	Big Creek
NWQI	HUC 12	Indian Bayou-Bayou Queue De Tortue
MRBI	HUC 8	Boeuf
MRBI	HUC 8	Bayou Macon
MRBI	HUC 8	Lower Mississippi-Baton Rouge
MRBI	HUC 8	Lower Mississippi-Natchez
MRBI	HUC 8	Mermentau
MRBI	HUC 8	Tensas

Figure 9. Watershed characterization, source identification, and prioritization are essential to the success of the Louisiana Nutrient Management Strategy. USDA NRCS programs including the Mississippi River Basin Healthy Watersheds Initiative (MRBI) and the National Water Quality Initiative (NWQI) have coordinated with the LDEQ-NPS Unit to identify watersheds at the HUC 8 and 12 level for water quality improvements through implementation of best management and conservation practices.



E.3.7 Incentives, Funding, & Economic Impact Analyses

Ensuring that adequate technical assistance and funding are available for the implementation of voluntary nutrient management strategies will improve participation and minimize any economic losses associated with strategy implementation. Taking advantage of leveraging opportunities among programs and providing incentives for nutrient strategy implementation will encourage voluntary participation. Leveraging funds from LDEQ, LDAF, USDA, USEPA, and local parish governments has resulted in economic incentives, technical support, and funding sources for implementation of conservation practices (CPs) in priority watersheds.

Economic impact analyses may be necessary in order to determine the relative costs associated with improving water quality through nutrient management for point as well as nonpoint source inputs to Louisiana's water bodies. Determining economic impacts is of interest to the regulatory and non-regulatory stakeholders. Thus, specific economic impact analyses may be warranted to determine costs associated with various nutrient management activities and implementation in relation to economic gains of Louisiana agriculture (Figure 10). These costs are addressed in Section F.4.3. Louisiana agriculture was responsible for over $9.8 billion for the top 10 commodities in 2017, representing an increase of nearly half a billion dollars from reported 2012 values (Louisiana Nutrient Management Strategy Interagency Team 2014). The increase in agricultural revenue was accounted for primarily by increases in forestry ($1 billion) and marine fisheries and aquaculture (over $263.3 million), with subsequent decreases in poultry, soy, cattle, horse, and rice commodities.

Economics of nutrient management play a large role in whether or not stakeholders participate in voluntary programs. Two notable voluntary programs in Louisiana are the Master Farmer program administered by LDAF and the Environmental Leadership Program (ELP) administered by LDEQ. These programs educate and certify agricultural producers (Master Farmer) and recognize industries (ELP) for taking voluntary steps to improve water quality through nutrient management. The Master Farmer program requires classroom education and the development of a nutrient management plan for their specific operations. The ELP recognizes industry leaders that take the initiative to make voluntary reductions in nutrient discharge above and beyond their permit requirements. These voluntary programs will be promoted, opportunities for financial and technical assistance will be pursued, and synergies and partnering opportunities will be sought for leveraging nutrient management projects with other programs.

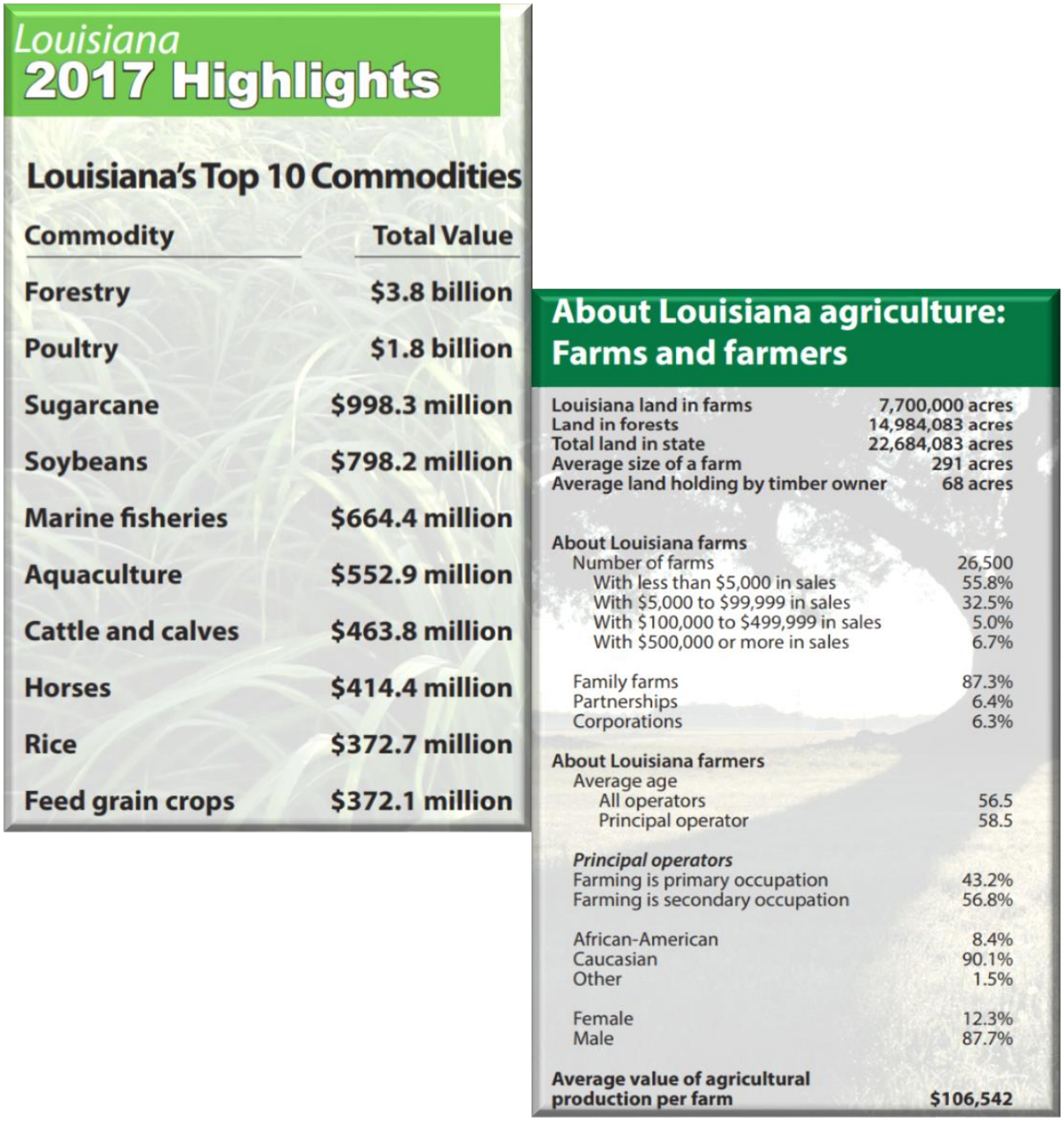
The strategic actions for Incentives, Funding, & Economic Impact Analyses under the Nutrient Management Strategy are to:

- Promote voluntary participation in incentive-based programs
- Identify and communicate new funding initiatives/projects
- Promote assistance (financial or technical) for BMP/CP implementation
- Promote assistance (financial or technical) for point sources
- Document economic impacts from available sources
- Develop and implement a water quality water quality credit trading program

Timelines and milestones for these strategic actions are given in Appendix A.

The Tulane Nitrogen Reduction Challenge, an innovative incentive based program with a $1 million prize for a solution to address hypoxia funded by Mrs. Phyllis Taylor, was awarded in 2017. Applications were accepted and reviewed by a Science Advisory Board and in December 2016 five finalist teams were selected. These five teams include ADAPT-N, AgDNA, Cropsmith, PIVOT and Stable'N (Tulane University 2019). In 2017, the five teams competed in Phase 2, which involved in-field trials on a plot of farmland in Tensas Parish in northeast Louisiana. In December 2017, it was announced that Adapt-N was awarded the prize for the impact their solution has on crop yield, management of nutrient runoff, and cost (Tulane University 2017). ADAPT-N is an agronomy tool that provides farmers with precise nitrogen recommendations for every section of their fields.

Figure 10. Economics play an important role in agricultural production. Agricultural production within the state of Louisiana totaled more than 9 billion in 2017 for the top ten commodities. With the average value produced by a farm in Louisiana valued at $106K among 27,000+ farms within the state, Louisiana has a major stake in agriculture production (reproduced from LSU AgCenter, Guidry, and Niu, 2017 Highlights of Louisiana Agriculture 2017).



E.3.8 Targets & Goals

Targets and Goals under the Louisiana Nutrient Management Strategy will focus on the strategic actions outlined in the other nine strategic components and the agency commitments, timelines, and milestones to accomplishing these strategic actions. Commitments from agencies on programs and available resources are necessary to accomplishing these actions. A timeline from 2019 to 2023 is presented for the updated 2019 strategy, which allows for interim milestones charting progress toward this nutrient management collaboration for protecting, improving, and restoring water quality in Louisiana's water bodies. All strategic actions for Targets and Goals including agency commitments, timelines, and milestones are presented in Appendix A. The majority of the strategic actions were initiated 2014 and are ongoing.

In 2023, an assessment of the strategy will be conducted to allow for indication of progress to date and updates based on new information that has become available. Amendments or adjustments to strategic actions may occur as necessary. As multiple entities are committed to the protection, improvement, and restoration of Louisiana's water quality, this adaptive management approach is integral to the Louisiana Nutrient Management Strategy. An adaptive management approach allows us to capitalize on the successes, incorporate new science as it becomes available, and reconsider management activities that are found to be less effective.

While in many cases resolving water quality issues including nutrient concerns is a long-term challenge, a short-term assessment of progress to date allows Louisiana entities to chart progress, make needed adjustments based on newly available information, and integrate new research, technologies, and opportunities into the Louisiana Nutrient Management Strategy. Other Louisiana programs such as the LDEQ Nonpoint Source Program (LDEQ 2018n) and CPRA 2017 Coastal Master Plan (CPRA 2017) utilize a 5- or 6-year timeline for program evaluation that incorporates adaptive management. This adaptive management approach is crucial to ensuring that the methods for managing nutrient remain effective and that results that demonstrate successful nutrient management within Louisiana and the larger MARB are communicated. The Targets and Goals schedule for strategic actions under all strategic components of the Louisiana Nutrient Management Strategy is presented in Appendix A, and includes agency commitments, timelines, and milestones from 2019 to 2023.

E.3.9 Monitoring

Monitoring will allow for documentation of nutrient levels and other relevant information regarding nutrient management activities. Monitoring will facilitate the demonstration and verification that nutrient management measures are having the desired effect on water quality. In the event that water quality has not improved, monitoring data will guide improvements in the application of more robust and effective nutrient management actions.

The LDEQ conducts monitoring through its Ambient Water Quality Monitoring Network (AWQMN; Figure 11). Currently LDEQ monitors nearly 500 water bodies (subsegments) statewide on a four-year rotating cycle where each water body is monitored monthly for one year out of the four-year cycle; thus, approximately 25% of the surface water bodies are

monitored within a given year. LDEQ also currently monitors 21 stations located on larger water bodies in the state as part of long-term monitoring; these stations are monitored monthly every year. These data are now directly available to the public via the LEAU Data Portal (LDEQ 2018a). The data are also available via the USEPA's current Water Quality Portal, and impairment categories and details, including nutrients, will be available through the re-designed 'How's My Waterway' webpage (anticipated release 2019; USEPA 2018d). Furthermore, the LDEQ Nonpoint Source Program monitors watersheds where Watershed Implementation Plans (WIPs) were developed to address water body impairments through implementation of conservation practices (LDEQ 2011).

The LDEQ Louisiana Pollutant Discharge Elimination System (LPDES) Permit Program has previously collected nutrient effluent monitoring data from major facilities discharging to the Mississippi River. In May 2016, LDEQ began executing the Point Source Implementation Strategy, where initial development began alongside the 2014 Louisiana Nutrient Management Strategy as a means to track point source nutrient contributions, especially of Publicly Owned Treatment Works (LDEQ 2018m). In this point source strategy, major and minor sanitary permitted dischargers began reporting TN and TP on a quarterly basis, and reporting requirements were added to new and renewal permits. In addition, other types of dischargers may now undergo a nutrient review to determine if reporting requirements will be included in their new or renewal permit. Nutrient monitoring requirements have been established in 47% of all individual sanitary treatment plant LPDES permits as of May 2019. It is projected nutrient monitoring requirements will be established in all individual sanitary treatment plant permits by 2021.

Point source wetland assimilation permittees must monitor nutrients in their effluent. In addition, Municipal Separate Storm Sewer (MS4) storm water permittees discharging to waters with dissolved oxygen/nutrient TMDLs are required to develop monitoring programs to evaluate the effectiveness of best management practices (BMPs) are controlling pollutants in runoff. The multi-sector general permit requires nutrient (e.g. nitrogen and phosphorus) and/or nutrient-related parameter (e.g. nitrate/nitrite-nitrogen) monitoring for specific sectors and subsectors within each of the following industry categories: chemical and allied products, metal mining, mineral mining and dressing, food and kindred products, and fabricated metal products. A requirement of the monitoring process is the reporting of nutrient (and other pollutants) to the LDEQ and USEPA via Discharge Monitoring Reports (DMRs).

A review of DMRs submitted to LDEQ online through the NetDMR system to USEPA Integrated Compliance Information System (ICIS) was conducted for Total Nitrogen (TN, STORET code 00600) and Total Phosphorus (TP, STORET code 00665) requirements. Over forty-one thousand data records were examined from January 1, 2000 to December 31, 2018 for reporting compliance. Overall, about 92% of DMRs were successfully submitted for both nutrients, resulting in approximately 8% data violations that may have been related to overdue reporting or non-receipt. Of the 4,549 records with TN or TP limits, only about 0.5% of the DMR submissions were effluent violations.

CPRA currently conducts monitoring within the coastal zone of Louisiana through its Coastwide Reference Monitoring System (CRMS)-*Wetlands* (2018), as well as through its System-Wide Assessment and Monitoring Program (SWAMP). SWAMP was initially implemented as a pilot project in Barataria Basin (west of the Mississippi River), and subsequently expanded to hydrologic basins east of the Mississippi River. The design for SWAMP for the remainder of Louisiana's coastal zone is currently under development. SWAMP provides leveraging of resources and monitoring across several data types including water quality within Louisiana's coastal zone (Figure 12).

A Gulf of Mexico Monitoring Community of Practice (GoM MCoP), currently under development through GOMA, will provide a forum for the dissemination of information from monitoring activities throughout the GOM, and will enable interested parties to identify projects that can potentially fulfil nutrient data needs and gaps (GOMA 2016; GoM MCoP 2018). Initial funding for the MCoP is through the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE) Council Monitoring and Assessment Program, with product output anticipated in July 2020. This GoM MCoP product will also help track projects directly associated with RESTORE Act projects.

Louisiana will investigate opportunities to leverage monitoring resources with the USEPA, USDA, and USGS through the Mississippi River Monitoring Collaborative joint effort. A tiered approach to monitoring at edge-of-field, in-stream, and watershed level may provide necessary information on the effectiveness of conservation practices on the farm as well transport of nutrients and sediment in-stream and downstream. Edge-of-field monitoring (EOFM) may become more important especially as lag times in water quality improvements from implementation of conservation practices are recognized (Figure 13). The *Journal of Soil and Water Conservation* released in 2018 a special issue that describes current practices, obstacles, progress, history and advances, and alternative methods in EOFM practices of agricultural runoff (J. Soil Water Conserv. 2018).

The strategic actions for Monitoring under the Louisiana Nutrient Management Strategy are to:

- Monitor in-stream nutrient water quality
- Monitor water quality relative to BMP/CP implementation
- Monitor nutrients associated with riverine diversions
- Monitor nutrients in point sources
- Evaluate compliance with point source permits
- Identify and communicate new monitoring projects/initiatives

Timelines and milestones for these strategic actions are given in Appendix A.

Figure 11. The Louisiana Department of Environmental Quality (LDEQ) performs routine water quality monitoring within the state's water bodies through its Ambient Water Quality Monitoring Network (AWQMN).

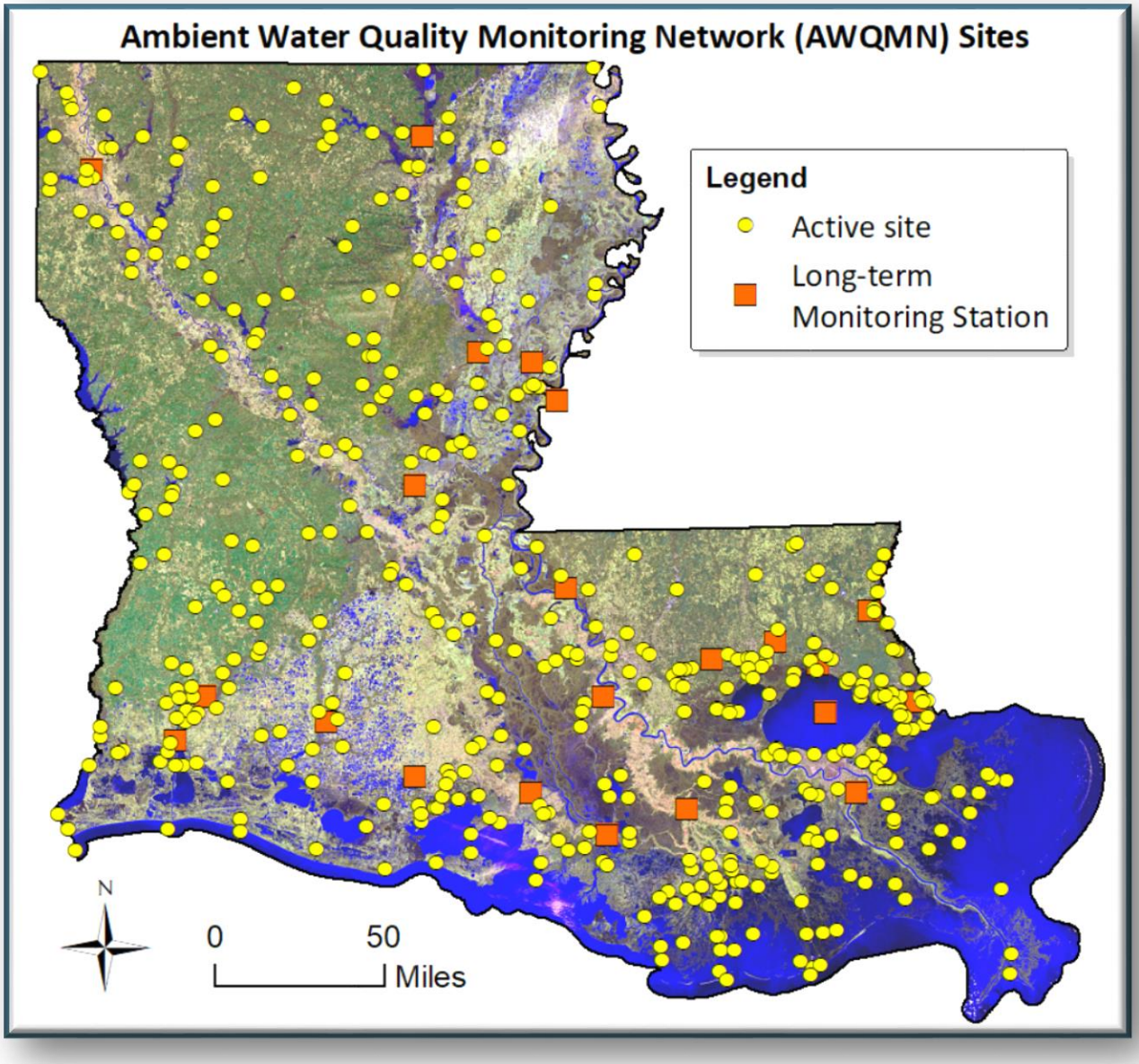


Figure 12. Coastwide Reference Monitoring System Hydro Stations and System Wide Assessment and Monitoring Program (SWAMP) currently implemented water quality stations leveraged by the Coastal Protection and Restoration Authority.

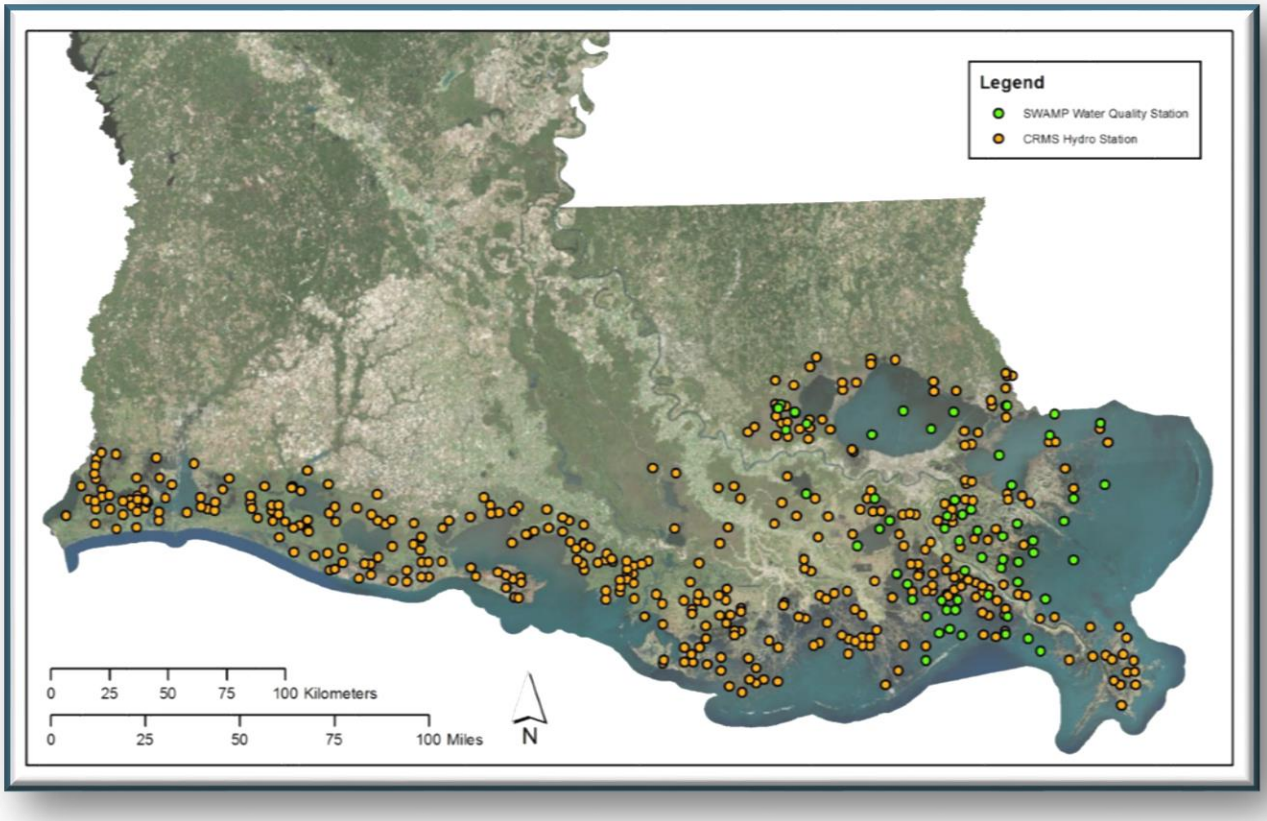


Figure 13. Edge-of-field monitoring of implemented agricultural best management practices (BMPs) and conservation practices (CPs) may provide valuable data on the effectiveness of a practice at the farm level to address nutrients while acknowledging that short and long-term effects may differ and that results could vary with environmental conditions such as rainfall or drought.

E.3.10 Reporting

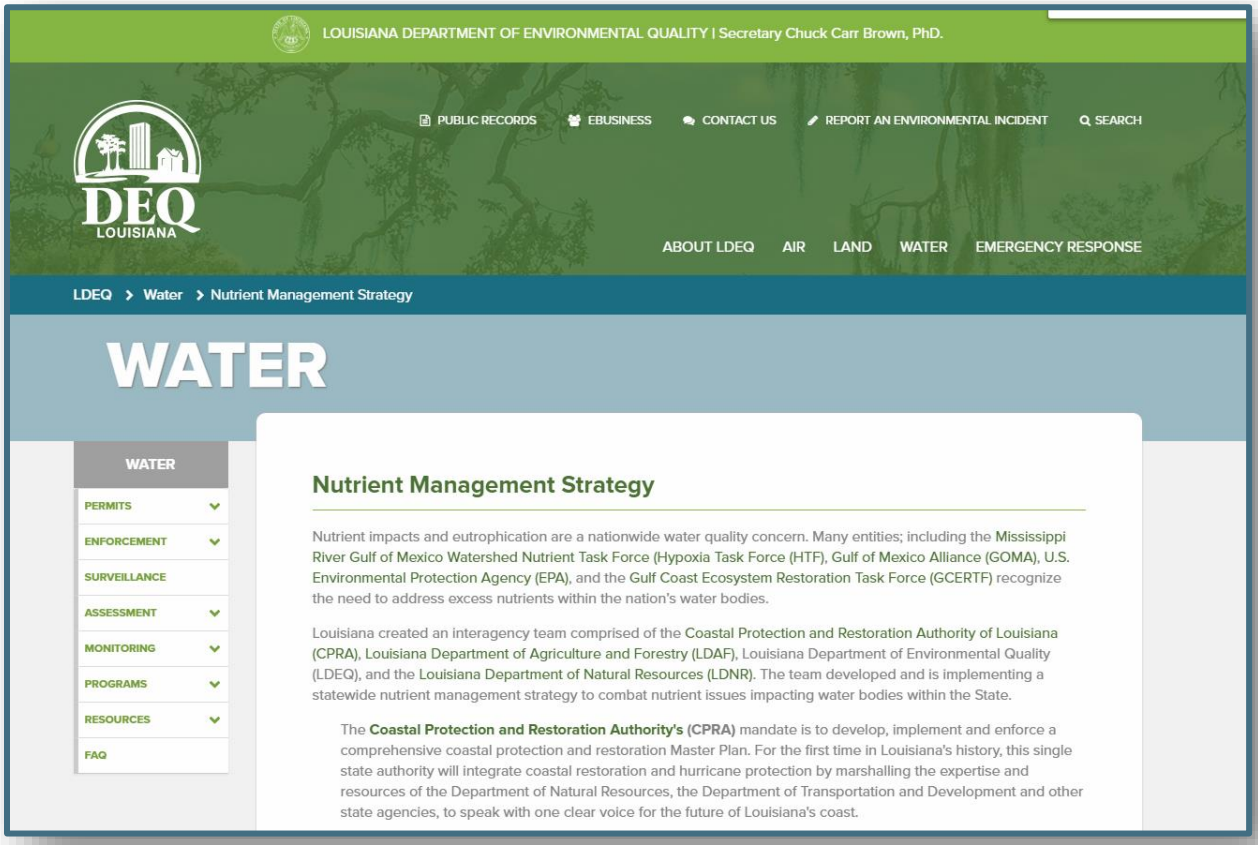
Reporting is a critical component of Louisiana's Nutrient Management Strategy. Communication to all stakeholders is important to learn from the practices that are implemented. Reporting can take many forms including traditional reports, websites, presentations, and meetings. Information and documents related to the Louisiana Nutrient Management Strategy (2014 and 2019) may be found on the web (LDEQ 2018).

The strategic actions for Reporting under the Nutrient Management Strategy are to:

- Conduct 5-year strategy review
- Report annually on strategy activities
- Disseminate information through strategy website (Figure 14)
- Document spotlight(s) of nutrient management successes

Timelines and milestones for these strategic actions are given in Appendix A.

Figure 14. Reporting nutrient management strategy activities and results is important to the success of the Louisiana Nutrient Management Strategy. Through accessing the website https://deq.louisiana.gov/page/nutrient-management-strategy, stakeholders can learn more about current and planned nutrient management activities within Louisiana.



F. IMPLEMENTATION OF LOUISIANA'S NUTRIENT MANAGEMENT STRATEGY

Nutrient management within Louisiana's water bodies relies on methods for control and capture of nutrients to ensure the receiving water body maintains nutrient levels suitable to maintain biogeochemical processes and productive ecosystems (Figure 15). Methods that promote incentives may foster voluntary participation, and opportunities for leveraging among programs, partnerships, and stakeholders will be necessary for ultimate water quality protection, improvement, and restoration within Louisiana's water bodies.

Nutrient management methods will be appropriate for watersheds regionally and temporally based on land use practices. A one-size-fits-all approach is not appropriate for the state of Louisiana given the unique geographic features located within the state (uplands, alluvial plains, coastal wetlands and deltas, etc.) and associated variety of land uses (cultivated crops, forests, pasture, wetlands, etc.). Appropriate conservation and management practices may differ among watersheds and within the year timing for nutrient water quality impacts may differ depending on when those management and conservation practices are implemented.

The Louisiana Nutrient Management Strategy will utilize river diversions, nonpoint source and point source management, and voluntary incentive-based programs to address nutrient issues within the state. Additionally, leveraging opportunities are being identified that will allow for multi-entity collaboration on watershed scale projects to engage all stakeholders and promote enhanced participation in order to protect, improve, and restore Louisiana's water bodies.

River diversions are a central component of *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (2017 Coastal Master Plan, CPRA 2017). These diversion projects reconnect the Mississippi and Atchafalaya Rivers to the adjacent deltaic wetlands and estuaries to re-establish land-building and land-sustaining processes that have been disrupted by river management and flood protection projects over the past century. Sediment diversion projects will result in the Mississippi and Atchafalaya River flow of nutrients, freshwater, and sediments to bays, wetlands, and estuaries. In addition to the restoration benefits of building and sustaining coastal land, diversions have the potential to improve offshore water quality (including mitigation of hypoxia) through enhanced wetland nutrient retention.

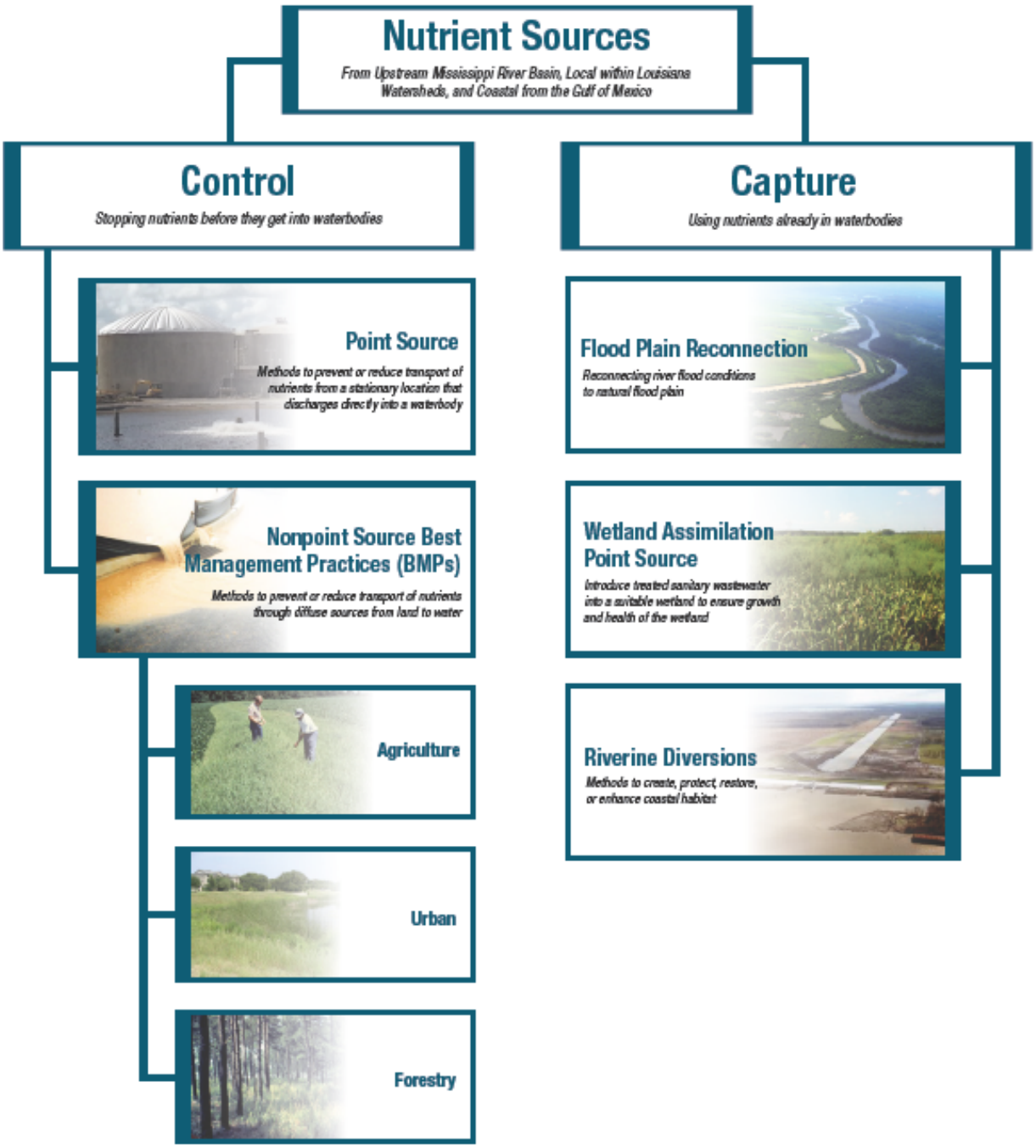
Louisiana has an active and effective Nonpoint Source (NPS) program that operates through a NPS Management Plan, recently appended for years 2018 to 2022 (LDEQ 2011). One of the important aspects of this NPS Management Plan is inclusion of statewide and watershed annual milestones where state and federal agencies worked in collaboration with watershed stakeholders to select and prioritize water bodies to partially or fully restore by 2022. Additionally, assistance programs through the USDA NRCS and LDAF Office of Soil and Water Conservation (OSWC) aid with the identification and implementation of appropriate nonpoint source Best Management Practices (BMPs) and conservation practices (CPs) for a given watershed in the state.

Managing point source nutrient discharges is also an important component of overall nutrient management. Since the creation of the Clean Water Act in 1972, the National Pollutant Discharge Elimination Systems (NPDES) program has been a major force in the nation's efforts to protect and restore the quality of our rivers, lakes, and coastal waters. Louisiana's Water Quality Regulations (LAC 33: Part IX) require permits for the discharge of pollutants from point source into waters of the state of Louisiana. This surface water discharge permitting system is administered under the Louisiana Pollutant Discharge Elimination System (LPDES) Permit Program.

Methods that incorporate sustainability and innovation to ensure nutrient water quality protection, improvement, and restoration will be developed based on specific diagnoses of the true nutrient issues within a watershed. Whether watersheds are nutrient-rich, nutrient-starved, or currently at an appropriate nutrient-level, Louisiana's Nutrient Management Strategy will identify and encourage the most appropriate solution to be identified and implemented.

Figure 15. Conceptual model of nutrient sources entering Louisiana water bodies locally, from upbasin, or even from the coastal area. Methods for nutrient control or capture specific to Louisiana landform, geography, and agricultural and industrial production will aid in managing nutrients within Louisiana water bodies.

Photos provided by CPRA, LDAF, LDEQ, and USDA NRCS.



F.1 River Diversions

Louisiana is situated at the bottom of the Mississippi-Atchafalaya River Basin (MARB) watershed, where watersheds that drain from upriver terminate. In its unique position at the mouth of the Mississippi-Atchafalaya River Basin, Louisiana faces the aggregate effects of nutrients introduced to the system in each upriver state. Over 98% of the nitrogen load and over 97% of the phosphorus load, entering the Gulf of Mexico is introduced to the system upriver of Louisiana (Alexander 2008). Once nutrients have entered the Mississippi River system, they are on a highway to the Gulf of Mexico (GOM) where they contribute to GOM hypoxia. One of the ways to address this challenge is to trap nutrients in aquatic and coastal systems, for example through nutrient uptake by wetland vegetation.

A quarter of Louisiana's productive coastal landscape has been lost over the past century, with greater losses predicted in the future. Diversions of water from the Mississippi and Atchafalaya Rivers into adjacent bays and wetlands to restore natural land building processes have been a significant component of coastal restoration strategies since the 1990s (Gagliano and Van Beek 1993; LCWCRTF-WCRA 1998; USACE and LDNR 2004; and CPRA 2007, 2012, 2017). Louisiana's Coastal Master Plan identifies a number of river diversion projects designed to divert freshwater and sediment from the Mississippi River into adjacent coastal wetlands in an effort to restore deltaic land-building processes disrupted by the construction of levees on the river and to reverse the trend of land loss that has plagued coastal Louisiana since at least the 1930s (CPRA 2017). The river diversion projects could have multiple potential restoration benefits in addition to building and sustaining coastal land, including improvement of offshore water quality (including the mitigation of hypoxia), through enhanced wetland nutrient retention. This trapping of nutrients by wetlands receiving the diverted river water has the potential of lower nutrient loads that reach the Gulf of Mexico. A study on river diversions found that operating river diversions to flow over the surrounding marshes maximizes the potential for removal of riverine nitrate and limits delivery of nitrate to the coastal ocean, thereby mitigating expressions of eutrophication including algal blooms and hypoxia (VanZomeren et al. 2013).

Louisiana's 2017 Coastal Master Plan (CPRA 2017) prescribes a portfolio of projects to reduce land loss and preserve coastal ecosystems and communities (see Figure 6). The 2017 Coastal Master Plan utilized decision criteria to assess risk reduction and restoration potential and identified 124 projects that maximize these benefits (CPRA 2018). CPRA also used metrics as criteria to evaluate the effectiveness of projects and understand how benefits differ between projects. Water quality changes in open water areas are calculated by the Master Plan model, and are used by the Fish and Shellfish Community Model to represent changes in fish biomass and distribution. Nutrient uptake potential was evaluated by calculating the potential fate of nitrogen in open water bodies and different types of wetlands (CPRA 2012, 2017).

Reconnecting the river with the coastal wetlands through diversion projects is not a new concept or endeavor; a number of diversion projects and siphons have already been constructed and are operating (Figure 16). River diversion projects have been a significant component of every coastal planning effort since the 1990s and are a keystone project of the 2017 Coastal Master

Plan. The 2017 Coastal Master Plan predicts 802 square miles (2,077 km^2) of land built or sustained under a medium 50-year future environmental scenario, compared to 2,255 square miles (5,838 km^2) lost without action. River diversion projects are predicted to contribute a large portion of this built or sustained land.

The integration of science-based nutrient management and restoration approaches in Louisiana is ongoing, with CPRA focusing on increasing understanding of the nutrient uptake potential of restoration activities. Identified critical diversion-related uncertainties include (1) the transformation and assimilation pathways of the diverted nutrients in the receiving basins, (2) the occurrence of eutrophication in response to sediment diversions, and (3) the capacity of receiving basins to remove diverted riverine nutrients prior to entering the northern Gulf of Mexico (TWIG 2014). To address these uncertainties, CPRA has supported efforts to develop a numerical nutrient budget model that addresses the fate and transport of nutrients to open water, sediment/soil layers, and vegetated areas (Baustian et al. 2018). CPRA also partnered with leading academic scientists to synthesize the state of the science with respect to predicting the response of deltaic plan emergent wetlands and estuarine open water bodies to freshwater and river diversions. This large, peer-reviewed effort will be summarized in a report and in journal articles in a Special Issue of Estuarine, Coastal and Shelf Science.

The CPRA has developed a System-Wide Assessment and Monitoring Program (SWAMP) to monitor and assess both natural and human systems in coastal Louisiana. The development and implementation of SWAMP provides the framework to evaluate to evaluate and manage the overall protection and restoration program and also serves as the backbone of project-related monitoring needs. Through SWAMP, a regional water quality monitoring pilot was planned and implemented in Barataria Basin, Louisiana. The regional SWAMP water quality network in Barataria Basin leverages existing long-term water quality programs (Louisiana Department of Environmental Quality, Louisiana Department of Wildlife and Fisheries, and United State Geological Survey), combined with the implementation of new water quality stations for a total of 23 discrete and 7 continuous water quality stations. Water quality parameters measured include nitrogen [(total Kjeldahl nitrogen (TKN), nitrate+nitrite nitrogen (NO3NO2), and ammonia (NH3)], phosphorus [(total phosphorus (TP), orthophosphate (PO4)], silica (SiO2), chlorophyll a, total suspended solids (TSS), turbidity, dissolved oxygen (DO), dissolved oxygen percent saturation, temperature, salinity, and pH. The monitoring data collection was implemented starting in 2015 to understand system conditions and dynamics at the basin scale. SWAMP has been expanded to east of the Mississippi River, with water quality data collected since 2016, and is being expanded to the western portion of the state.

A tremendous amount of research has been done over recent decades to investigate nutrient transformation and assimilation in areas receiving diverted Mississippi River water. This research includes empirical studies in a variety of habitats including coastal swamps, wetlands, and estuaries. Furthermore, this research suggests that estuaries have a number of biotic and abiotic pathways to remove nutrients from the water column, including denitrification, burial, plant uptake, and assimilation into the food web. Thus, the overall amount of nitrogen and phosphorus

reaching the GOM can be reduced by reconnecting the Mississippi River to coastal estuaries (DeLaune et al. 2005; Lane et al. 2004).

A collection of studies on existing diversions has pointed out the variations within nutrient reductions and nutrient loading rates among coastal projects. These reductions provide important information for the planning, development, and monitoring of projects:

- Breton Sound (Caernarvon Diversion)
    - Diversion supplied 60-71% of TN input (Hyfield et al. 2008)
        - Loading rate 2.1-3.5 g N m-2 y-1 (Total study area, Hyfield et al. 2008)
        - Loading rate 8.9-23.4 g N m-2 y-1 (Lane et al. 1999)
    - Diversion supplied 41-60% of TP input (Hyfield et al. 2008)
        - Loading rate 0.24-0.53 g P m-2 y-1 (Total study area, Hyfield et al 2008)
        - Loading rate 0.9-2.0 g P m-2 y-1 (Lane et al. 1999)
    - Non-conservative nutrient reductions (Lane et al. 2004)
        - 44% for TN (Lane et al. 1999 reported 32-67% removal rate
        - 62% for TP (Lane et al. 1999 reported 46% removal rate
        - 57% for DIN (dissolved inorganic nitrogen)
- Bonnet Carrie Spillway (Bargu et al. 2019)
    - Addresses toxic algal blooms and concerns with the nutrient inputs
- Barataria Bay (Davis Pond Diversion) (Bargu et al. 2019)
    - Upper estuary is hyper eutrophic
- Atchafalaya Delta (Lane et al. 2002)
    - Atchafalaya delta complex removes 41-47% of the Atchafalaya River NOx load before reaching gulf-stratified waters

Figure 16. Example of an existing diversion Davis Pond Freshwater Diversion connecting the Mississippi River (foreground) with coastal wetlands (background).

As the understanding of the nutrient removal capacity of Louisiana's estuaries is increased, landscape and project-level nutrient reduction estimates can be better refined. For the 2012 Coastal Master Plan, a spatial statistical approach was developed to estimate the nutrient uptake under various future environmental conditions for both future with and without restoration project implementation. It was estimated that coastwide, NO_3^- + NO_2^- removal capacity rates with Coastal Master Plan implementation were increased up to 0.55 g N m^2 y^{-1}, compared to future without action. This corresponds to an estimated 25% of the Mississippi and Atchafalaya River nitrate load that could be removed (Rivera-Monroy et al. 2013).

To estimate the potential nitrogen and phosphorus assimilation capacity of existing and future planned diversion projects, a first order, area-based model following Kadlec and Knight (1996), and updated in Kadlec and Wallace (2009) was used to provide ranges in nitrogen and phosphorus removal with full implementation of the existing and proposed diversions (CH2M Hill 2013). The river diversion operational strategies used in the model were those used in CPRA project planning efforts or were based on actual operations (for existing diversions). These operational scenarios considered average river hydrographs, climate variables, diversion capacity, river nutrient load variations, and receiving basin characteristics (CH2M Hill 2013). The model utilizes conservative inputs, considering the existing landscape, and does not account for

future added benefits and synergies with increased land building from future projects under the 2012 Coastal Master Plan (CH2M Hill 2013; CPRA 2012).

Existing river diversions in Louisiana that were modeled during this study include the gated structures at Davis Pond and Caernarvon (both authorized under the Water Resources Development Act) and siphons at Naomi and West Pointe a la Hache (Figure 17; Table 10). The actual operations of these diversions over the past 5 years were incorporated into the nutrient model. Assuming average river conditions, a total annual removal of 4,381 tons of total nitrogen (TN) and 129 tons of total phosphorus was calculated (TP; Figure 18).

CPRA also investigated the potential for future planned diversions to assimilate nutrients. It is anticipated that CPRA will begin construction of two of these planned diversions, the Maurepas and the Mid-Barataria diversions, within the next 5 years. The modeled annual nutrient removal capacity of these two projects is 10,187 tons of TN and 124 tons of TP during an average river year. With all of the 2012 Coastal Master Plan diversions constructed and fully operational, Louisiana has the potential in an *average* river-year to remove 68,317 tons of TN and 1,341 tons of TP, preventing these loads from reaching the GOM (Table 8).

Total nutrient loadings in the Mississippi and Atchafalaya Rivers are estimated at 1,567,900 t/yr for TN, and 136,500 t/yr of TP (Goolsby et al. 1999). The USGS developed a Spatially Referenced Regressions on Watershed Attributes (SPARROW) model, which reported contributions of each state to the average annual loading in the MARB. For Louisiana, the model reported contributions of 1.7% of the total loading for total nitrogen (26,654 tons/year) and 2.4% of the total phosphorus (3,276 tons/year) (Alexander et al. 2008). Evaluating these modeled estimates in the context of river diversions suggests that existing and planned river diversion projects in Louisiana could remove a significant portion, if not all, of the TN loads and a large portion of the TP loads attributed to Louisiana.

Figure 17. Location of existing and planned 2012 Coastal Master Plan river diversions in Louisiana (see Table 10).

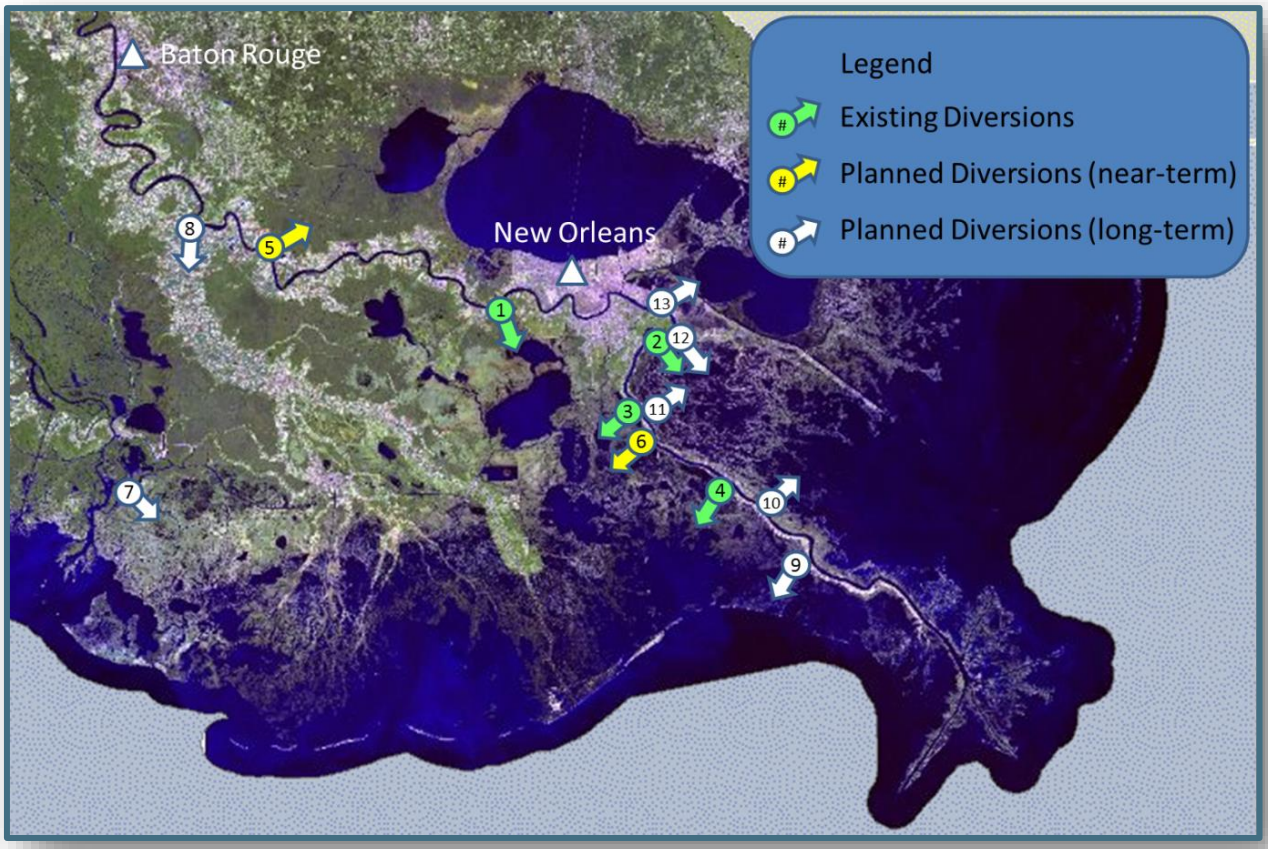
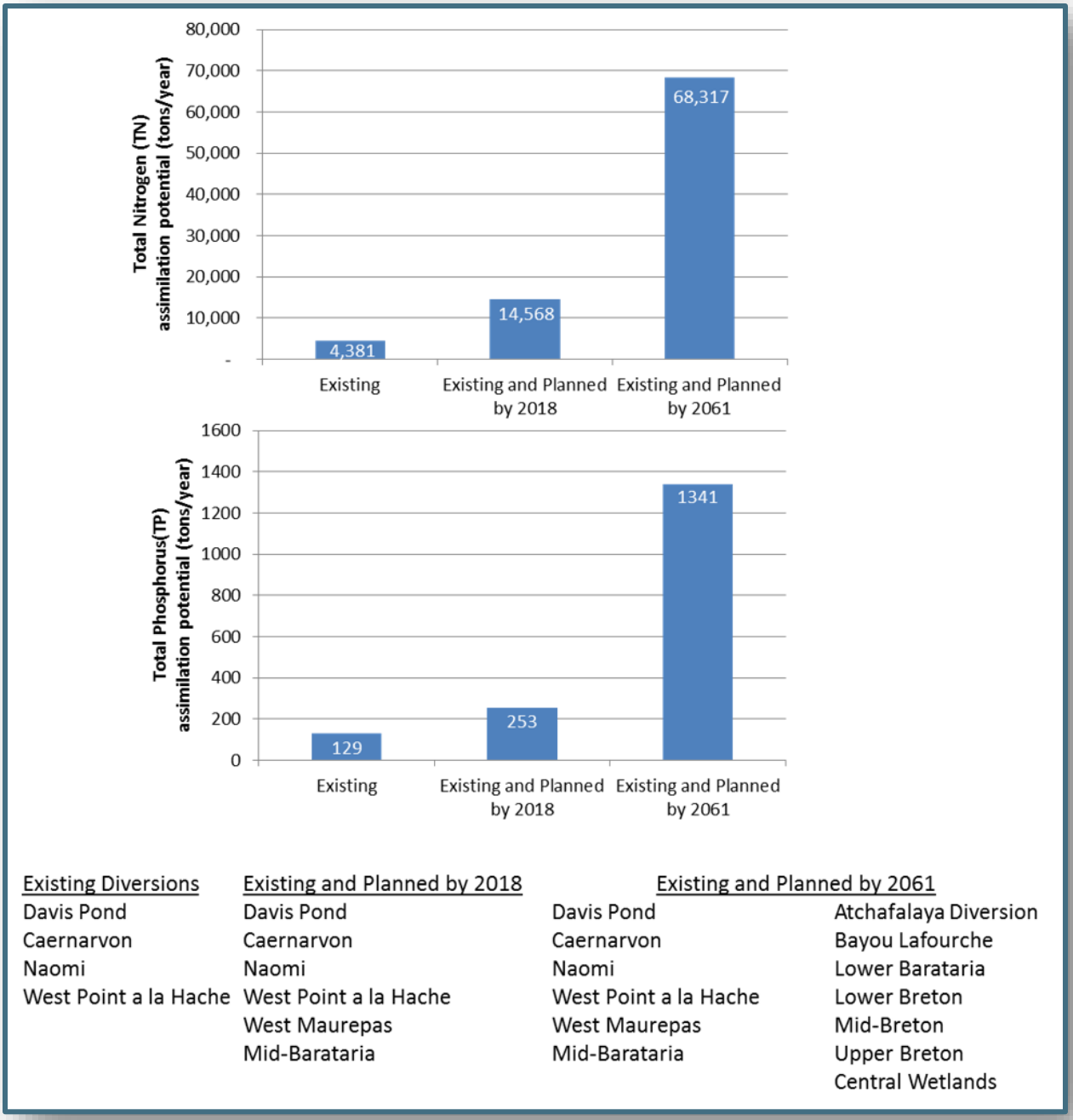


Table 10. Estimates of total nitrogen (TN) and total phosphorus (TP) assimilation potential for existing and 2012 Coastal Master Plan river diversion projects in Louisiana (CH2M HILL 2013).

Existing Diversion Projects		TN Assimilation Potential (tons/year)	TP Assimilation Potential (tons/year)
1	Davis Pond	1,635	60
2	Caernarvon	1,656	45
3	Naomi	401	8
4	West Point a la Hache	689	16
Total Potential for Existing Projects		**4,381**	**129**
Planned Diversions (0-5 years)			
5	West Maurepas	1,677	23
6	Mid-Barataria	8,510	101
Total Potential for Near-Term Projects		**10,187**	**124**
Planned Diversions (6-50 years)			
7	Atchafalaya Diversion	16,556	168
8	Bayou Lafourche	460	9
9	Lower Barataria	6,233	85
10	Lower Breton	3,805	110
11	Mid-Breton	1,457	10
12	Upper Breton	22,332	629
13	Central Wetlands	2,906	77
Total Potential for Long-Term Projects		**53,749**	**1,088**
GRAND TOTAL Assimilation Potential		***68,317***	***1,341***

Figure 18. Total nitrogen (top) and total phosphorus (bottom) assimilation potential for existing and planned river diversions in Louisiana (based on CH2M Hill 2013).



Existing Diversions	Existing and Planned by 2018	Existing and Planned by 2061	
Davis Pond	Davis Pond	Davis Pond	Atchafalaya Diversion
Caernarvon	Caernarvon	Caernarvon	Bayou Lafourche
Naomi	Naomi	Naomi	Lower Barataria
West Point a la Hache	West Point a la Hache	West Point a la Hache	Lower Breton
	West Maurepas	West Maurepas	Mid-Breton
	Mid-Barataria	Mid-Barataria	Upper Breton
			Central Wetlands

F.2 Nonpoint Source Management

Nonpoint source pollution (NPS) is a type of water pollution that is not generated from a discrete conveyance, such as a discharge pipe, but is generated during rainfall events. Nonpoint sources include agricultural and urban runoff. Section 319 of the Clean Water Act (CWA) required that

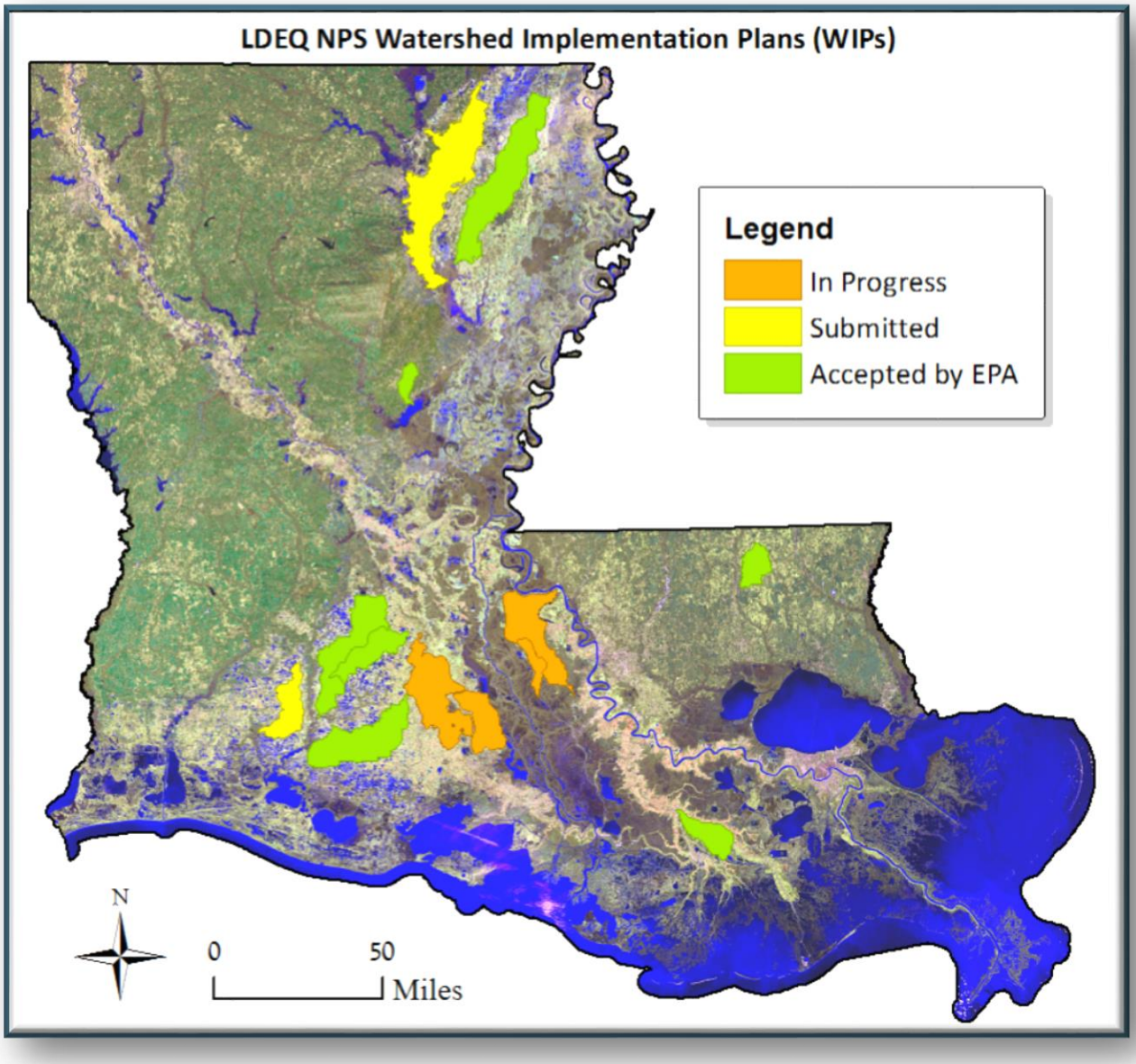
the states develop a NPS Management Plan to reduce and control nonpoint sources of pollution from the various types of land-uses that contribute to water quality problems across the United States.

An important regulatory effort is the Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program ('new vision'; USEPA 2013, LDEQ 2015). The LDEQ is part of this national collaborative effort by states and the USEPA to promote alternative measures to water body protection and restoration, targeted for 2016-2022. As part of the prioritization goal of the new vision, the LDEQ, through collaboration with various stakeholders including state, federal and watershed-based entities, identified six priority watersheds for remediation effort (LDEQ 2016, 2018b).

The Louisiana Department of Agriculture and Forestry (LDAF), the Louisiana Department of Environmental Quality (LDEQ), and the Louisiana Department of Natural Resources (LDNR) developed a NPS Management Plan for the state of Louisiana, which includes nonpoint source prevention and implementation measures for both inland and coastal water bodies of Louisiana (LDEQ 2012). New watershed Implementation Plans (WIPs), based on EPA's guidance for 9-minimum element watershed based plans for restoring watershed use support through BMP implementation, have been submitted for nine subsegments in Louisiana, with seven of them accepted by EPA, and the remaining two still under review. Four more WIPs are currently in development for Louisiana (LDEQ 2012; Figure 19). Development and implementation of these plans is ongoing. Prior to adoption of the EPA 9-element based plans, BMP implementation was conducted in watersheds identified in the 2011 LDEQ NPS Management Plan as "Priority Watersheds". Through NPS projects, additional agencies and other entities including the USDA, collaborate and leverage to develop and implement these WIPs, and describe the BMPs and CPs, management programs, and milestones to address NPS issues within a given watershed.

In the state of Louisiana agriculture, forestry, urban storm water runoff, and home sewage systems contribute to nonpoint source pollution issues and may be a source of nutrients into Louisiana's water bodies. Nonpoint source issues can be addressed through BMPs or CPs specific to the suspected source of pollution (LDNR 2013b, c). Another method for nonpoint source management is floodplain reconnection, which is a management practice where hydrologically modified areas are reconnected to the natural floodplain. BMPs, CPs, and floodplain reconnection that may be used to help address nonpoint source pollution in Louisiana's water bodies are discussed below.

Figure 19. The LDEQ Nonpoint Source Program has developed and implemented Watershed Implementation Plans (WIPs) in over 50 subsegments in Louisiana to address water quality impairments. Improvements in water quality are being observed in such watersheds.



F.2.1 Best Management Practices (BMPs) and Conservation Practices (CPs)

For nonpoint source pollution that originates from diffuse sources through runoff, best management practices (BMPs) and conservation practices (CPs) are key to addressing suspected sources of nutrients. These practices are specific to the source of the suspected pollutant and those for agricultural, forestry, urban storm water runoff, and home sewage systems may help to address nutrients within Louisiana's water bodies.

F.2.1.1 Agricultural

Agricultural practices associated with crops, pastures, dairies, and aquaculture may result in nonpoint sources of nutrients into Louisiana's water bodies. The LSU AgCenter has developed a series of BMP guidance documents for these major agricultural activities within Louisiana (LSU AgCenter 2018). BMPs specific to aquaculture, beef, crawfish, dairy, poultry, rice, sweet potato, sugarcane, and swine are available through the LSU AgCenter (Table 11).

In October 2013, an Interagency Agreement through the USEPA Gulf of Mexico Program Office and the USDA NRCS in Louisiana was signed to increase measurement efforts at edge-of-field to show how conservation practices are working on farms. This agreement also helps the Louisiana Master Farmer Program implement conservation practices as recommended in existing regional strategies that USEPA has supported with partners. A program coordinator is being supported as well to help make sure the measurable environmental results are reported back to USEPA and USDA for on-farm conservation practices from the Louisiana Master Farmer Program participants in Louisiana who conduct edge-of-field monitoring. Objectives include: 1) increase the number of farms in Louisiana participating in the Master Farmer Program; 2) regional partnership to support Master Farmer conservation efforts and the implementation of the Gulf of Mexico Regional Ecosystem Restoration Strategy, Gulf Hypoxia Action Plan and the Gulf of Mexico Alliance's Governors' Action Plan; 3) facilitate a coordinator position for the Master Farmer Program in cooperation with Louisiana State University Agricultural Center; and 4) use edge-of-field monitoring to evaluate conservation practices effect on water quality at selected cooperator farms.

Through the LDAF, there are several agricultural-based programs regarding management practices currently in place. These agricultural programs include Louisiana Master Farmer Program, Louisiana Master Poultry Producer Program, Louisiana Master Rice Grower Program, Master Cattle Producer Certification, Prescribed Agriculture Burning Management Certification, Prescribed Forest Burning Management Certification, Master Gardener Certification, Louisiana Yards & Neighborhood Initiative - Best Practices Education & Outreach, Louisiana Master Naturalist, and the Pesticide Safety Applicator Certification.

USDA NRCS recommends a 'systems approach' to nonpoint source management that targets core and supporting conservation practices and management techniques to address water quality concerns due to sediment and nutrient runoff (USDA NRCS 2013, 2018c). This systems approach

concept is referred to as Avoiding, Controlling, and Trapping (ACT). Primarily agriculture-based, ACT provides an approach to help producers avoid pollution by reducing the amount of agricultural nutrients available in runoff or leaching into water bodies; to control by preventing the loss of pollutants; and to trap as a last line of defense against potential pollutants at edge-of-field, or in facilities to trap and assimilate nutrients before entering water bodies. Core and supporting practices for water quality that are part of the ACT are listed Table 12. Additionally, see Appendix B for description of USDA NRCS conservation practices in Louisiana.

Table 11. Best Management Practice (BMP) manuals produced specifically for Louisiana (LDAF 2007; LDNR 2013, 2013a, 2013b; LSU AgCenter 2018).

1	Hydromodification	**8**	Swine
2	Rice	**9**	Beef
3	Poultry	**10**	Aquaculture
4	Agronomic Crops	**11**	Crawfish
5	Dairy	**12**	Urban Storm water
6	Sweet Potato	**13**	Urban Storm water: Highways, Roads, Bridges
7	Sugar Cane	**14**	Forestry

Table 12. USDA NRCS core and supporting conservation practices (CPs) for water quality in Louisiana (reproduced from USDA NRCS and LDAF OSWC 2012).

	CORE PRACTICES		SUPPORTING PRACTICES	
	Code	***Practice Name***	***Code***	***Practice Name***
AVOIDING	328[a]	Conservation Crop Rotation[2]	327	Conservation Cover[4]
	340	Cover Crop[2]	381	Silvopasture [5]
	528	Prescribed Grazing[1]	382[c]	Fence[0]
	590[b]	Nutrient Management[5]	464	Irrigation Land Leveling[2]
	633	Waste Recycling[0]	472	Access Control[2]
			511	Forage Harvest Management[1]
			561	Heavy Use Area Protection[1]
			612	Tree/Shrub Establishment[2]
CONTROLLING	329	Residue & Tillage Management No-Till[4]	324	Deep Tillage[1]
	330	Contour Farming[2]	342[d]	Critical Area Planting[1]
	345	Residue & Tillage Management Reduced Till[2]	362	Diversion[0]
	412	Grassed Waterway[2]	386	Field Border[2]
	512	Pasture & Hayland Planting[1]	410	Grade Stabilization Structure[0]
	554	Drainage Water Management[1]	430[e]	Irrigation Pipeline[1]
	643	Restoration & Management of Declining Habitats[0]	447	Irrigation System, Tailwater Recovery[2]
	645	Upland Wildlife Habitat Management[0]	449	Irrigation Water Management[2]
			468	Lined Waterway or Outlet[0]
	Conservation Practices Physical Effects (CPPE) factors for Water Quality Degradation - Nutrients in Surface Water (superscripts match color formatting): [5]Substantial Improvement; [4]Moderate to Substantial Improvement, [3]Moderate Improvement, [2]Slight to Moderate Improvement; [1]Slight Improvement; [0]No effect; [-1]Slight Worsening; [-2]Slight to Moderate Worsening.		484	Mulching[2]
			533	Pumping Plant[0]
			558	Roof Runoff Structure[2]
			587	Structure for Water Control[0]
			606	Subsurface Drainage[-2]
			607	Surface Drainage[-2]
			620[f]	Underground Outlet[-1]
			638	Water & Sediment Control Basin[0]
TRAPPING	332	Contour Buffer Strips[2]	350	Sediment Basin[5]
	342	Critical Area Planting[1]	356	Dike[0]
	390	Riparian Herbaceous Cover[5]	436[g]	Irrigation Reservoir[0]
	391	Riparian Forest Buffer[5]	490[h]	Tree/Shrub Site Preparation[0]
	393	Filter Strip[4]	533	Pumping Plant[0]
	601	Vegetative Barriers[2]	587	Structure for Water Control[0]
	635	Vegetated Treatment Area[4]	629	Waste Treatment[2]
	656	Constructed Wetland[4]	638	Water & Sediment Control Basin[0]
	657	Wetland Restoration[3]	646	Shallow Water Development & Management[1]
	658	Wetland Creation[3]		
	659	Wetland Enhancement[3]		
Conservation Activity Plans	102	Comprehensive Nutrient Management Plan	a. minimum of 3 different crops must be used and/or at least 2 years in perennial vegetation; b. Fall application will give lowest ranking; c. Only use with 511, 512, and 528; d. As a component of wetlands, construction, or earth-disturbing practices; e. In conjunction with Waste Transfer (634); f. As a supplement to terraces and sediment basins; g. Only to be used with Tailwater Recovery (447); h. For use with 612, 381, and 391	
	118	Irrigation Water Management Plan		
	130	Drainage Water Management Plan		

F.2.1.1.1 Agricultural Studies

Kröger et al. (2012) conducted an initial review of agricultural BMP efficiency specific to the Lower Mississippi Alluvial Valley, which includes a significant portion of the state of Louisiana including the eastern portion of the Ouachita River Basin and the Atchafalaya and Mississippi River Basins (Table 13). This review of agricultural BMPs in the Lower Mississippi Alluvial Valley indicated that total nitrogen (TN) and total phosphorus (TP) reduction efficiency ranged from 15 to 100%, with some variability noted depending on practice type and site specific conditions. In the southern portion of Louisiana, one study reported the effectiveness on sugarcane agriculture of BMPs and wetland assimilation in reducing nutrient loads by up to 100% (LeBlanc 2008).

A string of studies were performed from 2013 to 2018 concerning two specific BMP types within the lower Mississippi River Basin and/or the Mississippi River Alluvial Valley: low grade weirs (water held in drainage ditches at multiple locations on field) and tailwater recovery (re-use of irrigation and storm water runoff, TWR). Kröger et al. (2013, 2014) examined low-grade weirs for accumulation capacity and denitrification potential compared to control areas and found that after 1 year, weirs increase the hydrological capacity of drainage ditches and significantly retain more sediment and particulate bound phosphorus than reference sites, but that denitrification was not improved. Other weir studies indicate that they are effective at nutrient reduction, but that there is high variability, and efforts should be tailored to drainage acreage and site specifics (Littlejohn, et al. 2014; Baker et al. 2016; Table 13). Velocity of the water is an important factor for weirs. A study combining weirs with slotted inlet pipes and two-stage ditching is proposed as a 'stacked benefit' when used in conjunction for obtaining improvements in nutrient reduction efforts in the Mississippi River Basin, with total P accumulation between 3.32 and 18.86 kg (Kröger et al. 2013a). In addition, Kröger et al. (2013b) review downstream approaches (including weirs) specific to phosphorus removal across agricultural landscapes throughout the US and their applicability. Further, Kröger et al. (2015) highlight BMPs used in tandem for nutrient reductions in the Mississippi River Basin. A landowner's guide is available that outlines how to implement these and other BMPs for multiple benefits in the Mississippi Alluvial Valley (Baker et al. 2017).

Karki et al. (2015) examined the effectiveness of on-farm water storage systems, which consists of a tail water recovery (TWR) ditch and a water storage pond; preliminary results supported the reduction of nitrate concentrations in stormwater runoff. TWR systems were found to be effective at recycling solids, but not as a fertilizer substitute (Omer et al. 2017). A continued study by Omer et al. (2018) states that TWR systems were effective at reducing loads of solids, P and N by 43%, 32%, and 44% respectively, but not at reducing concentrations of solids and nutrients (Table 13). Furthermore, Omer et al. (2017a) found that surface water grab samples were representative of nutrient concentrations and solids irrigated at the moment of time on site.

A cost/benefit analysis on TWR based on net percent value and benefit-to-cost ratios (under various scenarios) was performed, as well as the impact of the level of USDA NRCS financial assistance on net present value (Omer et al. 2019). Results indicate that benefits were greater

for producers that owned their own land, and that renters did not achieve the same level of benefits; TWR systems were not considered economically viable for those that did not own land.

As part of the special issue *Journal of Soil and Water Conservation* related to edge-of-field activities, the effectiveness of a suite of BMPs was investigated across two watersheds in the lower Mississippi Alluvial Plain from 2011 to 2015 (Baker et al. 2018). The ability of BMP practices to reduce nutrients for four management systems was found to be variable, with no strong improvements in water quality due to environmental and management parameters. Baker et al. (2018) note that routine maintenance may improve some structural BMP performance, and that soil type/quality may limit effectiveness.

USEPA (2010) reviewed agriculture BMP effects on nutrient loads, and a national agricultural BMP database is also available that evaluates BMP performance (Geosyntec Consultants 2010a, 2013). Studies of the short- and long-term effects of conservation practices and studies that can tie practices to water quality improvement will continue to be essential. In a review of literature concerning the adoption of BMP practices worldwide from 2007 and 2008 data, Liu et al. (2018) present a conceptual framework for BMP adoption decisions, and provide input on further research needs such as the social aspect of BMP adoption (social norms and the potential influence of social media).

Continued effort on BMPs has been recognized as a major factor in reducing nutrient pollution in the '*Renewed Cal to Action to Reduce Nutrient Pollution and Support for Incremental Actions to Protect Water Quality*' by the USEPA (Beauvais Memo), where acceleration of efforts in the agricultural sector is identified as an important NPS nutrient reduction activity (USEPA 2016). Highlighted aspects include the "Nutrient Recycling Challenge" for livestock, which is a competition to find affordable and effective nutrient recovery technologies to use, transport, or sell their nutrient products (waste). Videos and winners of the challenge can be found on the Livestock and Poultry Environmental Learning Community Website (2019). Also highlighted is the need for collaboration among stakeholders, where training and partnerships can lead to nutrient reductions (e.g., crop advisors and citywide projects). In addition to these new actions, the USEPA, in partnership with the USDA and USGS, state that appropriate technologies and basic knowledge concerning active nitrogen loss currently exist, but adoption of these strategies has not progressed (USEPA 2015a). The report goes on to identify workshop results that identified needs of the agencies for the science and management of reactive nitrogen and co-pollutants (phosphorus and sulfur).

Table 13. Review by Kröger et al. 2012 of efficiency of agricultural best management practices (BMPs) in the Lower Mississippi Alluvial Valley (LMAV) which includes the Atchafalaya, Mississippi, and Ouachita River Basins in Louisiana (modified from Kröger et al. 2012). Recently published studies with relevant information are also included.

Reference	Study Location	BMP type	Nitrogen reduction efficiency (%)	Phosphorus reduction efficiency (%)	Control
Anders et al. 2004[1]	Arkansas LMAV	No-till/conservation tillage	-	TP: 45 DP: -96	Conventional tillage
Bengston et al. 1995	Louisiana LMAV	Subsurface drainage	TN: 17	TP: 31	Surface drained field
Blanco-Canqui et al. 2004	Missouri	Vegetated filter strip	TN: 77 NO_3: 51 NH_4: 58	PP: 68 DP: 62	Continuous cultivated fallow
Cullum et al. 2010[2]	Mississippi LMAV	Conservation Reserve Program (CRP)	TN: 60 NO_3: 71 NO_2: 83 NH_4: 35 TKN: 54	TP: 52 DP: 36	Row crop
DeLaune et al. 2005	Louisiana LMAV	Wetland	NO_3: 38	-	Inflow - outflow
Kovacic et al. 2000	Illinois	Constructed wetland	TN: 37 NO_2: 28	TP: 2	Inflow - outflow
Kröger et al. 2007[3]	Mississippi	Drainage ditches	DIN: 57 NO_3: 42 NH_4: 59	-	Inflow/runoff-outflow

Reference	Study Location	BMP type	Nitrogen reduction efficiency (%)	Phosphorus reduction efficiency (%)	Control
Kröger et al. 2008[3]	Mississippi	Drainage ditches	-	DP: 44 PP: 44 TP: 44	Inflow/runoff-outflow
Manley et al. 2009	Mississippi LMAV	Winter rice field Management (stubble residual left standing and field flooded over winter)	NH_4: 26 NO_3: 100	SRP: 0	Control field(rice straw disked into field, no flooding)
McDowell and McGregor 1980	Mississippi LMAV	No-till/conservation tillage	TN: 90	TP: 84	Conventional tillage
McDowell and McGregor 1984	Mississippi	No-till/conservation tillage	Reduced till: TN: 71 No-till: TN: 75	Reduced till: TP: 82 No-till: TP: 84	Conventional tillage
Mitsch 1992	Illinois LMAV	Wetland: constructed and natural	-	Constructed: TP: 75 Natural: TP: 7	Inflow-outflow
Mitsch et al. 2005	Louisiana LMAV	Wetland	NO_3: 46	-	Inflow-outflow
Moore et al. 2010[4]	Mississippi LMAV	Drainage ditches	TN: 31 NO_3: 76 NH_4: 66 TKN: 85 NO_2: -68	TP: 91	Inflow-outflow
Rebich 2004		Slotted board riser	TN: 26	DIP: -105	Control watershed

Reference	Study Location	BMP type	Nitrogen reduction efficiency (%)	Phosphorus reduction efficiency (%)	Control
	Mississippi LMAV		NO_3: 41 NH_4: 44	TP: 24	
Rebich 2004	Mississippi LMAV	No-till/conservation tillage	TN: 66 NO_3: 79 NH_4: 44	DIP: -230 TP: 46	Control watershed
Udawatta et al. 2002	Missouri	Contour buffer strips	TN: 20 NO_3: 39 NH_4: 32	TP: 26	Control watershed
Zhu et al. 1989[5]	Missouri	Cover crops-brome, Canada bluegrass and chickweed	NO_3: 75 NH_4: 37	DP: 37	No cover crop plot
Littlejohn et al. 2015[6]	Mississippi	Low-grade weirs	NO_3^-: 25 NO_2^-: 67 $NH3^+$: 67	DIP: 14 TIP: 46	Inflow/runoff-outflow
Baker et al. 2016[7]	Mississippi	Low-grade weirs	TIN: -39	TIP: range from 24 to -41	No weir ditch
Omer et al. 2018[8]	Mississippi LMAV	Tailwater recovery system	TN: 44	TP: 32	-

[1]Percentage reductions estimated from figure in manuscript and not from raw/published data; [2]Data averaged over four years, and three CRP treatments; [3]Data averaged between two different drainage ditches, over two years; [4]Averaged between vegetated and nonvegetated treatments; and [5]Nutrient reduction efficiencies averaged across cover crop treatments.6 Median values with cold weather storm event influences, 13 month study; 7Averaged over study locations for 2 and 4+weir ditches, 2.5 year study; Composite samples over 2-year period, 6 TWR systems.

Notes: TP = total phosphorus; DP = dissolved inorganic phosphorus; PP = particulate phosphorus; SRP = soluble reactive phosphorus; DIP = dissolved inorganic phosphorus; TN = total nitrogen; NO3 = nitrate; NH4 = ammonium; TKN = total Kjeldahl nitrogen; NO2 = nitrite; DIN = dissolved inorganic nitrogen. Please check original studies for all details.

F.2.1.2 Forestry

Forestry practices can help ensure water quality during forestry operations from forestry landowners, logging contractors, and forest industry (LDAF 2009). Forestry BMPs and CPs include those aimed at managing forest roads, timber harvesting, site preparation/reforestation, silvicultural chemicals such as fertilizers or pesticides, fire management, and forest wetlands.

Studies conducted in Gulf Coastal Plain area of Louisiana which is characterized by low flow and intermittent streams, reported that current forestry BMPs for timber harvesting are effective in mitigating sediment runoff and limiting water quality degradation (Brown 2010; DaSilva 2012; DaSilva et al. 2013). BMP compliance rates averaged 96% and over 95% of individually rated BMPs met or exceeded minimum BMP requirements from 2000-2014 (Ice et al. 2010; Stich et al. 2013). The Louisiana Department of Agriculture and Forestry estimates the current (2018) compliance rate for BMP implementation by Louisiana foresters is 97%.

The Louisiana Forestry Association (LFA) works with various forestry industries across the state to implement training workshops for loggers on forestry BMPs (LFA 2018). The U.S. Forest Service (USFS) has become more involved in water quality monitoring on water bodies that run through Forest Service lands. Both LFA and the USFS work closely with LDEQ on forestry educational programs that help Louisiana meet goals and objectives of Section 319 of the CWA.

F.2.1.3 Urban Storm Water Runoff

Urban storm water runoff is a source of pollution to water bodies. Some urbanized areas are covered by Municipal Storm Sewer System (MS4) permits (see Section F.3.1); however, many urban areas remain unregulated sources of pollution. Storm sewers collect and convey the urban runoff to surface waters. While nutrient concentrations in urban runoff are generally not as high as concentrations in urban point sources, such as municipal wastewater discharges, or nonpoint agricultural sources, urban areas are often not designed with consideration for their effects on nutrient export. Consideration of the complex interactions urban development has on water quality during the design and planning process can reduce negative impacts. An approach that includes strategies to plan construction and conserve natural areas can reduce the impact of urbanization on stormwater transport of nutrients to adjacent water bodies.

Best management practices to address urban storm water runoff include those aimed at site design, biofiltration, permeable pavement and media filtration, rooftop/building, and retention and detention. Specifically, an urban storm water BMP manual has been developed for New Orleans and Jefferson Parishes in south Louisiana (Geosyntec Consultants 2010), while East Baton Rouge Parish has its own Master Development Program for storm water (City of Baton Rouge et al. 2007). An international BMP database report was released in 2010 to assist federal, state and local governments, watershed organizations, environmental groups and other interested parties in choosing, designing and developing performance expectations for stormwater BMPs with regard to nutrients.

In addition, the Louisiana Yards & Neighborhood Initiative Program through the LSU AgCenter aims to encourage homeowners to create and maintain landscapes in ways that minimize environmental damage (LSU AgCenter 2018a). This is accomplished by focusing on water quality and conservation, reducing stormwater runoff and decreasing nonpoint source pollution of surface water, enhancing desirable wildlife habitats and creating functional, attractive landscapes. At the individual level, homeowner fertilizer application to grass (or 'turf' grass) lawns and ornamental plants can contribute to nutrient enrichment in storm water runoff in the urban environment (Martinez et al. 2012). BMPs for Louisiana lawns have also been developed by the LSU AgCenter (2006) to specifically address the best way to maintain a lawn while minimizing loss to the environment. Levy (2018) indicates that urban and suburban homeowners in Louisiana would benefit from educational intervention to illustrate actual effects of fertilizer misapplication and the benefits of soil testing.

F.2.1.4 Individual Home Sewage Systems

Nonpoint source nutrients from home sewage systems may also impact Louisiana's water bodies. LDEQ partners with Louisiana Department of Health and Hospitals (LDHH) on more efficient ways to coordinate inspections and field work on home sewage systems in impaired waters that are listed for fecal coliform bacteria. Individual home sewage system BMPs are available for homeowners to address this type of nonpoint source pollution (Hendrick 2007; USEPA 2012).

F.2.2 Floodplain Reconnection

Restoring the natural hydrology of a stream can be an important factor in improving water quality. Upriver (non-coastal) diversions where river water is reintroduced to the floodplain and then channeled back into the river may act to reduce sediment and nutrients loads in that diverted water. Floodplain reconnection projects involve reverting human-altered drainage patterns toward more historic and natural floodplain drainage patterns in an attempt to address problems associated with artificially altered hydrology. On a large scale, this technique may involve locks or gates on major navigation channels; on a smaller scale, it may involve blocking dredged canals or cutting gaps in levee banks that were created by canal dredging. Such floodplain reconnection projects located within Louisiana include Mollicy Farms, Atchafalaya River Basin (ARB), Cat Island National Wildlife Refuge, and Three Rivers Wildlife Management Area.

Mollicy Farms, which covers a 17,000-acre tract, is a floodplain reconnection project located in the Upper Ouachita National Wildlife Refuge in the Ouachita River Basin of Louisiana (The Nature Conservancy 2012, 2018; The Conservation Fund 2019). This project is the largest floodplain restoration effort in the Lower Mississippi Alluvial Valley, and one of the largest in the entire US. The Nature Conservancy (TNC), USFWS, and partners removed portions of a 17-mile-long, 30-foot-tall levee constructed more than 30 years ago and reestablished functional internal hydrology to restore natural floodplain functions and processes. In addition, more than 3 million bottomland hardwood trees were planted (Hurst 2016). Completed in October 2013, a 2.5-mile reconstructed Mollicy Bayou connects the area with the Ouachita River. In 2015, Louisiana State University and TNC measured nitrate reduction rates at a control site and in the restored area to

determine the nitrate reduction potential of Mollicy Farms. The hydrologic reconnection improved the ability of the restoration area to remove nitrate from Ouachita River releases, with a potential removal rate of 48.1 metric tons of NO_3-N annually (Hurst et al. 2016). TNC is currently working in partnership with USGS to publish a paper providing an analysis of sediments and nutrients from Mollicy Farm. The overall objective of this work is to estimate the efficiency of sediment and nutrient trapping of the reconnected floodplain of Mollicy Farm compared to the adjacent, natural and intact floodplain on the Upper Ouachita National Wildlife Refuge (Bergan 2019).

The Atchafalaya River is the largest distributary of the Mississippi River. The Atchafalaya River Basin (ARB) receives 30% of the flow from the Mississippi and Red Rivers and new deltas are actively forming at the mouth of the Atchafalaya River and at Wax Lake Outlet. The ARB may act as a nutrient sink and retain and remove nutrients as they enter the ARB from the Mississippi and Red Rivers and flow out into the Gulf of Mexico. The ability of the ARB to remove and sequester nutrients has been previously evaluated (Mitsch et al. 1999; Committee on Environment and Natural Resources 2010; Scaroni 2011). Studies estimate the ARB removes on average 27% of the organic nitrogen (TKN) (Xu 2006), 43% of TN, and 82% of TP (Perez et al. 2011) from water that flows through the basin. Another study by Xu (2013) found that the ARB acted as a significant sink for TKN (annual retention: 24%), TP (41%), and TOC (12%). Further, nutrient removal and retention may be related to habitat type within the ARB, underscoring the need for habitat restoration projects within the basin (Scaroni et al. 2010, 2011). In flood conditions such as in May through July 2011, water was diverted through the Morganza Spillway into the ARB to alleviate impacts of flooding downstream on the Mississippi River. In that 2011 flood event, the ARB acted as a nitrate sink and retained nearly 4% nitrate that entered the basin (Bryant-Mason and Xu 2011). Morganza Spillway was not opened during the 2016 flooding event.

The Atchafalaya Basin Program, now managed by the Coastal Protection and Restoration Authority (CPRA), focuses on water quality/water management as a key category for managing projects within the basin. A sediment and water budget for the Atchafalaya River Basin was completed in 2013 to aid in management of those resources to be best utilized for coastal restoration efforts (CPRA 2013). A draft plan for management of the basin was completed by LDNR in 2018 in accordance with Act 606 of the 2008 Regular Session of the Louisiana Legislature (LDNR 2018). Act 606 required the Atchafalaya Basin Program (ABP) to identify water management, access, and recreation projects, as well as make recommendations for state funding and implement projects.

Seasonal flooding at unleveed areas reconnects the floodplain at some wildlife management areas in Louisiana. The Cat Island National Wildlife Refuge located in St. Francisville, Louisiana is adjacent to an unleveed area of the Mississippi River, while the Three Rivers Wildlife Management Area located near Vidalia, Louisiana is subjected to seasonal flooding from the Mississippi and Red Rivers.

F.3 Point Source Management

Point sources are those that originate from a stationary location or fixed facility from which pollutants are discharged directly into a water body. Point source discharges into Louisiana waters are managed through the Louisiana Pollutant Discharge Elimination System (LPDES) Program through permits regulated by the Louisiana Department of Environmental Quality (LDEQ) under Louisiana's Water Quality Regulations (LAC 33: Part IX) (LDEQ 2016). Permits may contain effluent limitations requiring control and treatment equivalent to secondary treatment, best practicable control technology currently available (BPT), best conventional technology (BCT) for conventional pollutants, best available control technology economically achievable (BAT) for nonconventional or toxic pollutants, and/or water quality based effluent limits (WQBELs). Point source management regarding nutrients in Louisiana is primarily addressed through water permits, wetland assimilation projects, and biosolids land application. In the past, nutrient limits in Louisiana focused primarily on ammonia-nitrogen. In 2016, Louisiana began implementing total nitrogen (TN) and total phosphorus (TP) monitoring requirements for selected facilities (LDEQ 2018m).

F.3.1 Wastewater Permits

Louisiana's Water Quality Regulations (LAC 33: Part IX) require permits for the discharge of pollutants from any point source into waters of the state of Louisiana. This surface water discharge permitting system is administered under the Louisiana Pollutant Discharge Elimination System (LPDES) program (LDEQ 2018h). LDEQ became the state agency delegated to administer the National Pollutant Discharge Elimination System (NPDES) Program in August of 1996. There are over 13,000 LPDES permitted dischargers within the state of Louisiana. Related to nutrients, input from point sources may include industrial and municipal wastewater, industrial or construction storm water, and Concentrated Animal Feeding Operation (CAFO) permits. In addition, the Louisiana Small Business/Small Community Assistance Program (SB/SCAP) provides free technical assistance to small business related to permits.

Wastewater permits for discharge of industrial and treated sanitary wastewater are designed to support water quality standards. The limitations and narrative conditions included in permits are developed in accordance with LDEQ's Water Quality Management Plan, Volume 3: Permitting Guidance Document for Implementing Louisiana Surface Water Quality Standards (LDEQ 2014). Nitrogen and phosphorus limits may be included in a permit if USEPA has developed a nitrogen and/or phosphorus Effluent Limit Guideline (ELG) for a particular point source category. Facility specific limits may be calculated from the ELG using production values, facility effluent flow, and receiving stream flow data. Without ELG values, monitoring only requirements may be included in a permit. Storm water permits may be needed for industrial or construction activities. Industrial stormwater permits are sector-specific and are required for industry types that may contribute to nutrient runoff, such as the agricultural chemical industry. These permits require the permit-holder to monitor storm water discharges for nitrogen and/or phosphorus, minimize exposure, and implement BMPs in order to achieve benchmark pollutant levels or effluent limitations. While these nutrient-related BMPs are required for industrial storm water permits, they are not required in construction storm water permits. For permitted construction storm

water discharges, required BMPs are primarily intended to reduce and/or eliminate discharges of sediments, debris, paints, fuel, etc.

Storm water permits may also be required for Municipal Separate Storm Sewer Systems (MS4) (LDEQ 2018i). An MS4 is a conveyance or system of conveyances designed or used for collecting or conveying storm water from urbanized areas. An urbanized area is a densely settled core of census tracts and/or census blocks that have a population of at least 50,000, along with adjacent territory containing non-residential urban land uses as well as territory with low population density included to link outlying densely settled territory with the densely settled core. It is a calculation used by the Bureau of the Census to determine the geographic boundaries of the most heavily developed and dense urban areas. An MS4, which by definition is a government entity, is considered "regulated" and is required to obtain a LPDES permit when 1) the MS4 met the population threshold of the 1990 US Census (Phase I); 2) all or a portion of the jurisdictional area is located within an urbanized area according to the latest US Census (Phase II); or 3) the MS4 is designated by the permitting authority. However, only the governmental entity and the infrastructure owned and/or operated by that entity is considered "regulated." The point source is where the outfall of a regulated MS4 discharges urban storm water into a water of the state. Individual permits and the master general permit for small regulated MS4s require that the Storm Water Management Plan (SWMP) include certain minimum storm water control measures. Flexibility in development and implementation of control measures is included in the permits so that each MS4 may address water quality management issues unique to its area. The required control measures may include targeting residential or non-industrial areas in order to control the discharge of certain pollutants in storm water (such as fertilizers, pesticides, trash, pet waste, etc.), if such pollutants are determined to be a potential source of water quality impairment. Control of pollutants from residential or non-industrial areas normally occur as part of community education programs or local ordinances. However, storm water discharges from a single privately owned building is not defined as a point source and is addressed through LDEQ's nonpoint source pollution program. LDEQ has issued 4 major (Phase I) MS4 permits and 49 authorizations (Phase II) under the small MS4 General Permit (LAR040000).

Permits are required for any Concentrated Animal Feeding Operation (CAFO) that discharges pollutants to waters of the state. Louisiana operations are typically designed to land apply wastes. As long as the operation's Nutrient Management Plan (NMP) complies with technical standards and there is no discharge of pollutants to state waters, a LPDES permit is not required.

The Louisiana Small Business/Small Community Assistance Program (SB/SCAP) provides free technical assistance to small businesses in understanding and complying with wastewater permits and environmental regulations (LDEQ 2018j). SB/SCAP operates in accordance with the Confidentiality option provided by the EPA Enforcement Response Policy, effective August 12, 1994, regarding Section 507 of the Clean Air Act; under this policy, violations detected through assistance will be kept confidential. Assistance is provided through various forms that includes consultation, assistance with permit applications and new permits, pollution prevention audits

and follow-up activities from other LDEQ departments (enforcement, permitting, and/or surveillance). From 2014-2018, nearly 17,000 assistance activities have been provided by the SB/SCAP group (Table 14).

Table 14. Louisiana Small Business/Small Community Assistance Program Activities from 2014 to 2018.

Year	Water Assists	Compliance Consultations	Newly Permitted Assistance	Permit Applications	Pollution Prevention Audits	LDEQ Referrals
2014	1,980	807	373	536	536	259
2015	1,989	444	167	266	4	165
2015	2,303	743	269	445	2	270
2017	1,355	653	234	243	1	209
2018	1,096	828	236	184	6	114
Total	**8,723**	**3,475**	**1,279**	**1,674**	**549**	**1,017**

F.3.2 Point Source Wetland Assimilation

A specific type of permit under the LPDES Program is the point source wetland assimilation permit (LAC 33:IX.1109.J and LAC 33:IX.1113.B.12.b) (LDEQ 2016a). Many wetlands have been cut off from a supply of fresh water and are degrading. Wetlands areas naturally act as biological filters for pollutants including nitrogen wastes from sewage pollutants and nutrients that are trapped in the soils, where the roots of wetland plants thus promoting wetland health take them up. Point source wetland assimilation projects facilitate the efficient capture and removal of nutrients in wastewater by flowing treated wastewater through a wetland area. This type of project provides nutrients to the wetland to promote growth, and also removes a majority of the nutrients in the wastewater. Environmental benefits of point source wetland assimilation projects include removing direct discharges of treated wastewater into rivers, lakes or streams; helping to prevent saltwater intrusion into the wetland; adding an abundance of needed nutrients into the wetland to stimulate plant growth; and carbon sequestration.

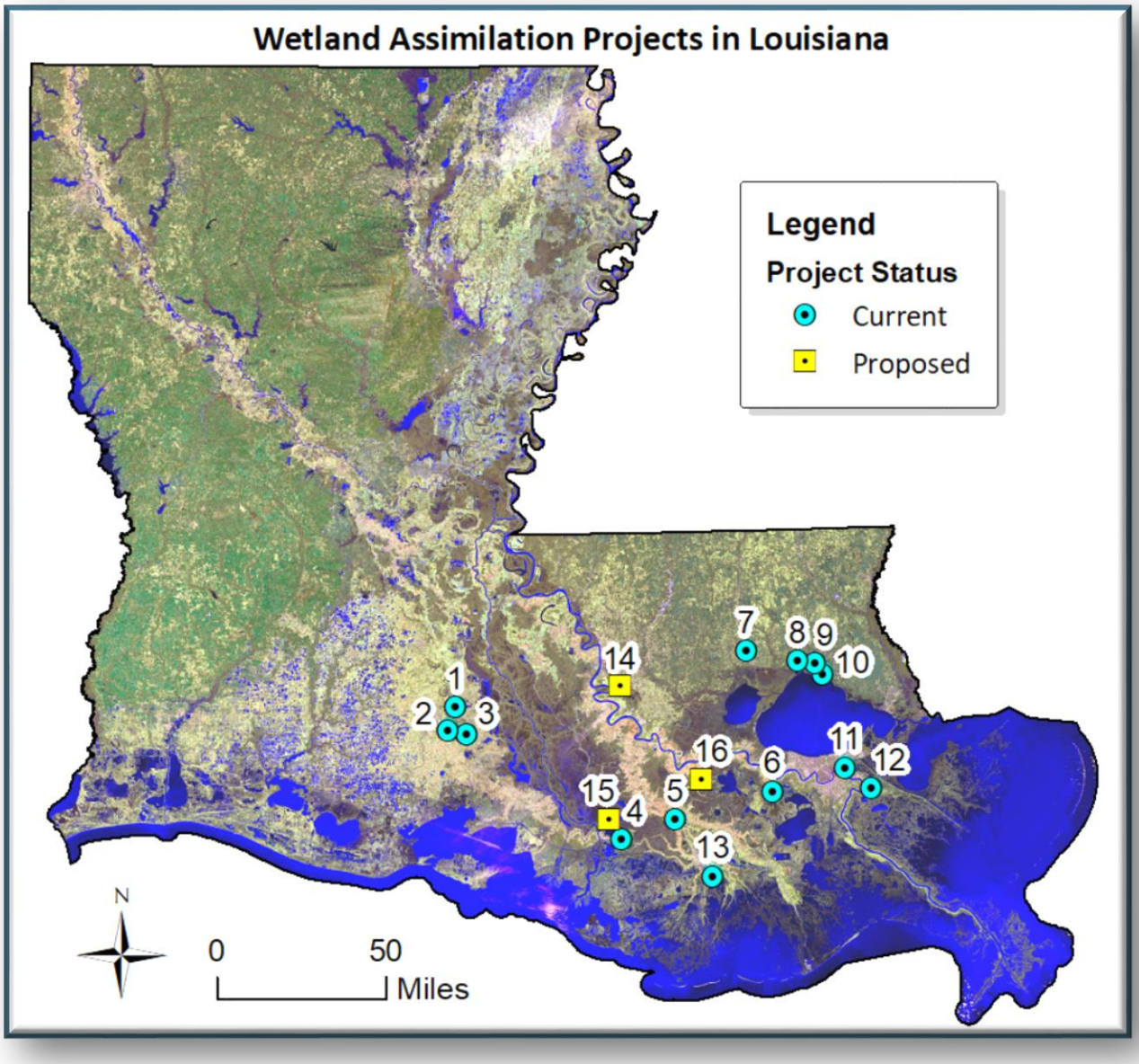
There are currently 13 point source wetland assimilation projects in south Louisiana and more are proposed (Figure 20). Mean nutrient removal efficiencies for assimilation wetlands in Louisiana have been reported as 96% for TN, 75% for TKN, 97% for nitrate-nitrite nitrogen, 85% for TP, and 74% for phosphate (Day et al. 2004; Hunter et al. 2009a, 2009b). Thus, the nutrient removal observed in assimilation wetlands is considerable. Further, Hunter et al. (2009b) observed that freshwater forested wetlands receiving secondarily treated effluent could reduce nutrient concentrations to background concentrations present in relatively undisturbed wetlands. LDEQ calculated nutrient removal efficiencies (2011 to 2017) measured by permitted wetland assimilation projects ranged from 16% to 96% for total nitrogen, and no removal to 97% for total phosphorus, with an average of 72% and 29% respectively (averages from positive removal values only; LDEQ 2019a). Nutrient removal efficiencies may range up to near 100% for

nitrogen and phosphorus compounds in some years, although there is variability among efficiencies; at times, positive fluxes of phosphorus have occurred.

F.3.3 Biosolids Management

Biosolids, or sewage sludge, are also regulated and permitted through the LDEQ's permit program (LDEQ 2018k). Biosolids are nutrient-rich organic matter obtained from wastewater treatment that can be recycled and used beneficially. One such use is for fertilizer as the biosolids contain nutrients such as nitrogen and phosphorus that can be applied to the land (USEPA 2000, 2018a; Water Environment Federation 2010). Biosolids applied to agricultural land, forest, a public contact site, or a reclamation site are done so in accordance with agronomic rates and slope requirements.

Figure 20. Point source wetland assimilation projects in Louisiana.



Current Projects: 1 - City of Breaux Bridge-Cypriere Perdue Swamp (design capacity 1.27 MGD); 2 - City of Broussard-Cote Gelee (1 MGD); 3 - City of St. Martinville-Cypress Island Coulee (1.5 MGD); 4 - St. Mary Parish-Ramos Wetland (0.9 MGD); 5 - City of Thibodaux (4 MGD); 6 - St. Charles Parish-Luling Oxidation Pond (3.5 MGD); 7 - City of Hammond-South Slough (8 MGD); 8 - Guste Island Utility in Mandeville (1.03 MGD); 9 - Tchefuncta Club Estates in Covington (0.14 MGD); 10 - City of Mandeville-Chinchuba Swamp and East Tchefuncte Marsh (4 MGD).; 11 - City of New Orleans East Bank Sewage Treatment Plant (STP) Central Wetlands (0.288 MGD); 12 - St. Bernard Parish Government/ Riverbend Oxidation Pond (0.7-1.0 MGD); 13 - Terrebonne Parish Consolidated Government – Ashland Wetlands in Terrebonne Parish (up to 8.0 MGD). Proposed: 14 - Harveston Wastewater District, LLC in East Baton Rouge Parish (0.055 MGD); 15 – St. Martin Water & Sewer Commission #1 - Stephensville Wastewater Treatment Plant (0.25 MGD); 16 - St. James Parish – South Vacherie WWTP (MGD as yet undetermined).

F.4 Incentives

Incentive-based programs involving watershed stakeholders are an integral part of Louisiana's water quality protection, improvement, and restoration efforts. Incentive-based programs and activities may aid to foster stewards to the environment to support nutrient management in Louisiana.

F.4.1 Voluntary Incentive Based Programs

During the development of the 2014 Louisiana Nutrient Management Strategy, regulations, policies, and programs were inventoried and perceived gaps were noted. Stakeholders at this time expressed interest in voluntary incentive-based programs such as water quality credit trading in Louisiana, which is discussed in Section F.4.3. In addition, regional collaborations through the Lower Mississippi River Valley Nutrient Compact and the Mississippi Rivers and Cities Initiative were created in 2013. Within the state of Louisiana, the Louisiana Agriculture and Forestry Nutrient Management Task Force (2012; see Box 2) with representation from major agriculture groups, and the Louisiana Water Synergy Project (2019; see Box 3) with representation from major industrial groups, were created and both groups aim to improve water quality through stakeholder participation and voluntary efforts.

F.4.2 Voluntary Stewardship

Voluntary stewardship activities are foundational to nutrient management within Louisiana's water bodies. Louisiana is fortunate to have very active participation in both nonpoint source and point source programs. Nonpoint source stewardship initiatives in the state of Louisiana areas are coordinated with federal agencies, such as the USDA, USEPA, and USGS; state agencies, such as CPRA, LDAF, LDEQ, and LDNR; and additional stakeholder groups. These efforts facilitate implementation and coordination of management strategies to manage nonpoint source nutrients to protect, improve, and restore the water quality in Louisiana's water bodies and to subsequently, along with similar efforts in upbasin states, aid in prevention and reduction of nutrient inputs to the GOM. In addition, Louisiana has created a voluntary point source stewardship program, which recognizes industries and other groups for voluntary nutrient reductions. These nonpoint and point source programs are discussed below.

F.4.2.1 Nonpoint Source Stewardship

Nonpoint source stewardship programs include federal and state level programs designed to promote voluntary participation in conservation practice implementation. Federal level nonpoint source stewardship programs include USDA NRCS Farm Bill programs. State level nonpoint source stewardship programs include Louisiana Master Farmer, Louisiana Master Gardner, and Louisiana Master Naturalist Programs through the LSU AgCenter, and the Louisiana Master Logger program administered by the Louisiana Forestry Association (LFA).

Agriculture and forestry organizations agree that environmental stewardship programs maintain a strong agriculture and a healthy environment. Core principles of these organizations:

- Focus on private lands and encourage leadership from the agricultural community, commodity and trade organizations and entities

- Support policies and programs necessary to maintain the economic viability of agriculture allowing farmers to utilize the land for production while promoting conservation and being environmental stewards
- Utilize non-regulatory/voluntary approaches
- Develop and implement locally led projects through accelerated technical and financial assistance and share the results across states in the Mississippi-Atchafalaya River Basin
- Provide technical assistance based on decisions derived from sound science
- Solicit, promote and achieve wide public and governmental support with ongoing coordination
- Enhance the research and extension capacity of the Land Grant University systems
- Forge partnerships with nonagricultural agencies and organizations to promote, develop and implement cost effective, scientifically based conservation programs and site specific practices

BOX 2: LOUISIANA AGRICULTURE AND FORESTRY NUTRIENT MANAGEMENT TASK FORCE

The Louisiana Department of Agriculture and Forestry's Louisiana Agriculture and Forestry Nutrient Management Task Force studies the topics related to agricultural nutrient issues and evaluates their impact on our agricultural industries. The Task Force will eventually be charged with support of the agency in multiple water-related issues, but the immediate priorities are to review and make recommendations on the following topics:

- Research, education and training in the selection and application of agricultural fertilizer and soil nutrients in the state;
- Best practices for the selection, purchase, storage, and application of agricultural fertilizer and soil nutrients, including the soundness of rules for on-farm storage;
- State level agriculture certainty certification programs that encourage the implementation of best management practices in the generation, handling or land application of nutrients in Louisiana;
- Systematic and economically viable nutrient management program that will both maintain agricultural profitability and improve water quality in Louisiana.

This Task Force is a working group of producers, industry, universities and state governments working together to address nutrient concerns and will continue to do so in a manner that is consistent with sound science and practical application. Task Force members representing Louisiana agriculture and forestry stakeholders and industry are as follows:

- LSU Agricultural Center
- Louisiana Association of Conservation Districts
- Louisiana Farm Bureau Federation
- Louisiana Soybean and Grain Association
- Louisiana Forestry Association
- Louisiana Landowners Association
- Louisiana Agriculture Consultants Association
- Louisiana fertilizer industry
- Louisiana Cattleman's Association
- Louisiana poultry industry
- American Sugarcane League
- Louisiana Rice Growers Association

BOX 3: LOUISIANA WATER SYNERGY PROJECT

The U.S. Business Council for Sustainable Development (US BCSD) launched the Louisiana Water Synergy Project in May 2012. Since then, 21 companies have been working together with local and state governments and other stakeholders to find mutually beneficial solutions to address water quality, quantity, and storm water challenges in southeastern Louisiana. The project goals are to achieve tangible water synergy benefits in the region, link the efforts of the private sector with those underway in the public sector, establish a long-term collaboration plan for this region, and develop a replicable process that can be taken to other watersheds/regions.

Project activities are focused in several areas including: Wetlands Restoration, Nutrients Management Issues, Freshwater Sustainability, Water System Sharing, and Financing Innovations for Coastal Restoration and Process Water Reuse.

Nutrients Management Issues Working Group
This working group links the efforts of the private sector with those underway in the public sector to address nutrient impacts in the water bodies of Louisiana. Current and planned activities include:

- Collaborating with LDEQ and LDAF to provide input to the Louisiana Statewide Nutrient Management Strategy.
- Updated the report entitled: "Nutrient Releases to the Mississippi River in Louisiana Industrial Corridor", University of New Orleans, Knecht (2000), to provide a current baseline of point source nutrient discharges from 1999 through 2013 (USBC 2014).
- Exploring the opportunities to create a nutrient trading program in Louisiana.
- Defining alternative methods of nutrient removal, for example, diverting water through vegetative wetlands for nutrient removal.

F.4.2.1.1 Farm Bill Programs

The conservation provisions in the Agricultural Act of 2014 (2014 Farm Bill) provided conservation opportunities for farmers and ranchers through 2018 (USDA NRCS 2018d), and these conservation programs have benefited Louisiana. Annual funding from 2005 through 2017 ranged from $70.9 million to $139.00 million and included annual financial, technical, and reimbursable assistance (Figure 21). Acreage of conservation practices through these programs increased from nearly 250,000 acres in 2005 to a high of over 1,000,000 acres in 2011, with an average of around 800,000 through 2017 (Figure 22).

Specifically, the Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), Conservation Stewardship Program (CSP), Environmental Quality Incentives Program (EQIP), Grassland Reserve Program (GRP), Regional Conservation Partnership Program (RCPP), and Wetlands Reserve Program (WRP) are discussed more below and funds provided from 2005-2017 are highlighted in Figure 23. The EQIP program provides funds to the Mississippi River Basin Health Watersheds Initiative (MRBI), with $288 million provided through EQIP to MRBI from 2010 to 2018 with treatment to over 1.3 million acres (USDA NRCS 2019). These programs vary in their applicability and are all utilized in Louisiana to encourage and support voluntary stewardship in the most appropriate circumstances. As of April 2019, the 2018 Farm Bill (Agriculture & Nutrition Act of 2018) has been passed with continued funding for conservation features such as the CSP and the EQIP.

A recently published document provided by Louisiana's Conservation Partnership (2019) outlines investment returns on conservation efforts in the state of Louisiana from many farm bill supported programs. In 2018, 422,888 acres were treated to improve water quality, 297,823 acres underwent conservation plans, 72,625 acres incurred improved soil heath and sustainability, 226,648 acres were affected by stewardship activities, and nearly 100,000 acres had wetlands restored or wildlife habitat improved. In addition, vegetation or irrigation management improvements occurred on an additional 86,379 acres, indicating that investments from these programs have affected over 1 million acres within the state.

Figure 21. USDA NRCS programs in Louisiana from 2005 through 2017 (reproduced from USDA NRCS et al. 2017).

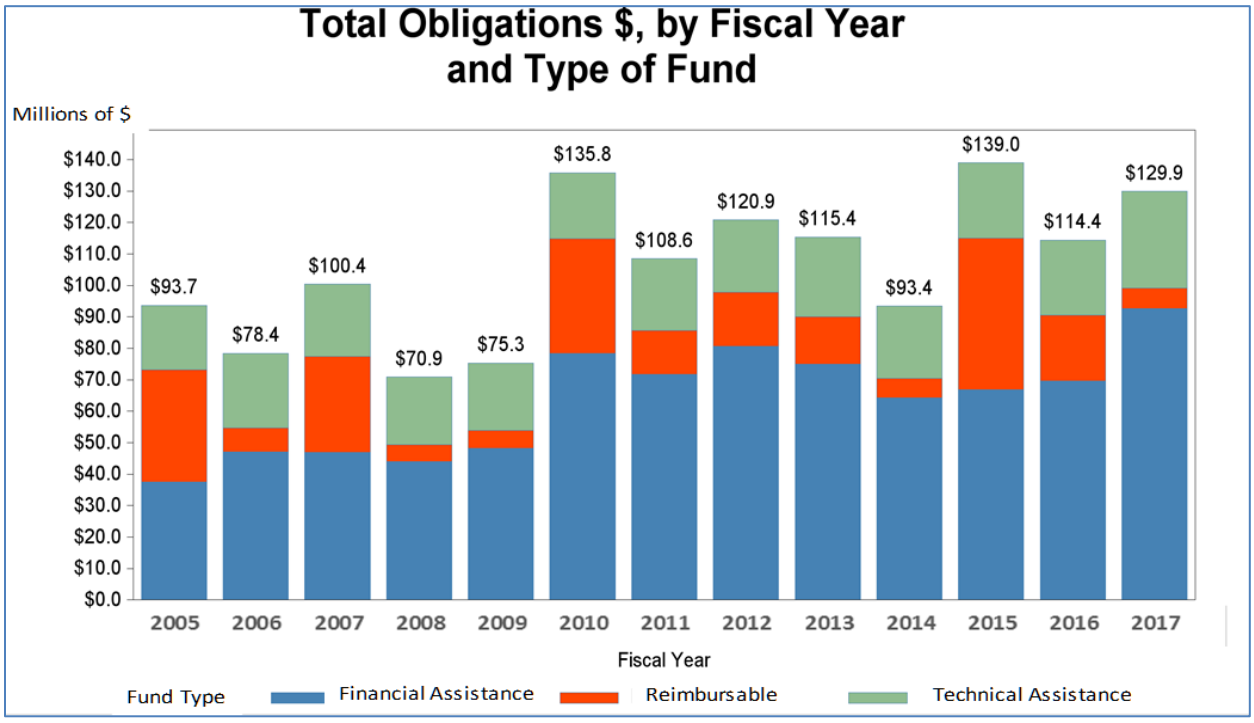


Figure 22. Acres receiving conservation through USDA NRCS in Louisiana from 2005 through 2017 (reproduced from USDA NRCS et al. 2017).

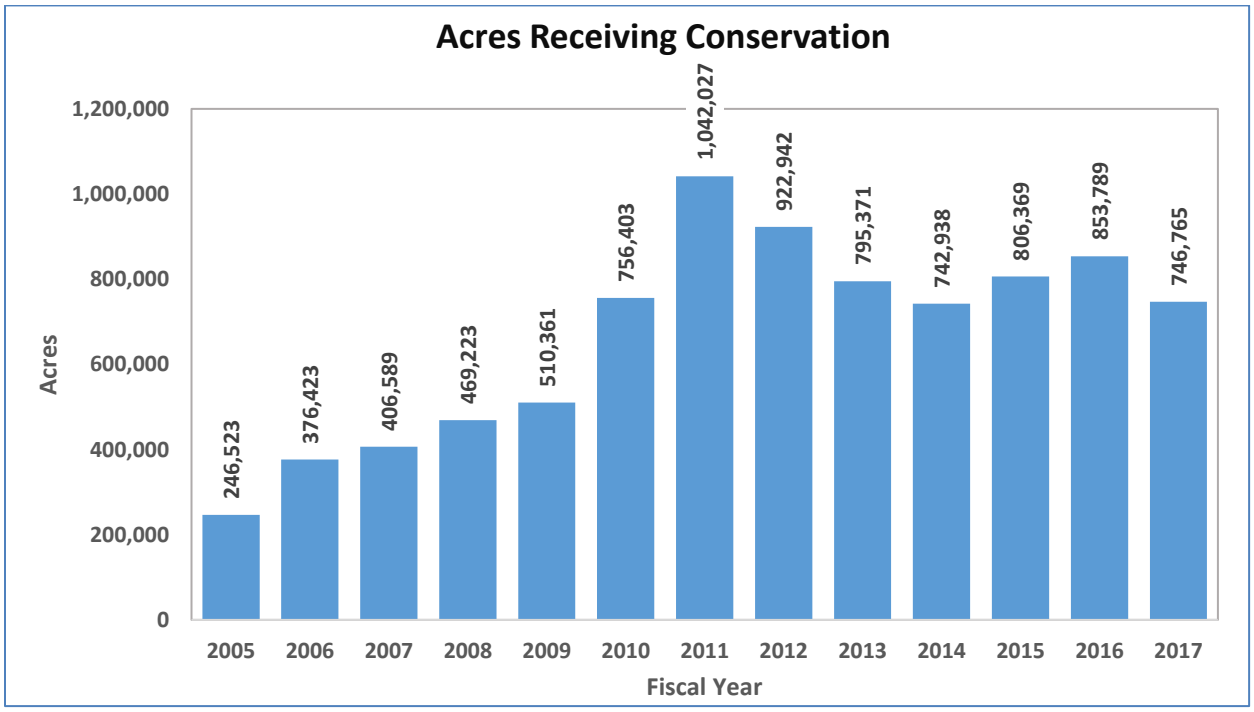
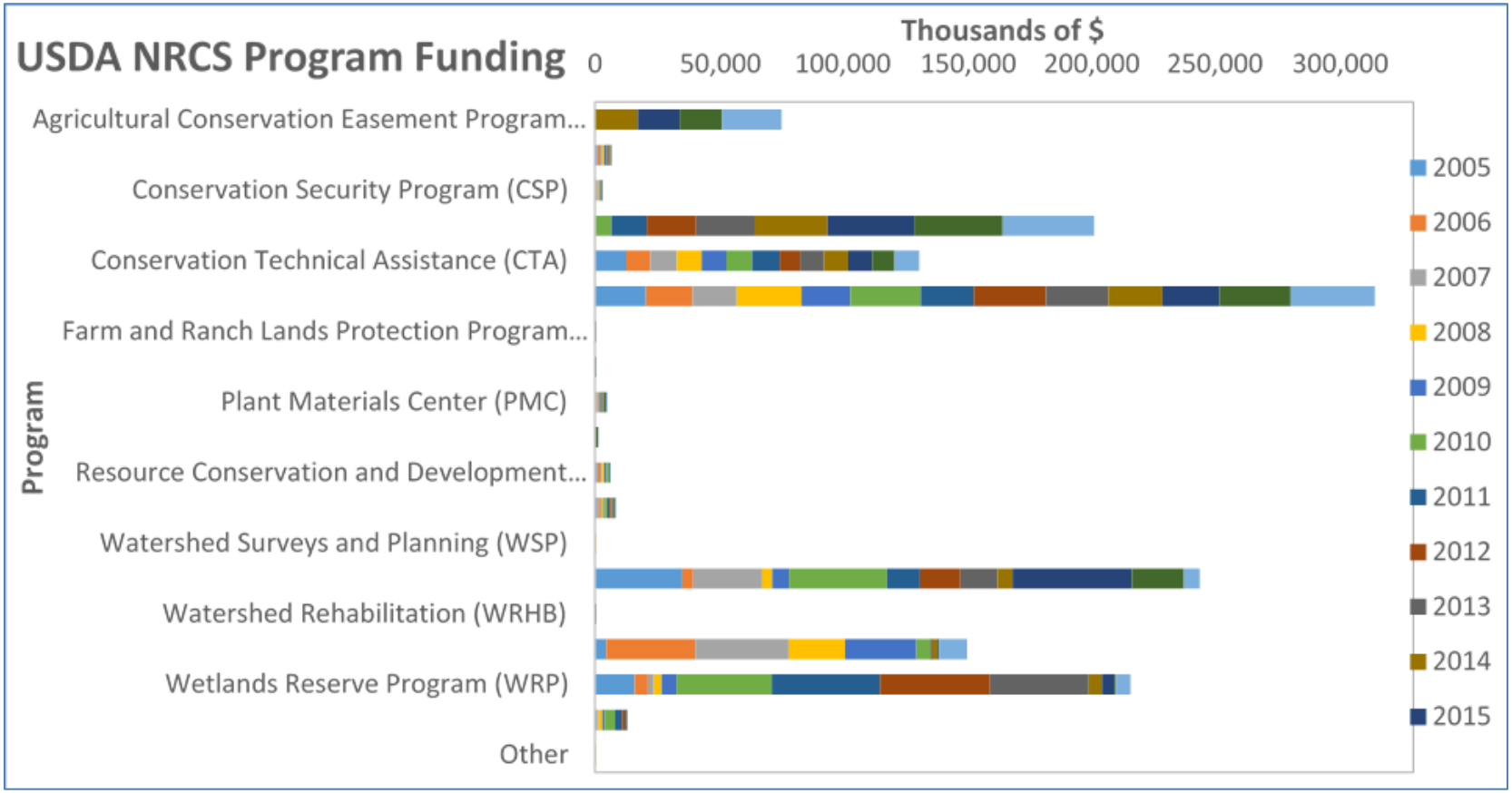


Figure 23. Funding for USDA NRCS Conservation Programs in Louisiana from 2005 to 2017. Total Obligations, by Program Fund and Fiscal Year, includes Technical and Financial Assistance and Reimbursable Fund Types, in thousands of dollars (reproduced from USDA NRCS et al. 2017).



Notes: Data Source: USDA-NRCS, 2012-2017 data from Financial Management Modernization Initiative (FMMI); 2005-2011 data from Foundation Financial Information System (FFIS). Totals may not exactly match sum due to rounding. Negative numbers reflect fund adjustments made throughout the year, are minor and not shown, and do not total more than $150.00. Additional notes provided within citation.

F.4.2.1.1.1. Conservation Reserve Program (CRP)

The Conservation Reserve Program (CRP) was signed into law by President Ronald Reagan in 1985 and is the country's largest private-lands environmental improvement program, is run through USDA's Farm Service Agency (FSA), and is a voluntary program for agricultural landowners. In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled in CRP are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

F.4.2.1.1.2. Conservation Reserve Enhancement Program (CREP)

The Conservation Reserve Enhancement Program (CREP) is an offshoot of the Conservation Reserve Program (CRP) and targets high-priority conservation issues identified by local, state, or tribal governments or non-governmental organizations. It is also a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. Through this program, eligible landowners may receive financial incentives to remove environmentally sensitive cropland and grazing land from production for up to 15 years; these areas are then converted to native grasses or trees. Like CRP, CREP is administered by the USDAFSA. By combining CRP resources with state, tribal, and private programs, CREP provides farmers and ranchers with a sound financial package for conserving and enhancing the natural resources of farms. CREP 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. CREP is a community-based, results-oriented effort centered on local participation and leadership. In addition to contributing to improvement of the environment in multiple ways, those enrolled in CREP receive an annual rental payment for their enrolled acres. FSA also provides cost-sharing and other incentives to help offset the costs associated with putting these practices in place.

In 2018 in Louisiana, nearly 50,000 acres of such marginal cropland in the Boeuf-Tensas and Lower Ouachita basins (spanning the Lower Ouachita, Boeuf, Bayou Macon, and Tensas Subbasins) in northeast/central Louisiana have been enrolled in CREP, reducing soil erosion and nonpoint source pollution, improving water quality in rural drinking water sources, and improving critical wildlife habitat (Table 15).

Table 15. Conservation Reserve Enhancement Program (CREP) acres enrolled in 2018 in northeast Louisiana (LDAF OSWC 2018).

Practice Code	Practice Description	Parish Office	Acres	Totals
CP1	Establishment of Introduced Grasses and Legumes	Franklin	131.3	
		Morehouse	27.7	
		Ouachita	1.7	160.7
CP2	Establishment of Native Grasses	Franklin	12.5	
		West Carroll	474.3	486.8
CP3	Tree Planting	Morehouse	178.8	
		Richland	539.6	718.4
CP3A	Hardwood Tree Planting	East Carroll	36.2	
		Franklin	1835.2	
		Richland	265.4	2136.8
CP4D	Permanent Wildlife Habitat, Noneasement	Catahoula	474.2	
		East Carroll	989.7	
		Franklin	6213.7	
		Madison	1853.8	
		Morehouse	6192.1	
		Ouachita	208.8	
		Richland	7713.7	
		West Carroll	8518.7	32164.7
CP9	Shallow Water Areas for Wildlife	Franklin	63.2	
		Morehouse	5.0	
		Richland	34.7	102.9
CP12	Wildlife Food Plot	East Carroll	1.9	
		Franklin	12.1	
		Ouachita	15.0	29.0
CP22	Riparian Buffer	Caldwell	38.5	
		Catahoula	8.7	
		Franklin	142.7	
		Ouachita	36.0	
		Richland	21.1	
		West Carroll	243.0	490.0
CP31	Bottomland Hardwood Restoration	Catahoula	471.6	
		East Carroll	1661.0	
		Franklin	1174.6	
		Madison	1345.4	
		Morehouse	1445.6	
		Ouachita	508.9	
		Richland	4621.2	
		West Carroll	534.6	11762.9
Totals			**48052.2**	**48052.2**

F.4.2.1.1.3. Conservation Stewardship Program (CSP)

The Conservation Stewardship Program (CSP) is a voluntary conservation program that encourages producers to address resource concerns in a comprehensive manner by undertaking additional conservation activities; and improving, maintaining, and managing existing conservation activities.

F.4.2.1.1.4. Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. These contracts provide financial assistance to help plan and implement conservation practices that address natural resource concerns and for opportunities to improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland. In addition, a purpose of EQIP is to help producers meet Federal, State, Tribal and local environmental regulations.

F.4.2.1.1.5. Grassland Reserve Program (GRP)

The Grassland Reserve Program (GRP) is a voluntary conservation program that emphasizes support for working grazing operations, enhancement of plant and animal biodiversity, and protection of grassland under threat of conversion to other uses. Participants voluntarily limit future development and cropping uses of the land while retaining the right to conduct common grazing practices and operations related to the production of forage and seeding, subject to certain restrictions during nesting seasons of bird species that are in significant decline or are protected under Federal or State law. A grazing management plan is required for participants.

F.4.2.1.1.6. Regional Conservation Partnership Program (RCPP)

The Regional Conservation Partnership Program (RCPP) promotes coordination between USDA NRCS and its partners to deliver conservation assistance to producers and landowners. USDA NRCS provides assistance to producers through partnership agreements and program contracts or easement agreements. As of 2018, there are currently three projects in Louisiana: The Gulf Coast Water and Wildlife Conservation by Ducks Unlimited, Improving Soil and Water Quality in Bayou Pierre project by the Red River Soil and Water Conservation District (SWCD), and Cultivating Water Conservation on Working Lands project by Ducks Unlimited.

F.4.2.1.1.7. Wetlands Reserve Program (WRP)

The Wetlands Reserve Program (WRP) is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA NRCS provides technical and financial support to help landowners with their wetland restoration efforts. The program goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

F.4.2.1.2 Louisiana Master Farmer Program

To offer Louisiana farmers a voluntary education option to improve environmental stewardship, in 2001 the Louisiana State University Agricultural Center developed an Environmental Stewardship educational module in an agricultural proficiency "Master Farmer" program (Oldham and Castille 2003; LSU AgCenter 2018b). Another component of this program is the incentive-based financial assistance portion of the program. For this environmental stewardship module, state agencies and advocacy groups developed a three-phase program (Figure 24):

Phase 1. Six hour environmental stewardship training
Phase 2. Approved Farm field day/Virtual Model Farm workshops
Phase 3. Development and implementation of a farm-specific conservation plan

The classroom instruction in Phase 1 presents material on the Clean Water Act, national and Louisiana water quality standards, TMDLs, impacts of nonpoint source pollution in the coastal zone, BMPs, role of Conservation Districts, the Natural Resources Conservation Service planning process, and current conservation programs. Phase 2 of the Master Farmer certification process consists of a visit to a commodity specific model farm that demonstrates environmental BMPs 'on-the-ground.' In addition, implementation videos and other materials on BMP utilization are being developed. Phase 3 is the development of farm-specific conservation plans in cooperation with local Natural Resource Conservation Service and/or Soil and Water Conservation District.

The Louisiana Master Farmer Program also includes three specialized tracks for Master Poultry Producer Program, Master Rice Grower Program, and Master Cattle Producer Program. In July 2002, a significant piece of legislation unanimously passed the Louisiana legislature called Act 145, which certifies that producers successfully completing all phases of the Louisiana Master Farmer Program will be presumed in compliance with the Louisiana soil and water conservation requirements. This legislation allows for reasonable assurance that producers are being educated to make better decisions on research-based BMPs, that these BMPs are being implemented, and that producers will verify the implementation of these practices by developing and implementing a comprehensive conservation plan (Oldham and Castille 2003). Administration of the certification is supervised by LDAF.

In October 2013, the LSU AgCenter launched an additional format for Phases 1 and 2 of the training. This Master Farmer University is a 2-day training event that maximizes a farmer's time and effort spent in the training program by offering Phase 1 and Phase 2 training in a back-to-back format. After completion of the Master Farmer University, a farmer must then only complete Phase 3 to receive certification. This streamlined format encourages increased participation in the program and result in more farmers becoming certified.

Currently, over 3,800 farmers have participated in the educational phase of the program and are continuing in the subsequent phases (Figure 25 top). These participants span 97% of the parishes within the state (62/64 parishes), and of these participants, over 254 farmers have completed the three phase training program to become Certified Master Farmers. Certified Master Farmers

are found in 80% of the parishes in the state (51/64 parishes in 2019; Figure 25 bottom). Table 16 lists the partnering agencies and organizations in the Louisiana Master Farmer Program. As of February 2019, 254 Master Farmer certificates have been obtained in Louisiana.

Table 16. Partners of the Louisiana Master Farmer Program.

LSU AgCenter
United States Department of Agriculture
Natural Resources Conservation Service
Louisiana Department of Agriculture and Forestry
National Oceanic and Atmosphere Administration
Louisiana Department of Natural Resources
Louisiana Department of Environmental Quality
Louisiana Soy Association
Louisiana Cattleman's Association
Louisiana Rice Growers Association
Louisiana Farm Bureau
Potash & Phosphate Institute
American Sugar Cane League
National Association of Conservation Districts
Louisiana Forage and Grassland Council
Louisiana Cotton Producers Association
Louisiana Crawfish Association
Louisiana Soybean Association

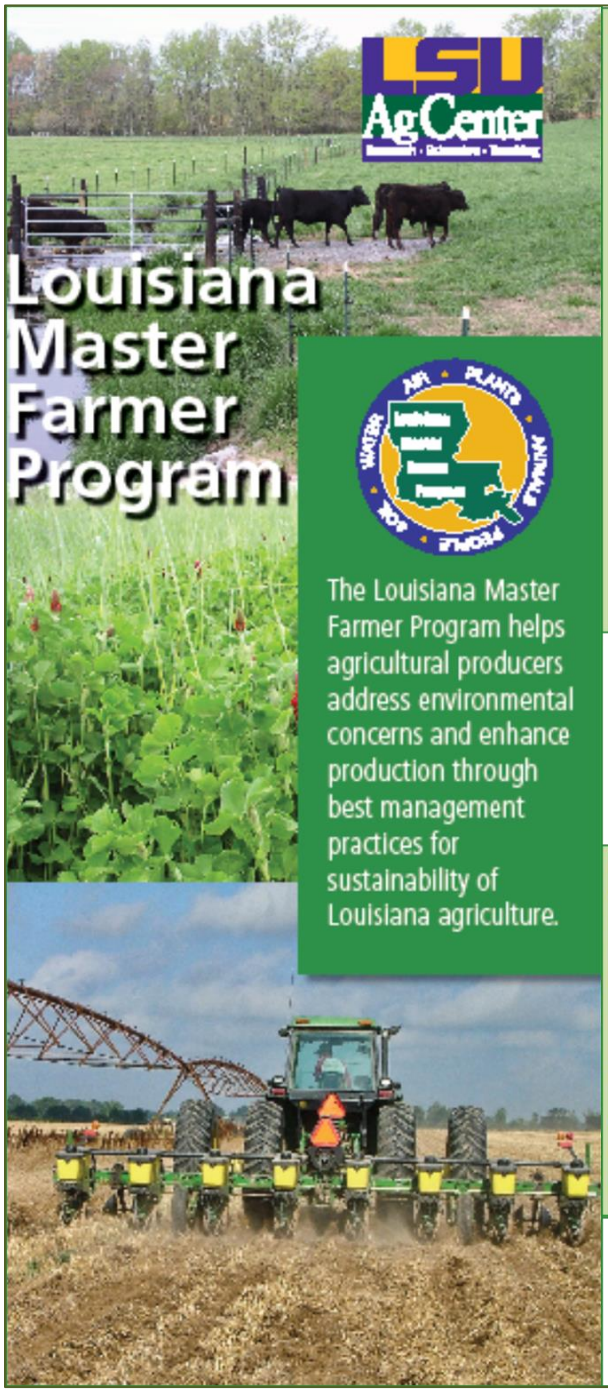
Zhong (2003) studied the effectiveness in the participation of the Master Farmer Program as it relates to the adoption and production of Best Management Practices (BMPs) in the Louisiana sugarcane industry. The study concluded that awareness of the Master Farmer program had a positive impact in the implementation of sugarcane BMPs for soil erosion and sediment control practice and using vegetative field borders or filter strips. Results also indicate that those who had knowledge of the Master Farmer Program for sugarcane were more likely to adopt two, three, or four best management practices within the soil erosion and sediment control measures.

The study concluded that 74% of respondents were aware of the Master Farmer program for sugarcane; of this seventy-four percent, 34% had participated in the training curriculum, which at the time was only two years old. Zhong also recommended continuing education programs, such as the Master Farmer program, to promote BMP adoption by Louisiana sugarcane producers. It was also recommended that additional educational programs through the LSU AgCenter and the continued reliance on the Louisiana Cooperative Extension Service should be supported to promote BMPs to producers across the state.

Adusumilli and Wang (2018) performed an analysis of the adoption of BMPs from data collected by the LSU AgCenter Master Farmer program, and a Nutrient Management survey (performed in 2016). BMPs were split between soil and water practices. Overall, the top five BMPs identified were soil testing, conservation tillage, crop rotation, grassed waterways, and water control structures. These practices were employed by over 50% of survey respondents. The least frequently adopted practices were: terraces of contour farm on extreme slopes, sup-soil or chisel in the fall, zero grade fields (rice), side inlet irrigation (rice), and tail water recover systems. The tendency of production enterprises to adopt multiple conservation methods was common in this study (34-40%). Furthermore, 500 farmer's responses to study-specific questions were modeled to determine variables that influence simultaneous adoption of soil and water conservation practices. The top three explanatory variables were attitude (believe practices affect water quality), crop type (multiple or row only), and number of years as a farmer.

In regard to Louisiana Rice Growers, a voluntary program provides incentives to qualified farmers for sustainable production practices. Through the Louisiana Master Rice Grower Program, participants go through the process of becoming a Louisiana Master Farmer. Financial incentives are offered through this program, which may include a cents per barrel incentive for completion of phases in the Master Farmer program.

Figure 24. Louisiana Master Farmer Program is a voluntary incentive-based program in Louisiana where participating agricultural producers learn about water quality and conservation practices and develop a management plan specific to their commodity needs.



Louisiana Master Farmer Program

Phase I

Producer attends classroom instruction on environmental stewardship issues related to:

- The Clean Water Act of 1972
- National and Louisiana water quality standards
- Effects of nonpoint source pollution on coastal zone and the Gulf of Mexico
- Best Management Practices (BMPs)
- Role of conservation districts in conservation planning/implementation
- Resources conservation planning processes
- Farm Bill conservation programs
- Spill prevention control and countermeasures
- Other conservation-related topics such as prescribed burning, septic system, or watersheds

Phase II

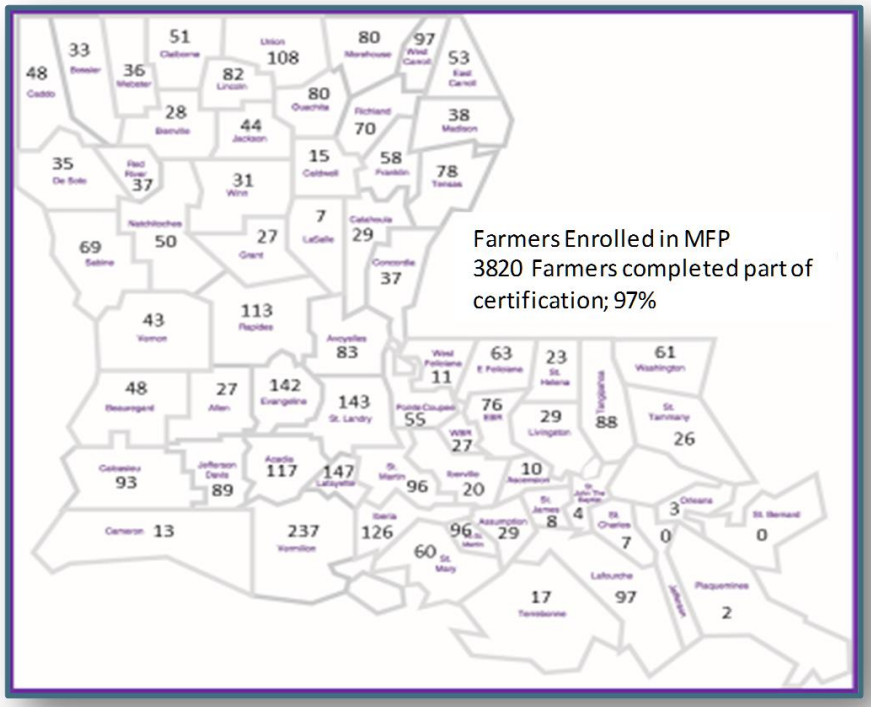
Producer attends a conservation education field day where specific BMPs are demonstrated and discussed. This also may include pasture walks, soil quality workshops and other commodity-specific demonstrations.

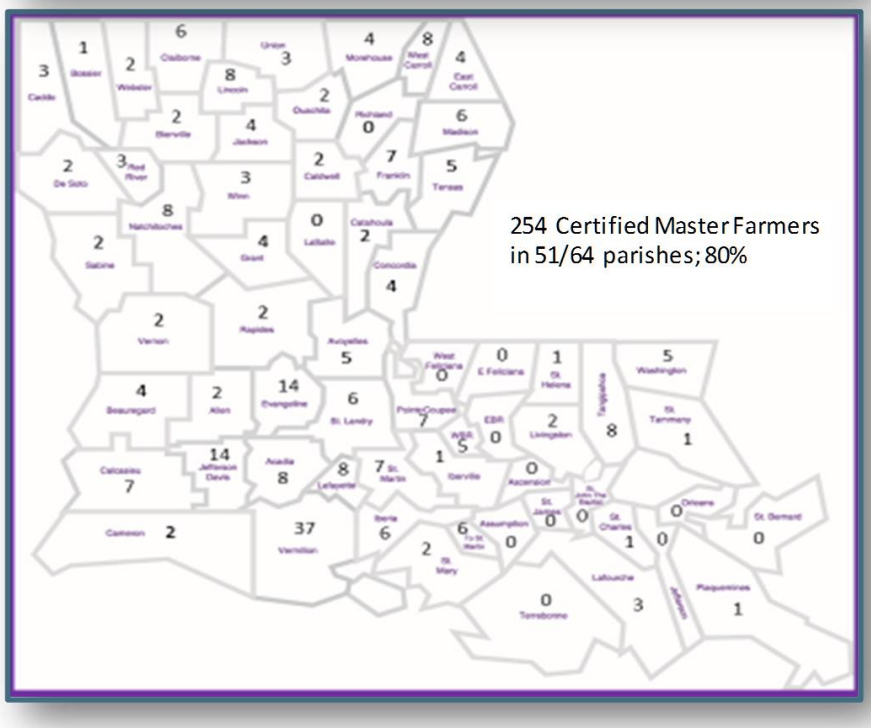
Phase III

A producer must request a farm-specific Resource Management System (RMS) level conservation plan through the USDA's Natural Resources Conservation Service and their local Soil and Water Conservation District. This plan includes a comprehensive summary of all resource concerns on land which the producer has control and goals to address these concerns. Once plan is complete, the producer may then apply for Master Farmer Certification from LDAF.

Upon Completion of all three phases of the Louisiana master Farmer Program, producers are presumed to be in compliance with Louisiana's soil and water conservation requirements

Figure 25. The Louisiana Master Farmer Program (MFP) has more than 3,800 participants in various phases of the program (top), and has fully certified 254 farmers who have completed all three phases of the training (bottom). Participation covers 97% of the parishes in Louisiana (62/64 parishes), and certified farmers are located in over 80% of the parishes (51/64 parishes).





F.4.2.1.3 Louisiana Master Gardener Program

The Louisiana Master Gardener Program through the LSU AgCenter offers home gardeners opportunities to develop their skills and share their knowledge with others (LSU AgCenter 2018c). Volunteer participants in the Master Gardener program must attend at least 80% of scheduled instruction, pass an open-book examination and volunteer a minimum of 40 hours of service to earn the title of Louisiana Master Gardener. Certification is restricted to one year and new certifications are issued each year only to those individuals who make a commitment to participate for the coming year. Master Gardener's perform outreach in the community to share horticultural knowledge.

F.4.2.1.4 Louisiana Master Naturalist Program

The Louisiana Master Naturalist Program (LMNP) is a voluntary certification program sponsored by the LSU AgCenter where citizens can expand their natural history knowledge base of Louisiana resources (LSU AgCenter 2018d). The primary purpose of the LMNP is to offer a statewide program that educates Louisiana citizens about their precious flora and fauna, as well as other aspects of their environment and ecosystems. To become certified, citizens will complete training requirements of 46-58 hours of class and field training, 20 hours volunteer service, 8 hours advanced training, and successful completion of an exam. Attending annual educational programs (8 hours) and continued volunteer opportunities are needed for annual recertification. Certified Louisiana Master Naturalists are required to use their talents to educate others or assist programs that promote and protect Louisiana's natural heritage.

F.4.2.1.5 Louisiana Master Logger Program

Awareness of forestry issues has been promoted through various programs that concentrate on sustainable forestry (USDA 2000; Louisiana Forestry Association 2013). Sustainable forestry practices are based on a stewardship ethic that includes all of the values of forestland such as aesthetics, water quality and conservation of wildlife habitat (Makuch and Muth 2008).

One of the most recognized expressions of this ethic is the Sustainable Forestry Initiative (SFI; SFI 2013). The forestry community of Louisiana has developed a comprehensive 30-hour program to provide training to loggers, foresters, and forest landowners in the management and harvesting of trees. The program covers safety requirements, environmental concerns, sustainable forestry practices, and business management. This program aims at enhancing professionalism among foresters, timber harvesters, and others that participate in the forestry industry. A key component of the training program is the effective implementation of Louisiana's forestry BMPs for the protection of water quality. In addition, the LDWF recently (2017) certified about 490,000 acres of state-owned wildlife management forestland through the 2015 to 2019 Forest Management Standard (SFI 2017).

The Louisiana Master Logger designation recognizes logging contractors and others who have completed 30 hours of instruction in five Professional Logger Education and Training Seminars. Master Loggers must also complete six hours of continuing education annually to maintain their certificates. Since the beginning of Best Management Practice (BMP) training in 1999 for water

quality protection and forest sustainability, the Louisiana Forestry Association has trained over 10,000 foresters, loggers, and landowners. In 2018, 900 loggers, foresters and landowners were trained in water quality BMPs. During this period, there were 52 first-time participants to the training, with the balance receiving refresher training.

F.4.2.2 Point Source Stewardship

The primary and most comprehensive voluntary point source stewardship program in Louisiana, which recognizes point source contributors for voluntary improvements in water quality, pollution prevention and waste reduction, is the Louisiana Environmental Leadership Program (ELP). This program was established in 1995 as a voluntary incentive program sponsored by Louisiana professional, environmental, industrial, and municipal associations to improve the quality of the state's environment through pollution prevention, community outreach and environmental management (LDEQ 2018l). LDEQ and USEPA Region 6 provide financial and logistical support for the program.

The ELP supports water quality pollution prevention and reduction including nutrient management. Several industrial and municipal facilities and others have been recognized for their pollution prevention and reduction efforts specific to nutrients and water quality (Table 17). Participants are recognized by the Secretary of LDEQ, and if selected by the Steering Committee, may be recognized at an annual award ceremony hosted by the Governor of Louisiana.

The ELP also commissioned a review of point source nutrient reductions in the Mississippi River Industrial Corridor (MRIC) from a baseline year of 1987 (when Toxic Release inventory [TRI] reporting initiated) through 1998. The findings were first published in a report entitled *Nutrient Releases to the Mississippi River in the Louisiana Industrial Corridor* (Knecht 2000), and were updated in 2014 (US BCSD 2014). These reports highlight significant voluntary reductions in nitrogenous and phosphatic compounds achieved by Louisiana industries along the MRIC, an area covering 12 parishes (West Feliciana Parish, East and West Baton Rouge, Iberville, Ascension, St. James, St. John, St. Charles, Jefferson, Orleans, St. Bernard and Plaquemines parishes) along the lower Mississippi River.

Some specifics from the US BCSD (2014) update report include: the MRIC corridor continued to receive the greatest load of TRI in the State of Louisiana, accounting for 66% of the loads to surface waters for the 2012 reporting year; there was a considerable increase in industry along the corridor from 2008 to 2013, though total nitrogen releases continued to decrease; and ammonia and nitrate compounds were found to dominate nutrient releases to the Mississippi River (88%) during this time. For phosphorus, an average concentration decrease of 0.01 mg/L was reported for 1999 to 2012. The report goes on to address the nutrient contributions of industry in the MRIC to the GOM. The findings indicate that the industrial point source and estimated sanitary wastewater contribution of total nitrogen (19,543,321 pounds/year) accounts for just over 6% of the estimated total nitrogen discharged annually to the gulf from man-made point sources in the MARB. Further, 1.5% of the estimated total nitrogen from point sources

comes from the MRIC, representing 0.56% of the estimated total nitrogen load from all sources entering the GOM.

In addition, US BCSD (2014) highlighted several significant nutrient reduction efforts. For example, BASF was awarded an ELP award for installing denitrification capabilities at its Geismar Plants wastewater treatment facility. The project resulted in the removal of approximately 78,000,000 pounds of nitrogen from the wastewater discharge during the period of 1999 through 2013 (mean efficiency 83%), for which the company has received and ELP award.

Significant contributions to phosphorus reductions were highlighted by Knecht (2000). One of the largest nutrient reductions was accomplished by IMC-Phosphates (formerly IMC-Agrico). In 1994, IMC-Phosphates finished a project that by 1998 had reduced phosphoric acid, the major phosphatic compound, discharges to the river by over 80 million pounds per year, or 91%. IMC-Phosphates voluntarily spent $27 million on their phosphate reduction project, and later received an ELP award for this reduction (Table 17). The fertilizer industry in the MRIC likewise reduced phosphoric acid releases into the Mississippi River by 80% between 1987 and 1998.

Since 2001, there have been 13 ELP awards for projects and technologies put into place concerning nutrient pollution reduction throughout the state. Awards have ranged from small business recognition for individual projects, to multiple awards for greater corporations/municipalities, concerning targeted reductions in nitrogen and/or phosphorus to Louisiana waterways (Table 17).

Table 17. Voluntary point source management stewardship recognized for water quality improvement measures or nutrient reductions through the Louisiana Environmental Leadership Program (ELP).

Entity	Location	Year	Stewardship
BASF Corporation	Geismar, Louisiana	2001	Developed a biological treatment system that converts over 2.3 million pounds of nitrates annually in their wastewater to atmospheric nitrogen and non-nutrient parameters.
IMC Phosphates, now Mosaic Fertilizer	Uncle Sam & Faustina plants, St. James, Louisiana	2001	Special Recognition for Outstanding Nutrient Reductions. At Uncle Sam and Faustina Plants, an 80% reduction in average annual phosphorus discharges to the Mississippi River, or over 100 million pounds of nutrient loads, was achieved.

Entity	Location	Year	Stewardship
ExxonMobil	Baton Rouge, Louisiana	2003	Recognized by both the ELP program and Gulf of Mexico (GOM) Program's Gulf Guardian Award in 2004 for reducing nitrate discharges to the Mississippi River. Nitrate was reduced from 4.1 million pounds per year in 1999 to 1.47 million pounds in 2003.
Marathon Petroleum Company	Garyville, Louisiana	2009	Special Recognition Award for Nitrate Reduction. Marathon Louisiana Refinery Division committed to bringing the Garyville Major Expansion Project online with no increase in permitted effluent limits as the expanded refinery will be totally self-sufficient for water supply, treatment, and disposal. Wastewater treatment plant (WWTP) modifications include installation of a biological reactor train, consisting of an Induced Gas Flow Unit, a Closed Circuit Cooling Tower, an Advent Integrated System (AIS), Biological Reactor and an Integral Clarifier. These Biological Reactors have the ability to remove between 85-90% of dissolved nitrates, a common nutrient in treated refinery effluent.
City of Ruston	Ruston, Louisiana	2009	Municipality Achievement Award in Pollution Prevention for expansion and upgrades to the city wastewater treatment plant including improvements to the collection, transmission and treatment systems. These changes have resulted in discharge reductions that far exceed regulatory requirements, which include nutrient management, and the city is also better able to collect data on every part of the system through implementation of a Global Positioning System (GPS)/Geographic Information System (GIS) mapping program. All of the waste sludge generated at the WWTP is pumped to a city-owned Beneficial Use Facility where sludge is land applied at the 100-acre hay farm site that is commercially available for non-dairy use, thus eliminating disposal of sludge offsite.

Entity	Location	Year	Stewardship
Nalco Industries	Garyville, Louisiana	2010	Special nutrient reduction recognition award for Outfall Nitrate Reduction Program. Nalco has reduced nitrate compounds in its plant effluent by maintaining a low dissolved oxygen concentration in the effluent prior to discharge to the environment. Analytical results at the company indicated that this process reduced the nitrate compound concentration in the effluent by 50%. An additional 25% reduction was achieved with the installation of an online meter. The reductions from the company help to reduce hypoxia in the GOM.
City of Denham Springs	Denham Springs, Louisiana	2010	Municipality Recognition Award in Pollution Prevention for building a new sewage treatment facility that also included in the treatment facility design, nutrient removal (nitrogen and phosphorus), tertiary treatment (sand filters), odor control and exceptional quality sludge processes. The new sewage treatment facility will decrease the total contaminant discharge by approximately 1 ton per day, and will remove an additional 2.3 tons per day of contaminants once operating at full capacity.
City of Carencro	Carencro, Louisiana	2012	Municipality Recognition Award in Pollution Prevention for improving the efficiency of its wastewater treatment system, which includes nutrient management, and installing over 2,000 automatic meter-reading devices on water meters throughout the city.
Martin Ecosystems	Baton Rouge, Louisiana	2013	Special Recognition Award in Pollution Prevention. Installed BioHaven® Floating Islands at Elayn Hunt Correctional Facility to optimize habitat and improve water quality and managing nutrients by transforming pollution into healthy biological diversity through a vegetative and microbial foundation.

Entity	Location	Year	Stewardship
City of West Monroe	Monroe, Louisiana	2014	Special Recognition Award in Pollution Prevention for the Sparta Re-Use Facility. This project was designed to reduce the draw on the strained Sparta Aquifer while reducing the flow and nutrient/pollutant loading to the Ouachita River in an effort to preserve the aquifer.
Martin Ecosystems	Baton Rouge, Louisiana	2015	Martin Ecosystems was awarded a Small Business Achievement Award in Community Environmental outreach for their Isle de Jean Charles Floating Island Project. Martin Ecosystems strategically installed floating islands in Pointe-Aux-Chene in Terrebonne Parish for marsh protection that may be useful for nutrient management.
ExxonMobil	Baton Rouge, Louisiana	2016	ExxonMobil Refinery received the ELP Large Business Achievement Award in Pollution Prevention for its development of Biox basins with new Biox tanks for denitrification. The "tank-in-tank" design helps to reduce nitrate in wastewater discharges to the Mississippi River.
St. Tammany Parish Government	Mandeville Louisiana	2019	An outstanding Achievement Award was presented to the parish for development of a Decentralized Management Program in Bayou Liberty Watershed in Slidell, for stream segment improvements and water quality restoration. Repairs of sewage pipes and septic tanks, replacement of tanks, and homeowner education led to a 400% reduction in biological oxygen demand in two LDEQ subsegments. This program has been extended parish wide.

F.4.3 Economic Costs

Costs associated with nutrient pollution have been examined in recent years by various organizations and programs in an effort to quantify, in dollars, the effects of increasing nutrient levels throughout the country and the world (e.g., Liu et al. 2018, Adusumilli et al. 2017). Several recent publications outline these efforts and are of interest for managing nutrients within Louisiana.

The USEPA (2015) reported on the costs associated with nutrient pollution nationally, separating these costs into two broad categories: 1) source pollution (costs associated with reducing nutrients at the source) and 2) environmental impacts (costs external to the source due to impact). The USEPA report is a compilation of various sources and is aimed at providing an understanding the substantial costs of not controlling nutrient pollution, for example, the $37-$47 million dollar loss in tourism/recreation due algal blooms in Ohio. Losses identified were: (1) commercial fishing, property values, human health, drinking water treatment, mitigation, and restoration (impacts), and (2) wastewater treatment (municipal, decentralized, industrial) and storm water runoff (source).

In a study for LDEQ funded by the USEPA, Westra and Qushim (2016) evaluated economic impacts for both point and nonpoint source stakeholders in order to determine the relative costs associated with improving water quality through nutrient management. For nonpoint source (NPS) pollution, various BMPs were evaluated according to land use, such as agriculture/farming, and residential areas utilizing on-site wastewater treatment systems. Farmers have dozens of BMPs proven to reduce nutrient loadings available to them via USDA subsidies; costs and USDA cost-share rates vary greatly per BMP. For example, contour buffer strips have an average TN and TP removal efficiency of 57% and 70%, respectively. It costs $429.56/acre to implement this BMP. Implementation of effective BMPs is dependent upon each farmer's ability to pay for their share of the costs (Westra and Qushim 2016).

On-site wastewater treatment systems are primarily designed for disinfection, not nutrient control. Most technologies could cost individual homeowners hundreds to thousands of dollars to implement and yield low to moderate (<50%) nutrient removal efficiencies. Technological controls for point sources, such as municipal wastewater treatment plants and industrial facilities, were also evaluated. Point source technologies include retrofitting treatment units with a new process unit and/or utilization of media filters. Nutrient reduction costs largely depend on design capacity and flow rate. Based on 4.9 mg/L ammonia effluent limitation, average ammonia effluent concentration before treatment at 5 million gallons per day (MGD) and 7 MGD waste water treatment plants (WWTPs) were 392.83 lb/day and 406.92 lb/day, respectively. Average costs for decreasing ammonia effluent from 27.2 mg/L to 4.9 mg/L were $576,400.72 and $173,776.66, respectively, at 5 MGD and 7 MGD WWTPs (Westra and Qushim 2016).

In another Louisiana study, Adusumilli et al. (2017) examined ecosystem services resulting from local farmers' implementation of BMPs in Lake St. Joseph Louisiana (Upper Tensas River

watershed) after delisting for turbidity. Proposed increased fish populations, and associated recreation use, could be significant to the local economy, although ecosystem services are not bought and sold in the market.

F.4.4 Economic Incentives

Incentives that provide financial support for water quality improvement projects are necessary in accomplishing nutrient management in the state of Louisiana. Such economic incentives in Louisiana include those targeted toward agricultural producers, coastal groups and communities, both point and nonpoint sources within watersheds. These incentives are necessary to both fulfilling CWA requirements for impaired waters and for offsetting costs of current water quality issues resulting from nutrient pollution.

F.4.4.1 Agricultural Economic Development Assistance, LDAF

The LDAF Agricultural Economic Development Assistance program assists by linking agricultural/forestry related businesses with financial resources (including loans and grants), identifying raw material supplies and directing such entities to various state sponsored business incentives (LDAF 2018). Assistance is available to local and out of state business interests as well as through community and economic development organizations. Staff may assist in the identification of financial resources outside of the programs offered by the LDAF and provides assistance to businesses by making them aware of USDA grant opportunities and helping complete grant applications. The following entities offer financial assistance: USDA Rural Development and Farm Service Agency, Ag Credit Corporations First South Farm Credit and Louisiana Ag Credit, Louisiana Land Bank, the Louisiana Economic Development Corporation at Louisiana Department of Economic Development as well as commercial banks.

F.4.4.2 Clean Water Act Section 319, LDEQ

The LDAF works with LDEQ, the USDA NRCS, and local Soil and Water Conservation Districts (SWCDs) to coordinate the planning and voluntary implementation of Agricultural Best Management Practices (BMPs) and conservation practices (CPs) on farms in priority watersheds to reduce the amount of nonpoint source pollutants entering water bodies. These BMPs and CPs comprise various structures and methods of operation whereby sediment, pesticides, nutrients and organic matter are stabilized or beneficially utilized on the landscape with lessened susceptibility of runoff. This program is closely coordinated with LDEQ's water quality protection efforts (LDEQ 2018g).

F.4.4.3 Coastal and Estuarine Land Conservation Program (CELCP), LDNR

The National Oceanographic and Atmospheric Administration (NOAA) established the Coastal and Estuarine Land Conservation Program (CELCP) in 2002 to protect coastal and estuarine lands considered important for their ecological, conservation, recreational, historical or aesthetic values. The LDNR, Interagency Affairs and Field Services Division is the state lead coastal management agency (LDNR 2018a). The program provides state and local governments with matching funds to purchase significant coastal and estuarine lands, or conservation easements on such lands, from willing sellers. Lands or conservation easements acquired with CELCP funds

are protected in perpetuity so that they may be enjoyed by future generations. To date the program has funded eight grants within Louisiana.

F.4.4.4 Clean Water State Revolving Fund Program (CWSRF)

The Clean Water State Revolving Fund (CWSRF) Program was established pursuant to Title VI of the Clean Water Act, as amended in 1987 (the Act). The CWSRF program presently operates under R.S. 30:2301-2306 (Act 296 of the 2010 Regular Session of the Louisiana Legislature). This statute established a state revolving loan fund capitalized by federal grants (Capitalization Grants for Clean Water State Revolving Funds, CFDA 66:458), by state funds when required or available, and by any other funds generated by the operation of the clean water revolving loan fund. LDEQ is authorized to engage in activities regarding the sums on deposit in, credited to, or to be received by the state revolving loan fund (LDEQ 2018c).

The Financial Services Division and Water Planning and Assessment Division within LDEQ are responsible for the operations of the CWSRF program in the State of Louisiana. These divisions within LDEQ provide assistance to municipalities in developing, financing, and implementing wastewater treatment and/or storm water management plans. The Water Planning and Assessment Division provide engineering oversight, design review, and inspection services as well as environmental assessments. The Financial Services Division oversee grant management, program administration, and financial services on eligible projects. All efforts are directed toward improving water quality by assisting communities in providing wastewater treatment processes that meet established effluent limits and achieve the goals of the Clean Water Act. Since 2014, the CWSRF program has committed to funding nearly 80 projects for over $600 million for renovations and upgrades to wastewater treatment plants, rehabilitation to collection systems and pump stations, and stormwater management projects. Nearly half of those projects, approximately $322 million, are proposing to achieve system compliance and/or discharging into impaired waterbodies. In particular, the following projects are proposing to upgrade or rehabilitate the wastewater treatment plants and/or changing the discharge locations to aid in water quality improvements: Zwolle ($1.059 million), Bossier City ($13 million), Georgetown ($550,000), New Iberia ($3.5 million), Iberia Parish sewer district #1 ($3 million), St. Gabriel ($3 million), Youngsville ($13.2 million), Thibodaux ($6.2 million), Calvin ($760,000), Athens ($480,000), Kinder ($3.35 million).

F.4.5 Trading

Trading is a market-based tool where water quality goals are achieved through connecting different sources of pollutants, such as nonpoint and point sources (USEPA 2012a). The pollutant control costs of these different sources may differ significantly thus allowing for trading as a cost-effective means to achieve water quality goals by engaging these different sources (CTIC 2006). Through the work of the 2014 Louisiana Nutrient Management Strategy, state agencies in Louisiana began to set a course for developing a water quality trading program that could involve activities such as river diversions, nonpoint sources, and for municipal and industrial point sources that may provide a cost-effective means for nutrient management. In addition, President Trump's efforts in infrastructure development and technologies to improve America's water

quality led to a policy memorandum in 2019 to modernize USEPA water quality trading policies, which aims to facilitate the use of market based programs. The new USEPA trading memo identifies six 'Market Based Principles' to encourage innovation in the development and implementation of programs to reduce pollutants in the Nation's waters (USEPA 2019):

- States, tribes and stakeholders should consider implementing water quality trading and other market-based programs on a watershed scale
- EPA encourages the use of adaptive strategies for implementing market-based programs
- Water quality credits and offsets may be banked for future use
- EPA encourages simplicity and flexibility in implementing baseline concepts
- A single project may generate credits for multiple markets
- Financing opportunities exist to assist with deployment of nonpoint land use practices

An effective WQT program could lead to greater nutrient reductions in the lower Mississippi River Basin and the Gulf of Mexico more quickly and at a lower overall cost than traditional regulatory approaches. In addition, water quality trading could provide some point sources and agriculture businesses the opportunity to generate revenues, and offer local regulators more policy options for improving water quality. The desired outcome of this project is to implement a WQT program and demonstrate that water quality trading is a cost-effective approach for reducing nutrients and improving water quality. Much progress has been made in the development of a water quality trading program for Louisiana.

In 2017, the Enrolled Act No. 371 (House Bill No. 423) of the 2017 Regular Session of the Louisiana Legislature amended and reenacted R.S. 30:2074(B)(9)(a), (b), and (c) and repealed R.S 30:2074(B)(9)(d) and (e), relative to water quality; to provide for the powers and duties of the secretary of the Department of Environmental Quality; to provide for the establishment and administration of a water quality trading program; to provide for certain criteria for credits; to provide for limitations on use of credits; to provide for records; to provide for a pilot program; to provide for legislative oversight; and to provide for related matters. This revised statute update allowed for consideration of both point and nonpoint sources in a water quality trading program for Louisiana.

Louisiana agencies reviewed the National Network on Water Quality Trading document to evaluate options and considerations for a water quality trading program in Louisiana (National Network on Water Quality Trading 2015). Findings from this review aided Louisiana in identifying options and considerations that were helpful in designing and implementing a water quality trading program for Louisiana. In addition, the Association of Clean Water Administrators (ACWA) and the Willamette Partnership made available a water quality trading toolkit that provides a blueprint for states seeking to create a water quality trading program (ACWA and Willamette Partnership 2016). The water quality trading toolkit consists of five templates [1) state guidance, 2) watershed framework, 3) state rule, 4) NPDES permit, and 5) program annual report] that can be used as a starting point for trading and can be customized based on a state's needs. ACWA also formed a workgroup for state and federal representatives to participate in discussions on water quality trading; LDEQ is participating in this workgroup.

In December 2017, LDEQ issued a Potpourri Notice (1712Pot1) to inform the public of a stakeholder meeting in January 2018, the availability of draft guidance document, and that the agency was interested in hearing comments on aspects of a water quality credit trading program development and implementation to help advance trading as a cost-effective means for nutrient management and general water quality protection and restoration (LDEQ 2019b). In total six stakeholder meetings were held in 2018 with participation of 116 individuals representing 63 entities. In January 2019, LDEQ proposed a rule (WQ099) for the establishment and administration of a water quality trading program for Louisiana, with a public hearing being held on March 1, 2019 and written comment period ending March 8, 2019. LDEQ is in progress of reviewing public comments on the draft rule but anticipates the final rule may be available later in 2019.

Additionally in late 2018, USEPA and USDA encouraged the use of market-based approaches to address excess nutrients (USEPA 2018f). In early 2019, USEPA announced the availability of a new water quality trading policy memorandum that further supports the use of market-, incentive-, and community-based programs to reduce excess nutrients and improve water quality (USEPA 2019).

F.5 Leveraging Opportunities

Nutrient management projects and activities are the focus of many programs within Louisiana as well as up-basin in the larger Mississippi-Atchafalaya River Basin (MARB). In addition to those numerous programs already discussed above, opportunities of leveraging with existing programs will be pursued as a means to collaborate and share information regarding nutrient management. These leveraging opportunities are a chance to combine or expand benefits from these multi-faceted programs that may be working within the same watershed.

The stakeholder groups and programs currently identified where leveraging may be beneficial to nutrient management within Louisiana are given in Appendix C (listed alphabetically by group/program). It is anticipated that more leveraging opportunities will continue to be identified as the Louisiana Nutrient Management Strategy progresses.

F.6 Science-based New Technologies/Applications

Science-based methods must be employed in order to realize improvements in nutrient management. Development and utilization of advancing and new technologies are an integral part of improving nutrient management within Louisiana's water bodies. These science-based new technologies and applications may be implemented close to the source of nutrients such as through agricultural production or wastewater treatment, or may be implemented in-stream or further downstream in order to improve water quality.

F.6.1 Agricultural Production

Globally, the human population currently over 7 billion is projected to increase 32% to 9.1 billion by 2050 and it has been estimated that the demand for food and energy may rise 50% by 2030

and demand for fresh water by 30% as the human population exceeds billion (The Population Institute 2010). Within Louisiana, agriculture and forestry combined make up one of the state's largest and economically dependent industries.

Science-based technologies and applications for agricultural production will be necessary to meet future demand of production as human population continues to increase exponentially and while efforts are ongoing to protect, improve, and restore water quality. The Conservation Effects Assessment Project (CEAP) of the USDA NRCS provides an assessment of the agricultural production and effectiveness of conservation practices in place. Fertilizer application methods and technologies promote the most effective means to apply fertilizers to maximize uptake by the plants that need them and to minimize loss from runoff.

F.6.1.1 Conservation Effects Assessment Project (CEAP)

The Conservation Effects Assessment Project (CEAP) was created in 2003 to help USDA NRCS better understand and optimize environmental benefits of conservation practices and programs. The program aims to quantify the environmental effects of conservation practices and programs. Additionally, CEAP aims to develop science-based management for agricultural environments to help inform decision and policy-makers and farmers alike. CEAP produces regional and watershed based assessment of conservation practices from data gathered in two phases: 2003-2006 (CEAP-1) and 2015-2016 (CEAP-2). Currently available CEAP assessments include cropland, wetlands, grazing land, and wildlife from CEAP-1 data, although reports utilizing data from CEAP-2 are due beginning 2019 (CEAP 2018 personal communication). Independent assessments such as the CEAP-1 report provide high-level validation that conservation practices are working. Forty-two CEAP-1 watershed studies have been initiated to provide in-depth analysis and quantification of the measurable effects of conservation practices at the watershed scale to understanding of the effects of conservation in the biophysical setting of a watershed (USDA NRCS 2018e).

The CEAP-1 report for the Lower Mississippi River Basin, which includes most of Louisiana and parts of Arkansas, Kentucky, Mississippi, Missouri, and Tennessee (USDA NRCS 2013g), indicated that voluntary, incentives-based conservation approaches are effective and should be expanded. Model simulations in the Lower Mississippi River Basin of conservation practices in use on cultivated cropland in 2003-2006, including land in long-term conserving cover, show reduced sediment and nutrient loads delivered to rivers and streams and to the GOM from cultivated cropland sources per year. Conservation practice implementation resulted in an average of 35% reduction for sediment, 21% for nitrogen, and 52% for phosphorus delivered to rivers and streams; and 4% reduction for sediment, 17% for nitrogen, and 22% for phosphorus reaching the GOM. It is estimated that implementation of further conservation practices could result in potentially more reduction in sediment and nutrient loading (USDA NRCS 2013g). While not modeled in the CEAP report, 'legacy phosphorus' that may result from the over-application of phosphorus on farm fields in past years was indicated as an important contributor to current levels of in-stream phosphorus loads to be considered.

As previously mentioned, CEAP-2 reporting is underway utilizing 2015-2016 data, and products from this data are estimated to be released beginning in 2019 and continuing through 2022. Literature in support of CEAP measures include White et al. (2014) and Garcia et al. (2016). Both of these studies indicate that conservation measures to reduce nutrient loads are effective, with the latter study providing empirical evidence of reductions at the regional scale.

F.6.1.2 Fertilizer Application

The fertilizer industry endorses a concept known as 4R nutrient stewardship (The Fertilizer Institute 2018). The 4R philosophy is an innovative and science-based approach that enhances environmental protection, expands production, increases farmer profitability and improves sustainability. The concept is to use the right fertilizer source, at the right rate, at the right time, with the right placement. 4R nutrient stewardship requires the implementation of best management practices (BMPs) that optimize the efficiency of fertilizer use. The goal of fertilizer BMPs is to match nutrient supply with crop requirements and to minimize nutrient losses from fields. Selection of BMPs varies by location, and those chosen for a given farm are dependent on local soil and climatic conditions, crop, management conditions and other site specific factors. Other agronomic and conservation practices, such as no-till farming and the use of cover crops, play a valuable role in supporting 4R nutrient stewardship. As a result, fertilizer BMPs are most effective when applied with other agronomic and conservation practices.

Management practices that control the fate of fertilizer treatments, whether commercial or residential, or use practices that promote the efficient use of nutrients by plants will minimize the amount of nutrients that could potentially be lost from the application site. In addition, applying controls to prevent runoff and erosion will help maintain fertilizers in the areas where they are applied.

Enhanced Efficiency Fertilizers (EEF) are those that can reduce nutrient losses to the environment while increasing nutrient availability for the plant or the crop. These fertilizers can either slow the release of nutrients for uptake or alter the conversion of nutrients to other forms that may be less susceptible to losses. Categories of EEFs include slow and controlled release nitrogen fertilizers, nitrogen stabilizers and phosphate management products (The Fertilizer Institute 2014). Further, the precision agriculture method of variable rate technology (VRT) provides the means to change the rate of fertilizer application through mapping the soil characteristics of a farm and determining the appropriate rate and amount of application for a given area of land. These and other means of managing fertilizer application are useful and necessary in managing nutrients applied to a field and in minimizing nutrients lost through runoff.

F.6.2 Wastewater

Treating nutrients in wastewater at the source is an effective method for ensuring excess nutrients do not enter water bodies. Primary treatment involves physical removal of floatable or settable solids. Secondary treatment involves the biological removal of dissolved solids. Advanced treatment methods may allow for tertiary treatment that includes processes to remove nutrients.

Biological nutrient removal (BNR) removes TN and TP from wastewater through the use of microorganisms under different environmental conditions in the treatment process (USEPA 2007). BNRs for nitrogen and/or phosphorus include 4- and 5-stage Bardenpho processes; Step-feed activated sludge process; Concentric oxidation ditches; Denitrification filters with carbon sources; Modified Ludzack-Ettinger (MLE) Process; Sequencing Batch Reactor (SBR) Process; Rotating Biological Contactor (RBC) Process; Biological phosphorus removal (without filters or chemical addition); Trident filter; Dynasand D2 advanced filtration system; Membrane filtration processes; Land application of tertiary effluent through soil; A/O Process-MLE process preceded by an initial anaerobic stage; Modified Bardenpho Process-Bardenpho process with addition of an initial anaerobic zone; Modified University of Cape Town (UCT) Process; and Oxidation Ditch.

F.6.3 River Diversion Research

Constructing projects in Louisiana that divert Mississippi River water into surrounding wetlands is not a new concept. Such projects have been in place since the 1930s. The first river diversion projects were constructed for flood control. Later, various diversions and siphons were constructed to combat salt water intrusion and improve fish and wildlife habitat. The most recently planned diversions are aimed at diverting sediment to build wetlands.

Understanding deltaic geology and the land-building processes, such as those that built the Mississippi River Delta, are critical to the effective engineering, design, and construction of river diversions that are capable of building and sustaining land. Likewise, understanding the effects of river diversions on the receiving basins containing coastal wetlands and estuaries is also important. CPRA has commissioned scientists over the years to study the effects of existing river diversions on coastal wetlands and estuaries to better understand and predict what will happen when the river is reconnected to coastal areas after decades of being isolated from riverine inputs. Even though this body of science has grown exponentially, there are still uncertainties to be resolved.

Researchers such as Mitsch et al. (1999) emphasized the importance of targeting wetland creation and restoration in areas where nitrogen concentrations and loads were highest as a means of removing nutrients from local rivers and streams as a method of nonpoint source control. Perez et al. (2011) also said that based on their research, diversions from the Mississippi River into shallow estuarine systems can result in significant reductions in nutrients, especially nitrogen, prior to reaching offshore waters. Additional research suggests that estuaries have a number of biotic and abiotic pathways to remove nutrients from the water column, including denitrification, burial, plant uptake, and assimilation into the food web. Thus, reconnecting the Mississippi River to the coastal estuaries in Louisiana can assimilate nutrients through several pathways, thereby reducing the overall amount of nitrogen and phosphorus exported from the system before they reach the GOM (DeLaune et al. 2005; Lane et al. 2004). Studies conducted over the past 1-2 decades have reported that Breton Sound wetlands receiving Mississippi River water through the Caernarvon Diversion act as a sink for nitrogen (Day et al. 2009; Lane et al. 1999).

CPRA is working to identify and synthesize the relevant and current state of the knowledge with respect to hydrologic basins receiving riverine diversion flows of freshwater. A technical guidance document containing a summary of the use of diversions as component of the Master Plan and an analysis of available data regarding a set of priority topics will be presented. Among other issues, the fate and transport of the associated nutrients and sediments will be included as a technical topic in the guidance document.

LIST OF APPENDICES

APPENDIX A: STRATEGIC ACTIONS SCHEDULE

Targets and goals for strategic actions from 2019 through 2023 for the Louisiana Nutrient Management Strategy ("strategy").
X = Completed activity; O = Ongoing activity; T = Target date for completion of activity; -- = Activity not initiated during that period.
Activities may be dependent on resource availability.

Strategic Action	Agency Commitment(s)	2019	2020	2021	2022	2023
1. Stakeholder Participation						
1.a. Identification and engagement of stakeholders	Interagency Team	O	O	O	O	O
1.b. Perform outreach/education on strategy activities	Interagency Team	O	O	O	O	O
1.c. Identify and promote partnerships/leveraging opportunities	Interagency Team Stakeholders	O	O	O	O	O
2. Decision Support Tools						
2.a. Identify, evaluate, and document selected tools	Interagency Team	O	O	O	O	O
3. Regulations, Programs, & Policies						
3.a. Propose or establish new regulations, policies and/or programs pertinent to strategy objectives	Interagency Team	O	O	O	O	O
4. Management Practices & Restoration Activities						
4.a. Document current practices related to nutrient management	Interagency Team	O	O	O	O	O
4.b. Identify areas where practices being implemented	Interagency Team	O	O	O	O	O
	Interagency Team	O	O	O	O	O

Strategic Action	Agency Commitment(s)	2019	2020	2021	2022	2023
4.c. Identify case studies/modeling efforts for strategy leveraging	CPRA					
4.d. Integrate science-based nutrient management approaches	Interagency Team	O	O	O	O	O
4.e. Promote BMP/CP implementation by farm in priority watersheds	USDA NRCS LDAF OSWC LSU AgCenter	O	O	O	O	O
5. Status & Trends						
5.a. Model nutrient loading estimated within Louisiana watersheds	USGS Interagency Team	O	O	O	O	O
5.b. Document/trends for in-stream nutrient water quality (long-term)	LDEQ	O	O	O	O	O
5.c. Document/trends for Social Indicators of nutrient management behavior	LSU AgCenter	O	O	O	O	O
5.d. Document/trends for BMP/CP implementation in watersheds	USDA NRCS LDAF OSWC LSU AgCenter LDEQ	O	O	O	O	O
5.e. Document/trends for permitted discharger inventories	LDEQ	O	O	O	O	O
5.f. Document/trends for river diversion efforts	CPRA					
5.g. Document coastal protection and restoration activities	CPRA	O	O	O	O	O

Strategic Action	Agency Commitment(s)	2019	2020	2021	2022	2023
6. Watershed Characterization, Source Identification, & Prioritization						
6.a. Maintain watersheds and/or water body characterization through time	LDEQ USDA LDNR	O	O	O	O	O
6.b. Identify potential pollution sources through Desktop Analysis/Windshield Survey	Interagency Team	O	O	O	O	O
6.c. Identify unpermitted point sources	LDEQ	O	O	O	O	O
6.d. Identify priority watersheds from leveraging programs	USDA GoMI USDA MRBI USDA NWQI LDAF/LDEQ/LDNR NPS	O	O	O	O	O
6.e. Determine priority watershed & subwatershed basins	Interagency Team	O	O	O	O	O
6.f. Develop/leverage Watershed Nutrient Management Projects for priorities	Interagency Team Stakeholders	O	O	O	O	O
7. Incentives, Funding, & Economic Impact Analysis						
7.a. Promote voluntary participation in incentive-based programs	Louisiana Master Farmer Louisiana Master Poultry Producer Louisiana (Kellogg) Master Rice Grower Louisiana Master Cattlemen	O	O	O	O	O

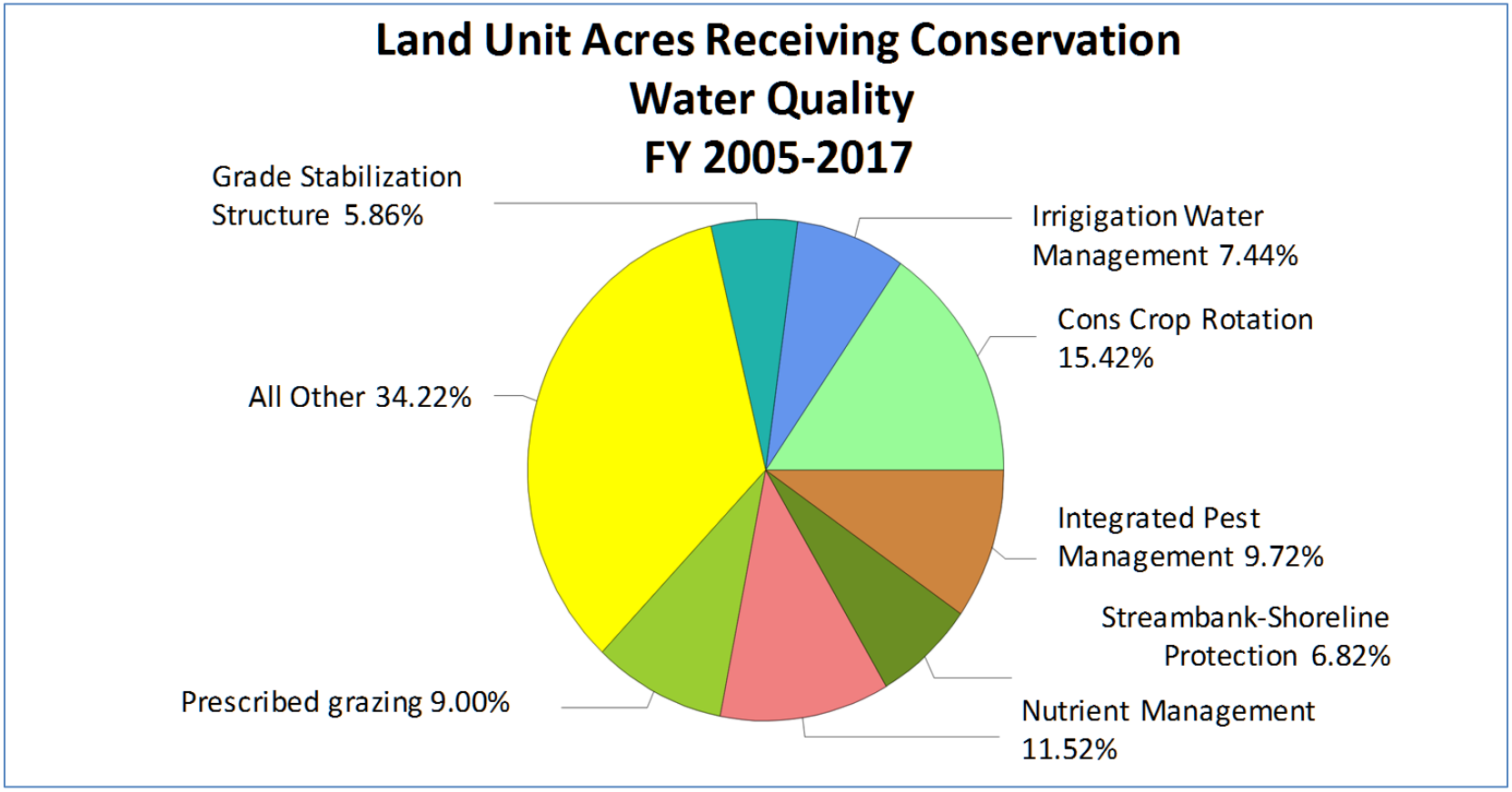
Strategic Action	Agency Commitment(s)	2019	2020	2021	2022	2023
	Louisiana Master Gardner Louisiana Master Naturalist Louisiana Environmental Leadership					
7.b. Identify and communicate new funding initiatives/projects	Interagency Team Stakeholders	O	O	O	O	O
7.c. Promote assistance (financial or technical) for BMP/CP implementation	LDAF/LDEQ/LDNR NPS USDA NRCS LDAF OSWC	O	O	O	O	O
7.d. Promote assistance (financial or technical) for point sources	SB/SCAP	O	O	O	O	O
7.e. Document economic impacts from available sources	Interagency Team LSU AgCenter Stakeholders	O	O	O	O	O
7.f. Develop and implement a water quality credit trading program	Interagency Team Stakeholders	O	O	O	O	O
9. Monitoring						
9.a. Monitor in-stream nutrient water quality	LDEQ	O	O	O	O	O
9.b. Monitor water quality relative to BMP/CP implementation	USDA GoMI USDA MRBI USDA NWQI LDAF/LDEQ/LDNR NPS	O	O	O	O	O

Strategic Action	Agency Commitment(s)	2019	2020	2021	2022	2023
9.c. Monitor nutrients associated with riverine diversions	CPRA	--	--	--	O	O
9.d. Monitor nutrients in point sources	LDEQ LPDES Permitted Dischargers	O	O	O	O	O
9.e. Evaluate compliance with point source permits	LDEQ	O	O	O	O	O
9.f. Identify and communicate new monitoring projects/initiatives	Interagency Team Stakeholders	O	O	O	O	O
10. Reporting						
10.a. 5-year strategy reviews	Interagency Team	--	--	--	--	O
10.b. Report annually on strategy activities	Interagency Team	O	O	O	O	O
10.c. Disseminate information through strategy website	Interagency Team	O	O	O	O	O
10.d. Document spotlight(s) of nutrient management successes	Interagency Team Stakeholders	O	O	O	O	O

Abbreviations: *BMP*: Best Management Practice; *CP*: Conservation Practice; *CPRA*: Coastal Protection and Restoration Authority; *LDAF OSWC*: Louisiana Department of Agriculture and Forestry, Office of Soil and Water Conservation; *LDEQ*: Louisiana Department of Environmental Quality; *LDNR*: Louisiana Department of Natural Resources; *LPDES*: Louisiana Pollutant Discharge Elimination System Permit Program; *NPS*: Nonpoint Source Program; *LSU AgCenter*: Louisiana State University Agricultural Center; *SB/SCAP*: Louisiana Small Business/Small Community Assistance Program; *USDA GoMI*: U.S. Department of Agriculture, Gulf of Mexico Initiative; *USDA MRBI*: U.S. Department of Agriculture, Mississippi River Basin Initiative; *USDA NRCS*: U.S. Department of Agriculture, Natural Resources Conservation Service; *USDA NWQI*: U.S. Department of Agriculture, National Water Quality Initiative; *USGS*: U.S. Geological Survey.

APPENDIX **B: USDA NRCS LAND UNIT ACRES RECEIVING CONSERVATION FOR PRACTICES RELATED TO WATER QUALITY IN LOUISIANA, 2005-2017**

Reproduced from USDA NRCS et al. 2018, *NRCS Conservation Programs: Louisiana 2005-2017*.



The following chart and table includes practices that are related to Water Quality. Water quality is an indicator of the health of our environment and reflects what occurs on the land. The primary water quality issues from agriculture are sediment, nutrients, pesticides, pathogens, and in some parts of the country, salinity. Using conservation practices to improve land in an environmentally sound manner will result in better water quality for drinking, recreation, wildlife, fisheries and industry. Only practices representing a significant portion of the total for the period are included. Practices not included are summed into the All Other category.

Practice Name	Practice Code	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		2016		2017	
		Acres	Count	Acres	Count	Acres	Count	Acres	Count	Acres	Count	Acres	Count	Acres	Count	Acres	Count	**Acres**	**Count**	Acres	Count	Acres	Count	Acres	Count	Acres	Count
Access Control	**472**	16,351	652	33,422	1528	17781	850	38733	1546	8,872	381	14025	672	24110	911	31,031	726	**31003**	**947**	7,649	214	25,357	644	24764	894	20919	703
Access Road	**560**	1761	20	2360	60	324	9	190	4	1099	14	405	11	173	3	3505	22	**1492**	**21**	2	1					244	6
Animal Mortality Facility	**316**											36	1			13	1	**7**	**1**	18	2	54	2	32	2	6	1
Composting Facility	**317**	102	40	247	30	225	31	202	11	44	4	60	4	44	4	60	4	**53**	**6**	13	2			1	1		
Conservation Cover	**327**	7,832	378	38,007	1775	21,508	1,183	18,790	928	12,497	567	13,065	557	23,685	1,186	19,678	893	**12318**	**568**	3,962	110	13,006	605	12,200	490	6,216	335
Conservation Crop Rotation	**328**	32421	756	29450	772	47127	1149	45063	1769	64401	3797	65983	3542	92471	2826	76123	2316	**1E+05**	**2950**	1E+05	2896	75246	2552	1E+05	3461	1E+05	13203
Contour Farming	**330**					71	2					239	11					**126**	**10**								
Cover Crop	**340**	3,341	85	2,358	44	6,718	145	5,814	169	2,357	42	1,119	12	3,796	62	1,750	44	**4952**	**77**	3,965	89	7,527	112	7,401	155	19,993	409
Critical Area Planting	**342**	4185	171	9628	397	9794	227	9589	180	12712	190	9055	221	5914	168	5787	134	**8104**	**173**	4584	126	5458	127	6848	133	6877	160
Diversion	**362**			31	1			200	5	103	3	49	1			78	2	**44**	**2**	54	2	407	7	3	1		
Filter Strip	**393**	261	7	1,411	29	603	18	192	5	519	11	181	8	201	2			**421**	**12**	78	1						
Grade Stabilization Structure	**410**	18778	409	26322	497	34,703	681	44,783	728	43,265	838	24536	588	35702	633	31743	599	**27281**	**733**	24452	427	24686	757	27,337	616	26,671	588
Grassed Waterway	**412**	420	11	966	46	1,603	19	1,698	34	1,413	18	283	6	34	1	96	2	**140**	**3**	22	1						
Heavy Use Area Protection	**561**	3,676	151	4,721	254	6,788	322	12,251	465	11,506	418	16,854	646	17,952	684	14,129	675	**12939**	**496**	10,264	575	22,941	678	31,929	477	41,906	433
Integrated Pest Management (IPM)	**595**	45,439	1265	40,065	1454	44792	1224	38174	1310	30,896	886	40029	1361	39836	794	67,783	2399	**90826**	**5299**	68,273	6316	34,984	1693	52699	3352	53338	6988
Irrigation System, Microirrigation	**441**					436	9			94	1	21	2	13	3	3523	7	**18**	**7**	142	11	81	5	47	6	1	1
Irrigation System, Tailwater Recovery	**447**			206	3			562	1	243	2							**74**	**1**					40	1		
Irrigation Water Management	**449**	17,118	507	18,906	490	24,774	622	30,224	721	32,892	724	35,200	730	23,817	337	96,280	1528	**75582**	**1528**	41,692	1059	29,837	801	30,717	773	37,944	907
Mulching	**484**	1,540	81	5,325	292	2,978	101	2,690	40	2,375	53	2,020	53	2,329	49	3,202	70	**2871**	**65**	2,485	67	3,568	86	3,202	75	3,741	86
Nutrient Management	**590**	50746	1668	47536	1891	42651	1660	62272	1936	76000	1943	63764	2076	59130	1449	87433	2107	**69365**	**1704**	52161	1756	51738	1527	50489	1458	53681	1945
Prescribed Grazing	**528**	30,650	1093	72,625	2809	56,313	2374	58,218	1994	46,226	2016	55,635	2212	58,715	2117	51,793	2052	**62807**	**2265**	39,536	1265	23,204	772	25,605	874	17,511	597
Residue and Tillage Management, Mulch Till	**345**	550	9	2,588	38	624	10	1,475	42	3,908	85	394	17	886	23	4,013	97	**1897**	**53**	1,270	29	10,686	649	17,672	429	22,046	801

Practice Name	Practice Code	2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		2016		2017	
Residue and Tillage Management, No-Till/Strip Till/Direct Seed	329	3879	84	11233	189	8400	178	6018	137	4808	85	3222	123	4602	69	1456	34	**3519**	**78**	1608	38	3422	85	2437	61	6430	125
Residue and Tillage Management, Ridge Till	346	4742	154	4,759	148	7871	190	5919	132	6365	209	3830	72	11125	248	3951	144	**5482**	**182**	4526	280	1,186	53	584	11	484	33
Riparian Forest Buffer	391	4,313	236	2,104	128	2,440	115	2,094	59	812	21	1,159	62	3,301	60	2,340	48	**1480**	**66**	577	17	452	19	428	12	626	15
Riparian Herbaceous Cover	390													6	1			**118**	**3**								
Roof Runoff Structure	558													88	1												
Stream Crossing	578			370	2	37	3	183	1	20	2	18	1	56	2	10	1	**83**	**5**	109	2	12	1			256	6
Streambank and Shoreline Protection	580	29,573	13	########	8	3,490	10	3,729	5	8,357	7	8,345	1	41,247	7	9,434	9	**214**	**1**	4,428	1	1,870	1	23,489	18	12,650	11
Structure for Water Control	587	26,155	61	5,138	147	4088	79	1327	43	2,613	50	9708	37	2455	63	1,453	40	**1649**	**43**	1,199	35	2,137	53	3351	71	2385	62
Tree/Shrub Establishment	612	30862	799	1E+05	1630	39523	1190	13199	454	10422	298	17128	638	16467	522	13106	410	**16227**	**680**	9499	184	13645	234	5605	170	5960	182
Waste Facility Closure	360			14	1	42	3			2	1	66	8					**29**	**2**			3	1	11	3	8	2
Waste Recycling	633	2,413	142	6,997	387	4,919	235	4,818	222	3,903	181	5,719	248	5,537	228	6,033	196	**7002**	**291**	3,633	168	761	34	5,375	163	159	9
Waste Storage Facility	313	125	54	244	38	237	27	191	13	110	7	23	2	212	5	18	2	**104**	**10**	7	1	63	4	35	3	8	2
Waste Transfer	634					55	3	39	6	25	2	0	1	160	9	19	1	**59**	**5**	1871	57	490	29	652	22	290	6
Waste Treatment Lagoon	359					4	1	2	1	3	1	44	5	17	2	13	2	**112**	**7**	23	3	39	5	160	7	124	5
Water Well Decommissioning	351	456	7	380	17	55	13	1,480	36	3,788	73	2,965	57	1,863	33	1,291	30	**563**	**15**	4,824	16	569	13	422	7	3	1
Wetland Creation	658	6	1	781	40	2019	17	2166	16	148	3	1955	10	362	10	1	1	**28**	**1**								
Wetland Enhancement	659	36369	23	12,545	32	21390	10	23848	3	28113	22	28288	6	1E+05	38	30826	375	**11939**	**61**	1042	7	3,710	3			209	3
Wetland Restoration	657	28,863	582	24,374	662	25,657	445	14,796	348	56,866	160	45,508	403	53,793	422	37,910	301	**18484**	**257**	8,222	106	4,585	132	6,135	166	5,449	127

USDA NRCS Land Unit Acres Receiving Conservation (including practice count) by Fiscal Year, Water Quality Practices in Louisiana (USDA NRCS et al. 2018).
Notes: Data Source USDA-NRCS, National Planning and Agreements Database, October 2017
Land unit acres may be counted multiple times across practices and fiscal years

APPENDIX C: LEVERAGING OPPORTUNITIES

Leveraging opportunities for nutrient management within Louisiana may exist through collaboration with numerous and diverse stakeholder groups such as these described below.

Stakeholder Group	Description	Web Resource
4R Nutrient Stewardship	4R Nutrient Stewardship is an innovative and science-based approach that offers enhanced environmental protection, increased production, increased farmer profitability, and improved sustainability. The 4R concept is the use of the right fertilizer source, at the right rate, at the right time, with the right placement.	http://www.nutrientstewardship.com/
American Farmland Trust	American Farmland Trust is working with farmers, planners and policy makers to ensure a regionally diverse structure for agriculture and more favorable economic conditions to keep farmers and ranchers on the land.	http://www.farmland.org/
America's Watershed Initiative	This initiative seeks to build and implement a vision based on collaboration and mutually beneficial outcomes in contrast to single purpose advocacy. It builds upon strong leadership present in many tributary watersheds. America's Watershed also seeks to link and augment these efforts, creating a broader partnership that can serve as a unified voice for the whole system, and support the effective resolution of issues that span multiple regions and issues such as energy, transportation, water quality and floodplain management.	http://americaswatershed.org/
Atchafalaya Basin Program (ABP)	The Atchafalaya Basin Program, now managed by the Coastal Protection and Restoration Authority (CPRA), focuses on water quality/water management as a key category for managing projects within the basin. The ABP operates under the authority of Act 3 of 1998 and Act 920 of 1999. CPRA, the federal U.S. Army Corps of Engineers, and the basin parishes work together in creating projects by executing cooperative endeavors or agreements that protect and enhance the basin.	http://coastal.la.gov/atchafalaya-basin-program/

Stakeholder Group	Description	Web Resource
Barataria-Terrebonne National Estuary Program (BTNEP)	BTNEP is one of 29 National Estuary Programs throughout the United States and its territories. The National Estuary Program was established by Congress through section 320 of the Clean Water Act of 1987 and BTNEP became a National Estuary in 1990. Priority areas for BTNEP include hydrologic modification, sediment reduction, habitat loss, eutrophication, pathogens, toxic substances, and changes in living resources.	https://btnep.org/
Delta REACH (Research and Education to Advance Conservation and Habitat)	The REACH program will be a Mississippi state-wide, producer driven, "hands on" delivery vehicle, that will provide coordination and support for documenting the benefits of conservation efforts to natural resources and agriculture on specific farms. Similar land use and conservation practices within the Mississippi delta region are found in Louisiana, and this REACH effort could inform Louisiana producers.	http://www.reach.msstate.edu/
Ducks Unlimited (DU)	DU works on conservation programs within Louisiana through restoring grasslands, replanting forests, restoring watersheds, working with landowners and partners, acquiring land, conservation easements, and management agreements. These efforts by DU aimed at restoring habitat for waterfowl also act to improve water quality.	http://www.ducks.org/louisiana/louisiana-projects
Field To Market	Field To Market is a nonprofit organization of a diverse alliance working to create opportunities across the agricultural supply chain for continuous improvements in productivity, environmental quality, and human well-being. Field to Market provides collaborative leadership that is engaged in industry-wide dialogue, grounded in science, and open to the full range of technology choices. Currently 50 organizations participate in Field to Market and this participation includes growers, conservation, agribusiness, and academic/research groups.	http://www.fieldtomarket.org/

Stakeholder Group	Description	Web Resource
Gulf of Mexico Alliance (GOMA)	GOMA is composed of state and federal agencies along with partners and covers the five Gulf states of Alabama, Florida, Louisiana, Mississippi, and Texas. The goal of GOMA is to increase regional collaboration to enhance the ecological and economic health of the Gulf of Mexico. Five priority issue areas have been identified: Data & Monitoring, Educations & Engagement, Habitat Resources, Water Resources, and Wildlife and Fisheries. Cross Initiatives include: Comprehensive Conservation, Restoration, and Resilience Planning Ecosystem Services, and Marine Debris. The **GOMA Monitoring Community of Practice**, which provides a forum for sharing and coordination monitoring knowledge with the larger restoration community, is housed under GOMA.	http://www.gulfofmexicoalliance.org/index.php
Gulf of Mexico Hypoxia Watch	the Gulf of Mexico Hypoxia Watch collaborative project (2001 to 2018) conducts annual cruises to provide scientists with difficult-to-obtain environmental and fishery-independent data (on long-term resource monitoring needs) to allow them to understand the effects of the physical environment on fish and other marine organisms. As part of these efforts, Hypoxia Watch disseminates near real-time data and maps of the hypoxic zone online from data collected during the annual SEAMAP summer ground fish surveys. These maps have been instrumental in monitoring changes in hypoxia throughout the Gulf, outside of the cruise window, and for providing much-needed data for hypoxia model calibration and validation.	https://www.ncddc.noaa.gov/hypoxia/
Healthy Watersheds Protection, USEPA	This USEPA encourages local and state agencies to be proactive and place a stronger emphasis on protecting their remaining healthy watersheds as a way to save money and the environment. The program also supports and integrates the work of these efforts to encourage more holistic protection of aquatic ecosystems.	https://www.epa.gov/hwp

Stakeholder Group	Description	Web Resource
Lake Pontchartrain Basin Foundation (LPBF)	The LPBF is dedicated to restoring and preserving the water quality, coast, and habitats of the entire Pontchartrain Basin. The Lake Pontchartrain Basin is a 10,000 square mile watershed encompassing 16 Louisiana parishes. Through coordination of restoration activities, education, advocacy, monitoring of the regulatory process, applied scientific research, and citizen action, LPBF works in partnership with all segments of the community to reclaim the Basin for this and future generations.	https://saveourlake.org/
Louisiana Agriculture and Forestry Nutrient Management Task Force	This Task Force was formed in 2012 by the Louisiana Department of Agriculture (LDAF) to study topics related to agricultural nutrient issues and evaluate their impact on our agricultural industries. The Task Force members include representatives from Louisiana agriculture and forestry stakeholders and industry: Louisiana Cooperative Extension Service, Louisiana Agriculture Experiment Station, Louisiana Association of Conservation Districts, Louisiana Farm Bureau Federation, Louisiana Soybean and Grain Association, Louisiana Forestry Association, Louisiana Landowner's Association, Louisiana Agricultural Consultants Association, Louisiana fertilizer industry, Louisiana Cattleman's Association, Louisiana poultry industry, American Sugar Cane League, and Louisiana Rice Growers Association. This Task Force is an excellent example of producers, industry, universities and state governments working together to address nutrient concerns and will continue to do so in a manner that is consistent with sound science and practical application (Strain 2013).	NA

Stakeholder Group	Description	Web Resource
Louisiana Trustee Implementation Group	The Deepwater Horizon Oil Spill Louisiana Trustee Implementation Group (Louisiana TIG) has released the Final Restoration Plan and Environmental Assessment #4: Nutrient Reduction (Nonpoint Source) and Recreational Use. This Final Restoration Plan describes and proposes restoration project alternatives considered by the Louisiana TIG to improve water quality by reducing nutrients from nonpoint sources and to compensate for recreational use services lost as a result of the Deepwater Horizon oil spill.	https://la-dwh.com/final-restoration-plan-and-environmental-assessment-4-nutrient-reduction-nonpoint-source-and-recreational-use/
Louisiana Universities Marine Consortium (LUMCON)	LUMCON was formed in 1979 to coordinate and stimulate Louisiana's activities in marine research and education. LUMCON provides coastal laboratory facilities to Louisiana universities, and conducts in-house research and educational programs in the marine sciences. Monitoring and research on the Gulf of Mexico seasonal hypoxic zone is led by LUMCON and funded by NOAA (USEPA has also provided funding in previous years).	http://www.lumcon.edu/
Louisiana Water Synergy Project, U.S. Business Council of Sustainable Development	The Water Synergy Project creates an industry forum for regional collaboration to address water quality, quantity, and storm water challenges in southern Louisiana, with a focus on the New Orleans to Baton Rouge Mississippi River Corridor. In this structured forum, business leaders from multiple industries will work together to identify water management issues, identify solutions that work, and implement.	http://usbcsd.org/water

Stakeholder Group	Description	Web Resource
Louisiana Watershed Initiative	In May 2018, Louisiana state Gov. Edwards issued an executive order establishing the Council on Watershed Management to develop and implement a statewide floodplain management program based on watersheds as opposed to political and jurisdictional boundaries, which water does not recognize. The Council was charged with empowering local jurisdictions and communities to implement regional, long-term solutions that follow watershed boundaries to better reduce flood risk in Louisiana communities. The Louisiana Watershed Initiative serves as the program through which floodplain management responsibilities are coordinated across federal, state and local agencies, supported by experts who serve as advisors in building a foundation of data, projects, policies, standards and guidance.	https://watershed.la.gov/
Lower Mississippi River Conservation Committee (LMRCC)	The LMRCC is a coalition of 12 state natural resource conservation and environmental quality agencies in Arkansas, Kentucky, Louisiana, Mississippi, Missouri and Tennessee. It provides the only regional forum dedicated to conserving the natural resources of the Mississippi River's floodplain and focuses on habitat restoration, long-term conservation planning and nature-based economic development.	http://www.lmrcc.org/

Stakeholder Group	Description	Web Resource
Lower Mississippi River Sub-basin Committee (LMRSBC)	The LMRSBC is composed of representatives from of five states including Arkansas, Louisiana, Mississippi, Missouri, and Tennessee. Key to the mission of the LMRSBC are 1) support and coordinated implementation of the Gulf Hypoxia Action Plan, and 2) compiling nutrient loading information and assessing impacts of current programs, coordinating interstate watershed programs, promoting and coordinating regional programs, and establishing open process for stakeholder engagement.	https://www.facebook.com/pages/category/Agricultural-Cooperative/Lower-Mississippi-River-Sub-basin-Committee-on-Gulf-Hyxpoxia-1729071427312143/
McKnight Foundation	This Minnesota-based family foundation, seeks to improve the quality of life for present and future generations. The Mississippi River Program goal is to use resources to restore the water quality and resilience of the Mississippi River and strategies include: restoring and protecting floodplains and wetlands; reducing agricultural pollution in four states along the northern half of the river (Minnesota, Wisconsin, Iowa, and Illinois); focusing on farmland and operations with high levels of nitrogen and phosphorus runoff; and in the 10-state Mississippi River corridor, achieving cross-boundary and interagency coordination (among government agencies) that improves the river's water quality and resilience.	https://www.mcknight.org/programs/mississippi-river/
Migratory Bird Habitat Initiative (MBHI), USDA NRCS	Through the MBHI, NRCS will work with farmers, ranchers and other landowners to manage portions of their land to enhance habitat for migrating birds. Participating states are: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, and Texas. Eligible areas for FY 2012 MBHI include portions of 22 parishes across southern Louisiana. Funding will be provided through the Environmental Quality Incentives Program and will be used for protecting, restoring, and enhancing migratory bird habitat.	https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=steldevb1027669

Stakeholder Group	Description	Web Resource
Mississippi River Basin Healthy Watershed Initiative (MRBI), USDA NRCS	Through the MRBI, NRCS and partners work with producers and landowners to implement voluntary conservation practices that improve water quality, restore wetlands, enhance wildlife habitat and sustain agricultural profitability in the Mississippi River Basin. NRCS has identified the Mississippi River Basin as a top priority due to water quality concerns, primarily related to the effects of nutrient loading on the health of local water bodies and, eventually, the Gulf of Mexico. The 13-state Initiative builds on the cooperative work of NRCS and its conservation partners in the basin, and offers agricultural producers in priority watersheds the opportunity for voluntary technical and financial assistance. The participating States are Arkansas, Kentucky, Illinois, Indiana, Iowa, Louisiana, Minnesota, Mississippi, Missouri, Ohio, South Dakota, Tennessee and Wisconsin.	https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=stelprdb1048200
Mississippi River Cities and Towns Initiative (MRCTI)	The MRCTI was created by the Northeast-Midwest Institute (NEMWI) through a grant from the Walton Foundation. The goal of the MRCTI is to create a new and influential voice for the Mississippi River and to demand effective river protection, restoration, and management in Washington, D.C. MRCTI is a local government-lead effort empowering the ten states and over one hundred cities that border the Mississippi River to act for its continued prosperity, sustainability, and economic growth. There are 124 Mississippi River main stem cities and towns. These riparian population centers are soundly River-centric. MRCTI gives a common voice to those who depend most upon the River, and by virtue of doing so, spans political and economic interests.	https://www.mrcti.org/

Stakeholder Group	Description	Web Resource
Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Hypoxia Task Force)	The Hypoxia Task Force consists of 5 federal agencies, 12 states and the tribes within the Mississippi-Atchafalaya River Basin (MARB). The Task Force was established in 1997 to reduce and control hypoxia in the Gulf of Mexico.	http://water.epa.gov/type/watersheds/named/msbasin/index.cfm
National Water Quality Initiative (NWQI), USDA NRCS	The NWQI will work in priority watersheds to help farmers, ranchers and forest landowners improve water quality and aquatic habitats in impaired streams. NRCS will help producers implement conservation and management practices through a systems approach to control and trap nutrient and manure runoff. Qualified producers will receive assistance for installing conservation practices such as cover crops, filter strips and terraces.	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=stelprdb1047761
Office of Soil & Water Conservation (OSWC), LDAF	The Office of Soil & Water Conservation provides financial assistance, administrative support, centralized direction and coordination to Louisiana's 44 Soil & Water Conservation Districts (SWCDs) which provide conservation planning services to landowners within their individual districts. SWCDs are local units of state government with capabilities very unique to any other form of state or local government, due mainly to their capability of entering private property at the request of landowners to plan and/or construct various conservation systems. Each of Louisiana's 44 SWCDs are assisted by the USDA NRCS.	http://www.ldaf.state.la.us/conservation/
Resource Conservation & Development (RC&D), USDA	There are seven RCDs located within Louisiana: Acadiana, Bayou Land, Capitol, Imperial Calcasieu, Northeast Delta, Trailblazer, and Twin Valley. These RCDs work on implementation of watershed level plans to improve and restore water quality.	https://www.nrcs.usda.gov/wps/portal/nrcs/detail/la/people/partners/?cid=nrcs141p2_015725

Stakeholder Group	Description	Web Resource
Source Water Protection Program (SWPP), LDEQ	LDEQ manages the SWPP to protect the state's ground water aquifers and surface waters utilized as drinking water supplies. The SWPP builds upon the Source Water Assessment Program (SWAP) that was completed by LDEQ in 2003 that determined the susceptibility of public water supplies to contamination after assessing nearby type, number and location of potential sources of contamination and hydrogeologic sensitivity factors.	
Southeast Aquatic Resources Partnership (SARP)	SARP is a regional collaboration of natural resource and science agencies, conservation organizations and private interests developed to strengthen the management and conservation of aquatic resources in the southeastern U.S.	https://southeastaquatics.net/
The Conservation Fund	This program boasts over 200,000 acres saved in the state of Louisiana. Selected projects in Louisiana include the Upper Ouachita National Wildlife Refuge, Maurepas Swamp Wildlife Management Area, and the Joyce Wildlife Management Area. In 2017, a $500,000 grant was awarded to match federal dollars to permanently protect a portion of Live Oak Farm, which has provided valuable agricultural and ecological resources for the community and native wildlife for the past century.	http://www.conservationfund.org/
The Nature Conservancy (TNC), Louisiana	Within the state of Louisiana, TNC has protected nearly 300,000 acres of crucial habitats for people and nature. TNC has helped create or significantly expand 9 State Wildlife Management Areas, 13 National Wildlife Refuges, and 2 State Conservation Areas.	http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/louisiana/index.htm
U.S. Environmental Protection Agency (USEPA)	The USEPA is the federal agency responsible for protecting and improving water quality. USEPA provides programs related to both nonpoint and point source management activities.	http://water.epa.gov/

Stakeholder Group	Description	Web Resource
U.S. EPA Recovery Potential Screening (RPS) Tool	Restoring the nation's tens of thousands of impaired waters is an immense challenge. No single restoration program, public or private, has the resources to work on all impaired waters at once. The RPS website offers a flexible framework of methods, technical information, instructional examples and tools that can be tailored to any watershed program or purpose in any geographic locality. This website provides a 'one-stop shop' for technical assistance in using RPS. Its major components include a step-by-step methodology, access to downloadable tools, reference materials on watershed indicators and user training and support. The multi-step RPS Methodology is described at a clear and basic level but also supported by hyperlinks to more complex technical tools, documents and training resources throughout the website.	https://www.epa.gov/rps
U.S. Fish and Wildlife Service (USFWS)	The USFWS is active in environmental projects within the state of Louisiana and the Mississippi-Atchafalaya River Basin that can impact water quality of the state's waters. The USFWS recently released a vision document for the GOM (USFWS 2013) which addresses focal areas of the Mississippi River Delta, Coastal Wetlands and Barrier Islands; Mississippi River Alluvial Valley; and Atchafalaya River Basin in Louisiana for gulf restoration priorities.	http://www.fws.gov/
USGS National Water-Quality Assessment (NAWQA) Program, USGS	The USGS NAWQA program provides information that can help managers tailor protection strategies to fit a given need, providing high quality water while minimizing costs. Examples of two significant projects driven by the NAWQA program include the Nutrients National Synthesis and the SPARROW model.	https://www.usgs.gov/mission-areas/water-resources/science/national-water-quality-assessment-nawqa?qt-science_center_objects=0#qt-science_center_objects
Water Environment Research Federation (WERF)	WERF, formed in 1989, is an independent scientific research organization dedicated to wastewater and storm water issues.	http://www.werf.org/

Stakeholder Group	Description	Web Resource
Walton Family Foundation (WFF)	The WFF focuses on protecting oceans and rivers and the livelihoods they support, for the benefit of people and the environment. Focus for the 2020 Environment Strategic Plan includes the Mississippi River and Coastal Gulf of Mexico (with emphasis on supporting oil spill recovery projects). In 2018, a total $90.3 billion in environmental grants were awarded, with over $25 billion focusing on the Mississippi River and coastal areas (worldwide). Nearly $3 million dollars were earmarked specifically for water quality improvements in the Mississippi River Basin for 2018.	http://www.waltonfamilyfoundation.org/

APPENDIX D: REFERENCES

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