Louisiana Adaptive Management Status and Improvement Report: Vision and Recommendations

March 2020

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Acknowledgements

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The Louisiana Adaptive Management Status and Improvement Report: Vision and Recommendations builds on a series of previous efforts towards programmatic and project coastal ecosystem restoration adaptive management in the state of Louisiana ("Appendix F Implementation and Adaptive Management," 2012, p. 1; Hijuelos & Reed, 2017; Raynie, 2017; Raynie & Visser, 2002; Steyer et al., 2004; Steyer & Llewellyn, 2000)**.**

DETAILS OF DOCUMENTS

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Executive Summary

BACKGROUND TO REPORT

As part of the process to increase implementation of adaptive management for ecosystem-based coastal restoration within Louisiana, we aim for this report to be broadly applicable across planning processes as well as funding and implementing entities. It compiles technical knowledge and guidance summarized as key findings through the text which lead to eight priority recommendations to improve application of adaptive management in Louisiana. This report identifies critical linkage points and opportunities for knowledge and data transfers within, and among, agencies in Louisiana. The primary focus is on CPRA and others affiliated with the LA TIG.

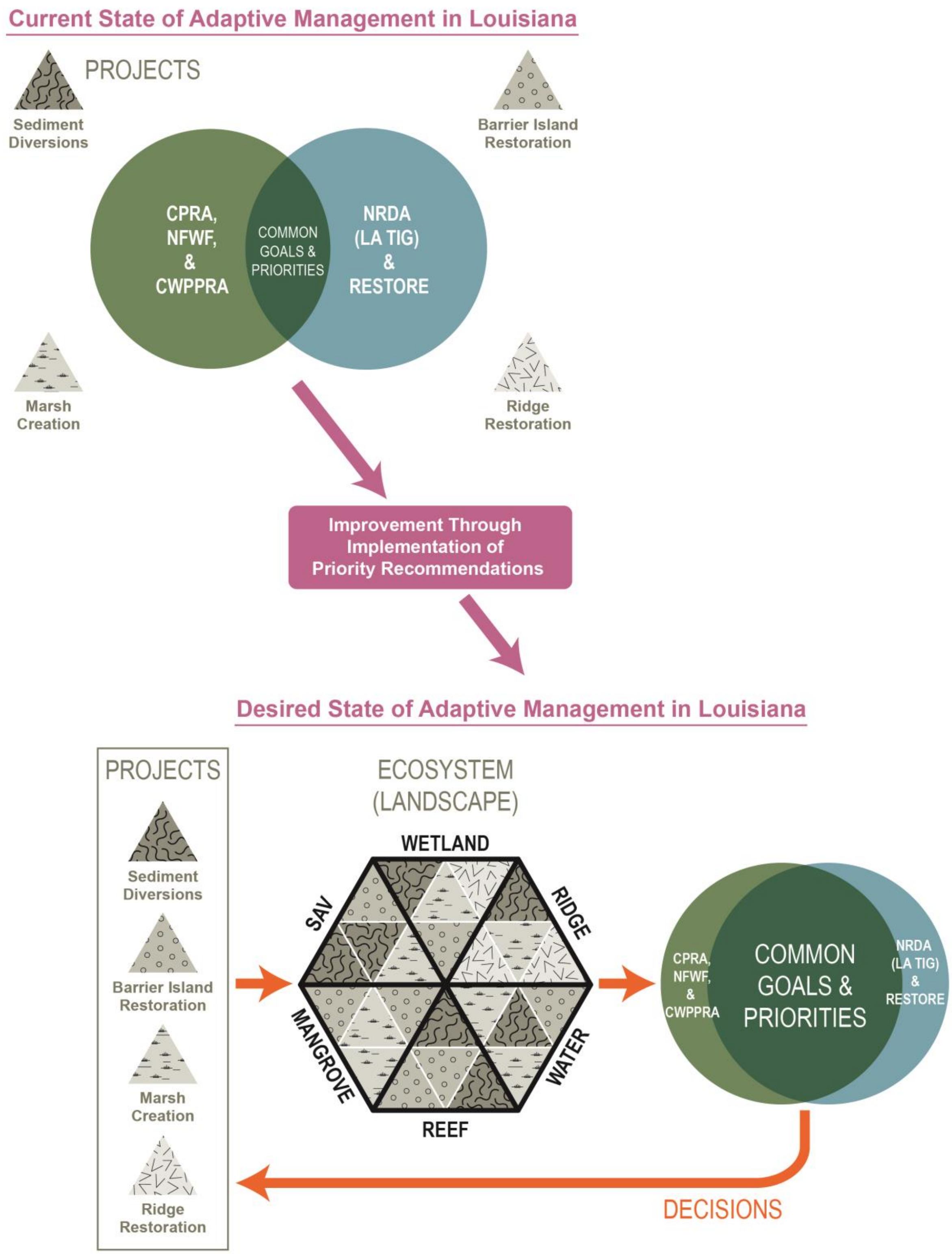
This report presents a consensus based common vision for adaptive management of coastal restoration implementation in Louisiana. As CPRA is the primary agency responsible for coordinating and facilitating coastal restoration projects within the state of Louisiana, the primary source of information and experience was collated from personnel and processes carried out at CPRA. To capture needs and mechanisms across agencies, extensive input was also received from the LA TIG, representing the other state and federal Trustees.

CURRENT STATE OF ADAPTIVE MANAGEMENT IN LOUISINA

Louisiana has a long history of coastal management and restoration actions with multiple projects implementing common approaches. CPRA has practiced informal adaptive management as key personnel pass on accumulated wisdom and lessons learned. There is currently an increased need for large-scale restoration, due to ongoing land loss and to restore for injuries associated with the DWH spill. Thus there is increased incentive to develelop processes that formalize common learning to improve decision making. Restoration efforts have been ongoing in Louisiana by state and federal agencies through CWPPRA and are now expanded through funding and implementing entities such as the RESTORE Council, NRDA through the LA TIG, and NFWF. In this report we present an adaptive management vision for restoration funding entities and recommend priority actions to improve and formalize current adaptive management processes in coastal Louisiana.

A VISION FOR IMPROVED ADAPTIVE MANAGEMENT IN LOUISIANA

Before the restoration funding entities associated with DWH settlements, the majority of funding for coastal restoration in Louisiana came through CWPPRA. The desired state of adaptive management is to maximize synergies and opportunities for efficiency across implementing entities. This synergy can be realized through increased commonality of goals and objectives, recognizing that there will always be some goals that are agency or funding source specific. Considering a broader ecosystem or landscape context for implemented restoration projects can provide a framework for emphasizing commonality of restoration goals. Such a framework allows for multiple benefits of restoration efforts to be quantified, including prioritized natural resources, ultimately assessing the effectiveness of large-scale restoration efforts in coastal Louisiana. The recommendations we developed here provide a road map towards the desired state of governance for adaptive management in coastal Louisiana.



A vision for adaptive management implementation in coastal Louisiana

PURPOSE OF THIS DOCUMENT

We present a roadmap of eight recommended priority actions to improve adaptive management implementation for coastal restoration efforts in Louisiana. Each action includes first order cost estimates and indicative time to complete. Each recommendation includes multiple potential tasks, all are scalable and can be phased over time. Some include setting up processes that would need ongoing effort and financial support. We developed the recommendations through discussions at an initial three-day workshop in May 2018 in Baton Rouge, Louisiana, with more than 60 participants from six state and federal agencies. This was followed by more than 100 in-person meetings and webinars. Fifty-eight authors developed a technical document on the background, current adaptive management approaches, and future adaptive management needs for Louisiana. More than 50 key findings were identified and then distilled down to eight priority recommendations. The recommendations are presented in priority groups, recommendations 1-5 are very high priority, recommendations 6-8 are high priority. Those recommendations identified as moderate or low priority were not fully developed and are not included in this document.

SUMMARY OF RECOMMENDATIONS

VERY HIGH PRIORITY

- **1.0 Coordination:** Fund and establish dedicated additional adaptive management capacity, including but not limited to, funding an LA adaptive management coordinator
- **2.0 Data Management:** Develop a "lessons learned database" in addition to interoperability of CIMS and DIVER to facilitate transfer and synergies, while minimizing duplication of data access and utilization for restoration management, planning, and decision making
- **3.0 Ecosystem Reporting:** Cross disciplinary coastal ecosystem condition reporting (physical, ecological, social)
- **4.0 Restoration Goals:** Identify commonalities of restoration goals across implementing entities to maximize co-benefits of restoration
- **5.0 Common Processes:** Operationalize electronic handbook for implementation of adaptive management in Louisiana

- **HIGH PRIORITY**
- **6.0 Communication:** Develop science communication approaches that increase effectiveness of information dissemination to communities (outreach) and within agencies (inreach) to maximize information delivery to support adaptive management of coastal restoration
- **7.0 Modeling:** Develop common repository and clearinghouse for numerical models and tools
- **8.0 Stakeholder Engagement:** Establish standard operating procedures for stakeholder engagement, specifically including active and two-way mechanisms to ensure feedback and engagement throughout restoration planning, implementation, and operation

1.0 Background to Adaptive Management

Aim:

To provide relevant background and context to understand the information, descriptions, and recommendations within the "Louisiana Adaptive Management Status and Improvement Report: Vision and Recommendations"

INTRODUCTION TO ADAPTIVE MANAGEMENT IN LOUISIANA

A major goal of the 'Louisiana Adaptive Management Status and Improvement Report: Vision and Recommendations' is to identify synergies and coordination opportunities across entities currently implementing restoration in coastal Louisiana. In addition, the aim of this report is to summarize key needs for improving adaptive management implementation and develop priority recommendations on how to meet those needs. For nearly three decades the largest single mechanism for funding and implementing restoration projects in Louisiana has been through CWPPRA which has driven the development of many of the procedures and processes currently utilized by CPRA in implementing restoration projects (CWPPRA, 2014). Over the next 15 years, the largest source of restoration funding is expected to be through DWH settlement entities. In particular, the funds through NRDA which are managed through the LA TIG and funding provided to the state of Louisiana and Louisiana parishes through the RESTORE Act.

Natural resources of coastal Louisiana support communities and the economy of Louisiana and the whole of the United States. However, future conditions of coastal Louisiana are highly uncertain due to the dynamic processes of the Mississippi River delta, unpredictable storm events, subsidence, sea level rise, and increasing temperatures. Extensive human interventions intended to protect communities and infrastructure have additionally altered or ceased natural processes. Managing such a complex system is inherently difficult as the natural and socio-economic systems are highly integrated and there is a high degree of uncertainty in future condition. Adaptive management in deltaic environments encourages an integrated and flexible approach to land and water management that considers risk and uncertainty. It promotes solutions that are sustainable under changing, or unknown, conditions by providing a science based and structured process for making decisions and programmatic or project adjustments. Connecting short-term investments with long-term changes and the selection of actions that allow for maximum flexibility of future decisions are two of the key concepts of "Adaptive Delta Management" (Delta Alliance, 2014). Historically, as human developments increased in the Mississippi delta, decisions were made that could not be easily changed (such as the location of New Orleans, or constructing training levees on the Mississippi River, both of which have resulted in long-term consequences (Khalil & Raynie, 2015). This resulted in some "path dependency," meaning that future options were limited or constrained by past decisions. However, learning from past decisions and understanding resultant limitations to the range of possible future options can minimize future constraints by using "adaptation pathways" to make decisions that allow for maximum future flexibility (Delta Alliance, 2014; Haasnoot, 2013). Successful adaptive management is iterative, allowing for the incorporation of new knowledge through every step of the process (Institute, 2013).

BACKGROUND TO REPORT

As part of the process to develop an implementation plan for adaptive management of ecosystem-based coastal restoration within Louisiana, this report aims to be broadly applicable across planning processes, funding entities, and implementing agencies or organizations. It aims to compile technical knowledge and guidance for the development of priority recommendations to improve application of adaptive management in Louisiana. It identifies critical linkage points and opportunities for knowledge and data transfers within, and among, agencies within Louisiana, primarily focusing on CPRA and others affiliated with the LA TIG.

This report includes a consensus based common vision for adaptive management of coastal restoration implementation in Louisiana. As CPRA is the primary agency responsible for coordinating and facilitating coastal restoration projects within the state of Louisiana, the primary source of information and experience was collated from personnel and processes carried out at CPRA. Additionally, to capture needs and mechanisms across agencies, extensive input was also received from the other LA TIG state and federal Trustees.

IMPORTANCE OF ADAPTIVE MANAGEMENT TO LARGE-SCALE ECOSYSTEMS

Environmental systems are inherently complex and non-linear, and consequently, predicting the success of restoration projects is an inexact science (National Research Council & Academy of Sciences, 1992). Therefore, decision making to reduce impacts relies on available knowledge about the state of the ecosystem and the prognosis for further development, both of which have a degree of uncertainty (Thom, 2000). Adaptive management relies on the accumulation of evidence to support decisions that demand action (Walters & Holling, 1990). It also relies on maintained flexibility, allowing for management adjustments to changing conditions or based upon increased knowledge. For adaptive management to be successful, it is critical to have a defined framework and specified actions. This clarity ensures feedback of information among all aspects of coastal restoration implementation. Adaptive management is an active process to capture and communicate institutional knowledge. It can improve understanding of the system and assist management actions to best achieve restoration goals. All phases of restoration management must be coordinated and share information, not only to maximize the benefits on a project-by-project basis, but also to carry the information learned from past projects into the development of future projects and programmatic success (Raynie & Visser, 2002). A high level of institutional commitment is needed to successfully incorporate adaptive management into ongoing programmatic coastal ecosystem restoration efforts.

DEFINITION OF ADAPTIVE MANAGEMENT

The following high-level statement defines adaptive management, as used in this report. It applies to both programmatic and project adaptive management, although each is dealt with separately in detail throughout the report:

Adaptive management: A systematic process to incorporate new and existing knowledge into management decisions (Williams et al., 2009). It is a learning based, iterative process to improve management decisions, and actions, based on increasing understanding and feedback between this learning and subsequent decision making (Williams, 2011).

- ***Structured process for making decisions*** over time through active learning
- ***Enables programmatic and project adjustments*** based on new information
- ***A science-based approach*** including
  - Identification of explicit goals and objectives
  - Management action planning and implementation
  - Assessment of ecosystem response to implemented actions
  - Use of best available science for all stages of decision making

The information in part one is divided into the following two sections:

1.1 Governance Context for Adaptive Management in Louisiana

Describes the key federal, state, and local partners that play a role in the funding, management, and implementation of coastal restoration in Louisiana

1.2 Adaptive Management Process

Describes the ten steps of adaptive management as applied to coastal restoration in Louisiana, as well as the essential elements of the knowledge base that supports adaptive management coordination.

1.1. Governance Context for Adaptive Management in Louisiana

1.1.1. Governance Structures in Louisiana

Implementation of coastal restoration involves a large number of individuals and entities in a complex governance framework (Table 1). Decision making authority for different aspects of a restoration project resides across the entire governance spectrum. This includes individual landowners, the federal government, and every level of local and state government in between. Non-governmental organizations, private consultants, research institutions including universities, and local or regional management entities also provide important input to restoration implementation. In some instances, these additional entities have decision making authority for project operations. (For reference, note list of acronyms on p 174)

The four main current restoration entities (RESTORE, NRDA, CWPPRA, GEBF) report to slightly different subsets of state and federal agencies (Figure 1). These crossover points in governance are important to identify synergies and opportunities, as well as potential conflicts, for implementing adaptive management across restoration efforts in coastal Louisiana. CPRA also plays a central role in coordinating, facilitating, and implementing coastal restoration in Louisiana. Opportunities for increased linkage between these mechanisms are discussed in Section 1.1.4. It is important to note that none of the governance structures described have responsibilities over the entirety of the coastal restoration efforts in Louisiana (Figure 1). Even CPRA Board's responsibilities, although the most comprehensive among the structures listed, is not universal. Part of the Treasury-administered Direct Component of the Gulf Coast Ecosystem Restoration Fund ('Bucket 1') is managed directly by the U.S. Department of the Treasury and the coastal parishes (Figure 2).

Table 1. Roles and responsibilities of the entities engaged with ecosystem restoration in Louisiana

Type	Organization	Funder	Coordinator	Planning	Design	Permitting	Construction	Monitoring		Applied Research	Land Owner
								Project	*Ecosystem*		
Government Agencies or Mechanisms	**NRDA (LA TIG)**	X	X	X	X	X	X	X	X	X	
	CWPPRA	X	X	X	X		X	X	X	X	
	USACE	X		X	X	X	X	X	X	X	
	DEQ/DNR					X					
	CPRA	X		X	X		X	X	X	X	
	NOAA	X	X	X	X	X	X	X	X	X	
	USEPA	X				X				X	
	USDOA	X									
	DOI	X	X	X	X	X	X	X	X	X	X
	NRCS	X								X	
	RESTORE Council	X	X								
	NFWF	X	X								
	LDWF		X			X			X	X	X
	Parish Governments	X		X	X	X	X				
NGO	**DU**			X	X		X	X	X	X	X
	CCA			X	X		X	X	X	X	
	CRCL		X					X		X	
	TNC			X	X		X	X	X	X	X
	Audubon							X	X	X	X
	EDF			X						X	
	R the EF	X					X			X	
Large Land Owner	**Conoco**			X							X
	APACHE			X							X
	Miami Corp.			X							X
	Continental Land and Fur			X							X
	School Boards										X
	Catholic Parish										X
	Vermillion Corp.			X							X
Other	**Consultants**			X	X		X	X	X		
	BTNEP		X							X	
	LPBF		X							X	
	Universities								X	X	

Note: list of acronyms on p 174

The key groups that inform programmatic decisions at some level include the following:

State of Louisiana

CPRA Board: CPRA's board serves as the single state entity with authority to articulate a clear statement of priorities and to focus development and implementation efforts to achieve comprehensive coastal protection and restoration for Louisiana. The CPRA board works closely with other entities on coastal issues, including the state legislature, the Governor's Advisory Commission on Coastal Protection, Restoration and Conservation, among many others. The board represents the state's position in policy relative to the protection, conservation, enhancement, and restoration of the coastal area of the state. It oversees the Coastal Protection and Restoration Trust Fund and approves the Coastal Master Plan and fiscal year annual plans for protecting, conserving, enhancing, and restoring the coastal area through the construction and management of integrated restoration effort. The board is also charged with enforcing compliance with the Coastal Master Plan. The board is chaired by the Governor's Executive Assistant for Coastal Activities. Board members represent state agencies, local governments, local levee authorities, state and local government officials, and the Chair of the Governor's Advisory Commission on Coastal Protection, Restoration and Conservation.

Deepwater Horizon Natural Resource Damange Assessment (NRDA)

Deepwater Horizon Trustee Council (Total $8.8 billion) (section 7.2.2; DWH NRDA, 2016): The Trustee Council is a collaborative body comprised of a designated Natural Resource Trustee Official from each DWH Trustee (specific state agencies from all five Gulf States, NOAA on behalf of the Department of Commerce, Department of the Interior, Department of Agriculture, Environmental Protection Agency). The DWH Trustees are the government entities authorized under the OPA to act on behalf of the public to: 1) assess the natural resource injuries resulting from the 2010 DWH oil spill, and then 2) plan and implement restoration to compensate the public for those injuries. The Trustee Council has responsibilities related to administration, finance, restoration planning and implementation, monitoring and adaptive management, data management and reporting, and public affairs and outreach. Trustees fulfill these responsibilities by developing restoration plans, providing the public with a meaningful opportunity to suggest restoration projects and to review and comment on proposed plans, implementing and monitoring restoration projects, managing natural resource damage funds, and documenting trustee decisions through a public administrative record.

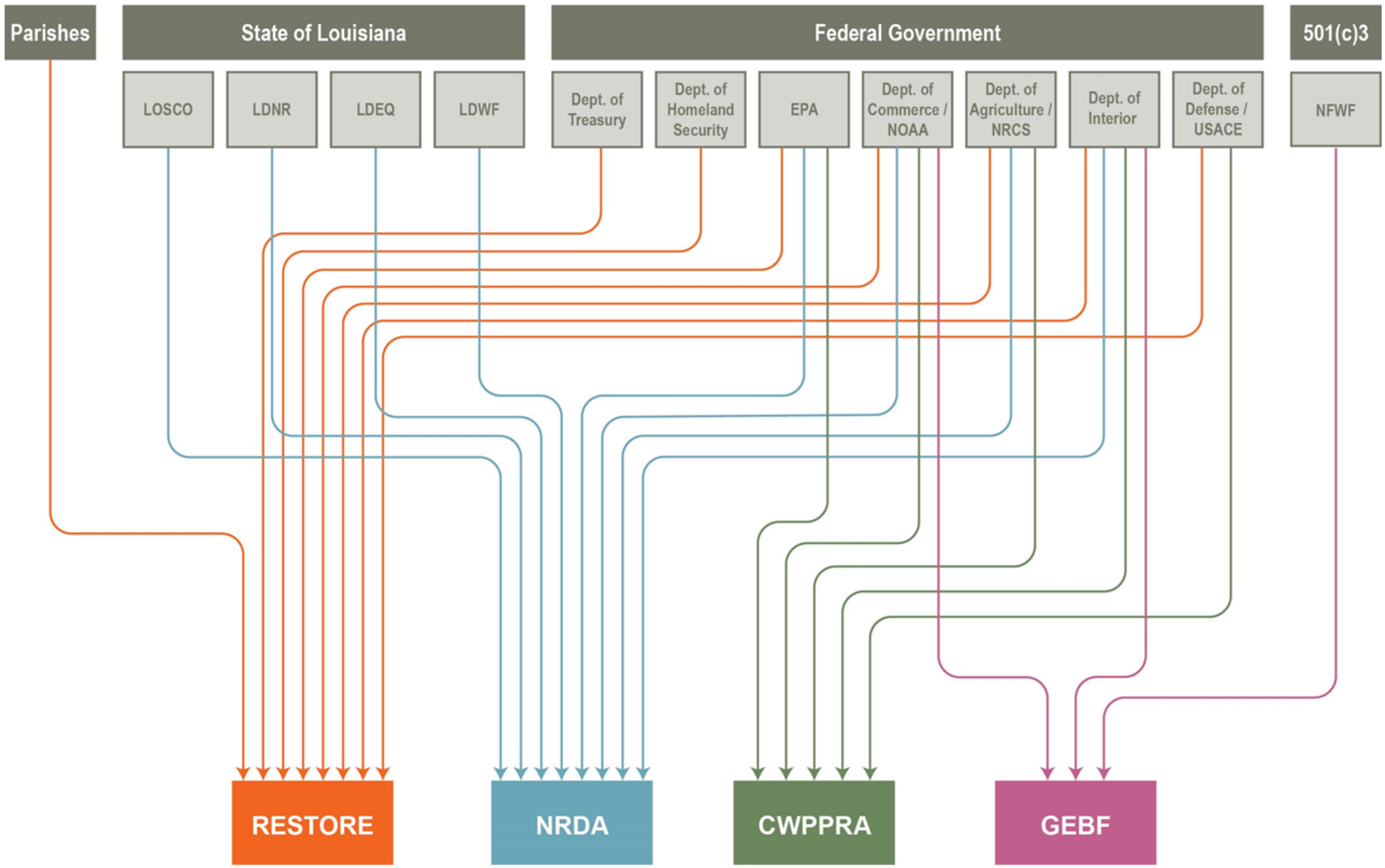


Figure 1. Illustration of institutional responsibilities related to the key governance structures listed above. Note that CPRA is engaged with all these mechanisms and the illustrated responsibility pathways are for programmatic governance only and do not reflect implementation, regulatory, or other programmatic roles. LOSCO – LA Oil Spill Coordinator's Office, LDNR – LA Department of Natural Resources, LDEQ-LA Department of Environmental Quality, LDWF-LA Department of Wildlife and Fisheries, NRCS-Natural Resources Conservation Service

Louisiana Trustee Implementation Group (TIG) (LA Restoration Area $5 billion) (DWH NRDA, 2016): The LA TIG is one of eight Trustee Implementation Groups established under the Deepwater Horizon Trustee Council, each one serving as the governing body for a Restoration Area defined in the Consent Decree (84 FR 34888, FRL-9996-65-OW) (one for each Gulf State and one each for the Regionwide, the Open Ocean, and the Adaptive Management and Unknown Conditions restoration areas – see section 1.4.2). TIGs are composed of individual DWH Trustee agency representatives; TIG members work together to accomplish TIG activities, including interacting with the public and stakeholders and planning for, selecting, and implementing specific restoration actions under the PDARP/PEIS. TIG decisions are made by consensus. Each TIG makes all restoration decisions for the funding allocated to its Restoration Area, and ensures its actions are fully consistent with OPA requirements, Programmatic Damage Assessment and Restoration Plan (PDARP) and Programmatic Environmental Impact Statement (PEIS), Consent Decree, and Trustee Council Standard Operation Procedures (SOPs).

RESTORE

U.S. Department of Treasury: (Taken from https://www.treasury.gov) - The Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012 (RESTORE Act) established a new trust fund in the Treasury of the United States, known as the Gulf Coast Restoration Trust Fund. The RESTORE Act divides DWH civil penalties into five categories, or “buckets” (Figure 2). The Treasury-administered Direct Component – Bucket 1 – makes 35 percent of the civil penalties deposited into the Trust Fund available to five Gulf Coast states, including portions of the Florida and Louisiana allocations to 23 Florida counties and 20 Louisiana parishes (Treasury has a specific list of eligible counties and parishes), respectively (http://eli-ocean.org/wp-content/blogs.dir/2/files/Restore-Presentation.pdf). As provided in the RESTORE Act and final rule, activities, programs, and projects that are eligible for grants awarded under the Direct Component (eligible activities) include: Restoration and protection of the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches and coastal wetlands of the Gulf Coast Region; mitigation of damage to fish, wildlife and natural resources; implementation of a Federally-approved marine, coastal, or comprehensive conservation management plan, including fisheries monitoring; workforce development and job creation; improvements to or on state parks located in coastal areas affected by the DWH oil spill; infrastructure projects benefitting the economy or ecological resources, including port infrastructure; coastal flood protection and related infrastructure; planning assistance; promotion of tourism in the Gulf Coast Region, including promotion of recreational fishing; and promotion of the consumption of seafood harvested from the Gulf Coast Region.

RESTORE Council (LA $553 million of Spill Impact component + LA allocation of $1.6 billion Restoration component) (GCERC, 2016): (Taken from https://restorethegulf.gov/) - The RESTORE Act established the Gulf Coast Ecosystem Restoration Council (Council). The Council includes the Governors of the States of Alabama, Florida, Louisiana, Mississippi, and Texas, the Secretaries of the U.S. departments of Agriculture, the Army, Commerce, Homeland Security, and the Interior, and the Administrator of the U.S. Environmental Protection Agency. One of the primary responsibilities of the Council is to develop and implement a comprehensive plan to restore the ecosystem and economy of the Gulf Coast region (Comprehensive Plan Component – Bucket 2) (Figure 2). The Council approved an Initial Comprehensive Plan in

August 2013 and an Updated Comprehensive Plan in November 2016 that outline the overarching goals and objectives for restoration; and are used as guidance for the Council to submit a list of projects and programs to be prioritized for funding under "Funded Priorities Lists." The RESTORE Council also oversees the Spill Impact Component – Bucket 3 – which requires a State Expenditure Plan that also describes the types of activities eligible for funding (Figure 2). Some of those activities include: Restoration and protection of natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches and coastal wetlands; mitigation of damage to fish, wildlife and natural resources; implementation of a federally-approved marine, coastal, or comprehensive conservation management plan; workforce development; improvements to or on state parks; infrastructure projects benefitting the economy or ecosystem resources; coastal flood protection and related infrastructure; and planning assistance.

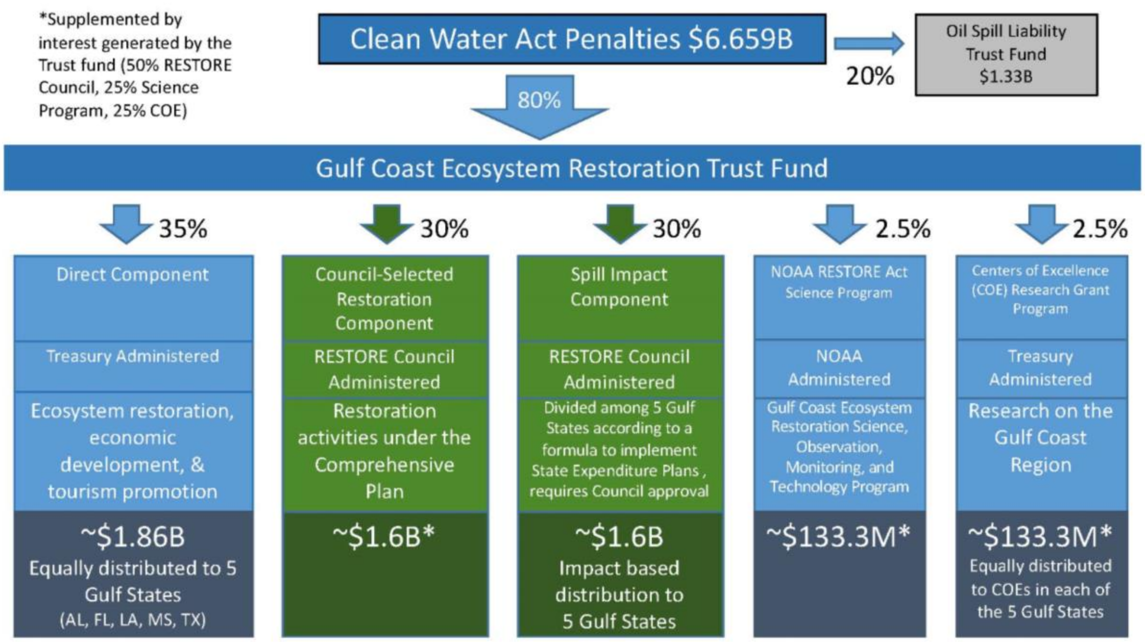


Figure 2. Allocation of the Gulf Coast Restoration Trust Fund based on settlements with BP, Transocean, and Anadarko (RESTORETHEGULF.GOV)

CWPPRA

Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Task Force (LA $30 - $80 million per annum) (lacoast.gov): (Taken from CWPPRA (2014)) - The CWPPRA Task Force was created in 1990 as the first interagency, state/federal partnership to create, restore, enhance and protect coastal vegetated wetlands. The task force is comprised of one member each, respectively, from five federal agencies and the State of Louisiana. The federal agencies of CWPPRA include the USFWS of the Department of the Interior, the NRCS of the USDA, the NMFS of the USDOC, the EPA, and the USACE. The Governor's Office of the State of Louisiana represents the state on the task force. The task force provides guidance and direction to subordinate organizations of the program through the technical council, which reports to the task force. The task force is authorized by CWPPRA to make final decisions concerning issues, policies, and procedures necessary to execute the program and its projects. The task force makes directives for action to the task force, and the task force makes decisions in consideration of the technical council recommendations. The District Commander of the USACE, New Orleans District, is the chairman of the task force. The task force chairman leads the task force and sets the agenda for action of the task force to execute the program and projects. At the direction of the chairman of the task force, the New Orleans District: (1) provides administration management, oversight of the Planning and Construction programs, and acts as accountant, budgeter, administrator, and disburser of all federal and non-federal funds under CWPPRA, (2) acts as the official manager of financial data and most information relating to the CWPRPA program and projects. The State of Louisiana is a full voting member of the TF except for selection of the PPL [Section 303(a)(2) of the CWPPRA], as stipulated in President Bush's November 29, 1990 signing statement of the CWPPRA. In addition, the State of Louisiana may not serve as a lead task force member for design and construction of wetland projects on a PPL.

- CWPPRA Technical Committee: (Taken from CWPPRA (2014)) - The technical committee is established by the task force to provide advice and recommendations for execution of the program and projects from a number of technical perspectives, which include engineering, environmental, economic, real estate, construction, operation and maintenance, and monitoring. The P&E is the working level committee established by the technical committee to form and oversee special technical workgroups to assist in developing policies and processes and recommend procedures for formulating plans and projects to accomplish the goals and mandates of CWPPRA. The seat of the chairman of the P&E currently resides with USACE, New Orleans District. The P&E chairman leads the P&E and sets the agenda for action of the P&E to make recommendations to the technical committee for executing the program and projects. At the direction of the chairman of the technical committee, the chairman of the P&E executes the program.

Gulf Environmental Benefit Fund

NFWF Board of Directors (Gulfwide $2.544 billion; LA $1.272 billion over 5 years for barrier island and river diversion projects): (Taken/modified from https://www.nfwf.org/gulf/Pages/home.aspx) - The NFWF GEBF arose from the settlement of criminal charges related to the DWH oil spill and funds projects benefiting the natural resources of the Gulf Coast that were impacted by the spill. In Louisiana, projects focus on actions to restore barrier islands and implement river diversions. The NFWF Board of Directors has the responsibility to administer the funds and works with each of the states to identify projects to remedy harm and reduce the risk of future harm to natural resources affected by the oil spill. NFWF, on an annual basis, consults with the Louisiana CPRA, USFWS and NOAA to identify priority projects for future consideration under the GEBF.

1.1.2. Restoration Governance Within the LA TIG

The LA TIG comprises five Louisiana state trustee agencies and four federal trustee agencies: CPRA (the lead trustee for the state of Louisiana), LDNR; LDEQ; LOSCO; LDWF; DOC, represented by NOAA; DOI, represented by USFWS and NPS; USDA; and EPA. Decision-making functions on a consensus basis, but in the case of disputes, the state has one vote and the four federal members have one vote for TIG decisions.

LA TIG has the following responsibilities:

- Administration (e.g., document decisions and submit to the Administrative Record);
- Finance (e.g., oversee general management of TIG funds);
- Restoration planning and implementation;
- Monitoring and adaptive management (e.g., identify MAM priorities for the TIG's Restoration Area);
- Data management and reporting; and
- Public affairs and outreach.

The LA TIG establishes small working groups when a particular topic requires in-depth review or development. Small working groups may focus on a particular geographic area (e.g., all projects within Barataria Basin) or may collaborate to develop specific portions of a restoration plan. Examples include aquatic resource impacts, modeling parameters and results, or to develop a project-specific Monitoring and Adaptive Management Plan. Each small working group is generally comprised of Trustee agency staff members and contractors who have relevant technical expertise, a role in linking the specific topic to the broader project, or in linking to other Louisiana restoration projects. A small working group may draft documents or processes that it then presents to the LA TIG for consideration and review, and this may occur in multiple steps as the Restoration Plan (RP) components are developed. For example, the MAM small working group for a project might create a conceptual model to identify important ecosystem influences and the monitoring parameters that would capture their impacts. The small working group would then present those suggested monitoring parameters to the LA TIG, which would review and revise the suggested list; the refined list would then go back to the small working group to be further developed into a set of monitoring protocols to be presented to the LA TIG. Small working groups usually hold calls or meetings twice a month or as needed, with progress updates shared at a monthly LA TIG meeting.

An LA TIG MAM representatives also participate in the Cross-TIG Monitoring and Adaptive Management Working Group, which the Trustee Council established as a forum to collectively address MAM topics relevant to multiple TIGs. The group operates on a consensus basis to provide recommendations to the Trustee Council regarding MAM responsibilities, procedures and guidelines, but has no independent authority to act except when directed by the Trustee Council. The group is available upon request to support the TIGs and Implementing Trustees in meeting their MAM responsibilities.

1.1.3. Restoration Governance Within CPRA

When implementing adaptive management within an agency it is important to identify personnel that have responsibility to contribute to, or utilize, each component of the knowledge base. Within CPRA, tabulating personnel titles with primary roles and interaction with the knowledge base components shows that even administrative staff have responsibility for information management and agency inreach (Table 2). Across the technical personnel positions there is a need to interact with most, if not all, aspects of the knowledge base; information management, stakeholder engagement (or outputs of stakeholder engagement), communications, and applied synthesis and research (

Table 3). There are many administrative personnel positions within CPRA that currently serve key functions in supporting habitat restoration project implementation. These linkages to administrative personnel are important to consider in terms of the entire adaptive management process (Table 4).

A key planning mechanism of coastal restoration in Louisiana is the Coastal Master Plan which looks forward 50 years and identifies large-scale actions to create a more sustainable coastal Louisiana landscape. The Coastal Master Plan has specific goals and objectives:

- **Flood Protection.** Reduce economic losses from storm surge-based flooding to residential, public, industrial, and commercial infrastructure.
- **Natural Processes.** Promote a sustainable coastal ecosystem by harnessing the natural processes of the system.
- **Coastal Habitats.** Provide habitats suitable to support an array of commercial and recreational activities coast wide.
- **Cultural Heritage.** Sustain the unique cultural heritage of coastal Louisiana by protecting historic properties and traditional living cultures and their ties and relationships to the natural environment.
- **Working Coast.** Promote a viable working coast to support regionally and nationally important businesses and industries.

Two teams have primary roles in updating the Coastal Master Plan every six years (previously five):

- Coastal Master Plan Delivery Team (MPDT): In the development of previous Coastal Master Plans, the MPDT was comprised of Louisiana's Coastal Protection and Restoration Authority (CPRA) staff and a few technical experts, including a program manager. The MPDT was responsible for communicating with CPRA's Executive level and completing the development of the Coastal Master Plan.

- Coastal Master Plan Modeling Decision Team (MDT): In the development of previous Coastal Master Plans, the MDT was comprised of two to three CPRA staff and a few technical experts. The MDT was responsible for revisiting previous lessons learned, Model Improvement Plans, making improvements to the models, identifying uncertainties, and conducting production runs.

Table 2. Detail of CPRA personnel that currently interact with the adaptive management knowledge base (Section 1.2) or would need to interact for adaptive management to be fully implemented. This is based on current practice, recognizing personnel in other positions may be capable or permitted to carry out additional roles. Current CPRA Divisions are abbreviated as Engineering (Eng), Executive (Exec), Operations (Ops), Planning and Research (P&R), and Project Management (PM)

CPRA positions	Current CPRA Divisions	High Level Decision making	Budget/ Accounting	Legal	Applied Research	Synthesis Reports	Data Collection	Information Management	Stakeholder Engagement	Management of Advisory Boards	Outreach	Inreach
Executive Director	Exec	X						X			X	X
Deputy Executive Director	Exec	X						X			X	X
Chief Financial Officer	Exec	X	X					X				X
Coastal Resources Administrator (Chief)	P&R	X						X			X	X
Accounting Administrator	Exec	X	X					X				X
Accounting Manager	Exec	X	X					X				X
Accountant	Exec		X					X				X
Budget analyst	Exec		X					X				X
Business Analytic Specialist	Exec		X					X				X
General Counsel	Exec	X		X				X				X
Deputy General Counsel	Exec	X		X				X				X
Paralegal	Exec			X				X				X
Attorney	Exec	X		X				X				X
Executive staff officer	Exec							X				X
Executive Management Administrator	Exec	X						X				X

CPRA positions	Current CPRA Divisions	High Level Decision making	Budget/ Accounting	Legal	Applied Research	Synthesis Reports	Data Collection	Information Management	Stakeholder Engagement	Management of Advisory Boards	Outreach	Inreach
Executive Management Officer	Exec	X						X				X
Internal Auditor	Exec		X					X				X
Administrative Program Specialist	Exec							X				X
Administrative Assistant	Eng, Exec, Ops, P&R, PM							X				X
Coastal Resources Program Specialist 1, 2, 3	Exec		X					X	X	X	X	X
Coastal Resources Program Supervisor	Exec		X					X	X	X	X	X
Coastal Resources Program Manager	Exec		X					X	X	X	X	X
Coastal Resources Scientist 1, 2, 3,4	Ops, P&R, PM				X	X	X	X	X	X	X	X
Coastal Resources Scientist Supervisor	Ops, P&R, PM				X	X	X	X	X	X	X	X
Coastal Resources Scientist Manager	Ops, P&R, PM				X	X	X	X	X	X	X	X
Coastal Resources	P&R, PM				X	X	X	X	X	X	X	X

CPRA positions	**Current CPRA Divisions**	**High Level Decision making**	**Budget/ Accounting**	**Legal**	**Applied Research**	**Synthesis Reports**	**Data Collection**	**Information Management**	**Stakeholder Engagement**	**Management of Advisory Boards**	**Outreach**	**Inreach**
Assistant Administrator												
Coastal Resources Administrator	Exec				X	X	X	X	X	X	X	X
Dual Career Ladder (DCL) A or B	Eng, Ops, P&R, PM				X	X	X	X	X	X	X	X
Engineer 1-9	Eng, Ops, PM, Exec	X			X	X	X	X	X	X	X	X
Public Information Director 1,2	Exec				X			X	X	X		
Engineer Technician	Eng, Ops				X	X	X	X	X	X	X	X
Surveyor	Eng						X	X	X	X	X	X
Geologist	P&R				X	X	X	X	X	X	X	X
Geologist Assistant Administrator	P&R				X	X	X	X	X	X	X	X
Land Manager	Exec							X	X	X	X	X
Land Specialist	Exec							X	X	X	X	X

Table 3. Detail of CPRA technical personnel that currently serve key functions in supporting habitat restoration project implementation. This is based on current practice, personnel in other positions may be capable or permitted to carry out those roles. Current CPRA Divisions are abbreviated as Engineering (Eng), Executive (Exec), Operations (Ops), Planning and Research (P&R), and Project Management (PM)

CPRA positions	**Current CPRA Division**	**Study Manager**	**Topic Scientist**	**Project Manager**	**Compliance Permitting**	**Land rights**	**Engineer**	**Engineer (Field)**	**Monitoring Manager**
		Personnel functions in implementing restoration projects							
Coastal Resources Scientist 1, 2, 3, 4	Ops, P&R	X	X	X	X				X
Coastal Resources Scientist Supervisor	Ops, P&R	X	X	X	X				X
Coastal Resources Scientist Manager	Ops, P&R, PM	X	X	X	X				X
Coastal Resources Assistant Administrator	P&R, PM			X					X
Dual Career Ladder (DCL) A or B	Ops, P&R, PM	X	X	X			X	X	X
Engineer 1-9	Eng, Exec Ops, PM			X			X	X	
Engineering Intern	Eng, Ops			X			X	X	
Engineer Technician	Eng, Ops			X			X	X	
Surveyor	Eng		X						
Geologist	P&R		X	X					
Geologist Assistant Administrator	P&R		X	X					
Land Manager	Exec					X			
Land Specialist	Exec					X			

Table 4. Detail of CPRA administrative personnel that currently serve key functions in supporting habitat restoration project implementation. This is based on current practice, personnel in other positions may be capable or permitted to carry out those roles. Current CPRA Divisions are abbreviated as Engineering (Eng), Executive (Exec), Operations (Ops), Planning and Research (P&R), and Project Management (PM)

CPRA positions	Current CPRA Division	High Level Decision making	Budget and Accounting	Legal	Outreach and Engagement	Administrative
		Personnel functions in supporting implementation of restoration projects				
Executive Director	Exec	X				
Deputy Executive Director	Exec	X				
Chief Financial Officer	Exec	X	X			
Coastal Resources Administrator (Chief)	P&R	X				
Engineer 1-9	Eng, Exec, Ops, PM	X				
Accounting Administrator	Exec	X	X			
Accounting Manager	Exec	X	X			
Accountant	Exec		X			
Budget analyst	Exec		X			
Business Analytic Specialist	Exec		X			
General Counsel	Exec	X		X		
Deputy General Counsel	Exec	X		X		
Paralegal	Exec			X		
Attorney	Exec	X		X		
Executive staff officer	Exec					X
Human Resources analyst	Exec					X
Human Resources specialist	Exec					X
Executive Management Administrator	Exec	X				X?
Executive Management Officer	Exec	X				X?
Internal Auditor	Exec		X			X
Administrative Program Specialist	Exec					X?
Administrative Assistant	Eng, Exec, Ops, P&R, PM					X
Coastal Resources Program Specialist 1, 2, 3	Exec		X		X	
Coastal Resources Program Supervisor	Exec		X		X	
Coastal Resources Program Manager	Exec		X		X	

1.1.4. Synergies in Programmatic Planning Processes and Goals

1.1.4.1. INTRODUCTION

To attain a common programmatic vision for restoration goals and priorities and maximize effectiveness across all entities involved with restoration in Louisiana, linkage points within CPRA also need to connect with inputs and outputs from LA TIG and Trustees. RESTORE Council and NFWF will also be major funders of restoration in Louisiana over the next 15 years. However, their goals and requirements are, for the most part, captured within the goals and requirements of the LA TIG (RESTORE) or CPRA (NFWF), recognizing that there is also substantial commonality in the goals of NRDA and CPRA (Figure 3).

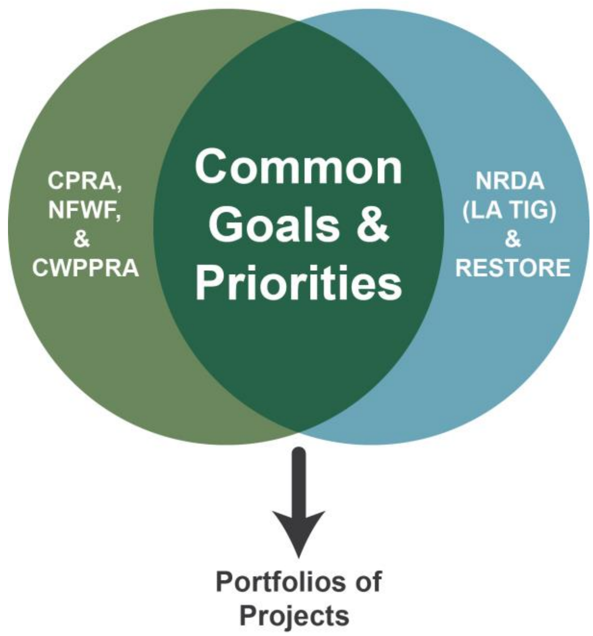


Figure 3. Conceptual representation of the common goals and priorities of the major restoration entities in coastal Louisiana

1.1.4.2. SYNERGIES BETWEEN NRDA REPORTING AND THE ADAPTIVE MANAGEMENT CYCLE OF CPRA IMPLEMENTED PROJECTS

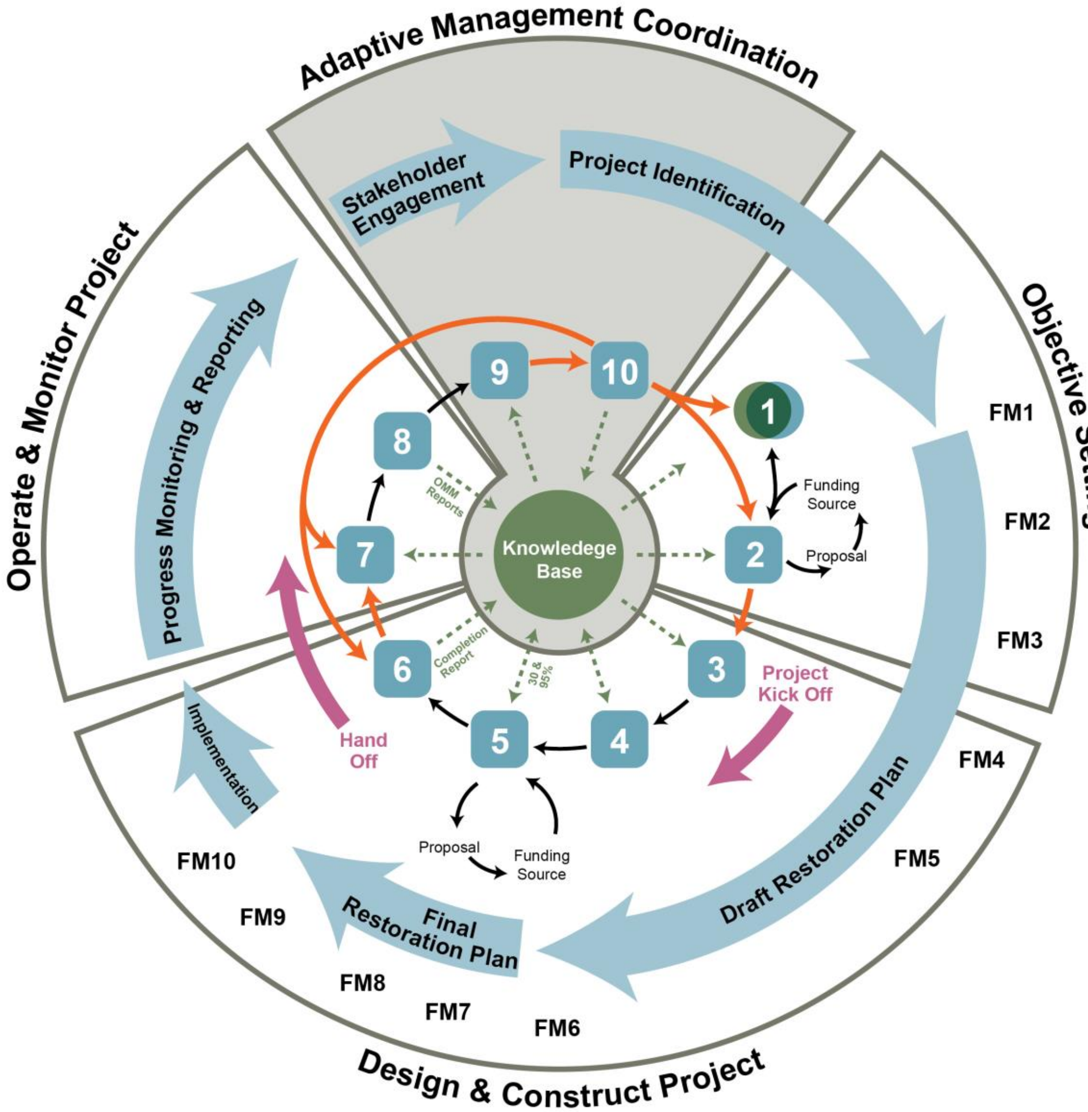
Every NRDA-funded project is implemented by one or more of the Trustee agencies. The relationships between LA TIG and the steps of adaptive management are illustrated in Figure 4. The RP development process is intended to evaluate a proposed restoration action, to analyze alternatives to the project, to ensure that the proposed project meets the criteria required for projects to be funded under the OPA, and to evaluate potential impacts of the project (Figure 4). When possible, the RP is developed in coordination with the NEPA documentation (e.g., EIS) or combined into a single document (e.g., RP/EA) to increase efficiency. Detailed timelines are developed and coordinated with other projects being considered by the LA TIG. Each RP has a timeline with major federal milestones identified (e.g., publication of the draft plan). These federal milestones vary by project but provide specific opportunities for adaptive management feedback, such as capturing lessons learned and documenting the reasons for important decisions. This adaptive management feedback process could be further institutionalized to increase efficiency. For example, developing a subset of common Federal Milestones that apply to all projects having RPs developed through the LA TIG could be used as a guide for development of each project MAM. Milestones will vary depending on restoration type, Lead Trustee agency requirements, and relevant legislation (e.g., infrastructure projects under Title 41 FAST Act have inflexible timelines under the Permitting Dashboard *(FAST) Act*, 2015).

An example of a project with some typical federal milestones is shown in Figure 4. Linking these RP Federal Milestones to the relevant adaptive management step establishes a process to capture documents, lessons learned, and information required to support key decisions. Establishing this linked process would increase the potential for improved implementation of adaptive management within the LA TIG.

Key Finding 1	*An LA TIG MAM small working group could focus on programmatic MAM planning for DWH Restoration Actions.*

Key Finding 2	*The LA TIG could request assistance or feedback from Cross-TIG MAM representatives to support development of a programmatic MAM.*

Key Finding 3	*Coastal restoration programs could add an additional formal step in restoration planning that would feed knowledge and lessons learned into ongoing and future restoration projects. For example, the LA TIG MAM working group could identify specific federal milestones at which the AM feedback loop would be linked to each restoration project.*



Federal Milestones

FM 1: Notice of Initiation for Restoration Planning
FM 2: Notice of Solicitation of Project Ideas
FM 3: Develop statement of Purpose and Need
FM 4: Develop reasonable range of alternatives
FM 5: Initiate compliance
FM 6: Publish Draft RP with MAM Plan
FM 7: Public meeting; public comment period
FM 8: Consider public comments
FM 9: Publish Final RP
FM 10: Record of Decision/ Notice of Availability

Project Flow

Information Transfers
Critical Transfer Points
Key Meetings

Figure 4. Linkages between the ten steps of project adaptive management, the four project phases (Section 2.2), the TIG restoration planning cycle, and examples of project Federal Milestones for NRDA projects funded through LA TIG (for explanation of adaptive management steps; Section 1.2)

1.1.4.3. NEED FOR FURTHER CLARIFICATION OF SYNERGIES IN PROGRAMMATIC RESTORATION GOALS IN LOUISIANA

Programmatic adaptive management focuses on reducing the uncertainty surrounding how a portfolio of projects contributes to achieving the goals of natural resource restoration and determining if those goals need to be revised. This assessment and refinement of programmatic goals informs project portfolio decision making within different entities (i.e., CPRA, LA TIG, RESTORE, NFWF, CWPPRA).

The shared programmatic goals of restoration entities in Louisiana address the problems of land loss, flooding risk, and DWH injured resources. CPRA, NRDA Trustees, RESTORE Council, and NFWF have common objectives associated with habitat, water quality, water quantity, living coastal and marine resources, community resilience, Gulf economy, and monitoring and adaptive management. For CPRA, these goals are nested under the overarching goals for restoration and protection identified in Louisiana's Coastal Master Plan: ensuring a sustainable and resilient coastal landscape and providing increased flood protection for communities. For the LA TIG and NRDA, restoration project portfolio goals (e.g., for a geographic basin) tier directly from the high-level goals established in the Gulf Wide DWH Restoration program documents (CPRA, 2017b; DWH NRDA Trustees, 2016).

To develop a full comparison of common goals, and NRDA restoration categories, it will be necessary to summarize and compare the full goals for CPRA, NRDA (LA TIG), RESTORE Council, and NFWF. These objectives and principles for CPRA are detailed in the Louisiana Coastal Master Plan (CPRA, 2017), for the DWH NRDA Trustees (LA TIG) in the PDARP (DWH NRDA, 2016), for RESTORE Council in the Comprehensive Plan update in 2016 (GCERC, 2016), and for NFWF in the settlement plea agreements (USDC, 2012, 2013). This will require consideration of the detailed definitions of terms and implications of generic terms within each document, using a collaborative approach with representatives from CPRA, LA TIG, RESTORE Council, and NFWF.

Key Finding 4	*Mechanisms to support cross program adaptive management could be developed to support a more holistic consideration of coastal resources, including how coastal restoration actions interact and how programmatic goals relate.*

1.2. Adaptive Management Process

1.2.1. Definition of Adaptive Management

The following statement defines adaptive management as used in this technical report:

Adaptive management is a systematic process to incorporate new and existing knowledge into management decisions (Williams et al., 2009). It is a learning based, iterative process to improve management decisions and actions based on increasing understanding and feedback between this learning and subsequent decision making (Williams, 2011).

- ***Structured process for making decisions*** over time through active learning
- ***Enables programmatic and project adjustments*** based on new information
- ***A science-based approach*** including:
    - Identification of explicit goals and objectives
    - Management action planning and implementation
    - Assessment of ecosystem and socio-economic responses to implemented actions
    - Use of best available science in all stages of decision making

Adaptive management is applied both programmatically (i.e., portfolios of projects) and within individual projects. Programmatic adaptive management provides a structured process for making decisions over time through active learning based on the relative success of implemented projects or portfolios of projects. Extending beyond the life of any one project, it enables adjustments in design, management, and selection of projects as new information becomes available on a routine and recurring basis. Project specific adaptive management occurs for the life of that individual project and maximizes the success of that project by accessing knowledge from previous projects of relevant type or geographic location. In addition, it provides a structured process for using quantified assessments of project performance to refine project operation and monitoring or even project redesign.

1.2.2. Iterative Adaptive Management Activities

The iterative nature of adaptive management involves a number of steps that represent the integration of design, management, and monitoring in a structured process to facilitate learning and improve restoration effectiveness (Figure 5). The following ten steps are summarized for coastal restoration in Louisiana:

1. Define the problem;
2. Set goals and objectives;
3. Develop or refine models;
4. Identify and prioritize uncertainties;
5. Plan formulation and engineering design;
6. Implement or construct;
7. Operate, maintain, and monitor;
8. Assess and evaluate;
9. Recommend revisions; and
10. Approve adjustments.

The programmatic scale and project scale of adaptive management are directly linked. Project portfolios are developed as part of the programmatic adaptive management cycle (Section 2.1). Each of those projects when implemented, additionally goes through a full adaptive management process (Figure 5). This is most effective when there is strong linkage in the adaptive management coordination mechanisms used within projects and programmatically. Practically, the point of linkage is information and knowledge flow (Section 1.2.13) to support improved decision making.

The following sections describe the steps for adaptive management. Although these steps and processes are presented in a circular fashion, they do not always occur sequentially. It may be necessary to move forward or backward through the cycle or repeat certain steps. An example of a non-sequential process could be the development of a phased restoration plan that goes through steps for assessing feasibility and then requires further development for full project implementation.

1.2.3. Step 1 - Define the Problem

A clearly defined problem statement articulates the underlying reason why restoration action is needed and establishes a foundation for programmatic or project implementation (Figure 5, Table 5). Defining the problem ensures common expectations among stakeholders, specifically what is within, or beyond, the scope for a particular restoration effort. At the project scale, accurately identifying the problem will ensure that the project is addressing the correct stressors and will greatly improve the chance for project success. If there is uncertainty with regard to the problem, this can be identified as an applied research need.

Within Louisiana, the CPRA Board has overall responsibility for defining the problems that CPRA will address through the Coastal Master Plan process. The problem statement (philosophy) has remained essentially the same since the first Coastal Master Plan in 2007 – rapid rate of coastal land loss and resultant flood risk (CPRA, 2017a). Actively engaging community and stakeholder input in refining a problem statement over time will ensure it remains relevant through changing ecological, social, and economic conditions.

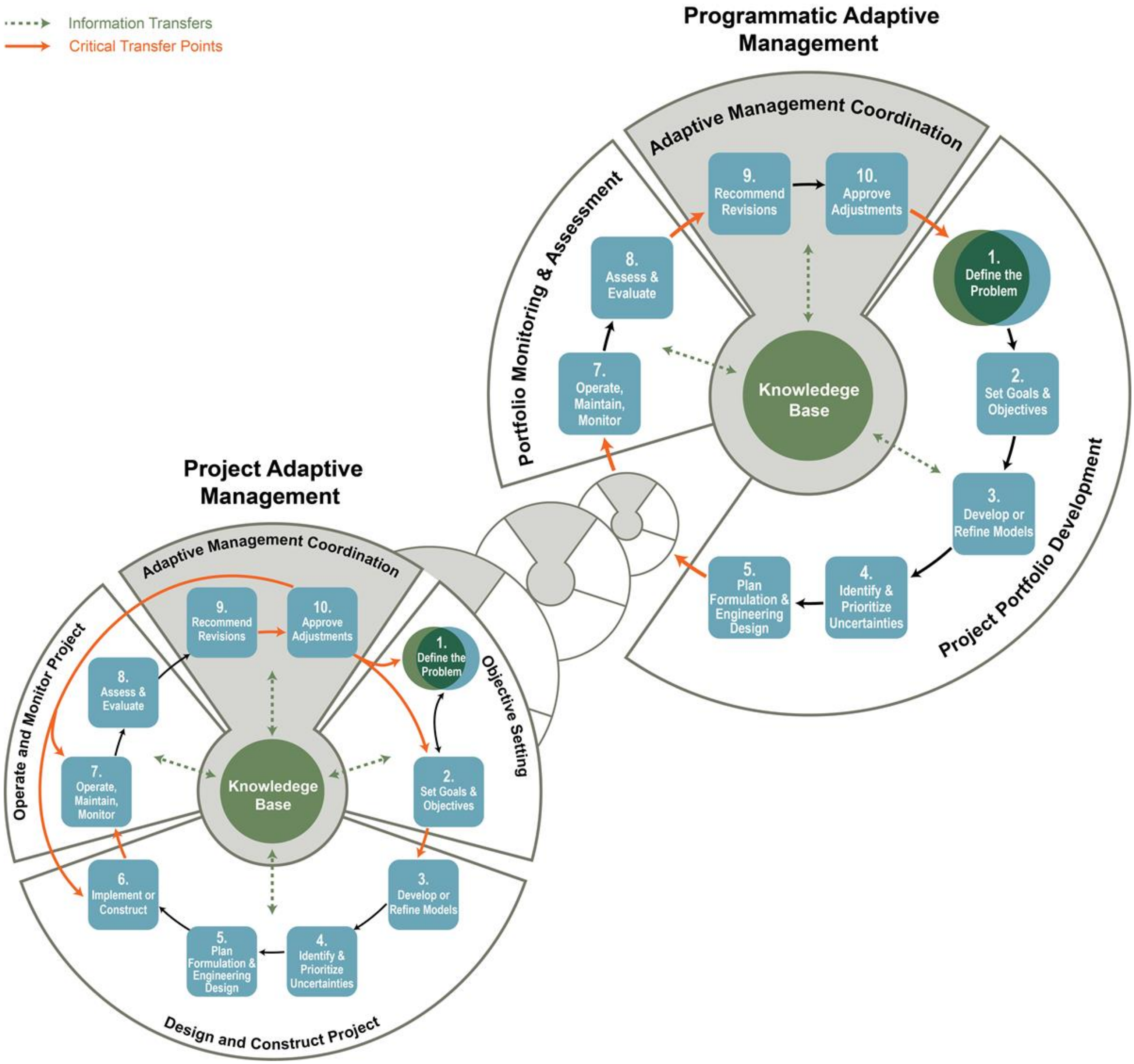


Figure 5. The ten steps for adaptive management to implement coastal restoration in Louisiana, indicating linkages between project and programmatic adaptive management

Restoration activities funded by NRDA under the OPA are intended to return injured natural resources and services to their baseline condition (primary restoration). In addition, it also works to compensate the public for interim losses that occurred between the incident and recovery of resources and services (compensatory restoration). To address this problem statement, restoration activities need to produce benefits that are related to, or have a connection to, natural resource injuries and service losses from the oil spill.

1.2.4. Step 2 - Set Goals and Objectives

Measurable goals and objectives need to be developed to address the defined problem and to outline a common vision of restoration success (Figure 5, Table 5). Goals are broad and inclusive, most commonly defined at the programmatic scale. These goals are intended to encompass more specific and measurable ecological or geographic objectives, frequently established at the project or resource scale. For example, the current restoration goals of the CPRA, RESTORE, NRDA, and NFWF provide broad guidance to planning in terms of programmatic aims, but they are not sufficiently specific to be used to direct or refine project-specific actions. For a specific project, measurable objectives can guide the project at every step. Project features are identified and designed with a purpose to obtain the project objectives based on the current state of scientific and technical understanding. Programmatic and project objectives are most effective when clear and quantifiable, so that specific variables can be monitored to determine restoration success.

An essential part of adaptive management is revisiting the goals and objectives once the assessment findings are available from the previous cycle, in consideration of data and knowledge summaries, analyses and syntheses. When goals or objectives are revised, other modifications or updates may become necessary in subsequent adaptive management steps.

1.2.5. Step 3 - Develop or Refine Models

Conceptual, numerical, physical, and other models are often used to explicitly describe the relationship between restoration management actions and the system response. It is important that these models consider key assumptions and identified uncertainties (Schreiber et al., 2004). Developing or refining models is an important step in the adaptive management cycle (Figure 5, Table 5). Numerical models also provide an opportunity to test and evaluate the sensitivity of the system to known uncertainties. Using simulations, or possible scenarios, to predict how projects and project portfolios may impact a system (compared to no action) serves three functions:

1. Allows for identification and communication of the overall system (and its potential response to change) among scientists, engineers, managers, and stakeholders.
2. Informs prioritization of efforts and screening of options that are unsuitable or ineffective.
3. Helps identify how knowledge gaps and uncertainty influence model results (Walters, 1997).

CPRA has developed a suite of planning scale models for coastal Louisiana to predict the ways in which restoration and risk reduction projects support the overall goals and objectives of the Coastal Master Plan as well as restoration funding mechanisms such as the LA TIG. This approach includes a number of linked models that predict change in the conditions of the

Louisiana coastal system under both a future without additional restoration projects, as well as under a range of project portfolio implementation scenarios. Numerical models improve the understanding of interactive effects of multiple projects, and outcomes of the Coastal Master Plan implementation. Potential synergistic or conflicting effects among projects can also be identified to determine the net effects of coastal restoration implementation over time.

At a regional or project-specific scale, additional modeling tools are used by CPRA to answer more refined questions. These models are specific to a project or group of projects being investigated and include conceptual models, statistical and process models, ecological models, and small-scale physical models. For successful adaptive management, models are reevaluated if goals and objectives change or when conditions change.

Table 5. Description of adaptive management activities

ACTIVITY	DESCRIPTION
Knowledge Base Components	
Information management	Organizing, managing, and making relevant data and information readily available in a format that is useful to inform management decisions.
Applied synthesis and research	Research to resolve specific uncertainties at project, regional, or coastwide scales. Synthesis and assessment documents summarize studies and compare/contrast research findings and their relevance to programmatic implementation.
Stakeholder engagement	Dialogue, deliberation, and two-way communication with residents and stakeholders with diverse perspectives helps remove barriers to program and project success
Communication	One-way communication to disseminate knowledge and information to multiple audiences. Includes both inreach (within agency) and outreach (outside of agency).
Steps of Adaptive Management	
1. Define the Problem	A clearly defined problem statement articulates the underlying reason why action is needed and establishes a foundation for restoration implementation.
2. Set Goals and Objectives	Identifying (or reassessing) goals and objectives that specifically address the problem is critical to successful restoration implementation and assessment.
3. Develop or Refine Models	Models may be necessary to understand the relationship between the problem, goals, objectives, and proposed restoration actions. Models also help identify critical uncertainties that need to be monitored to evaluate success.
4. Identify and Prioritize Uncertainties	Quantifying uncertainty is critical to understand modeling limitations, identify confidence in planning processes, and target future monitoring and research needs.
5. Plan Formulation and Engineering Design	Plans should be designed in a manner that is robust and targeted to the problems identified and the specific goals/objectives. However, they need to remain sufficiently flexible to address any identified uncertainties.

ACTIVITY	DESCRIPTION
6. Implement or Construct	Programmatically implementing a formulated plan to efficiently address a specific problem, related goals and objectives. At the project level, this includes the construction activities specific to the project. Implementation of the plan and construction of projects must also remain flexible to ecosystem changes and document actions related to changes during implementation.
7. Operate, Maintain, and Monitor	Operation and maintenance are critical to ensure that the project (or project portfolio) is functioning as expected. Operations refer to the daily running of a project in response to external decision drivers (for example weir opening in response to river stage). Maintenance is any action to repair or update the project to ensure continued performance. Monitoring is a means both to track performance against expectations and to advance scientific understanding. Monitoring data provide feedback between decision-making and ecosystem response relative to goals and objectives. This data also supports other aspects of adaptive management, such as problem identification, model development, and plan formulation.
8. Assess and Evaluate	Assessment of restoration performance can resolve uncertainties to increase understanding and predictive capability and identify the need to change course. This is also where problem statement and goals and objectives are reassessed.
9. Recommend Revisions	Utilize findings of assessment and evaluation to recommend programmatic or project modifications or refinements (both structural and operational) to improve overall performance.
10.Approve Adjustments	Take technical recommendations through appropriate approval processes or seek funding (if needed) to implement adjustments.

1.2.6. Step 4 - Identify and Prioritize Uncertainties

Adaptive management is used because management decisions must frequently be made under high levels of uncertainty, but these actions can influence the effectiveness of management decisions that are repeated over time. Quantifying uncertainty is a necessary component of the adaptive management process and is used to understand limitations of numerical modeling, identify confidence in planning processes, set stakeholder expectations, and identify applied research needs (Figure 5, Table 5).

Programmatically, uncertainties affect more than a single project and are ecologically, geographically, or temporally broad. Uncertainties can relate to the inherent variability in natural and human systems or variability arising from multiple restoration projects within one ecologically connected geography. Uncertainties can also arise from the interconnectedness of the Gulf ecosystem and associated indirect effects, the available resources (economic, geological, ecological, etc.), or the limits of scientific and technical understanding about current or future conditions. Uncertainties that are related to random or stochastic processes (e.g., storm location and intensity) have the potential for significant impacts on project performance and adaptive management decisions (Ascough et al., 2008). Informing management decisions to minimize the potential for negative consequences of these uncertainties is an important role for adaptive management.

Uncertainty at the project scale may arise from limited scientific understanding of target resources, the use of novel restoration approaches or techniques, influence of external factors over large spatial scales and/or long time scales, and socioeconomic influence (e.g., willingness to adopt new fishing gear; (DWH NRDA, 2016)). In addition, some projects are novel or at a large enough scale that there is uncertainty about the ultimate effects of operation. Only through adaptive management of operations can this uncertainty be reduced. The understanding of linkages between project features and ecosystem responses will inform objective setting and metrics to include in the monitoring plan. Resolving and minimizing uncertainty for specific projects improves predictions of project outcomes and facilitates learning that can be applied to similar future projects. Common uncertainties for coastal restoration actions are identified in the DWH NRDA MAM manual, within the monitoring guidance attachments (DWH NRDA Trustees, 2017).

1.2.7. Step 5 - Plan Formulation and Engineering Design

Comprehensive plans are developed to solve defined (yet complex) problems and achieve specific measurable goals and objectives (Figure 5, Table 5). Plans should be designed in a manner that is robust and flexible to the underlying uncertainties previously identified. This includes creating an implementation timeline and specifying adaptive management actions if the plan is not performing as anticipated. Existing approaches, such as adaptive pathways (e.g., Haasnoot et al., 2012), can be used to outline a path forward and create “road maps” for plan implementation in the face of multiple uncertainties. Road maps provide a plan for adjustments if the system changes unexpectedly and it becomes clear that action(s) are not meeting the specified goals and objectives. Several statistical- and model-based methods have been developed to assist with anticipating tipping points in the natural or human system (e.g., Carpenter & Brock, 2006; Dakos et al., 2012; Drake & Griffen, 2010).

Development of programmatic plans includes the identification of a project portfolio which will collectively contribute to achieving programmatic goals. The Coastal Master Plan, for example, is supported by a computer-based, decision-support tool, called the planning tool, and by stakeholder engagement. The planning tool was developed as part of the 2012 Coastal Master Plan and was used to:

1. Make analytical and objective comparisons over a 50-year period of hundreds of different flood risk reduction (including nonstructural protection measures) and restoration projects.
2. Identify and assess alternatives that could collectively offer comprehensive solutions.
3. Display the hard decisions (i.e., tradeoffs) interactively to support iterative deliberation over alternatives (Groves & Sharon, 2013). The use of the planning tool allows evaluation of many different combinations of project portfolios to address land loss and reduce flooding risk for coastal communities. The planning tool can be refined during each planning cycle.

Once a project is selected for implementation, additional modeling may be carried out using higher resolution models, incorporating additional processes and spatial or temporal scales not possible in programmatic scale numerical models. Full feasibility studies may be required, and there are usually well-established design guidelines for restoration projects to ensure a consistent framework for designing projects. During the engineering and design process there are multiple formalized opportunities for stakeholder engagement as well as opportunities to incorporate the most current and relevant advances in science and technology into project design.

1.2.8. Step 6 - Implement or Construct

Implementation and/or construction follows the development of a formalized programmatic plan (developed portfolio of projects) or a construction design for a specific project (Figure 5, Table 5). This part of the adaptive management process moves projects from paper to the field, or programmatically involves the implementation of a portfolio of projects. There are multiple steps involved throughout this process with varying degrees of complexity. These may include development of supporting legislation, policies, or contracting mechanisms to streamline the implementation process. In addition, permitting, construction oversight, securing the necessary permits, landowner agreements, or contracts, all need to be carefully planned and coordinated for successful implementation. Adaptive management throughout this step creates opportunities to preemptively eliminate events or hurdles during construction that might compromise a project's success or, eventually, programmatic success. One example is discovery of unappropriated sediment structure at the site of a marsh creation project that makes the project non feasible. Alternately, unforeseen occurrences may occur such as a major storm that changes the structure of a barrier island planned for restoration making the project non feasible or overly costly.

At the programmatic scale, CPRA reports implementation progress in annual reports, which document the collective progress made by providing:

1. An inventory of projects for which the state planned to expend money and resources for a given fiscal year.
2. Recommendations for allocating coastal protection and restoration funds to those projects. Additionally, the Annual Plan provides an expanded discussion of the CPRA's progress in protecting and restoring the coast and outlines an implementation plan for the next fiscal year. The reporting frequency and its focus on maintaining a strategic direction helps to anticipate and prevent roadblocks and hurdles that could impede programmatic progress. For individual projects, CPRA documents lessons learned from construction in a construction completion report, which is made available through CIMS to other practitioners to inform similar projects.

For each DWH NRDA restoration project, one (or more) Implementing Trustee(s) is identified as being responsible for all implementation tasks to complete implementation phases (e.g., contracting), conducting project-specific monitoring and adaptive management, and operating and maintaining projects in the long term. The LA TIG tracks whether projects are implemented consistent with final restoration plans and applicable MOU and SOPs, and coordinates with both the Implementing Trustee(s) and the Trustee Council. The Trustee Council coordinates with the LA TIG to track and report the aggregated implementation status of the restoration program to the public and ensures that implementation is consistent with the commitments described in the PDARP/PEIS (DWH NRDA, 2016). Project-specific MOUs and Implementation Plans may be used to identify which Individual Trustee Agency is responsible for each project phase, including long-term management and oversight. The LA TIG summarizes progress toward completing the engineering and design, construction, monitoring and adaptive management, and long-term operations and maintenance project phases. It then submits this information to the Trustee Council through the DWH Restoration Portal, as each phase is complete and/or as part of development of the Trustee Council's Annual Report for the public on Deepwater Horizon restoration (DWH NRDA, 2016; DWH NRDA Trustees, 2016).

1.2.9. Step 7 - Operate, Maintain, Monitor

OM&M occur after a project is constructed, or at points throughout programmatic implementation (Figure 5, Table 5). OM&M is advocated in adaptive management as a means to track performance against expectations and advance scientific understanding in order to adjust policies as part of the learning process (National Research Council, 2004). To ensure that a project is maintained and operated as planned, routine inspections of project condition are required. Operation and maintenance are largely managed on a project-by-project basis, but monitoring occurs at both a programmatic and a project level.

Long-term monitoring can support adaptive management by:

1. Producing information on the status of critically important natural and socio-economic resources over time.
2. Enabling assessments of how systems are changing.
3. Allowing determination of whether goals or targets are being achieved for sustainable landscapes, resilient communities, and/or specific resources.
4. Explaining outside drivers.
5. Identifying and reducing critical basin-wide or regional uncertainties.
6. Informing the planning of future restoration projects. In order to be successful, the quality, scale, and resolution of the data must be appropriate to meet the monitoring program's specific objectives. As a result, thorough planning of the objectives, analysis, design, and measurement choices must be conducted prior to the actual data collection.

Programmatic monitoring for coastal Louisiana is conducted under SWAMP. The purpose of SWAMP is to ensure that a comprehensive network of coastal data collection activities is in place to support the development, implementation, and adaptive management of coastal protection and restoration within coastal Louisiana (Hijuelos & Hemmerling, 2016). Monitoring plans have been developed for both the natural and human systems using an iterative process to identify the overarching goal and monitoring variables, objectives, and sampling designs. The monitoring variables and objectives identified by SWAMP fall under the general categories of weather and climate, biotic integrity, water quality, hydrology, physical terrain, population and demographics, housing and community characteristics, economy and employment, ecosystem dependency, residential properties protection, and critical infrastructure and essential services protection. A rigorous statistical analysis, examination of modeling needs, and thorough reviews of previous planning and monitoring efforts were conducted to develop the sampling designs for the natural and human system monitoring plans. The program builds upon several existing data collection networks, such as the CRMS and the BICM programs. In addition, SWAMP builds on agency-specific monitoring efforts such as fisheries-independent monitoring through the LDWF and the American Community Survey conducted by the U.S. Census Bureau. SWAMP and associated resources also provide a wealth of data and a foundation for DWH NRDA restoration projects. Some programmatic project portfolios additionally require monitoring efforts focused on regulatory compliance requirements or specific Restoration Types (e.g., birds, marine mammals) in an area or watershed (e.g., Barataria Basin).The LA TIG may also decide to fund additional programmatic monitoring to evaluate restoration for injured resource categories in Louisiana (e.g.,bird and marine mammal monitoring).

The data produced by SWAMP and other monitoring efforts directly support both the modeling and assessment activities of the adaptive management process to quantify trends and restoration effectiveness at obtaining objectives. For example, topographic and bathymetric data are important model inputs, and assessment of changes in wetland biomass, nekton community, human population changes, or reliance on natural resources may indicate a change in system state and a need for action. Monitoring occurs throughout the planning cycle, although the temporal frequency of individual variables is subject to the type of data being collected and how it will be used (for more information, see Hijuelos & Hemmerling, 2016).
At the project scale, operations, maintenance, and monitoring provide critical feedback between decision-making and system response. They also provide data to evaluate whether or not the project is functioning as intended and whether it is having the desired effect on the landscape. Monitoring is also fundamental for improving system knowledge and understanding. Project-specific monitoring plans prescribe the monitoring data necessary to optimize project implementation, to support adaptive management and when to make decisions about corrective actions. They also outline the process to evaluate project effectiveness, resolve uncertainties and understand why a project is (or is not) successful, and identify new uncertainties. Project-specific monitoring plans may build on the overall monitoring framework of SWAMP by adding spatial density or temporal frequency to address the scale of project-specific questions (Hijuelos & Hemmerling, 2016). The project monitoring plan may also call for new types of monitoring related to the resource being restored or to meet a regulatory compliance requirement. The DWH NRDA MAM manual includes specific guidance on requirements to justify monitoring metrics, methods, timing, frequency and duration of monitoring to evaluate progress toward Restoration Type goals as well as compliance to relevant regulations and management protocols (DWH NRDA Trustees, 2017).

DWH NRDA restoration projects with a published MAM plan must also have information on project restoration objectives, monitoring activities, parameters, and performance criteria uploaded in National Oceanic and Atmospheric Administration's DIVER Restoration Portal. These entries require annual review and updates, if needed, to reflect the status of MAM activities. Additionally, if changes arise during implementation that will alter the planned MAM activities, those details are updated accordingly, and the revised MAM Plan is uploaded. This database will be expanded to include adaptive management activities, such as lessons learned and new reporting templates, as they are developed. CPRA reports lessons learned from project monitoring and recommendations for improvements in periodic Operations, Maintenance and Monitoring reports.

1.2.10. Step 8 - Assess and Evaluate

The assessment and evaluation activity in adaptive management is designed to assess performance (Figure 5, Table 5) Currently, approaches for effectively assessing and evaluating programmatic performance are still being developed and need to be more than just the summed assessment of all projects within a particular programmatic portfolio. Specifically, there is a need to assess overall effect of collective restoration efforts upon the ecosystem. The goals of assessment and evaluation are to synthesize and analyze monitoring data, determine if performance is as expected, and identify potential performance issues. During project assessment and evaluation, information is used to inform project-level decisions, such as proposing potential corrective actions. Understanding the specific drivers that influence project performance, such as unanticipated outcomes or events, can help guide the development and implementation of appropriate corrective actions. New information learned through project evaluation can also be used to inform the current understanding of the project's environmental setting to determine how the system may respond to future corrective actions or changes to project operations. The assessment and evaluation activity is often recognized as a necessary but technically challenging process and it can be difficult to get commitment to quantifiable metrics for fear of having projects or project portfolios receive a negative assessment (Gosselin, 2009). However, a lack of specific and quantifiable assessment and evaluation will limit the effectiveness of an adaptive management process and ultimately restoration effort.

Project assessment and evaluation provides meaningful feedback on project performance and can document recommendations for improvements and lessons learned that can be used to improve future projects. The results of restoration assessments need to be communicated to managers and lessons learned from the assessment and evaluation need to be readily discoverable.
For CPRA projects, the end results of the assessment activity are a series of summary reports highlighting the main messages and any uncertainties that have (or have not) been resolved. The RECOVER MAP program for the Everglades produces System Status Reports and Scientific Knowledge Gained documents in addition to Peer Review Reports. The System Status Report evaluates current monitoring data to determine if the goals and objectives of the CERP are being met. Although coastal Louisiana faces a different range of issues, these reports from south Florida can serve as useful templates to the development of a comprehensive analysis report for coastal Louisiana.

For DWH NRDA projects, assessment and evaluation are captured in interim and final MAM Reports, which are uploaded for public viewing in the DWH Restoration Portal. Interim MAM Reports contain results of the evaluation, summary statistics for MAM data, an overview of progress toward project restoration objectives, a determination of the need for corrective actions, an adequate description of the methods used to obtain the project MAM results, and any additional relevant information. Final MAM reports are written once the project is complete and no additional NRDA monitoring is planned. These reports contain a final evaluation of project monitoring data; a report on the final project outcomes, including lessons learned or uncertainties addressed; considerations for planning and implementation of future projects; and any additional relevant information. Adaptive management relies on the communication and the integration of these lessons learned into future decision-making processes. Intermediate-scale assessments and evaluations to address technical issues are discussed in Section 2.4. The Cross-TIG monitoring and adaptive management work group, working at the direction of the DWH Trustee Council, will synthesize monitoring information and overall restoration results across the TIGs and Restoration Types. This is intended to occur at appropriate intervals to evaluate and report to the Trustee Council on the Trustees' collective progress toward meeting the resource-level and ecosystem goals described in the PDARP/PEIS. This information will contribute to overall DWH NRDA program reviews that the Trustee Council will conduct approximately every five years and provide feedback to TIGs for consideration in future restoration decision-making. As part of this process, the LA TIG will aggregate and evaluate monitoring data, restoration results, and other information related to the combined impact of implemented restoration projects on the restoration of the resources injured by the DWH spill, as appropriate, to document progress toward meeting Restoration Type and Programmatic Goals within the Louisiana Restoration Area (DWH NRDA, 2016; DWH NRDA Trustees, 2016). In accordance with the OPA and the NEPA, the federal and state natural resource trustee agencies (Trustees) have prepared a Final PDARP/PEIS. The Final PDARP/PEIS considers programmatic alternatives, composed of Restoration Types, to restore natural resources, ecological services, and recreational use services injured or lost as a result of the DWH oil spill incident. The OPA natural resource damage assessment regulations guided the Trustees' development and evaluation of programmatic restoration alternatives. The Final PDARP/PEIS also evaluates the environmental consequences of the restoration alternatives under NEPA. This document shows that the injuries caused by the DWH oil spill incident affected such a wide array of linked resources over such an enormous area that the effects must be described as constituting an ecosystem-level injury. Consequently, the Trustees' preferred alternative for a restoration plan employs a comprehensive, integrated ecosystem approach to best address these ecosystem-level injuries. Specific restoration projects, to be selected in subsequent planning phases and evaluated under OPA and NEPA, will take place primarily in the northern Gulf of Mexico, Texas, Louisiana, Mississippi, Alabama, and Florida. (DWH NRDA, 2016; DWH NRDA Trustees, 2016)

1.2.11. Step 9 - Recommend Revisions

New information resulting from assessment and evaluation may identify opportunities to improve coastal restoration success (Figure 5, Table 5). The foundation of adaptive management is to learn from experience, from new information or discoveries, and to incorporate that new knowledge into management decisions for optimal programmatic and project outcomes.

At the programmatic level, the development and reassessment of the Coastal Master Plan has already successfully incorporated many aspects of adaptive management, despite the complexity of the problem at hand:

- Stakeholders are engaged throughout all aspects of plan development;
- Clear goals and objectives have been identified to address the problems, currently these do not have quantifiable metrics;
- System models have been developed and continue to be improved from one planning cycle to the next;
- Model uncertainties are identified during model development; and the implementation of SWAMP supports the development and refinement of Master Plan models and future assessment activities.

For DWH NRDA projects, the Cross-TIG MAM work group serves as a forum for the TIGs to share knowledge gained through the implementation, monitoring, and evaluation of individual restoration projects. The Cross-TIG MAM work group may share project-level outcomes across TIGs to identify any lessons learned that can inform the design and implementation of future, similar projects. The work group can then share lessons learned with other DWH restoration programs as part of their external engagement efforts.

Improvements at the project level are undertaken continually through project implementation, as necessary. Governance structures create a project-specific process for changes and improvements to individual projects. Any changes made to a project as a result of the adaptive management process will ideally be documented and communicated throughout the governance structure.

1.2.12. Step 10 - Approve Adjustments

Assessment and evaluation may highlight the need for corrective actions to improve project performance (Figure 5, Table 5). For DWH NRDA projects, if proposed corrective actions require additional environmental review, the permits and consultations will be modified as needed. If the modifications result in a material change to the project as selected in the final Restoration Plans, public notification may be required. Decision making processes are not always clear and vary greatly between projects, restoration entities, and types of decisions. To most effectively utilize best available science in informing these decisions it will be necessary to explicitly document these decision-making processes for both CPRA and the LA TIG. It would then be beneficial to recommend linkages to knowledge and learning captured, key personnel, and key advisory committees involved in the adaptive management process.

1.2.13. Knowledge Base Components and Interactions

Adaptive management is divided into the ten steps of adaptive management and the knowledge base, which includes activities that are over-arching and supportive of all adaptive management activities (Figure 6). The knowledge base is defined here as the accumulated institutional knowledge, data, lessons learned, and discussions that inform adaptive management coordination and implementation. The knowledge base includes four components: Information Management, Applied Synthesis and Research, Stakeholder Engagement, and Communication. Building accessible institutional knowledge is essential to preserve and provide lessons learned and improve understanding of system functioning to reduce uncertainties. Actively maintaining this knowledge, data, and information ensures a continuation of knowledge growth that transcends individuals and will improve projects and collectively improve programmatic success in achieving restoration outcomes.

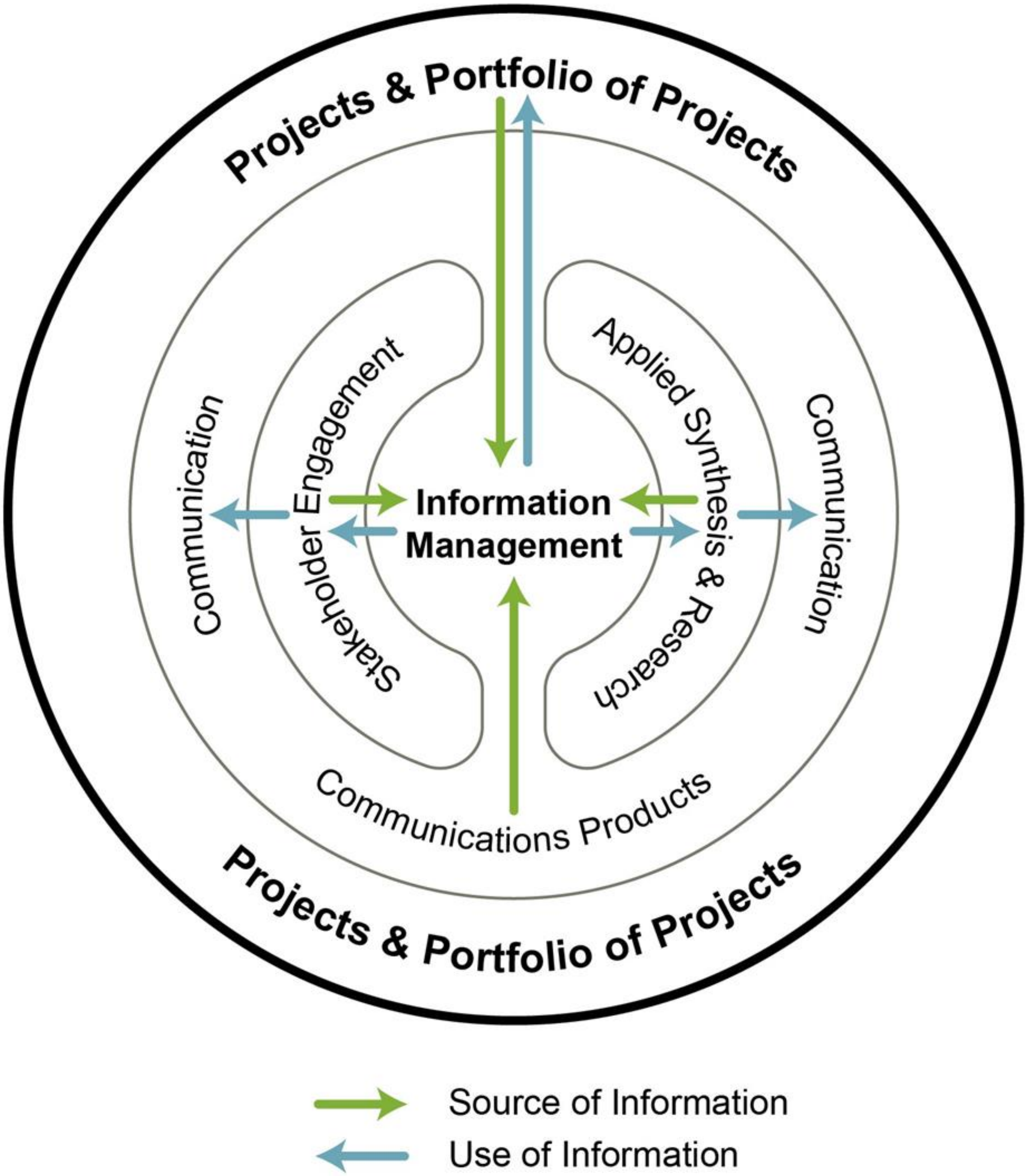


Figure 6. The four components of the knowledge base: are Information Management, Stakeholder Engagement, Applied Synthesis and Research, and Communication

1.2.13.1. INFORMATION MANAGEMENT (SECTION 2.3)

Informed restoration decisions resulting in effective adaptive management rely on data and information being easily available and accessible to managers and decision makers. One of the foundations of successful adaptive management is that relevant data, decisions, documents, and other information, are available to make timely and informed decisions. Programmatically, it is important to maintain consistency in formats, quality standards, and availability of data and documents across all of efforts, incorporating specific requirements from a variety of funding sources. This consistency helps facilitate the aggregation of data and information to make decisions that are larger in scale than individual projects. It also facilitates the use of data and information generated in coastal Louisiana for decisions which may affect the entire Gulf of Mexico region (such as oil spill-related restoration decisions).

To ensure data and information availability to decision-makers, there is a need for a well-organized and easily accessible data and information management platform. It is important that restoration data and information generated by large implementing agencies, such as CPRA, are centrally managed and readily available. This includes monitoring data and information relevant to environmental compliance, land rights, engineering and design, etc., all needing to be centrally located and discoverable by those making restoration project decisions.

1.2.13.2. APPLIED SYNTHESIS AND RESEARCH (SECTION 2.4)

Applied Synthesis and Research consists of efforts to resolve scientific and technical uncertainties which can be related to individual projects or larger regional uncertainties (such as regional subsidence). It also includes efforts to improve and refine planning and numerical models (such as Coastal Master Plan models), resolve uncertainties with respect to model calibration and validation, and direct research to improve model prediction accuracy. Results from project-level monitoring may raise site or project knowledge gaps to prioritize as research needs. Resolving these uncertainties may require applied research, this could take the form of feasibility studies, numerical or physical models, or experimental projects.

Understanding collective effects of projects at varying scales is important to the assess the programmatic success of restoration. In addition to project-specific assessment reports, there is a need to evaluate larger-scale (e.g., state-level) performance and to synthesize new knowledge and lessons learned. Assessing the collective performance of the Coastal Master Plan at achieving its goals of a sustainable coast requires analysis of repeated long-term (e.g., years to decades) measurements that can be analyzed to detect change. This change may result from a variety of sources, including large-scale restoration and protection projects, environmental disturbances, and other major drivers that can impact the ecosystem. Intermediate-scale syntheses, such as regional or basin-level assessments that evaluate synergies of multiple projects on a resource or ecosystem type, or assessments based on project type, can also provide insight to improve adaptive management (Raynie & Visser, 2002). Previous examples of intermediate-level assessments related to Louisiana’s barrier islands include Knotts et al. (2007) which describes performance of Louisiana barrier island projects; Khalil (2008) which describes the need for sand fencing; and Poff et al. (2015) which discusses unique challenges in restoring Louisiana’s barrier islands.

1.2.13.3. STAKEHOLDER ENGAGEMENT (SECTION 2.5)

Stakeholder Engagement is an essential component of coastal restoration adaptive management (in particular large scale or contentious projects). Involving stakeholders in planning ensures transparency and consideration of stakeholder interests, values, and ideas, experiences, and expectations. Engaging and collaborating with stakeholders builds trust, thereby increasing the likelihood of support for the restoration process by providing a common vision of success and creating the opportunity to resolve conflicts. It can also limit costly delays from legal actions and support policy clarifications by building trust and shared understanding about the need for an individual project. Examples of Stakeholder Engagement include collaboration with federal, state, and local agency partners, non-governmental organizations, landowners, and local community groups. For example, the Coastal Master Plan process includes a number of avenues by which stakeholders are engaged, from advisory boards and technical committees, to citizen groups and meetings with elected officials. A variety of funding sources and programs (such as CWPPRA) also have specific sets of stakeholders that must be engaged. Opening and maintaining two-way communication pathways among stakeholder groups is critical to adaptive management.

1.2.13.4. COMMUNICATION (SECTION 2.5)

Communication is critical to maintain connectivity with stakeholders and to provide ongoing opportunities for information updates throughout the restoration development and implementation process. Communication differs from Stakeholder Engagement in that it is more limited to delivering information (one way) whereas stakeholder engagement represents a two-way flow of information. Inreach refers to communication within an agency or decision-making authority (e.g., CWPPRA, LA TIG). Mechanisms need to be in place to inform agency staff of progress and direction. Informed staff will generally make more informed decisions relative to their own job responsibilities, and opportunities to implement lessons learned across projects are more likely to happen with increased communication and emphasis on inreach. Outreach includes actions to keep stakeholders informed, such as emails, press releases, internet messaging, briefings, meetings, and presentations. Communication tools such as ecosystem report cards can also track progress towards achieving programmatic goals and are critical to inform a large diverse audience on the effectiveness of projects and collective performance of groups of projects.

1.2.13.5. KNOWLEDGE BASE LINKAGES AND FLOWS (SECTION 2.5)

At the core of the knowledge base and the primary mechanism for providing knowledge, data, and information to programs and projects is Information Management (Figure 6). Information management can be one or multiple information centralization and delivery systems, including databases, project management mechanisms, commonly accessible drives, or website portals, etc. An essential element of information management to support effective adaptive management is some centralized, accessible, and searchable mechanism for capturing and storing lessons learned, as well as documenting approaches and information used to support decision making. The format is not important, but functionality is very important, so this mechanism or tool must be broadly accessible, easy to access and use, dynamic (searchable), and adaptable so that it can evolve and change as funding sources, needs and technologies change over time. Primary input to information management is from projects and portfolios of projects. This includes programmatic vision statements, planning documents, background resources and information, project design, completion and monitoring reports, and outputs from modeling efforts to support project design and operations. These primary documents are used to inform stakeholder engagement; to provide source documents to inform synthesis documents (multiple formats such as by geography and restoration type); and to serve as a resource for identification and prioritization of applied research needs.

Developed synthesis reports, completed applied research, and compilations of stakeholder input are subsequently deposited back into the central Information Management systems. Synthesis documents are used for communication, both inreach within the parent organization and primary agency, as well as outreach to other agencies or organizations. These communication efforts result in additional products, including newsletters and fact sheets, which once again are deposited back into the central information management systems. This summary of information, knowledge, and data flow highlights the importance of the Information Management system to effective adaptive management of projects and programs (Figure 6).

How to disperse this information, provide access to this information, and identify who would benefit the most from this information is further is essential to ensure that future decisions are making best use of this knowledge, and is elaborated in sections 2.5, 2.1, and 2.2.

2.0 Adaptive Management in Louisiana

Aim:

To summarize current processes and procedures within the state of Louisiana associated with implementation of adaptive management

The information in part two is divided into the following six sections:

2.1 Programmatic Adaptive Management
Considerations for programmatic adaptive management, as well as summarizing the process for development of project portfolios and monitoring and assessment of project portfolios for major programmatic restoration implementation mechanisms within Louisiana.

2.2 Project Adaptive Management
Details of project-related considerations for adaptive management with specific focus on processes at CPRA and discussion of relevant NRDA processes through the LA TIG.

2.3 Information Management
An overview of information management mechanisms currently used within Louisiana, in particular at CPRA and through NRDA processes. This includes data management, document storage, with specific mention of opportunities for synergies and the development of centralized capture and delivery mechanisms for lessons learned.

2.4 Applied Synthesis and Research
Past approaches and mechanisms to develop and carry out applied synthesis and research, as well as opportunities for linkages and closer connections between priorities for and outputs from applied synthesis and research activities.

2.5 Stakeholder Engagement and Communication
Description of flows of information, specifically with respect to stakeholder engagement and communication (both inreach and outreach), highlighting steps in the adaptive management cycle where these flows and connections are particularly important.

2.6 Adaptive Management Coordination
A description of this essential process for adaptive management, with specific consideration of transfers of knowledge and information between project adaptive management and programmatic considerations.

2.1. Programmatic Adaptive Management

2.1.1. Introduction

Application of adaptive management to programmatic decisions utilizes the steps defined in Section 1.2 that are summarized into three overarching phases (Figure 7):

Phase 1. **Project Portfolio Development**: Tens to hundreds of projects are identified/proposed, screened, and ultimately selected for a restoration plan. This phase incorporates the following steps of the adaptive management cycle: Define the Problem; Set Goals and Objectives; Develop or Refine Models (including numerical and conceptual models); Identify and Prioritize Uncertainties; and Plan Formulation and Engineering Design.

Phase 2. **Portfolio Monitoring and Assessment**: Selected portfolio of projects is implemented, monitoring is conducted, and resulting data is used to assess and evaluate the progress towards reaching the goals and resolving uncertainties identified in Phase 1. This phase incorporates the following steps of the adaptive management cycle (Figure 7): Operate, Maintain, Monitor and Assess and Evaluate.

Phase 3. **Adaptive Management Coordination**: Information learned from the portfolio development and portfolio monitoring and assessment phases is gathered to technically inform the next portfolio of projects to achieve programmatic goals. This phase incorporates two steps of the adaptive management cycle; Recommend Revisions and Approve Adjustments.

Each of these phases intersect with the knowledge base. As described in Section 1.2, the knowledge base comprises the information resources and personnel capacity supporting adaptive management and includes Information Management (databases, model repositories, lessons learned, document libraries), Applied Synthesis and Research (execution of and the resulting outputs), Stakeholder engagement (activities and outputs), and Communication (web sites, electronic, printed materials, verbal communications, fact sheets, etc.). The knowledge base is therefore the central hub for building, retaining, and communicating institutional knowledge to future decisions regarding portfolio development (Figure 7). The specific feedback processes differ under the governance structures of the various protection and restoration entities Section (1.1). Principles of learning, knowledge capture and feedback for successful programmatic adaptive management are shared and provide an opportunity to integrate this feedback across entities via the knowledge base.

In the following sections, the personnel involved, the tools and approaches used and how these might vary across different agencies conducting programmatic adaptive management, are described for each of the phases. Opportunities for maximizing the success of adaptive management, identify synergies among restoration programs utilizing adaptive management, and descriptions of how each of the phases intersect with the knowledge base components are all identified.

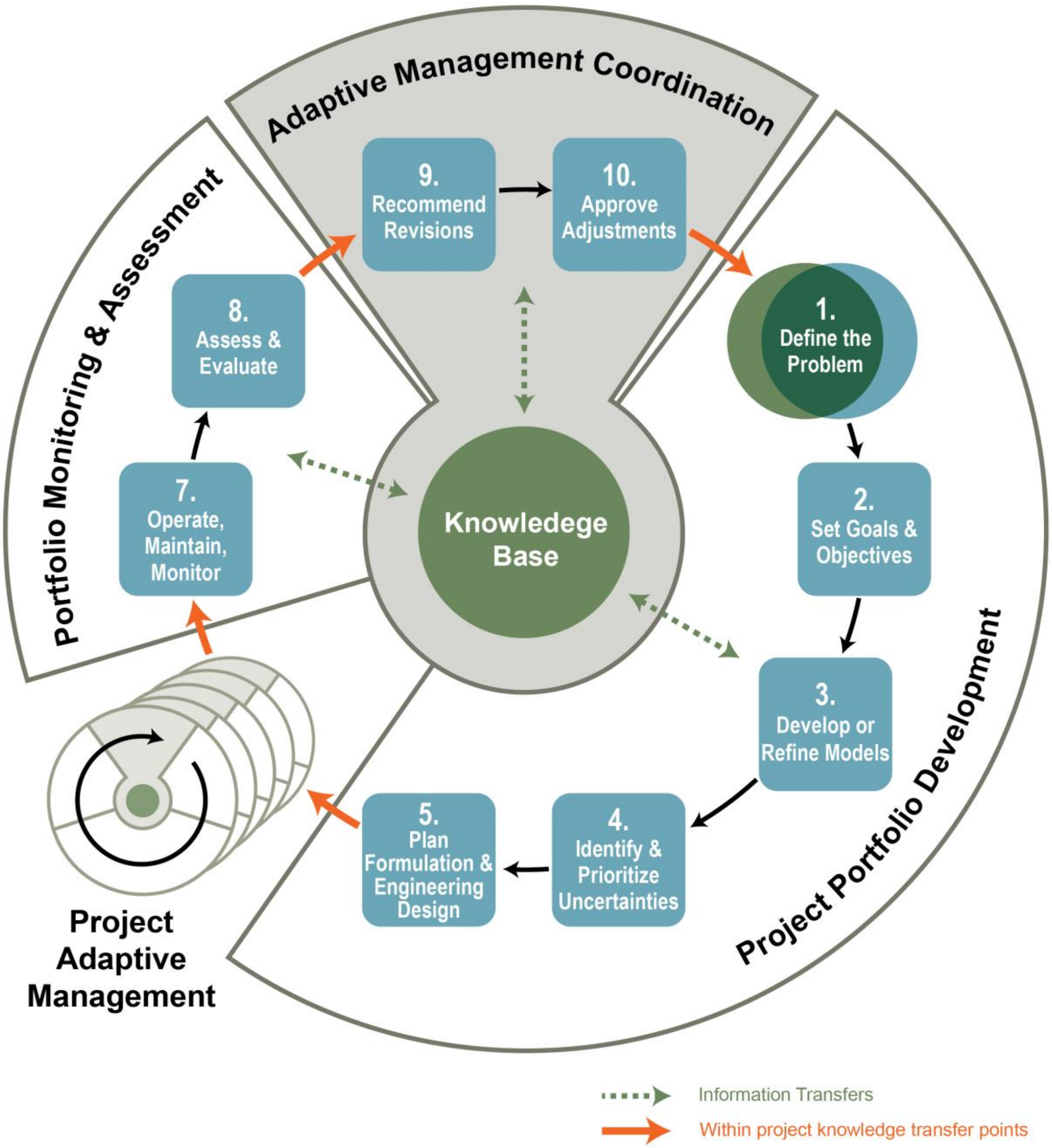


Figure 7. The three phases of programmatic adaptive management: Project Portfolio Development, Portfolio Monitoring and Assessment, and Adaptive Management Coordination, showing how these connect to the steps of the adaptive management cycle (blue fill) as well as the knowledge base (green fill: for description of the knowledge base; Section 1.2)

2.1.2. Phase 1: Programmatic: Develop Project Portfolio

2.1.2.1. SUMMARY

The complexity of funding allocations and the multitude of decision makers and governance structures presents a challenge, but also significant opportunities, for implementing programmatic adaptive management (Section 1.1). Successful programmatic adaptive management requires moving beyond divisions imposed by entities, funding availability, geography, or restoration type and applying a holistic view of decisions that influence the portfolio of projects pursued in a given implementation cycle.

2.1.2.1.1. Step 1: Define the Problem

Problem statements guide the development of goals and objectives and form the basis of establishing and assessing specific portfolios of projects. Problem statements are currently defined in CPRA's founding legislation, CPRA's Coastal Master Plan, NRDA's 2016 PDARP/PEIS, RESTORE's 2016 Comprehensive Plan Update, CWPPRA's authorization under Public Law 101-646, and NFWF GEBF Criminal Settlements. (CPRA, 2017b; CWPPRA, 2014; DWH NRDA, 2016; GCERC, 2016; USDC, 2013, 2012). CPRA's founding legislation, Coastal Master Plan, and CWPPRA focus on the causes and implications of land loss in coastal Louisiana, while NRDA PDARP and NFWF GEBF focuses on injuries that were documented following the DWH oil spill gulf-wide. RESTORE's Comprehensive Plan takes a broader focus on the long-term health of the ecosystem and economy of the Gulf coast region. Synthesizing these problem statements among entities provides an opportunity to identify commonalities and distinct differences in what each entity is responsible for addressing. To support programmatic adaptive management, problem statements should be revisited during every implementation cycle. Additionally, they should be revised if new restoration program authorizations (and associated problem statements) are established, changes in coastal conditions warrant reframing, or if projects are not adequately addressing the underlying problem and no viable alternatives can be identified (Hijuelos & Reed, 2017).

Key Finding 5	*Revisit problem statements at the beginning of each programmatic adaptive management cycle and synthesize across entities to identify commonalities and differences.*

2.1.2.1.2. Step 2: Set Goals and Objectives

Programmatic goals provide a common vision and context for executing a portfolio of restoration projects. Each of the entities within Louisiana has established a set of programmatic goals and these are documented in the Coastal Master Plan, PDARP/PEIS, and RESTORE Comprehensive Plan. The scale at which these goals are applied varies among entities. PDARP/PEIS and RESTORE Comprehensive Plan goals were established for their funding programs and are thus applicable Gulfwide, or wherever restoration may occur. The Coastal Master Plan established Louisiana coastwide goals. A systematic effort to link goals between programs has not yet been completed, this would provide an opportunity for identifying commonalities and differences. Furthermore, it would enable stakeholders to understand the linkages across entities and how projects collectively address multiple goals. If programmatic goals are added or revised, an advisory team (e.g., the Coastwide Advisory Team used in the Coastal Master Plan process) should revisit all goals to determine whether (1) they are appropriate to address the problem statement(s), (2) they have objectives that are SMART (specific, measurable, achievable, relevant, time-bounded), and (3) there is observational data that can be synthesized to assess progress towards achieving goals.

Active stakeholder engagement is essential during the step of defining goals to ensure they capture local knowledge and values. Numerous existing stakeholder groups and meetings have been established across the Louisiana restoration entities, including advisory boards, technical committees, and citizen groups and could be leveraged during the review stages of programmatic goals (Section 2.5). Mechanisms beyond public meetings are needed to further capture and compile input from stakeholders and incorporate this community knowledge into the knowledge base.

Key Finding 6	*Active efforts and approaches are required to incorporate stakeholder input into the adaptive management knowledge base.*

Programmatic assessment requires a set of core performance monitoring metrics to quantitatively evaluate progress. These metrics should be "SMART" and directly assess progress towards programmatic goals and inform refinement of objectives in an adaptive management context. Once metrics are identified to assess programmatic objectives, analytical approaches should be developed, tested, and conducted (see Hijuelos & Reed (2017)). This may also include characterization of natural variability for some metrics through analytical or numerical modeling approaches. Some of these analyses and assessments may occur over more than one cycle of particular project portfolio implementation processes (e.g., the Master Plan Process six-year cycle) and may need to be phased or subdivided to build knowledge.

Key Finding 7	*Programmatically assess ecosystem effects of project portfolios by setting explicit goals and quantifiable objectives.*

Broad goals for the project portfolios may not be addressed individually in each geographic unit, such as hydrologic basins (Calcasieu-Sabine, Mermentau, Teche-Vermilion, Atchafalaya, Terrebonne, Barataria, Breton Sound, Pontchartrain, and bird's foot of the Mississippi River Delta), or even larger geomorphologic units (Mississippi River Delta Plain, Mid-Deltaic Plain, and Chenier Plain) in Louisiana. Alternately, these can be summarized by restoration type (i.e., marsh creation, barrier island restoration, etc.), or by entity (i.e., CPRA, LA TIG, RESTORE, NFWF, CWPPRA). Stepping down the broad goals and objectives to each geographic unit and identifying how they contribute to higher-level programmatic goals can inform can provide a geographic framework for linking restoration efforts from multiple entities. This can provide targeted outcomes or trajectories of change (compared to no action) by basin and help determine if interim goals and objectives are realistic and have been achieved or whether a new course of action is needed in the next planning cycle. Aggregating and assessing goals and objectives by restoration type would be beneficial in the same way for assessing progress toward achieving goals established in the PDARP, for example in the development of an LA TIG MAM strategy.

Key Finding 8	*Synthesis of the explicit goals and quantifiable objectives of different portfolios of projects implemented across multiple entities within watersheds and/or large basins.*

Since entities have their own requirements and mandates, there may be occasions where the development of project portfolios to address goals and objectives need to be modified to fit specific funding programs. For example, the approach and process for developing project portfolios under NRDA needs to be consistent with "Trustee Council Standard Operating Procedures for Implementation of the Natural Resource Restoration for the Deepwater Horizon (DWH) Oil Spill" – Originally approved May 4, 2016; revised November 15, 2016 (DWH NRDA Trustees, 2016). This may require additional objectives to be included for Louisiana Coastal Master Plan projects identified for implementation within the Louisiana TIG.

2.1.2.1.3. Step 3: Develop or Refine Models

A critical part of the programmatic planning process is to reduce uncertainty over time. This uncertainty can be captured in conceptual and numerical models. Within the context of ecosystem restoration and management, conceptual models represent the current understanding of functional relationships among essential components of the ecosystem. Numerical models are then used to understand current processes and quantitatively indicate how scenarios of restoration project portfolios may influence ecosystem components in the future. Evaluating uncertainties with numerical models therefore serves as a mechanism to continually update knowledge, a key component of the adaptive management processes. Both conceptual and numerical models can be scaled to the geographic units of management decisions or relevant to assessing programmatic goals.

Conceptual models have been used in Louisiana as a tool to consolidate understanding of system processes and highlight knowledge gaps within hydrological basins (Costanza, 1983; Nuttle et al., 2008). Conceptual models should illustrate the effects of important natural and anthropogenic activities that result in different ecological stressors on the system. Conceptual models can provide a reference point throughout the whole adaptive management cycle if they include: Specific physical, chemical, biological, and human use attributes of the system that determine system dynamics (influences approaches for ecosystem and project monitoring); ways in which system drivers cause change in the ecosystem (influences steps to develop or refine models); critical thresholds of ecological processes and environmental conditions (supports assessing ecosystem condition); assumptions and gaps in the state of the knowledge (to identify research needs), especially those that limit the predictability of restoration and protection outcomes; and current characteristics of the system that may limit achievement of management outcomes (important when revising programmatic goals). Revisiting conceptual models at the start of each planning cycle should correspond with the re-evaluation of problem statements, goals, and objectives in Phase 1 when project portfolios are being developed. Furthermore, unifying conceptual models across Louisiana restoration entities and revisiting them collectively at the start of planning cycles is needed to ensure there is shared understanding and agreement on system dynamics, underlying assumptions, and critical uncertainties.

Key Finding 9	*Develop or modify conceptual models for geographic units, such as hydrologic basins, in coastal Louisiana, and unify models across Louisiana restoration entities.*

Within Louisiana, there is extensive experience utilizing numerical models throughout the planning and design process, in particular by CPRA (Section 2.2.3.1.1). The last two Coastal Master Plan cycles (CPRA, 2012, 2017b) utilized a suite of numerical models and decision-support tools (Brown et al., 2017; CPRA, 2017b; Groves et al., 2017; Meselhe et al., 2017) that have undergone systematic improvements (CPRA, 2013), incorporating feedback from regular engagement with stakeholder and advisory groups (e.g., FDT, PM-TAC). Applied collectively to all the projects in a portfolio, numerical models are important for predicting and assessing the ability to make progress toward programmatic goals and objectives, such as how much land area will be built or maintained into the future. The Coastal Master Plan models predict project "performance" based on land area and risk reduction relative to the future without action over a 50-year period.

Numerical models used for establishing project portfolios as well as for project planning, design, and construction/implementation should have assumptions that are clearly documented and summarized into technical reports for easy reference to support programmatic adaptive management. CPRA currently does this in a series of technical appendices in the Coastal Master Plan. Where considered to have high potential relevance to future efforts, information about each model used for restoration efforts is included as part of CPRA's model inventory, which is currently available online as the Model Domains layer in the Main Spatial Viewer of CIMS - *https://cims.coastal.la.gov/*. In addition to inventories of models, development of common repositories of model code as well as input and output files, accommodating versioning records and coordinating common model development has high potential to improve adaptive management.

Key Finding 10	*Identify opportunities to leverage Coastal Master Plan modeling and planning tool to support other restoration entities.*

For the models used within the Coastal Master Plan, CPRA currently places reports and documentation of general model attributes in CIMS. Templates for summary tracking tables (with pre-defined formatting for easy incorporation into a data management system) should be developed and then filled out for each modeling effort. Two distinct tables are proposed: One to incorporate a version tracking capability as the modeled processes and assumptions are adjusted and a second simulation tracking table. Changes from one model version to the next should be summarized in a single table that tracks all changes/updates for a model by version. Such a table would be a Model Versioning Table (Table 13 and

Table 14 in Annex 5.1). Additionally, all model simulations and production runs should be tracked
Table 15 in Annex 5.1.

This Model Simulation Table should clearly indicate which simulations are FWOA runs and should provide succinct information on the model and model version used as well as any other assumptions or conditions that may differ among runs (e.g., rate of sea level rise, diversions operations, etc.). These changes should also be documented and explained in more detail in technical memos or reports for each new version. These processes and recommendations are already in place for CPRA specific to coastal master plan models; however, a shortcoming is the narrow scope of the goals and objectives relative to all restoration entities in Louisiana. An important consideration is to identify leveraging opportunities from the well-established processes of CPRA in the modeling arena to the goals and objectives of funding entities resulting from the DWH oil spill (RESTORE, NRDA, NFWF). This could be facilitated and advanced through establishment of a common approach to model versioning such as a centralized repository for numerical models within Louisiana.

Key Finding 11	*Establish consistent model tracking templates and seek opportunities for refinement and application of current CPRA processes to other restoration entities.*

Reports related to numerical modeling are also linked to a model inventory spatial database which is currently available online as the *Model Domains* layer in the Main Spatial Viewer of the CIMS. In some cases, model development and analysis are also documented in peer-review journal publications, such as Special Issue #67 of the Journal of Coastal Research entitled "Louisiana's 2012 Coastal Master Plan Technical Analysis." Formal mechanisms to capture the key decisions and lessons learned, such as in Appendix D of the Coastal Master Plan 2017, and access in a fully searchable format would increase support to programmatic adaptive management decision making.

Various restoration planning models are used under different entities in Louisiana. The different numerical modeling efforts provide the potential for comparing model outputs or ensemble modeling. Even when specifically planned these comparisons are challenging, as different models have different strengths and weaknesses, so often provide specific information on different aspects of restoration success or potential futures. For example, a project undergoing a feasibility study may be subjected to sea level rise assumptions in line with USACE guidance; whereas, the Coastal Master Plan process chooses future environmental scenarios in a separate process. Previously, in Louisiana, these model comparison efforts have occurred in an ad-hoc manner for examining what model improvements may be needed in the respective models. When models with different underlying assumptions are predicting similar outcomes, there is strong inference that those outcomes are highly supported and the correct ecosystem drivers are being considered. As uncertainty surrounding objective quantification becomes better understood the modeling tool most suitable for quantifying programmatic or project success in achieving objectives and sub-objectives may change. Numerical model improvement, or development of new models, should be regularly assessed with respect to their ability to quantitatively assess success in achieving programmatic objectives. Overall for numerical modeling, maximizing consistency while minimizing redundancy will provide the best support to programmatic adaptive management.

Key Finding 12	*Examine current numerical models for their ability to quantify programmatic objectives and sub-objectives. Revise models, where appropriate, or formally conduct cross-model comparisons.*

Key Finding 13	*Programmatically consider synergies in numerical modeling tools and metrics utilized in coastal Louisiana to promote consistency, reduce duplication of effort, and refine future modeling efforts.*

2.1.2.1.4. Step 4: Identify and Prioritize Uncertainties

Many uncertainties influence implementation of coastal restoration including uncertainties in knowledge, variability, and language (Hijuelos & Reed, 2017). There are multiple ways to identify and prioritize these uncertainties either qualitatively or quantitatively. These include:

- Interviews with project managers about the critical questions they face in project planning, implementation, or evaluation.
- Assessment of data on failed or under-performing projects.
- Thoughtful consideration of the state of the science relative to various aspects of the ecosystem restoration.
- Systematic literature review.
- Assessment of model predictions relative to actual conditions.

The Coastal Master Plan process has considered how to address various types of uncertainty and DWH NRDA is identifying knowledge uncertainties associated with restoration types to inform future project portfolios (DWH Trustees, 2017b; Hijuelos & Reed, 2017).

Modeling analyses including sensitivity testing serve as means to understand uncertainties of the system and of the decision-making process (Table 6). For example, model analyses can be used to evaluate uncertainties in coastal processes (e.g., how organic accretion responds to nutrient loading to a wetland system), parametric data variability and error (e.g., precision of water level data loggers), and model-produced variability and error (e.g., numerical estimation/representation of physical processes, calibration/validation error). Uncertainties surrounding the inherent variability of environmental conditions (e.g., wet versus dry years) and the unknowability of future conditions (e.g., future landfall of hurricanes, sea level rise, etc.) can also be examined within a modeling framework. Additional uncertainties important to the decision-making context are also commonly addressed via modeling exercises (e.g., population growth, future availability of project funds, etc.).

Table 6. Uncertainty Typologies, Types, Definitions (Ascough et al., 2008) and Examples from the Coastal Master Plan (Hijuelos & Reed, 2017)

Typology	Type		Definition/Source	Coastal Master Plan Example
Knowledge Uncertainty	Process Understanding		The limits of scientific understanding including spatial and temporal scales at which knowledge applies	The processes controlling marsh edge erosion and marsh collapse
	Model Uncertainty	Parametric Data	Model parameters which may arise from measurement error, type of data, or length of data record	Errors in LIDAR data; dated bathymetric surveys
		Structure	Use of surrogate variables, exclusion of variables, relationships among variables, and approximations from functional forms, equations, and mathematical expressions used to represent the system	Vegetation response as dictated by salinity and water depth look-up tables
		Technical	Software or hardware; coding; algorithms	Sensitivity to floating point calculation that lead to changes in model outcomes
		Output	Accumulated uncertainty propagated through model; discrepancy between true value of an outcome and model predicted value	Joint probability model used to estimate flood depths in the CLARA model
Variability Uncertainty	Natural		Inherent randomness of nature, i.e., the chaotic and unpredictable quality of natural processes	Frequency and location of storms
	Human		Values and attitudes of the environmental manager/decision maker, current political climate	Elevation standards for nonstructural flood protection
	Institutional		Social, economic, and cultural dynamics (societal variability)	Response of populations to coastal change and flooding
	Technological		New developments or breakthroughs in technology or unexpected consequences ('side-effects') of technologies	Project costs associated with dredge/placement of material

Typology	Type	Definition/Source	Coastal Master Plan Example
Linguistic Uncertainty	Vagueness	When a precise description of a quantity or entity is not available	Habitat suitability as a way to describe relative importance of an area to an organism, such as blue crabs
	Ambiguity	Words have more than one meaning	Land loss as a term to describe coastal change when many do not consider wetlands as land
	Under specificity	Unwanted generality in the data	Exact sampling location for a data point is not recorded (e.g., Lake Lery as opposed to the exact GPS coordinates)
Decision Uncertainty	Goals/Objectives	Ambiguity in how to quantify or compare objectives	Whether metrics based on model results can meaningfully represent the outcomes anticipated by the master plan objectives
	Assessment Criteria	Quantitative policy analysis after the estimation of risk has been generated	Planning Tool algorithms used to rank based on metrics and model outputs
	Future Courses of Actions	The way model predictions are interpreted and communicated, especially with regard to future courses of action	Whether project design and implementation timelines have been estimated accurately and whether other factors will influence actual time to project execution; availability of funding streams over time

An example of how this process is applied within the Coastal Master Plan is that uncertainties (e.g., sea level rise, subsidence rates, precipitation, evapotranspiration, frequency and intensity of tropical events) are revisited at the beginning of every Coastal Master Plan cycle. Key uncertainties are identified by the Coastal Master Plan Delivery Team and/or the Model Development Team, new information is gathered/evaluated, and ranges of environmental uncertainty for use in the 50-year model runs are revised. Within each modeling development cycle of the Coastal Master Plan, information and decisions related to model uncertainties for previous Coastal Master Plans are reviewed by stakeholder and advisory groups (e.g., 2017 Coastal Master Plan Appendix C, Chapter 2, and Attachments C2-1 – C2-5). (Meselhe et al., 2017). Model uncertainties surrounding specific decision metrics (e.g., land area gain and flood risk reduction) need to be quantified and incorporated into the decision-making process, which is mostly focused on the environmental uncertainties (e.g., sea level rise) that are tested in scenario-based analyses. In addition to clarifying specified management decisions (based on programmatic goals), thorough uncertainty analysis is also important for other model output related to assessing programmatic goals (e.g., Habitat Suitability Indices, vegetation type cover, fisheries biomass, etc.).

Development of uncertainty matrices can help organize and document the identified knowledge, variability, and decision uncertainties within and across entities. Uncertainty matrices can be used to document uncertainties; including quantifying their relative magnitudes and determining whether they can be resolved. Matrices can also include assessments of the relative significance of uncertainties in development of future project portfolios or the tools that support portfolio development. Uncertainty assessments would therefore inform:

- The prioritization of model improvements.
- Setting of programmatic goals and objective.
- Engineering and design processes.
- Plan formulation and/or project construction.
- Monitoring programmatic development.

Examples of such matrices can be found in the Comprehensive Everglades Restoration Plan adaptive management plan (RECOVER, 2015).

Key Finding 14	*Develop uncertainty matrices for numerical modeling efforts, and other types of uncertainty, that inform programmatic adaptive management.*

2.1.2.1.5. Step 5: Plan Formulation and Engineering Design

During plan formulation, individual projects and the portfolio of projects are evaluated with respect to benefit, cost, and other factors. As an example, within the Coastal Master Plan process, the portfolio resulting from each planning cycle is a collection of projects to be considered for future implementation. Projects identified during the previous Coastal Master Plan that have not been built are modeled again along with newly proposed projects. As a result, it is possible that a project recommended in one planning cycle may not be selected in subsequent planning cycles. However, projects on-the-ground or those undergoing implementation are not reevaluated by the Coastal Master Plan, although new projects that are being evaluated will consider the presence of projects undergoing implementation. At the beginning of each Coastal Master Plan cycle, the MPDT meets with feasibility and engineering teams to discuss the list of candidate projects and formulate updated assumptions for each project (cost, design, operations, etc.). This “project attribute” information, input for the models, is documented in project fact sheets (e.g., 2017 Coastal Master Plan Appendix A) (McMann et al., 2017). In the 2012 and 2017 Coastal Master Plans, input on projects evaluated for potential inclusion was also provided through stakeholder and advisory teams as well as public solicitation.

Project portfolios that come out of CWPPRA, LA TIG and NFWF restoration plan development processes must consider and/or be consistent with, the Coastal Master Plan. This does not mean that CWPPRA, LA TIG and NFWF utilize Coastal Master Plan models to formulate their project priority lists; however, some projects that are considered in the portfolios have already been evaluated by Coastal Master Plan models. Additionally, due to NFWF’s fiduciary role, their decision metrics and goals are primarily fiduciary, intended to manage the risk and uncertainty of project implementation. An underlying assumption is that the project portfolios developed under CWPPRA, LA TIG and NFWF will address the overarching goals of the Coastal Master Plan.

Project portfolios are generated by the LA TIG through the restoration planning process. The resultant restoration plans consider funding available for each Restoration Type within the LA Restoration Area (e.g., Wetlands, Coastal, and Nearshore Habitats, Federal Lands, Water Quality, Birds, Oysters, SAV, Sea Turtles, Marine Mammals, Recreational Use). In addition, they consider the restoration approaches and techniques defined for those Restoration Types in the PDARP/PEIS, and the TIGs need to sequence restoration for these resources and habitats over time. The LA TIG and individual Trustees within the TIG consider project ideas developed by the Trustees and relevant Coastal Master Plan projects as well as those submitted by the public. The TIG screens all project ideas to arrive at a reasonable range of project alternatives that will continue to be considered. Screening adheres to project selection criteria consistent with OPA regulations (CFR, 1996b); https://darrp.noaa.gov/sites/default/files/OPA_CFR-1999-title15-vol3-part990.pdf), the PDARP/PEIS, the TC SOP, and any additional evaluation criteria established by the TIG, such as consistency with the Coastal Master Plan. The TIG analyzes the reasonable range of alternatives to describe how a preferred alternative addresses injury from DWH spill and fits within the goals both programmatically and for the restoration type. The LA TIG provides an opportunity for public review and comment on the draft and final restoration plans and provides notifications through the *Federal Register*, web-based outreach through the Trustee Council website, and other communication to reach affected stakeholders. Details are specified in the Trustee Council SOP (DWH NRDA Trustees, 2016)(www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/DWH-SOPs.pdf).

To support ongoing programmatic adaptive management, it is necessary to regularly re-assess the validity of assumptions used to identify project portfolios to confirm that the assumptions allow adequate evaluation of goals and objectives. One example that has been identified is improving the process and standards for project cost estimation to apply programmatically across restoration project types. Cost estimation and implementation periods that have implications for financial constraints within the 2017 Coastal Master Plan are discussed in Appendix D with some additional detail on cost estimation in Appendix A. Unit costs and other costing assumptions and uncertainties are assessed for each Coastal Master Plan cycle with input from design engineers.

Key Finding 15 *Identify and assess assumptions used in the development of project portfolios.*

2.1.2.1.6. Interaction with the Knowledge Base

During the project portfolio development phase, programmatic adaptive management will be informed by, and provide input to, results and lessons learned from constructed projects, inputs of scientific data and syntheses from the Applied Synthesis and Research component of the knowledge base, and compiled data and information available from the Information Management component. Stakeholder Engagement and Communication will also provide key science communication and outreach materials support, especially in the problem statement and goals and objectives steps of the adaptive management cycle. Those knowledge bases support recommendations for improvements in each project portfolio planning cycle, decisions regarding those recommendations, and documentation of those decisions and the lessons learned, regardless of restoration funding entity.

2.1.3. Implementing Project Portfolio

Implementation for a portfolio of projects involves the specific execution of individual projects. Adaptive management for project implementation is discussed in detail in Section 2.2.

2.1.4. Phase 2: Programmatic: Portfolio Monitoring and Assessment

2.1.4.1. SUMMARY

Monitoring, assessing, and evaluating programmatic performance is essential but challenging. The purpose of performing these activities on all Louisiana restoration efforts is to determine how any given portfolio of projects contributes to achieving overarching programmatic goals. Monitoring, assessment, and evaluation are required at multiple spatial scales: Project, basin, regional, and coastwide. Although assessment of programmatic performance will ultimately be conducted at the Louisiana coastwide (or Gulfwide) scale, assessments performed at the other spatial scales or of specific restoration types can provide important context to decision makers throughout the restoration governance network.

Multiple funding entities and a complex governance structure presents a challenge for monitoring and assessing portfolios of restoration projects. Each entity has a responsibility to report out on the effectiveness of their individual efforts to improve coastal ecosystems. It is challenging to collect and collate the necessary data to evaluate programmatic success when cumulative effects of multiple projects and programs are implemented in the same geographic areas. Examples exist of evidence-based evaluation approaches to assess cumulative effects of restoration where there are complex linkages between restoration actions and ecosystem responses (Diefenderfer et al., 2016), although this has not been formally applied in Louisiana.

2.1.4.1.1. Step 7: Operate, Maintain, Monitor

Programmatically, operating and maintaining refers to continued development of portfolios of projects and ensuring that those project portfolios are implemented (Figure 7). However, programmatically, the monitoring component of this adaptive management step is the most important. SWAMP is a long-term comprehensive coastal data monitoring network and is intended to support the development, implementation, and adaptive management of coastal restoration projects and programs within coastal Louisiana (Hijuelos et al., 2013; Hijuelos & Hemmerling, 2015). Nested within SWAMP are the CRMS (Steyer et al., 2003) and the BICM (Kindinger et al., 2013) programs, as well as other project- or basin-level monitoring efforts. CRMS and BICM have been collecting a comprehensive set of core programmatic monitoring parameters for wetlands and barrier islands, respectively, since the mid-2000s. Detailed information on SWAMP and other existing monitoring efforts in Louisiana are described in Hijuelos & Hemmerling (2016) and in section 2.3 Information Management. As part of the hierarchical framework, project-level monitoring is typically nested within basin and coastwide scale monitoring, allowing results to be summarized at site, project, basin and coastwide scales.

Other state and federal agencies also collect data within Louisiana and those efforts are leveraged as part of the SWAMP design. Under the DWH settlements, additional data collection efforts at scales beyond the individual project may also be implemented to inform the planning, implementation, and evaluation of restoration. For the LA TIG, for example, coastwide colonial bird monitoring and marine mammal monitoring were planned and/or conducted in 2018 to support restoration efforts under DWH NRDA as well as 12 months of enhanced fish monitoring within the SWAMP monitoring framework. As the LA TIG identifies their MAM Priorities, additional data collection will be identified and implemented. Other TIGs such as the Regionwide TIG or Open Ocean TIG may also fund or conduct data collection in or around Louisiana to support restoration planning, implementation or evaluation. Communication and coordination between CPRA and other entities collecting data in Louisiana's coast is critical to ensure consistency in approaches, avoid duplication of effort, maximize monetary and field resources, and increase leverage capability of data coming in from different sources (e.g., colonial waterbird monitoring and BICM).

As the geographic extent of SWAMP increases in Louisiana, there are increasing opportunities to incorporate new monitoring data into both programmatic planning and numerical model improvement processes. Formalized and reoccurring discussions between modelers and individuals managing the monitoring programs would be beneficial, at a minimum, at the start of each programmatic planning cycle. For the CPRA Coastal Master Plan, for example, the development of a model improvement plan should consider any new monitoring data collected through SWAMP. To facilitate this process, a monitoring inventory database, as recommended in Hijuelos & Hemmerling (2016), should be created, maintained, and utilized. A team within CPRA, either the SWAMP planning and implementation team or a new team, should update the monitoring database compiled during SWAMP development (Hijuelos & Hemmerling, 2015) and that team should be responsible for continual maintenance and periodic updating of the database. Other tasks of this team could include maintaining the monitoring QA/QC processes, ensuring variables remain relevant, and ensuring variables are collected at appropriate spatial and temporal scales (Section 2.3).

Key Finding 16	_Facilitate expanded use of SWAMP monitoring data in programmatic planning._

Key Finding 17	Actively seek opportunities to align programmatic planning cycles amongst restoration funding and implementing entities.

Standard operating procedures, quality control and quality assurance methodologies, and data management are all vital elements to implementing and managing monitoring efforts. Data for CPRA are managed in CIMS (https://cims.coastal.la.gov/; see Information Management Section 2.3), while under the DWH NRDA, data are managed using DIVER (https://www.diver.orr.noaa.gov/). SOPs and QA/QC processes have been developed for all the data types collected by CRMS including water level, salinity, vegetation, elevation change, accretion, soils and land change; and procedures are in development for data types collected under SWAMP in association with CRMS sites including biomass and water quality. CRMS and SWAMP QA/QC processes are described in detail in the CRMS SOP (Folse et al., 2018). However, existing gaps in these procedures are recognized and further described in the Recommended Procedures section below. Under DWH NRDA, a monitoring and adaptive management manual (version 1) describes universal QA/QC approaches and provides monitoring guidance for specific restoration approaches associated with projects that create, restore, and enhance coastal wetlands; create, restore, and enhance barrier and coastal islands and headlands; restore and enhance dunes and beaches; reduce nutrient loads and pollution and hydrologic degradation to coastal watersheds; enhance public access to natural resources for recreational use; and enhance recreational experiences (DWH NRDA Trustees, 2017). The guidance recommends core restoration project performance monitoring parameters, objective specific performance monitoring parameters, and other supporting parameters for consideration. Additional monitoring guidance will be developed for future versions of the MAM Manual, such as guidance for oyster, SAV, bird, sea turtle, and marine mammal restoration projects. Alignment of monitoring methodologies and core performance monitoring parameters with SWAMP, CRMS and BICM, along with those under DWH NRDA, RESTORE, and NFWF will ensure that collected data can be aggregated across projects to inform programmatic evaluations and reporting. There are some existing coordination mechanisms to facilitate collaborative learning (transfer of lessons learned amongst entities) and optimize monitoring, synthesis, research, data management, and reporting efforts and responsibilities. Groups such as the Cross-TIG MAM Work Group, RESTORE Council Monitoring and Assessment Workgroup and the RESTORE Council Monitoring Coordination Committee can serve as venues to collate and share information, and leverage lessons learned to improve programmatic adaptive management in coastal Louisiana.

Key Finding 18	Align monitoring methodologies and core performance monitoring metrics amongst Louisiana data collection efforts.

2.1.4.1.2. System-Wide Assessment and Monitoring Program (SWAMP)

CPRA developed SWAMP in recognition of the critical role of monitoring in conducting adaptive management (Hijuelos et al., 2013; Hijuelos & Hemmerling, 2015). The goal of SWAMP is to be a unified plan for evaluating programmatic monitoring and assessment needs, identifying critical data gaps, and strategically filling those gaps. SWAMP is envisioned as scalable, allowing for data assessments of various geographic units (e.g., project-, basin-, and coastwide scales). Individual projects have monitoring plans which are nested within the larger SWAMP framework to assess project performance against original performance goals, SWAMP data provides reference information for these project assessments. The stations measure a common suite of parameters to provide data necessary to develop, implement, and manage protection and restoration efforts within coastal Louisiana (Table 7). Both CRMS and BICM have already been considered within the SWAMP framework, while other aspects of system dynamics, including offshore and inland water-body boundary conditions, nontidal freshwater habitats, riverine conditions, risk evaluations, and protection performance, are still to be fully incorporated.

Performing and documenting SWAMP's monitoring will allow the effort to adapt to changing needs over time. The assessment of SWAMP should include evaluating monitoring sampling design and SWAMP should be updated to incorporate new SOPs or restoration goals and objectives. Updating should occur, at a minimum, every six years to coincide with the Coastal Master Plan planning cycle to maximize best available science being incorporated into the development of system models and planning. Hijuelos & Reed (2017) recommend re-assessing SWAMP at year two of the Coastal Master Plan planning cycle or more regularly to align with other adaptive management processes. Regular reevaluation of SWAMP will support being responsive to changes in the knowledge base (e.g., changing needs, latest technology).

Key Finding 19 *Regular evaluation and refinement of SWAMP monitoring purpose and design.*

Table 7. Data types and when they were collected for each basin in coastal Louisiana within SWAMP (Adapted from Raynie (2018))

	Coastal Basin								
	CS	ME	TV	AT	TE	BA	MR	BS	PO
Weather & Climate									
Evapotranspiration									
Precipitation									
Wind Speed & Direction									
Biotic Integrity									
Wetland Biomass				2019	2019	2016		2017	
Nekton	2018	2018	2018	2018	2018	2015	2018	2018	2018
Oysters	2018	2018	2018	2018	2018	2015	2018	2018	2018
Soil Condition	2018	2018	2018	2018	2018	2018	2018	2018	2018
Vegetation Composition	2015	2015	2015	2015	2015	2015	2015	2015	2015
Physical Terrain									
Bathymetry					2018	2015		2017	2017
Subsidence						2018	2019	2019	2019
Surface Elevation	2017	2017	2017	2013	2015	2015	2011	2011	2017
Land Area	2016	2016	2016	2016	2016	2016	2016	2016	2016
Water Quality									
Chlorophyll a						2015		2017	2017
Dissolved Oxygen						2015		2017	2017
Nutrients						2015		2017	2017
Salinity						2015		2017	2017
Turbidity						2015		2017	2017
Total Suspended Solids						2015		2017	2017
Hydrology									
Current Velocity									
Water Level	2015	2015	2015	2015	2015	2015	2015	2015	2015
Waves									
Human Dimensions									
Population Demographics									
Housing and Community Characteristics									
Economy & Employment									
Ecosystem Dependency									
Protection of Residential Properties									
Protection of Critical Infrastructure & Services									

CS: Calcasieu, ME: Mermentau, TV: Teche-Vermilion, AT: Atchafalaya, TE: Terrebonne, BA: Barataria, MR: Mississippi River, BS: Breton Sound, PO: Pontchartrain

2.1.4.1.3. Barrier Island Comprehensive Monitoring (BICM)

BICM uses both historical and current data collections to assess and monitor changes in the aerial and subaqueous extent of barrier islands and shorelines. The data includes: Habitat types, sediment texture, geotechnical properties, environmental processes, and vegetation composition. Aerial still and video photography is used for documenting shoreline changes, habitat mapping, land change analyses, topographic (LiDAR) surveying for elevation determination, bathymetric surveying, and sediment sampling (Haywood, 2017). CPRA has also developed protocols for system-wide geophysical data acquisition that aid in the collection of data under LASARD (Section 2.3.2.2.2) and are incorporated as a part of CIMS (Khalil et al., 2016). Utilizing standard data collection protocols and a core set of metrics has allowed for an ecosystems or landscape approach to be used when evaluating collective performance of barrier island projects on shoreline and land area change. Evaluation of long-term trends and performance of past restoration projects allows for comparison of projected year of island disappearance with and without project. These data are essential in each planning cycle to inform future project portfolio selection as well as best project designs.

2.1.4.1.4. Coastwide Reference Monitoring System (CRMS)

CRMS data collection focuses on hydrology, vegetation, surface elevation dynamics, soil properties, and land/water configuration. The network includes 390 sites across coastal Louisiana that encompass the range of ecological conditions and habitat types where restoration actions are considered. Trajectories of reference sites are compared with project site data to assess attainment of restoration objectives by individual projects in reference to the wider system. Standard protocols for data acquisition (collection and processing), quality assurance, and quality control are outlined to ensure data quality prior to incorporation in the CIMS database. Data from the CIMS database are summarized, assembled into metrics (e.g., water and marsh elevation calculated into flooding), derived into indices (e.g., floristic quality index), and presented on the CRMS website (Folse et al., 2018) to support evaluation of ecological condition within sites or at a basin and Louisiana coastwide scales. The data from long-term (i.e., decadal) monitoring programs such as CRMS provide input data for numerical and empirical planning models and the testing of assumptions and uncertainties in those models, leading to model improvements. They also support basin-level assessments and broader synthesis of the effects of suites of restoration projects on ecosystem conditions (Section 2.4.4).

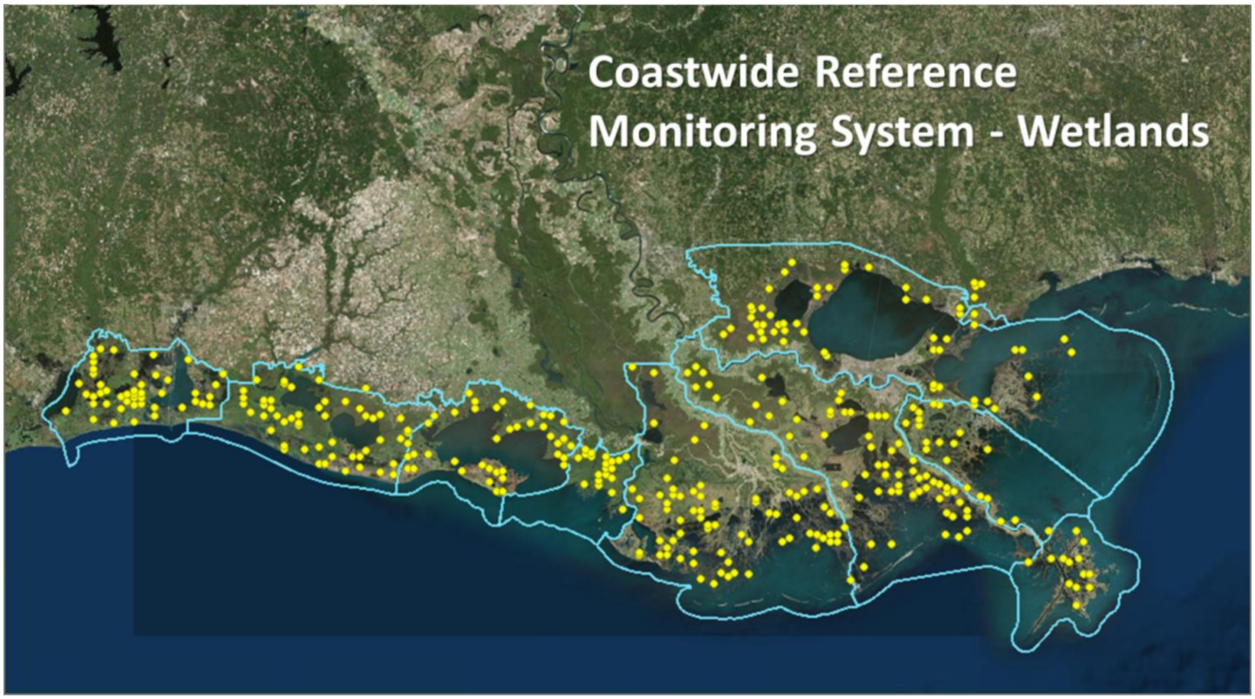


Figure 8. CRMS station locations in Louisiana (Raynie, 2018)

Key Finding 20	*Programmatic synthesis and communication of data gaps and knowledge uncertainties should be shared within and between entities for project portfolios.*

2.1.4.1.5. Step 8: Assess and Evaluate

Assessment and evaluation of a portfolio of projects is a systematic process of compiling, testing, and analyzing data to test underlying assumptions and make recommendations for future project selection. The assessment is a combination of data analyses, synthesis, and interpretation to "tell the story" of how the system is changing including the current particular portfolio and whether performance and ecosystem condition align with those predicted during the programmatic Project Portfolio Development phase (Section 2.5) (Hijuelos & Reed, 2017). While several monitoring efforts have been implemented in coastal Louisiana, comprehensive assessment and synthesis of natural and human systems status and evaluation of progress towards programmatic goals has not been fully developed or implemented. CPRA's Operations Division has started to compile basin reports to summarize trends in existing data. The Coastal Master Plan Delivery Team will capitalize on this effort for the 2023 Coastal Master Plan process. CRMS has also developed core metrics used for CWPPRA reporting to Congress (see 2.4 Synthesis and Applied Research). For LA TIG NRDA projects, Trustees have specific responsibilities to assess and evaluate performance including at annual and five yearly intervals. There is currently a need to formalize quantifiable objectives for each restoration type, this will be incorporated into the LA TIG MAM Strategy.

Incorporating assessment and evaluation into future decision processes will result in greater success in meeting programmatic goals (as well as being able to quantify if those goals were met). Assessments should directly inform the progress towards short (interim) and long-term programmatic goals and objectives.

Broadly speaking, assessments should be used to:

- Incrementally refine the original quantifiable programmatic objectives and metrics with post-construction landscape and data to determine how the system has changed and discuss trends/trajectories of land loss, flood risk, and injured resources;
- Re-evaluate past portfolio performance based on land, risk, and ecosystem outcomes;
- Test accuracy of numerical model outputs and test assumptions of the models;
- Determine whether short and long term coastwide goals and objectives are being met
- Track performance for the project portfolio implemented through the Coastal Master Plan, CWPPRA, NRDA LA TIG, Louisiana RESTORE and other relevant entities.

Key Finding 21	*Ensure that synthesis, assessment, and evaluation directly inform progress towards short- and long-term programmatic goals and objectives.*

Establishing interim targets establishes a framework to assess performance towards attainment of restoration objectives. Fundamental objectives may be developed using coastwide model outputs (e.g., Coastal Master Plan model) or basin-level model outputs and should reflect desired hydrological, geomorphological, ecological, and societal responses tempered against the reality of system dynamics.

Monitoring data can support numerical modeling in four ways. First, it can improve the ground-truthing/validation of model results to identify model strengths and weaknesses with respect to how well the system processes are simulated. Second, as new system processes are identified, it can provide a means to determine important processes not currently included in models and may justify future model improvements. Third, numerical models can be rerun using current monitoring data to test if the trajectories of system responses match modeled futures. Finally, observational data can be used to test the assumptions in the models.

When long-term (decadal) changes detected through coastwide monitoring do not match futures projected by numerical modeling those changes should be investigated with any ancillary data, project-level assessment, or peer-reviewed research. While some of these deviations may be due to individual project performance, some may be programmatic in nature, for example, if project interactions do not occur as anticipated or there are drivers outside the system, like water delivery from flood releases, or extreme weather events. If deviations from expected condition are still unexplained, then uncertainty should be documented using the typology defined in Table 6, conceptual models updated, and alternate hypotheses generated for testing during the subsequent planning cycles. This ensures the uncertainties are actively being considered within the programmatic adaptive management process.

Key Finding 22	*Interpretation of analyses should include comparison of modeled future condition and monitored condition relative to restoration objectives.*

For the coastal master planning process, considerations that could be added (or slightly re-framed) within the numerical modeling process include:

- Future with the Coastal Master Plan (currently referred to as Future With Action).
- Future without additional action (currently referred to as Future Without Action).
- Hindcast of existing conditions (model validation on observed landscape/boundary conditions).
- Hindcast "Without Past Actions" (additional scenario) so that the entire suite of all implemented actions can be quantified as well as the influence of solely the additional projects from the current planning cycle.
    - This would allow for the modeling framework to be used to assess the effects of the project portfolio for mid-range (e.g., year 10) targets.
    - This could assist in clarifying project impacts where they cannot be easily identified in monitoring data (especially when multiple projects are built in the same basin).
    - This simulation would aim to remove the environmental uncertainty surrounding future conditions and could be used to quantitatively assess successes, failures, and help identify key uncertainties/mistaken assumptions in past planning exercises that may have been overwhelmed by the magnitude of the uncertainties surrounding future environmental conditions.

Key Finding 23	*Expand model-based comparisons of predicted future condition in terms of programmatic objectives with synthesized observational data.*

Further analyses of programmatic performance should include:

- Identifying the direction and magnitude of change and the potential variability that may be experienced in the system over time.
- Methods (statistical or model based) to define and identify tipping points.
- Development of a process to evaluate interactive effects of multiple projects and project portfolios and the effectiveness of different project types in different environmental settings.

The outcomes of the analysis should be able to:

- Assess basin-wide and/or restoration-type trends, as appropriate for each programmatic goal being evaluated, and quantify programmatic impacts relative to previously identified goals.
    - Assess variability, uncertainties, and model sensitivities to processes the Coastal Master Plan models or other restoration models and sub-routines are designed to represent.
- Identify circumstances where programmatic restoration implementation is not resulting in the modeled expected changes in system state or progress towards restoration goals.
- Reassess metrics and develop new metrics, as needed, if change cannot be detected or metrics are not adequately connecting back to decision making.
- Reassess constraints (for example, current funding and sediment availability, protected species, extrinsic infrastructure development) to inform the next portfolio.

- Reassess the decision framework to inform the next portfolio of projects. This will require coordination with appropriate governance structures across restoration programs.
- Update knowledge on how the system works and Revise the knowledge uncertainties identified in Table 6 to evaluate whether the data support the current understanding or whether alternate hypotheses may be used to explain patterns and processes.

Key Finding 24	*Continually advance analytical and modeling approaches used to evaluate restoration effectiveness.*

The key outcomes of the programmatic assessment should be communicated in a variety of formats to multiple audiences. This needs to be an active process and not rely on passive feedback of these lessons learned into future efforts and planning cycles. First, a technical report detailing the analytical approaches and interpretation of findings should undergo an external or peer review process to ensure analysis of data and associated interpretations are valid. Secondly, a higher-level report that summarizes the key findings and progress towards meeting programmatic goals should be produced. This report should be made available via the internet to reach a wide variety of audiences, and possibly, the web-based platform should be interactive such as through an ecosystem report card framework. This idea has previously been recommended, including guidance on content, community engagement approaches, communication strategies, roles and responsibilities, and example end products by Hijuelos et al. (2013).

Several of the DWH programs also has a responsibility to communicate key findings. Coordination during the development of the product and communication strategies would help ensure a clear message is communicated to the public within Louisiana, as well as informing programmatic adaptive management and the success of restoration in Louisiana in a Gulfwide context.

Key Finding 25	*Assessment results need to be fully transparent and communicated with the public.*

Under the DWH NRDA settlements, the Trustee Council will conduct programmatic reviews to evaluate the Trustees' collective progress toward meeting the restoration goals described in the Final PDARP/PEIS and provide feedback to TIGs for consideration in future restoration decision making (DWH NRDA Trustees, 2016). As part of this effort, the Trustee Council has tasked the Cross-Trustee Implementation Group Monitoring and Adaptive Management (Cross-TIG MAM) Work Group to develop options for programmatic reviews including what data may be needed for programmatic evaluation. This may include processes to evaluate monitoring results across TIGs and restoration types along with other relevant scientific information to identify any trends and unanticipated results that may signify existence of unknown conditions. Likewise, the RESTORE Council may develop a reporting strategy including core monitoring performance parameters needed to evaluate programmatic performance. Given the multitude of project portfolios being implemented (Section 2.1.2), consideration must be given to how assessment can be conducted in a way that informs not only restoration under any specific entity, but the cumulative effects of all restoration on the landscape, regardless of funding source. This will require agreement on core programmatic monitoring performance parameters that address common goals. The cumulative assessment can then be used to help determine whether programmatic restoration goals need to be revised, which project types to include in future project portfolios, and which processes to include in numerical modeling to support evaluations of project portfolios.

2.1.5. Phase 3: Programmatic: Adaptive Management Coordination

Adaptive Management Coordination is the third phase in the programmatic adaptive management cycle. This phase includes the adaptive management steps of recommending revisions and approving revisions, so that revisions can: 1) result in alterations or redesign of project elements or changes to project operation, monitoring, or assessment, and; 2) assist in understanding of overall problem, or the refinement of attainable or realistic goals and objectives for future projects (Figure 7). This is a point where additional adaptive management specific staff, or mechanisms, could be engaged to help facilitate transfer of recommendations to decision makers, especially when recommendations require high level, administrative, or financial approval.

The processes of decision recommendation and approval are important inputs to the knowledge base, not only as lessons learned, but for communication inreach, outreach, and stakeholder engagement. As in the previous phases, communication outreach, as well as stakeholder engagement, can be extensive or relatively minor at this phase. At the conclusion of this phase, it is especially important to document the recommended revisions, approved adjustments, the associated decisions made, and the information utilized to make the decisions as well as the rationale for those decisions. Adaptive Management Coordination is the third phase in the programmatic adaptive management cycle including adaptive management steps 9: Recommend Revisions and 10: Approve Adjustments.

This phase is described in detail in Section 2.6: Adaptive Management Coordination.

2.1.6. Mechanisms for Interaction with Knowledge Base Components

During the Portfolio Monitoring and Assessment Phase, programmatic adaptive management will be informed by results and lessons learned from constructed projects, inputs of scientific data, syntheses from the Applied Synthesis and Research (Section 2.4), and compiled data and information available from the Information Management (Section 2.3). Stakeholder Engagement and Communications (section 2.5) will also provide key science communication and outreach materials support, especially regarding peer-review of findings and communication of results, and information from stakeholders that should be considered in future projects or portfolios. Those interactions are essential to support recommendations for improvements in the monitoring and assessment tools that inform the project portfolio planning cycle, decisions regarding those recommendations, and documentation of those decisions and the lessons learned, regardless of restoration entity.

2.2. Project Adaptive Management

2.2.1. Introduction

The project adaptive management cycle has ten steps, which can be grouped into four main phases (Sections 2.2.2, 2.2.3, 2.2.4, and 2.2.5):

Phase 1: Project: Objective Setting,
Phase 2: Project: Design and Construct Project,
Phase 3: Project: Operate and Monitor Project, and
Phase 4: Project: Adaptive Management Coordination

The ten steps of project adaptive management apply both to CPRA habitat restoration projects, such as CWPPRA projects, and to DWH NRDA Restoration Type projects that restore for injuries to a specific resource such as marine mammals or recreational use. The adaptive management actions, personnel involved, processes for capturing lessons learned, data, and need for knowledge support vary by phase.

Each phase engages a diversity of personnel including accountants, administrative specialists, attorneys, data managers, engineers, executive administrators, land rights specialists, monitoring managers, permitting specialists, planners, project managers, and social and natural resource scientists. Figure 10 illustrates the interaction of each personnel function with adaptive management planning phases. Personnel roles are not summarized here for DWH NRDA projects funded through the LA TIG as they vary greatly across resource restoration project types (for example establishing a stranding network or species recovery plan).

Every phase also interacts with the knowledge base (Section 1.2.13 and 2.5.2). When project adaptive management is being conducted successfully, restoration projects are linked closely with the knowledge base. Examples include documenting decisions and their associated rationale, utilizing monitoring data, and capturing lessons learned from project planning, implementation, and operations. Successful project adaptive management also requires that data and knowledge are being effectively communicated between phases of the project and transferred to future project planning (within and between agencies). This not only supports improved project objective setting and planning but also greater restoration outcomes.

The four project phases are described in the following section as they apply to both habitat restoration projects (including projects that create habitat, such as sediment diversions) and resource restoration projects (for example focused on sea turtles or marine mammals). Habitat and resource restoration projects have many aspects in common but vary in personnel and implementation as resource restoration projects do not include engineering and construction in their implementation. Habitat restoration projects involve engineering, design, and construction; examples include marsh creation, ridge restoration, sediment diversions, and terrace construction. Resource restoration projects primarily involve active management of a resource to ameliorate an identified threat to that resource, or to alter or engineer a resource or injury. Examples include establishment of a marine mammal stranding network, enforcement of regulations related to a resource, sea turtle by-catch reduction, addressing illegal feeding of marine mammals at fish cleaning stations, and reduction of marine debris that negatively impacts specific marine resources.

The descriptions of processes and examples in the sections below are based upon extensive project implementation experience by CPRA and other entities in Louisiana. Functional roles in project implementation are generalized to any implementing entity (i.e., agency or organization) for restoration projects within Louisiana, for example other Trustees of the LA TIG. However, to fully apply this report to an agency, it would be necessary to develop an agency-specific table of administrative personnel titles for the implementing agency and indicating which positions will carry out particular functions in project implementation. Within Section 1.1.3, example tables are presented for CPRA administrative positions and divisions.

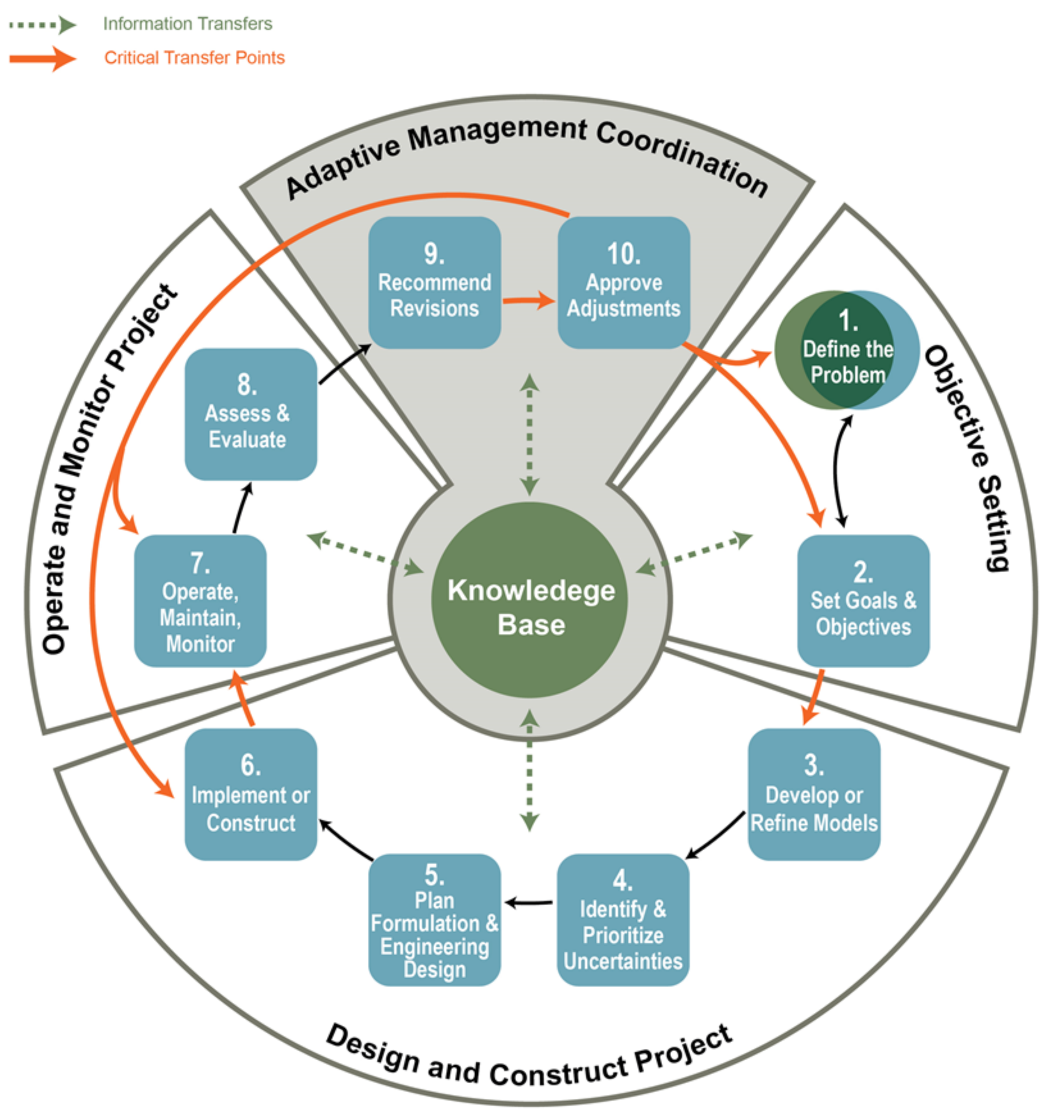


Figure 9. The four phases of a project Objective Setting, Design and Construct Project, Operate and Monitor Project, and Adaptive Management Coordination, showing how these connect to the steps of the adaptive management cycle (this generic process applies to habitat restoration, Figure 10 as well as resource restoration, Figure 4)

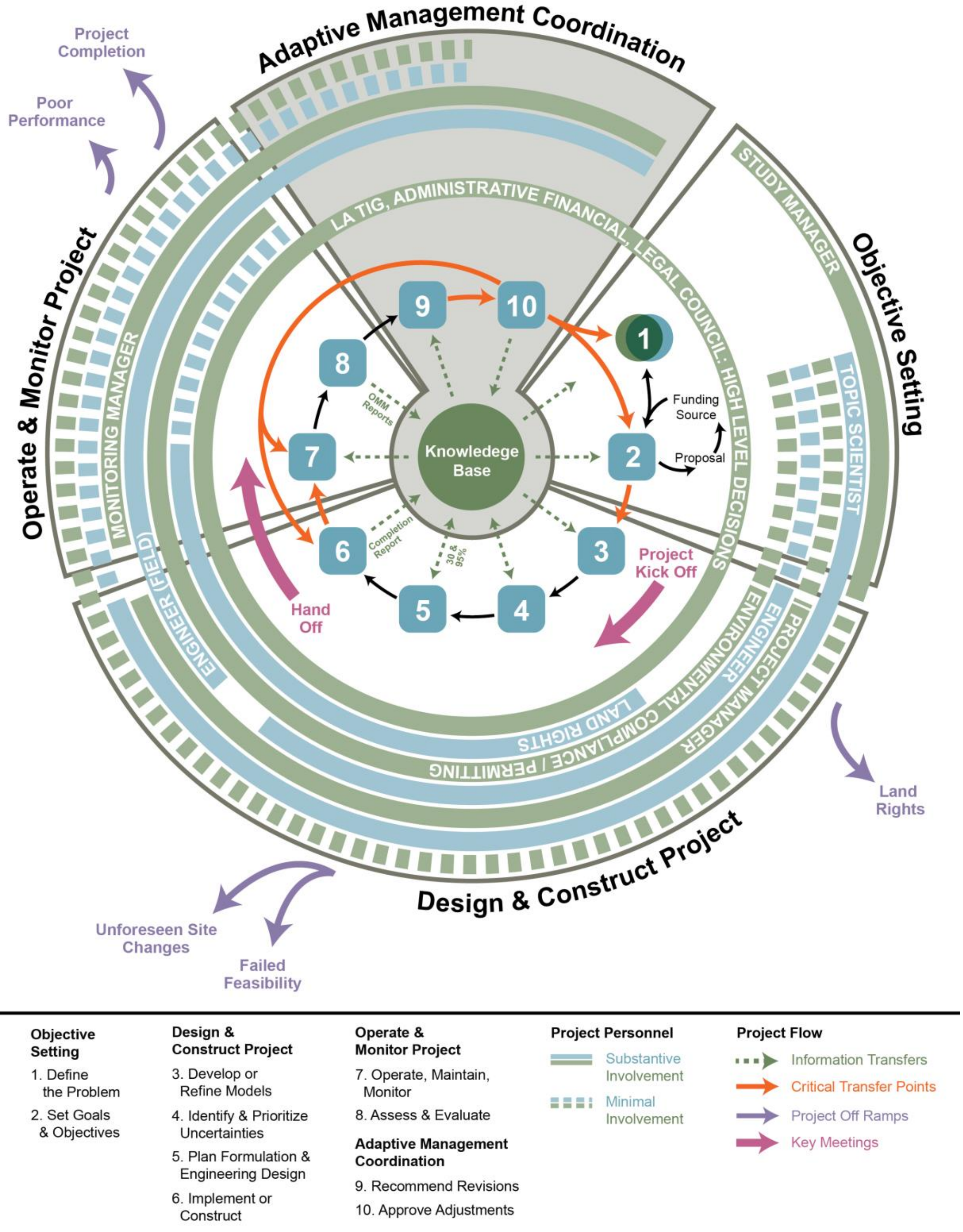


Figure 10. Detailed adaptive management cycle for habitat restoration projects, including key personnel functions (green and blue) in each phase, main reporting points, meeting points, and project off ramps (figure is explained fully in text)

2.2.2. Phase 1: Project: Objective Setting

2.2.2.1. SUMMARY

The *Objective Setting Phase* of a project includes the greatest range of inputs and external linkages and includes identifying or defining the problem and setting the project goals and objectives (Figure 10). During the objective setting phase of some projects, a small number of staff (for example a study manager) will develop a project concept and proposal targeted at a funding source. If the funding source has a defined problem statement and associated goals or objectives, these will be combined with objectives of the implementing agency (for example CPRA, drawing goals and objectives from the Louisiana Coastal Master Plan, adding objectives from NRDA when that is the project funding entity). Topic specific scientists with relevant knowledge and experience will also be involved in this goal setting phase. Increased linkage to the rest of the project adaptive management cycle could be achieved by the inclusion of design, construction, and operations staff (i.e., project managers, engineers, monitoring staff) at this Objective Setting phase. This would ensure that goals are consistently incorporated throughout the project life and that realistic goals are set based on past project implementation. The Objective Setting phase ideally draws on many aspects of Information Management, including lessons learned, data and data syntheses, as well as applied research from previous projects. Communication outreach, as well as Stakeholder Engagement, can be extensive or relatively minor, depending on the specific details of the project such as spatial and/or temporal extent of the project, project type, project goals and objectives, and stakeholder interest, which is often related to the project's location or its proximity to resources of particular interest or concern. Communication inreach should ideally occur often, especially at the end of the phase. At the end of the project goal setting phase there is also a critical knowledge transfer to the design and construct project phase, which begins with a project kick off meeting. Project kick off meetings provide an opportunity to discuss the problem being address as well as clarify the project specific goals and objectives. Detailed project specific goals and objectives may be based on lessons learned from other projects implemented within a similar geographic, morphological, hydrological, or ecological context.

This phase includes two steps in the adaptive management cycle (Figure 10):

Step 1: Define the Problem

Step 2: Set Goals and Objectives

2.2.2.1.1. Step 1: Define the Problem

A problem statement (or statements) is the basis of project objective setting and therefore establishing the framework for all subsequent phases of project development and adaptive management. Defining the problem to be addressed by restoration projects occurs at different spatial, temporal, and governance scales and is often first accomplished programmatically (see Section 2.1.2.1.1).

The project specific "problem statement" is usually a more detailed or refined version of the programmatic problem being addressed, and is specific to the geographical, morphological, and ecological context of the specific project being developed. For example, a programmatic problem statement may be “land loss” while a project specific problem statement may be “edge erosion”, “subsidence,” “sediment starvation,” or “plant death.”

Programmatic scale and project scale problem statements are hierarchical, and need to be considered throughout planning, design, construction, operation and monitoring of project, and in particular as a context to assessing project success and the lessons learned both for that individual project and collectively assessed programmatically.

The personnel involved in Step 1: Define the Problem will differ between the kinds of restoration projects.

For habitat and resource restoration projects, a subset of the following CPRA personnel will be involved (Section 1.1.3):

- Coastal Master Plan team (problem statement establishment) (McMann et al., 2017)
- Federal and state agency staff (problem statement establishment)
- Programmatic staff from implementing mechanism
  (possible problem statement establishment)
- Study manager
- Communications staff (inreach, outreach, stakeholder engagement)
- Project manager
- Engineer

2.2.2.1.2. Step 2: Set Goals and Objectives

Objectives for individual projects are established in the project Objective Setting phase; they are distinct from goals, which are based on programmatic vision statements. Establishing project objectives that are as specific as possible, and quantifiable, supports a successful adaptive management process by allowing for the design, construction, operation, and monitoring a project to be targeted towards achieving these specific objectives.

Project objectives are formally documented when a project concept or need is formalized into a project proposal targeted at a particular funding source. The process of taking a project concept through the proposal phase to receipt of funding is led by the study manager and relevant topic scientists (e.g., geologists or ecologists as relevant). Not all projects require a proposal to initiate planning, but the general process is the same regardless of the requirement for a project proposal. Non-attainment of project specific objectives, both short term and long term, provides an opportunity for mid-course correction and reevaluation of conceptual understanding, allowing for learning and improved programmatic restoration goals overall, as well as improved restoration success. The options for course correction if a goal is not attained should be identified ahead of the assessment and should be informed by lessons learned in previous projects. For DWH NRDA projects, the MAM plan will have specific performance criteria that will result in a corrective action if not attained.

Project development personnel (e.g., project manager, engineer, permitting staff) as well as representation from operations staff (e.g., monitoring manager or engineer (field) should be included in strategic and targeted meetings at the Objective Setting phase. This would require identification of all personnel (Objective Setting, Design and Construct Project, Operate and

Monitor Project) that will potentially be involved with the project over the full life of the project. This would allow project continuity, establish more specific objectives and allow for course correction options to be identified in planning if quantifiable monitoring targets are not met.

Key Finding 26	*Include project development personnel and representation from operations staff in strategic and targeted meetings at the objective setting phase.*

After objectives are identified, it would be beneficial to enter them into a proposed project adaptive management tool/database with justification and explanation (i.e., why they were written in that way or resources that were used to develop them) for the finalized objectives. Additionally, writing down the rationale for why draft objectives were removed or substantially revised would be beneficial in future objective setting exercises for similar projects however legal considerations must be taken into account prior to establishing such a practice.

Key Finding 27	*After objectives are identified, enter them into the project adaptive management tool/database with justification and explanation.*

The personnel involved in Step 2: Set Goals and Objectives will differ between the kinds of restoration projects.

For habitat and resource restoration projects, a subset of the following CPRA personnel will be involved (Section 1.1.3):

- Study manager
- Topic scientist
- Finance staff
- Administrative staff
- Project manager
- Engineer
- Environmental compliance and permitting
- Monitoring manager

2.2.2.1.3. Interaction with the Knowledge Base

The Objective Setting phase interacts with all four knowledge base components and much of this information is managed and accessible through CPRA's CIMS database, which will be described more thoroughly in Section 2.5.

Personnel involved in the objective setting phase can ideally download information and knowledge gained from past and current project's reporting and documentation, communication inreach, communication outreach, stakeholder engagement, and advisory groups. This could include lessons learned, data and data syntheses, and applied research containing summarized information from previous projects. Data and documents are contained within CIMS (Section 2.3.2.2.1) and other relevant databases, including DIVER (Section 2.3.2.1).
The level of communication outreach and stakeholder engagement can range from extensive to relatively minor for a project, depending on the specific details of the project such as spatial and/or temporal extent of the project, project type, project objectives, and stakeholder interest,

which is often related to the project's location or its proximity to resources of particular interest or concern. All resulting information should be captured and provided as an output to the knowledge base. Communication inreach should ideally occur often, especially at the end of the phase, so that project specific objectives are broadly recognized and understood by other personnel who may have project responsibilities.

At the end of the project objective setting phase there is a critical knowledge transfer to the design and construct project phase, which begins with a project kick-off meeting. This meeting provides an opportunity to discuss the problem being addressed and to clarify the project-specific objectives. It also provides opportunities to more formally capture decisions, for example in the proposed adaptive management lessons learned and decision database, and their associated rationale, lessons learned, and for attaining more direct input from operations staff, engineers, project managers, and permitting staff to improve the ability to adaptively manage individual projects and inform future projects.

A project adaptive management database (preferably within one of the current information management mechanisms, such as CIMS, P6, or common share drive for CPRA would be beneficial. It would not only be used to capture lessons learned but utilized to maintain a project log of decisions, background information used to support those decisions, and documentation of lessons learned, throughout the entire life of every project. For NRDA funded projects, key decisions are documented in the *Deepwater Horizon* case administrative record (https://www.doi.gov/deepwaterhorizon/adminrecord). Expanding these adaptive management tools would allow personnel to query out relevant information based on project type or location, such as the ability to query specific lessons learned or executive summaries. In addition to lessons learned, it could include decisions, the position responsible, reasons for the decision, information and knowledge base components that were accessed to inform the decision. This would not only provide a practical and tangible adaptive mechanism in and of itself but would provide data to assess the effectiveness and implementation success of adaptive management (that is a record of whether lessons learned are being captured and subsequently used to improve future decision making).

Key Finding 28	*Develop a project adaptive management database/s (preferably within one of the current information management mechanisms, such as CIMS, P6, or common share drive within CPRA or Data Integration Visualization Exploration and Reporting (DIVER) across LA TIG considering linkage and exchange where applicable/appropriate).*

2.2.2.2. RELEVANT DOCUMENTS

The Objective Setting phase of the project may benefit from historical information from more than three decades of work on Louisiana's coast, include the following types of resources:

- Research
- Synthesis of data
- PDARP (DWH NRDA, 2016)
- Strategic Framework for Bird Restoration Activities (DWH Trustees, 2017a)
- Strategic Framework for Marine Mammal Restoration Activities (DWH Trustees, 2017b)

- Strategic Framework for Oyster Restoration Activities (DWH Trustees, 2017c)
- Strategic Framework for Sea Turtle Restoration Activities (DWH Trustees, 2017d)
- Relevant Restoration Plans for the project
- CWPPRA SOP (CWPPRA, 2017)
- Louisiana's Comprehensive Master Plan for a Sustainable Coast (CPRA, 2017b) and other planning efforts
- RESTORE comprehensive Plan (GCERC, 2016)
- NFWF Louisiana objectives (USDC, 2013, 2012)

2.2.2.3. CPRA CONSIDERATIONS, APPROACH, AND PROCESS

There are three processes through which a CPRA project, with defined problem, may require objectives to be established:

1. A new project concept or location, as described for the Coastal Master Plan in Appendix A (problem defined prior to project selection) (McMann et al., 2017).
2. A major change to a project or in use of a built project (such as a diversion with initial objectives for managing salinity may transition to being managed for delivery of sediment) (previously unforeseen problem identified during operation and maintenance).
3. A major addition, expansion, or alteration to a project that is of sufficient scale to require additional funding, or need to be considered as a project in its own right (an example is Caminada Headland, which started out as one project but was split into two projects with different funding sources, and therefore revised or additional objectives were established) (problem arose during the process of project planning or implementation).

The first case is discussed previously. The second and third case show the need for detailed project specific objectives to be established, as they need to be consistent and complementary to the initial or aligned project. The problem statement is based upon the need determined in the initial project, and the objectives would be established accordingly. A specific example would be a levee that is built as one project, followed by a second project to install pumps behind the levee. The problem for the second project is based on the maintenance or operation of the first project, the objectives would primarily be project specific objectives related to the identified need (such as water volume and pumping height) determined by the primary levee building project.

2.2.2.4. LA TIG CONSIDERATIONS, APPROACH, AND PROCESS

Objectives for projects funded by DWH NRDA must be specific to the DWH injury and be directly related to restoration goals outlined in the DWH oil spill final PDARP/PEIS (OPA NRDA regulations sec, 990.55(b)(2)). Examples for application to individual projects are presented in the MAM Manual (DWH NRDA, 2016; DWH NRDA Trustees, 2017). Multiple plans tier from that overarching document, including plans developed by the LA TIG for specific basins and projects within coastal Louisiana. For example, Restoration Plan and Environmental Assessment #3 (RP/EA #3) is a Strategic Restoration Plan for Barataria Basin; RP/EIS #3.2 tiers from that document and evaluates the Mid-Barataria Sediment Diversion project. Each tier (level) of planning or each project within a plan will go through the adaptive management steps two through five (objective setting through to Plan formulation), with the interim outputs being a more focused Restoration Plan that, among other purposes, also serves as the basis for gaining funds to accomplish the next project stage or phase.

The objectives/purpose and need of each DWH NRDA project should be specific enough to allow OPA and LA TIG-specific screening criteria to be applied to the project for development and evaluation of a reasonable range of alternatives (both preferred and non-preferred) for a restoration plan.

2.2.3. Phase 2: Project: Design and Construct Project

2.2.3.1. SUMMARY

During the Design and Construct Project phase, the project moves to a new team led by the project manager, with an engineer, and environmental compliance and permitting personnel, supported by the study manager, topic scientist(s), as well as land rights and project control staff. Project control staff provide support on budget, scope, scheduling, and tracking through this phase. This phase utilizes many aspects of Information Management (Section 2.3), Applied Synthesis and Research (Section 2.4), Stakeholder Engagement (Section 2.5), and Communication (Section 2.5) from previous projects. Throughout this phase, data, knowledge and lessons learned are developed that will, ideally, be communicated to and captured within the knowledge base, especially to Applied Synthesis Research and Information Management. As in the Objective Setting phase, Communication outreach, as well as Stakeholder Engagement, can be extensive or relatively minor, depending on the specific details of the project. Communication inreach should occur often during this phase as there are likely many changes and decision points during design and construction. During this phase, operations and monitoring plans are developed, if required by funding source that may also require the development of restoration targets or threshold points to trigger action or alterations to project operation. Potential for adaptive management could be increased by additional engagement of the field engineer and regional office monitoring manager as early as possible during this phase, so that those staff become familiar with unique project characteristics and the reasons for any modifications that have been deemed necessary during project planning and construction. Design and construction of a project has a critical connection point to project operation and maintenance. A key hand off meeting occurs between these phases, but some staff changes are staggered. The engineer (field) takes over during construction and that engineer, and the monitoring manager develop the monitoring and operations plans during the Design and Construction Project phase. In addition, key technical documents (such as 30 and 95% design reports and project completion report), provide resources to the Operate and Monitor Project phase, and important project information, and lessons learned, that resides within the knowledge base.

This phase includes four steps in the adaptive management cycle (Figure 9):

Step 3: Develop or Refine Models
Step 4: Identify and Prioritize Uncertainties
Step 5: Plan Formulation and Engineering Design
Step 6: Implement or Construct

The Design and Construct Project phase of a project has the greatest number of internal personnel and is the most complex phase due to the many internal and external controls on project progress through to construction completion (Figure 10). Project type, size, and location have a large influence on the complexity and number of personnel involved in this phase of a project. This phase involves many staff transitions and a strong need for effective inreach and outreach.

1. Information from the Objective Setting phase is transferred at the project kick-off meeting.
2. Information from the Design and Construct Project phase is transferred to the Operate and Monitor Project phase at the hand off meeting.

A project outreach and stakeholder engagement plan could be developed at the project kick-off meeting. At the project kick-off meeting, adaptive management would be fully supported by the project manager presenting the initial project plan and objectives, in light of lessons learned and reasons for decisions in other projects of similar type, scale, or location.

Key Finding 29	*Within project kick off meetings project manager should explicitly assess project plan and objectives in light of previous project lessons learned and discuss the stakeholder engagement plan for remaining project implementation.*

Design and construction of a project has a critical connection point to project operation and monitoring. A key hand off meeting occurs between these phases, but some staff changes are staggered. The engineer (field) takes over during construction and along with the monitoring manager develops the monitoring and operation plans during the Design and Construct Project phase. For NRDA funded projects this may be an update of the restoration plan, which is initially drafted along with the project MAM plan during step 2 (Set Goals and Objectives) (Figure 4).

Some projects are initiated as feasibility studies, which have a slightly altered approach, with different staff responsible for adaptive management steps 3-5. Rather than transitioning from a study manager to a project manager, these projects remain the responsibility of the study manager (and topic scientists). Only when a project is found to be feasible is planning level design completed so that a project can move onto full engineering and design or construction. The number of specific steps and processes throughout this phase are conducted at different speeds depending on many external processes (permitting, funding delivery, land rights, consultant engagement and progress, weather, etc.), and for some projects, steps occur simultaneously (for example developing or refining models can co-occur with identifying uncertainties as well as initial project engineering and design). In addition, there are multiple responsible staff, with a range of project functions, from many different agency divisions (Section 1.1.3). This complexity highlights the need for additional mechanisms to capture and centralize knowledge gained, lessons learned, and rationale for decision making. It also provides an opportunity to improve adaptive management during this phase and support more effective critical transfers into this phase and hand off from this phase.

Key Finding 30	*Capture lessons learned and project decisions for projects, and then synthesize by restoration type, geographic unit, implementing mechanism.*

2.2.3.1.1. Step 3: Develop or Refine Models

To predict potential project effects, conceptual or numerical models may be developed or refined. A model can assist with project design to help accomplish project objectives. Models can also assist with evaluating tradeoffs among objectives, identify instances in which objectives may not be met and need for any mid-course project adjustments. Models also represent our current understanding of how we think the system is working (or can be used to explore different hypotheses as to how we think the system is working), where we are most uncertain, and determine which of those uncertainties actually matter to the decision. The need for project specific models is highly dependent upon the type, size, uncertainty of outcomes, and location of the project. Modeling may be required as a condition of funding, or as part of a compliance or regulatory process (for example NEPA as part of an EIS). Modeling is generally carried out by subcontractors although if a permit request is submitted to a federal agency such as the USACE, they may also carry out the modeling. The process of handling and tracking numerical models has been most fully developed for the ICM within the coastal master plan process, which is detailed further in Section 2.1.2.1.3.

During Step 3: Develop or Refine Models, the following CPRA personnel are involved in habitat restoration projects (or projects that directly or indirectly create habitat) (Figure 10; Section 1.1.3):

- Study manager
- Topic scientists
- Project manager
- Engineer
- Environmental compliance / permitting
- Trustee representative (NRDA projects)

2.2.3.1.2. Step 4: Identify and Prioritize Uncertainties

Ecosystems are inherently uncertain, but not all uncertainties may matter in every decision context. To increase confidence in expected restoration outcomes, it is important to list areas of scientific uncertainty that may affect a project's effectiveness or ability to accomplish stated objectives. Uncertainties can be intrinsic or extrinsic to the project, again being highly dependent upon timing, longevity, project type, location, and size, interactions with temporal events such as storms and with other restoration projects, and socioeconomic factors such as recreational use of a resource. Some project considerations are highly uncertain, but well known, such as the rate of relative sea level rise (SLR) or subsidence at the specific project location. Other project considerations can specifically be informed by previously implemented projects, such as effectiveness of marsh creation using different types of sediment (e.g., structure and grain size), or likelihood of success at a particular salinity, or basin, within coastal Louisiana. Finally, some uncertainties are recognized to have no precedents and require detailed project specific modeling to provide best available projections of project effects and outcomes with respect to defined project objectives and programmatic goals. In the context of the coastal master plan a framework for identifying and classifying the multiple types of uncertainty has been developed with more specific detail (Hijuelos & Reed, 2017). For projects requiring a MAM plan, uncertainties are specifically identified within that document. The MAM Manual includes lists of most common sources of uncertainty for similar types of restoration projects (DWH NRDA Trustees, 2017). During Step 4: Identify and Prioritize Uncertainties, the following CPRA personnel are involved in Habitat restoration projects (Figure 10; Section 1.1.3):

- Study manager
- Topic scientists
- Development project manager
- Development engineer

- Environmental compliance
- Permitting
- Project control
- Lands rights
- Operations staff, including both engineers and monitoring focused staff

2.2.3.1.3. Step 5: Plan Formulation and Engineering Design

During this step, operation plans and monitoring plans are developed or updated (Section 2.2.4.3). Some funding sources also require the development of restoration targets or threshold points to trigger action or alterations to project operation. For NRDA projects this happens during project planning, except for projects initially selected only for engineering and design, which only develop a MAM plan once they have been selected for construction/implementation within a TIG restoration plan. This step in the adaptive management cycle may be carried out by staff within an agency, or may be contracted out, depending on the scale, size, and complexity of the project. During engineering and design there is a need for continual communication and engagement between a range of technical staff actively working on the project, stakeholders, other staff within the agency, compliance, permitting, land rights staff, and operations staff. This step may include pre-construction monitoring that has implications for project design.

Two key milestones occur during this adaptive management step and provide opportunity for direct feedback in an adaptive management context, the 30 percent and 95 percent design meetings and associated reports. Funding agencies may use these milestones for decision making points to determine whether to fund construction (for example the 30 percent report is aligned with the RP development for NRDA projects and will inform the decision of whether to fund full project design and construction).

During Step 5: Plan Formulation and Engineering Design, the following CPRA personnel are involved in habitat restoration projects (or projects that directly or indirectly create habitat) (Figure 10; Section 1.1.3):

- Study manager
- Topic scientists
- Project manager
- Engineer
- Environmental compliance and permitting
- Project control
- Lands rights
- Finance staff
- Administrative staff
- Engineers (field)
- Monitoring manager

2.2.3.1.4. Step 6: Implement or Construct

Project construction is conducted by contractors and subcontractors based on bidding documents that are developed by the project team. Regardless of the implementing mechanism, it is the responsibility of the agency project manager and engineer to ensure that the project design will meet the project specific objectives. If something changes during construction that demands a change to the structure of the project design or specifications, the agency project manager and engineer are responsible for ensuring that the project still meets project objectives or, in the case where objectives need to be altered, that the revised objectives still meet the needs of the agency and funding source. These changes should all be fully documented, and the project completion report currently has the most comprehensive documentation of lessons learned and process during project engineering and design. During project construction there is a “hand off” from the engineer (usually in the central office) to the engineer (field) (usually in the relevant regional office). During project construction there is a need for continual communication and engagement between many technical staff actively working on the project, stakeholders, other staff within the agency, compliance, land rights staff, and operations staff. The project completion report includes required changes in design and lessons learned, making it a major milestone report providing opportunity for adaptive management during this phase.

During Step 6: Implement or Construct, the following CPRA personnel are involved in habitat restoration projects (or projects that directly or indirectly create habitat) (Figure 10; Section 1.1.3):

- Study manager
- Topic scientists
- Finance
- Administrative
- project manager
- Engineer (initiates)
- Engineer (field) (takes over during construction)
- Environmental compliance and permitting
- Project control
- Lands rights
- Finance staff
- Administrative staff
- Engineers (field)
- Monitoring manager

2.2.3.1.5. Interaction with the Knowledge Base

Steps 3 through 5 require input from the knowledge base. The amount of engagement or information needed is directly related to the type, spatial scale, and location of the proposed project. Data and knowledge are drawn from appropriate databases (CIMS for data and documents - Section 2.3.2.2.1, P6 for project scheduling and process – Section 2.3.2.2.3, common share-drives) to ensure up to date design or construction approaches are used and track the project through construction. Knowledge gained from Applied Synthesis and Research or previous lessons learned can also be used to refine design and construction.

Communication inreach (Section 2.5.1.1)should occur often during this phase to communicate the many changes and decision points during design and construction and to assist with project continuity throughout the project’s life as it transitions between staff. As in the objective setting phase, Communication outreach and Stakeholder Engagement (Section 2.5.1.2) can be extensive or relatively minor, depending on the specific details of the project. Stakeholder engagement may be required (project dependent) and advisory groups are common (for example, CWPPRA-funded projects have a series of committees and subcommittees).

Throughout this phase, the data, knowledge and lessons learned that are developed should be communicated to and captured within the knowledge base, especially to the Applied Synthesis and Research and Information Management. Key technical documents (such as 30 percent and 95 percent design reports and project completion report) should be incorporated into the knowledge base because they provide resources to the Operate and Monitor Project phase, and they capture important project information and lessons learned.

Adaptive management during this project phase would be improved by earlier and greater engagement with operations staff (field engineers, project managers, regional office monitoring staff) to facilitate greater continuity to the Operate and Monitor Project phase. For example, by increasing familiarity with unique project characteristics and the reasons for any modifications that have been deemed necessary during the Design and Construct Project phase or updates to the project MAM plan.

An additional improvement would be the expansion of opportunities for capturing gained knowledge, lessons learned, and detailed reasons for decisions. Typically, there are many subcontractors engaged in this project phase. Ensuring that sub-contractors are engaged in capturing lessons learned, reasons for project decisions, and transferring gained knowledge would improve the effectiveness of project level adaptive management. Finally, there is an opportunity for increased information capture and transfer during the critical transfer points; the project kick-off meeting and the project hand off meeting (Figure 10).

Include requirements to document lessons learned and document decisions including information used to support the decision into the statement of work for key contractors involved in the engineering, design, and construction of projects, as well as model development.

Key Finding 31	*Include requirements to document lessons learned and document decisions including information used to support the decision into the statement of work for key contractors.*

In person meetings to discuss and present lessons learned from large projects have been helpful. This mechanism could be expanded, either with annual meetings by project type for knowledge transfer and discussion amongst project implementation personnel. Additionally, this could be a targeted focus of multiple sessions at locally important scientific meetings (such as State of the Coast conference), to specifically focus on approaches, decisions, alterations, and lessons learned from implementation of projects by restoration type. An alternative would be to host a CPRA industry day to meet with contractors and facilitate interactive discussions with an emphasis on challenges and lessons learned.

2.2.3.2. RELEVANT DOCUMENTS

Work on this project phase may benefit from information captured in the following resources:

- CWPPRA SOPs (CWPPRA, 2014). The purpose of the SOP is to establish standard procedures in the management of CWPPRA projects. The procedures cited herein are not inclusive of all CWPPRA activities; rather, provide guidelines for collaboration/coordination between the agencies for recurring activities. The procedures cited herein are to be used as general guidelines for coordination and are not meant to limit the Task Force's ability to make decisions regarding the most effective and efficient use of resources to accomplish the goals of CWPPRA (CWPPRA, 2014).

- Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0 (DWH NRDA Trustees, 2017)
- Appendix F. 2017 Coastal Master Plan (Hijuelos & Reed, 2017)
- Trustee Council Standard Operating Procedures 2.0 (DWH NRDA Trustees, 2016)
- DIVER Portal – DWH Restoration User Manual.
- Fast Act (*Title 42. Fixing America's Surface Transportation (FAST) Act*, 2015)

The following two documents (Khalil et al., 2015a; Khalil, 2019) provide guidance for data collection by consultants on contract to CPRA:

Khalil, S.M., 2019. General Guidelines: Exploration for Sediment Resources for Coastal Restoration. Baton Rouge, LA: Coastal Protection and Restoration Authority. Version_VIII.pdf. Available online at: http://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=1034

Khalil, S. M., Haywood, E. and Forrest, B., 2015. Standard Operating Procedures for Geoscientific Data Management, Louisiana Sand Resources Database (LASARD), Coastal Protection and Restoration Authority of Louisiana (CPRA), 30P. Available online at: https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=12362

2.2.3.3. CPRA CONSIDERATIONS, APPROACH, AND PROCESS

The most detailed process document for overall Design and Construct Project phase within CPRA is the CWPPRA SOPs (https://lacoast.gov/reports/program/CWPPRASOPVersion24FINAL.pdf).
During the Design and Construct Project phase, CPRA processes apply to all four of the relevant adaptive management steps: development or refinement of models, identification and prioritization of uncertainties, plan formulation and engineering design, and project implementation or construction. As such, the processes are collectively described below and reference the specific adaptive management steps where relevant.

Four databases or data management systems are utilized extensively by CPRA during the Design and Construct Project phase of project adaptive management. CIMS and LASARD (Khalil et al., 2016) are both interactive repositories for a wide range of monitoring and research data and final reports, these are fully described within Section 2.3.2.2.1 (CIMS) and Section 2.3.2.2.2 (LASARD). LAGOV is used for managing financial and reporting aspects of federally funded projects, and the 'Primavera 6' or 'P6' database is a CPRA internal database that is managed by Project Control and has a primary function of providing support to managing project budgets, project scoping, and project scheduling (Section 2.3.2.2.3). Finally, a common share drive is utilized for development of project documents, particularly during the drafting phase of reports and documents. Currently the information in P6 is only accessible to project control staff, and not project managers, to maximize opportunities for adaptive management through the capture of lessons learned, processes, and reasons for project and site-specific decisions. If project managers had access to (at least) some key fields within this database it might be possible to make it more dynamic, capturing more information and developing a stronger resource to support adaptive management.

Key Finding 32	*If project managers could access key information in the CPRA P6 database (project administrative information) this would increase knowledge transfer and maximize opportunity for collective learning and adaptive management.*

The *Internal Monthly Progress Report (IMPR)* is a summary of the status of all current projects. This internal report is produced by project control (from the P6 database) and targeted at executive staff. This report includes:

- Executive summary: identifies projects for particular attention, projects that have moved phase since previous report, and new projects on the hotlist (active projects) since previous month
- Section 1: Projects summary: includes project name. type, location, project manager, current phase of project, federal sponsor, quantified outcome, estimated cost, comments from project manager
- Section 2: Schedule and financial information: current phase completion date, budget breakdown and status
- Section 3: Projects awaiting funding
- Section 4: Projects on hold
- Section 5: Hotlist (active projects): includes construction award and project mobilization dates, O&M manager, parish, funding

A quarterly outreach report is synthesized from the monthly IMPR reports for broader dissemination and outreach to the public.

The current IMPR has a specific decision making and management role and is therefore a concise summary of project information. It is therefore not considered advisable to add additional information to these reports (such as lessons learned or documenting decision-making processes). However, as described above, monthly project manager meetings and the P6 (or other database mechanism) could potentially be used to capture this information, building a "Project Decision Log" that would be built over the entire life of each project.

Project control meetings are held between each project manager and project control on a monthly basis to provide updates and status, updating the P6 database and becoming the basis for the monthly IMPR report. The monthly meeting between each project manager and project control is an opportunity to capture lessons learned during the preceding month. Questions such as, what decisions were made, what precipitated any need for changes to the project and what information (from information management or elsewhere) was utilized to inform the decision, could be discussed. This could then be captured directly into a project decision log, especially if this was developed and maintained within the P6 database. Additionally, at the monthly project manager meeting with project control, stakeholder engagement could be discussed and documented through the question to the project manager "Did you have any need for stakeholder engagement and what was the need and outcome?" Further formalizing this meeting and more fully documenting the meeting is specifically recommended.

Key Finding 33	*Further formalizing the capture of regular (monthly in the case of CPRA) meetings between a project manager and project control (project administration) would increase opportunities for, and efficiency of, adaptive management.*

30 percent and 95 percent design meetings and reports are developed by the project team during the plan formulation and engineering design step. They represent a developed and formalized process. These documents are broadly disseminated to the relevant parish, stakeholders, project funding body, depending on the specific funding source.

While key lessons learned are captured in the 30 percent and 95 percent engineering design meetings and reports and project completion report, there is currently no formal assessment or comprehensive documentation of lessons learned or documentation of reasons for decisions made in the engineering and design process. These could be added to current reporting mechanisms, however, the existing reports already have many purposes, so it may be preferable to use the opportunity of these meetings and report development to capture lessons learned and reasons for design and engineering decisions into an additional database or mechanism. If areas of uncertainty are specifically captured, these could additionally inform needs and priorities for future applied research and synthesis. Thirty percent design report includes (for example) land rights and cultural resources considerations, fishing lease assessments, existing physical conditions, survey data, geotechnical engineering analysis, hydrodynamic modeling, restoration design and construction plan.

Key Finding 34	*Establish a process for formal assessment or comprehensive documentation of lessons learned and documentation of reasons for decisions made during the engineering and design process.*

The *project fact sheet* originally developed in the project objective setting phase, and stored on CIMS, is updated and revised during the Design and Construct Project phase. In addition, a *project managers technical fact sheet* is developed including, contacts, project location, description, status, and funding status, as well as known or expected dates for approvals and project completion.

Project completion reports are technical reports developed at the end of the Design and Construct Project phase. They include financial summaries of design and construction, equipment used, construction activities, problems encountered and solutions, details of construction change orders and summaries of justifications, additional information, comments or "lessons learned." Lessons learned may also be discussed at a meeting and captured within the completion report.

During the Design and Construct Project phase, both the *Operations and Maintenance Plan* as well as the *Project Monitoring Plan* are developed.

2.2.3.4. LA TIG CONSIDERATIONS, APPROACH, AND PROCESS

During the Design and Construct Project phase of a project that is funded by NRDA, the project will be evaluated as to whether it meets OPA criteria and complies with NEPA (EA or EIS). The project specific RP is developed by a representative from the lead Trustee for that particular project and, generally, a contractor, or contractors, who support that Trustee representative. The process of developing the OPA and NEPA documentation will require completion of adaptive management steps three through five (model refinement, identifying uncertainties, and project engineering and design). The OPA NEPA documentation, along with the 30 percent design reports and the implementation plans, are subsequently assessed by the Trustees to make a determination on whether funding for construction will be approved. There are therefore strong linkages between the practical project development and the project regulatory processes with respect to adaptive management, specifically data collection, model development, decision-making and lessons learned.

Additionally, during the development of a project RP for a project proposed for funding through the LA TIG, a MAM plan is required, as detailed in the MAM Guidelines Manual, which also contains a MAM template document (DWH NRDA Trustees, 2017).

Key Finding 35	*Apply the MAM plan template to further operationalize adaptive management processes within LA TIG projects.*

Detailed timelines are developed and combined across projects being considered by the LA TIG. One major consideration of project development and timelines are the major Federal Milestones established for a RP. These Federal Milestones vary by project but provide specific opportunity to serve as a process step for adaptive management actions (e.g., formalize the process of capturing lessons learned and reasons for important decisions by completing these actions when a specific Federal Milestone is reached). The LA TIG MAM subgroup could identify a subset of Federal Milestones that would be appropriate points for adaptive management actions. The mechanism for registering these milestones depends on project type, and therefore environmental compliance documentation, that needs to be considered in development of that project.

Establish (for example through the LA TIG MAM subgroup) a standard minimum subset of key Federal Milestones at which all NRDA projects would document information and lessons learned. This would greatly increase the opportunity for effective adaptive management while being streamlined with the development of timelines and schedules for new RPs.

Table 8. Examples of high-level Federal Milestones as listed in DIVER

TIG Plan EA	TIG Plan EIS
TIG Initial Restoration Planning *TIG develops initial RP development timeline* *TIG begins initial project identification* 1st TIG notice (website): solicit public project ideas TIG initial project screening 2nd TIG notice: initiate restoration planning *TIG continued project screening* *TIG continued project review, develop project details* **Prepare Draft RP/EA** **Environmental Compliance** **TIG Draft RP/EA Review** **Public comment and review period** **Prepare Final RP/EA** **TIG Final RP/EA Review** **Prepare FONSI as appropriate** **Prepare Project Implementation Plans (PIPs)**	**TIG Initial Restoration Planning** *TIG develops initial RP development timeline* *TIG begins initial project identification* **TIG initial Restoration Planning** 1st TIG notice (website): solicit public project ideas TIG initial project screening 2nd TIG notice: initiate restoration planning [NOI for scoping] *TIG continued project screening* *TIG continued project review, develop project details* **Prepare Draft RP/EIS** **Environmental Compliance** **TIG Draft RP/EIS Review** **Public comment and review period** **Prepare Final RP/EIS** **TIG FINAL RP/EIS Review** **Prepare Record of Decision (ROD)** **Prepare Project Implementation Plans (PIPs)**

Key Finding 36 *Establish a standard minimum set of key Federal Milestones that can be used as adaptive management action points by all NRDA projects.*

Key Finding 37 *Establish a mechanism for interactively compiling and combining schedules for all projects in the process of implementation across entities.*

2.2.4. Phase 3: Project: Operate and Monitor Project

2.2.4.1. SUMMARY

The Operate and Monitor Project phase includes a new, and smaller, team of personnel that includes the monitoring manager and the engineer (field), with support from environmental compliance and land rights staff, and occasional input from the study manager or topic scientists (Figure 10). Operation, maintenance and monitoring draws on many aspects of information management, including lessons learned, monitoring data and data syntheses, and applied research from previous projects. Throughout this phase, data, knowledge, and lessons learned are developed that should be captured within information management, as well as providing input to needs and priorities for Applied Synthesis and Research. Drawing on all previously developed project documents, operations and monitoring may be adjusted as outlined in the project adaptive management plan, or in response to crossing a predetermined threshold for action (when required for particular funding source, such as NRDA). In the assessment and evaluation step, information is assembled on project performance through regular OM&M reports and monitoring data. OM&M reports are a major output from this phase and provide a connection mechanism to the final phase of project based adaptive management, adaptive management coordination. The Operate and Monitor Project phase is usually the longest component of a project but can be relatively straightforward once the project and all monitoring and operation procedures are established.

This phase includes two steps in the adaptive management cycle (Figure 9):

1. Operate, Maintain, Monitor
2. Assess and Evaluate

There is one critical transfer point: the hand off meeting from the Design and Construct Project phase, with potential for enhanced knowledge and data transfer for improved adaptive management.

2.2.4.1.1. Step 7: Operate, Maintain, Monitor

The Operate, Maintain, and Monitor step draws on many aspects of information management, including lessons learned, monitoring data and data syntheses, and applied research from previous projects. Drawing on all previously developed project documents, this step may be adjusted as outlined in the project adaptive management plan, or in response to crossing a predetermined threshold for action (when required for particular funding source, such as NRDA). There may be a need to alter operations, an opportunity to reduce uncertainty, and assessing attainment of objectives will be required. This is also when a large amount of data will be uploaded to databases such as CIMS (Section 2.3.2.2.1) and DIVER (Section 2.3.2.1), and based on project knowledge may necessitate revising MAM plans.

An active process of synthesizing lessons learned from OM&M reports, for a given project, restoration type, and/or geographic unit could be developed. This could be further facilitated by adding this information to a project decision log or interactive project lessons learned and decision-making database.

During Step 7: Operate, Maintain, Monitor, the following CPRA personnel are involved in habitat restoration projects (Figure 9; Section 1.1.3):

- Monitoring manager
- Engineer (field)
- Environmental compliance (for any maintenance alterations or adjustments to project)
- Land rights (while establishing monitoring sites or alterations to project)
- Study manager (occasional targeted input to meetings for problem solving)
- Topic scientists (occasional targeted input to meetings for problem solving)

2.2.4.1.2. Step 8: Assess and Evaluate

In the Assess and Evaluate step, information is assembled on project performance through regular OM&M reports and monitoring data in relation to performance goals or thresholds for decision points in the project MAM plan. OM&M reports, and assessments relative to need for operational changes, as established in the MAM plan, are a major output from this phase and provide a connection mechanism to the final phase of project based adaptive management, adaptive management coordination.

For implementation there is no common format or template developed for Operation Maintenance and Monitoring reports. A common format could be adapted from the format used currently within CPRA and the high level MAM report template (for NRDA projects), taking the opportunity to emphasize lessons learned and reasons and information used to support key operation and maintenance decisions (DWH NRDA Trustees, 2017).

A mechanism to capture lessons learned and reasons for operation and maintenance decisions is required, this could be a written document or database to capture knowledge, and/or a meeting/workshop/mini conference session to facilitate lessons learned and cross learning between managers and engineers working on the same project types.

Key Finding 38	*A mechanism to capture lessons learned and reasons for operation and maintenance decisions is required.*

Key Finding 39	*Develop an active process of synthesizing lessons learned from OM&M reports.*

Key Finding 40	*Inreach could be improved by informing all staff when OM&M reports and inspection reports are posted to CIMS.*

All DWH NRDA projects are subject to an approved MAM plan that includes specific objectives and performance criteria that will inform required actions or changes in operation in response to project performance. The MAM manual includes a MAM plan template and guidance on how to complete the various sections and requirements (DWH NRDA Trustees, 2017).
During Step 8: Assess and Evaluate, the following CPRA personnel are involved:

- Monitoring manager
- Engineer (field)
- Environmental compliance (for any maintenance alterations or adjustments to project)
- Study manager (occasional targeted input to meetings for problem solving)
- Topic scientists (occasional targeted input to meetings for problem solving)

2.2.4.1.3. Interaction with the Knowledge Base

Throughout this phase, data, knowledge, and lessons learned are developed; these should be captured within information management and provided as input to needs and priorities for Applied Synthesis and Research.

Frequency of interaction with the knowledge base depends on whether the project requires active monitoring for implementation (such as a water management control) or not (such as marsh creation). For a project that is built and then monitored with no intervention unless the project is starting to degrade or fails to meet project objectives, such as a marsh creation project, then the main adaptive management engagement will be capturing knowledge from ongoing monitoring of the project, resultant data and lessons learned that have potential to inform future project design.

However, for a project that requires active daily, weekly, or monthly operational management, such as a water management structure, every time the structure is opened or closed provides a learning and feedback opportunity for future decisions about timing and volume of opening. Over time this increased knowledge of action and response allow for future operations of that particular project to be adaptively managed based upon previous decisions. Capturing lessons learned for projects requiring active operation can be informative on a day by day or week by week basis, as well as on a year to year basis or from one project to the next, increasing the value of formally documenting lessons learned and information used to inform decisions.

Another opportunity to inform adaptive management is when a project fails to meet performance criteria stated in a MAM plan. Data, knowledge, and lessons learned should be effectively captured, synthesized as necessary and transferred to the knowledge base, and successfully communicated as a "learning moment", especially through Communication inreach, to improve implementation of future projects of the same type, at a similar location, or likely to experience similar circumstances or extrinsic factors.

2.2.4.2. RELEVANT DOCUMENTS

This project phase may benefit from information captured in the following resources:

- CWPPRA SOPs, Revision 25, January 2017. https://lacoast.gov/reports/program/CWPPRASOPVersion25.pdf
- Project Monitoring Plan
- MAM plan

2.2.4.3. CPRA CONSIDERATIONS, APPROACH, AND PROCESS

At the commencement of this phase, each project has a hand off meeting with the Design and Construct Project personnel as well as the Operate and Monitor Project teams. Formalizing this meeting and the information that is transferred could provide an opportunity for enhancing adaptive management.

A quarterly adaptive management newsletter has been developed within CPRA in the past, this could be expanded to include the project reports that have been completed and listed in CIMS over the past three months.

Key Finding 41	*Expand internal CPRA adaptive management newsletter to include new project reports listed in CIMS database and to engage personnel in expanded adaptive management tools and processes.*

Generally on-site project inspections and *inspection reports* are performed annually. These are cursory visual inspections, and reports focus on the engineering or structural integrity of the project.

A more comprehensive *Operation Maintenance and Monitoring* (OM&M) report is developed less frequently, based upon the site monitoring schedule. In this report there is a summary of monitoring data and assessment of how the project is performing compared to the established objectives for the project. While OM&M reports do include a "lessons learned" section, these reports are long, and each project has numerous reports over time. Therefore, lessons learned are difficult to find and therefore frequently not accessed or utilized for future project planning, design and operations.

Monitoring or Data specific reports are also developed on an ad hoc basis to meet specific needs, for example development of a habitat map, or a highly specific monitoring report to address a question or issue that has arisen or is considered likely.

Key Finding 42	*Develop a searchable and discoverable lessons learned database to support adaptive management of restoration decision making.*

2.2.4.4. LA TIG CONSIDERATIONS, APPROACH, AND PROCESS

Every DWH NRDA project will have the monitoring and adaptive management plan that should include a list of monitoring parameters that will be measured. Performance monitoring parameters are used to evaluate progress toward the project's restoration objectives. Additional monitoring parameters may help resolve uncertainties, explain outside drivers, optimize project implementation, support decisions about corrective actions or other adaptive management of the project, and/or inform the design of future DWH NRDA projects.

For each parameter, the MAM plan should describe the reason for monitoring that parameter; methods; the timing, frequency, and duration of data collection; the sample size; and the monitoring design. For those parameters intended to evaluate progress toward meeting restoration objectives, performance criteria and corrective actions should also be identified. The MAM Plan should also include parameters needed to evaluate progress toward Restoration Type goals and objectives, as appropriate for each Restoration Approach. When applicable, the MAM Plan should also include the monitoring needed to track compliance with appropriate regulations and adaptive management protocols.

Key Finding 43	*Identify and provide guidance on how project success should be measured quantitatively (in terms of time and amount, such as 75 percent cover of vegetation by year three).*

When relevant existing datasets are available for restoration decision-making, the Trustees should confirm that the collection methods are well-documented, the data are current and complete, and the data collection methods and timing / frequency of data collection are appropriate to address the project's monitoring needs. SWAMP is an example of a data collection and collation mechanism that could be used in this way (Section 2.1.4.1.1).

The project-specific MAM plan should include information on how project performance will be assessed in terms of meeting its restoration objectives and performance criteria, informing whether corrective actions are needed, and identifying potential corrective actions that could be taken if the performance criteria are not met. An example performance criterion would be for vegetative cover to have reached 75 percent by year three. If monitoring criteria show that the cover is lower, then the corrective action of additional planting at the site will be carried out. The reason for this difference to many projects currently carried out in Louisiana, for example through CWPPRA, is that the aim for NRDA projects can be to have met design criteria within five to seven years (although the length of time can vary by Trustee and project), whereas CWPPRA projects are generally designed with a 20-year monitoring and outcome plan.

2.2.5. Phase 4: Project: Adaptive Management Coordination

Adaptive Management Coordination is the fourth phase in the project adaptive management cycle. This phase includes the adaptive management steps of recommending revisions and approving revisions, so that revisions can: 1) result in alterations or redesign of project elements or changes to project operation, monitoring, or assessment, and/or; 2) assist in understanding of overall problem, or the refinement of attainable or realistic goals and objectives for future projects (Figure 10). Recommendation of revisions can engage multiple personnel and sources external to the agency, but are primarily generated from the regional offices staff, with input primarily from the Project Manager, Project Engineers, Study Manager and topic scientists. This is a point where additional adaptive management specific staff, or mechanisms, could be engaged to help facilitate transfer of recommendations to decision makers, especially when recommendations require high level, administrative, or financial approval. Developing recommendations will rely on input from information management, including lessons learned, data and data syntheses and applied research from current and previous projects.

The processes of decision recommendation and approval are important inputs to the knowledge base, not only as lessons learned, but for communication inreach, outreach, and stakeholder engagement. As in the previous phases, communication outreach, as well as stakeholder engagement, can be extensive or relatively minor at this phase, depending on the specific details of the project. Communication inreach should occur often, especially at the end of the phase. At the conclusion of this phase, it is especially important to document the recommended revisions, approved revisions, the associated decisions made, and the information utilized to make the decisions as well as the rationale for those decisions. Adaptive Management Coordination is the fourth phase in the project adaptive management cycle.
This phase has two steps (Figure 10):

Step 9: Recommend revisions
Step 10: Approve adjustments

This phase is described in detail in section 2.6: Adaptive Management Coordination.

2.2.6. Exiting the Project Adaptive Management Cycle

There are five points during the project adaptive management cycle that can result in a project exiting the cycle temporarily or permanently; these points are identified as project off ramps (Figure 10). Projects that are not pursued have an important set of lessons learned, including the information and knowledge that was used to arrive at the decisions for not proceeding with the project. This information should be documented in a current, or newly developed, mechanism to associate lessons learned and decisions from individual projects.

During the Design and Construct Project phase, the project can exit and potentially be removed from further consideration due to issues of land rights; because the project is found to be unfeasible; or due to unforeseen site changes, such as a major storm, that greatly increase the cost or scope of a project, thus making a previously feasible project unfeasible. During the Operate and Monitor Project phase, monitoring may show that the project is performing poorly, possibly in comparison to project costs, and if conditions do not allow for project adjustments or improvements, the project may be discontinued. The final project off ramp occurs when a project reaches the end of its intended life span or operational period.

In all five cases, the project exits the project adaptive management cycle. Project off ramps provide an important opportunity to capture lessons learned (i.e., successes and challenges) and, as such, the decision-making process must be documented to facilitate adaptive management.

2.3. Information Management

2.3.1. Introduction

Collecting, organizing, managing, and providing relevant data and information in a format that is useful to management decisions is a key element to successfully implementing adaptive management. This includes providing ready access to high-quality data necessary to identify system baseline conditions and relevant data for modelling efforts. Additionally, it will support development of tools and outputs capable of assessing the success of restoration and protection activities through synthesis of management and monitoring data and information.

Various forms of information are managed based on their capability to inform adaptive decision making. In this document, “information” is used as a broader definition of “data” and refers to observations, correlative data, metadata, technical reports, lessons learned, synthesis reports, communications products, and research outputs, as all require management for effective access. Traditionally, “data” refers to raw data, or unprocessed data, which hasn’t been analyzed or manipulated in any manner, where “data” is used in the more restrictive sense of spatial or point quantifications in this report, it is specifically clarified.

For successful adaptive management, proper information management, storage, and access to data must occur. Personnel at every step of the adaptive management cycle must be informed about how to properly collect data, where and how to store data, and how to retrieve information when required in subsequent steps of adaptive management. Specific to adaptive management, the flow of data to information considers the linkages in and out of the knowledge base components at each step of the cycle. While the primary personnel transferring and managing data in the knowledge base are database managers, all personnel engaged in implementing adaptive management have a relationship to the knowledge base. This is the case in every step of the adaptive management cycle, all steps both require and develop information, whether formulating measurable goals at the start of a project, providing information for modeling activities, or assessment of programmatic or project success through monitoring feedback. The Open Data Act applies to all federal agencies or where funding comes through department of Treasury. The Act requires data and metadata to be made public and that chief data officers be appointed at agencies to ensure compliance.

2.3.2. Louisiana Coastal Data Management Systems

Monitoring provides a means to track restoration performance (e.g., identifying unwanted condition of non-compliance) and a way to advance scientific understanding of the status and trends of the broader ecosystem. Monitoring data provides feedback on decision-making by assessing system response relative to identified goals and objectives at various spatial scales. Monitoring data also supports other aspects of the adaptive management cycle, such as Define the Problem, Develop or Refine Models, and Applied Synthesis and Research. The following sections describe systems currently being used to manage monitoring data for Louisiana coastal restoration. CPRA manages CIMS and an Oracle Enterprise Project Management System and interacts with other state and federal agencies through the LA TIG.

2.3.2.1. LA TIG MONITORING AND DATABASE MANAGEMENT

LA TIG monitoring data are managed by NOAA, USGS, EPA, and Louisiana state agencies. NOAA manages data associated with the evaluation and restoration of environmental injuries from hazardous waste releases, oil spill, marine debris, and vessel groundings in its role as a steward for the nation's coastal and marine resources. DIVER is the online database through which NOAA provides public access to project data, assessment, and restoration data including injury assessment samples, observation data, restoration project status, financial information, and restoration monitoring data. DIVER provides access to data from many sources including the NRDA Trustees, BP, and historical information from prior to DWH spill. The DIVER Explorer query tool can be used to filter, perform spatial queries, and download data and results. Spatial data can be mapped using the Environmental Response Management Application (ERMA; NOAA, 2014), but there is no direct linkage between ERMA and DIVER. All LA TIG funded project data are hosted within the DIVER Restoration Portal or similar outside data platform (DWH NRDA Trustees, 2017) in accordance with the Federal Open Data Policy. Project-specific monitoring for LA TIG funded projects is conducted in accordance with each project's MAM plan and QA/QC procedures in the MAM Manual (DWH NRDA Trustees, 2017). If project monitoring data are provided by an outside data platform, the data should be linked to DIVER. The nature of the linkage may vary depending on the degree of interoperability desired.

Other agencies in Louisiana also manage data that is often utilized as part of restoration project development, management, and implementation. For example, LDWF manages data related to alligator, bears, oysters, fish, and other species within the LEADMS and the EDMS (LDEQ, n.d, 2018). The USGS has databases related to surface and groundwater, including the NWIS which catalogues observations regarding the occurrence, quantity, quality, and movement of water and allows for dissemination of data to the public (*National Water Information System: Web Interface*, n.d.). EPA also manages data (in partnership with state agencies) related to water quality and quantity within the Water Quality Exchange framework structured to facilitate submission of local, state, and tribal observations to their legacy data repository, STORage and RETrieval (STORET); (EPA, 2018).

2.3.2.2. CPRA MONITORING AND DATABASE MANAGEMENT

For more than 20 years CPRA has made its restoration data and information publicly available on the internet (Section 2.1.4.1.1). Continuously widening responsibilities in conjunction with an increase in the amount of data being generated as well as the need to deliver this information more rapidly have pushed CPRA to significantly improve its data management and delivery capabilities. The initial step, undertaken in 2013, involved the development and incorporation of a formalized Data Management Plan. Following this effort, CPRA partnered with the USGS's Wetland and Aquatic Research Center to restructure and increase their information management capabilities by developing CIMS; (http://cims.coastal.louisiana.gov/). CPRA continues to expand its data management capacity but there is still a need for additional capability to fully support adaptive management efforts.

The current data management capacity within CPRA requires further expansion to address increased requirements concerning data collection, assessment, and modeling efforts. Understanding the full linkage potential between existing monitoring efforts such as SWAMP, BICM, and project-specific modeling efforts could identify strategies to increase efficiency. Additional data types that need to be incorporated into CPRA's existing data management paradigm include, but are not limited to, LiDAR data, ADCP data, Laser In-situ, LISST data, water quality data, qualitative and quantitative fisheries data, and other biotic data. It is necessary to assess and develop the linkage capabilities between CIMS and DIVER as well as the state's CRMS and other existing partner data repositories. It is important to recognize that these different systems have varying capacity and technical ability to handle these diverse data types. DIVER has developed data delivery templates and while it is technically possible to script from CIMS to DIVER, increasing data discoverability, the systems would require additional capacity (assessing this need would be an essential first step). Regarding scaling the current capacity of both data repositories, it would be useful for either system to facilitate storage of large data sets (e.g., photos, georeferenced data and large survey data) and numerical or conceptual models so that project designers and researchers best utilize existing models. A mechanism for centralization, a repository or clearing house of data code as well as input and output files would increase opportunities for adaptive management and minimize duplication of effort.

DIVER allows for model storage in a zipped file, and currently does not allow searching within these files. While there are options for expanding this functionality (Environmental Response Management Application, adding indexing terms or keywords), the more important need is to determine what functionality is desirable for numerical models within current or future data management mechanisms. Any further capacity or functionality for data management should leverage existing system capabilities (CIMS and DIVER) and clearly identify the required needs and users.

Key Finding 44 *Expand current data management, storage, and distribution capacity.*

Data management plans (DMPs) describe data that will be acquired or produced during research, both during a project and after project completion. It includes how the data will be managed, described, and stored, as well as necessary use standards and security. For example, currently within CPRA DMPs are only required for projects from specific funding sources such as RESTORE, and NFWF (Haywood, 2017). However, data reliability, uniformity, accuracy, and discoverability can all be improved when a defined DMP process is applied to all new projects. In order to assure agency-wide adoption, DMP requirements should be realistic, concise, and manageable. Identification and exclusion of cumbersome elements will further acceptance and implementation from late-adopters. A guidance document and template should be developed using existing resources such as those developed by USGS (USGS, n.d.) and/or NOAA (NOAA EDMC, 2015) and then a mechanism to check for compliance to these documents prior to project completion.

Key Finding 45 *Finalize common guidelines and templates for data management plans.*

For adaptive management to be fully implementable within CPRA and the LA TIG, additional processes need to be developed which are capable of cataloging restoration lessons learned and decision logs, as well as stakeholder data. Currently both DIVER and CIMS lack the explicit ability to capture lessons learned, or decision logs, during restoration project implementation and monitoring. Both systems have the capacity to address these needs if there is a desire to develop this functionality.

Key Finding 46	*Both CIMS and DIVER have technical capacity to capture lessons learned and programmatic/project decision logs, impetus, personnel, and funding are required to implement.*

2.3.2.2.1. Coastal Information Management System (CIMS)

CIMS is the enterprise data repository employed by CPRA and combines a network of webpages hosted by the agency (www.coastal.la.gov). It includes a GIS database and relational tabular database in one public-facing, GIS-integrated system capable of robust visualizations and data delivery. CIMS facilitates public access to CPRA's suite of protection and restoration projects as well as Coastwide Reference Monitoring System (CRMS) stations, Coastal Master Plan activities, geophysical data, and coastal community resiliency information. CIMS is the official repository for environmental, modeling, and monitoring data for restoration and protection projects undertaken by the state of Louisiana (CPRA, 2018).

Currently, most restoration and project data are made available on CPRA's CIMS portal and through DIVER for LA TIG supported projects (CPRA, 2018; NOAA, 2017). Despite being publicly accessible, a majority of stored data is not easily discoverable. Some of these discoverability limitations could be addressed through optimization of search engine resources and through continued development and expansion of controlled vocabularies, potentially being expanded to include CRMS and CIMS lists. As opposed to natural language vocabularies, controlled-vocabularies mandate the use of predefined terms, thereby limiting the word choice available to describe a data element. A CV should include any and all terms necessary to describe restoration-associated data (Lightsom et al., 2015). Detailed metadata also adds to the discoverability of data through use of keywords and required fields. Discussion of paths forward to more fully coordinate DWH long term data management is ongoing and provides context for the additional coordination with CIMS and CRMS in Louisiana (CRRC, 2019).

Several controlled-vocabularies currently exist and selection of a controlled-vocabulary from an agency with similar scientific endpoints would improve CPRA's ability to integrate with national data repositories. In DIVER, while all data is uploaded and available, some data is structured, searchable by automated algorithms, and therefore easily discoverable, while other data is unstructured, not amenable to entry into a database format, and difficult to locate. It is recommended that data be structured and that templates be developed for high-priority data types in order to facilitate easy inclusion within DIVER (DWH NRDA Trustees, 2016). Relatedly, if data is exposed as a web service between analogous repositories such as CIMS and DIVER, then data in both systems can be accessed and queried from a single host, simplifying the process of data gathering (e.g., GRIIDC, ERDDAP). Additionally, it would be useful to clearly define the circumstances in which CPRA and restoration implementing mechanisms in Louisiana should use DIVER, CIMS, or other state or federal databases, and to facilitate linkages to other databases for the purpose of discoverability. For example, storage of large datasets such as LiDAR surveying might be hosted within a single system and linked to other repositories whose users might benefit from the data's visibility.

Key Finding 47	*Improve upon existing data discoverability.*

In addition, to meet programmatic restoration goals related to portfolios of projects (e.g., for CPRA and LA TIG), data included as a part of CIMS benefits from being readily available for synthesis and analysis with data from other systems such as NOAA's DIVER (https://www.diver.orr.noaa.gov/) repository.

For example, if a barrier island restoration project were to have a goal of restoring habitat to increase bird nesting, traditionally, the relevant bird monitoring data would not have been included as a part of BICM, and as such would not be stored in CIMS. However, bird nesting would need to be monitored as part of the project, and could be stored in DIVER. The collective data within the two systems could be synthesized and used to assess restoration success. Having readily accessible tools in both CIMS and DIVER for synthesis and assessment would further support adaptive management by reducing uncertainties associated with future activities, and informing appropriate decision making.

CPRA and LA TIG members have noted the need to develop more tools for data summarization, analyses, and understanding, these exist in DIVER but could be expanded preferably after end user surveys so that identified uses and needs can be targeted. These tools could take the form of automated analysis products, summary visualizations, online ArcMap server, and report cards. Leveraging the existing GIS cyberinfrastructure could expand the capabilities of real-time statistical analysis and provide additional data visualization techniques as well as increased graphical performance. However, for this to occur, several of the aforementioned gaps need to be filled and additional tools need to be developed. Specific to synthesis capability, standardized reporting of project objectives would facilitate comparison of similar projects in different locations and would allow the ability to build a narrative focused on the real-world performance of projects over a given timespan. Both DIVER and CIMS have the capacity to meet this need, if desired. Synthesis reporting should focus on high-priority data types useful for programmatic evaluation and reporting. Usability surveys of DIVER and CIMS end users would also be beneficial to target future efforts in developing utility of these databases.

Key Finding 48	*Develop additional tools for data summarization, analysis, interpretation, visualization and synthesis, automating these outputs where feasible.*

2.3.2.2.2. Louisiana Sand Resources Database (LASARD)

Sand and sediment resources in Louisiana are limited and crucial for barrier island and marsh restoration. The success of Louisiana coastal restoration efforts depends on locating sufficient volumes of sand and mixed sediment suitable for placement on beaches or dunes and for creation and nourishment of marshes and ridges. It follows that locating potential borrow sites with suitable, extractable sediment resources at acceptable costs is a crucial element to the success of broad coastal restoration goals (Finkl & Khalil, 2005). Knowledge of system's sediment budget and inventory is essential for regional sediment management (Khalil, 2012). To help facilitate the identification and management of nearshore, offshore and riverine sediment resources, CPRA developed the LASARD. This database is used to manage, archive, and maintain geological, geophysical, geotechnical and other related data pertinent to the exploration of sand and sediment in various environments (Khalil et al., 2010). In LASARD, the geoscientific and related data acquired for ecosystem restoration are archived, populated, and maintained on a GIS platform. Once standardized, LASARD data are made available to users through the publicly accessible spatial viewer on CIMS. The overall objective of LASARD is to centralize relevant data from various sources for better project coordination and to facilitate future planning for delineation and utilization of sediment resources capable of sustaining ecosystem-level restoration in coastal Louisiana (NOAA, 2017). Data collected over the course of sand and sediment research investigations were identified for incorporation into the LASARD database. The identification of sediment resources and final design of borrow areas is achieved through the integration of geophysical surveys and geotechnical investigations. Each data type incorporated into LASARD plays a unique role in delineating sediment resources and finally designing a borrow area. The resulting data are analyzed to identify the most compatible sediment for a specific restoration project while avoiding potential cultural resources, existing infrastructure, and negative environmental impacts.

2.3.2.2.3. Oracle Primavera P6 Enterprise Project Management

P6 Enterprise Project Portfolio Management (P6) is an integrated management application for project portfolios. It is intended to be used by teams or individuals involved in project management. CPRA uses P6 to manage restoration and protection project activities in all phases of the project implementation process, although currently it is not connected to other information repositories in the agency and not all project related staff have access. The ability to track and manage the development of a project over its lifetime is an essential component of CPRA's adaptive management effort. Its functionality in visually depicting interacting deadlines and time periods for multiple project components allows more efficient scheduling and communication of milestones and other due dates within and between agencies, and improves the ability to balance workloads within and between projects. Within the DIVER Portal, Smartsheet has been used to provide some of the same functionality.

2.3.3. Current Data Collection and Information Processes Within Louisiana

2.3.3.1. CPRA CONSIDERATIONS, APPROACH, AND PROCESS

CPRA has an established DMT that is the primary contributor to the agency's data system with additional input from federal, state, academic and private data streams and services (Haywood, 2017). CPRA has developed and documented policies, standard operating procedures, data conventions, and QA/QC for collection for much of the data generated in support of the programmatic coastal restoration (Folse et al., 2018; Khalil et al., 2015; Institute, 2013). However, standards regarding data and information management are fragmented and, in some cases, incomplete. For example, standard operating procedures for CRMS (fully described in Section 2.1) vary from the standard operating procedures developed for LASARD (fully described below) which in turn vary from the Contractor's Guide to Minimum Standards for Surveys (CPRA, 2016; Folse et al., 2018; Khalil et al., 2015a).

Key Finding 49	*Developing common standard operating procedures (for each type or class of data) would facilitate a more complete systems perspective for data collection and management, and increase possibility to use data for programmatic and ecosystem assessment.*

It is necessary to develop comprehensive data standards relevant to CPRA's ongoing restoration and protection efforts. Developed standards should consider the entire data life cycle from collection, submission to CIMS, storage, visualization, and dissemination. It is important that resultant standards be realistic and attainable to ensure agency-wide adoption. Complex standards will likely result in reduced compliance and will reduce the overall adaptive management capabilities of the agency. Not all data types will require immediate comprehensive standards; one-off data collection efforts (e.g., leaf litter collected as a part the RESTORE River Reintroduction into the Maurepas Swamp project) can be implemented using existing best practices and fully developed if, or when, this data type is more commonly collected. The CIMS digital library can be used to store one-off data within the system by tagging it with its data type to ensure that it is discoverable.

Data standards development is an ongoing, iterative process that benefits from guidance from a relevant data steward, or specific guidance and templates such as the MAM plan template (DWH NRDA Trustees, 2017). Data management considers the storage and accessibility of data based on two classifications: structured or unstructured. Structured data follows established reporting and storage protocols as defined by the host repository. Structured data are indexed and can be queried based on content specifications and related fields. Unstructured data are considered to be difficult to search due to wide variation in formatting and file structure (NOAA, 2017).

Additional efforts to structure all data within restoration data repositories will further the desired goals of adaptive management in Louisiana by making data more easily discovered, queried, and compiled and therefore more likely to be used.

Key Finding 50	*Develop, finalize, and unify data repository reporting and storage protocols.*

The data management regime currently employed by CPRA lacks defined QA/QC procedures for several data types (e.g., biomass). Automation of currently manual QA/QC procedures, such as the new data types being collected as part of SWAMP and those collected for project modeling, would decrease the agency's standing workload and reduce associated human error. QA/QC procedures in place for CPRA modeling efforts include a reliability assessment of input and output data associated with the ICM, EwE model, the ADCIRC/SWAN models, and Coastal Louisiana Risk Assessment model (Haywood, 2017)

A data dictionary describes the structure, format, and contents of a database as well as the relationship between individual elements. An authoritative data dictionary assists end-users by cataloging the organization, contents, and conventions of one or more databases. A typical data dictionary includes the names and descriptions of various tables, entities or records, and their contents (Northwest Environmental Data - Network (NED), 2006). DIVER has included guidance within its environmental data specification (NOAA, 2019). Concise guidance on the keywords associated with information hosted within the state's data repositories would widen accessibility for all Louisiana restoration projects and data repositories.

Key Finding 51	*Develop more comprehensive quality assurance/quality control (QA/QC) standard operating procedures based on tiered importance of data.*

The term QA/QC refers to two distinctly different elements. Despite being used interchangeably, QA applies to prevention of data defects, while QC refers to the detection of existing data defects. In the context of data management, defective data refers to any issue that negatively affects the use of data, whether it be an error or an issue with transformation. When considering the project and data collection lifecycle, QA is generally an ongoing process during collection or acquisition while QC is applied after acquisition. QA may also be applied to a draft final data package that has been QC-ed, i.e., to ensure principles such as transparency and completeness are met. QA/QC can be facilitated under contract from an outside agency, as with model data for the 2017 Coastal Master Plan (Conzelmann et al., 2017).

Formalized QA/QC procedures are used to define the criteria and processes that will ensure (and verify) that data meet specific quality objectives throughout the data lifecycle. These procedures can be revised as needed during a project lifecycle or if an adjustment to data workflow and project activities is necessary. Formalized QA/QC procedures, sometimes referred to as a Quality Assurance Plan (QAP), require the use of well-documented methods for data acquisition and should include descriptions of quality criteria for all datasets. These exist for some data sets handled by CPRA such as model outputs for the coastal master plan, but not all data types. Equally important is the formalization of a data schema capable of defining the structure and properties of data to be collected, edited, or stored. Formalized data schemas exist for the majority of data types collected by CPRA and plans exist to incorporate undefined datatypes under the newest iteration of SWAMP (Raynie, 2018).

An additional best practice involves the use of lookup tables (implemented as data domains) to standardize acceptable values for data fields. Periodic data assessments during a project's lifecycle are necessary to identify errors prior to project completion. Data quality indicators should be stored with the data values, in separate fields, to allow potential data users to determine which values are suitable for specific uses. Explicitly documenting quality management in the QAP or DMP, as well as in the metadata record of the data simplifies the exchange of quality information and would likely result in a reduction of time spent looking for high quality data.

CPRA is currently using the Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata (https://www.fgdc.gov/standards/standards_publications/). Adoption of ISO 19115 will provide an internationally standardized means of documenting geospatial data resources and incorporate international references including language and character sets. ISO 19115 addresses new developments in geospatial data structures and models and includes metadata structures for geospatial data applications and services (FGDC, 2011). Although it does not enforce them, DIVER has adopted the ISO 19115 metadata standard for environmental data query outputs, and a transition within CPRA to an identical standard would be prudent.

Key Finding 52 *Update comprehensive metadata standards.*

Data stewardship is administered by the DMT and associated consultants. Data integrity is checked with detailed and complex QA/QC software routines prior to input into the database, ideally this would also be carried out at earlier stages of data collection or analysis. Intensive use of data by CPRA staff and contractors who collect and input data into the database provides feedback on data quality and software routines to the CPRA DMT (Villarubia et al., 2017). Preservation of the CIMS application and database suite are largely done through regular tape backup and/or cloud storage for disaster recovery and service continuity. The CIMS database, or application suite, is a production-level, enterprise database that includes current and legacy data. All data and documents in the CIMS database/application suite are publicly available and will continue to be accessible in perpetuity and/or for the life of the agency. All the monitoring efforts and databases are discussed in previous sections. However, as a restoration manager initiates new work, they should consult the DMT for existing processes, documents, and SOPs as they are constantly changing. The gaps and associated key findings as well as understanding the linkages in the adaptive management cycle in the sections below reference existing processes within the adaptive management steps while also identifying gaps that need to be filled for adaptive management to be successfully implemented.

Several processes currently exist in CPRA and have been documented, although many are still being developed.

- Data sharing related to all National Fish and Wildlife Foundation (NFWF) projects and associated data management plan template.
- Data sharing related to all RESTORE projects and data management plan template.
- Data management for Master Plan modeling and associate File Naming Convention.
- Standard Operating Procedures for CRMS.
- Standard Operating Procedures for LASARD.
- CPRA Standards of Practice for GPS surveys.
- Data Descriptions for CIMS and File Naming Convention.
- CPRA Quality Management Plan for FY18.
- CPRA Data Management Plan (2013).
- SWAMP variable definitions.

2.3.3.2. LA TIG CONSIDERATIONS, APPROACH, AND PROCESS

The LA TIG has several existing processes set up through the Cross-TIG MAM Workgroup and significant investment in the DIVER data repository intended to store and help manage data and information for projects funded by the LA TIG. There is a Monitoring and Adaptive Management Manual (MAM Manual) as well as a DIVER Application Environmental Data Specification. The MAM Manual provides instructions and information on the management of data and information collected for projects funded by DWH NRDA funds. The DWH Trustee Council developed standards and protocols that are outlined in the Trustee Council Standard Operating Procedures for Implementation of the Natural Resource Restoration for the Deepwater Horizon (DWH) Oil Spill.

The Implementing Trustee(s) is responsible for ensuring that documents and electronic data files are stored in a secure location in such a way that accessibility is guaranteed for as long as the agency requires. The DIVER Restoration Portal offers a centralized storage option for each Trustee that will meet data storage and accessibility (internal and public) requirements; however, the Trustees may maintain records on other platforms. If data are stored on another platform, an explanation of where the data originated from, as well as a description of the original source data's long‐term management and archiving, should be provided in the data management component of the MAM plan, which is available in the DIVER Restoration Portal. More detailed data entry steps and workflows for restoration data management can be found in theMAM Manual (DWH NRDA Trustees, 2017).

The OPEN Government Data Act ("Foundations for Evidence-Based Policymaking Act of 2018", Pub. L 115-435, 44 U.S.C. 3502, January 14, 2019), requires that public data be in an open format, machine-readable, and with established standards. However, some MAM data may be exempt from these requirements due to protection from public disclosure under other regulatory authorities (e.g., Privacy Act, ESA, MSA). No data release can occur if it is contrary to federal or state laws (DWH NRDA Trustees, 2016).

There is guidance on data recording as part of the MAM Manual, for example, following data collection, data should be recorded in accordance with the MAM Plan, QA/QC procedures (if a separate document), QAPP, and/or SOW (if applicable). The steps are detailed in the MAM Manual and include guidance on digital data related to data standards, datasheets, required metadata standards, and directions to store and manage electronic files. The variable approach to data collection and management by the LA TIG currently limits the ability to adaptively manage projects due to the technical difficulties associated with developing basin or system wide data summaries to assess change.

A shift towards requirement rather than guidance will serve to unify LA TIG and CPRA data management procedures by enforcing a standardization of the data to information workflow.

Key Finding 53	*Move away from "guidance" and towards LA TIG commitments to specific data management practices that will better serve both DWH and State goals.*

Before being added to the DIVER Restoration Portal, all data goes through the appropriate QA/QC process in accordance with the data management section of the MAM Plan, and QA/QC procedures and must be consistent with the outlined process in the MAM Manual which includes the following steps: Data Verification (including verification of digital data and transcription of data entry), Data Procurement, Data Validation, Final QA/QC, and Information Package Creation for public release.

With streamlining and coordination of data and knowledge gathering, efficiencies can be increased. By coordinating CIMS and DIVER, identifying priority data, and investing in capacity building for data management and synthesis, greater efficiency in data management and greater ability to access important information and to build on previous experience could be achieved by both CPRA and the LA TIG. Because of the magnitude of the DWH NRDA restoration effort and the data management processes, mandates, specifications, and general guidance designed to help the Trustee Council meet case-level reporting and adaptive management objectives, the DWH case is likely to pose a unique coordination challenge to a broader Louisiana information management strategy. For this reason, the LA TIG is positioned to play an important role in addressing many of the key information management findings identified in this chapter as they relate to DWH data and systems.

To achieve these objectives there will need to be a dedicated effort to identify goals, priorities, opportunities, and develop a detailed implementation plan for better coordination between the Louisiana and DWH data systems and processes. This effort would require participation by the LA TIG, CPRA, the Cross-TIG MAM Workgroup, and technical representatives from DIVER, CIMS and other relevant systems. Subsequent implementation would require a workplan with defined goals, levels of effort, commitments, and resources provided by each of the participating groups.

Key Finding 54	*The LA TIG and CPRA should develop a plan that defines and prioritizes specific actions and implementation strategies for coordinating the information management goals of the DWH Trustee Council and the State of Louisiana.*

Key Finding 55	*Redundancy in processes and feedback mechanisms ensures that data, information, and lessons learned remain available to support adaptive management.*

2.4. Applied Synthesis and Research

2.4.1. Introduction

Applied Synthesis and Research provides essential support to the adaptive management process (Section 1.2). Applied Synthesis and Research includes the process for identifying, compiling, and prioritizing information needs, and subsequently addressing those information needs through targeted studies (research) and/or through data and information aggregation, integration, and interpretation (synthesis). The outcomes of Applied Synthesis and Research will help resolve scientific and technical uncertainties and inform science-based decision making.

Aims of this section:

- Document existing applied synthesis and research processes and efforts within DWH programs and at CPRA.
- Identify where improvements to existing processes are needed or new processes developed. These are noted as "key findings" throughout chapter.

2.4.2. Existing Applied Synthesis and Research Processes Within DWH Programs

The DWH oil spill settlements provide opportunities to fund or implement science, research, and/or monitoring to support restoration and provide better understanding of the ecosystem (Table 9). These data and information needs may cross or overlap jurisdictional boundaries indicating the need for joint discussions of funding priorities Gulfwide. Some of the funding streams have already established priorities for science, such as the NOAA RESTORE Science Program and the National Academy of Science NAS Gulf Research Program, while others are still under development, such as monitoring and adaptive management priorities for the NRDA TIGs. The following sections provide more information only on those entities in which CPRA participates in the decision-making process: The RESTORE Act COE, RESTORE Act Gulf Coast Ecosystem Restoration Council, and the NRDA LA TIG. As some processes are still under development within these entities, the level of detail in each of the following sections varies.

2.4.2.1. RESTORE ACT CENTERS OF EXCELLENCE RESEARCH GRANTS PROGRAM

The RESTORE Act, signed into law on July 6, 2012, dedicates penalties paid in connection with the DWH oil spill to a Trust Fund for Gulf Coast restoration and protection. The RESTORE Act dedicates 2.5 percent of the Trust Fund to the Centers of Excellence Research Grants Program, administered by the Department of Treasury. These funds may be used to establish Centers of Excellence in each Gulf state for science, technology, and monitoring. Louisiana will receive approximately $26 million over 15 years to support research relevant to implementing the Coastal Master Plan through grant allocation. CPRA is identified in the RESTORE Act as the entity eligible to receive funds for the grants program in Louisiana and is ultimately responsible for LA-COE.

The mission of the RESTORE Act LA-COE is to support research directly relevant to implementation of Louisiana's Coastal Master Plan by administering a competitive grants program. Researchers receive grants to contribute knowledge from a variety of fields that will inform and support the Coastal Master Plan decision-making, with a focus on science, technology, and monitoring. The LA-COE is also responsible for providing the appropriate coordination and oversight support to ensure that success metrics are tracked and achieved (e.g., research findings are utilized, deliverables completed on time; see RESTORE Act Center of Excellence for Louisiana, 2019.). On April 8, 2014, CPRA named The Water Institute of the Gulf (the Institute) as the LA-COE. On November 1, 2015, the U.S. Department of the Treasury awarded CPRA a grant to begin its research program. A core component of the LA-COE is the Research Needs document. It guides the competitive research that the LA-COE supports and is focused on the disciplines established by the U.S. Department of Treasury with emphasis on supporting and advancing Louisiana’s Coastal Master Plan. The Research Needs document was developed using a two-phased approach. During the first phase, in year one of LA-COE operations (November 1, 2015 – October 31, 2016), key topical near-term and mid-term research needs were identified. The second phase included revisiting the document during years two and three of LA-COE operations (November 1, 2016 – October 31, 2018), and key topical, long-term research needs were included, resulting in a final Research Needs document.

2.4.2.1.1. Roles and Responsibilities

CPRA is the LA-COE prime awardee and contract manager with ultimate responsibility over the LA-COE. CPRA is responsible for LA-COE and financial reporting to the Department of Treasury. The Institute is responsible for coordinating committees and working groups, supporting the development of operational procedures (i.e., Standard Operating Procedures (SOP) (RESTORE Act Center of Excellence for Louisiana, 2019), and developing and issuing Requests for Proposals (RFPs) for research sub awards. Additionally, the Institute administers the competitive grants process, coordinating independent reviews by subject matter experts, managing the research grants, monitoring the research progress, establishing and monitoring data management practices, and reporting on progress using success metrics. CPRA works with LA-COE to develop the SOP, Research Needs, and RFPs, and is involved in all aspects of proposal review and selection. CPRA scientists, engineers, and managers from all CPRA divisions assist in identifying key research priorities prior to the development of an RFP.

Key Finding 56 *Develop targeted RFPs that address specific management questions and develop tracking system to document when research findings are used in decision making.*

LA-COE has three advisory entities. The Executive Committee comprises senior research officials from Louisiana’s universities and research organizations and is weighted towards those with a strong historic focus on coastal issues. The primary responsibilities of the Executive Committee are to: 1) Work with the LA-COE to develop the SOPs and Research Needs document; 2) Approve guidelines and requirements for the competitive grants program; 3) Approve processes to ensure research conducted and reports produced are appropriately reviewed and consistent with the Research Needs document; 4) Approve success metrics for the program; 5) Work with the LA-COE to establish the External Review Board; and 6) Work with the LA-COE to establish the Technical Working Group.

The External Review Board is a group of independent scientists and engineers convened to provide technical feedback on the Research Needs and to serve as a panel for research proposal review. Based on subject matter expert reviews, the External Review Board provides recommendations to LA-COE and CPRA on which research projects should be funded.

The Technical Working Group is composed of subject matter experts and works with LA-COE staff to develop the Research Needs. The first Research Needs (formerly called Research Strategy) was also informed by a Coastal Research Priorities Town Hall meeting held in conjunction with Louisiana Sea Grant and comments from the public.

2.4.2.1.2. Mechanisms for Information Exchange

The LA COE has several existing mechanisms for sharing and exchanging information within the organization, as well as with external partners. For internal communication of products, the LA COE hosts an annual All-Hands meeting. Attendees include principal investigators of Collaborative, Research, and Graduate Student Awards, CPRA Liaisons and planning and implementation staff, the Institute Technical Point of Contacts (TPOCs), and graduate students. This meeting serves as an avenue to gather researchers funded by the LA COE to promote collaborations and inform research progress. A principal investigator (PI) or graduate student from each award is expected to describe their research progress-to-date and upcoming activities. It also provides understanding of the Coastal Master Plan planning and implementation process and goals and how the research will be used. Finally, it provides interaction between PIs, CPRA Liaisons, and TPOCs to discuss projects, any possible issues, and ideas for resolution.

Research subrecipients are also required to submit quarterly progress reports and final reports are due within 30 days of the close of the award. The final report includes copies of thesis/dissertations for graduate students, final report describing all research activities and findings, management implications of the research findings, and copies of all publications and presentations made during the award period. All collected data products and metadata must be made publicly available within two years after the final report is submitted to the CPRA contract manager.

LA COE and CPRA staff also exchange information regularly externally with other funding programs and the broader scientific community. For example, the LA COE and CPRA meet regularly with other RESTORE Act Centers of Excellence and other funding programs in the Gulf region through the Gulf Restoration and Science Programs Coordination Forum. Furthermore, the LA COE coordinates with the Louisiana Sea Grant College Program to communicate release of RFPs and to co-host a Town Hall meeting in which the broader scientific community is invited to participate. Lastly, LA COE and CPRA staff moderate conference sessions, such as State of the Coast, where researchers funded by LA COE present their results to the broader scientific community.

Table 9. Summary of DWH Programs (listed in alphabetical order) funding or conducting monitoring, research, or synthesis in or around Louisiana

DWH mechanism	Funding or conducting		Description of efforts related to monitoring, research, or synthesis	Time Period (if known)	Process for Identifying monitoring, research, or synthesis Needs	Process for funding or conducting monitoring, research, or synthesis	Website
GOMRI	Funding		Fund research that “improves society’s ability to understand, respond to and mitigate the impacts of petroleum pollution and related stressors of the marine and coastal ecosystems, with an emphasis on conditions found in the Gulf of Mexico. Knowledge accrued will be applied to restoration and to improving the long-term environmental health of the Gulf of Mexico.”	10 years, from 2010 – 2020		Projects are selected by an independent research board.	
RESTORE Act COE	LA	Funding	Each COE must focus on science, technology, and monitoring in the Gulf Coast within one or more of the following disciplines: coastal/deltaic sustainability, restoration, and protection; coastal fisheries and wildlife ecosystem research and monitoring; offshore energy development; and comprehensive observation, monitoring, and mapping.	15-year period and until the trust fund is depleted.	Strategic Plan	Competitive grant program that funds efforts.	https://thewaterinstitute.org/la-coe
	TX	Funding			Strategic Plan	Competitive grant program that funds efforts.	http://www.texasonegulf.org/
	MS	Funding			Science Plan	Competitive grant program that funds efforts.	https://mbrace.usm.edu/
	AL	Funding			Under development	To be determined.	
	FL	Funding			Strategic Plan	Competitive grant program that funds efforts.	https://www.fio.usf.edu/flracep/about

DWH mechanism	Funding or conducting	Description of efforts related to monitoring, research, or synthesis	Time Period (if known)	Process for Identifying monitoring, research, or synthesis Needs	Process for funding or conducting monitoring, research, or synthesis	Website
RESTORE Act Gulf Coast Ecosystem Restoration Council	Both Funding and Conducting	Potential to fund and conduct research, monitoring, and synthesis to support the comprehensive plan, science-based decision making	Until the trust fund is depleted.	Under development.	Members of The RESTORE Council nominate funding proposals to the RESTORE Council itself. The RESTORE Council will consider all proposals and publish a draft Funded Priorities List (FPL) showing the projects it intends to fund. The public will review and comment on the draft FPL. The Council will carefully consider the public comments, change the list as needed, and publish the final FPL.	
NAS Gulf Research Program	Funding	Research program focused on human health and environmental protection including issues relating to offshore oil drilling	30 years, from 2013 to 2043	NAS appointed an advisory group to create a strategic plan.	Competitive grant program that funds efforts. Proposals undergo independent peer review. Advisory Board Members recommend a list of projects to fund.	http://nas.edu/gulf/index.html
NOAA Restore Act Science Program	Funding	Fund "research, observation, and monitoring to support, to the maximum extent practicable, the long-term sustainability of the ecosystem, fish stocks, fish habitat, and the recreational, commercial, and charter fishing industry in the Gulf of Mexico"	Until the trust fund is depleted.	Science Plan	Competitive grant program	http://restoreactscienceprogram.noaa.gov/

DWH mechanism	Funding or conducting	Description of efforts related to monitoring, research, or synthesis	Time Period (if known)	Process for Identifying monitoring, research, or synthesis Needs	Process for funding or conducting monitoring, research, or synthesis	Website
NRDA	Both Funding and Conducting	Potential to fund data collection, analysis, and synthesis activities under any of the TIGs and either under Restoration Type funding or MAM allocation funding. Potential to conduct synthesis and reporting at TIG, Restoration Type, and/or programmatic scales to evaluate and communicate restoration progress or address key uncertainties.	15 years, from 2016 to 2031	Each TIG is responsible for identifying their MAM needs. Processes vary by TIG. The Cross-TIG MAM work group is currently developing a process on behalf of the Trustee Council for programmatic evaluation and review. Individual TIGs will develop their own processes for TIG-level evaluations. MAM Manual; Trustee Council SOP;	Science, monitoring, and synthesis that address questions relevant to restoration planning, implementation, and/or evaluation may be funded. Process for funding MAM activities is to be determined. The Cross-TIG MAM will conduct programmatic evaluation and reporting on behalf of the Trustee Council approximately every 5 years.	http://www.gulfspillrestoration.noaa.gov/

2.4.2.2. RESTORE ACT GULF COAST ECOSYSTEM RESTORATION COUNCIL

The Gulf Coast Ecosystem Restoration Council through the Council-Selected Restoration Component has funded a Monitoring and Assessment Program as the foundation for monitoring and assessment to support the Council's goals, objectives, and commitments. Through this program and ongoing work within the Council, the Council also has reporting requirements which may require synthesis efforts both within Louisiana and across the Gulf. As the Council begins to develop their reporting frameworks, Louisiana should consider how existing, or planned, reporting frameworks could help inform the Council's reporting strategy. Early coordination on the reporting needs across multiple DWH programs could potentially lead to a more streamlined reporting approach that meets multiple needs (Section 2.4.4).

2.4.2.3. DWH NRDA LOUISIANA TRUSTEE IMPLEMENTATION GROUP

The PDARP and the Trustee Council's SOP outline expectations for TIGs to evaluate and report[2] on restoration progress and progress toward achieving restoration goals. As part of the Trustee Council meetings that will occur at least once a year, each TIG is expected to provide an annual update on the status of activities, including a summary of monitoring results by restoration type and/or geographic focus areas. TIGs may also provide similar updates during their annual meetings. TIGs will coordinate with Implementing Trustees to aggregate monitoring data by restoration type for reporting to the Trustee Council on a yearly basis (the Trustees may utilize the Restoration Portal to make automated reports). Further analysis, beyond aggregating data, may be done less frequently. The Trustee Council will also perform a programmatic review approximately every five years, which includes aggregation and synthesis of restoration data across TIGs. Further guidance for monitoring data aggregation, analysis, and reporting will be included in the MAM Manual (Section 10.7.2, of SOP; DWH NRDA Trustees, 2016). Through these efforts, reporting (i.e., synthesis) needs will emerge within the LA TIG, including the data, information, and communication mechanisms needed to generate the reports.

The LA TIG will need to determine:

- How the information will be fed back into the adaptive management cycle and support the decision-making process
- Data management needs and data compatibility with existing datasets
- Mechanisms for communicating to the public

Information gained through TIG restoration and reporting activities could inform the Trustee Council's decisions on the timing and purpose of establishing the Adaptive Management and Unknown Conditions TIG (Section 10.0 of SOP; DWH NRDA Trustees, 2016).

In addition to reporting responsibilities, TIGs will also identify MAM priorities for use of their designated MAM funds, including MAM activities to identify and possibly address critical science and monitoring gaps relevant to its restoration priorities (Section 10.4.1.2 of SOP; DWH NRDA Trustees, 2016). MAM priorities are defined as the knowledge gaps or information needs relevant to planning, implementing, and/or evaluating restoration that, if addressed, would help

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[2] For the purposes of this report, we consider the TIG's reporting responsibilities synonymous with the concept of synthesis reports described herein.

the Trustees successfully implement Gulf restoration (DWH NRDA Trustees, 2017). Numerous information gaps have already been identified in settlement documents, through restoration planning, and by Trustees agencies and these sources of information could initially be leveraged by the TIG (e.g. (DWH Trustees, 2017c, 2017a, 2017b)). For each of the identified MAM Priorities, how the information informs or supports restoration planning, implementation, or evaluation or other TIG decisions should be documented and used to guide the development of MAM activities to ensure the information collected is focused on its specific purpose.

Documentation of reporting needs and processes, MAM Priorities, and MAM Activities should be documented in a broader MAM Strategy. The strategy would describe the role of adaptive management in the LA TIG restoration planning process and aim to capture the:

- Approach to evaluate programmatic performance within the LA TIG, including how it may inform the Trustee Council's programmatic review (e.g., how LA TIG restoration efforts have contributed to each of the PDARP goals) and the overall preferred alternative of an "integrated, ecosystem approach to restoration."
- Restoration Type and across Restoration Types' science questions, critical uncertainties, and information gaps that are relevant to restoration planning, implementation, and/or evaluation.
- Process for prioritizing MAM Priorities to inform decisions for funding and timing of MAM activities.

Given that MAM priorities will change over time and new MAM activities to address priorities will emerge, the MAM Strategy is intended to serve as a living document that would be reviewed annually to determine whether any adjustments or updates are needed. Furthermore, as needs are prioritized and MAM activities to address those priorities begin to emerge, other considerations may be relevant prior to funding any MAM activity:

- Investigating opportunities for leveraging and collaborating with other Gulf programs planning and implementing MAM activities. This may also be conducted via the Cross TIG MAM work group or involve sharing with Council Monitoring and Assessment Work Group to determine whether there is opportunity to build off other planned MAM activities. Coordination and communication of needs may assist in streamlining synthesis efforts or addressing research needs (Section 2.4.4).
- Review existing monitoring or research programs to determine whether data provided by those programs could be used directly, expanded, or modified to become an activity.
- Reviewing whether the activities would benefit more than one Restoration Type or geographic area.
- Identifying where these activities may take place, geographically and whether the activity warrants coordination with other TIGs, such as instances where the activity may cross into or influence neighboring TIG geographic areas.
- Determining the timing of when these activities need to take place for the data to be useful, such as how long it will take to implement and complete, how quickly the information is needed, the frequency of the information need (e.g., one time versus ongoing information need).
- Exploring other potential funding streams and mechanisms for addressing identified MAM priorities.

Key Finding 57 *Develop a LA TIG MAM Strategy.*

2.4.3. Existing Applied Research Processes Within CPRA

CPRA's Research Section has the responsibility for identifying, soliciting, and compiling research needs from all of CPRA. The compilation of research needs has most recently been done in conjunction with development of the LA COE Research Needs document (Section 2.4.2.1), although the current process for soliciting, compiling and prioritizing across all funding programs is not formalized. Input on these needs are typically requested from CPRA through email communications and meetings with personnel from all divisions of CPRA. Needs are also identified through:

- Individual projects and databases within CPRA (e.g., Delta Development, LASARD, LASMP, and BAMM.
- Literature compilation and review.
- Input from external entities such as science advisory panels (Section 2.5) technical workgroups, individual researchers, or research collaborators.
- Information gaps identified during programmatic or project development, engineering and design, project construction, or post construction operations, maintenance, and monitoring and documented in project reports (e.g., monitoring reports).
- Specific environmental events (e.g., Roseau cane scale invasion or Brown Marsh-Spartina die-back) and other ad hoc sources.
- Coastal Master Plan model improvement strategy.

Several research programs are currently being implemented within CPRA to address scientific and technical uncertainties at the project-type level, across multiple individual projects, or programmatically. Each is discussed with recommendations on how they may be improved or expanded.

2.4.3.1. COASTAL SCIENCE ASSISTANTSHIP PROGRAM (CSAP)

The CSAP directs scientific research to answer questions about planning, designing, constructing and evaluating coastal protection and restoration projects. This program provides assistantships for up to three years to support Master of Science students both enrolled full-time at Louisiana colleges/universities and involved in science or engineering research relevant to Louisiana coastal protection and restoration efforts. Four proposals are funded each year and any remaining funds from students who graduate in less than three years can be used to fund additional students, pending approval of the research proposal. For the past 11 years, more than 60 students have received funding support through the CSAP program. The duration of awards should be reviewed each funding cycle to determine whether fewer proposals of longer award lengths (three or more years) versus more proposals of shorter award lengths (two years) are best suited to achieve the goals of the program and best support decision making. The CSAP allows CPRA to address two recurring problems: The lack of funding for applied coastal ecosystem restoration research and the lack of relevant work experience among CPRA job applicants. In addition to monetary support for up to three years, participation in the CSAP provides students invaluable professional working experience beyond that gained in traditional academia. The required internship with CPRA staff offers on-the-job training that promotes understanding of CPRA's daily activities and of broader issues relevant to coastal protection and restoration. This training produces attractive job candidates, thus increasing their opportunity for employment within CPRA after graduation. If not ultimately employed with CPRA, students will have been exposed to the issues of coastal land loss and will hopefully remain engaged with the protection and restoration effort in some other capacity. This program is also considered complementary to research funded through the LA-COE and both are vital funding opportunities for Louisiana graduate students that will both help train future scientists and advance the science critical to Louisiana coastal restoration and protection.

Key Finding 58 *Increase the Applicability of CSAP Research Findings.*

2.4.3.1.1. Key Personnel

The CSAP is a partnership between the Louisiana Sea Grant College Program, which is responsible for contracting, and CPRA, which is responsible for funding and internship supervision. Louisiana Sea Grant and the CPRA CSAP project manager, a Coastal Resources Scientist in the Planning and Research Division's Research Section, work together to develop an annual call for proposals. In the fall of each year, Louisiana Sea Grant releases a call for proposals to the in-state academic community soliciting applications for funding to support graduate students involved in research relevant to Louisiana coastal protection and restoration. This call for proposal could be tailored to specific management questions and research needs in order to improve the relevance and applicability of CSAP Research. Faculty at Louisiana colleges and universities are responsible for submitting applications, and research must be consistent with the CPRA missions of coastal protection and restoration. CPRA personnel evaluate each application for technical merit, originality, credibility, relevance to ongoing or proposed CPRA activities, and whether the project would significantly increase understanding of the proposed topic. The CPRA Review Team consists of CPRA personnel (both scientists and engineers) from the Planning and Research, Engineering, and Operations Divisions, with expertise in a variety of scientific topics. The CPRA CSAP project manager leads the application review process, reviews quarterly invoices and progress reports, monitors progress on thesis research activities, and ensures the completion of program requirements by each of the funded students. The CSAP project manager also coordinates the internships by matching each graduate student with a CPRA personnel (scientist or engineer) who will supervise the student. The internship supervisor will assign the intern with a task and provide him or her with the guidance and training needed to complete the task. Tasks might include compiling and analyzing data, entering data into databases, literature reviews, report writing and editing, and similar technical tasks that the internship supervisor feels will be beneficial to both the student and CPRA. There is a need, however, to evaluate lessons learned on an annual basis to maximize the benefits that student thesis research and internship tasks have for coastal protection and restoration projects. The lessons learned from the CSAP projects can be discussed during an annual meeting with regards to their application to CPRA and the identification of additional research needs.

2.4.3.1.2. Products and Outputs

Students are required to give a presentation on their thesis research findings to CPRA personnel upon completion of their research and to provide a digital copy of their thesis. Each completed thesis is loaded to the CPRA CIMS Document Library (https://cims.coastal.la.gov/) and is available to the public. CSAP student authored journal publications are also available in CIMS for internal use by CPRA personnel.

The CPRA CSAP project manager monitors the progress of the graduate students through written quarterly reports. The CSAP project manager also tracks the career successes of graduates and obtains copies of journal publications. The CSAP project manager provides regular updates to CPRA personnel through invitations to student presentations, one-page project summaries, and copies of journal publications and completed theses in CIMS. Updates are also provided via the CPRA Quarterly Adaptive Management Bulletin, for example, Issue 6 (https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=19613).

2.4.3.2. RESEARCH BY PROJECT TYPE AND TOPIC

Efforts to identify and address research needs at project scales occur as needed within CPRA (e.g., LA-39 Coastwide Planting Project, a CWPPRA project testing the survival and growth of different plants in delta areas impacted by Roseau cane scale). For complex restoration or protection projects types (e.g., diversions), funds are available to support science that addresses specific information gaps or uncertainties. As part of the formalized effort to prioritize research needs (Key Finding 60), project type or topic based research needs should be considered.

2.4.3.2.1. Key Personnel

The personnel involved vary by project and funding entity. The CPRA point of contact for these types of research projects include project managers, feasibility study managers, engineers, or other technical staff as assigned. These POCs would be responsible for providing oversight of the project for CPRA.

2.4.3.2.2. Sources of Information

Statements of need are typically developed by CPRA and submitted to appropriate engineering and consulting firms or academic institutions, with which professional services contracts have been established. CPRA staff then works with the selected researcher to develop scopes of work and budgets for the project and provide oversight during the duration of the project (i.e., track progress, approve invoices and deliverables, etc.).

2.4.3.2.3. Products and Outputs

Information from these types of research projects is shared internally for review and utilization. The exact mechanism for this exchange depends on the volume of information produced, with secure FTP sites set up for larger projects, and feasibility studies that disseminate a lot of information. Much of this information is also uploaded to CIMS as appropriate. Because the majority of these projects/studies are conducted in collaboration with other federal or state agencies, the information is also shared with other research programs. The information will most likely include a final report, along with data, models, maps, and other deliverables specified in the contract and catalogued in CIMS. When deliverables are received, they are typically disseminated to a larger team of CPRA staff (and external people as appropriate) for review and comment. Although some external peer-review has occurred, a regular process for peer review could help ensure scientific rigor of all results.

2.4.3.3. APPLIED RESEARCH PROGRAM

The Applied Research Program is a discontinued program previously funded by CPRA and administered by the Institute. The overarching goal of the program was to fund research investigations and tool development activities that would enable CPRA to more effectively protect and restore coastal resources. The CPRA Research Section and the Institute worked together to craft an annual RFP which was then announced and managed by the Institute. The Institute received all proposals and reviewed the proposals for technical merit and relevance. A multi-disciplinary team of CPRA staff selected proposals for funding using the reviews provided by the Institute. In order to monitor progress and help guide the research, CPRA assigned an internal point of contact (POC) to each funded research project.

The annual RFP included several general research topics of interest: understanding uncertainties in project engineering and design, implementation, and sustainability; reducing uncertainties in future environmental conditions; improving data collection and utility for assessment, predictive models, and decision support tools; understanding the dynamics of the social, environmental, and economic coastal system, and the effects of land loss and implementation of the Coastal Master Plan on these systems; and understanding social, cultural, and economic resilience, and the adaptability of coastal communities to natural disasters and long-term land loss. In the last year of funding, more specific topics were solicited from CPRA staff and included in the RFP.

Internal communication was ensured through regularly scheduled status meetings. The meeting schedule was project-specific and included the researcher(s), Institute personnel, the CPRA liaison for the project, and any other interested CPRA staff. Upon completion of the research project, findings were formally presented to CPRA and a final report, along with any collected data, was submitted and made available to the public through the CIMS document library. The program produced high quality research results that are directly applicable to restoration implementation.

Although this program is no longer funded, there is an opportunity to evaluate the lessons learned from each research project that was previously funded and how they may be used to improve and inform CPRA's other research programs.

Lessons learned from each program are not currently catalogued. The following questions, among others, could be used to evaluate the lessons learned from former research programs as well as ongoing programs like CSAP. Current discussions around data management could provide useful insight into how to capture and maintain these data.

- How much funding was contributed over the program lifetime? What was the funding source?
- How many projects has this program funded over its lifetime?
- What were the outcomes of this program? Do you have specific examples? (i.e., publications, implications for master plan projects or numerical models)
- What were the deliverables to CPRA? Were they sufficient? Was there anything you would change?
- What were the advantages and disadvantages of having the program administered externally?
- How many students were supported?

- How were proposal reviews communicated? Was there anything that could improve?
- How was success “measured” (performance measures etc.)?
- How were results communicated within CPRA and to stakeholders?
- What would change or improve this program?
- How could gained knowledge be retained in the program (what works/doesn’t work, more related to administrative)?
- Did the program meet its goals?

Key Finding 59	*Evaluate Former Research Programs and Projects and Apply Lessons Learned in CSAP, LA-COE Research Funding, and Other Applicable Programs.*

2.4.3.4. EXPANDING AND IMPROVING RESEARCH PROCESSES

Although several existing research programs are currently in place within CPRA and through DWH programs, there is no formalized process for compiling research priorities and deciding which DWH or CPRA research program to utilize to meet identified research needs.

The existing sources of research priorities (Section 2.4.3) serve as a good starting point for compiling those needs, and input from additional stakeholders, federal agencies, and other partners (e.g., LA TIG, RESTORE LA COE) would ensure a comprehensive and coordinated list. The DWH programs previously described have (or intend to) compile research, science, and/or monitoring needs as well, and discussions on the priority lists with these programs will be necessary. The research list would then be summarized into a master matrix containing: Priority level, summary of CPRA’s past and current efforts related to the research need, relevance to planning, implementation, and evaluation, and how the research informs decision making. This master matrix would be developed annually and shared publicly, for example in a dedicated adaptive management bulletin that summarizes all recent adaptive management activities (e.g., research, monitoring, data management). The information would also be posted on CPRA’s website and distributed to the research and funding communities, to focus scientific efforts on the most critical questions surrounding restoration and protection in Louisiana.

To maximize the utility of existing research efforts as part of the structured adaptive management effort, a research roadmap would assist CPRA in selecting which research program for meeting particular research needs. The research roadmap will serve as a decision tree to help decide which research program is best suited for addressing each research need, including how CPRA might use different programs as tools to satisfy those needs. Each year, the status of previous year’s research and synthesis should be reviewed, including how the findings can be integrated into CPRA planning and implementation and any new research needs identified through the adaptive management cycle and master matrix that emerged during the year. Research roadmaps will then be developed for high priority research needs.

The roadmaps would include:

- An outline of initial and intermediate steps needed,
- summary of past and current efforts,
- estimated level of effort,
- assessment of internal resources,
- potential funding sources,
- integration into restoration implementation,
- communications plan, and
- potential issues.

Timing will be a key part of the research roadmap, such as how the timeline for the different research programs aligns with the timeline for when answers are needed. The team will evaluate internal and external resources (both funding and personnel/expertise) to address priority research needs.

CPRA has recently developed an ad-hoc group that is working on prioritizing research needs and developing such roadmaps. Formalization of this group will require developing explicit roles and responsibilities, schedules, timelines, meeting frequencies, communication strategy (internally and externally) and end products to ensure all elements of this component described in this chapter are carried out. Makeup of the group should include staff from all disciplines (ecologists, engineers, geologists, social scientists) and divisions. The group could also be involved in reviewing and selecting proposals to fund and serve as "points of contact" or liaisons for all funded research projects.

Key Finding 60	*Formalize the process within CPRA for identifying, compiling, prioritizing, and addressing research needs across entities, including needs that can be addressed through existing or planned restoration projects.*

2.4.4. Existing Syntheses Efforts Within CPRA

Synthesis involves the compilation of data, information, and knowledge to resolve an information gap. A few synthesis efforts currently exist within CPRA such as CWPPRA reports to Congress and basin-level assessments. Synthesis efforts within Louisiana have also occurred in the past [(Raynie & Visser, 2002); Ecological Reviews from 2000 to 2011] but there are currently no centralized efforts for identifying what new synthesis reports are needed or how might existing synthesis reports be refined.

The following sections include descriptions of the underlying processes of each existing synthesis effort including 1) key personnel, 2) sources of information needed to produce the synthesis report, and 3) what information is produced (i.e., outputs).

2.4.4.1. CWPPRA REPORTS TO CONGRESS

Congress established CWPPRA in 1990 (Public Law 101–646, Title III) in response to recognition of the ongoing severe coastal wetland losses in Louisiana and the increasing impacts on locally, regionally, and nationally important resources. Since its inception, CWPPRA has protected and restored almost 90,000 acres (138 square miles) of Louisiana's coastal wetlands in its first 25 years (1990 to 2018). As part of CWPPRA, Congress established and directed the

Louisiana Coastal Wetlands Conservation and Restoration Task Force (Task Force) to prepare, annually update, and implement a list of coastal wetland restoration projects in Louisiana to provide for the long-term conservation of wetlands and dependent fish and wildlife populations. In addition, Congress directed the Task Force to provide scientific evaluation every three years on the effectiveness of the projects as required by Section 303 (b) (7) of CWPPRA and their benefit to fish and wildlife. The purpose of the CWPPRA Report to Congress, which is published every three years, is to meet this requirement. The report typically provides an overview of CWPPRA administrative processes, CWPPRA's benefits to fish and wildlife, information on the CWPPRA project selection process and planning and implementation, evaluation of the CWPPRA with monitoring data from the CWPPRA Coastwide Reference Monitoring System (CRMS), and evaluation summaries of selected CWPPRA projects.

2.4.4.1.1. Key Personnel

The Report to Congress is developed by a workgroup of the CWPPRA Planning and Evaluation Committee, which is typically led by one of the member agencies. There are no requirements regarding the content or format of the report other than the requirement to provide scientific evaluation on the effectiveness of the projects and their benefit to fish and wildlife. The CWPPRA Technical and Public Outreach Committees review the Report to Congress before the Task Force reviews and approves its dissemination to Congress.

2.4.4.1.2. Sources of Information

The general outline of the CWPPRA Report to Congress is repurposed for subsequent reports. Information from past Reports to Congress, CWPPRA project reports, and CRMS reports and special analyses are incorporated into the Report to Congress. New projects are selected to be highlighted in each report based on input from the CWPPRA member agencies. The highlighted projects are typically those that were active in the three-year reporting period of the report and noteworthy for their success and impact. The Report to Congress workgroup compiles information for the report from CWPPRA member agencies, project managers, CRMS, past Reports to Congress, CWPPRA general information materials, and the Technical and Public Outreach Committees document review. CWPPRA collects information both at the project level and coastwide through CRMS to assess cumulative benefit of restoration on land building and land sustained. There is not substantial information exchange with non-CWPPRA efforts or entities incorporated into the report.

2.4.4.1.3. Products and Outputs

Copies of the Report to Congress are sent to members of Congress, the Office of Management and Budget, Natural Resources Committees, state legislators, and others. They are also made available at public events throughout the year, although they are not the primary means of communicating with the public. Archived reports are available at the following link: https://www.lacoast.gov/new/Pubs/Reports/program.aspx.

The 2018 Report to Congress aims to be limited to 20 pages with projects highlighted by basin. In contrast, previous reports have ranged from 50-150 pages; for example, the 2015 Report to Congress was approximately 75 pages long, in color, and included photos, maps, tables, and other graphics. One of the greatest challenges with the Report to Congress is the length. The Report to Congress workgroup and Public Outreach Committee consistently aim to develop a "short and sweet" report, knowing that legislators and legislative staffers are unlikely to have time to read a lengthy report. Other formats of reporting have been considered in the past, such as a video format, but has not yet been further explored.

2.4.4.2. BASIN ASSESSMENTS

Basin assessments are intended to synthesize information and data at the regional, or basin level. The assessment aims to 1) synthesize historical and current conditions; 2) summarize the constructed restoration and protection projects within the basin; 3) assess the individual and cumulative effects of a project or suites of projects on the condition (e.g., localized land loss, hydrologic functioning), and restoration objectives within the basin; and 4) improve the understanding of the effectiveness of restoration projects. Within basin sources of variation are also assessed, with a current primary focus on recent CRMS and Louisiana's SWAMP data within the basin. Recommendations are included to improve the outcomes of restoration and protection implementation. At the time of this report, only the Mermentau Basin assessment has been completed, but assessments of other basins are also being explored (e.g., Calcasieu-Sabine Basin). The purpose of the Mermentau Basin report is to describe the historical and current environmental conditions within the basin, document the coastal protection and restoration projects that have been constructed within the basin, and relate how these projects are affecting localized land loss, hydrologic functioning, vegetation, and elevation change. Other types of syntheses may be needed beyond the basin-level and will need to be explored, as indicated in Key Finding 61.

2.4.4.2.1. Key Personnel

Basin assessments are currently developed by CPRA scientists, with input from engineers and managers. Reports undergo an internal review process by CPRA scientists and engineers. Contracting parties, under the direction of a CPRA scientist, can also contribute expertise for a particular assessment. As projects are funded and implemented within the basin by other agencies and restoration programs, there will be a need to include these partners in the development and review of future basin assessments.

2.4.4.2.2. Sources of Information

Datasets are identified at the beginning of the assessments, and include basin-wide CRMS, BICM, and SWAMP data, satellite imagery and products (e.g., land loss maps), project survey and monitoring data, and other available data. Documents such as project design reports, post construction reports, and survey data reports are also used. Scientific and gray literature are also used as sources of information for historical conditions and system modifications.

2.4.4.2.3. Products and Outputs

Findings are currently summarized in reports that are distributed via the CIMS Document Library. Results are also communicated at project team meetings, presentations to CPRA staff, and at scientific conferences. Future assessments should consider contributing their findings to the peer review literature, because they address difficult, large-scale issues that would be of interest to the broader scientific and management question. Likewise, the peer review process could provide valuable feedback and ideas to the reports' authors, strengthening the scientific rigor and integrity of the documents. Explicit linkages back to the Coastal Master Plan modeling effort are also encouraged to evaluate whether trajectories of outcomes (e.g., land loss) and within basin variation are in line with Coastal Master Plan predictions.

2.4.4.3. EXPANDING AND IMPROVING EXISTING SYNTHESIS EFFORTS

Although recent efforts such as the Mermentau Basin assessment report serve as illustrative examples as to how synthesis efforts may be conducted, comprehensive assessment and synthesis of natural and human systems status and evaluation of progress towards meeting program goals have not been fully developed. CPRA's development of synthesis reports will need to be expanded to:

- Collectively assess both human and natural systems.
- Characterize the linkages between project and programmatic performance to predict outcomes relative to objectives.
- Identify or resolve problems.
- Conduct cross-project synthesis (beyond a project scale).

A thorough description of how this may be done is described in Section 2.1.4.1.5.

Outcomes of these analyses would be developed into new reports:

- Initial Basin Report. An initial effort should aim to assess every basin either as a basin-specific report or in combined basin reports (i.e., Breton Sound and Pontchartrain).
- Basin Report (six years). Thereafter, the initial report should be updated within every Coastal Master Plan cycle. Reports should be prioritized based on the current needs of the CPRA and include a summary of restoration projects and cumulative effects, with basin sources of variation. Requires quantitative objectives to be established.
- Regional or Coast Wide Synthesis Report (six years): State of region or coast, including summary of restoration project types and cumulative effects.
- Annual High-Level Assessment (every year): Initiate an assessment of highly aggregated indices (to be determined) from various developed reports.
- Project Type Synthesis (as needed): Synthesize project-specific reports across similar types of projects

2.4.5. Developing a Communication Strategy for Disseminating Research Results and Synthesis Reports

A successful communication strategy will provide avenues of dissemination information to multiple audiences, such as scientists, managers, practitioners, policy makers, and the general public. Several communication options exist within CPRA: (such as one to two-page annotations or summaries).

- Agency-wide email announcements. These emails sometimes contain a short summary of the research, with a particular emphasis on results most relevant to CPRA.
- Quarterly Bulletins. These bulletins describe CPRA's Adaptive Management and highlight recent activities, including research projects, CIMS updates, and other applicable resources. These bulletins are also publicly available through the CIMS document library.
- Annual Adaptive Management Bulletin: Could summarize quarterly bulletins into an overall annual report.
- Oral presentations of the project and results by researchers or CPRA staff.
- CIMS document library. Final reports and associated materials for all CPRA-funded applied research projects and synthesis reports are posted to the CIMS document library

(https://cims.coastal.louisiana.gov/default.aspx). An additional dropdown menu item could be added to catalogue those reports and materials that are directly linked to the Adaptive Management program.

- For certain research products that are more GIS-oriented, custom application interfaces are created or layers are added to the CIMS Main Spatial Viewer to facilitate the display and usage of the research findings and data.
- A database of past and current CPRA funded research projects is maintained, which includes a brief description of the main results of the research and a link to the research deliverables in the CIMS library.

These diverse mechanisms ensure findings are communicated to people working on similar projects in CPRA and could potentially be used in a way that would lead to direct changes in the program based on new information. However, key to the success of a communication strategy is ensuring end users are part of the applied synthesis and research efforts from the beginning, as an integral part of the project team, such that results are directly addressing their research and synthesis needs and communicated in a meaningful and useful way.

Key Finding 61 *Formalize the process within CPRA for developing Synthesis Reports with other entities.*

2.4.6. Coordinating Synthesis and Research Processes in Louisiana

The dynamic nature of Louisiana's coastal environment increases the urgency to identify and prioritize research that can fill information gaps and synthesis that can pull information together to tell a broader story. Some applied synthesis and research needs have been identified by specific agencies within Louisiana, as described throughout this chapter. However, coordination and collaboration in the identification and prioritization of research and synthesis needs across entities in Louisiana is needed to identify where common needs may exist, discuss opportunities for leveraging resources to address needs, and share key findings as needs are addressed. Within CPRA, coordination between divisions can help reduce duplication of effort and create a report that is more applicable to multiple users and ensure better linkages from post construction reports to the planning reports of subsequent projects. Furthermore, collaboration between entities on report outs, such as the five-year programmatic review within NRDA, three-year CWPPRA report, and RESTORE Council report outs (to be determined), could provide an opportunity to streamline processes and create efficiencies, where overlap in the content exist. This could also help the public understand how these different programs are working together to collectively achieve restoration goals in Louisiana.

Within CPRA, coordination between divisions can also help reduce duplication of effort and create research findings and synthesis reports that are applicable to multiple users and ensure better linkages from post construction reports to the planning of subsequent reports. Joint working sessions on an annual basis would allow DWH representatives to share programmatic priorities, newly identified information needs, and recently resolved information needs. This would also allow for discussions of internal and external resources (both funding and personnel/expertise) to address priority research needs.

At a Gulf-wide scale, the Gulf Restoration and Science Programs Coordination Forum or the Monitoring Coordination Committee (as part of the RESTORE Council Monitoring and Assessment Project) are two groups that, if continued into the future, could coordinate how research and synthesis needs are addressed in the Gulf of the Mexico. Alternatively, a subset of these groups focused specifically on Louisiana needs may be developed. The working sessions could discuss several important topics:

- Near-term versus long-term research priorities and how those priorities address specific uncertainties.
- How synthesis reports might be connected or streamlined across the different entities funding and/or implementing restoration.
- Identify connection points between research needs such that projects or activities could be implemented in a way to meet multiple needs.

Key Finding 62	*Develop a formalized process for coordinating existing applied synthesis and research needs programmatically and across implementing agencies and jointly identifying new programmatic needs shared by multiple agencies.*

2.5. Stakeholder Engagement and Communications

2.5.1. Introduction

This section describes key aspects of information and knowledge capture, flow, and dissemination within agencies, between agencies, and to the broader stakeholder community that are essential to effective adaptive management. This section first describes the 'knowledge base', the repository and transfer of knowledge and information that drives adaptive management. It then discusses communication (one-way dissemination of information) for CPRA and then LA TIG and finally, stakeholder engagement (two-way discourse to solicit input, knowledge and participation by community and stakeholders) for CPRA and then the LA TIG.

Public outreach (included here within 'communication') and stakeholder engagement are frequently mixed. While the concepts of outreach and engagement are not mutually exclusive, they do differ in a number of important ways.

CPRA has defined the following:

- stakeholder engagement as "two-way dialogue with the purpose of transferring information, problem solving, and resolving any anticipating conflict," and
- public outreach as "the way in which we deliver a message to make sure it is understood and reaches target audiences" (Crutcher, 2018).

Implementing an effective public outreach process is often tied to the degree of stakeholder engagement that has occurred throughout all phases of programmatic or project planning and implementation. Stakeholder engagement is often conceptualized as a mode of science communication that is focused on using science to inform decisions (Dietz, 2013). This can be particularly challenging when the public hold misconceptions about the scientific concepts underlying the decision-making process, if the scientific issues are socially contested, or if the hazard threat is politically charged (Stewart et al., 2018).

According to the National Academies of Sciences, Engineering, and Medicine, science communication, a key component of public outreach, is often undertaken to achieve goals that go beyond simply discussing the science itself, such as encouraging a particular policy choice or affecting health behaviors (NASEM, 2017). To assure that scientific messages are effectively conveyed, the public outreach process requires identification of the facts relevant to stakeholder decisions, identifying and assessing the magnitude of any uncertainties, drafting possible messages, and evaluating the success of these messages (Fischhoff & Davis, 2014). The final evaluation phase is key to the ability of policy makers and coastal planners to continually improve the public outreach and science communication process. This can be particularly challenging, however, as there are currently few guidelines to identify what constitutes successful public participation and what measures can be used to promote trust building between residents and key stakeholders, policy makers, and the scientific community (Stewart et al., 2018). Existing metrics have often resulted in frustration due to a lack of confidence and clarity in their meaning.

2.5.2. Knowledge Base

Adaptive management is divided into traditional activities, described sequentially as a series of steps (see Section 1.2), and the "knowledge base," which includes activities that support the capture and dissemination of knowledge, data, and lessons learned and are therefore over-arching and supportive of all adaptive management activities (Figure 11; Section 1.2).

- The knowledge base is defined here as the accumulated institutional knowledge, data, lessons learned, and discussions that form the basis to adaptive management coordination and implementation.

The knowledge base includes four components: Information Management (Section 2.3), Applied Synthesis and Research (Section 2.4), Stakeholder Engagement (Section 2.5.1.2), and Communication (Section 2.5.1.2). These activities support and interact with multiple steps of restoration implementation. Building accessible institutional knowledge is essential to preserve, and allow access to, lessons learned and improve understanding of system functioning to reduce uncertainties from restoration actions. Actively maintaining this knowledge, data, and information ensures a continuation of knowledge growth that transcends individuals and will improve projects and collectively improve programmatic success in achieving restoration outcomes. Maintaining the knowledge base to effectively support adaptive management requires dedicated staff time and resources.

Key Finding 63	*Establishing and maintaining knowledge linkages and information flow to support effective adaptive management requires dedicated staff time and resources.*

2.5.1. Adaptive Management Framework

Communications and Stakeholder Engagement are more important in some steps of programmatic planning and project implementation than others and the need for both varies with the size, geographic location, and governance context of a particular project. The following paragraphs describe the key interaction points (most important or always necessary) and the case-by-case interaction points (sometimes required, depending on the project) for both Communications and Stakeholder Engagement, Communications examples are primarily focused at a project scale (Figure 13).

2.5.1.1. COMMUNICATIONS

2.5.1.1.1. Key Interaction Point Communication: Adaptive Management Step1-Step 2 (Figure 12)

Although the project management team may communicate with the public early in the goal-setting phase, planning information is frequently not available until goals and objectives are thoroughly developed. The project team will benefit, at this point, from identifying concerned or knowledgeable stakeholders within the public who likely have valuable input. During the interaction point, the proposed project will be under public scrutiny, and it is important for the project's goals and objectives to be carefully developed prior to that interaction.

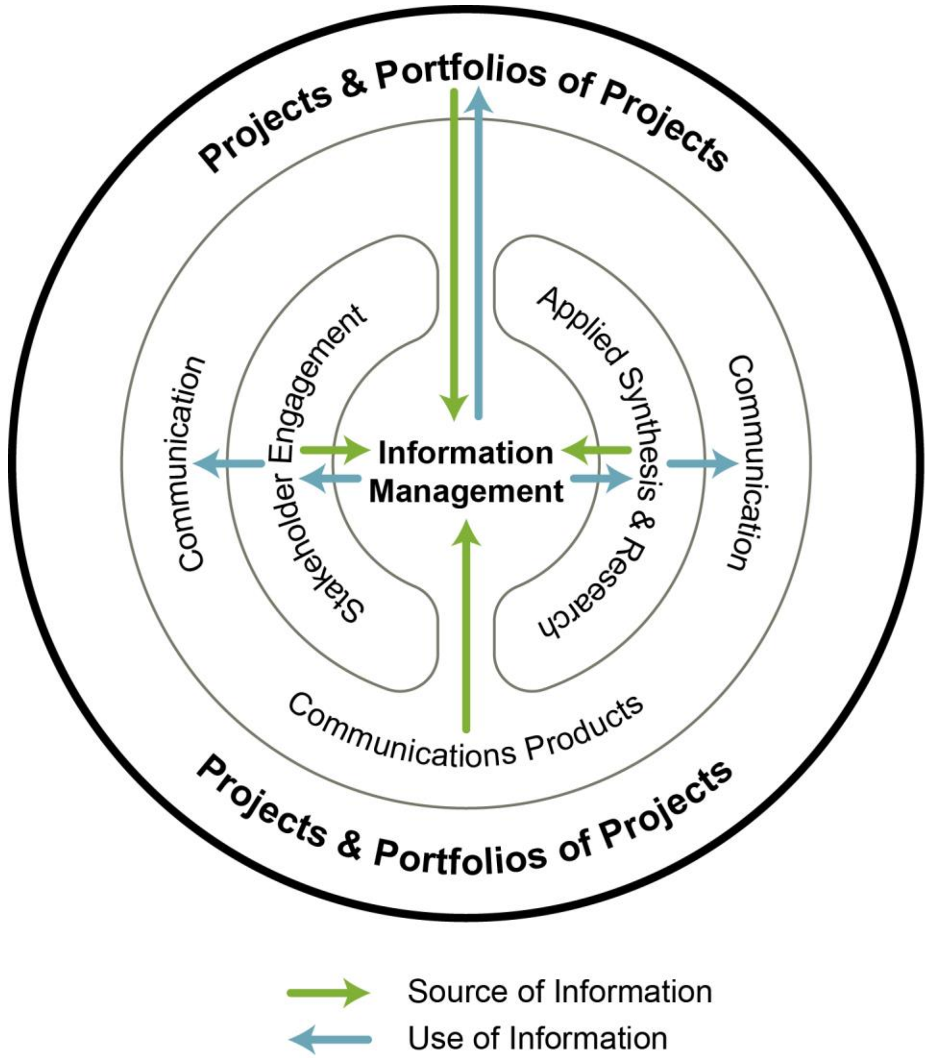


Figure 11. The knowledge base is the essential mechanism for information and knowledge capture and transfer for effective adaptive management and is composed of Information Management (Section 2.3), Stakeholder Engagement (Section 2.5.1.2), Applied Synthesis and Research (Section 2.4), and Communication (Section 2.5.1.1)

2.5.1.1.2. Key Interaction Point Communication: Adaptive Management Step 6 (Figure 12)

Members of the public have particular interest in the project implementation stage. At this point, the project numerical models will be fully developed, uncertainties will have been identified, and the project will be fully formulated. Having prior experience of engagement with the project's goals and objectives, the public will be most interested on hearing the planned implementation stages and process. Targeting specific audiences, such as the locally affected population or leaders of industries, is key to this step in the project development process. The project team will benefit from due diligence with these stakeholders at this stage, before commencing implementation of the proposed project. The stakeholders will have very specific concerns about how their group may be affected. Thorough and effective communication with them will have a positive effect on the physical implementation as well as public sentiment in general (avoiding potential future conflicts). Tasks within this stage of interaction include outreach staff and resource requirements, a workplan, a budget, and communication with project partners. Working on marketing and outreach plans is an on-going process that involves continuous adjustment and quantified assessment of effectiveness.

2.5.1.1.3. Key Interaction Point Communication: Adaptive Management Step 7 (Figure 12)

Enhancing communication is an integral part of the operation maintenance stage. Public engagement prior to and during the operation maintenance stage aids in a smooth transition from project implementation to maintenance. Stakeholders are likely interested in the logistics of operation and can help identify possible oversights of project implementation and maintenance. For example, the team would be protected from overlooking critical local environmental factors or variables that may be seldom discussed in scientific circles but would seem obvious to the local population. Stakeholders will also be interested to know the cost, as these projects are often tax-payer funded. It is worth taking time to ensure that the team's project is well-justified with the appropriate graphic displays and distributable fact sheets. Having peace of mind that the project is cost-efficient and will do minimal harm to peoples' everyday lives will go a long way towards having a consensus-based relationship with stakeholders. Again, for large or controversial projects, more frequent interaction is recommended. However, getting through this stage of public outreach is typically sufficient for proceeding to assessing and evaluating the project and submitting for review with Adaptive Management Coordination.

2.5.1.2. STAKEHOLDER ENGAGEMENT

2.5.1.2.1. Key Interaction Point Stakeholder Engagement: Adaptive Management Step 1 (Figure 12)

Stakeholder engagement is most effective when considered right from the outset, from programmatic or project problem definition, through implementation, to monitoring and evaluation of outcomes. During programmatic or project planning, information should be gathered from key stakeholders and residents as early as possible, particularly as planners are beginning to identify and define the problem that they are trying to address. Early engagement with stakeholders has been frequently cited as essential if participatory processes are to lead to high quality and durable decisions (Reed, 2008). Engaging stakeholders during the planning process also assures that restoration efforts are relevant to current decisions faced by the public and coastal planners. Integrating stakeholder input into the restoration planning process can be beneficial by providing early feedback and developing consensus before a new project, program, or decision is implemented, which can lead to avoidance of unnecessary conflict (Vogler et al., 2017)

2.5.1.2.2. Key Interaction Point Stakeholder Engagement: Adaptive Management Step 4 And Step 5 (Figure 12)

Stakeholder engagement during the ‘project phase 2: design and construct project’ of the adaptive management cycle can lead to improved outcomes as project managers are able to incorporate more sources of information into their decision making process, allowing for a more rigorous understanding of uncertainties and assumptions, ultimately leading to more robust project management decisions (Reed, 2008). Issues and concerns of stakeholders often represent uncertainties of restoration projects, or of programmatically implementing coastal restoration. Therefore, this is a critical point for engaging stakeholders to both identify and prioritize uncertainties, recognizing that not all uncertainties can be reduced within any particular adaptive management cycle, rather this is an iterative process as knowledge increases over time. Engaging stakeholders is also particularly important during plan formulation and project engineering and design, where incorporating the knowledge of local stakeholders can help assure that the planned solutions are well suited to the social and cultural context of a region (Estrella & Gaventa, 1998).

2.5.1.2.3. Key Interaction Point Stakeholder Engagement: Adaptive Management Step 8 (Figure 12)

The final key interaction point is during the monitoring and performance phase of the adaptive management cycle as stakeholders should be involved in both assessing and evaluating the outcomes of the decision-making process. This is particularly important as coastal planners evaluate the impacts of a given restoration effort. The incorporation of local knowledge into assessment and evaluation, including citizen scientists, can allow managers to better distinguish whether or restoration is achieving desired objectives, whether these objectives remain relevant over time, and whether or not the best action strategies have been pursued (Estrella & Gaventa, 1998).

It is important to note that the stakeholder engagement process is most effective when iterative and flexible. While key interaction points for stakeholder engagement have been identified, the process needs to be flexible enough to allow for engagement with stakeholders at any point during the adaptive management cycle as potential problems arise or when local knowledge can enhance the decision-making process. This may make it a challenge to motivate stakeholders to engage with the decision-making process, and those who are engaged may be placed in a reactive position, where they are asked to respond to proposals that they perceive to have already have been finalized (Reed, 2008).

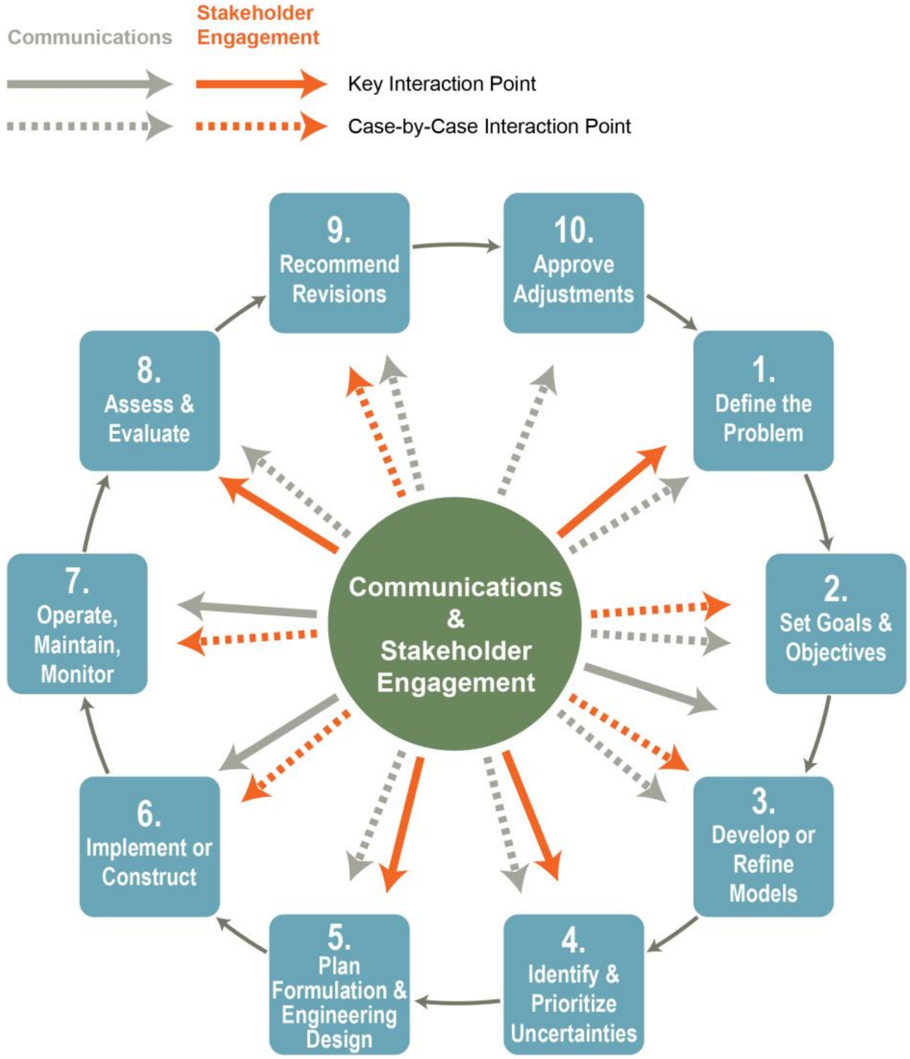


Figure 12. The ten steps for adaptive management indicating the key interaction points (orange arrows) for communications (solid arrows) and stakeholder engagement (dashed arrows), and interaction points required only in some projects (gray arrows)

2.5.2. Communications

Communicated scientific research, especially when synthesized through science communication, may be considered sufficient for people to make choices consistent with scientific evidence. Although it is mostly beneficial to have more information or to have information presented more clearly, research has shown that a focus on knowledge alone often is insufficient for achieving public outreach goals (NASEM, 2017). For this reason, outreach (and inreach) efforts need to be measured in terms of a number of factors beyond simply presenting scientific data to the public or staff. This can be achieved by quantifying the effectiveness of communication of specific messages, the effectiveness of the message itself, or the utilization of information. A number of suggested metrics have been identified that can be used to assess the effectiveness of the science communication process:

Message getting out can be measured by:

- Communications output metrics (press release count, news story counts across media markets, social media posts, post reach, likes, and shares)
- Attendance at public meetings
- Website analytics (website hits, with spatial data where possible)
    - For example: CIMS viewer
    - Report downloads

Effectiveness of messaging:

- Focus group assessments (coastal communicators)
- Public surveys

Utilization of information:

- Public surveys
- Technology polls

Change of behavior:

- Methods of work or harvesting or resources
- Engagement in formal comment and review processes

Key Finding 64	*Goals set in existing outreach and engagement plans would have greater value with quantifiable metrics to assess progress towards achieving these goals.*

The research on science communication shows that local residents and key stakeholders may already understand what scientists know but do not agree or act consistently with that science (NASEM, 2017). This discrepancy arises in large part because science communication usually engages only facts and not values. However, science communication for the purpose of supporting decision-making must also address values (Dietz, 2013). People rarely make decisions based only on scientific information; they typically also take into account their own goals and needs, knowledge and skills, traditional ecological knowledge, and values or beliefs (NASEM, 2017). Understanding how specific restoration actions impact communities beyond solely the scientific data can be vital for restoration success. The values assessment of the community that will be affected by restoration must be considered by project managers in their development and implementation of those projects. The response of the community to restoration must also be monitored and should inform adaptive management of the project after it is implemented.

Key Finding 65	*For effective science communication to support decision making during project development and operation, the values of the audience must be presented and considered as well as the known facts.*

2.5.2.1. CPRA COMMUNICATIONS

2.5.2.1.1. Outreach Principles, Goals, and Objectives

CPRA's current outreach and communications activities, approaches, and processes aim to move beyond a purely reactionary framework and follow the principles of being proactive, responsive, interactive, empowering, data rich, and programmatic (CPRA Project Management Stakeholder Engagement Standard Operating Procedures). CPRA outreach seeks to clearly communicate and develop a common and wide knowledge base around the risks of coastal land loss and storm and tidal surge events and the state's actions to protect Louisiana's coast (CPRA, 2015). Key outreach objectives include developing public confidence, establishing CPRA as the leading state voice on coastal protection and restoration, making the case for funding and investment, and ultimately building broad-based support for the Coastal Master Plan and CPRA programs (CPRA, 2015; Speyrer & Gaharan, 2017). Inreach within CPRA aims to develop an institutional understanding across administrations and to integrate and align communications activities across divisions and sections within the agency.

2.5.2.1.2. Existing Publicly Available Outreach Resources

CPRA has developed a suite of compelling and accessible communications materials that describe coastal science and processes and the risks of land loss and storm surge and frame what is at stake for Louisiana's economy and communities. These materials, such as the Coastal 101 presentation (Fig. 2.5.2), are made available on the CPRA website for partner organizations and educators to access and use.

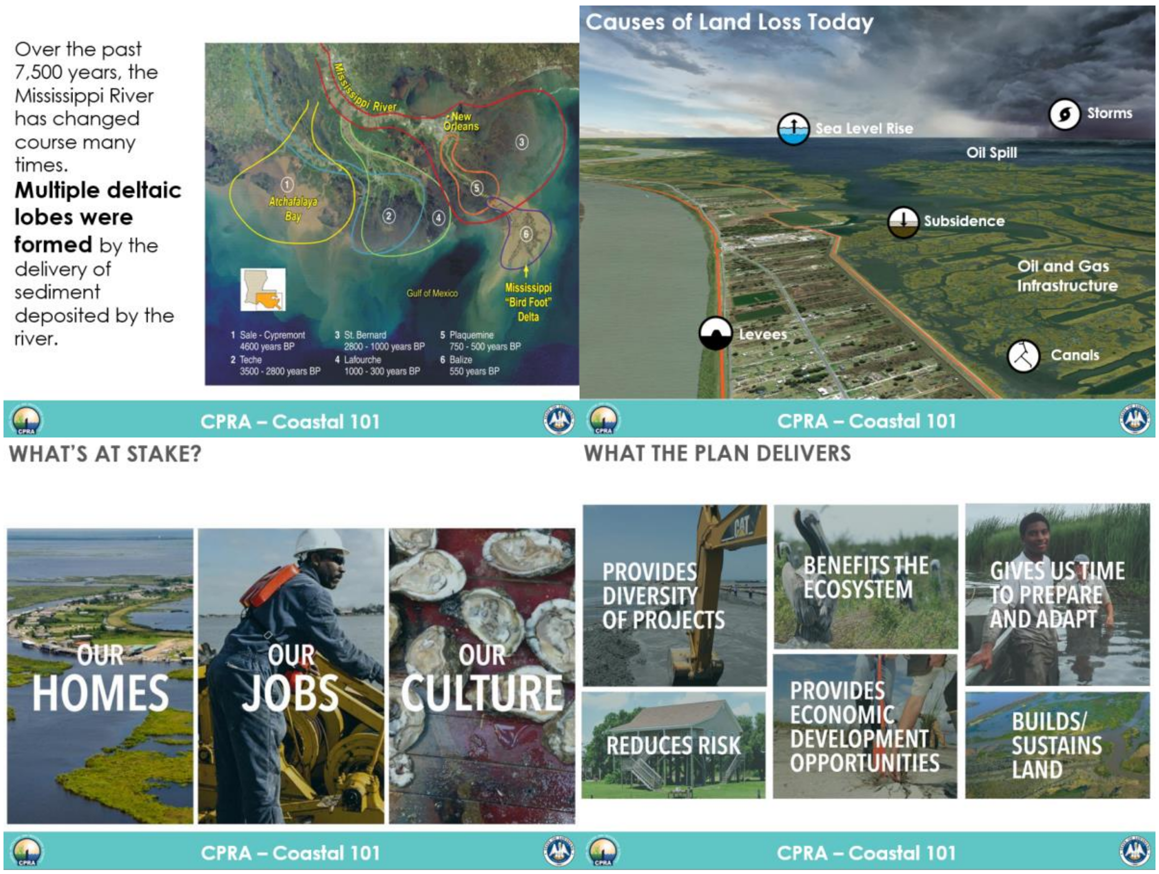


Figure 13. Sample slides from Coastal 101 Presentation

CPRA has also developed interactive mapping tools to help the public understand how coastal land loss will impact them and what projects are planned in their communities. The online Master Plan Data Viewer allows the public to view land change, flood risk, social vulnerability, and 2017 Coastal Master Plan projects near where they live and to access resources to reduce risk. The online Interactive Project Viewer includes project footprints, pictures, and technical documents on any project since 2007 that has been completed or has funding identified for its future development. Projects can be searched by parish, status, basin, or project type. The Media Resources page of the CPRA website also includes parish fact sheets with detailed information on projects and their status in each parish.

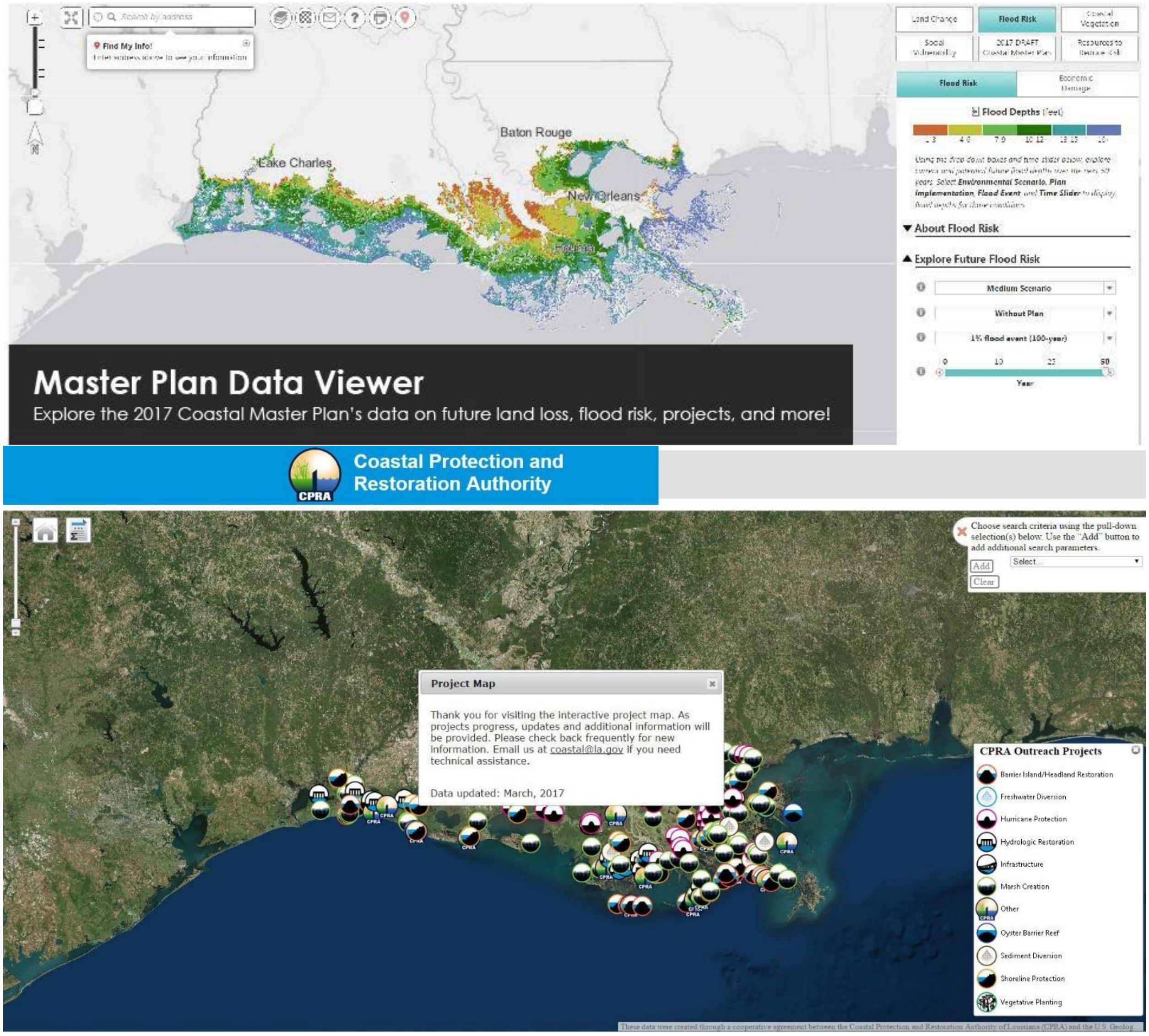
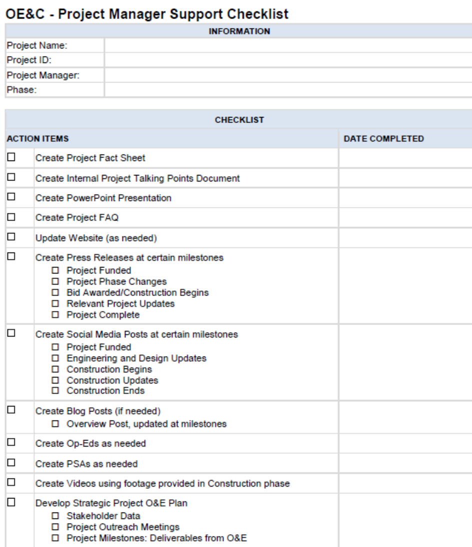


Figure 14. CPRA online mapping resources: Master Plan Data Viewer and Interactive Project Viewer

2.5.2.1.3. Communications Support for CPRA Project Managers

CPRA Outreach and Engagement has established standard communications procedures and checklists to streamline outreach protocols across each project's lifecycle to support collaboration with project managers. Outreach and Engagement has identified project milestones that serve as trigger points for outreach activities. These milestones include a change in project phase, the awarding of a project construction bid, a media site visit, a mid-construction progress update, and the completion of project construction. Outreach and Engagement manages a comprehensive Trigger List spreadsheet that tracks every active project, including project details (type, project manager, parishes, funding program, federal sponsor), current project phase and phase end date, notes and next steps, and the status/completion date of communications materials (project fact sheet, strategic plan, bid award PR, Media Site Visit, progress update, project completion dedication/PR). At each trigger point, Outreach and Engagement and the project manager consider different communication opportunities that may include a press release, presentation to the board, project site visit, ground-breaking or dedication ceremony, updated project materials, blog and social media posts. As a supplement to the Trigger List, Outreach and Engagement has created a Project Manager Support Checklist to coordinate and track specific communications tools and tactics needed for each project. CPRA is working to develop standard templates for project tools such as fact sheets, slide decks, FAQs, talking points, public meeting agendas, and reports. Outreach and Engagement also manages an Outlook calendar of external meetings and events that may be relevant for project specific outreach activities.


OE&C - Project Manager Support Checklist

INFORMATION	
Project Name:	
Project ID:	
Project Manager:	
Phase:	

CHECKLIST

	ACTION ITEMS	DATE COMPLETED
☐	Create Project Fact Sheet	
☐	Create Internal Project Talking Points Document	
☐	Create PowerPoint Presentation	
☐	Create Project FAQ	
☐	Update Website (as needed)	
☐	Create Press Releases at certain milestones ☐ Project Funded ☐ Project Phase Changes ☐ Bid Awarded/Construction Begins ☐ Relevant Project Updates ☐ Project Complete	
☐	Create Social Media Posts at certain milestones ☐ Project Funded ☐ Engineering and Design Updates ☐ Construction Begins ☐ Construction Updates ☐ Construction Ends	
☐	Create Blog Posts (if needed) ☐ Overview Post, updated at milestones	
☐	Create Op-Eds as needed	
☐	Create PSAs as needed	
☐	Create Videos using footage provided in Construction phase	
☐	Develop Strategic Project O&E Plan ☐ Stakeholder Data ☐ Project Outreach Meetings ☐ Project Milestones: Deliverables from O&E	

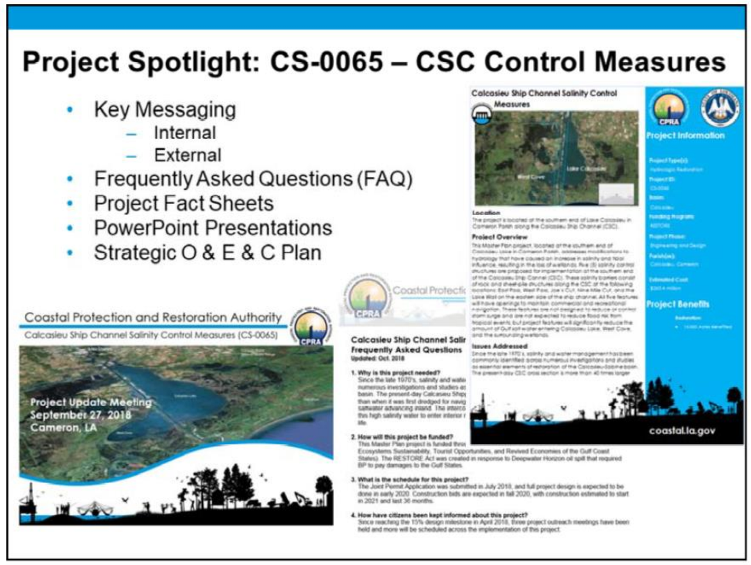


Figure 15. Outreach and Engagement Project Manager Support Checklist and example project communications materials

2.5.2.1.4. Common Server and Filing System: Overcoming Silos

A lack of coordinated inreach communication within agencies can result in redundant work efforts, especially when CPRA administrative divisions create institutional barriers to inreach communication and information transfer. Certain segments (and individual staff members) of the agency, at various times, are insulated from existing information, meaning that staff from those divisions must independently recreate work products. Additionally, agency reorganization, staff turnover, and lack of mentoring and knowledge transfer between senior and junior staff often means loss of institutional knowledge. Within CPRA, a common server and filing system has been implemented for file storage moving forward, this needs to be widely communicated amongst staff and would greatly increase the ability for project staff to find information if this also included historic files. A common resource library folder with factsheets, photographs, PowerPoint presentations is currently in development to serve as an agency wide resource.

Key Finding 66	*Within CPRA, improve inreach communication by finalizing, updating and ensuring all staff are aware of the common server and filing system, as well as the common resource library folder – to access historical and current communications resources.*

2.5.2.1.5. Coordinating Across Projects to Achieve Communications Goals

Within CPRA there are a number of resources that are produced, or there is opportunity to develop with available information. These resources can specifically support improved adaptive management through increasing communication, between staff roles within one project, or between staff responsible for separate, but similar projects (inreach). Some of these could be automated and in general would save time for project managers and project staff, rather than adding additional reporting or communication tasks.

- Automate the Parish Fact Sheets using existing data
- Automate the Project Fact Sheets by amending existing data
- Develop project specific outreach and engagement plans as part of project goal setting phase (outreach and engagement staff meeting with PMs)
    - Review or develop the project outreach and engagement plan (review or develop)
    - Both PM and outreach and engagement staff review key project documents prior to meeting
- When a project transitions to the Design and Construct Project phase the Project Manager should:
    - Produce fact sheet to include baseline data, stats, cost, funding, etc. (CIMS, project file, IMPR)
    - Identify stakeholders from stakeholder database (type of project, parish, region)
    - Retrieve the parish fact sheet for the relevant area(s)
    - Retrieve the MP fact sheet for the relevant area(s)

Note that these documents should be housed in CIMS (see section 2.3 data management)

Key Finding 67	*Where possible, automate production of communications products such as parish and project fact sheets from data that is already collected at a project, and parish scale.*

Key Finding 68	*Project Managers and communications staff develop project specific outreach and engagement plans, or clarify that one is not needed, in project Phase 1 – Objective Setting.*

Key Finding 69	*Communications efficiency will be maximized when at the commencement of project Phase 2, Design and Construct Project, available fact sheets and communications are accessed, project fact sheet is developed, and stakeholders are explicitly identified (to clarify communication needs).*

2.5.2.2. LA TIG COMMUNICATIONS

The LA TIG consists of federal and state agency Trustees tasked with managing the restoration of natural resources in Louisiana that were injured by the DWH spill. Of key importance to the LA TIG is the ability to maximize outreach and communicate with as wide an audience as possible. This is important for several reasons:

1. Public understanding and oversight of how their DWH NRDA funds are being used.
2. Public understanding of, and engagement in, development and improvement of ongoing and future restoration projects.
3. Public access to data and information for use in other efforts such as conservation, research, or development.

The LA TIG uses multiple strategies to communicate with key stakeholders and other interested members of the public:

1. Emails and eblasts to communicate with those who have opted in to receiving notifications via (https://www.gulfspillrestoration.noaa.gov/media).
2. Press releases posted to (https://www.gulfspillrestoration.noaa.gov/restoration-areas/louisiana) in addition to some of the Trustee agencies' websites and local media.
3. Fact sheets for individual restoration projects (e.g., https://www.gulfspillrestoration.noaa.gov/sites/default/files/2018-12%20LA%20Final_Queen_Bess_Draft%20Plan%20factsheet.pdf)
4. Individual web pages for each project, linked from (https://www.gulfspillrestoration.noaa.gov/restoration-areas/louisiana)
5. A storymap allowing the public to view project locations on a map and click on each for more information (https://www.habitat.noaa.gov/storymap/dwh/?LA)
6. DIVER database containing data related to the DWH oil spill and status of restoration projects funded by DWH NRDA funds (https://www.diver.orr.noaa.gov/web/guest/home)
7. Public comment meetings (in person or online) held in association with each Restoration Plan, and including interpreters (Vietnamese and/or sign language) as appropriate, with TIG Trustee representatives and printed materials such as posters
8. Draft and Final Restoration Plans distributed to 16 repositories in Louisiana and online
9. Annual meeting to present annual accomplishments and status of Louisiana restoration efforts

Key Finding 70	*Implementation of an effective communications plan must include dedicated programmatic level infrastructure, including resources for staff.*

The LA TIG noted that the public should be engaged throughout the development of the adaptive management strategies for the LA TIG, including the outreach and communications plan in order to maximize the effectiveness of the communications process.

Key Finding 71	*Engage the public in the development of the LA TIG MAM Outreach and Communications Plan.*

It is important to measure the effectiveness of LA TIG outreach and communications efforts. While measures such as public meeting attendance, the number of report downloads, and website analytics can be useful, these only show the effectiveness of the agencies in transferring information, but not in public comprehension of the information and its use to improve coastal restoration. The LA TIG has acknowledged that tools such as surveys would provide effective means of gauging the effectiveness of the communications process, which would be necessary for the adaptive management of the communications process, but because of restrictions established by the Paperwork Reduction Act, federal agencies' collection of information from the public via surveys require high level review and approval (44 USC §3501 et seq., 1980). As a result, the ability of these agencies to collect information via public survey is largely restricted. It was noted that states have more capability to gather this type of data, but there can be no federal funding or transfer of federal funds to accomplish this. For this reason, the LA TIG has noted that collaboration and information sharing among the TIG members is key to developing a plan for an outreach and communication process that will fully support adaptive management of restoration actions and decisions. The LA TIG needs an understanding of what each of the TIG's Trustee agencies are doing and how they can leverage resources or participate.

Key Finding 72	*Develop methods to measure the effectiveness of public outreach and communication.*

Key Finding 73	*Leverage opportunities for state Trustee agencies to collect and utilize public data.*

2.5.3. Stakeholder Engagement

Effective coastal management is a process that works to understand, incorporate, and communicate the interests of both upstream and downstream stakeholder groups within a linked coastal and estuarine ecosystem. The process involves the co-development and co-implementation of coastal management plans and policies and the subsequent decision making, monitoring, education and enforcement. A central goal of coastal management is to create and sustain a process that is just, transparent and accountable to those affected by its actions (Olsen et al., 2006). To be both effective and sustainable, coastal management efforts must be supported by the generation and incorporation of reliable knowledge that allows affected stakeholders and the project management teams to better understand and anticipate the consequences of different courses of action. This knowledge should be drawn from both the scientific community and from the traditional ecological knowledge and observations of community members who reside and work in the managed coastal systems.

The design of a participatory process should create opportunities for both program managers and key stakeholders to assess project outcomes as they are both underway and at the end of the process. By incorporating local knowledge into the adaptive management process, coastal managers are able to more effectively adapt to local needs and changing circumstances, particularly when knowledge is shared horizontally between stakeholder groups and vertically to higher institutional levels (Stringer et al., 2006). The participation of local knowledge experts provides insight into social, ethical, and political values that cannot be gained through scientific approaches (Stringer et al., 2006). Stakeholders can generate more alternatives, resulting in flexible actions and mutual benefits (Dietz & Stern, 2008). According to the National Research Council, when government agencies conduct stakeholder engagement, they should do so with a commitment to self-assessment and learning from experience, key aspects of adaptive management (Dietz & Stern, 2008).

The participation of local knowledge experts in the planning process provides insight into social, ethical, and political values that cannot be gained through pure scientific assessments (Richards et al., 2014; Stringer et al., 2006). For this reason, key stakeholders should be engaged at some level in the management of all programs and projects, including those that the project management team feels will not result in any community-level impacts. To maximize the efficiency of the Stakeholder Engagement process, it is necessary to develop a systematic means of scoping projects based upon a set of established triggers, with more complex or controversial projects requiring deeper levels of engagement.

Stakeholder Engagement should not be confused with communications or public outreach. These processes are very different and involve a very different set of inputs, outputs, and key engagement points. When fully realized, Stakeholder Engagement represents a means of integrating stakeholder knowledge with scientific knowledge to more fully understand the complex linkages of environmental change, key ecosystem services, and community resilience, vulnerability, and wellbeing. To maximize the effectiveness of the stakeholder engagement process, planners need to ensure that key stakeholders are identified and consulted early and often, with key engagement points (Ebberts et al., 2018) occurring at several times in the adaptive management cycle (Figure 12).

Finally, the adaptive management literature emphasizes the need for iterative learning in long-term participatory processes, where participants experimentally monitor the outcomes of their decisions and adapt them accordingly (Reed, 2008). If Stakeholder Engagement is carried out poorly or inappropriately, time and resources may go to waste and problems may very well go unnoticed, subsequently hindering project performance and community building, highlighting the need for systematic and participatory procedures to monitor and evaluate the Stakeholder Engagement process itself (Estrella & Gaventa, 1998).

Effective public engagement at multiple levels involves dialogue, deliberation, and integration of multiple perspectives and helps remove barriers to project success. Early and frequent communication with all stakeholders is encouraged to promote Stakeholder Engagement, interagency collaboration, and conflict resolution. The benefits of Stakeholder Engagement (adapted from RECOVER (2006)) include:

- Building better collective understanding of the resource issues and the science used in the planning process;
- Conducting program or project planning openly and transparently ensures that the full range of stakeholder interests, values, ideas, and expectations are considered and documented in the decision-making process;
- Promoting relationships and trust as well as establishing lines of communication, which often can take considerable time to build;
- Engaging and collaborating with stakeholders in project planning and as citizen scientists builds trust, thereby increasing the likelihood of support for the restoration process by providing a common vision of success and creating the opportunity to *resolve conflicts;*
- Enabling cooperative learning, especially regarding issues that may be confusing, unclear, or unknown;
- Providing forums to promptly identify and address key issues and concerns related to potential master plan actions or master plan projects;
- Creating networks for disseminating new or updated information to improve understanding as project and program implementation unfolds; and
- Developing creative solutions that address varying stakeholder interests while fulfilling goals and objectives.

2.5.3.1. CPRA STAKEHOLDER ENGAGEMENT

A number of principles, goals, and objectives related to Stakeholder Engagement have been established for planning and management, both programmatically and at a project scale. Engagement activities will occur over the life of the project and are standardized by identified triggers within each project phase to transfer information, problem solve, resolve and anticipate conflict or simply to communicate specific information. In order to monitor the effectiveness of this process, engagement would ideally be documented within a stakeholder portfolio containing a list of stakeholder interests and concerns. Additional information could be a timeline of engagement activities for each category of stakeholder, the method of engagement (ex. one-on-one meeting or town hall meeting), a log of interactions, staff commitment to follow up, and finally a stakeholder contact list.

Stakeholder Engagement is a critical piece of CPRA's adaptive management program and facilitates the inclusion of knowledge from a variety of perspectives from communities and families who live and work along Louisiana's coast and have first-hand experience with coastal issues. Advisory boards are one key mechanism for stakeholder engagement at CPRA. These advisory boards play an important role and represent subject matter experts who provide external review of activities and recommendations based on career experience throughout the country and internationally. Examples of advisory boards at the programmatic level include the Science and Engineering Board which advised the Coastal Master Plan, and at the project scale, the Diversion Advisory Board provided review and recommendations related to the mid-Barataria diversion project (Table 10).

The FDT is the primary collaborative group supporting and providing insight and counsel to the Coastal Master Plan Team during Coastal Master Plan development. FDT membership has included federal, state, and local governments; Non-governmental organizations, not-for-profit organizations, business and industry; academia; and coastal communities. FDT members offer specific guidance on major elements of the Coastal Master Plan and, as key advisors, they identify, discuss, and reach a common understanding about the tough choices that lie at the heart of protecting and restoring Louisiana's coast. FDT members informally reach out to citizens, bringing their ideas to the table and, later, reporting back to these citizens about how their ideas were discussed and addressed in the Coastal Master Plan. In this capacity, the FDT serves as an important distribution network for early-stage communications.

Focus groups meet regularly with the Master Plan Team to discuss plan development and implementation as part of CPRA's effort to expand stakeholder engagement and to incorporate their input on an ongoing basis. Large-scale coastal restoration and risk reduction affects communities, businesses, and industry in south Louisiana, the entire state, and even the nation. For the 2017 Master Plan, five focus groups were utilized to integrate community, fisheries, landowner, energy, industry, and navigation perspectives. Results from the focus groups' deliberations are reported at FDT meetings.

The Science and Engineering Board was created to assist CPRA with development of the 2012 and 2017 Coastal Master Plans. Both Science and Engineering Boards were composed of scientists, engineers, and planners with national and/or international experience who cover the range of disciplines addressed in the Coastal Master Plans. The Science and Engineering Board provided independent technical review of plan elements and made recommendations about how the Planning Team could improve the scientific basis and/or planning elements to create the most credible approach to Coastal Master Plan development. TACs were small advisory groups made up of nationally known researchers and practitioners who offered insight into specific elements of the 2012 and 2017 Coastal Master Plan process. The 2017 Coastal Master Plan included two technical advisory committees. The Resiliency TAC offered working-level guidance and recommendations on the programmatic and policy measures needed to implement a comprehensive Flood Risk and Resilience Program. The Resiliency TAC is composed of experts in the areas of climate adaptation planning, community planning, socio-economics, social vulnerability, and hazard mitigation, disaster planning, and environmental policy. The Predictive Models TAC advised the planning and technical teams working to improve the analytic tools that assessed how the coastal Louisiana landscape will evolve over the next 50 years, and that helped to prioritize effective protection and restoration projects that comprise the Coastal Master Plan. In addition, the Predictive Models TAC advised the technical team working to implement the model improvement plan.

CPRA has considered cataloguing interactions project managers have with stakeholders towards the development of a Master Stakeholder Database. This would consist of state, local, and federal elected officials, representatives from relevant local, state, and federal agency staff, user groups, non-profits, potentially impacted residents, and lessees (hunting lessees, etc.) that can be accessed and used to query out key stakeholders within the project or program impact area. It would consist of a collection of information derived from those individuals who have attended and will attend CPRA meetings, or who electronically have indicated interest in learning more about projects and programs in their area. These stakeholders would be classified by a broad audience label and then further refined by target audience. The impact area used to query out potentially relevant stakeholders will be project-specific and initially be identified by the project management team. Depending on the scale and complexity of the program or project, the impact area might consist of a buffer zone around the project, the parish, or watershed, for example. This process of targeted community engagement is called the "snowball effect" within SciTEK process, and enhances input from knowledgeable stakeholders who often do not attend large public meetings (Richards et al., 2014).

This preliminary stakeholder list could then be used to enhance discussion at the project team level about who may be impacted by or who may impact the project to further develop and refine the list. Groups of stakeholders including both organizations and individuals will then start to emerge. It may be the case that some searching for the most appropriate individuals to represent a group or an organization may occur due to either the incomplete nature of the source or the need to update the database. Once stakeholder groups have been identified, appropriate communications and engagement strategy should be chosen and planned, based upon the complexity and contentiousness of a project.

Table 10. Summary of stakeholder groups currently engaged in the master plan process and the exchange of information that occurs across adaptive management activities (Hijuelos & Reed, 2017)

Stakeholder Group	Information Discussed	Relevance to Adaptive Management Activities
CPRA Board	Briefings and discussion at key benchmarks in the master plan process	Information is used to ensure all activities remain relevant to the coastal protection and restoration program in a larger context.
Predictive Models-Technical Advisory Committee (TAC)	Technical details on the modeling used to support the master plan	Information is used to refine and improve system models as well as identify knowledge uncertainties.
Resiliency TAC	Technical details of the flood risk and resilience program and the underlying analysis	Information is used to refine and improve the flood risk and resilience program and communicate to those affected.
Science Engineering Board (SEB)	Technical overview of analytical tools and how they are used to produce the master plan	Information is used to refine and improve system models, formulate the plan, as well as identify linguistic and decision uncertainties.
Framework Development Team (FDT)	Regular summaries of progress including project information, scenario specification, model results, preliminary formulations, etc.	Information is used to ensure all activities remain relevant to the realities experienced by people who live and work on the coast every day.
Focus Groups	Sector-specific information on projects, metrics, and issues of concern	Information is used to ensure all activities remain relevant to coastal communities and can aid in identifying linguistic and decision uncertainties.
Flood Risk and Resilience Subcommittee	Specific insight into future nonstructural measures and activities	Information is used to enhance decision making, focus resources on critical areas of need, and provide recommendations on policies and procedures for nonstructural implementation.
Parish Floodplain Managers Group	Guidance into the implementation of nonstructural projects	Information is used to guide policies and procedures for nonstructural implementation.
State Steering Committee	Updates and discussion at key benchmarks in the master plan process	Information is used to ensure all activities receive input from the state departments and agencies to establish shared ownership.

The CPRA Project Management Plan Template establishes that the stakeholder engagement process should operate through a series of identified triggers within each project phase to transfer information, problem solve, resolve and anticipate conflict or simply to communicate specific information. Criteria have not been defined to prescribe what methods are most effective to engage with identified stakeholder groups. To adaptively manage the stakeholder engagement process effectively, it is necessary to first establish a set of standardized procedures used to engage key stakeholders. For each category of stakeholder, an appropriate engagement strategy should be chosen and pursued in a systematic manner appropriate to the complexity and contentiousness of the program or project. Successful engagement mechanisms include the use of interactive techniques, such as unstructured conversations, one-on-one interviews, structured workshops focus groups, and scenario development. In each of these mechanisms, social learning is facilitated, and information flows between different stakeholders are multi-directional (Olsen et al., 2006; Stringer et al., 2006). To more effectively manage outcomes, the project management team should apply a mix of these techniques to conduct the analysis depending on the geographic scale and complexity of the project area and resources available.

Key Finding 74	*Establish a standardized operating procedure for stakeholder engagement and evaluation of effectiveness to facilitate effective adaptive management both programmatically and for different projects.*

Following established CPRA protocols, when a project is announced, an impact area will be determined. Geospatial analysis will be used to query out and develop a list of potentially impacted stakeholders from the CPRA Master Stakeholder Database. These stakeholders should be provided with information on the project and alternatives under consideration for feedback in the interest of bringing diverse even conflicting interests towards a working relationship. Given sufficient time to review this information stakeholders could then be polled to identify any potential negative impacts on their community or stakeholder group and propose alternate scenarios based upon their local knowledge. If the poll results reveal no unanticipated impacts, the project design can move forward without additional data collection. If on the other hand, stakeholders identify concerns that have not been addressed in the project management plan, additional data should be gathered through focus groups or one-on-one interviews with stakeholders, depending on the number of stakeholders identified in the preliminary list. The goal of engagement at this stage is to review and assess the concerns identified by stakeholders in the initial poll. Additional stakeholder groups will be engaged at this phase as needed. If the concerns of the stakeholders are adequately addressed during this phase, then the project design can move forward without additional research.

Key Finding 75	*Where institutionally appropriate (e.g., within state agencies such as CPRA), development of a stakeholder database could increase efficiency and facilitate between project adaptive management, additionally allowing for two-way discourse with key stakeholders to be documented.*

If the concerns cannot be addressed by the project management team at this point or are deemed significant enough to warrant additional data collection, it will be necessary to conduct a more detailed study to explore the potential impacts of the project on the communities or stakeholder groups involved. This detailed research should utilize a combination of qualitative and quantitative methods using perspectives from a range of sources in order to obtain a more complete overview of the project impacts, thereby creating a more robust factual base and reducing uncertainty (Stringer et al., 2006). Certain concerns identified by stakeholders should automatically trigger a more detailed review, including potential environmental justice issues or direct impacts on cultural heritage sites or resources. The use of local knowledge mapping, including the Sci-TEK methods previously developed by CPRA, spatial video geo-narratives, social return on investment, and scenario building have all been used to assess the community level impacts of both environmental crises and coastal restoration projects (Carruthers et al., 2017; Colten, 2014; Curtis et al., 2018; Hemmerling et al., 2017; Richards et al., 2014). The scope and scale of the qualitative research methods used at this phase will be largely dependent on the complexity and contentiousness of the issues identified.

Key Finding 76	*If concerns or considerations from stakeholders on initial engagement cannot be resolved immediately by the project management team, more in depth quantitative and qualitative stakeholder engagement should be undertaken.*

Meaningful and continued involvement of the key stakeholders throughout the process is critical to success. If all relevant stakeholders have not been involved in the processes of analysis and in weighing the options suggested by the scenarios, it will be difficult to win their trust and support during later project planning and implementation stages (Olsen et al., 2006). To maximize the value and utility of stakeholder engagement, this suggested process should occur at three key points during the project planning process. At 30 percent design, stakeholders will be given the opportunity to review project alternatives under consideration. It may be necessary at this point to go back out and get more feedback from specific stakeholders. Finally, at 95 percent design, the project management team will present the final plans and specifications. At this point, they should re-engage stakeholders to inform of schedule and likelihood of project going to construction.

Key Finding 77	*Stakeholder engagement should happen throughout project planning, implementation, and operation processes.*

Formal public hearings ideally enable large numbers of people to have their say; provide opportunity to explain processes, share information, and gain feedback, can demonstrate openness and transparency if the public feel that they are being provided with full disclosure and if the information is easily digestible; can attract media attention or be used as a launch event; and can enable participants to develop networks to the extent that folks interact with each other at the meeting. However, this can become more of a communication (information dissemination) rather than an interactive two-way dialogue as full stakeholder engagement. Formal Public Hearings as part of the permitting process where stakeholders are given three minutes to speak while agency personnel are not allowed to respond encourage adversarial dynamics are unlikely to be representative of a population, can have a low attendance unless people feel deeply concerned, can have extremely high attendance creating long and late meetings, can lead to conflict when aggressive comments exacerbate others' feeling of frustration, leading to increasingly negative comments. When they are largely attended by "the usual crowd" providing well know positions or arguments, they may not help to advance public understanding, even when the recorded public comments are specifically and individually responded to in written project documents.

Key Finding 78	*Stakeholder engagement within formal public hearings would benefit from smaller group discussions with knowledgeable, or trained, facilitators and a mechanism to capture and initiate dialogue on stakeholder input and concerns.*

It can be beneficial to hold Community Conversations in small communities, locally advertised to occur out of hours, potentially concurrent with an evening or weekend festival or market. This approach can enable a new crowd of participants who would not have otherwise attended due to meals not being provided, need for childcare, or intimidation of a formal meeting process. The informal setting can enable participants to develop networks allow residents to have direct interaction with agency staff, temper comments fueled by anger with face to face interaction and small group dynamics, and produce a discussion arising from multiple perspectives.

Key Finding 79	*Community Conversations, as distinct from formal public hearings, are a useful tool for broad and interactive Stakeholder Engagement.*

2.5.3.2. LA TIG STAKEHOLDER ENGAGEMENT

Stakeholder Engagement is seen as an opportunity to bring the public and stakeholders in to the planning process more proactively. This is important for several reasons:

1. Public input into how their DWH NRDA funds should be used.
2. Public ideas for restoration opportunities.
3. Refine projects by incorporating stakeholder input, such as local knowledge and lessons learned, opportunities for complementary/synergistic restoration efforts, and concern about undesired effects.
4. Public understanding of, and engagement in, development and improvement of ongoing and future restoration projects.
5. Public support for restoration efforts.
6. OPA and NEPA requirements for public to have the opportunity to review and comment.

Restoration efforts, and the monitoring and adaptive management of those efforts, all benefit from stakeholder engagement. The LA TIG has noted that the public should be engaged throughout the development of the Louisiana adaptive management planning process, including the public engagement plan, and has three main processes in place to accomplish this.

1. LA TIG solicits the public for ideas for restoration projects through an online portal (https://www.gulfspillrestoration.noaa.gov/restoration/give-us-your-ideas/suggest-a-restoration-project). Submitted projects are screened and considered during the development of Restoration Plans. The online portal also allows the public to view submitted projects.
2. LA TIG annual meetings - particularly the open house held before in-person public meetings, when members of the public have the opportunity to ask questions and provide input in an informal manner, in addition to the opportunity to submit formal public comments.
3. For each Restoration Plan that the LA TIG develops (https://la-dwh.com/restoration-plans/), a public review and comment period is held, including a public comment meeting

(in person or via webinar) with TIG representatives. During that period, the public can learn more about the proposed restoration projects in that particular Restoration Plan and can provide comments, all of which the LA TIG must consider and some of which the LA TIG provides written responses to, before publishing the final Restoration Plan.

The level of Stakeholder Engagement needed to make each project successful varies by project, and may not be obvious during project planning, for example if a controversial aspect or impact of a project was not anticipated early in the planning process. If the optimal level of stakeholder engagement was not initially incorporated into the planning process, the adaptive management process should include the option for modification to enhance the stakeholder engagement component. To address shortcomings such as this, flexibility in the budget could allow additional funds to supplement project-level stakeholder engagement efforts if necessary. One example of small facilitated working groups for targeted input was the OO TIG workshop, held as a pre-meeting workshop for Gulf of Mexico Oil Spill & Ecosystem Science Conference annual meeting in New Orleans. It was free to register and open to any member of the public to attend, the majority of attendees were also part of the Gulf of Mexico Oil Spill & Ecosystem Science Conference. The breakout groups (each focused on one restoration type or species) were highly knowledgeable about or interested in the resources (e.g., consultants, industry, academics, government employees).

Key Finding 80	*Identify restoration funds that can be used to supplement stakeholder engagement efforts where the need is greater than anticipated.*

Some types of Stakeholder Engagement are not feasible with federal funds but could potentially be accomplished by Trustees using State funding. These strategies include public surveys and development of a stakeholder database, which has been identified as a potentially valuable component of the stakeholder engagement processes for CPRA. For this reason, the LA TIG has noted that collaboration and information sharing among the trustee groups is key to outreach, communication, and stakeholder engagement within the adaptive management process.

Key Finding 81	*Identify opportunities for multiple trustees to collaborate on outreach, communication, and stakeholder engagement.*

Key Finding 82	*Develop methods to measure the effectiveness of stakeholder engagement. Leverage opportunities for state Trustee agencies to collect and utilize public data.*

2.5.4. Benefits of Strong Information Linkages and Flows

The quality or quantity of information and data collected during restoration efforts will not improve restoration outcomes unless there is connection between implementation stages. Only with strong information flow can stronger linkages between decision makers, planners, and project implementation staff be generated. Formalizing roles and responsibilities relative to managing these flows of information, lessons learned, and the resulting linkages between funding and implementing entities, across governance scales (federal, state, local) is what an effective adaptive management effort will establish or improve (Ebberts et al., 2018). In short, adaptive management is only possible when there are strong and stable processes for capturing information and knowledge and allowing access to that information, and lessons learned, so that it can flow on to those making future plans and decisions.

Key Finding 83	*Adaptive management can only occur when there are established and effective mechanisms for capturing information and knowledge and facilitating access to that information and knowledge, this needs to be an active process with dedicated staff capacity.*

2.6. Adaptive Management Coordination in Louisiana

2.6.1. Introduction

Adaptive management provides the mechanisms and tools for improved decision-making, specific to shared objectives, by continually learning from new information. The feedback loops for generating recommendations and delivering them to decision-makers vary under the different governance structures of the various restoration implementation entities in Louisiana. However, the learning outcomes and recommendations should have applicability and be widely used programmatically across restoration types.

2.6.2. Programmatic and Project Adaptive Management Coordination

2.6.2.1. SUMMARY

The last phase in the Adaptive Management Cycle is Adaptive Management Coordination; Phase 3: Programmatic (Section 2.1) and Phase 4: Project (Section 2.2). It is the critical phase to complete the adaptive management cycle, taking lessons learned and information gained through programmatic and project implementation to inform future goal setting and decision making. This phase occurs at the end of each adaptive management cycle and has two steps that should occur at both a project scale and a programmatic scale:

Step 9: Recommend revisions

Step 10: Approve revisions

At the conclusion of this phase, it is especially important to document the recommended revisions, approved revisions, and the associated decisions made. In addition, it is necessary to document the information utilized to make the decisions, the rationale for those decisions, and any instances where there was insufficient information to fully inform a decision (or where additional information would be desirable for future decisions).

2.6.2.1.1. Step 9: Recommend Revisions

On a programmatic level, the lessons learned from the portfolio development and portfolio monitoring and assessment phases are used to inform the next portfolio of projects to achieve overarching programmatic goals and fundamental objectives. Recommendations on specific mechanisms and tools that can support decisions on project portfolios can be made within any organizational unit (e.g., planning, engineering & design, construction, and/or Operation Maintenance & Monitoring) of the various restoration implementation entities. Revisions are primarily recommended by the regional offices staff (project manager, project engineers, study manager, and topic scientists), although they may also be recommended by multiple personnel and sources external to the agency.

To help facilitate transfer of recommended revisions to decision makers, some mechanisms will necessarily build on current structures, for example within CPRA an Adaptive Management Implementation Team to engage additional adaptive management specific staff, or mechanisms, especially when recommendations require high level, administrative, or financial approval. The chair of this team would be identified as the institutional lead on adaptive management, and division representatives would be responsible for keeping their respective divisions informed on aspects of adaptive management.

More generically, the following personnel (example roles currently at CPRA) or equivalent DWH Trustee personnel functions should be involved (Section 1.1.3):

- Engineer (field)
- Monitoring manager
- Topic scientists
- Study manager

Within CPRA, recommendations that could influence project portfolios are generated through the Coastal Master Plan processes. Recommended revisions to previous Coastal Master Plan(s) have been based on assessments conducted under steps 1-7 of the adaptive management cycle. Iterative updates to each Coastal Master Plan reflect this process, and recommendations are typically generated in Year 5 (now Year 6) of the Coastal Master Plan Planning Cycle (Hijuelos & Reed, 2017). The technical recommendations for revisions are generated by the Coastal Master Plan Modeling Decision Team. Per executive order, all restoration projects that use any amount of State funds must be consistent with the Coastal Master Plan; and recommendations generated are carried over to NRDA, CWPPRA, RESTORE, NFWF, Partnership Fund, Parish Matching, State Coastal Impact Assistance Program, etc. Revisions are recommended through specific advisory and governance structures, such as CWPPRA which utilizes technical work groups (i.e., environmental, economic and monitoring) through the Planning and Evaluation Subcommittee, where they are carried forward to the Technical Committee for consideration.

Within the context of DWH NRDA restoration, this phase in the adaptive management cycle includes implementing corrective actions, when necessary, to projects that are not trending toward established performance criteria. It may also involve making adjustments over time to projects that require recurrent or ongoing decision-making, in order to reduce uncertainties about restoration decisions. Understanding the specific drivers that influence project performance, such as unanticipated outcomes or events, can help guide the development and implementation of appropriate corrective actions.

For DWH NRDA projects, the LA TIG or Implementing Trustee suggests revisions to the project based on the project MAM plan, which often includes these strategies:

- Revisit ecosystem models (water quality, marsh, fish, etc.) if conditions change, or at strategic reporting points if new monitoring data is available to validate model output.
- Add ecosystem models if uncertainties are not resolved. Remove ecosystem models if uncertainties are resolved.
- Assess synthesized data to evaluate progress towards meeting goals and to identify whether thresholds for action have been met.
- Follow MAM plan for project modifications as needed. If operations change, consider adding outreach component or engage stakeholders, including if additional funding will be needed.

To improve adaptive management for NRDA projects in Louisiana, one option is to formalize a LA TIG MAM small working group. Although currently there is an informal subset of LA TIG Trustee personnel active in providing the LA TIG with input on NRDA MAM needs, the group does not have a formalized role in interacting with adaptive management amongst agencies for coastal restoration in Louisiana. Determining the most efficient and effective governance structure requires some targeted engagement amongst partners in relation to coordination, common processes, and linkage mechanisms, developing working papers and scopes of work for these needs are specific recommendations from this work.

A formalized LA TIG MAM small working group would actively participate in MAM needs of LA NRDA projects, and would establish mechanisms to centralize lessons learned and document process for key decisions for NRDA projects implemented by all Trustees in Louisiana. The working group should have formal membership by all Trustees, and should have a committee chair that is fully or partially funded to run the committee and to facilitate implementation of adaptive management for the LA TIG and within the state of Louisiana. It would also hold regular - perhaps monthly - meetings, two of which each year would programmatically engage a broader group of Louisiana agencies implementing adaptive management-- the LA Adaptive Management Cross Agency Working Group. The current ad hoc LA TIG MAM subgroup could develop Terms of Reference (TORs) for the establishment of a formal LA TIG MAM small working group.

Key Finding 84	*Formalize an LA TIG MAM small working group.*

Key Finding 85	*Establish mechanisms to centralize lessons learned and document process for key decisions for NRDA projects.*

CPRA currently has an informal committee prioritizing research needs, developing research roadmaps, and providing support for progressing adaptive management; the committee could act in this capacity in an interim period prior to establishing a formal Adaptive Management Implementation Team across relevant technical and administrative personnel (Section 1.1.3). The first task of the interim committee would be to establish TORs for the adaptive management implementation team, including who should be represented on the committee, how communications and inreach from the team would occur, establishing a chair for the committee, and identifying a set of recommendations on which roles and responsibilities require funding of staff time, additional to current staff roles and responsibilities. The interim committee would also be given responsibility to coordinate input on prioritizing an initial list of recommendations from this Louisiana Adaptive Management Implementation Plan to immediately progress this initiative.

Some initial recommendations are that the CPRA Adaptive Management Implementation Team should:

- Coordinate adaptive management needs and identify and track implementation of processes or procedures to facilitate adaptive management.
- Have an official role and targeted decision-making authority.
- Consider both incentives and punitive measures to regulate the implementation of adaptive management.
- Be funded in some capacity, recognizing that for adaptive management to function it requires an active process rather than be an additional unfunded task.
- Update and implement the TORs for the committee.

- Provide technical support to project teams that are developing MAM plans for their projects.
- Provide support to the Coastal Master Plan team with the project portfolio development process.
- Have an institutional lead that will chair the committee and lead the adaptive management implementation effort for Louisiana.
- Develop a structure for the committee, for example with representation from all CPRA Divisions (Table 4), with divisional representatives (or their alternates) being responsible for providing adaptive management updates and needs to their separate divisions.
- Determine the period of tenure that individuals should serve in a role on the Adaptive Management Implementation Team.
- Recognize that to be effective, the Adaptive Management Implementation Team will need full support from upper management (Section 1.1.3), so the committee should report to a meeting of division heads on a six monthly (or annual) basis, reporting on adaptive management tasks and processes successfully implemented in the past period and propose actions for the following period, likely with a funding request.

Key Finding 86	_Create a CPRA Adaptive Management Implementation Team to engage additional adaptive management specific staff or mechanisms._

2.6.2.1.2. Step 10: Approve Revisions

For Step 10: Approve revisions, the following CPRA (Section 1.1.3) or equivalent DWH Trustee personnel will be involved:

- Implementing engineer (with input from topic scientist and study manager)
- Monitoring manager (with input from topic scientist and study manager)
- Finance staff
- Administrative decision makers

On a project level, revisions within a project may result in changes to operations, monitoring, maintenance, or design. In that case, the engineer (field) and monitoring manager, with input from topic scientists and the study manager, will develop and ultimately approve recommendations for these revisions or changes (Section 1.1.3). If recommended revisions are so significant that they hold implications for either programmatic goals or major design considerations for other projects going forward, the decision-making process to approve the revisions may be at a higher administrative or financial level. At the other extreme, some projects may have no opportunity for revision (either due to funding or small spatial or temporal scale of project) and so any lessons learned would need to occur programmatically (that is within subsequent portfolios of projects).

The CPRA Board ultimately approves revisions to the Coastal Master Plan and any updates prior to submission to the legislature. Those approved revisions are also carried forward in the CWPPRA process, where project portfolios (i.e., project priority lists) need to be consistent with the Coastal Master Plan. The CWPPRA Task Force serves as the decision-making body for project priority lists and CPRA brings forward recommendations generated from the Coastal Master Plan process. Although the specific approval and tracking process is very varied at CPRA, due to the diversity of projects and partners, changes and modifications are always initiated by the project manager and finally approved by CPRA Chairman or Executive Director (Section 1.1.3; see also Sections 2.1 and 2.2).

For DWH NRDA projects, modifications to a project or the project MAM plan are done by the Implementing Trustee (s) in coordination with the TIG. Public notification is required if the corrective actions require additional environmental review (e.g., modification to regulatory permits) or a material change to the project. Those decisions are maintained within the NRDA administrative record (https://www.doi.gov/deepwaterhorizon/adminrecord).

2.6.3. Interactions with the Knowledge Base

During Adaptive Management Coordination (Phase 3: Programmatic and Phase 4: Project), development of recommendations will rely on input from information management, including results and lessons learned from constructed projects; inputs of scientific data and syntheses from Applied Synthesis and Research; and compiled data and information available from Information Management. Stakeholder Engagement and Communication will also provide key feedback from restoration implementation staff and external stakeholders on lessons learned from current efforts and considerations for future efforts. Those interactions are essential to support recommendations for revisions to the project portfolio planning, monitoring and assessment cycle, decisions regarding those recommendations, and documentation of those decisions and the lessons learned, regardless of restoration funding mechanism. As in the previous phases, communication outreach, as well as stakeholder engagement, can be extensive or relatively minor at this phase, depending on the specific details of the project.

At the conclusion of this phase, it is especially important to document the recommended revisions, approved revisions, the associated decisions made, and the information utilized to make the decisions as well as the rationale for those decisions. This information is important inputs to the knowledge base not only as lessons learned, but for communication inreach, outreach, and stakeholder engagement.

Although recommendations and approvals of revisions do occur informally in Louisiana, incorporation of lessons learned have been limited by a lack of formalized processes to identify personnel, incentives, support mechanisms (knowledge base support and interactions), and funding to drive systematic progress in adaptive management. Additionally, the abundance of projects has increased the individual and collective knowledge of restoration approaches and needs. These steps in the adaptive management process specifically can be improved in process and efficiency. Decisions and lessons learned should be documented, and the knowledge made easily accessible to staff participating in restoration efforts under any of the implementing mechanisms.

For CPRA projects, the Coastal Master Plan and its appendices document how technical recommendations are incorporated into a transparent structured decision process. For example the technical appendices include lessons learned, the modeling appendix includes highlights of current iteration, identified model limitations, and possible improvements (Cobell et al., 2017, p. 5). It is suggested that similar documentation is generated for other aspects of the Coastal Master Plan processes for transparency and that they are maintained in a programmatic decision log. The decision log could serve as an internal decision documentation tool for all implementing mechanisms, including CPRA and the LA TIG, to track recommendations and decisions over time. The log is important for informing future revisions and passage of future project and project portfolio recommendations, especially in light of high turnover among restoration staff.

Key Finding 87	*Maintain a programmatic decision log to track recommendations and decisions, and to inform future revisions.*

For DWH NRDA projects, the progress of restoration projects is shared with the public and stakeholders annually via the DIVER Restoration Portal. The Implementing Trustee submits interim MAM reports and a Final MAM Report that contains a final evaluation of project monitoring data; a report on the final project outcomes, including lessons learned or uncertainties addressed; considerations for planning and implementing future projects; and any additional information deemed relevant by or TIG. These reports are uploaded to the DIVER Restoration Portal and made publicly available. To improve capture of this knowledge, it is recommended that project MAM plans explicitly identify linkages to the key CPRA and LA TIG adaptive management information and knowledge transfer steps identified in the Louisiana Adaptive Management Implementation Handbook.

Key Finding 88	*MAM plans for DWH NRDA projects should explicitly identify linkages to adaptive management knowledge transfer steps.*

On a programmatic level, the Cross-TIG MAM work group may share aggregated project-level outcomes across TIGs to identify any lessons learned that can inform the design and implementation of future, similar projects. For example, in DIVER this information can be searched for by restoration type as well as keywords such as project title or location. This knowledge can be shared through annual meetings, through updates by work group members that act as liaisons to each of the TIGs, and as part of their external engagement efforts where relevant.

There are also opportunities to improve cross-agency collaboration and communication. To ensure that projects targeting NRDA funding set objectives that are fully inclusive of LA TIG needs, practical mechanisms of linkage and information transfer are needed, including dedicated staff time or personnel. Likely the greatest likelihood of success would come from the establishment of a new full time position (or new role if re-assigned) called the 'Louisiana adaptive management coordinator'.

Key Finding 89	*Establish a position for a Louisiana adaptive management coordinator.*

To facilitate cross-agency collaboration and communication with current mechanisms, it is recommended that, twice a year, the formalized LA TIG MAM small working group chair work with the formalized CPRA Adaptive Management Implementation Team chair to coordinate an LA Adaptive Management Implementation Working Group meeting. This could be greatly simplified with one overall group coordinated by a LA adaptive management coordinator with all agencies and implementing mechanisms represented, chaired by CPRA. This group, even if informal, would be supported by the formalized CPRA and LA TIG teams, and would act as a linkage and exchange mechanism for all mechanisms and agencies carrying out adaptive management for implementing restoration in the state of Louisiana. The cross-agency meeting would be non-regulatory and would not have decision making authority, but would serve explicitly to seek opportunities for synergy, efficiency, transfer of information, and transfer of lessons learned amongst agencies implementing restoration in Louisiana. For example, if a new protocol were needed by CPRA or the LA TIG, an existing CWPPRA protocol could serve as a model along with its strengths and weaknesses, thereby transferring lessons learned. This cross-agency group could also discuss common needs or challenges that limit implementation of adaptive management, and could be prioritized for funding through multiple mechanisms.

Key Finding 90	*Coordinate biannual LA Adaptive Management Implementation Working Group meeting to seek opportunities for knowledge transfer across agencies involved in Louisiana restoration.*

Keeping stakeholders informed and engaged on the progress of restoration efforts and identifying new priorities moving forward is critical. Once identified, key responsible adaptive management coordination staff need to be able to articulate how programmatic objectives are achieved from the projects implemented, the anticipated time-bound outcomes, and the progress to date. For that reason, it is recommended that the agencies or implementing mechanisms expand or develop workshops or presentations to present an overall system-status report including all projects to stakeholders (key recommendation is to develop such an integrated system-status reporting mechanism), similar to or building on the public LA TIG DWH Annual Meeting.

Key Finding 91	*Establish communication outreach events to articulate restoration progress.*

3.0 Vision and Recommended Priority Actions for Improved Adaptive Management in Louisiana

Aim:

To provide a road map of priority actions to improve implementation of adaptive management for coastal restoration in Louisiana

CURRENT STATE OF ADAPTIVE MANAGEMENT IN LOUISINA

Louisiana has a long history of coastal management and restoration actions with multiple projects implementing common approaches. CPRA has practiced informal adaptive management as key personnel pass on accumulated wisdom and lessons learned. There is currently an increased need for large-scale restoration due to ongoing land loss as well as major new restoration funding entities resulting from the DWH spill. Thus there is increased incentive to develelop processes that formalize common learning to improve decision making. Restoration efforts have been ongoing in Louisiana by state and federal agencies through the CWPPRA and are now expanded through funding and implementing entities such as the RESTORE Council, NRDA through the LA TIG, and NFWF. In this document we present a common vision for restoration funding entities and recommend priority actions to build on and formalize current processes for adaptive management in coastal Louisiana.

A VISION FOR IMPROVED ADAPTIVE MANAGEMENT IN LOUISIANA

Before the restoration funding entities associated with DWH settlements, the majority of funding for coastal restoration in Louisiana came through CWPPRA. The desired state of adaptive management is to maximize synergies and opportunities for efficiency across implementing entities. This can be realized through increased commonality of goals and objectives, recognizing that there will always be some goals that are agency or funding source specific. Considering a broader ecosystem or landscape context for implemented restoration projects can provide a framework for emphasizing commonality of restoration goals. Such a framework allows for multiple benefits of restoration efforts to be quantified, including prioritized natural resources, ultimately assessing the effectiveness of large-scale restoration efforts in coastal Louisiana. The recommendations provide a road map towards the desired state of governance for adaptive management in coastal Louisiana.

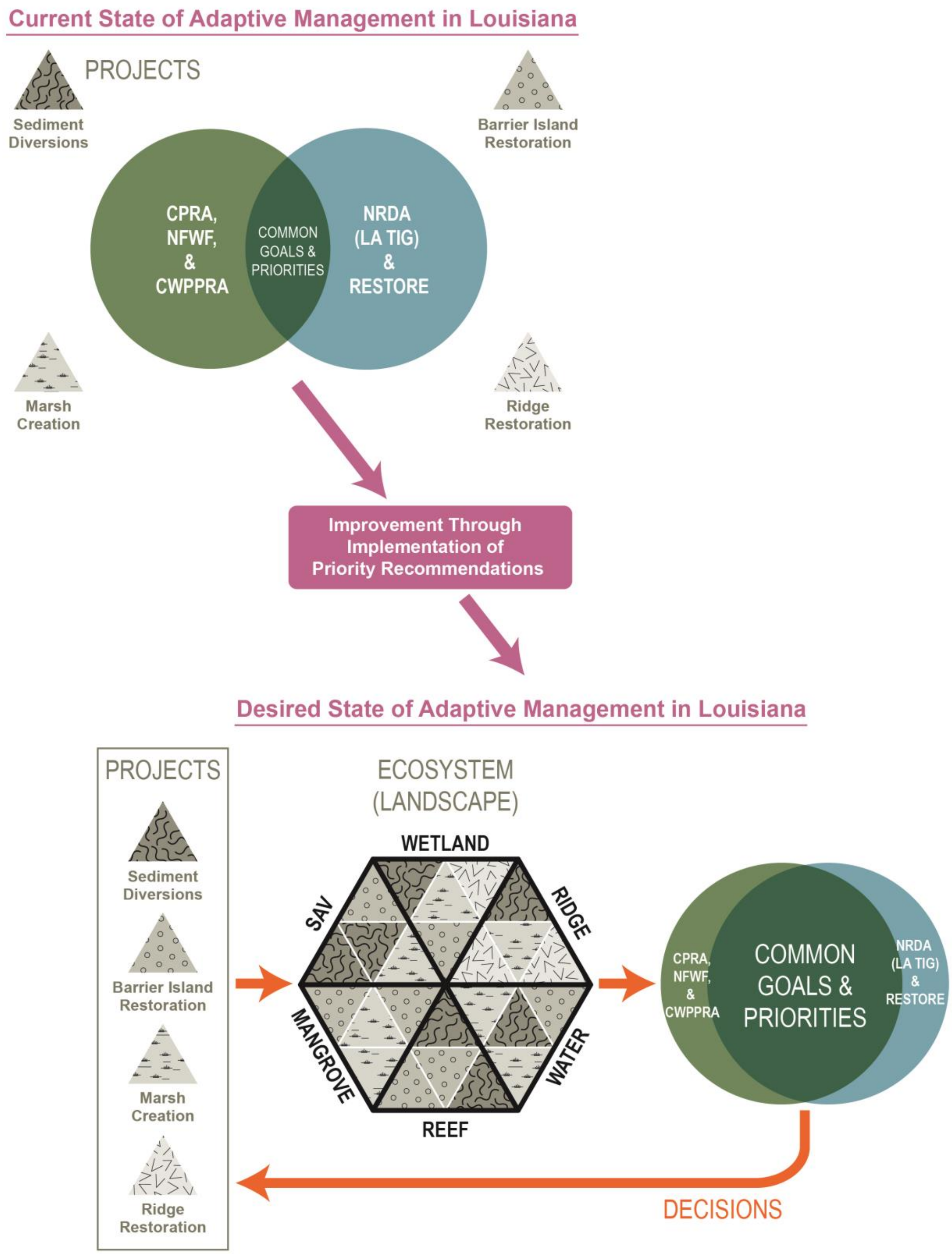


Figure 16. A vision for adaptive management implementation in coastal Louisiana

PURPOSE OF THIS DOCUMENT

We present a roadmap of eight recommended priority actions to improve adaptive management implementation for coastal restoration efforts in Louisiana. Each action includes first order cost estimates and indicative time to complete. Each recommendation includes multiple potential tasks, all are scalable and can be phased over time. Some include setting up processes that would need ongoing effort and financial support. We developed the recommendations through discussions at an initial three-day workshop in May 2018 in Baton Rouge, Louisiana, with more than 60 participants from six state and federal agencies. This was followed by more than 100 in-person meetings and webinars. Fifty-eight authors developed a technical document on the background, current adaptive management approaches, and future adaptive management needs for Louisiana. Ninety one key findings were identified and then distilled down to eight priority recommendations. The recommendations are presented in priority groups, recommendations 1-5 are very high priority, recommendations 6-8 are high priority. Those recommendations identified as moderate or low priority were not fully developed and are not included in this document. In prioritization of recommendations, the likelihood of support from other funding mechanisms (outside adaptive management) was considered.

Note, references to ***Key Findings*** are indicated in parentheses in the following recommendations.

SUMMARY OF RECOMMENDATIONS

VERY HIGH PRIORITY

- **1.0 Coordination:** Fund and establish dedicated additional adaptive management capacity, including but not limited to, funding an LA adaptive management coordinator
- **2.0 Data Management:** Develop a "lessons learned database" in addition to interoperability of CIMS and DIVER to facilitate transfer and synergies, while minimizing duplication of data access and utilization for restoration management, planning, and decision making (consider making first/highest priority)
- **3.0 Ecosystem Reporting:** Cross disciplinary coastal ecosystem condition reporting (physical, ecological, social)
- **4.0 Restoration Goals:** Identify commonalities of restoration goals across implementing entities to maximize co-benefits of restoration
- **5.0 Common Processes:** Operationalize electronic handbook for implementation of adaptive management in Louisiana

- **HIGH PRIORITY**
- **6.0 Communication:** Develop science communication approaches that increase effectiveness of information dissemination to communities (outreach) and within agencies (inreach) to maximize information delivery to support adaptive management of coastal restoration
- **7.0 Modeling:** Develop common repository and clearinghouse for numerical models and tools
- **8.0 Stakeholder Engagement:** Establish standard operating procedures for stakeholder engagement, specifically including active and two-way mechanisms to ensure feedback and engagement throughout restoration planning, implementation, and operation

1.0 Coordination: Fund and establish dedicated additional adaptive management capacity, including but not limited to, funding an LA adaptive management coordinator

Approximate Cost: $100,000 - $500,000 (per annum)

- **Time Frame of Cost**: Ongoing cost
- **Time to Implement**: Ongoing
- **Priority**: Very High
- **Action Items**:
  - Develop a position description
  - Determine the most synergistic and opportunistic administrative location for the person (initial recommendation is that this position is located within CPRA)
  - Work with the LA TIG to develop an LA TIG MAM Strategy to support MAM prioritization and decision making for the NRDA LA Restoration Area
  - Coordinator to work with CPRA and LA TIG to facilitate adaptive management implementation and:
    - Develop engagement and communication mechanisms (potentially including CPRA Adaptive Management Implementation Team and LA TIG Monitoring and Adaptive Management small team)
    - Work with CPRA and LA TIG to clarify governance around decision making processes and identify where within those processes technical information is most relevant
    - Explore options for formal role for LA adaptive management coordinator to bring science into the decision-making processes of CPRA and the LA TIG
    - Set up and run workshops and meetings as needed to facilitate adaptive management
    - Engage with state and federal agencies as well as other Gulf states for exchange of information about adaptive management process
    - Support organizational structures in developing summaries and synthesis to implement adaptive management
    - Facilitate multi-agency meetings focused on specific project types (e.g., marsh creation) to discuss lessons learned across similar projects and how these lessons can be actively incorporated into future project decisions

Adaptive management will only be implemented effectively when there are established and effective mechanisms for capturing and facilitating access to information and knowledge. This is an active process that will require a full-time employee dedicated to implementing adaptive management (63; 83). Within CPRA, this position will be the coordinating technical lead for a CPRA Adaptive Management Implementation Team to engage additional adaptive management staff and mechanisms (86). This Team would be chaired by an executive level individual, with cross divisional representation. The coordinator is a moderate to high level technical position to ensure that it carries authority and the individual can work within, and with high-level support of, both CPRA and the LA TIG. This individual will develop mechanisms that become established practice within decision-making, facilitating transfer of appropriate knowledge and lessons learned among agencies and entities. This position (with the Team) will lead, initiate, or facilitate development of standard operating procedures for data management plans (45), mechanisms for collaborative learning (18), and programmatic synthesis and communication of data gaps and knowledge uncertainties (20).

We recommend establishing a formal process to apply the MAM plan template to operationalize adaptive management processes in CPRA and LA TIG needs projects (35), develop a list of minimum key project development and implementation Federal Milestones that could serve as links to the AM cycle for all NRDA projects (18) and develop an active process for synthesizing lessons learned from OM&M reports (39).

2.0 Data Management: Develop a "lessons learned database" in addition to interoperability of CIMS and DIVER to facilitate transfer and synergies, while minimizing duplication of data access and utilization for restoration management, planning, and decision making

- **Approximate Cost**: $500,000 - $2,000,000
- **Time Frame of Cost**:
  - A: Immediate (<$100,000)
  - B: Based upon output of A ($400,000 - $1,900,000)
- **Time to Implement**:
  - A: 6-12 months
  - B: 12-24 months with ongoing refinement
- **Priority**: Very high
- **Action Items**:
  - A: Develop working paper on priorities, mechanism and detailed actions for establishing interoperability between CIMS and DIVER; include recommended host mechanism and structure for "lessons learned" project database; ensure to address potential to host or accommodate numerical and conceptual model needs (Recommendation 7.0)
  - B: Invest in CIMS as a central content management system for coastal restoration data in Louisiana
    - Develop lessons learned database that captures refinements, reductions in uncertainty, and/or new insights learned from restoration actions
    - Update and unify, where possible, comprehensive data and metadata standards
    - Develop SOPs for implementing and ensuring compliance with data and metadata standards through QA/QC
    - Increase discoverability of synthesis and applied research

Develop an adaptive management database; preferably within one of the current information management systems, such as CIMS or DIVER across LA TIG (42, 28, 85, 87). Regardless of the system selected, additional resources (both personnel and funding) will be needed to implement the database (46). This database needs to capture project objectives in a standardized way that also includes the cited justification for each objective (27). The database should also provide a searchable (key words/topics/locations) means for agency staff and contractors to document lessons learned and information used in decision making (31), as well as meeting notes and outcomes, such as regular project manager - project control meetings where many of the decisions affecting adaptive management are made (33). Any database expansion in capacity needs to consider options for hosting, versioning, and distribution of numerical and conceptual models (Recommendation 8.0).

We recommend identifying (and then implementing) improvements to existing data discoverability (47) while expanding tools for data summarization, analysis, interpretation, and synthesis (48). To increase consistency and therefore data value, we recommend development of comprehensive data standards (50), more comprehensive QA/QC standard operating procedures (51), and updated metadata standards (52).

3.0 Ecosystem Reporting: Cross disciplinary coastal ecosystem condition reporting (physical, ecological, social)

- **Approximate Cost**: $750,000 - $2,000,000 (depends on scale and scope, but does not include expansion of monitoring, new numerical modeling efforts, or major updates to monitoring database structure or access)
- **Time Frame of Cost**:
  - A: Finalize approach 9-18 months (<$500,000)
  - B: Following from A calculate condition report 12-24 months ($100,000 - $500,000)
  - C: and D: Can be concurrent with other tasks ($150,000 - $1,000,000)
  - Ongoing for regular reporting (e.g., some annual, more comprehensive every 5 or 6 years)
- **Time to Implement**:
  - A: 9-18 months to finalize approach
  - B: 12-24 months to develop initial assessment (some overlap in timing possible)
- **Priority**: Very High
- **Action Items**:
  - A: Define and clarify purpose and goals of reporting, and ensure linkage to explicit and quantifiable metrics tied to restoration goals (Recommendation 4.0), develop synthetic metrics where necessary
    - Develop and refine conceptual models for geographic units (e.g., basins, ecoregions that are collections of basins, or functional ecosystem areas)
    - Identify or develop ecosystem relevant synthetic metrics of raw monitoring data, where needed
    - Develop an ecosystem condition reporting schedule to meet all reporting needs
    - Identify the role of numerical models, and the need/frequency to revisit numerical models that are used in project planning
    - Link assessment framework to programmatic goals and objectives to ensure that learning is iteratively incorporated into future decision making
  - B: Collate available data, finalize reporting regions, develop or refine reporting thresholds, calculate ecosystem condition report, and develop outputs for multiple audiences
  - C: Formalize basin synthesis reporting process within CPRA and link to A and B (above)
  - D: Expand targeted numerical models to be updated with monitoring data as a component of assessing attainment of programmatic goals

We recommend conducting an integrated assessment (25), building on the "report card" framework for ecosystem condition reporting proposed for coastal Louisiana by CPRA in 2013. As part of initiating an overall process of ecosystem reporting we recommend refining and clarifying the purpose and goals of the assessment and evaluation (21), establishing explicit and quantifiable goals and associated metrics to programmatically assess ecosystem condition from portfolios of projects within landscape units or ecosystems (7). We recommend developing or revising conceptual models for geographic units (e.g., basins or ecoregions) (9) expanding and formalizing the current process within CPRA for basin synthesis reports (61). This should directly incorporate lessons learned from projects in those basins (30) as well as synthesize lessons learned that are currently reported in OM&M reports (39). To support improved adaptive management of projects or portfolios of projects, we recommend expansion of SWAMP monitoring data for programmatic and project planning (16), which will require identifying approaches for analyzing this monitoring data and relevant numerical model outputs (23). An expanded numerical model assessment of programmatic goals based on observational data is also recommended (23).

4.0 Restoration Goals: Identify commonalities of restoration goals across implementing entities to maximize co-benefits of restoration

- **Approximate Cost**: $100,000 - $250,000
- **Time Frame of Cost**: One-time initial cost to identify and assess commonalities, ongoing review may be needed as priorities shift
- **Time to Implement**: 18 months
- **Priority**: Very High
- **Action Items**:
    - CPRA, NRDA (LA TIG), RESTORE, NFWF, and CWPPRA representatives refine and finalize a detailed crosswalk of restoration goals identifying both complementarities and dissonance
    - Identify potential performance metrics and interim targets for each goal and convene a workshop (or similar formalized process) to establish a commonly agreed upon suite of metrics and targets
    - Propose approaches for increasing linkages in the goals that are complementary between agencies and funding sources
    - Develop mechanism for programmatically revisiting the problem statements within the cycle of adaptive management, revising goals and performance metrics as necessary (potentially within a cycle of measuring progress toward meeting restoration goals)

Mechanisms to support cross entity adaptive management must consider how they programmatically interact and how goals relate to each other, as well as how they collectively support a more holistic consideration of coastal resource restoration (4). Previous efforts within Louisiana as well as within the LA TIG and the cross TIG MAM have initiated efforts to compare goals of the different restoration entities, however these have not been formalized or finalized. After common goals are determined, establish programmatic performance monitoring metrics (7), including interim targets for restoration outcomes. These explicit and quantifiable objectives will be synthesized programmatically, with consideration of how they can be used to inform performance of project portfolios in common geographic space into the future (8).

5.0 Common Processes: Operationalize electronic handbook for implementation of adaptive management in Louisiana

- **Approximate Cost**: $100,000 - $500,000
- **Time Frame of Cost**: Initial expense with small ongoing maintenance cost
- **Time to Implement**: 6-9 months, ongoing minor maintenance
- **Priority:** Very High
- **Action Items**:
    - Develop and conduct user surveys for beta version of Louisiana implementation adaptive management electronic handbook
    - Refine information to be included within the electronic handbook with representative input from a range of personnel at CPRA and LA TIG
    - Establish access specifications and identify mechanism for hosting electronic handbook (which may include CIMS and/or DIVER) (Recommendation 2.0)
    - Launch adaptive management electronic handbook to LA TIG, CPRA staff, and others engaged in coastal restoration adaptive management in Louisiana

To facilitate coordination of approaches to adaptive management of coastal restoration in Louisiana, an essential tangible need is to have a common and easily accessible handbook of standard processes and procedures. We recommend that this handbook identify adaptive management tasks for staff involved in all steps of coastal restoration (from conception and planning; through implementation, monitoring and maintenance; to decision making and prioritization). The required information and actions were drafted during this work, for each of the identified ten steps of the adaptive management cycle (Sections 1.2, 2.1, and 2.2). For daily use and continued access, it is needed in a short, easily accessible, dynamic format to be used by personnel at any position and from any agency. This dynamic database will allow a user to produce a personalized set of information either for a particular position (e.g., project engineer) or organization/agency.

This information would include the required actions (e.g., archive a document in a database), responsible party (e.g., project manager), who carries out the action (e.g., project engineer), when and why it is carried out, the technical mechanism (e.g., access CIMS or DIVER database) and identify the history of that information. In addition, the user will be able to get documented technical supporting information to explain the technical or theoretical background to specific actions (i.e., relevant subsections of this report). The specific actions table and supporting information will be accessible in multiple formats such as .pdf, excel, .txt. This task will include end user testing across different staff positions and agencies to ensure the electronic adaptive management handbook best meets the needs of all users. This testing will maximize usability and uptake of the handbook and therefore maximize engagement of practitioners in this common approach to adaptive management. We recommend it is closely linked to, or co-developed with, the “lessons learned” database (Recommendation 2.0).

6.0 Communication: Develop science communication approaches that increase effectiveness of information dissemination to communities (outreach) and within agencies (inreach) to maximize information delivery to support adaptive management of coastal restoration

- **Approximate Cost**: A: <$200,000 - $400,000
- **Time Frame of Cost**:
    - A: One-time, develop science communication improvement working paper (<$100,000)
    - B: Additional cost, protocol development and initial implementation and communications tool development ($100,000 - $300,000)
- **Time to implement**:
- A: 6 months
- B: subsequent 12-24 months
- **Priority**: High
- **Action Items**:
    - A: Develop working paper on mechanisms and processes to improve communication
    - B: Implement new processes:
        - Develop specific protocols on how and when to explicitly and formally engage communications staff, project managers and technical staff, and the public in development restoration outreach and communication plans
        - Establish communication protocols to specifically address restoration efforts that may negatively impact specific stakeholder groups or generate public controversy
        - Automate production of project and parish fact sheets and other standard communications outputs to establish quality assurance standards and insure consistency in science communication outputs, ensuring high discoverability (e.g. CIMS, DIVER, or additional mechanism
        - Develop approach and metrics to quantify effectiveness of public outreach communications

For effective science communication to support decision making, the values of the audience must be considered in addition to presenting the facts (65). Science communication should begin early and occur continuously throughout the planning process, recognizing that social impacts begin to accumulate before implementation. Communications staff should develop methods to measure the effectiveness of public outreach and communication and to leverage opportunities for state Trustee agencies to collect and utilize public data (72). To quantify if the outreach and science communication processes are being effective, it is recommended to identify metrics to determine if the communicated knowledge and information is being received by residents and other stakeholders, the effectiveness of the messaging, and whether or not the information is being utilized by the public and affected stakeholders. Within CPRA, it is recommended to improve inreach communication by finalizing, updating and ensuring all staff are aware of the common server and filing system, as well as the common resource library folder – to access historical and current communications resources (66). Where possible, automate production of communications products such as parish and project fact sheets from data that is already collected at a project, and parish scale (67). Project Managers and communications staff are recommended to develop project specific outreach and engagement plans, or clarify that one is not needed, in project Phase 1 – Objective Setting (68). Communications efficiency will be maximized when at the commencement of project Phase 2, Design and Construct Project, available fact sheets and communications are accessed, project fact sheet is developed, and stakeholders are explicitly identified (to clarify communication needs) (69). For the LA TIG MAM it is specifically recommended to engage the public in the development of a LA TIG MAM Outreach and Communications Plan and in the LA TIG MAM Strategy development and implementation. (71).

7.0 Modeling: Develop common repository and clearinghouse for numerical models and tools

- **Approximate Cost**: <$250,000 – $550,000 (actions A and D)
- **Time Frame of Cost**:
  - A: One-time cost to trial options and propose a detailed plan (<$250,000)
  - B, C: Timeframe and cost dependent upon outputs from A
- **Time to implement**:
  - A: 12 months
  - B, C: Phased
- **Priority**: High
- **Action Items**:
  - A: Explore, document feasibility, and trial options for a repository and centralized clearinghouse for numerical models through engagement of key partners including the CPRA Modeling Work Group, the LA TIG MAM POCs, and USACE Federal Trustee modeling working group (UFT):
    - Define the tools and models to include in a repository.
    - Establish procedures for an effective repository
    - Evaluate model components to include within the repository
    - Consider approaches for near-term and long-term storage
    - Collaborate with groups experienced with the development of repositories
    - Assess ongoing needs and cost to set up and manage the proposed clearinghouse options over time, user access, model versioning, etc.
  - B: Draft standards for version control, documentation requirements, model testing and benchmarking, and procedural standards like model check in and check out:
    - Drafting common standards for the repository (e.g., CSDMS format)
    - Draft standards and processes specific to selected models
    - Assess version control requirements needed within the repository
    - Establish exceptions to use of common standards (e.g., commercial codes)
    - Work with the 2023 Coastal Master Plan models as a case example
  - C: Implement selected option for long-term development and support of a centralized numerical model clearinghouse(s)

It is recommended to programmatically consider synergies in modeling tools and metrics utilized in coastal Louisiana to promote consistency and collaboration, reduce duplication of effort, and target future modeling efforts (13). This can be achieved through a central clearing house and repository. This process would support consistent use of current CPRA processes for model tracking templates (11). We recommend that current numerical models are examined for their ability to quantify programmatic goals and objectives (12) (Recommendation 4.0), in particular developing uncertainty matrices for numerical modeling efforts that inform programmatic adaptive management (14).

8.0 Stakeholder Engagement: Establish standard operating procedures for stakeholder engagement, specifically including active and two-way mechanisms to ensure feedback and engagement throughout restoration planning, implementation, and operation

- **Approximate Cost**: $100,000 - $500,000
- **Time Frame of Cost**:
  - A: Developing the approaches 1 2 months (<$100,000)
  - B: Following from A develop assessment and impact measures 12-24 months (<$200,000)
  - C: Stakeholder database following from A 12 – 24 months (<$200,000)
- **Time to implement**:
  - A: 12 months
  - B: subsequent to A, 12-24 months
  - C: subsequent to A, 12-24 months
- **Priority**: High
- **Action Items**:
  - A: Establish scientifically rigorous and replicable procedures (formalized as standard operating procedures) to gather local and traditional ecological knowledge through community conversations or other forms of facilitated small group discussion; ensuring to more directly incorporate the participation of local knowledge experts (12 months)
    - Commence implementation of improved approaches and SOPs (ongoing)
  - B: Develop assessment methodologies (12 – 24 months):
    - Develop procedures to identify social impacts, including potential environmental justice concerns and direct impacts on cultural heritage sites or resources, that would require more detailed qualitative data assessment
    - Develop methods to measure effectiveness of stakeholder engagement
  - C: Develop within-agency stakeholder database to support stakeholder engagement procedures (24 months)

As distinct from communication or information dissemination, stakeholder engagement using active two-way communication is recommended to support effective adaptive management of coastal restoration in Louisiana. This is most effective when it occurs throughout project planning, implementation, and operation, recognizing that the scope varies with project size and location (77). It will benefit from active facilitation with small group discussions within formal public hearings (78) or a "community conversation" approach to gathering local and traditional ecological data (79), including innovative geospatial approaches such as Sci-TEK, spatial video geonarratives, and local knowledge mapping (75). To ensure consistency, we recommend establishing SOPs for stakeholder engagement for coastal restoration in Louisiana related to adaptive management (74). Additionally, develop and apply methods for quantitatively assessing effectiveness of current and newly implemented approaches to stakeholder engagement (82). Where institutionally appropriate, stakeholder databases should be developed to increase efficiency (82).

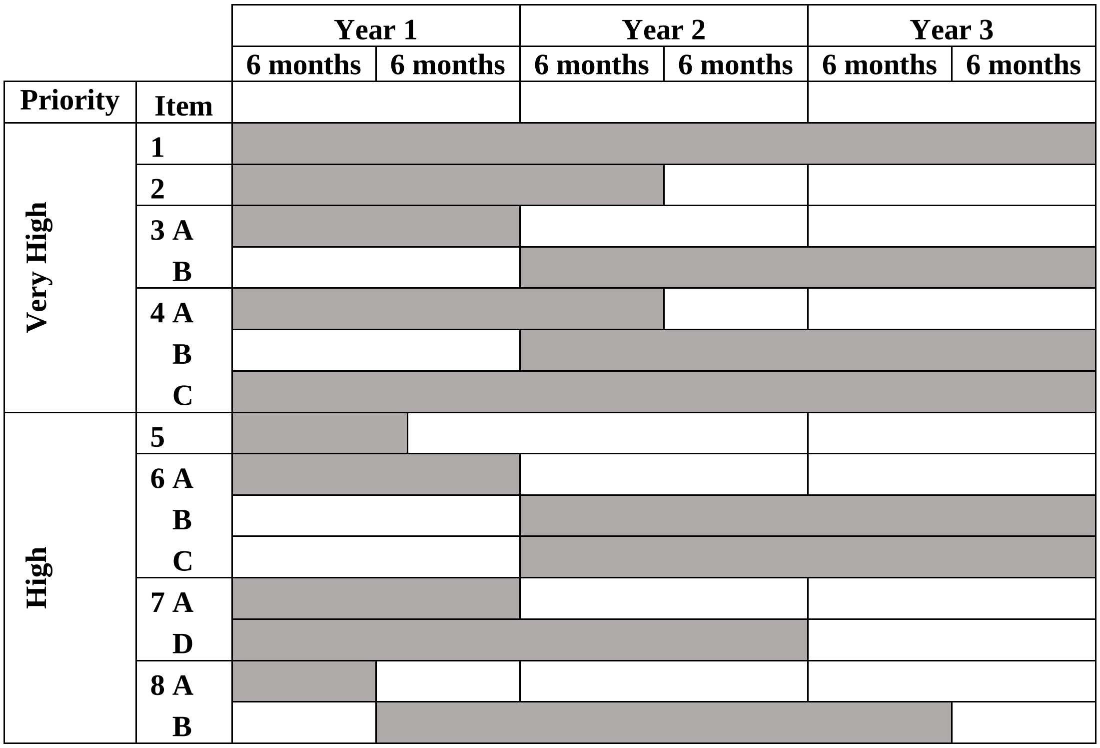


Figure 17. Gantt chart over 36 months for implementation of priority recommendations 1.0-8.0

Table 11. First order cost estimate (in $'000s) to implement priority actions 1.0-8.0: low range

	Year 1		Year 2		Year 3	
Priority	**6 months**	**6 months**	**6 months**	**6 months**	**6 months**	**6 months**
Very High	$330	$330	$380	$200	$200	$200
High	$335	$240	$125	$125	$125	$100
Low range cost estimate						
Total ('000s)	**$665**	**$570**	**$505**	**$325**	**$325**	**$300**

Table 12. First order cost estimate (in $'000s) to implement priority actions 1.0-8.0: high range

	Year 1		Year 2		Year 3	
Priority	**6 months**	**6 months**	**6 months**	**6 months**	**6 months**	**6 months**
Very High	$735	$735	$1,255	$1,015	$1,015	$1,015
High	$650	$550	$225	$225	$200	$100
High range cost estimate						
Total ('000s)	**$1,385**	**$1,285**	**$1,480**	**$1,240**	**$1,215**	**$1,115**

Acronyms

Acronym	Definition
ADCIRC/SWAN	Advanced Circulation and Simulating Waves Nearshore
ADCP	Acoustic Doppler Current Profile
BICM	The Barrier Island Comprehensive Monitoring Program
CERP	Comprehensive Everglades Restoration Plan
CIMS	Coastal Information Management System
COE	Center of Excellence
CPRA	Coastal Protection and Restoration Authority
CRMS	Coastwide Reference Monitoring System
CSAP	Coastal Science Assistantships Program
CWPPRA	Coastal Wetland Planning, Protection, and Restoration Act
DCL	Dual Career Leader
DEM	Digital Elevation Model
DIVER	NOAA's Data Integration Visualization Explorations and Reporting
DMP	Data Management Plan
DMT	Data Management Team
DNR	Department of Natural Resources
DOI	U.S. Department of Interior
DOTD	Department of Transportation and Development
DU	Ducks Unlimited
DWH	Deepwater Horizon
DWH NRDA	Deepwater Horizon Natural Resource Damage Assessment
EIS	Environmental Impact Study
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EwE	Ecopath with Ecosim
FDT	Framework Development Team
FEMA	Federal Emergency Management Association
FGDC	Federal Geographic Data Committee
FONSI	Findings of Significant Impacts
FPL	Funding Priority List
GCERC	Gulf Coast Ecosystem Restoration Council
GEBF	Gulf Environment Benefit Fund
GIS	Geographic Information Systems
HUD	Housing and Urban Development
ICM	Integrated Compartment Model

Acronym	Definition
IMPR	Internal Monthly Progress Report
LA-COE	RESTORE Act Center of Excellence for Louisiana
LASARD	Louisiana Sand Resource Database
LASMP	Louisiana Sediment Management Plan
LA TIG	Louisiana Trustee Implementation Group
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LDWF	Louisiana Department of Wildlife and Fisheries
LEADMS	Louisiana Environmental Analytical Data Management System Resource
LED	Louisiana Economic Development
LiDAR	Light Detection and Ranging
LISST	Laser In-situ, Scattering and Transmissometry
LOCD	Louisiana Office of Community Development
LOSCO	Louisiana Oil Spill Coordinator's Office
LSU	Louisiana State University
LULC	Land Use Land Cover
MAM	Monitoring and Adaptive Management
MAMPG	Monitoring and Adaptive Management Procedures and Guidelines Manual
MBrSD	Mid Breton Sediment Diversion
MBSD	Mid-Barataria Sediment Diversion
MBTA/BGEPA	Migratory Bird Treaty Act / Bald and Golden Eagle Protection Act
MDT	Modeling Decision Team
MPDT	Master Plan Delivery Team
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act
NFWF	National Fish and Wildlife Foundation
NMFS	National Marine Fisheries Services
NOA	Notice of Action
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRDA	Natural Resource Damage Assessment
NWIS	National Water Information System
O&M	Operation and Maintenance
OCD	Office of Cultural Development
OCM	Office of Coastal Management
OFR	Office of the Federal Register
OM&M	Operation, Maintenance, and Monitoring

Acronym	Definition
OMMAM	Operations, Maintenance, Monitoring and Adaptive Management
OPA	Oil Pollution Act
P&E	Planning and Evaluation Subcommittee
P6	Primavera Enterprise Project Portfolio Management
PDARP	Programmatic Damage Assessment and Restoration Plan
PEIS	Programmatic Environmental Impact Statement
PI	Principal Investigator
PM	Predictive Models
POC	Point of Contact
PPL	Priority Project List
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Plan
QAPP	Quality Assurance Plan Procedures
RECOVER	Restoration Coordination and Verification
RESTORE	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States
RFP	Request for Proposal
RP	Restoration Plan
RP/EA	Restoration Plan/Environmental Assessment
SOP	Standard Operating Procedure
SOW	Statement of Work
STAR	Scientific Technical Assessment and Reporting
STORET	STORage and RETrieval
SWAMP	System-Wide Assessment and Monitoring Program
TAC	Technical Advisory Committees
TC	Technical Committee
TEK	Traditional Ecological Knowledge
TIG	Trustee Implementation Group
TIG MAM	Trustee Implementation Group Monitoring Adaptive Management
TOR	Term of Reference
TPOC	Technical Point of Contacts
TWG	Technical Work Group
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

Glossary

Adaptive management – Adaptive management is a form of structured decision-making applied to the management of natural resources in the face of uncertainty (Pastorok et al., 1997; Williams, 2011). It is an iterative process that integrates monitoring and evaluation of management actions with flexible decision-making, where adjustments are made to management approaches based on observed outcomes (NRC, 2004)Within the context of ecological restoration, adaptive management addresses uncertainties by linking science to restoration decision-making (Steyer & Llewellyn, 2000; Thorn et al., 2004).

Collaboration – Stakeholders work together to define and solve problems to achieve common goals. *

Cross-Trustee Implementation Group (Cross-TIG) Monitoring and Adaptive Management (MAM) work group – The Cross-TIG MAM work group was established by the Trustee Council to serve as a forum for the TIGs to collectively address MAM topics relevant to multiple TIGs. The Cross-TIG MAM work group has no independent authority to act except when directed by the Trustee Council. See Trustee Council SOPs for more information (DWH NRDA Trustees, 2016).

Data Integration Visualization Exploration and Reporting (DIVER) – DIVER is a data warehouse and query application developed by the National Oceanic and Atmospheric Administration (NOAA). DIVER integrates and standardizes datasets so users can query across data holdings and download information and results. See the DWH DIVER website for more information (https://dwhdiver.orr.noaa.gov/). DIVER has both an authorized user access and publicly available access.

Design – Specifications of a selected planning alternative. *

DIVER Explorer – The DIVER Explorer is a querying tool that provides the ability to quickly browse, search, visualize, and download that data using different data categories:

- Projects and planning details: Logistical, financial, and organization information specific to projects, including site-specific restoration efforts.
- Environmental data: Detailed field and laboratory-based environmental characterization data obtained from the files collected in DIVER. These may include field observations; laboratory results for samples; and photographs that were logged and keyword-tagged using NOAA's Photologger, telemetry, and continuous-read instruments [e.g., conductivity temperature depth (CTD)]. See the DWH DIVER website for more information.

DIVER Restoration Portal – The DIVER Restoration Portal was created by the Trustee Council to provide a centralized platform to support tracking and reporting of the Trustee Council restoration planning and project activities, monitoring, and financial expenditures. The Restoration Portal includes information for the project description, the location, the budget, restoration activities, monitoring, as-built accomplishments, and environmental compliance. Authorized users may access the Restoration Portal at https://portal.diver.orr.noaa.gov/group/trustee-council. The information and data gathered from the DIVER Restoration Portal are available for public consumption through the DIVER Explorer interface or through the Trustee Council Gulf Spill Restoration website (http://www.restoration.noaa.gov/dwh/storymap/).

Ecosystem – The complex of a community of organisms and its environment functioning as an ecological unit. *

Management Action – Manipulation or modification of a structure or process to achieve a desired goal or objective. *

Monitoring – Systemic collection and analysis of data that provides information useful for assessing project performance, determining whether project/program success has been achieved, or whether AM may be needed to attain project benefits. *

Project evaluation: A project evaluation is the synthesis of project-specific monitoring information to understand restoration effectiveness and the need for corrective action.

Restoration Type evaluation: A Restoration Type evaluation is the synthesis of monitoring information at the resource level to understand restoration benefits within each of the Restoration Types. This evaluation will provide the feedback needed for adaptive management at the Restoration Type level and inform the planning and implementation of future restoration actions for a specific Restoration Type.

Programmatic evaluation: Programmatic evaluation is the synthesis of monitoring information and overall restoration results to document progress toward meeting restoration goals and objectives. This evaluation will provide the feedback needed for adaptive management at the programmatic level, and inform the planning and implementation of future restoration actions under the Restoration Plan.

Implementing Trustee – The Trustee Agency designated by the TIG that is responsible for leading the implementation of a specific restoration project and MAM activities.

Natural resource damage assessment (NRDA) – NRDA is the process of collecting and analyzing information to evaluate the nature and extent of injuries resulting from an incident, and determining the restoration actions needed to bring injured natural resources and services back to baseline and make the environment and public whole for interim losses (CFR, 1996b).

Oil Pollution Act (OPA) – OPA means the Oil Pollution Act of 1990, 33 U.S.C. 2701 et seq.

Objective-specific performance monitoring parameters – Objective-specific performance monitoring parameters are those parameters that are only applicable to projects with a particular restoration objective.

Performance criteria – Performance criteria are used to determine the success of restoration or the need for corrective actions (CFR, 1996a). Performance criteria may include structural, functional, temporal, and/or other demonstrable factors (CFR, 1996a). Performance criteria may include post-construction/post-execution performance criteria as well as construction/execution performance criteria, if those construction/execution criteria are related to the project’s performance monitoring.

Performance monitoring – Performance monitoring is the collection of monitoring information to support the evaluation of effectiveness of the project in meeting the established restoration objectives and assist in determining the need for corrective actions. Performance monitoring is intended to document whether the projects have met their established performance criteria and determine the need for corrective actions (CFR, 1996a).

Pre-restoration baseline monitoring – Pre-restoration baseline monitoring is information collected before or at the start of a given project that provides a basis for planning and/or evaluating subsequent progress and related impacts(NAS, 2016).

Programmatic goal (also referred to as programmatic trustee goals and ecosystem goals). Programmatic goals are the overarching goals the Trustees identified for restoration planning specific to addressing injury. Programmatic goals include Restore and Conserve Habitat; Restore

Water Quality; Replenish and Protect Living Coastal and Marine Resources; Provide and Enhance Recreational Opportunities; and Provide for Monitoring, Adaptive Management, and Administrative Oversight to Support Restoration Implementation ("A Comprehensive Restoration Plan for the Gulf of Mexico | NOAA Gulf Spill Restoration," n.d.; DWH NRDA Trustees, 2016).

Stakeholder – One who is affected by a management action. *

Success Criteria – Standards used in determining the extent to which a performance measure is being or has been achieved. *

Trustee Implementation Groups (TIGs) – TIGs are the groups the Trustees established for the purposes of planning, administering, and implementing restoration. There are currently seven active TIGs, one for each Restoration Area, as follows: Alabama, Florida, Louisiana, Mississippi, Texas, Regionwide, and Open Ocean. An eighth TIG, the Adaptive Management and Unknown Conditions TIG, may be established by the Trustees 10–15 years following the settlement.

Trustees – Trustees (or natural resource trustees) are those officials of the Federal and State governments, of Indian tribes, and of foreign governments, designated under 33 USC 2706(b) of OPA (15 CFR § 990.30), to assess damages to natural resources, and develop and implement plans for the restoration, rehabilitation, replacement, or acquisition of the equivalent, of the natural resources under their trusteeship. The DWH NRDA Trustee Council is comprised of Trustee agencies from the States of Texas, Louisiana, Mississippi, Alabama, Florida, and four Federal agencies: the U.S. Department of Commerce (represented by NOAA), the U.S. Department of the Interior, the U.S. Department of Agriculture, and the U.S. Environmental Protection Agency.

Uncertainties – Uncertainties are information gaps that may affect decisions for a project or groups of projects that focus within the context of adaptive management.

Unknown conditions – Unknown conditions are factors that may be discovered in the future that could influence the overall restoration progress and/or the recovery of resources.

Water Resource Development Act – Public laws enacted by congress to manage aspects of water resources including, for example, environmental effects, structural modifications, navigational issues, flood protection, and hydrology. *

*** USACE Adaptive Management**

(DWH NRDA Trustees, 2017)

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5.0 Annexes

5.1. Model Tracking Examples

Table 13. Model Versioning Table for Delft3D Basinwide Model: Example

For clarification, model versions should be named with sequential Version numbers (e.g., Version 1, Version 2, Version 3, etc.; can be abbreviated as V1, V2, V3, etc.), and these names should be used consistently throughout all documentation. As updates to new model versions are finalized and documentation becomes available for any models used by CPRA, information should be provided as an update in CPRA's CIMS-based model inventory.

General Model Attributes

Model Name	Delft3D Basinwide Model
Model Software*	Delft3D
Study Name*	Basin Wide Model Development for the Louisiana Coastal Area Mississippi River Hydrodynamic and Delta Management Study
CPRA Project Association*	MR-0016
Study Date*	2015
Modeled Processes*	Landscape change; Hydrodynamics; Water quality; Sediment transport; Ecological
Study Area*	Barataria Basin; Breton Sound Basin
Modeler Name*	Dr. Ehab Meselhe et al.
Modeler Affiliation*	The Water Institute of the Gulf et al.
Model Sponsor *	Coastal Protection and Restoration Authority (CPRA); U.S. Army Corps of Engineers (USACE)
Model Sponsor Contact	Elizabeth Jarrell (CPRA)
Model Description/Context*	A basin-wide Delft3D model was developed that simulates: 1) morphological evolution processes that result from sediment deposition into wetland areas from a suite of diversion locations and sizes, and (2) salinity and nutrient-related effects of these diversions on the wetland vegetation, soils, and open waters of Barataria and Breton Sound Basins.
Primary Input Data*	Water level; discharge; sediment loads; water quality constituent loads; and salinity at the boundaries; bathymetry; topography; air temperature; precipitation; wind; bed sediment characteristics; vegetation coverage and biomass allocation
Primary Output Data*	Water level; salinity; water temperature; sediment loads; bed elevation change; landscape configuration; water quality/nutrient concentrations; chlorophyll concentration; phytoplankton species composition; vegetation biomass
Report Link*	https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=20974

Version-Specific Model Attributes

Version name; abbreviation	**Version 1; V1**	**Version 2a; V2a**	**Version 2b; V2b**	**Version 2; V2**	**Version 3; V3**
Temporal Scale*	1-minute time step				
Spatial Scale*	Grid cells variable, ranging from 100 m x 100 m (near diversion outfalls) to 4 km x 4 km (in Gulf) for the flow module; coarser cell aggregations used for water quality module				
Initial Landscape	Initial FWOP projects	Additional projects added to FWOP			More new projects added
Vegetation-inundation response: Critical Depth	80% height	50% height	20-30% height		
Vegetation-inundation response: Lag time	21 days	0 days	1 day		
Vegetation-inundation response: Mortality	0.01-0.1/day	0.11-0.15/day	0.0		
Organic Accretion Process	Net concentration converted to thickness with bulk density		Updated calculation based on mortality flux		
Organic Accretion Limits	none	Min 1 mm/year	Min 7.5 to Max 15 mm/year		Adjusted rates to better capture Breton Sound loss
Land/Water Definition	Depth criteria	Elevation criteria			
Other Model Updates		Grid refinement			
		Improved dredging template			
		Improved flows at passes			
		Adjusted bulk densities			
		Improved water quality calibration			
		Improved vegetation coupling to better capture inundation effects and establishment			
			Update to internal vegetation model dynamics		
					Flow recalibration
					Bathymetry updates
					Mardi Gras Pass added

Table 14. Model Versioning Table for Integrated Compartment Model: Coastal Master Plan Example

General Model Attributes			
Model Name	Integrated Compartment Model		
Model Software*	ICM		
Study Name*	2017 Coastal Master Plan Appendix C: Modeling, Chapter 3 - Modeling Components and Overview		
Study Date*	2017		
CPRA Project Association*	n/a		
Modeled Processes*	Landscape change; Hydrodynamics; Water quality; Sediment transport; Ecological; Shoreline response; Beach-dune erosion		
Study Area*	Louisiana coastal zone		
Modeler Name*	Stokka Brown et al.		
Modeler Affiliation*	Moffat & Nichol et al.		
Model Sponsor*	Coastal Protection and Restoration Authority (CPRA)		
Model Sponsor Contact	Mandy Green (CPRA)		
Model Description/Context*	The Integrated Compartment Model (ICM) was used as the central modeling platform for the 2017 Coastal Master Plan to analyze the landscape performance of restoration projects and alternatives. The ICM combined the individual models used for the 2012 Coastal Master Plan, which were improved and dynamically-linked as subroutines (hydrology, morphology, barrier islands, and vegetation). Habitat suitability indices were also integrated into the ICM but provide no feedback to the other subroutines.		
Primary Input Data*	water level, discharge, salinity and water quality constituents at the boundaries; topography; bathymetry; rainfall; evapotranspiration; wind; wave conditions; initial landscape configuration; initial vegetation conditions; storm data		
Primary Output Data*	water level; discharge; salinity; water quality constituents; total suspended sediment; sediment accretion; along-shore and cross-shore sediment transport rates; land area and elevation change; landscape configuration; vegetation species coverage; habitat quality		
Report Link*	http://coastal.la.gov/our-plan/2017-coastal-master-plan/planning-process/modeling/		
Version-Specific Model Attributes			
Version name; abbreviation	**Version 1; V1**	**Version 2; V2**	**Version 3; V3**
Temporal Scale*	Hydro: 30-sec; BIMODE: monthly; LAVegMod: annual; Morph: annual; HSI: annual; EwE: monthly		
Spatial Scale*	Hydro: 946 variable compartments; BIMODE: 100-m long-shore, 2-m cross-shore; LAVegMod: 500-m grid; Morph: 30-m grid; HSI: 500-m grid; EwE: 1000-m grid		
Initial Landscape	2014 topobathy DEM; 2014 LULC; 2017 Coastal Master Plan FWOA projects		
Vegetation-inundation response: Critical Depth	Intermediate marsh: 0.358-m Brackish marsh: 0.256-m Saline marsh: 0.235-m		
Vegetation-inundation response: Lag time	Morph models collapse if area is inundated by annual mean water level two years in a row		
Vegetation-inundation response: Mortality	Inundation stress and salinity spikes (maximum 2-week mean salinity) result in collapse from vegetated land to open water; gradual changes in water level variability and salinity during growing season results in vegetation shifts		
Organic Accretion Process	Mean values for each vegetation type determined in CRMS – averaged by CWPPRA basin		
Organic Accretion Limits	Input lookup tables based on CRMS data		
Land/Water Definition	Land gain and collapse thresholds vary by vegetation type		Bare ground without any vegetation allowed to collapse if inundated by annual mean water level by at least 0.2-m
Other Model Updates		Salinity mass balance in overland flow network improved but no re-calibration was performed	Re-calibrated salinity diffusion parameters to account for mass balance fix in V2
***attribute is already included in *Model Domains* repository in CIMS**			

Table 15. Model Simulation Tracking Table: Example for simulations and assumptions

Production Run	1 (FWOA)	2	3	6 (FWOA)	7	9 (FWOA)	10	11 (FWOA)	12	13 (FWOA)	15	16
Model	Delft3D Basinwide Model					ICM				Delft3D Basinwide Model		
Model Version	V1			V2		V3				V3		
Sea Level Rise by 2100	0.5 m							1.5 m				
Subsidence	20th percentile											
Projects*	none	MBSD	MBrSD	none	MBrSD; MBSD	none	MBrSD; MBSD	none	MBrSD; MBSD	none	MBSD	MBrSD
Diversion Max Flow	n/a	75k cfs	35k cfs	n/a	35k cfs; 75k cfs	n/a	35k cfs; 75k cfs	n/a	35k cfs; 75k cfs	n/a	75k cfs	35k cfs
Diversion on/off Trigger	n/a	600k cfs	600k cfs	n/a	450k cfs	n/a	450k cfs	n/a	450k cfs	n/a	450k cfs	450k cfs
Mississippi River Hydrograph	Representative			Historic (1964 – 2013)								
Mississippi River Sediment Rating Curves	Simple			Hysteresis		Simple				Hysteresis		
Davis Pond & Caernarvon	Average historic flow			Real-time control (salinity trigger @ 4 stations)		Rating curve developed in model calibration period				Real-time control (salinity trigger @ 4 stations)		
***MBSD = Mid-Barataria Sediment Diversion, MBrSD = Mid Breton Sediment Diversion**												

5.2. Adaptive Management Lessons Learned from Other Ecosystems

5.2.1. Lessons Learned from Large U.S. Ecosystems

Experts in adaptive management of four large U.S. ecosystems shared lessons learned with Louisiana coastal restoration practitioners through presentations, interactive working sessions, and responses to targeted questions. The recommendations arising from their experiences in the Everglades, Chesapeake Bay, Platte River, and Columbia Estuary are summarized in the tables below, and related to the relevant steps of adaptive management. These lessons learned were considered in discussions capturing the current processes and key findings for adaptive management for coastal restoration in Louisiana.

Table 16. Key lessons learned from other large ecosystems relevant to implementing adaptive management within Louisiana

ECOSYSTEM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Chesapeake	Science, policy and financial personnel should have intermittent engagement in revising problem statements and project goal setting.	• Define the Problem • Set Goals and Objectives • Recommend Revisions • Approve Adjustments	Goals and objectives should explicitly consider fiscal, policy, or science understanding changes.
Chesapeake, Columbia	Summarize relevant fiscal, policy and science change every two years.	• Define the Problem • Set Goals and Objectives • Recommend Revisions • Approve Adjustments	Develop a summary of fiscal, policy and science understanding changes on a regular (e.g., each 2 years) basis.
Columbia	Project site visits provide excellent stakeholder engagement.	• Define the Problem • Set Goals and Objectives • Recommend Revisions	Maximize or formalize stakeholder site visits to relevant project sites.
Columbia	Connect metrics to action types and identify how each project contributes to the overall program goal.	• Set Goals and Objectives • Recommend Revisions • Approve Adjustments	Develop a mechanism to connect individual projects to the program.
Everglades and Chesapeake	Create goal teams to determine interim check points or goals (e.g., every 2 years) to better identify progress towards large term programmatic goals (Everglades – this was in authorizing legislation for restoration).	• Set Goals and Objectives • Recommend Revisions • Approve Adjustments	Develop interim (every 2 years) project goals connected to the program.
Chesapeake	Cross program guidance questions and logic table were valuable tools when implementing adaptive management.	• Recommend Revisions • Approve Adjustments	Develop a mechanism to assist in implementation coordination through recognition of commonality in program goals.
Chesapeake	Implementation grants were valuable for incorporating Adaptive Management into the workflow.	• Define the Problem • Set Goals and Objectives • Recommend Revisions • Approve Adjustments	Mechanism in place.
Platte River	Implementing via the “top down” approach (i.e., Executive Director implementation) is crucial for implementing and prioritizing Adaptive Management into the workflow.	• Define the Problem • Set goals and Objectives • Recommend Revisions • Approve Adjustments	Mechanism in place.
Columbia	Conducting a nationwide review of other programs was helpful when implementing programmatic Adaptive Management.	• Define the Problem • Set goals and Objectives • Recommend Revisions • Approve Adjustments	Mechanism in place.
Platte River	Present design makers with tools in advance to solicit feedback and increase future project buy in.	• Define the Problem • Set goals and Objectives • Recommend Revisions • Approve Adjustments	Mechanism to improve project or programmatic buy in.

Table 17. Key lessons learned from other large ecosystems relevant to information management

PROGRAM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Platte River	Data management requirements are built into the reporting structure.	• Define the Problem • Assess and Evaluate	Follow SOPs for data management Plans within agencies and according to DWH program guidelines.
Columbia Estuary	Build Data Management Plans into SOPs.	• Define the Problem • Assess and Evaluate	Follow SOPs for data management Plans within agencies and according to DWH program guidelines.
Everglades	Effort to develop integrated physical, chemical, and biological data model.	• All	Develop a mechanism to simplify data to information workflow.
Everglades	Round-robin, blind standards QA/QC testing for all water quality laboratories.	• Operate, Maintain, Monitor • Assess and Evaluate	Develop an SOP for outside QA/QC procedures.
Columbia Estuary & Chesapeake Bay	Quality control can be tiered by prioritization of data use.	• Operate, Maintain, Monitor	Develop a mechanism to prioritize quality control efforts based on data use.
Platte River	Long standing issues with information workflow would benefit from greater synthesis capabilities.	• Assess and Evaluate • Recommend Revisions • Approve Adjustments	Develop a mechanism to support data synthesis.
Columbia Estuary	Use Data Exchange Templates to minimize reporting error.	• Identify and Prioritize Uncertainties • Operate, Maintain, Monitor	Mechanisms in place for DIVER entries and CRMS databases.
Platte River	Lean into collaborative editing capabilities, reduce amount of intermediate document creation.	• All	Develop an efficient documentation process.
Everglades	Data publication requires a significant and dedicated time investment.	• Identify and Prioritize Uncertainties • Assess and Evaluate • Recommend Revisions • Approve Adjustments	Develop a mechanism to automate synthesis reporting.
Chesapeake Bay, Columbia Estuary, Platte River	Shift towards non-centralized data.	• All	Develop SOPs and support software development to reference or access external data by repositories.
Chesapeake Bay, Columbia Estuary, Platte River	Work on increasing data discoverability.	• Identify and Prioritize Uncertainties • Assess and Evaluate • Recommend Revisions • Approve Adjustments	Develop SOPs and mechanism for data/information synthesis.

Table 18. Relevant to applied synthesis and research: Key lessons learned from other large ecosystems

ECOSYSTEM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Platte River	Prioritization of research or synthesis needs.	• Define the Problem • Assess and Evaluate	Develop a mechanism or metric to prioritize critical issues that emerge (e.g., invasive species), surprises, basic research gap (identified by independent Scientific Advisory Committee).
Columbia Estuary	Prioritization of research or synthesis needs.	• Define the Problem • Assess and Evaluate	Develop a mechanism or metric to prioritize questions posed: Will research or synthesis change a decision or outcome?
Everglades	Prioritization of research or synthesis needs.	• Define the Problem	Conceptual models or legal requirements/actions.
Everglades	Maximize utilization of information.	• Identify and Prioritize Uncertainties • Recommend Revisions • Approve Adjustments	Delegate an effective scientific communicator to sit with decision makers through the process.
Chesapeake Bay and Platte River	Maximize utilization of information.	• Recommend Revisions • Approve Adjustments	Incorporate decision makers early in the process to ensure buy in on the synthesis. This will streamline the process and create shorter documents. Effectively communicate technical information to decision makers.
Columbia Estuary & Chesapeake Bay	Maximize utilization of information.	• Identify and Prioritize Uncertainties	Develop a mechanism to incorporate information into the knowledge base and prioritize needs. Create a small, committed adaptive management group who is charged with staying up to date on all generated information and reports (e.g., Scientific Technical Assessment and Reporting (STAR)).
Everglades	Incorporate information into the knowledge base and ensure synthesis report development.	• Assess and Evaluate	Require researchers (contractually) to write synthesis reports.
Columbia Estuary	Incorporate information into the knowledge base and ensure synthesis report development.	• Assess and Evaluate	Contact researchers yearly to determine if there is new information to synthesize and develop a synthesis memorandum (include multiple lines of evidence) every 5 years.
Platte River	Incorporate information into the knowledge base and ensure synthesis report development.	• Assess and Evaluate	Select a small team to write the synthesis reports.
Platte River and Everglades	Incorporate information into the knowledge base and prioritize needs.	• Assess and Evaluate	Annual Adaptive Management workshop/conference.

Table 19. Relevant to stakeholder engagement: Key lessons learned from other large ecosystems

ECOSYSTEM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Everglades	The stakeholder process ensured that their feedback would be taken seriously by CERP actively involving them in the planning process.	• Define the Problem	Pre-permit application stakeholder consultation may potentially be perceived as more valuable by the public than public comment period.
Everglades	Not all people feel comfortable speaking in meetings, and thus feedback may be lost. Find ways to elicit feedback through multiple channels.	• Define the Problem • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design • Assess and Evaluate	In larger meetings, consider breakout groups where introverts may feel more comfortable speaking out and a facilitator can help track feedback and even help define it. Also, provide comment cards so that people who do not feel comfortable speaking have an alternative.
Everglades	Put out broad calls for public meetings.	• Define the Problem • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design • Assess and Evaluate	When advertising meetings, take into consideration how a community receives information, including language translations (e.g., Vietnamese fishing community).
Everglades	Workshops to evaluate and develop alternatives were an effective way of getting feedback and created a sense of involvement and ownership in the process.	• Plan Formulation and Engineering Design	Create criteria to determine when to use workshops as a tool to develop and evaluate alternatives.
Everglades	Allow stakeholders the ability to ID themselves.	• Define the Problem • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design • Assess and Evaluate	In signing up for the stakeholder register, provide subscription services that allow stakeholders to categorize themselves.

ECOSYSTEM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Everglades	Involve the full range of stakeholders, including those with the most divergent views	• Define the Problem • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design • Assess and Evaluate	Do not dismiss a viewpoint because the messenger is difficult. Seek to understand it. Address the concern objectively through available media.
Everglades	A lack of litigation, or lack of obstacles, is often the default measure of success. Seek to define and measure success in ways that are not passive to champion successes.	• Assess and Evaluate	In development. Some proposals on the table: community participation in the process (attendance), number of people seeking information (website analytics), level of project understanding (poll everywhere, polls).
Chesapeake	Find ways to define and measure success or failure.	• Assess and Evaluate	In development. Some proposals on the table: community participation in the process (attendance), number of people seeking information (website analytics), level of project understanding (poll everywhere, polls).
Chesapeake	Process for stakeholder engagement varies according to what is being accomplished. Standardization may not always be necessary. Ensure that the effort devoted to engagement is less than or equal to what you get out of it.	• Define the Problem • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design • Assess and Evaluate	A handbook for stakeholder engagement is in development that would identify triggers for various levels of activity best gauged to the situation.
Chesapeake	Stakeholders engaged should vary depending on the scale of the project.	• Define the Problem • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design • Assess and Evaluate	Know when the agency needs to communicate directly with residents and when it is more efficient to do so indirectly through community representatives or other entities.

ECOSYSTEM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Columbia River	Utilize citizen science to engage, impassion, and educate the public about the issue.	• Operate, Maintain, Monitor • Recommend Revisions	Possible opportunities for citizen science around monitoring. Planting programs exist coast wide but the state is not affiliated with them.
Columbia River	Find ways to define and measure success.	• Approve Adjustments	In development. Some proposals on the table: community participation in the process (attendance), number of people seeking information (website analytics), level of project understanding (poll everywhere, polls).
Columbia River	Identifying failures to effectively engage the public is easier to do than identifying successes and thus carry more weight in the public dialogue.	• Approve Adjustments	Ensure that examples of successes are readily available to counter very public “failures” or incidents and be prepared to quickly address incidents.
Columbia River	Use of monthly science working group meetings that put people in the field builds common understanding.	• Develop or Refine Models • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design	There are numerous field opportunities for staff which are also costly. Ensuring that the outcomes of these visits have clearly defined contributions to the process and measures of success is important to justify them.
Platte River	Stakeholder Engagement should be hardwired and embedded into the structure of the program.	• Define the Problem • Set Goals and Objectives • Plan Formulation and Engineering Design • Implement or Construct • Operate, Maintain, Monitor • Assess and Evaluate • Recommend Revisions	Having an organizational process is recommended and is in development. The LA TIG also holds public meetings for each restoration plan, and annual meetings to report on restoration progress.

ECOSYSTEM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Platte River	Write a charter for each key stakeholder or interest group to encourage accountability and engagement. This encourages self-organization.	• Identify and Prioritize Uncertainties	Depending on the level of engagement, it may be important to have informal/formal means of accountability, perhaps not a contract, but terms of reference, etc.
Platte River	To avoid surprise from the public, solicit feedback from as many interests as possible so that later in the process, surprise obstacles are less likely.	• Define the Problem • Identify and Prioritize Uncertainties	A standardized, rigorous engagement process should help identify interests.
Platte River	Create and maintain transparency through keeping all meetings open to the public.	• Define the Problem • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design • Assess and Evaluate	As a state government entity, CPRA is required to do this. The LA TIG also holds public meetings for each project's public comment period, and annual meetings to report on restoration progress.
Platte River	Success is defined by lack of conflict. All problems are seen as the result of the governance structure and a lack of engagement.	• Assess and Evaluate	For those projects requiring adaptive management of operations, governance structures will be required.
Platte River	Development of alternative hypotheses can and should integrate qualitative data.	• Define the Problem	See workshop idea above, and other means of collecting feedback.
Platte River	Take the time to identify key stakeholders, build relationships, to help better understanding and ability reach consensus.	• Define the Problem • Identify and Prioritize uncertainties • Plan Formulation and Engineering Design • Assess and Evaluate	Continue to maintain a high level of professionalism. A culture of community meals fosters interaction at meal.

Table 20. Relevant to communications: Key lessons learned from other large ecosystems

ECOSYSTEM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Everglades	Public outreach could be much broader.	• Plan Formulation and Engineering Design; • Implement or Construct • Operate, Maintain, Monitor	Could expand social media, have people more adept in charge of social media. Strength is complete inclusion; weaknesses are cost, time, effort.
Everglades	Public outreach could be much broader.	• Plan Formulation and Engineering Design; • Implement or Construct • Operate, Maintain, Monitor	Shape the message by publishing newspaper articles following workshops.
Everglades	Public outreach could be much broader.	• Plan Formulation and Engineering Design; • Implement or Construct • Operate, Maintain, Monitor	Use email lists. The Gulf Oil Spill website allows the public to subscribe to email updates.
Chesapeake	Information materials available online.	• Plan Formulation and Engineering Design; • Implement or Construct • Operate, Maintain, Monitor	Press releases are posted on the Gulf Oil Spill website and distributed to email subscribers.
Columbia River	Agency inreach should include staff conducting monitoring.	• Define the Problem • Set Goals and Objectives • Develop or Refine Models • Identify and Prioritize Uncertainties • Plan Formulation and Engineering Design • Implement or Construct • Operate, Maintain, Monitor • Assess and Evaluate • Recommend Revisions • Approve Adjustments	Monitoring staff would take a lead role during the maintenance and performance phase, but also should be involved in earlier phases.

ECOSYSTEM	LESSON LEARNED	RELEVANT STEP OF ADAPTIVE MANAGEMENT	APPLICATION TO COASTAL LOUISIANA (TOOL/ACTION/PROCESS)
Columbia River	Information can be effectively transferred using informational fact sheets.	• Plan Formulation and Engineering Design; • Implement or Construct • Operate, Maintain, Monitor	BPA usually creates glossy 2 pagers.
Columbia River	Development of K-12 education opportunities.	• Continuing beyond the implementation and the adaptive management cycle	Develop strong education opportunities (e.g.,fishing). Public education opportunities will potentially enhance future stakeholder engagement efforts.
Platte River	Have regular communication with stakeholders and build off previous efforts.	• Plan Formulation and Engineering Design; • Implement or Construct • Operate, Maintain, Monitor	Social events. Give presentations regularly. New website – presentation. Generate user friendly documents.