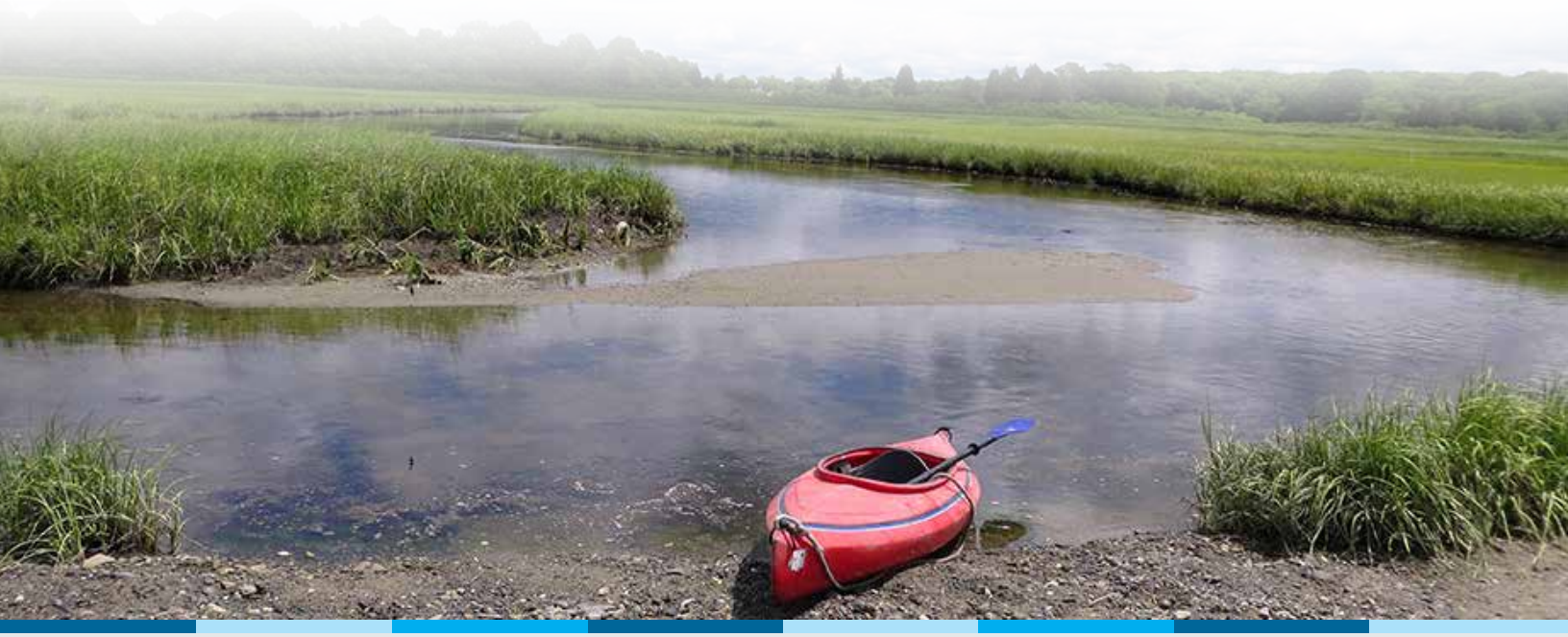
Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program

NOAA RESTORE Act Science Program

Science Plan



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Acknowledgements

The National Oceanic and Atmospheric Administration and U.S. Fish and Wildlife Service acknowledge the valuable contributions stakeholders have made to this science plan. Our stakeholders have included, but are not limited to, the Gulf States Marine Fisheries Commission (GSMFC), Gulf of Mexico Fishery Management Council (GMFMC), the academic community, other federal agencies, state agencies, and nongovernmental organizations. The input provided by stakeholders throughout the development of the plan, including the public review period, will ensure it is responsive to the science and management needs for the Gulf of Mexico region.

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Executive Summary

The Gulf of Mexico is essential to our nation and our economy, providing valuable seafood, recreational opportunities, transportation routes and ports, energy resources, and a rich cultural heritage. However, the region has been significantly impacted in recent years. The Gulf of Mexico ecosystem has experienced loss of critical wetland habitats, erosion of barrier islands, overfished fish stocks, water quality degradation, significant coastal land loss, and, in 2010, the Deepwater Horizon oil spill, the largest spill in our nation's history. To help the region recover, Congress passed the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012 (RESTORE Act), which included authorization and funding for a Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program to be administered by the National Oceanic and Atmospheric Administration (NOAA) in consultation with the U.S. Fish and Wildlife Service (USFWS).

This science plan lays out a path forward for the Program, commonly known as the NOAA RESTORE Act Science Program, beginning with the Program's vision for 'the long-term sustainability of the Gulf of Mexico ecosystem and the communities that depend on it' and its mission, as defined in the RESTORE Act, 'to carry out 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.' The legislative requirements of the RESTORE Act also led to the Program's goal to support the science and coordination necessary for better understanding and management of the Gulf of Mexico ecosystem, leading to:

- *Healthy, diverse, sustainable, and resilient estuarine, coastal and marine habitats and living resources (including wildlife and fisheries); and*
- *Resilient and adaptive coastal communities.*

By pursuing this mission and accomplishing this goal, the Program anticipates the following outcomes:

- *The Gulf of Mexico Ecosystem is understood in an integrative, holistic manner; and*
- *Management of, and restoration activities within, the Gulf of Mexico ecosystem are guided by this ecosystem understanding.*

The plan also establishes 10 long-term research priorities, which will guide how the Program invests its funds, and explains the process by which these areas of investment were determined. Using the legislative requirements for the NOAA RESTORE Act Science Program as the boundaries, we reviewed numerous science needs assessments prepared for the Gulf of Mexico over the past several years to identify common priorities. We also hosted engagement events and held extensive meetings with stakeholders, including representatives from the Gulf States Marine Fisheries Commission, Gulf of Mexico Fishery Management Council, the academic community, federal and state agencies, and non-governmental organizations, to gather additional input. This process resulted in the following set of long-term research priorities for the Gulf of Mexico ecosystem:

- Comprehensive understanding of ecosystem services, resilience, and vulnerabilities of coupled social and ecological systems;
- Construct management-ready and accessible ecosystem models;
- Improve monitoring, modeling, and forecasting of climate change and weather effects on the sustainability and resiliency of the ecosystem;
- Comprehensive understanding of freshwater, sediment, and nutrient flows and impacts on coastal ecology and habitats;
- Comprehensive understanding of living coastal and marine resources, food web dynamics, habitat

utilization, protected areas, and carbon flow;
- Develop long-term trend and variability information on the status and health of the ecosystem, including humans;
- Develop, identify, and validate system-wide indicators of environmental and socioeconomic conditions;
- Develop decision-support tools to assist resource managers with management decisions planned to sustain habitats, living coastal and marine resources, and wildlife;
- Network and integrate existing and planned data and information from monitoring programs; and
- Develop and implement advanced technologies to improve monitoring.

These long-term research priorities will serve as the basis for future funding opportunities from the Program. We will select the priorities to be addressed in each funding opportunity based on several factors including stakeholder input on critical regional science and management needs, the topics being addressed by other science initiatives, new research results and the potential for additional funding to expand the impact of new advancements, and the extent to which addressing a priority will advance the mission of the Program.

In its last section, the plan explains how NOAA is administering the Program and the structure and function of the bodies providing oversight and advice to the Program. We provide detail on who is eligible to compete for funding and describe the peer-review process that will be used to select projects for funding and the mechanisms available for making those awards. We also provide detail on the Program's commitment and approach to consultation and coordination. To achieve our outcomes it is essential that we work with our partners, which includes the other science initiatives established in the wake of the Deepwater Horizon oil spill. We must share and integrate our scientific findings in a timely manner to both inform our partners and the broader scientific community of gaps and needs that warrant further scientific inquiry and arm the management community with the most current and comprehensive information to incorporate into their decision-making processes.

Section I: Program Overview

The National Oceanic and Atmospheric Administration's (NOAA) Gulf Coast Ecosystem[1] Restoration Science, Observation, Monitoring, and Technology Program ("NOAA RESTORE Act Science Program") will conduct, coordinate, and integrate science; integrate and coordinate observations; and provide useful scientific information to inform management decisions, science-based restoration projects, and ecosystem sustainability. The purpose of this plan is to describe the initial path forward for the Program, which will be executed over the next 10 years. It provides an overview of the Program and its authorizing legislation, describes our three short-term and 10 long-term research priorities and the process by which they were determined, and summarizes the Program's structure and administration. Given that funding levels for this Program are yet unknown, NOAA envisions that its science investments will be scalable and evolve over time, adapting to changing information, knowledge, and funding levels. This plan will be refined approximately every five years.

1. RESTORE Act Section 1604

In 2012, Congress passed the "Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act" (Pub. L. 112-141, RESTORE Act). The RESTORE Act specifies that 80% of administrative and civil Clean Water Act penalties paid by responsible parties in connection with the *Deepwater Horizon* incident be deposited into the Gulf Coast Restoration Trust Fund. The remaining 20% is directed to the Oil Spill Liability Trust Fund. The RESTORE Act also establishes several programs, which will be funded by the Trust Fund, to aid in the ecological and economic recovery of the Gulf of Mexico and its coastal states. Under section 1604 of the RESTORE Act, NOAA, in consultation with the U.S. Fish and Wildlife Service (USFWS), is directed to establish a Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program ("NOAA RESTORE Act Science Program"). NOAA and USFWS have drafted this science plan to guide implementation of this section of the Act.

The RESTORE Act Science Program will be funded by 2.5% of the funds deposited into the Trust Fund plus 25% of the Trust Fund's accrued interest. Appendices I and II provide funding information for Deepwater Horizon Gulf of Mexico restoration initiatives. The mission of this new Program, as defined in the Act [Section 1604(b)(1)], is to:

> "Carry out 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."

Section 1604 also includes the following specific instructions regarding the Program:

- NOAA and USFWS must consult with the Gulf of Mexico Fishery Management Council (GMFMC) and the Gulf States Marine Fisheries Commission (GSMFC) in carrying out the Program [Section 1604(b)(4)];
- Funds "may be expended for marine and estuarine research; marine and estuarine ecosystem monitoring and ocean observation; data collection and stock assessments; pilot programs for fishery-independent data and reduction of exploitation of spawning aggregations; and cooperative research" [Section 1604(b)(2)];

[1]Refer to Section VI, Glossary, for definitions of select words throughout this document.

- In distributing funds for research, "priority shall be given to integrated, long-term projects that build on, or are coordinated with, related research activities and address current or anticipated marine ecosystem, fishery, or wildlife management information needs" [Section 1604(d)];
- NOAA, in consultation with USFWS, shall seek to avoid duplication with other research and monitoring activities [Section 1604(e)];
- NOAA, in consultation with USFWS, will develop a plan for the coordination of projects and activities with existing federal and state science and technology programs, including Centers of Excellence [Section 1604(f)];
- Administrative expenses cannot exceed 3% of the funds provided to the Program [Section 1604(g)(1)];
- Funds cannot support existing or planned research led by NOAA unless agreed to in writing by a grant recipient [Section 1604 (g)(2)(A)];
- Funds cannot be used to implement existing or initiate new regulations promulgated or proposed by NOAA [Section 1604(g)(2)(B)]; and
- Funds cannot be used to develop or approve a new limited access privilege program for any fishery under the jurisdiction of the South Atlantic, Mid-Atlantic, New England, or Gulf of Mexico Fishery Management Councils [Section 1604(g)(2)(C)].

2. Program Vision, Goal, and Outcomes

Our 20-year vision for the RESTORE Act Science Program is:

Long-term sustainability of the Gulf of Mexico ecosystem and the communities that depend on it.

The overarching goal for this Program is to:
Support the science and coordination necessary for better understanding and management of the Gulf of Mexico ecosystem, leading to:

- *Healthy, diverse, sustainable, and resilient estuarine, coastal and marine habitats and living resources (including wildlife and fisheries); and*
- *Resilient and adaptive coastal communities.*

Our vision, mission, and goal statements serve as the basis for the design of the Program. We intend to invest in and support necessary research, modeling, the integration of observations and monitoring information, and coordination among Deepwater Horizon funded entities to move toward a comprehensive understanding of, and consequently improved management of, the Gulf of Mexico ecosystem as a whole. As a result of these investments, our desired outcomes for the NOAA RESTORE Act Science Program are:

- *The Gulf of Mexico Ecosystem is understood in an integrative, holistic manner; and*
- *Management of, and restoration activities within, the Gulf of Mexico ecosystem are guided by this ecosystem understanding.*

3. Research Scope, Short- and Long-term Priorities

Focusing our scope of activities will help ensure that the science, observations, modeling, and technology supported by this program are responsive to the guiding legislation; are coordinated with related RESTORE and Deepwater Horizon sponsored science and restoration activities; complement and leverage existing and future science efforts; and address, in an integrated and holistic manner, the critical knowledge needed for

Gulf of Mexico ecosystem restoration and management. The Program developed 3 short-term priorities and 10 long-term research priorities to guide the Program's investments. This section reintroduces the short-term priorities and introduces long-term research priorities and the processes by which they were identified. Short-term priorities had previously been introduced under the Program's *Science Plan Framework* (NOAA 2013), the foundational document for the development of this plan. Focus areas (refer to Appendix III) were also introduced and discussed in the framework to guide this Program and ensure we address known regional priorities and expends funding judiciously. While the focus areas are not reiterated in this science plan, they were fundamental in establishing the short-term priorities and eventually the long-term research priorities.

Short-term Priorities: Early in the development of the NOAA RESTORE Act Science Program, we learned from discussions with stakeholders and from other science and restoration initiatives focused on the Gulf of Mexico region that it would be valuable to support work on a set of short-term priorities to be completed within 3 years. The rationale was that it would allow the research community to compete for funding for short-term projects whose results would guide the future direction of this Program as well as the other science and restoration initiatives planned or underway. Therefore, we proposed the following short-term priorities (released in the Program's framework document, December 2013), vetted them in engagement sessions with stakeholders, and used them to form the basis of the initial federal funding opportunity released by the Program on December 17, 2014 (FFO-2015):

- Comprehensive inventory and assessment (i.e., strengths/weaknesses) of ongoing ecosystem modeling efforts (conceptual and quantitative);
- Identification of currently available health/condition indicators of Gulf of Mexico ecosystem components, including humans, followed by comparative analysis of strengths and weaknesses and design/testing of additional indicators; and
- Assessment of monitoring and observation needs and development of recommendations to build from existing assets to establish a Gulf wide monitoring and observation network.

It is expected that many of the projects (1-2 year duration) that support these short-term priorities will establish or further support the acquisition of baseline data and information that describes the current state of science and knowledge of the Gulf of Mexico ecosystem. Products, such as needs assessments, synthesis documents, inventories, and gap analyses, are intended to provide a foundation for science activities associated with the development of practical ecosystem management tools to facilitate science-based decisions.

Long-term Research Priorities: To ensure that this Program addresses known regional science and management priorities and expends funds judiciously, we identified 10 long-term research priorities to guide investment. These priorities were drawn from prior science and research needs assessments for the Gulf of Mexico ecosystem and from input the Program received while engaging with stakeholders. Many of these documents were produced with extensive stakeholder input and in consultation with resource managers throughout the Gulf States. In addition, the Program hosted over 100 meetings to gather input from stakeholders. Participants included representatives from the GSMFC, GMFMC, academic community, Federal agencies, State agencies, and nongovernment organizations. We looked for commonalities between assessments and stakeholder input to identify priorities; then cross-checked what was assembled through additional discussions with resource managers and researchers. Providing the science necessary for resource managers to make sound management decisions is foundational to this program. Hence, primary consideration was given to priorities that support the science needs of the management community.

Priorities for the long-term implementation of this Program were further refined based on consideration of the following criteria:

- What are the management and restoration science needs?
- How will the research priority support management science needs?
- How will the research priority help achieve the Program's overarching goal and outcomes?
- Is the priority duplicated within other science programs in the Gulf of Mexico?
- Will the priority fill scientific knowledge gaps for the Gulf of Mexico ecosystem, leading to a more holistic understanding of the ecosystem?
- Is the priority within the scope of this Program?

The long-term priorities presented in this plan do not define specific science needs for proposed scientific investigations; rather, they encompass a suite of scientific objectives that will be detailed within future funding opportunities. Investigations supporting these objectives, taken together, will meet the desired outcome of improved holistic understanding and management of the Gulf of Mexico ecosystem. Our long-term priorities for the Gulf of Mexico ecosystem are as follows (Refer to Section II for more details):

- Comprehensive understanding of ecosystem services, resilience, and vulnerabilities of coupled social and ecological systems;
- Construct management-ready and accessible ecosystem models;
- Improve monitoring, modeling, and forecasting of climate change and weather effects on the sustainability and resiliency of the ecosystem;
- Comprehensive understanding of freshwater, sediment, and nutrient flows and impacts on coastal ecology and habitats;
- Comprehensive understanding of living coastal and marine resources, food web dynamics, habitat utilization, protected areas, and carbon flow;
- Develop long-term trend and variability information on the status and health of the ecosystem, including humans;
- Develop, identify, and validate system-wide indicators of environmental and socioeconomic conditions;
- Develop decision-support tools to assist resource managers with management decisions planned to sustain habitats, living coastal and marine resources, and wildlife;
- Network and integrate existing and planned data and information from monitoring programs; and
- Develop and implement advanced technologies to improve monitoring.

4. Synthesis and Integration

We recognize that synthesis and integration are important elements for this program to realize its vision, mission, and overarching goal. We must work with other regional research programs to share and integrate our scientific findings in a timely manner to inform our partners and the broader scientific community of gaps and needs that warrant further scientific inquiry and arm the management community with the most current and comprehensive information to incorporate into their decision-making processes. Only integrated products can foster a more holistic understanding of the Gulf of Mexico ecosystem's condition, including coastal communities.

5. NOAA's Roles

The RESTORE Act [Section 1604(b)(4)] directs NOAA, in consultation with the USFWS, to establish the Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program. Under this mandate, NOAA will:

- Provide staff to manage the program;
- Execute a competitive science program;
- Not use program funds for any existing or planned NOAA research programs;
- Allow NOAA scientists to apply for competitively awarded funding, subject to some restrictions (e.g., no conflict of interest, funds cannot be used for salaries of permanent federal employees);
- Establish and appropriately seek advice from a standing working group under NOAA's Science Advisory Board (SAB);
- Solicit input broadly on the development and implementation of this plan; and
- Revise the plan approximately every five years or as necessary.

6. Geographic Scope

In authorizing this Program, the RESTORE Act stipulates that funds be expended "with respect to the Gulf of Mexico" but does not define geographic boundaries. To focus the geographic scope of this Program, we define the Gulf of Mexico ecosystem as the ocean basin bounded by the United States along its northeastern, northern, and northwestern edges; Mexico on its southwestern and southern edges; and Cuba on its southeastern edge (***Figure 1***). The Gulf of Mexico is connected to the Caribbean Sea through the Yucatan Channel between Mexico and Cuba and connected to the Atlantic Ocean through the Florida Straits between Cuba and the United States. This definition of the Gulf of Mexico ecosystem includes the estuarine and marine environments of the basin's continental shelf and its deepwater environments. International, federal, and state waters are encompassed within this defined area. In addition to supporting research conducted in the Gulf of Mexico, the Program will also support research on processes that impact the Gulf of Mexico in a direct, significant, and quantifiable way, which includes processes in the watersheds draining into the Gulf of Mexico and coastal terrestrial areas that provide habitat for important wildlife species.

Figure 1*: The geographic area of the Gulf of Mexico ecosystem outlined in blue.*

7. Engagement

To be successful, the NOAA RESTORE Act Science Program must harness the expertise of the research community that works in the Gulf of Mexico ecosystem and link the community to the region's pressing science and management needs. An engagement process is required that connects researchers, resource managers, and resource users and utilizes the input of their collective knowledge to facilitate the progress and direction of the Program. NOAA, in collaboration with the USFWS, has and will continue to actively engage stakeholders including representatives from the GSMFC, the GMFMC, the academic community, RESTORE Act Centers of Excellence (once designated by the Treasury Department), Federal agencies, State agencies, and nongovernmental organizations. These interactions shaped the Program's science plan framework and, subsequently, this plan and the long-term research priorities included within it.

Because this plan grew out of the Program's science plan framework, it was strengthened by the input gathered and assimilated during the construction of the framework. That input was gathered during a series of virtual engagement sessions hosted by the Program in August and September of 2013, an engagement session held in conjunction with the Gulf of Mexico Alliance All-hands Meeting in June 2013, and from correspondence sent directly to the Program. Feedback from a series of presentations on the Program offered at conferences and workshops throughout the beginning of 2014 and input from an engagement session at the Gulf of Mexico Oil Spill and Ecosystem Science Conference in January 2014 also shaped the development of this plan. Finally, a public comment period and a series of virtual engagement sessions, focused on gathering specific input on the plan, provided stakeholders with the opportunity to review and respond to details of the plan and offer constructive suggestions on how to ensure that it responded to the research and management needs of the Gulf of Mexico.

In general, the engagement approach taken has been to raise awareness of the Program and to solicit input through several different avenues. In addition to one-on-one meetings and seminars with stakeholders, the Program needs a continued presence at ocean and coastal science and resource management conferences and at workshops within the Gulf of Mexico region and nationally. At these venues, the Program has and will continue to present updates and, when possible, host structured engagement sessions. The Program has held virtual engagement sessions in the past and will continue to use this approach. The Program maintains a website (http://restoreactscienceprogram.noaa.gov) where the latest information on the Program is available and stakeholders can sign up to receive alerts and announcements about the Program. Finally, stakeholders can always submit input to the Program at noaarestorescience@noaa.gov.

One goal of this engagement process is to ensure that activities supported by the NOAA RESTORE Act Science Program complement the research and monitoring activities supported by other organizations in the Gulf of Mexico region including the Centers of Excellence established by the RESTORE Act, the Gulf Coast Ecosystem Restoration Council, and Gulf States [Sections 1604(e) and (f)]. In addition, our Program is engaging with other research programs that stemmed from the Deepwater Horizon oil spill, such as the Gulf Research Program at the National Academy of Sciences (NAS), the Gulf of Mexico Research Initiative, and the National Fish and Wildlife Foundation's (NFWF) Gulf Environmental Benefit Fund [Sections 1604(e) and (f)]. NOAA is also actively engaging and coordinating with government and nongovernment research programs that were active in the region before the Deepwater Horizon oil spill [Section 1604(f)]. Additional information on coordination can be found in Section III.2, *Consultation and Coordination*.

Section II. Long-term Research Priorities

The Program identified 10 long-term research priorities through the process described in Section I that are responsive to research and management needs in the Gulf of Mexico ecosystem. For each, we describe the management needs that drive the priority, a list of example activities, anticipated outputs, and desired outcomes. The following priorities are not listed in rank order, order of importance, or programmatic priority. Rather, the priorities as listed here transition from activities supporting holistic understanding to model development, assessment of ecosystem status and dynamics to integrating observations and improving observing technologies. For a summary of the factors that will inform prioritization and sequencing of these research priorities, refer to Section III.4, Funding Opportunities and Competitive Process.

Example activities and outputs listed for each long-term research priority represent the types of activities and outputs that could be undertaken and developed in support of research and management needs and do not represent an exhaustive list. The example activities and outputs do not provide one-to-one coverage of all actions necessary to fully support each specific long-term priority. Additional management needs and outcomes will likely be identified as the program matures and future revisions to this plan will capture those needs.

Comprehensive understanding of ecosystem services, resilience, and vulnerabilities of coupled social and ecological systems

Ecosystem services, the contributions that ecosystems provide that support, sustain, and enrich human life, have long been recognized by scientists and communities. It is well documented that the structural and functional characteristics of ecosystems brings about the services that humans have come to depend on for food and water (provisioning services), regulation of disturbances (regulating services), habitat for wildlife (supporting services), and aesthetics (cultural services). However, incorporation of ecosystem services into ecosystem management policy and decision-making remains inadequate (NAS 2005; Anton et al. 2011).

The need to use information on ecosystem services in decision-making in the Gulf of Mexico was highlighted by Santos and Yoskowitz (2012):

> *"Although ecosystem services are critical to human well-being, cases in which they have been applied to real policies and decisions are rare. For society to make informed decisions about a sustainable use of the environment, a link from the quantification of [ecosystem services] to society's needs is necessary."*

The Millennium Ecosystem Assessment: Research Needs (Carpenter et al. 2006) identified numerous needs to improve ecosystem management. Among the gaps noted by Carpenter et al. (2006), gaps iv – vii are particularly relevant for the Gulf of Mexico:

> *"…(iv) systematic information on stocks, flows, and economic values of many ecosystem services (e.g., freshwater fisheries, natural hazard regulation, groundwater, and pollination); (v) knowledge of trends in human reliance on ecosystem services, particularly services without market values (e.g., domestic fuel wood and fodder); (vi) systematic local and regional assessments of the value of ecosystem services; and (vii) connections between data on human systems and ecosystems."*

For a coastal community to manage towards resiliency, it must understand the ecosystem services it presently or could obtain from its natural surroundings. Coastal communities, for example, are increasingly vulnerable to coastal threats such as hurricanes, sea level rise, inundation, storm surge, oil spills, and subsidence. A community's resilience is improved when it plans and mitigates for the loss of natural buffers that, when present, reduce damages from these coastal threats. Understanding the services these natural buffers provide, such as wave attenuation and water retention, informs our understanding of how best to reduce the vulnerability of coastal communities to these threats through the protection of existing habitat or its restoration. Managers need additional or improved methodologies to aid with identifying services provided by natural buffers, appraising the quality and quantity of those services, assigning values (including non-monetary) to those services, and quantifying how interactions with humans impact those services. Having additional Gulf-wide knowledge of ecosystem services will help inform community planners so that strategic decisions can be made to reduce vulnerability and improve resiliency.

Once ecosystem services are identified and methodologies for assessing quality and quantity are established, the issue still remains for how managers go about integrating consideration of ecosystem services into decision-making processes. Over the past decade or so, many researchers have attempted to tackle this obstacle by developing "frameworks" that guide integration of these services into decision-making. While many of these "frameworks" have been proposed, including for the Gulf of Mexico (see, for example, Yoskowitz et al. 2013), adoption of them has been slow.

Management Needs:

- Improved knowledge of the ecosystem services provided in the Gulf of Mexico;
- Understanding of how biodiversity produces or contributes to production and delivery of ecosystem services;
- Improved methodologies to assess the quality and quantity of, and assign values to, ecosystem services; and
- Integrating those ecosystem services values into management decision-making.

Examples of Key Activities:

- Develop approaches and tools for assigning values to ecosystem services in the Gulf of Mexico;
- Track trends in ecosystem services over time;
- Determine how connections among Gulf of Mexico habitats influence the quality and quantity of ecosystem services currently provided;
- Analyze socioeconomic and cultural linkages with ecological processes in the Gulf of Mexico; and
- Increase understanding of importance of specific and aggregate ecosystem services to human health and well-being.

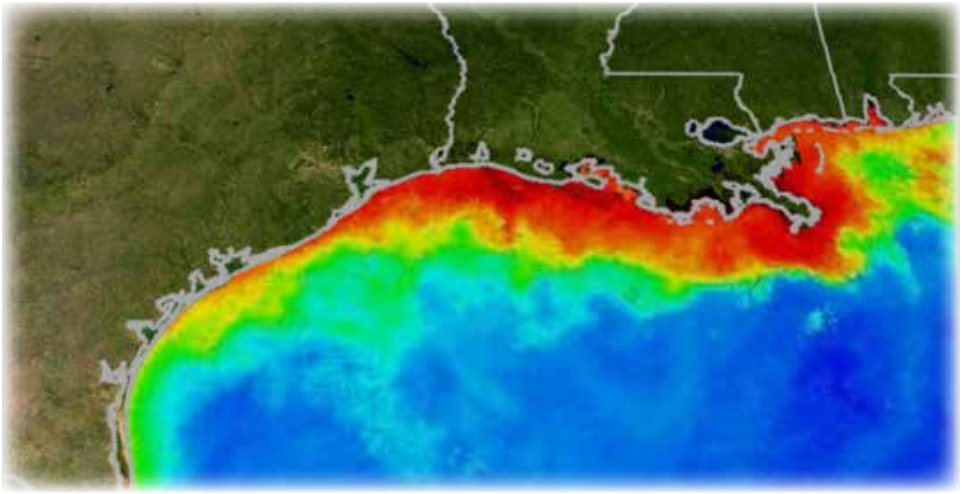
Example Outputs:

- A comprehensive inventory of Gulf of Mexico habitats and the ecosystem services (quality and quantity) each provides;
- A report on socioeconomic and cultural linkages with ecological processes, including identification and measurement of cultural ecosystem services, in the Gulf of Mexico;
- A rating system that defines the quality of and assigns values to ecosystem services in the Gulf of Mexico;
- Improved quantification of ecosystem services provided by restoration projects/programs in the Gulf of Mexico; and
- Approaches for working with and educating the resource management community about incorporating ecosystem services valuations in their decision-making processes.

Outcomes:

- Gulf of Mexico resource managers better understand the linkages among habitats, ecosystem services, and human well-being;
- Environmental management policies and decision-making processes in the Gulf of Mexico ecosystem include consideration of ecosystem services; and
- Gulf of Mexico resource managers are able to consider and incorporate knowledge of ecosystem service benefits when making restoration decisions.

Construct management-ready and accessible ecosystem models



Modeling is an important tool for developing a holistic understanding of the Gulf of Mexico ecosystem. A robust and rigorous modeling approach grounded in observations and an experimentally derived understanding of the components and processes within the ecosystem can clarify connections between these components and processes. Such an approach can also identify gaps in our understanding to be targeted for future observational and experimental work. A modeling approach can be particularly useful in simulating an observational network and making informed decisions about where to place new observational assets. Once a model or a suite of models are robust enough, they can be used to inform management decisions and, in the best-case scenario, accurately predict the changes that will result from a given management action and/or change in environmental conditions.

To arrive at this end goal of model development, a forum for bringing ecosystem model developers and users together is helpful. Testbeds, such as those often developed by NOAA (www.testbeds.noaa.gov) for meteorological applications, have been used to transition new capabilities from research to application. The development of Louisiana's Coastal Master Plan is another example of developers and users coming together in a community of practice to collaborate on model development and implementation (Coastal Protection and Restoration Authority of Louisiana 2012). In both cases, scientists were brought together from the research and development communities with operational end-users such as forecasters and decision-makers to test and successfully develop advanced capabilities useful for forecasting and decision-making.

In addition to improvements in models focused on specific processes (e.g., hypoxia) or areas of the Gulf of Mexico ecosystem (e.g., oyster recruitment in a specific estuary), an initiative to regionally integrate these models is also needed to develop a more comprehensive understanding of how the entire Gulf of Mexico ecosystem functions. These more comprehensive system-wide models would aid the management community when it comes to making decisions about species with broad ranges or complex and diverse life cycles and begin to consider and account for the full geographic extent of decisions.

Management Needs:

- Models that can quantify and track sources, fate, and transport of abiotic and biotic components within the ecosystem;
- Integration of socioeconomic drivers and outcomes into ecological models to create more accurate representations of the linkages between social and ecological systems;
- Regional integration of models to produce a more comprehensive understanding of how the entire

Gulf of Mexico ecosystem functions;
- A forum for ecosystem modelers and resource managers to evaluate and refine ecosystem models; and
- Data dissemination tools that translate model output into information ready to use in a timeframe consistent with management needs.

Examples of Key Activities:

- Incorporate in a holistic fashion the multiple pathways by which nutrient and other pollutants impact the Gulf of Mexico ecosystem, including humans;
- Synthesize new and existing data and advancements in understanding ecosystem processes to improve ecosystem modeling, especially for predictions of ecosystem change in the Gulf of Mexico;
- Model and predict the effects of major environmental events, both natural and human driven (e.g., floods, spills, hurricanes, and fire);
- Model resource stability and sustainability and include interactions between and among fisheries, habitat, threatened and endangered species, ecosystem processes, and stressors to assist with making ecosystem-based management decisions;
- Model connectivity patterns for management of conservation areas in the Gulf of Mexico;
- Use objective modeling techniques, including observing system simulation experiments, to evaluate optimal deployment of ecosystem monitoring and observing assets;
- Model health and sustainability of marine mammals, sea turtles, and other protected living coastal and marine resources populations, such as threatened or endangered shorebirds and beach mice; and
- Model resource management practices and policies in the Gulf of Mexico, including socioeconomic components, and their impact (pressure) on resources.

Example Outputs:

- A suite of ecosystem models that collectively clarify the connections between and among components (e.g., physical, chemical, biotic) and processes in the Gulf of Mexico ecosystem;
- A suite of ecosystem models that have the capacity to accurately predict changes in the Gulf of Mexico ecosystem in response to environmental change and management action;
- Modeling tools that translate ecosystem model outputs into ready-to-use information received in timeframes consistent with management needs;
- An ecosystem modeling testbed or similar forum where ecosystem modelers and resource managers can test and evaluate models; and
- System-wide models for the Gulf of Mexico ecosystem that incorporate individual models targeting different components and processes in areas of the Gulf of Mexico ecosystem.

Outcomes:

- Gulf of Mexico resource, environment, industry, and public health managers have confidence in the outputs and utility of Gulf of Mexico ecosystem models;
- Gulf of Mexico resource managers have tools or a forum where modeling results are presented in a usable format and in a suitable timeframe to inform management decisions;
- Resource management practices and policies in the Gulf of Mexico ecosystem consider and incorporate ecosystem modeling, including socioeconomic components;
- Ecosystem models underpin adaptive management and integrated ecosystem assessment in the Gulf of Mexico ecosystem; and
- A community of ecosystem modelers aware of each other's work and interested in integrating their models to develop more comprehensive system-wide models for the Gulf of Mexico ecosystem

Improve monitoring, modeling, and forecasting of climate change and weather effects on the sustainability and resiliency of the ecosystem

It is well known that climate and weather-related events have significant impacts on ecosystems worldwide. For example, recent analysis of indicators for the Gulf of Mexico ecosystem by Karnauskas et al. (2015) found significant shifts in the higher-level ecosystem dynamics in the mid-1960s and mid-1990s, which align with changes in the Atlantic Multidecadal Oscillation, a major climate mode. Weather-related events have also impacted the ecosystem altering the landscape and impacted natural and human-built environments. The impact of climate and weather-related events on the sustainability and resiliency of the Gulf of Mexico ecosystem is less well understood. As stated by the National Academy of Sciences in the report *Ecological Impacts of Climate Change* (NRC 2008), "The concept that a change is beneficial or detrimental has meaning mainly from the human perspective. For an ecosystem, responses to climate change are simply shifts away from the system's prior state." For us to assess those changes, and make a determination whether they will impact the sustainability and resiliency of the Gulf of Mexico ecosystem requires consistent, standardized, and reliable monitoring, modeling, and forecasting abilities. Further, this knowledge and the tools to apply it must be routinely integrated, reviewed, and updated to be of use to resource managers tasked with conserving and promoting the sustainability and resiliency of the ecosystem.

In addition to the overall ecosystem impacts from climate change and weather events, billions of dollars will likely be spent to construct restoration projects over the next two decades in the Gulf of Mexico. Trustee state and federal agencies need to determine the types of information that should be incorporated into the design of large-scale restoration projects to ensure their long-term sustainability in the face of anticipated climate-driven changes and extreme weather. The impacts of climate change (e.g., sea level rise, salinity changes, landscape changes, temperature increases) or extreme events such as hurricanes have only recently begun to be incorporated into restoration planning (Coastal Protection and Restoration Authority of Louisiana 2012). This should become more common as science-based predictive guidance on climate change and extreme weather becomes more prevalent, robust, and applicable to the spatial and temporal scales of restoration.

Gulf-wide, little is known about how project sponsors should develop and implement strategies for monitoring and observing projects to effectively assess the impacts of climate change and extreme events on specific types of restoration projects and overall on restoration programs across the large-scale ecosystem. Despite existing observation and monitoring activities in the Gulf of Mexico focused on water levels, habitat change, and salinity among others, little is known about the parameters and instrumentation necessary to measure climate change and extreme events as they relate to Gulf of Mexico restoration projects (Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative [GCPO LCC] 2013, Walker et al. 2012).

Management Needs:

- Knowledge of how to best incorporate the anticipated impacts of climate change and extreme events in planning and execution of restoration projects in the Gulf of Mexico;
- Knowledge of methods and instrumentation necessary to measure the impacts of climate change and extreme events on restoration projects and support adaptive management;
- Better understanding and predictive capability regarding subsidence and its spatial variability for effective coastal management decisions; and
- Improved observation and monitoring strategies to develop adaptive management plans for projects and programs as climate change and extreme events alter physical and biological conditions.

Examples of Key Activities:

- Investigate how climate and climate change (i.e., changes in ocean acidity, temperature, precipitation patterns, sea-level rise, etc.) shape the structure and function of the ecosystem and the connection between its living resources and coastal communities;
- Conduct research to forecast direct and indirect effects of climate change on indicator, particularly significant, or susceptible species;
- Analyze, model, and predict the effects of major natural and human driven environmental events in the future (e.g., floods, spills, nutrients, hurricanes, fire, etc.);
- Develop sound approaches for downscaling global and regional climate models and projections to provide guidance for local and regional predictions;
- Develop and apply dynamically coupled earth system (i.e., atmospheric, hydrodynamic, oceans) and ecological models to forecast the impacts of sea-level rise and storm inundation;
- Incorporate climate-related effects and thresholds into ecosystem modeling platforms;
- Integrate downscaled climate models with existing and improved hydrologic modeling platforms focused on forecasting freshwater and sediment delivery to coastal systems;
- Determine the observation and monitoring requirements for effective assessment of climate change and extreme event impacts on various types of restoration projects common for the Gulf of Mexico; and
- Assess the ability of key coastal habitats (e.g., coastal dunes, marshes, and barrier islands) to adapt to sea-level rise and climate change to inform and guide restoration priorities.

Example Outputs:

- Recommendations for a Gulf of Mexico implementation strategy for monitoring and observing ecosystem response and restoration projects to better detect the impacts of climate change and extreme events; and
- Guidance tools for predicting impacts of climate change and high-impact weather on the Gulf of Mexico ecosystem, particularly restoration and recovery activities.

Outcomes:

- Gulf of Mexico resource managers and project sponsors understand the potential impacts of climate change and extreme events on the Gulf of Mexico ecosystem and various types of restoration projects;
- Observation and monitoring practices in the Gulf of Mexico include instrumentation and methods to effectively measure impacts of climate change and extreme events; and
- Restoration projects in the Gulf of Mexico are adaptively managed and effectively sustained in the face of these impacts.

Comprehensive understanding of freshwater, sediment, and nutrient flows and impacts on coastal ecology and habitats

The quantity, quality, and timing of freshwater and associated suspended sediments and nutrients transported into the coastal zone from watersheds significantly influences coastal and marine habitats and life in the Gulf of Mexico. Freshwater, suspended sediments, and nutrients are critical to many processes that create and nourish habitats and living resources; however, human activities have greatly altered these transport processes. Management of Gulf of Mexico ecosystem impacts from altered freshwater flows, excessive nutrients, and increased/reduced suspended sediments has been fragmentary and often ineffective, which has led to continued degradation of habitats. Many believe that we are nearing "tipping point" levels of degradation in some of the Gulf of Mexico's habitats and living resources; beyond that point, the ecosystem could suffer catastrophic impacts that would be extremely difficult, if not impossible, to reverse.

Along the Gulf of Mexico, most of the rivers carry elevated levels of nutrients. The combination of excess nutrients and freshwater inputs that cause density stratification fuels massive algal blooms each spring that results in the largest measured hypoxic zone in North America. Upstream, agricultural, residential, industrial and commercial water usage and discharges are intertwined with reservoir and dam management practices. Much of the sediment transported by the Mississippi River that formerly nourished coastal marshes is now captured upstream by the many dams in the river. The levees along the lower river block remaining suspended sediments from reaching the marshes where they would normally raise elevations to keep pace with subsidence and rising sea levels. However, since these sediments are contained within the river channel by the levees, many of the marshes are starved of sediments necessary to maintain themselves and prevent conversion to open water. Understanding the connection between upstream land-use practices, hydrologic modifications, dam and reservoir management, and variability in downstream freshwater and sediment flows is needed to address this issue (Walker et al. 2012, USFWS 2013).

The impacts of diversions must be vigorously studied before actions are taken. For example, redistribution of sediment through diversion may cause a loss of sediments necessary to build up or maintain land areas that can contribute to land loss. Further, diverted waters may contain high concentrations of nutrients that may result in less robust and resilient marsh grass growth. However, after many years of having been diverted, reestablishment of freshwater flows in some areas may dramatically alter adapted habitats, potentially impacting the abundance of economically important resources.

Management Needs:

- Holistic ecosystem approaches to the management of freshwater flows, nutrients, and suspended sediments;
- Comprehensive understanding of the factors contributing to land loss and inundation;
- A better understanding and predictive capability regarding subsidence and its spatial variability for effective coastal management decisions;
- Comprehensive ecosystem goals for restoration and accompanying management approaches that consider the range of benefits and consequences of alternative management scenarios; and
- Tools to forecast outcomes of restoration actions with the confidence sufficient to drive the large expenditures needed to reach restoration goals.

Examples of Key Activities:

- Develop holistic understanding of the relationship among nutrients, sediments, and freshwater inputs, including their timing, and their effects on ecosystem structure and function under a range of scales of variability, both natural and anthropogenic;
- Determine the sources, sinks, and transport pathways between watershed, coastal and deep water environments to develop sediment, nutrient, and carbon budgets for the Gulf of Mexico ecosystem;
- Determine cause-and-effect relationships among sediment, nutrient loading and freshwater inputs, as well as the distribution and sustainability of estuarine habitats and associated ecosystem services;
- Characterize the quality, quantity, and variability of freshwater, sediments, nutrients and pollutants that enter the Gulf of Mexico, including current and historical loads in rivers/tributaries and Gulf of Mexico receiving waters;
- Quantify and delineate the historical and current hydrologic regimes of watersheds that support key coastal habitats (e.g., bottomlands, swamps, marshes, sea grasses) and potential changes under various future scenarios;
- Develop the capacity to examine the effects that upstream (e.g., reservoir and dam management) and coastal hydrologic modifications (e.g., diversions) have on the timing and delivery of freshwater, nutrients, and sediments to coastal ecosystem structure and function; and
- Develop the capacity to determine extant and optimal levels and timing of sediment, nutrients, and water delivery to support sustainable coastal ecosystems and associated habitat and living resources within the context of management-driven goal setting.

Example Outputs:

- Operational ecosystem-based scenario forecast models and tools to inform management goal-setting for establishing and revising Best Management Practices for nutrient, sediment, and freshwater loads most effective for conservation and restoration of the Gulf of Mexico ecosystem;
- Identification of watersheds or sub-watersheds where nutrient reduction strategies are most likely to be effective; and
- Document that articulates societally supported and science-based quantitative ecosystem restoration goals.

Outcomes:

- The scientific basis and compelling societal benefits to drive holistic ecosystem approaches to management with respect to sediment, nutrient, and water flows, as well as their impact on coastal ecosystems are identified;
- Ecosystem structure and function are maintained and highly resilient to changes in nutrient, sediment, and water discharge under different natural and anthropogenic scenarios;
- Land loss is understood and preventive measures are implemented; and
- Adaptive management of the Gulf of Mexico ecosystem and its associated habitats and living resources is proactive.

Comprehensive understanding of living coastal and marine resources, food web dynamics, habitat utilization, protected areas, and carbon flow

The ecological interplay within and among species, such as resource and mate competition, predator-prey and parasite-host interactions, habitat utilization, larval dispersal, juvenile refugia, and disease transmission, is fundamental to understanding community and ecosystem functioning. At higher levels of biological organization, research into habitat utilization and species movement patterns such as large-scale tagging and tracking programs for wildlife, sea turtles, and marine mammals will help managers understand how these interactions cause populations to expand and contract. At more basic levels, information on the larval movements and early life-history development processes of important fish and invertebrate species in the Gulf of Mexico will help to drive management and restoration options. An even deeper understanding of the processes that drive ecosystems may be obtained by clarifying trophic interactions through such techniques as stable isotope and fatty acid analyses in combination with diet studies conducted at the finest taxonomic resolution possible (Sempier et al. 2009, Petersen et al. 2011, Walker et al. 2012, National Marine Fisheries Service [NMFS] 2013).

The demographics and movement patterns of living coastal and marine resources between habitats at various life stages is an important determinant of ecosystem health in the Gulf of Mexico. Quantifying and understanding these variables and the relationships among habitats (living coastal and marine resources and wildlife), populations, and communities are necessary to achieve a holistic ecosystem-based understanding of resource management outcomes. This understanding could be enhanced by developing and utilizing a comprehensive habitat and living coastal and marine resources database that integrates biogeochemical and oceanographic data (Holling and Gunderson 2002, GMFMC 2014, Sempier et al. 2009, Petersen et al. 2011, Walker et al. 2012, NMFS 2013).

The Gulf of Mexico Fishery Management Council and Commission and certain state and federal agencies would benefit from several areas:

- Spatially explicit, fishery-independent habitat surveys;
- Fishery-integrated ecosystem assessments that include habitat-specific vital rates;
- Additional fishery surveys within and outside existing programs;
- Research to determine impacts of fishery and other human activities on habitats essential for sustaining living coastal and marine resources;
- More efficient, less destructive, and bycatch-reducing fishing gear;

- Management strategies to accompany implementation of improved gear efficiency; and
- Foundational studies that compile existing data to demonstrate changes in status and population dynamics of important species and to explicitly identify data gaps (GMFMC 2014).

One way that connections among the ecosystem, living coastal and marine resources, and humans can be understood is by tracking and quantifying the flow of fixed carbon. In addition, quantifying the rates of primary and secondary production, decomposition, and respiration in Gulf of Mexico habitats should provide a fuller understanding of the net accumulation or loss of biomass and the potential for carbon sequestration (NMFS 2013).

The Gulf of Mexico is surrounded by numerous federal marine-protected areas, refuges, and parks, as well as many state and non-governmental areas managed for natural resource protection. These areas are thought to be vital to maintaining a healthy Gulf of Mexico for humans and other living animals and plants. Research is needed to better understand how these protected areas influence the health and resiliency of floral and faunal populations within their boundaries and in adjacent areas (Petersen et al. 2011, Ocean Conservancy and the Gulf of Mexico University Research Collaborative 2012, USFWS 2013).

Management Needs:

- Inventory, review of applicability and utility, and gap analysis of management actions that have been or could be applied to enhance the health and sustainability of Gulf of Mexico living coastal and marine resources;
- Better understanding of food-web dynamics, larval movements, and ecological interactions within and among species and habitats;
- An understanding of baseline conditions of living coastal and marine resources and wildlife;
- Better understanding of fish, invertebrate, and wildlife populations in the Gulf of Mexico and how these populations interact with each other and within habitats to create a healthy marine ecosystem;
- Guidance and decision-support tools for effective ecosystem-based living resources management;
- Better understanding of the factors that control primary production and respiration and the sources, fate, and transport of fixed carbon throughout the Gulf of Mexico ecosystem;
- Better understanding of how and where upstream land uses are affecting coastal and marine habitats and living resources of the Gulf of Mexico; and
- Better understanding of whether and how marine protected areas influence floral and faunal populations within their boundaries and in adjacent areas.

Examples of Key Activities:

- Develop and apply tools for understanding how the various trophic levels in the Gulf of Mexico interact to create a sustainable and resilient ecosystem;
- Develop and apply tools that increase our understanding of the role of habitats in supporting healthy populations of fish, invertebrate, wildlife, and indicator or sentinel species;
- Develop guidance approaches and decision-support tools for effective ecosystem-based fisheries management;
- Expand and refine existing fishery stock assessments to include habitat-specific vital rates (e.g. fecundity, mortality);
- Develop and apply the monitoring and assessment tools necessary to effectively evaluate restoration and recovery actions; and
- Investigate the factors that influence the transformation and movement of carbon through the Gulf of Mexico ecosystem.

E***xample Outputs:***

- Critical analysis, assessment, and improvement of Gulf of Mexico ecosystem indicators that support sustainable living coastal and marine resources;
- Data and analysis of food web dynamics, larval movements, and ecological interactions within and among species and habitats;
- Data and analysis of interspecific interactions among Gulf of Mexico fish, invertebrate, and wildlife populations and their habitats;
- Guidance and decision-support tools for managers engaged in ecosystem-based fisheries management or planning, conducting, and evaluating restoration/recovery projects targeted toward living coastal and marine resources;
- Analysis of factors controlling primary production, respiration, and fixed carbon movement in the Gulf of Mexico;
- Analyses to describe how and where upstream land use practices and water discharges affect Gulf of Mexico habitats and living coastal and marine resources;
- Analyses of the factors that influence ecosystem, community, and population resiliency;
- Analyses of assessment and monitoring associated with restoration and recovery actions; and
- Analyses to enhance understanding of the effectiveness of marine protected areas and coastal refuges and parks.

Outcomes:

- Increased understanding of how primary production, respiration, and carbon flow influences productivity of Gulf of Mexico living coastal and marine resources;
- Increased understanding of how management actions that influence primary production and carbon flow in one area might affect another;
- Increased understanding of the impact changes in upstream water management actions has on Gulf of Mexico living coastal and marine resources;
- Increased ability to use information about habitat (including offshore) utilization and the movement of species within the Gulf of Mexico to improve habitat conservation and support restoration;
- Increased ability to predict how natural and human-caused stressors will impact the resiliency of living coastal and marine resources within the Gulf of Mexico ecosystem;
- Increased ability to separate effective and sustainable recovery and restoration actions in the Gulf of Mexico from those that provide minimal benefit; and
- Increased ability to effectively manage marine protected areas and coastal refuges and parks to enhance the health and resiliency of humans and Gulf of Mexico flora and fauna.

Develop long-term trend and variability information on the status and health of the ecosystem, including humans

The ability to conduct truly integrative and synthetic analysis of the Gulf of Mexico ecosystem depends in large measure upon the ability to construct and analyze high-quality datasets that are temporally and spatially extensive, spanning several decades and covering the entire ecosystem. Careful analysis of such data reveals long-term trends and rates, allows comparative studies, promotes the development and assessment of high-fidelity ecosystem models, and provides context for the establishment of restoration endpoints and baselines.

Traditionally, data collection in the Gulf of Mexico, as elsewhere, was accomplished through a substantial number of largely uncoordinated federal, state, and academic monitoring programs. The present data record was built up over many decades by programs that were designed and carried out for different and largely unrelated reasons. Previously, the data record for any given measured parameter was generated using a range of sampling, analytical, and reporting protocols. This heterogeneity provides challenges for building the record for individually measured ecosystem variables; beyond this, a tremendous variety across the range of different data types is required and should include not only biological data but also supporting chemical, physical, and geologic data. In addition, socioeconomic data will be required to examine the historic and ongoing evolution of ecosystem service provisions.

Assembling these varied datasets into a quality-controlled, integrated, coherent whole that allows truly long-term and/or regional analyses requires a careful and dedicated effort by experts. In other words, this work is a highly significant step beyond simply identifying individual historical datasets and providing for discovery and access. An analogy can be made with the climate science community: to document the extent, location, and rates of climate change, the community has undertaken the initiative to build and maintain Climate Data Records, which are defined by the National Research Council as "a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change" (National Research Council 2004a and 2004b). These records are built, maintained, and curated over the long term by designated (and funded) entities. A similar effort is required to construct Ecosystem Data Records to support Gulf of Mexico assessment and restoration.

Management Needs:

- A data system that "…fosters data comparability, consistency, standardization across programs, projects, and habitats" with an emphasis on reuse of existing data;
- A compilation and synthesis of biological, physical, chemical and socioeconomic data; and
- Integrated data products that represent the health of the Gulf of Mexico.

Examples of Key Activities:

- Create and maintain long-term, quality-assured and controlled Ecosystem Data Records that highlight historical trends and anomalies in important ecosystem parameters, including the human dimension;
- Implement agreed-upon standards for data documentation, nonproprietary data formats, and transport protocols;
- Analyze integrated data to assess ecosystem health; and
- Develop long-term environmental and socioeconomic trend products.

Example Outputs:

- Agreement upon a key set of consistent ecosystem and socioeconomic parameters monitored across data records;
- Quality-controlled, consistently formatted, and spatially and temporally continuous records of key ecosystem and socioeconomic parameters;
- Protocols for collecting additional missing data in a coordinated way and for incorporation into management decision processes;
- A set of guidelines on best practices about social data collection; and
- Comprehensive, integrated data analyses of program-funded project research results.

Outcomes:

- Researchers and managers have easy access to a spatially and temporally extensive body of quality-assured and controlled ecosystem and socioeconomic data that enables a more synthetic, holistic understanding of the Gulf of Mexico ecosystem; and
- Researchers and managers can incorporate socioeconomic data to inform decision processes.

Develop, identify, and validate system-wide indicators of environmental and socioeconomic conditions

As resource managers shift from single-species management toward a more holistic, integrated approach, much discussion has surrounded the indicators necessary to measure and monitor the state of health at an ecosystem level. It is increasingly evident that managers must not only focus on the environmental elements and associated indicators, but also socioeconomic and human well-being (Kelble et al. 2013). This long-term research priority is about identifying indicators to serve as valid proxies for the environmental, socioeconomic, and human well-being elements of the ecosystem and allow for periodic assessments of the state of health.

The Sea Grant publication, *Gulf of Mexico Research Plan* (Sempier et al. 2009), identifies, "[determining] the correct variables to use as indicators of ecosystem health, [identifying] the optimal methods to measure the indicators, and [designing] better-defined indices with more indicators to evaluate the status of ecosystems" as a top five priority research need. Before routine *State of Health* assessments for the Gulf of Mexico can be contemplated, a standard set of ecosystem indicators must be established. This standard must determine the minimal set of indicators and the confidence associated with those indicators to truly reflect the health of the ecosystem and its components. Once a standard set of indicators has been established, agreement must be made on how those indicators will be measured. The sampling protocol, frequency, and spatial distribution of these indicators must be defined in the methodology. Without standardized methodology, managers will not be able to rely on ecosystem indicators for the long-term status and trends assessments upon which management decisions will be based.

Ecosystem indicators must reliably reflect the ecosystem's state of health and serve as suitable proxies for human well-being. Three of the top ten priorities identified by Sempier et al. (2009) were focused on ecosystem indicators and effective management, and synoptic assessments and the link to human uses of the ecosystem. Ecosystem indicators can be an effective tool for the management decision-making process if they are correctly vetted, represent the factors of the environment that are most suitable for assessing ecosystem health, and provide a valid proxy to establish a linkage to human well-being.

Management Needs:

- A standard set of ecosystem indicators to reflect ecosystem health;
- Methodology to consistently measure widely agreed upon ecosystem indicators;
- Broadly accessible datasets (proper temporal and spatial scales) to design ecosystem indicators; and

- An ability to use ecosystem indicators to link ecosystem health to human well-being and for management decisions.

Examples of Key Activities:

- Develop, identify, and analyze ecosystem indicators to support decision-making on coastal and marine resources and conservation areas;
- Understand optimal threshold numbers for indicator and particularly important species; and
- Coordinate and integrate existing Gulf of Mexico monitoring efforts to track indicator species and sentinel sites.

Example Outputs:

- Analysis of the utility of ecosystem and human well-being indicators to effectively represent the state of ecosystem health;
- A standardized set of ecosystem indicators for use in State of Health assessments;
- A guidance manual that defines protocols for use and design of indicators (both ecological and human well-being), including (minimally) best methodology, spatial distribution, and frequency; and
- Guidance for managers to incorporate data from indicators into the decision-making process.

Outcomes:

- Resource managers routinely use ecosystem indicators in the decision-making process;
- Coastal communities are knowledgeable about State of Health reports and use them to inform improvement of their community's ecosystem health and human well-being; and
- Coastal communities and ecosystem managers use ecosystem indicators to assess the impact and tradeoffs of individual and/or combinations of management actions.

Develop decision-support tools to assist resource managers with management decisions planned to sustain habitats, living coastal and marine resources, and wildlife

Gulf of Mexico habitats, from wetlands and barrier islands to the deep ocean, are adversely affected by numerous and diverse processes, including (but not limited to) sea level rise, nutrient overloading, extreme weather events, and extraction of living coastal, marine, and energy-related resources. Evaluating the effects of these harmful processes on habitat, ecosystem function, living coastal and marine resources, and wildlife requires timely access to decision-support tools, which may include data on location, baseline, and current conditions (Petersen et al. 2011, Ocean Conservancy and the Gulf of Mexico University Research Collaborative 2012, Walker et al. 2012). Ecosystem decision-support tools enable researchers and resource managers to identify the type, structure, and function of habitats; assess the progress of restoration measures; and monitor habitat health and resiliency under pressure from long-term and episodic stressors (Petersen et al. 2011, Walker et al. 2012). This information about habitat may serve as a proxy for living coastal and marine resources and wildlife to determine if there is enough suitable habitat available to support population needs. For example, NOAA's Office for Coastal Management developed a Benthic Habitat Atlas (National Ocean Service [NOS] 2015) that contains shallow-water habitat information for over 190 miles of Texas coastal bays. Users can access individual maps in an Internet viewer, download, and print them. These maps are useful for public meetings, field activities, and planning related to other management activities that could impact habitats of concern or perhaps critical habitats for endangered or threatened species, and consequently the species themselves. Having this sort of tool can aid with planning to avoid unwanted impacts on these important habitats.

Baseline habitat information often varies from one location to another based on technologies, expert knowledge, and classification systems; therefore, it is imperative that there is a standardized approach used for categorizing habitat-related data. Having all the baseline data for the entire Gulf of Mexico would have no contribution to a holistic understanding of the Gulf of Mexico ecosystem if those data are named differently from one state to another or one county or parish to another. Living coastal and marine resources and wildlife do not recognize political boundaries nor does the habitat in which they reside. Habitat should be classified using a common language to communicate information (McDougall et al. 2007). Complexity and significance of marine resource issues are mounting and the need for additional habitat observations is increasing, particularly with respect to understanding impacts of natural and man-made disasters. Use of a federally recognized classification standard is necessary to accurately inventory, monitor, and assess habitats. Tools such as the Coastal and Marine Ecological Classification Standard (CMECS) Crosswalk Tool (NOS 2015) translate existing spatial benthic habitat data into output data compliant with CMECS. This type of tool

allows managers working throughout the Gulf of Mexico to "speak" the same language when communicating about different aspects of habitat, and, using habitat as a proxy for living coastal and marine resources and wildlife, can help with resource planning and conservation measures.

Management Needs:

- A baseline assessment of all Gulf of Mexico coastal and marine habitat locations, distribution, and conditions using existing information that can then be used to direct and prioritize the acquisition of new data and product development;
- An understanding of the ecological connections between habitats and living coastal and marine resources and wildlife;
- The scientific basis to identify and provide metrics for habitat-specific vital rates;
- Planning tools to assess resource use and provide information to managers to ensure critical habitats are protected and the living resources that they support are managed sustainably; and
- Planning tools to support consideration of restoration options.

Examples of Key Activities:

- Complete integration and characterization of available coastal and marine (including deep-ocean) habitat data using standard methods (e.g., Coastal and Marine Ecological Classification Standard) for remote sensing and a full suite of hydrographic parameters (e.g., high-resolution bathymetry and backscatter); and
- Identify gaps in habitat data and develop spatial sampling and mapping protocols to improve habitat identification and monitoring strategies.

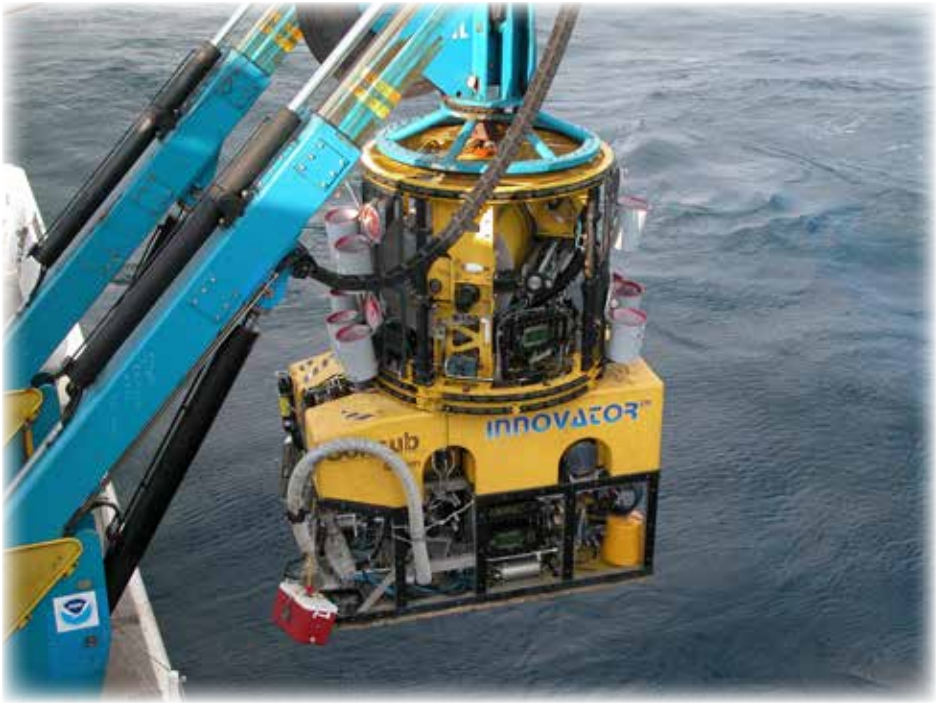
Example Outputs:

- Comprehensive inventory of Gulf of Mexico habitats, ensuring that current formats and classification standards have been applied;
- Listing of prioritized areas or life stages for data collection to fill gaps for important habitats, living coastal and marine resources, and wildlife;
- High-resolution maps that identify critical habitats "of great economic significance, ecological sensitivity, or rarity:"
- Analytical tools able to assess and rank habitat health, identify and predict impacts from stressors, and provide spatial analyses to support marine resource management and marine protection actions; and
- Decision support tools for managing habitats, living coastal and marine resources, and wildlife.

Outcomes:

- Gulf of Mexico habitats are protected and managed using methods that promote sustainability and resilience;
- The State of Health of Gulf of Mexico habitats is accurately assessed and easily compared with the state of reference sites;
- Gulf of Mexico resource managers can identify healthy versus at-risk habitats, living coastal and marine resources, and wildlife and make informed protection and conservation decisions based on a strong foundation of scientific knowledge; and
- Gulf of Mexico resource managers are able to monitor the progress of restoration and recovery programs with increased accuracy.

Network and integrate existing and planned data and information from monitoring programs



Data comparability, consistency, and standardization across programs, projects, and habitats are crucial, as are improved tools for data dissemination, visualization, and application by resource managers. However, the multitudes of tools used by managers to assess resources and make management decisions are far from achieving consistency and standardization.

Population assessments and ecosystem and habitat suitability models are examples of decision support tools that can assist regional resource managers in planning, designing, and implementing a successful management process. These models are most effective when they are built and validated with comprehensive data sets from rigorous integrated monitoring efforts. To achieve holistic ecosystem-based protection and restoration in the Gulf of Mexico, decision support tools must be developed with high quality data from throughout the ecosystem.

Similarly, managers often rely on spatially and temporally comprehensive multimedia monitoring networks to determine the condition of important ecosystem components, including the population structure of managed fisheries, wildlife, and protected resources. In addition, associated climatological, biogeochemical, physical oceanographic, and socioeconomic data are critical to fully understand the health and demographics of coastal and marine resources. In the context of Gulf of Mexico protection and restoration, a comprehensive observation and monitoring network will provide the data foundation necessary to support the development and selection of management and restoration project alternatives and assess and adaptively manage restoration projects.

The constellation of programs (Appendices I-II) engaged in monitoring extends to other science and restoration initiatives that have emerged from the oil spill including: the Gulf of Mexico Research Initiative ($500M over 10 years), the NAS Gulf Research Program ($500M over 30 years), the Natural Resource Damage Assessment process, and the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund ($2.544B over 5 years). These recent initiatives are occurring against the backdrop of existing federal and state research, observing, and monitoring programs operating in the Gulf of Mexico. Conversations have begun on the integration of monitoring and observation systems. The NOAA RESTORE Act Science Program will focus on developing strategies and soliciting recommendations for integrating existing data and expanding opportunities to incorporate new data collected by other sources.

Management Needs:

- Assessment and tracking of ecosystem status and trends;
- Integrated monitoring and observation programs;
- Standardized monitoring protocols; and
- Data to build and maintain robust decision-support tools for adaptive, ecosystem-based management.

Examples of Key Activities:

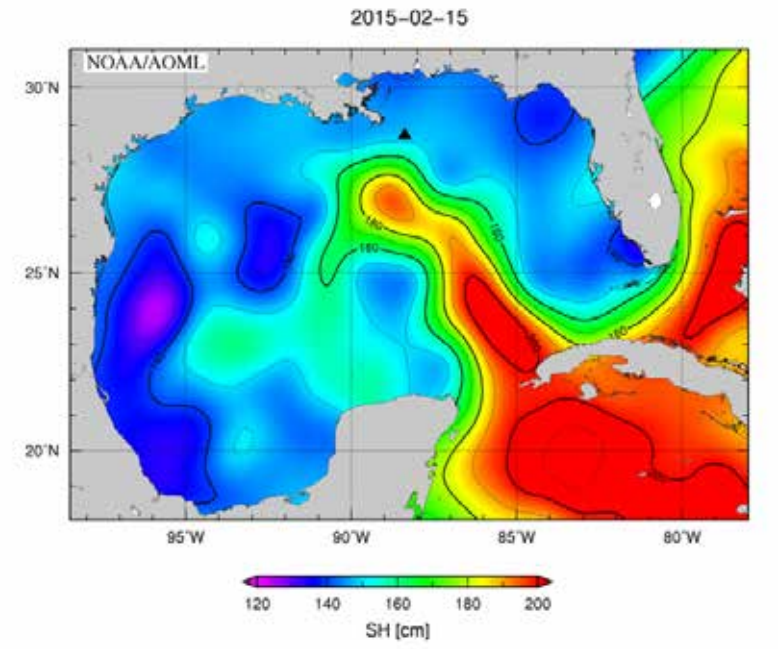
- Coordinate and integrate data from fishery-independent and existing recreational and commercial fishery-dependent sampling programs;
- Coordinate and integrate existing Gulf of Mexico observations and monitoring efforts to promote a monitoring network, including characterization of physical and biogeochemical properties, food web dynamics, habitat, wildlife, living coastal and marine resources, and fisheries data collection; and
- Identify opportunities to expand and refine existing monitoring and observation systems to support hydrodynamic, biogeochemical, and ecological models that assess and predict the effects of natural and anthropogenic stressors on ecosystem stability and sustainability.

Example Outputs:

- Integrated monitoring and observation programs with consistent database structure;
- Gap analysis to identify missing information (e.g., spatial, temporal, life history, habitat, and gear types); and
- Incorporation of monitoring programs into adaptive management implementation plans in selected regions.

Outcomes:

- Gulf of Mexico resource managers have access to integrated observations and monitoring programs and their data;
- Gulf of Mexico resource managers, modelers, and researchers have access to ecosystem modeling results and access to the supporting data and associated visualization tools; and
- Integrated monitoring and observation programs support improved ecosystem modeling, restoration, and adaptive management.



Develop and implement advanced technologies to improve monitoring

Advances in our understanding of an ecosystem and its components can be the result of the development and application of a new technology or the application of an existing technology in a new way. The application of molecular biology techniques initially developed for diagnostic application in a medical setting have been applied to wildlife and fisheries populations to better understand population and stock structure, assist in larval identification, and to reveal evolutionary history. The use of remotely operated vehicles both in the air and underwater has increased observing capacity and led to new discoveries about atmospheric processes and the deep sea. With advances in camera, sensor, and mobile computing technology over the past decade and additional innovation in these areas expected in the future, it is likely that our understanding of the Gulf of Mexico ecosystem and its components will increase as the result of the development and application of an array of advanced technologies. Additionally, the amount and types of information available to resource managers can be expected to increase as well. With proper investment, this innovation could be accelerated.

One area where technological innovation could increase knowledge and assist resource managers is in the understanding of the status of living coastal and marine populations in the Gulf of Mexico. New approaches to collecting data could address the current over-reliance on fishery-dependent data, the large number of moderate-to-small stocks, and the complication of managing international transboundary populations. The development of innovative tools, using advanced technologies, could decrease the costs of observations, mapping and monitoring. For example, more effective quantification of bycatch will allow managers to fully realize the value of target fisheries without impacting non-target, overfished or protected species. Investments in innovative fishery monitoring techniques, such as electronic fishing logbooks and video monitoring, could provide a cost-effective means of producing more information.

In addition, information on genetic characteristics and migrations of stocks could best be understood by applying state-of-the-art tagging and genetic methodologies. Several investigators suggest that lack of information about movements and stock structure limits our ability to manage transboundary stocks. In addition, tagging programs are needed that will improve the accuracy of fisheries' stock assessments by developing improved estimates of natural and fishing mortality rates (GMFMC 2014). Development of large-scale fish genetic and smart tagging programs will allow more accurate estimates of population status and assist in examining population connectivity among Gulf of Mexico living coastal and marine resources to better understand species-specific resiliency (Ocean Conservancy and the Gulf of Mexico University Research Collaborative 2012).

Comprehensive characterization of microbial communities is now possible through such molecular- and image-based sensor technologies as advanced automated underwater samplers and submersible flow

cytometers, respectively. For example, these technologies have been deployed on buoys and used for real-time detection of harmful algal blooms and their toxins. Continued development of these technologies, especially the development of low-cost samplers, could substantially increase the breadth of microbial and microalgal sampling in the ecosystem and provide resource managers with a much higher-resolution picture of these important ecosystem components.

Deployment of advanced survey technologies such as autonomous vehicles (e.g., gliders), which can be outfitted with sensors to capture physical, chemical, and biological properties targeting all ecosystem components, increases the spatial and temporal breadth of monitoring capabilities. The integration of these technologies into existing monitoring and observing frameworks could expand the reach of these frameworks and lead to more complete habitat maps. In addition, their application in remote areas of the Gulf of Mexico ecosystem could provide detailed observing data where gaps currently exist.

Management Needs:

- Improved quantity and quality of information for stock assessments of fish and wildlife (e.g., sea turtles, marine mammals, birds), including for protected species, in the Gulf of Mexico;
- Improved information to understand the connectivity between various components of the ecosystem (e.g., from microbes to whales);
- Cost-effective approaches for increase scope of observing and monitoring; and
- More effective quantification of bycatch to inform management decisions on bycatch reduction.

Examples of Key Activities:

- Improve technology to support large-scale tagging programs to better quantify fishing mortality rates and movements, and to improve estimates of natural mortality;
- Identify or develop and implement advanced technologies (e.g., autonomous vehicles, acoustic, genetic, optical and tagging technologies) to improve understanding of ecosystem structure and function, including assessment of living coastal and marine resources; and
- Develop and provide new and improved by-catch reduction devices and methods.

Example Outputs:

- Advanced technologies (e.g., tagging methods, autonomous vehicles, environmental sampling processors, etc.) for enhancing existing monitoring programs to support ecosystem (including living coastal and marine resources) assessments;
- Implementation plan for application of advanced technologies for improved stock assessment of living coastal and marine resources;
- Improved methodologies for collecting data on the actual number of vessel interactions with sea turtles and marine mammals; and
- New sensors for the detection of changes in water quality.

Outcomes:

- Gulf of Mexico resource managers are provided more precise data that allows for accurate and effective implementation of management measures;
- International transboundary populations are managed more effectively;
- Gulf of Mexico resource managers are able to consider an expanded data inventory when making conservation decisions;
- Improved by-catch information; and
- Improved stock assessments including information about stock structure and movement.

Section III. Program Structure and Administration

The NOAA RESTORE Act Science Program is the responsibility of NOAA in collaboration with the USFWS. Within NOAA, the National Ocean Service has responsibility for program planning and implementation, with advice from our Executive Oversight Board (EOB) composed of senior executives representing all NOAA Line Offices and the USFWS. The Program will generally use peer-reviewed competitions (e.g., FFOs and other mechanisms) to request proposals from eligible groups and independent mail and/or panel reviewers to evaluate those proposals. The processes for announcing, awarding, and overseeing research investments comport with all applicable federal, Department of Commerce (DOC) and NOAA regulations and guidance for federal assistance. For the RESTORE Act Science Program, additional requirements will be included to comply with the legislation and any applicable Treasury regulations.

1. Program Management Structure

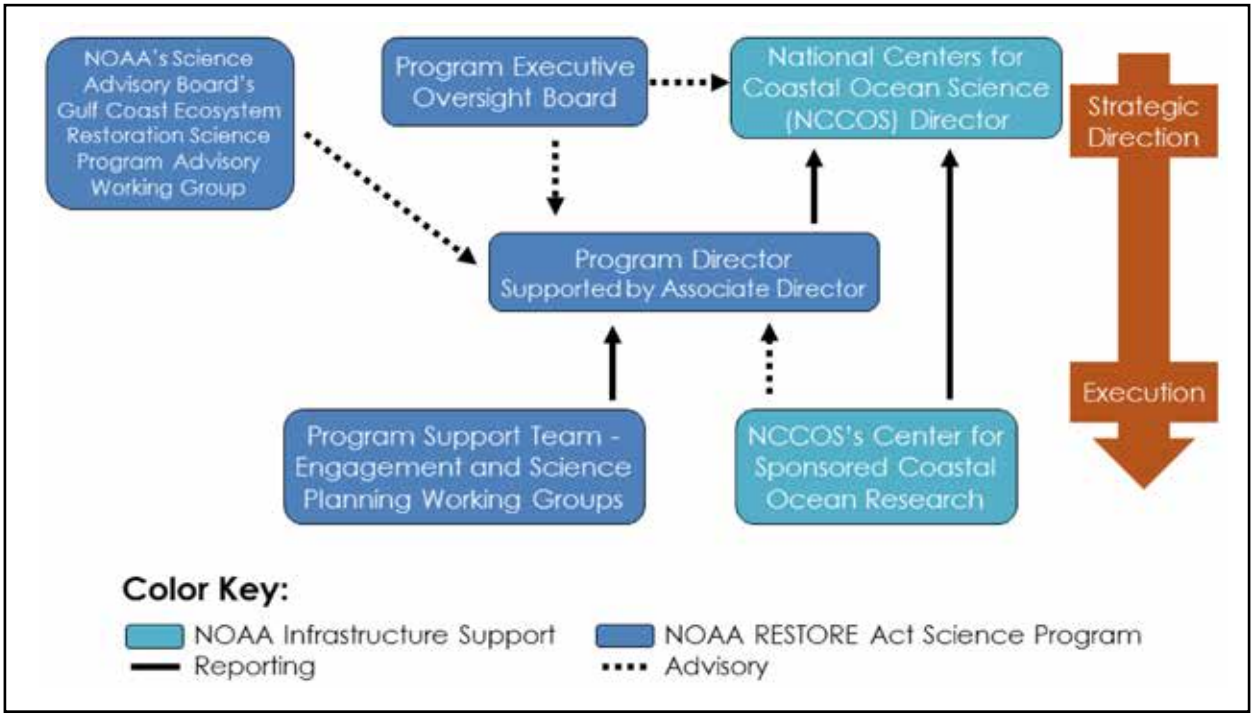


Figure 2: NOAA RESTORE Act Science Program management structure.

NOAA RESTORE Act Science Program Leadership and Support Team: The *Program Director* and *Associate Director* lead planning, execution, and review of science, engagement, and program management and serve as primary points of accountability and authority for execution of the Program (**Figure 2**). The *Program Director* will reside in the Gulf of Mexico region to directly coordinate and partner with the academic, resource management, governance, and other stakeholder communities essential to the success of the Program. The *Associate Director* will reside in NOAA headquarters to manage and support Program administration and competitions by directly interfacing with the rest of NOAA. The *Director of the National Centers for Coastal Ocean Science (NCCOS)* provides supervisory executive leadership, oversight, and administrative support to the *Director* and *Associate Director* in carrying out Program strategies and actions. NCCOS's Center for Sponsored Coastal Ocean Research (CSCOR) provides administrative and process support for grants management. The *Program Support Team*, led by the Program's *Director* and *Associate Director,* has responsibility to develop short- and long-term research priorities, in consultation with partners

and stakeholders, for the Program to implement. The *Team* has representation from the USFWS and from across NOAA. Collectively, the *Science Support* and *Engagement Teams* are responsible for science planning, coordination, and engagement; communication of stakeholder needs; maintaining transparency between federal, state, academic and nongovernmental organizations; and facilitating and supporting outreach and engagement.

Internal and External Advisory Bodies: Internally, NOAA's *Executive Oversight Board (EOB)* provides strategic advice and guidance on development and implementation of the Program. It is comprised of senior executives from each of NOAA's line offices and the USFWS. The EOB may collaborate with the Gulf Coast Restoration Council and other science advisory bodies and other entities as deemed appropriate by NOAA or DOC.

Externally, the *Gulf Coast Ecosystem Restoration Science Program Advisory Working Group (RSPAWG)*, established as a standing working group under NOAA's Science Advisory Board (SAB), provides independent advice and review of the Program. The RSPAWG is comprised of subject matters experts and representatives from the GSMFC, the GMFMC, and the Centers of Excellence authorized under the RESTORE Act (once designated by the Treasury Department). The RSPAWG also has ex-officio members from the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund, Bureau of Ocean Energy Management, the NAS Gulf Research Program, and the Gulf of Mexico Research Initiative. The RSPAWG will provide advice to NOAA's SAB on strategic aspects of the Program, including:

- Coordination and integration of Program activities with other research initiatives either underway or anticipated in the Gulf of Mexico region;
- Managing interdependencies and sequencing among the Program's long-term research priorities;
- Ensuring we are on course with the Program's long-term goals, outcomes, and measures of performance; and
- Translating or transitioning research sponsored by the Program into applications used by resource managers and the scientific community.

In addition to the RSPAWG, we will periodically conduct an independent, external review of the Program to assess its effectiveness. We envision conducting an independent review on a regular basis, perhaps every 4-5 years. We are also developing a performance management plan that will aid the Program in tracking and evaluating progress.

2. Consultation and Coordination

Pub. L. 112-141 Section 1604(b)(1) of the RESTORE Act specifies that NOAA shall consult with the Director of the USFWS, and coordinate [Section 1604(f)] with "other existing Federal and State science and technology programs in the States of Alabama, Florida, Louisiana, Mississippi, and Texas, as well as between the Centers of Excellence." Section 1604(b)(4) of the Act also requires that NOAA consult with the GMFMC and GSMFC in carrying out the program.

To address this mandate and need for coordination, NOAA will continue to coordinate with science and technology programs that are actively focused on the Gulf of Mexico. In many cases, NOAA already has established working relationships with these programs and will simply expand the scope of discussion to include the NOAA RESTORE Act Science Program. Several of these programs are represented on the NOAA

SAB's RSPAWG and will be able to provide advice and guidance to the program and promote coordination through that means.

The NOAA RESTORE Act Science Program is also leading the Gulf Restoration Science Programs Ad Hoc Coordination Forum, which is a body focused on coordination and integration among entities funded through Deepwater Horizon-related penalty funds. In addition to our Program, the members of this Forum include the Gulf Coast Restoration Council, Gulf of Mexico Research Initiative, National Fish and Wildlife Foundation Gulf Environmental Benefit Fund, NAS Gulf Research Program, North American Wetlands Conservation Fund, and representatives from the Natural Resource Damage Assessment process. Through this Forum, our Program will ensure that its activities complement and augment the activities of these other initiatives.

The Program will continue to engage with other programs and initiatives active in the region through meetings, conferences, and at other venues where information can be constructively shared to promote coordination and leveraging opportunities. While the Program will share information about its future plans with those with whom coordination is necessary, the Program will not share non-public information about future federal funding opportunities with individuals or organizations who may choose to compete in those funding opportunities to avoid giving any individuals or organization a real or perceived advantage.

3. Program Parameters

Eligible Activities: Refer to Section I.1, *RESTORE Act Section 1604*, for legislative language regarding eligible activities. In addition, the Act also instructs NOAA as follows:

- "Species included – The research, monitoring, assessment, and programs eligible for amounts made available under the program shall include all marine, estuarine, aquaculture, and fish species in State and Federal waters of the Gulf of Mexico; and
- Research Priorities – In distributing funding under this subsection, priority shall be given to integrated, long-term projects that 1) build on, or are coordinated with, related research activities; and 2) address current or anticipated marine ecosystem, fishery, or wildlife management information needs."

Ineligible Activities: The Act stipulates activities that are not eligible under this program. The funds provided will not be used:

- "For any existing or planned research led by NOAA, unless agreed to in writing by the grant recipient;
- To implement existing regulations or initiate new regulations promulgated or proposed by the NOAA; or
- To develop or approve a new limited access privilege program for any fishery under the jurisdiction of the South Atlantic, Mid-Atlantic, New England, or Gulf of Mexico Fishery Management Councils."

NOAA has interpreted "existing or planned research led by NOAA" to specifically mean that the research being proposed is not eligible for funding if it:

- Is substantially part of work that is currently tracked in NOAA Line Office Annual Operating Plans, any grant or other funding mechanism documentation, or other budgetary or program management documents (using appropriated funds);
- Is substantially part of work that has been proposed in a NOAA budget formulation program change summary (regardless of success) or other budget formulation documents at the NOAA line office level

since July 2012 (using appropriated funds); or
- Substantially duplicates efforts implemented by NOAA (i.e., conducted by NOAA federal scientists or contract scientists on behalf of NOAA) using appropriated funds.

Program Duration: Initial investments from the NOAA RESTORE Act Science Program using penalties generated by the Transocean settlement will be expended over a period of 7-10 years. Should the Program receive access to additional funds from the Treasury Department from resolved civil litigation then the Program may have an operating timeline of approximately 20 years.

Project Duration: As stipulated in the Act, priority shall be given to integrated long-term projects. We define "integrated" projects as those that are cross-discipline with respect to science and/or synthesize and link observations/monitoring, modeling, and/or field/laboratory research. Proposals for projects supporting the long-term priorities may be supported for up to 3-years, with potential for merit-based renewal. Shorter-term awards may be required to support Program execution or initial investments in our short-term priorities.

4. Funding Opportunities and Competitive Process

Funding Mechanisms: The NOAA RESTORE Act Science Program will generally use peer-reviewed competitive approaches (e.g., FFOs and other mechanisms) to advance our long-term research priorities and rely most heavily on grants and/or cooperative agreements to make awards. The Program may also use other means, including contracts, to ensure we have the flexibility needed to do the work required and involve appropriate partners.

Development of Funding Opportunities: The long-term research priorities detailed in Section II of this plan represent the focus for the Science Program for the next 5 to 10 years and possibly beyond. These long-term research priorities will form the basis for subsequent FFOs to be issued by the Program. The long-term research priorities are broad and individual FFOs to be issued by the program are not anticipated to address all of the management needs associated with a given priority, nor result in the complete list of outcomes and outputs associated with each priority.

The leadership of the Program will determine the order in which these long-term priorities will be addressed. The factors we will use to inform sequencing may include:
- Importance of a priority at the time funding becomes available;
- Management needs;
- Expected impact of and return on investments;
- Relevance of the priority within the context of the Program's overarching goal;
- New research results;
- Scientific gaps and interdependencies among priorities;
- Coordination with other science initiatives in the region and the topics being addressed in their funding opportunities; and
- Stakeholder engagement.

Once the program's leadership team has selected a long-term priority to be addressed, a development team for the federal funding opportunity will be convened from relevant experts within NOAA and the USFWS. Before funding opportunities are released, a comprehensive review of the state of science and further

elucidation of management needs will be carried out to ensure funded research will meet management needs. This process may include workshops with resource managers and researchers to gather the input needed to construct focused federal funding opportunities.

The Program's EOB will review draft federal funding opportunities proposed by the Program and the RSPAWG of NOAA's SAB will continue to provide strategic advice on science priorities (but will not be involved in the development of federal funding opportunities). Refer to Section III.1, *Program Management Structure*, for more information on the EOB and RSPAWG.

Peer Review Process: The Program will apply the rigorous, competitive, peer-review process established by NOAA's CSCOR to select research projects that will be funded by grants or cooperative agreements. This review process, which utilizes mail and/or panel peer-reviews, is extensive, well-documented, and as transparent as possible. To avoid conflicts of interest in the selection of funded research, independent reviews will be performed by scientific peers not affiliated with institutions that propose projects (NOAA Policy on Conflicts of Interest for Peer Review).

Scientific Integrity: The NOAA RESTORE Act Science Program maintains strict adherence to the principles of scientific integrity as defined in the NOAA Administrative Order on Scientific Integrity (NAO 202-735D). Consistent with the NAO, NOAA RESTORE Act Science Program staff and scientists funded by the Program are responsible for abiding by the principles contained in the NAO.

Eligibility: The following guidelines describe eligibility requirements for competitive funding announcements through the NOAA RESTORE Act Science Program:

- Eligible applicants are institutions of higher education; other nonprofits; state, local, and Indian Tribal Governments; commercial organizations; and U.S. Territories that possess the statutory authority to accept funding for this type of research;
- Federal agencies that possess the statutory authority to accept funding for this type of research are eligible; however, federal agencies are strongly encouraged to collaborate with partners from a non-federal eligible entity.
- Foreign researchers may apply for sub awards through an eligible US entity;
- Principal investigators (PIs) are not required to be employed by an eligible entity that is based in one of the five Gulf of Mexico States (Florida, Alabama, Mississippi, Louisiana, Texas); however, PIs that are not from Gulf of Mexico-based eligible entities are encouraged to collaborate with partners from a Gulf of Mexico-based eligible entity; and
- NOAA RESTORE Act Science Program funding opportunities will not be used to hire and/or fund the salaries of any permanent Federal employees, but may fund travel, equipment, supplies, and contractual personnel costs associated with the proposed work.

Partnerships: Recognizing the inherent complexity of the Gulf of Mexico ecosystem and the diversity of disciplines and expertise that will be required to advance current understanding and support long-term sustainability of the ecosystem, preference will be given to collaborative efforts. The Program particularly encourages partnerships with scientists located in the Gulf of Mexico.

5. Environmental Compliance

The National Environmental Policy Act (NEPA), 42 U.S.C §§ 4321-4335, and the Council for Environmental Quality's (CEQ's) implementing regulations at 40 C.F.R. Parts 1500-1508, set forth a process for federal agency decision-makers to identify and consider the effects of proposed federal actions and alternatives on the quality of the human environment. The CEQ regulations (40 C.F.R. §1508.14) define the "human environment" comprehensively as "the natural and physical environment and the relationship of people with that environment." NEPA provides a mandate and a framework for federal agencies to consider all reasonably foreseeable environmental effects of their proposed actions and to involve the public and solicit information that will ensure the use of the best available science to assist the decision-maker's consideration of environmental effects, alternatives, and mitigation measures that can be used to reduce adverse environmental effects.

NEPA and its implementing regulations prescribe certain responsibilities for federal agencies including preparation of the appropriate level of environmental analysis and documentation. Projects in the Gulf of Mexico supported by the NOAA RESTORE Act Science Program are subject to NEPA and its implementing regulations. Concurrent to development of this science plan, a programmatic environmental assessment (PEA) has been in development. Drafting of the PEA was initiated at the same time as the draft science plan in January 2014. A draft version of the PEA was submitted to NOAA's Office of Program Planning and Integration for an informal review during the summer of 2014 to ensure the PEA was on track and meeting the legislative requirements of NEPA. The PEA for the program summarizes the current environmental setting of the Gulf Coast region, describes the purpose and need for the science plan, identifies the No Action and Proposed Action Alternatives, including a description of the process for developing the Proposed Action (the plan), and assesses the potential environmental consequences based upon available information. With release of this final science plan, the draft PEA will be finalized and released for public comment.

In addition to NEPA, the actions proposed in the science plan must conform to other environmental compliance legislation. These include, but are not limited to, the Marine Mammal Protection Act, Endangered Species Act, Magnuson-Stevens Act/Essential Fish Habitat, and National Marine Sanctuaries Act. The draft PEA will be provided for review to the NOAA staff responsible for compliance with these regulations. The resulting best management practices and mitigation methods will be included in the PEA.

6. Data and Information Sharing

There is a need for a comprehensive mechanism to preserve, discover, and access data and information resulting from research activities funded through this Program to maximize return on the investment made by the government and various agencies. This mechanism will facilitate multiple uses of the data while minimizing duplication of effort. Eligible applicants awarded funding under the NOAA Restore Act Science Program are required to comply with the Administration's policy for Public Access to Research Results and the NOAA Administrative Order on Management of Environmental Data and Information (NAO 212-15), which states that environmental data are to be managed based upon a lifecycle that includes developing and following a data management plan. The goal of the data management plan is to ensure that data are properly collected, documented, made accessible, and preserved for future use in a NOAA Data Center or other long term archive facility. Grant or cooperative agreement recipients must also comply with NOAA's data sharing policy for grants and cooperative agreements.

Environmental data and information collected and/or created under an awarded grant or cooperative agreement will be made visible, accessible, and independently understandable to users in near real-time when appropriate and within two years after the data are collected or created. Data should also comply with federal standards. The data will have undergone quality assurance/quality control procedures using community-accepted standards and protocols and will be accessible to the public free of charge or at minimal cost that is no more than the cost of distribution to the user, except where limited by law, regulation, policy, or by security requirements. Awards that include collection of ocean and coastal mapping data are required to share their proposed mapping areas, objectives, and acquisition strategies with NOAA's Integrated Ocean and Coastal Mapping Coordinator. Their data will be factored into the national mapping coordination site in order to reduce overlaps, eliminate redundancies, and further leverage federal investments in mapping.

Section IV. Summary

Improved knowledge of the ecosystem and its chemical, physical, biological (including living coastal and marine resources, wildlife, and humans), and socioeconomic components is essential to manage human impacts on the ecosystem in a holistic, systematic fashion. Information must be made available for managers operating at different geographic scales, with largely diverse demographics, and complex management issues to make informed decisions and modify their actions as needed to mitigate human impacts on ecosystem resources throughout the Gulf of Mexico in an integrated, adaptive manner. Adaptive management requires that actions be modified to maximize their efficacy for restoring or maintaining an ecological system in a desired state or ecological potential (Holling and Gunderson 2002). A key component of adaptive management is a feedback mechanism based on characterizing current ecosystem conditions and measured responses to management actions supplemented with an understanding of the system dynamics and baseline conditions. This information is obtained through rigorous monitoring, modeling, and research combined into integrated assessments and syntheses (Walker et al. 2012). Attaining the long-term research priorities presented in this plan will provide the knowledge necessary to support adaptive management, which will lead to long-term sustainability of the Gulf of Mexico ecosystem.

Section V. Acronyms and Abbreviations

ACRONYM	ABBREVIATION
CEQ	Council for Environmental Quality
CMECS	Coastal and Marine Ecological Classification Standard
CSCOR	Center for Sponsored Coastal Ocean Research
DOC	Department of Commerce
EOB	Executive Oversight Board
FFO	Federal funding opportunity
GMFMC	Gulf of Mexico Fishery Management Council
GCPO LCC	Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative
GSMFC	Gulf States Marine Fisheries Commission
NAO	NOAA Administrative Order
NAS	National Academy of Sciences
NCCOS	National Centers for Coastal Ocean Research
NEPA	National Environmental Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA RESTORE Act Science Program	Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program
NOS	National Ocean Service
NRDA	National Resource Damage Assessment
PEA	Program environmental assessment
PI	Principal Investigator
RESTORE Act	Resources and Ecosystems Sustainability, Tourist Opportunity, and Revived Economies of the Gulf States Act of 2012
RSPAWG	Restoration Science Program Advisory Working Group
SAB	Science Advisory Board
USFWS	U.S. Fish and Wildlife Service

Section VI. Glossary

A

Abiotic
A nonliving (physical or chemical) component of the environment (NMFS 2006).

Adaptive management
1. A management process involving step-wise evolution of a flexible management system in response to feedback information actively collected to check or test its performance (in biological, social, and economic terms). It may involve deliberate intervention to test the system's response.
2. The process of improving management effectiveness by learning from the results of carefully designed decisions or experiments (NMFS 2006).

B

Best Management Practices
Acceptable methods or techniques found to be the most effective, practical, and environmentally responsible means of achieving an objective, such as to protect water quality or minimize pollution.

Biotic
Pertaining to the living components of their environment (NMFS 2006).

Bloom
A sudden increase in the abundance of alga or phytoplankton resulting in a contiguous mass of highly concentrated phytoplankton in the water column (NMFS 2006).

Bycatch
Fish other than the primary target species that are caught incidental to the harvest of the primary species. By-catch may be retained or discarded. Discards may occur for regulatory or economic reasons (NMFS 2006).

C

Carbon flow
The energy that flows through an ecosystem in the form of carbon-based molecular reactions that involve the abiotic and biotic (producers, consumers and decomposers) species in an environment.

Clean Water Act (CWA)
The Clean Water Act establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis for the CWA was the Federal Water Pollution Control Act, which was reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with these amendments in 1972.

Code of Federal Regulations (C.F.R.)
A codification of the regulations published in the Federal Register by the executive departments and

agencies of the Federal government. The Code is divided into 50 titles that represent broad areas subject to Federal regulation. Title 50 contains wildlife and fisheries regulations.

D

Decision support tools
Tools used to support a decision-making process (e.g., sea level rise viewers, scenario models, etc.).

Downscaling climate models
A method by which regional or global scale information is used to generate information about more local scale conditions.

E

Ecosystem
A geographically specified system of organisms (including humans), the environment, and the processes that control its dynamics (Murawski and Matlock 2006).

Ecosystem indicators
Types of data that are used to detect and track changes in the ecological condition of an area.

Ecosystem Services
Ecosystem services are the benefits people obtain from ecosystems. These benefits include provisioning services, such as food and water; regulating services, such as flood and disease control; cultural services, such as spiritual and cultural benefits; and supporting services, such as nutrient cycling and filtration (e.g., via oyster reefs or vegetation), that maintain the conditions for life on Earth (NMFS 2006).

Endangered species
A species, as defined in the Endangered Species Act, that is in danger of extinction through a significant portion of its range. A species classified as threatened is likely to become an endangered species (NMFS 2006).

Endangered Species Act
The Endangered Species Act statute was enacted in 1973 to conserve species and ecosystems. Under its auspices, species that face possible extinction are listed as threatened or endangered, or as candidate species for such listings. When such a listing is made, recovery and conservation plans are drawn up to ensure the protection of the species and its habitat (NMFS 2006).

Environmental Sampling Processor
A tool developed by the Monterey Bay Aquarium Research Institute, which collects and analyzes water samples underwater (in situ).

F

Federal trust species
Pursuant to 16 USCS § 3772 (1), [Title 16. Conservation; Chapter 57B. Partners for Fish and Wildlife], the term

Federal trust species means "migratory birds, threatened species, endangered species, interjurisdictional fish, marine mammals, and other species of concern."

Fish stock
The living resources in the community or population from which catches are taken in a fishery. Use of the term "fish stock" usually implies that the particular population is more or less isolated from other stocks of the same species and hence is self-sustaining. In a particular fishery, the fish stock may be one or several species of fish but here is also intended to include commercial invertebrates and plants (NMFS 2006).

Fishery-dependent
Data collected directly on a fish or fishery from commercial or sport fishermen and seafood dealers. Common methods include logbooks, trip tickets, port sampling, fishery observers, and phone surveys (NMFS 2006).

Fishery-independent
Characteristic of information (e.g., stock abundance index) or an activity (e.g., research vessel survey) obtained or undertaken independent of the activity of the fishing sector. It intends to avoid the biases inherent to fishery-related data (see fishery-dependent) (NMFS 2006).

Fixed carbon
The inorganic carbon that is converted to organic carbon by living organisms.

Food webs
The complex predator-prey and consumer-resource relationships between all consumers and producers in an ecosystem.

G

Gap analysis
As used in this plan, gap analysis a tool to determine where there is a lack of information/data necessary for sound management; also may be used to determine whether a particular process is meeting established objectives. For example, does a fishery independent monitoring program collect adequate data to conduct an acceptable stock assessment?

Gulf of Mexico Fisheries Management Council (GMFMC)
A regional fisheries management body established by the Magnuson-Stevens Act to manage fishery resources in The Gulf of Mexico region of the United States.

Gulf States Marine Fisheries Commission (GSMFC)
Established by an act of Congress (P.L. 81-66) in 1949 as a compact of the five Gulf States with a charge, "to promote better utilization of the fisheries, marine, shell and anadromous, of the seaboard of the Gulf of Mexico, by the development of a joint program for the promotion and protection of such fisheries and the prevention of the physical waste of the fisheries from any cause".

H

Habitat
The environment in which the living coastal and marine resources and wildlife live, including everything that surrounds and affects their lives, e.g., water quality, ocean bottom, vegetation, land surface, associated species (including food supplies), human impact, etc. The locality, site, and particular type of local environment occupied by an organism (NMFS 2006).

Habitat utilization
Habitats that a species or assemblages of species prefer or seem utilize in preference to other habitats.

Harmful Algal Bloom
Blooms of algae fueled by nutrient pollution that produce toxic or harmful effects on people, fishes, shellfish, marine mammals, and birds.

Health[y]
Suitable for human use.

Holistic
Concerned with the entire system, not just the parts.

Hypoxia
Conditions when oxygen concentrations fall below the level necessary to sustain most animal life.

I

Indicators
1. A variable, pointer, or index. Its fluctuation reveals variations in key elements of a system. The position and trend of the indicator in relation to reference points or values indicate the present state and dynamics of the system. Indicators provide a bridge between objectives and action.
2. Signals of processes, inputs, outputs, effects, results, outcomes, impacts, etc., that enables such phenomena to be judged or measured. Both qualitative and quantitative indicators are needed for management learning, policy review, monitoring, and evaluation.
3. In biology, an organism, species, or community whose characteristics show the presence of specific environmental conditions, good or bad (NMFS 2006).

Invasive species
An introduced species that out-competes native species for space and resources (NMFS 2006).

J

Juvenile refugia
That part of a fish or animal's habitat where the young develop and grow and that is protected from predators; also known as nursery areas.

L

Landscape changes
A change in an area of land with distinct geographical characteristics that alters the structure and function of the ecology.

Life history
References the history of the changes through which an organism passes in its development from the primary stage to its natural death.

Living Coastal and Marine Resources
Living organisms found in the marine (estuarine, nearshore, and offshore) environment. Generally thought of as those organisms that depend on the marine environment and that are also of concern or importance to humans.

M

Management ready
Tools and information that have been reviewed and vetted and are considered ready for use by managers in their decision-making.

Marine mammals
Warm-blooded animals that live in marine waters and breathe air directly. These mammals include porpoises, dolphins, whales, manatees, seals, and sea lions (NMFS 2006).

Marine Mammal Protection Act (MMPA)
The MMPA prohibits the harvest or harassment of marine mammals, although permits for incidental take of marine mammals during commercial fishing may be issued subject to regulation (NMFS 2006).

Meta-analysis
A quantitative statistical analysis of several separate but similar experiments or studies to test the pooled data for statistical significance.

N

National Academy of Sciences (NAS)
A private nonprofit, self-perpetuating society of scientists. The NAS was granted a charter by Congress in 1863 that requires it to advise the Federal Government on scientific and technical matters.

O

Ocean acidification
The increase in acidity of the ocean due to the introduction of carbon dioxide into the ocean and the subsequent production of carbonic acid.

P

Primary production
Assimilation (gross) or accumulation (net) of energy and nutrients by green plants and by organisms that use inorganic compounds as food (NMFS 2006).

Protected species
Refers to any species which is protected by either the ESA or the MMPA, and which is under the jurisdiction of the NMFS and/or the USFWS. Includes all threatened, endangered, and candidate species, as well as all cetaceans and pinnipeds, excluding walruses (NMFS 2006).

R

Resilience
Capacity of a natural system (fisheries community or ecosystem) to recover from heavy disturbance such as intensive fishing, storm events, acute and chronic pollution events, and sea-level rise (NMFS 2006).

Restoration
The process of returning a damaged ecosystem to a less degraded state.

S

Secondary production
Generally the biomass produced by organisms consuming organic carbon. In some cases secondary production refers only to the biomass produced by organisms that eat plants (herbivores), and tertiary production refers to that produced by carnivores.

Sentinel species
Organisms used to warn of environmental change. Typically, these organisms are particularly susceptible to certain environment changes and therefore may provide early warning of environmental changes or threats.

Socioeconomic
Pertaining to the combination or interaction of social and economic factors. Involves such topics as distributional issues, labor market structure, social and opportunity costs, community dynamics, and decision-making processes (NMFS 2006).

Stock
A part of a fish population that usually has a particular migration pattern or specific spawning grounds and is subject to a distinct fishery. A fish stock may be treated as a total or a spawning stock. Total stock refers to both juveniles and adults, either in numbers or by weight, and spawning stock refers to the numbers or weight of individuals that are old enough to reproduce (NMFS 2006).

Stock structure
1. The spatial organization of a species in terms of the genetic structure of the species across geographic space (e.g., a species of large pelagic fish (tunas) may be composed of three separate stocks in the North Atlantic, South Atlantic, and Pacific Ocean).

2. The structure of a particular stock, in terms of its size or age composition or in terms of its species composition (for a multispecies stock) (NMFS 2006).

Submersible flow cytometer
An underwater flow cytometer used for counting and classifying cells by passing cells in a liquid stream through a light source and typically uses either impedance or optical systems.

Sustainability
Ability to persist in the long-term. Often used as "short hand" for sustainable development. Characteristic of resources that are managed so that the natural capital stock is non-declining through time, while production opportunities are maintained for the future (NMFS 2006).

T

Threatened species
As defined by the ESA, any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Transboundary stocks
A group of commercially exploitable organisms, distributed over, or migrating across, the maritime boundary between two or more national jurisdictions, or the maritime boundary of a national jurisdiction and the adjacent high seas, whose exploitation can only be managed effectively by cooperation between the States concerned (Caddy 1997).

Trophic interactions
Interactions between groups of organisms eating resources from a similar level in the energy cycle (NMFS 2006).

W

Wildlife
Living things, especially mammals and birds that are not domesticated.

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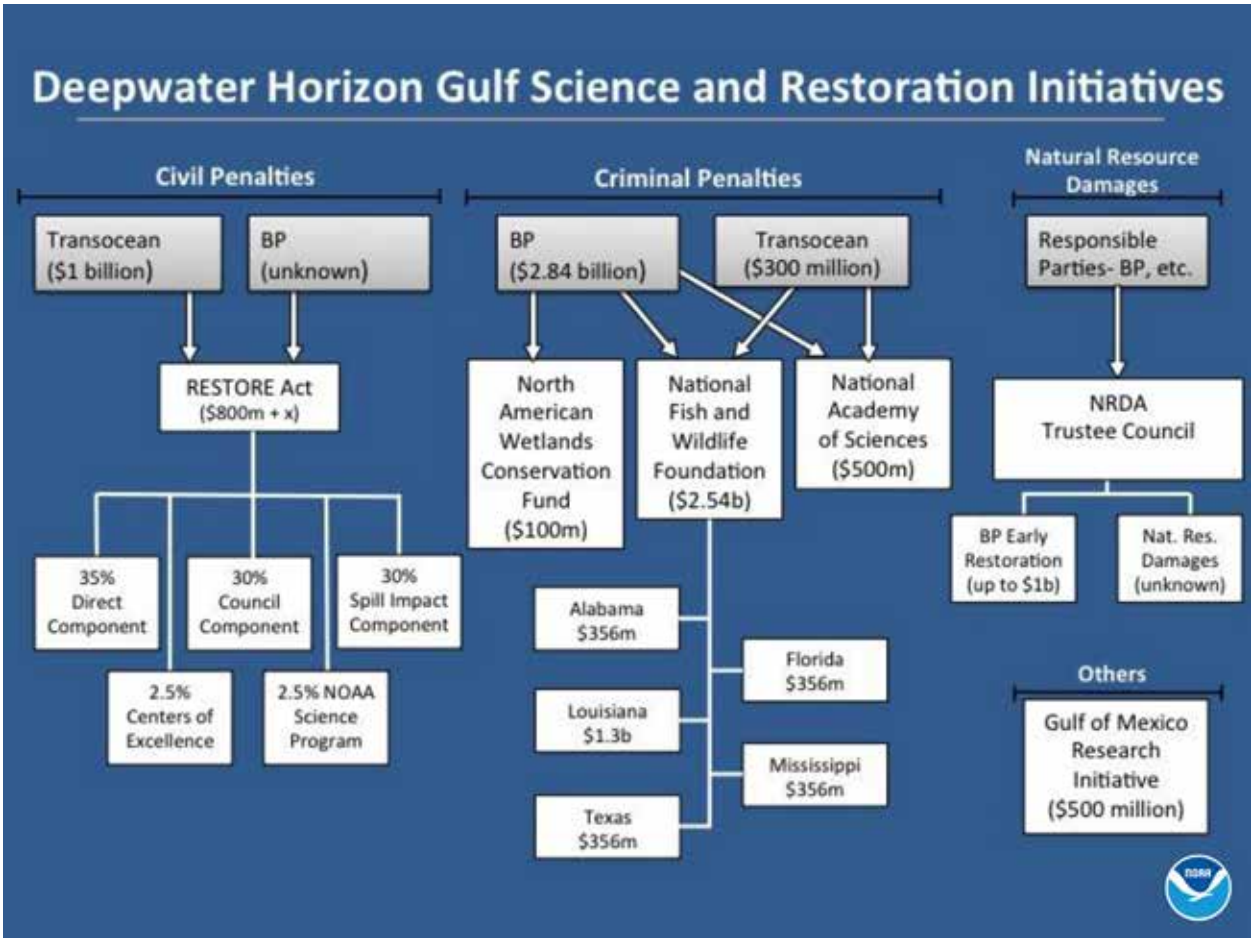
Appendix I. Deepwater Horizon Gulf of Mexico Science and Restoration Initiatives - Overview

The claims against BP for the Deepwater Horizon oil spill are primarily brought under the Oil Pollution Act and the Clean Water Act. Natural resource damage assessment (NRDA) claims and civil penalty claims comprise the civil complaint that was filed by the U.S. in December 2010. On November 15, 2012 the Department of Justice announced an agreement with BP to resolve all criminal claims under the Clean Water Act, Migratory Bird Treaty Act, and other related statutes against the company related to the Deepwater Horizon oil spill.



Appendix II. Deepwater Horizon Gulf of Mexico Science and Restoration Initiatives - Program Descriptions

This appendix is not comprehensive of all research programs in the Gulf of Mexico and does not imply these are the only programs with which the NOAA RESTORE Act Science Program will coordinate. Refer to Section III.2, Consultation and Coordination, for additional details on NOAA's approach for coordination.

Entity	NOAA RESTORE Act Science Program
Themes/ Priorities/Eligible Activities	• Marine and estuarine research; • Marine and estuarine ecosystem monitoring; • Ocean observation; • Data collection and stock assessments; • Pilot programs for— 1. Fishery-independent data; 2. Reduction of exploitation of spawning aggregations; and • Cooperative research.
Amount of Funding	2.5% of the Gulf Coast Restoration Trust Fund plus 25% of any accrued interest ($20M based on Clean Water Act penalty settlements as of August 2014)
Timeframe	RESTORE Act specifies that the Program will end when the Gulf Coast Restoration Trust Fund is fully expended and all Clean Water Act liabilities by responsible parties have been resolved.
Geographic Scope	Gulf of Mexico ecosystem

Entity	National Academy of Sciences Gulf Research Program
Themes/ Priorities/Eligible Activities	• Foster innovative improvements to prevention, safety technologies, safety culture, and environmental protection systems associated with offshore oil and gas development; • Improve understanding of the links between environmental conditions and human health to strengthen the resilience of Gulf communities and ecosystems to environmental stressors; and • Advance understanding of the Gulf of Mexico region as a dynamic system with complex, interconnecting human and environmental systems, functions, and processes to inform the protection and restoration of ecosystem services in the Gulf of Mexico.
Amount of Funding	$500M
Timeframe	2013-2043 The funds accumulate over 5 years (2013-2018) and must be disbursed within 30 years.

Entity	**RESTORE Act Centers of Excellence**
Themes/ Priorities/Eligible Activities	Each center of excellence shall focus on science, technology, and monitoring in at least one of the following disciplines: • Coastal and deltaic sustainability, restoration and protection, including solutions and technology that allow citizens to live in a safe and sustainable manner in a coastal delta in the Gulf Coast Region; • Coastal fisheries and wildlife ecosystem research and monitoring in the Gulf Coast Region; • Offshore energy development, including research and technology to improve the sustainable and safe development of energy resources in the Gulf of Mexico; • Sustainable and resilient growth, economic and commercial development in the Gulf Coast Region; or • Comprehensive observation, monitoring, and mapping of the Gulf of Mexico.
Amount of Funding	2.5% of the Gulf Coast Restoration Trust Fund plus 25% of any accrued interest ($20M based on Clean Water Act penalty settlements as of August 2014)
Timeframe	TBD[1]
Geographic Scope	TBD[2]

Entity	Gulf of Mexico Research Initiative
Themes/ Priorities/Eligible Activities	• Physical distribution, dispersion, and dilution of petroleum (oil and gas), its constituents, and associated contaminants (e.g., dispersants) under the action of physical oceanographic processes, air–sea interactions, and tropical storms; • Chemical evolution and biological degradation of the petroleum/dispersant systems and subsequent interaction with coastal, open ocean, and deepwater ecosystems; • Environmental effects of the petroleum/dispersant system on the sea floor, water column, coastal waters, beach sediments, wetlands, marshes, and organisms; • The science of ecosystem recovery; • Technology developments for improved response, mitigation, detection, characterization, and remediation associated with oil spills and gas releases; and • Impact of oil spills on public health including behavioral, socioeconomic, environmental risk assessment, community capacity and other population health considerations and issues.
Amount of Funding	$500M
Timeframe	10 years (2010-2020)

Entity	National Fish and Wildlife Foundation Gulf Environmental Benefit Fund
Themes/ Priorities/Eligible Activities	Fund projects benefiting the natural resources of the Gulf Coast that were impacted by the spill, specifically, support projects that remedy harm to natural resources (habitats, species) where there has been injury to, or destruction of, loss of, or loss of use of those resources resulting from the oil spill.
Amount of Funding	$2.544 B $1.272 billion for barrier island and river diversion projects in Louisiana. $356 million each for natural resource projects in Alabama, Florida, and Mississippi. $203 million for similar projects in Texas.
Timeframe	5 years (2013-2018)
Geographic Scope	Reasonable proximity to where the impacts occurred.

Entity	**National Resource Damage Assessment (NRDA)**
Themes/ Priorities/Eligible Activities	30% of the Gulf Coast Restoration Trust Fund equally divided among the Gulf States ($240M based on Clean Water Act penalty settlements as of August 2014)
Amount of Funding	$1 billion early restoration; final damage assessment TBD.
Timeframe	TBD
Geographic Scope	Coastal counties and parishes of the five Gulf States.

Entity	**RESTORE Act – State Allocation (Direct Component)**
Themes/ Priorities/Eligible Activities	The Council will select and fund projects and programs that restore and protect the natural resources, ecosystems, water quality, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Gulf Coast region.
Amount of Funding	35% of the Gulf Coast Restoration Trust Fund equally divided among the Gulf States ($280M based on Clean Water Act penalty settlements as of August 2014)
Timeframe	TBD[1]
Geographic Scope	Gulf States

Entity	RESTORE Act – Gulf Coast Ecosystem Council (Council Component)
Themes/ Priorities/Eligible Activities	The Council will select and fund projects and programs that restore and protect the natural resources, ecosystems, water quality, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Gulf Coast region.
Amount of Funding	30% of the Gulf Coast Restoration Trust Fund ($240M based on Clean Water Act penalty settlements as of August 2014)
Timeframe	TBD[1]
Geographic Scope	Gulf States

Entity	**Spill Impact Component of the RESTORE Act**
Themes/ Priorities/Eligible Activities	State expenditure plans (SEP) must meet the statutory requirements of the RESTORE Act, including: (1) All projects, programs and activities included in the SEP are eligible activities as defined by the RESTORE Act; (2) all projects, programs and activities included in the SEP contribute to the overall economic and ecological recovery of the Gulf Coast; (3) the SEP takes the Council's Comprehensive Plan into consideration and is consistent with the goals and objectives of the Comprehensive Plan; (4) no more than 25 percent of the allotted funds are used for infrastructure projects unless the SEP contains certain certifications from the Gulf Coast State submitting the SEP. The funds the Council disburses to the Gulf Coast States upon approval of a SEP will be in the form of grants.
Amount of Funding	30% of the Gulf Coast Restoration Trust Fund will be disbursed to the five Gulf Coast States or their administrative agents based on an allocation formula established by the Council by regulation based on criteria in the RESTORE Act. The RESTORE Act establishes a statutory minimum under which each of the five Gulf Coast States is guaranteed 5% of the funds made available in a fiscal year under this component. ($240M based on Clean Water Act penalty settlements as of August 2014)
Timeframe	TBD[1]
Geographic Scope	Coastal counties and parishes of the five Gulf States.

Entity	**North American Wetlands Conservation Fund**
Themes/ Priorities/Eligible Activities	Funds wetlands restoration and conservation projects.
Amount of Funding	$100 million; BP fine for violations of the Migratory Bird Treaty Act.
Timeframe	Received from 2014 to 2019, and disbursed: $20 M within 60 days of sentencing (Jan. 29, 2013), $20 M within 1 year, $20 M within 2 years, $12 M within 3 years, $12 M within 4 years, and $16 M within 5 years.
Geographic Scope	States bordering the Gulf of Mexico or otherwise designated to benefit migratory bird species and other wildlife and habitat affected by the oil spill

[1]Duration of programs established under the RESTORE Act is dependent on the total amount of funds deposited in the Gulf Coast Restoration Trust Fund.
[2]The Centers of Excellence established under the RESTORE Act have not been named. Geographic scope will be determined once those entities have been selected.

Appendix III. Focus Areas from the Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program Science Plan Framework.

The Focus Areas described below were previously introduced under the programs Science Plan Framework (NOAA 2013), the foundational document for the development of this plan. Focus areas were intended to guide this Program and ensure we addresses known regional priorities and expend funding judiciously. While the focus areas are not reiterated in this science plan, they were fundamental in establishing the short-term priorities and eventually the long-term priorities.

Ecosystem structure, functioning and connectivity through integrative field and laboratory studies; for example,

- Support research and analysis to understand interconnections between the ecosystem, its living resources, and the human element to inform the ecosystem perspective and support ecosystem management:
- Provide contextual information to support fisheries and wildlife sciences and restoration planning and implementation; and
- Develop ecosystem-based scenario forecast and integrated assessment models to inform goal-setting and evaluate effectiveness of management and restoration strategies, including climate-related and other drivers of change.

Holistic approaches to observing and monitoring with advanced and innovative technologies to monitor fisheries, Federal trust species, and other natural resources, and data integration tools focused on the observing needs in the Gulf of Mexico; for example, support development of:

- Observation and monitoring efforts to identify, map, and assess habitats, including poorly known deep-water habitats, including relevant physical and biochemical parameters; and
- Observation assets to monitor resources, including fisheries and protected species, and to enhance and improve fishery and wildlife management in the Gulf.

Integrated analysis and synthesis of existing and new data to advance the state of ecological knowledge through the search for patterns and principles; for example,

- Organize, synthesize and present ecological information in a manner useful to researchers and resource managers; and
- Support meta-analyses, data mining, policy research, development and application of science-based measures of ecosystem integrity, productivity, resiliency, recovery, and restoration.

Periodic state of health assessments, incorporating environmental, socio-economic, and human well-being benefits and elements; for example,

- Support iterative gap analysis to identify priority needs to support broader ecosystem understanding; and
- Support development of ecological and socio-economic indicators, including those specifically related to fisheries in both state and federal waters, as well as Federal trust species such as migratory birds, threatened and endangered species, and marine mammals, to inform regular assessment activities and evaluate success of restoration projects and management activities.


NOAA