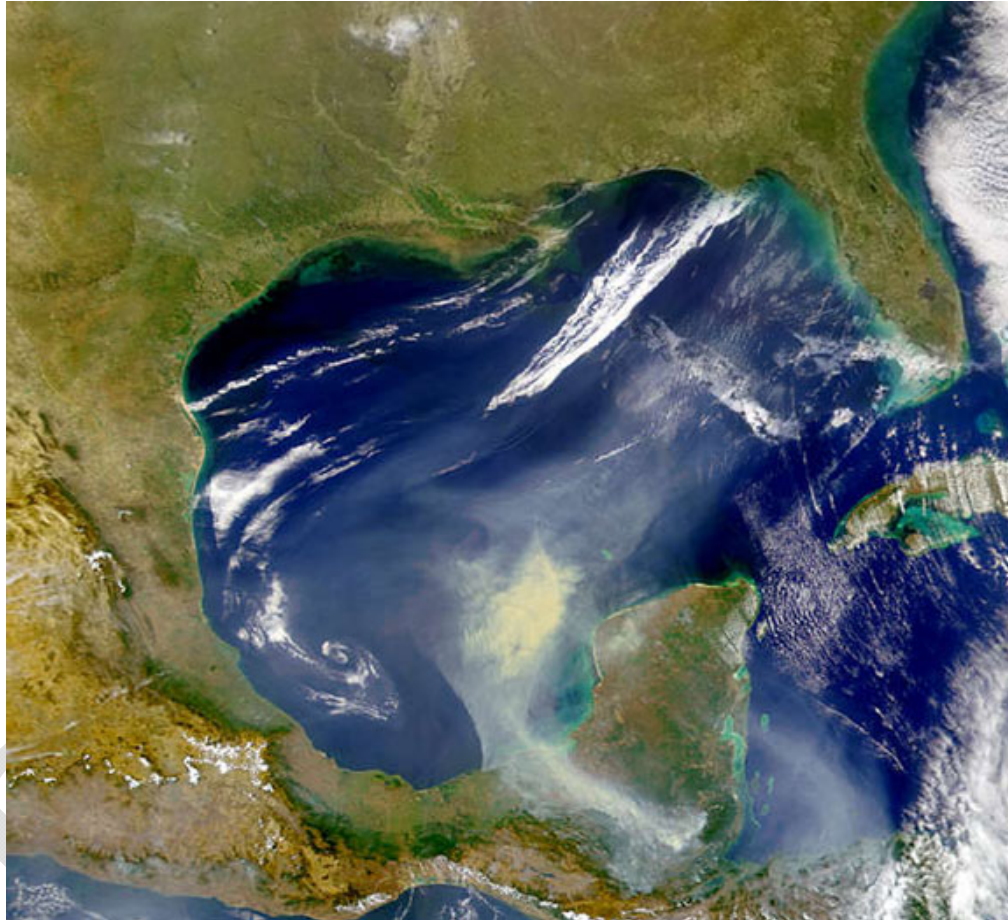
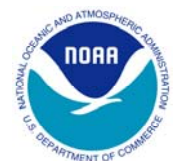


Gulf of Mexico Research Plan



**Produced as a Service to the Research and Resource Management Community
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Executive Summary

The depth and breadth of research needs in the Gulf of Mexico are too great for the limited financial and human resources that are available. In order to use these limited resources efficiently, the research community needs a prioritization process. In 2006, the National Oceanic and Atmospheric Administration (NOAA) National Sea Grant College Program provided funding to the four Gulf of Mexico Sea Grant College programs to develop a research plan for the Gulf of Mexico. The mission of the Gulf of Mexico Research Plan (GMRP) is to identify priority research needs for the Gulf of Mexico through broad constituent input and to implement strategies to address those needs. The goal is to assist the Gulf of Mexico research community including those who conduct or administer research or use research findings. More than 1,500 people from 233 organizations, universities, and federal and state departments completed a survey. Nearly 300 people from 77 organizations, universities, and federal and state departments participated in regional workshops. The research priorities outlined in this document were distilled from the survey and workshop results.

The general framework for the GMRP is based on the Joint Subcommittee on Ocean Science and Technology's report, "Charting the Course for Ocean Science in the United States for the Next Decade: An Ocean Research Priorities Plan and Implementation Strategy." The report, also referred to as Ocean Research Priorities Plan (ORPP), defines national priorities and identifies six societal themes and 20 equally weighted research priorities. Information in the GMRP prioritization process was analyzed both within this ORPP framework and independent of the ORPP categories. People who completed the survey or participated in workshops identified most priorities within two of the ORPP societal themes: "Improving Ecosystem Health" and "Stewardship of Natural and Cultural Ocean Resources." Despite the 20 ORPP-defined research priorities being equally weighted on a national level, the survey and workshops revealed that this is not the case for the Gulf of Mexico.

The highest rated Gulf of Mexico research priorities are framed within five topic areas. These topic areas, presented alphabetically, are:

- Connectivity of habitats and habitats to resources
- Ecosystem health indicators
- Freshwater input and hydrology
- Sea level change, subsidence, and storm surge
- Water quality and nutrients

The five Gulf of Mexico topic areas include 17 "Top Tier" research priorities, and there are 35 "Second Tier" research priorities that were not captured in the five topic areas but were ranked highly at workshops or in the survey. The research priorities for the Gulf of Mexico cover disciplines, including anthropology, biology, chemistry, climatology, ecology, economics, engineering, geology, hydrology, oceanography, physics, sociology, and many others.

The next step to effectively address the regional research needs is to develop an implementation plan. The region is well prepared to address issues on a regional scope due to recently established regional frameworks; the formation of a new regional governance structure in the Gulf of Mexico Alliance; and the continuity provided by well-established research cooperatives throughout the Gulf of Mexico. To implement a regional research plan, it is essential that the research community recognize opportunities in funding partnerships to optimize the use of expertise and limited resources throughout the region.

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Public Comments

Comments were received from state and federal government agencies, U.S. and Mexican universities, and non-governmental organizations.

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Introduction

On January 26, 2007, the Joint Subcommittee on Ocean Science and Technology released “Charting the Course for Ocean Science in the United States for the Next Decade: An Ocean Research Priorities Plan and Implementation Strategy,” also referred to as Ocean Research Priorities Plan or ORPP¹, in response to the U.S. Ocean Action Plan². Twenty-four federal agencies used input from hundreds of individuals to develop the plan. The ORPP is now a guiding document for addressing national ocean research needs. It contains six societal themes and 20 equally weighted research priorities.

There is also value in identifying and prioritizing needs on a regional level. Coastal and marine issues are not easily framed within local, state, or international boundaries. In addition, interest in regional governance and ecosystem-based management of coastal and marine resources in the Gulf of Mexico continues to increase as the Gulf of Mexico Alliance, Gulf of Mexico Coastal Ocean Observing System Regional Association, Mississippi River/Gulf of Mexico Watershed Nutrient Task Force and other efforts examine and address regional needs.

Recognizing the need to prioritize research on a regional level as described by the Pews Ocean Commission³, U.S. Commission on Ocean Policy⁴, U.S. Action Plan, and ORPP, in 2006 the National Sea Grant College Program provided funding to the four Gulf of Mexico Sea Grant College Programs to acquire and analyze information from thousands of people. This effort is also incorporated into the Subcommittee on Integrated Management of Ocean Resources’ (SIMOR) workplan⁵. Broad constituent input was used to identify priority research needs for the Gulf of Mexico. Once identified, the research and information needs were linked to the societal themes and research priorities defined in the ORPP. This framework enabled regional research priorities to connect to national priorities, while maintaining the necessary flexibility to address Gulf-specific needs. These linkages will be especially valuable during the implementation phase of the project. In addition, constituent input was also examined independent of the ORPP to identify broad research topics that are high priorities in the Gulf of Mexico.

The GMRP Planning and Review Council (PRC) provided guidance on identifying regional priorities throughout the process and will continue to play a role in the implementation phase of the project. The PRC members serve as liaisons to stakeholder groups, provide feedback on the planning process, participate in planning events, and comment on planning documents. PRC members are listed in Appendix A.

The GMRP briefly describes the methods used to identify the top research needs for the Gulf of Mexico and the results of this effort. This report contains numerous appendices that are referenced throughout the document. The appendices are available on the Web at: <http://masgc.org/gmrp/report.htm>.

¹ Charting the Course for Ocean Science in the United States for the Next Decade: An Ocean Research Priorities Plan and Implementation Strategy is available at: http://ocean.ceq.gov/about/sup_jsost_prioritiesplan.html.

² U.S. Ocean Action Plan is available at: ocean.ceq.gov/actionplan.pdf.

³ Information about the Pews Ocean Commission is available at: http://www.pewtrusts.org/our_work_detail.aspx?id=130.

⁴ The U.S. Commission on Ocean Policy report, “An Ocean Blueprint for the 21st Century” is available at: <http://oceancommission.gov>.

⁵ Subcommittee on Integrated Management of Ocean Resources (SIMOR) workplan is available at: http://ocean.ceq.gov/about/sup_simor_workplan.html#pr1wg2.

Methods

Data Collection

The GMRP used a three-pronged approach to collect constituent input. The approach included an analysis of existing research and management strategic plans, a Web-based survey, and five workshops.

In the spring of 2007, 117 strategic plans from local, state, federal, university-based, and other programs that conduct or use Gulf of Mexico research were analyzed. Research-oriented goals, themes, and priorities described in each strategic plan were linked to the ORPP research priorities. This analysis placed equal weight on each goal, theme, or priority within and between strategic plans and revealed where recent research emphasis has been in the Gulf of Mexico.

In the fall of 2007, a Web-based survey (Appendix C) was sent to at least 7,571 listserv and e-mail contacts, 68 media outlets and 7 Web sites. Participants at five or more conferences and workshops were also informed of the survey. Those completing the survey were asked to rate the ORPP-defined research priorities within the context of Gulf of Mexico research needs.

In January and February 2008 one workshop was held in each U.S. Gulf of Mexico state. At each workshop, participants were divided into six groups; each group addressed one of the ORPP themes-identifying research priorities and non-research related needs related to that theme. Groups shared their lists of research priorities with all workshop participants, and the participants ranked their most important research priorities across all themes.

Data Analysis

Part I: Analysis Independent of the ORPP Framework

To identify high-priority Gulf of Mexico topic areas, the Top 10 research priorities from each of the five workshops were examined together, and related priorities combined under a broad Gulf of Mexico topic area. A topic area was considered high priority if the research priorities associated with it were 1) ranked in the Top 10 at two or more workshops, 2) had an average workshop rank in the top five, and 3) was linked to one of the top five ORPP research priorities reported in the Web-survey and/or was in the top five most mentioned comments in the survey. The underlying research priorities that support the Gulf of Mexico high-priority topic areas were considered "Top Tier" research priorities. Gulf of Mexico research priorities that were ranked from 11 to 20 at the five workshops and in the comments of the web-survey that provided supplemental information that supported these highly ranked priorities were added to the description of research priorities.

Part II: Analysis Using the ORPP Framework

After Part I was complete each of the Top 10 workshop priorities from the five workshops were linked to specific ORPP research priorities. Short statements describing research priorities were organized by the ORPP framework and categorized as "Top Tier" if they fell within a Gulf of Mexico high-priority topic area. The remaining research priorities were designated "Second Tier." Since the "Second Tier" research priorities were ranked in the Top 10 at one or more workshops, they also should be considered priorities for the region.

Results

Survey and Workshop Results

More than 1,200 people from 233 organizations, universities, and federal and state departments in the U.S. and Mexico with over 20,000 years of experience rated the importance of the 20 ORPP-defined research priorities. In addition, there were 571 survey comments about regional research priorities. People who completed the survey were from universities (34%), government agencies (30%), business and industry (17%), and NGOs and other organizations (19%). More information and results of this effort are included in Appendix D.

Approximately 300 people from 77 organizations, universities, and federal and state departments in the U.S. and Mexico participated in the regional workshops (Appendix E). Workshop participants identified 261 high-priority research topics and 251 non-research topics for the Gulf of Mexico. The reports from the five workshops are in Appendix F.

Part I: Results from the Analysis Independent of the ORPP Framework

The five high-priority Gulf of Mexico topic areas in alphabetical order are Connectivity of Habitats and Habitats to Resources; Ecosystem Health Indicators; Freshwater Input and Hydrology; Sea Level Change, Subsidence, and Storm Surge; and Water Quality and Nutrients. Detailed descriptions of the “Top Tier” research priorities that support the five high-priority Gulf of Mexico topic areas are presented in Table 1.

Part II: Results from the Analysis Using the ORPP Framework

The survey ranking and number of links between Top 10 workshop priorities and the 20 ORPP research priorities are presented in Table 2. There were 54 top priorities that were identified as Top 10 workshop priorities due to ties at some workshops. These 54 top priorities represented 21 percent of all research priorities identified and 45 percent of total votes from workshop participants. Sixty-nine percent of the 54 top workshop priorities linked to two of the six ORPP societal themes. According to people who completed the survey, the top 10 ORPP research priorities supported four of the six broad ORPP societal themes. Additional results from this analysis are on page 14.

Strategic Plan Results

The strategic plans used in this synthesis are available at <http://masgc.org/gmrp/plans.htm>, and results of the synthesis effort are included in Appendix B. Almost 68 percent of the goals, themes, or priorities from the strategic plans aligned with two of the six ORPP societal themes (Table 3). The same two themes emerged as priorities in the workshop, survey, and strategic plan analyses and are “Improving Ecosystem Health” and “Stewardship of Natural and Cultural Resources.”

Table 1. High-priority Gulf of Mexico topic areas from the ORRP independent analysis, related ORPP themes in italics, and supporting top tier research priorities.

High-priority Topic Area	Supporting Top Tier Research Priorities
<p>Connectivity of Habitats and Habitats to Resources <i>(Stewardship of Resources)</i></p>	<p>Identify connections between habitats, such as deepwater hard bottom to estuaries or upstream to downstream habitats, and connections between habitats and living marine resources</p> <p>Model resource stability and sustainability and include interactions between fisheries, habitat, threatened and endangered species, forcing functions and ecosystem processes to assist with making ecosystem-based management decisions</p> <p>Examine changes in habitat quality and quantity over time and identify the effects of changes on marine organisms including the threshold level of habitat quality and quantity required to support sustainable populations of living resources</p>
<p>Ecosystem Health Indicators <i>(Ecosystem Health)</i></p>	<p>Determine the correct variables to use as indicators of ecosystem health, identify the optimal methods to measure the indicators, and design better defined indices with more indicators to evaluate the status of ecosystems</p>
<p>Freshwater Input and Hydrology <i>(Ecosystem Health, Climate, and Marine Operations)</i></p>	<p>Predict the impacts of current building and permitting practices on freshwater inflow and examine the affects of human manipulation (e.g. upstream impoundments, causeways, placing processed water into confined areas) on the amount, timing, and type (ground water versus surface water) of freshwater inflows on natural resources and the environment</p> <p>Analyze the role of freshwater input on coastal wetlands and habitat change over time to determine the hydrologic requirements of healthy marsh systems and quantify effects of sediment discharge reduction on erosion rates and habitat loss</p> <p>Examine how river diversions and the placement of sediment impacts water quality, sediment processes, shoaling, coastal processes, fisheries, habitat utilization by organisms, and marshes and other habitats</p> <p>Examine the impacts of higher saline water and temperature change on water stratification, biodiversity, species composition and production, benthic communities, trophic interactions, fisheries, the range of native and non-native species, emergent coastal habitats, and sediment transport and shoreline erosion</p> <p>Determine changes in freshwater, nutrient, pollution, groundwater and sediment input due to changes in pattern and quantity of precipitation and predict the subsequent impact of these inputs on biological (including benthic and epibenthic) communities, geochemical, and physical coastal processes</p>
<p>Sea Level Change, Subsidence, and Storm Surge <i>(Resilience to Hazards and Climate)</i></p>	<p>Determine and predict the physical impacts of climate change on coastal and upland areas in terms of sea level change, rate of elevation change, shoreline change, loss of barrier islands, role of coastal development in preventing migration of marshes and other habitats, and changes in inland, coastal, and ocean hydrology; and apply this knowledge in habitat restoration efforts</p> <p>Examine the public's perception of sea level change; evaluate hazard-related communications and people's change in behavior in relation to hazard mitigation; and identify approaches that local governments are employing to adapt to sea level change</p> <p>Identify the optimal use and allocation of sediment and evaluate the rates of shoreline change from anthropogenic and natural impacts including sediment mobilization, transport, and deposition from major storm events</p> <p>Determine how storm surge, subsidence and sea level change impacts ecosystems, native coastal habitat, wetland composition, salt water intrusion, coastal flooding, cultures, agriculture, and human health</p> <p>Predict socioeconomic impacts of climate and sea level change on population dynamics, community infrastructure, short- and long-term community demographic shifts, social capital, and commerce and shipping centers</p>
<p>Water Quality and Nutrients <i>(Ecosystem Health)</i></p>	<p>Evaluate the relationship of coastal development, land use, land cover, storm water and wastewater management on eutrophication, nutrient loading, water quality, and the environment</p> <p>Identify the relationships between nutrient loading, eutrophication, hypoxia and harmful algal blooms, examine their impacts on ecosystem health, sea grasses and higher trophic organisms, and determine the effects of freshwater diversion on hypoxia</p> <p>Model the impacts of non-point source pollution on coastal resources</p>

Table 2. ORPP research priorities for the Gulf of Mexico according to average survey rank and number of links to the 54 priorities that were rated in the Top 10 at the five workshops.

ORPP Theme ^a	ORPP Number	ORPP Research Priorities	Survey Rank	Workshop Links
Eco	14	Understand and predict the impact of natural and anthropogenic processes on ecosystems	1	11
Stw	3	Understand human-use patterns that may influence resource stability and sustainability	2	2
Stw	2	Understand interspecies and habitat/species relationships to support forecasting resource stability and sustainability	3	11
Eco	16	Apply understanding of marine ecosystems to develop appropriate indicators and metrics for sustainable use and effective management	3	3
Stw	1	Understand the status and trends of resource abundance and distribution through more accurate, timely and synoptic assessments	5	1
Res	6	Understand the response of coastal and marine systems to natural hazards and apply that understanding to assessments of future vulnerability to natural hazards	6	2
Clm	12	Understand the impact of climate variability and change on the biogeochemistry of the ocean and implications for its ecosystems	7	3
Eco	15	Apply understanding of natural and anthropogenic processes to develop socioeconomic assessments and models to evaluate the impact of multiple human uses on ecosystems	8	6
Clm	11	Understand ocean-climate interactions within and across regions	9	0 ^b
Clm	13	Apply understanding of the ocean to help project future climate changes and their impacts	10	0 ^b
Ops	8	Understand the interactions between marine operations and the environment	11	3
Res	5	Understand how hazard events initiate and evolve, and apply that understanding to improve forecasts of future hazard events	11	2
Res	7	Apply understanding to develop multi-hazard risk assessments and support development of models, policies, and strategies for hazard mitigation	13	4
Stw	4	Apply advanced understanding and technologies to enhance the benefits of various natural resources from the open ocean and coasts	14	2
Hth	17	Understand sources and processes contributing to ocean-related risks to human health	15	2
Hth	18	Understand human health risks associated with the ocean and the potential benefits of ocean resources to human health	16	1
Hth	19	Understand how human use and valuation of ocean resources can be affected by ocean-borne human health threats and how human activities can influence these threats	17	0
Ops	9	Apply understanding of environmental factors affecting marine operations to characterize and predict conditions in the maritime domain	18	0
Hth	20	Apply understanding of ocean ecosystems and biodiversity to develop products and biological models to enhance human well-being	19	1
Ops	10	Apply understanding of environmental impacts and marine operations to enhance the marine transportation system	20	0

^aThe key for the ORPP theme codes are Eco for Improving Ecosystem Health; Stw for Stewardship of Natural and Cultural Resources; Res for Increase Resilience to Natural Hazards; Hth for Enhancing Human Health; Ops for Enabling Marine Operations; and Clm for The Ocean's Role in Climate.

^bA "0" indicated that there was no primary link between the 54 Top 10 workshop priorities from the five workshops and ORPP research priority. Several climate-related Top 10 workshop priorities were linked to ORPP research priorities that better fit themes other than "The Ocean's Role in Climate" ORPP theme.

Table 3. Results from the strategic plan analysis, survey, and workshop organized by Ocean Research Priorities Plan themes.

Ocean Research Priorities Plan Theme	Percent of Strategic Plan Priorities that Match Theme	Average Survey Rating of Research Priorities within Theme*	Number of Top 10 Workshop Priorities within Theme
Improving Ecosystem Health	34.8%	4.21	20
Stewardship of Natural and Cultural Resources	32.9%	4.14	16
Increase Resilience to Natural Hazards	8.7%	4.00	8
Enhancing Human Health	8.7%	3.75	4
Enabling Marine Operations	8.4%	3.73	3
The Ocean's Role in Climate	6.6%	4.07	3

*Rating ranged from 5 (very high importance) to 1 (very low importance).

DRAFT

Additional Needs

Information, Education, Management, and Other Needs for the Region

The primary focus of the Gulf of Mexico Research Plan is to identify research priorities for the Gulf of Mexico region. However, people who completed the survey or participated in workshops identified information that is needed to frame research questions or provide baseline information from which to conduct research. The continuum from research to application is wide, and Gulf of Mexico needs fall on different places along the continuum. Some survey respondents and workshop participants considered a specific need to be a research need, while others classified the same need as an informational need. For the purposes of the GMRP, research needs to be addressed by researchers in social sciences (e.g. economics, sociology, anthropology) and natural sciences (e.g. biology, geology, chemistry, physics), and includes the development of new models and predictive tools.

Survey respondents and workshop participants identified numerous non-research needs. This information is valuable and included in this report. The comments can be found in Appendices D and G.

Non-research needs fall into these categories:

- Education and Communication Needs
- Information Needs
- Coordination, Policy, and Management Needs
- Habitat and Restoration Topics
- General Responses to Open-Ended Question
- Socioeconomic Needs
- Other Needs

Economics and Gulf of Mexico Research

Wise use of limited regional research resources is imperative due to the current economic climate at a regional, national, and international level. Throughout the planning process stakeholders identified the need to efficiently and effectively utilize research dollars and demonstrate the economic return on investment. This requires close examination of proposed and ongoing research and the ability to accurately determine and convey the economic benefits of this work at the local, state, regional, national, and/or international level. Economic research and analysis is often needed to achieve this goal and was recommended as an important component to regional research.

Initial Progress Toward Implementation

The region is well prepared to address Gulf of Mexico research priorities. The next step is to develop an implementation plan to address the highest priority needs identified in the GMRP. There are well-established research entities throughout the Gulf of Mexico and new collaborative regional frameworks have been established over the last five years. These frameworks include cooperation with local, state, federal, academic, NGO, and private entities.

The GMRP provides an outline of regional priorities that can be used to bolster and support local, regional, national, and international research programs. To be successful, it is essential that members of the research community identify how their work can complement each others' work. This collaboration will optimize the use of expertise and limited resources. Partnerships between research programs and participation in collective efforts, such as the Gulf of Mexico Alliance, Gulf of Mexico Coastal Ocean Observing System Regional Association, and Mississippi River/Gulf of Mexico Watershed Nutrient Task Force are examples of this collaboration. Joint RFPs are another avenue to leverage resources.

There are numerous challenges to successfully implement the GMRP. Organizations follow strategic plans, which can provide flexibility in addressing regional needs in some cases but not in other cases. Due to differing funding cycles, RFP requirements, and scopes of work, there can be challenges to jointly funding research. However, these obstacles can be overcome through entities funding separate elements of a common research priority and coordinating the timing of RFP releases.

The research priorities identified in the GMRP provide a starting point for addressing priorities on a regional level. Several groups, such as Florida Sea Grant College Program, Gulf of Mexico Alliance, Louisiana Sea Grant College Program, Mississippi-Alabama Sea Grant Consortium, Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, NASA, NOAA Center for Sponsored Coastal Ocean Research (CSCOR), NOAA Gulf Coast Services Center, Northern Gulf Institute, Southeast Aquatic Resource Partnership, Southern Association of Marine Laboratories, Texas Coastal Coordination Council, and Texas Sea Grant College Program and others, have indicated that they have or will be incorporating the GMRP research priorities into their planning processes. Now that regional research priorities are identified, plans for implementation can begin. The implementation process will include identifying, implementing, and evaluating strategies to address these research priorities.

Early Success—Research Initiative Transitions GMRP from Planning to Implementation

The Gulf of Mexico Research Initiative is an example of the GMRP transitioning from the planning phase to implementation phase. EPA's Gulf of Mexico Program, Florida Sea Grant College Program, Louisiana Sea Grant College Program, Mississippi-Alabama Sea Grant Consortium, Northern Gulf Institute, Texas Sea Grant College Program, and the U.S. Geological Survey are pooling resources to jointly sponsor research and outreach that address priorities identified by the GMRP and Gulf of Mexico Alliance. Successful projects will help Gulf of Mexico communities better understand and become more resilient to climate and natural hazards. Approximately \$1.5 million research and outreach dollars and matching funds will be used for this initiative during 2010-2011.

The GMRP PRC, principal investigators, and coordinator are developing the GMRP as a service to the region. The implementation phase will be most successful if the majority of research-based groups and organizations working in the Gulf of Mexico are actively involved in the effort. This involvement will start with input from the PRC and coordination with groups throughout the Gulf of Mexico, including colleagues in Mexico.

Supplemental: First and Second Tier Gulf of Mexico Research Priorities

Gulf of Mexico Research Priorities Arranged by ORPP-defined Societal Themes and Research Priorities
Gulf of Mexico research priorities are arranged by “Top Tier,” which are the research priorities that support the Gulf of Mexico high priority topic areas and are included in Table 1, and “Second Tier” priorities, which are the remaining highly ranked workshop priorities that were not captured within a high priority topic area. The priorities are arranged by ORPP theme and research priority and in some cases individual workshop priorities were broken into several bullets or merged with other bullets. In addition, supplemental information from the Top 11 to 20 workshop priorities and survey comments were used if they provided clarification for a bullet.

ORPP Theme: Improving Ecosystem Health

Understand and predict the impact of natural and anthropogenic processes on ecosystems

Ocean Research Priorities Plan Research Priority 14 (ORPP RP14)

Top Tier Gulf of Mexico Priorities

- Predict the impacts of current building and permitting practices on freshwater inflow and examine the affects of human manipulation (e.g. upstream impoundments, causeways, placing processed water into confined areas) on the amount, timing, and type (ground water versus surface water) of freshwater inflows on natural resources and the environment
- Analyze the role of freshwater input on coastal wetlands and habitat change over time to determine the hydrologic requirements of healthy marsh systems and quantify effects of sediment discharge reduction on erosion rates and habitat loss
- Examine the impacts of higher saline water and temperature change on water stratification, biodiversity, species composition and production, benthic communities, trophic interactions, fisheries, the range of native and non-native species, emergent coastal habitats, and sediment transport and shoreline erosion
- Evaluate the relationship of coastal development, land use, land cover, storm water and wastewater management on eutrophication, nutrient loading, water quality, and the environment
- Identify the relationships between nutrient loading, eutrophication, hypoxia and harmful algal blooms, examine their impacts on ecosystem health, sea grasses and higher trophic organisms, and determine the effects of freshwater diversion on hypoxia
- Model the impacts of non-point source pollution on coastal resources

Second Tier Gulf of Mexico Priorities

- Examine impacts of global climate change on local ecosystems, and design flexible ecosystem models to predict local impacts
- Determine the response of organisms and the emergence or prevalence of pathogens in response to changing levels of temperature, salinity, carbon dioxide, wind, and other climate-linked factors
- Examine Gulf of Mexico watershed systems in terms of evaluating current sediment, freshwater volume, and nutrient loads in these systems to better assess the potential for restoring critical areas and habitats
- Evaluate the total potential of Mississippi River restoration considering sediment, freshwater volume, nutrients, and optimal distribution of the Achafalaya and Mississippi Rivers.

Apply understanding of natural and anthropogenic processes to develop socioeconomic assessments and models to evaluate the impact of multiple human uses on ecosystems (ORPP RP15)

Second Tier Gulf of Mexico Priorities

- Identify social and economic drivers that influence how communities use their resources; examine why communities make different conservation decisions; and determine and catalog the socioeconomic impacts and value of changing the level of protection (increasing or decreasing protection) and restoration of

ecosystems at various scales and determine how this impacts resource users, communities, and the environment (including if habitat functions as expected)

- Identify the true costs and true benefits of future coastal development and include the economic impacts of climate change on maritime activities, oil and gas, fisheries, infrastructure, and tax base
- Predict the socioeconomic and ecological impacts of future coastal development and population growth in the coastal zone based on projections of future development and including an examination of the historic and prehistoric human densities in the coastal zone
- Examine the balance between optimizing future coastal development while minimizing environmental impacts, maximizing quality of life, and maintaining public access
- Examine the economic, cultural, and intrinsic value of working waterfronts including economic, social, and environmental cost-benefit analyses of working waterfronts to compare with other waterfront uses
- Characterize Gulf of Mexico fishing communities using socioeconomic methods, and determine the economic feasibility of alternatives to wild harvest fisheries such as aquaculture
- Model economic impacts to fisheries production, recreational uses of the resources, and community resiliency
- Determine the benefits and costs of restoration and include the development of models to understand these costs and benefits
- Evaluate the effectiveness of the educational programs related to our natural resources and improve the methodologies of sharing information with the public so that communities can make more informed decisions

Apply understanding of marine ecosystems to develop appropriate indicators and metrics for sustainable use and effective management (ORPP RP16)

Top Tier Gulf of Mexico Priority

- Determine the correct variables to use as indicators of ecosystem health, identify the optimal methods to measure the indicators, and design better defined indices with more indicators to evaluate the status of ecosystems

Second Tier Gulf of Mexico Priority

- Design rapid field-based standardized tests for the detection of specific variables that will identify the presence of bacteria, contaminants, toxins, and pathogenic organisms at harmful levels

ORPP Theme: Stewardship of Natural and Cultural Resources

Understand interspecies and habitat/species relationships to support forecasting resource stability and sustainability (ORPP RP2)

Top Tier Gulf of Mexico Priorities

- Identify connections between habitats, such as deepwater hard bottom to estuaries or upstream to downstream habitats, and connections between habitats and living marine resources
- Model resource stability and sustainability and include interactions between fisheries, habitat, threatened and endangered species, forcing functions and ecosystem processes to assist with making ecosystem-based management decisions
- Examine changes in habitat quality and quantity over time and identify the effects of changes on marine organisms including the threshold level of habitat quality and quantity required to support sustainable populations of living resources

Second Tier Gulf of Mexico Priorities

- Analyze the trophic relationships of commercially valuable species, endangered species, and invasive species and predict ecosystem changes influencing the removal of commercially valuable species
- Determine how resource diversity and abundance responds to changes in ecosystem structure and function; identify what changes are caused by natural versus anthropogenic causes; and analyze the relationship between living resource sustainability and water quality, invasive species, tourism, coastal development, urban development, land use, and marine aquaculture

- Examine the impact of climate change on fish ecology, mortality, fecundity, recruitment, distribution, migration, and predator-prey interaction
- Evaluate the relative importance of different sites in the Gulf of Mexico that support resource abundance and diversity by examining water circulation, gene flow, larval transport and connectivity of habitats and populations in the region
- Formulate a method to measure the effectiveness of Marine Protected Areas

Understand human-use patterns that may influence resource stability and sustainability (ORPP RP3)

Second Tier Gulf of Mexico Priorities

- Establish the value of Gulf of Mexico ecosystem services, including depleted and renewable resources
- Model the value of various habitats and ecosystems to allow for informed decisions on the placement, construction, development, and expansion of marine facilities and operation

Apply advanced understanding and technologies to enhance benefits of various natural resources from the open ocean and coasts (ORPP RP4)

Second Tier Gulf of Mexico Priorities

- Identify methods for improving aquaculture grow-out technology for stock enhancement and other purposes and examine the environmental and economic impacts of marine and estuarine aquaculture in the Gulf of Mexico including the impacts of mariculture in shallow, warm waters
- Evaluate innovative uses of oil platforms such as generating alternative energy, collecting weather data, developing ecotourism options, and rearing marine organisms

Understand the status and trends of resource abundance and distribution through more accurate, timely, and synoptic assessments (ORPP RP1)

Second Tier Gulf of Mexico Priority

- Develop more accurate assessments of biodiversity on a micro (genetic and molecular ecology) and macro (population) level

ORPP Theme: Increase Resilience to Natural Hazards

Apply understanding to develop multi-hazard risk assessments and support development of models, policies, and strategies for hazard mitigation (ORPP RP7)

Top Tier Gulf of Mexico Priorities

- Determine and predict the physical impacts of climate change on coastal and upland areas in terms of sea level change, rate of elevation change, shoreline change, loss of barrier islands, role of coastal development in preventing migration of marshes and other habitats, and changes in inland, coastal, and ocean hydrology; and apply this knowledge in habitat restoration efforts
- Examine the public's perception of sea level change; evaluate hazard-related communications and people's change in behavior in relation to hazard mitigation; and identify approaches that local governments are employing to adapt to sea level change
- Predict socioeconomic impacts of climate and sea level change on population dynamics, community infrastructure, short- and long-term community demographic shifts, social capital, and commerce and shipping centers

Second Tier Gulf of Mexico Priorities

- Characterize and model community and ecological resilience to natural hazards considering the ecological footprint and level of vulnerability of the built environment and identify methods to reduce losses; and model the attributes, factors, and strategies that contribute to making a community successfully resilient

Understand response of coastal and marine systems to natural hazards and apply that understanding to assessments of future vulnerability to natural hazards (ORPP RP6)

Top Tier Gulf of Mexico Priorities

- Determine how storm surge, subsidence and sea level change impacts ecosystems, native coastal habitat, wetland composition, salt water intrusion, coastal flooding, cultures, agriculture, and human health
- Identify the optimal use and allocation of sediment and evaluate the rates of shoreline change from anthropogenic and natural impacts including sediment mobilization, transport, and deposition from major storm events

Second Tier Gulf of Mexico Priorities

- Analyze how coastal and nearshore morphology, vegetation, beaches, dunes, coastal forests, and wetlands protect inland areas from hurricane impacts by absorbing wind and storm surge energy; and determine the economic value (e.g. costs and benefits) of natural protective features

Understand how hazard events initiate and evolve, and apply that understanding to improve forecasts of future hazard events (ORPP RP5)

Second Tier Gulf of Mexico Priorities

- Design updated real-time storm surge models and products that include meteorological, land use and land cover, and improved boundary data to better predict impacts from storms

ORPP Theme: Enhancing Human Health

Understand sources and processes contributing to ocean-related risks to human health (ORPP RP17)

Second Tier Gulf of Mexico Priorities

- Determine how environmental factors (e.g. sea temperature, salinity, industrial discharge, agricultural inputs, freshwater inflow, and water quality) and large-scale events (e.g. climate change and tropical storms) influence the occurrence, intensity, and duration of harmful algal blooms, toxins, and pathogens and develop harmful algal bloom transport models for near shore waters
- Incorporate integrated studies to examine the affects and transport of wastewater on human health, drinking water, and water quality including improving the ability to identify contaminant sources such as raw and partially treated sewage

Understand human health risks associated with the ocean and potential benefits of ocean resources to human health (ORPP RP18)

Second Tier Gulf of Mexico Priorities

- Examine and predict how changes in water quality, temperature, runoff, and mercury levels impact seafood safety and quality and determine the effects of bioaccumulation, harmful algal blooms and other harmful substances on the safety of seafood products
- Identify the relationship between temperature change and Vibrio species and improve prediction capabilities related to the occurrence and duration of this pathogen in a given body of water

Apply understanding of ocean ecosystems and biodiversity to develop products and biological models to enhance human well-being (ORPP RP20)

Second Tier Gulf of Mexico Priority

- Analyze marine and coastal derived products to determine their potential for pharmaceuticals and other biological-based products

ORPP Theme: The Ocean's Role in Climate

Understand the impact of climate variability and change on the biogeochemistry of the ocean and implication for its ecosystems (ORPP RP12)

Top Tier Gulf of Mexico Priorities

- Determine changes in freshwater, nutrient, pollution, groundwater and sediment input due to changes in pattern and quantity of precipitation and predict the subsequent impact of these inputs on biological (including benthic and epibenthic) communities, geochemical, and physical coastal processes

Second Tier Gulf of Mexico Priority

- Develop and validate numerical circulation models and techniques for data assimilation
- Evaluate the best locations for sensors to record climatological, wind, atmospheric, and ocean circulation data and use Observation System Simulation Experiments (OSSE) to determine optimal placement of sensors

Note: Other climate-related research priorities are captured elsewhere in this document.

ORPP Theme: Enabling Marine Operations

Understand the interactions between marine operations and the environment (ORPP RP8)

Top Tier Gulf of Mexico Priority

- Examine how river diversions and the placement of sediment impact water quality, sediment processes, shoaling, coastal processes, fisheries, habitat utilization by organisms, and marshes and other habitats

Second Tier Gulf of Mexico Priority

- Determine impacts of past and present navigation practices, shipping including shallow-draft PANAMAX super-containers, port facilities, shallow-water dredging and non-dredging sediment management on water and air quality, sediment transport, land loss and erosion, circulation, ecosystem health, and human health