CHALLENGES IN SCIENCE -- GULF OF MEXICO REGION

Recommendations to the Ocean Policy Commission
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In November 2001, Dr. James Coleman, a member of the Ocean Policy Commission, asked us to prepare a paper on scientific challenges in the Gulf of Mexico region, and in particular in coastal Louisiana. He wanted the perspective of scientists with many years of experience in that region. This paper resulted from that effort. We thank the members of the Ocean Policy Commission for the opportunity to provide recommendations about science needs and challenges in the Gulf of Mexico region.

It is appropriate that the Department of the Interior (DOI), and specifically scientists from the U.S. Geological Survey (USGS), be involved in the Commission's deliberations. In the Gulf coastal counties/parishes alone, the Department of the Interior manages 44 National Wildlife Refuge units and 9 National Parks with a total of 3,581,137 acres. It also manages America's rich reserves of oil and gas in the Outer Continental Shelf. As the DOI science bureau, the USGS provides the information and technology needed to better manage America's inland, coastal, and marine resources, reduce the impacts of natural disasters, and plan for growth in human populations. Indeed, it is part of USGS's mission to provide the geologic, hydrologic, mapping, and biologic framework and processes for the United States. That science mission includes all regions of the Nation, from the tallest mountains to the coasts and continental shelves, seaward 200 nautical miles to the Exclusive Economic Zone boundary. The USGS has 36 offices in the Gulf Coast States, including 5 State water resources district offices and major multidisciplinary research centers located in Lafayette, LA, St. Petersburg, FL, and Gainesville, FL. These research centers are also co-located with major universities.

Gulf Of Mexico Setting

The Gulf of Mexico receives freshwater from 33 major rivers, which drain 31 States (more than 2/3 of the contiguous United States), in addition to a similar drainage area from Mexico. The 1,630-mile Gulf Coast shoreline is longer than the Atlantic and Pacific coastlines, and the 30 Gulf Coast estuaries account for 42% of America's estuarine area. Most of the billion-dollar U.S. weather disasters during the past 20 years occurred in the coastal regions of the 5 Gulf States. Recent studies have confirmed that rising sea level, in conjunction with increases in rainfall and the intensity of storms, are a potential threat to low-lying Gulf coastal plain wetlands, estuaries, and fringing terrestrial ecosystems where most of the Gulf Coast population

is located. The Mississippi River deltaic plain is experiencing the most extreme rates of coastal erosion, subsidence, and land loss on the continent. About 25% of the Gulf Coast's shellfish growing areas are closed because of pollution, and increased nutrient loading of the Mississippi River causes hypoxia in a 7,000-mi^2 area of nearshore Gulf waters each summer and chronic algal blooms in many of the region's inshore coastal waters. Invasive species are a serious threat to native biota in many Gulf Coast ecosystems; aquatic nuisance species pose serious economic problems in many coastal counties, interfering with transportation, energy production, reservoir capacity, and recreational uses.

Over 80% of U.S. coastal wetland losses have occurred in the Gulf Coast region since 1940, and predictions of future population growth, coupled with accelerated sea-level rise, portend increasing pressure on Gulf Coast communities and their environment. Despite these pressures, overall biodiversity is high, and the Gulf coastal margin remains important to the Nation in terms of both nonrenewable and renewable resources. Gulf Coast ecosystems support most of the Nation's wintering waterfowl and account for about half of the fisheries production in the lower 48 states.

The health, safety, and economic well-being of the 23 million U.S. Gulf Coast residents are dependent upon the integrity of coastal systems and wise, informed decisions that will enhance their sustainability. It is imperative that Federal, State and local resource managers have information needed for science-based strategies that integrate the complex natural processes in this region with population protection and growth.

Human populations along the 1,630-mile Gulf Coast have greatly increased in the past 50 years. What was once a rural and somewhat sleepy coast is now much more urbanized with large and small ports, sprawling subdivisions, malls, high-rise condos, and in some places casinos. This coast now supports about 23 million people, and over the next 25 years this population is expected to grow by another 37%. By 2026 this coast could be home for 31 million people plus host to very large populations of tourists. Moreover, the Gulf of Mexico continental shelf accounts for about 95% of the U.S. outer continental shelf oil and gas production, and the region processes over 2/3 of the Nation's oil imports. This rapidly expanding population and large oil and gas production provide the setting for a discussion of science, science information needs, and models for implementing science.

Science Information Needs

As practitioners of science, we believe it is important to understand the science information needs of individuals who are responsible for managing coastal and ocean resources. We used their input to design science programs and initiatives, including a Gulf Coast Initiative. Accordingly, we meet with Federal and State managers in a number of different forums to gain that understanding. In the past year we've had a number of meetings and workshops with Gulf Coast State and Federal managers. Moreover we also used the World Wide Web to poll 60 natural resource managers from all of the Gulf States, most involved in wetland restoration, to get their advice. These included land owners/managers; local, State and Federal natural resource experts; State and Federal regulatory agencies; not-for-profit organizations; and scientists. About half responded to the query, providing details on what they saw as the needs for science information. The following is a summary of what these managers saw as the challenges for

science information, and they directly attribute most of these challenges to past human population increases and projections of continued rapid growth along the Gulf Coast. Please note that most of these science challenges or information needs cross many interest groups, State boundaries, and also traditional scientific disciplines. They also require long-term collection of scientific information.

- **Freshwater** – There is a diminishing availability and flow rates of freshwater from rivers and streams, and inflows to estuaries, increasing nutrients, contaminants (including nontraditional contaminants such as medicines), and salinities. Managers indicated they need baseline information, predictive models, and potential impacts on human health and aquatic organisms.
- **Habitat Change** – Many issues and science needs were noted, including loss, displacement, and change of wetland habitats, loss and displacement of fish and wildlife, increasing habitat changes from human endeavors (more channelization, dredging, bulkheads, roads, etc.), and importance of wetlands for carbon sequestration. Managers want these losses monitored. They need estimates of losses, gains, and values and predictive models.
- **Gulf Hypoxia** – A very large hypoxic or low oxygen zone that forms in the Gulf each year is most likely due to mainland runoff of nutrients from the Mississippi River basin. Managers want this hypoxic zone monitored. They also want information and predictive models on solutions, including agricultural management of nutrient runoff in critical subbasins, or diversions of river water into adjacent wetlands, particularly coastal wetlands.
- **Invasive Species** – Numbers and populations of invasive species of both plants and animals are growing. Invasives are currently costing the Nation billions of dollars each year for control. Managers want to know what we can do to lower the risks of invasive species and reduce the annual costs significantly.
- **Hurricanes and Storm Disasters** – Managers noted that they know these storms are inevitable but indicated we need to do more to assess vulnerability and risks, and provide baseline information during these events, including the risk of coastal erosion. They also want better information and models so they can anticipate, plan, and design for these events.
- **Sea-Level Rise and Global Change** – The certainty of impacts from global change are just gaining widespread acceptance in the science community, but they have yet to impact coastal planning, permitting, water projects, or wetland restoration. Included here is not only sea-level rise but also subsidence. Managers need better information on sea-level rise and predictive models that examine future impacts.
- **Oil and Gas Development** – There will be a continuation of existing development and expansion into new areas: new technologies for exploration, extraction, and transportation are increasing. And there are new opportunities, and hazards, such as gas hydrates. Managers asked if we could reduce or minimize the risks of oil and gas development even further.
- **Acquisition of Public Lands** – Public lands will be needed to meet the needs of the current and expanding population, but the issues are where, how much, and what uses. Managers want better information on status and trends of possible additions and natural resource values.

- **Engineering Guidelines for Development** – Many managers felt guidelines for development of coastal infrastructure are inadequate or lacking in many areas.
- **Legal Reform** – Managers felt we should be sharpening the legislative tools for wetland restoration, coastal planning, and permitting within and across State boundaries.
- **Public Education and Attitudes Toward Coastal Wetlands** – Wetland education is a huge issue along some parts of the coast. Managers see us moving from a wetland-dependent society (economically and culturally) to casual or recreational use of wetlands. They want more education for the public on natural resources.

All of these issues have a science underpinning that requires more data, more information, and better scientific understanding. Most are **geographically specific --** they may loom larger in some geographic areas of the Gulf. It is important to engage natural resource agencies and experts in a dialog to **identify the highest priority science needs**. Each geographic area will require a variety of science information, hence there is a strong need for **integration of scientific disciplines** as they endeavor to tackle these issues. These are **long-term science issues** that require inventory, monitoring, and standardized methodologies, as well as modeling and hypothesis testing. And, they require an **integrated science approach and information sharing**. No one science institution has the wherewithal to adequately address all of the needs, so there is also a strong need for **partnerships.** And last there is a need for **real-time science information sharing** among scientists and **accelerating the availability of science information** to natural resource managers and the general public.

New and improved science programs are needed to address these Gulf of Mexico issues. Our understanding of coastal processes in this region needs substantial improvement, particularly to understand the wide variability in process and process outcomes that dominates this region. We also need to better understand the status and trends of ecosystems in the region, particularly barrier islands, wetlands, benthos communities, and the river/estuary interface. Freshwater quantity and water-quality issues are foremost in the minds of many natural resource managers; what are the limits of freshwater for human development and what sources exist to provide for the future? We need better information on hazards to human populations and infrastructure, information that can be used in real time to lessen risks of hazards such as hurricanes. Education also becomes a major need, for many of the people of this rapidly growing human population have little understanding of the importance of the natural systems to the overall economy. And socioeconomic information is badly needed to understand change in human populations and predict future population characteristics and needs.

Some of these science information needs would best be fulfilled by using standardized approaches to gather data over the entire Gulf Coast. These data may include: sea level, tides, marsh and submerged bottom elevations, salinity, sediments, benthic communities, vegetation, nutrients, water quality and contaminants, rainfall, winds, and wave heights and direction, as well as other critical data. These data sets should be integrated and sufficiently robust in sampling design to be useful for measuring status and trends and predicting future conditions. Such an Integrated Coastal Monitoring System could be similar in scope to the Global Ocean Observing System (GOOS) but dedicated solely to coastal systems.

A Model For Addressing Science Needs

To address science needs in the coast USGS has developed a model approach that includes the eight elements described above and are piloting this model in the Tampa Bay area. We offer it here as one example. The Tampa Bay Pilot Study is an integrated science effort by the USGS that combines the expertise of Federal, State, and local partners to address some of the most pressing societal and ecological problems of the Tampa Bay Estuary. In addition, it is noteworthy that many of the issues that emerged from Tampa Bay are the same in kind as those found in other estuaries nationwide. The focus on integrated science in a geographically specific area attempts to provide a more holistic approach to science while at the same time addressing real world issues. The project is being developed to serve as a template for application of integrated research projects in other geographically specific areas such as the other estuaries of the Gulf of Mexico.

Tampa Bay is one of the Gulf of Mexico's largest estuaries and exemplifies the environmental stresses that our Nation's bays and estuaries face in general. More than 2 million people live in the Tampa Bay watershed, and the population continues to grow. Increased development demands more fresh water, causes habitat change and loss, and creates greater air and water pollution. Despite the changing quality and quantity of water entering the bay and dramatic alteration of sensitive coastal environments, the scientific baseline controls documenting these changes and providing a scientific foundation for future development have not been established. The Tampa Bay Pilot Project started with an assessment of issues and needs in the Tampa Bay area as perceived by a wide variety of stakeholders. Working with these natural resource managers, regulators, or experts, the project managers identified four of the most critical needs for science information:

- establish baseline maps of hydrology, biology, geology, land-use history, and bathymetry and enter this information into a geographic information system for analysis;
- identify sources and quality of ground water seeping into the bay;
- establish current, historical, and prehistorical wetland conditions to document trends in ecosystem health and status; and
- provide for information sharing and a Web-based clearinghouse of information for scientists and the public, including a prototype Tampa Bay Decision Support and Query System for decision makers.

To address these critical science information needs the project managers invoked a competitive process for obtaining quality proposals and insisted that proposals be based upon partnerships among scientists and science institutions and upon data sharing. USGS brought a broad base of expertise required to address these issues and supplemented that with specialized expertise from academic and other agencies as required. The Tampa Bay Project was implemented with partners from 10 Federal agencies, 11 State agencies and academic institutions, and 11 local organizations. It involved a wide variety of scientific disciplines.

A Model For Interagency Cooperation And Coordination

While the Tampa Bay Pilot Project offers one model for how to address research in the coastal area of the United States, it does not fully address the coordination of the broad variety of Federal and State agency activities, all who have a strong stake in the future of the coast. As a

result it may appear from time to time that agency activities are fragmented and incomplete, addressing only part of the problems or focused on narrow science needs as seen by a single agency. This should not be surprising considering the variety of missions of the agencies, differences in structure and culture, and differing congressional oversight and appropriations. We need to do a better job of coordinating across agency lines, not only nationally but also linking national programs to a more regional basis where problems are identified, and where science information and solutions are required. We also believe that the very broad suite of management issues in areas like the Gulf Coast, overwhelming science information needs, and a sense of urgency make this even more difficult. Some targeted issues, such as mapping the northeastern Gulf involving USGS, National Oceanic and Atmospheric Administration and Minerals Management Service, or addressing hypoxia involving NOAA, Environmental Protection Agency, Department of Agriculture and USGS, have had considerable success due to in large part to interagency coordination.

One science interagency coordination model is offered by the Interagency Task Force under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) or "Breaux Act." While this Task Force was not formulated to coordinate science we believe it offers one model for interagency coordination that could be applied to science. This task force was established by law and has roughly $45 million in funding available to it on an annual basis and has a mission to restore coastal wetlands in Louisiana. It is made up of representatives from Department of the Interior, Department of Agriculture, Department of Commerce, Environmental Protection Agency, and the Louisiana Governor's office. They meet four to five times a year as a task force but program planning is a continuous activity. Every five to ten years Congress has an opportunity to review the program and its successes, and reports to Congress are required. The task force develops long-term strategies for restoring coastal wetlands and on an annual basis decides what projects to fund and implement. The task force has a host of meetings with advisors (government and non-government) to assure they are dealing properly with their mission. In a science setting, separate interagency science task forces – established for larger areas of coast – could (1) establish science and information needs, (2) set priorities for scientific endeavors and information and technology development, and (3) oversee a competitive process to distribute science funds to more adequately deal with societal natural resource issues in that area of coast. It could provide a much needed link between Federal agencies, national programs, and implementation to address regional issues. The distribution of these science funds could and should include all scientists (Federal, State, university, and private).

Science Issues In Restoring Coastal Louisiana

Coastal Louisiana is an area of rapid change. Louisiana still has a very large, broad fringing area of marsh and ponds ranging from fresh to saline waters. Every year about 25-35 mi^2 of marsh converts to open water. This amounts to 80 percent of the coastal wetland loss in the lower 48 states. Louisiana has already lost about 1,000,000 acres this century and, if nothing is done, is expected to lose another 600,000 acres over the next 40 years. This habitat loss is due to a mixture of human and natural causes. We believe it is feasible to reverse this huge loss and to strike a new balance of marsh loss and gain, but the costs will be large. Some have estimated the costs of restoration at $15-20 billion over the next 40 years. Science has played an important role in efforts thus far to restore coastal Louisiana and must play an even more important role in the future as State and Federal agencies undertake such huge restoration projects. Again, we

believe integrated science is a key to providing scientific information that is useful to the agencies practicing restoration.

Key data sets are needed. Some of these data sets such as subsidence rates, freshwater flows and biologic change, are needed to provide the most basic information for coastal restoration planning, project implementation, and monitoring. And gathering sufficient and long-term science information using standardized methodologies poses a significant challenge in such remote areas such as coastal Louisiana. Equally important is our need to improve our understanding of the processes involved in the development and deterioration of coastal marsh and how these processes interact. These information needs become even more critical during the planning and implementation of very large river diversion projects where not only water but also sediments are diverted from the Mississippi River and its tributaries. Indeed, the success of these costly projects will depend heavily on the accuracy and reliability of such scientific information. While there is a need for more natural resource data and information so too is there a great need to improve our abilities to analyze such data, develop models that not only characterize the processes and structure of these marsh systems, but also predict the consequences of management actions. Much of the need for these capabilities will be on a geographic basis, hence it is important that we push the state of the art for geographic information systems, geographic-based predictive modeling, and decision support tools to a new level. A close partnership of science agencies and universities providing integrated science should form the base for restoration activities in Louisiana and elsewhere around the Gulf of Mexico.

Summary

In summary, we recommend you consider these two models for expansion and coordination of science in the Gulf of Mexico region. First is a place-based, integrated coastal science program, based upon an assessment of information needs in each coastal area. Key to this model are long-term efforts, standardized approaches, and information sharing, first among investigators, and then among scientists and managers. Second is a regional task force approach for evaluating information and science needs, and joint decisions that establish priorities and funding for research and development. On a national scale it is also important that national programs be linked to regional issues and needs such as those along the Gulf Coast. Key to this model is the availability of funds to implement such a program and advice to the Interagency Science Task Force on what is to be accomplished. Last, all of our efforts must be bolstered by partnerships among agencies and universities, and among scientists and natural resource managers, all with a mission to improve science coordination and assure the best outcomes.

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