

July 2016

Effective Monitoring to Evaluate Ecological Restoration in the Gulf of Mexico

A tremendous number of restoration projects are planned and underway in the Gulf of Mexico to help mitigate damage done by the 2010 Macondo Well Deepwater Horizon oil spill. In order to ensure that restoration goals are met and money is well spent, restoration monitoring and evaluation should be an integral part of those projects. However, evaluations of past restoration efforts have shown that monitoring is often inadequate, or even absent. This report explains the value of monitoring restoration activities and lays out essential elements for effective monitoring.



The Macondo Well Deepwater Horizon rig explosion in the spring of 2010 resulted in the largest accidental oil spill in U.S. history. Gulf Coast communities and natural resources suffered extensive direct and indirect damage to wetlands, coastal beaches and barrier islands, marine wildlife, seagrass beds, oyster, and other habitats. Losses include, for example, an estimated 20% reduction in commercial fishery landings across the Gulf of Mexico and damage to as much as 1,100 linear miles of coastal salt marsh wetlands.

The disaster spurred a restoration effort unparalleled in complexity and magnitude. Approximately \$16 billion in legal settlement money was set aside for restoration projects that are being administered by three major programs (see Box 1). Some settlement money also was used to create science programs, including the sponsor of this study, the Gulf Research Program (GRP)¹ of the National Academies of Sciences, Engineering and Medicine.

THE CASE FOR RESTORATION MONITORING

Restoration monitoring serves three primary purposes: (1) to assure projects are constructed or implemented and are initially functioning as designed (*construction monitoring*); (2) to assess whether restoration goals and objectives have been or are being met (*performance monitoring*); and (3) to inform

¹ After the DWH oil spill, “as part of legal settlements with the companies involved, the federal government asked the National Academy of Sciences (NAS) to establish a new program to fund and conduct activities to enhance oil system safety, human health, and environmental resources in the Gulf of Mexico and other U.S. outer continental shelf regions that support oil and gas production.” (<http://www.nationalacademies.org/gulf/>)

Box 1. Gulf Restoration Programs

Three major programs administer the ~\$16 billion in funds awarded in legal settlements for restoration programs: the Natural Resource Damage Assessment (NRDA) Trustee Council, the National Fish and Wildlife Foundation (NFWF) Gulf Environmental Benefit Fund, and the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States (RESTORE) Council. These three restoration programs have similar high-level restoration goals as they relate to habitat, living coastal and marine resources. The NRDA Trustee Council and the RESTORE Council also aim to restore water quality. The NRDA Trustee Council includes explicit goals to enhance recreational opportunities and for monitoring and adaptive management of its restoration efforts. The RESTORE Council also aims to enhance community resilience and revitalize the Gulf economy.

restoration management and to improve design of future restoration efforts (*monitoring for adaptive management, see Figure 1*). Without adequate monitoring, it is not possible to determine whether restoration objectives and programmatic goals have been achieved or whether funding is used wisely.

There are several cases where monitoring has been shown to improve restoration effectiveness. One is in efforts to restore oyster reefs in the Chesapeake Bay, where oysters provide a number of beneficial services such as supporting biodiversity and protecting shorelines. Efforts to restore native oyster populations led to less than adequate results leading some to believe it might not be possible to restore the populations. However, through *monitoring for adaptive management*, researchers were able to distinguish the main factors determining oyster recovery and amended the restoration efforts accordingly.

Although the need for restoration monitoring is widely acknowledged, studies have shown that it is often insufficient to draw strong conclusions about restoration efficacy or is absent entirely. For example, the National River Restoration Science Synthesis, one of the few efforts to evaluate restoration efforts objectively, found fewer than half of all restoration projects had measurable objectives or collected quantitative data to evaluate a given project's outcomes.

To ensure that the effectiveness of restoration projects can be evaluated, rigorous monitoring should be viewed as an integral part of restoration, and detailed monitoring plans should be required by restoration funders at the time of restoration proposal submission. Without effective monitoring, programs administering the restoration funds will not be able demonstrate the benefits derived from restoration investments and justify the expenditure of funds.

ELEMENTS OF RIGOROUS RESTORATION MONITORING AND EVALUATION

This report provides general guidance for restoration monitoring, assessment, and synthesis that can be applied to most ecological restoration supported by the major programs. The committee considered project-level monitoring (for localized restoration activities), monitoring to evaluate restoration outcomes for highly mobile species (e.g., marine mammals, turtles, and birds) over large spatial areas such as watersheds and regional assessments, and monitoring in support of larger-scale programmatic evaluations across multiple states and sub-regions. Essential elements of monitoring plans are lists in Box 2.

Because of the breadth and diversity of coastal habitats and species subject to restoration or restoration plans, Part II of this report provides specific guidance for a

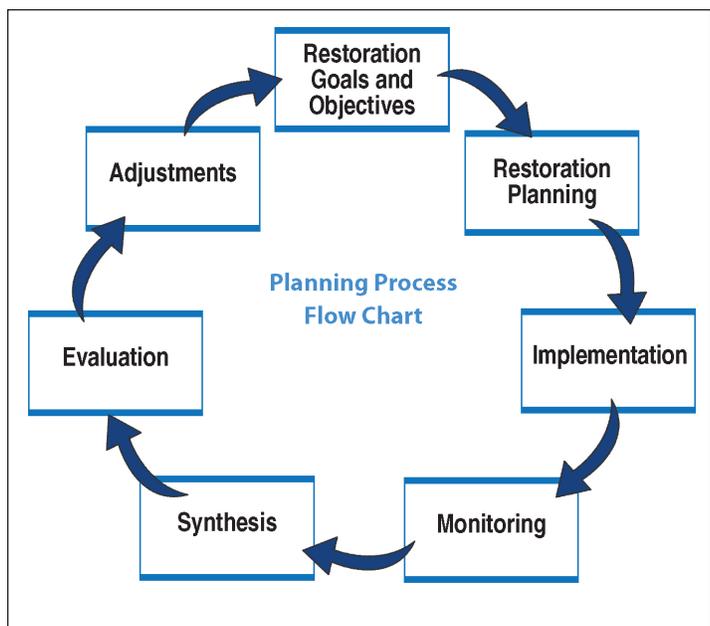


Figure 1. The Adaptive Management Life Cycle.

Adaptive management is a flexible process in which new knowledge gathered at any stage (planning, design, construction, operation) during the lifetime of a project can be used to adjust the course of a restoration project or future projects, thereby increasing the likelihood that restoration goals will be achieved and undesirable outcomes avoided.

subset of restoration monitoring efforts, including oyster reefs, tidal wetlands, and seagrass habitats, as well as a variety of birds, sea turtles, and marine mammals. This more specific guidance links restoration objectives with potential restoration measures to assess performance.

OVERARCHING RECOMMENDATIONS

The magnitude of restoration funding available as a consequence of the DWH oil spill provides an unprecedented opportunity to accomplish substantial ecological restoration throughout the Gulf of Mexico region. Given this historic opportunity, restoration funders have the responsibility to demonstrate in a transparent fashion how funds are allocated, whether ecological restoration objectives are accomplished, and what is learned from these restoration efforts. To undertake such a monitoring and evaluation effort and to ensure restoration efforts are effective and self-sustaining over the long term, the report recommends the following:

- 1. Establish measurable objectives.** Gulf restoration programs need to develop clear and measurable environmental and, where appropriate, socio-economic objectives at project and program levels to guide monitoring plans and against which to evaluate restoration progress.
- 2. Require monitoring plans.** All restoration administered by the NRDA Trustee Council,

Box 2. Essential Elements of Monitoring Plans

The committee recommends that monitoring plans be considered a prerequisite for restoration funding and that those plans contain, at minimum, the following essential elements:

- Clearly articulated, measurable restoration objectives (from the project plan);
- Well-articulated management questions that monitoring and evaluation seek to address using conceptual system and causal models that link ecological and socio-economic drivers and stressors with both biophysical and ecological processes to outcomes such as populations, habitats, ecosystem, ecosystem service, and human well-being (as appropriate) (derived from a given project plan);
- Appropriate metrics, targets and criteria for addressing the management questions, such as measuring ecological, and where appropriate, social and economic restoration outcomes;
- Evaluation of available baseline data appropriate to a given project objectives and/or plans to collect new baseline data if needed;
- Appropriate sampling and analysis designs, including consideration of reference and/or control site(s), sampling locations, timing, frequency, and sample size;
- Well-documented and, where possible, standardized sampling protocols;
- Rigorous data management plan (see below for details);
- Anticipated methods for data analysis and associated evaluation;
- Realistic project budgets and staffing to support the appropriate level of monitoring, study design, data acquisition via monitoring, data analyses, modeling, scientific oversight, training, data management, quality assurance, and reporting, etc.; and
- Monitoring program management plan (including timely reporting and communication plan) to assure that the applied monitoring program is efficient, accountable and transparent at all phases of a given effort.

RESTORE Council, NFWF, and the Gulf states should be accompanied by a strategic and rigorous monitoring effort, described in a monitoring plan, that enables an assessment of progress relative to the restoration goals and objectives articulated by the programs and projects.

- 3. Make data consistent and comparable.** Gulf restoration programs should work together to ensure that monitoring data are as consistent and comparable as possible across the Gulf by (a) assembling teams of restoration scientists, managers, and practitioners that will identify critical metrics and protocols that should be standardized for a given restoration type and (b) coordinating with existing or related environmental monitoring efforts to establish or expand existing reference site and monitoring networks.
- 4. Provide open access to data.** Gulf restoration programs should ensure that restoration monitoring data are publicly available by establishing and enforcing clear policies for data archiving and sharing. Policies need to also ensure that monitoring

data and metadata are submitted to one or more data portals and archived with a digital repository that has long-term support and can be trusted to provide open data-access for several decades. This can be accomplished by making data management plans with deliverables a contractual requirement in a funder's requests for restoration proposals.

- 5. Synthesize what is learned across restoration activities.** Because synthesis of monitoring data is required for evaluating restoration performance beyond individual projects and restoration outcomes for wide-ranging species such as marine mammals, sea turtles, and birds, Gulf restoration programs should consider creating a specific enterprise for synthesis in support of Gulf restoration.
- 6. Use adaptive management.** Where it is deemed appropriate, all Gulf restoration projects and programs should apply knowledge gained through analysis and synthesis of monitoring data by implementing adaptive management to improve restoration effectiveness.

COMMITTEE ON EFFECTIVE APPROACHES FOR MONITORING AND ASSESSING GULF OF MEXICO RESTORATION ACTIVITIES

Frank W. Davis (*Chair*), University of California, Santa Barbara; **David M. Burdick**, University of New Hampshire; **Loren D. Coen**, Florida Atlantic University; **Peter Doering**, South Florida Water Management District; **Frances Gulland**, Marine Mammal Center; **Kenneth L. Heck**, Dauphin Island Sea Laboratory; **Matthew K. Howard**, Texas A&M University; **Michael S. Kearney**, University of Maryland; **Paul A. Montagna**, Harte Research Institute; **Pamela T. Plotkin**, Texas A&M University; **Kenneth A. Rose**, Louisiana State University; **Eric P. Smith**, Virginia Polytechnic Institute and State University; **Heather M. Tallis**, The Nature Conservancy; **Ronald Thom**, Pacific Northwest National Laboratory; **Mark S. Woodrey**, Mississippi State University; **Claudia Mengelt** (*Senior Program Officer, Ocean Studies Board*), **Stephanie Johnson** (*Senior Program Officer, Water Science and Technology Board*), **Heather Coleman** (*Postdoctoral Fellow, Ocean Studies Board*), **Payton Kulina** (*Senior Program Assistant, Ocean Studies Board*), National Academies of Sciences, Engineering, and Medicine

For More Information . . . Contact the Ocean Studies Board at (202) 334-2714 or visit <http://www.nas.edu/osb/>. *Effective Monitoring to Evaluate Ecological Restoration in the Gulf of Mexico* can be purchased or downloaded free from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; or as free PDFS at www.nap.edu.

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