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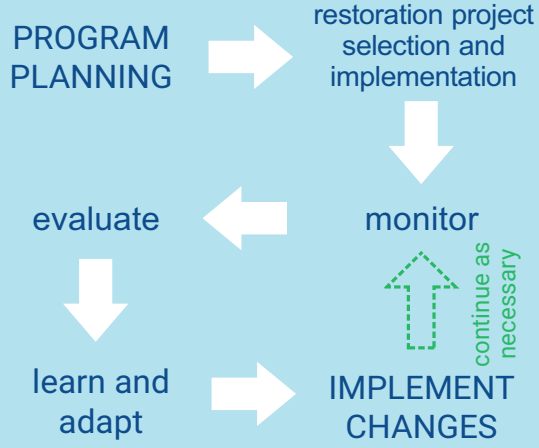
ADAPTIVE MANAGEMENT

IN ECOSYSTEM RESTORATION

Three Case Studies from Ecosystem Restoration Programs around the U.S.

Adaptive Management for Restoration Projects: Process



Adaptive management begins in the planning stages and continues over the life of a project. Hallmarks of the process include ecosystem monitoring, science-based decision-making and stakeholder engagement.

Important potential benefits can include:

- Reduced long-term cost
- Decreased risk of failure
- Strengthened credibility
- Increased public trust
- Objective basis for decisions
- Chance to test-drive before investing in larger projects
- Improved restoration outcomes

This report illustrates adaptive management in action for three large-scale restoration projects: the Platte River Recovery, Yolo Bypass Floodplain Restoration and Biscayne Bay Coastal Wetlands Restoration programs. Challenges, strategies and solutions are examined. Together, these case histories can offer valuable insights for today's restoration leaders.

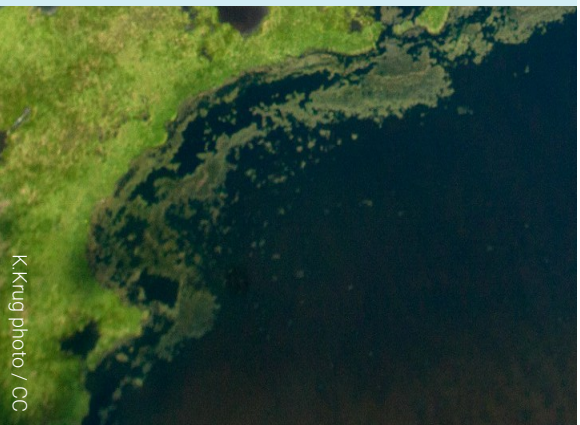
Introduction

There is a lot at stake in the current effort to restore the Gulf of Mexico in the wake of the BP *Deepwater Horizon* oil disaster, including the people, wildlife and coastal economies that rely on a healthy Gulf. For this reason, it is incumbent on our Gulf leaders to make the most of this once-in-a-lifetime opportunity. Restoring an ecosystem is rarely simple, but it can be a lot less risky and more cost-effective when adaptive management is built into the decision-making process. Fortunately, several large-scale, long-term restoration programs around the country can shed light on the value of adaptive management.

Adaptive management is a science-based resource management approach that is helpful for dealing with uncertainty in restoring an ecosystem. Supported by a science feedback loop, adaptive management helps decision-makers meet their goals by planning restoration actions and reducing the risk of setbacks, therefore increasing the probability of success. This enables restoration practitioners to better understand why projects underperformed or how changes in the ecosystem affected project performance. Adaptive management also helps to design and implement more cost-effective approaches to get better results.

This synopsis showcases the use of adaptive management for three large-scale restoration projects that mirror the Gulf restoration effort and ecosystem in many ways. These examples involve multiple agencies working in collaboration to achieve recovery goals within multi-use, dynamic environments. They illustrate key components that contribute to project success, and each provides a unique perspective on the role and benefits of adaptive management. Now that our Gulf leaders, like the Gulf Coast Ecosystem Restoration Council and the Natural Resource Damage Assessment Trustees, have taken the important first step of developing adaptive management frameworks, it's time to take the next critical step of implementing that process successfully as demonstrated in these case studies.

Restoring an ecosystem is rarely simple, but it can be a lot less risky and more cost-effective when adaptive management is built into the decision-making process.

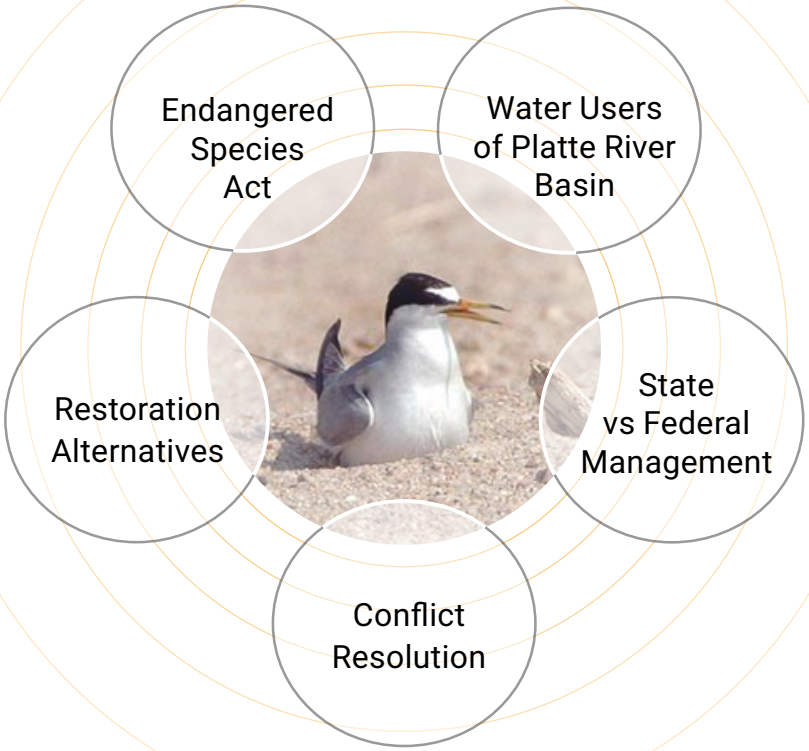


K.Krug photo / CC

Platte River

Habitat for Interior Least Terns and Piping Plovers

CORE ISSUES



CHALLENGES

- Large scale
- Controversial
- Historical conflicts
- Uncertainty about effects of the available management options

KEYS TO SUCCESS

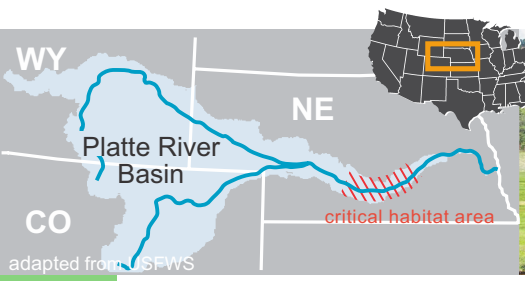
- Transparent and inclusive decision-making
- Monitoring designed specifically to inform management questions
- Modeling and testing early in planning phase
- Species' and resource-users' needs evaluated on an equal footing

Adaptive management helped to:

Validate choices

Manage risk

Build trust



PROJECT SNAPSHOT

History

The Platte River Basin is important for agricultural production and is also home to threatened or endangered least terns, piping plovers, whooping cranes and pallid sturgeon. Area farmers use water and land that also supports critical habitat for federally protected species, creating potential conflicts between users and the Endangered Species Act (ESA). The $325 million Platte River Recovery Implementation Program established a collaborative framework among state and federal agencies and stakeholders to achieve ESA recovery objectives for listed species. The framework also reduces potential future listings while meeting water users' needs by managing land and water resources. One such objective is to protect, restore or maintain breeding habitat for the interior population of threatened least terns and piping plovers. The least tern and piping plover habitat restoration project highlighted here is a component of the full-scale Platte River program.

Governance

Colorado, Nebraska, Wyoming and the Department of the Interior created the program in 2007. The restoration program was authorized for an initial 13-year period (2007-2019). An 11-member governance committee, consisting of state and federal agency representatives and stakeholders, leads the program and makes decisions on a consensus basis. The three states, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, water users and the conservation community are all represented on the committee. Much of the program success can be attributed to the neutral role of the office of the executive director and staff. Because the office is independent of partner agencies and associated mandates, it is able to act as a neutral broker in planning, program management and conflict resolution. It also serves as the common link between the governance committee and the advisory committees.

Strategy

Since 2007, the program has been testing different management strategies, evaluating the tradeoffs and selecting the best combination of alternative strategies for implementation. Program leaders knew that achieving their objectives meant minimizing the risk of selecting a less viable, more costly strategy. The governance committee identified two potential management options for creating and improving breeding habitat for interior least terns and piping plovers. The first approach focused on altering river flow to

create new sandbars for bird nesting; however, the results of this option were difficult to predict. The second focused on mechanical intervention to create sand bar breeding habitat. The program adopted an adaptive management approach that would systemically reduce risk by resolving key uncertainties associated with each strategy, moving the governance committee closer to an optimal strategy. This process was supported by a monitoring system established in 2001, which standardized the protocols for monitoring reproductive success and reproductive habitat parameters of least terns and piping plovers.

Science

Program leaders, in collaboration with science advisors and stakeholders, developed critical questions that needed to be answered before moving forward with restoration, each one reflecting a key area of uncertainty. Crucially, stakeholders set aside their biases to build an adaptive management plan that incorporated competing views of how the Platte River functions. They often agreed to disagree and treated program manipulation options as experiments to test outcomes of thoughtfully prepared management actions. This type of cooperative agreement allowed all parties to get past impossible discussions of how the system functions. Ecosystem models and experts addressed stakeholder questions and key uncertainties, clarifying the degree to which the bird species would benefit under each strategy. Next, scientists assessed various combinations of specific management actions, such as creation of different habitat types to support nesting, or enhanced flows to estimate the impact on tern and plover nesting success. As a result of modeling and iterative valuation of management actions, the program was able to develop a clear understanding and make an informed decision about how to balance tradeoffs across tern and plover populations and water users.

Outcome

In the end, the program used performance measures of nesting success and habitat availability to determine that terns and plovers would benefit most from land management rather than enhanced flows. They decided that acquiring an additional 60 acres of strategic habitat and the annual creation or maintenance of 10 aces of sandbar habitat was the best strategy. The science showed that increasing water flows would not have been as effective at improving nesting success through habitat creation as acquiring and managing adjacent land for increasing tern and plover nesting. The cost of reallocating the water would have been too high for farmers and other users relative to the habitat created. This science-based, structured decision-making process helped the program avoid a less

effective, more costly flow release strategy, opting instead for an approach that supports both ESA recovery objectives and water user needs.

Lessons Learned

The Platte River program is similar to Gulf restoration efforts in that multiple agencies and states collaborate to achieve recovery goals within a multi-use, dynamic ecosystem. This case study demonstrates that a robust adaptive management framework is as indispensable to the planning phase of restoration as it is to the evaluation of projects underway for ensuring success in achieving restoration objectives. The following lessons learned from the Platte River program's adaptive management framework are specifically applicable to Gulf restoration:

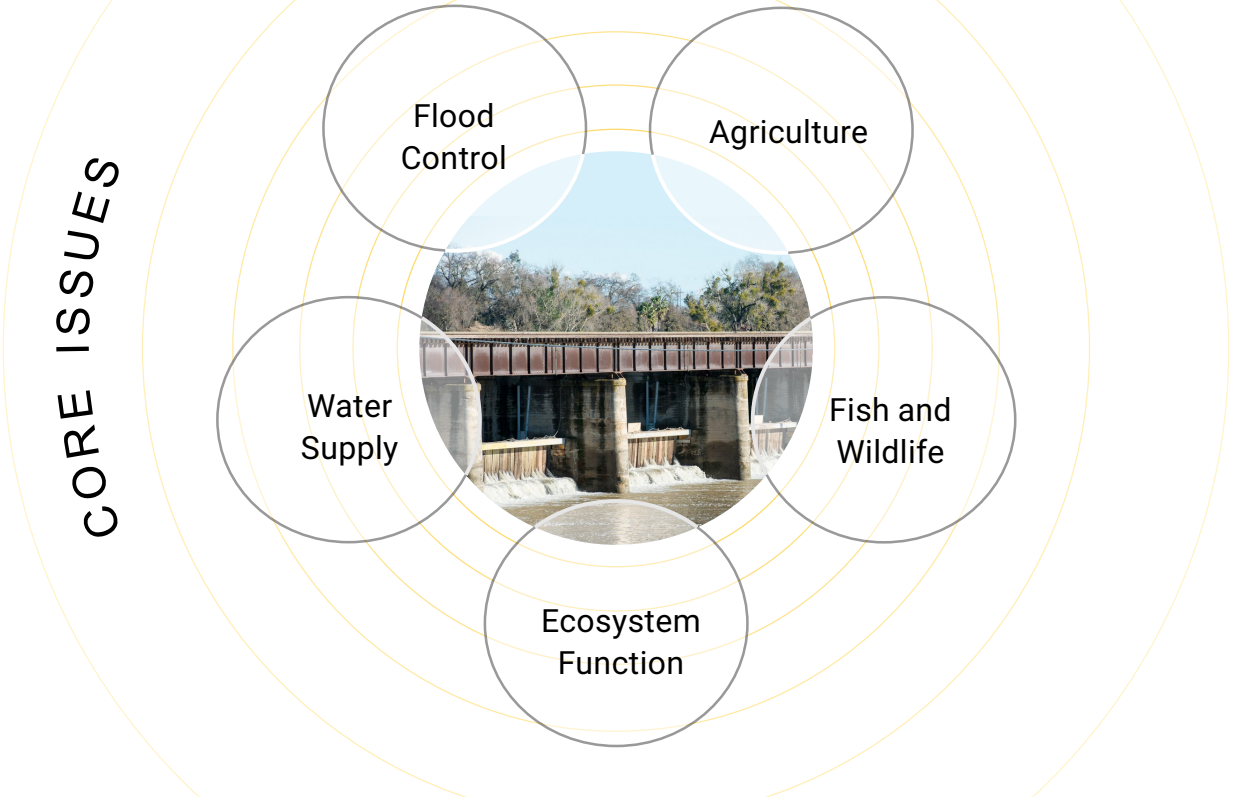
- Data collection and analysis must be driven by the specific relevant hypotheses or management goals.
- Identifying and resolving key questions or uncertainties reduces the risk of setbacks and increases likelihood of a successful outcome.
- Collaborating with independent science advisors strengthens the outcome and credibility of the decision-making process.
- An iterative and inclusive evaluation of alternatives is important to hone in on the best performing alternative to balance the goals of all objectives and tradeoffs.
- Integrating stakeholder needs upfront into management options can help build trust and prevent unforeseen conflicts when restoration projects are proposed. This includes involving stakeholders in actual decision-making as opposed to utilizing them just in an advisory role.

"The key to success has been independence in program administration and science review. Administration through a non-agency lead has built trust in the process among all stake-holders. Independence in science review has created confidence in research and analysis results to inform restoration decisions."

Rich Walters
The Nature Conservancy

Yolo Bypass

Floodplain Restoration in the California San Joaqin Delta



CHALLENGES

- Ecologically and socially important environment
- Complex, multi-stakeholder issues
- Regulatory restrictions
- Funding limitations

KEYS TO SUCCESS

- Science funded on front end to inform decisions
- Robust monitoring program supports decisions
- Small-scale trials used to justify larger investments
- Ecological benefits communicated to public
- Vital partnerships

Adaptive management helped to:

Test-drive solutions

Navigate uncertainty

PROJECT SNAPSHOT

History

The Delta Stewardship Council's mission is to restore the Sacramento-San Joaquin River Delta, ensuring reliable water supplies for the state and maintaining an enduring place of natural and social value. The Yolo Bypass, located just west of Sacramento, is the largest floodplain in California's Central Valley and is a critical component of the restoration plan for the delta. It was engineered to allow Sacramento Valley floodwaters to inundate a broad floodplain as part of the Central Valley Flood Control System. The floodplain is also utilized for agriculture and, when inundated, is a valuable habitat for birds and fish, including species federally listed as endangered such as the Delta smelt and Chinook salmon. Through an extensive, long-term estuarine monitoring program it is evident that the basin provides a vast food bank for aquatic species and a large nursery area to fish species targeted for restoration. However, the floodplain connection to the nearby Sacramento River needs improvement to restore the ecological benefits in the basin. Through field experiments, the Council learned the best restoration actions were: 1) to install a fish ladder to allow for migration and 2) to increase the hydrologic connection with the river by adding a small cut in the existing Fremont Weir.

Governance

The Delta Stewardship Council was established in 2009 by the California Delta Reform Act. Through the Act, the state legislature defined the legal requirements that support the program's function and hold the Council accountable. The Council is comprised of leaders from state and local agencies, as well as federal representatives. A key function of the Council is to coordinate the actions of the state and federal agencies managing different aspects of the Delta, and to collaboratively resolve management conflicts. An independent science board advises the Council on the integration of best available science and reviews of management actions to ensure that restoration policies and actions are based on sound science. Stakeholder groups, such as the Yolo Bypass fish technical team, are also in place to support the Council and help resolve scientific disagreements.

Strategy

To balance competing objectives and needs, managers needed to weigh the regulatory requirements and ecological benefits of flooding the Yolo Bypass against the impacts of flooding on agriculture lands, which results in

unusable farmland and a loss of county farm revenue. On top of these challenges, managers working on Yolo Bypass connectivity and broader Delta restoration were faced with many uncertainties such as persistent drought, water quality concerns from adjacent tributaries, potential contamination from using agricultural waterways and impacts from invasive species. The Council approved directed research to help answer key questions, reduce uncertainties and balance the ecological effectiveness and risks of different restoration approaches.

Science

The Yolo Bypass is considered one of the more promising sites for habitat restoration in the Bay-Delta system, because it is a large area of mostly undeveloped public land known for its many benefits to fish and waterfowl species. The ability to understand its ecosystem benefits would not have been possible without a strong estuarine monitoring program, which enabled managers to document changes in productivity under varying conditions. For instance, during summer and fall, the driest time of the year, the Yolo Bypass does not receive excess river water. However in 2011, an unusually wet year, the Yolo Bypass flooded, generating the first fall plankton bloom in over 20 years. This pulse of food presumably produced faster growing Chinook salmon and resulted in a more productive food web and larger native fish populations within the Bypass and the downstream estuary. Researchers concluded from this natural experiment that the productivity of the Yolo Bypass can be greatly enhanced when water from the deep, rip-rapped channels of the Sacramento River flows into the Bypass. To meet the requirements of the 2009 National Marine Fisheries Service biological opinion it was recognized enhanced flows would serve as a key tool to improve Chinook salmon habitat and recovery.

Outcome

The natural experiment of the 2011 flooding was so promising that agencies used it as the basis for a field experiment to test whether a better connected Yolo Bypass floodplain would be beneficial for the ecosystem and help the recovery of federally protected fishes. Resource agency managers initiated pilot studies to provide supplemental flows from the Sacramento River through the Bypass during the dry season and to improve fish passage. To this end, managers from the California Department of Water Resources and the U.S. Bureau of Reclamation used local sources of water to seasonally inundate the Bypass. In addition, officials manually relocated fish to the Bypass to study the food web response and corresponding changes in the growth and survivability of fish in the Bypass and downstream in the Delta. They found that juvenile salmon grow larger

and healthier when their floodplain habitat is inundated and more food is available. This small-scale demonstration was well-received by the public and laid the foundation for the $500 million scaled-up version now underway.

Lessons Learned

The Delta Stewardship Council is a complex, multi-stakeholder restoration effort. This case study illustrates the value of robust monitoring and policy experiments to support restoration actions that integrate the needs of water use, flood control and ecosystem function. The following lessons from the Council's adaptive management framework are specifically applicable to Gulf restoration:

- A robust monitoring program supports decisions requiring a high bar of evidence for controversial actions in an ecologically and socially important environment (e.g., endangered species, water restrictions, flood control, business interests).
- Targeted field experiments can provide evidence for actions and build off of observational studies.
- Showing the benefits of management actions is important to build public support.
- Partnerships with local stakeholders and non-profits from the beginning are important to build trust and support.

"The planning process needs to be tied to on-the-ground pilot projects in order to direct potential land management decisions, allowing for their implementation in the real world. People on the ground need to be consulted and convinced the project will benefit their environment and then they will help you build it. Lots of good ideas do not happen because they never make it out of the cubicle."

John Brennan
Robbins Rice Company

Biscayne Bay

Coastal Wetlands Restoration

CHALLENGES

- Large system with complex dynamics
- Technical uncertainties
- Funding constraints
- Previously cumbersome project planning and authorization processes

KEYS TO SUCCESS

- Ecosystem monitoring prevented project failure
- Science review allowed for efficient course corrections
- Monitoring ensured that objectives were met
- Projects were planned and reviewed at a system-wide scale

Adaptive management helped to:

Track response

Improve confidence

Choose best strategies


evergladesrestoration.gov photo


National Park Service photo

PROJECT SNAPSHOT

History

The Comprehensive Everglades Restoration Plan is a collaboration of federal, state, tribal and local governments and stakeholders to reverse decades of environmental decline. One project in the plan is the $500 million Biscayne Bay Coastal Wetlands Project, which is designed to bring more water through the coastal wetlands to Biscayne National Park and Biscayne Bay. Biscayne Bay, between Miami and Key Largo, is a popular recreational area and an important part of Florida's economy. Historically, water flowed south through the Greater Everglades ecosystem hydrating the coastal wetlands that fringe the clear-water bay, but today the ecosystem is degraded. This area is an important estuarine nursery habitat for coastal and reef wildlife as well as for seagrasses, sponges and other habitats that support the recreational fishing economy.

To restore the Biscayne Bay wetlands, managers developed hypotheses about how the system would respond to re-established natural flows in a landscape altered by development and by flood and mosquito control infrastructure. Initial restoration actions were evaluated through the science review process with the aid of monitoring information and conceptual models of the estuary to be restored. With this information, managers determined that the current timing of operational water releases and distribution patterns of freshwater flows were not replicating the natural patterns required to restore nearshore estuarine communities and coastal wetlands.

Governance

In 2000, Congress approved the Comprehensive Everglades Restoration Plan as a framework for modifications to water management and flood control infrastructure. The plan is governed by the South Florida Ecosystem Restoration Task Force, comprised of seven federal members, two Native American tribes and five state representatives. The task force makes the final decisions on policies, strategies and projects to restore the Greater Everglades ecosystem and operates by consensus or at a minimum two-thirds majority. The REstoration COordination VERification (RECOVER) team is tasked with evaluating the progress of implementing the plan and maintaining a system-wide science perspective in achieving goals. RECOVER has the mandate, resources and ability to coordinate the

Everglades plan's adaptive management process and, as a result, recommend programmatic and project-level improvements.

Science

The RECOVER team and the lead project scientists were able to more effectively evaluate the wetland and estuarine response to water flow patterns and resulting salinity conditions using regional and local ecosystem monitoring. Integrating information on water management strategies and data on ecological response was a driving force for recommendations to improve the restoration project design. The system-wide Everglades Monitoring and Assessment Plan provides data on the broad-scale context of restoration, while the project-level Biscayne Bay Coastal Wetlands Ecological Monitoring Plan generates fine-scale information on performance of restoration strategies.

Program managers recognized that the benefits of individual projects in the Comprehensive Everglades Restoration Plan are greater when they are planned and assessed within the full program. This type of systemic approach maximizes systemwide effects on the ecosystem rather than isolated solutions. This process of tying ecosystem response to monitoring data is critical to building confidence with decision-makers, stakeholders and citizens in the quality and credibility of the science that underlies restoration decisions.

Strategy

The systemwide monitoring program gave the RECOVER team the ability to measure wetland and coastal responses that were then used to direct the adaptive management process if wetlands are not recovering as expected. This process identified several key improvements through flooding dynamics. They involved changes to water flow timing, water conveyance structures used, understanding where water is moving in the basin, and pilot studies to design the final water control features. The RECOVER team recognized that unless these operational adjustments were made, maintaining desired flooding would not be possible and could further delay restoration.

Outcome

The RECOVER team developed a systemwide and program-level adaptive management plan used to support project goals by providing a peer-reviewed synthesis of management options. The plan lays out how to track progress with acceptable thresholds, when triggers for management action should go into effect and the best options to use when performance thresholds are not met. This helped determine the key improvements in

project design for achieving overall restoration objectives. The RECOVER team also used a science-based feedback loop in its review of the project to understand how the ecosystem functions. This feedback loop addressed critical uncertainties. This enabled decision-makers to incrementally adapt strategies with each new line of evidence.

Lessons Learned

The Biscayne Bay project illustrates several key lessons for implementing adaptive management in restoration initiatives faced with uncertainties about the effectiveness of management techniques.

- Ecosystem indicators, performance thresholds, triggers for action and monitoring data are essential elements of a restoration play-book.
- Consensus from the general public, industry and trade organizations, other stakeholders, and the scientific community is necessary to move forward in successful restoration.
- Commitment to long-term monitoring is essential because the system may not respond as expected, and the understanding of desired conditions may change.
- Pilot studies prior to final project design and full construction are valuable to help determine techniques most likely to succeed.

"You cannot expect to successfully implement projects of this scale if they are not based in science. Projects could actually do more harm than good if they are not properly vetted scientifically and within the context of understanding derived from ecosystem monitoring."

Captain Dan Kipnis
Biscayne Bay Restoration Review
Coordination Team Member

Summary: Lessons Learned

The Benefits of Adaptive Management: Three Case Studies from Ecosystem Restoration Programs around the U.S.

	ACTION	OUTCOME
PLATTE RIVER	• Integrate stakeholder needs	to build trust and reduce conflict
	• Align data collection with relevant hypotheses	to focus results
	• Identify and resolve key uncertainties	to reduce risk of setbacks
	• Collaborate with independent science advisors	to strengthen outcomes and credibility
	• Use iterative and inclusive evaluation of alternatives	to find best-performing alternative and balance all objectives
YOLO BYPASS	• Use a robust monitoring program	to support decisions requiring a high bar of confidence
	• Use field experiments as well as monitoring observations	to provide evidence for actions
	• Build partnerships with stakeholders and NGOs	to increase trust and support
	• Ensure good communication with the public	to increase awareness of benefits
BISCAYNE BAY	• Use ecosystem indicators, performance thresholds and monitoring data	to track progress within acceptable thresholds
	• Build consensus with the public, industry, stakeholders and scientists	to move forward with successful restoration
	• Conduct long-term monitoring	to determine the system's response
	• Implement pilot studies	to find techniques most likely to succeed

NOAA photo

Conclusion

Restoring the Gulf of Mexico after the BP oil disaster is a once-in-a-lifetime opportunity to invest in the Gulf ecosystem, economy and quality of life for current and future generations.

Restoring the Gulf of Mexico after the BP oil disaster is a once-in-a-lifetime opportunity to invest in the Gulf ecosystem, economy and quality of life for current and future generations. As with any investment, it is important to minimize risks and optimize returns. Each of the case studies presented shows how adaptive management can effectively reduce inherent risks in restoring a changing ecosystem. Scientific tools and the information they generate can lessen uncertainties and provide a more reliable foundation for decision-makers, helping to select the strategies that will best achieve recovery goals at the lowest possible cost.

Whether it's programmatic learning based on modeling to evaluate different approaches, expert judgement from independent science support, or testing project viability on an experimental basis, these case studies show how adaptive management improves stakeholder confidence in the decision-making process, particularly for novel, large-scale or controversial projects.

As Gulf restoration continues for the next 15 years or more, adaptively managing programs and projects will be essential to the evolution, cost-effectiveness and success of the effort.

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