An Integrated Framework for Evaluating Wetland and Stream Compensatory Mitigation

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LIST OF ACRONYMS

API – Application Program Interface

BMP – Best Management Practice

CEM/SEM – Channel Evolution Model/Stream Evolution Model

CRM – California Rapid Assessment Method

DOC – Dissolved Organic Carbon

EC – Electroconductivity (aka specific conductance)

FQAI/FQI – Floristic Quality (Assessment) Index

GIS – Geographic Information System

GRTS – Generalized Random Tessellation Stratified (sampling)

HCP – Habitat Conservation Plan

HGM – Hydrogeomorphic Method

IBI – Index of Biotic Integrity

ILF – In-lieu Fee

MB – Mitigation Bank

MMI – Multimeric Index

NARS – National Aquatic Resources Survey

NGO – Non-governmental Organization

NMFS – National Marine Fisheries Service

NMRAM – New Mexico Rapid Assessment Method

NOAA – National Oceanographic and Atmospheric Administration

NPDES – National Pollutant Discharge and Elimination System

NWCA – National Wetland Condition Assessment

O/E – Observed to Expected

OGC – Open Geospatial Consortium

ORAM – Ohio Rapid Assessment Method

PRM – Permittee Responsible Mitigation

QA/QC – Quality Assurance/Quality Control

RESTful – Representational State Transfer

RIBITS – Regulatory In-lieu Fee and Bank Information Tracking System

STORET – data STOrage and RETrieval

TDS – Total Dissolved Solids

USACE – United States Army Corps of Engineers

USEPA – United States Environmental Protection Agency

USFWS – United States Fish and Wildlife Service

VIBI – Vegetation Index of Biotic Integrity

WAM – Wetland Assessment Methodology

WQX – Water Quality eXchange

EXECUTIVE SUMMARY

Compensatory mitigation is a commonly utilized strategy for offsetting unavoidable, adverse impacts to wetlands, streams and other aquatic resources as a result of permitted activities that affect aquatic resources. Program managers who are tasked with implementing and overseeing compensatory mitigation for wetlands, streams, and other aquatic resources often struggle to identify rigorous, standardized approaches for conducting monitoring and performance assessments, and to access and manage data relevant to their compensatory mitigation projects. To provide clearer recommendations and improve consistency of compensatory mitigation performance assessments across the country, the United States Environmental Protection Agency (USEPA) Office of Wetlands, Oceans, and Watersheds, in partnership with the Southern California Coastal Water Research Project (SCCWRP) and the Environmental Law Institute (ELI) have developed a set of best practices for conducting compensatory mitigation assessments.

This technical resource document is intended to help states and other interested parties develop a long-term, scientifically rigorous approach to evaluating the overall performance of their wetland and stream compensatory mitigation programs. The document provides a proposed framework for combining site-specific and regional evaluations to improve the ability of states to report on the administrative and ecological success of their compensatory mitigation programs at achieving stated goals and desired objectives. The proposed framework was developed based on peer-reviewed literature and agency reports on past mitigation practices and monitoring approaches, interviews with program managers from 15 state programs, and input from a team of nationwide technical experts.

State program managers are a primary target audience for this publication for the following reasons: 1) most of the past studies of compensation performance have been conducted by states or defined by state boundaries (Morgan and Hough 2015); 2) states have an interest in the long-term performance of compensatory mitigation project sites (e.g., all states have Clean Water Act Section 401 certification authority and 29 states have relevant independent state permitting programs (ASWM 2015)); and 3) state agencies have mechanisms for conducting evaluations and access to resources to fund such evaluations (e.g., USEPA Wetland Program Development Grants). By targeting states, we are not suggesting that federal agencies such as USEPA, the US Army Corps of Engineers (USACE), US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) do not have an interest in compensation performance. These federal agencies have in the past and continue to have a keen interest in compensation performance; representatives from all these agencies participated in the development of this document. But robust compensation performance evaluation efforts are resource intensive and federal agencies have not had sustained access to adequate resources to perform these kinds of evaluations. In contrast, states have led many efforts in compensation performance evaluation, in part, because they have access to resources to conduct such evaluations that are not available to federal agencies (e.g., USEPA Wetland Program Development Grants). By targeting states with this document, we are attempting to build on

their demonstrated success and experience in this area and expect federal agencies to continue to support and partner with states on compensation performance evaluation efforts.

The proposed framework includes a series of recommendations and best practices that states can use to augment their existing programs and ultimately improve their effectiveness. Also included in the proposed framework are recommendations for data management that are aimed at helping to improve data accessibility across agency programs and to the public.

The proposed framework recommends that comprehensive compensatory mitigation evaluation include assessments of both project and program performance. To achieve this, the framework recommends a flexible, modular approach (Table ES-1) that allows states to prioritize different modules depending on their needs and the status of their existing assessment programs. Where feasible, the framework recommends implementation of all three modules to provide a comprehensive evaluation of program performance. The three proposed modules are:

1) Compensatory mitigation site performance ("Performance"): This module evaluates the success of mitigation projects relative to defined ecological endpoints (e.g., morphology, habitats, species, communities), functional goals and permit requirements. This module can also help assess factors that influence mitigation success and the length of time necessary to achieve desired targets.

2) Program effectiveness ("Effectiveness"): This module evaluates the overall effectiveness of the regulatory program at achieving programmatic goals, such as no-net loss, specific area goals, and/or desired ecological targets at reach, watershed and regional scales.

3) Resiliency of compensatory mitigation practices ("Resiliency"): This module evaluates likely long-term trajectories of compensatory mitigation sites at achieving functional replacement of aquatic resource impacts. This includes the role of adaptive management, ability to adapt for climate change effects, and vulnerability to future degradation due to changing land use, climate, and management practices.

TABLE ES-1: Summary of Major Elements for Each of Three Compensatory Mitigation Evaluation Modules

	PERFORMANCE	EFFECTIVENESS	RESILIENCY
Goal	Ecological success of compensation sites and regulatory compliance	Effectiveness of program at offsetting aquatic resource losses and contributing to no-net loss goals	Long-term resiliency and sustainability
Design Approach	Comprehensive	Probabilistic	Targeted sentinel sites
Reference Approach	Performance standards, pre-vs. post mitigation site, comparison to impact site or reference sites	Comparison to regional/ambient condition, comparison to impact sites and reference sites	Comparison to regional/ambient condition, comparison to reference standard sites

The three modules should be applicable to all aquatic resource types and include the following general practices:

- All compensatory mitigation sites should be catalogued in a database with appropriate metadata and geospatial information.
- Data entry should be standardized and streamlined with appropriate QA/QC procedures, building data dictionaries is valuable.
- Compensatory mitigation sites (and impact sites if possible) should be available on maps, which will be essential for site selection in all three modules.
- Data should be stored in an open-data format and linked to the internet to facilitate access by the public, sharing among agency partners, and incorporation by USEPA into national assessments.
- Assessments should be integrated into ongoing, sustainable agency programs to facilitate long-term implementation. These could be existing or newly created programs that measure ambient conditions in specific areas or aquatic resource types.
- Assessments should include regular reporting targeted to both agency/professional staff and the public – this may require multiple reporting formats and approaches.

Successful monitoring and assessment programs should include the following core elements:

- Standard bioassessment indices or other quantitative measures with standard operating procedures and consistent approaches that can be applied in a repeatable manner, with associated quality control procedures.

- Established (and protected) reference standard sites that reflect the range of stream or wetland types occurring within the jurisdiction of the state program.
- Clear targets based on reference condition and related to wetland/stream function and programmatic goals.
- Strong guidance documents on monitoring and assessment requirements to provide a clear structure for program implementation.
- Easy to use project/permit tracking system with automated reminders for both agency staff and permittees.
- Simple and transparent data management systems that are integrated into the permitting workflow and provide ready access to data over time.

In developing capacity for these core elements, state programs may draw from the tools and resources developed through USEPA's National Aquatic Resource Surveys (NARS), which include standard protocols, guidance for defining and selecting reference sites, methods for establishing thresholds of response, and suggested analytical approaches. Tools and resources are also available through a broad set of existing state, regional and national guidance documents.

In addition to the general recommendations above, this technical resource document provides detailed recommendations for the design of each of the three modules. These recommendations include:

- Recommended indicators of condition (or function) for streams and wetlands (although detailed protocols are not included).
- Best practices for developing performance standards.
- Recommendations for opportunities to leverage efforts between compensatory mitigation monitoring and other monitoring programs (e.g., regional monitoring, reference site monitoring, status and trends assessments).
- Suggested data management structures and open data approaches.

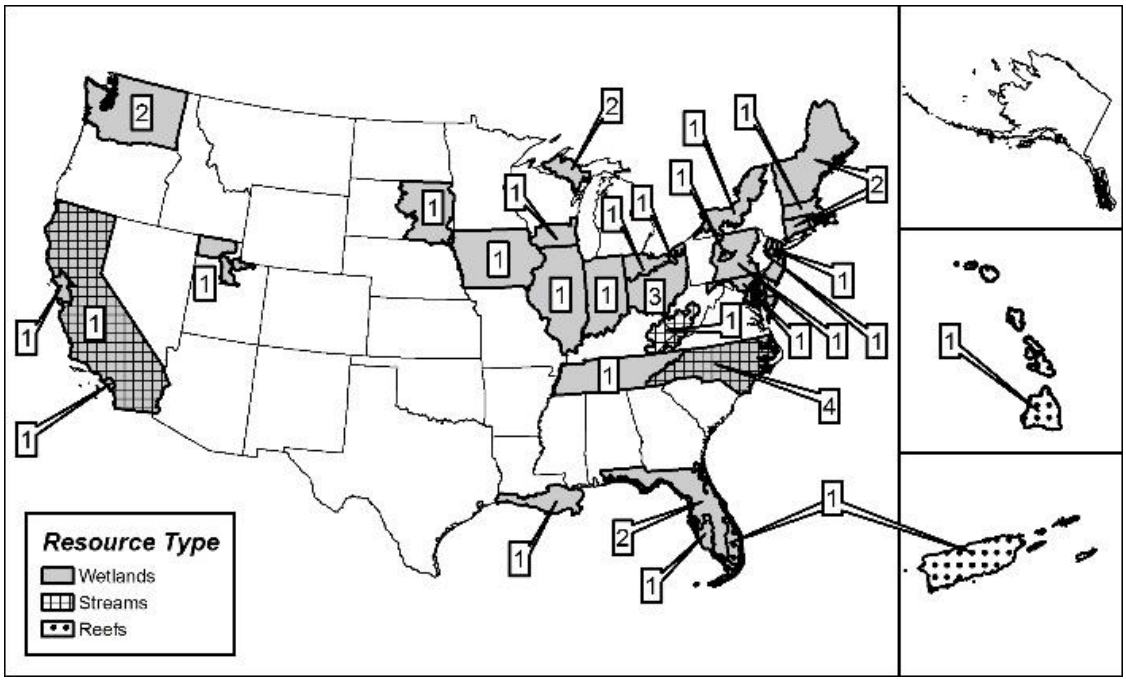
Finally, a series of examples and case studies are provided to illustrate the concepts presented.

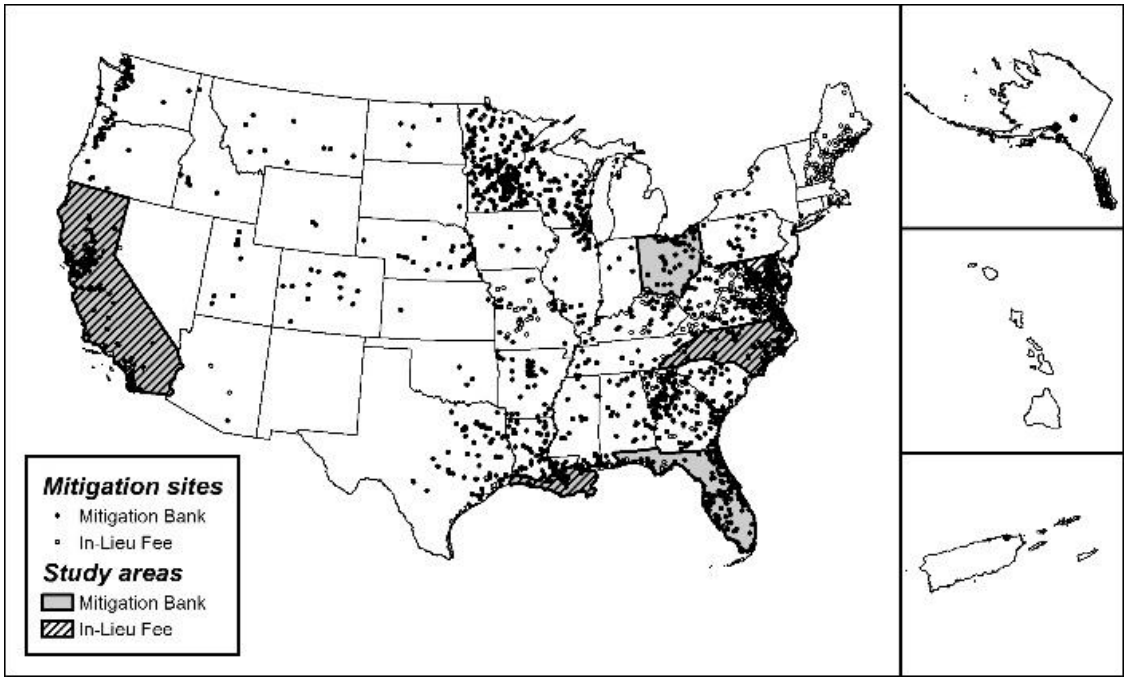
1. BACKGROUND, OBJECTIVES, AND APPROACH

Motivation and Objectives

Substantial effort has been expended in evaluating wetland, stream, and other aquatic resource compensatory mitigation in the US over the last few decades (Figure 1). Deficiencies in compensatory mitigation performance identified by these reviews have resulted in changes to regulatory and technical tools aimed at improving compensatory mitigation performance and better achieving programmatic aquatic resource protection goals. However, evaluation of compensatory mitigation performance remains challenging. Sustained improvement in wetland and stream compensatory mitigation requires establishment of ongoing evaluation efforts that provide continued feedback to aquatic resource programs that allow them to adapt, evolve, and improve over time. Ideally, such evaluation efforts would be implemented at the state, regional or tribal level and provide data that could be consolidated by USEPA and other federal agencies for national assessments and to guide development of state and national policy and regulation. The status of institutionalized compensatory mitigation evaluation varies widely across the country, and past studies suggest that guidance on how to develop and implement sustained compensatory mitigation evaluation efforts would lower barriers to implementation within state and tribal programs (Morgan and Hough 2015).

FIGURE 1: **Studies evaluating compensatory mitigation performance since 2000 (top) and location of mitigation banks and in lieu fee program sites (bottom). Figure on the bottom does not include permittee-responsible mitigation sites. From Morgan and Hough 2015.**





The goal of this technical resource document is to help states and other interested parties develop a long-term, scientifically rigorous approach to compensatory mitigation evaluation. The intent is to provide a basic approach for evaluating and improving the ecological and administrative performance of compensatory mitigation programs that can be implemented at the state, regional, tribal and national scale. ***The document is not intended to provide uniform guidance for evaluating individual compensation sites, but rather a framework for using data from individual sites to assess overall program performance.*** Improved program performance should ultimately translate to improved compensatory mitigation by providing better information on practices that contribute to ecological success of compensatory mitigation sites. The approach should be customizable to individual state needs, sustainable over very long-time horizons, and facilitate compilation of information that can be used to evaluate national trends.

BOX A: Compensatory Mitigation Definitions

What is Compensatory Mitigation?

- Compensatory mitigation means the restoration, establishment, enhancement, and/or in certain circumstances preservation of wetlands, streams, or other aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

What are the Methods of Compensatory Mitigation?

- **Restoration** means the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.
  - **Re-establishment** means the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions.
  - **Rehabilitation means** the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function but does not result in a gain in aquatic resource area.
- **Establishment (Creation)** means the manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area and functions.
- **Enhancement** means the manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource function(s) but may also lead to a decline in other aquatic resource function(s). Enhancement does not result in a gain in aquatic resource area.
- **Preservation** means the removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area or functions.

What are the Mechanisms for Compensatory Mitigation?

- **Mitigation Bank** (MB)means a site, or suite of sites, where resources (e.g., wetlands, streams, riparian areas) are restored, established, enhanced, and/or preserved for the purpose of providing compensatory mitigation for impacts authorized by Department of the Army (and other agency) permits. In general, a mitigation bank sells compensatory mitigation credits to permittees whose obligation to provide compensatory mitigation is then transferred to the mitigation bank sponsor. The operation and use of a mitigation bank are governed by a mitigation banking instrument.
- **In-Lieu Fee (ILF) Program** means a program involving the restoration, establishment, enhancement, and/or preservation of aquatic resources through funds paid to a governmental or non-profit natural resources management entity to satisfy compensatory mitigation requirements for Department of the Army (and other agency) permits. Similar to a mitigation bank, an in-lieu fee program sells compensatory mitigation credits to permittees whose obligation to provide compensatory mitigation is then transferred to the in-lieu program sponsor. However, the rules governing the operation and use of in-lieu fee programs are somewhat different from the rules governing operation and use of mitigation banks. The operation and use of an in-lieu fee program are governed by an in-lieu fee program instrument.
- **Permittee-Responsible Mitigation (PRM)** means an aquatic resource restoration, establishment, enhancement, and/or preservation activity undertaken by the permittee (or an authorized agent or contractor) to provide compensatory mitigation for which the permittee retains full responsibility.

Source: 40 CFR 230.92/33 CFR 332.2

The proposed compensatory mitigation evaluation framework is recommended to be applicable to all stream and wetland types that commonly occur in the US. The evaluation framework should provide recommendations on how to design a programmatic compensatory mitigation monitoring and assessment program, including site selection, monitoring approach, and selection of indicators that are designed to answer key assessment questions. The framework is intended to support ongoing efforts to assess compensatory mitigation success and program effectiveness, and state (and tribal) programs by providing recommendations for how to monitor program performance/success, as well as report on the results, and improve data availability. The aim is to help improve the evaluation of program effectiveness so that the information can be used to inform decisions about state program enhancement or improvement. States will benefit from improved ability to share data, protocols, and templates across programs (so there are fewer parallel or duplicative efforts); increased efficiency for agency staff because it is easier to find data and information and to use past project information to support decisions; and improved public access to data (i.e., increased transparency). Improved data access will have the secondary benefit of facilitating USEPA's ability to compile data from states to conduct national assessments.

State program managers are a primary target audience for this publication for the following reasons: 1) most of the past studies of compensation performance have been conducted by states or defined by state boundaries (Morgan and Hough 2015); 2) states have an interest in the long-term performance of compensatory mitigation project sites (e.g., all states have Clean Water Act Section 401 certification authority and 29 states have relevant independent state permitting programs (ASWM 2015) and 3) state agencies have mechanisms for conducting evaluations and access to resources to fund such evaluations (e.g., USEPA Wetland Program Development Grants). By targeting states, we are not suggesting that federal agencies such as USEPA, USACE, USFWS, and NMFS do not have an interest in compensation performance. These federal agencies have in the past and continue to have a keen interest in compensation performance; representatives from all these agencies participated in the development of this document. But robust compensation performance evaluation efforts are resource intensive and federal agencies have not had sustained access to adequate resources to perform these kinds of evaluations. In contrast, states have led many efforts in compensation performance evaluation, in part, because they have access to resources to conduct such evaluations that are not available to federal agencies (e.g., USEPA Wetland Program Development Grants). By targeting states with this document, we are attempting to build on their demonstrated success and experience in this area and expect federal agencies to continue to support and partner with states on compensation performance evaluation efforts.

In addition to its inherent value for reflective assessment, the proposed assessment framework should also be viewed as a bridge to future planning efforts. Analysis of compensatory mitigation practices is critical to better understand how effective programs have been at achieving their stated objectives and contributing to the overall extent and condition of aquatic resources. Conclusions derived from monitoring and retrospective analysis allow refinement of policies and improvement of implementation programs. However, the knowledge gained through these assessments should also be used to inform watershed and regional plans.

Over the last decade, there has been much discussion of the importance of landscape or watershed scale planning to help prioritize allocation of scarce resources. Mitigation in the watershed context is a key tenet of the 2008 Mitigation Rule and embodies the idea that the type of aquatic resources restored and the location where they are placed should be done in consideration of how materials and organisms move through the landscape and how resiliency can be promoted across the entire system.

It is recommended that information produced as part of the proposed compensatory mitigation assessment framework be used to support these planning decisions. This is particularly true for the larger-scale questions addressed through program effectiveness assessment and the longer time scale questions addressed through long term monitoring of the resilience of compensatory mitigation sites. The former can provide insight into the appropriate distribution of streams and wetlands across the landscape necessary to achieve integrated watershed health, whereas the latter can inform design and management actions that promote long-term sustainability. Creating a bridge between retrospective assessment and prospective planning will require embracing the concepts of transparent evaluation tools and open accessible data, but if realized, will greatly expand the return on the resources invested in monitoring and assessment.

Approach to Developing the Framework

The integrated compensatory mitigation evaluation framework reflects both the experience and the needs of state programs. As the intended end-users of this framework, input from state programs was critical in identifying priority needs and in developing recommendations that are useful and pragmatic for potential incorporation at state or regional scales.

Using the results of an initial literature review of past studies on compensatory mitigation effectiveness, state program managers were contacted regarding their willingness to participate in phone interviews on the structure of their compensatory mitigation programs, approaches to monitoring and assessment, and data management practices. Fifteen states responded to the request and were subsequently interviewed (Table 1). The outcomes of the interviews were documented and verified by state program managers and are summarized in Appendix A.

TABLE 1: States surveyed regarding mitigation assessment structure and needs

California	Maryland	New Jersey
Florida	Massachusetts	North Carolina
Illinois	Michigan	Ohio
Iowa	Minnesota	Washington
Louisiana	Missouri	Wisconsin

Most states have some programs in place for assessing project-specific performance. Few have any structured programs for measuring overall mitigation program effectiveness or long-term performance/sustainability of compensatory mitigation. State program managers were generally receptive to additional tools and guidance regarding how to improve compensatory mitigation assessment. ELI conducted an additional assessment of current practice in collecting and tracking compensatory mitigation data at the state level to help refine data management recommendations (Appendix B). Interviews identified a common set of high priority needs related to compensatory mitigation performance assessment and data management; these needs form the foundation for this technical resource document and can be broken into two main categories:

Monitoring and Performance Assessment Needs

- Interpretive framework for assessing monitoring data
  - The appropriate spatial and temporal resolution for different indicators
  - Methods or approaches to differentiate reliable patterns in monitoring data from background variability/noise to draw more defensible conclusions
  - Options for how to use data to establish thresholds or targets
  - Examples of how monitoring data can be appropriately used to improve program performance, along with potential pitfalls for misuse of monitoring data
- Standardization of monitoring requirements and performance standards by stream or wetland class used to assess functional gains. The need is particularly great for stream mitigation and includes the following:
  - Standard measures/indicators to be used by all projects within an aquatic resource type, with an emphasis on measures of improved physical processes
  - Standard monitoring protocols or approaches
  - Recommended monitoring endpoints that are most sensitive to measuring gains associated with compensation methods and least sensitive to normal climatic and environmental variability
  - Checklist of items/measures that should be included in all routine assessments
- Guidance on how to define reference conditions (and reference standard) and development of a national registry of reference sites
- Guidance on how to assess watershed condition and how compensatory mitigation projects contribute to overall watershed condition
  - Metrics and monitoring recommendations for how to synthesize results from numerous projects to evaluate improvements at the reach and catchment scale.

Data Management Needs

- Web-based or off-the-shelf data management tools that could help get data from project files to a queryable database (with reminders to help keep track of deadlines and due dates)
    - Better ways to compile and reconcile data from different sources
    - Standard data templates and automated data checkers (to improve quality control), including for geospatial data
- More integrated data tools that include data capture, compilation, and querying capability and have the flexibility for modifying and appending data as necessary.
- Improved access to existing data management systems and GIS data from other agencies and programs, potentially through web services or open data access

Recommendations to address the needs identified through state-level interviews were developed in coordination with technical experts from selected states, USEPA, USACE, USFWS, and NMFS, as well as scientists from academic and non-governmental organizations.

The technical expert reviewers provided individual input to help USEPA ensure that the final report reflects the best available science, best practices from past studies, and the needs and interests of states, tribes, academics and others interested in evaluating compensatory mitigation programs. The technical reviewers also provided input on the practicality of recommendations and the likelihood that they could be implemented in ways that would address the identified needs.

2. OVERALL RECOMMENDATIONS

Modular Approach

Comprehensive compensatory mitigation evaluation should include assessment of both project and program performance. A modular approach provides a flexible framework to achieve different elements of compensatory mitigation assessments. States can prioritize different modules depending on their needs and priorities, and the status of existing assessment programs. However, implementation of all three modules would provide a comprehensive assessment program. The three modules proposed are:

1) Compensatory mitigation site performance: This module evaluates the success of mitigation projects relative to defined ecological endpoints (e.g., morphology, habitats, species, communities), functional goals and permit requirements. This module can also help assess factors that influence mitigation success and the length of time necessary to achieve desired targets.

2) Program effectiveness: This module evaluates the overall effectiveness of the regulatory program at achieving programmatic goals, such as no-net loss, specific area goals, and/or desired ecological targets at reach, watershed and regional scales. This includes an evaluation of the relative success of different compensation mechanisms (e.g., MB, ILF, PRM) and practices (e.g., use of standard performance standards) at achieving programmatic goals.

3) Resiliency of compensatory mitigation practices: This module evaluates likely long-term trajectories of compensatory mitigation sites at achieving functional replacement of aquatic resource impacts. This would include the role of adaptive management, ability to adapt for climate change effects, and vulnerability to future degradation due to changing land use, climate, and management practices.

The three modules should be applicable to all aquatic resource types and include the following general practices:

- All compensatory mitigation sites should be catalogued in a database with appropriate metadata and geospatial information.
- Data entry should be standardized and streamlined with appropriate QA/QC procedures; building data dictionaries is valuable.

AMBIENT ASSESSMENT

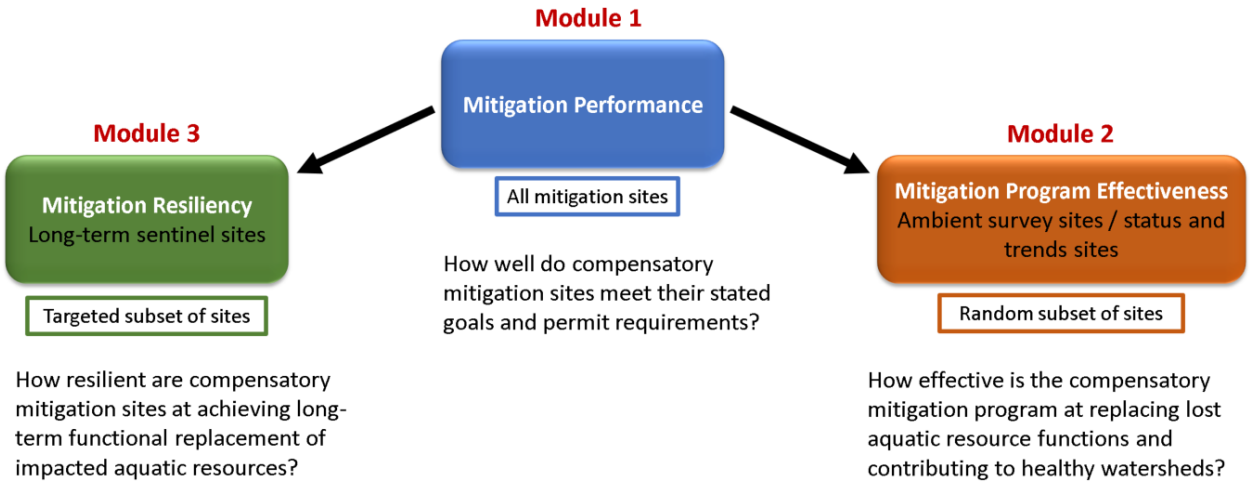
Ambient assessment refers to the characterization of regional (or statewide) conditions. Ambient assessment provides information on the extent, distribution, and condition of aquatic resources across a defined geography.

Ambient assessments sample a broad range of indicators at sites selected following a systematic or random study design.

- Compensatory mitigation sites (and impact sites if possible) should be available on maps, which will be essential for site selection in all three modules.
- Data should be stored in an open-data format and linked to the internet to facilitate access by the public, sharing among agency partners, and incorporation by USEPA into national assessments.
- Assessments should be integrated into ongoing, sustainable agency programs to facilitate long-term implementation. These could be existing or newly created programs to measure ambient conditions in specific areas or aquatic resource types.
- Assessments should include regular reporting targeted to both agency/professional staff and the public – this may require multiple reporting formats and approaches.

Together, the three modules address a comprehensive set of questions about short and long-term effectiveness of compensatory mitigation programs (Figure 2). The modules are designed to be nested such that sites evaluated as part of the program effectiveness are a subset of the sites used for the performance assessment. Sites used for the resiliency evaluation are also a subset of the sites used for the performance assessment and may or may not be a subset of sites used for effectiveness evaluation, as shown in Figure 3.

FIGURE 2: Overview of the three modules of an integrated framework for evaluating compensatory mitigation



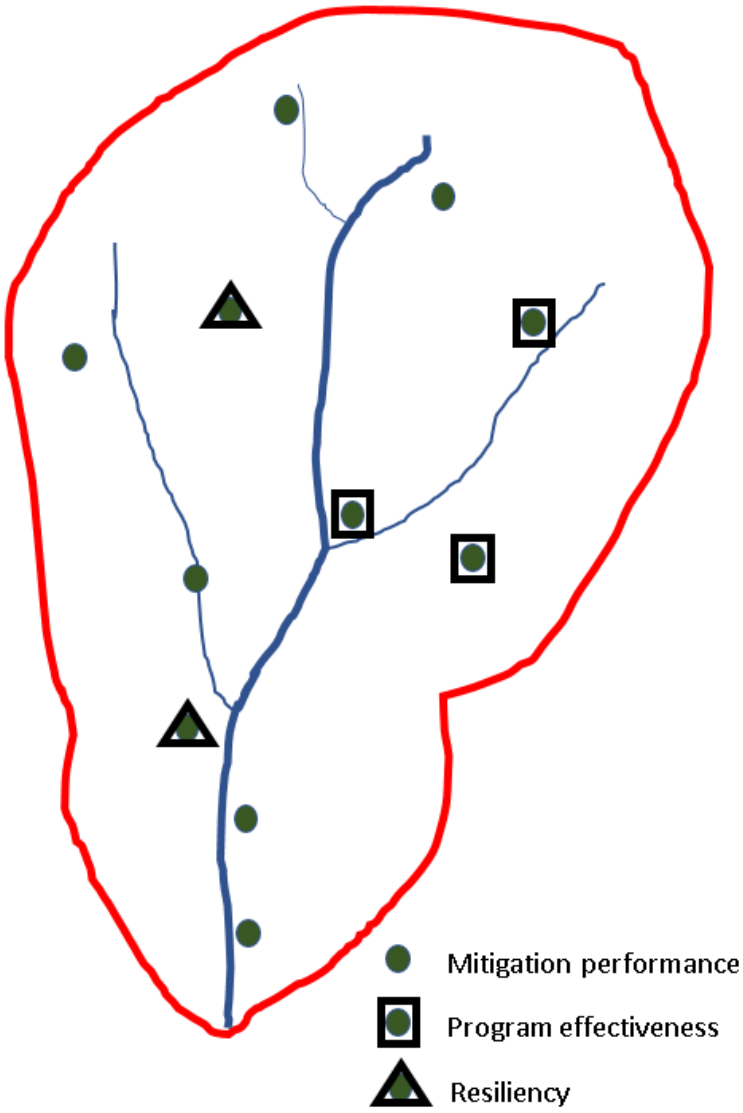


FIGURE 3: **Illustration of nesting of sites used for each of the three modules. All sites are used for the performance assessment, a subset of sites is used to evaluate program effectiveness. The sites used to assess resiliency are a subset of those used to assess performance and may or may not be a subset of sites used to assess effectiveness. Sites should include all stream and wetland types within a watershed.**

Each module described below is organized around the following elements: general goal, main question, assessment approach, site selection, and approach to reference and indicators. The main elements of each module are summarized in Table 2 and discussed in detail below:

TABLE 2: **Summary of major elements for each compensatory mitigation evaluation module**

	PERFORMANCE	EFFECTIVENESS	RESILIENCY
Goal	Ecological success of compensation sites and regulatory compliance	Effectiveness of program at offsetting aquatic resource losses and contributing to no-net loss goals	Long-term resiliency and sustainability
Design Approach	Comprehensive	Probabilistic	Targeted sentinel sites
Reference Approach	Performance standards, pre- vs. post-mitigation site, comparison to impact site or reference sites	Comparison to regional/ambient condition, comparison to impact sites and reference sites	Comparison to regional/ambient condition, comparison to reference standard sites

General Recommendations

Wetland, stream and other aquatic resource regulatory programs are structured around specific projects. Consequently, most monitoring programs focus on performance of individual compensation sites (e.g., MB, ILF and PRM sites). Few states have any structured programs for measuring overall program effectiveness or long-term performance/sustainability of compensatory mitigation. Arguably, these assessments are critical measures of how well compensatory mitigation offsets permanent losses associated with permitted activities. Given the inherent budget and staffing challenges of conducting more holistic assessments, all monitoring and assessment programs are recommended to consider the following:

1) Establish goals against which overall programmatic success can be gauged. These may include "no-net loss," achieving specific areal targets, establishing desired distributions of aquatic resources, or restoring landscape-scale functions. Clearly articulated goals make it easier to focus resources toward development of tools and capacity that are best suited to evaluate these goals.

2) Program effectiveness and long-term resiliency assessments should be conducted by state, academic, or NGO entities with dedicated staffing and funding for these activities in coordination with state wetland, stream or water quality monitoring program staff.

3) Effectiveness assessment (Module 2) is best accomplished in one of two ways:

    a) Improving data management systems to allow information from compensatory mitigation sites to be more readily accessed and analyzed for programmatic trends

b) Partnering with an existing state or regional ambient monitoring or status and trends program. Comparing results from a subset of compensatory mitigation sites to ambient assessment data, which is often collected probabilistically, or to standard status and trends plots may provide an efficient way to evaluate how compensatory mitigation contributes to overall aquatic resource gains (or losses). The subset of compensatory mitigation sites evaluated can be selected randomly or systematically to represent the full set of required compensatory mitigation sites.

4) Long-term resiliency (Module 3) is best assessed through ongoing monitoring of targeted (or sentinel) sites for a minimum of 20 years. Some stream or wetland types, including, but not limited to, forested systems, arctic wetlands, or fens take much longer to mature and may require monitoring of up to 50 years. Monitoring at these sites can occur less frequently and should be funded through long-term dedicated funding, such as endowments established using mitigation funds or permit fees or targeted program funds.

Core Elements for Monitoring and Assessment

Successful monitoring and assessment programs should include the following core elements, which are discussed in more detail in the subsequent sections of this document:

1) Bioassessment indices or other quantitative measures that include standard operating procedures that can be applied in a repeatable manner and have associated quality control procedures.

2) Established (and protected) reference standard sites that reflect the range of stream or wetland types occurring within the jurisdiction of the state program. Reference sites should be monitored over time to provide insight into long-term patterns and natural variability in condition.

3) Clear targets based on reference and related to wetland/stream function and programmatic goals.

4) Strong guidance documents on monitoring and assessment requirements to provide a clear structure for program implementation – both for the agencies and the regulated community. This guidance should include procedures for analyzing data, interpreting results, and preparing reports.

5) Easy to use project/permit tracking system with automated reminders for both agency staff and permittees.

6) Simple and transparent data management system that is integrated into the permitting workflow. The following features promote efficient program implementation:

   a) Map-based data management that tracks basic project information, location, and key performance standards

b) Integrated data tools that include data capture, compilation and querying capability and have the flexibility for modifying and appending data as necessary

c) Ability to schedule automatic reminders via email, group calendaring, etc.

d) Web-based systems that are readily accessible and can be queried by the public

e) Use of "web-services" that allow dynamic linkage to other databases and facilitate data sharing between programs

In developing capacity for these core elements, state programs may draw from the tools and resources developed through USEPA's National Aquatic Resource Surveys (NARS), which include standard protocols, guidance for defining and selecting reference sites, methods for establishing thresholds of response, and suggested analytical approaches. State programs should also take advantage of the existing networks of reference sites established through the NARS program to help provide context for site-specific and regional monitoring of compensation sites.

Recommended Indicators

A common set of field indicators should be used to facilitate data sharing across the three modules and support the nested design. Indicators should be based on the USEPA Level 1, 2, and 3 approach as described in *Elements of a State Water Monitoring and Assessment Program* (USEPA 2003; EPA 841-B-03-003; Figure 4). Level 1 indicators are important for tracking gains and losses in aquatic resource area and should include measures of jurisdictional and non-jurisdictional wetlands and waters, adjacent upland and buffer habitats, and open water. At a minimum both hydrogeomorphic (HGM) and Cowardin classification systems should be used for wetlands. For streams, Level 1 indicators should include areal measures such as catchment area, catchment description and condition, reach length, corridor width, and valley morphology. Standard stream classifications such as Leopold and Wolman (1957), Montgomery and Buffington (1997), Cluer and Thorne (2013) or Rosgen (1994) may be used.

PROBILISTIC ASSESSMENT

Probabilistic assessment is often used to develop estimates of overall extent or condition when comprehensive sampling is not possible.

Probabilistic assessment involves assessing a randomly selected set of sites and then extrapolating to a regional or statewide estimate of extent or condition.

Local or state classification systems can also be used, if classification details are included in the data dictionaries.

FIGURE 4: Overview of the USEPA Level 1-2-3 assessment framework - wetlands example.

Level 1 – Landscape Assessment: Use GIS and remote sensing to gain a landscape view of watershed and wetland condition. Typical assessment indicators include wetland coverage (NWI), land use and land cover.
Level 2 – Rapid Wetland Assessment: Evaluate the general condition of individual wetlands using relatively simple field indicators. Assessment is often based on the characterization of stressors known to limit wetland functions e.g., road crossings, tile drainage, ditching.
Level 3 – Intensive Site Assessment: Produce quantitative data with known certainty of wetland condition within an assessment area, used to refine rapid wetland assessment methods and diagnose the causes of wetland degradation. Assessment is typically accomplished using indices of biological integrity or hydrogeomorphic function.

Level 2 rapid assessments can be used to provide general assessments of condition through common field indicators. For wetlands, Level 2 assessments provide easily interpretable output, generally on a 0-1 scale that facilitate comparison of scores across different wetlands and can be readily used for assessing mitigation performance. Many states have rapid wetland assessments (e.g., ORAM, NMRAM, CRAM, WAM); those that don't can use the USA RAM developed as part of the National Wetlands Condition Assessment (NWCA). For streams, there are numerous rapid assessment methods that focus on relatively simple visual observations of reach-scale geomorphic, hydrologic, water quality, and biological indicators, as well as measures of riparian condition. A summary of available physical stream assessment methods is provided by Somerville and Pruitt (2004) and Somerville (2010). More recent methods include the Function-Based Rapid Stream Assessment Methodology (Starr et al. 2015) and the Rapid Stream Riparian Assessment (RSRA; Stacey et al. 2009). Some states and USACE Districts have developed their own rapid assessment methods for stream compensatory mitigation programs.

Level 3 intensive indicators are necessary to provide more information on function or condition and to guide adaptive management. The USEPA National Aquatic Resource Surveys (NARS) have developed protocols for a suite of Level 3 indicators (Table 3). Specific indicators may vary by aquatic resource type and different portions of the overall indicator list may be used for the different modules. For example, a subset of Level 3 indicators may be used for mitigation performance assessment (Module 1) and a broader set of indicators may be used for program evaluation and resiliency assessment (Modules 2 and 3). Finally, bioassessment indices (e.g., IBI, FQAI) can be used to provide integrated measures of community composition on a common scale that can be readily compared among streams and wetlands. Existing protocols developed by the various NARS programs (e.g., National Rivers and Streams, National Wetland Condition, National Lakes Assessments) should be used to the extent possible (Kaufmann et al. 2014). Examples of the relationship between indicators and specific functions are provided in the national and regional HGM guidebooks developed by the USACE and its partners (https://wetlands.el.erdc.dren.mil/guidebooks.cfm).

TABLE 3: **Level 3 indicators of aquatic resource condition. Indicators are color coded by the aquatic resource type to which they pertain.**

	FRESHWATER WETLANDS	ESTUARINE WETLANDS	RIVERS & STREAMS	LAKES
Buffer and Landscape Context				
Width and condition of buffer				
Connectivity to adjacent wetlands/floodplain				
Hydrology/Geomorphology				
Duration of ponding, saturation or inundation				
Flow dynamics and floodplain connection				
Evidence of hydrologic alteration				
Sediment deposition or erosion/CEM class				
Channel planform				
Bank height, angle, consolidation				
Water level or flow				
Depth to subsurface water or soil water loss				
Soils/Substrate				
Soil morphology and type				
Structure of soil column (including subaqueous)				
Bedform				
Substrate (surface) composition/structure				
Sediment chemistry				
Redox conditions				
Water Chemistry				
Ph, EC, TDS, temperature				
Clarity, suspended sediments, turbidity				
Algal toxins (or toxic forming species)				
Dissolved organic carbon				
Chlorophyll a				
Organic matter/metabolism				
Dissolved oxygen (continuous)				
Nutrients				
Vegetation				
Vegetation cover				
Community composition & structure				
Physical disturbance of the plant community				
Invasive plants				
Age-stand distribution				
Evidence of recruitment				
FQAI (or equivalent)				
Shoreline and littoral habitat extent				
Bioassessment Indicators				
Algal index (e.g., IBI, MMI)				
Macroalgal extent				
Benthic invertebrate index (e.g., IBI, MMI, O/E)				
Amphibian index				
Fish community index				
Evidence of wildlife/bird use				

Level 1 assessment tools will be applicable to tracking aquatic resource area under all three modules. Levels 2 and 3 tools will be useful for Modules 2 and 3. Level 2 rapid assessments will be appropriate for answering questions of general condition and some degree of regulatory compliance. Level 3 tools will provide detailed evaluation of condition or function and support adaptive management decisions in addition to regulatory compliance.

Adaptive Management

Measures of landscape or local stress may be measured along with condition indicators and can be used as a way to evaluate compensatory mitigation performance and understand reasons why sites do or do not succeed. Stress measures may be Level 1 (landscape-scale), such as land use/land cover, Level 2 (rapid assessment), such as buffer condition, or Level 3 (intensive), such as sediment/contaminant input or patterns of human visitation. Compiling stressor information over time at many sites can be used to both interpret compensatory mitigation performance and improve mitigation practices, such as improving site selection, restoration design, or management measures.

Review of data from numerous compensation sites can be used in conjunction with land use factors (e.g., intensity and proximity of adjacent development, streamflow diversions, groundwater extraction) to assess factors that contribute to mitigation success. Application of standard monitoring and assessment approaches allows for statistical analysis of relationships between factors internal to the wetland (e.g., hydrology) and external (e.g., runoff from adjacent land uses) and various performance standards. These relationships can inform adaptive management actions at the individual site level as well as programmatic changes (e.g., improving permit conditions). Analysis of stress-response relationships over time can also provide information to factors that contribute to long-term success and can inform site selection and watershed planning efforts, which may be able to address upland stressors that are impacting compensation sites.

Performance Standards

Best Practices for Developing Performance Standards

Performance standards allow objective evaluation of the condition or function of a compensatory mitigation site relative to an agreed upon target. Ideally, performance standards should be related to design parameters, based on the same indicators used for monitoring, similar to crediting and debiting measures (for MB and ILF), and should provide both interim and ultimate measures of success relative to objectives/targets. Developing common sets of performance standards at national or regional scales is not practical given the immense diversity of wetland/stream types, physical settings, and regulatory priorities across the country. Specific state or local performance standards should be developed based on literature review, evaluation of past monitoring data, and local expert judgement. Development of performance standards can also be informed by condition data from national assessment programs (such as NRSA and NWCA), state, tribal, or regional monitoring programs.

The following general recommendations regarding the structure of effective performance standards can serve as a guide, or template, for development of program or project specific standards. Effective performance standards generally address "*what to measure,*" "*how to measure,*" and "*when to gauge success,*" and have the following attributes:

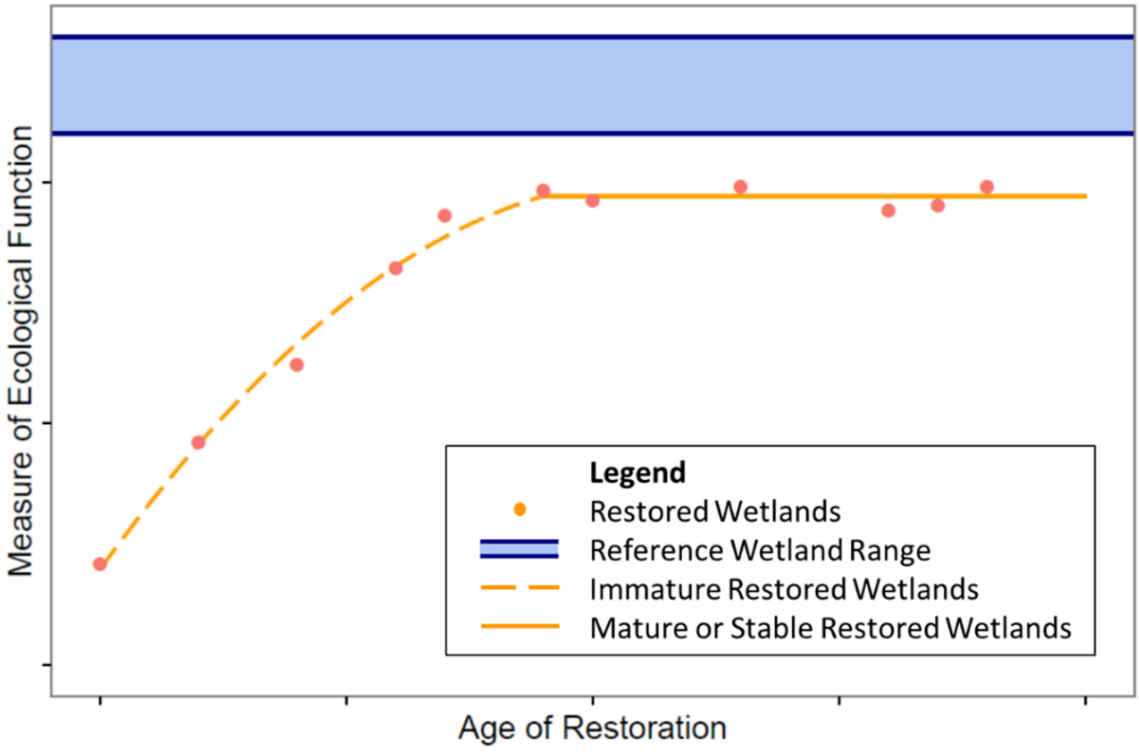
1) Measures a single aspect of condition/function - Each standard should attempt to isolate one aspect/indicator of function, such as recruitment of native plant communities or appropriate hydrology during the growing season. Although compensatory mitigation should strive to restore fully integrated functional ecosystems, measuring specific indicators is often more practical and enforceable, and can be more easily tied to adaptive management.

2) Can be measured objectively and in a repeatable manner – To the extent possible, standard acceptable protocols should be used so that independent practitioners are producing data in a consistent, repeatable manner. This allows for comparison of data over time at a given site or between sites within a region.

3) Quantifiable targets with known certainty – Standard protocols are typically associated with specific error rates that provide known levels of confidence. These error rates may result from variability during data collection or analysis (e.g., inherent errors in species identification or instrument measurements) and should be accounted for during data interpretation. Data from past mitigation sites and ambient monitoring programs can be used to estimate natural variability between aquatic resources and help bound the ranges of expectations for performance standards. Performance standards should account for such measurement uncertainty.

4) Clear target or benchmark anchored to reference – Performance should be assessed relative to a defined target and should include an expected timeframe to meet that target (e.g., at year 5 following construction, 3 years after the first 5-year flow event). The target can be based on conditions at reference sites (e.g., either minimally impacted or best attainable) or relative to regional or ambient condition (e.g., comparable to the 75% of the range of ambient conditions). Some states have begun the process of developing performance trajectories that can be used to evaluate reasonable progress toward meeting defined targets (Figure 5). Performance trajectories can also support the development of interim performance standards that assess progress toward ultimate targets and can inform adaptive management decisions.

FIGURE 5: **Hypothetical performance curve showing a trajectory of expected response relative to a range of reference conditions.**



5) Clear and concise wording – The period of performance evaluation often exceeds the tenure of an individual permit manager or may involve staff who were not involved in writing the performance standards. The language of each standard should be written so that an uninitiated staff person can readily interpret the intent of the standard and reach a clear determination of compliance. Clear and unambiguous standards can also reduce disagreements between mitigation providers and regulators as to whether the standard has been achieved. An example standard is provided in Box B below:

BOX B: **Sample Performance Standard Wording**

SAMPLE PERFORMANCE STANDARD

At the end of year 3, at least 80% of Area A shall have a benthic invertebrate index score within 10% of the median reference population score.

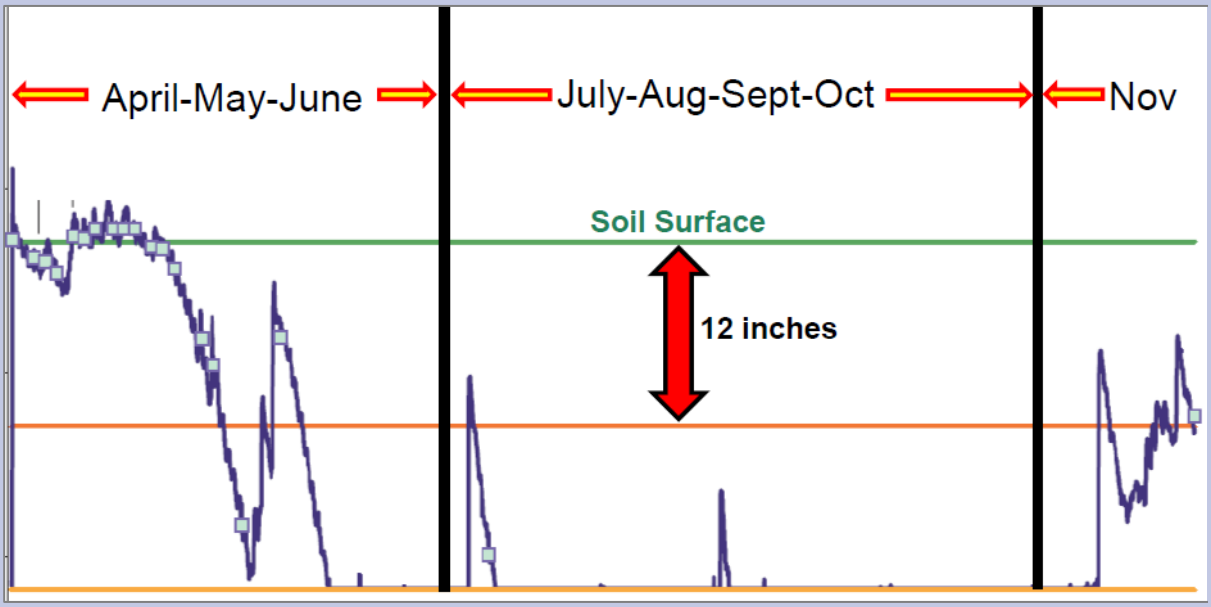
- If this standard is not met, the site will be re-evaluated within 120 days of the original field assessment
- If the standard is still not met, metric level analysis and/or causal assessment shall be conducted to identify likely reasons for failure

6) Scientifically defensible – Standards should be grounded in sound scientific principles and preferably related to peer-reviewed studies. Technical studies and data used to support development of state water quality standards can be used to help inform compensatory mitigation performance standards. Analysis of data from past mitigation projects and/or reference wetlands/streams can also provide scientific rationale and support for development and ongoing refinement of performance standards, which should not be static, but evolve over time as lessons are learned from past practices. Box C below provides an example standard for wetland hydrology from the St. Paul District of the USACE, that provides defensibility based on data from locally relevant reference sites.

BOX C: Sample Hydrology Performance Standard

SEASONAL WATER LEVELS AT REFERENCE SITE

Vertical lines indicate seasonal breaks



PERFORMANCE STANDARD BASED ON REFERENCE DATA:

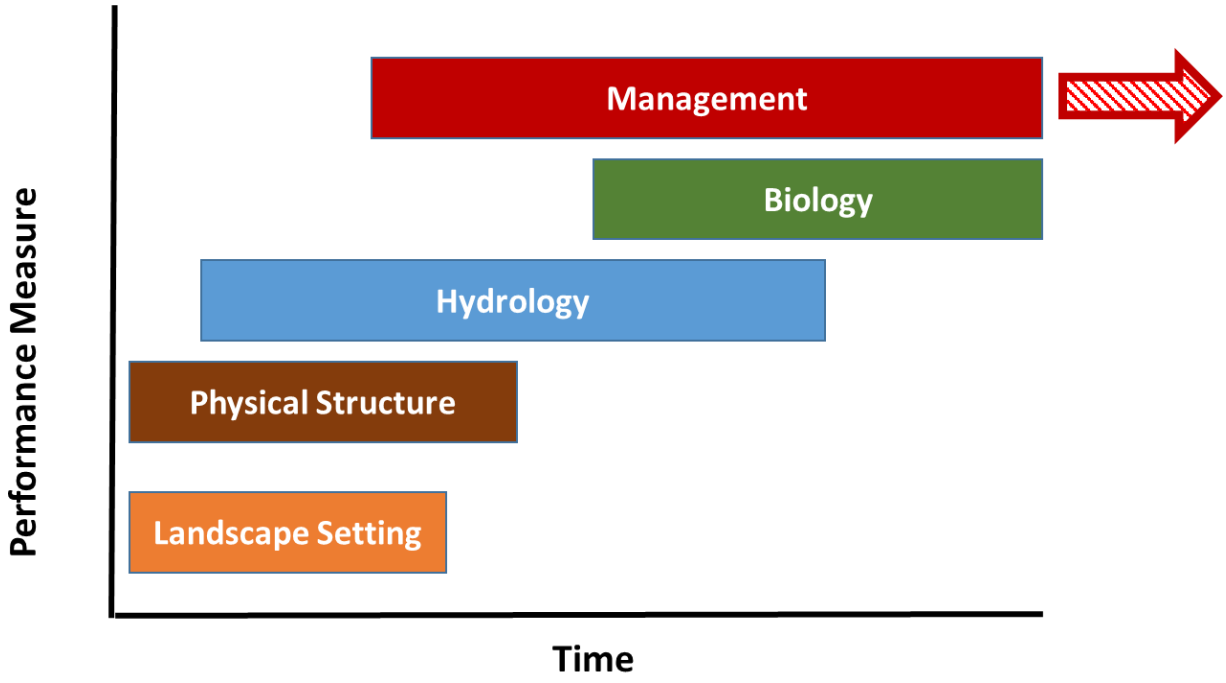
Hydrology shall consist of a water table 12 inches or less below the soil surface for a minimum of 28 consecutive days during the growing season under normal to wetter than normal hydrological conditions (typically July-Oct).

Inundation during the growing season shall not occur except: (1) at the start of the growing season (following snowmelt); and (2) following the 10-year, 24-hour – or greater – precipitation events. Depth of inundation shall be less than 6 inches with a duration of less than 14 consecutive days.

St. Paul District Compensatory Mitigation Policy for Minnesota, 2009

7) Phased - Performance standards can be phased over time with performance of the physical aspects of the stream or wetland being evaluated earlier in the restoration process and obtainment of the biological aspects occurring later, once the physical and hydrologic elements are well established (Figure 6). Such a phased approach may be more conducive to development of interim performance targets and to earlier identification of problems that require remedial action or adaptive management.

FIGURE 6: Phased implementation of performance standards can facilitate early intervention and adaptive management, which may in turn promote increased likelihood of mitigation success.



Assessing Wetland Performance

The following should be considered when developing standards to assess the performance of **wetlands**:

- Wetland typology to ensure that the physical setting of the wetland being restored is at the appropriate landscape position. For example, groundwater dependent wetlands must be in a topographic low (or geologic contact point for slope and seep wetlands) and have adequate groundwater connection. Hydrogeomorphic (HGM) classification should be used to support development of targets that are based on the physical setting and hydrologic regime of the mitigation site.
- Performance relative to appropriate reference or analogue wetlands. Reference standard sites should be in the same HGM class and landscape position and should be subject to

minimal disturbance. Ideally reference sites should be subject to ongoing monitoring to provide for meaningful targets that account for natural variability associated with weather patterns and periodic natural disturbance.

- The characteristic hydrologic regime necessary to support the desired wetland class. This is particularly important for groundwater dependent wetlands which require connection with subsurface water (often of specific chemical composition) during key portions of the growing season).
- Soil chemistry and structure. Where appropriate, hydric soils should be present. In all cases, the soil profile should reflect appropriate zonation with appropriate organic matter. Certain wetland types may require specific soil salinities. Specific metrics may include:
  - Presence of hydric soils or specific soil morphology (e.g., thickness of an O-horizon)
  - Soil salinity or cation-exchange capacity
- Self-recruitment of diverse native plant communities of multiple age classes and spatial heterogeneity. Initial active planting and invasive species control may be necessary, but standards should reflect a long-term goal of self-recruitment. Specific metrics may include:
  - Relative abundance or cover of various age classes, including evidence of recruitment
  - Maximum allowable cover of invasive plant species
- A measure of faunal community use. Indices of biological integrity based on benthic invertebrates, fish or amphibians are effective measures of the health of faunal communities and are often available from ambient monitoring programs. Specific metrics may include:
  - Indices of biotic integrity
  - Presence of key indicator taxa, sensitive species
  - Absence of nuisance invasive animal species

Assessing Stream Performance

The following should be considered when developing standards to assess the performance of **streams**:

- Hydrology - Begin by classifying streams based on their flow persistence (i.e., perennial, intermittent, or ephemeral). This may be difficult because streams occur along a continuum of flow permanence, which may vary based on climatic condition; most likely flow type is sufficient. Streams should also be classified based on their predominant source of water (e.g., snowmelt runoff, winter rain, groundwater dependent). McManamay et al. (2014) provides a nationwide hydrologic classification (that is an update of the classification developed by Poff (1996)) that combines both flow persistence and source of water. In some cases, region or state specific classification systems may be available.
- Geomorphology – Several national systems have been developed for the US and others have been developed for Europe and Australia. Geomorphic classification can be based on valley

and channel form, morphology, equilibrium conditions, or combinations. Some states and regions have developed localized classification systems (e.g., the Hydrologic Landscape Regions approach for the Oregon Stream Functional Assessment Method; Nadeau et al. 2018). Examples of common stream classification systems and channel evolution models include:

  - Montgomery and Buffington (1997) classifies streams based on bed morphology, such as braided, pool-riffle, plane-bed, step-pool, cascade, bedrock, and colluvial.
  - Rosgen (1994) classifies streams into eight general types based on basic quantitative measures of single versus multi-thread channel configuration, degree of entrenchment, width-depth ratio (W/D), and planform (sinuosity). Slope and bed material are used to provide further classification detail.
  - Cluer and Thorne (2013) classification is an extension of the classic channel evolution model and is based on the evolution of responses and recovery that occur as channels incise, widen and eventually re-establish equilibrium.

- Appropriate reference analog streams should be established based on the proposed/target stream type. Reference streams must be in the same flow class, geomorphic type, and have similar bed material and boundary conditions (Hey 2006). If possible, reference analogues should also be in a similar geologic setting and sediment regime class (e.g., depositional, transport; see Church 2006) and should not be actively aggrading or degrading. This is more important for vegetation and biological metrics than some geomorphic metrics that can be normalized by the bankfull dimensions (Hey 2006). In landscapes that have been substantially altered through land use change, analog streams will seldom represent "historic" conditions, but rather represent reasonable expectations for the best possible condition (or function) given the landscape setting.
- Establish a domain of analysis. Streams are intimately linked to the conditions in upstream and downstream reaches. Conditions with a reach can be influenced by adjacent reaches; conversely mitigation/restoration actions in a specific reach may affect upstream or downstream areas positively or negatively; for example, trapping sediment in one reach may result in downstream incision due to sediment starvation. The "domain of analysis" establishes the zone that should be assessed when evaluating mitigation performance.
  - Upstream domain should be defined as a distance equal to 20 channel widths or to the next upstream natural or engineered grade control, whichever comes first.
  - Downstream domain should be defined as the closest of the following:
    - At least one reach downstream of the first grade-control point (but preferably the second downstream grade control location)
    - Tidal backwater/lentic waterbody
    - Equal-order tributary
    - A two-fold increase in drainage area

  - Upstream and downstream areas should be evaluated based on their hydraulic/geomorphic condition, channel evolution class, and degree of sediment continuity with the reach of interest (i.e., the mitigation or impact reach).

- Evaluate a core set of indicators relative to appropriate reference analogs based on stream classification. These indicators should be assessed throughout the entire domain of analysis:
  - Bedform diversity (sequences of riffle, run, pool, and glide) stratified by flow and stream type.
  - Channel planform appropriate for valley type, stream type, and substrate type.
  - Bank stability: height, bank angle, evidence of mass wasting and/or toe erosion, consolidation of bank materials.
  - Lateral migration rates stratified by flow type and stream type.
  - Substrate composition, embeddedness.
  - Evidence of aggradation/degradation.
  - Full annual hydrograph appropriate for the stream type and watershed position, including peak stormflows, rate of change (flashiness), recessional flows and baseflows. Specific metrics may include floodplain connectivity/inundation, frequency and duration of saturation or depth of inundation, attenuation, and flow metrics relative to dynamic equilibrium and species life history needs (e.g., timing).
  - Basic water chemistry as listed in Table 3.
  - Plant community using more "universal" indicators such as prevalence index, age-stand distribution, evidence of recruitment, all strata present.
  - Index of biotic community condition (e.g., IBI/MMI, O/E) – for bugs, algae, fish.
- Evaluate trends over appropriate time frames. The inherent variability and highly dynamic nature of streams makes it difficult to establish static performance standards at a given time point (e.g., achieve reference planform by year five). Instead, stream mitigation performance should be evaluated based on the trajectory of indicators relative to appropriate reference analogs over extended time periods (minimum of 10 years) that preferably includes at least one 10-year flow event or larger. Streams in watersheds with highly variable (flashy) flows in unconfined valleys and/or rapidly changing land use and hydrology may need to be monitored longer than streams with more consistent flow patterns that have coarse substrates and occur in confined valleys.

Accounting for Non-Stationarity (Change Over Time)

Standards to assess the performance of wetland and stream compensation sites should account for the inherent non-stationarity of most landscapes. Conditions will inevitably change over the period in which compensation sites are maturing, and standards used during the monitoring period and especially those employed after regulatory closeout should account for this (Robertson et al 2018). Natural events such as floods or fires may change physical or

biological conditions. New invasive species or threatened/endangered species may inhabit the site. Long-term climate change may alter hydrologic and temperature regimes over the decades in which compensation sites are developing. Finally, other management programs, such as stormwater runoff control, low impact development, water reuse and recycling, or groundwater infiltration may fundamentally alter catchment water balances and affect the amount and timing of water available to support compensation sites.

Standards should attempt to accommodate such changes to the extent that they can be identified from existing conditions or reasonable future projections. Moreover, standards should be periodically reevaluated for their relevancy as part of the ongoing assessment process. This will support a determination of whether partial success (or failure) is due to site conditions or a landscape-level shift across the range of conditions that would indicate a need to adjust the standards. Development of function-based standards and coupling of performance standards to reference conditions that are adjusted over time (based on ongoing monitoring programs or, at a minimum, monitoring across a network of control sites) can help improve their longevity and continued relevance.

3. MODULE 1: *Compensatory Mitigation Site Performance*

At a Glance

This module is intended to help states better assess if compensatory mitigation projects (i.e., MB, ILF, and PRM sites) are meeting their permit requirements and/or achieving functional success. It contains recommendations for the type of data collected and evaluated to address compensatory mitigation goals, and includes recommendations for improving the flow of data, to make sharing easier for evaluations on a regional, state, or national level.

Goal:	◦ **Assess compensatory mitigation site success** ◦ **Evaluate regulatory compliance**
Main Questions:	◦ **How well do compensation sites meet their stated goals and permit requirements?**
Design Approach:	◦ **Comprehensive assessment during the permit-required monitoring period** ◦ **Compensation sites assessed under this module become the sample frame for the Program Effectiveness assessment**
Site Selection:	◦ **All sites and/or assessment at end of required monitoring period**
Approach to Reference:	◦ **Compare to permit conditions/performance standards** ◦ **Pre-project site conditions (if applicable)** ◦ **Conditions at the impact site (which is the site creating the need for compensation)**

Goals

The intent of most compensatory mitigation projects is to replace aquatic resources area and function that are unavoidably lost (or reduced). They may do this by creating, restoring, enhancing, or in some cases preserving a surrogate stream or wetland to replace the function that is lost at the altered site. Permit requirements usually specify the mechanism (or approach) to stream or wetland replacement but may not require a strategy that specifically evaluates whether aquatic resource function is being replaced. In addition, differences among projects and the lack of a strategy for sharing monitoring results makes it difficult to examine compensatory effectiveness among projects on a regional or state level.

This module lays out recommendations for the type of data collected and evaluated to address compensatory mitigation goals, which could be applied among projects to ensure that data are more uniform and therefore can more easily be compiled to make overall

programmatic evaluations. This module also includes recommendations for improving the flow of data, to make sharing easier for evaluations on a regional, state, or national level. From a permit-perspective, the questions being addressed by this module include:

1) Is the amount of compensation sufficient to replace (or increase) the aquatic resource being lost?

2) Is the compensation replacing an appropriate/equivalent type of aquatic resource?

3) Is the compensation replacing (or offsetting) the functions being lost?

4) How long will it take for the compensatory mitigation sites to reach desired condition or function?

Design Approach

The intended outcome of this module is for states to be able to better assess if compensatory mitigation projects are meeting their permit requirements. The design assumes application to new compensation sites; however, many elements of this design can also be used for retrospective evaluation of past compensation sites. To achieve desired outcomes, monitoring data are needed from *all compensatory mitigation projects*. Each mitigation project should be associated with a spatially-explicit polygon and a unique site ID. Each project should also include the following basic data:

- Permit information
  - Name and contact information of the applicant or current holder of the permit
  - Permit number
  - Land owner and easement holder information
  - Project beginning and closing dates
  - Required compensation and compensation mechanism (MB, ILF, PRM)
  - Permit conditions, including performance standards, crediting mechanisms (etc.)
- Wetland or stream type for both the impact and compensation site(s)
  - HGM and Cowardin wetland type, including hydrologic modifiers
  - Stream class (e.g., Montgomery and Buffington, Rosgen)
  - Stream flow class (i.e., perennial, intermittent, ephemeral)
  - Dominant plant community
- Compensatory mitigation information
  - Compensation method (e.g., restoration, establishment, enhancement)
  - Associated MB or ILF information (if applicable)

- Geospatial data of both the impact and compensation site (or MB or ILF)
  - Coordinates
  - GIS layer
  - Wetland size (total, wetted, buffer)
  - Stream length and width, including riparian zone
  - Surrounding land use composition, buffers

In addition to keeping track of compensatory mitigation sites, a consolidated database allows for stratification of the data for analysis based on characteristics such as wetland type, hydrologic regime, project size, location, or compensation mechanism. The monitoring data generated by the permittees should be maintained by the state entity in an open data format (discussed in Section 6) to facilitate access by the public, sharing among agency partners, and incorporation by USEPA into national assessments.

The frequency of sampling should coincide with the expected rate of measurable change and allow for intervention in case unforeseen corrections are necessary. Permitted impact sites should be assessed prior to alteration, to establish a baseline for comparison of gains achieved through compensatory mitigation relative to losses at the permitted project site. A baseline should also be established at the compensatory mitigation site, before restoration activities begin. At a minimum, compensatory mitigation sites should be assessed:

- Prior to performing compensation activities (i.e., baseline conditions)
- Immediately after initial compensation activities are completed (i.e., as-built conditions)
- Upon completion of each milestone or remedial measure
- Annually and/or at each performance standard deadline

Monitoring periods may vary based on the type of aquatic resource being restored and the desired functional lift (i.e., the gain in function achieved as a result of the compensation). At a minimum, sites should be monitored at years 1, 3, and 5; slowly maturing sites, such as forested wetlands, fens, permafrost or bottomlands may require monitoring for up to 10 years or longer. Stream sampling often focuses on channel stability and in-stream habitat features in the early years, with the later years focused on the riparian vegetation and any water quality and biological metrics included. Sampling usually occurs during the growing season, which varies by such factors as aquatic resource type, vegetation composition, altitude, latitude, and rainfall. Specific indicators can be staggered such that greater emphasis is placed on hydrologic and physical factors early in the monitoring period, with biological measures becoming more important later in the monitoring period as the mitigation site matures.

Approach to Reference

Evaluation of compensatory mitigation performance requires a basis of comparison, or reference. Here, "reference" is used in a broader sense to mean target conditions. For all projects, there are several options for reference approaches. These are not mutually exclusive and multiple reference approaches can be used:

1) Conditions at the mitigation site may be compared with mitigation performance standards and permit requirements. This may include items written into the permit such as a targeted tree density, minimum vegetation cover, or maximum allowable slope in the littoral zone, or other performance standards in a mitigation plan.

2) Pre- and post-restoration conditions at the mitigation sites may be compared to pre- and post-impact conditions at the impact site (i.e., partial or complete loss of area or function). Comparison of gains at the compensation site relative to losses at the impact site allows for direct comparison of areal or functional replacement (although post-project assessment of impacts is desirable, it may not always be practical). For MB and ILF, the aggregate losses at all impacts sites using the MB or ILF could be compared to overall gains.

3) Conditions at the compensation site can be compared with regional reference conditions [e.g., undisturbed ("pristine") streams or wetlands (see Stoddard et al. 2006 for reference definitions), unaltered portions of the impact site that are fully functioning, or a mature and successful mitigation site (of the same wetland or stream type and landscape setting)]. Past mitigation sites may not achieve fully pristine reference standard conditions; however, they can be important benchmarks for what is achievable in future compensation sites. Reference sites should be in the same aquatic resource type, landscape position, hydrologic regime, and similar soil type as those that are mitigated. For streams, comparisons should be to streams in the same hydrologic and geomorphic class and in a similar landscape/watershed position. The reference approach allows for interpretation and accounting of regional variances in the environment, caused by such factors as wet-dry conditions, fire, floods, or other natural events.

Evaluation of mitigation performance requires a comparison approach that is appropriate for each indicator. For many indicators, comparison between reference and compensation site condition is conducted using a statistical analysis approach (e.g., t-test of soil redox values, or ANOVA with a multiple comparison test when more than one site is assessed). However, some indicators, such as indices of biological integrity or rapid assessment methods may have an internal reference standard, which can be expressed as a threshold or target. Standardized indices are typically developed and calibrated based on response along a gradient of disturbance. Their derived threshold values represent an upper reference interval measured at relatively undisturbed streams or wetlands along the gradient of sites. For these indicators, the response at the compensation site would be compared to the published threshold value. Measurements exceeding the threshold may be considered as out of compliance or in need of remedial measures.

Indicators

Mitigation performance should be assessed using Level 1 mapping and Level 2 rapid assessment as discussed earlier in this document (Section 2). Level 1 tools can be used to track aquatic resource area and habitat distribution of individual compensation sites, while Level 2 tools can be used to track general aquatic resource condition at those sites. A core set of Level 3 indicators (shown in Table 3) should also be included to capture general condition over the course of the mitigation monitoring period. Recommended Level 3 indicators include:

Wetlands

- Width and condition of buffer
- Duration and frequency of ponding, saturation or inundation
- Hydric soils, measures of reducing conditions in the soil
- Soil organic matter, bulk density
- Evidence of hydrologic alteration
- Vegetation cover
- Plant community composition & structure
- Age-stand distribution and evidence of plant recruitment
- Physical disturbance of the plant community
- Invasive plants
- Evidence of wildlife/bird use

Streams

- Width and condition of riparian corridor
- Evidence of hydrologic alteration
- Continuous flow and/or water level
- Bedform composition and structure
- Channel planform and lateral migration
- Channel evolution stage
- Vegetation cover
- Plant community composition & structure
- Age-stand distribution and evidence of plant recruitment
- Physical disturbance of the plant community
- Invasive plants
- Evidence of wildlife/bird use

The set of Level 3 indicators above should be used for all mitigation sites and form a core assessment that can be integrated with assessments conducted under Module 2 (program effectiveness) and Module 3 (resiliency). Detailed protocols for Level 3 indicators are available from a variety of programs including the USEPA National Aquatic Resource Surveys (NARS) program and the Bureau of Land Management AIM National Aquatic Monitoring Framework. Additional indicators may be included to accommodate specific performance standards (or targets) or MB or ILF crediting/debiting schemes.

Box D provides an example of comprehensive performance standards from Ohio. Box E, from Wisconsin, illustrates how different vegetation measures can be used together to assess compliance and how hydrology standards can be customized by wetland type. Performance standards can also be staggered such that more structural measures are monitored earlier, while biological community measures are monitored at less frequent intervals (Table 4).

TABLE 4: **Conceptual 10-year schedule for required monitoring and reporting at mitigation bank sites. From Ohio Mitigation Banking Guidelines**

	Years										
Monitoring activity	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Delineation		X		X		X		X			X
Hydrologic monitoring		X	X	X	X	X	X	X	X	X	X
Vegetation sampling		X		X		X		X		X	
Amphibian sampling		X		X		X		X		X	
Soil and water sampling		X		X		X		X		X	
Other taxa group sampling		X		X		X		X		X	
Mapping, % relative covers		X		X		X		X		X	
Ecological services		X		X		X		X		X	
As-built report	X										
Annual report		X	X	X	X	X	X	X	X	X	X

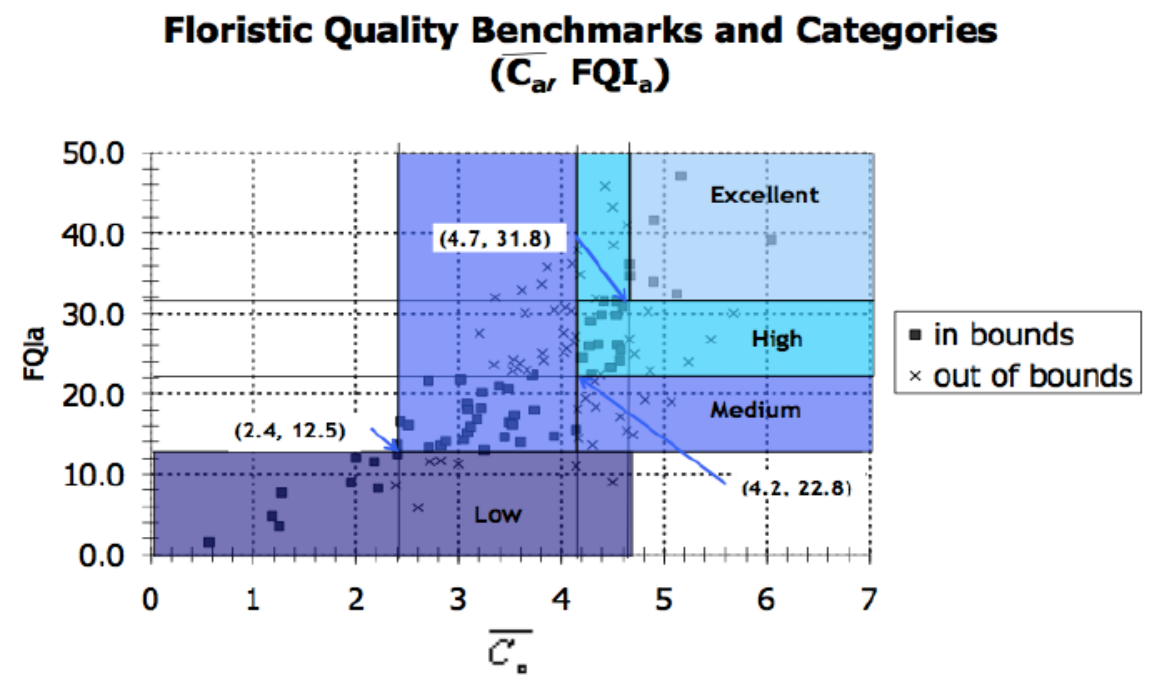
BOX D: Sample Performance Standards

Performance standards developed for use in Ohio

CATEGORY	STANDARD	TIME FRAME
Acreage	Achieve a mitigation wetland that has the minimum area specified in the certification or permit	End of monitoring period
Morphometry	Side slopes of 15:1 (horizontal:vertical) or shallower for the first 15 m, for ≥50% of perimeter.	
Perimeter: Area Ratio	The perimeter length of the mitigation wetland shall be greater than or equal to 75% of the perimeter length of the impacted wetland	
Hydrologic Regime	A hydrologic regime equivalent to the regime of a natural wetland of that hydrogeomorphic (HGM) class	
Vegetation	<10% total area unvegetated open water	
	>75% total area vegetated with native, perennial hydrophytes	
	<5% total area with invasive species	
	Achieve the minimum Vegetation IBI score for that type of wetland (HGM class, plant community, ecoregion)	End of the monitoring period unless the monitoring data demonstrates that the wetland is on a clear trajectory to achieve the appropriate score within 2 years of end of the monitoring period
Amphibian Community	Achieve the minimum Amphibian IBI score for that type of wetland (HGM class, plant community, ecoregion)	End of the monitoring period unless the monitoring data demonstrates that the wetland is on a clear trajectory to achieve the appropriate score within 2 years of end of the monitoring period
Soil Chemistry Process	Median values of the soil chemistry parameters, by HGM class and plant community, for % solids, % total organic carbon, % total nitrogen	At the time construction is completed. Alternatively, end of the monitoring period or the monitoring data submitted by the applicant shall demonstrate that the wetland is on a clear trajectory to achieve those values within 2 years of end of the monitoring period.
Ecological Services	Performance and success quantitatively measured using methods appropriate to evaluating whether the specific function or value was created and to what extent	

Source: Mack et al. 2004

BOX E: Composite Performance Standards from Wisconsin. Source: Haber 2013



Vegetation performance standards based on a combination of the mean coefficient of conservatism (mean C) and Floristic Quality (FQI)

Wetland Type	Minimum Soil Saturation to Inundation			Maximum Inundation		
	Saturation (from soil surface)	Inundation	Duration (minimum)	Measure	Duration (maximum)	Storm Event
General	Within 12 inches	≤ 6 inches	28 consecutive days or two 14-day hydroperiods	–	–	–
Shallow Marsh	0 inches	≤ 6 inches	56-60 consecutive days, two 28-30 day or four 14-15 day hydroperiods	≤ 18 inches	30 days	≥ 2 year
Sedge Meadow	Within 12 inches	–	28 consecutive days or two 14 day hydroperiods	≤ 6 inches	14 days	≥ 10 year
Wet Meadow	Within 12 inches	–	28 consecutive days or two 14 day hydroperiods	≤ 6 inches	14 days	≥ 10 year
Shrub-Carr	Within 6-12 inches	≤ 6 inches	28-30 consecutive days, or two 14-15 day hydroperiods	6-12 inches	14-15 days, except in hollows	≥ 10 year
Hardwood Swamp	Within 6-12 inches	≤ 6 inches	28-30 consecutive days, or two 14-15 day hydroperiods	6-12 inches	14-15 days, except in hollows	≥ 10 year

4. MODULE 2: *Program Effectiveness*

At a Glance

This module is intended to help states assess the overall effect of their compensatory mitigation program and evaluate if the compensation program is helping/contributing to achieving policy or resource management goals, such as no net loss, achieving specific aquatic resource acreages and distributions, or realizing functional goals relative to natural or reference conditions. Data collected during this module may also be used to assess the relative performance of different restoration practices and the relative efficacy of watershed vs. local scale practices and restoring both site and watershed function.

Goal:	• **Evaluate effectiveness of compensatory mitigation program at offsetting overall aquatic resource losses** • **Evaluate the overall effectiveness of the regulatory program at contributing to no net loss, target area or other regional or watershed goals**
Main Question:	• **How effective is the overall compensatory mitigation program at achieving programmatic goals of offsetting permitted wetland and stream impacts?**
Design Approach:	• **Probabilistic site selection through ambient or status and trends assessment OR comprehensive synthesis of gains and losses data assessed across all compensatory mitigation and impact sites**
Site Selection:	• **Subset of sites from a probabilistic survey OR all sites at the end of required monitoring period over a defined time period.**
Approach to Reference:	• **Comparison to ambient condition, comparison to reference standard sites**

Goals

Offsetting unavoidable wetland or stream impacts is a central goal of most state programs and is required under Section 404 of the Clean Water Act. Evaluating long-term goals such as "no net loss," achieving a desired aquatic resources extent and distribution, or realizing landscape condition relative to reference is difficult because some aquatic resource changes occur outside the purview of regulatory programs. For example, such changes include unregulated or unauthorized activities, activities that fall below required notification thresholds, grant funded restoration, and changes due to natural events such as floods or fires. This module is intended to help evaluate the contribution of wetland and stream compensatory mitigation to overall wetland/stream change.

This module is focused on overall program performance as opposed to individual site performance which was emphasized in Module 1. The emphasis moves beyond evaluating whether a site is meeting permit requirements, to assessing program goals on a regional and state-level. While the main question of this module is "how effective is the compensatory mitigation program at achieving no net loss in area or function, or other regional or state goals?" information collected through this module can also be used to assess questions related to the relative performance of different compensation practices, such as:

- Which compensation mechanism (MB, ILF, or PRM) is most successful at replacing wetlands or restoring streams?
- Which compensation method (restoration, establishment, enhancement, preservation) is most successful at replacing or enhancing aquatic resource function?
- Which specific restoration practice is most successful?
- What is the correct time-frame to expect sustainable stream or wetland function to occur?
- What factors influence the degree to which compensation sites succeed?
- Which aquatic resource types are most difficult to replace?
- Which aquatic resource types are not being replaced in kind?

Results from assessments under Module 2 can also be used to assess the efficacy of performance standards by allowing for an evaluation of how well sites that meet required performance standards contribute to no net loss or other programmatic goals.

Design Approach

Two alternative approaches are available for evaluating overall program effectiveness. The first approach uses only data generated in Module 1, and program effectiveness is based on the proportion of compensation sites determined to be successful based on pre-determined criteria and/or relative to the permitted area of loss (Figure 7). Only sites that have reached the end of their permit requirements and have been deemed successful based on their permit conditions are included in the assessment, since newly restored streams or wetlands may not have the ecological function and habitat value of a mature compensation site. To make data retrieval and analysis more efficient, the data collected from each of the individual compensation projects should be consolidated and maintained in a central database. Compensatory mitigation data should be attributable to the associated impact sites. This is particularly important for mitigation banks and in-lieu fee programs where multiple impacts may be associated with a single compensatory mitigation site. Under this approach, total gains at compensation sites are compared to total losses at permitted impact sites to determine overall program effectiveness. The benefit of this first approach is that it is a direct measure of program success. It is important to acknowledge only considering compensation sites does not account for unregulated or unreported impacts that affect the overall change in extent and distribution of aquatic resources.

The second alternative approach is to include compensation sites as part of a broader ambient assessment. In this approach, regulatory and non-regulatory activities are used to assess the state's overall progress toward defined targets or goals. Ambient assessment programs already exist for many states and adding mitigation sites to a state's ongoing Clean Water Act Section 305(b) assessment program could provide an opportunity to leverage funding among programs (Figure 8). This is particularly true for streams, where most states have an ambient stream monitoring program that could be leveraged to help assess mitigation program effectiveness. Integration of compensatory mitigation assessment with broader ambient assessment requires harmonization of indicators and data management, which are often developed and managed under separate programs. Such harmonization would allow completed compensation sites to become part of the sample frame for ambient assessment while allowing ambient assessment sites to provide context for interpreting the overall contribution of compensation sites to change in wetland and stream extent and condition. If integration with a state ambient monitoring programs is not possible, states may consider partnerships or intensifications of the USEPA National Aquatic Resource Assessments which can also provide information on ambient and reference conditions that can be used to assess compensatory mitigation program effectiveness.

FIGURE 7: **Evaluation of mitigation bank program effectiveness in Ohio based on a vegetation IBI (VIBI). VIBI scores of 50-65 are considered "good" condition; scores >65 are considered "excellent" condition. Results are from the 2011 Great Lakes Basin Evaluation of Compensatory Sites.**

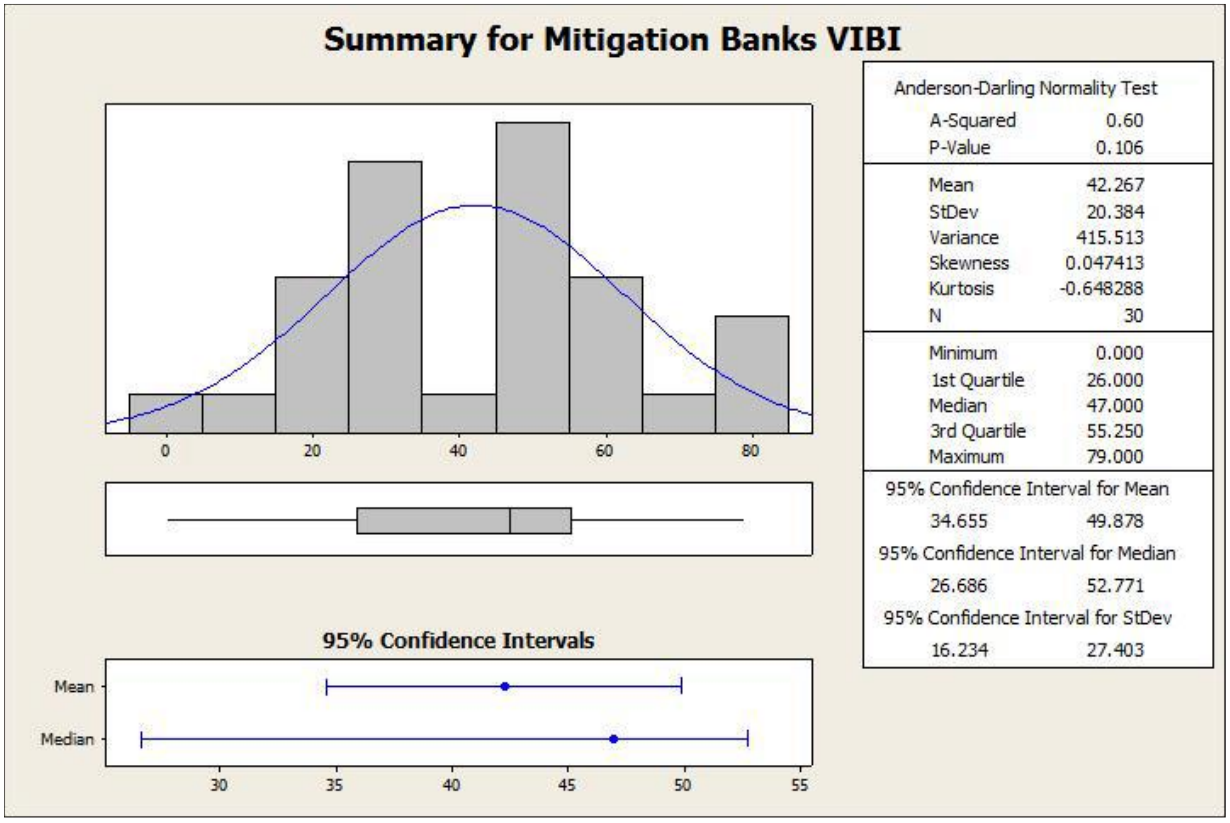
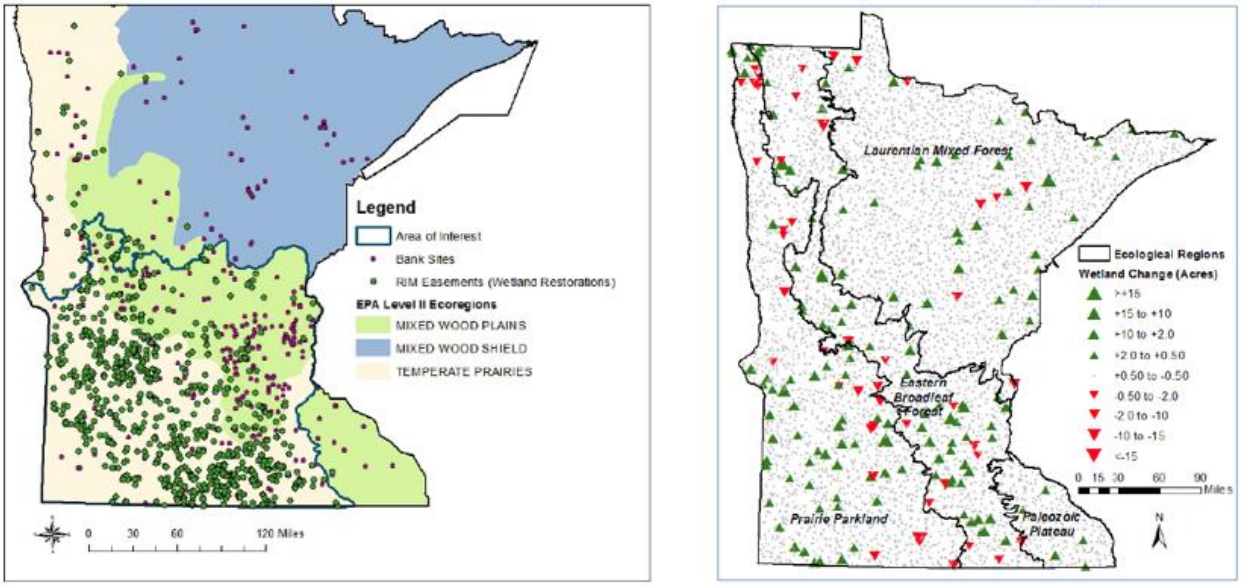


FIGURE 8: **Relationship between Minnesota compensatory mitigation sites (left) and ambient monitoring of status and trends sites (right) illustrating opportunities to leverage ambient assessment programs to help evaluate program effectiveness.**



Under the second approach, all compensation sites deemed to have achieved final performance standards should be included in the sample draw, and since the total number of compensation sites will increase over time, new sample draws will be required at regular intervals. Over long periods of time, stratification may be necessary to ensure that the sample draw includes both past compensation and non-compensation sites. The sample draw should use a weighted probability distribution approach to ensure representativeness and avoid "clumping" of sites (e.g., GRTS approach). To investigate specific elements of performance, sites can be stratified to include wetlands or streams of different sizes, different watersheds or geographic regions, or different types of mitigation mechanisms (e.g., MB, ILF, PRM) or different compensation practices. Sites can be stratified or given unequal weighting in the probability distribution to ensure that strata of interest are represented. In general, 30-50 sites are needed for each stratum. Probability based effectiveness assessments should be ongoing, but can occur every year, or at specific intervals (e.g., every 5 years).

Approach to Reference

There are multiple options available for defining reference, in part depending on whether program effectiveness is based on compensatory mitigation sites alone, or as part of a broader ambient survey.

1) The preferred option is to establish a network of representative reference sites to allow comparison to minimally impacted conditions. Past mitigation sites can be added to the

reference network if they meet established reference criteria described in Module 1. Past mitigation sites may not achieve fully pristine reference standard conditions; however, they can be important benchmarks for what is achievable in future compensation sites. A reference network must match the categories of interest for program evaluation (e.g., size distribution, setting, mitigation type).

2) The second option is to evaluate program effectiveness relative to ambient conditions. If ambient assessment data are available, data from compensatory mitigation sites can be compared to ambient to determine their function/condition relative to the region as a whole. This option is not only suitable for sites that are part of an ambient survey, but also for evaluating how mitigation sites fare in the context of overall ambient conditions.

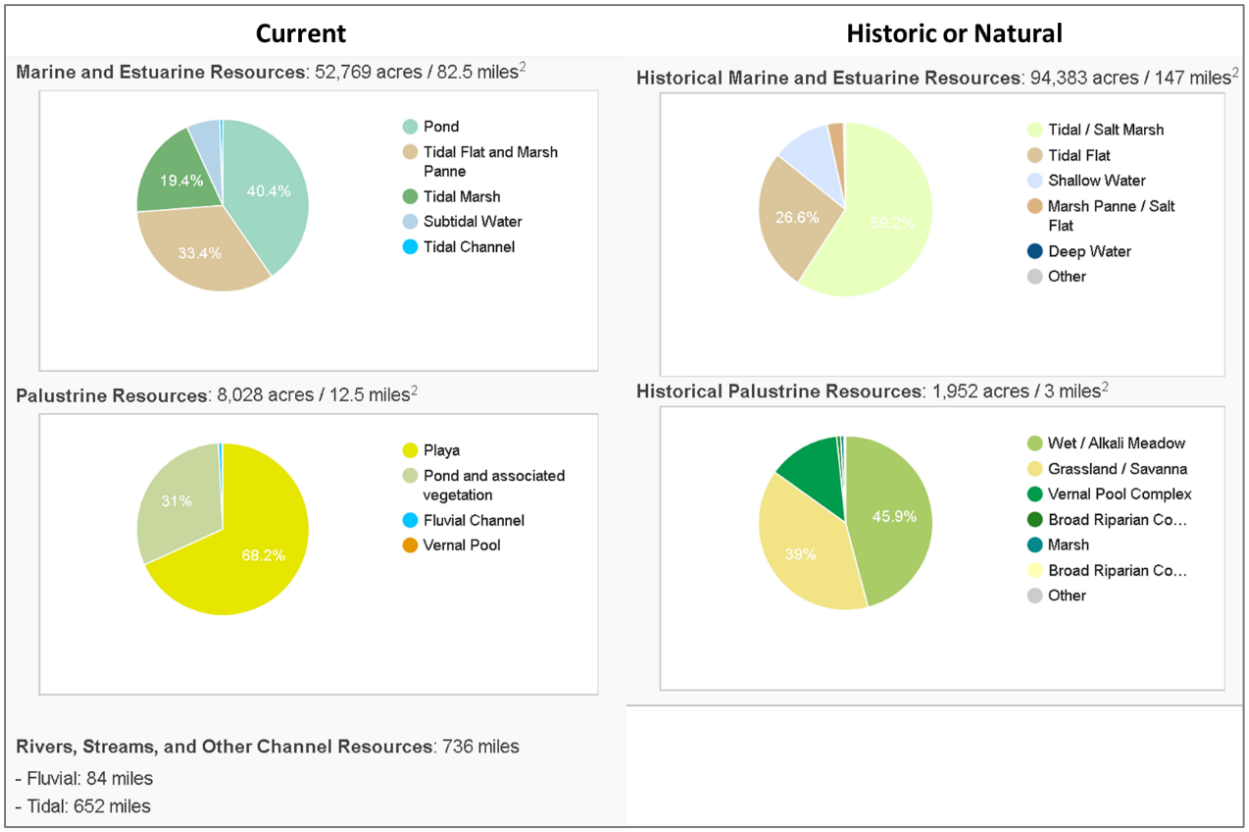
3) The third option uses the reference thresholds established for each of the biological indices measured, such as macroinvertebrate and vegetation IBIs. Threshold values can be identified from the literature or defined and re-calibrated from a local population for use on a regional basis. Measurements exceeding the threshold are considered outside of the reference condition.

Indicators

Level 1 landscape or watershed-scale indicators go beyond the Level 3 site-based indicators listed in Table 3 by assessing the composition of streams and wetlands within a specific geographic boundary and the physical and biological connections between those streams and wetlands. The contribution of mitigation projects toward restoring desired landscape-scale composition and connectivity is an important indicator of success. Moreover, landscape assessment also provides insight into how setting or landscape position contributes to success of compensatory mitigation.

Landscape profiles provide a summary of the composition and proportion of streams and wetlands in the landscape (Figure 9). Program effectiveness can be evaluated by tracking the change in aquatic resource profiles toward a desired landscape objective (e.g., historic, natural, sustainable given current constraints). Success can be based on how well compensatory mitigation sites in aggregate improve the trajectory of the landscape profiles.

FIGURE 9: **Example of landscape profile (from California) that could be compared to a profile of compensation sites to evaluate how well wetland compensatory mitigation sites have restored the appropriate composition of aquatic resources in a defined area. Profiles can be based on area, condition, or both.**



In addition to composition, landscape indicators can evaluate the physical and biological connectedness of streams and wetlands. The contribution of compensatory mitigation projects to restoring appropriate landscape processes is an important indicator of success. Profiles can be coupled with an assessment of the connectivity between compensation sites, other aquatic resources, and natural upland areas. Example Level 1 indicators may include:

Wetlands

- Wetland density or average distance between wetlands
- Hydrologic or physical connectivity between adjacent/nearby wetlands
- Proportion of groundwater dependent wetlands relative to shallow groundwater zones
- Average buffer width

Streams

- Intactness of riparian corridor
- Drainage density and intactness of the drainage network (relative to reference)
- Condition of hydrologic and sediment source areas
- Overall catchment hydrology OR patterns of hydroperiod
- Average buffer distances or riparian width
- Number of fish passage barriers or obstructions to water or sediment flow

Compensatory mitigation projects can be evaluated for their consistency with watershed or regional plans developed as part of other programs. For example, Habitat Conservation Plans (HCPs) developed under the Endangered Species Act and water quality improvement plans developed pursuant to the National Pollutant Discharge and Elimination System (NPDES) often include objectives for restoring wetlands and floodplains, reducing stressors, and mitigating past effects through use of Best Management Practices (BMPs). The location and function of completed compensatory mitigation relative to the objectives of these plans can be used as a measure of programmatic success.

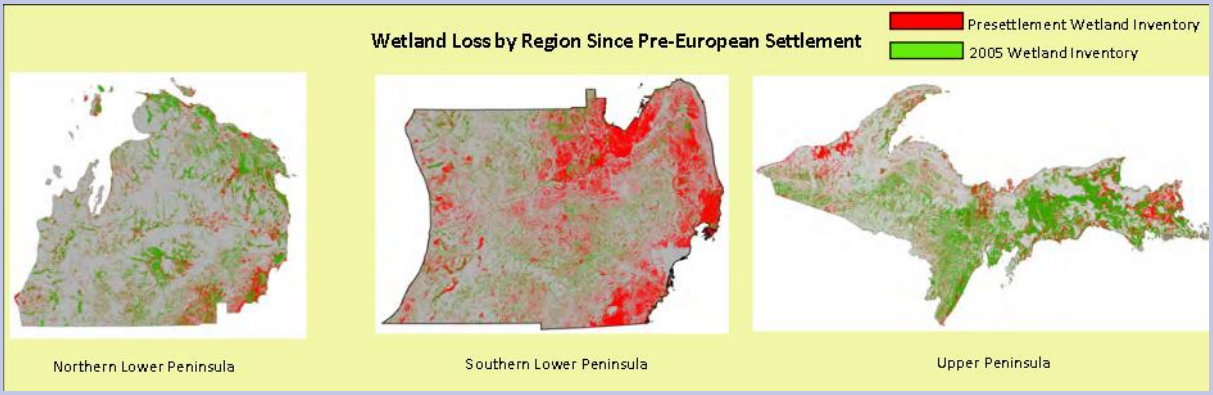
In addition to Level 1, the same Level 2 and 3 indicators used for Module 1 can be applied to assess overall program effectiveness. Ranges of Level 2 and 3 indicator values for all completed compensation sites (i.e., those that have achieved final performance standards) can be compared to the ranges of indicator values for reference or ambient wetlands. Programs may be considered successful at achieving their objectives if the ranges of values from compensation sites are statistically the same as at reference networks or within a designated upper range of ambient condition (e.g., upper quartile).

Inclusion of measures of local or landscape stress (as previously discussed) also allow for programmatic evaluation of factors that contribute to success or failure of compensation sites. Analysis of relationships between stressors and condition or function (as indicated through performance standards) can be used to improve mitigation practices over time. Examples may include improved site selection, improved performance standards and monitoring requirements, or improved management actions.

BOX F: Opportunities to Leverage Programs to Conduct Programmatic Evaluations

Evaluation of overall program effectiveness can be aided by taking advantage of existing state programs such as status and trends evaluations and ambient assessments:

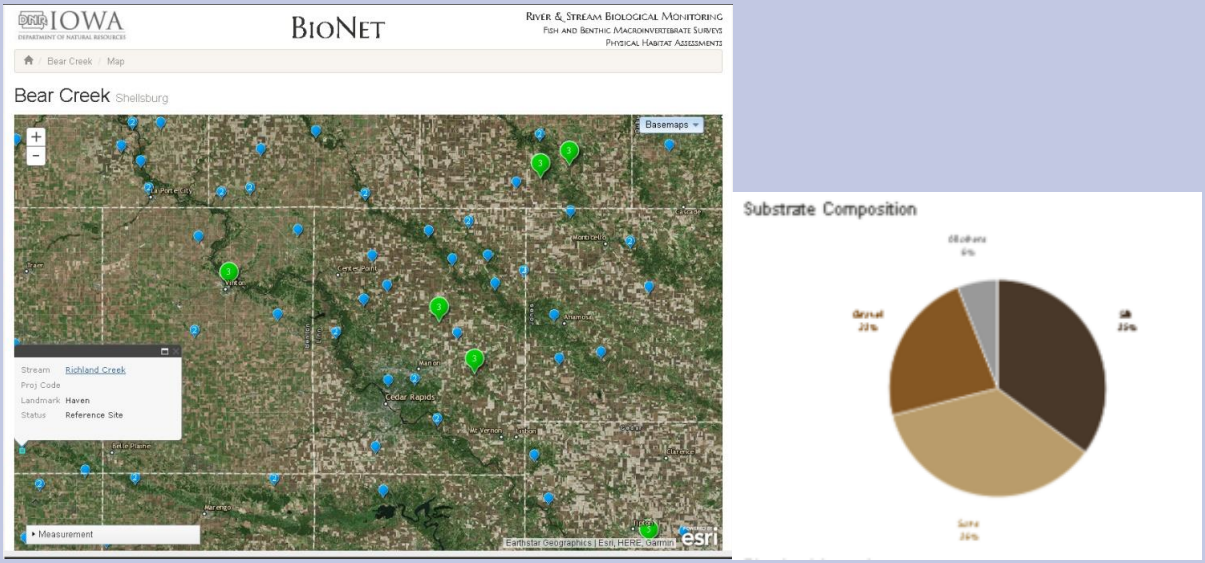
Michigan Status and Trends:



UPPER PENINSULA	17% LOSS (638,000 acres)
NORTHERN LOWER PENINSULA	20% LOSS (387,000 acres)
SOUTHERN LOWER PENINSULA	66% LOSS (3,320,000 acres)

The state of Michigan's assessment of wetland status and trends can be used to provide context for evaluating how compensatory mitigation efforts have contributed to offsetting these losses for specific wetland types or geographic regions.

Iowa Ambient Monitoring:



Iowa's stream ambient monitoring program provides information on ranges of conditions, including reference. Comparing mitigation sites to these locations using similar data provides information on how well mitigation sites perform relative to the range of conditions in the landscape.

5. MODULE 3: *Resiliency of Compensatory Mitigation Practices*

At a Glance

This module is intended to evaluate the long-term outcome of compensatory mitigation by monitoring a subset of sites over extended periods of time, well beyond the permit required monitoring period. The goal is to assess how well compensatory mitigation sites replace impacted stream or wetland functions and how resilient compensation sites are to natural climatic variability, episodic events, and long-term climate change.

Goal:	• **Assess long-term resiliency and sustainability of compensation sites**
Main Questions:	• **How well do compensation sites perform over the long-term in terms of achieving functional replacement of impacted streams or wetlands?**
Design Approach:	• **Assess a subset of "permanent" sentinel sites relatively infrequently (e.g., every 5 years) over long periods of time**
Site Selection:	• **Select compensation sites that have completed their required monitoring periods and been deemed "successful"** • **Sites should be subject to long-term protection (e.g., conservation easement) and readily accessible**
Approach to Reference	• **Compare reference standard sites in conserved areas** • **Compare to ambient conditions**

Goals

Compensatory mitigation is intended to offset permitted wetland and stream impacts, which often involve permanent loss. To fully compensate for long-term or permanent loss, mitigation sites must be resilient over the long-term, have the ability to recover from natural events, such as droughts, floods, fires, etc., and be adaptive to long-term climate change and changing landscape/watershed conditions. Most programs assume that if performance standards are met at the end of a 5-10-year monitoring period, the mitigation site should be self-sustaining over the long term. Unfortunately, this assumption is not well tested, and retrospective studies have shown that many mitigation sites do not function beyond the permit-mandated monitoring period once active management ceases (Robertson et al. 2018). In addition to assessing long-term resiliency, ongoing monitoring can detect changes in the trajectory of legacy compensation sites due to climate change, severe natural disturbances, pest infestation, or unanticipated changes in land use. Trajectories at compensation sites can be

compared to reference sites to determine whether they are exhibiting similar patterns or responding to natural disturbances in similar ways. This may provide the opportunity for intervention or adaptive management to help ensure long-term viability of past mitigation sites. From a program perspective, the questions addressed by this module include:

1) How persistent/resilient are gains achieved by required compensatory mitigation?

2) How long does it take for restored wetland/stream condition or function to be comparable to reference or to some agreed upon target of long-term sustainability?

3) What factors affect long-term resiliency of wetlands/streams?

4) How much, if any, ongoing management is necessary to sustain restored wetlands/streams?

Design Approach

Long-term monitoring should be done at a representative subset of sites at relatively infrequent intervals, i.e., every five years. A subset of sites from the overall sample frame (i.e., map of compensation sites) should be selected for long term monitoring. These sites should represent the major categories of interest (as described above). Additional sites may be selected to represent specific management or restoration practices of interest. The size and scale of sites should be selected to represent the various mitigation practices. For example, stream stabilization may require reach scale assessment, whereas restoration of groundwater dependent wetlands may require regional analysis that accounts for hydrologic processes. Sites should be selected for inclusion in long term monitoring based on several considerations/criteria:

- Deemed successful at the conclusion of the permit-mandated monitoring period
- Subject to long-term protection, such as conservation easement or on managed reserve lands
- Are readily accessible
- Can be instrumented for long-term monitoring
- Represent the range of wetland/stream types typically used as mitigation

As a general rule, at least 30 sites per category of interest should be included to provide a robust evaluation of trends (although this may not always be possible). Sites should be revisited at regular intervals, such as every 3-5 years to establish long-term trends in condition relative to short and long-term climate patterns, changing land use and water use practices, and various management strategies. Additional sampling may be warranted following episodic events that can fundamentally

SENTINEL SITES

Sentinel sites are targeted sites established for long-term ongoing monitoring where more in-depth data can be collected to assess trends and variability over long time scales.

Sentinel sites should represent all major aquatic resource types and can be used to inform questions of resiliency and long-term performance.

alter wetland trajectories, such as large storms, fires, or sudden pest infestations. Sites can be integrated into existing long-term or sentinel monitoring programs. An example of long-term monitoring of compensatory mitigation is provided in Van den Bosch and Matthews (2017).

Approach to Reference

Long-term sentinel compensation sites should be compared to reference standard and ambient assessments (as described for the Program Effectiveness module). Reference standard sites should ideally be sites that have had little historical impact. Ideally, compensatory mitigation sites would be expected to function similarly, and ultimately be indistinguishable from reference standard sites (although this may take a long time and may not always be a realistic expectation). Long-term sentinel sites can also be compared to the range of conditions observed in ambient monitoring, status and trends sites, or National Aquatic Resource Survey sites. This comparison will provide the ability to compare trajectories of response at past compensation sites to regional patterns in wetland/stream condition. Ultimately, this will allow evaluation of the long-term condition/function of compensation sites relative to regional trends.

Indicators

Long-term success should be evaluated using Level 1, 2, and 3 indicators. Level 1 indicators of wetland area, stream linear distance, and distribution of habitat types can be compared to long-term objectives for wetland gain as the first measure of performance. Level 2 rapid assessment methods are a useful tool to create time series of data that can support evaluation of success and be used to develop habitat development performance curves to evaluate future compensatory mitigation projects.

Level 3 indicators of long-term success should include more detailed assessment of biological communities across trophic levels (i.e., food web analysis) and analysis of age-structure and successional type of plant communities (including evidence of natural recruitment). Long-term data sets can be used to develop performance trajectories that can be used to predict changes in assessment indices over time. These trajectories can be used to inform monitoring and performance evaluation on subsequent mitigation projects. Sentinel sites may also be instrumented to provide semi-continuous data on water level, stream flow, soil saturation, etc. For wetlands, hydric soils should also be evaluated during periodic monitoring. Level 3 long-term indictors should include:

Wetlands

- Water surface or water level
- Hydric soils and measures of reducing conditions
- Duration and frequency of ponding, inundation or saturation

Streams

- Continuous flow (preferably through permanent instrumentation)
- Geomorphic condition, cross section and profile
- Floodplain connection
- Channel planform and evidence of migration
- Stage of channel evolution as well as bank height and angle
- Bedform diversity / instream habitat
- Evidence of sediment deposition or erosion

Both Wetlands and Streams

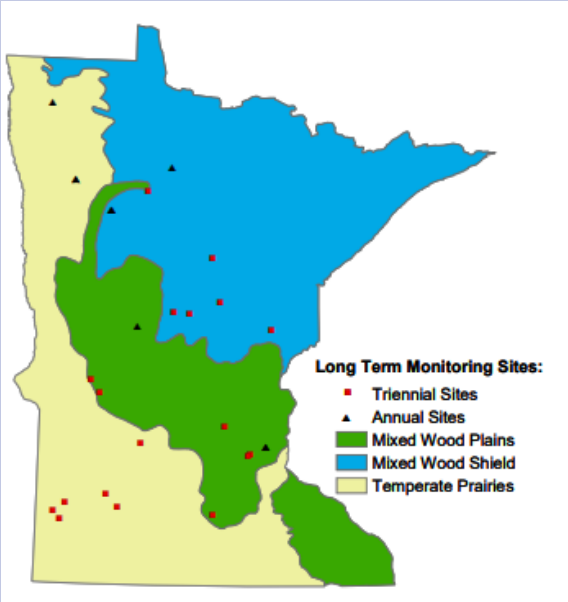
- Vegetation cover, community composition and structure
- Physical disturbance of the plant community
- Age stand distribution
- Evidence of recruitment
- Invasive plants
- Wildlife use and trophic structure
- Bioassessment indices based on benthic invertebrates, algae, fish, or amphibians

Data management is particularly important and challenging at long-term sentinel sites where staff consistency and institutional knowledge may wane over time. It is critical to include these sites in an agency database with detailed metadata on site history, original requirements, and past monitoring data so that the sites can reliably be located by future agency staff.

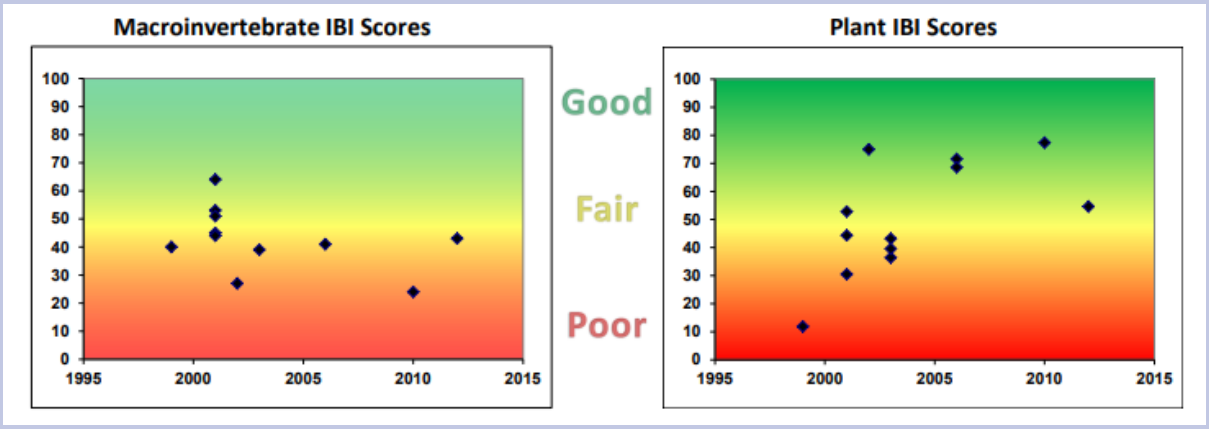
BOX G: Long-term Monitoring of Sentinel Compensatory Mitigation Sites

Few states currently conduct long-term monitoring of completed mitigation sites, yet many states have programs in place for long-term protection and stewardship. Several states have long-term monitoring programs for reference or sentinel sites. Such programs provide an opportunity for assessing long-term performance or condition of past mitigation sites to determine if functions or habitat have been replaced in perpetuity, as is the intent of many regulations. Completed mitigation sites could be incorporated into existing long-term trend monitoring programs and evaluated relative to other sites in the program (e.g., natural or reference sites or other restoration sites).

In 2004, the State of Minnesota began designating long-term depressional wetland monitoring sites that would be sampled every three years to determine temporal variability in indicators, trends in condition due to regional effects, and the impacts of global climate change.



Condition is measured using macroinvertebrate and plant indices of biotic integrity. Selected water quality parameters are also measured. Opportunities exist to incorporate past mitigation sites into this program to assess long-term trends in condition and resiliency.



6. DATA MANAGEMENT

Data management provides the conduit to transform data compiled from project and program evaluation to information that can be used to support management decisions. Although it is a critical element of program management, data management is often underfunded and under developed. As a result, information is often fragmented, difficult to coalesce, and/or largely inaccessible. This has limited the ability of state agencies to conduct evaluations of the administrative and ecological success of their compensatory mitigation programs and to determine whether and what changes need to be made to improve outcomes. Advances in software, open source analytical tools, web services, and cloud storage have improved accessibility and may lower overall costs of data management, especially when data is leveraged to support science-based decision making. Allocation of staff and funding for ongoing data management should be prioritized as a critical element of state, regional, and tribal mitigation evaluation programs.

The suggestions below are not intended to imply that states should "redo" their data management systems. State programs have made many advancements in information collection, storage, display, and analysis. Rather, they are intended to provide suggestions for enhancements (as opportunities arise) and to help states who may be contemplating updates/revisions to their data management systems.

General Philosophy of Data Management

In developing a data management system for compensatory mitigation evaluation, the following general considerations and practices are recommended:

- Strive for an integrated, electronic data flow through all steps of the data management process from data collection through publication (Figure 10);
- Manage data in a geospatial format to enhance data visualization and interpretation and facilitate data integration across programs; and
- Use an open data format, which may include web services and application program interfaces (APIs), to facilitate data access and sharing.

In addition to these general practices, there are other desired properties that will improve the success and longevity of data management systems. These include accessibility, integration, stability, and quality control, and are discussed in more detail below. Where possible, a range of options for incorporating these desired properties are provided. Additional discussion of the need for and recommended approaches to data management can be found in the Internet of Water Principles (see https://internetofwater.org/internet-of-water-principles/) and the Findability, Accessibility, Interoperability and Reuse principles see: https://www.go-fair.org/fair-principles/.

FIGURE 10: The Four Stages of Electronic Data Flow for Mitigation Data Management

Electronic Data Flow

Integrated, electronic data flow is the foundation that enables all other desirable data management properties (e.g., accessibility, integration, and sustainability). Data flow begins with **data collection**, where data is captured electronically using, for example, standardized web-based forms or data collectors. Built-in QA/QC procedures (such as drop-down menus and automatic range checkers) are necessary at the data collection stage – and throughout – to ensure that information is captured correctly. The next component is the design – or **organization** – and maintenance of the database so that stored data can be readily used by state agency staff and partner agencies and organizations to answer identified questions. Ensuring standardized data fields, numerical formats (e.g., units), and naming conventions across all entries will facilitate later program-wide assessments. Data dictionaries provide important information about the data (i.e., metadata), including format, structure, and how it will be used. **Visualizing** all compensation sites as geospatial entities provides opportunities to overlay mitigation data (e.g., using the National Hydrography Dataset) with other data layers (e.g., soils, geology, land use, etc.) and enhances data processing and interpretation. **Publication** includes outputs at different levels based on the uses of the data (e.g., leveraging the Water Quality Portal, available at https://www.waterqualitydata.us/) and public access to data. Data should be connected to the web to allow data to be accessible for scientific analysis and public interpretation.

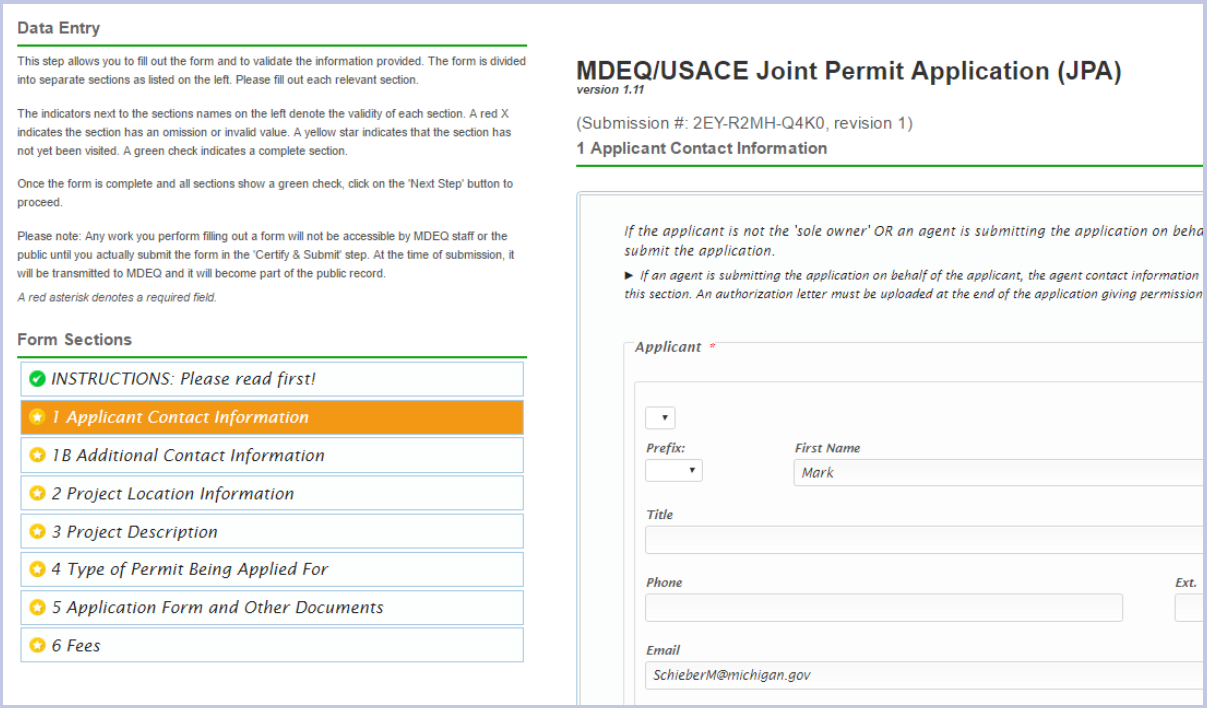
Data Collection

Ideally, data is entered into a database efficiently and accurately. Using standardized forms or templates for all entries/sites (for basic mitigation project data as well as monitoring data) can help ensure data are entered correctly and with the appropriate metadata. Standardized forms also help to ensure data is comparable from the point of collection, rather than relying on processing or interpretation at a later stage. Database applications often allow users to develop standardized forms for data entry. Separate forms may be needed for different types of data, such as, information on the mitigation site (e.g., site identity, location, contact information, mitigation method, size, etc.), or various types of monitoring data (e.g., vegetation, hydrology, module, etc.).

Electronic data capture (e.g., through data collectors or web-based data entry forms) improves accuracy and efficiency over traditional collection on paper data forms and transcription to electronic format. Where possible, allowing permittees/applicants to upload information to the database would save valuable staff time (See Box H). Additionally, remote entry (e.g., via mobile apps for field data collection) can reduce effort by allowing staff conducting on-site inspections to upload data directly from the site. For many database programs, available web-based submission tools allow data to be automatically uploaded to the database.

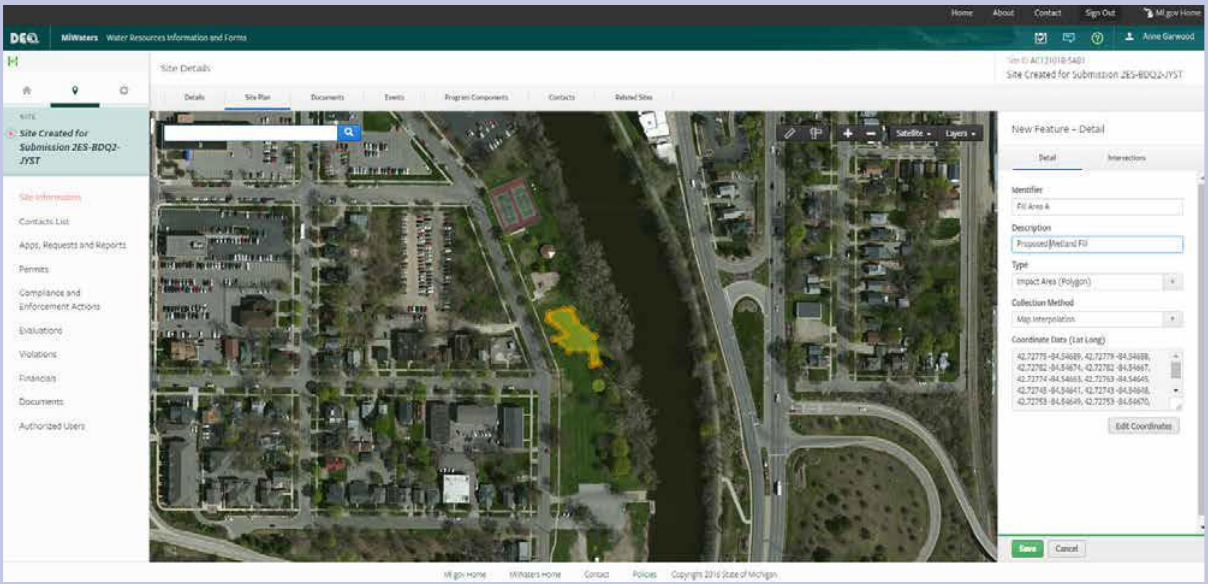
BOX H: Michigan's MiWaters allows permittees to electronically submit projects for review

The Department of Environmental Quality in Michigan processes §404 permits, among others, through its online portal, MiWaters. After setting up an account, applicants may submit projects for review. The software automatically tracks the application and allows for online fee payments.



Michigan's MiWaters MDEQ/USACE Online Joint Application Form

MiWaters' interface also allows the applicant to create a polygon of their site.



Michigan's MiWaters

To ensure data consistency and accuracy, data collection tools should have automatic QA/QC procedures, such as drop-down data menus and automatic data checkers (many data programs have data checkers available as add-ons). Regular staff review of data may also be necessary to catch errors, address blank values, or otherwise clean-up the dataset. It is good practice to document identified errors and corrections made to the dataset.

Data Organization

Each mitigation project should be associated with a unique project ID and spatial location to facilitate tracking of basic information on the mitigation site (e.g., size, location, mitigation method, mitigation mechanism, resource type, contact information, etc.) as well as monitoring data and performance standards. Entering monitoring data directly into the database (versus entering links to reports) improves access to important project information and is more efficient for use in evaluations. Tracking monitoring data by creating links to monitoring reports (e.g., pdfs) should only be used as a last resort when interactive databases are not available.

Data should be organized in such a way that it can be queried to find the relevant information to answer a given question based on specific criteria. This requires consistency in data fields, acceptable ranges for entered values, specified data formats, clear naming conventions, and standard units across all sites. Data dictionaries are a convenient way to summarize metadata and specified data attributes to ensure data consistency and accessibility over time (Appendix C).

Data standardization is especially important since databases may be built in stages; as new data types or analyses are added. Consistency also helps to reconcile different sources of data; originating from various staff within the agency or stakeholders from outside of the agency. Care should also be taken to ensure that any data submitted by applicants/permittees is comparable across projects and modules.

Using web-based data management tools maintained by state agencies is recommended. Web-based (or at least linked) systems are generally readily accessible and can be more easily queried by scientists at partner agencies or organizations and by the public (e.g., Water Quality Portal or other web services). If web-based tools are not available, data can still be published to the internet by uploading information (e.g., spreadsheets) to an open data portal. When uploading to a public data portal (e.g., git, CRAN, EDI or STORET), information on sources and data quality for all data types should be included. It is also important to include clear information on versioning and the dates of the most recent updates.

Data Visualization

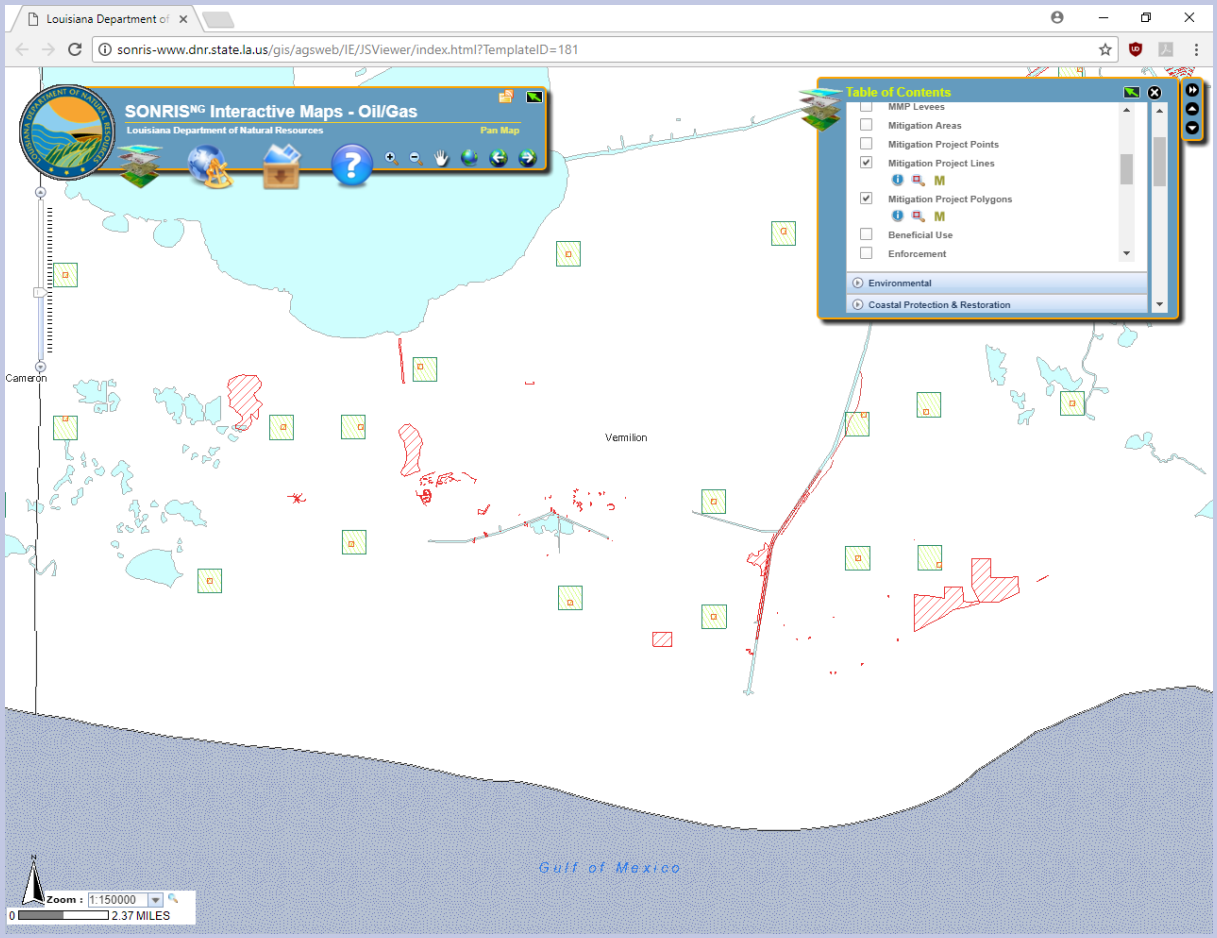
Data visualization is the visual representation of data, including maps, plots, and other graphics. Visualization helps to make mitigation data accessible and understandable by scientists, managers, and the public and can reveal trends and patterns not recognizable in the raw data. The desirable outputs of the visualization tools will depend on the questions that

managers are trying to answer, but the goal should be to present the data to target audiences in a way that allows them to assess trends most efficiently and effectively.

For mitigation data, maps may offer the most accessible form of displaying the data; offering ability to overlay with other data sources (e.g., other protected areas, water quality data, etc.) (See Box I).

BOX I: Louisiana's SONRIS Database

The Louisiana Department of Natural Resource's SONRIS Interactive Maps allow users to access multiple map layers, including mitigation sites, various natural resources, municipal boundaries, and more.

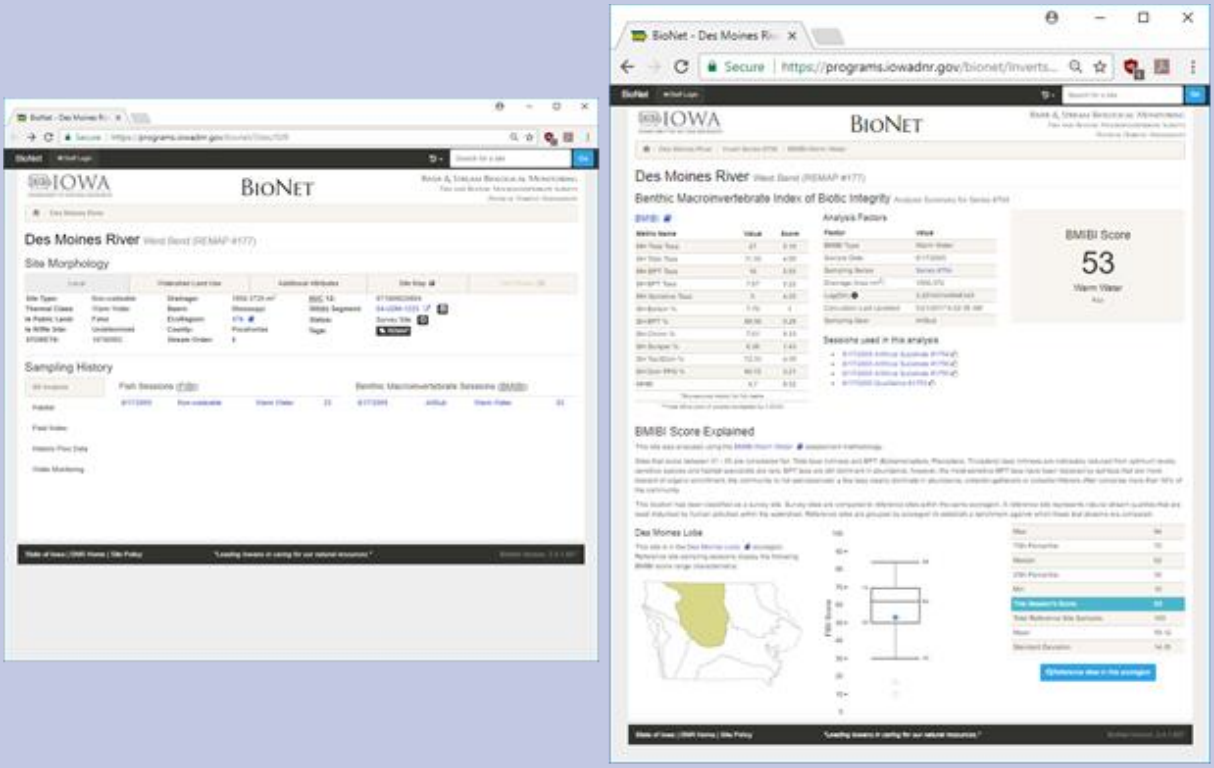


Louisiana's SONRIS allows users to choose what is shown on the map, including mitigation projects as polygons or lines.

Dashboards are also a useful way to display data (see Box J). Dashboards can include graphs, tables, and other data summaries that are generated by dynamic queries of the data. Thus, they can provide up-to-date illustrations of the information in the database. Dashboards can be designed to answer or inform a variety of questions.

BOX J: Iowa's BioNet Dashboard

The Iowa Department of Natural Resources' BioNet (https://programs.iowadnr.gov/bionet/) allows public users to access monitoring data for sites around the state. Each site's profile consists of site morphology data (including local information, watershed land use, additional attributes, and a map) and sampling history data (including IBI analysis, fish summary, habitat, field notes, historic flow data, and water monitoring). Note the use of tables, maps, and graphics that help users readily access and interpret data.



Site information and reported data accessible on Iowa's BioNet

Data Publication

When designing a data management system, careful consideration should be given to both how and why users might access and use the data. What questions might users ask about the mitigation program? Will certain users, like researchers, want access to all raw data; will others look for summaries/processed data? Some users may want specific information on a specific condition/quality (e.g., water quality) or resource (e.g., streams).

Data management systems should provide access at different levels based on the uses/outputs of the data. Three possible levels include output based on specific questions, output based on maps/geography, and dynamic data linkages.

1) Question driven information output. The first level of output should be information in response to questions readily understandable to the public. Example questions could include:

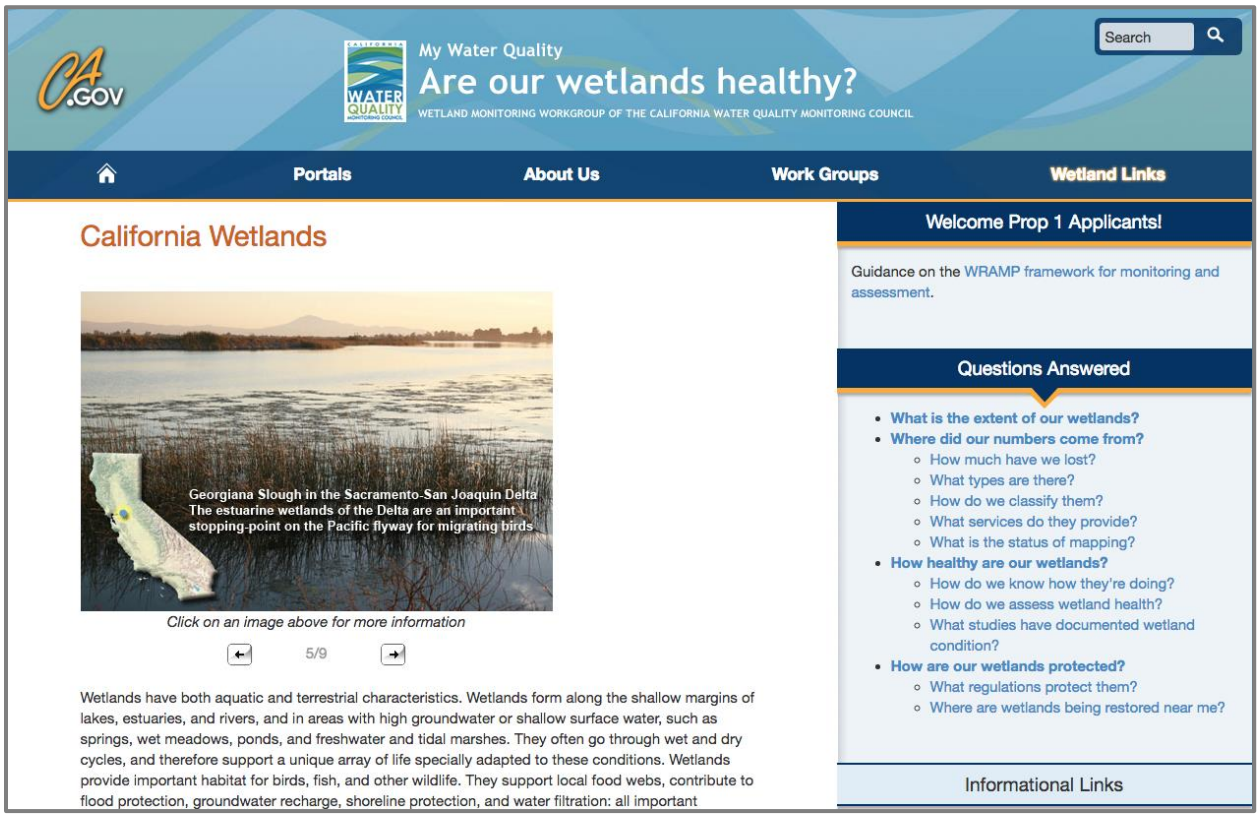
   a) How much wetland/stream loss vs. gain has occurred in my watershed?

   b) What is the condition of restored wetlands/streams?

   c) How is wetland/stream condition measured?

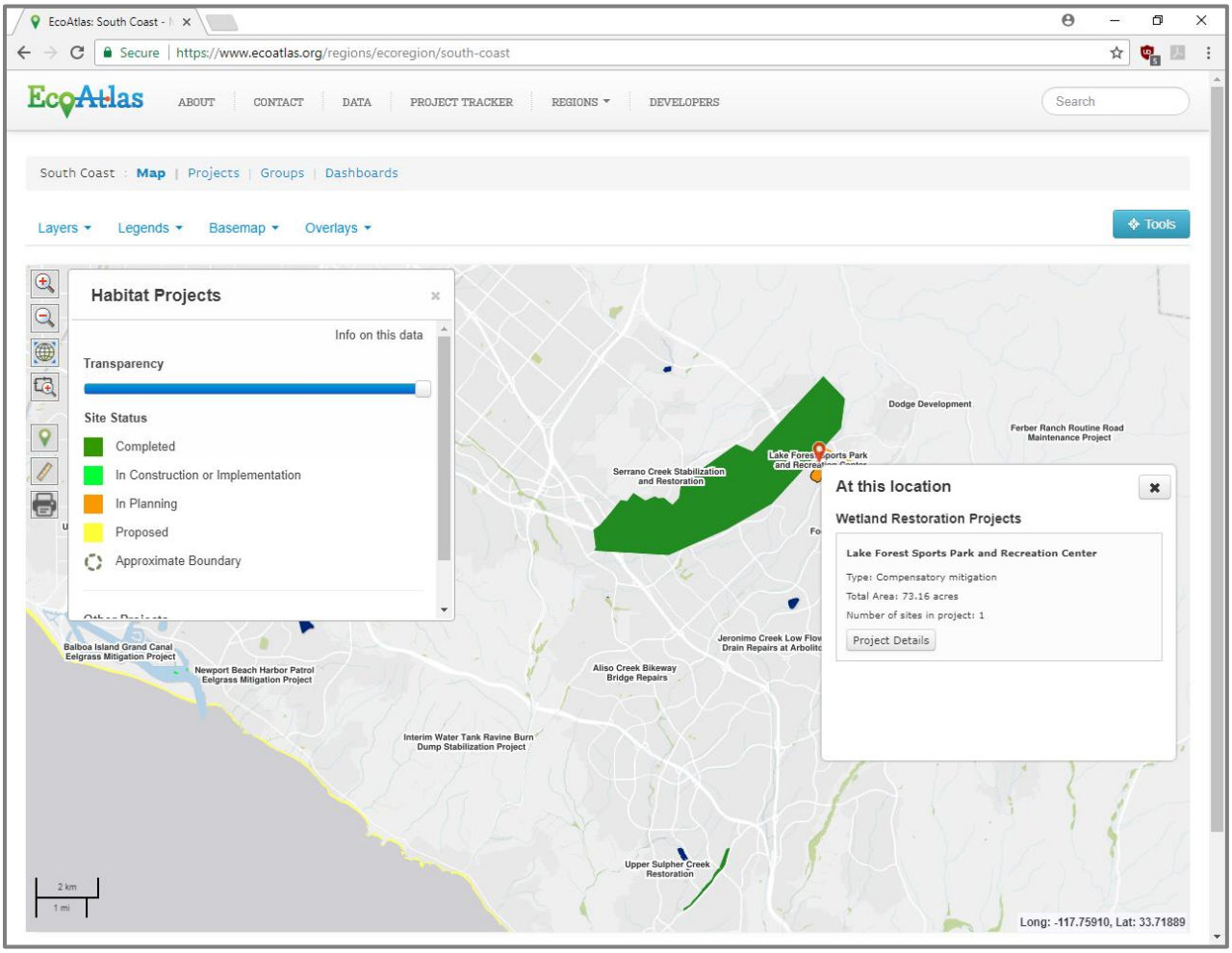
This level of information dissemination requires processing of raw data through standard indices or metrics that interpret and simplify data into easily understandable outputs, such as indices of biological integrity or rapid assessment scores. Many database applications have calculator tools that will automatically calculate or summarize data to automate this process. These can simplify the process of report writing and aid in data visualization. See Figure 11 for an example of question driven data portal from California (http://www.mywaterquality.ca.gov/eco_health/wetlands/index.html).

FIGURE 11: Example of question driven data portal from.



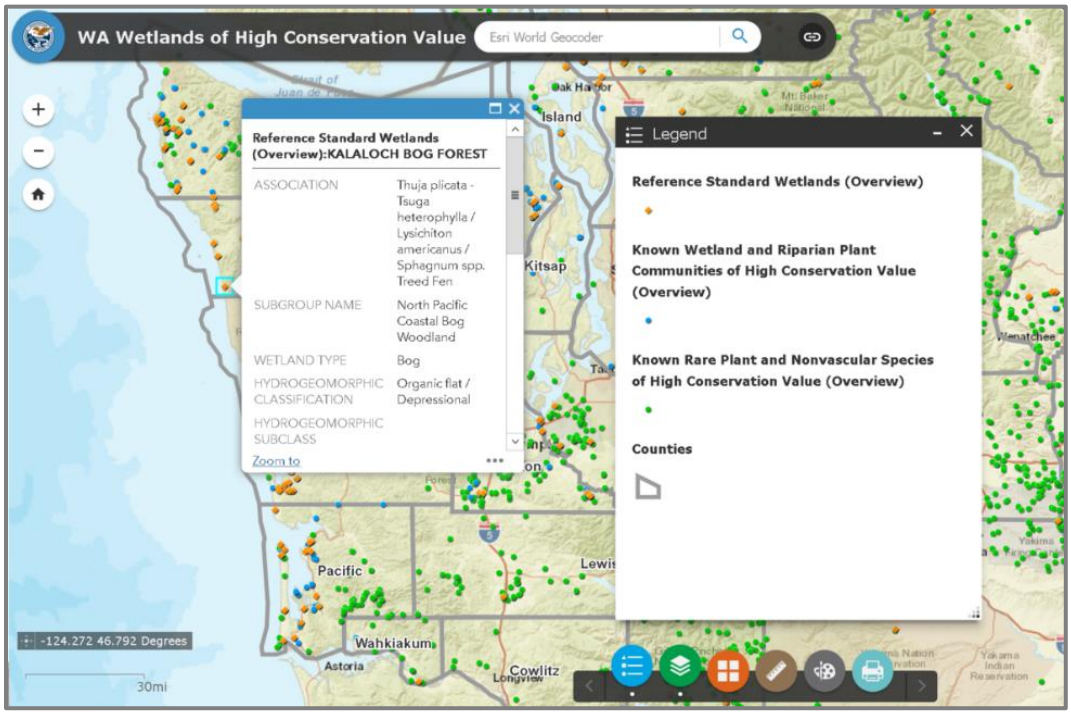
2) Map-based data queries. The second level of output allows users to identify polygons or locations on a map and query data associated with those locations. Ideally, data could be filtered in various ways to customize outputs based on user needs. For example, California's EcoAtlas allows users to identify mitigation sites as polygons on a map. The status of projects is color-coded for easy identification (Figure 12).

FIGURE 12: California's EcoAtlas's maps include mitigation projects.



3) Dynamic data linkages. The third level of output would use APIs and web services that allow other data systems to dynamically "pull" mitigation performance data (e.g., USEPA or other state programs) (Figure 13). This would allow mitigation evaluation data to be linked with other data types, such as wetland mapping data, ambient monitoring data, or reference data sets (See Figure 14 for an example of overlays of multiple data sources).

FIGURE 13: **Example of open data portal from state of Washington showing web-based access of geospatial data, data query, and API.**



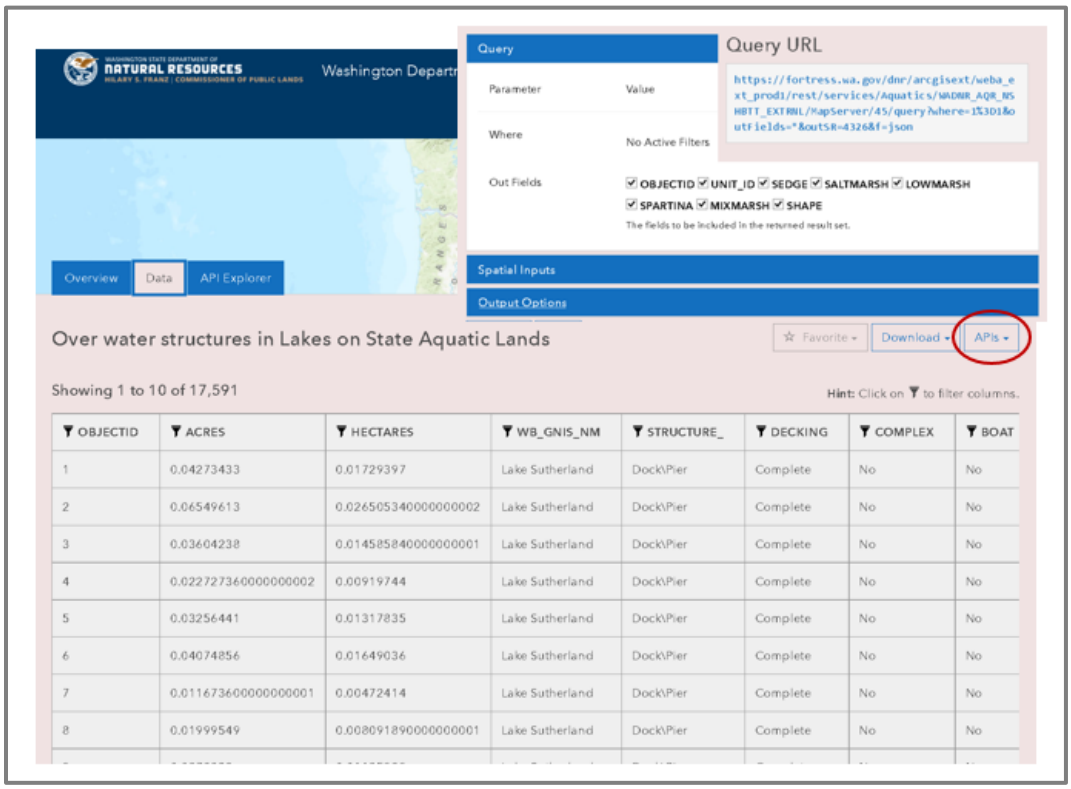
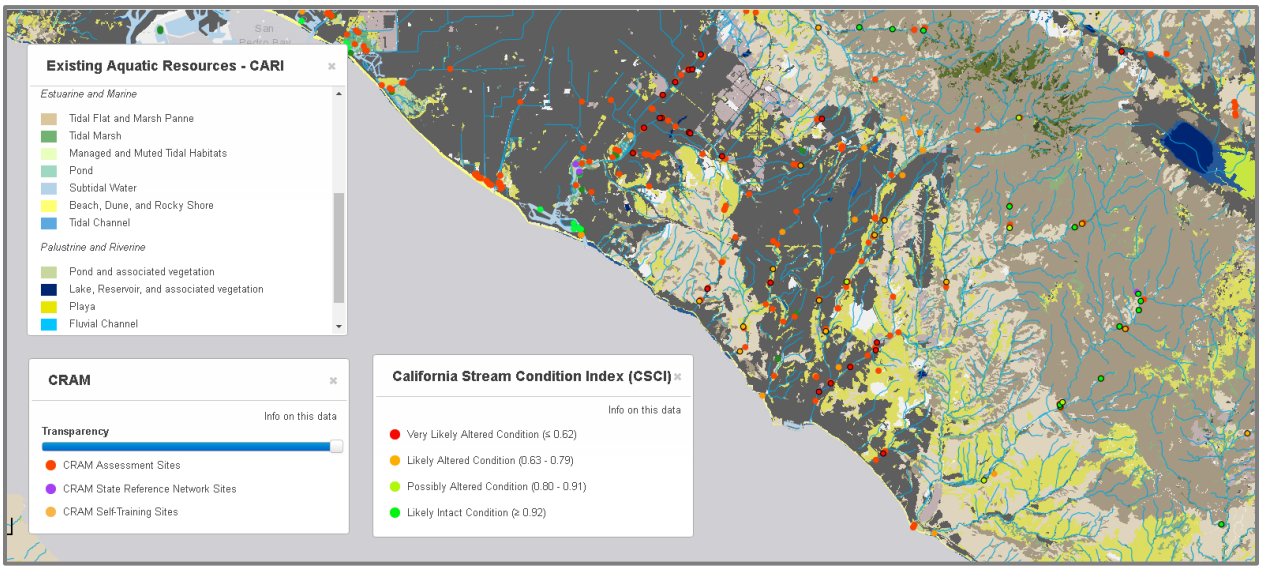


FIGURE 14: Example overlay of wetland projects, ambient wetland condition data, and wetland mapping.



Desired Properties of Data Management Systems

Geospatial Format

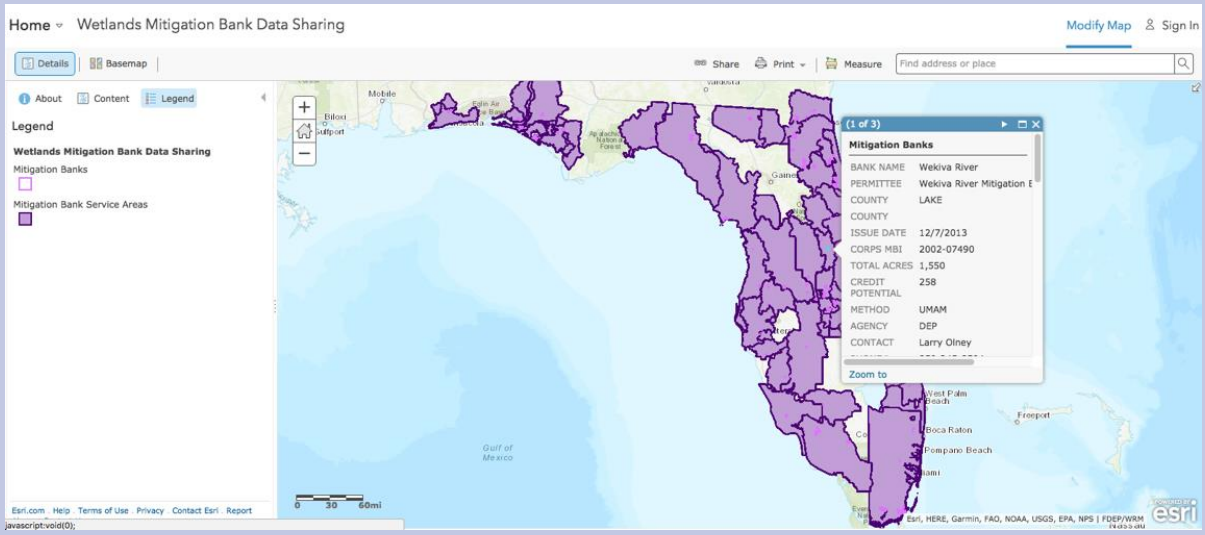
Data should be managed in a geospatial format. To the extent possible, all mitigation sites should be associated with a distinct geospatial entity (e.g., polygon, line, point) that facilitates attribution of appropriate metadata and provides opportunities to overlay with other data layers, such as soils, geology, land use, etc. Use of geospatial format also enhances data visualization and interpretation and facilitates data flow across all modules/elements of the mitigation evaluation process.

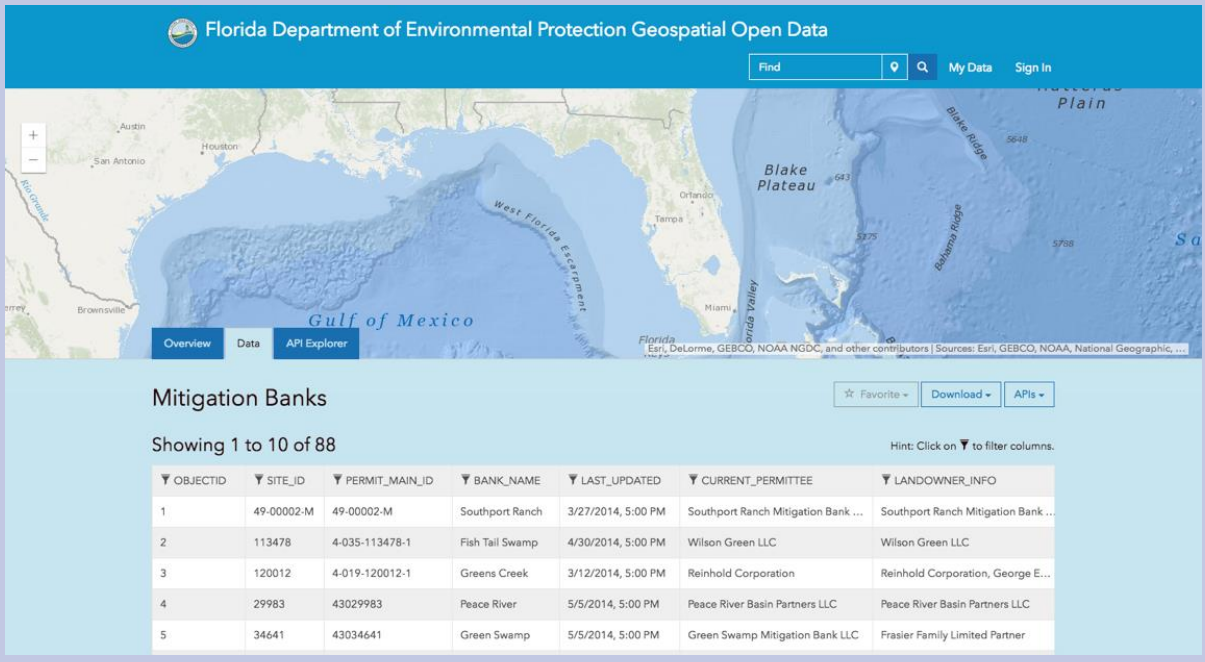
The Federal Geographic Data Committee develops or adopts standards for implementing the National Spatial Data Infrastructure, including standards for Classification of Wetlands and Deepwater Habitats in the United States, Vegetation Classification, and Soil Geographic Data, as well as those for metadata, web coverage service, and others (See https://www.fgdc.gov/standards).

Many states already have web-based geospatial open data portals that could provide a home for compensatory mitigation data (See Box K for an example from Florida).

BOX K: Florida's geospatial data portal.

The Florida Department of Environmental Protection Agency's Geospatial Data Portal includes a mitigation bank service area layer. Banks and their service areas can be visualized on the site. In addition, the user can download the full dataset (attributes include bank name, bank website, permittee, permit link, site id, potential credits, and total size, among others) as a spreadsheet, kml, or shapefile.





Florida's Mitigation Bank Data Sharing

Open Data Format

Data should be accessible and available for sharing. An open data format that includes web services and APIs can facilitate data access and sharing. Open data formats allow the public and other agencies to readily link to data products using dynamic connections reducing the need to actively "upload" data to a central database. This is especially useful for mitigation databases that will be consistently added to as new sites are added and monitoring data is collected. It also reduces challenges with "version control" associated with data updates. Relevant international (e.g., ISO) and US (e.g., ANSI) standards for open data formats can be found at https://project-open-data.cio.gov/open-standards/ or http://datastandards.directory/ and should be used whenever possible.

For example, California's EcoAtlas is an open data portal providing public access to information about the state's wetlands. EcoAtlas provides various webservices to developers for accessing and displaying data. These include web map services created in accordance with the Open Geospatial Consortium (OGC) WMS protocol and RESTful (Representational State Transfer) APIs (allowing for access of data over HTTP). See https://www.ecoatlas.org/developers/.

For water quality data sharing, the Water Quality eXchange (WQX) is a common water data sharing format – developed under the Advisory Committee on Water Information, via the National Water Quality Monitoring Council which represents federal, state, tribal and local agencies, and watershed organizations. See https://www.epa.gov/waterdata/water-quality-data-wqx. Data are are shared with 400 federal, state, tribal and other partners through the Water Quality Portal as a single access point for over 300 million water quality data records.

If a state does not expect to have data available in an open data format, there are other ways to make data available. For example, states may be able to upload Excel or CSV files to a publicly available website (e.g. HydroShare https://www.hydroshare.org/) or share them via a FTP site. See sections on accessibility and integration below.

System Attributes

When choosing or developing a data management system, states should strive to achieve the following attributes:

1) Accessible – The data should be easy to access and navigate and able to accommodate different outputs for different users. As already mentioned, APIs and web services can allow data systems to dynamically link to mitigation databases.

   There are also other options for making data accessible, including standalone data hubs or independent ftp servers. Careful consideration should be given to the file types of the shared data (see Table 5).

TABLE 5: Some Common Formats for Data Exchange

File Type	JSON	XML	XLSX	CSV
Description	JavaScript Object Notation	Extensible Markup Language	Microsoft Excel spreadsheets	Comma separated values
Example	{"SiteID" : 1002, "OwnerLast" : "Doe", "OwnerFirst" : "Jane" }	<site> <SiteID>1002</SiteID> <OwnerLast>Doe</OwnerLast> <OwnerFirst>Jane</OwnerFirst> </site>	(Excel Doc)	SiteID, OwnerLast, OwnerFirst 1002, Doe, Jane
Major Advantages	Very efficient, can be read quickly by programs.	Readily understandable and compatible with many languages	Accessible by anyone with Excel software.	Readable by many programs.

Regardless of whether static or dynamic information sharing is used, agencies should use versioning to ensure that it is clear if an old data standard is being used in such exports.

Web-based systems or data portals may offer different dashboards for different types of users. For example, agency staff may find a highly technical interface/dashboard that allows for rapid access to specific data most useful, while members of the agency may share data with the public via a simplified interface that allows access to a subset of final data. This can be accomplished with different types of log-ins, which allow access to varying levels of data. The underlying database should provide the ability to attribute data as public vs. draft (private) to differentiate between interim and final data (or data that the state may wish to keep confidential, such as contact information for landowners). The public/private categorization should be explained in the metadata.

The public interface may also allow the user to query the database for a subset of information on mitigation sites (e.g., water quality data). Where data are web-based, this could be done through an online form. For example, the Water Quality Portal allows users to select data for download based on location, site parameters, sampling parameters, and data source (See https://www.waterqualitydata.us/portal/).

Web interfaces should be as intuitive as possible for the user, but a tutorial or instruction document is also helpful. Tutorials or instructions should detail how the user can query the relevant data, find metadata, and download selected data (or link to the data via webservers). See EcoAtlas tool at https://www.ecoatlas.org/about/.

Web sites should be easy to find. This may involve outreach to target audiences or one-on-one meetings with partner agencies/organizations to publicize the availability of the site,

discuss how to access the resource, and provide technical assistance on how to use the site, if necessary.

2) Integrated **–** Systems should be able to integrate data from multiple sources and attribute them through unique geospatial locations. As discussed, the system should be able to accommodate dynamic linkages with other data systems, such as ambient monitoring or other geospatial data (e.g., state water quality databases, federal databases such as WQX). This should include a mechanism for verifying connections with partners' data systems on a regular basis.

Many states have existing permitting databases where some mitigation data may already be stored. In many cases, mitigation sites are not entered as separate entries, but mitigation data may be found by querying the information. It may make sense to integrate mitigation and permitting data, where possible.

In addition, some states also have existing web-based open water quality data portals, environmental databases, and GIS viewers/data portals that may also include permitting data (although water quality and permitting databases may not be linked). These may also provide a platform for integrating mitigation data. Examples include the Louisiana Department of Natural Resources' SONRIS and Wisconsin Department of Natural Resources' Surface Water Data Viewer. Some of these platforms are already integrated with monitoring programs or other related information. For example, Wisconsin's Surface Water Data Viewer has wetland inventory, wetland restoration, and potentially restorable wetlands layers. It also includes some water quality monitoring data, including the location of monitoring stations, and data is linked to the state's surface water integrated monitoring system (SWIMS) - https://dnr.wi.gov/topic/surfacewater/swims/. It does not include mitigation data at this time.

Some users may prefer to analyze data with their own software, so a robust system should allow for easy exportation of large amounts of data. For example, the Louisiana Department of Natural Resources has implemented a subscription service that provides an automatic way to access some specific datasets through its SONRIS system (http://sonris-www.dnr.state.la.us/Data_Subscription_Service_Announcement.pdf). Data can be downloaded via automated utilities or to data extracts (in CSV format).

3) Stable – Any data management system will require time and funding to develop and maintain. Special attention should be given to the system's stability over time. Using off the shelf and/or open source tools whenever possible is recommended. Systems should be easy to maintain through changes in personnel, easy to update, and have low maintenance costs. Cloud storage options should be explored as a strategy to maximize stability over time. Regardless, agencies should allocate some funding to support database upgrades and upgrades associated with browser updates.

4) Flexible – At a minimum, databases should include basic information on mitigation sites such as location and contact information for the site manager (see section below on

minimum data needs). This information allows for later evaluation. The information in the database should be expanded to include monitoring data and reports as needs arise and resources allow. This may also include additional file uploads, such as scanned documents or site photos. The database should be designed to be flexible enough to incorporate these changes in future generations. This could be accomplished by integrating new tables in a database as they are available. Multiple tables can be uploaded to a web-based system and attributed by geospatial locations and unique project IDs. Again, standard formats (file formats, data languages, common names for common fields (e.g., Site ID, Contact Info, Lat, Long, etc.)) need to be consistent across all tables/databases to ensure that the integration is seamless. This is where a data dictionary is valuable.

5) QA/QC – QA/QC procedures should be in place at all stages of the data flow. Systems should include data dictionaries that support use of automatic data checkers. Data checkers provide an easy way to standardize data inputs and provide immediate feedback to data providers on the "acceptability" and completeness of their data. Most database programs include some range of available data checkers, and add-ons or plugs-ins are available for some of the open source programs.

   QA/QC can also help to reconcile different sources of data. Michigan's MiWaters, for example, includes a map-checker so that, when site location coordinates are entered on an application, the applicant may instantly confirm that they have entered the correct coordinates.

   Overall, data systems should also provide transparent information on sources and data quality for all data types. Periodic staff review, and database maintenance are also good practice.

6) Reminders – Ideally the data management system should track tasks and send email reminders to permittees or agency staff. For example, reminders could be sent when monitoring reports are due. Florida's databases include calendaring and reminders to help track deadlines, materials due, permit process, workloads, and compliance deadlines, among other tasks. Similarly, Louisiana's mitigation database includes scheduling and reminders to keep track of what is due on a monthly basis.

   As mentioned above, open-source database programs may include options for reminders, either as built-in features or via plug-ins. Reminders can also be programmed into Access databases. These off the shelf programs offer enough flexibility to set up the kind of reminders that would be useful for regular project tracking.

Database Software Options

Many state agencies use programs such as Microsoft Excel or Microsoft Access to store their program data. Access allows for the creation of data input forms, automatic email reminders (via custom code or plug-ins), and reports. However, Access requires a paid license and may not be able to handle many entries or users (i.e., greater than a few dozen).

Several states also use ArcGIS for visualizing some mitigation data (e.g., Florida's Department of Environmental Protection Geospatial Open Data Mitigation Bank Service Areas - http://geodata.dep.state.fl.us/datasets/mitigation-bank-service-areas). ArcGIS, or another GIS platform, may be synced with another database (such as Access).

Other states have developed Oracle-based SQL databases. SQL is a standard language for storing, manipulating, and retrieving data in databases. SQL databases can provide better performance, especially for large number of entries and users. For Oracle databases, the most recent versions are subscription based. Agencies may also consider using open-source platforms. Not only are such systems routinely updated, but they are also free, minimizing the costs of implementation and upkeep. Such open-source database systems include Cubrid, MariaDB, MySQL, PostGreSQL, and Greenplum Database, all of which are SQL-based systems. The chart below describes some of their differences. Note, there are many more technical differences between these and other open-source database systems. The descriptions below are meant to be read at the most general level.

TABLE 6: Some Common Open Source Database Systems

	PRO	CON
MySQL	Widely used, has many third-party plugins that have additional features; Fast; Scalable; Supported by Oracle	May not be able to support all data types (including geometric information)
Cubrid	Somewhat faster than MySQL	Not as widely used as other database engines
PostGreSQL	More powerful than MySQL, supporting more data types; Also has third-party plugins	May be more complicated than agencies require; Slower than MySQL; Fewer service providers are able to host these databases
MariaDB	Includes additional features, enhancements, and better security than MySQL	No commercial-grade option
Greenplum Database	Is based on PostGreSQL, but provides additional analytical features	Greenplum is optimized for very large data sets, but may be slow given the size of mitigation program datasets

Although no single database engine may provide all the functionality agencies desire, there are many after-market plugins that provide additional features. These plugins can automatically create email reminders, improve remote access, and provide cleaner interfaces for interacting with the database. For example, see the applications built by Kintone and Zoho Creator. State IT staff will likely be critical partners in helping to guide mitigation programs to select a system that has the desired features and is practical and supportable over extended periods of time.

Tables created in Excel and Access can both be linked to SQL or other databases. For example, staff can enter data into tables created in Access and then either link (synchronized so data updates automatically) or import (a one-time transfer of information) to a managed database. Thus, less time is required to train staff on new software, while the program as a whole benefits from the advantages an open-source database software can provide.

Rules of Practice

It is impossible to prove a standard set of recommendations or template that will be applicable (or appropriate) for the range of data management needs across all programs. However, some desirable "rules of practice" that can improve data access by agencies and the public, facilitate data sharing between programs, and provide longevity that supports analysis of trends in mitigation practices are provided. Table 7 summarizes the recommended "best practices" for data management.

TABLE 7: General rules of practice for data tracking

BEST PRACTICE	METHODS
Standardize Data Entry	Use **standardized data forms** to minimize errors and ensure comparable data. Use **electronic data capture** when possible.
Organize Data Tables for Consistency and Efficiency	Associate Data with a **Unique Project ID and Unique Geospatial Location** Upload **Raw Monitoring Data** Construct a **Data Dictionary** to improve data quality and comparability Data table must include **Metadata** to allow for comparisons and facilitate long-term assessments
Ensure QA/QC	Use **Automatic Data Checkers** or other data validation mechanism (e.g., drop down menus) Ensure **Regular Staff Review** of data
Facilitate Access to Data Among Agency and Other Partners and the Public	Data should be stored in an **Open Data Format** and **Linked to the Internet** Use **Open Data Standards** when possible Use web services and APIs to provide **Dynamic Data Linkages** Include clear information on **Versioning** and provide ability to attribute data as **Public vs. Private/Draft** as appropriate
Use Visualization Tools to Make Data Accessible and Understandable	Attributing data to a **Unique Geospatial Location** provides opportunity for spatial analysis with other data layers **Maps** may offer the most accessible form of displaying the data **Dashboards** can provide up-to-date illustrations of the information in the database
Systems should be able to integrate data from multiple sources and attribute them through unique geospatial locations	Allow for easy **Exportation of Data**, via dynamic linkage or uploading data to a publicly available site Existing **State Mitigation Databases and Water Quality Data Portals** provide integration opportunities
Make Use of Database Tools for Analysis and Program Operation / Stability	**Calculator Tools** can help automatically calculate or summarize data to easily understandable outputs Use database system tools to track tasks and send email **Reminders** to permittees or agency staff
Invest in database maintenance	Use **Open Source** database management tools when possible Design the database to be **Stable** and **Flexible**

Data and Metadata Requirements

All mitigation projects should be associated with a *unique polygon and project ID*. The following metadata should be included:

- Data generator or owner, with contact information
- Date of record creation
- Contact information for property owner
- Contact information for mitigation provider or key point of contact

In addition, each mitigation site should include the following minimum data fields (see Data Template attached):

- Permit number
- Location
- Size
- Area of each habitat type, including area of jurisdictional waters and wetlands
- Resource type (wetland, stream, etc.)
- Wetland type/stream class – at a minimum HGM and Cowardin classes should be used, including relevant hydrologic modifiers
- Mitigation method
- Mitigation mechanism
- Date project began (or approved)
- Project status

Other information collected on the mitigation project may include links to documents (e.g., mitigation and/or monitoring plans), performance standards, surrounding land use, etc. For banks and ILF programs, additional information may include number of credits, credit types, credit assessment methodology.

The minimum monitoring data to be collected will depend on the questions that managers are trying to answer, monitoring requirements, resources involved (e.g., wetlands versus streams), etc. Table 3 lists level 3 indicators of aquatic resource condition. These priority indicators can be found on the template data table (Appendix C).

All data fields should be accompanied by data dictionaries that list acceptable values for categorical or discrete data or acceptable ranges for continuous data. Data dictionaries should be used in concert with data checkers employed as part of the QA process to improve data quality and comparability.

Collecting Historical Data

While collecting historical data on sites will allow for a more complete analysis of mitigation programs, migrating that data into a new or unified system may be cost prohibitive. For example, many states have paper copies of mitigation site data, but digitizing all of those records is a time-intensive process, especially for resource-scarce state agencies. This section discusses strategies to most effectively add historical data to a data management system.

Don't Seek Out All Historical Data

Data may have been stored in different formats throughout the life of a mitigation program, so it may be most effective to focus on only certain eras of the program. For example, if the agency changed practices after the 2008 Mitigation Rule, that agency may focus its migration efforts on data from 2008-present.

Similarly, it may be most effective to focus on tiers of data. The locations of all old projects may be simpler to find and input into a new data management system than other project information.

Finally, even if the historical reports cannot be migrated immediately, paper records should still be digitized. This will not only ensure that the data is not lost forever but may also allow for automatic conversion of the scanned documents into usable data.

Find Community Partners to Aid in the Migration

Instead of relying on staff time to input historical data, agencies may utilize community partners (e.g., AmeriCorps volunteers or interns). Similarly, graduate students may find the experience useful, either to increase their understanding of the state's mitigation practices or to allow for later use of the data in their own research. Agencies should reach out to local universities or other community partners to explore opportunities for collaboration.

Identify Alternative Sources of Historical Data

Even if state records are incomplete or inaccessible, the data may be stored in other databases. For example, mitigation bank and in-lieu fee program data may be pulled from USACE's RIBITS site (https://ribits.usace.army.mil/) to populate a state database.

7. CASE STUDIES AND BASELINE APPLICATIONS

Comprehensive evaluation of compensatory mitigation programs should include all three modules. No state was identified that currently incorporates all recommended elements into an integrated assessment strategy; however, examples of all three modules exist individually around the country. Below example applications (i.e., one-time assessments) of each module are provided to illustrate the analysis and products that may be produced, along with lessons learned that can guide states should they decide to incorporate specific modules into their program.

Module 1: Compensatory Mitigation Site Performance

At a Glance

Goal:	• **Assess compensatory mitigation site success** • **Evaluate regulatory compliance**
Main questions:	• **How well do compensation sites meet their stated goals and permit requirements?**
Design approach:	• **Comprehensive assessment during the permit-required monitoring period** • **Compensation sites assessed under this module become the sample frame for the Program Effectiveness assessment**
Site selection:	• **All sites and/or assessment at end of required monitoring period**
Approach to reference:	• **Compare to permit conditions/performance standards** • **Pre-project site conditions (if applicable)** • **Conditions at the impact site (which is the site creating the need for compensation)**

Module 1, Example #1

Assessment of compensatory mitigation site success in Florida through evaluation relative to performance standards

Question Addressed:

- Are wetlands meeting the criteria and conditions set forth in their mitigation bank permits?

General Approach:

- The study determined the performance of 28 mitigation banks in Florida by comparing permit success criteria with related field measurements. Wetland types included depressional herbaceous, depressional forested, forested strand, and floodplain wetlands. Streams were not part of the investigation.
- Site selection criteria included length of time since permit issuance, progress towards mitigation activities, and land owner or manager cooperation for site access. Permits were issued between 1996-2005, and assessments took place in 2005 and 2006.
- Most of the information for the review document was compiled from staff reports, monitoring reports, and site visit summaries. Field assessments specific for the review document were conducted at select wetlands. Baseline reference conditions were developed from a database of prior work by the authors, or from reputable sources (universities and state government). Assessments were conducted in phases, according to credit release schedules. Final assessments compared field measurements (undertaken by the permittees or as part of the review study) with permit criteria.

Data Source:

- Reiss, K.C. et al. 2007. An Evaluation of the Effectiveness of Mitigation Banking in Florida: Ecological Success and Compliance with Permit Criteria. p149

Data Availability:

- Synthesis of the information was provided by Reiss et al. 2007 in two tables, one of the success criteria (TABLE), and one of regulatory compliance (TABLE 9).

Data Analysis:

- Compliance success for each project was evaluated by comparing permit criteria to field measurements.
- Permit criteria varied by project, but usually involved measurements such as a minimum percent area with plant cover, a minimum proportion of native plant species, and minimum survivability (TABLE).

Assumptions in Use of Data:

- The numeric criteria often varied among projects and by wetland type, even when performance standards used the same indicator and metric. For example, the minimum percent plant cover varied from >50% to >90% among projects (TABLE). Therefore, interpretation of success among projects can be affected by the criteria being applied, as well as the baseline conditions at the site and the specific expectations for the site. For Module 1 performance is a relative measure of success for each specific site.
- The sites were not necessarily mature compensatory projects (e.g., one site was only 1-2 years old), although all were still within the permit mandated monitoring period. This

may affect the conclusions because newer plantings may not have the same amount of plant cover as older established projects. The inclusion of immature sites in this case study is not wholly consistent with the recommendations of Module 1 but is still illustrative.

- This study was completed prior to the 2008 Mitigation Rule, so the results may not be reflective of more current compensatory mitigation practices.

Conclusions:

- Overall banks were only partly successful. Only three of the 28 mitigation banks evaluated had reached final success criteria for the entire bank.
- Not all projects allowed for comprehensive assessment. Some monitoring reports consisted of only plant lists, with minimal analyses and vague descriptions. It could be that some early permits did not specify enough detail as to what was required for monitoring, making assessment difficult.
- Compliance reports indicated that seven banks did not report on areas that were not demonstrating ecological improvement or did not submit a report because no activities were taking place.
- Wetland scientists have recognized that permit success criteria and achieving wetland function may not be equivalent (Mitsch and Wilson 1996), yet changes have not been made in the permitting process to require completion of functional assessments for attaining credit release.

Lessons learned, provided by Reiss et al. 2007:

- Regulatory agencies must endeavor to write permit conditions that can be followed and enforced that use the best available technology or protocol for restoration, be vigilant in demanding accurate and representative monitoring reports, withhold credit for underachieving sites, and ensure frequent communication and inspection of the sites.
- Permits and attached or referenced documents should contain the detailed community goals and/or reference conditions the site is anticipated to attain. Florida Natural Areas Inventory (FNAI) descriptions could provide a valuable starting point to ensure that more than just vegetation is included. It is important to evaluate wildlife responses to mitigation activities.
- Final success criteria should be quantifiable reflections of these goals. Incorporation of function-based performance standards, such as those recommended in this report could help improve ecological success of completed compensatory mitigation projects.

TABLE 8. **Success criteria related to native vegetation cover and survivability of planted vegetation in state permits, for the first of 28 wetland compensatory mitigation banks, from Reiss et al. 2007.**

Bank Name	Dominant Habitat at Site Visit	Final Success Criteria - percent cover of native vegetation	Survivability of planted vegetation
Barberville	Flatwoods	Not specified	400 trees per acre
Bear Point	Mangrove swamp	> 50%	No planting in phase reviewed
Big Cypress	Flatwoods	Herbaceous: ≥ 80% cover native wetland spp. and ≥ 20 wetland herbaceous spp. The herbaceous vegetation shall cover ≥60 % with plant species listed FAC or wetter and be rooted for at least 12 months and be reproducing naturally Forested: ≥70% coverage by desirable ground cover plants, with ≥ 75% of spp. being listed FAC or wetter. Hydric pine flatwoods: diversity of ≥ 30 herbaceous spp. shall be present. For each 5 species over 30 a 1% credit bonus will be given for hydric pine flatwoods. Evidence of natural regeneration of planted species	≥ 80% survival of all planted trees and shrubs
Bluefield Ranch	Flatwoods	Flatwoods graminoid vegetation in groundcover strata ≥ 50% of total coverage ≥ 70% of total groundcover strata consists of wetland vegetation (hydric pine flatwoods only) ≥ 80% of total herbaceous groundcover strata FACW and/or OBL vegetation or OBL vegetation > upland vegetation	≥ 80% survival of planted trees
Boran Ranch	Flatwoods, marsh	85 to 90% cover for desirable vegetation depending on community type	No planting in phase I
CGW	High marsh, mangrove swamp	90%	No planting
Colbert-Cameron	Flatwoods, cypress domes	Percent cover not specified, bank is primarily preservation with some enhancement	No planting
Corkscrew Regional	Mixed forest, cypress domes, hydric flatwoods	Minimum percent cover of groundcover is 70% for hydric pines. Minimum percent cover of groundcover in cypress and mixed forest areas is 75% unless there is a lower percent because of open water or shading. Must show evidence of natural recruitment	No explicit numbers for survivorship in final success criteria.
East Central	Wetland forested mixed	Bank was monitoring for vegetative cover but this study did not acquire documentation that stated what that final success criteria was.	Unknown if there was a requirement for survivorship

TABLE 9. **Summary of regulatory compliance for the first of 28 wetland compensatory mitigation banks, from Reiss et al. 2007.**

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Barberville	Problems with planting pines, have had to replant several times but latest monitoring report reports good success with second planting which occurred in 2004. Bank has not had a permit modification yet but has planted cypress in areas that were more wet than anticipated, pine is not surviving. Bank did not request credit release when plantings were failing, now that they are finding better success they have asked for credit release.	Long ways off.	No problems.	Pretty good with communication, good about district visit.	New district staff has been out to the bank a couple of times, and going again now because of credit release request. If the bank is not improving, then the district will allow more time to meet criteria.
Bear Point	First release for exotic species control, preservation, and financial assurance.	Practically meeting success criteria after only 1-2 years.	Need reminders when submitting reports.	Needed help with process but good communicating.	1-2 times/yr - with every credit release.
Big Cypress	Time zero was reset because could not get ground cover to proper specifications. Recently bank submitted request for credit release, but the district only gave a partial release because the herbaceous level 1 criteria could not be met because torpedograss (*Panicum repens*) cover was greater than 10%. Bank has finished all planting.	Permit may have to be modified either in number of credits or type of credits because they may not be able to get the torpedograss within success criteria requirements. (this may not have ever been done before as far S.McCarthy knows) May experiment with different techniques to try and control the torpedograss.	Pretty good about submitting reports on time although did withhold a monitoring report for a while because they were trying to do better with the torpedograss, fell a little behind trying to get it under control.	Communicating pretty well. Usually on time except for what was previously mentioned.	Generally visit Big Cypress every time a request for credit release is submitted. Other than that, site visits may happen at the request of the permittee to address a specific issue (i.e., analyze methods to eradicate torpedograss). Site visit may be requested if there are any glaring non-compliance issues from the monitoring reports. District staff has visited the bank for training and educational type purposes for district staff in the past. The bank has always been very accommodating.

Module 1, Example #2

Assessment of compensatory mitigation sites to meet project success criteria in Pennsylvania.

Question Addressed:

- Are the wetlands meeting the criteria and conditions set forth in the permit?

General Approach:

- The study determined the effectiveness of 23 compensation sites in Pennsylvania by comparing permit success criteria with related field measurements. Wetlands were selected for the study by age class; there were 8 sites from 1–5 years of age, 11 from 6 to 10 years, and four more than 10 years old. Hydrogeomorphic classifications included depressional, slope, headwater floodplain, mainstem floodplain, and fringe wetlands. The type of compensation mechanism used for each permit was not discussed.
- Wetland plant community structure, percent plant cover, and evidence of hydrology were visually evaluated by the authors during a field inspection of each site. Mitigation success was based on comparing plant cover evaluated in the field with permit criteria.

Data Source:

- Cole, C. A. and D. Shafer. 2002. Section 404 Wetland Mitigation and Permit Success Criteria in Pennsylvania, USA, 1986–1999. Environmental Management 30:508–515.

Data Availability:

- Synthesis of the information was provided by Cole and Shafer 2002 in

- TABLE 10.

Data Analysis:

- Compliance success for each project was evaluated by comparing permit criteria to field measurements.
- Permit criteria varied by project, but usually involved measurements of minimum percent area with plant cover, and minimum survivability (

- TABLE 10).

Assumptions in Use of Data:

- The numeric criteria often varied among projects, even when the same compliance category was used. For example, the minimum percent plant survival varied from 75% to 85% among projects (

- TABLE 10). Therefore, interpretation of success among projects is affected by the criteria being applied.
- This study was completed prior to the 2008 Mitigation Rule, so the results may not be reflective of more current compensatory mitigation practices.

Conclusions, by Cole and Shafer 2002

- About 60% of the mitigation wetlands were judged as meeting their originally defined success criteria.
- Many of the permit files lacked sufficient information to determine whether the project was successful. This was either due to a lack of clarity in the permit requirements, and/or a lack of monitoring of the mitigation wetlands during and after construction. Performance standards for the determination of success were found in only 13 of 23 files (57%).
- The permit process appears to have resulted in a net gain of almost 0.05 ha of wetlands per mitigation project. However, based on details provided in the mitigation monitoring reports, there appears to have been a replacement of emergent, scrub–shrub, and forested wetlands with open water ponds or uplands, mitigation practices probably led to a net loss of vegetated wetlands. Combining Level 1 assessment of habitat distribution of compensation sites with Level 2 and 3 assessments of condition provides this more comprehensive evaluation of performance.

Lessons Learned, by Cole and Shafer 2002:

- Although measurement of plant percent cover is a convenient method for assessing mitigation wetlands, just what it assesses is subject to considerable debate. The correlation between percent herbaceous plant cover and most wetland functions is not clear. Having more than 80% plant cover (as is frequently required in a permit) is not necessarily desirable in all cases. Somewhere in the transition from diverse to monotypic plant communities, there is a loss in the suite of available functions, but it is difficult to pin down exactly where that loss occurs.

TABLE 10. Criteria required for assessment of success of wetland compensatory mitigation project, from Cole and Shafer 2002. Sites without a criterion had none found in the permit file.

Site	Age (yr)	Success criteria	Did the site still meet success criteria?
1	1+	85% coverage of hydrophytes after 5 years	Yes
2	3	85% coverage of hydrophytes after 3 years	Yes
3	3		
4	4	85% coverage of vegetation	Yes
5	4		
6	4	85% cover of proposed plant species after 2 years	No
7	5	85% survival of planted hydrophytes after 2 years	Yes
8	5	85% survival of planted species after 5 years	No
9	6	85% coverage of vegetation	Yes
10	6		
11	6	85% cover of hydrophytic vegetation after 2 years	No
12	6	85% cover of hydrophytic vegetation after 2 years	Yes
13	7		
14	8		
15	8	75% survival of planted species after 2 years	Yes
16	8		
17	9	Predominance of species adapted for life in saturated soils	Yes
18	10	80% survival rate of transplanted species	unknown
19	10		
20	12	85% cover of hydrophytes after 2 years	No
21	13		
22	13		
23	14		

Module 1, Example #3

Assessment of compensatory mitigation wetland sites to meet project success criteria over time in Washington (state).

Question Addressed:

- Are the wetlands meeting the required performance standards?
- How does the ability of compensatory mitigation to provide functions vary over time?
- How much time is required for the performance to stabilize following construction?

General Approach:

- The study determined the effectiveness of 327 compensatory mitigation sites in Washington by comparing permit performance standards with related field measurements. Ages ranged from 1-17 years, with a median age of 4 years; most permits were issued to be monitored for 10 years.
- The performance standards based on an evaluation of the effectiveness of controlling non-native plants (non-native, invasive, noxious, or weed) were assessed over 673 sampling events.

- Both wetlands and streams were included.
- Mitigation banks made up most of the sites (n=260), while "other mitigation" accounted for 67 projects

Data Sources:

- Washington State Department of Transportation public FTP site: ftp://ftp.wsdot.wa.gov/public/tesc
- T. Bush (WA Department of Transportation).

Data Analysis:

- Comparison of permit performance standards to measured values to evaluate success.
- The percent of sites meeting a performance standard was calculated by wetland age. Evaluation ratings indicating whether the standard was achieved or not (e.g., "yes", "no") were provided for each measurement in the dataset.

Assumptions in Use of Data:

- Assumption that measurements of plant percent cover is a reasonable surrogate for project success.
- For both performance standard categories evaluated (cover of native vegetation, and control of non-native plants), there were multiple performance standards enforced. Three examples of the standards for native plant cover were: "aerial cover of native woody species will be at least 50 percent in the urban forest riparian plantings", "native salt marsh species will achieve approximately 15 percent coverage", and "three native facultative or wetter vegetation species will achieve 8 percent or greater relative cover in each forested wetland community". For this document, the success rate of meeting permit standards was not broken down by each specific requirement. Rather, the overall rate of success was considered, regardless of the specific standard.
- For this document, when more than one standard was applied at a site, the site was considered out of compliance if any of the measurements failed to meet a standard.
- Measurements that had an ambiguous evaluation rating relative to the standard (e.g., "maybe", "depends") were omitted from the analysis.
- Data accessible through the public ftp site only included measurements related to vegetation (cover and survival of native species, and control of non-native species)
- Hydrology data were also collected by Washington DOT but were not available through the ftp site and were therefore not included in the analysis.

Conclusions:

- Most wetlands met the performance standard for control of noninvasive species (87% of sites) and minimum native plant coverage (81% of sites; Table 11).
- Both performance standards continued to have high rate of success 10 years into the projects (Figure 15)

Lessons Learned:

- Evaluating permit performance standards resulted in replanting of native vegetation and control of invasive species for some sites.
- Permit standards are helping to address project closeout requests.
- Public data access is extremely beneficial for long-term assessments as it allows for extended evaluation beyond permit mandated monitoring periods.
- Ambiguous assignment of success determinations (e.g., "possibly," "maybe," "depends") makes evaluation difficult and required substantial amount of data to be omitted from the analysis.
- Lack of ambient or regional reference data limited a functional assessment of performance.

FIGURE 15: **Rates of success at meeting performance standards for invasive plants (top) and native plant cover over time (bottom). X-axis is age of site.**

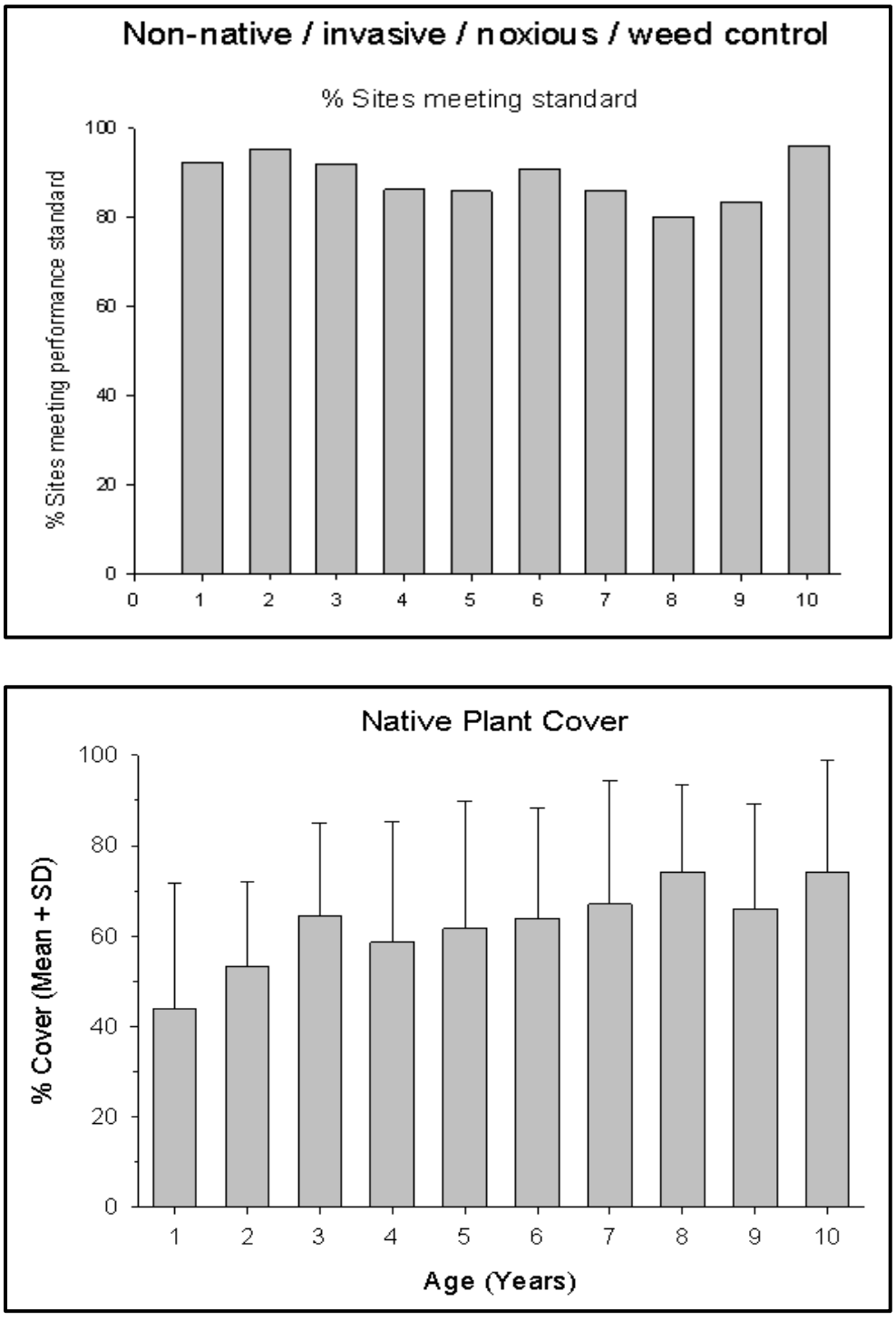


TABLE 11. Performance standards and results of three of the 327 wetlands assessed, courtesy of T. Bush.

SITE NAME	PERFORMANCE STANDARD	RESULT	ACHIEVED
099 West Fork Hylebos Creek	All woody vegetation installed in restoration areas should have 100% survival one year following installation. If dead plantings are replaced, the first year plant establishment criteria will be met.	96% survival (CI80% = 93-99%)	Close
	King County noxious weeds and species will be controlled. The presence of any non-native knotweeds will initiate the invasive species contingency measures.	Achieved (<1% cover); No knotweeds observed on-site	Yes
532 Dugualla Bay	Native salt marsh species will achieve approximately 15% coverage in the high and low salt marsh zones, based on visual estimates.	2% cover (qualitative)	No
	Native woody species (planted and volunteer) will achieve an average density of at least four plant per 100 square feet in the buffer planting areas.	9.5 plants/100ft2 (CI80%= 8.8-10.1)	Yes
	WSDOT will attempt to eradicate Washington State-listed or county-listed Class A weeds and Class B weeds designated for control by Island County. In accordance with this commitment, the presence of knotweeds and purple loosestrife will not be tolerated. All occurrences of Class A or Class B noxious weeds, including knotweeds and purple loosestrife, will be immediately reported to the site manager and an eradication program will be initiated within 30 days of the report.	No Class A weeds observed. Class B-regulated spurge laurel (*Daphne laureola*) reported for control.	Yes
	In addition, invasive species listed in Table 20 and any other species that competes with desirable vegetation will be controlled across the mitigation site until performance standards for native vegetation have been achieved in the wetland and buffer zones.	Canada thistle (*Cirsium arvense*) and bull thistle (*C. vulgare*) observed and reported.	Yes
	Island County Class A, Class B, Class B non-designated, and Class C noxious weeds will not exceed 20 percent aerial cover.	<5% cover (qualitative)	Yes
542 Anderson Creek	The vegetation will achieve 100% survival of planted woody species at the end of the first year plant establishment period. If all dead woody plantings are replaced, the performance standard will be met.	98% survival (CI80%= 96-99%)	Close
	No more than 20% cover by non-native invasive species as listed in Table 5 in the buffer communities across the entire site. Any presence of Japanese knotweed will initiate the invasive species contingency measures.	3% cover (qualitative)	Yes

Keys to implementing Module 1:

- Clear articulation of performance standards
- Unambiguous measures of success that can be readily quantified
- Monitoring data collected in a manner consistent with performance standard, using standard protocols, with clearly documented confidence levels
- Monitoring data includes both abiotic and biotic measures of aquatic resource condition

Module 2: Program Effectiveness

At a Glance

Goal:	• **Evaluate effectiveness of compensatory mitigation program at offsetting overall aquatic resource losses** • **Evaluate the overall effectiveness of the regulatory program at contributing to no net loss, target area or other regional or watershed goals**
Main Question:	• **How effective is the overall compensatory mitigation program at achieving programmatic goals of offsetting permitted wetland and stream impacts?**
Design Approach:	• **Probabilistic site selection through ambient or status and trends assessment OR comprehensive synthesis of gains and losses data assessed across all compensatory mitigation and impact sites**
Site Selection:	• **Subset of sites from a probabilistic survey OR all sites at the end of required monitoring period over a defined time period.**
Approach to Reference:	• **Comparison to ambient condition, comparison to reference standard sites**

Module 2, Example #1

Evaluation of the condition of compensatory mitigation streams relative to ambient, and reference conditions in southern California.

Questions Addressed:

- How does the condition at compensatory mitigation sites compare to reference or ambient condition in the region?
    - Is compensatory mitigation producing streams that contribute to an improvement in regional stream condition?

- What level of improvement in stream condition has occurred as a consequence of compensatory mitigation activities?

General Approach:

- The effectiveness of the compensatory mitigation program at offsetting stream impacts was assessed by comparing the condition at 23 mitigation streams to 707 ambient and 40 reference sites in southern California, using the California Rapid Assessment Method (CRAM).

Data Sources:

- Compensatory mitigation data were taken from Fong et al. 2017. Perennial or intermittent compensatory mitigation streams from 23 projects consisting of mechanical channel grading and riparian re-vegetation were sampled. The projects ranged in age from 2-26 years post-construction, with a subset of the sites having completed the required mitigation monitoring period. The sites were visited for CRAM assessments in 2012 or 2013.
- Data for ambient monitoring sites were taken from the Stormwater Monitoring Coalition (SMC) regional monitoring database, and included data from both the SMC regional program, as well as data collected as part of the statewide Perennial Streams Assessment (PSA) program. The PSA is a long-term statewide survey of the ecological condition of wadeable perennial streams and rivers throughout California, although only southern California PSA sites were used for this analysis. The SMC is a regional cooperative formed by National Pollutant Discharge Elimination System (NPDES) permittees and regulators in southern California to coordinate and leverage existing monitoring efforts in order to produce regional estimates of condition, improve data comparability and quality assurance, and maximize data availability. Both stream assessment programs use a probabilistic sampling design. Data for the ambient monitoring streams were collected between 2009-2017 and included 707 sampling events. The SMC database maintains data in an electronic format.
- Reference site data were collected as part of the State's Reference Condition Monitoring Program (RCMP). This statewide program uses a targeted approach to sample the healthiest, highest quality streams in California as a foundation for establishing a framework to identify and protect healthy watersheds. Data from this program are also stored within the SMC database. Data were obtained for forty RCMP sampling events conducted between 2009 and 2017.

Data Analysis:

- Changes in the condition of compensatory mitigation sites were assessed relative to the initial post-construction condition. All compensatory sites in the study were restored from graded and recontoured channels that began with no native habitat, and therefore

would have the lowest possible scores for the CRAM metrics assessed from within the stream corridor.

- Restoring streams to a reference condition is often the goal of compensatory mitigation programs. Therefore, the condition at compensatory sites was compared with the condition at regional reference sites.
- The CRAM scores at compensatory sites were then compared with the range of scores from the ambient programs to determine where they fall relative to overall regional stream conditions.
- Significant differences among groups were determined using an analysis of variance (ANOVA) of the CRAM scores, followed by Tukey's multiple comparison test.

Assumptions in Use of Data:

- The age of some of the compensatory mitigation streams was not known and had to be estimated based on the year of Section 404 permit issuance (Fong et al. 2017).

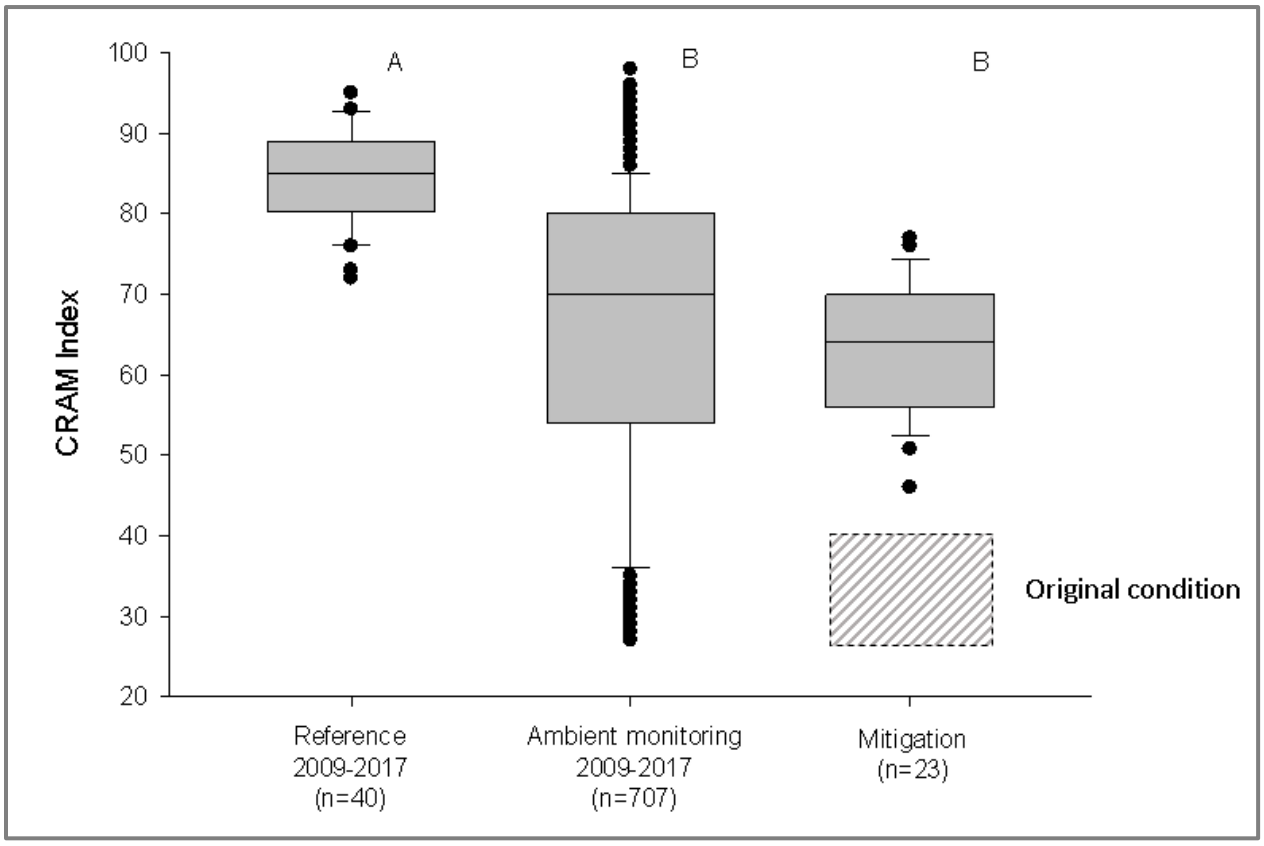
Conclusions:

- The condition at the compensatory mitigation sites improved relative to the estimated initial post-construction condition. The lower 5th percentile of compensatory site scores (represented by the lower whisker of the box and whisker plot) was greater than the highest value in the range of estimated initial post-construction CRAM scores (
- 16).
- CRAM scores at compensatory mitigation sites were significantly lower than at reference sites but were statistically similar to the scores at ambient monitoring sites. The median CRAM score at compensatory sites, however, was lower than the median score at ambient sites.
- While conditions at the compensation sites had improved relative to pre-construction conditions, the overall program failed to create streams that were comparable to the reference condition, or even the best scores in the ambient assessment programs.

Lessons Learned:

- At minimum, data from compensatory mitigation sites should be compared with data collected from ambient monitoring surveys to determine how the mitigation program contributes to overall regional condition. As a rule, at least 30 probabilistically selected sample sites should be used to determine ambient condition. Targeted reference sites can be included in the comparison, since restoring streams to a reference condition is often the goal of compensatory mitigation programs.

FIGURE 16. **California Rapid Assessment Method (CRAM) scores for streams monitored as reference sites, ambient monitoring sites, and compensatory mitigation sites in southern California. The letters indicate results of Tukey's multiple comparison test, following ANOVA ($p<0.01$). The striped box indicates the estimated range of initial post-construction scores.**



Keys for Implementing Module 2

- Ongoing and accessible regional/ambient monitoring programs and/or reference condition monitoring programs
- Common indicators that are used in both compensatory mitigation monitoring and ambient and/or reference monitoring
- Sufficient geospatial and metadata to allow comparisons between mitigation and ambient monitoring sites

Module 3: Resiliency of Compensatory Mitigation Practices

At a Glance

Goal:	• **Assess long-term resiliency and sustainability of compensation sites**
Main Questions:	• **How well do compensation sites perform over the long-term in terms of achieving functional replacement of impacted streams or wetlands?**
Design Approach:	• **Assess a subset of "permanent" sentinel sites relatively infrequently (e.g., every 5 years) over long periods of time**
Site Selection:	• **Select compensation sites that have completed their required monitoring periods and been deemed "successful"** • **Sites should be subject to long-term protection (e.g., conservation easement) and readily accessible**
Approach to Reference	• **Compare reference standard sites in conserved areas** • **Compare to ambient conditions**

No Module 3 examples in state programs were found that included compensation sites that had been monitoring over extended periods of time after the completion of their permit mandated monitoring, and conditions compared to long-term goals or to regional reference. However, two examples found in the literature are presented here:

Module 3, Example #1

Evaluation of plant community composition and mangrove stand structure at 23 compensatory mitigation sites in central and southern Florida 17 years after the sites were first sampled.

Questions Addressed:

- How persistent are compensatory mitigation sites at maintaining ecological condition over time?
- How similar are compensation sites to natural reference sites over the long-term?

General Approach:

- Eighteen of the 23 sites were monitored using the same indicators used during the 5-year performance monitoring period required by the terms and conditions of the permits.

- Canopy height and species composition for three mangrove species were measured in 2005 and compared to data collected during the initial (1988) monitoring period.
- Structural characteristics of the mitigation sites in 2005 were compared to natural mangrove wetlands to determine if the sites approach reference condition over time.

Data Source:

- Shafer, D.J, T.H. Roberts. 2008. Long-term development of tidal mitigation wetland in Florida. *Wetlands Ecology and Management* 16:23–31

Data Analysis:

- Paired t-tests were used to evaluate changes in average canopy height between 1988 and 2005. The 95% confidence intervals constructed from the paired t-test analyses were then used to estimate rate of height increase during the first two decades of monitoring.
- A structural complexity index (Ic) was calculated according to the formula Ic = number of species times mean stem density (stems > 2.5 cm DBH/ ha) and compared between 1988 and 2005.
- Structural characteristics (e.g., number of mangrove species, mean height, mean basal area, and mean stem density) of the sampled mitigation sites were compared to natural mangrove wetlands in Florida using multi-dimensional scaling (MDS) and Euclidean distance as the similarity measure.

Conclusions:

- Of the 18 sites revisited, 72% would be considered successful based on the performance criteria in the Section 404 permit
- Canopy height and plant community richness and age-stand distribution all increased between 1988 and 2005.
- Mangrove mitigation wetlands ranging in age from 13 years to 23 years had not yet reached a canopy height similar to that of natural mangrove forests (Figure 17)

Lessons Learned by Shafer and Roberts 2008:

- Access to older permit records was challenging, so it was difficult to reconstruct the original requirements for all sites.
- Factors limiting mitigation site development included incorrect site elevation and hydrology, invasion by exotic species, conflicting land uses, and human activity.
- Three sites were apparently unsuccessful due to inappropriate planting elevation (either too low or too high). Incorrect site elevations can lead to invasion and dominance by exotic species

FIGURE 17: Multidimensional scaling plot showing that mangrove structural characteristics in mitigation sites differed from those of natural mangrove wetlands in Florida. From: Shafer and Roberts 2008

Module 3, Example #2

Evaluation of floristic quality of 30 permittee responsible compensatory mitigation sites in Illinois 8-20 years after restoration was completed to determine if they continue to meet performance standards and to determine ecological quality relative to adjacent natural wetlands.

Questions Addressed:

- How persistent are compensatory mitigation sites at continuing to meet performance standards over time?
- How similar is the ecological condition at older compensatory mitigation sites relative to nearby natural wetlands?

General Approach:

- Performance standards were grouped into nine categories based on restoration goals

- All 30 compensation sites were surveyed in 2012 to assess performance relative to the original performance goals. The amount of time since the "final" required monitoring period ranged from 3-16 years
- An additional 15 adjacent natural wetlands were surveyed for the same indicators
- In addition to the original performance standards a Floristic Quality Assessment was completed at all 45 sites.

Data Source:

- Van den Bosch, K., J.W. Matthews. 2017. An Assessment of Long-Term Compliance with Performance Standards in Compensatory Mitigation Wetlands. *Environmental Management* 59:546–556

Data Analysis:

- A nonparametric Wilcoxon signed rank test was used to test the null hypothesis that there was no difference, between time periods, in the percentage of performance standards that were successfully achieved.
- A linear mixed effects model was used to determine the effects of time period (end of permit monitoring period (EOM) vs. 2012) and the floristic quality of the adjacent reference wetland on floristic quality in compensation wetlands.

Conclusions:

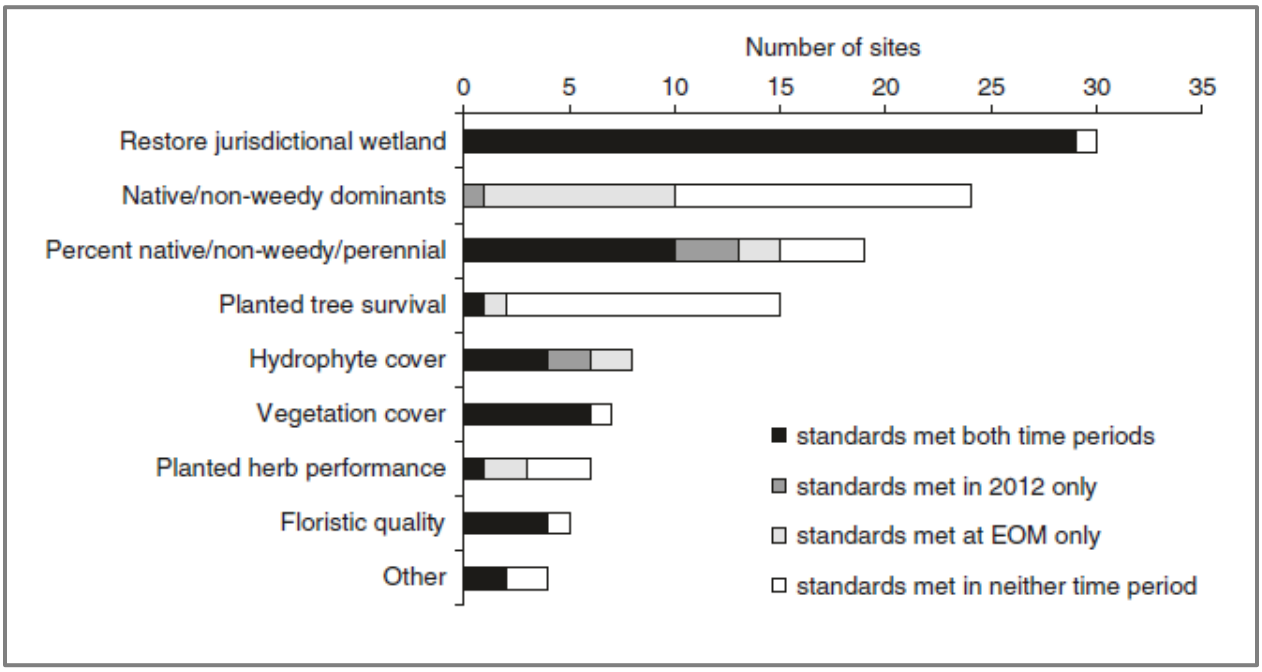
- On average, compensation sites met 65% of standards during the final year of monitoring and 53% of standards in 2012, a significant decrease in compliance (Figure 18).
- The presumption of continued compliance with performance standards after a 5-year monitoring period was not supported.
- Standards related to the survival or establishment of planted trees and herbaceous species were also often unmet at the end of the monitoring period and remained unmet in 2012
- Floristic Quality (FQI) was lower in compensation wetlands compared to reference, but FQI in compensation wetlands increased significantly with increasing quality of the adjacent reference wetlands.
- Wetlands restored near better quality natural wetlands achieved and maintained greater floristic quality, suggesting that landscape context was an important determinant of long-term restoration outcomes.

Lessons Learned from Van den Bosch and Matthews (2017):

- Five-year monitoring period is too short to assure ecological success.

- Proximity to high quality wetlands improves the chances of a compensation site exhibiting high ecological condition.
- Decrease in achievement of performance standards was driven primarily by the increasing dominance of nonnative and invasive plant species through time.

FIGURE 18: Number of compensation sites with performance standards related to nine categories of restoration goals, and number of sites meeting those goals at the end of site monitoring (EOM) and in 2012–2013. From Van den Bosch and Matthews 2017



Keys for implementing Module 3

- Long-term monitoring requires clear and unambiguous success determinations. It is likely that assessments will be done by different individuals than those that developed the initial permit and monitoring requirements or that made the initial success determinations. Clear terminology and definitions of "performance" or "success" are very important.
- Public access to data in a simple and easy to understand format, including metadata will facilitate long-term assessments.

Overall Lessons from Case Studies

The case studies were somewhat limited by a common set of challenges to directly applying the proposed performance evaluation modules. The ability of state programs to more fully assess compensatory mitigation performance would be enhanced by addressing these challenges based on the recommendations provided in this document:

- Few, if any, states have a comprehensive network of reference sites that represent all major wetland and stream classes present in the state. Establishment of reference networks would provide important context for interpreting compensatory mitigation program effectiveness and would support application of all three Modules.
- Performance standards don't always reflect ecological or functional success. By and large, most performance standards are based on structural elements (although this is changing). This disconnect makes it difficult to draw conclusions about functional replacement of impacted aquatic resources over time.
- Potential causal factors or stressors are seldom measured (or compiled) in association with compensatory mitigation monitoring. For example, measures of upstream hydrologic alteration, sedimentation, water quality, buffer condition, or documentation of human use and visitation provide important insight into the reasons why a compensation site may or may not be meeting its performance standards. Inclusion of such measures as part of routine monitoring and assessment would aid in adaptive management.
- Lack of comprehensive, integrated, and accessible data management systems is the most consistent impediment to compensatory mitigation performance assessment. Data is often incomplete and difficult to access, and different programs or departments often maintain independent data management systems. This makes it difficult to conduct the assessments recommended in this document, particularly those associated with Modules 2 and 3.

8. PATHWAYS TO IMPLEMENTATION

Implementing a comprehensive compensatory mitigation evaluation program can take many pathways depending on the status, resources, needs, and priorities of individual regional, state or local programs. The following steps provide a general implementation process that can provide the information necessary to efficiently answer the questions of compensatory mitigation performance, program effectiveness, and resiliency outlined in this document. The implementation process is divided into *planning, infrastructure development,* and *operationalization* phases. Programs may focus on different steps in the process depending on their needs and priorities:

Planning

1) Identify (or develop) ***programmatic goals*** for the compensatory mitigation evaluation program. Programmatic goals should reflect the goals for each module discussed in this document and include measures of permit compliance, area compensated, function relative to reference or ambient condition, and long-term sustainability. In developing the goals, it may be helpful to explore opportunities across various programs to inform programmatic goals that support multiple agency mandates and are relevant to a broad constituency of end users (e.g., local watershed plans, wetland program plans, habitat conservation plans). For example, goals can support regulatory programs in terms of compliance, regional or watershed restoration targets, monitoring and reporting (e.g., Status and Trends or Clean Water Act Section 305(b) requirements), community education, or evaluation of restoration and management efficacy.

2) Assess the ***current condition and needs*** of your program in terms of:

   a) Availability of Standard monitoring designs, protocols, or guidance documents

   b) Training, auditing, and quality control procedures

   c) Data analysis approaches and tools to support data analysis

   d) Standard data formats and metadata templates

   e) Database that allows easy data submittal and retrieval through an open data approach

   f) The likelihood that the program design can achieve the stated programmatic goals

   g) Staff to implement, manage, and support the program

3) Establish ***priorities*** for program development based on current conditions/needs relative to the agreed upon programmatic goals. The priorities should reflect areas of greatest deficiencies, opportunities for greatest gains, abilities to form connections between programs that improve leveraging of resources and information, or simply "low hanging fruit". Priorities can also inform the identification of project partners who can contribute to achieving the overall programmatic goals and project objectives.

Infrastructure Development

4) Develop, test, and refine standard ***protocols, procedures, best practices, and quality control measures*** using the information provided in this document. This should include specific indicators for monitoring and assessment, field and lab procedures, and basic reporting requirements. Procedures should be clear and easy to consistently implement. Protocols may draw from the tools and resources developed through USEPA's National Aquatic Resource Surveys (NARS). Tools and resources are also available through many state, regional and national guidance documents. Protocols and procedures should be developed collaboratively among the different program partners and stakeholders/end users identified during the goal-setting step. This will help ensure broad support for the final products.

5) Develop ***data templates, checkers, and data management*** systems based on the open-data approaches discussed in this document. Data templates should be flexible enough to be used across multiple platforms and produce data that can be readily submitted via web-based data submittal portals and can be shared across programs. Templates should be accompanied by data dictionaries that define terms, metadata fields, and automatic data checkers. The data should include coordinates, polygons or other geospatial information that allows data to be managed using a map-based approach. To the extent possible, existing or "off-the-shelf" data management tools should be considered as they will likely be easier to maintain over the long-term. Once the initial data templates are developed, they should be beta tested by a diverse group of stakeholders/end users to ensure that they work intuitively. Ultimately data workflows should be integrated into standard permitting and monitoring workflows so that data can support decisions and daily program administration.

6) Identify ***reference wetland/stream networks and ambient monitoring*** programs that can be used to provide context for evaluating compensatory mitigation monitoring data. In many cases, there will be opportunities for compensatory mitigation programs to partner with existing programs. Ambient assessment programs may already exist and provide opportunities for leveraging funds and efforts, e.g., Status and Trends or Clean Water Act Section 305(b) assessment programs, and/or states can partner with or intensify National Aquatic Resource Survey assessments. Integration of compensatory mitigation assessment with broader ambient assessment will require harmonization of indicators and data management. Such harmonization will allow completed compensation sites to become part of the sample frame for ambient assessment while allowing ambient assessment sites to provide context for interpreting the overall contribution of compensation sites to change in wetland and stream extent and condition. If networks of reference wetlands or streams do

not already exist, it may be necessary to develop definitions and criteria for inclusion of sites into reference networks so that they can be established over time. Ultimately, compensatory mitigation monitoring should be coupled with monitoring of both ambient and reference monitoring.

Operationalization

7) Establish ***institutional partnerships*** to support implementation in a manner that supports cross-program objectives and information sharing. In addition to resource leveraging, partnerships enhance the ability to disseminate performance information to a broad constituency and improves the ability to maintain long-term implementation support. Partnerships may include:

    a) Academic or NGO partners that can help develop protocols, assessment tools and data management structures. They can also provide ongoing technical review, support data analysis, and periodically serve as external auditors.

    b) Other state, regional or federal programs can provide data, tools and resources that support compensatory mitigation evaluations. Water quality, ambient monitoring, or resource management programs may have data or tools that can support mitigation program evaluation, provide contextual information, or provide stressor data that can help with interpretation why mitigation programs succeed or fail.

    c) Conservancies or land management entities may be excellent partners for long-term monitoring and resiliency assessment. They are also important partners for long-term data stewardship and for helping with evaluation of adaptive management needs.

8) Develop ***shared funding mechanisms*** that can support ongoing program implementation. Program development can often be funded through grants, such as those available under the USEPA Section 104(b) program. However, ongoing implementation is best funded through continuous funding streams, such as those provided through ambient or compliance monitoring programs. Some states may also have funds for reporting status, trends or condition that can be used to support Module 2 and 3 assessments. Permit fees may also be a funding option for some programs. Finally, periodic resiliency evaluations and adaptive management assessments may also be funded through grant funding to state agencies, or academic or NGO partners. Partnering with other state programs through all phases of compensatory mitigation evaluation will illuminate opportunities for joint funding, cost leveraging, data sharing, or cross-program staffing.

9) Conduct ongoing ***outreach and reporting*** using a variety of outlets and media. The information and knowledge gained through a comprehensive compensatory mitigation assessment program is valuable to agencies, practitioners, decision makers, and the general public. At the agency level, data supports evaluations of program performance, reasons for success or failure, and informs adaptive management measures. Practitioners similarly gain by having ready access to information that can improve the science and practice of wetland

and stream restoration. Decision makers and the general public will support program implementation, refinement, and expansion by having access to knowledge and reports that demonstrate the value and effectiveness of compensatory mitigation programs. A multi-faceted communication strategy can help identify the most appropriate mechanism to convey information to each entity, such as reports, fact sheets, web sites, blogs, email updates etc.

A mature compensatory mitigation evaluation program will include all elements of this implementation pathway and provide for comprehensive and ongoing evaluation of compensatory mitigation effectiveness. Some programs may be close to maturity, only needing to develop a few outstanding critical pieces to complete their capacity for comprehensive assessments. Other programs may require substantial time and resources to build a program from near-infancy. In either case, regional or state programs should engage in the implementation process wherever it makes the most sense for them and demonstrate patience and persistence in developing their ultimate programs that meet the agreed upon goals and priorities.

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APPENDIX A – SUMMARY OF STATE INTERVIEWS

Introduction

State interviews were an important component of background research on standards of practice. The knowledge and insight gained through these interviews was an integral part of the process of developing a basic approach and guidelines for evaluating and improving the ecological and administrative performance of compensation projects. Offsetting unavoidable wetland or stream impacts is required under Section 404 of the Clean Water Act, as well as many state programs. However, the mechanism of coordination with the USACE's 404 program varies by state, as do the mitigation and monitoring requirements placed on permittees. An understanding of the various approaches used by states, what they find effective, and their needs, provides critical information to inform development of national recommendations or guidance. To this end, we reviewed monitoring and data management strategies adopted by states that were available online or through journal articles, then followed up with interviews with a subset of states to obtain greater details of their mitigation practices. This section summarizes the information identified during the interviews, including the strategies used by states, and a list of products and guidance that states would like to see in a document to help them improve the effectiveness of their program.

Methods

Fifteen states were interviewed by phone between December 22, 2017 and February 1, 2018 based on their positive response to an email query (Table A-1). Representatives familiar with their state's mitigation evaluation program were asked a variety of questions regarding the background of their program, short- and long-term monitoring practices, leveraging opportunities with other state programs, and database management strategies (see below for the complete list of questions). States were also asked for input on lessons they had learned through the development and implementation of their program. Meeting summaries were reviewed by every state interviewed for accuracy and completeness prior to being finalized.

TABLE A-1: States interviewed regarding mitigation assessment structure and needs

California	Maryland	New Jersey
Florida	Massachusetts	North Carolina
Illinois	Michigan	Ohio
Iowa	Minnesota	Washington
Louisiana	Missouri	Wisconsin

Mitigation Evaluation Interview Questions

Part 1 – Program Overview

1) Describe ongoing wetland/stream (and/or mitigation) monitoring programs administered by your agency – focus on ongoing program vs. project specific monitoring

2) What are the key questions/issues that you are trying to address?

3) What is the basis of comparison for performance evaluation (reference sites, permit standards)?

4) How do you select sites for inclusion?

5) What indicators do you measure and what frequency? How long does monitoring last?

6) Are there other monitoring and assessment programs that you coordinate with?

7) What are the strongest elements of your program that contribute to its success?

8) What are the weakest elements/things you would like to modify?

9) What advice might you give to other programs/states wanting to build an evaluation program?

10) Do you have external or alternative funding? How does financing impact your program?

    - What is the level of effort associated with this program in terms of staff, number of sites assessed per year etc.

11) What are your initial reactions/feedback to the draft document we sent you?

    - Do you have any suggestions or examples for the approach we are pursuing?

Part 2 – Data Management

12) What is the source of the data you use for evaluations (submitted by permittees, collected by your program, compiled from other programs)?

13) How do you manage your data – what type of system?

    - Do you use custom built software, or off-the-shelf/open source software?
    - How is the data inputted? Does a staff member do this?
    - Can the data be entered remotely?
    - What data is included (numeric only, or files/photos too)?

- What QA/QC measures are used to ensure that the data is entered correctly?

14) What role does the public play in data input/management?

- How can the public or other agencies access the data?
- Do you have public collaborations to input current or historic data?
- Do you have public partners (e.g., universities) that aid with data storage/interpretation/dissemination?

15) Does your database include historical data? How far back does that data go?

16) What data products does your program produce?

Can you provide any examples, documents or web links that we might want to review that would help in our preparation of the guidance document?

Results

Summary of Practices

Most of the states interviewed have some type of independent authority to regulate wetlands and streams, although the way the programs are administered varies. In the majority of states interviewed, permits are issued by state agencies; however, some states delegate that authority to local jurisdictions for specific areas, waterbody types, or compensation mechanisms. Regardless of how the programs were administered, each state coordinates with the USACE, including those that do not have independent authority under state statute. Much of the coordination with USACE was through the Interagency Review Teams that provide mitigation bank review, approval and oversight.

While most state programs require some level of project-specific monitoring (Module 1), the strategies employed varied among states. For example, the minimum duration of sampling ranged from three years up to 20 years (Figure A-1). Five years was the typical duration, and most states increased their monitoring time frame for sites that were not meeting permit requirements. All states interviewed use traditional condition indicators (e.g., vegetation or macroinvertebrate IBIs, percent invasive plant species, soil indicators), while only three of the states use formal functional or condition assessment methods. Within-program differences were also noted. For example, most states do not use consistent performance standards across projects. The three main reasons for this included geographic diversity, differences among the local jurisdictions issuing permits, and practices where the permittee recommends the performance standards to follow. Banks and permittee-responsible mitigation (PRM) activities were the most common mitigation mechanisms, with most states seeing a shift toward banks since the 2008 mitigation rule. Less than half of the states interviewed use in-lieu fee (ILF) arrangements. Many states use a combination of mechanisms.

A quarter of the states interviewed conducted some form of programmatic assessment (Module 2). These were either formal evaluations conducted through probabilistic assessments, or an informal annual synthesis of gains and losses for internal use. Most often, theses assessments focus on administrative and compliance aspects of the mitigation program, with less emphasis on programmatic assessment of functional gains or losses. The majority of states interviewed have either a stream or wetland ambient monitoring program or status and trends program (82%), although only one state combines mitigation and ambient monitoring programs when evaluating overall wetland loss. Typically, ambient monitoring is conducted by separate programs, departments, or agencies with minimal interaction between those programs and mitigation programs.

Few states conduct sentinel monitoring of their sites once mitigation projects are completed (Module 3), whether for lack of funding or the expectation that wetlands will continue to function properly after the monitoring has stopped. Long-term monitoring usually entailed examination of aerial photography or the occasional visitation to check on encroachment of exotic plants and maintenance needs, although one state conducted conditional assessments for up to 50 years. All states that were asked had some type of long term stewardship for their sites, whether protection in perpetuity by the mitigation banker, water management district, county conservation board, state or federal park system, or non-governmental organization (NGO). In many cases, a statewide or local entity has authority to enforce easement conditions, but seldom do they conduct any long-term monitoring, nor do they have authority to require remedial actions once the required mitigation monitoring period is complete and the site/bank has been deemed "final" or "successful".

Less than half of the states maintain monitoring data in a database (Figure A-1). In most cases, monitoring reports are submitted annually for review and reports are attached to the project file as pdfs; few states enter raw monitoring data into a database that is easily accessible. For project tracking, most states maintain an electronic inventory, but few programs have a system that tracks monitoring and management activities and provides reminders of upcoming deadlines and milestones.

The type of information accessible to the public and the method available to retrieve that information also varied by state. Data were available only by request by four of the ten states asked this question. Two states had data available online to the public, while three other states only had permit information available online, and one state only had an incomplete GIS layer of mitigation sites.

Summary of State Needs

As part of the interviews, states were asked what products and guidance would be useful to improve the effectiveness of their compensatory program. Fourteen of the fifteen states interviewed had at least one need. While no single product was mentioned by the majority of states, three items were requested by half of the participants (Figure A-2), including:

- Guidance on selecting appropriate indicators

- Standardized data templates
- Recommendations for a data management and retrieval system

A fourth need that almost half of the states wanted guidance on was:

- A framework that would help with interpreting data and determining appropriate actions

We have attempted to incorporate these products into the three modules of our reference document.

FIGURE A-1: Summary of responses to selected questions asked of state program representatives

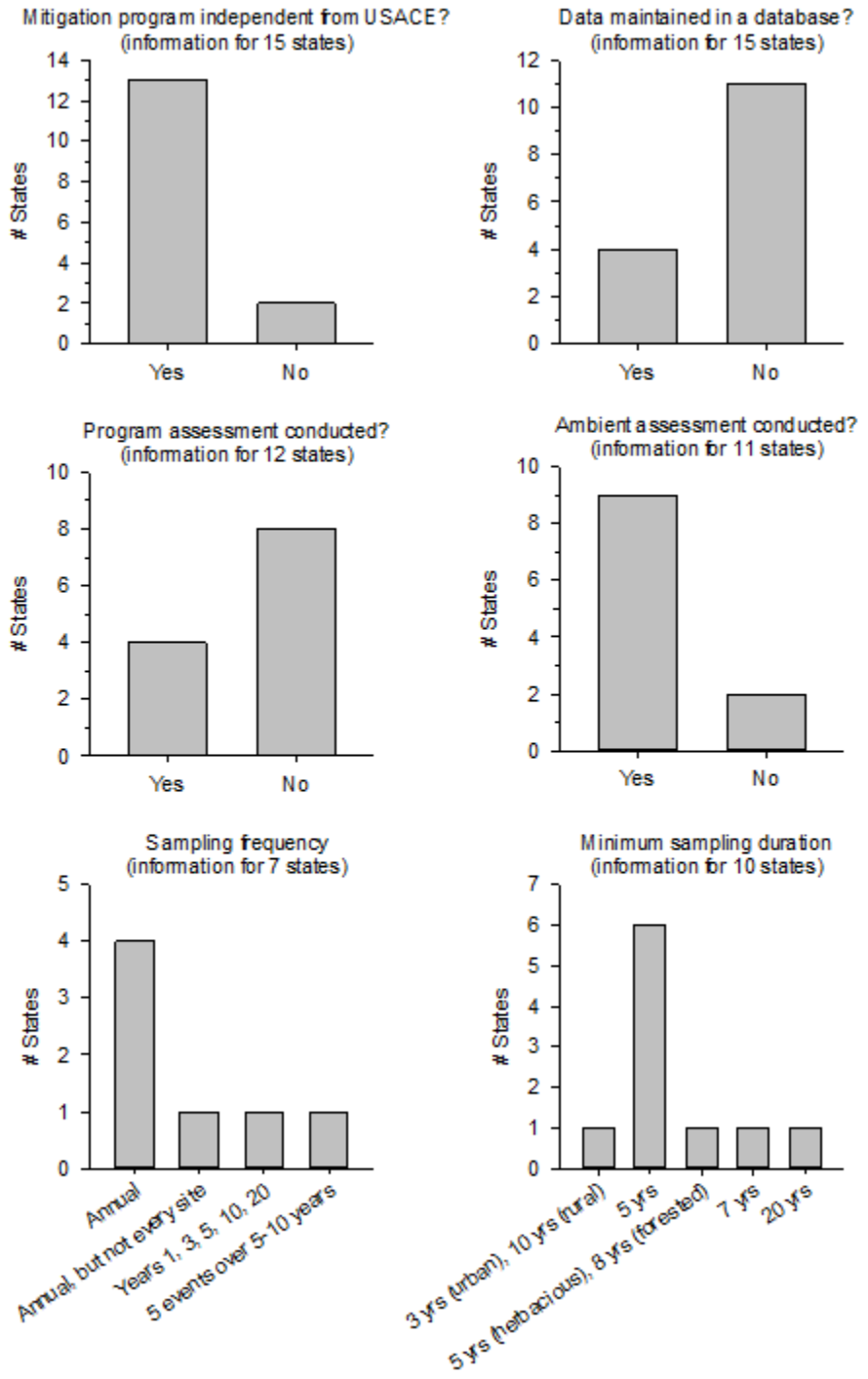
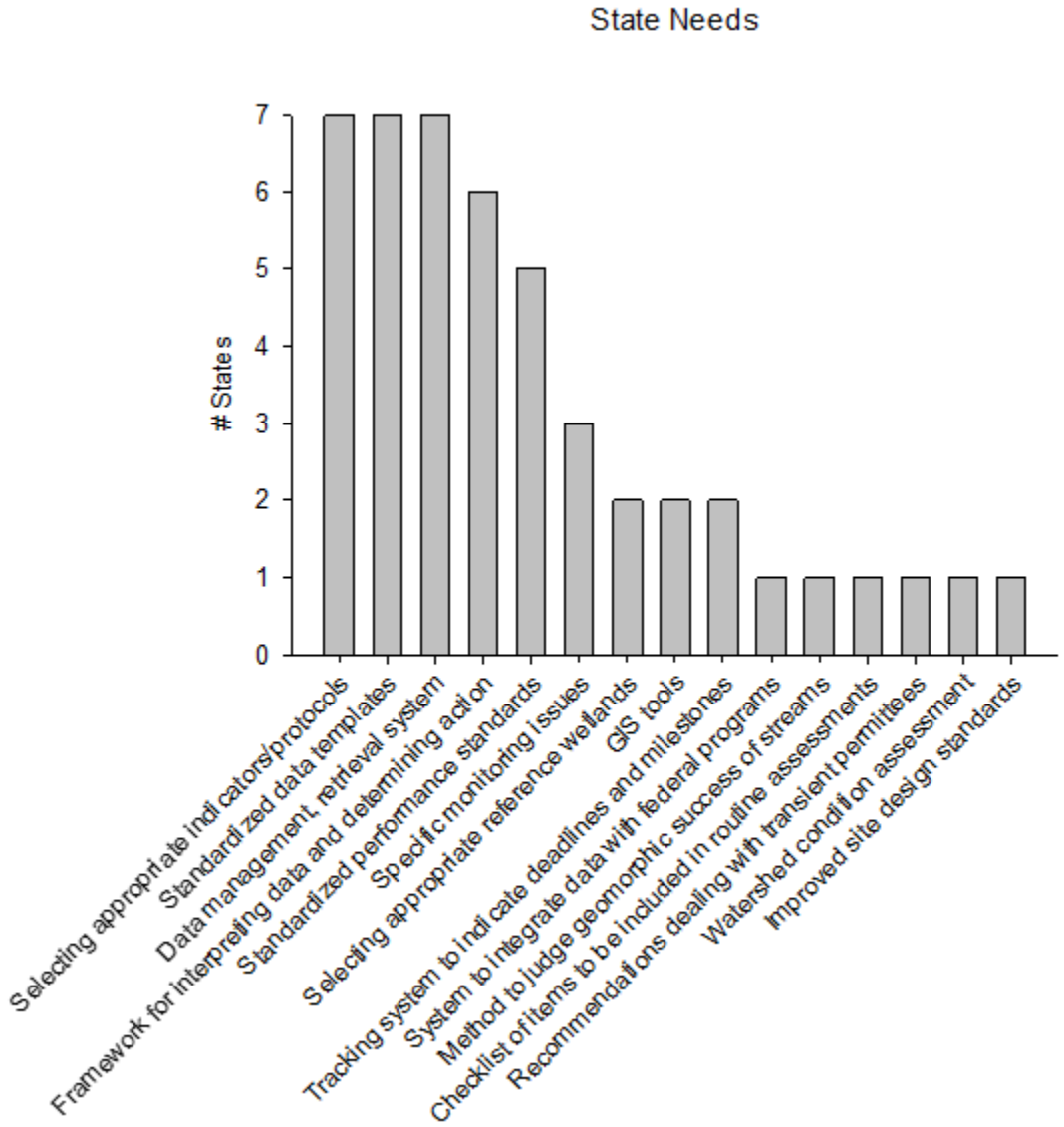


FIGURE A-2: Products and guidance that states would like to incorporate to help them improve the effectiveness of their program. Fourteen of the 15 states interviewed identified at least one need.



Notes from Each State Interview (in alphabetical order)

California

Bill Orme, Jean Bandura

California Water Resources Control Board, Division of Water Quality

January 12, 2018

- The State Water Board is working on a wetland policy (see below). The Water Boards currently regulate water quality for all surface waters and groundwater, including saline waters, within the boundaries of the state under the authority of the Porter-Cologne Water Quality Control Act. A number of Water Boards have addressed wetlands in water quality control plans and have established specific wetland beneficial uses. The Water Boards regulate discharges of dredged or fill material to wetlands under the Clean Water Act 401 Certification program for federal waters and issue WDRs for non-federal waters under Porter-Cologne. Other agencies regulate wetland flora and fauna, such as CA Dept of Fish and Wildlife, and CA Coastal Commission.
- For discharges of dredged or fill material, Water Boards issue 401 water quality certification and can issue Waste Discharge Requirements (WDRs) for state waters that are not subject to federal jurisdiction.
    - In California, the State Water Board establishes state policy for water quality control; regional boards formulate water quality control plans and policies for their jurisdiction subject to state board approval. Regulatory programs are generally implemented via one of nine regional water boards, each of which operates largely autonomously.
- Separate from Water Board regulatory programs, the State Water Board directs a strong ambient monitoring program (Surface Water Ambient Monitoring – SWAMP). On paper the SWAMP program includes all surface waters, but in practice has focused on wadeable streams.
    - Results of the ambient monitoring are used to identify impaired water bodies.
    - Assessments based on benthic macroinvertebrates (BMI) and algae.
    - Works with CA Fish and Wildlife.
    - Regional boards also have programs similar to SWAMP.
    - No wetland monitoring program (analogous to SWAMP). No institutional connection between SWAMP and wetland/stream permitting program.

- California Rapid Assessment Method (CRAM) is the main level 2 assessment tool. Can be used for all water body types – streams, wetlands, lakes, estuaries. Prior to CRAM (released in 2006), there was no practical and consistent methodology for evaluating wetlands.
    - Do now have CRAM assessment manuals, CRAM assessments are approved by USACE and Water Boards for regulatory applications; applicants are encouraged to use CRAM for wetland assessments at the impact and mitigation sites.
    - USACE South Pacific Division references CRAM in Standard Operating Procedure for mitigation.
    - State Water Board needs to establish wetland beneficial uses to encourage wetland monitoring by the Water Boards.
        - Ambient assessment of watersheds would answer the question of wetland health at the population level, either project could help (especially the beneficial uses).
- California has developed a probability-based wetland status and trends program (funded by USEPA 104 grants) – program has been developed and pilot tested but is not being implemented due to lack of funding.
- Wetland Mitigation
    - State is working on three phase wetland and riparian protection policy. The first phase is a water board definition of wetland and dredge and fill procedures modeled after federal guidelines, especially in relation to mitigation. SWRCQB is adopting 404(Subpart J) almost wholesale to provide consistency with the USACE program
    - SWRCB contracted with Dr. Ambrose at UCLA in 2007 to do an assessment of wetland mitigation (~150 sites)
        - Evaluated two questions:
            - Meeting permit conditions
            - Wetland in good condition
        - Largely, sites met permit conditions, but were not in good condition – not successful from a functional perspective
        - https://www.waterboards.ca.gov/water_issues/programs/cwa401/docs/mitigation_finalreport_full081307.pdf
    - Water Boards, region-by-region, require mitigation (as condition to USACE permit) – mainly through Section 401 certifications.
        - Some/most do not require above USACE standards
        - Others are much stricter (may even deny permits if avoidance and minimization not sufficient)
        - Large impact projects tend to require more mitigation by Boards
        - Authority for conditions comes from § 401 WQC and Porter-Cologne

        - Monitoring required for ~5 years unless performance standards were not met (then longer)
            - Other projects (e.g., vernal pools) default to 10yrs of monitoring
        - Projects may use PRM, Banks, or ILFs, sometimes mixing them
        - At closure of mitigation, new policy will require conservation easement and financing for mgmt.
            - Turned over to NGO to manage – this has been only marginally effective
    - Wetland Definition and Dredge & Fill Procedures
        - New policy for evaluating permit applications
        - Will encourage use of same mitigation ratio calculator as USACE SPD which evaluates how much functional lift is provided by the site
            - Based on CRAM or best professional judgment
- Data
    - Boards require monitoring reports
        - Permittees don't always turn in reports though (see Ambrose Report). Poor methods to track projects are partly to blame.
    - SWRCB has developed a permit template, trying to get regional boards to adopt currently, there is not consistently used tracking system for mitigation projects, although recently the database was updated to include geographic referencing of sites
        - Mostly narrative conditions in template
    - SWRCB has a list of all approved projects in the state
        - Mitigation required, methods used
        - Goes back to 2005, but data entry was inconsistent until 2014 when new data entry rules were adopted
        - Information on mitigation sites should be available, but have to find through permit entries – can query database for list of projects that required mitigation
            - Includes information on how much mitigation and what type (PRM, ILF, Bank)
        - Some regions required that data is mapped in EcoAtlas – www.ecoatlas.org, for other regions user could query the database to obtain list of all projects requiring mitigation to get lat-long information which could be plotted as points on a map
            - Can go to EcoAtlas to find map of mitigation sites for those specific regions
    - New § 401 data mgmt. system being developed (proposal with state's data management division)
        - Applicant would enter data

- All electronic
- Project mgmt. system, tracking and tickling, staff assigning
- GIS component (project and mitigation information)
- Custom pilot software, newer system is getting bids now
- Maps could be exported to EcoAtlas
- Old data could be imported
- May take a few years to build

In response to questions about what products/guidance would be useful for state programs:

- Reinforce need to standardize beneficial uses for wetlands.
- California has a stated no-net loss policy. Guidance for no net loss on a project-by-project basis, incorporated into the performance standards for individual projects – no programmatic approaches for ensuring no net loss.
- For data management, wetland data is largely being managed and developed by a third party, non-governmental entity who has developed EcoAtlas using USEPA funds allocated to develop state agency wetland development programs. It is not an official state data management system, although SWRCB staff make can access the site and utilize the system for mitigation project management and tracking.
- Contractors developing the new State Water Board WQC data management system understand the business application (project management) of the system, but may need more guidance a wider management need by staff to assess impacts on water quality standards at the watershed level using GIS.

Florida

Tim Rach, Donna Kendall, Nia Wellendorf

Florida Department of Environmental Protection

January 22, 2018

- State of Florida issues Environmental Resources Permits (ERPs) for activities in, on or over wetlands or surface waters; mitigation bank permits are ERPs.
  - ERP and 404 programs operate in parallel and state DEP coordinates with USACE in terms of evaluations. However, given different regulations and jurisdictions, mitigation requirements and bank credits can differ between state and federal programs.
  - https://floridadep.gov/Water/Submerged-Lands-Environmental-Resources-Coordination
- State uses the Uniform Mitigation Assessment Method (UMAM), Rule 62-345, Florida Administrative Code to define the number of credits available in a bank.
  - State vs. federal credits and services areas may differ slightly.
  - DEP participates as a member of the IRT.
- There are no ILFs under ERP program, but USACE has some. Similarly, the state has Regional Offsite Mitigation Areas (ROMA), Chapter 373.4135, Florida Statutes as a state analogue.
- Banks conduct quantitative assessments annually using standard field indicators until banks are deemed successful by DEP – typically 5-8 years.
  - Success criteria are not standardized, but developed specifically for each bank.
  - Banks either identify reference sites themselves or use a state list of reference sites.
- Once banks are complete they are protected in perpetuity by banker, water management district, state or federal park, local government, NGO. There is no long-term monitoring of condition, but qualitative monitoring of site management issues (security, exotics, maintenance needs, etc.) occurs in perpetuity.
- Annual reports are submitted to DEP and tracked via their custom built ERPCE database and stored in OCULUS database. Monitoring reports are stored with the project file, but actual data is not compiled in a database.
  - State feels that they have good experience and technical resources to guide successful mitigation, so they mainly want to track performance on an individual project/bank level – no real need to compile the raw data; data is not submitted in a standardized format, so compilation would be difficult without a rule requiring a standardized format

- Success is based on comparison to previous year's data (i.e., improvement along an expected trajectory) and based on comparison to reference site - which are identified for each bank based similar wetland communities (using the FL Natural Areas Inventory).
- Data provided by bankers and field-confirmed by agency staff.

- The ERP database (PA – Permit Application) includes basic bank information (administrative aspects, such as name, location, etc.) as well as all actions taken on the bank (including credit sales). The PA and ERPCE databases include calendaring and ticklers to help track deadlines, materials due, permit process, workloads, compliance deadlines etc.
  - All banks and service areas are tracked in geospatial database and basic info is available to the public via a web interface.
    - http://fdep.maps.arcgis.com/home/webmap/viewer.html?webmap=e88e14fa17ad4a2ca49d63a6016f3eaf&extent=-88.8398,24.5257,-76.7108,31.5023
    - http://geodata.dep.state.fl.us/datasets/63be3554c59a4fcc8af4f34c64cb43b4_0?selectedAttribute=TOTAL_ACRES
- Florida has an ambient bioassessment program for stream and lakes, not for wetlands. Benthic macroinvertebrate Stream Condition Index (SCI) is their main assessment tool for streams, and they use rapid assessment methods for algae and plants as part of the numeric nutrient standard.
  - https://floridadep.gov/dear/bioassessment
  - Florida Bioassessment method information: https://floridadep.gov/dear/bioassessment/content/bioassessment-methods
  - Training and proficiency requirements, method links: https://floridadep.gov/dear/bioassessment/content/bioassessment-training-evaluation-and-quality-assurance
  - Statewide Biological Database information (can't pull bioassessment data, can pull attribute information for taxa): https://fldeploc.dep.state.fl.us/sbio/database.asp
- Have bioassessment indices for wetlands, developed in the early 2000s for specific wetland types, but not routinely used for ambient assessment. There is no real connection or intermingling of the ambient monitoring program and wetland permitting program – ERP process will consider impacts to impaired or high-quality waters – but no routine sharing of assessment methods, data, etc.
  - Bioassessment data is stored in an internal database. Public can request data, but there is not publicly accessible portal to retrieve data.
  - Data are stored in Oracle tables. User interface is old custom software, and is currently being upgraded in new custom software.

In response to questions about what products/guidance would be useful for state programs:

- Information on available data management tools or standard data forms
- Ways to improve data comparability between sites and ensure more consistent data quality
- Guidance on data analysis approaches to improve repeatability and validity of analysis – ***NOTE, under the current rules DEP can only recommend, not require that specific methods be used for mitigation bank vegetative monitoring***

Illinois

Keith Shank

Illinois Dept. of Natural Resources

Division of Ecosystems & Environment, Chief, Impact Assessment Section

December 22, 2017

- The state of Illinois does not regulate wetlands. They have an interagency wetland policy, which is largely discretionary (i.e., no penalty for not following the policy).
    - The general policy is to encourage state agencies to avoid wetlands entirely when funding actions.
- Illinois EPA administers the 401 certification program and 9 of 102 counties have local wetland regulatory programs (largely in more developed parts of the state). For the most part, regulation occurs through the USACE Section 404 program. – McHenry, Lake, Cook, DuPage, Kane, Will, Kendall, Madison, St. Clair counties have local regulatory programs.
- Most compensatory mitigation is done through mitigation banks – often once the bank is sold out it is turned over to the State for permanent conservation and management.
    - IL coordinates with USACE for certification.
        - Usually, IL defers to USACE's judgement.
    - One difficulty of the mitigation banks is that they work on a credit system, but don't necessarily ensure that there is functional equivalence of lost and replaced wetlands.
    - Monitoring is largely restricted to bank compliance and typically measures, such as wetland hydrology, vegetation, lack of invasives, etc.
        - USACE gets this data, IL has no separate database.
    - No structured assessment of program effectiveness.
    - Once banks are turned over to the state, there is no real long-term monitoring of function or condition due to lack of staff, funds, and political support.
- Historically, Illinois had a well-structured, strategic monitoring program for streams, wetland and lakes, that used a combination of agency, academic, and citizen science – program existed for about eight years before falling victim to budget cuts –The program was called the Critical Trends Assessment Program, which looked at economic and social factors in addition to natural resource trends.
- Currently, no one tracks wetland losses/gains in the state.

- Some nonprofits may on a local level. See the Nature Conservancy, Open Lands, Chicago Wilderness. These nonprofits can be more effective at land conservation than the state

In response to questions about what products/guidance would be useful for state programs:

- Proposed definition of reference – not reference sites per se, but definitions of what might comprise reference condition for different wetland classes
- Guidelines on indicators and basic protocols that could be included in monitoring programs
  - Guidance on specific wetland types that should be avoided due to the difficulty in replacing them, e.g., groundwater dependent wetlands.
    - Note, guidelines have limited utility because they are not enforceable, or communities may treat them as rules instead of recognizing that they should not be applied in all situations

What is really missing is an interpretation framework that helps agencies better understand how to use monitoring data to inform decisions. For example, how to determine when differences are sufficient to trigger action. How to distinguish real effects from noise or natural variability. What are the appropriate spatial and temporal scales to look at in order see effects?

Iowa

Christine Schwake, Environmental Specialist, Section 401 Water Quality Certification

Claire Hruby, Geologist 3, GIS Section

Jackie Gautsch, Natural Resource Biologist

Nate Hoogeveen, Executive Officer 2, River Program Coordinator

Tim Hall, Hydrology Resources Coordinator

Iowa Department of Natural Resources

January 8, 2018

- Iowa does not have independent regulatory authority. They administer the Section 401 certification program in coordination with USACE.
  - Historically, most mitigation projects were via PRM. More recently, banks have become more prevalent. However, most of the banks are for wetlands; there is currently one stream mitigation bank, and several pending.
  - Iowa is considering development of a state level ILF.
  - Performance standards and monitoring requirements are developed in a project specific manner – there are no standard conditions used across all projects.
- Monitoring data includes vegetation, hydrology, soils and basic (photo) observations.
  - Paper and electronic reports; if paper, scanned into electronic storage.
    - The only hard data included are acreage/length of mitigation and vegetation. All else is narrative.
  - Reports are available through RIBITS, but raw data is not readily accessible.
  - Stream data may include bioassessment (bugs and fish) and stream physical habitat measures.
  - PRM provides annual report on USACE form.
  - Banks provide semiannual reports. Include more data.
- Mitigation monitoring reports go to USACE and the State is sent copies. The State does not have its own database for tracking mitigation data. State tracks basic administrative information, but monitoring data is not put into any sort of database that an easily be accessed (only in project files) – there is also no State GIS for tracking locations of mitigation sites.

- ILF may have an Excel sheet with cumulative data, but only for the sites they evaluated.

- Once completed many mitigation sites are protected in perpetuity through easements that are held by the local county conservation board and/or by filing the permit/certification with the County Recorder's Office. They are responsible for ensuring compliance with the terms of the easement, but there are no structured field audits of past mitigation sites to assess long-term performance of the mitigation sites. USACE staff inspect a percentage of PRM's annually and banks once a year, but it is somewhat ad hoc –there is no separate auditing/inspecting/evaluating of older mitigation sties done by the State.
  - *No organized evaluation of program effectiveness.*
- Iowa has both wetland and stream ambient monitoring programs (two separate programs).
  - Ambient monitoring sites include probabilistic and targeted, minimally disturbed sites.
  - Currently the ambient monitoring programs are separate from the 401 program, so the two programs are not leveraged. There is opportunity to use the ambient monitoring data to provide context (or reference) for mitigation sites, share data through common indices or incorporate older mitigation sites (legacy sites) into future ambient monitoring programs – this would help assess the contribution of mitigation sites to overall wetland or stream condition.
- The ambient monitoring program has a database. There is a geospatial base that uses NWI and NHD. The ambient program also has a second database that tracks water chemistry and biological data collected as part of the ambient program (but web based data entry capacity is not currently available).
  - Stream ambient monitoring data is available on the web at Iowa BioNet - https://programs.iowadnr.gov/bionet/
    - Uses EQuiS.
    - Note, has point-based map, no polygons.
    - Is helpful for site-by-site analysis, but has no aggregation tool for all sites.
    - Is an effective option given the budget constraints.
    - Data can be entered electronically, but all of this is done in-house.
  - There is no current analogue for making the wetland data readily available.
  - The state is developing a "river restoration toolbox" of best practices – goal is to eventually make this web-based.

In response to questions about what products/guidance would be useful for state programs:

- Guidance on ways to integrate data with federal programs – the timing would coincide with proposals for new data systems. Improved awareness of ways to connect with other data systems through open data standards etc.
- Data templates and data checkers that could employed "off the shelf."

- Guidance on ways to select appropriate benchmarks for ecological lift. Recommendations for ways to gauge ecological success (e.g., based on bioassessment scores). Which metrics/measures are good choices for measuring success/progress vs. those that are not expected to change much over the duration of the mitigation project?
- For streams, need suggestions for ways to judge geomorphic success. When are reach-scale vs. watershed scale measures appropriate to use? This may be another opportunity use ambient monitoring programs to provide data that can help assess watershed scale condition/success.

Louisiana

Karl Morgan and Kelley Templet

Louisiana Department of Natural Resources (DNR), Office of Coastal Management

January 9, 2018

- In Louisiana, the only separate state wetland regulatory program is for coastal wetlands under the CZMA. The 401 program is administered by the Dept. of Environmental Quality, but they don't require mitigation separate from what is required by USACE under the 404 program. New Orleans District of the USACE typically does not require mitigation for stream impacts, so the main state level compensatory mitigation program is under the CZMA program administered by DNR.
- DNR issues approximately 1500-1800 permits/year. For each project, the Wetland Value Assessment (WVA) is used to assess the Average Annual Habitat Units (AAHU) lost at the impact site. Mitigation is required to offset the lost AAHUs. A WVA is also run in order to assess AAHUs gained for PRMs to verify that the AAHUs lost from the permitted activity are replaced by the AAHUs gained by the PRM project. Monitoring focuses on documenting the replacement of lost AAHUs. All WVAs run are reviewed by two DNR staff before approved.
- In the past, PRM was the predominant source of mitigation. In the past 5-10 years, many more banks have opened. The state regulations prioritize the use of PRMs, but permittees typically prefer to use banks. The current requirements for conservation easements on PRM projects and the requirement for long term monitoring tend to encourage permittees to use banks as the preferred option.
- Monitoring reports are required at years 1, 3, 5, 10, and 20 (for forested wetlands, monitoring may be required up to 50 years). Reports are reviewed by two DNR staff. If necessary, a field audit is conducted.
    - Few (if any) sites have conservation easements – the sites are typically remote and not likely to be subject to development. No follow up monitoring of old (legacy) mitigation sites.
- In addition to WVA scores, monitoring typically includes elevation surveys, acres, percent cover of vegetation, percent emergent marsh, and photo documentation. Monitoring reports are not too detailed (don't want too much burden on PRMs). Reports do not have a standard format.
- The state has a database for tracking mitigation projects. It includes scheduling and ticklers to keep track of what is due on a monthly basis.

    - State tried to develop an electronic field data entry system (on a laptop or tablet), but it was not successful.
        - Some difficulty in getting older staff to be able to use it.
        - Problems getting the system to link to the online database.
        - Instead, field visits use paper forms.
- DNR uses the SONRIS site for storing data and reports http://www.sonris.com/. Reports are uploaded to the site and associated with the project file. However, the raw data used to generate the reports and WVA are not stored in any sort of central database. It is, however, possible to obtain the total AAHUs lost in a given time period. This information also provides each individual habitat type.
    - SONRIS provides a GIS-based web access to project locations and basic project information.
    - DNR staff upload information provided by the project proponents.
    - Project proponents can also upload files to their projects and staff are sent a notification when a new file is uploaded so they can review and approve uploads.
    - System includes capability for (limited) batch download of data (data dumps).
    - Database that supports SONRIS is ORACLE with an ArcGIS front end.
        - Custom configuration, maintained by DNR IT staff.
    - Data includes permit number, applicant, size, photos, and type of wetland.
    - Minimal QA/QC, mostly field filtering.
- The state does not do any sort of routine programmatic assessment of effectiveness – there are no resources for this type of assessment. The state is currently evaluating different assessment methodologies under a NOAA grant.

In response to questions about what products/guidance would be useful for state programs:

- Tools or guidance on developing tracking systems – this is the most valuable part of the Louisiana data management system
- Examples of good quantitative standards to assess mitigation success
- Audit both banks and permittee-responsible mitigation sites
- Recommendations for how to deal with the problem of transient permittees. Legal entity responsible for the mitigation may dissolve after a specific time; nobody to hold accountable for the mitigation site

Maryland

Kelly Neff

Maryland Department of the Environment

Wetlands and Waterways Program, Mitigation and Technical Assistance Section, Chief

December 22, 2017

- Maryland produced a program evaluation in 2007 that included recommendations for improving mitigation monitoring and performance evaluation. Several improvements have been made based on the recommendations in this document; however, regulatory changes and increased budget/staffing would be required to implement all changes:
  - Following up on a project earlier in the process.
  - Requiring performance bonds earlier and to be maintained through monitoring.
  - Changes in the design requirements – for signs to reduce encroachment and required soil amendments.
  - Requiring payment into a compensation fund or bank prior to permit issuance.
  - Requiring that monitoring include testing for presence of anaerobic soils.
- State program consists mainly of site-based evaluation vs. structured program effectiveness assessment.
  - Data comes from project proponents and their consultants. State staff verify all sites at least once through routine site visits.
  - In rare cases, certain projects (e.g., stream restorations, projects involving rare or unique resources) may be independently assessed by the State Resources Agency.
  - Some coordination with other programs on individual projects, but no programmatic connections to other state monitoring and assessment programs.
  - The mitigation permittee or sponsor completes monitoring in the form of area gained compared to losses, basic plant community measures, soils, and hydrology. If wetland mitigation sites have more specific goals (e.g., for habitat of RTE species), the monitoring and performance standards will be adjusted accordingly. Stream mitigation projects generally have monitoring and performance standards tied to project goals.
  - MDE also completes a rapid scoring method developed by the State. This method used by MDE staff as part of their assessment of program effectiveness (i.e., not really used for project evaluation.
  - Few wetland mitigation sites include measures of function, wildlife use, etc., but MDE staff do a qualitative evaluation of functions.

- *State produces an annual synthesis of gains and losses for internal use, but not a routine program evaluation report that is made more broadly available.*

- Maryland has developed a template for required mitigation bank performance standards, which is also being used for PRM. Maryland is working with some mitigation bankers to evaluate how these standards should be adjusted to better reflect desirable site conditions. Maryland is encouraging permittee-responsible mitigation projects to use those standards as appropriate. This equivalency standard will be better clarified through an SOP that is currently being developed.
  - Monitoring and performance standards are on MDE website: http://mde.maryland.gov/programs/Water/WetlandsandWaterways/AboutWetlands/Pages/mitigationbanks.aspx
  - The PRM standards are located at https://mde.maryland.gov/programs/Water/WetlandsandWaterways/AboutWetlands/Pages/permitteeresponsmitigation.aspx)
  - Additional information is available on their general mitigation website: http://mde.maryland.gov/programs/Water/WetlandsandWaterways/AboutWetlands/Pages/mitigation.aspx
- Tracking is done through a state-specific database of gains and losses. Data is being migrated over to a custom data management system called TEMPO – which is available for internal use only. It is not readily accessible to other agencies or to the public, *i.e., no web services.*
  - TEMPO was custom built, migrating data from the old database system (RAMS). However, relatively little mitigation data was located in RAMS, since it wasn't built for that type of data. Most of the detailed mitigation data was in a separate database (Access based), which was not migrated over. TEMPO tracks acreage gains at mitigation sites vs. losses at impact sites.
  - Sites tracked as lat/long. It would be helpful to find a way to include polygons, which may be done in the future.
  - Working to connect TEMPO to e-permitting system to improve automated data reporting.
    - The e-permitting system is still in its early stages.
    - In the meantime, data is only publicly accessible through Public Information Access requests.
  - Desire to add additional indicators of function/condition (see above).
  - Need resources to try and get historical data into TEMPO.
  - Most important data to grab would be site location (county, watershed, etc.) and information on impacts and gains. Need to improve data QA and data checking functions of TEMPO.

        - QA/QC currently consists mainly of limiting choices through the use of dropdown lists.
    - Data must be entered manually, no remote access from the field.
    - Data may include files or photos.
- In response to a question on what the Maryland program does well, Kelly suggested that their "to do" list function has great potential to help track information and provide reminders of deadlines, due dates, etc.
    - Can be sorted in various ways.
    - Is internal to TEMPO, does not link to Outlook or other mail clients (as far as I know).
- MD also has some good performance standards (e.g., for presence of anaerobic soil).
    - These may be updated soon though as we see how effective they are at capturing site success.
- Mitigation data locations (points) is also uploaded to the watershed resources registry - http://watershedresourcesregistry.com/. Bank service areas and site polygons will also be added shortly. Data from mitigation banks may be added to USACE's RIBITS system.

In response to questions about what products/guidance would be useful for state programs:

- Registry of reference wetlands and data associated with those sites.
- Tools that can provide an easy way for users to provide GIS polygons vs. points in standard way that can be readily error checked.
- Some standard templates for monitoring data/indicators.
- Standardized performance standards.
- Improved design standards.

Massachusetts

Lisa Rhodes

Massachusetts Department of Environmental Protection (DEP)
Wetlands Program, Manager of Wetlands Monitoring and Assessment

January 10, 2018

- Massachusetts' state law, the Wetland Protection Act, requires permits and 1:1 mitigation for all wetland impacts that exceed specified guidelines and standards. Permits are typically issued by local jurisdictions (local Conservation Commissions). State DEP will rule on local appeals, and also issue permits for "variance" projects that don't meet basic standards due to size (e.g., > 5,000 s.f. of impacts) + meet the overriding public interest criteria + No Alternative.
    - Local permits often contain § 401 Water Quality Certification.
- Wetland Protection Act expresses a preference for on-site permittee responsible mitigation (PRM). There are no mitigation banks in MA. They were tried in the 1990s, but did not take hold, due to:
    - Concern that use of banks would discourage avoidance and minimization.
    - Hard to administer because use of banks would require mitigation in different jurisdictions, which is challenging in a program that is based on implementation at the local jurisdiction level.
- Mitigation criteria:
    - Compensation surface area shall be equal to lost area.
    - Groundwater and surface elevation shall be similar to lost area.
    - Horizontal configuration with respect to bank similar to lost area.
    - Unrestricted hydraulic connection to same waterway or body as lost area.
    - Same general area or reach of waterway or body as lost area.
    - 75% surface shall be reestablished with indigenous wetland plant species within two growing seasons.
- Mitigation monitoring is administered separately by the local conservation commissions for normal projects and the State DEP for appeals and the variance projects. Variance projects have rigorous monitoring requirements.
    - Monitoring requirements vary by jurisdiction, some don't require monitoring, others don't enforce requirements.
    - Reports are varied, and agency staff may conduct field audits, if necessary.

- No easy way to combine monitoring data from local jurisdictions and DEP.
- Monitoring reports stay with the project file – *no central database.*
  - LCC's often use paper files.

- The state DEP has worked with U. of Mass Amherst to study the effectiveness of the wetland mitigation program by looking at data from a series of randomly selected towns (done in 1998 and again in 2012-2016 (pending release)).
  - 4,718 files reviewed for projects filed between 2004 and 2007 – to allow time for mitigation sites to be established and mature.
  - Of the files reviewed, 176 projects required wetland replacement (creation) which was the subject of the study.
  - Due to landowner access issues, the team was only able to review 91 wetland replacement sites.
  - 86% of sites were actually implemented (built) – those 79 sites were evaluated for vegetation, soils, and hydrology.
  - 65% of the 79 sites created a wetland – the 35% that failed were due mainly to poor hydrology.
  - 70% met the required size, less met all the performance standards.
  - 39/91 sites were built, were wetlands, and were large enough (i.e., met size criteria).
- MA also has a *wetland monitoring and assessment program.*
  - Statewide mapping of wetlands – very intensive.
  - Updated maps based on 2005 imagery recently completed.
- Working with U. Mass, Amherst on developing monitoring and assessment tools.
  - Landscape assessment models.
  - Level 2/3 assessment tools – used to calibrate landscape assessment models.
  - Developed a plant IBI for forested wetlands, working on shrub swamps and salt marsh.
  - Testing assessment methods using a rotating basin/catchment approach.
- MA has used monitoring and assessment program data to help interpret/understand mitigation monitoring results.
  - Identified indirect impacts through monitoring and assessment program that can be addressed through regulatory requirements.
  - Incorporate tools from monitoring and assessment program into compensatory mitigation monitoring (e.g., Veg. IBI).
  - Compared forested wetland mitigation Vegetation IBIs associated with variance projects to landscape level data – typically conditions at variance project mitigation sites were

found to be within acceptable ranges for ecological integrity, but the results did raise questions about whether vegetation based IBI's are the best tool to evaluate mitigation areas that have been built using nursery stock and seed mixes. More research is needed.

- The state has no real mitigation tracking system for data collection/management, etc. and no standardized reporting templates – but there are many experienced practitioners who tend to use fairly consistent approaches.
- The state has a map-based viewing system that allows projects to be accessed and see location. System will indicate if there is mitigation associated with the project, but the actual data is not available through the system.
    - Individual conservation commissions can enter data to the system to track basic project information.
    - State Environmental Information Management folks are updating all of Massachusetts' data management systems, so the current system may become obsolete.
    - Data includes Name, Applicant, Location, Type, Resource Impacts, and whether mitigation was required.

Data comes from 1) applicant (electronically), 2) Local Conservation Commission, or 3) State Agency (uploaded by staff).

In response to questions about what products/guidance would be useful for state programs:

- Data templates, data structures, simple databases that can help states manage data better
- Common understanding of success and criteria for evaluating success for different mitigation strategies. For example, what criteria should be used to evaluate success for preservation vs. success for restoration.
    - As an illustration: Is 1 acre of successful wetland creation the equivalent of 1 acre of preservation? If you use the USACE ratios for mitigation such as preservation, more acres of preservation are needed for the equivalent of 1 acre of impact. But in many cases a fee is calculated for in-lieu fee. That fee may go into a larger pot for purchase of a parcel (funded by many sources). How much credit is given for the actual parcel purchased if only a portion is funded by the in-lieu fee? In summary, what is the equivalent of 1 acre of successful wetland creation if the mitigation is restoration, enhancement or preservation? To get a common answer regionally or nationally this question should be addressed.

Michigan

Amy Lounds, Michael Pennington, Bethany Matousek:

Michigan Department of Environmental Quality - Wetlands, Lakes, and Streams Program

January 11, 2018

- Michigan is one of two states that has state assumption of the Section 404 program. Michigan's Wetlands and Inland Lakes and Streams Statutes provide Michigan's authority to administer the 404 program.
  - State program is administered independent of the federal agencies – USEPA has oversight and provides input on large projects (only about 2% of total permits).
  - In instances where state assumption is not allowed (Great Lakes coastal areas) – the State and Federal programs are parallel and USACE and state permits are required.
- The state had developed standard permit conditions and mitigation requirements.
  - Stream mitigation program (more recent than wetland mitigation program) has developed standard monitoring and performance standards based on Will Harman's stream pyramid concepts. Monitoring is required for five or more years. Standard performance standards (and monitoring) include:
    - Floodplain connectivity.
    - Bank migration and lateral stability.
    - Large woody debris.
    - Riparian buffer – size and vegetation quality.
  - The state is developing a spreadsheet tool in collaboration with Will Harman, called the Stream Quantification Tool, to quantify conditions based on these indicators and facilitate data compilation.
  - Wetlands mitigation program (has been around for longer) includes standard indicators for soil, hydrology, vegetation, and wildlife.
    - Standard vegetation worksheet (linked to master plant list) and mitigation plan and monitoring report templates to improve consistency.
    - Working on an ArcGIS data collector to improve consistency, ease and quality of data collection. Ultimately hope to link this to the state data management system.
    - Guidance on siting mitigation in a watershed context and better replacement of impacted functions.
    - Standard documents for conservation easements, long term management, stewardship agreements and endowments.

        - Require financial assurances (e.g., letter of credit or bond) for mitigation requirements.

- State has a Landscape-level Functional Assessment that addresses landscape and watershed function and allows investigation of functions based on impacted systems compared to landscape functions where mitigation has been done.
    - http://www.mcgi.state.mi.us/wetlands/
    - https://www.michigan.gov/deq/0,4561,7-135-3313_3687-10332--,00.html
- Michigan has regional monitoring program (ambient assessment) for streams, and a wetland monitoring program to look at overall status and trends at three different levels (i.e., landscape level, rapid, and intensive site assessment). This includes watershed-based assessment of trends in function (using the landscape level functional assessment method). They are also updating NWI.
    - State is planning to use status and trends/ambient data to inform refinement of monitoring requirements and performance standards.
    - The stream quantification tools will be used through the regional monitoring programs to assess overall program success and revise requirements based on the results of the assessment.
- Past studies of long-term success of mitigation have focused more on regulatory success than ecological success.
    - PRMs don't typically have long-term monitoring and management associated with them.
    - Mitigation banks and preservation sites are required to have perpetual monitoring via an endowment.
- Michigan's MiWaters web site - https://miwaters.deq.state.mi.us/ - is a central repository for information from all "aquatic programs", e.g., stream and wetland programs, water quality (402), floodplain protection etc.
    - Custom developed application.
    - Has a GIS viewer.
    - Includes a joint permit for 404, floodplain protection, critical dunes, Great Lakes, high risk erosion, dam safety, etc.
    - Permittees can submit information electronically to MiWaters (with an account). Once a permit is issued, the system generates a compliance schedule, tracks easements, including ticklers and tasking to both the permittees and agency staff. Mitigation information is associated with the permit location.
    - Includes rules and data checkers to address QC issues.
    - Database is largely accessible to public – addresses many Public Records Act/FOIA request.

        - *No easy way for bulk download of data.*
        - Working on developing standard reports and queries from the database. *Data synthesis tools still need to be more fully developed.*
    - Old data was migrated in, but with errors.
        - Student is currently fixing.

Minnesota

Ken Powell and Tim Smith

Minnesota Board of Water & Soil Resources

January 4, 2018

- Minnesota has independent regulatory authority under the State Wetland Conservation Act. The state program largely mirrors USACE's 404 program but has broader jurisdiction. State and Federal programs coordinate on development of performance standards and monitoring requirements. Because MN has a state wetland regulatory program, the 401-certification program is less significant (i.e., not as big of a driver as it is in other states).
- Wetland programs are administered by three agencies in Minnesota:
  - Department of Natural Resources – Wetland Status and Trends.
  - Minnesota Board or Water & Soil Resources – State Wetland Conservation Act.
  - Pollution Control Agency – 401 Water Quality Certification Program.
- Due to geographic diversity, no one performance standard is used throughout the state. All mitigation sites are independently assessed by a technical evaluation panel of wetland experts annually for performance relative to standards in the permit as required by law, and as a follow up to reports provided by project proponents. Data from assessments primarily includes photographs, water levels, veg composition, etc. In addition, annual monitoring reports are required for all mitigation projects (banks and PRM sites). Monitoring results are used to inform credit release at banks (which typically occurs over about 5 yrs). Currently, monitoring reports are kept with the project files – *MN does not currently have a main database for compiling mitigation monitoring data in a readily accessible digital format. Reports may not be in a standard format.*
  - Reports are not publicly accessible unless specifically requested.
- Mitigation bank locations (currently around 400 banks) are mapped in a GIS system with basic info, including some general information on the impact sites (Sec. Township, Range) that purchased credits from each bank. The State incentivizes the use of banks over PRM.
  - Readily accessible aerial imagery facilitates basic landscape scale evaluations.
  - Currently use ESRI ArcGIS online with standard format requirements for shapefiles.
- The state used to track wetland gains and losses based on permitted impacts and mitigation at over 300 local government units. However, this approach was deemed less than desirable because many changes in wetland extent may not be captured through this accounting (e.g., exempt activities). Now the state uses their probabilistic wetland status and trends program

as a better way to account for overall gains and losses. *Based on their experience, they recommend the following for Module 2 of our guidelines document:*

  - A more modest and realistic goal for module 2 would be to evaluate the overall effectiveness of compensatory mitigation in providing high quality, high functioning wetlands. This could be assessed by comparing indicators of function and condition for compensatory mitigation sites with other reference wetlands on the landscape. In reality, most programs use replacement ratios to establish wetland quantity requirements for compensatory mitigation, so as long as the program uses those requirements, then it is easy to document impact amount and mitigation amount in terms of acres. What is typically missing in program evaluations is data/information on the condition and functional level of compensatory mitigation as compared to some type of reference wetland. Trying to make conclusions about program effectiveness beyond this level of comparison is a stretch when just looking at impact and mitigation sites alone.
  - The state is currently working on a study (USEPA program development grant) that in part is being used to assess the long-term condition of compensatory mitigation sites in relation to a set of reference wetlands. The study also couples information from the status and trends program with information from mitigation banks to better understand how banks contribute to status and trends .

- The state holds conservation easements on all banks. They conduct basic monitoring of compliance with conditions of the easement every five years. The basic evaluation is GIS based using imagery. If the basic assessments reveal potential issues of concern, there may be a follow up field visit. For example, last year 100 sites were subject to the basic assessment; follow up field assessments were conducted at 20-30 sites.
  - There is current project funded under 104 that is using a FQAI to assess condition at these older sites to determine long-term performance/success.

In response to questions about what products/guidance would be useful for state programs:

- Standard data templates and data entry approaches – it is a challenge to get data from files into a readily accessible online data system where it can be used for performance evaluations. Off-the-shelf database structures and guidance regarding how to set up data in formats that make readily standardized.
- Guidance on what kinds of variables should be measured under different circumstances. For example, condition vs. function indicators or recommended indicators that can be used to gauge success for different wetland types and different landscape settings.

Missouri

Stacia Bax

Missouri Department of Natural Resources

January 3, 2018

- Missouri does not have its own separate wetlands program beyond administering 401 water quality certifications. USACE typically takes the lead on wetland permitting in the state. Staff from the DNR do participate on mitigation bank IRTs.
    - Most mitigation in the state is through mitigation banks. In lieu fee programs exist to cover mitigation where there are no banks. There are very few off-site permittee responsible mitigation sites; those that do occur are poorly tracked.
    - Banking has been in place since the 90's/2000's.
    - Onsite mitigation is usually only required when the party has already damaged the wetland (without any permits).
- Monitoring consists of permit mandated monitoring which is conducted by permittees and/or bankers. Monitoring reports are submitted to USACE and the State DNR for review. There is no independent monitoring or auditing mechanism conducted by the state.
- Performance monitoring typically consists of vegetation criteria (e.g., percent survival, plant density), some hydrologic monitoring and occasional soils assessment. The state does have a stream and wetland condition assessment method that is used to help establish and adjust credits and debits at banks (the method is based on the Charleston District Method).
- Monitoring is conducted for the life of the bank (typically 3-10 years urban areas and 10-20 years in rural areas). Once the bank is sold out, the IRT will conduct a final review of condition. *No subsequent or ongoing assessments are conducted once the bank is closed out. However, the data collected during the life of the bank may provide some information on long-term ecological condition of mitigation sites.*
- The state does not have its own mitigation database or tracking system. Monitoring information is largely located in project files. Tracking consists mainly of basic accounting, such as the number of actions taken, number of site visits, etc.
    - The state had a minimal database in 2009, but doesn't use it any longer
- Biggest impediments to state programs are:
    - Lack of staff – 1.5 FTE to administer the entire 401 program
    - Lack of access to USACE or USEPA data systems (i.e., ORM and DARTER)

  - Inconsistency between USACE districts – the state is covered by five USACE districts (in three different divisions). Different levels of expertise and experience between the districts result in inconsistent approaches across the state
  - IT is statewide, making it difficult for the department to get attention
- The state's Water Resources Center (through the State Geologic Survey) collects data on wetlands located on public lands. They monitor hydrology and climate data and have/are developing assessment indices (e.g., IBI, FQAI). Information and tools developed as part of this program could be leveraged for mitigation evaluation. For example, data could be used as reference or comparison sites for mitigation banks. Assessment tools developed through these programs could be incorporated into mitigation monitoring. Wetland water quality standards could be incorporated into performance standards for wetlands.

In response to questions about what products/guidance would be useful for state programs:

- Recommendations for monitoring approaches and performance evaluation methods that could improve consistency across projects
- Checklist of items to be included in routine assessments
- Recommended monitoring endpoints
- Improved access to existing data management systems and GIS data, potentially through web services or open data access
- Web-based or off the shelf data management tools that could help get data from project files to a queryable database (with ticklers to help keep track of deadlines and due dates)

New Jersey

Susan Lockwood

New Jersey Department of Environmental Protection, Division of Land Use Regulation

January 19, 2018

- New Jersey is one of two states (besides Michigan) to have state assumption of the 404 program.
  - The state Mitigation program has been in existence since 1990. The State has had a freshwater wetland protection program since 1988 (law passed in 1987 with implementation beginning in 1988). New Jersey obtained assumption of the Federal 404 program in 1994.
  - The NJDEP applies its wetland program to all areas of the State of New Jersey. In areas where state assumption applies, NJ DEP is solely responsible for all aspects of permit review including mitigation and monitoring. In non-assumed areas of the state, New Jersey shares that responsibility with the USACE.
  - In New Jersey, assumption does not apply in coastal wetland areas, because the Federal law and rules on assumption do not allow a State to assume wetlands that are tidally flowed, or adjacent to tidally flowed waters. Therefore, in those areas (in NJ this includes wetlands and waters along the Atlantic Coast in the east and along the Delaware River to the west), the State applies its State program but the USACE also continues to apply the Federal 404 program. The State reviews proposed Mitigation Bank projects in non-assumed areas together with the Federal agencies, as one member of the Interagency Review Team process (IRT) as established in the Federal regulations. For non-bank mitigation projects in non-assumed areas, the State and USACE operate independently under their own respective laws. However, New Jersey works to coordinate with the USACE on issues like mitigation so that an applicant can satisfy both USACE and the State with the same mitigation project.
- State law provides for development of tools to support program implementation. Application of these tools occurs via joint coordination with USACE.
- Monitoring requirements usually follow standard USACE monitoring guidelines – largely derived from Wilmington (North Carolina) District.
  - Most mitigation projects require 5 years of monitoring.
- Most monitoring is done by permittees / bankers. The state staff conduct audits and site inspections to ensure compliance. The state currently is working on updating their monitoring requirements to better reflect actual site condition/function.

- NJ had an older (not very functional) database. They currently have a Section 104 grant from USEPA to update their database. *Old permit files are being manually entered into the new database, documents are being digitized, and geospatial information is being added. Together these new data will provide the capability for the state to conduct more comprehensive programmatic assessments.*
    - This will help guard against new projects being proposed on the location of prior mitigation sites – currently, there is no easy way to prevent this from happening.
    - New data system is NOT easily compatible with RIBITS.
    - To date, there have been no programmatic big picture evaluations of the mitigation program's performance. However, the new database will position the state to be able to do these assessments.
    - An earlier assessment in the 1990s found generally poor performance of compensatory mitigation. This report led to upgrades to the program in terms of increased requirements, better standards, and more staff.
    - Database allows for setting deadlines, but does not automatically send reminders to staff and does not track projects with ticklers.
    - Database includes information on approved plans, but does not include all collected data.
    - QA/QC is performed through personal review of files (x2).
    - No remote or electronic entry into database, but permittees use standardized forms.
- Once mitigation standards are met, long-term stewardship is done by a state agency or a conservation entity with some sort of an easement. However, there are no State provisions for ongoing long-term monitoring of legacy sites.
    - The exception is a series of sites in the Meadowlands portion of the state, where there is long-term data available on older bank sites.
- NJ has an ambient monitoring program. However, there is little communication between that program and the wetland regulatory program. BUT, if the ambient monitoring program identifies high quality (Category 1) waterbodies, that can trigger extra regulatory protections.

In response to questions about what products/guidance would be useful for state programs:

- Example monitoring protocols and ways to assess monitoring data in statistically appropriate ways – pitfalls to be aware of in terms of how data analysis can be misused.
- Methods that allow sites to be looked at more holistically in the context of watershed condition.
- Guidelines on monitoring time frames

- Examples of how to write clearly defined goals of the mitigation project and for the mitigation plan with quantifiable and measurable performance standards to measure whether they have been met.
    - Suggestions on how to view a mitigation site comprehensively, and how to translate that into success criteria. For example, if a site has a target goal as a forested wetland, and the applicant plants one-year old seedlings, and annually conducts a "woody stem count," is it reasonable to declare the site a successful wooded wetland after 5 years when none of the woody plants have escaped the herbaceous layer to reach the tree or shrub layer? Technically, the site MAY turn into a wooded wetland, but it also may not since the woody vegetation is so small that it has yet to outcompete the herbaceous layer and may not ever.
- Specific guidance on vegetation-based performance standards
    - An action threshold for invasive species. Currently New Jersey allows a final composition of up to 10% invasive species. We think it may be too high and that perhaps there ought to be a lower "action" threshold.
    - Suggested methods for measuring the presence of invasive species. For example, they should be characterized on a sitewide basis and displayed spatially to illustrate estimated overall percent coverage.
    - Discussion of monocultures. If there is a site where native species have volunteered but they have formed monocultures effectively eliminating all the original, more diverse plantings, is this desirable, and should the site be considered "successful" simply by virtue of the fact that the species are native?
    - Guidelines on when monitoring should commence. If plants are planted in the spring, can you/should you monitor that same fall and call it "one year" of monitoring.
    - When monitoring vegetation, methods of evaluating and reporting on each vegetative stratum. For example,
        - The herbaceous layer - all vegetation less than 1.5ft in height
        - The shrub layer – Woody vegetation 1.5 to 3ft in height
        - The tree layer - Woody vegetation above 3ft in height. Perhaps there should be a DBH and height requirement before signoff if someone is selling forested wetland mitigation credits.
    - Suggestions and perhaps compare and contrast using a plot-based system of monitoring, vs. transects in terms of how that may affect or skew data.
    - Suggestions on the percentage of a site that should be monitored as representational. Should it be 5% of a site? 30%?

North Carolina

Mac Haupt –North Carolina Department of Environment and Natural Resources

Todd Tugwell & Andrea Hughes – USACE, Wilmington District

January 5, 2018

- North Carolina coordinates closely with the USACE District. Historically most mitigation occurred through ILFs, which are managed through the State's Division of Mitigation Services (DMS). In recent years, mitigation banks have become more prominent. The amount of mitigation provided by banks now eclipses the amount of mitigation provided by the ILF program (DMS); there are very few PRMs. The IRT processes banks and ILF projects in the same manner. DMS provides a website for their projects and provides some oversight but the IRT is still in charge of reviews/approvals.
- The state has developed mitigation guidelines for both wetlands and streams (available on the Wilmington District RIBITS page) that provide monitoring recommendations—these are enforced by the IRT and required for mitigation banks and the ILF program. Annual monitoring includes the following types of indicators:
  - Vegetation data – growth, vigor, survival.
  - Photo documentation.
  - Hydrology data (e.g., wells).
    - Groundwater gauges for wetlands.
    - In stream gauges for documentation of overbank (bankfull) events, typically pressure transducers are best, sometimes they just put a crest gauge which uses sawdust.
  - Bank stability and floodplain connectivity (for stream mitigation).
  - Some benthic invertebrate assessments and water quality – not for all sites.
- ILF and bank sites also include a watershed-scale assessment component.
- Monitoring data from ILFs is housed/managed by DMS. For banks, monitoring data is in annual reports and kept with the project file – there is no online database/repository for banks as there is for ILFs. To date, there has been no attempt to combine or consolidate bank and ILF monitoring data.
  - There is no mandate (and therefore no easy mechanism) to develop a standard, consolidated database.
  - DMS currently has a web portal for vegetation monitoring data that provides a way for electronic data entry, management, and access.

  - Ideally there would an analogous portal for other types of monitoring data (e.g., hydrology), but that has not been developed at this time.
  - Other DMS databases (note, none are consolidated together DMS is working on linking these data streams through their Customer Relationship Management system):
    - Geospatial.
    - Hydrological.
    - Stream (almost completed).
    - Credits.
- The standard monitoring period is seven years. The DMS QA/QCs the monitoring reports and DENR/IRT reviews and approves all mitigation and conducts an independent review of performance at the site/bank level.
- The state does not conduct any regular program evaluation or effectiveness assessment (although it would be a good idea) – there are no staff or resources for this.
  - Annual reports by DMS.
  - Periodic academic study of the program – last one was in 2013.
  - *Compilation of data to conduct a program evaluation would be difficult because of data discrepancies (e.g., different ways of measuring stream length) – no current mechanism for automated data checking or QC to make synthesis easier (and more meaningful).*
- Once projects are completed the State Stewardship Program is responsible for ensuring long-term protection. There are other stewardship programs that are utilized, some of these include local land conservancies or other privately managed land conservation groups. They need to be approved by the IRT. There may be occasional or ad-hoc review of some sites, but there is no systematic ongoing assessment of older sites to assess long-term success/condition.
  - There is interest, but currently no resources, for assessment of legacy project.
  - *Some discussion of ways to incorporate older projects into periodic regional or national assessments*.
- The DMS has a CRM system for data management. It includes monitoring data, basic permit data, information on impact sites, and financial data. It is connected to a geospatial database for project locations – *there is no current analogue for mitigation banks.*
  - Credit tracking is done separately.
  - Data is available in reports and upon request, but no publicly accessible web-based data query system – Geospatial/GIS data is available via web interface, but not monitoring data (at this time).

In response to questions about what products/guidance would be useful for state programs:

- Basic monitoring metrics and methods that all are required to utilize. These could be set up by anybody (state, federal, academics) but should be approved by the District IRT. It is likely more practical for the specifics to be done at the state level, but within general guidelines. There will always be a need to balance this with cost considerations.
- Tools and methods that provide the ability to import data into a database from the beginning. Also, having the ability to modify the database based on changes in restoration practices overtime.
- Recommendations for project-level criteria that can be used to gauge success, especially for streams.
- Data collection and assimilation tools → better ways to compile and reconcile different sources of data.
- Guidance on how to assess watershed condition and contribution of mitigation projects to watershed condition.
    - Metrics and monitoring recommendations for how to synthesize results from numerous projects to gauge the uplift at the catchment scale – possibility for some sort of catchment mitigation units.

Ohio

Mick Micacchion

Wetland Ecologist, Senior Research Associate, Midwest Biodiversity Institute

Formerly of Ohio EPA, PWS

January 17, 2018

- Ohio has independent regulatory authority under its own wetland (and isolated waters) statute. The statute differentiates protections/demonstrations needed and mitigation ratios based on wetland size and quality. Ohio also reviews Section 401 WQCs and some isolated wetland permits (higher quality isolated wetlands) using a set of rules (Ohio Administrative Code 3745-50 to 54), known as Ohio's Wetland Water Quality Standards. The Wetland Antidegradation Rule (OAC 3745-54) provides standards for three categories of wetlands and the different levels of protection and the demonstrations needed to receive a permit to impact them. The Antidegradation Rule also includes language on how and where compensatory wetland mitigation will be performed and specifies the mitigation ratios (1.5 to 3.0) for different categories of wetlands Historically, there was a lot of PRM, but over the past 10 years the majority of mitigation is done through banks. ILFs are also becoming a lot more common as another option (in addition to banks).
- The state has invested heavily over the years in developing quantitative assessment tools, such as their vegetative IBI and amphibian IBI based on robust data sets of natural wetlands across gradients of disturbance. They also have a rapid assessment method (ORAM) that has been around since the early 2000s. The biological indices are used to set quantifiable performance standards for mitigations sites/banks. ORAM is only used to assess natural wetlands and not compensatory wetland mitigation projects. Many of the metrics and submetrics in ORAM evaluate the intactness/disturbance levels of the wetland. Recent disturbances associated with compensatory mitigation construction activities leads to low scores, if evaluated correctly, on these metrics and an overall low ORAM score. Therefore, the level 2 ORAM is not appropriate and level 3 IBIs and other quantifiable performance goals are used.
- The state has also invested heavily in developing distinct and specific guidance for different types of mitigation (e.g., PRM, banks) and different types of sites, that include things like site selection, what to monitor, when, how, etc.
- The availability and use of biological indices and guidance to provide consistent, quantitative standards for mitigation has been one of the keys to the success of the Ohio program because it provides clear structure for the program to operate. (Mack et al. 2004).

- Monitoring data is provided via paper reports- there are automated spreadsheets available for calculating the IBIs, to reduce errors. The monitoring reports are associated with the project file.
    - The paper reports are largely standardized.
    - Some QA/QC is built into the automated spreadsheets, as they give error messages when data is not entered correctly, and further calculations are not possible.
    - Off-site data entry was tested several years ago, but software reliability issues led to staff reverting back to the use of paper forms – (same is true for 2016 NWCA).
    - Mitigation monitoring data is not readily accessible to the public (has to be requested), i.e., no online system to access monitoring data or results.
    - Paper files are stored for 5-10 years, then archived off-site.
- The state has a database to track the administrative aspects of mitigation projects, but there is no database for tracking the monitoring data – it is still largely associated with individual projects through reports vs. a central database. Bank and ILF reports and other information are posted on RIBITS.
    - Database is organized by permit number or bank name.
    - Data is often in Excel files – especially true for data collected on natural and mitigation wetlands that were part of studies funded by USEPA Wetland Program Development Grants. This information has been used by many others for a broad range of reasons.
- Bank sponsors or their consultants perform monitoring of wetlands and submit data in reports to the Ohio IRT. Bank performance is independently audited through Ohio EPA and IRT, through site visits and at times Ohio EPA sampling. Credits are not released unless performance standards are met
    - The Ohio IRT is strong and serves to help ensure required performance standards are met.
    - No good mechanism for cataloguing specific data that may be produced through monitoring or auditing.
    - Banks monitored periodically, primarily using agency scientists assisted by summer interns to do field sampling visits – Ohio EPA has a wetland mitigation coordinator whose job is to assure compensatory mitigation is meeting permit conditions/performance standards and wetland ecologists who monitor compensatory mitigation when the studies are funded by a Wetland Program Development grant.
- Ohio's Wetland Ecology Group does conduct probabilistic assessments of mitigation sites in order to report on overall program performance. They are also conducting a watershed study to better understand how natural and mitigation wetlands affect watershed condition.
    - Conducted a study of 32 bank wetlands in 2003 and 2004 using level 3 tools and found extremely low levels of performance (Mack and Micacchion 2006).

- Conducted probabilistic study of permittee-responsible sites across the state in 2007 and again found extremely low levels of performance (Micacchion et al. 2010).
- Ohio conducted an intensification of the 2011 NWCA that allowed them to report on state-level status and trends (Gara and Schumacher 2015, NWCA Intensification).
- Watershed studies or probabilistic chosen wetlands in the Cuyahoga River watershed and urban central Ohio wetlands have been performed using level 1, 2, and 3 assessment tools. (Fennessy et al. 2007(Cuyahoga Report), Mack and Micacchion 2007 (L919, Vol. 1), Grody et al. 2007 (L919, Vol. 2), and Micacchion and Gara 2008 (L919, Vol. 3).

- Long-term stewardship is generally done on a bank by bank basis. No additional monitoring is typically required (to minimize additional burdens on the stewards). Once banks are signed off on, the conservation entity is relied upon for long-term management; there is no formal follow up by the state
  - One exception is 30 sites in the Lake Erie drainage that were monitored by Midwest Biodiversity Institute in 2011 under contract with USEPA using NWCA and Ohio methods (2012 Great Lakes Basin Evaluation of Compensation Sites Report, Micacchion and Kirkeby). The same sites were monitored again in 2017 for USEPA using a different contractor (document pending: Great Lakes Basin Compensation Sites: Lake Erie Basin Reevaluation).
  - Banks usually aren't closed until long-term success seems certain or all credits have been released. (Ohio IRT 2011).

In response to questions about what products/guidance would be useful for state programs:

- Examples or recommendations for how to use monitoring data to improve program performance. Examples of what adaptive management at the program level would look like.
- Example performance standards along with a discussion of the relationship of ecological function to the traditional community-based measures of condition that are more commonly used for monitoring and assessment.

Washington (state)

Dana Mock, Lauren Driscoll, Amy Yahnke, and Patricia Johnson

Washington Department of Ecology

January 22, 2018

- Has § 401 authority.
  - Ecology tracks mitigation for projects that were issued under a 401 water quality certification.
  - Many projects fall under Nationwide Permits, which are not tracked by Ecology.
- Also regulate wetlands not under Federal Authority (isolated wetlands, prior converted croplands that meet wetland criteria).
  - These wetlands are tracked under the same project.
- Local jurisdictions can also have requirements.
  - E.g., requiring mitigation within their jurisdiction.
    - Not necessarily bound by watershed, just the physical limits of the city/county.
- Majority sites are PRM, has banks and ILF as well.
  - ~250 active PRM currently tracked.
  - About 50 active projects have used banks or ILF.
  - 17 approved banks; 4 currently under review.
  - Encouraging more banks, because they are considered to have less risk than PRM.
    - But permittees suggest the mitigation they'd like to use, Ecology cannot require a particular method.
    - Ecology generally follows preference hierarchy of USACE.
- Performance Standards are unique to project.
  - Some are usually required for all projects, but agencies can only comment on the permittee's proposal.
  - Ecology can add specific performance standards as conditions to the permit (401 water quality certification) if necessary.
  - Guidance on performance standards is provided in an Interagency Wetland Mitigation Guidance document.
- Long-term.

- Most PRM are simply closed.
- Banks and ILF do have long-term requirements, but none have gotten to that point yet.
- Monitoring is typically 10yrs, some are 5yrs for emergent wetlands, some are longer for more complex projects.
- Conservation Easements have grantees, who may act as long-term stewards.

- Site Visit Form.
  - The form itself doesn't go into the database.
    - Form is saved in the project/site file.
  - Sites are visited by Ecology staff ~3x during the site's lifetime.
- Monitoring Reports.
  - These also go into project files, not the database.
  - Currently, permittees cannot electronically file their reports [in a way that connects the data to the permit database].
- Permit Database.
  - Database goes back to 2004.
    - Early system included far more data, but required too much personnel time to enter that data and would crash/not save entered data.
    - Custom software, built by contractor based in Portland + India.
  - Permit Database was rebuilt in 2014/15.
    - This one records minimal info.
      - Permit No.
      - Applicant Info/Contact Info.
      - Impact Site Location.
      - Date of Permit Issuance.
    - Also, custom built, but in house.
    - Was able to migrate in data from old database.
  - Monthly Reports/Permit Data can be pulled from database.
    - Staff converts that to a SharePoint/Excel.
    - Each project is assigned to a person for follow up.
  - Applicant reports are stored in electronic and paper copies.
  - Database does not automatically do any administrative tracking.
- Public Access.

    - Permit database connects with a publicly accessible Ecology facility site database.
        - Includes GIS.
        - The only information pulled into the Ecology database is site long/lat (automatically pulled) and unique facility site ID.
        - Ecology database covers essentially all projects that deal with Ecology.
        - ~10% of the total statewide mitigation sites are entered and viewable.
    - Otherwise, the permit database is not public-facing.
- Ambient Monitoring.
    - Ecology doesn't conduct for wetlands, just does compliance monitoring.
    - Participated in National Wetland Condition Assessment.
    - Also has list of reference wetlands, but no monitoring happens at those sites.
        - Tribal Institutes may be doing reference.
        - Reference sites were used to calibrate WA wetland rating system scores, but no specific metrics used for performance standards.
- Programmatic Evaluation.
    - Ecology wants to do this, hasn't yet because not enough sites have gone through 10-yr monitoring lifecycle. Programmatic evaluation is part of Ecology's approved 2015 Wetland Program Plan.

In response to questions about what products/guidance would be useful for state programs:

- Data Management general information.
- Balancing clear performance standards with the need for flexible, site-specific standards.
    - Repeatable standards.
    - What makes a good standard.
- Ways to determine if current standards yield ecological success.

Wisconsin

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- Wisconsin has independent permitting authority under state statute. State regulations require mitigation for wetland impacts (but not for impacts to streams) – current policy has been in place since 2012.
- The state regulations have a hierarchy of mitigation with a preference for use of banks, followed by ILFs, and finally PRM.
    - Recent analysis shows 150 banks, 90 ILFs, and 10 PRMs since July 2012.
- The state participates with USEPA and USACE on the IRT and uses that process to help coordinate the federal and state oversight of banks.
- There are no set standards for performance standards. DNR staff use their experience from past mitigation to develop performance standards for new mitigation projects – no standard set that are used from project to project.
    - USACE St. Paul district is developing mitigation guidelines for vegetation and hydrology; Wisconsin DNR is coordinating with St. Paul District on these.
    - There are set reporting requirements that banks must use that guide credit release, trigger adaptive management actions, etc.
    - Wisconsin has a wetland rapid assessment method that can be used for monitoring and is developing a Floristic Quality Index.
- Five monitoring reports are required over the life of a project, which is typically 5 years for herbaceous wetland mitigation and 8-10 years for forested wetlands. Reports are used to determine credit release.
    - Data based on site-specific performance standards (vegetation and hydrology data).
    - DNR has general outlines for report requirements, but no standardized format.
- State DOT has a separate mitigation program – DNR ensures consistency, but does not "permit" DOT project.
- DNR tracks the administrative aspects of banks and uploads information to RIBITS. There is no tracking of the raw data that is collected as part of mitigation monitoring.
- There is no structured reporting of program effectiveness beyond the annual reporting on administrative aspects of the program

  - There was a previous USEPA-funded study on the effectiveness of various restoration practices.
  - From the DNR website - *The Department has recently been awarded a Wetland Grant (from Oct 2014 – September 2016) to develop a suite of GIS Functional Assessment Tools to conduct watershed scale assessment of the wetland functions covered in the WRAM. The tools will be developed in partnership with The Nature Conservancy and will be designed to be used in 9-Key Element Plan and TMDL Plan development, In-Lieu Fee and compensatory mitigation program implementation, and for wetland conservation planning by land trusts and local governments.*

- No requirements for ongoing/long-term monitoring of closed out banks or completed mitigation. This would be at the discretion of each bank.
  - DNR often holds the easement for closed banks, and could, in theory, enforce the terms of the easement.
  - There is a new project recently funded by USEPA to look at closed out sites and determine their long-term success.
- Wisconsin administers a lake, river, and stream monitoring program that has long-term data on water quality, bioassessment etc. – however, the program does not include wetlands.
  - Staff are consulted on water quality effects of projects, but there is no formal crossover between ambient monitoring and compensatory mitigation programs in terms of shared data, common tools, etc.
- Monitoring reports (hard copy and electronic) are attached to the mitigation project file. Mitigation projects are tracked through an old Access database that needs to be updated manually.
  - Databased tracks administrative aspects (e.g., sponsor info, approval date, report dates), but not the actual data.
  - Administrative database does not provide notifications for required administrative actions.
- DNR has a separate Oracle database for permits (Waterway and Wetlands Permitting Database), parts of which are publicly accessible. However, the permitting and mitigation databases are separate.
  - Last few years, the state has transitioned to electronic permitting, which should increase the opportunities for improved data access in the future.
  - Can't bulk download data – needs to be obtained via a public records request.

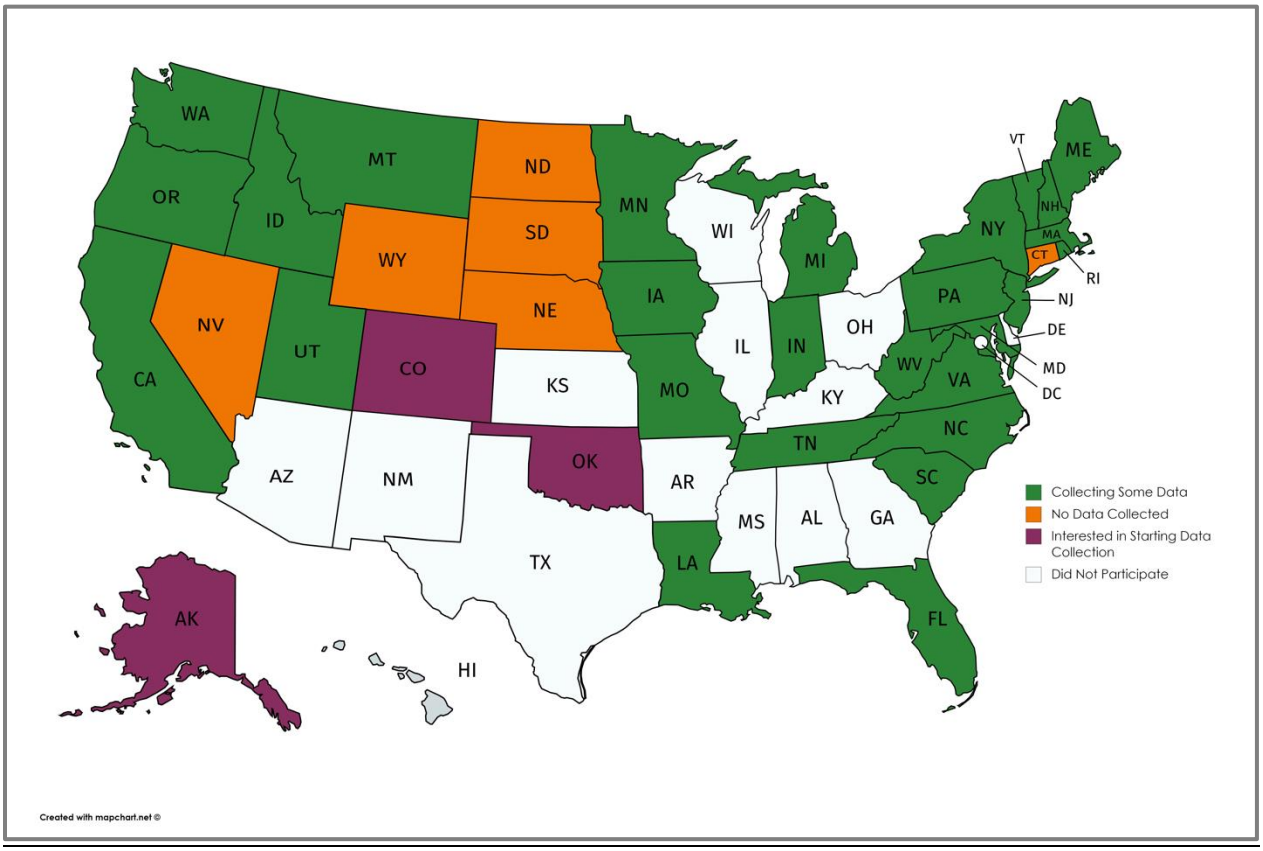
In response to questions about what products/guidance would be useful for state programs:

- Information on specific metrics that should be used to assessment mitigation success (e.g., species richness, water levels).
  - Guidance on basic designs for mitigation monitoring (e.g., appropriate plot density).
  - Off-the-shelf data templates or data management tools.

APPENDIX B - SURVEY OF STATE DATA MANAGEMENT PRACTICES

ELI conducted an assessment of current practice in collecting and tracking compensatory mitigation data at the state level. The assessment, developed in collaboration with an advisory committee of experts, was sent to wetland contacts at state government agencies across the country.[1] Information from 35 states was collected through the assessment (Figure B-1). Non-participation does not necessarily indicate that no data is being collected in those states, but rather that we did not receive a response to our assessment.

FIGURE B-1: Map of the states participating in the study.



I. Compensatory Mitigation Tracking

We started by asking a series of question related to the tracking of compensatory mitigation data. The goals of this section were to identify the types of data being collected, how the data is being collected, and accessibility of the data.

A preliminary list of possible data types being collected was provided for participants to review. This list was in part identified from a previous ELI study, *Towards a National Evaluation*

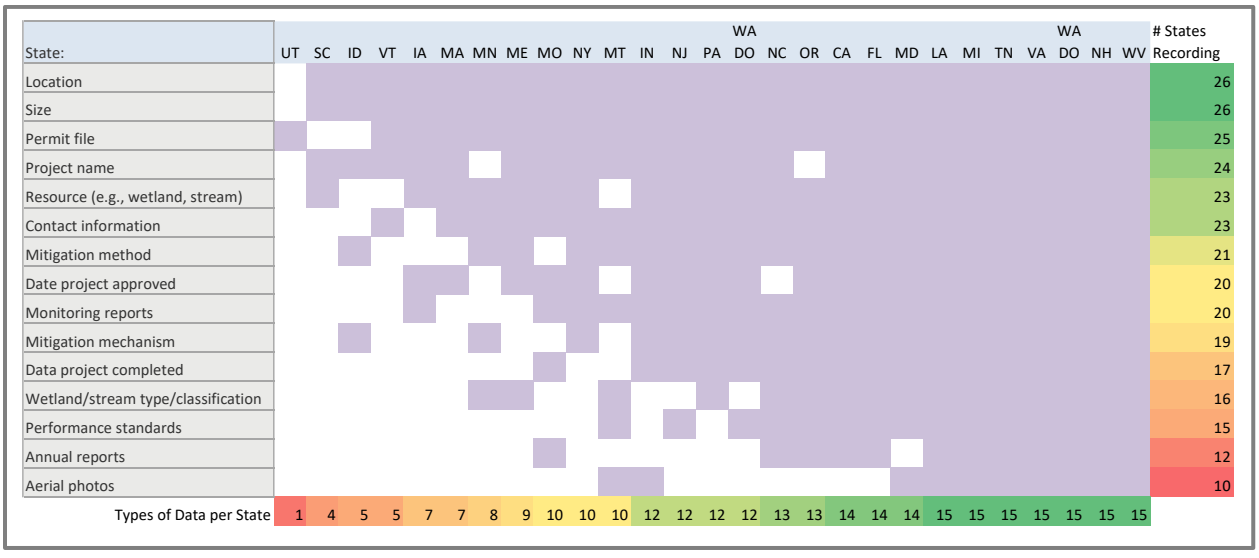
[1] The contact list was based on contacts found in Association of State Wetland Managers, Status and Trends Report on State Wetland Programs in the United States (2015) and in ELI's database of wetland program contacts. New contacts were added over time as agencies suggested appropriate staff to complete the assessment.

of Compensatory Mitigation Sites: A Proposed Study Methodology.[2] These data types were determined to be the minimum information needed in order to effectively evaluate the success of compensatory mitigation on a national level. The data included:

- Project name
- Location
- Size
- Mitigation mechanism
- Mitigation method
- Date project approved
- Data project completed (e.g., monitoring completed)
- Resource (e.g., wetland, stream)
- Wetland/stream type/classification
- Permit file
- Monitoring reports
- Annual reports
- Performance standards
- Aerial photos
- Contact information (for the permittee, consultant, and/or project manager)

Of the states that reported collecting data, about 90% collected the location, size, and permit file of each mitigation site (Figure B-2). Many others also collected the project name, resource type, site owner's contact information, date of project approval, and mitigation method. The figure below illustrates the data collected by each state.

FIGURE B-2: Data collected by states participating in the study. Note that Washington data is from the Department of Transportation and not from Department of Ecology

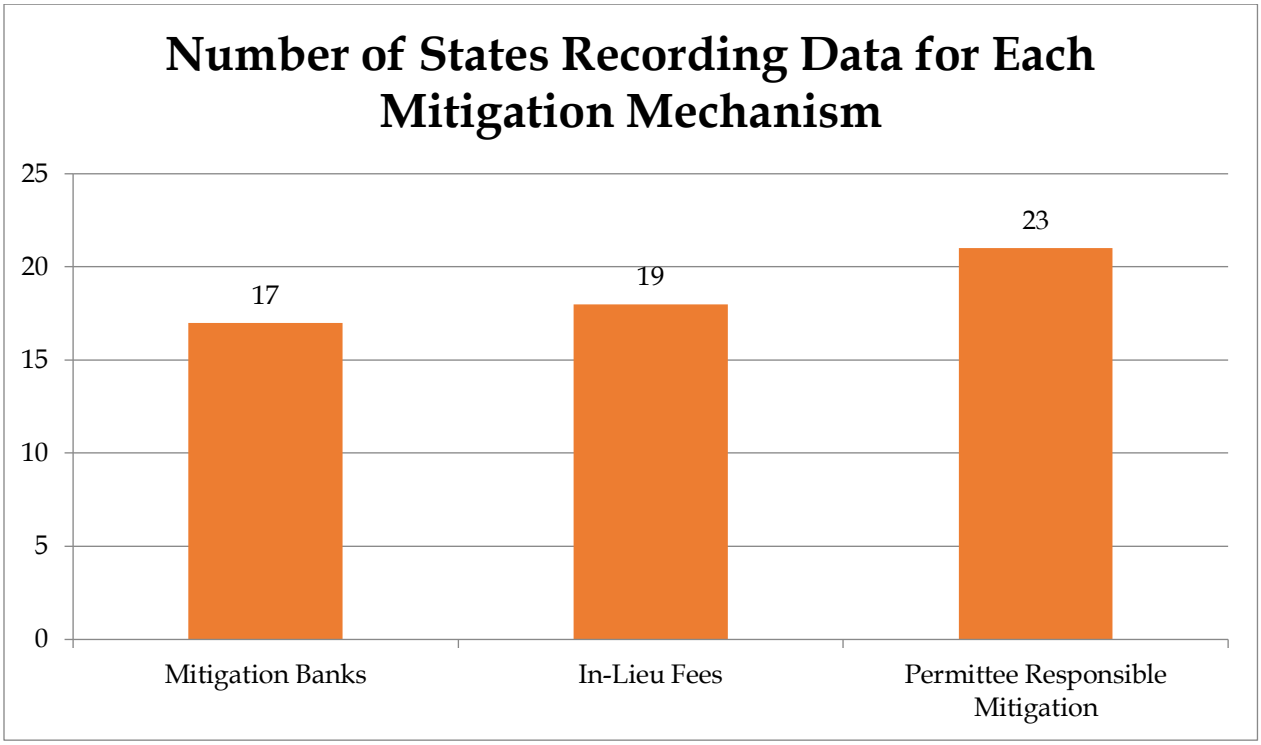


[2] M. Siobhan Fennessy et al., Towards a National Evaluation of Compensatory Mitigation Sites: A Proposed Study Methodology, Environmental Law Institute (2013).

Participants also reported collecting additional data, including: maps, compliance status, ledger transactions for credits, e-mails related to the mitigation site, and best professional judgment on likelihood of success.

The assessment also asked participants to indicate what types of mitigation projects were being tracked. This question was used to better understand what types of projects are currently driving or enabling the collection of data at the state level. Many fewer states indicated that data were being collected for federally permitted projects alone; 73% of the 30 states responding to this question indicated they track data associated with state permits where no federal permit was required and 23% indicated collected data for only federal permits (where no state permit applies). Among the states that reported collecting data (30 states), permittee responsible mitigation had the highest rate of being tracked at the state level (77%), followed by In-Lieu Fee projects (63%), and then mitigation banks (57%) (Figure B-3).

FIGURE B-3: The number of states that reported recording data for each mitigation mechanism.



Understanding the current extent to which states share data collected on compensatory mitigation with other agencies, entities, and the public was an important goal of this section of the assessment. The results indicated that 60% of participants share their data to some extent with other agencies or entities; however, this is primarily being done on a case-by-case basis or upon request. The most common context is related to compliance with other state agency requirements. However, participants reported some regular coordination with federal agencies due to federal regulation or permit requirements.

Similar results occurred when participants were asked if compensatory mitigation data were made available to the public, with 63% indicating that they make the data available to the public. Again, this sharing is typically being done only upon request. While some states have made the raw data available through online databases or have incorporated it into GIS layers, or are working towards this capability, it is not common for data to be available to the public in a readily usable format.

Participants reported that state employees were most often responsible for data collection. A few states reported that data is collected in collaboration with a federal agency or other organization. State permit fees or regular state funding (i.e., appropriation) were the most commonly reported funding sources for data collection and tracking. Other funding sources included in-lieu fee program funds (for data tracked by in-lieu fee programs) and grants.

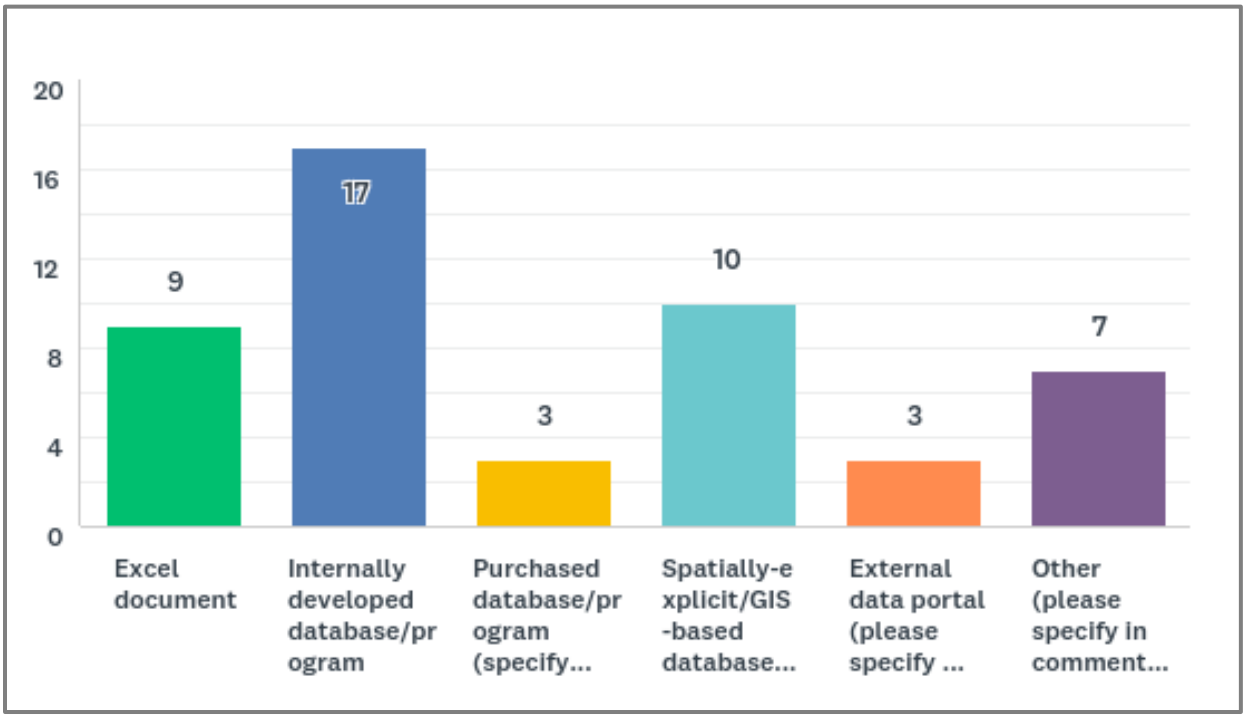
II. Data Management Logistics

The second section of the assessment asked participants about their data management systems. The goal of this section was to determine how states are storing, managing, and utilizing their compensatory mitigation data. Participants were asked whether they use any of the following to manage data:

- Excel document
- Internally developed database/program
- Purchased database/program
- Spatially-explicit/GIS-based database
- External data portal

The majority of states are using an internally developed program or system (often Access or Oracle based), but three respondents indicate that they have purchased a database or program (Figure B-4). Also, nine programs reported using Excel to manage at least some of their data, with most using the program in addition to another program. Several respondents mentioned using ArcGIS databases for spatial data and visualization.

FIGURE B-4: The data management systems states reported using to track compensatory mitigation project data



Several participants noted that their programs use multiple databases, including separate databases for project tracking and mapping. Often, historical data is also stored in a separate database.

Participants were also asked about the visualization capability of their data management systems. More than half of respondents indicated that their state incorporated spatial data in a viewer or mapper. Examples provided show this is done in a variety of ways across the states. For example, Florida's Wetlands Mitigation Bank Data Sharing Site[3] "provides mitigation bank information for permits issued statewide by either the FDEP or the Water Management Districts." Louisiana's SONRIS database site[4] includes interactive maps with layers for mitigation areas. Other examples included the Watershed Resources Registry,[5] Pennsylvania Department of Environmental Protection's eMapPA,[6] and the Center for Coastal Resources Management's Wetlands Data Viewer.[7] For some states, the spatial data is only available internally to state employees.

[3] Available at http://fdep.maps.arcgis.com/home/webmap/viewer.html?webmap=e88e14fa17ad4a2ca49d63a6016f3eaf&extent=-88.8398,24.5257,-76.7108,31.5023.

[4] Available at http://sonris-www.dnr.state.la.us/gis/agsweb/IE/JSViewer/index.html?TemplateID=181.

[5] Available at www.watershedresourcesregistry.com.

[6] Available at http://www.depgis.state.pa.us/emappa/.

[7] Available at http://ccrm.vims.edu/gis_data_maps/interactive_maps/disclaimer_wetlandsdataviewer.html.

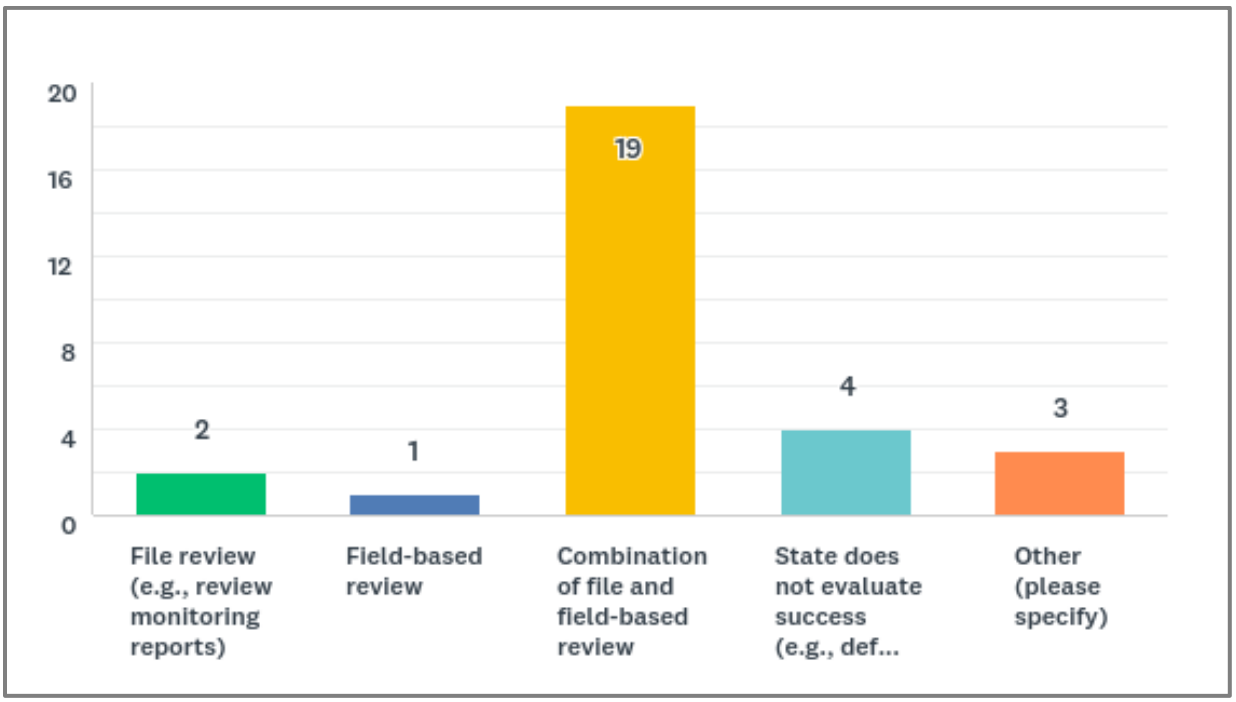
III. Evaluating for Success

In this section of the assessment, participants were asked how they evaluate the success of compensatory mitigation across their state, based on the following choices:

- File review (e.g., review monitoring reports)
- Field-based review
- Combination of file and field-based review
- State does not evaluate success (e.g., defer to USACE)

Of the 22 states that reported that they evaluate success of compensatory mitigation, the responses nearly all indicated that they do a combination of file and field-based review (Figure B-5). However, this is often case dependent or only when funding is available. Four participants reported that their state does not evaluate success.

FIGURE B-5: State evaluation of the success of compensatory mitigation.

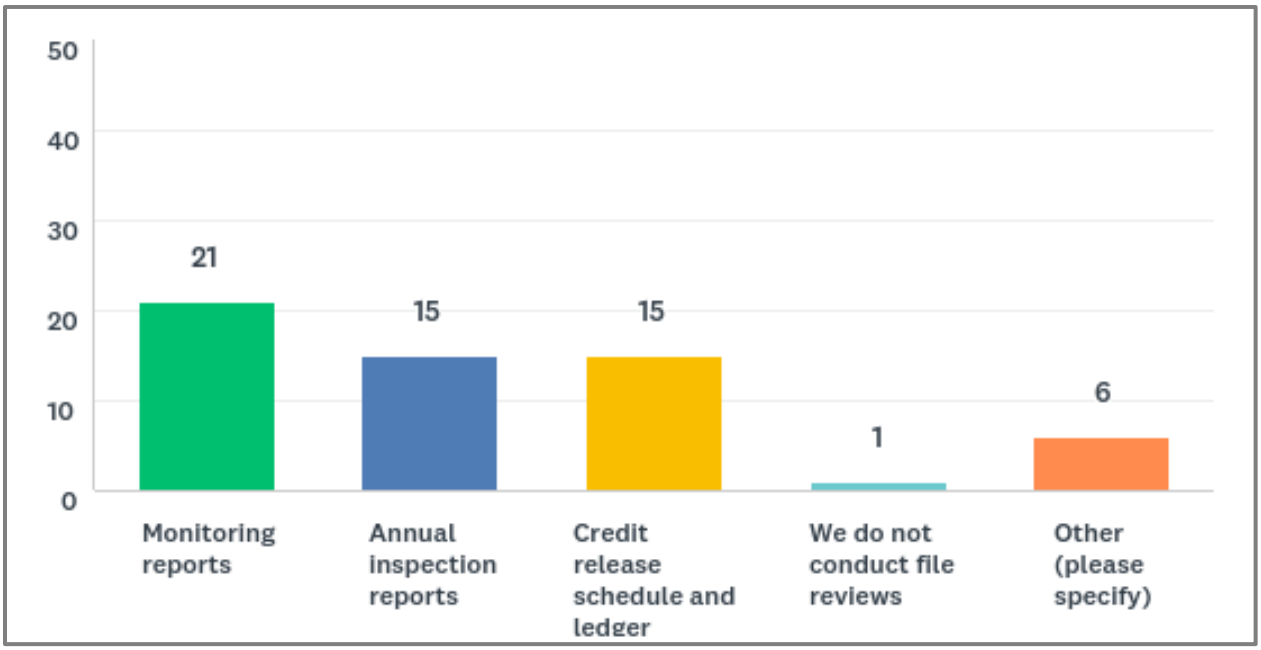


When project files are being evaluated, the majority of states are reviewing monitoring reports to determine whether project is meeting performance standards (Figure B-6). To a lesser extent, states are also looking at annual inspection reports, as-built reports, permit documents, protection mechanisms, and credit release schedule and ledgers.

When evaluations are being conducted in the field, states are mostly verifying results in monitoring reports to determine whether the project is meeting performance standards. Only four respondents indicated that they determine whether goals and objectives are being met using

measures other than the performance standards. Similarly, only two respondents determine whether the project is meeting water quality standards or other independent measures of function or condition.

FIGURE B-6: Project documents that states reported evaluating to determine success.



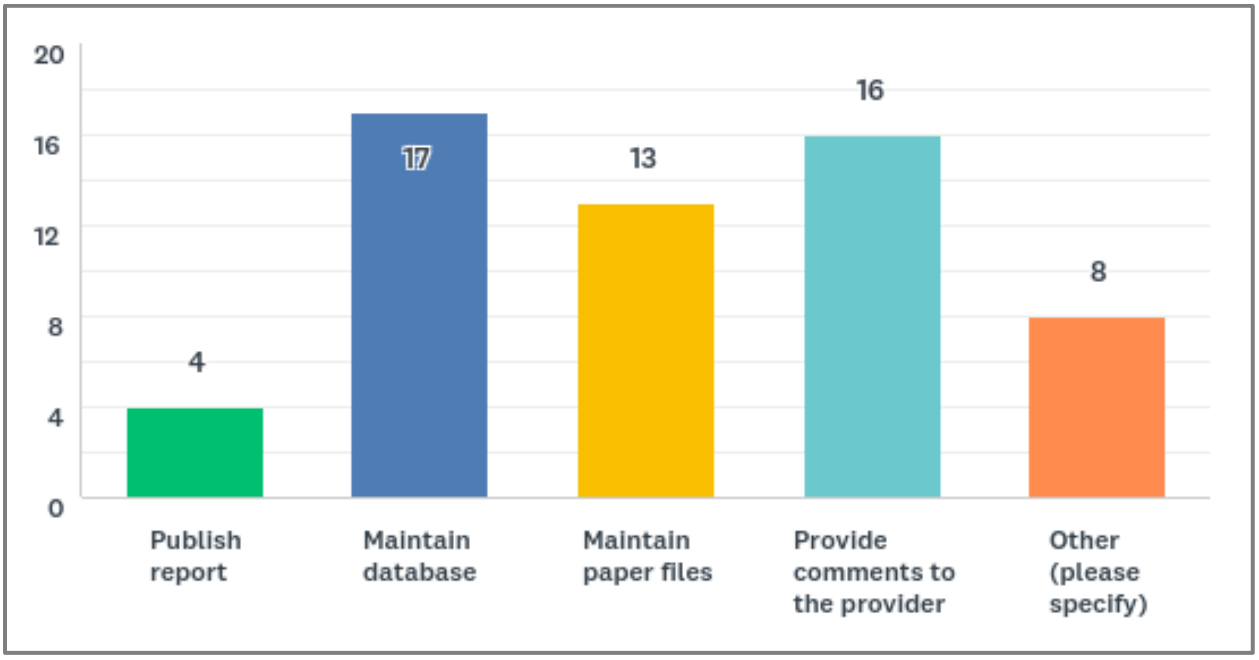
Based on responses, the selection and frequency of site evaluations is variable across states in both protocol and practice. Some states indicated that they attempt to have all sites evaluated annually, but that may not actually occur due to a variety of obstacles. Some states resort to random selection of review sites, prioritize sites to review based on risk, or evaluate when complaints are received--all of which are done when time allows.

Participants were also asked what they do with the results of evaluations. Answer choices included:

- Publish report
- Maintain database
- Maintain paper files
- Document in comments to the mitigation provider and/or the permitting authority

Most participants indicate they are maintaining a database and providing comments to mitigation providers or regulators (Figure B-7). Additionally, approximately half still maintain paper files. Overall, the data is mainly being used for internal purposes related to permit compliance requirements. The data is also used to determine timing on site and credit releases and maintenance or adaptive management needs. Only four states indicated that they publish reports.

FIGURE B-7: What states reported doing with the results of evaluations.



The availability of reports to the public is mainly a case-by-case situation for most states. In addition to what is eventually posted to RIBITS for mitigation banks and ILF projects, most states indicate that, upon request, they will share the results of evaluations. Some states also post the results on a publicly accessible internal site or public database. Certain regulatory agencies and groups additionally receive the evaluations for banks and ILF program projects due to involvement on the interagency review team.

IV. Enhancing Compensatory Mitigation Work

The final section of the assessment asked several questions on challenges and success in working toward improving the efficiency and effectiveness of compensatory mitigation.

Staffing issues was cited as the main problem for the majority of the states in their efforts to track and evaluate compensatory mitigation. This is true both in terms of the needing funding for sufficient staffing and high turnover rates generally in the field. The lack of staff prevents the ability of states to do long-term evaluations or conduct field monitoring and analysis. States also indicated there was a need for more support staff in both the IT and legal departments. As states begin to update old management systems or programs, there is insufficient staff available to properly carry out these transitions.

Consistency and quality control issues in data management were another frequently reported problem. Incomplete or inaccurate data can prevent the state from conducting long-term analyses or contributing to national analyses. States are also facing problems from data being submitted from mitigation providers, contractors, or other outside sources in the wrong

format or incomplete. Participants indicated a need for standardized protocols across mitigation programs and types.

In addition to a general lack of funding or resources being an obstacle that prevents states from undertaking this effort, the lack of support or priority by decision makers impedes the ability of states to carry out this work.

Participants also shared details on successes and strengths in their programs. Open communication and long-standing partnerships with other agencies, nongovernmental organizations, and other groups is great benefit to compensatory mitigation. Supporting watershed planning on a state level is also an important step in effective mitigation.

Additionally, states that issue their own permits and have a strong compliance program have more success with ensuring effective mitigation. Another strategy provided is to focus on avoiding and minimizing impacts to avert the need for mitigation.

Finally, the ability to utilize data in a spatially relevant way was seen as crucial for state evaluation of compensatory mitigation. This is particularly true for states in the process of digitizing files or moving to new formats or programs to keep in mind. Additionally, finding a way to incorporate this visual element in such a way that not only meets internal state agency needs, but also benefits the federal government, academia, and the public, is seen as equally crucial.

APPENDIX C – DATA COLLECTION TEMPLATE

The compensatory mitigation data collection template is an Excel-based spreadsheet that includes several tabs designed to track the minimum data that recommended to be collected at each compensation site. The template is meant to provide a starting point for states that have not already developed databases for tracking data on compensatory mitigation projects. But, it provides recommendations for how to structure a database, including the necessary metadata that should accompany each worksheet, and some tips for QA/QC that may be applicable for all states.

TAB NAME	DESCRIPTION
Metadata	Data that should be included with the dataset so that it can be shared across agencies.
Project ID	Tracks information about the project that will carry across all data entry worksheets. Data Includes project ID, permit number(s), and contact information for each mitigation project.
Basic Information	This worksheet tracks the minimum information about each compensation project necessary to conduct further evaluation of the state's compensatory mitigation program. Data includes background information, size, location, mitigation mechanism, mitigation method, resource type and classification.
Basic Information Dictionary	This worksheet includes information about each of the data elements/attributes in the basic information worksheet. This information helps to ensure quality control in the data collection and input and allows data to be more readily shared among internal and external users.
Monitoring Data	This worksheet tracks the minimum monitoring data necessary to conduct the kind of evaluations outlined in this report. The fields in this tab are designed to track summaries of collected monitoring data. If appropriate and feasible, database designers may want to design a tab(s) to track the actual monitoring data. Additional monitoring data worksheets could be added as needed and appropriate to collect various kinds of data (e.g., water quality, vegetation, hydrology, etc.).
Monitoring Indicator Measure Options	The monitoring indicator measure options worksheet lists the measurement options for each of the monitoring indicators included in the monitoring data spreadsheet (in the drop down menus for each indicator). This should be customized to include the methods/protocols employed by the state.
Monitoring Data Dictionary	This worksheet includes information about each of the data elements/attributes in the monitoring data worksheet. This worksheet should be customized based on the indicators and measures employed by the state.

The complete data collection template (Excel spreadsheet) is available on EPA's website under Compensatory Mitigation Resources - https://www.epa.gov/cwa-404/background-about-compensatory-mitigation-requirements-under-cwa-section-404.