USES OF WETLAND MONITORING AND ASSESSMENT: CONSIDERATIONS FOR STATE AND TRIBAL PROGRAMS

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Preface and Acknowledgments

Wetland management has been described as an intersection of science, law, and public policy. However, whenever law and policy become contentious, we hear the call for better science. And at the heart of the scientific process is the gathering and analysis of data to help us answer questions about our world.

Numerous techniques to measure and evaluate wetlands have been developed and refined in recent decades, and ongoing academic research will undoubtedly continue this trend. However, state and tribal wetland management programs are still learning how to use the wealth of data being collected, and to design and integrate the best monitoring approaches into their own wetland programs and strategies. The purpose of this report is to help states and tribes to advance their use of current and sound data in decision making.

Although many approaches to wetland monitoring will be referenced, it is not our goal to provide a handbook on the use of technical methods, or to direct basic academic research goals in monitoring program design. In short, this is not a handbook on *how* to monitor and assess wetland status and condition, but rather a consideration of *why* we should conduct monitoring as a component of other state and tribal wetland program elements, and of how data can be used in decision making. We will provide basic information regarding various approaches and their use, and links to references.

In gathering information for this report, we have relied heavily on the experience of a number of states and tribes; those who participated in workgroups or other settings are listed in Appendix 2. We are also grateful for the funding of this project by a U. S. Environmental Protection Agency (EPA) Wetland Program Development Grant from the EPA Office of Wetlands, Oceans and Watersheds and The McKnight Foundation. EPA also provided significant technical support and advice from numerous individuals, including but not limited to our project officer Myra Price as well as Regina Poeske and Gregg Serenbetz. Thank you all for your support.

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INTRODUCTION:
WETLAND MONITORING FACTS AND FRAMEWORK

For purposes of this report, ***wetland monitoring*** refers to the gathering of scientific information to use in answering one or more management questions. ***Wetland assessment*** refers to the companion task of evaluating data to reach conclusions regarding a wetland or group of wetlands. In most state and tribal programs, wetland monitoring and assessment are not ends in themselves, but are used to guide decisions in a science-based manner. (By contrast, some basic research may have less specific goals, seeking greater understanding of the components of wetland systems but with a less defined ultimate application.) Monitoring and assessment programs may obtain data from a range of sources, including on-the-ground sampling, remote sensing (and GIS methods), or current research by sister organizations or institutions. While wetland assessment is also informed both by existing published information and by professional judgment, this report will focus on the gathering of new data.

Of course, not all management decisions require monitoring. In many instances, and through most of the era of active wetland management in accordance with the federal Clean Water Act and parallel state and tribal regulations and programs, wetland managers have relied on research results published in textbooks and journals, on their academic background, and on best professional judgment developed during a career of working with wetland ecosystems. These sources of information will continue to be the basis for the majority of day to day tasks.

But given the complexity and diversity of wetland systems, their functions, and their relationship to other natural resources, more detailed and site-specific or current information may be needed to provide the best response to management concerns. The following are just a few of a wide array of questions facing wetland managers:

- What is the condition (sometimes referred to as health) of wetlands in my state or on tribal lands?
- Where is the best location for wetland restoration projects to improve habitat?
- Should a permit be issued for a construction project that will alter or destroy a wetland?
- How do wetlands in this watershed contribute to flood storage? To water quality protection?
- How should purchase/preservation of wetlands in this ecoregion be prioritized?
- How successful was this mitigation/restoration technique in replacing lost functions and values?
- How is storm damage related to the extent of wetland buffers?

Additional examples of monitoring questions are included throughout this report.

An EPA framework for wetland monitoring and assessment programs The study of wetlands is as diverse as wetland ecosystems themselves. The EPA has developed an effective framework to organize the multiple activities that can be incorporated into state, tribal or other monitoring and assessment programs. This framework, illustrated in Figure 1, organizes assessment and monitoring into three levels:

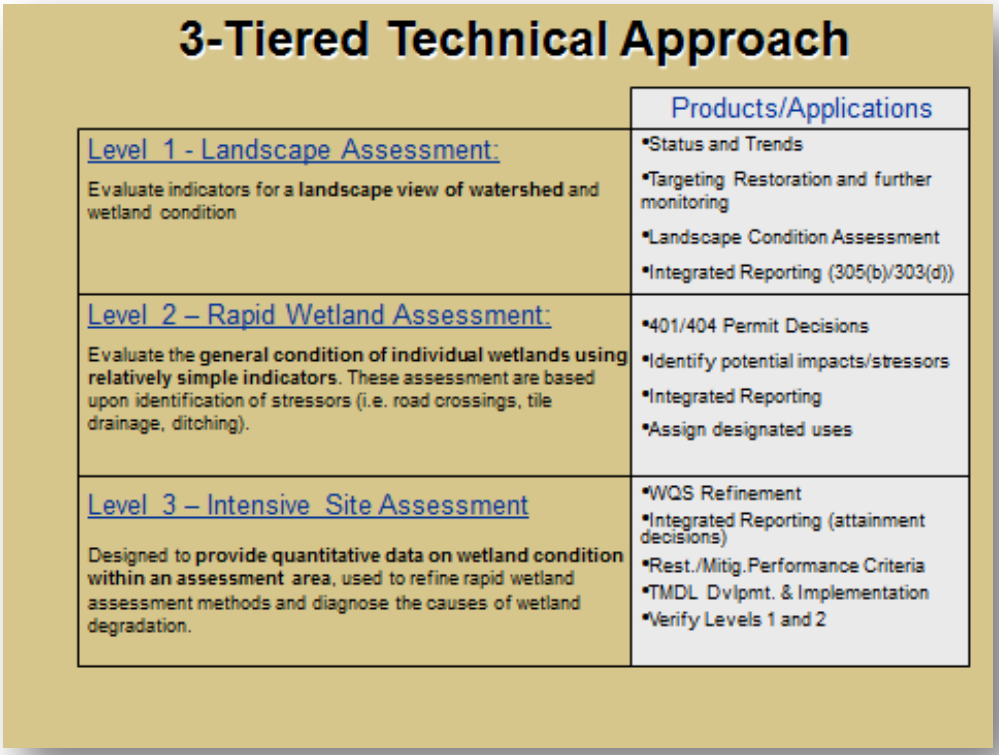
Note: Throughout this document, follow the hyperlinks for additional information on the indicated topic.

- Level 1 – Landscape Assessment - relies primarily on mapping, remote sensing, and modeling to evaluate wetlands on a regional, statewide, or watershed scale. This approach provides a "big picture" that can be very useful for explaining state/tribal wetland condition to the public, and for tracking changes over time.

- Level 2 – Rapid Wetland Assessment – refers to on-the-ground site specific work that can be done quickly and in a single visit. As such, rapid assessment methods rely heavily on readily visible indicators of wetland condition, on identification of local stressors (e.g. land use, wetland alteration) which impact condition, and on best professional judgment to fill in gaps. This type of assessment can support regulatory decision making, decisions regarding restoration or preservation, and similar needs.

- Level 3 – Intensive Site Assessment – includes more traditional, longer term scientific investigations. Detailed chemical, physical, and biological information may be gathered over time using traditional scientific methods. Intensive assessment may often be conducted by third parties as academic research, but results can be evaluated to develop more rapid indicators or indices.

Please refer to Appendix 1 for an overview of some commonly used wetland monitoring and assessment methods.



EPA Framework for Wetland Monitoring and Assessment

An EPA framework for state and tribal wetland programs The U.S. EPA has also developed an approach to organization of the components of state and tribal wetland programs. This framework envisions a focus on one or more of four "core essential elements" of a state or tribal wetland program. These include:

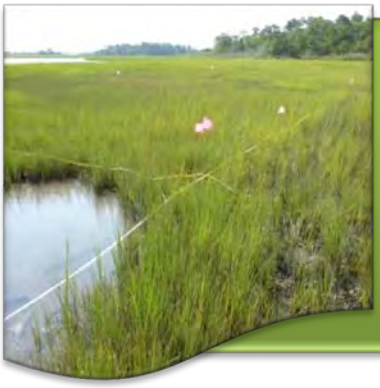
- **Regulatory activities, including §401 certification;**
- **Voluntary restoration and protection;**
- **Water quality standards for wetlands; and,**
- **Monitoring and assessment.**

These common elements were defined with state and tribal input, and provide a logical and comparable framework for planning and discussion in all states and tribes. However, this framework is also highly flexible. EPA encourages but does not mandate inclusion of all of these elements in a state program strategy. On the other hand, states and tribes have added other elements that are key to their individual needs, such as education, climate change adaptation, or cultural concerns.
While monitoring and assessment is listed as a stand-alone element (and in fact is likely to require significant attention given the complexity of a well-designed monitoring program), monitoring should typically be closely linked to other program elements, and designed to respond to one or more programmatic questions or concerns of those elements.

In this review, ASWM has added program elements that can also be supported by monitoring and assessment. These include climate change, public education and information, and integration or coordination with other water programs to illustrate how states and tribes can add program elements as needed. Note that development of a state or tribal wetland monitoring program may begin anywhere within this matrix, although some starting points are easier than others.

A few additional definitions may prove helpful when reading this report:

> ***Wetland condition*** refers to the chemical, physical, and biological characteristics of a wetland and how those conditions compare to a ***reference*** or undisturbed wetland. Wetland condition may be defined by terms such as good/fair/poor; pristine/degraded; type A/B/or C; or by more specific measurements defined by the monitoring technique.
>
> ***Wetland function(s)*** are the physical, chemical, and biological processes that occur in wetlands that often provide human uses or benefits, such as flood storage, filtering of sediment from runoff, provision of fish and game habitat, or recharge of aquifers. The ability of a wetland to provide functions that are beneficial (or of value) to humans may be related to its condition, but is more closely related to its type, its location on the landscape, and need for the benefit provided.
>
> ***Wetland status*** typically refers to the current extent of wetlands and their current condition.
>
> ***Wetland trend*** refers to the relative gain or loss of wetlands, the rate of ongoing gain or loss of wetlands, or changes in wetland condition over time.
>
> ***Sampling design*** is a plan for sample collection that specifies the number, type and locations (spatial and/or temporal) of units used in the assessment. One major purpose of the design is to ensure the collection of data that are (1) representative of the area or type of wetland of interest, and (2) adequate to support logical conclusions about the population of interest. [ref – GLWC plan]
>
> ***Reference wetlands*** can be defined in more than one way depending on the purpose of a study. Generally, reference areas are ecosystems that are essentially undisturbed – i.e. that have a condition similar to what would have been expected prior to European settlement. Where no such wetlands still exist, reference wetlands may be the *least* disturbed existing sites. In some instances, however, where the full range of wetlands is being defined, "reference" sites may refer to those that exhibit the best, the worst, and average wetland conditions.



Basic Considerations for Development and Design of a State or Tribal Wetland Monitoring Program

Wetland monitoring is expensive and time-consuming. It demands significant technical expertise – in gathering of chemical, physical and biological data; in the assessment of remote imagery and use of GIS; and in data interpretation and management. The development of a monitoring program should thus be well planned, defined in a manner that makes the need for and benefits of the program clear to managers, and carried out with the highest degree of technical expertise possible.

It is expected that the needs and concerns as well as resources of each state or tribe will be somewhat unique, and that an effective wetland monitoring program will thus be tailored to those needs. This handbook includes typical questions for each wetland program element that may be addressed by monitoring and assessment programs. These questions – and others unique to each agency – are intended as a starting point for thinking about monitoring and related program development. We also offer examples of how various states and tribes make use of monitoring data.

Guidance on development of a water monitoring program for wetlands is available from EPA in these documents:

Elements of a State Water Monitoring and Assessment Program

Application of Elements of a State Water Monitoring and Assessment Program for Wetlands

EPA's guidance recommends inclusion of the following 10 elements:

1. **Monitoring Program Strategy**
2. **Monitoring Objectives**
3. **Monitoring Design**
4. **Core and Supplemental Indicators and Methods**
5. **Quality Assurance**
6. **Data Management**
7. **Data Analysis/Assessment**
8. **Reporting**
9. **Programmatic Evaluation**
10. **General Support and Infrastructure Planning**

General considerations for development of a wetland monitoring program regardless of the associated program element(s) include the following:

- **Match monitoring to existing program elements and needs.**

- **Identify available (or potentially available) staff expertise. Consider the need for new hires, training, or collaboration to obtain necessary knowledge and experience.**

- **Do not overlook the need for appropriate statistical analysis in the sampling design.**

- **Consider availability of sampling and analytical equipment needed (including boats etc.), as well as computer resources.**

- **Provide adequate staff training in monitoring methods.**

- **Take the opportunity to collect data that can serve multiple needs.**

- **Consider partnering with other programs (water, fisheries, forestry, highways), federal agencies, with academic institutions, or with business or nonprofit organizations (NGO's). (Many business interests, for example, use GIS data.)**

- **Plan for and consider long term needs – how frequently will monitoring be repeated? How will cost be routinely covered?**

- **Plan for data storage in a location that is accessible to all users. Consider sharing with the public to the extent possible given security needs.**

- **Develop a long term plan to help define the sequence for development of program elements. For example, if Level III data is needed to develop a Rapid Assessment Method, this work will of necessity proceed first. Establish priorities to obtain most important information first.**

"...deciding how to sample is often difficult, because one must consider trade-offs between the costs and benefits of the amount and type of sampling undertaken. Thus, any sampling design represents a balance between the study objectives and the constraints of cost, time, logistics, safety, and existing technology."

-*Great Lakes Wetland Consortium Sampling Plan*

The Importance of Sampling Design and Statistics

Once the goals of a monitoring program are defined, the importance of sampling design and statistical analysis cannot be overemphasized. A detailed discussion of statistical design is beyond the scope of this report (and also well beyond the expertise of the authors), but early consultation with an expert in this area is essential.

If data is being routinely gathered for general information purposes (e.g. updating maps of the extent of wetlands of various types, or of permitted wetland losses), then the statistical design may be less important. However, if the intent is to demonstrate variation in condition, or to evaluate trends over time, then the design must ensure collection of enough of the right kind of data to make these distinctions.

For examples of design of a complex wetland monitoring program, see materials developed for the National Wetland Condition Assessment, including information on design and the field manual.

For a complex regional assessment see the Great Lakes Coastal Wetland Monitoring Plan, developed by

the Great Lakes Coastal Wetlands Consortium. This is a joint project of multiple academic institutions in the U.S. and Canada, and was carefully designed to collect a great deal of information that would be useful to state and provincial agencies, with a design that is practical enough to be repeated over time. It includes a chapter on the statistical design that was used.

Please see Appendix 5 for a summary of current state wetland monitoring programs and projects as reported by the states under an ongoing ASWM study.

Monitoring to Inform Wetland Extent, Condition, and Water Quality Standards

The Federal Regulatory Basis for Water Quality Standards and Related Programs

The federal Clean Water Act includes provisions for definition of water quality standards by all states and tribes in §303 of the Clean Water Act (CWA). Simply speaking, water quality standards are narrative (descriptive) or numeric standards used to define the range of physical, chemical, and/or biological conditions in "normal" ("clean" and uncontaminated) waters within the state or tribal boundaries. Waters that have been polluted or degraded have characteristics that fall outside of the normal conditions defined by the standards. States are obligated to provide a biennial report to EPA that defines the extent of waters that fail to meet either state water quality standards, or to meet federal fishable/swimmable goals. The EPA has issued National Guidance on Water Quality Standards for Wetlands (designated as Appendix D of the Water Quality Standard Handbook: Second Edition, August 1994).

State water quality standards are also critical in making decisions regarding certification of federal regulatory decisions under §401 of the Clean Water Act. This provision gives states the opportunity to review and either block or condition permitting or licensing decisions by federal agencies that would result in a violation of state water quality standards or other appropriate requirements under state law. §401 thus provides the states with a significant role in review of permitting decisions under §404 and other federal programs that could impact state lakes, streams, and wetlands.

Development of wetland water quality standards Water quality standards for lakes, streams, and marine waters are relatively well-defined at this point in time, although most state standards have been and continue to be refined since passage of the CWA. However, it has proven more challenging to define water quality standards for the wide array of wetland ecological types – and in particular for "drier" wetlands that do not always have standing water. Defining "normal" numeric chemical standards in particular is challenging in wetlands given that under normal conditions metrics such as pH, nutrient concentrations, and dissolved oxygen can cover an extremely wide range, and many metrics vary greatly daily or seasonally. Given these factors, biological standards for wetlands are often emphasized (for an overview, see EPA's Wetland Bioassessment Fact Sheets). Narrative standards requiring that wetlands be "free from" contaminants such as oil and grease are also often utilized.

More specific standards must typically be supported by monitoring data that can define wetland

condition in terms of biological integrity or distinguish between fully functioning and polluted or degraded wetlands. Common methods used to evaluate biological condition include Indices of Biological Integrity and Floristic Quality Assessments. Measures of soil condition, water chemistry, and hydrologic factors have also been considered.

Biological integrity is "the ability of an aquatic ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region."

-Karr, J.R. and D.R. Dudley, 1981

Typical Monitoring Questions Associated with Wetland Water Quality Programs

Monitoring and assessment programs are used to address numerous questions raised in the development of wetland water quality standards, as well as during evaluation of the status of and trends in wetland condition and function. Typical questions that may be answered by wetland monitoring and assessment programs include the following, which may be based on state or federal, regulatory or non-regulatory concerns.

- What is the **extent** of wetland gains and losses in a given state since a specified baseline (e.g. European Settlement, initiation of a regulatory program, or initiation of a monitoring program)?

  This type of question is typically addressed by a Level I (landscape level) measure, often using GIS or other remote sensing methods.

- What is the **condition** of wetlands in a given state?

  Measurement of condition generally requires Level II or III methods, which may be carried out based on statistically random sample of all wetlands or specific wetland types, or of wetlands in a priority geographic area or watershed.

- What are the **trends** in wetland extent and condition in a given state?

  Development of a long term strategy to repeat monitoring, possibly combined with evaluation of remote data collected over time is needed to respond to this inquiry. It will be important to limit changes in sampling methods over time so that results are comparable and to develop a database that is populated consistently from the beginning.

- What is the condition of a wetland that may be impacted by dredge and fill or other federal permit programs? How will the state respond in terms of a §401 water quality certification?

  The evaluation of an individual site in a timely manner as needed to respond to a permit or license application is typically done using a Level II Rapid Assessment Method (RAM), Floristic Quality Assessment (FQA), or similar method that can be carried out in a matter of hours, rather than days. These methods are scientifically based, but also require application of best professional judgment. Over time, the accumulation of data from rapid assessments can provide a broader view of condition at a state or watershed level.

- How should numeric limits be defined in my state or tribe's water quality standards?

  Definition of the range of normal chemical, physical, or biological conditions will require Level III monitoring for the parameters of concern over a wide geographic area. Literature values are a good starting point, but will need to be confirmed within the state across the full range of conditions (from undisturbed to highly degraded). It is expected that water quality standards will be refined as the state or tribal database of sampled wetlands expands.

Some examples of monitoring programs and data applications

States and tribes rely on data collected from wetlands by their own programs, by federal agencies, or in collaboration with other entities in evaluating wetland condition. State or tribal programs are more apt to collect data specifically needed by a state, and to draw appropriate conclusions regarding conditions specific to a state or sub-state area. However, even larger scale national programs may provide information that is useful in a general manner, or as a starting point for state efforts.

Measuring national status and trends – USFWS Reports
Since the 1980's, the U.S. Fish and Wildlife Service (USFWS) has produced a series of reports on the status and trends of wetlands in the nation and various regions. These reports make use of landscape level methods and GIS resources to summarize changes nationwide, and to highlight trends over time. The information provided by these reports has contributed significantly to development of national priorities and policy.

Evaluation of state level status and trends – an example from Oregon
Some states, including Oregon, have built on national status and trends reports to compile a more detailed evaluation at the state level. In Oregon, reports on wetland status and trends are made available to the public through the *Oregon Wetlands Explorer* digital library.

Development of state wetland water quality standards – use of monitoring in New Mexico's
In New Mexico, the protection of relatively rare wetland resources is being advanced by development of water quality standards that are backed up with statistically valid water quality monitoring data. See this PowerPoint presentation on ASWM's web pages for a summary of the project.

Great Lakes Coastal Wetland Monitoring Project – an international basin wide study
This project, as noted above, is collecting chemical, physical, and biological data from coastal wetlands across the Great Lakes basin. Data may be used in a number of ways, but is intended to allow for evaluation of multiple trends over time.

The National Wetland Condition Assessment
In 2011, the U.S. EPA and cooperating state and tribal partners carried out the first National Wetland Condition Assessment (NWCA). This wetland monitoring program – carried out nationwide during a single season – follows other national water assessments for inland lakes, wadable streams, rivers, and nearshore waters. The EPA has defined the following three goals for NWCA:

1. Produce a national report that describes the quality of the nation's wetlands;

2. Help States and Tribes implement wetland monitoring and assessment programs to guide policy development and project decision-making; and,

3. Advance the science of wetlands monitoring and assessment.

The metrics (or measurements) included in the NWCA procedures were developed following extensive discussions among EPA, other federal agency staff, states and tribes, and academic partners over a period of years. Initial sampling protocols were simplified to make the process both economically and logistically feasible, and to encourage repetition on a 5 year cycle.

One purpose of the 2011 NWCA was the continued development and testing of effective and efficient monitoring protocols. In addition, state and tribal staff were invited to participate in gathering of data; in the process, detailed training was provided to participating states in new monitoring methods, and participants also gained on the ground experience.

As of this writing, the U.S. EPA is continuing to evaluate data collected in 2011. States will have access to a draft report by early 2015, and it is anticipated that a final report will also be released in 2015. See Appendix 4 for NWCA outreach templates.

Monitoring to Support Science-Based Regulatory Decisions

Wetland regulations have arisen from public recognition of the need for protection of the wetland component of aquatic ecosystems. State and tribal, as well as national regulations also recognize the necessity of making sustainable use of the multiple benefits provided by wetlands, and that impacts for a number of purposes may be unavoidable. Regulations thus require routine decisions that reflect the reality of specific proposals (permit applications), and involve assessment of the importance of a specific wetland ecosystem, the impact of a proposed action on that system, and the definition of regulatory conditions that will minimize unavoidable impacts or mitigate for their loss. In spite of the fact that both state and federal agencies issue the majority of permits requested – albeit with conditions – there remains a perception among some policy makers that wetland decisions are somewhat arbitrary or excessively burdensome. Public officials have often emphasized the need to make science-based decisions based on a project and site specific assessment.

This desire for scientific specificity is impeded by an opposing desire for rapid permit review and decision-making with limited additional cost to the project sponsor (or to publicly funded agencies). The practical result of all of these factors are regulatory criteria and guidelines that generally reflect published and accepted wetland science, and application of this knowledge using best professional judgment on a routine basis. There is no doubt that regulatory guidelines have improved with development of the science; they have also become more complex.

Cost and timeliness. As noted elsewhere in this report, both the development and implementation of monitoring methods are expensive and time consuming. Ultimately, the gathering of a reasonable amount of information is essential to the development of an effective and balanced regulatory program that meets the specific needs of a state or tribe. Evaluation of the effectiveness of a regulatory program should also include specific information that will lead to conclusions regarding the benefit to wetland resources.

However, the application of monitoring methods in permitting decisions needs to be carefully planned to gather only information that is useful in decision-making. This means significant data needs to be collected while avoiding collection of data that is unlikely to be used in permit decision-making. The regulatory process becomes less effective and efficient when agencies carry out unnecessary studies, or require inappropriate evaluations from a permit applicant. Best professional judgment has always played an important role in wetland regulatory decision making, and for minor projects an assessment by experienced staff is often totally sufficient without site specific monitoring. This is particularly true when the applicant has provided a complete permit application containing good information on current

conditions and projected impacts. Where minor projects are covered by nationwide or other general permits, no additional site assessment may be needed if a project meets general permit criteria.

In other instances, a formal rapid assessment of a site may help to ensure consideration of all important factors, to improve consistency among decisions made by different staff or agencies, to analyze the multiple factors associated with a large or complex project, and to provide documentation of a scientific review if a permit decision is challenged. Additional time spent early in the review process may thus save time later during evaluation of a permitting decision.

In considering monitoring approaches, both the short term and long term information needs and benefits should be weighed in deciding on an appropriate monitoring program that will yield useful and valuable data.

Some typical regulatory questions addressed by monitoring

State and tribal wetland monitoring programs are used to support the regulatory framework in a number of important ways. Questions addressed by monitoring include the following:

- **What is the condition of a wetland that may be altered as a result of permit decisions and how important is that wetland? What functions and public benefits does it provide?**

  Level I information provides basic information regarding the location of the wetland in the landscape, its size relative to other wetland resources and potential functions based on landscape position and adjacent land uses.

  A Level II rapid assessment may also be utilized to obtain more detailed, on the ground information regarding boundaries and ecological conditions.

- **What secondary and cumulative impacts may result from a proposed action?**

  Level I information may be useful in determining both secondary and cumulative impacts. Secondary impacts are likely related to adjacent and downstream land uses and hydrologic patterns that may be altered by a project. Mapping of historic wetland changes, or Level I tracking of permitted wetland alterations over time can assist greatly in assessment of cumulative impacts.

  Level II and III information gathered in watershed plans can also inform these decisions, as is done in the Wisconsin DNR's *Wetland Rapid Assessment Methodology*, in which secondary impacts are identified based on an evaluation of buffer areas.

- **In the event that a proposed project must be significantly modified, or denied, what evidence is there to support that decision?**

  Completion of a science-based and site specific assessment (Level II) will help to support a permit denial in the face of challenge (and likewise support issuance of a permit in controversial situations) and support the decision if there are legal challenges. Level I information may be useful in exhibits to explain the decision.

- **If mitigation is required, where should it be located and how should it be designed?**

  Given the focus on off-site mitigation in current regulations, the use of Level I maps and watershed plans will help to guide planning and acceptance of mitigation proposals.

- **From a programmatic standpoint, what routine permitting criteria and standards should be used? Mitigation requirements?**

  Follow up studies (Level II or III) of permitted projects may help to establish the effectiveness of current permitting guidelines.

  Evaluation of the success of mitigation projects associated with issued permits will help to guide revisions of mitigation requirements.

- **What is the extent of unauthorized impacts associated with permit violations, and to what extent can they be corrected?**

  Multiple forms of monitoring and assessment may be used to gather information in an enforcement investigation. Level I information may provide a basic assessment of before and after conditions. Level II or III assessments of adjacent undisturbed wetlands may help to define the loss.

  Can altered wetlands be restored? If so, what criteria should be used to define attainment of project goals?

  If illegally impacted wetlands cannot be restored, how might the functions and values that those wetlands provided be replaced elsewhere? Level III watershed studies, if available, can support these decisions.

Some Examples of Data Applications

Given the variation in state and tribal wetland programs across the geographic expanse of the U.S., there are many approaches that could be used in monitoring wetlands to support program needs. Some of the questions listed above are related to the development of a regulatory program, while others are applicable to the review of individual permits or mitigation requirements. Both categories are good reasons to develop a monitoring program, but it should be noted that rapid site assessment methods (for individual permit decisions) must generally be based on and confirmed by a broader and more intensive monitoring program.

The follow examples are included to provide some idea of how states and tribes apply monitoring and assessment data in a regulatory context.

Those who are unfamiliar with the methods discussed in these examples may want to begin by reviewing Appendix 1, which provides a broad overview of common methods and provides references to additional information.

Definition of regulatory criteria – an example from Ohio

The Ohio Environmental Protection Agency (OEPA) has a long history of water quality monitoring – including biomonitoring. The state's methods for wetland monitoring were developed in collaboration with nationally known research scientists. Their regulatory program for wetlands is built on §401 certification of U.S. Army Corps of Engineers permits – and thus is closely tied to state water quality standards. Ohio also has an isolated wetland law to protect wetlands not regulated under the CWA.

Ohio's wetland regulatory program is significantly enhanced by the Ohio Rapid Assessment Method (ORAM) which has been developed, tested, and refined extensively in Ohio, and also used as the basis for a number of rapid assessment methods (RAMs) in other states. Significantly, ORAM not only provides an overview of wetland condition at a specific site, but the results – the ORAM score - are used to guide application of the state's antidegradation requirements. Other monitoring methods, including a vegetative Index of Biotic Integrity (VIBI), amphibian index of biotic integrity (AIBI), and a Floristic Quality Assessment for Ohio may also be used to support decision making.

These assessment methods, and ORAM in particular, are used to rank wetlands into one of three categories.

- Category 1 wetlands are considered to be limited quality waters. They may be isolated and significantly degraded, such that functions and values are limited. In the regulatory process, the state's antidegradation rule (a part of the water quality standards) sets a lower bar for approval of actions that may further degrade these wetlands by limiting the social and economic justification that is required. Mitigation for the loss of Category 1 wetlands may also be considered earlier in the review process, rather than as a "last resort".

- Category 2 is a large category of "good" wetlands. The antidegradation rule requires a sequencing of regulatory considerations including avoidance, minimization of impacts, and social/economic justification for the project. Compensatory mitigation is considered only as a last resort.

  A special category of "degraded but potentially restorable wetlands" are also considered to be Category 2.

- Category 3 wetlands are rare or provide superior habitat. For these wetlands, the antidegradation rule, in addition to Category 2 sequencing, prohibits use of the wetland unless the proposed action is necessary to meet a demonstrated public need.

The ORAM scores that correspond to these categories include gray zones at the margins of these categories, recognizing the need for additional evaluation and judgment for wetlands that are close to a break point. Both the Ohio monitoring and assessment methods and regulatory procedures are detailed and very well-supported by agency study and documentation. A state or tribal program that is interested in linking assessment methods and regulatory requirements may want to carefully review Ohio EPA's approach.

For policy development – an example from Michigan's Great Lakes coast

In the early 2000's, a number of property owners responded to extremely low water levels in the Great Lakes by removing large areas of exposed emergent vegetation – in particular bulrushes. An extended political and legal debate arose regarding the right to remove vegetation below the Ordinary High Water

Mark. In 2003, the Michigan State Legislature authorized vegetation removal on a short term basis, and also required the Michigan Department of Environmental Quality (MDEQ) to study the impact of vegetation removal. A report released by the MDEQ in 2006 was in response to this mandate.

The key to the state's findings was research by scientists associated with state universities who had previously evaluated the impact of human development on fish communities in coastal wetlands. They continued this work in the area of vegetation removal, and their findings – included as an appendix of the MDEQ report – played a major role in limiting alteration of exposed bottomlands.

For rapid evaluation of permit applications – Great Lakes area examples

A number of states (in addition to Ohio) have developed RAM methods to support review of permit applications, as well as other assessment purposes. In order to identify effective indicators for use in a rapid assessment, significant information is needed regarding metrics that can reliably differentiate between degraded and non-impacted wetlands. Effective metrics will differ depending on geographic location, ecological type of wetland, and similar factors. For example, the workgroup that developed Michigan's RAM (MiRAM) found that certain metrics used in Ohio were not effective in Michigan, even given the relative proximity of these states, due to the differing landscape and conditions in Michigan. Development of a RAM may be reliant upon a more intensive (Level III) monitoring program that provides sound background and reference data, as well as the availability of GIS data. Background information may be available from other state or federal agencies, or may need to be obtained by the state or tribal agency.

The relatively new Wisconsin RAM (see text box) requires both desktop and review, and can be utilized to evaluate landscape scale criteria (ecoservices provided, cumulative and secondary impacts.

Some attempt has also been made to develop a rapid assessment method that is applicable nationally – the USA-RAM was tested during the 2011 National Wetland Condition Assessment. Results of this trial are pending.

Example: Wisconsin RAM

The Wisconsin Department of Natural Resources released the ***WDNR Wetland Rapid Assessment Methodology – User Guidance for version 2.0***, in March of 2014. This RAM method incorporates a functional assessment and a condition assessment, along with determination of floristic integrity, and an assessment of the buffer area (stressor checklist). Completion of the overall assessment provides information that can be used to complete a Project Impact Assessment, which identifies both positive and negative impacts of a proposed action, including **direct**, **secondary**, and **cumulative** impacts.

Use of the WDNR RAM requires both desktop and field review. The WDNR has made many of the map layers that may be needed for desktop review available through the WDNR Surface-Water Data Viewer.

For more extensive review of larger scale and complex projects

A portion of §404 permit applications are for large scale projects such as highways, mining, or dam construction. Activities of this scale typically require environmental evaluation under multiple state and federal programs, including the National Environmental Protection Act (NEPA). The Federal Highway Administration (FHWA) has developed procedures to coordinate review under §404 and NEPA, which may require monitoring to define direct, secondary and cumulative impacts. This may include intensive

monitoring (Level III, including use of IBI's) to evaluate the impact of stormwater runoff, landscape level monitoring to support evaluation of alternatives and to identify secondary impacts, and modeling using previously collected data. Typically, the cost of this type of monitoring is borne by state and federal highway agencies.

To assess the suitability of permit conditions and regulatory decisions (permit monitoring requirements) – a Pennsylvania example

It is quite typical for §404 and parallel state and tribal permits to include monitoring requirements, including measures to determine the attainment of performance standards for mitigation of unavoidable impacts. These monitoring requirements are included as permit conditions.

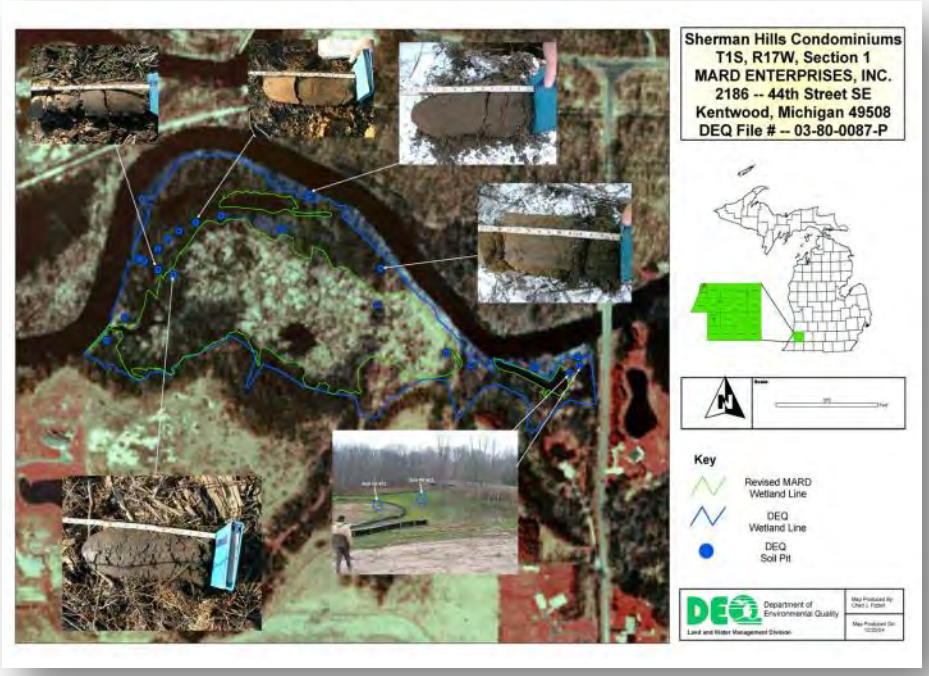
Through the Riparia project at Pennsylvania State University, Dr. Robert Brooks and colleagues have been collecting extensive wetland reference information that can be used to assist defining meaningful performance standards for compensatory mitigation projects as well as voluntary restoration.

To identify potential violations using remote sensing – as implemented in Massachusetts

The Massachusetts Department of Environmental Protection has developed an application of a computer model to detect changes in wetlands in the time period between two aerial photographs. Staff analysis of each change can then distinguish between violations of wetland protection regulations, and either permitted alterations or natural changes in condition. This information is shared with all federal, state, or local agencies to coordinate evaluation of the change and enforcement action. The method has been shown to not only improve enforcement, but to act as a deterrent to unauthorized alteration of wetland sites. Additional information and a summary of the GIS layer and method are available through the Massachusetts GIS program.

To support legal actions

Following a permit decision, monitoring may be carried out either to evaluate compliance with permit conditions, or to defend an appeal of the decision itself. Similarly, detailed assessment of a wetland that has been altered without issuance of a required permit may be needed to support a compliance action.



Courtroom Exhibit showing wetland delineation lines and soils information

The collection of data is simplified if the responsible state or tribe has an established monitoring program that will allow use of routine sampling methods, and also data storage and analysis. An established GIS system also allows for the preparation of exhibits that can greatly visually communicate the situation for legal representatives, and potentially for a trial situation. A sample legal exhibit – shown below – demonstrates use of aerial imagery to illustrate a site, use of GIS resources to measure the extent of impacts and location of on-the ground soil sampling sites, and photography to illustrate sampling. Staff who collected samples and prepared the exhibit testified at trial regarding data collection and interpretation.

Hard data from an established program provides both accuracy and scientific credibility. A wetland evaluation may be further enhanced if the condition of the site can be compared with other typical but undisturbed wetlands based on the results of an ongoing monitoring program.

Monitoring for related water programs

Data on wetland condition may also be used in other state and federal water or pollution control programs, including:

- The National Pollutant Discharge Elimination System (NPDES) to determine the need for discharge limits or to monitor the long term impacts of discharges to wetlands;

- To allocate and limit the discharge of pollutants from various sources (i.e. define Total Maximum Daily Loads or TMDL's) on a watershed basis. States that have reported use of wetland considerations in development of TMDL's include Arkansas, Indiana, Kansas, and Minnesota; or,

- To evaluate the damage caused by a pollution event such as an oil spill into a wetland.

Example: Oil Spill Damage Assessment: Kalamazoo River, MI

Enbridge oil pipeline near Marshall, MI released approximately 840,000 gallons of crude oil to Talmadge Creek, which flows into the Kalamazoo River. Because the river was a flood stage at the time of the spill, adjacent floodplain wetlands were also impacted. Significant natural resource damage resulted from the spill, and also from the use of equipment to remove oil and contaminated soils and sediment.

A Natural Resources Damage Assessment (NRDA) was carried out by state, tribal, and federal agencies to determine the extent of the damage, and to define appropriate compensation. The U.S. Fish and Wildlife Service web page for the NRDA includes extensive information about this process. In particular, note the 2012 Vegetation Assessment Survey Work Plan, which includes the use of Michigan's Floristic Quality Assessment, the Michigan Rapid Assessment Method for wetlands, and a number of additional site assessment methods.

Wetland Assessment & Monitoring to Guide Stewardship: Wetland Restoration, Preservation, and Management

Wetland management and restoration projects have been carried out for many decades, often with both on the ground and financial support from sportsmen or other non-profit groups. In the past, such projects were most often intended to expand or improve fish, wildlife, and waterfowl habitat. Goals were typically straightforward (e.g. an increase in the number of nesting mallards) and relatively simple to evaluate. While restoration and management are still important for fish and wildlife management, current restoration proposals are often more complex. For instance, they may include multiple goals, and design may be based on detailed hydrologic models or watershed plans.

Present day restoration costs are often significant, and may be borne in part by public agencies where a cost-benefit analysis is mandatory. Some funding sources may also require documentation of goal attainment. Wetland regulations may require permit review involving multiple agencies that may differ in their opinion of benefits and secondary impacts (both positive and negative).

Wetland stewardship also takes the form of permanent preservation of important wetlands, either through outright purchase, purchase of development rights, or establishment of conservation easements. Preservation programs can be sponsored by government agencies, or non-profit land conservancies or similar organizations. In any event, the establishment of sound priorities for preservation is important for the effective expenditure of funds as well as staff/volunteer time and attention. Finally, any entity that owns and actively manages a wetland area may be concerned with the effectiveness of management methods being applied, and may wish to evaluate the outcome of such measures. Combining the assessment of wetland resources and the ecological functions with options for wetland preservation, restoration, and management within a watershed can produce a wetland watershed plan that contributes significantly to the overall health of the watershed.

All of these stewardship actions raise questions that may entail assessment of existing wetland resources during the planning phase, as well as evaluation of the success of a management project or program.

Typical questions addressed by monitoring and assessment in wetland stewardship programs

- **What are the priority sites to meet restoration, preservation or management goals over a given geographic area?**

Multiple sources of information may be used to match wetland management sites with the priorities established by state or tribal programs. In some states, systems are in place to connect interested groups or individuals with appropriate restoration sites. The need for specific information should be considered when developing a long-term monitoring program. Missing information may be gathered either with remote sensing or on the ground assessments as needed to complete the picture.

Obviously, Level I mapping resources may provide an initial tool to review available sites and surrounding land use conditions, as well as ownership patterns.

- **Is wetland restoration, preservation, or management a reasonable option to achieve water management goals in lieu of engineered structures?**
  Level I assessment of current and past wetland extent and condition in the watershed may help to define how losses have contributed to current problems, and whether wetland restoration can replace lost functions. On the ground assessment may further help to define capacity to carry out the desired function, e.g. flood attenuation, carbon sequestration, groundwater recharge.

- **What factors may preclude a proposed project?**
  Rapid on site assessments (Level II) may help to screen the suitability of a given site for a proposed project. More detailed (Level III) assessments of hydrology, soil, or other factors may further ensure a successful management project. An evaluation of existing wetland functions may also help to preclude unintended consequences associated with modification ("enhancement") of those functions. In all instances, both current and future hydrology and other site conditions in light of climate uncertainty should be considered.

- **On a watershed scale, what ecological types of wetlands or wetland services are most needed?**
  Landscape level databases that estimate past conditions and wetland losses, may help to define current needs. Other modeling[1] of current or anticipated future flood conditions or water management needs may serve a similar purpose.

- **How effective were the restoration or enhancement methods that were used?**
  This is best achieved if measurable goals were clearly defined in advance of restoration, including time needed to achieve goals. A combination of monitoring methods can then be used to evaluate progress as well as ultimate attainment of goals. An adaptive management approach will allow for modification as dictated by interim (or final) goals and success in meeting those goals.

- **Is the proposed management action worthy of funding by this agency or organization?**
  Monitoring and assessment to demonstrate need, combined with modeling of potential benefits and on the ground evaluation of site suitability will all help to support this decision.

[1] Level I, II, and/or III data can be included in models to understand current condition and future changes.

Examples of monitoring and data applications in stewardship programs

Watershed Planning – an example from Michigan

Addition of key elements to National Wetland Inventory Maps (Level 1 monitoring and assessment) can provide information useful in assigning potential wetland functions or ecosystem services to these maps. The "LLWW" (Landscape Position, Landform, Water Flow Path, and Waterbody Type**)** process, also known as NWIPlus, was developed by Dr. Ralph Tiner of the U.S. Fish and Wildlife Service, and has been used in watershed planning in states including Delaware, Michigan, and Wisconsin.

The Michigan DEQ has used LLWW to support nonpoint source management and watershed planning in a number of watersheds. This post on the ASWM blog outlines one such project. MDEQ first explored used of the LLWW process in two pilot watersheds. Since then, this analysis has been carried out in part with support from the §319 nonpoint source program for state nonpoint source priority watersheds, and also with support for wetland watershed planning through EPA's state wetland program development grants. Completed mapping is posted on a mapping tool available to the public. Over time, the LLWW data coverage for the state has expanded one watershed at a time.

Targeting restoration dollars

The U.S. Fish and Wildlife Service - Prairie Pothole Joint Venture has developed spatial planning tools to support conservation of wetland species. The waterfowl planning tool is a good example of the importance of areas associated with wetlands to support conservation. It is not enough to identify the wetlands; large adjacent grasslands are necessary to hide duck nests from predators to improve nesting success. The size and number of wetlands also matter because certain waterfowl defend an entire wetland, meaning that many small wetlands in a larger grass landscape are needed. Level 1 spatial tools help to meet these planning needs.

Identifying local wetlands at risk – a Maryland example

The Wetlands at Risk Assessment Tool from the Center for Watershed Protection in Ellicott City, Maryland is a process to identify and protect wetland function at the local level. It includes Level 1 assessment of wetland condition and threats. This type of monitoring tool is an effective approach for communities that need to establish priorities and to plan for community development in a manner that also protects wetlands that provide important functions and services.

Prioritizing areas for wetland restoration, preservation, and mitigation

The Maryland Department of Environmental Protection has also carried out a project to identify priority areas for wetland protection and restoration on a statewide basis. Assessment was done at a landscape scale; a variety of GIS tools were used to combine existing sources of wetland information along with other land use information to identify priority wetland sites. A summary of the project is available here, including resulting reports for download.

Documenting the success of habitat restoration in WRP/CRP Conservation Projects

The USDA Natural Resources Conservation Service, Conservation Effects Assessment Project (CEAP) includes a Wetlands National Assessment that, "*facilitates the production and delivery of scientific data, results, and information… that routinely inform conservation decisions affecting wetland ecosystems and the services they provide, particularly focusing on the effects and effectiveness of USDA conservation practices and Farm Bill conservation programs on ecosystem services provided by wetlands in agricultural landscapes*." The Wetlands Assessment includes evaluation of conservation actions and success at multiple locations nationwide.

One example is the Conservation Effects Assessment Project - Prairie Pothole Regional Studies ,which include a detailed evaluation of the ecosystem services derived from wetland conservation projects. Numerous monitoring and assessment approaches were used to document the benefits of wetland restoration, informing future efforts.

Integrating Monitoring and Assessment into Studies of Restoration Success

The ASWM "Improving Wetland Restoration Success" project includes on ongoing series of webinars that serve as detailed case studies of wetland restoration in many different landscapes, including sensitive and difficult to protect types of wetland habitat. Webinars are recorded and made available on the ASWM website here. While these presentations do not focus specifically on monitoring, they will assist in understanding how monitoring and assessment tools are used in designing and evaluating restoration projects.

Wetland Monitoring and Climate Change

Climate change is not directly included as one of EPA's Core Essential Elements of a state or tribal wetland program. However, the challenges presented by current and predicted future climate impacts are of necessity interlaced with numerous resource management decisions. Climate is an overarching factor that should be considered in the implementation of any wetland program. This section is intended to draw attention to some important ways in which monitoring and assessment programs can play an important role in evaluating climate change impacts to make better decisions.

Wetland monitoring is likely to be initiated to address a number of distinct categories of climate questions, including the following.

- **What wetland resources are most vulnerable to projected climate change impacts**? Vulnerability assessments are most often carried out at a local or regional scale, and can incorporate questions regarding the impact of wetland loss or degradation on ecological services of local importance, as well as localized habitat concerns.

- **How are wetland ecosystems changing in response to climate shifts?** Long term assessment of climate impacts relies on establishment of baseline information, and subsequent tracking of changes over time. Data regarding the aerial extent of wetlands has been gathered for many years - e.g. through U.S. Fish and Wildlife Service reports on wetland Status and Trends and through assessment of sea level rise. These sources of information will help to support studies showing the change in extent of wetland systems including the impact of sea level rise, and both flooding or drying in freshwater systems.

  Less information regarding the more specific chemical, physical, and biological condition of wetlands has been compiled. The National Wetland Condition Assessment may provide a starting point for baseline information, but some sort of regional monitoring network for wetlands – paralleling the effort under development for wadable streams – may be appropriate.

- **How effective are mitigation measures used to reduce greenhouse gas emissions?** Questions remain regarding the potential for carbon sequestration in various types of wetlands, and how methane emissions factor into net greenhouse gas sequestration

potential. Academic research is currently addressing these questions, but more information regarding many wetland types is needed.

- **How successful are other climate adaptation measures using wetlands**? The effectiveness of numerous practices may need to be more thoroughly understood, from use of wetlands to store and filter more intense stormwater runoff, to expansion of wetland and upland habitat corridors to facilitate gradual plant and wildlife migration or change in home range. For each of these practices, both the benefit of the wetland system and any adverse impact on the wetland system will be topics of concern.

Wide scale assessment of climate impacts – national and international data

The collection of definitive information on the current impacts and modeling of future impacts of climate change on wetland systems is likely beyond the resources of any single state or tribal agency. However, assessments relating changes in temperature, precipitation, and extreme weather to water resources are available from a number of national and international agencies. Among the many sources of information that can be used to inform state and tribal programs are the following:

Executive Office of the President, June 2013. ***The President's Climate Action Plan.*** ***http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf***

IPCC, 2014: Summary for policymakers. In: ***Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*** https://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf

National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate. Interagency Climate Change Adaptation Task Force, October 2011. http://www.whitehouse.gov/sites/default/files/microsites/ceq/2011_national_action_plan.pdf

National Fish, Wildlife and Plants Climate Adaptation Partership, 2012. ***National Fish, Wildlife and Plants Climate Adaptation Strategy.*** Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. Washington, DC. http://www.wildlifeadaptationstrategy.gov/

National Oceanic and Atmospheric Administration (NOAA). 2010. ***Adapting to Climate Change: A Planning Guide for State Coastal Managers***. NOAA Office of Ocean and Coastal Resource Management. http://coastalmanagement.noaa.gov/climate/docs/adaptationguide.pdf

National Oceanic and Atmospheric Administration, Office of Ocean & Coastal Management. February 2012. ***Voluntary Step-By-Step Guide for Considering Potential Climate Change Effects on Coastal and Estuarine Land Conservation Projects.*** http://coastalmanagement.noaa.gov/resources/docs/guidecelpapp.pdf

U.S. Environmental Protection Agency, 2012. ***National Water Program 2012 Strategy: Response to Climate Change.*** http://water.epa.gov/scitech/climatechange/upload/epa_2012_climate_water_strategy_full_report_final.pdf

Global or national data may not be suitable for downscaling to a local level, although the level of detail provided is increasing over time. At a minimum, however, data from these sources can orient decision-makers regarding regional or other large scale wetland status and trends, and also provide a starting point for discussions of state or tribal level concerns and responses.

Evaluating impacts of climate change on wetland systems over time at the regional, state or local level
Monitoring to evaluate the impacts of climate change is frequently recommended as a strategic action on a more localized (statewide, watershed, community) basis. However, most recommendations that wetlands be monitored include little if any detail as to the type, extent, or methods suggested for monitoring to detect changes occurring as a result of climate change. More concrete recommendations are needed if local agencies and organizations are to undertake a meaningful monitoring program or to develop regional monitoring networks.

A number of strategic directions are suggested in various papers; examples are offered here to stimulate thinking about monitoring approaches.

- **Collection of baseline information on the ecology of typical wetlands for future change evaluation (Chu, 1997).** Taken from an evaluation of climate vulnerability of a large watershed in Ontario, this reference stresses that monitoring of wetland ecosystems in anticipation of climate change should focus on evaluation of the ecological significance of wetlands in the watershed, and collect of baseline inventories of plant and animal species to provide a basis for future assessment of community change.

- **Assessment of the vulnerability of wetlands to climate change.** In a large watershed in Ontario, the vulnerability of each wetland type present was assessed using projected air temperature, precipitation, and groundwater discharge potential, with the results being used to generate vulnerability matrices (Chu, 2011). The underlying premise was that comparatively greater increases in air temperature and decreases in precipitation and groundwater inflow are associated with greater vulnerability to climate change.

- **Development of permanent reference plots in key wetland ecosystems**. The Minnesota Department of Natural Resources has established 20 permanent monitoring plots in the peatlands to track changes in the system due to climatic conditions and other stressors according to a report that also recommends other monitoring approaches by multiple agencies *(**Adapting to Climate Change in Minnesota- 2013 Report of the Interagency Climate Adaptation Team**).*

- **Collection of data to evaluate proposed adaptation projects in coastal wetlands.** The report of a 2011 workshop by the NOAA restoration center – northeast region recommends that proposed restoration sites be evaluated in terms of water elevation data in coastal wetlands to support evaluation of sea level change impacts. Relative sea level rise impacts should be predicted for both the designed project and the site if no restoration action is taken to allow comparisons of benefits and drawbacks of restoration. The following impacts should be assessed: 1. Ecological impacts (e.g. vegetation zones, tidal range, potential for inland migration, fish and shellfish communities, protected resources, coastal geomorphology); 2. Infrastructure impacts (project infrastructure, adjacent property and resources); and 3. Storm and flooding impacts.

Climate change considerations in existing state wetland program monitoring programs

States and tribes that have implemented wetland monitoring programs for any other primary purposes may be collecting data that will prove useful in the context of climate change assessment. Likewise, minor additions to an existing monitoring routine may provide valuable information without a significant increase in field time/costs.

Likewise, information regarding current or predicted climate impacts may also be used to inform decisions on other aspects of wetland programs. Some possible examples follow.

- **Are changes observed in wetland systems related to climate change (e.g. changes in hydrologic condition)?** Analysis of wetland trends in combination with climate trends along with other stressors may help to answer this question over time.

  Is the hydrologic condition of the wetland inconsistent with vegetation? E.g. Facultative tree species indicative of wetlands may persist long after conditions become drier; understory vegetation is more likely to reflect current conditions.

- **Are there invasive species present in a wetland that are not anticipated due to any other factor such as land use impacts?** Is it possible that invasive species represent a shift in range of either the indigenous community, and/or the invasive species?

- **If a wetland is being considered a priority for stewardship activities, are there threats to continuation of current conditions under anticipated future climatic conditions?**

  How might future climate impact the sustainability of a restored wetland?

- **In a regulatory program:**
  Is the societal value of a given wetland increased by its individual and cumulative contribution to carbon sequestration, flood storage, storm surge protection, or other factors associated with climate change adaptation and mitigation?

  Is the future value of a given wetland on the other hand potentially decreased by anticipated drier conditions, by expected loss associated with sea level rise, or by similar factors?

  Is mitigation proposed for unavoidable losses reasonably consistent with future conditions? Is replacement of historic conditions appropriate in light of anticipated climate change?

The scope of monitoring and assessment of climate change is likely to seem overwhelming. However, attention to the need for specific types of data, and awareness of potential sources of that data, are likely to make the question at hand much more manageable. As with many issues related to climate change, a new program is not needed so much as the habit of routinely considering climate information in wetland management. Awareness of climate issues and impacts will improve decision- making in many areas of wetland management whether or not a state or tribe has embraced a climate strategy specifically for wetlands.

Building Support for State Wetland Monitoring: Gaps, Research Needs, and Barriers

During the compilation of this report, ASWM gathered information from a number of state and tribal programs, and from wetland scientists familiar with state wetland monitoring programs. We asked questions about current gaps and needs, and also about factors important in the development of state level monitoring programs. The information in this section reflects responses to the ASWM questionnaire (see Appendices 3a and 3b), as well as other comments made at various meetings and conferences.

Although there have been significant advances in wetland science in recent decades, gaps in our knowledge are often cited as impediments to effective wetland protection and management. However, given that the nature of scientific development is to raise new questions as old ones are answered, such gaps are to be expected. Identification of information needs, and sharing those needs with research institutions, is an important component of state program development. Research needs will, of course, be specific to the interests of various states, but we are sharing a sampling of such questions raised by states and tribes to encourage communication and collaboration among agencies, academic institutions, and other organizations.

We also asked states and tribes to identify other barriers to implementation of monitoring programs, and are including the most common responses here.

DATA AND INFORMATION NEEDS

States and tribes obtain data from a number of sources, relying heavily on other agencies as well as their own field work. However, research staff are limited in most state agencies, and most information used is readily available and easy to access. Data that is difficult to import or manipulate, that is outdated, or that has a high cost may not be available, limiting state capabilities. In addition, some in-house work by other agencies may not be publically reported or disseminated. In some instances, training is needed understand the data source and its uses. The following list includes typical unfulfilled needs.

- Mapping
    - Updated National Wetland Inventory maps
    - Additional land cover information
    - LIDAR maps (and access to data)
    - Readily accessible geo-referenced boundary maps
    - Littoral drift maps
    - Annual aerial photography

- Hydrologic information:
    - Results of hydrologic modeling
    - Understanding of the impacts of changing hydrologic conditions on plant communities
    - Soil moisture information

- Better nutrient data for wetlands (phosphorus in particular)

- More data describing the effectiveness of various restoration methods

- Additional trend monitoring results

- Information on the impacts of climate change
    - Specific methods useful to evaluate impacts at the local or community
    - Recommended methods to develop regional monitoring networks to track climate change impacts

NEED FOR NEW OR MORE EFFICIENT MONITORING AND ASSESSMENT METHODS

A number of well-tested monitoring methods are now available, but the need for cost effective, geographically specific, and informative methods remains. Examples include:

- Definition of indicators of developing anaerobic soil conditions, for monitoring of restoration or management projects;

- Examples of performance goals for mitigation or voluntary restoration projects, and how to measure them;

- Improved modelling of nutrient uptake and cycling in wetlands; and,

- Improved hydrologic modelling.

ASSISTANCE WITH DATA ANALYSIS AND INTERPRETATION

States and tribes have gathered a significant amount of information in an attempt to better describe and evaluate wetland resources, but may have difficulty in extracting meaningful conclusions from this data. In addition, states may be uncertain how to interpret data from regional or national studies (e.g. the National Wetland Condition Assessment) and understand its relevance in a specific state or reservation.

Explaining complex information to the public in a compelling and accurate manner is also an ongoing challenge. Some of these questions are common to all state programs, and may be assisted by a larger communication effort.

Typical needs include the following:

- Assistance in translating data into a definition of condition;

- Guidance on definition of “good” wetlands – distinguishing between “high-quality” and “degraded” sites;

- A means to effectively compare the condition of “wetter” and “drier” wetland types (or other very diverse ecosystem types);

- Identification of links between stressors and degradation, and comparison of the relative impact of different stressors on degradation;

- Assistance in sorting attributes related to “condition” versus “function”; and,

- Assistance in presentation and explanation of wetland data to the public. For example:

    - Providing definitions of “normal” and “degraded” that are useful for public outreach (good/fair/poor; pristine/beneficial/totally degraded; similar categories);
    - Assistance in explaining the distinction between the range of condition, and the range of function; and,
    - Accurate reporting on scientific uncertainty while supporting conclusions.

RESEARCH NEEDS

It has been noted that true research topics may be better suited to academic institutions, federal research agencies, or to collaborative efforts, especially where long-term monitoring is required. State and tribal monitoring can contribute to wetland research projects, but many state agencies lack the resources to plan, fund, and carry out long term research.

The following examples are a mix of general and specific research needs suggested by states and tribes.

- **Wetland condition assessment**

    - Development of a suite of macroinvertebrate indicators that can effectively define condition
    - Development of additional indicators that can be used in rapid assessment methods

- **Identification and evaluation of stressors**

    - Additional assessment of land use impacts on wetlands
    - Confirmation of connections between land use, groundwater impacts, and wetland condition
    - Impact of stressors on natural wetland functions
    - Evaluation of the impact of specific stressors, e.g. emerald ash borer on Black Ash wetland communities in Minnesota
    - Identification of reasons for habitat decline observed in some wetland systems

- **Evaluating attainment of restoration and management goals**

- Better understanding of the trajectory of successful restoration (especially for forested areas); indicators of a trajectory that demonstrate likely attainment of long term performance goals
- Definition of the amount and type of organic matter and soil type needed to obtain a desired wetland ecosystem
- Long term effectiveness of management methods, e.g. living shorelines

- **Wetland ecology**

    - Detailed (Level III) evaluation of priority wetland types and sites
    - Studies of genetic differences between certain native and non-native plants (e.g. *Phragmites*)
    - Long term studies of identified management concerns, e.g. fish passage, beaver management
    - Increased understanding of the sustainable use of wetlands to support watershed planning and mitigation design

OTHER BARRIERS TO IMPLEMENTATION OF STATE AND TRIBAL WETLAND MONITORING PROGRAMS

Not unexpectedly, the most commonly cited barriers to development and implementation of state/tribal monitoring programs are:

- Lack of funding, in particular as compared to federal funding available for other water programs; and,

- Lack of staff, either due to limited total agency funding, or because other priorities are more pressing.

By contrast, most states contacted did not list overall staff *technical expertise* as a primary barrier, although training may be needed to implement specific monitoring procedures.

In addition to basic funding and staffing needs, the following were listed as being useful in building monitoring and assessment programs:

- Training programs to provide specific expertise needed to implement monitoring methods, computer modeling, or other technical aspects of monitoring programs;

- Additional outreach to state, tribal, and other agencies to share the results and conclusions from federal or academic monitoring projects;

- Assistance in developing QAPP's for EPA-funded wetland monitoring;

- Guidance on cumulative impact assessment; development and documentation of practical methods; and,

- Development of information on the cost of a "wrong" decision, as compared to monitoring costs.

Science Outreach in the Information Age

Like climate change, outreach and education are overarching needs that impact multiple components of a state or tribal wetland program. In general, monitoring and assessment data may be important to provide sound scientific answers to questions from management, policy makers, and the public. The explanation of monitoring results – in terms that are readily understood by the public and by decisions makers – is often essential to build and guide program support and development.

It is easier than ever to disseminate information – by posting technical data on a website; publishing scientific papers and reports on line or in written materials; by forwarding information via social media (Facebook, twitter, LinkedIn); and by presenting findings either in person or on line through webinars. Most of these methods have been developed to support dissemination of information among scientists. But results of monitoring programs are less frequently analyzed and explained for the lay public, even though it is relatively easy to transmit graphic illustrations, charts, video explanations, and so on. Providing a clear analysis of monitoring results – and thereby avoiding erroneous interpretations – is an important aspect of a monitoring program.

Providing data that is on target in terms of the questions at hand, and taking steps to clearly present findings to policy makers and the public can greatly improve the decisions that are made regarding wetland management. Typical questions that may be asked by managers, by the public, and by legislative or other decision makers that may be informed by effective monitoring and assessment include the following.

- Why should this agency fund expensive wetland restoration (or other management) projects?
  What is the value of wetland resources to the public, and are these resources at risk?

- Was recently funded restoration (or other management) successful in meeting performance goals?
  Should similar projects be funded in the future?

- Are current regulations sufficient to protect wetland resources (or are these regulations necessary)?
  How are wetland status and trends linked to regulatory actions?

- Is this agency consistently acting in compliance with legal mandates?
  Do regulatory agencies use monitoring methods to make consistent and scientific decisions?

- Should our state/tribe support additional academic research regarding wetlands? On what topics?

- Why shouldn't we simply rely on federal research and existing expertise?
  What does state or tribal monitoring tell us about wetlands that are locally special or important?
  How is state level monitoring information used by various state and local agencies?

Appendix 4 includes examples of outreach materials that were developed by ASWM to support release of the National Wetland Condition Assessment results from 2011. NWCA data was collected based a highly sophisticated sampling design, using multiple complex sampling methods. However, the underlying concepts and conclusions can be framed and explained in a manner that is highly meaningful to policy makers at all levels of government, and with recognition of the particular needs and interests of each state. Additional materials will be developed to focus more on the NWCA data as it is released.

National Wetland Condition Assessment, 2016
NWCA is designed to repeat the sampling process every fifth year (other water resources including inland lakes, wadable streams, rivers, and nearshore waters are also sampled each fifth year, with one water sector being sampled each year). Planning has already been initiated for wetlands in 2016, with the expectation that many states will choose to collaborate with EPA in the process. Funding and training is provided by EPA to support state work, which supports the overall effort while providing experience with potentially new methods to state staff. For additional general information and program contacts, see EPA's **National Wetland Condition Assessment Fact Sheet.**

Outreach through volunteer monitoring
Another way to engage the general public and build support for and understanding of wetland science is through voluntary wetland monitoring programs. Such programs are not new, and have been used in a number of states not only to educate the public, but make use of volunteer time to gather information that would otherwise be unavailable. The U.S. EPA prepared the booklet, ***Volunteer Wetland Monitoring – An Information and Resource Guide*** to provide examples of how volunteer monitoring can initiated as a component of an outreach program for children, adults, or both.

Emerging challenges, emerging technology.
It is likely that the future will present multiple challenges, among them:

- The need for continued protection of human wellbeing, including clean and dependable water and food supplies for a growing population;

- Balancing the needs of emerging technologies with environmental impacts;

- Provision for increased protection from natural hazards, including severe storms, flooding, and drought;

- Pressures on the natural habitats of plants and animals on a global scale, and protection of biodiversity as human development continues; and,

- Mitigation of and adaptation to climate change.

Because wetland exist at the interface between land and other waters, including groundwater, they are likely to be impacted by many such challenges, or to play a role in management of natural resources. Fortunately, both our knowledge of wetlands, and the science of monitoring and evaluating all kinds of natural resources are growing rapidly. This is especially true in the domain of remote sensing, which is becoming ever more available, providing not only images of the earth's surface but information about the condition of the surface (e.g. soil moisture). Frequent remote images are also becoming more economically feasible with the development of highly affordable drones.

Example: Use of Drones

Wetland biodiversity studies are being carried out at Central Michigan University by Dr. Benjamin Heurmann, using an unmanned helicopter drone. Click here for an article about this work, including a recording of a National Public Radio (NPR) report on the project.

In addition, extensive monitoring of global conditions include weather, sea levels and ocean chemistry, patterns of storms and drought, and many other factors will provide the basis for increasingly sophisticated modeling of the causes and changes of natural systems. Although the future will provide great challenges, it will also provide improved tools for their evaluation.

Increased attention to wetland monitoring and assessment by states and tribes will improve their ability to address coming challenges, and to assist policy makers and the general public in understanding the role of wetlands in our lives, and in the biosphere. We must begin with the understanding that resource evaluations are an integral and essential component of natural resource management. Whether carried out by state agencies, or in collaboration with academic institutions and other entities, these studies should be used to guide decision making in all aspects of wetland management.

A Summary of Suggested Practices for Wetland Monitoring and Assessment Programs

The collection of scientific data is key to advancement of sound resource management, whether carried out by academic institutions, government agencies, or other organizations. A state or tribal monitoring and assessment strategy should be no less than the vehicle for obtaining the particular information that is needed to make the best programmatic decisions possible, whether the data is actually gathered and analyzed by the state program or through collaboration with others.

The need for and use of data that helps to explain wetland ecology, condition (status and trends), functions, or attainment of management goals (including restoration and preservation) will be specific to the requirements of a particular program. Examples of such needs have been discussed throughout this report. The following list of overarching considerations is applicable to an overall wetland monitoring and assessment program. Awareness of these practices can help to inform development and implementation of a useful and cost effective monitoring program, or to encourage the appropriate and beneficial use of current data in wetland management decisions.

Begin with the clear definition of the need for additional monitoring data

- Consideration of a potential monitoring program should begin with identification of the need for additional information regarding wetland resources. This report includes numerous examples of such needs and the applied uses of wetland monitoring and assessment data.

  The desire to simply know more about your state or tribal wetlands is a good starting point, but ultimately, a more specific goal or goals will be needed to build a useful program. Review programmatic goals, and envision the way in which new information or greater understanding of wetland resources may improve your program. Thinking strategically, do you have multiple uses for a particular type of data?

- Consider existing sources of information (published reports or studies carried out by other agencies or institutions). What other wetland research in your geographic area may be useful? Who are the potential collaborators? What data is needed that is not currently available?

- How do you envision the scale of monitoring to meet your needs?

- Do you require an overview of statewide resources, or much more specific data on individual sites or projects? Do you need a coarse screen to help guide actions, or improved information to guide complex or controversial decision making?

- Will your monitoring program include multiple approaches? If so, how can you integrate and make the most of your data?

- What is the scope of an appropriate monitoring program? Do you need random samples of a large number of wetlands statewide, or will you take a more targeted approach?

- If your approach is targeted, will you focus on particular ecological types, priority watersheds or communities, or the focus of a particular program (e.g. restoration sites)? Will monitoring be carried out routinely at a specified level, or used on an as-needed basis (e.g. in response to regulatory actions)?

- What is the time frame you anticipate for a monitoring program? A one-time project to gather a "snapshot" for future use, or to compile GIS data to be available for multiple users? Before and after impacts of a project or regulatory action? Or is it a long term or ongoing effort to evaluate trends over time?

Evaluate options for gathering data, including cost and feasibility

- What sampling methods are available to gather additional needed data (e.g. expansion of NWI maps; rapid assessment methods; published wetland IBI's)?

  What are the relative costs and logistical practicality of existing methods?

  Will you need to modify or tailor existing methods to your geographic area or need? If so, will you need background or reference data to develop your methodology, or can you work with another institution to gather needed data?

- Contact others who have experience in methods under consideration. Seek input from available federal experts – at academic institutions, related state or tribal programs, or federal agency research staff (e.g. the EPA Office of Research and Development in Corvallis, OR; NOAA's Coastal Service Center; or the Corps of Engineers Institute for Water Resources.

- If necessary, adjust the scale of the project. For example, functional assessments are costly, but you may be able to downscale a project to focus on high priority watersheds or geographic areas where you can obtain support from and complement other land use programs. Assessment of the extent to which restoration or management goals have been achieved can be focused on a more limited number of model or demonstration projects. The timeframe for date collection can be extended.

- Consider the resources available within your agency or organization.

- Does your agency have experience in water monitoring? What level of expertise is available among existing staff? Include GIS programs as well as field staff.

- Consider available funding sources, including state general funds, state or federal grants, and so on.

- Consider the benefits to be gained by monitoring. Will additional data improve the quality or efficiency of your program? Will it lead to more effective expenditure of funds for wetland management or restoration? Is data needed to support funding of regulatory programs?

- Do you have the expertise and resources to collect needed data on your own, or should you collaborate with other entities? Focus on priority questions that can be addressed with available resources – avoid trying to do everything.

- Development of a multi-faceted monitoring program can proceed in a variety of ways. You may start with landscape level information or a broad survey of wetland resources, and then focus on questions that are raised by that step. Alternately, you may start with evaluation of specific projects (e.g., evaluation of restoration projects, or site assessments in a regulatory program). As information is accumulated in that manner, it may point to broader investigations that are needed. Consider the best approach to meet your needs and resources.

Develop a monitoring strategy, including a sampling plan, training, and data analysis

- After defining needs and goals and resources available, focus on methods available to gather needed information. Do you need landscape level information, detailed site investigation, or a rapid assessment method?

  Are existing sampling methods available, or will you have to modify an existing method or create something specific for your needs (e.g., modification of another state RAM)?

  Have other states or program managers tried and rejected methods that interest you? Why?

- For potential methods, what approximate time would be involved, what staff resources, what cost? What specialized equipment or travel support is required? What expertise is needed in data analysis (e.g., evaluation of chemical results, hydrologic data, identification of biological samples)?

- In considering the scale of a monitoring plan, consider statistical design and analysis. You need sufficient data to draw meaningful conclusions, but avoid expending funds to gather information that will add little more to your project or is unusable.

- Consider again how data will be used and applied to supporting your goals and needs. Will the method that you have been considering meet your needs? Will it meet the needs of your collaborators (e.g., watershed planners or regulatory staff)?

- Who will collect and “own” the data?

- Will data be collected by other parties? By permit applicants, or restoration groups? Can it be aggregated over time to provide a programmatic perspective?

- How will costs be shared?

- How will you assure quality control?

- Will you have a database for the data? Who will populate it? Maintain it? Who will have access to it? Who will "own" and control this data?

Analyzing data and application to decision making

- Ecology is complex – you cannot necessarily anticipate clear and easily repeatable answers. Therefore, consider how will data be interpreted and combined with other information in making decisions.

  Who will be responsible for data analysis? Do those who will use the data understand how it was collected, and the limitations of the methods? Ensure adequate training.

- Science is a collaborative process; this is why scientific papers are subject to peer review. Be open to reviewing, discussing, and analyzing your data with those who have a variety of perspectives (e.g., watershed managers, research scientists, hydrologic engineers, chemists, colleagues from other agencies or programs, land use planners and legal experts as appropriate).

  Sharing information will not only assist you in evaluating results, but will help you learn best how to explain and present your data.

- Do you trust the accuracy of your data? Review quality control methods. Compare data with other sources or similar projects if possible. Does it make sense?

- Be open to unexpected insights or findings. Understanding often arises from information that was not anticipated, or that is different from what others have found.

- If you are using data collected by other agencies or organizations:

  - Be sure that you understand the goals of their project and nature of the data collected. Discuss the anticipated application of data with the primary investigators to ensure that use is an appropriate one (e.g., does the level of accuracy meet your program needs)? Can data collected for another purpose support a legal decision, or the significant expenditure of funds when proceeding with a management project?

  - Is supplementary information needed? Can you build upon the work of others to more definitively answer your own questions?

- How does the data from a sister organization compare with (confirm or contradict) what you already know about your wetland resources? Is there a difference? If so, why?

- Can you explain data from other sources to the public?

- Summarize data and provide results in "plain English". Be prepared to answer questions about conclusions using graphics or other aids appropriate for your audience (e.g., policy makers, project stakeholders, the general public). Be specific, but open about limitations of methods used as well as the benefits of the information obtained.

- Ensure training of all those who will used the data, including collaborators. Ensure that they understand methods used, and both the meaning and limitations of data collected.

  Discuss the nature and reliability of your data – is it a general indicator of potential or likely conditions, or an exact measure that will be applied directly to a decision point?

  Consider and discuss how your data will be merged with or weighted against best professional judgment or other published information.

- Document the benefits of using your data. How did it improve the selection or planning of a project, guide policy decisions, or bolster a regulatory decision? Did it improve decisions regarding the use of grant funds? This information will be needed to support future monitoring efforts.

Provide for long term management, sharing and use of data

- Your data has significant value, and was costly to collect. Make sure to protect it through a well thought out plan for database management.

- Consider how data can be used for multiple purposes; make it available to others who can use it. However, be sure to protect data from unintentional loss or mis-use. Provide secure storage for sensitive data such as that used in legal issues. There may also be a desire to protect information on particularly sensitive resources, such as the location of rare species.

- Apply the principles of adaptive management. Correct weak points in your sampling plan. Use data to improve your focus on priority concerns. Cease collection of data that does not prove useful.

- Allow your increased understanding to lead you in new directions as your wetland program evolves.

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APPENDIX 1:
OVERVIEW OF SOME COMMON WETLAND MONITORING AND ASSESSMENT METHODS

As noted in the text, the EPA has developed a three-level framework for wetland monitoring and assessment. Numerous monitoring methods have been developed within this framework. While it is not the purpose of this report to detail various methods available, the following summary provides sources of additional information regarding a number of the most common approaches. Additional assistance is available from EPA wetland staff, the Corps of Engineers, and various academic institutions.

There are a number of good overview documents that will help to orient users to wetland monitoring methods, which overlap but are necessarily very distinct from general water sampling methods. These include:

- EPA's wetland monitoring website. This includes links to a range of information. **http://water.epa.gov/type/wetlands/assessment/index.cfm**

- EPA's ***Wetland Bioassessment Fact Sheets,*** prepared by Tom Danielson. These provide a good overview of a number of biological assessment methods. http://water.epa.gov/type/wetlands/assessment/bio_fact_index.cfm

- EPA guidance on development of nutrient criteria for wetlands – see the section on monitoring and sampling designs. **http://www2.epa.gov/nutrient-policy-data/criteria-development-guidance-wetlands**

The full range of sampling methods for chemical, physical, and biological parameters for all wetland types from tidal marine areas to perched montane peatlands is enormous, and this summary by no means includes the best methods for various specific purposes. However, within the EPA three level assessment framework for wetlands, there are a number of very commonly used approaches as summarized below. Please note that many of these methods are modified and calibrated to meet specific geographic conditions. No method should be adopted wholesale without fully understanding its assumptions, limitations, and intended applications.

Level I. Some Common Landscape Scale Wetland Assessment Tools

Landscape scale methods generally rely on the analysis of data collected through remote sensing – e.g., aerial photography and various types of satellite imagery. Imagery that is stored in Geographic Information Systems (GIS) can be corrected based on ground-truthing, and analyzed using the overlay of multiple layers of data in the GIS (e.g., soils, elevation, hydrologic information, land use, etc.).

The National Wetland Inventory (NWI)
NWI maps were created by the U.S. Fish and Wildlife Service beginning in about 1975, and are still being updated and made digitally available. These maps delineate wetland boundaries and characterize wetlands using the Cowardin classification system. Maps are created using remote imaging and nowadays ancillary GIS information. These maps are not intended to provide jurisdictional boundaries, but are widely used as screening tools in regulatory programs, and in both land use and water resource planning. They are a primary source of information for many state, local, and federal wetland programs.

One-Stop Mapping

There are many kinds of remote imaging available to use to identify, monitor and assess wetlands. For more information visit the One-Stop Wetland Mapping webpage at http://www.aswm.org/wetland-science/wetlands-one-stop-mapping.

The Fish and Wildlife Service also developed methods to add descriptors to NWI maps that support prediction of wetland function – sometimes called NWI Plus, further advancing the utility of this system. The "LLWW" system adds descriptors of **Landscape position, Landform, Water flow path, and Waterbody type;** these physical characteristics together with the mapped imagery support modeling of watershed function.

LiDAR
"LiDAR" stands for Light Detection And Ranging, and refers to a method of remote sensing (usually from aircraft) somewhat similar to Radar that can provide extremely detailed and accurate elevation information. Because of its accuracy and ability to "see" through vegetation and surface debris, LiDAR can accurately detect even small channels or depressions that constitute surface connections among wetlands and among wetlands and other waters, or that demonstrate patterns of water flow, that are not readily visible even on the ground. Applications can range from measuring changes in coastal water elevations, to detailed floodplain mapping, and much more.

For an introduction, see NOAA's 2012 publication, ***Lidar 101: An Introduction to Lidar Technology, Data, and Applications***. For a presentation of additional applications, see the presentation by Amar Nayengandhi - ***LiDAR for Wetland Mapping*** on ASWM's web pages.

Level II. Some Common Rapid Site Assessment Methods)

Rapid Site Assessment Methods (RAMs)
Numerous states and other agencies have developed rapid site assessment methods (RAMs) for wetlands, and such methods are still being refined. These methods are distinguished, as their name suggests, by the use of readily observable metrics that allow completion of a site assessment in a few hours at most, with only a single visit being necessary. Thus, it is feasible to evaluate a wetland site prior to a decision on a permit application (given typical limited state deadlines for decision making), or to quickly screen sites for restoration, preservation, or other management purposes.

In a typical RAM method, information that is readily available in office is compiled, followed by an on-the-ground site visit. A series of questions leads to documentation of physical (including hydrological) and biological characteristics of the site, as well as surrounding land use and observable stressors (e.g.

the presence of storm drains, alteration of the site, etc.). A scoring system allows for comparison among sites, and, for some methods, and overall rating.

Most RAM procedures were initially developed to evaluate wetland condition, although some also include metrics that allow a quick evaluation of function. If existing methods are used or modified for a new purpose, the assumptions and limitations of the method should be thoroughly reviewed and understood. Some methods cannot be applied intact in a new geographic area; for example, when the Michigan DEQ was developing a method based on the Ohio Rapid Assessment Method, they found that certain scales needed to be adjusted for more northern climates.

For a review of RAM methods available as of 2004, see the EPA publication ***Review of Rapid Methods for Assessing Wetland Condition.*** Since 2004, additional methods have been developed and may be available through various states. In addition, EPA developed a "USA RAM" for testing as a component of the National Wetland Condition Assessment; information regarding the status of that method may be available through the NWCA program.

Hydrogeomorphic Approach to Wetland Assessment (HGM)

The U.S. Army Corps of Engineers developed the Hydrogeomorphic Approach (HGM) in the 1990s to meet the regulatory needs of Corps program staff. This approach differs from other methods in that it first classifies wetlands based on hydrogeomorphic characteristics (landscape setting, water source, hydrodynamics). Appropriate metrics are then used to indicate the functionality of a given wetland, as comparted to undisturbed reference sites for similarly situated wetlands. Essentially, HGM is intended to evaluate **function** based on the physical setting, but the results are often used as a surrogate for condition in the regulatory process.

HGM Example: State of Alaska

The Alaska Department of Environmental Conservation has developed a number of HGM guidebooks for use in their wetland program. These include:

Wetland Functional Assessment Guidebook: Operational Draft Guidebook for Assessing the Functions of Riverine and Slope River Proximal Wetlands in Coastal Southeast & Southcentral Alaska Using the HGM Approach

Wetland Functional Assessment Guidebook: Operational Draft Guidebook for Assessing the Functions of Slope/Flat Wetland Complexes in the Cook Inlet Basin Ecoregion, Alaska, using the HGM Approach

Although there was a great deal of initial interest in HGM, and the approach is used by some states, this method is considered too time consuming by many others. In part this is because a separate "guidebook" to the assessment must be developed and reference conditions defined for each wetland type.

For additional information, see the U.S. Army Corps of Engineers web page for HGM, and/or the U.S. EPA web page for HGM.

Floristic Quality Assessments (FQA's)

Floristic Quality Assessments (FQA's) provide an alternative, or a supplement, to other Rapid Assessment Methods. FQA's are based on the evaluation of all wetland plant species present in a state,

and assignment of a "coefficient of conservatism" by appropriate expert botanists familiar with each species. This coefficient reflects the extent to which the species can tolerate disturbance, and its dependence on non-degraded ecological conditions. A species having a low coefficient of conservatism may exist over a wide range of conditions, and thus is likely to be more widely dispersed, and thus more common. On the other hand, a high coefficient of conservatism reflects the need for highly specific conditions, and a lack of resistance to disturbance. Because such plant species are less tolerant of a range of conditions, they are more likely to be rare, although this is not necessarily the case.

During assessment using an FQA, all of the species present at a given site are listed, and the mean coefficient of conservatism is calculated. In addition, a floristic quality index (FQI) can be calculated to account for species richness (number of species present) along with the mean coefficient of conservatism. The results of this analysis can be used to compare biological condition, to evaluate the success of restoration or management actions, or to track trends at a site.

While this method has proven very effective in a number of states, it can only be used effectively by a well-trained botanist (or a team of botanists) who can identify virtually all of the plants present to species. Sufficient time must be taken to fully survey the site, and to complete all identifications. In addition, some users feel that it overemphasizes the importance of a potentially small number of rare species, a factor that may need to be taken into account.

For examples and additional information, see the following publications:

- ***Development of a Floristic Quality Assessment Methodology for Wisconsin.*** June, 2003. Wisconsin DNR.

- ***Floristic Quality Assessment with Wetland Categories And Examples Of Computer Applications For The State Of Michigan Revised, 2nd Edition***. October 2001. Michigan Department of Natural Resources.

- Medley, Leah, and Michael Scozzafava. 2009. ***Moving Toward a National Floristic Quality Assessment: Considerations for the EPA National Wetland Condition Assessment.*** National Wetland Newsletter (31)(1), published by Environmental Law Institute, Washington, D.C.

Level III. Some Common Approaches to Detailed Site Assessment

This category generally includes any detailed evaluation of a wetland site (or sites) that requires more than a quick, one time visit. This level of monitoring and assessment may be carried out for a variety of research purposes, or to gather the information needed to develop rapid site assessment methods. Any number of physical, chemical, and biological characteristics of the wetland may be evaluated, along with surrounding land use, stressors, and so on. This summary provides only a few examples of the type of sampling and analysis that may be carried out for a particular site.

Bioassessment, and Indices of Biological Integrity (IBI's)

Many wetland managers rely heavily on the biological characteristics of wetlands, in part due to the difficulty of identifying useful chemical or physical indicators of condition across the broad array of

wetland ecological types. Because of the importance of bioassessment, a number of "Bioassessment of Wetlands Working Groups" – whimsically known as BAWWG's ("bogs") – have been formed by various state and federal agencies to promote development of this approach. Bioassessment may rely on a species (e.g., extent of *Phragmites* growth, or dominance by reed canary grass); or any number of groups of species depending on the need.

Indices of Biological Integrity (IBI's) make use of a ***group*** of metrics - rather than a single measurement – to produce an index value which distinguishes among wetlands with good and poor condition. The use of multiple metrics combined by an appropriately weighted formula is much more effective in making these distinctions than a single measurement. The metrics that are combined in the IBI might include the presence or absence of key indicator species or groups of species; dominance by various groups of plants, macroinvertebrates, or other species; and so on. Important physical or chemical parameters can also be taken into account. Metrics which do little to improve the utility of the index are not included, even though they may be important to study the ecology of a wetland (rather than its condition).

Some basic sources for information on Bioassessment in wetlands include:

- EPA's website listing Bioassessment publications and methods.
- EPA's ***Methods for Evaluating Wetland Condition: Introduction to Wetland Biological Assessment.*** 2002.
- ***Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making,*** Edited by Wayne S. Davis and Thomas P. Simon, Lewis Publishers, 1995.

Examples of Comprehensive (multi-level) Monitoring Programs

Level I, II, and III assessments may be thought of as building blocks for much broader wetland monitoring projects or programs. Evaluations of the condition and importance of wetlands in a watershed are a common example of projects that may involve multiple assessment methods. Determination of current status and long term trends in wetland extent and condition may also rely on multiple methods.

Identification of the best, or most practical or feasible method or combination of methods is one of the keys to success for any large scale wetland assessment effort. The following are just a few examples.

The National Wetland Condition Assessment (NWCA)

First carried out in 2011, the NWCA is a nationwide assessment of wetlands – a component of EPA's National Aquatic Resource Surveys. The assessment is carried out by federal agencies and contractors, and by cooperating state and tribal staff. The assessment makes use of methods from all three monitoring levels. EPA's web page for the NWCA includes links to technical manuals and other reports.

The release of information from the 2011 NWCA is anticipated in mid-2015, and plans are underway for the second assessment in 2016 (assessments being carried out every 5th year).

Great Lakes Coastal Wetland Monitoring

In 2010, the U.S. EPA Great Lakes National Program Office provided funding for a 5 year study of Great Lakes wetlands by the Great Lakes Coastal Wetlands Consortium. The Consortium had previously mapped coastal wetlands, and developed a monitoring protocol, the Great Lakes Coastal Monitoring Plan, over a period of several years with input from a large workgroup of U.S. and Canadian scientists. Sampling is being carried out by 8 academic institutions across the Great Lakes basin, along with three other partnering organizations.

The monitoring program includes sampling of basic chemical and physical characteristics, along with evaluation of wetland plant, fish, bird, and reptile & amphibian communities. Land use is evaluated using remote sensing methods. The first round of sampling will provide a comprehensive set of baseline data, which can be used to identify trends through follow up studies.

Natural Resources Damage Assessment – Enbridge Oil Spill, Kalamazoo River, MI

In July of 2010, a break in an Enbridge oil pipeline near Marshall, MI released approximately 840,000 gallons of crude oil to Talmadge Creek, which flows into the Kalamazoo River, a tributary to Lake Michigan. Because the river was a flood stage at the time of the spill, adjacent floodplain wetlands were also impacted. Significant natural resource damage resulted from the spill, and also from the use of equipment to remove oil and contaminated soils and sediment. A Natural Resources Damage Assessment (NRDC) was carried out by state, tribal, and federal agencies to determine the extent of the damage, and to define appropriate compensation. The hyperlinked U.S. Fish and Wildlife Service web page for the NRDC includes extensive information about this process. In particular, note the 2012 Vegetation Assessment Survey Work Plan, which includes the use of Michigan's Floristic Quality Assessment, the Michigan Rapid Assessment Method for wetlands, and a number of additional site assessment methods.

http://www.fws.gov/midwest/es/ec/nrda/MichiganEnbridge/

APPENDIX 2: SUPPORTING ORGANIZATIONS AND INDIVIDUALS

This report has been made possible by input from numerous state and tribal staff and their partners, including a number of federal agencies, in addition to review of reference materials. We wish to acknowledge and thank these groups and individuals in particular for their input and assistance in fully understanding the challenges associated with wetland monitoring.

The following responded to a detailed questionnaire sent to states with active wetland monitoring programs and some technical partners:

- Denise Clearwater, Maryland DEP
- Jeanne DiFranco, Maine DEP
- Anne Garwood, Michigan DEQ
- Rick Gitar, Fond du Lac Tribe (Minnesota)
- Michelle Henicheck, Virginia DEP
- Ted La Grange, NE Game and Parks Commission
- Robb Macleod, Ducks Unlimited
- Maryann McGraw, New Mexico Environment Department
- Lisa Rhodes, Massachusetts DEP
- Gregg Serenbetz, U.S. EPA
- Rich Sumner, USEPA National Wetlands Program/ORD Western Ecology Division
- Doug Wilcox, SUNY College of Brockport

Our work was also informed by presentations, discussions, and notes from the following meetings; we thank all participants.

- National Wetland Monitoring and Assessment Workgroup – October 27-30, Denver CO; also notes from regular on-line meetings of this workgroup and particular assistance from Regina Poeske and Gregg Serenbetz of EPA.

- Meeting of EPA Region 5 and State Wetland Programs, October 29 – November 1, 2013, at Kellogg Biological Station, Hickory Corners Michigan

- ASWM Annual State, Tribal, Federal Coordination meetings in Shepherdstown, WV, March 19-21, 2013 and March 4-6, 2014.

- Michigan Wetlands Association – Fall Meeting, November 7, 2013 at Woldumar Nature Center; and 2014 Conference, August 27-29 in Grand Rapids, MI.

Two states and one tribe collaborated with ASWM in refining templates for outreach regarding NWCA results (see Appendix 4), providing a model for other users. Those who participated include:

- Kathleen Walz, New Jersey Department of Environmental Protection
- Rick Savage, North Caroline Division of Water Quality
- Barbara Scott, Kentucky Division of Water
- Lewis Messner, Kickapoo Environmental Services

Finally, all of the states provided information to ASWM regarding monitoring and assessment as a component of their wetland programs in a related project during 2013 – 2015. This information will be compiled in a separate report and available on the ASWM website in 2015. We thank all those individuals who participated.

Appendix 3a:
Questionnaires Sent to States and Tribes with Active Monitoring Programs

The following document was modified as appropriate and shared with a subset of the states and tribes known to have an active wetland monitoring and assessment program.

ASSOCIATION OF STATE WETLAND MANAGERS
2014 Monitoring & Assessment Questionnaire for State and Tribal Wetland Managers

Background: *You have received this document based on information that your state or tribe has an active wetland monitoring and assessment program. ASWM is seeking a deeper understanding of how monitoring data is used in decision-making in various aspects of wetland management. We also would like to understand gaps in monitoring, and insights into various barriers to the collection and analysis of data from wetland systems.*

Data Use: *This information will be shared with other states/tribes that are initiating or expanding monitoring and assessment of wetlands; with other entities (federal agencies, academic institutions) that are also involved in the gathering of data regarding wetlands; and in supporting these efforts through reports, webinars, or presentations on ASWM's online state summary pages. Please add comments, links to reports, or additional information to the extent that you have time to do so. Thank you in advance for your support.*

Name of State or Tribe:_____

Questionnaire Completed by (contact Name): _____

Position/Title: _____

Agency Name: _____

Address:_____

Telephone Number: _____Email Address:_____

____ Please check here if your state/tribe does **not** have an active wetland monitoring and assessment program at this time and return the first page of this document to ASWM.

SECTION A: GENERAL SCOPE OF MONITORING ACTIVITIES

1. **Using EPA's three-level framework for wetland monitoring, which of the following levels are included in your state/tribe's wetland monitoring and assessment?**
(Description of EPA's levels: http://water.epa.gov/grants_funding/wetlands/monitoring.cfm)
(Check all that apply)

   - ☐ Level I – Landscape Level Assessment and Monitoring (e.g. remote sensing, GIS tools)
   - ☐ Level II – Rapid Site Assessment (e.g. ORAM or similar quick site assessment tools)
   - ☐ Level III – Detailed site studies (e.g. IBI, HGM methods)

2. **Did your state or tribe participate in the first National Wetland Condition Assessment (NWCA)?**
   - ☐ Yes
   - ☐ No
   - ☐ Don't Know
   - ☐ Not Applicable

   If yes, in what capacity?_____

3. **How does your state/tribe make use of monitoring and assessment data?**

   *Directions: Please indicate whether or not data is used **to a significant extent** for each of the following monitoring activities AND check the appropriate level for each category.*

Activity	Data is Used to a Significant Extent (Yes/No)	Level 1	Level 2	Level 3
Watershed Planning				
To evaluate the success of watershed activities (e.g. establishment of green infrastructure or stormwater management)				
To identify and/or set priorities for wetland restoration				
To identify and/or set priorities for wetland protection through natural features programs, conservation easements, etc.				
Specifically to evaluate fish or wildlife habitat, or to make decisions regarding habitat management				

Q.3 Continued. How does your state/tribe make use of monitoring and assessment data?

Activity	Data is Used to a Significant Extent (Yes/No)	Level 1	Level 2	Level 3
To evaluate the success of voluntary wetland restoration				
Development of regulatory guidelines or regulations				
In making routine regulatory decisions for dredge and fill programs (issuance of permits under state laws, CWA §404 or §401 certification, etc.)				
To inform other types of regulatory decisions (e.g. NPDES)				
To provide legal evidence in a violation, or challenge of permit actions				
To support the development and use of wetland water quality standards				
To establish standards for mitigation or mitigation banks				
To evaluate the success of mitigation or mitigation banks				
To inform planning for climate change planning, mitigation, or adaptation				
To inform the public, legislators, or other decision-makers regarding the need for regulation and protection				
To provide information to EPA through the consolidated reporting process (305(b)/303(d))				
To provide information for routine state/tribal reports on water quality, natural resources, coastal resources, or similar topics.				
To evaluate the current condition (status) and trends of wetland resources in your state or on tribal lands				
Other (please specify)				

4. Who primarily carries out monitoring and assessment of wetlands for your state/tribe's wetland program? (Check all that apply and identify entities as appropriate)

- ☐ State or tribal staff
- ☐ Professional wetland consultants (e.g. in work on regulatory projects)
- ☐ Other state agencies

  Specify: _____
- ☐ Federal agencies

  Specify: _____
- ☐ Non-profit organizations

  Specify: _____
- ☐ Academic institutions

  Specify: _____
- ☐ Through volunteer monitoring programs or networks
- ☐ Other _____

5. If state or tribal staff routinely participate in wetland monitoring activities, please estimate the total number of FTEs dedicated to *the combined tasks* of planning, implementation, and data analysis monitoring and assessment:

Estimated Number of Fulltime Equivalent Employees: _____ FTE

6. If funds are specifically budgeted annually for monitoring and assessment for your state/tribal wetland program, please indicate the approximate annual dollar amount (or if that information is not available, a range in dollars):

a. Federal Funding: $_____

b. State/Tribal Funding: $_____

Feel free to provide additional explanation in the space below, so that estimates can be properly interpreted:

SECTION B. PRIMARY BENEFITS OF WETLAND MONITORING AND ASSESSMENT

This section evaluates the extent to which wetland data improves decision-making or program actions. Please feel free to add comments, links to reports, or other information that will help us in making this evaluation.

7. To what extent has wetland monitoring and assessment influenced the following?

Please indicate the extent of influence for each monitoring and assessment activity
(1 = Not at all, 5 = To a great extent)

Type of Change	Not at All (1)	(2)	(3)	(4)	To a Great Extent (5)	Example(s) of influence
Development and/or improvement of permit decisions/permit conditions	1	2	3	4	5	
Development of compensatory mitigation requirements or conditions	1	2	3	4	5	
Selection of wetland restoration projects	1	2	3	4	5	
Design and implementation of wetland restoration projects	1	2	3	4	5	
Selection of priority wetland areas for permanent protection	1	2	3	4	5	
Improvement of watershed management plans	1	2	3	4	5	
Development of fish and/or wildlife habitat/action plans	1	2	3	4	5	
Climate change planning decisions	1	2	3	4	5	
Budgeting or funding priorities for state/tribal wetland programs	1	2	3	4	5	
Development of state/tribal wetland policy	1	2	3	4	5	
To support public outreach/educational materials related to wetlands	1	2	3	4	5	
To define future research needs	1	2	3	4	5	
Other	1	2	3	4	5	

SECTION C: GAPS IN WETLAND INFORMATION AND BARRIERS TO NEEDED MONITORING AND ASSESSMENT

8. What type(s) of wetland data are needed, but not currently available to your state/tribal wetland program?

9. What decision making would such data support? (e.g. Is more monitoring of mitigation sites needed to improve design criteria?)

10. What type of basic academic research would be most helpful to your wetland program?

11. What additional assistance from research institutions would be welcomed?

- ☐ Increased communication on research results (e.g. summaries or fact sheets)?
- ☐ More practical, on the ground training of students (e.g. internships; joint training with professional state agency staff)
- ☐ Continuing education opportunities for state wetland staff
- ☐ Other_____

12. What additional assistance is desired from federal agencies?

- ☐ Development of improved rapid assessment methods
- ☐ Development of improved GIS tools

☐ GIS training; support in use of National Wetland Inventory and related tools

☐ Development of improved data storage/data sharing specifically for wetlands, including biological data

☐ Other_____

13. To what extent are the following barriers to collection of important data?

Select one number on the scale for each type of barrier
(1 = A primary barrier and 5 = No barrier)

Type of Barrier to Data Collection	Primary Barrier 1	2	3	4	No Barrier 5
Lack of technical support for development of an effective monitoring program	1	2	3	4	5
Lack of staff expertise/training to design, carry out sampling, analyze data	1	2	3	4	5
Lack of funding to carry out monitoring	1	2	3	4	5
Lack of staff --- because no FTE assigned to monitoring and assessment	1	2	3	4	5
Lack of staff --- because other work is a higher priority	1	2	3	4	5
Lack of baseline and/or reference information for comparison	1	2	3	4	5
Limited understanding of the importance of monitoring and assessment by agency management	1	2	3	4	5
Limited GIS capacity for Level 1 assessment	1	2	3	4	5
Other (Please specify)	1	2	3	4	5

SECTION D: WETLAND MONITORING PROGRAM DESIGN AND TECHNICAL SUPPORT

14. From the perspective of a state/tribe with an active wetland monitoring program, what are the most important factors in building an effective wetland monitoring and assessment program?

Factors in Building an Effective Wetland Monitoring and Assessment Program	Not at all important 1	2	3	4	Very important 5
Clear definition of monitoring and assessment goals	1	2	3	4	5
Consideration of federal monitoring and assessment goals	1	2	3	4	5
Collaboration with partners who have monitoring experience	1	2	3	4	5
Clear data analysis plans	1	2	3	4	5
Staff experience and training	1	2	3	4	5
Sampling design (including statistical analysis)	1	2	3	4	5
Identification of best methods	1	2	3	4	5
Other (please specify)	1	2	3	4	5

13. What support did your state/tribe using in development of a wetland monitoring and assessment program? Check all that apply.

- ☐ Federal wetland program grants
- ☐ Other federal grants or funding (including participation in NWCA)

  Specify: _____
- ☐ Technical support from federal agencies (e.g. EPA and Corps research units, NOAA, or transportation programs)

  Specify: _____
- ☐ Collaboration with an academic institution

  Specify: _____
- ☐ Collaboration with existing state water monitoring program specialists

  Specify: _____
- ☐ Collaboration with wetland research staff in other agencies or organizations

  Specify: _____
- ☐ Collaboration with local or regional agencies or organizations involved in watershed or landscape level planning

  Specify: _____
- ☐ Participation in national or regional workgroups (e.g. National Wetland Monitoring and Assessment Workgroup; Biological Assessment Work Groups; etc.)

  Specify: _____
- ☐ Technical support in development of GIS tools

  Source: _____

Please feel free to elaborate on support that was essential in developing an effective program in the space below:

14. What steps have you taken specifically to reduce the cost of monitoring and assessment to your program?

- ☐ Improved design to collect the most appropriate sample or limit unnecessary parameters
- ☐ Developed a collaborative program with other agencies or organizations
- ☐ Sought grants specifically to support monitoring and assessment
- ☐ Increased reliance on data collected to meet permit conditions (e.g. mitigation monitoring)
- ☐ Increased reliance on data reported in literature
- ☐ Development of a volunteer monitoring program
- ☐ Increased technical support from other agencies or organizations
- ☐ Other _____

APPENDIX 3B: QUESTIONNAIRE SENT TO NON-STATE SCIENTISTS

The following document was sent to a small number of scientists who are not affiliated with state agencies but who work closely with states in carrying out wetland monitoring and assessment.

ASSOCIATION OF STATE WETLAND MANAGERS
2014 Monitoring & Assessment Questionnaire for Wetland Scientists (other than state and tribal staff)

Background: *You have received this document because we are aware of your interest in or support of state or tribal wetland monitoring and assessment programs. ASWM is seeking a deeper understanding of how monitoring data is used in decision-making in various aspects of wetland management at the state level. We also would like to understand gaps in monitoring, and gain insights into various barriers to the collection and analysis of data from wetland systems. As you complete this questionnaire, we would appreciate inclusion of links to or citations of examples of your work that you think would be helpful to us.*

Data Use: *This information will be shared with states and tribes that are initiating or expanding monitoring and assessment of wetlands, and with other entities (federal agencies, academic institutions) that are also involved in the gathering and analysis of data regarding wetlands. Information will also be used to support these efforts through reports, webinars, and presentations, and on ASWM's online state summary pages. Please add comments, links to reports, or additional information to the extent that you have time to do so. Thank you in advance for your support.*

Questionnaire Completed by (Name): _____

Title: _____

Agency or Organization:_____

Address:_____

Telephone Number: _____Email Address:_____

____ Please check here if you are **not** affiliated with wetland monitoring and assessment work and return the first page of the survey to ASWM.

SECTION A: GENERAL SCOPE OF WETLAND MONITORING ACTIVITIES

7. **In what ways are you current involved in wetland monitoring and assessment?** Please check all that apply.

   ☐ Academic research

   ☐ Contribution of wetland data to individual state programs, including reference site information or other monitoring data

   ☐ Collaboration with specific states (e.g. shared sampling, working as a contractor for the state, data analysis)

   ☐ Primary responsibility for Implementation of wetland monitoring programs designed by the states

   ☐ Collaboration with federal agencies (e.g. participation in NWCA or other federal funded projects)

   ☐ Development/design of state/federal monitoring programs and procedures

   ☐ Other _____

8. **With which states/tribes have you worked on wetland-related projects in the past 3 years? Please describe the capacity in which you conduct(ed) work for each state. Describe any multi-state projects in the second matrix.**

State	General Role/Capacity	Comments

Multi-state or national projects supporting state/tribal wetland programs	General Role/Capacity	Comments

9. In your opinion, how effectively do state wetland programs make use of monitoring and assessment data? To answer this question, we are going to ask you to indicate approximate percentages and make sure they sum to 100%.

_____% of the states I have worked with rely heavily on monitoring data in decision-making, and make appropriate use of data.

_____% of the states I have worked with have access to good data regarding wetland systems, but do not always make good use of that data in decision-making.

_____% of the states I have worked with make good use of data that is available, but do not have access to sufficient wetland monitoring information.

_____% of the states I have worked with make inappropriate use of available wetland data.

_____% of the states I have worked with make very little use of monitoring and assessment information in decision-making.

_____% of the states I have worked with (specify here)_____

(Total =100%)

10. Did you participate in the first National Wetland Condition Assessment?

☐ Yes ☐ No

If yes, in what capacity?_____

11. Is a significant percentage of your wetland monitoring work financially supported by state wetland programs (including federal grant funds used by the states)? Y☐ N☐
If so, approximately what percentage of this funding is from state support_____%
Feel free to provide additional explanation in the space below, so that estimates can be properly interpreted:

SECTION B. PRIMARY BENEFITS OF WETLAND MONITORING AND ASSESSMENT

This section evaluates the extent to which wetland data improves decision-making or program actions in state and tribal wetland programs. The level of benefit will reflect both the gathering and use of data, and the effective use of data. Please feel free to add comments, links to reports, or other information that will help us in making this evaluation.

6. From your perspective, overall to what extent has the use of wetland monitoring and assessment data benefited or improved state and tribal programs with which you are familiar, in each of the following ways? (If monitoring data is not used at all, there is no benefit.)

Please indicate the extent of influence for each monitoring and assessment activity
(1 = Not at all, 5 = To a great extent)

Wetland program area	Not at All (1)	(2)	(3)	(4)	To a Great Extent (5)	Don't Know	Example(s) of influence
Development and/or improvement of permit decisions/permit conditions	1	2	3	4	5		
Development of compensatory mitigation requirements or conditions	1	2	3	4	5		
Selection of wetland restoration projects	1	2	3	4	5		
Design and implementation of wetland restoration projects	1	2	3	4	5		
Selection of priority wetland areas for permanent protection	1	2	3	4	5		
Development of fish and/or wildlife habitat/action plans	1	2	3	4	5		
Climate change planning decisions	1	2	3	4	5		
Budgeting or funding priorities for state/tribal wetland programs	1	2	3	4	5		
Development of state/tribal wetland policy	1	2	3	4	5		
To support public outreach/educational materials related to wetlands	1	2	3	4	5		
To define future research needs	1	2	3	4	5		
Other	1	2	3	4	5		

7. Please list any states with whom you have worked/are currently working that you believe would serve as positive case studies for wetland monitoring and assessment. If possible, identify a contact person for each state/tribe listed and their contact information.

State/Tribe Name	Why?	Contact Person	Contact telephone and/or email

8. Please list any states with whom you have worked/are currently working that you believe would serve as case studies for wetland monitoring and assessment lessons learned (i.e. that have faced specific challenges). If possible, identify a contact person for each state/tribe listed and their contact information.

State/Tribe Name	Why?	Contact Person	Contact telephone and/or email

SECTION C: GAPS IN WETLAND INFORMATION AND BARRIERS TO NEEDED MONITORING AND ASSESSMENT

9. What type(s) of wetland data are needed, but not currently available to the state/tribal wetland programs with whom you work/have studied? Please specify state names where appropriate.

10. What types of decision making would such data support? (e.g. Is more monitoring of mitigation sites needed to improve design criteria?)

11. In your opinion, what basic academic research would be most helpful to state/tribal wetland programs?

12. In your opinion, to what extent are the following limitations barriers to state/tribal collection of important data?

Select one number on the scale for each type of barrier
(1 = A primary barrier and 5 = No barrier)

Type of Barrier to Data Collection	**Primary Barrier 1**	**2**	**3**	**4**	**No Barrier 5**
Lack of technical support (from outside agencies or organizations) for development of an effective monitoring program	1	2	3	4	5
Lack of staff expertise/training to design, carry out sampling, analyze data	1	2	3	4	5
Lack of funding to carry out monitoring	1	2	3	4	5
Lack of staff --- because other work is a higher priority	1	2	3	4	5
Lack of baseline and/or reference information for comparison	1	2	3	4	5
Limited understanding of the importance of monitoring and assessment by agency management	1	2	3	4	5
Lack of recognition of wetland issues in state/tribal water monitoring programs	1	2	3	4	5
Limited GIS capacity for Level 1 assessment	1	2	3	4	5
Other (Please specify)	1	2	3	4	5

SECTION D: WETLAND MONITORING PROGRAM DESIGN AND TECHNICAL SUPPORT

13. From your perspective, what are the most important factors in building an effective state/tribal wetland monitoring and assessment program?

Factors in Building an Effective Wetland Monitoring and Assessment Program	Very Important 1	2	3	4	Not at all Important 5
Clear definition of monitoring and assessment goals	1	2	3	4	5
Consideration of federal monitoring and assessment goals	1	2	3	4	5
Collaboration with partners who have monitoring experience	1	2	3	4	5
Clear data analysis plans	1	2	3	4	5
Staff experience and training	1	2	3	4	5
Sampling design (including statistical analysis)	1	2	3	4	5
Identification of best methods	1	2	3	4	5

Comments:

APPENDIX 4: NATIONAL WETLAND CONDITION ASSESSMENT OUTREACH MATERIALS

FACT SHEET

(State Name) Wetlands and the Release of the National Wetland Condition Assessment (NWCA)

Photo Title: Provide name of wetland and location
Photo Credit: Anthony Bley, USACOE

Did You Know?

(Add appropriate bullets here; examples provided below –you may want to focus on ecosystem services; don't use acronyms or technical language. For example: Sediment retention = limit erosion)

- **Commercial fishing** in (State) is a $X million a year industry that employs X# state citizens? Sport fishing and hunting are important attractions to the tourists and seasonal residents who make tourism a $X billion a year industry employing another X# citizens. The majority of commercial and sport fish species spend some portion of their life cycle in wetland habitat.
- Tens of thousands of **hunters and trappers** in (State) know that wetlands mean valuable game, whether it is ducks in coastal salt marshes or deer, bear and small furbearers foraging in freshwater wetland habitat.
- Wetlands are the source of over three million acres of productive timberland, vital to the state's **forest products industry** which provides jobs for X# workers in (State).
- (State)'s wetlands save millions of dollars annually through **erosion control, reduced flood damage and pollution abatement.** Their water quality and flood control functions protect the public from otherwise harmful effects. (You may want to relate this information to a specific event, e.g. Hurricane Sandy, flooding or other)
- Over X% of all wildlife-related recreation in (State) is wildlife watching. Annually, over X citizens and visitore visit (State) to enjoy its natural beauty and view rare plants and wildlife. (List well-known species here) call (State)'s wetlands home. (Statistics for your state can be found here: http://www.census.gov/prod/www/fishing.html)

What is the National Wetland Condition Assessment?

The U.S. Environmental Protection Agency released their assessment of the condition of wetlands across the United States on (Add Date). The National Wetland Condition Assessment (NWCA) is the first-ever national survey on the ecological condition of the Nation's wetlands and is one of the five National Aquatic Resource Surveys initiated in 2006. These studies provide nationally-consistent and scientifically-defensible assessments of our lakes, rivers, wadeable streams, coastal waters, and wetlands, and can be used to track changes over time. The purpose of the survey is to generate statistically-valid and environmentally relevant reports on the condition of the Nation's wetlands. Of the 1,138 sites nationwide, a total of X wetland sites were selected by the EPA for assessment in (State), including X (wetland type), X (wetland type) and X (wetland type). The study is the product of cooperation and collaboration between EPA, states officials and scientists. EPA provided the funding for the study and states provided the fieldwork and expertise to complete the assessment.

EPA National Aquatic Resource Surveys (NARS) are conducted every five years to evaluate changes in wetland condition over time

2007	2008	2009	2010	**2011**
Lakes	Rivers	Wadeable Streams	Coastal Waters	**WETLANDS**
				→
2012	2013	2014	2015	**2016**
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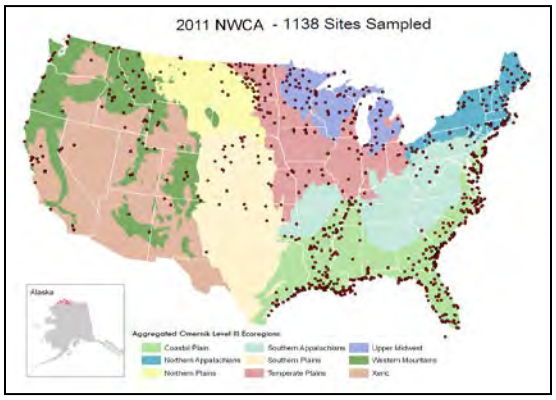


The NWCA is being used to:

- Determine the national & regional condition of wetlands (NWCA findings are not state-specific)
- Develop baseline information to evaluate change in condition over time
- Build state and tribal capacity for monitoring and analyses

Results and findings from the NWCA are not being used by EPA or the state to provide state-level information or for regulatory purposes.

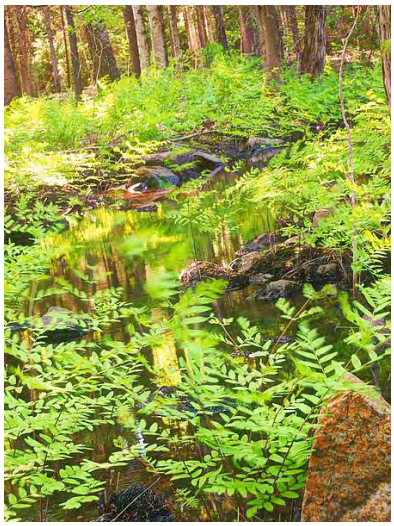
Key findings from the NWCA 2014 Report include:

(Insert appropriate bullets here)

- Add here
- Add here

What the NWCA tells us about (State Name) Wetlands

(Insert appropriate bullets here)



The EPA NWCA Projects' objective was to assess wetland condition at the national and regional level, but not the state level. While it can't tell us a lot about state-specific wetland conditions, it can tell us about specific ways to look at and assess wetland condition, how wetland condition looks in our region and emphasizes the value of monitoring and assessment data for our state's management of natural and water resources. *(If your state is a state where an intensification study was conducted, you can add this additional information):* EPA worked with our state to modify the NWCA design to include state-specific objectives, In (State) sufficient additional wetland sites were sampled to assess conditions at the state level. Findings from this additional state-level statistical assessment of wetland condition suggests that (State)'s wetlands are generally in a (similar/not similar) ecological condition to the findings of the NWCA. To learn more about the NWCA or download the complete report, go to: http://water.epa.gov/type/wetlands/assessment/survey/index.cfm

Protecting (State)'s Wetlands

(Add appropriate bullets here; examples provided below – note: If your state already has strong protections, may want to add that this continues to focus on improving functions).

The NWCA provides an opportunity for New Jersey to highlight the importance of high quality wetlands so that they can provide the functions and services that support our state's economy. More than X percent of (State)'s land area is wetlands. (May want to tie in with state-important information (example: Hurricane Sandy, drought, etc.) and the impacts that wetlands can have on protecting against these threats/buffering impacts.)

What We Need from You:

- Encourage enforcement of federal and state laws protecting wetlands
- Support funding for monitoring and assessment
- Experience (State)'s wetlands with your family and friends

For More Information:

Contact Bob Smith at the State Wetland Program *Add as appropriate - Like us on FB, Twitter, etc.*
Street Address. City/State/Zip
Telephone: (123) 123-1234; Email Bob.Smith@state.gov; Website Address;

Implications of the National Wetland Condition Assessment (NWCA) Report for the (State/Tribe Name)

A new EPA Report Assesses the Condition Wetlands Nationwide.
The U.S. Environmental Protection Agency released their first-ever assessment of the condition of wetlands across the United State/Tribes on December ___, 2014, called the *National Wetland Condition Assessment*. (NWCA).

The NWCA is one of the five National Aquatic Resource Surveys initiated in 2006. These studies provide nationally-consistent and scientifically-defensible assessments of our lakes, rivers, wadeable streams, coastal waters, and wetlands, and can be used to track changes over time. The purpose of the survey is to generate statistically-valid and environmentally relevant reports on the condition of the Nation's wetlands.

EPA National Aquatic Resource Surveys (NARS) are conducted every five years to evaluate changes in wetland condition over time

2007	2008	2009	2010	**2011**
Lakes	Rivers	Wadeable Streams	Coastal Waters	**WETLANDS**
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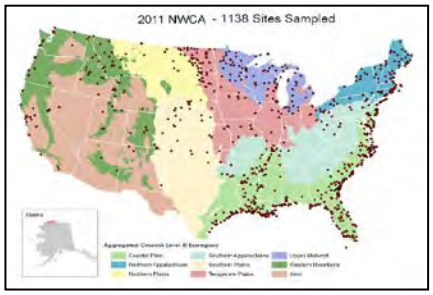

Of the 1,138 sites nationwide, a total of X wetland sites were selected by the EPA for assessment in (State/Tribe), including X (wetland type)s, X (wetland type)s and X (wetland type)s.

The NWCA study is the product of cooperation and collaboration between EPA, state officials and scientists. EPA provided the funding for the study and states provided the fieldwork and expertise to complete the assessment. To learn more about the NWCA or download the complete report, go to:
http://water.epa.gov/type/wetlands/assessment/survey/index.cfm

Key findings and conclusions from the NWCA include:
(Insert brief summary of NWCA findings relevant to your State/Tribe/Tribe)
- Overall condition of nation's wetlands
- The report finds that wetlands in our ecoregion are in (insert condition from report here) condition

How the NWCA relates to our work to protect (State/Tribe)'s wetlands:

The EPA NWCA Projects' objective is to assess wetland condition at the national and regional level, but not the state level.
(*If your state is a state where an intensification was conducted, you can add this additional information*): To determine the condition of wetlands in our state, the EPA has funded a multi-year intensification study, which will be completed in 2016. Findings from this additional state -level statistical assessment of wetland condition suggests that (State/Tribe)'s wetlands are generally in a (similar/not similar) ecological condition to the findings of the NWCA. Our State/Tribe will also be conducting additional analysis of this data.

The NWCA is being used to:
- Determine the national & regional condition of wetlands (NWCA findings are not state-specific)
- Develop baseline information to evaluate change in wetland condition over time
- Build state and tribal capacity for monitoring and analyses

Note: Results and findings from the NWCA are not being used by EPA or the state to provide State-level information or for regulatory purposes.

What are Wetlands?
Wetlands are part of the foundation of our nation's water resources and are vital to the health of waterways and communities that are downstream. Wetlands feed downstream waters, trap floodwaters, recharge groundwater supplies, remove pollution, and provide fish and wildlife habitat. Wetlands include swamps, marshes and bogs. Wetlands vary widely because of differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors.

Wetlands economic drivers in (State/Tribe) because of their key role in the State/Tribe's water quality, fishing, hunting, agriculture and recreation industries.

Did you know that (State/Tribe's name) wetlands provide critical services that support our economy? Wetlands provide:
(Insert appropriate bullets here)
- Contributions to clean water, flood control, groundwater recharge and other critical services,
- Nurseries for the vast majority of the State/Tribe's commercial and sport fish,
- Critical habitat for the State/Tribe's game and hunting industry,
- Natural resources relied on by the timber industry, and
- Habitat for hundreds of endangered species?

These services can save taxpayers hundreds of millions of dollars from water treatment facilities not having to clean more polluted water, from property damage from floods and storm surges and other expenses.

What are the biggest threats to (State/Tribe's name) Wetlands?
(Insert appropriate bullets here)
- Fragmentation, development and poor land management practices
- Recreational and agritcultural disturbances
- Storm surge and sea-level rise
- Stormwater pollution
- Invasive species

***Heading Option A:* What can be done to Better Protect (State/Tribe's) Wetlands?**

***Heading Option B:* While (State/Tribe) does a great job at protection its wetlands, what do we need in order to improve the condition of those wetlands?**
(Insert appropriate bullets here)
- More public awareness of the intrinsic and economic value of (State/Tribal) wetlands
- Increased monitoring & assessment to target resources more effectively, which can result in reduced costs and reduce property damage
- Consideration of wetlands in other areas of decision making
- Living shorelines and coastal resiliency

To learn more about what our state/tribe is doing to protect wetlands, we encourage you to look at our state wetland program plan (insert web address to appropriate plan here). (State may want to list the core elements that they emphasize, e.g. regulation and monitoring and assessment).

Actions (citizens/tribal residents and members) can to take to protect and restore our State/Tribe's wetlands:
(Insert appropriate bullets here)

- Consider wetland issues when you are working with others on flooding, pollution, storm surge and climate change issues. *Wetlands can play a critical role in reducing these impacts!*
- For State ---Better compliance with state rules and regulations that protect wetlands (Dredge and Fill Permitting, NPDES, etc.) **OR For Tribe ---** Support conservatory and stewardship practices of the tribe's wetlands (Dredge and Fill Permitting, NPDES, CAMA permitting, etc.)
- Increase State/Tribe support for wetland monitoring and assessment

Please Direct Questions about the NWCA Report/State/Tribe Wetlands to:

(State/Tribe) Wetland Program Contact
Joe Wetlands, State/Tribe Coordinator; Address: State/Tribe Drive, City, State/Tribe, Zip; Email/Phone: jwetlands@State/Tribe.gov, (111) WET-LANDS

The Association of State Wetland Managers
Telephone: (207) 892-3399
Email: info@aswm.org

FREQUENTLY ASKED QUESTIONS

The NWCA is likely to illicit some questions from interested parties. Think ahead about what you think will be asked, based on past responses from stakeholders. (Insert relevant Q&As here. The following have been provided as examples.)

Q. How will the NWCA Data be Used?

A. The NWCA data can be used in many ways. These will differ between users, depending on whether they are making decisions at the federal, state/tribal or local level. Examples of potential applications include:

- Results may inform future State/Tribe efforts to protect wetlands under the Clean Water Act (CWA);
- Results may be applied to coastal resiliency efforts in some parts of the country;
- Findings may help State/Tribe permit writers to better understand the condition of certain types of wetlands.

Q. The report indicates that the region's wetlands are in great shape. Why do we have such strong protections if they are doing just fine?

A. While the region's wetlands may be in generally good condition, that does not mean that all wetlands in the State/Tribe are healthy or protected from threats. There are many critical wetlands in the State/Tribe that are being destroyed or damaged. Specifically, we need to work hard at protecting our coastal wetlands, which serve as critical habitat for the State/Tribe's seafood industry and a critical part of our State/Tribe's defense against storm surge and sea level rise. They also play an important role in filtering pollutants from urbanized/urbanizing areas.

Q. Do dredge and fill permits still need to be filed for work in wetland areas?

A. Yes. All requirements for the protection of (State/Tribe's) wetland remain the same as before the report was issued. For more information about permitting, go to: http://www.specificwebsite.gov

Q. Which of (State/Tribe's) wetlands are most threatened?

A. All (State/Tribe's) wetlands have an important role to play in their specific geographic area. The group of wetlands most threatened in our State/Tribe are (insert here; e.g. coastal marshes, prairie potholes). Our State/Tribe's laws/regulations (add primary protections here, e.g. Coastal Zone Laws and Dredge and Fill permit process) work to protect these, yet losses are still occurring. For a map of (State/Tribe's) wetlands, go to: http://www.specificwebsite.gov

Q. Why is monitoring and assessment of wetlands important?

A. Monitoring and assessment allows the State/Tribe to better understand the health and condition of our wetlands and to allocate limited resources to the greatest benefit. Understanding trends and concerns are a critical part of protecting wetland resources. Knowing the health and condition of wetlands allows knowledgeable management decisions to be made about wetland services and benefits, which can result in significant savings to taxpayers.

Implications of the 2014 National Wetland Condition Assessment (NWCA) Report Findings for (State's Name)

Did you know that (State Name)'s wetlands provide critical services that support our state's economy? Wetlands provide: *(Insert appropriate bullets here)*

- Contributions to flood control, clean water, groundwater recharge and other critical services
- Nurseries for the vast majority of our state's commercial and sport fish species
- Critical habitat for (state name)'s game and hunting industry
- Natural resources relied on by the timber industry

These services can save taxpayers hundreds of millions of dollars as the result of water treatment facilities not having to clean more polluted water, from property damage from floods and storm surges or other expenses.

What are Wetlands?

(Insert appropriate description here)

Wetlands are part of the foundation of our nation's water resources and are vital to the health of waterways and communities that are downstream. Wetlands feed downstream waters, trap floodwaters, recharge groundwater supplies, remove pollution, and provide fish and wildlife habitat. Wetlands vary widely because of differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors. (State name)'s wetlands include *salt marshes, peat bogs, fens*…add more here.

What are the biggest threats to (State)'s Wetlands?

(Insert appropriate threats here)

- Habitat fragmentation, development and poor land management practices
- Recreational and agricultural disturbances
- Storm surge and sea level rise
- Stormwater pollution
- Invasive species

New EPA Report Assesses the Condition of Wetlands Nationwide:

A new EPA Report Assesses the Condition Wetlands Nationwide.
The U.S. Environmental Protection Agency released their first-ever assessment of the condition of wetlands across the United State/Tribes on December ___, 2014, called the *National Wetland Condition Assessment*. (NWCA).

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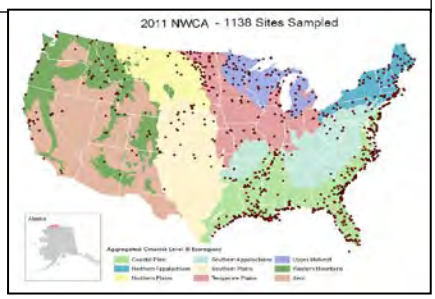


The NWCA study is the product of cooperation and collaboration between EPA, state officials and scientists. EPA provided the funding for the study and states provided the fieldwork and expertise to complete the assessment. To learn more about the NWCA or download the complete report, go to: http://water.epa.gov/type/wetlands/assessment/survey/index.cfm

The NWCA is being used to:

- Determine the national & regional condition of wetlands (NWCA findings are not state-specific)
- Develop baseline information to evaluate change in wetland condition over time
- Build state and tribal capacity for monitoring and analyses

It is important to note that results and findings from the NWCA are not being used by EPA or the state to provide State-level information or for regulatory purposes.

Key findings from the NWCA study include:
(Insert highlights from national report that are applicable to your state here)
- Add here
- Add here

How the NWCA relates to our state's work to protect wetlands in (state name):
(Insert information about how report relates to known wetland condition in your state here)

The EPA NWCA Projects' objective is to assess wetland condition at the national and regional level, but not the state level. (*If your state is a state where an intensification was conducted, you can add this additional information*): To determine the condition of wetlands in our state, the EPA has funded a multi-year intensification study, which will be completed in 2016. Findings from this additional state -level statistical assessment of wetland condition suggests that (State/Tribe)'s wetlands are generally in a (similar/not similar) ecological condition to the findings of the NWCA. Our State/Tribe will also be conducting additional analysis of this data.

What we need to accomplish in (State name) to better protect wetlands and their services:
(Insert appropriate goals here)

- More public awareness of the value of (state)'s wetlands
- Better compliance with rules and regulations that protect wetlands
- Increased monitoring & assessment to target resources more effectively

Actions we hope YOU will take to protect our state's wetlands:
(Insert appropriate actions here – Examples of possible actions below)

1. Support state laws and regulations that protect our state's wetlands (Dredge and Fill Permitting, NPDES, etc.)
2. Lobby for funding support (example: Increase state funding for wetland monitoring and assessment)
3. Focus resources on habitat enhancement
4. Support X bill
5. Contact us if you have any questions or seek technical support about wetland issues
6. Consider wetland issues when you are working with others on flooding, pollution, storm surge and a variety of other extreme weather-related issues. ***Wetlands can play a critical role in reducing these impacts!***

To learn more about what our state/tribe is doing to protect wetlands, we encourage you to look at our state wetland program plan (insert web address to appropriate plan here). (State may want to list the core elements that they emphasize, e.g. regulation and monitoring and assessment).

Please Direct Questions about the NWCA Report and/or (state)'s wetlands to:

(State/Tribe) Wetland Program
Primary Contact: Joe Wetlands, State/Tribal Coordinator Address: State Drive, City, State, Zip
Email: jwetlands@state.gov; Tel: (111) WET-LANDS

Potential Tweets FOR Use Sharing NWCA Information via Twitter
Provided by the Association of State Wetland Managers for States and Tribes
(Each line < 100 characters)

National report documents first ever assessment of condition of U.S. Wetlands. Read more: www.weblink.gov

National report informs state efforts to protect wetlands under the Clean Water Act. Read more: www.weblink.gov

(State)'s wetland program seeks to study wetland conditions documented in National Report. More: www.weblink.gov

State/Tribe benefits from monitoring and assessment data in national report. Read more: www.weblink.gov

National study provides insights into studying wetland conditions. Read more: www.weblink.gov

National report finds surprising trends in wetland conditions. To learn more: www.weblink.gov

National report helps state permit writers better understand the condition of wetland types. Read more: www.weblink.gov

EPA finds more wetland conditions poorest in the X region of the United States. To learn more: www.weblink.gov

X% of (Region)'s wetlands reportedly in good condition. Read more: www.weblink.gov

National report indicates (State/Tribe)'s wetlands in good condition. State data shows otherwise. Read more: www.weblink.gov

What impact do wetlands have on (State)'s economy? Find out: www.weblink.gov

10 things you can do to save (State)'s wetlands. Act now: www.weblink.gov

Wetlands critical in fight against sea level rise, storm surge, flooding, pollution. Read more: www.weblink.gov

What do (State)'s fishermen need to know about wetland conditions? Learn more: www.weblink.gov

Wetland restoration is working in the State of (State name)! Read more: www.weblink.gov

Other potential related topics for tweeting: Habitat loss, Homes for endangered species, Water quality impacts, Algal blooms, Changes in water chemistry, Loss of connectivity, Erosion, Fish Nurseries

Potential Hashtags

#NWCA	**#wetlands**	**#wetlandreport**	**#wetlandcondition**
#(state)wetlands	**#epawetlands**	**#savewetlands**	

NWCA Communications Guidance

PRESS KITS

Letter of Introduction –This should be your lead-off piece, which includes:

- Why they should care about this information
- Table of contents of what is in the kit
- A call-to-action
- Include your program's logo

NWCA and State Wetlands Status

One page, easy to digest, outlining:

- A brief summary of the NWCA and its goals
- You state's wetland stats (original acres, acres lost, etc.)
- How the results compare to what state has found/accomplished
- A basic summary your program (incl. mission statement and primary goals related to this issue)
- Call to action based on needs in your state (Less than 5 actions you want to be taken, by whom)
- Include ample high-quality images of wetlands (action shots of people working in wetlands or wetlands in obvious need – to a non-expert- of restoration)

Program Services – You should include a list of all of your program's services (and products if you have them), as well as the benefits of each. May want to make this a brochure.

Current News – Anything newsworthy regarding your program should be included. If you've had any articles published on other websites, have been interviewed, or if you've partnered with other agencies or nonprofits, be sure to list those activities and include any relevant materials (or links).

Contact Information – Each piece of the press kit should individually include contact information, including one point person, address, email and telephone number that is checked regularly.

Media-ready Story - Have one or more stories that make the points that you are trying to share that have a photographic quality to them (a pre-approved/arranged site visit or ready-to-go high quality images you can give upon request). Make sure you have several high quality action shots of your staff working in wetlands.

APPENDIX 5: STATE WETLAND MONITORING PROGRAM SUMMARIES

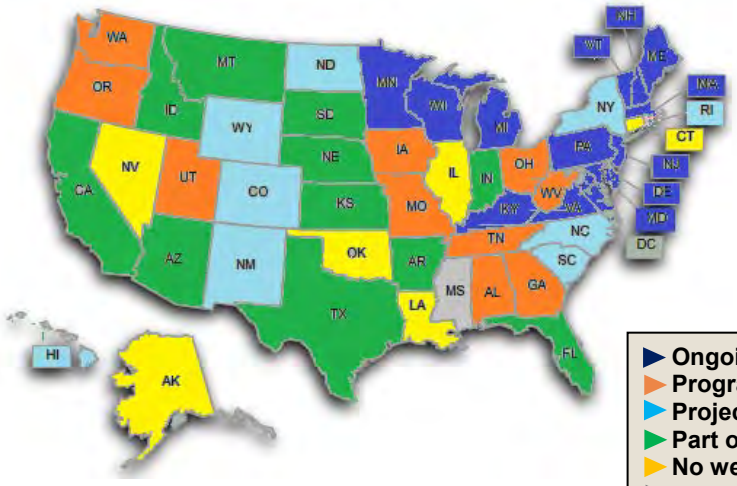
ASWM is currently in the process of completing a year-long study of state wetland programs, collecting and compiling information on EPA's Four Core Elements, climate change work and integration activities. The following excerpt from the study's status and trends report identifies key results from this study. This information is currently being verified by state wetland program staff. All data is a snapshot of state wetland programs as of December 2014. The final report will be available at: http://www.aswm.org/wetland-programs/state-wetland-programs

Core Element #2: Wetland Monitoring and Assessment

Background: Wetland monitoring is the systematic observation and recording of current and changing wetland conditions, while assessment is the use of that data to evaluate or appraise wetlands to support decision-making and planning processes. Wetlands can be characterized both by their condition and functions. EPA defines a "monitoring and assessment program" as the establishment and operation of appropriate devices, methods, systems and procedures necessary to monitor, compile, and analyze data on the condition of wetlands in a state or tribe.

Results: Thirteen states have a formal, ongoing wetland monitoring and assessment program. An additional ten states report that they are currently in the process of developing their program. Seven states that do not have a M&A program, report that they only conduct time-limited, project-specific monitoring and assessment efforts, while another eleven states that do not have a wetland-specific wetland monitoring program, do monitor at least some of the state's wetlands through other non-wetland monitoring programs (e.g. stream, surface water and other water resource monitoring programs). Six states do not monitoring wetlands through any of their programs or projects.

Most monitoring and assessment is project-specific monitoring, funded by limited-term grants. In many cases, states are reliant on a successive/progressive series of wetland program grants from EPA to conduct this work and indicate that their monitoring work/program would not exist without this support.



- **Ongoing formal M&A Program** (13 states)
- **Program under development** (10 states)
- **Project-specific M&A only** (9 states)
- **Part of non-wetland monitoring program only** (11 states)
- **No wetland monitoring** (6 states)
- **Unknown/No data available** (1 state)

Core Element #2: EPA Levels of Monitoring and Assessment

Background: EPA uses a three-tier framework to identify wetlands monitoring and assessment activities. Most states and tribes draw on one or more of these tiers when designing and implementing their wetlands monitoring programs.

- **Level 1** or landscape assessments rely entirely on GIS data, utilizing landscape disturbance indices to assess wetland condition.

- **Level 2** or rapid assessments use relatively simple metrics to assess wetland condition. They are customarily based on the readily observable hydrogeomorphic and plant community attributes of wetlands.

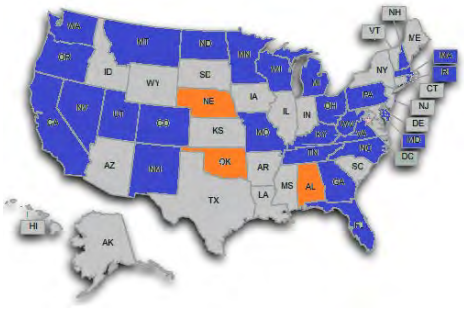
- **Level 3** or intensive site assessments provide a more thorough and rigorous measure of wetland condition by gathering direct and detailed measurements of biological taxa and/or hydrogeomorphic functions.

Wetlands assessment activities at all three levels can be effectively integrated with other surface water monitoring efforts, such as stream or habitat assessments. Doing so can provide a more integrated understanding of watershed health and a foundation for developing more effective management approaches.

Core Element #2: EPA Levels of Monitoring and Assessment – By Level

Monitoring and Assessment Capabilities Versus Ongoing Activities: These maps indicate all levels at which they have conducted wetland monitoring and assessment over time. A state may have tools for a level or have done a study at that level in the past, but not be conducting monitoring and assessment at that level currently. Verification with states indicates that not all states are clear about the formal EPA definitions of monitoring levels or how those relate to the monitoring work happening in their state. Additionally, in a few states, while all three levels of monitoring were being undertaken on an ongoing basis, it was unclear how much was actually committed to wetland work.

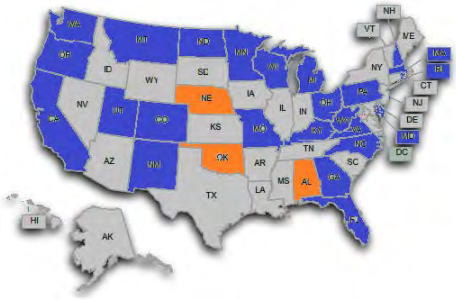
Level 1: A Level 1 or landscape assessment approach involves characterizing the lands that surround wetlands through the use of landscape metrics (e.g., percent forest cover and land use category). Assessment results can provide a coarse gauge of wetland condition within a watershed.



States with Level 1 Monitoring

Results: At least twenty-six states have completed at some wetland monitoring and assessment work at Level 1. Three states are in the process of developing this capacity.

Level 2: Level 2 or rapid assessments are customarily based on the readily observable hydrogeomorphic and plant community attributes of wetlands. They also can employ the use of a "stressor checklist." Rapid assessment methods typically produce a single score that describes where a wetland generally falls along a gradient of human disturbance and with respect to ecological integrity.



States with Level 2 Monitoring

Results: At least 23 states (slightly fewer) have done Level 2 monitoring and assessment. Three states are in the process of developing this capacity.

Level 3**:** Level 3 or intensive site assessments focus on wetland condition by gathering direct and detailed measurements of biological taxa and/or hydrogeomorphic functions. Two examples of the type of indicators that might be used in Level 3 assessment are plant composition/structure and soil organic matter content.

States with Level 3 Monitoring

Results: At least 19 states have done Level 3 monitoring and assessment work (less states than those conducting either Level 1 or Level 2 work). One state is in the process of developing this capacity.

- **Have conducted some wetland M&A at this level**
- **M&A at this level under development**
- **None/Unknown/No data available**

Core Element #2: Monitoring and Assessment – National Wetland Condition Assessment (NWC

The National Wetland Condition Assessment (NWCA) is the first-ever national survey on the ecological condition of the Nation's wetlands. Led by EPA and involving state, tribal and other partners, the survey was designed to provide regional and national estimates of wetland ecological integrity and rank the stressors most commonly associated with poor conditions. The process of designing and conducting the survey was also intended to help build state and tribal capacity to monitor and analyze wetland condition while promoting collaboration across jurisdictional boundaries. Field crews sampled 1,179 sites from Florida to Alaska during the spring and summer of 2011.

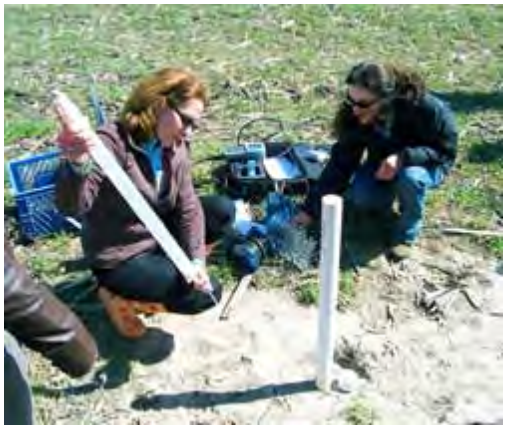
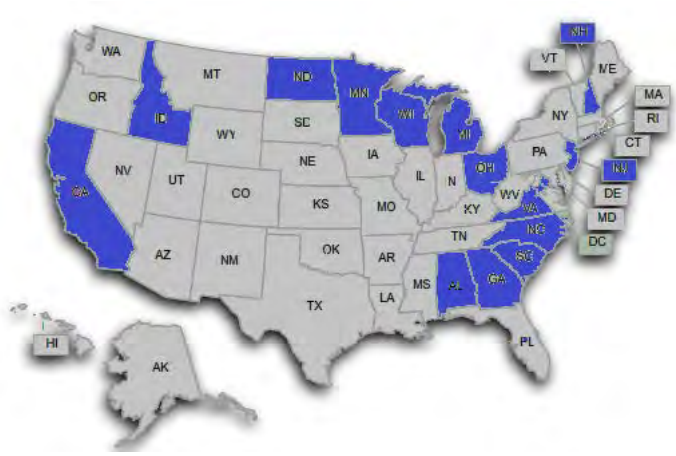


Photo credit: EPA

State Roles in Collecting and Reviewing NWCA Data: Many states worked with EPA staff and other partners to conduct sampling and/or analysis. States played various roles in completing the NWCA. In some cases, state staff applied for funding to conduct the sampling for the NWCA, other states applied for NWCA funds to hire contractors, some jointed federal contractors in the field as they did the work, and some states had no role in conducting the sampling, but did review the data that the federal project generated.

State Intensification Studies: Additionally, a number of states conducted NWCA State Intensification Studies, which allowed states to collect adequate data to statistically evaluate the condition of wetlands at the state level. The below map illustrates the 13 states that conducted intensifications. Additionally, Michigan conducted a coastal wetlands intensification study using NWCA protocols which may not be included in the final NWCA report.



The Role of NWCA as Foundation Building for State Wetland Monitoring and Assessment Efforts: For many states, NWCA viewed as a foundation-building/refining tool for the development of portions of the monitoring and assessment program. The ability to develop, test and implement many of the testing protocols and tools will serve as the basis for future wetland monitoring and assessment work in their state.

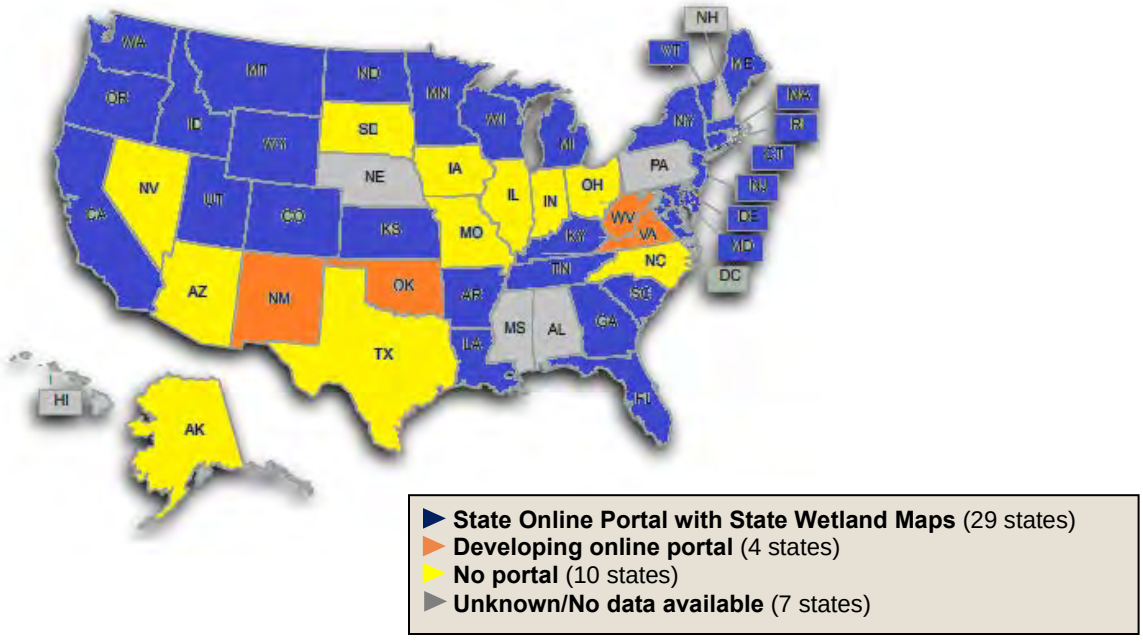
For more information on the NWCA study and final reports, please go to:
http://water.epa.gov/type/wetlands/assessment/survey/

Core Element #2: Monitoring and Assessment – Wetland Mapping

Background: Wetland maps play a critical role in wetland regulation, monitoring, and restoration activities. For example, wetland maps may be used in some states for determining regulatory control (e.g. New York State). In other states they are used in landscape level monitoring and assessment. Maps are also valuable for identifying and tracking restoration activities.

Results: Across the country, mapping and access to web-based maps has been growing exponentially. Most states rely on maps from the National Wetland Inventory (NWI) or NWI Plus mapping projects by the National Fish and Wildlife Service. Funding has been limited for NWI so some states have concerns that the NWI maps are not entirely representative of the current state of their wetlands. Some states have developed their own maps.

Access to wetland maps is becoming increasingly broad through the proliferation of state online "portals" (web-based sites that are accessible to the public) with links to wetland maps. Twenty-nine states provide access to state wetland maps through some form of online "portal" or dedicated website. Four additional states are in the process of developing these resources (NM, OK, VA, and WA). These states are identified in the map below.



Challenges with existing maps and lack of resources to update them: In some states, a lack of updated or promulgated maps causes problems for wetland regulators. Out-of-date maps lead to inaccurate assessment of wetland loss, untracked changes in condition, or even the inability to regulate a wetland that by state definition would actually be considered as regulated under the regulations of the state.

Core Element #2: Monitoring and Assessment - Wetland Mapping Public Portals

Photo credit: NPS

Examples of specific state-developed online portals that provide public access to wetland maps:

AR: Arkansas Wetland Resource Information Management System:
http://awrims.cast.uark.edu/home/wetland-resources.aspx
CA: California Environmental Resources Evaluation System (CERES) Program:
http://ceres.ca.gov/
FL: MapDirect 5.0: http://ca.dep.state.fl.us/mapdirect/gateway.jsp
GA: Georgia GIS Portal: https://data.georgiaspatial.org
IN: DEC Mapviewer: http://mtnhp.org/mapviewer/
MI: DEQ MapsViewer: http://www.mcgi.state.mi.us/wetlands/
MT: Ripairan Mapping Center: http://mtnhp.org/nwi/
NC: Division of Coastal management Estuarine Shorelines GIS Data Download Page
http://portal.ncdenr.org/web/cm/gis-data-download-page
NJ: NJ Geo-web: http://www.nj.gov/dep/gis/geowebsplash.htm
NY: DEC GIS: http://gis.ny.gov/gisdata/inventories/member.cfm?organizationID=529
OK: The Oklahoma Water Resources Board NWI Maps
https://www.owrb.ok.gov/learn/wetlands/NWImaps.php
RI: Rhode Island Monitoring and Assessment Wetland Map Links:
http://www.dem.ri.gov/programs/benviron/water/wetlands/wetldocs.htm
SC: DNR Mapping Clearinghouse: http://www.dnr.sc.gov/maps.html
VA: WETCAT: http://www.mawwg.psu.edu/docs/resources/VA_Assessment_Tool_Summary.pdf
WA: Coastal Atlas Website: https://fortress.wa.gov/ecy/coastalatlas/
WI: Surface Water Data Viewer: http://dnr.wi.gov/topic/surfacewater/swdv/

Examples of Monitoring and Assessment Training Needs

- Training on targeted monitoring and assessment tools
- Guidance on how to adapt targeted monitoring and assessment tools for their state
- Training on how and when to use Hydrogeomorphic Assessements (HGM)
- How to use tools to measure success
- How to target data collection to support program goals
- Field-based training to see and test on real-world examples

Conclusions

Wetland monitoring and assessment has been the greatest growth area in EPA Core Elements across the nation. While only thirteen states have a formal wetland monitoring and assessment program, an additional ten states are working on developing their state wetland monitoring and assessment programs. In some cases, those states without a wetland monitoring and assessment program include monitoring of wetlands in other water resource monitoring programs, but others find they are not able to do this work because their wetland program is not part of programs monitoring lakes, rivers and streams (e.g. KY).

The vast majority of monitoring and assessment of wetlands across the nation is project-specific, funded by limited-term grants, rather than ongoing, state-funded monitoring and assessment programs. In many cases, states are reliant on a successive/progressive series of wetland program grants from EPA to conduct this work and indicate that their monitoring work/program would not exist without this support. There appears to be a shift in methodologies from more intensive and thorough hydrogeomorphic methodologies to rapid assessment models, primarily due to limited resources. States use wetland maps extensively and are reliant on NWI and NWI Plus efforts, though some states have their own. An area of growth has been the use of online public portals to share this information with a broader audience of stakeholders, including consultants, nonprofits and the general public.

PHOTO CREDITS

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Pg. 4 – header: *EPA National Wetland Condition Assessment*

Pg. 8 – header: *EPA National Wetland Condition Assessment*

Pg. 11 – header: *EPA National Wetland Condition Assessment*

Pg. 14 – vegetation sampling: *EPA National Wetland Condition Assessment*

Pg. 15 – header: *Michigan Dept. of Environmental Quality*

Pg. 20 – legal exhibit: *Michigan Dept. of Environmental Quality*

Pg. 21 – oil coated turtle from Enbridge spill, Kalamazoo River: *Michigan Department of Natural Resources*

Pg. 23 – header – native cranberry bog: *Michigan Dept. of Environmental Quality*

Pg. 25 – header - Lake Erie lighthouse during Hurricane Sandy: *Tony Dejak*

Pg. 33 – header – drone in use to monitor flamingo population at Al Wathba Wetland Reserve: *Environmental Agency Abu Dhabi*

Pg. 35 – use of drone in wetland assessment: *Central Michigan University*

Pg. 38 – header: *EPA National Wetland Condition Assessment*