Great Lakes Commission
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NATIONAL WILDLIFE FEDERATION

Best Practices *for* Climate Change Adaptation: Spotlight on Michigan Coastal Wetlands

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Acknowledgments

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Preface

Evidence of climate change is increasing across the Michigan, as it is elsewhere in the Great Lakes region, the nation and across the globe. Temperatures in Great Lakes region have shown an average increase of 2.3 degrees during the last third of the last century, while ice cover and snow days declined during that same period. The polar vortex of the winter of 2013-14 is expected to show as a spike on charts, but not to alter overall climate trends. Impacts of climate change vary by region, and observed and anticipated impacts in Michigan are similar to what can be expected across the Great Lakes region overall.

Unless adequate measures are taken, climate change impacts could result in significant losses in the Michigan's coastal wetlands—in terms of quantity and quality. The loss in coastal wetlands portends associated losses in the ecosystem services that coastal wetlands provide: fish and wildlife production; habitat for rare and endangered species; shoreline protection against wind and waves; aesthetics and green space; water storage for flood protection; groundwater recharge; water filtration and pollution control; and carbon sequestration. Paradoxically, there is an even greater need for many wetland ecosystem services under changing climate conditions that are expected to bring more frequent and intense storms and associated flooding, increased wind and wave action, and intensified pollution runoff. Implementing climate adaptation policies and practices for wetlands will ensure that wetlands continue to provide these important ecosystem services, even under changing climate conditions.

When it comes to adaptation, however, there is no single best practice or policy. This toolkit offers a menu of 18 different, yet complementary, preferred strategies and practices. Two general types of practices are provided: *institutional-level* best practices that are more strategic in nature and designed to be incorporated into policy and programming; and *project-level* best practices that are intended to be used by wetland managers as they plan, design, implement and assess on-the-ground wetland restoration and management projects.

The institutional-level practices are designed to assist the State of Michigan, but will likely be helpful for other jurisdictions looking to enhance their policies and programs for wetland adaptation. Similarly, the project-level best practices were designed with Michigan's freshwater coast in mind, but may be useful for a variety of coastal wetlands.

As the field of climate adaptation is still emerging, this toolkit includes practices that have been previously applied and show promise, as well as approaches that are new and have not yet been tried, but were identified by experts as needed for successful coastal wetlands adaptation.

The best practices herein are associated with six principle phases of wetland management, as illustrated in Figure 1. This toolkit suggests the most appropriate phase or phases for implementing each best practice. It also attempts to identify challenges and benefits of each practice so that implementers can anticipate factors that might help or hinder and thereby more efficiently implement the practice.

Where possible, case examples are provided to illustrate where and how that best practice has been used in planning or management.

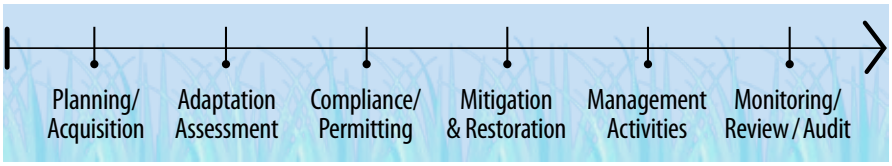

Figure 1: Phases of Wetland Management

The best practices in this toolkit are framed as guidance for natural resource planners, regulators and managers within the state of Michigan. Not every practice will be relevant for every project. Some of the ideas and approaches identified herein may already be being implemented by local governments, or wetland managers. Applying just one best practice or policy to a project does not guarantee coastal wetland resiliency to climate change. Conversely, neglecting a single best practice may not compromise adaptation efforts. Optimally, users of this toolkit should consider all of the practices in the context of their responsibilities and select and apply appropriate combination that fits the conditions of a particular natural resource management program or wetland project.

The toolkit was developed by the Great Lakes Commission in partnership with the National Wildlife Federation and with the input and feedback from a diverse group of individuals with expertise in either wetland management or climate adaptation. Financial assistance for this project was provided, in part, by the Michigan Coastal Zone Management Program, Department of Environmental Quality (DEQ), through a grant from the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendation in this document are those of the authors and do not necessarily reflect the views of the DEQ and NOAA.

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Institution-Level Wetland Adaptation Best Practices

Project-Level Wetland Adaptation Best Practices

Wetland Adaptation Forums

Conduct periodic public wetland symposiums/forums to advance adaptation knowledge

In rapidly evolving fields like climate change adaptation, regular opportunities for practitioners and key thinkers in the field to come together to exchange experiences and ideas are essential. Small focused invitational workshops are helpful, but there should also be a regional symposium or forum every 1-3 years. This could be open to all interested parties focused either specifically on wetland conservation and restoration in a changing climate or more generally on climate change adaptation. Unrestricted attendance broadens the adaptation network and provides more opportunity for new voices to participate and emerge.

The format can be more directed, for example, built around a set of invited speakers and workshops put together by the organizers, or more participant-driven, with open submission of proposals for presentations, posters or workshops. In either case, the schedule should include ample time for informal interaction and networking, which are essential components of the empowerment and internalization of climate-smart thinking that are such important outcomes of this sort of forum. Webinars may also be considered to reach more people.

The outcomes of wetland adaptation forums are two-fold. There should be a set of written outputs in the form of proceedings, synthesis reports or overview essays. These may be disseminated via websites and blogs, published reports, or a collection of papers published in a peer-reviewed journal. No less important, however, is the creation of partnerships, project ideas and general inspiration to act; forum organizers and participants should consider ways in which these latter outcomes can be fostered.

Case Example | Coastal Habitat Conservation in a Changing Climate Workshop

In September 2011, the National Wildlife Federation and the National Oceanographic and Atmospheric Administration (NOAA) hosted a two-and-a-half day workshop titled "Coastal Habitat Conservation in a Changing Climate: Strategies and Tools for the Great Lakes Region." The meeting began with a series of presentations giving an overview of regional climatic variability, longer-term changes and impacts. Presenters addressed questions such as how particular climatic changes might affect species, ecosystems, water quality and economies; possibilities for ecological adaptations; and how to integrate climate information into coastal conservation and management despite uncertainties. These presentations provided a common understanding of the state of knowledge for meeting participants.

The second day consisted of breakout sessions built around issues of regional importance, including fish passage, Areas of Concern, invasive species management, agricultural watersheds, and conservation and acquisition. There was also a Tools Café introducing participants to a range of tools supporting regional conservation and restoration work. The breakout format provided an opportunity for extensive interaction and sharing among meeting participants. The second day concluded with field trips to ground participants in the reality of Great Lakes coastal habitat management and restoration work. The third day included another set of breakout sessions as well as an overview of ongoing efforts and next steps.

In evaluations, participants commented on the value of the workshop in providing a diversity of new information and developing new collaborations and partnerships.

Challenges and Benefits

Organizing and implementing regional meetings are not small tasks, requiring a host of logistical considerations including venue, catering, registration, and corralling the necessary staff and volunteers to support speakers, posters and workshop facilitators. Attendance can also pose a challenge. Agency staff and other natural resource practitioners typically have their plates full meeting their day-to-day responsibilities, and it can be difficult to secure the time and funding (if travel is required) to attend meetings not directly linked to project work. Webinars are another option that reduce travel expenses. Webinars have the benefit of reaching more dispersed audiences but are limited to those with Internet technology. Also, they don't provide the same level of interaction that in-person meetings do.

The potential benefits of wetland adaptation forums make dealing with these challenges worthwhile. They allow the sharing of experiences and ideas among a broad audience in a short period of time, and provide an opportunity for back-and-forth discussion and brainstorming that webinars or presentations do not. They can also limit the frequency with which people "reinvent the wheel," meaning more resources can go toward on-the-ground action than toward searching for solutions that already exist.

Who should implement the practice?

Symposia or forums should be organized by teams made up of a diversity of players, including federal, state, local or tribal government agencies, intergovernmental groups, non-profits, academic institutions, and businesses engaged in wetland conservation and restoration. Groups charged with supporting regional adaptation outreach and capacity-building, such as Landscape Conservation Cooperatives or NOAA climate hubs, are particularly well-suited to these sorts of efforts.

When should this practice happen?

Tools and Resources

National Adaptation Forum | This biennial forum is not wetlands-focused, but it is one of the largest gatherings of adaptation professionals, and materials from previous NAFs can serve as models for a wetlands-focused forum. | www.nationaladaptationforum.org

The Climate Adaptation Knowledge Exchange | CAKE's calendar of adaptation events can help users see when and where related events are happening, and use its georeferenced search capability to find potential partners. | www.cakex.org

Michigan Wetlands Association | The annual meetings are not all adaptation-focused, but typically there are opportunities through one or more sessions to address adaptation issues. | www.miwetlands.org

Adaptation-Informed Funding

Integrate climate adaptation into coastal restoration projects by including adaptation considerations in RFPs and other project evaluation criteria

Public agency programs, private foundations and other groups that fund coastal conservation or wetlands work have tremendous leverage in terms of what work moves forward and how it is done. Just by asking applicants to include climate considerations in all proposals and projects, these groups could get more people thinking about the importance of adaptation, as well as creating a broader set of ideas and options for how to do climate-smart wetlands work.

First, at a strategic planning level, funding agencies should consider incorporating adaptation considerations in decisions about funding priorities or priority restoration areas. Second, at a more tactical implementation level, every Request for Proposals (RFP) should include one or more of the following: a) a requirement to conduct an assessment of how the proposed work itself is or is not vulnerable to climate change; b) a requirement to discuss how the project reduces the vulnerability of the species, habitats and systems of concern to climate change; and c) acknowledgment that these two considerations will count for some number of points in the overall proposal score. The depth of discussion required should be scaled to the RFP, and proposal reviewers should be provided with a clear adaptation checklist or evaluation criteria. Several funding organizations have an adaptation component in their requirements, but a model screening tool or checklist should be developed for use by these organizations.

To support these new requirements, funders should provide guidance, resources and potentially webinars or trainings to enhance applicant ability to meet these requirements. They may provide this support directly, or by funding other groups to provide it.

Case Example | Climate-Ready Great Lakes Restoration

The National Atmospheric and Oceanic Administration (NOAA) has taken a systematic and multi-phased approach to incorporating climate considerations in coastal investment decisions. This began with the 2010 release of the *Programmatic Framework for Considering Climate Change Impacts in Coastal Habitat Restoration, Land Acquisition and Facility Development Investments*. The Framework included recommendations relevant to all programs as well as more targeted recommendations regarding the project selection, project monitoring and project planning phases of coastal habitat restoration.

Following the release of the Framework, NOAA's Great Lakes Habitat Restoration Program partnered with National Wildlife Federation and EcoAdapt to incorporate climate considerations into the process of evaluating proposals for funding and into the design and implementation of Great Lakes restoration projects (including those funded through the Great Lakes Restoration Initiative). This included the development of *Restoring the Great Lakes' Coastal Future*, a climate-smart restoration guide for the Great Lakes (updated in 2014), as well as targeted support for seven coastal restoration projects in the region.

Challenges and Benefits

Particularly at the outset, funding applicants, proposal reviewers and funders may be uncertain about how to incorporate adaptation into the funding process. Without a checklist or rubric that funders can readily use and adapt to integrate into their request for proposals, funders will have to develop their own criteria for evaluating the strength of adaptation elements in proposals. Implementing this practice effectively could require additional or unexpected capacity building and support for both the funder and the applicant. Bringing in climate considerations can also increase the burden on funding applicants, requiring them to identify and integrate climate information into all stages of project development, implementation and monitoring.

The benefits of this practice include an increased return on investment for funders, and an increase in longer-term wetland restoration and conservation success, by decreasing project vulnerability to climate change. It also provides an impetus for funders and potential grantees to ensure that there are mechanisms for easy access to the most recent and applicable climate science. Finally, building adaptation considerations into wetland funding processes will increase the understanding of adaptation considerations among wetland managers and other restoration professionals.

Who should implement the practice?

Landscape Conservation Cooperatives, NOAA climate hubs, Great Lakes Restoration Initiative, among other initiatives, are particularly well-suited to these sorts of efforts.

When should this practice happen?

Tools and Resources

Wildlife Conservation Society of North America Climate Adaptation Fund | This fund is not wetland focused, but the Applicant Guidance Document provides good input on what type of characteristics should be considered when integrating climate change in a grant proposal. | www.wcsnorthamerica.org/ClimateAdaptationFund/tabid/4813/Default.aspx#.U8bd-5RdVZA

U.S. Army Corps of Engineers Adaptation Program | www.corpsclimate.us/cca.cfm

Organization for Economic Co-operation and Development Review of Screening and Assessment Tools (2011) | Reviews nine adaptation screening and assessment tools, five of which were built to inform funding decisions. | www.oecd-ilibrary.org/environment/harmonising-climate-risk-management_5kg706918zvl-en

National Oceanic and Atmospheric Administration – Climate-Ready Great Lakes | Provides modules designed to give stakeholders information about climate change in the Great Lakes region and what needs to be done to reduce vulnerability to these impacts. | www.regions.noaa.gov/great-lakes/index.php/resources/climate-ready-great-lakes

The Georgetown Climate Center's Adaptation Clearinghouse | Provides a wealth of information, including a searchable library of existing adaptation policy and analysis. | www.georgetownclimate.org/adaptation/clearinghouse

Update State Planning Documents

Regularly update state planning documents with new climate information including Midwest technical input reports to the National Climate Assessment

Our understanding of the effects of climate change continues to evolve, as does our understanding of the effectiveness of various approaches to restoration and conservation under changing conditions. While adaptation plans cannot be updated every time a new study comes out—results need to be tested, confirmed and put in context—there needs to be a mechanism for periodically taking stock of whether plans need to be adjusted to reflect the current state of knowledge. Similarly, other natural resource management plans that affect wetlands should be periodically reviewed and updated to reflect the latest understanding of climate adaptation. These include Michigan's Wildlife Action Plan, work through the Michigan Waterfowl Legacy, the Michigan DNR Fisheries Division Strategic Plan and the Michigan Coastal Management Plan, among others. The main intent of this practice is to keep documents that affect wetlands management updated with adaptation-relevant information.

For plans that have regularly scheduled reviews, the incorporation of new climate information can be rolled into those reviews. If no such schedule exists, a climate change update review schedule should be established. It could be linked to the release of major climate change syntheses (e.g., the Intergovernmental Panel on Climate Change, the National Climate Assessment, or regional or state-level report releases), or set independently. In either case, a team of experts on climate science, ecological response and adaptation effectiveness should participate. Beyond scheduled updates, there should be a mechanism for incorporating important developments that occur between scheduled updates.

Groups updating plans should release internal memorandum notifying all those who are responsible for implementing the plan and possibly a media release or other communication to external audiences, notifying them of the plan updates. Making the process more transparent decreases resistance to the plan and to changes in it, and supports broader learning by the wetland adaptation community.

This best practice can be applied to all planning documents with a wetland component, but two are particularly important to mention here: the Climate Change Adaptation Plan for Coastal and Inland Wetlands in the State of Michigan and the Michigan Hazard Mitigation Plan.

Case Example | Integrating Climate Change into State Hazard Mitigation Plans

Columbia Law School recently reviewed state hazard mitigation plans (SHMP) to see how well they deal with climate change. Plans were grouped into four categories, ranging from "No discussion of climate change or inaccurate discussion of climate change" (worst) to "Thorough discussion of climate change impacts on hazards and climate adaptation actions" (best). Eleven states had plans in the "best" category. These include Colorado, whose SHMP includes annexes describing climate change models and projections as well as the state's drought response plan; California, whose SHMP goes into detail not just on climate change but on adaptation, mitigation and all state initiatives related to climate change; Massachusetts, whose SHMP includes model-

based risk assessments; and Washington, which by defining climate change as a technological hazard makes it easier for planners to address both causes and consequences of climatic change.

Case Example | Michigan Hazard Mitigation Plan

In the Michigan Hazard Mitigation Plan (MHMP), wetlands are considered to play important roles in water retention, property drainage, storm water runoff control, and sedimentation storage area, among others. It points out the importance of strict regulation to protect and preserve these ecosystems and how the wetlands are included in the Great Lakes Shoreland Management Program, which regulates the permitting of activities performed in wetlands and other coastal areas.

According to federal regulation – 44 CFR 201.4(d) (Standard State Mitigation Plans) – states have to update their mitigation plan every three years. The first Plan was produced in 2005 and updated in 2008 and 2011. For the 2011 version, the team working on the plan thought about adding a section about climate change issues. They attended meetings and symposia where participants could talk about the issues and the impacts of these changes on public health and the environment. After discussions with experts, they realized that most of the issues relative to climate change were overlapping with the hazards themselves – extreme temperatures, floodings, severe weather, erosion for example – and decided to consider the impacts of climate change directly in the appropriate sections of the state hazard mitigation plan. The plan notes that climate change "can eventually exacerbate the severity of thunderstorms, severe winds, extreme temperatures, flooding, drought, erosion, wildfires and invasive species." These considerations will be included gradually, as information becomes available.

Challenges and Benefits

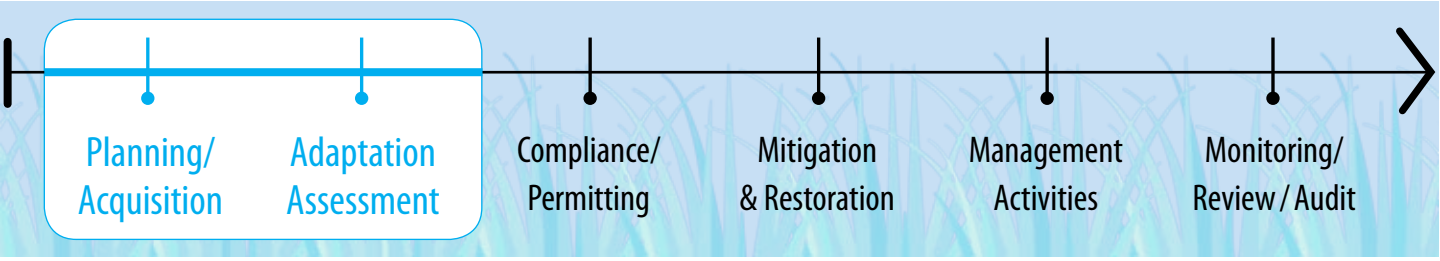
Regular updates ensure that plans are not based on out-of-date information, thus increasing the likelihood of achieving the plans' goals and objectives. Regular updates also provide an opportunity to assess overall plan awareness and implementation, decreasing the likelihood that adaptation plans will simply sit on shelves gathering dust.

A challenge for keeping plans up to date is creating criteria for what new information is included. While relying only on information in intergovernmental or governmental synthesis reports is one option, such reports often exclude the most recent information due to the review times required before these major reports are released. Ensuring that all regionally relevant information is included can also be a problem if the update is linked to processes with longer timeframes or broader geographic coverage. Nonetheless, these documents provide a reliable source of credible climate change information, which would otherwise be difficult for state or local agencies and organizations to assemble on their own. Updating state plans can also take a lot of time when several specialists and departments are reviewing the information. The revision period should take this into consideration.

Who should implement the practice?

This practice should be implemented by anyone with a wetland adaptation plan, including governmental agencies, non-profits and businesses. Climate scientists and other relevant experts should be recruited as needed to identify and evaluate information.

When should this practice happen?



Tools and Resources

Michigan Hazard Mitigation Plan (2014) |
http://www.michigan.gov/documents/msp/MHMP_2014_UPDATE_PART_1_INTRODUCTION_AND_PLANNING_PRELIMINARIES_SECTION_DRAFT_449964_7.pdf

Climate Change Adaptation Plan for Coastal and Inland Wetlands in the State of Michigan (2012) | Report of Association of State Wetland Managers that reviews numerous climate change issues relevant to wetland protection and restoration in Michigan. |
www.michigan.gov/documents/deq/Michigan_Wetlands_and_Climate_Change_Report_Final_Final_403251_7.pdf

U.S. Army Corps of Engineers – Climate Change Adaptation Plan and Report (2012) | This report is not wetland focused, but it explains that climate change might have an impact on wetlands and that it should be considered. It gives a case example from California. |
www.corpsclimate.us/docs/2012_USACE_Adaptation_Plan_and_Report_23_June_2012%20final.pdf

New York City Wetland Strategy (2012) | The report describes practices to adopt in the context of wetland loss due to several factors, including climate change. | www.nyc.gov/html/planyc2030/downloads/pdf/nyc_wetlands_strategy.pdf

Columbia Law School Center for Climate Change Law State Hazard Mitigation Plans & Climate Change: Rating the States (2003) |
web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Publications/Students/SHMP%20Survey_Final.pdf

Continuing Education of Practitioners

Provide continuing education and cross training to support a coordinated response to changes in coastal wetlands

The importance of continuing education is well-established for many fields of practice, particularly for relatively new and emerging natural resource management fields. The style and content of continuing education and training varies depending on the goals and target audience. In general, organizations with capacity-building mandates (e.g., Sea Grant programs, agricultural or forestry extension) identify needs through formal (e.g., surveys) or informal (e.g., conversations with practitioners) means and develop programs to address those needs. Options range from presentations to standardized trainings to tailored, in-depth trainings for particular groups or projects.

Trainings, including modules and tutorials related to natural resource management, and wetlands in particular, should be periodically amended to reflect the latest best practices for wetland management related to climate adaptation, such as a those practices included in this toolkit, especially the project level best practices (see pages 26 to 55). These education and training initiatives should target natural resource managers, municipal planning and zoning officials and staff, local government consultants, and watershed and other environmental non-profit organizations. Such efforts should consider including diverse practitioners (e.g., climate, engineering, wetland management, etc.) as both speakers and participants to support the multidisciplinary exchange of ideas and information that can maximize the integration of different areas of focus. Participation from multiple disciplines helps ensure that the training and education efforts can improve the chances of informed decisionmaking under uncertainty. Additionally, continuing education should be incorporated into planning processes so that those processes that engage practitioners and stakeholders can be leveraged to also provide educational opportunities.

Curriculum developers should not just create slides, worksheets or other curricular material, but should also design trainings for interactive engagement of practitioners to "solve" real world climate challenges. If trainings or workshops are likely to be offered more than once, guidance for future trainers should be developed that can be readily modified to reflect new audiences or information.

Case Example | NOAA Climate-Ready Great Lakes

The National Atmospheric and Oceanic Administration has set up eight regional teams to support capacity-building and coordination, including the Great Lakes Regional Collaboration Team (GLRCT), established in 2004. Through this team, the Great Lakes Sea Grant Network and other NOAA entities, NOAA has supported significant adaptation capacity-building in the Great Lakes region. One such effort is *Climate-Ready Great Lakes*, a set of three training modules, a support notebook, and a variety of supporting documents.

GLRCT and Sea Grant, working with other partners, established 10 working groups including students and professionals from NOAA. Three working groups, including a literature review team, a needs assessment team and a tools inventory team, focused on gathering necessary information. Three other working groups focused on developing specific modules for use in the training. The remaining working groups focused on piloting the training, evaluation, marketing and budget. The training was piloted via a train-the-trainer workshop with Sea Grant agents from Michigan, Wisconsin, Minnesota, Pennsylvania and New York. In 2014, the

three *Climate-Ready Great Lakes* training modules are being reassessed in cooperation with the Great Lakes and St. Lawrence Cities Initiative (GLSLCI) and revised to incorporate feedback they are receiving from the GLSLCI member cities from across the binational Great Lakes region.

The training modules address impacts ("What Am I Adapting To?"), adaptation planning ("Developing a Climate Adaptation Plan") and resources ("Climate Change Adaptation Tools"). Each module includes both slides and presentation notes, and there is a training manual, annotated bibliography, a table of relevant federal laws and executive orders, and a list of potential federal funding sources. Modules are designed for flexibility; they can be used either in their entirety or easily adapted for specific needs.

Challenges and Benefits

An obvious benefit to continuing education is that it helps to create more confident, capable, and informed stakeholders and practitioners. It can also provide a forum for interaction between scientific and management experts, "boundary organizations" (organizations whose role is to bridge science and decisionmaking), wetland managers and other practitioners. A key value is that continuing education provides a forum for those with different experience or expertise to learn from one another as well as from the formal instructor or instruction materials. Depending on the continuing education program, practitioners may be able to get continuing education credits or certificates of completion.

A challenge for continuing education efforts is that funding is required for development, updating the curriculum and offering the trainings. People in the target audience may have limited time or funding to devote to continuing education. Furthermore, an individual or organization carrying out the training needs to take responsibility for ensuring that training materials remain relevant and accurate.

Who should implement the practice?

Any number of groups with the necessary expertise in professional education in natural resource management or a related field may develop and offer continuing education for wetland adaptation. This includes agencies or organizations charged with continuing education generally (e.g., natural resource extension agencies), boundary organizations charged with linking science and practice or policy, environmental non-profit organizations, and institutions of higher learning. Agencies or organizations that have or need staff with wetland adaptation expertise (e.g., land use planning groups or consultants targeting wetland conservation and restoration) could be part of the training or continuing education effort, either as students or teachers.

When should this practice happen?

By definition, continuing education should occur regularly, particularly in rapidly growing fields, such as wetland adaptation. Ideally, practitioners engaged in coastal wetland management or associated policy or administration should participate in continuing education prior to any decisionmaking, and annually thereafter.

Tools and Resources

Association of Natural Resource Extension Professionals (ANREP) | An association of professionals whose goal is to provide different approaches to help educate stakeholders. | **www.anrep.org**

ANREP Climate Science Initiative | Provides a place where educators communicate, collaborate and share resources related to climate change science and managing natural resources in a changing climate. | **sites.google.com/site/anrepclimate**

U.S. Fish & Wildlife Service – National Conservation Training Center | Provides a large variety of training resources. | **training.fws.gov**

National Oceanic and Atmospheric Administration – Climate-Ready Great Lakes | Provides modules designed to give stakeholders information about climate change in the Great Lakes region and what needs to be done to reduce vulnerability to these impacts. | **www.regions.noaa.gov/great-lakes/index.php/resources/climate-ready-great-lakes**

National Oceanic and Atmospheric Administration – National Estuarine Research Reserve System | In partnership with Washington Sea Grant, the NERR System's Coastal Training Program developed a one-day "Planning for Climate Impacts" workshop that was later adapted for the Great Lakes. Workshops have been held in Cleveland, OH; Green Bay, WI.; and Duluth, MN | **nerrs.noaa.gov/CTPIndex.aspx?ID=663**

Lake Superior Reserve - Needs Assessment | This needs assessment helps to help guide its coastal training program, and climate change impacts on natural systems was a priority topic. | **lsnerr.uwex.edu/CTP/Docs/LSNERRCTPStrategicplan.pdf**

Climate Screening of Wetland-Related Policies

Analyze existing policies and modify where needed to address gaps to respond to climate adaptation

Most natural resource management policies were not written with climate change in mind. Such policies may become less effective as climate change and its impacts become increasingly evident, and may inadvertently increase societal vulnerability to climate change by creating barriers to adaption. This is particularly true for policies relating to or affecting wetlands, given the sensitivity of wetlands to changes in temperature and precipitation.

Accordingly, it makes sense to analyze existing natural resource management policies to see which, if any, could be modified to increase opportunities for wetland adaptation and decrease wetland vulnerability to a changing climate. Existing policies that influence coastal wetland health, restoration and conservation should be assessed to identify and amend provisions that create obstacles to adaptation (e.g., expressly prohibit managing for transformation rather than stasis), and to insert provisions that would facilitate adaptation (e.g., requiring evaluation of a regulation's effectiveness over multiple climate scenarios or time horizons). Many existing policies may not directly hinder adaptation but, without a deliberate review, they also will not encourage adaptation. A review to build in "adaptation friendly" provisions will ensure that adaptation is institutionalized across the multiple policies that affect wetland management.

The output of screening should include an explanation of how the screening was conducted, information sources used in the screening, suggested changes to policy wording, and a list of related planning documents that might need updating to reflect the new policy.

Case Example | National and City-Wide Policy Screening

There are few examples of climate-related policy screenings specific to wetlands, so this example summarizes a report that evaluated the implications of climate change for Habitat Conservation Plans (HCP), which are conducted by the U.S. Fish and Wildlife Service pursuant to the federal Endangered Species Act. These plans address the effects of proposed development or other land use changes on threatened and endangered species. This report, prepared for the Berkeley Center for Law, Energy and the Environment and the Center for Global Energy, International Arbitration and Environmental Law (see reference below), examined overarching complexities climate changes poses to HCP and options for addressing them, and also looked at provisions in HCP regulations that may hinder or facilitate the incorporation of climate considerations. The report highlighted the need to include climatic changes and impacts as part of the baseline condition against which proposed actions are evaluated, and to adjust "no jeopardy" thresholds if these climatic changes might increase species' vulnerability to habitat loss or other proposed actions. It also proposes incorporating climate-related uncertainty in evaluations of proposed reserve designs and adaptive management plans.

In exploring elements of HCP-related law, regulation and practice, the HCP authors found some elements, such as the mandate to use best available science, which would seem to mandate consideration of climate implications, and others that might limit the ability to do so. For example, regulations state that habitat destruction must be mitigated by protection of habitats as similar as possible to the area of impact. This could prevent the creation of reserves in areas thought to be more resilient to change, or thought to be of increasing importance as future habitat.

Case Example | Great Lakes Regional Water Quality Agreement

The 2012 revision to the Great Lakes Water Quality Agreement reflects an increasing awareness of and desire to address climate change impacts. While not explicitly a screening tool, the revised agreement calls for incorporating climate change impacts into actions. There is an Annex focused specifically on climate change impacts, and climate considerations are also integrated throughout the Agreement. For example, the Agreement mandates consideration of climate change impacts be integrated into a new nearshore framework. Also, the Agreement cites the need to consider the effects of climate change on the "use, release, transport and fate of chemicals of mutual concern," how phosphorus targets are set, effects of nutrient inputs, and on aquatic invasive species. Finally, it includes climate regulation as an ecosystem service to be considered.

Challenges and Benefits

Developing feasible and effective suggestions for policy or regulatory change requires collaboration among those with relevant scientific expertise (e.g., understanding of coastal wetland structure, function and processes, and understanding of potential vulnerabilities to climate impacts) and those with experience in policy development and implementation. Furthermore, implementing policy changes can be politically difficult, and opening up a policy change runs the risk that the policy will be weakened rather than strengthened.

On the other hand, there are cases where policy stands in the way of wetland adaptation, so policy screening and adjustment is an important enabling condition for adaptation action. If policy screening and updating is handled effectively, it can also provide an opportunity to increase the climate awareness of policymakers and the policy awareness of climate and adaptation scientists.

Who should implement the practice?

Entities with responsibility for policy development and/or promulgation should implement this practice. This includes, for example, legislative and executive branch staff and decisionmakers at state and local levels, as well as environmental nonprofit organizations and other groups that advise those who make policy. Regardless, the policy analysis, development and any recommendations for policy change should be informed by findings and/or expertise from academia, nonprofits and businesses engaged in coastal wetland-related work.

When should this practice happen?

Tools and Resources

Michigan Hazard Mitigation Plan (2014) | http://www.michigan.gov/documents/msp/MHMP_2014_UPDATE_PART_1_INTRODUCTION_AND_PLANNING_PRELIMINARIES_SECTION_DRAFT_449964_7.pdf

Climate Change Adaptation Plan for Coastal and Inland Wetlands in the State of Michigan (2012) | Report of Association of State Wetland Managers that reviews numerous climate change issues relevant to wetland protection and restoration in Michigan. | www.michigan.gov/documents/deq/Michigan_Wetlands_and_Climate_Change_Report_Final_Final_403251_7.pdf

U.S. Army Corps of Engineers – Climate Change Adaptation Plan and Report (2012) | This report is not wetland focused, but it explains that climate change might have an impact on wetlands and that it should be considered. It gives a case example from California. | www.corpsclimate.us/docs/2012_USACE_Adaptation_Plan_and_Report_23_June_2012%20final.pdf

New York City Wetland Strategy (2012) | The report describes practices to adopt in the context of wetland loss due to several factors, including climate change. | www.nyc.gov/html/planyc2030/downloads/pdf/nyc_wetlands_strategy.pdf

Columbia Law School Center for Climate Change Law State Hazard Mitigation Plans & Climate Change: Rating the States (2003) | web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Publications/Students/SHMP%20Survey_Final.pdf

Resources for the Future | Series of reports reviewing options for incorporating adaptation into policy, regulation, and management in different sectors. | www.rff.org/News/ClimateAdaptation/Pages/domestic_publications.aspx

Great Lakes Water Quality Agreement | www.epa.gov/greatlakes/glwqa/20120907-Canada-USA_GLWQA_FINAL.pdf

Climate-Informed Buffer Ordinance Language

Create a model ordinance that requires buffers between wetlands and certain activities and uses

Buffers are important tools to protect space around valued resources. They can be recommended practices or incorporated into local laws (i.e., ordinances). Many municipalities have adopted ordinances specifically to protect sensitive coastal resources and wetlands generally (both inland and coastal). Buffers can be designed to reflect anticipated climate change impacts (e.g., changing lake levels and expanded ranges of invasive species). Indeed, some municipalities along the U.S. marine coasts have also adopted ordinances dealing with sea level rise adaptation. The appropriate counterpart in the Great Lakes would be a local ordinance to adapt to changing lake levels. The concept can be further enhanced so that buffers are designed to minimize vulnerabilities and maximize resiliency of coastal wetlands to the anticipated impacts of climate change. Expanding traditional floodplain buffers to consider more frequent flood events under climate change is one example.

Many municipal planners and decisionmakers say that seeing example or model ordinances makes it easier for them to understand the issue and to write their own ordinances. Model ordinances can be aimed at reducing wetland climate vulnerability generally, or they may focus only on particular vulnerabilities (e.g., lake level change or altered runoff) and related adaptation techniques. Model coastal wetland ordinance language provides planners and decisionmakers with adaptation-specific language that is ready to integrate into a new or existing ordinance. Where model ordinance language is not available, simply borrowing relevant ordinance language that is already developed can serve the same purpose. Either way, this practice enables existing coastal wetland and related ordinances to be readily modified to reflect adaptation considerations. Integrating such ordinances into broader awareness and education campaigns can increase both support and compliance.

Case Example | Huron River Watershed Council

The Huron River Watershed Council (HRWC) recognizes climate change as an overarching threat to the watershed and to their work, e.g. through decreased water quality and quantity, increased temperatures and flooding. The Winter 2009 edition of their quarterly Huron River Report focused on climate change, including implications for different subsections of the watershed and for fish, as well as adaptation options and examples, including a model stream buffer ordinance. The U.S. Environmental Protection Agency and the Michigan Dept. of Environmental Quality funded the creation of the model stream buffer ordinance. This model was based on an existing ordinance used in other townships that was modified by the HRWC and members of an advisory committee.

HRWC initiated many programs aimed at addressing climate change, including a stream buffer initiative recognizing the ability of forested buffers to reduce water temperature, help absorb and store water during floods, and reduce moisture loss during droughts. Scio and Green Oak townships have adopted the model ordinance, which addresses issues such as allowable uses and activities within the buffer zone and buffer zone width.

Challenges and Benefits

Having a model ordinance makes it easier for governments to adopt climate-informed ordinances and increases the likelihood that ordinances will address issues important for wetland resilience. The flip side of this is that model language may be seen as part of an effort to push an environmental agenda or undermine local authority, although a strong outreach and education campaign leading up to adoption of the ordinance can reduce this perception.

Depending on how they are written, model ordinances can also highlight how actions not directly affecting wetlands can nonetheless influence the ability of wetlands to adjust to climate change.

Who should implement the practice?

While ordinances must be implemented by bodies with regulatory authority, typically local governments, model ordinances can be written or supported by any group concerned about wetlands. They are typically created by groups whose interests cover multiple municipalities.

When should this practice happen?

Tools and Resources

National Environmental Law Institute – Planner's Guide to Wetland Buffers for Local Governments (2008) | This guide identifies practices in the protection of wetland buffers by local governments through wetland buffer ordinances. | www.eli.org/sites/default/files/eli-pubs/d18_01.pdf

Huron River Watershed Council – Model Ordinance for Riparian Buffer | This document provides a model ordinance developed by the HRWC. | www.hrwc.org/wp-content/uploads/2009/11/HRWC_riparianbuffer_model_ordinance.pdf

Huron River Watershed Council's Guide to the Model Wetland Ordinance | www.planningtoolkit.org/natural_resources/wetland_ord_guide.pdf

Climate Adaptation Knowledge Exchange – Building Capacity for Climate-Resilient Communities and Water Conservation in the Huron River (2012) | www.cakex.org/case-studies/building-capacity-climate-resilient-communities-and-water-conservation-huron-river-wate

Processes for Information Access

Create a process to enable managers to evaluate regional climate models, reports and relevant websites to better understand localized climate impacts

Managers, planners and others interested in engaging in wetland climate adaptation are often frustrated by both a dearth and an overabundance of information. Because there is so much information targeting so many different audiences and provided by so many organizations in so many ways, it can be difficult to obtain accurate, relevant information. Many groups have worked to address this issue, but more outreach and communication is necessary to make key sources known. Further, there is a need to more directly connect and improve communication between scientists and practitioners. Contextualizing new scientific information to focus specifically on wetland conservation and restoration can be more effective than more generic efforts.

Although wetland forums or workshops as described in Best Practice #1 may be one element of this Best Practice, the focus here is on *processes* as a way to enable more sustained, targeted and diverse approaches to supporting information access and use. Existing planning activities involve processes that regularly engage stakeholders and can be used to bring new climate information forward for consideration. This approach has the benefit of leveraging existing forums and activities in which people are already engaged, in contrast to approaches that invite people to get information through separate or new means.

To ensure that information use is maximized for its intended purpose, it is critical to understand the target audience and what they consider trusted, familiar sources of information.

On a general level, there are two types of information sources that people are most likely to use to inform wetlands management for climate adaptation: professional social networks comprised of regular human interactions and adaptation websites (web-based social network sites, and other websites and clearinghouses).

Professional colleagues are the primary source of new information for most natural resource managers. People gain knowledge and information from colleagues and others with whom they interact on a regular basis either in person or via phone or email. Professional social networks—groups of professionals with common interests—should be established that bring together climate and wetland professionals in a collaborative fashion. These collaboratives can be used to sustain targeted engagement of networked professionals.

Climate adaptation websites and social networking websites focused on wetlands management can serve as a centralized hub of relevant information, and provide additional options for information access that might not readily exist through regular professional interactions. In addition to specific websites, these can include a web-based team of adaptation experts providing help desk or reference librarian-type services.

These professional collaboratives, other social networks, and websites can be an excellent way to share locally relevant data such as downscale climate models and decision support tools which are often difficult to interpret and apply.

Case Example | Great Lakes & St. Lawrence Cities Initiative Municipal Adaptation & Resiliency Service

The Great Lakes & St. Lawrence Cities Initiative is a non-profit organization that brings together a coalition of mayors and other local officials from the United States and Canada to support Great Lakes-St. Lawrence River restoration and protection. One of GLSLCI's many projects is the Municipal Adaptation & Resiliency Service (MARS). The goal is to accelerate adaptation action for member municipalities by sharing information and resources and creating an engaged regional community.

MARS includes the following components:

1) **Call to Action.** This includes self-defined adaptation activities that municipalities will undertake. Twelve municipalities have completed Call to Action forms providing information on adaptation measures, funding, partners and other relevant information.
2) **Community of Practice.** The MARS CoP is facilitated by the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) and includes resources such as a library, case studies from around the country, fact sheets, adaptation tools, including risk assessment tools, historical and future climate data, news articles, and a calendar of events.
3) **Training for municipalities, hosted by Clean Air Partnership.** There have been nine webinars covering a range of topics and highlighting case studies of GLSLCI member municipalities.
4) **A MARS Award based on submitted Call to Actions.**
5) **Demonstration projects.**

Challenges and Benefits

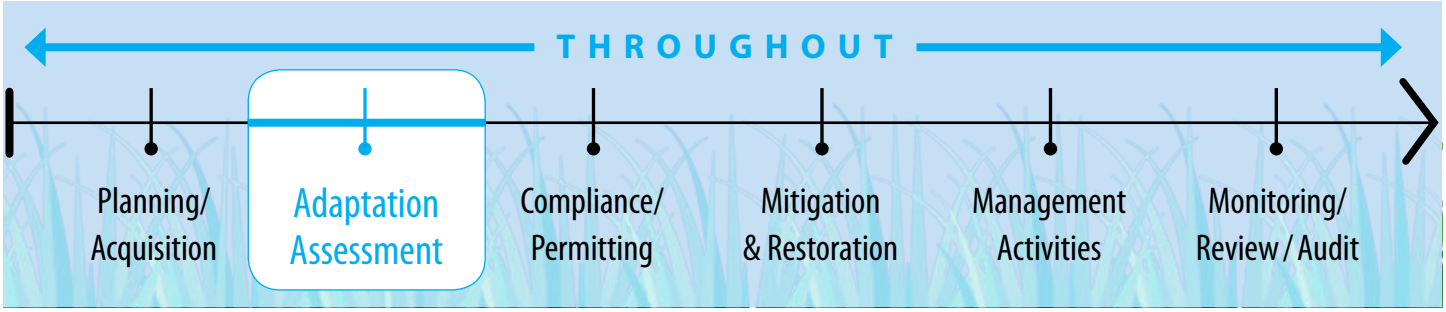
Many information-sharing projects have been developed by natural scientists with little communication or engagement with practitioners. Thus, while the quality of information is typically high, the actual use of the information is often low. In part, this is because it can be difficult to get funding and engagement to support the user-driven approach necessary to maximize the science-practice connection and, in part, it is because over-commitment by practitioners can make getting and maintaining engagement difficult.

If successful, information access and sharing processes and portals can dramatically increase the likelihood that restoration planners and practitioners will effectively incorporate climate considerations into their work, thereby increasing the likelihood of long-term conservation and restoration success.

Who should implement the practice?

This practice can be initiated by a wide range of groups, but to be successful it requires collaboration between the people who will be using the information, those who are creating the information, and those who are providing the options for information access. Typically this will include scientists from government and academia, managers and practitioners from private, non-profit, government and community groups, and a "boundary organization" such as Great Lakes Integrated Sciences + Assessments (GLISA) or Michigan Sea Grant.

When should this practice happen?



Tools and Resources

Great Lakes and St. Lawrence Cities Initiative – Municipal Adaptation & Resiliency Service (MARS) | www.ccadaptation.ca/en/mars

Climate Change Adaptation Community of Practice | Online community where researchers, experts, policymakers and practitioners can exchange information and ideas to contribute to advancing knowledge and action in climate change adaptation. | www.ccadaptation.ca/en/landing

Great Lakes Integrated Sciences + Assessments Center (GLISA) | Brings together collaborators who are working to address specific problems related to climate change in the Great Lakes region. | www.glisaclimate.org

San Francisco Bay Area – Adapting to Rising Tides (ART) | Collaborative planning project engaging local, regional, state and federal stakeholders to increase the San Francisco Bay Area's preparedness and resilience. | www.adaptingtorisingtides.org

The Georgetown Climate Center's Adaptation Clearinghouse | Provides a wealth of information, including a searchable library of existing adaptation policy and analysis. | www.georgetownclimate.org/adaptation/clearinghouse

Collaboratory for Adaptation to Climate Change | National Science Foundation-funded project involving University of Notre Dame and The Nature Conservancy compiling and disseminating information in support of research, education, and outreach on climate change adaptation. | https://adapt.nd.edu/

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Climate in Wetland Permitting

Evaluate wetland permit requirements and modify, if necessary, to incorporate climate adaptation considerations when issuing wetland permits

In coastal areas of Michigan, wetland restoration and enhancement projects typically require permits issued by the Michigan Department of Environmental Quality (DEQ) and the U.S. Army Corps of Engineers, under Section 404 of the federal Clean Water Act and Section 10 of the federal Rivers and Harbors Act, as applicable. A single "joint permit application" package is completed by the applicant and reviewed by both agencies.

Restoration and enhancement of wetlands can often include construction activities that might disturb a wetland temporarily, or modify it entirely, in order to restore desired ecological processes, features and functions over the long term. Methods commonly used in restoration are often similar to those methods that, in other circumstances, can degrade and destroy wetlands, including draining water, dredging or removing soil, or adding soil or fill. Restoration and enhancement projects have the end goal, however, of improving wetland functions and values. Placing a structure in a wetland, even structures such piers to support a boardwalk for management access or educational purposes, also requires a permit.

The permit process ensures that scientists, regulators and resource managers examine the project from a variety of standpoints to make sure there are no unintended consequences. For example, a wetland restoration project that aims to restore aquatic bird habitat may inadvertently impact habitat for fish species. Wetland planners are called upon to consider all ecological implications of a proposed project, including climate change. A project that fails to evaluate climate adaptation needs may not be effective under changing climate conditions. Anticipated climate change impacts and appropriate adaptation measures are important factors that should also be considered in the coastal wetland permitting process.

For coastal wetlands, permit requirements should include consideration of how the project will enhance local or regional climate change adaptation. This process starts during the development of the permit application form. The application form should include relevant questions such as: *"Does this project incorporate climate adaptation?"* and *"If so, please explain how this project will enable the wetland (including through human intervention) to better adapt to changing climatic conditions,"* Or *"If so, please explain how this project will improve climate resiliency of the local/regional community."*

A second and equally important step is to evaluate permit applications, in part, on inclusion of climate adaptation considerations. Section 30311 of the Michigan Natural Resources and Environmental Protection Act (Public Act 451) of 1994, as amended, sets forth statutory criteria for evaluation of permits by Michigan Department of Environmental Quality (DEQ). DEQ staff use an internal document called the Project Review Report to evaluate wetland permit applications against these statutory criteria. Michigan DEQ staff should expand or modify this checklist to more deliberately consider how climate change adaptation fits into determining whether or not a project satisfies the criteria in the checklist. For example, reviewers should con-

sider how adaptation elements of a wetlands project could be "in the public interest" or whether climate adaptation elements of a project might affect the "extent and permanence of the beneficial or detrimental effects that the proposed activity may have on the public and private uses and benefits the wetland provides," or "[t]he probable effects [of the project] in relation to the cumulative effects created by other existing and anticipated activities in the watershed." In other words, state permit application reviewers should incorporate evaluation of climate adaptation factors as part of their formal wetland permit application review process.

Case Example | San Francisco Bay Plan Implementation: San Francisco Bay Conservation and Development Commission

The San Francisco Bay Conservation and Development Commission (BCDC) is a state commission created in 1965 to protect and restore the San Francisco Bay. BCDC has authority to regulate new development activities that occur within 100 feet inland from the shoreline around the bay as well dredging and filling activities in the open water, marshes and mudflats of greater San Francisco Bay; portions of most creeks, rivers, sloughs and other tributaries that flow into San Francisco Bay; and diked salt ponds that were once connected to the bay.

In 1969, BCDC developed the San Francisco Bay Plan (the Bay Plan), which was amended in 2008 to include climate change adaptation by requiring that it be considered in planning and be addressed in projects affecting coastal wetlands through a focus on tidal marsh, tidal flat and shoreline protection projects. Specifically, the Bay Plan states:

"[a]ny ecosystem restoration project should include…an analysis of…how the system's adaptive capacity can be enhanced so that it is resilient to sea level rise and climate change…and an appropriate buffer, where feasible, between shoreline development and habitats to protect wildlife and provide space for marsh migration as sea level rises…"

For shoreline protection projects, the Bay Plan calls for the property where the project will occur to be *"properly engineered to provide erosion control and flood protection for the expected life of the project based on* a 100-year flood event that takes future sea level rise into account."

California state law, which authorizes BCDC to issue or deny permit applications, requires that adequate measures be provided to prevent damage from sea level rise and storm activity that may occur on fill or near the shoreline over the expected life of a project. It further stipulates that new projects on fill or near the shoreline should either:

- be set back from the edge of the shore so that the project will not be subject to dynamic wave energy;
- be built so the bottom floor level of structures will be above a 100-year flood elevation that takes future sea level rise into account for the expected life of the project;
- be specifically designed to tolerate periodic flooding; or
- employ other effective means of addressing the impacts of future sea level rise and storm activity.

Although the permit applications have not yet been formally changed to reflect these policy changes to address sea level rise, in practice, BCDC staff require applicants for larger fill projects to address the impacts of climate change on their project, including preparing risk assessments and maps showing projected sea level rise effects on the proposed improvements.

Challenges and Benefits

Permitting for activities in coastal wetlands is covered under statute in Michigan and all other coastal states. Because the permit application and review processes are established (and typically described in statutes and rules), modifications to include climate adaptation considerations would either require revisions to statute or rules, or would need to be within the discretion of permitting authorities, based on statutory language. While the relevant statutory language in Michigan does not specifically address climate change, it provides flexibility for regulatory authorities to consider climate and adaptation measures in the permit review process. The benefits to coastal wetlands and surrounding communities can be enormous. Building adaptation considerations into permitting can better ensure that coastal wetland restoration and enhancement projects will stand the test of time in a climate-changing world.

Who should implement the practice?

This practice should be implemented by wetland permitting agencies as a requirement of applications for projects that impact wetlands.

When should this practice happen?

Tools and Resources

2013 Public Act 98 | http://www.legislature.mi.gov/documents/2013-2014/publicact/pdf/2013-PA-0098.pdf

Michigan Natural Resources and Environmental Protection Act (Public Act 451) of 1994, as amended | http://www.legislature.mi.gov/%28S%28qskyhs55riyizi553oiexhri%29%29/documents/mcl/pdf/mcl-451-1994-iii-1-inland-waters-303.pdf

San Francisco Bay Conservation and Development Commission (BCDC) | www.bcdc.ca.gov

San Francisco Bay Plan | www.bcdc.ca.gov/laws_plans/plans/sfbay_plan

Partner with Experts

Partner with a climate expert for on-the-ground wetland restoration projects

It can be hard for climate experts to know exactly what information will be useful or relevant for wetland restoration decisions, and for wetland restoration practitioners to know what to explain about their work or what to ask climate experts. More active partnerships on actual projects increases the likelihood that practitioners will get relevant and useful information that improves project effectiveness, and that climate scientists will understand enough of what practitioners do to provide useful support.

Ideally, climate experts should be brought in at the start of the process so that climate considerations are included in the site selection, design, implementation, monitoring and evaluation phases. Experts can provide not just quantitative data or climate vulnerability assessments, but insight into plausible climatic changes or effects that could affect project performance or sustainability. The expertise needed depends on project focus, but can include climate effects on such issues as hydrology, habitat or species viability (including species physiology), or other factors. In all cases, limited knowledge of other disciplines (e.g., climate scientists vs. restoration practitioners) is a potential problem, so open communication and information flow in both directions is essential to maximize effectiveness of the partnership.

The academic community has long engaged with on-the-ground environmental practitioners, including through state university extension programs and partnerships such as the Sea Grant Program. More recently, dedicated academic programs and other institutions have been developed to serve as "boundary organizations" that act as a conduit of scientific findings and other information from the research community to practitioners. One such example is the NOAA-funded Regional Integrated Sciences + Assessments centers, including the Great Lakes Integrated Sciences + Assessments center, a joint effort of the University of Michigan and Michigan State University.

Case Example | Habitat Restoration in the Maumee River Area of Concern

NOAA awarded funds to The Nature Conservancy (TNC) for a habitat restoration project in the Maumee Area of Concern, which covers 130 river miles from Ft. Wayne, Ind., to Lake Erie, and sits adjacent to Lake Erie and the Ottawa National Wildlife Refuge. It will ultimately restore about 600 acres of wetland, forest, rivers and sedge meadow. The area is currently fallow agricultural land, with significant nutrient and pesticide pollution. There are four tracts of land, each with different restoration goals and approaches, including restoring wetlands, re-forestation, hydrologic reconnection and restoration of wet woods.

As part of this award, TNC was required by NOAA to consult with climate experts at the National Wildlife Federation (NWF) on how the project could be improved with regard to climate change considerations. NWF reviewed existing scientific literature to assess the vulnerability of target species, habitats, and systems to climate changes and impacts. Although not an exhaustive vulnerability assessment, this process yielded information that enhanced and complimented information on existing baseline conditions as recorded in the project's quality assurance project plan. In particular, the review helped to inform tree species selection and water control or fish passage measures.

Ottawa National Wildlife Refuge, Ohio, United States

Project partners worked with NWF to assess how restoration design and management could be made more climate smart, and suggestions have been incorporated into design work. For example, results of a U.S. Forest Service tool were used to identify tree species more likely to be viable in future climate conditions in the area. In addition, given potentially greater water level fluctuations in the future, it was recommended that plans for the Kontz tract, in particular, include potential consideration of additional fish passage structures (e.g., fish ladders).

Challenges and Benefits

Wetland projects generally have tight timelines and budgets. With busy schedules, this can make it difficult to get all parties to put in the time needed for effective collaboration. While some climate experts may be willing to work pro bono, it may be difficult to get extensive expert engagement without targeted funding. Also, if projects are truly "shovel ready," which has been of increasing interest to policymakers and funders, there may be limits on which climate considerations can be included. Nonetheless, there is usually room for recommendations entailing less dramatic alterations of existing plans.

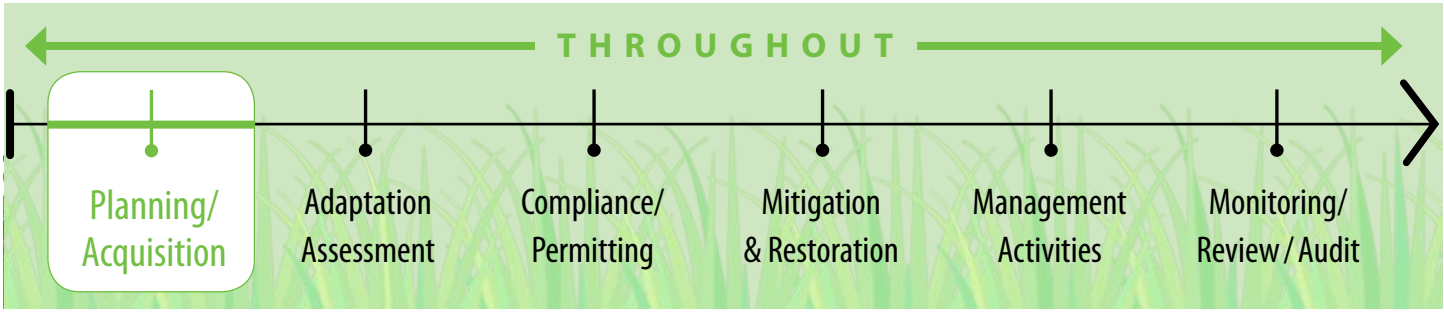
On the plus side, engaging climate experts in wetland restoration work can result in project outcomes that achieve adaptation-specific objectives (see Best Practice #16), as well as more traditional wetland restoration or conservation objectives. Overall, the collaboration between climate and wetland experts and practitioners increases the likelihood that projects will be more effective and more sustainable over the long run. By deepening connections between practitioners and scientists and increasing mutual understanding of each other's areas of expertise, partnerships are also more likely to have benefits well beyond individual projects.

Who should implement the practice?

All wetland conservation and restoration planners and practitioners, including those in government, non-profit and for-profit sectors.

When should this practice happen?

This practice should ideally begin during the Planning/Acquisition phase and continue throughout the project, but it can occur at any phase.



Tools and Resources

National Wildlife Federation and EcoAdapt – Restoring the Great Lakes' Coastal Future: Technical Guidance for the Design and Implementation of Climate-Smart Restoration Projects (2014) | This guidance document provides an overview of adaptation principles, guidance for climate-smart restoration projects in the Great Lakes, and reviews experience from seven case studies, including restoration in the Ottawa National Wildlife Refuge. | **www.nwf.org/~/media/PDFs/Global-Warming/Climate-Smart-Conservation/2014/Restoring-the-Great-Lakes-Coastal-Future-032114.pdf**

Great Lakes Integrated Sciences + Assessments Center (GLISA) | Brings together collaborators who are working to address specific problems related to climate change in the Great Lakes region. | **www.glisaclimate.org**

Landscape Conservation Cooperatives | Provides a forum for federal, state, tribal and nongovernmental stakeholders to work in partnership. | **www.fws.gov/landscape-conservation/lcc.html**

USDA Regional Climate Hubs | Provide information to farmers, ranchers and forest landowners to help them adapt to climate change and weather vulnerability. | **www.usda.gov/oce/climate_change/regional_hubs.htm**

Michigan Sea Grant | Includes a program on climate adaptation in the Great Lakes region. | **www.miseagrant.umich.edu**

Great Lakes Commission des Grands Lacs

NATIONAL WILDLIFE FEDERATION

Engage Stakeholders

Engage multiple stakeholders and interest groups in wetland management and restoration project decisionmaking

Effective and appropriate stakeholder engagement is a commonly recommended best practice for many sectors, and is no less important for adapting wetland restoration and conservation to climatic changes and effects. There are multiple reasons for its importance for climate-related wetland work. Different stakeholders and interest groups often have differing or even conflicting goals and objectives that can lead to challenges in making wetland management and restoration decisions. Some view wetlands as essential habitat, while others view wetlands as obstacles to agricultural, urban or other development. Given the politicized nature of discussions around climate change and the breadth of information and misinformation that permeates the media, bringing climate change into the mix can exacerbate or elevate these differences. Appropriate engagement of stakeholders can increase overall support and decrease the likelihood that projects will be sidetracked by unaddressed conflict. Funders should include stakeholder engagement as a criterion in grant requirements.

Stakeholder engagement vs. outreach

Engagement is a two-way information flow involving getting information from stakeholders and incorporating that information into the project. In contrast, outreach is more limited to delivering information to stakeholders and does not entail the same level of stakeholder involvement.

Goals for stakeholder engagement can vary significantly among projects. They may include gathering information that can inform project work, such as sociopolitical context or cultural values that can refine project scope and focus; bringing additional skills, funding or other resources to the project; and conducting outreach to build support for the project and/or climate adaptation, in general. Practices for engagement vary depending on goals. Stakeholder engagement processes range from detailed engagement in all project tasks from planning to monitoring, review and audit; or it might focus on engagement at specific intervals during project implementation. Common engagement activities include regular conference calls and meetings or field trips to develop or periodically review documents or field-level activities. Designing these activities with a specific focus on involving stakeholders is critical. Using interactive tools such as maps, instant polling technology, small group activities and interactive GIS applications can increase the likelihood of meaningful engagement. The approach must be tailored to the audience and budget.

The key to success is engaging the right people at the right time in the right ways. Goals and objectives for stakeholder engagement must be clear, articulating who needs to be involved and why (i.e., the type of organization being represented and the skills and abilities they are expected to bring to the project). The project managers must make a compelling case for why the stakeholders should be involved, what will be expected of them, and what they can expect to get out of the project. With people's busy schedules, it is important not to underestimate the need to clearly articulate the benefits stakeholders will get from engaging in the project. In some cases, a project should be designed to provide funding for travel or to

otherwise compensate stakeholders for their engagement in the project. This is especially important to do for key stakeholders whose involvement is critical to project success but who are reluctant about being involved. Project managers with good group facilitation skills will ensure that there is an appropriate balance among types of stakeholders and level of engagement so that, overall, the engagement process achieves the goals identified.

If a decision or planning process is likely to be contentious, sufficient and skilled support in facilitation, consensus decisionmaking and collaborative problem solving must be provided. The need for such skills should be factored into project planning and budgeting. In some cases, these sorts of expertise may be more important than expertise in climate science. In all cases, stakeholder input must be captured in such a way that it can be reviewed and referenced throughout the project process.

Case Example | Community-Based Adaptation in the Columbia Basin

In 2008, the Columbia Basin Trust, a group formed to enhance social, economic and environmental wellbeing in the Canadian portion of the Columbia River Basin, established its Communities Adapting to Climate Change Initiative (CACCI). That same year, Elkford, British Columbia, a community dependent on coal mining and logging, was revising its official community plan and agreed to be one of the pilot communities. The CACCI team discussed regional climate change impacts with council and district staff, and the group identified six areas on which to focus community engagement based on their knowledge of what mattered to the community. These were wildfires, flooding/landslides, snow, water availability, ecosystem change and diseases/pests.

Columbia River, Washington State, United States

The project team then developed a three-pronged approach for community engagement. The first involved a formal community meeting at which they set up 15 stations around the room, each focused on a different topic or climate impact. They even had a station addressing the question of whether climate change is real, since they knew many community members were doubtful. This format allowed attendees to spend time on topics that mattered to them and to engage in back-and-forth dialog with experts rather than simply sitting and listening to presentations.

The second engagement approach was for members of the project's community advisory committee to host less formal "coffee table" sessions where CACCI staff spoke about adaptation, the community plan, and attendees' ideas and opinions.

The third approach involved project consultants setting up booths in public places such as the Post Office or the mall. This involved the least commitment on the part of stakeholders, and allowed project staff to reach and interact with people who might not have the time or motivation to attend special events.

Based on input from stakeholder engagement, the project team narrowed the original six priority topics down to three (wildfires, flooding/stormwater management, and water supply) on which they focused for the more formal vulnerability assessment and adaptation planning activities that ultimately informed Elkford's revised community plan.

Challenges and Benefits

Good engagement can create a sense of trust and community that builds social and political support for the project and thereby enables long-term success. It can bring in time, skills, funding and information that may not otherwise have been available, and can help to identify and avoid pitfalls. It sends a message that stakeholders are important to the project, adds local expertise, and facilitates the ability to link the project with existing efforts.

However, pulling stakeholders together and engaging them in a meaningful way requires a large time investment, even when done through conference calls, webinars, virtual focus groups or other remote engagement methods. For contentious projects, just creating enough trust to bring different stakeholder groups into the same room can take significant time and energy and require dedicated resources for facilitation or collaborative decisionmaking. The consequences of not investing appropriate time and attention to stakeholder engagement should not be ignored, however: poorly executed engagement can undermine a project's success even if the technical work is well done.

Who should implement the practice?

Any organization implementing a wetland adaptation project should implement some level of stakeholder engagement.

When should this practice happen?

Tools and Resources

Columbia Basin Trust Adapting to Climate Change | The Communities Adapting to Climate Change section has links to detailed case studies from each CACCI community, as well as adaptation reports, videos and resources. | **www.cbt.org/Initiatives/Climate_Change/?Adapting_to_Climate_Change**

EcoAdapt's Great Lakes Climate Adaptation Toolkit | Includes tips for communicating about climate change as well as several case studies featuring strong stakeholder engagement components (including the Elkford story). | **ecoadapt.org/programs/awareness-to-action/freshwater-future-great-lakes-toolkit**

NOAA's Stakeholder Engagement Strategies for Participatory Mapping | Highlights how to target stakeholder engagement for particular needs. | **www.csc.noaa.gov/digitalcoast/_/pdf/participatory-mapping.pdf**

National Oceanic and Atmospheric Administration: Introduction to Stakeholder Participation | This guidance document covers best practices for planning, implementing and evaluating stakeholder engagement. | **www.csc.noaa.gov/digitalcoast/publications/stakeholder**

Public Participation in Environmental Assessment and Decision Making | This book from the National Academy Press provides a detailed look at the challenges, benefits, practice and context of public participation in environmental decisions. | **books.nap.edu/catalog.php?record_id=12434**

Great Lakes Commission des Grands Lacs

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Data Use and Trend Analysis to Inform Planning

Use land cover, land use data and spatiotemporal trend analyses to help inform wetland planning

Great Lakes wetlands and shorelines are dynamic systems on short and long timescales. This reflects climatic variability and change as well as changes in land use, water management and other human actions. As water levels rise and fall, wetland plant and animal communities shift in space and composition. Understanding the patterns and processes underlying past changes in wetlands and wetland responses to past changes in climate and weather can help us anticipate possible future changes. This, in turn, can help inform decisions about where to prioritize conservation and restoration projects by identifying areas where wetlands are likely to continue to thrive, where they will thrive if able to shift with changing water levels, and where wetlands are unlikely to survive without massive intervention. This approach can also help to identify areas where limits on allowable land use or changes in existing land use could make the biggest difference for wetland function and persistence. (Also see Best Practice #15 and #17.)

NOAA's Coastal Change Analysis Program (CCAP) is a source of nationally standardized inventories of land cover and use data that can be used to determine the extent and location of wetland losses and gains. For Oconto Marsh, CCAP showed that new wetlands were forming along the coast as water levels dropped. This data informs tools like the NOAA Coastal County Snapshots, which show wetland information at the County Level. Wetland-specific information is provided via the U.S. Fish and Wildlife Service administered National Wetlands inventory, the main federal effort at tracking wetland extent nationwide.

Using data and trend analysis for adaptation-oriented wetlands management and restoration starts with identifying the key drivers of wetland extent and condition in the area of concern (e.g., hydrological regime, development pressures) and the potential sources of information relevant to planning (e.g., hydrological data, land use/land cover data, growth projections).

For historical and recent changes, practitioners can use a diversity of sources including aerial photographs, remote sensing, peer-reviewed and grey literature, interviews, or historical documents to map or analyze changes in land use, lake level, and habitats over space and time, and to look for correlations. Spatiotemporal analyses can lead to a variety of outputs, including maps of past change or correlative models that generate projections of possible future changes.

Climate and weather data can be accessed in spatial or non-spatial formats, and integrated with habitat location, type, and cover information to further refine system understanding and model potential future changes resulting from climate change. Downscale climate models, derived from Global Circulation Models, should be used where available. The goal of downscale models is to connect global scale predictions and regional dynamics to generate regionally specific forecasts. By comparison, weather data are also useful,

but they are gleaned from networks of weather stations, so actual measurements may not be spatially consistent across a given area. A number of groups have used individual station measurements combined with statistical or dynamic modeling to create more fine-grained maps of past weather, but practitioners should be aware of the assumptions underlying these models and use the outputs accordingly.

Case Example | Canadian Great Lakes Coastal Wetlands

Great Lakes lake level change and variability are longstanding realities. With money from Natural Resources Canada's Climate Change Action Fund – Coastal Zone, a consortium of organizations, looked at how vegetation communities, breeding bird communities and fish habitat had changed in association with past lake level changes.

Using GIS-based spatiotemporal trend analyses of historical data, the Climate Change Action Fund – Coastal Zone consortium created a rule-based model for the relationship between the abundance and spatial distribution of wetland plant communities, water depth and past hydrological conditions. Sources of information included historical aerial photographs that showed long-term wetland plant community distribution and composition in relation to lake levels, literature reviews, wetland surveys and stakeholder input.

All wetland types responded to lake level change, although the response was most pronounced in drowned river-mouth wetlands. In all wetlands, drier vegetation types appeared as water levels dropped, but there was an expansion of vegetated wetland area lakeward and an overall increase in total wetland area. On Lakes Erie and Ontario wetlands became less fragmented and complex during dry years while Lake Huron wetlands became more fragmented and diverse. There can be a significant time lag for these effects.

Using the models developed based on responses to historical changes, researchers turned their attention to the future, projecting changes in wetland community under four climate change scenarios. They found that protected lacustrine wetland communities seemed most able to adapt to lake level changes.

Challenges and Benefits

A good model helps to demystify the changeable nature of wetland systems and highlights the need to plan for climate change impacts or anticipate coastal hazards. Practitioners can use analysis of historic and recent change and correlations to anticipate and prepare for potential future changes. Even a qualitative approach (e.g., comparing historical photographs of wetland health and extent for different lake levels) can facilitate visualization of future options.

However, model outputs are only as good as the data and assumptions that go into them. Adequate data or the right data may not be available for the modeling or analysis that is desired. Depending on data sources used, trend analysis can require a variety of expertise, and bringing in the right experts and acquiring the right data can be pricey. Further, due to uncertainties about future climatic variability, planning based on past trends should bear in mind that the past is not always the best predictor of what can be expected in the future.

Who should implement the practice?

Planners and managers should implement this practice with technical experts to perform the analyses.

When should this practice happen?

Data use and trend analysis should be done early in the planning process. In addition, data use/trend analysis might be useful at other times, as predictions may or may not be realized and new information may need to be assessed as a given project proceeds.

Tools and Resources

Great Lakes Coastal Wetland Communities: Vulnerabilities to Climate Change and Response to Adaptation Strategies (2006) | **www.env.uwaterloo.ca/research/aird/aird_pub/Great_Lakes_Coastal_Wetlands_Report_2006.pdf**

National Oceanic and Atmospheric Administration – Coastal Change Analysis Program | Provides a nationally standardized database of land cover and land change information for the coastal regions of the United States. | **www.csc.noaa.gov/digitalcoast/data/ccapregional**

NOAA Coastal Services Center, Lake Michigan Basin, Land Cover Change Report, 1985-2010 | One of a series of regional reports examining land cover status in 2010, and changes over the previous several decades, including covering categories from which wetlands were lost or gained. | **www.csc.noaa.gov/digitalcoast/publications/lake-michigan-basin-land-cover-change**

National Oceanic and Atmospheric Administration – Coastal County Snapshots | Fact sheets that provide an easy way to understand complex data. | **www.csc.noaa.gov/snapshots/**

Michigan wetlands map viewer | This free tool provides the public with access to wetland spatial data, allowing users the ability to view, print and export wetland mapping data from their computers. | **www.mcgi.state.mi.us/wetlands/**

National Wetlands Status and Trends – U.S. Fish and Wildlife Service | Provides a series of free, publicly-accessible national, state and regional reports and technical information. | **www.fws.gov/wetlands/Status-and-Trends/**

Incorporation of Climate Change in Land Protection Decisions

Use acquisition, conservation easements and other tools to preserve/conserve wetland habitat as lake levels fluctuate

Because of the ecological, cultural and social importance of wetlands as well as their loss over the years to agriculture, urbanization and other changes, acquisition and conservation easements are commonly used to conserve wetlands and associated habitat in perpetuity. Land protection is typically used to protect high priority areas for wildlife diversity by state, federal and/or private organizations, but these practices should also be considered in efforts to accommodate the effects of lake level changes in light of climate change.

Fluctuating water levels are important in maintaining the dynamics of coastal wetlands, including shifts in wetland type and composition with different water levels. Depending on the presence of coastal infrastructure, wetland extent may not change dramatically when water levels fluctuate however, in more natural systems, wetlands may migrate inland or shrink toward coastal edges seasonally, annually or in response to storm events. While earlier models suggested that Great Lakes levels were most likely to drop with climate change, more recent work suggests that water levels will continue to fluctuate both above and below long-term averages. Given that future lake levels will continue to rise and fall, it is important that managers consider options that are robust to these potential changes.

In areas where significant lake level change is expected, especially shallower bays, protections can be expanded to include submerged lands, so that wetlands can move along with lake levels. The regulatory framework for this varies across jurisdictions. In Michigan, as in many other states, a complex regulatory scheme at the land-water interface governs how and when easements might be used.

In Michigan, some coastal wetlands are designated Environmental Areas under Part 323, Shorelands Protection and Management of the Natural Resources and Environmental Protection Act, to protect habitat necessary for fish and wildlife. Within most of these Environmental Areas, the lakeward boundary of the protected area remains undefined. However, Part 323 provides for the designation of Environmental Areas up to 1,000 feet landward of the ordinary high water mark of a Great Lake or 1,000 feet landward of the ordinary high water mark of lands adjacent to waters affected by levels of the Great Lakes.

Similarly, resource managers may consider expanding the boundaries of their management area landward to increase the ability of wetlands to shift with lake levels and to maintain wetland function.

"A rolling easement is a legally enforceable expectation that the shore or human access along the shore can migrate inland instead of being squeezed between an advancing sea and a fixed property line or physical structure. The term refers to a broad collection of legal options, many of which do not involve easements. Usually, a rolling easement would be either a) a law that prohibits shore protection; or b) a property right to ensure that wetlands, beaches, barrier islands or access along the shore moves inland with the natural retreat of the shore."

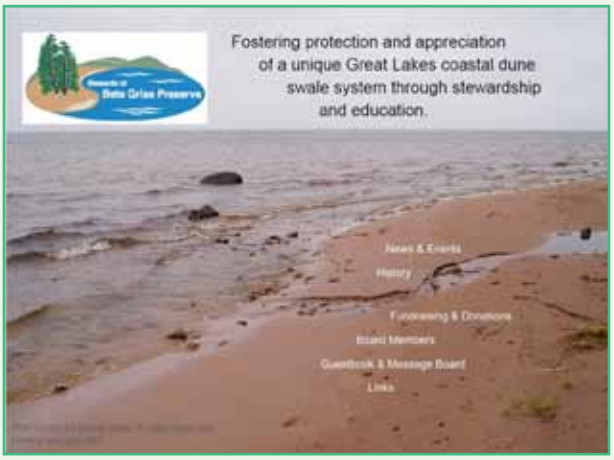
Rolling Easements, James G. Titus, Climate Ready Estuaries Program, U.S. Environmental Protection Agency, June 2010

Rolling easements are a related option for land protection under variable conditions such as climate change.

Rolling easements provide the assurance that the shore or public access along the shore can migrate (inland) instead of being squeezed between an advancing lake or sea and a fixed property line or physical structure.

Because land uses and actions throughout a watershed affect the health of coastal wetlands, land protection geared toward maintaining or improving coastal wetland health does not necessarily need to be immediately adjacent to the wetland. In Washington State, counties have the option (and in some cases the requirement) to establish shellfish protection districts (a.k.a. clean water districts) that give the county increased financial and regulatory options for limiting nonpoint sources of pollution in watersheds draining into important shellfish areas.

Case Example | Protecting Wetlands in Michigan's Upper Peninsula



The Bete Grise wetlands are an 8,000+ acre coastal wetland complex on the Keweenaw Peninsula in Lake Superior that contain a wide variety of habitats, including wetlands and high quality dune and swale habitats that are among the few remaining examples in the upper Great Lakes. Years ago, this area was targeted for residential development; however, project partners, recognizing the ecological significance of the area, rallied funding to protect part of the area as the Bete Grise Preserve. The initial conservation easements and land acquisition protected more than 1,800 acres of what has been described by the Michigan Natural Features Inventory as the single most important coastal plain marsh remaining in the upper Great Lakes region. Funding from the Great Lakes Restoration Initiative (GLRI), the NOAA Coastal and Estuarine Land Conservation Program (CELCP) Initiative and other partners enabled the Houghton Keweenaw Conservation District to purchase nearly 1,500 acres of wetlands adjacent to the existing preserve in 2012, and an additional 181 acres in 2013. Though the acquisitions were not explicitly carried out as an adaptation measure, project partners recognize that the overall effort should provide benefits to a changing climate by preventing development on those lands, which could alter natural resiliency of the adjacent coastal habitats.

Case Example | The Southwest Lake Erie Land Protection Strategy

Ducks Unlimited, Inc. (DU) has implemented the Southwest Lake Erie Land Protection Strategy to protect land surrounding the coastal marshes of western Lake Erie. The program focuses on the protection of existing private wetlands and adjacent agricultural property within the coastal zone of Lake Erie in Ohio and Michigan. Lands near large conservation areas, such as the Ottawa National Wildlife Refuge (NWR) and state wildlife areas will be targeted.

Utilizing funds from the GLRI and in partnership with the Great Lakes Fish and Wildlife Restoration Act, Michigan Department of Natural Resources, Ohio Division of Wildlife, USFWS Detroit River International Wildlife Refuge, USFWS Ottawa NWR, and Black Swamp Conservancy, DU will protect more than 670 acres of wetlands or restorable wetlands to increase connectivity and address urban sprawl and industrial development, which threaten remaining natural wetlands and rural agricultural areas. Though not explicitly undertaken for climate adaptation reasons, this project addresses the principles of climate adaptation by helping to ensure existing wetlands are adequately buffered from the upland edge. In 2012, a forested parcel along the western edge of the Ottawa NWR was protected with a conservation easement and will provide additional upland protection to the wetlands in the marsh.

Challenges and Benefits

The ecological benefits of allowing coastal wetlands to migrate and adapt naturally with changing climate can be significant. Even absent climate change, it is important that appropriate legal and regulatory structures be in place to protect coastal wetland areas. Another benefit is that this practice is not restricted to public agencies; land trust and other environmental organizations or even stewardship-minded landowners can purchase land and easements. Further, land protection adjacent to existing coastal wetlands provides ecological connectivity benefiting wildlife and ecological conditions.

Key among the challenges to land protection is that desirable lands may not be readily available for purchase, so "pre-emptive" protection is not always possible, especially for acquisition. Another challenge is that buying coastal land or acquiring conservation easements is costly. Public agencies face budget challenges restricting new acquisitions and occasionally face public scrutiny if the public benefit is not well-articulated. Further, public agencies must address the long-term challenges of expanded land management, and resources (i.e., funding, staff) are not always available to manage and maintain the land or easement over the long term. Even private land trusts that are in the business of buying land and easements for conservation purposes can face funding hurdles both during the acquisition process and in the enforcement of the conservation easement in perpetuity.

Who should implement the practice?

This practice can be employed by governmental agencies that own or manage coastal wetlands, state legislatures writing wetland laws, agencies that regulate use of submerged lands, land trusts and nonprofits engaged in wetland acquisition or easements. Mandates or incentives for naturalized shorelines can be put in place by local governments in coastal areas which have shoreline use jurisdiction. In some cases complementary zoning ordinances (see Best Practice #6) may need to be developed that can enable wetland acquisition and easements to take place more easily.

When should this practice happen?

Tools and Resources

National Oceanic and Atmospheric Administration – Coastal Change Analysis Program | Provides a nationally standardized database of land cover and land change information for the coastal regions of the United States. | **www.csc.noaa.gov/digitalcoast/data/ccapregional**

Rolling Easements (2011) | U.S. EPA's Climate-Ready Estuaries program comprehensive guide to rolling easements. | **papers.risingsea.net/rolling-easements.html**

Michigan Environmental Area Program | Describes the Michigan Environmental Area Program. | **www.michigan.gov/deq/0,4561,7-135-3313_3677_3700-10863--,00.html**

NOAA Coastal and Estuarine Land Conservation Program, Great Lakes Restoration Initiative | List and brief summary of selected GLRI projects in coastal areas. | **www.glerl.noaa.gov/pubs/brochures/GLRI_CELCP.pdf**

Michigan Office of the Great Lakes, Coastal Zone Management Program, Pristine Lands Protected at Bete Grise Preserve | Describes recent acquisition efforts at Bete Grise Preserve. | **www.michigan.gov/deq/0,4561,7-135-3313_3677_3696-311958--,00.html**

Ducks Unlimited Conservation Report (2011) | Summarizes various DU restoration projects planned, underway or completed in the Great Lakes region including the one cited in the case study. | **www.ducks.org/media/Conservation/GLARO/_documents/_library/_conservation/_states/2011/Ohio_Report2011.pdf**

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Lessons Learned Reports

In an annual report, document the successes or failures of implemented adaptation principles for wetland protection, restoration and management actions

Adaptive management is a commonly recommended approach when there is uncertainty about either management effectiveness or ecosystem function. In the case of adaptation principles for wetland protection, restoration and management, there is general uncertainty about the effectiveness of habitat management as well as the impacts of climatic changes on those practices, making this an essential component of an adaptive approach. Annual success and failure reports, or lessons learned reports, have been identified as one approach to help inform adaptive management.

To maximize learning, a systematic approach is required to assess what works, what does not work, and why. Thus, when developing a plan or a project, goals, objectives and expectations should be described explicitly. Project plans should not only identify tasks or activities, but also provide a rationale for the selected action and some description of what the expected outcomes or results will be. This shifts the learning potential from a somewhat passive mode into an active hypothesis-testing approach. This systematic approach is needed to ensure the best assessment of optimal approaches to wetland restoration in a changing climate.

Lessons learned reports provide the opportunity on a regular basis, to take stock of how well different projects performed, noting whether they were implemented as planned and whether they performed as expected. Rather than approaching reporting in an ad-hoc way, a template should be used that allows systematic tracking with standardized categories of information (e.g., project objectives and actions, expected outcomes and why project actions are expected to achieve those outcomes, key uncertainties about climate change impacts and action effectiveness). Reports and their results should be used to guide the next steps in the conservation of coastal wetland management. Further, reports should be made available to others to encourage communication and technology transfer, and the synthesis of such reports as they apply to common geographies or management practices. Annual reports should be produced, and the results should be presented and communicated.

Case Example | Great Lakes Restoration Initiative Projects

Wetlands restoration projects carried out under the Great Lakes Restoration Initiative (GLRI) have the potential to provide insight on this practice, through the Great Lakes Accountability System (GLAS). U.S. EPA requires inclusion of detailed information on all GLRI-funded projects into GLAS, including: the nature of the project, the responsible organization and point of contact, amount of GLRI funding, project location, and a measure of progress linked to the GLRI Action Plan.

Although GLRI does not specifically require reporting on lessons learned, the requirement to link to metrics identified in the Action Plan compels those doing the reports to provide a rationale for their approach and to account for whether selected actions and approaches achieved stated outcomes.

Old Woman Creek National Estuarine Research Reserve, Ohio, United States

One potential avenue to explore is reporting on wetland mitigation efforts, given that mitigation would typically entail regular reporting by permittees to state agencies. Examples are provided in *Protecting and Restoring the Kidneys of the Great Lakes: An Assessment of Wetlands Programs in Michigan, Minnesota, Ohio and Wisconsin (2009)*, referenced below. The state (or an outside party having access to the mitigation reports) could summarize any progress on incorporating adaptation measures into wetland mitigation projects. Such reporting could also indicate the potential need for regulatory changes (e.g., the need for permittees to incorporate adaptation planning and implementation into mitigation projects, if most project teams are not already doing so).

Other efforts have examined adaptation in individual case studies. One example is the recent effort involving the National Wildlife Federation and EcoAdapt (working with NOAA) involving seven restoration project case studies that provide advice on incorporating climate change considerations in restoration planning and implementation. Subsequent assessments of outcomes at these (and similar projects) could be carried out in the future to assess progress on implementing climate-smart practices in the restoration projects. Such assessments would require development of criteria with which to assess successful adoption of practices incorporating climate change considerations.

Challenges and Benefits

Publicly sharing both successes and failures in wetland adaptation can facilitate active learning and adaptive management by asking managers to reflect regularly on what has worked and what has not worked (see Best Practice #10). Documenting and sharing lessons learned includes sharing failures, which can be challenging or politically unacceptable. Because of this, practitioners may seek to overstate their successes and underplay their failures. Conversely, some practitioners may engage in humble-bragging where they focus on "failures" that are really veiled boasts.

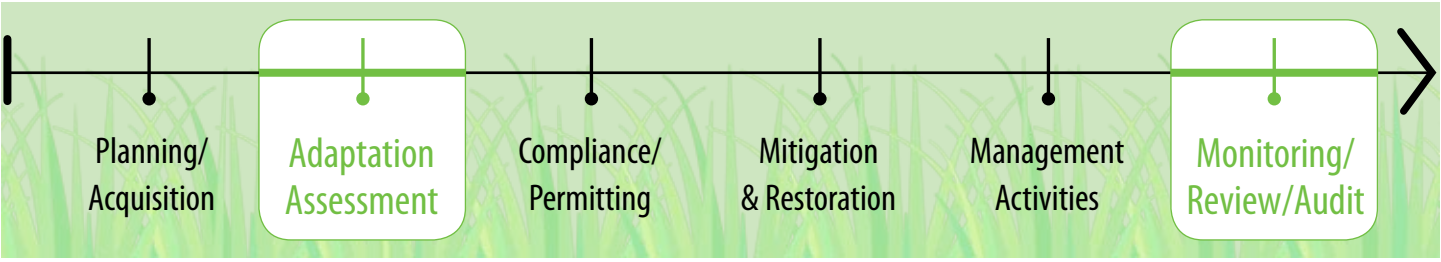
Also, documenting lessons learned is not always part of required reporting, so it takes additional time and energy. A legitimate concern is that such reports may not be read by anyone but the authors and that the production of such reports will become a rote exercise with little useful content. This type of range from thoughtful, useful reflection to more perfunctory reporting can be seen in the "lessons learned" sections of many project reports. Nonetheless, an honest accounting of lessons learned, what worked, what did not work and why can illuminate pitfalls to avoid and areas that merit expanded efforts in the future.

Who should implement the practice?

The practice would likely be implemented by an entity with ongoing ability to carry out a broad review of project implementation. This might be a government agency, NGO, or potentially an academic group, though, in all cases, resource availability over the longer-term would be an issue. An additional consideration is the independence of the assessment, and the potential value to an organization not involved in any of the projects themselves.

To increase collective learning around adaptation principles for wetlands work, an organization or agency should collate and summarize wetland adaptation lessons learned from the annual reports of related work. This could be a professional organization such as the Michigan Wetlands Association, or a government agency such as Michigan Department of Environmental Quality or NOAA.

When should this practice happen?



Tools and Resources

Climate Change Adaptation Plan for Coastal and Inland Wetlands in the State of Michigan (2012) | Report of Association of State Wetland Managers reviews climate change issues relevant to wetland protection and restoration in Michigan. | www.michigan.gov/documents/deq/Michigan_Wetlands_and_Climate_Change_Report_Final_Final_403251_7.pdf

Great Lakes Restoration Initiative Accountability System (GLAS), User Guide (2011) | U.S. EPA developed this system for collecting monitoring and reporting information on GLRI-funded projects. | www.greatlakesrestoration.us/pdfs/GLASv1.1_reporting_guidance.pdf

National Wildlife Federation and EcoAdapt – Restoring the Great Lakes' Coastal Future: Technical Guidance for the Design and Implementation of Climate-Smart Restoration Projects (2014) | Guidance document that provides an overview of adaptation principles, guidance for climate-smart restoration projects in the Great Lakes, and reviews experience from seven case studies. | www.nwf.org/~/media/PDFs/Global-Warming/Climate-Smart-Conservation/2014/Restoring-the-Great-Lakes-Coastal-Future-032114.pdf

Protecting and Restoring the Kidneys of the Great Lakes: An Assessment of Wetlands Programs in Michigan, Minnesota, Ohio and Wisconsin (2009) | Reviews general wetland policies in four Great Lakes states, including a brief review of mitigation policies and procedures. | online.nwf.org/site/DocServer/Wetlands_Report_July_2009.pdf?docID=10661

Mitigating Climate Change through Restoration and Management of Coastal Wetlands and Near-shore Marine Ecosystems – Challenges and Opportunities (2011) | This World Bank report underscores the need for protecting coastal wetlands as part of carbon emission reduction strategies and includes recommended improvements in monitoring and reporting under the United Nations Framework Convention on Climate Change. | portals.iucn.org/library/efiles/documents/2011-009.pdf

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Climate Vulnerability Assessments

Conduct climate change vulnerability assessments that include fish, wildlife, vegetation, invasive species and coastal communities to inform selection of appropriate response plan(s)

Climate change adaptation is generally conceived of as actions taken to reduce vulnerability to climatic changes or effects or to take advantage of opportunities presented by a changing climate. Reducing vulnerabilities means understanding them. The Intergovernmental Panel on Climate Change (IPCC) presented a generic approach to vulnerability assessment, and defines vulnerability as a combination of the target's exposure and sensitivity to climatic changes and its capacity to conduct vulnerability assessments. However, how vulnerability assessments are carried out in practice varies widely, and can include differences in spatial scale, temporal scale, complexity, components of vulnerability addressed, and the role of quantitative vs. qualitative input. The focus of different vulnerability assessments also varies widely, and can address anything of concern to practitioners, including biological or ecological targets (e.g., species, habitats, hydrology), infrastructure, wetland policies or practices, or socioeconomic targets. No approach is universally superior in all cases. There are also increasing examples of climatic changes and impacts being combined with other sources of vulnerability or risk into a single integrated assessment. Such integrated approaches may be most appropriate for wetlands given the number of non-climate-related threats to wetland structure and function, as well as possible interactions between climate-related changes and these other threats.

Practitioners can select or adapt assessment methodologies based on the goals and intended use of the assessment as well as available expertise, funding, information and time. The importance of clearly articulated goals and intended uses cannot be overstated, and should inform all elements of vulnerability assessment design and implementation. This is particularly true when assessments are intended to feed into established wetland conservation and restoration procedures and practices with standard sets of calculations and parameters used in design and decisionmaking. Strong involvement by individuals with deep familiarity with local wetland systems and local conservation and restoration practices is essential for such assessments.

Like all aspects of a vulnerability assessment, assessment outputs should be tailored to the objectives and intended use of the assessment. Common output types include vulnerability scores, maps of vulnerability or various components of vulnerability, a detailed narrative description, conceptual models, or some combination thereof. Vulnerability scores are useful for quick comparisons and ranking, but may not capture critical differences in sources of vulnerability. Vulnerability maps facilitate an understanding of spatial patterns in vulnerability, and can highlight vulnerability differences for a particular species or habitat type across its range, but like vulnerability scores, it may obscure important information on contributing factors. Detailed narrative descriptions can capture the most information but can be time-consuming to use. They can be particularly useful if the practitioners who will be using them are engaged in creating them. In these cases, the text serves as a reminder of what they learned as part of the process. Conceptual models can help to capture scientists and practitioners' understanding of how the system works and to identify key intervention points where vulnerability is greatest or adaptation action could be most useful.

Case Example | Vulnerability Assessment to Inform Climate-Smart Restoration in the Great Lakes

NWF, NOAA and EcoAdapt partnered to create a guidebook for doing climate-smart restoration in the Great Lakes (see Tools and Resources below). The steps of the climate-smart restoration process are as follows:

1) Identify restoration goals, targets and approaches
2) Sketch climate-smart process
3) Assess climate change vulnerability
4) Review and revise goals, targets and approaches
5) Identify and select climate-smart restoration options
6) Develop monitoring approach
7) Implement restoration options
8) Review, revise, reassess, recreate

This approach highlights that vulnerability assessment is not an end in itself, but a step in developing and implementing climate-smart restoration projects.

The guidebook appendices include a worksheet that supports a screening level vulnerability assessment by providing a table with various climate change parameters and asking project planners to describe the importance and relevance (if any) of each to the project. It also includes illustrative vulnerability assessments for common types of restoration projects within the Great Lakes, including:

- Fish passage restoration
- Drowned river-mouth wetland habitat restoration
- Coaster brook trout habitat restoration
- Whitefish habitat restoration
- Invasive species management
- Water quality restoration
- Oil spill damage assessment, remediation, restoration
- Amphibian habitat restoration
- Wild rice habitat restoration

The initial guidebook was released in 2011, and a revised version was released in 2014.

One unique element of this guidance is that the preliminary version was pilot tested with seven Great Lakes Restoration Initiative projects, allowing for refining the guidance (including recommendations) based on the case studies. Vulnerability assessments in these test cases relied on readily available information such as historical and projected temperature, lake level and rainfall information or past and projected future ranges for tree species. There were several vulnerabilities common to all projects, such as the possible shift in the suitability of tree and shrub species used in restoration projects. Other vulnerabilities were more project-specific. For example, one restoration project plan included the proposed reconnection of a diked 43-acre wetland to Bear Creek, a major tributary of Bear Lake, adjacent to Muskegon Lake in west Michigan. The wetland had been used for celery farming, leaving wetland sediments high in nutrients, particularly phosphorus. Reconnecting the wetland could thus lead to the remobilization of these sediments; climate change could increase this risk through projected increases in heavy rainfall and storm events. The increased nutrient input to Bear Lake, particularly in combination with projected increases in water temperature due to climate change, would lead to more severe harmful algal blooms. Responses to this information on vulnerability could include more limited reconnection of the wetlands to Bear Creek, treatment to reduce phosphorus release and transport, or full wetland restoration with water control structures.

An example of a more targeted and intensive vulnerability assessment comes from Environment Canada. The goal of this project was not to inform specific restoration decisions, but to deepen our understanding of sources and level of vulnerability in Great Lakes coastal wetland communities as a means of generating adaptation options. Researchers developed climate vulnerability indices for wetland vegetation communities and associated fish and bird species, and examined vulnerability under four different climate scenarios.

Saginaw Bay, Michigan, United States

Challenges and Benefits

Vulnerability assessments can help to increase the effectiveness and efficiency of wetland projects by avoiding or reducing vulnerabilities or by taking advantage of opportunities related to changes in the climate. They can also help focus wetland adaptation actions around key vulnerabilities or leverage points, and even build support for wetland conservation as a means of decreasing societal vulnerability to climate change-related drought and flooding.

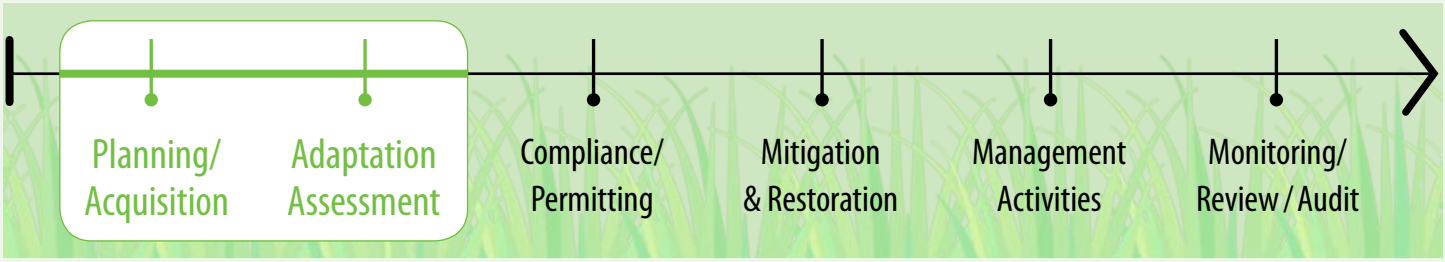
On the other hand, vulnerability assessments can put the focus on vulnerabilities and impacts rather than on taking action to increase wetland resilience and conservation, leading to "analysis paralysis" or a demotivating sense of doom. If people see climate change assessments as separate from or in addition to their existing work, they may see them as just one more item being added to an already long to-do list.

Vulnerability assessments with active, ongoing engagement and collaboration by scientists, managers and practitioners can be effective in building ongoing partnerships and collaboration, but they can also be complicated, expensive and time-consuming to carry out, and project timelines and budgets may not allow for detailed assessment. Without such engagement, however, it can be difficult to set assessment parameters that are meaningful and usable.

Who should implement the practice?

Anyone investing time or resources into coastal wetland restoration, conservation, or management should do some level of vulnerability assessment. At a minimum this should include a quick check to determine whether the likely vulnerability of target species, habitats, communities or proposed actions is high enough to warrant a more detailed vulnerability assessment.

When should this practice happen?



Tools and Resources

Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment (2011) | Guidance document produced to provide resource managers some background information and approaches to conduct vulnerability assessments. | www.habitat.noaa.gov/pdf/scanning_the_conservation_horizon.pdf

National Wildlife Federation and EcoAdapt – Restoring the Great Lakes' Coastal Future: Technical Guidance for the Design and Implementation of Climate-Smart Restoration Projects (2014) | Guidance document that provides an overview of adaptation principles, guidance for climate-smart restoration projects in the Great Lakes, and reviews experience from seven case studies. | www.nwf.org/~/media/PDFs/Global-Warming/Climate-Smart-Conservation/2014/Restoring-the-Great-Lakes-Coastal-Future-032114.pdf

Great Lakes Coastal Wetland Communities: Vulnerabilities to Climate Change and Response to Adaptation Strategies (2006) | www.env.uwaterloo.ca/research/aird/aird_pub/Great_Lakes_Coastal_Wetlands_Report_2006.pdf

ClimateWizard | Enables technical and non-technical audiences alike to access leading climate change information and visualize the impacts anywhere on Earth. | www.climatewizard.org/

The National Conservation Training Center | Offers in-person vulnerability assessment training and an online, self-paced version of the same training. | nctc.fws.gov/courses/programs/climate-change/training-resources.html

NatureServe's Climate Change Vulnerability Index | Helps identify plant and animals that are particularly vulnerable to the effects of climate change. | www.natureserve.org/conservation-tools/standards-methods/climate-change-vulnerability-index

Climate Change Vulnerability Index for Ecosystems and Habitats | Focuses on species and uses a scoring system that integrates a species' predicted exposure to climate change within an assessment area and three sets of factors associated with climate change sensitivity, each supported by published studies. | www.natureserve.org/conservation-tools/data-maps-tools/climate-change-vulnerability-index-ecosystems-and-habitats

Changing Climate, Changing Wildlife A Vulnerability Assessment of 400 Species of Greatest Conservation Need and Game Species in Michigan (2013) | Presents the results of a NatureServe CCVI analysis on 400 species of fish and wildlife in Michigan. | www.michigan.gov/documents/dnr/3564_Climate_Vulnerability_Division_Report_4.24.13_418644_7.pdf

Great Lakes Commission des Grands Lacs

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Consideration of Multiple Climate Scenarios

Evaluate climate scenarios before choosing a management or restoration technique to help ensure actions take potential future conditions into account

Scenario analysis was developed in the 1960s to help military strategists work with the many uncertainties inherent to combat. It was later taken up by businesses, and has gained traction in natural resource management as an approach to dealing with climate-related uncertainties. Scenarios can be built around many sources of uncertainty, not only climate trajectories. In climate adaptation work, it may sometimes make sense to build scenarios around something other than climate trajectories, such as human or ecosystem vulnerabilities, and/or responses to climatic changes. Scenarios can be qualitative or quantitative.

An overall goal of scenario analysis is to consider broad ranges of what is possible, and to inspire creative thinking around action options under each scenario. In some cases, building capacity for flexible, "what-if" thinking is a primary goal of scenario analysis. In other cases, the goal is to test the performance of different action options across a range of scenarios to develop risk management plans or to look for options that give an acceptable performance across all scenarios.

For wetland adaptation work, scenarios are typically built around different plausible future climatic conditions or for the responses of species, systems or people to those changes. The process for building scenarios (formal vs. informal method for generating scenarios) and the nature of the scenarios (qualitative vs. quantitative, spatial and temporal scale, complexity) can vary depending on available time, funding, capacity and the goal of the scenario exercise (exploratory vs. decision-focused).

At one end of the continuum, if time and funding are in short supply or if the stakes are low, a relatively informal process using existing scenarios for climate change or responses can be sufficient. On the other end of the continuum, if stakes are high and the decision and significant assets or resources are potentially at risk, a more formal, in-depth process led by someone with scenario planning expertise would be more appropriate. Quantitative scenarios are most useful when the decision or planning processes in question demand hard numbers and there are data and models to support a quantitative approach. However, reliable quantitative data and related models are not often readily available. Whether data and methods are qualitative, quantitative or a mix, it is important to maintain a record of data sources and methods. This way data and methods can be improved as new information and insights become available.

Once scenarios are created, they can be used to methodically test existing action alternatives, or to stimulate discussion and creative thought about goals, objectives and actions that make sense in light of the range of plausible futures.

Outputs of scenario analysis and planning processes range from:

- increased capacity for decisionmaking under uncertainty;
- an evaluation of how conservation or restoration targets and actions would fare under each scenario; or
- revised management or acquisition plans based on risks or opportunities revealed by scenario analysis.

Case Example | Prioritizing wetland restoration in San Francisco Bay

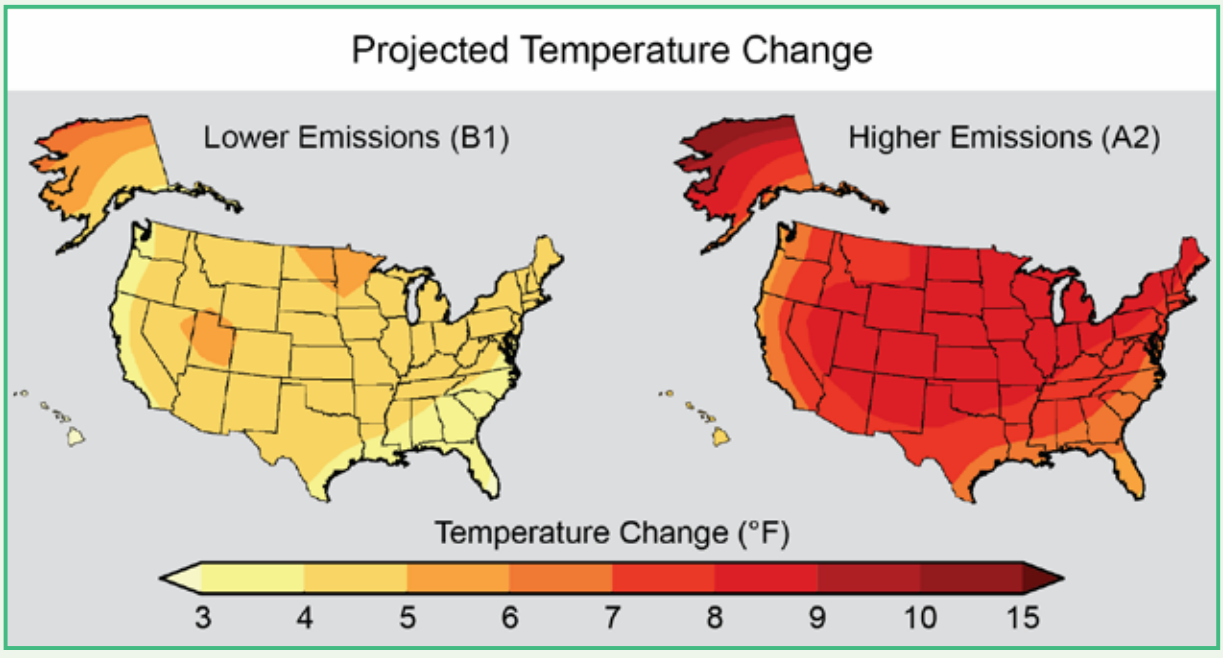
An example of using quantitative scenario analysis to assess prioritization of wetland restoration projects comes from the San Francisco Bay. Like the Great Lakes, the Bay is home to massive restoration efforts, with more than 34,000 acres either restored or planned for restoration. Also like the Great Lakes, there is uncertainty about how wetland systems will respond to climatic changes and impacts. For the Bay's coastal wetlands, two key determinants of how wetlands will respond to climate change are the rate of sea level rise and sediment availability for marsh accretion. There is significant uncertainty about both, yet wetland restoration decisions must be made.

A common element in prioritization of coastal marsh restoration work is which marshes have the best chance of providing high quality wildlife habitat over the long term. A team of researchers decided to test different prioritization schemes against four different sea level rise/sediment supply scenarios: high sea level rise + high sediment supply, high sea level rise + low sediment supply, low sea level rise + high sediment supply, and low sea level rise + low sediment supply. For each, they modeled abundance and distribution of five tidal marsh bird species as a measure of ecological function.

Researchers then used the conservation planning software Zonation 3.0, which creates hierarchical rankings, to prioritize areas for restoration. They created six ranking strategies—one assuming no change in sea level or sediment supply (the "head in the sand" scenario), one optimized for each of the four sea level rise/sediment availability scenarios, and one combining information from all scenarios as well as current conditions—and looked at the performance of each ranking strategy under each scenario. The results? Regardless of which scenario came to pass, the "head in the sand" approach to prioritization always performed the worst. In other words, planning for any of the change scenarios, even the wrong one, was better than planning for current conditions.

Challenges and Benefits

Scenario planning can be an effective way to start difficult discussions. Rather than relying on a single prediction of what the future will be, scenario planning acknowledges what could be possible. A benefit of this approach is that it circumvents the debate about which projection will be the future or which climate model is better. Instead, it enables consideration of what the future might hold under a range of plausible futures and allows the use of various models. This can facilitate active adaptive management and helps participants identify possible tipping points.



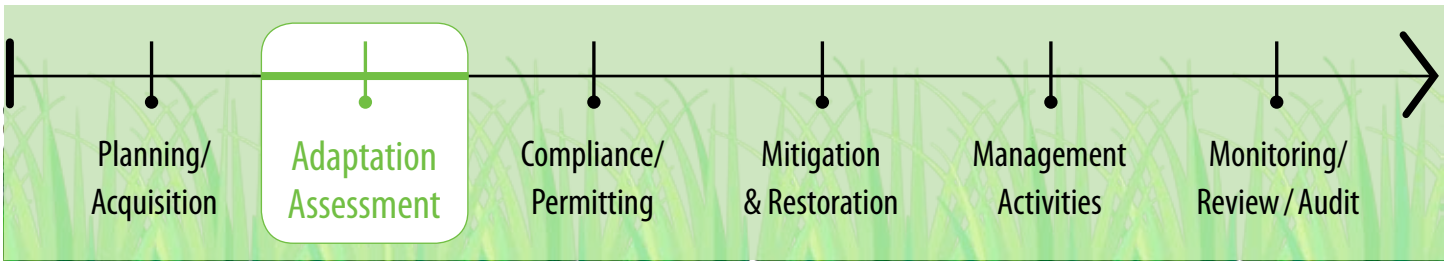
Projected change in average surface air temperature in 2071-2099 relative to 1970-1999. Source: Third National Climate Assessment

A risk of scenario planning is that participants fixate on the handful of scenarios they created or used, forgetting that many other scenarios are possible. Indeed, in most cases scenarios contain significant subjectivity and should not be seen as predictions of any sort. To minimize these risks, and to increase the effectiveness of the process, it is important to have a skilled process facilitator and, if relevant, someone with a solid understanding of climate models and their appropriate use.

Who should implement the practice?

This practice can be implemented by any group or organization, provided they have or bring in the necessary facilitation and scenario expertise.

When should this practice happen?



Tools and Resources

Using Scenarios to Explore Climate Change: A Handbook for Practitioners (2013) | Handbook that describes the five-step process for developing multivariate climate change scenarios. | **climate.calcommons.org/sites/default/files/CCScenarios-Handbook%20FINAL%20080113.pdf**

Scenario Planning for Climate Change Adaptation: A Guidance for Resource Managers (2013) | Step-by-step guide to using scenarios to plan for climate change adaptation. | **scc.ca.gov/files/2013/07/Scen-planning_17july2013_FINAL-3.pdf**

Modeling Climate Change Impacts on Tidal Marsh Birds: Restoration and Conservation Planning in the Face of Uncertainty (2013) | Peer-reviewed paper involving modeling of future distribution and abundance of five marsh bird species in light of projected climate change and other system changes. | **www.esajournals.org/doi/pdf/10.1890/ES12-00341.1**

Adaptation Performance Indicators

Establish indicators for climate change adaptation to measure performance

Establishing clear statements of desired outcomes, along with metrics to measure success at achieving those outcomes, is a well-established best practice in many fields. (Note this practice is related to others, including Best Practice #13.) Although there have been some conceptual papers around monitoring and indicators for adaptation performance there are few examples of adaptation performance indicators in practice. A major challenge is that many adaptation goals and objectives cannot be measured in the near-term because they target responses to climatic changes over decades. This can be addressed in part by developing more explicit short- and medium-term objectives for proposed adaptation actions. Such objectives may yield informative indicators that can be measured over short or intermediate time horizons, with the additional benefit of supporting active adaptive management. Longer-term performance may be assessed using the same indicators over longer time horizons or with the development of specific indicators that assess trends against objectives over the long term.

All projects should clearly articulate near- and longer-term adaptation-related objectives along with metrics that provide a means to measure progress toward those objectives. Indicators may address a range of objectives, including ecological (e.g., waters and watersheds, fish and wildlife), socioeconomic (e.g., outdoor recreation), and institutional or performance (e.g., organizational effectiveness), depending on the goals of the adaptation project. A number of efforts have been undertaken in the past two decades to develop and implement ecosystem indicators throughout the Great Lakes region, and various criteria have been proposed, including data availability, feasibility and meaningfulness (e.g., SOLEC, IJC indicators). Regarding performance indicators, simply measuring whether a set of actions was completed as planned is insufficient; some measure of their effects is also essential.

Even if a wetlands management or climate adaptation project is funded only in the short term, it should be designed so that it supports adaptation performance indicator implementation. This can be done by ensuring that data and information collected for the project comport with those data required to assess progress (i.e., implement the adaptation performance indicators) toward achieving intermediate or longer-term objectives.

For indicators to be effective, measurement of change must be accompanied by timely analysis and reporting of performance, trends and scientific assessments (which may involve hypothesis testing) as appropriate. Particularly since the field of adaptation indicators is in its infancy, sharing ideas and results will help move the field forward.

Point Pelee National Park, Ontario, Canada

Case Example

Case examples of adaptation performance indicators are lacking. As such, no case example is provided here. It is worth noting, however, that, the most recent U.S. National Climate Assessment also noted the paucity of adaptation indicators (see Tools and Resources). Performance monitoring has been identified in the literature as an important objective in coastal wetland restoration (see the Tools and Resources section below) and is described in Best Practice #17 in this Toolkit. In the Great Lakes, there have been numerous efforts to develop indicators of ecosystem health, most notably through the State of the Lakes Ecosystem Conference process and subsequent efforts to build on that process. While many of these are designed to assess the state of a resource or the level of stress on a resource, some "response" indicators are helpful in assessing whether a given action is performing the way it was intended.

Other efforts have been undertaken to develop performance indicators in related contexts. For example, the National Treasury of South Africa developed the *Framework for Managing Programme Performance Information*, which considered a number of institutions and components, including oversight, policy development, strategic planning, and operational planning, budgeting, reporting and institutional involvement from the national to local levels. The framework also includes criteria for performance indicators, including reliable, well-defined, verifiable, cost-effective, appropriate and relevant, and with a logic that ties ultimate impacts back to actions and activities. These types of considerations were used in developing criteria for identifying best practices in this project, and such an approach would be viable in identifying and implementing performance measures in the context of addressing adaptation concerns in coastal wetland restoration.

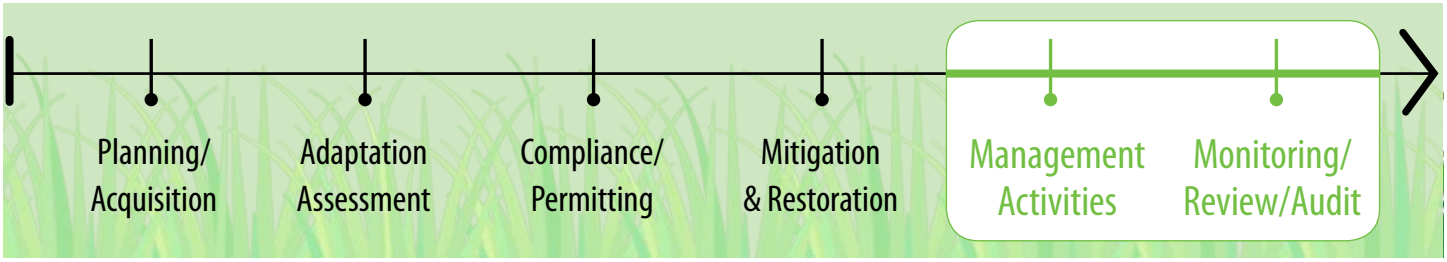
Challenges and Benefits

Because there is little precedent, coming up with practicable but informative indicators is difficult. Also, ensuring that shorter-term projects can support longer-term assessment of adaptation performance requires knowledge of longer-term wetland and climate change adaptation objectives before projects begin—usually in the planning and design phase. As noted above, a major challenge is that many adaptation goals and objectives cannot be measured in the near-term because they target responses to climatic changes over decades. The approach outlined above, however, offers a way forward despite this challenge. Monitoring performance of wetland adaptation efforts can support active adaptive management and provide data needed for evidence-based adaptation. Accordingly, a major benefit is the ability to determine whether adaptation efforts are actually making a difference at different spatial and temporal scales.

Who should implement the practice?

This practice should ideally be implemented at some level by anyone taking adaptation action, but is most important for those who develop and manage all types of wetland conservation and restoration projects. It should be used by planners and managers who have the opportunity to develop and build adaptation performance indicators into a project. To this end, public agencies and organizations interested in assessing ecosystem trends over time should also develop adaptation performance indicators that can readily be used by wetland managers.

When should this practice happen?



Tools and Resources

International Joint Commission – Indicators Assessment of Progress | Set of indicators to be used in the IJC's triennial assessment of progress. | **www.ijc.org/en_/AOP/Indicators**

State of the Lakes Ecosystem Conference (SOLEC) Indicators | Selection of indicators emphasizing ecosystem condition, including indicators addressing coastal wetland communities (i.e., plants, birds, amphibians), as well as indicators relevant to climate (such as air temperature and extreme precipitation events). | **binational.net/solec/pub_e.html**

National Climate Assessment Indicators: Background, Development and Examples (2012) | This report describes a rationale for developing a system of indicators for a climate assessment process, provides a set of examples and briefly touches on research needs, including those related to adaptation indicators. | **http://data.globalchange.gov/report/nca-ti-indicators-2012**

A Comprehensive Review of Climate Adaptation in the United States: More Than Before, but Less Than Needed (2013) | Review of adaptation activities in the United States. | **digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1301&context=publichealthresources**

Climate Change Adaptation Plan for Coastal and Inland Wetlands in the State of Michigan (2012) | Report of Association of State Wetland Managers that reviews numerous climate change issues relevant to wetland protection and restoration in Michigan. | **www.michigan.gov/documents/deq/Michigan_Wetlands_and_Climate_Change_Report_Final_Final_403251_7.pdf**

Framework for Managing Program Performance Information (2007) | Framework developed to identify and implement performance indicators and information in various program management contexts. | **www.thepresidency.gov.za/pebble.asp?relid=14809**

Ongoing Coastal Wetland Monitoring

Conduct ongoing monitoring of coastal wetlands to determine variations and trends over the long term

This best practice focuses on biological and other scientific monitoring as a way to provide field-level data for assessment of wetland status and functional change over time. Ongoing monitoring is essential to understand how wetlands are changing over time, both in extent and condition. What is more difficult to determine is the extent to which observed changes are evidence of degradation due to anthropogenic stresses, impacts of natural processes, impacts of human interventions (e.g., restoration), or some combination of these. More difficult still is determining direct cause and effect between any single management action, indirect human activity and an ecological outcome.

Monitoring is also an essential component of effective indicator implementation (see Best Practice #16). Some of the monitoring needed to inform adaptation work might already be covered through existing coastal wetlands monitoring efforts, however, modification or expansion of wetland monitoring indicators should be explored for climate-specific monitoring needs, and climate-related monitoring indicators should be incorporated into existing monitoring programs to minimize effort and redundancy. Such monitoring can also help in assessing the effectiveness of adaptation actions, and it is important that the monitoring plan for any project be designed to meet all of the intended needs.

Monitoring entails the collection of data that can be measured. The item that is measured through monitoring is the metric. When the metric is applied toward a goal or objective, it functions as an indicator. Thus monitoring is essential for effective indicator implementation—the assessment of change or progress toward ecosystem goals and objectives (see Best Practice #16).

It is essential to specify what is to be monitored and measured, how it will be monitored (what methods will be used), when (the timing of monitoring) and how frequently. Because understanding system responses to long-term change and variability requires long-term data, practitioners should use past monitoring results or other historical information to inform their monitoring programs. This can significantly lengthen the period over which analysis can be done. In cases where historical data are minimal or even largely absent in a given project area, it is important to obtain good baseline data prior to project activities, to ensure a better understanding of the system response to project actions.

Monitoring plans should include a schedule for regular data analysis to look for trends and variations (including trend analysis as discussed in Best Practice #11) to assess progress toward stated goals and objectives. Ideally, raw monitoring results as well as analysis of individual data sets should be made available in ways that allow other resource management agencies and interested parties to compile monitoring results across landscapes to identify broader trends. Uploading metadata for the monitoring data into various regional data portals is a good way to allow people to discover that the data exists while managing access to it.

Saginaw Bay, Michigan, United States

Case Example | Great Lakes Coastal Wetlands Consortium Monitoring Plan

The Great Lakes Coastal Wetlands Consortium (GLCWC) was formed in 2000 to develop and implement a regional monitoring program to track coastal wetland condition. Following implementation of pilot projects, the Great Lakes Coastal Wetland Monitoring Plan, a compilation of recommended protocols for monitoring fish, invertebrates, birds, amphibians, vegetation, chemical/physical parameters and landscape parameters, was released in 2008. The monitoring plan is ambitious in that it sets universal monitoring protocols for all Great Lakes coastal wetlands even as it recognizes different classes of wetlands.

A five-year basinwide coastal wetland monitoring effort was funded through the Great Lakes Restoration Initiative in 2010 to implement the recommended monitoring protocols from the Great Lakes Coastal Wetland Monitoring Plan at more than 1,000 coastal wetlands throughout the Great Lakes. This project is being conducted through a partnership among 14 U.S. and Canadian universities and governmental agencies. Results are being made available through an online GIS resource at http://greatlakeswetlands.org/. It is important that data collected through monitoring activities be analyzed in the context of climate change to determine whether or not observed changes are climate-related (see Best Practice #11).

Challenges and Benefits

In areas where wetlands are extensively altered or managed, identifying trends and variability over time can be difficult. Monitoring is often seen as ancillary to wetland management or restoration. It can also be expensive, time consuming and may require expertise beyond existing capacity. However, monitoring is a critical step to evaluate the impact of any restoration effort. Funding for monitoring should be built in to coastal wetland restoration projects.

It is crucial to have adequate quality control measures in place to ensure reliable results and sufficient documentation of data. Restoration efforts entailing data collection funded by the Great Lakes Restoration Initiative require preparation of a Quality Assurance Project Plan. Alternative approaches to some intensive biological monitoring can also be considered (e.g., landscape level

monitoring through analysis of aerial or satellite imagery, modeling or rapid assessment methods), in particular where funding is not available, and the data or modeling methods are reliable and respected. If much of the monitoring is carried out by volunteers, it is important that adequate training and quality control practices are in place to ensure adequate data quality and consistency.

Who should implement the practice?

Organizations responsible for managing wetlands should establish ongoing monitoring on the sites for which they are responsible, or research entities should establish ongoing monitoring efforts for long-term, large or regional focus areas. As noted above, where funding or other resources for monitoring are not available, alternative methods to assess conditions and trends should be employed. In addition, entities carrying out wetland restoration projects should be conducting monitoring and should ensure adequate coverage of climate parameters as part of that monitoring. To the extent practicable, site-level monitoring should be linked with regional monitoring programs. Regional monitoring is best carried out by organizations or consortia with a broader scope (such as the GLCWC noted above, or other agency or nonprofit-led networks).

When should this practice happen?

Tools and Resources

National Oceanic and Atmospheric Administration – Water Level Observations | www.glerl.noaa.gov/data/now/wlevels/levels.html

National Oceanic and Atmospheric Administration – Water Level Dashboard tool | www.glerl.noaa.gov/data/dashboard/GLWLD.html

Great Lakes Coastal Wetlands Consortium – Great Lakes Coastal Wetlands Monitoring Plan (2008) | This plan was produced using a scientifically validated sampling design and a suite of indicators and metrics developed by project partners. It also includes a cost analysis chapter. | glc.org/files/docs/Great-Lakes-Coastal-Wetlands-Monitoring-Plan-FINAL-March-2008.pdf

Implementing Great Lakes Coastal Wetland Monitoring (2013) | Presentation by Dr. Donald G. Uzarski at the 2013 National Conference on Ecosystem Restoration. | www.conference.ifas.ufl.edu/ncer2013/Presentations/4-Innovation/1-Tuesday/9-Session/YES/0140%20Don%20Uzarski.pdf

Great Lakes Coastal Wetland Monitoring Project Data Website | The goal of this project is to sample Great Lakes coastal wetland biota, habitat, and water quality to provide information on coastal wetland condition. | greatlakeswetlands.org

Climate Considerations in Wetland and Shoreline Restoration

Consider water quantity management needs when designing coastal wetland and shoreline restorations

There are many factors that can contribute to the challenges of coastal wetland management in light of climate change, and water level fluctuations may be one of the most difficult to predict. Due to the alteration of coastal habitats for agricultural or other development, restoration of these habitats can involve the development of water level management infrastructure, such as dikes, water control structures and pumps to restore and then facilitate management to emulate natural wetland conditions.

Regulatory agencies, grant funding agencies and landowners often have concerns over the use of such infrastructure because they can impede fish passage, inhibit development of certain wetland zones, or be used to manage the wetland in a way not perceived as "natural." While these are valid concerns, climate change-related shifts in precipitation and evapotranspiration are already affecting fish habitat connectivity and overall wetland structure and function. Combined with the heavily altered state of many wetlands and coastal areas in the Great Lakes region, this makes a return to previous "natural" conditions difficult. Instead, restoration practitioners in these situations should consider future climate, species distribution and water supply scenarios in developing approaches to restoring wetlands and shoreline habitats. In some cases, water control structures, pumps and fish passage structures, among others that allow managers to emulate natural conditions may be the best approach for ensuring long-term connectivity and ecosystem function, including invasive species control and fish passage. Practitioners can also advocate for naturalized shorelines to increase the ability of wetlands to shift with lake levels and to maintain wetland function. Naturalized shorelines can have additional benefits of reducing polluted runoff from land or reducing flood intensity by absorbing and slowly releasing floodwaters.

This practice can be approached in one of two ways. One is for restoration plans (including goals, objectives and approaches) to be developed based on an understanding of site conditions, landscape position and features, and what water levels are achievable given the reality of climatic variability and change, as well as competing water uses. This is a "climate-smart from the start" approach (involving an assessment of climate vulnerability on all aspects of the project) and, ideally, will become the standard practice. A second option, to be used if goals, objectives and approaches have already been established, is to have planners determine water levels needed to achieve them and then assess the vulnerability of the goals, objectives, approaches and any relevant species, habitats and ecosystem processes to climatic and other changes. Such vulnerability assessments may trigger changes in the approaches used, or even a re-examination of goals and objectives (see Best Practice #14).

In developing action alternatives, planners should consider natural, engineered (i.e., management infrastructure-intensive), social (e.g., water conservation measures allowing for greater water use in environmental projects) and integrated approaches to meeting water supply needs. Alternatives should be evaluated for their ability to maintain expected performance as climate change progresses while minimizing the potential negative ecological effects, as well as for ongoing costs such as repair or upgrading. Planners

opting for a less management-intensive approach (i.e., shoreline softening) may also design projects to leave the option open of using a more managed approach in the future, or vice versa. This may mean building water control or fish structures that will remain unused unless certain conditions come to pass, or it may mean using a restoration design that would allow for the relatively easy removal or decommissioning of infrastructure in the future, should it become necessary.

Case Example | Erie Marsh Wetland Restoration

Erie Marsh, just north of the Michigan-Ohio border along Lake Erie, is one of the largest coastal wetlands on Lake Erie. The Erie Marsh Preserve, owned and managed by The Nature Conservancy, covers more than 2,200 acres and contains 11 percent of southeast Michigan's remaining coastal marshes. Wetland hydrology was altered by construction of dikes in the 1940s and 1950s, and ongoing degradation of hydrology and habitat has harmed fish and aquatic birds. A four-phase restoration initiative was begun in 2013 to restore hydrologic connectivity to Lake Erie. With Phase I now complete, fish passage is now occurring for the first time in 60 years.

The other three phases will address other functions and needs in the wetlands complex. Challenges in the case of Erie Marsh include the presence of a state highway, which prevents wetland movement that would otherwise occur with changing lake water levels, and an infestation of invasive *Phragmites*, for which control often entails some type of hydrologic change (e.g., flooding following herbicide treatment and prescribed burn). In light of these conditions, capabilities for some type of finer water level management in much of the complex were recognized, and the addition of dikes in some locations was pursued. These additional water-level management capabilities can assist in both addressing immediate stresses (e.g. *Phragmites*) as well as near- and medium-term threats associated with climate impacts (e.g. lake level changes) in an already-altered ecosystem.

In addition, a number of soft shoreline engineering (or naturalization) projects have been undertaken along the Huron-Erie corridor over the past two decades. Though many projects were undertaken before the recent era of considering climate adaptation, an assessment of ecological effectiveness has been carried out, and subsequent assessments could potentially identify project modifications necessary in light of vulnerabilities associated with climate change.

Challenges and Benefits

Explicitly addressing how water availability and emulating "natural" wetland conditions may change in the future can support more creative thinking around wetland restoration, as well as identify and avoid potential negative ecological effects. It shifts the focus to achieving the ecological goal rather than focusing on specific actions that are available, and allows the consideration of potential outside constraints on objectives (e.g., water supply constraints). Discussing the full range of options—natural, engineered and social—can alienate constituencies that support "all natural" approaches to restoration, or that support extensive engineering. Discussing climate change can also disaffect some stakeholders, although there are a variety of approaches to minimizing this issue (see Best Practice #10).

The up-front cost of wetland management infrastructure can be significant, but managers must also consider the costs of long-term management and maintenance of that infrastructure, and weigh those expenses with the ecological benefits. However, while a less engineering–intensive approach may come with a lower initial price tag, and may appear more "natural," the lifespan and adaptability of such approaches must also be evaluated. Although infrastructure that facilitates adaptation may be more expensive to develop, it could be considered more preemptive methods of including climate change adaptation into a wetland restoration, as it recognizes and prepares for water level uncertainty.

Most types of water level management infrastructure (e.g., dikes, weirs, control structures) require permits for installation, and given longstanding concerns over wetland loss and degradation in the country (as well as statutory and regulatory requirements),

Water control structure - Crow Island State Game Area, Saginaw, Michigan, United States

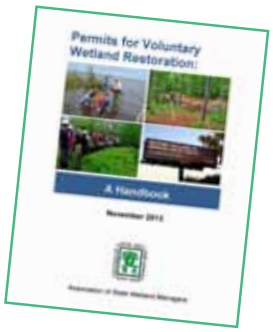
such proposals will be scrutinized carefully. For example, the construction of dikes for water level management may require filling portions of a coastal wetland, which would require a permit. Regulatory agencies may require modifications to the plan or compensatory mitigation for the impacts of the fill. In these cases, planners must justify the need for these actions to regulatory agencies or alternative methods of wetland management may be necessary. Although this can be a challenge, these issues are highly site-specific and require close consultation with regulatory agencies.

Who should implement the practice?

This practice should be implemented by coastal and wetland managers including federal, state, and local agencies and private or non-governmental organizations that actively manage coastal wetland areas.

When should this practice happen?

Tools and Resources



Permits for Voluntary Wetland Restoration: A Handbook, Association of State Wetland Managers (2013) | Includes various aspects involved in permitting for voluntary wetland restoration projects, such as general approaches to permitting, facilitating the process and special considerations that can arise. | **aswm.org/pdf_lib/permits_for_voluntary_wetland_restoration_handbook.pdf**

The Nature Conservancy, Erie Marsh Preserve: Major Restoration Project Brings Back Fish and Birds to Healthier Habitats | Brief overview of site history and recent restoration efforts at Erie Marsh. | **www.nature.org/ourinitiatives/regions/northamerica/unitedstates/michigan/explore/erie-marsh-comeback.xml**

Great Lakes/Atlantic Regional Office Engineering | Brief summaries of recent engineering projects (including Great Lakes region), some of which have the capacity (e.g., water management structures) to address climate change threats to project wetlands or other habitats. | **www.ducks.org/conservation/glaro/engineering**

University of Windsor, Soft Shoreline Engineering | Website summarizing brief case studies on 38 soft shoreline engineering projects in or near the Huron-Erie corridor, including high-level lessons learned and links to ecological effectiveness manuscripts. | **web4.uwindsor.ca/units/stateofthestraight/softs.nsf/inToc/D27D2ED7AB6CBCE48525775F00726983?OpenDocument**

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p. 44: Saginaw Bay, Michigan, United States | ©Anne Garwood

p. 47: Projected change in average surface air temperature in 2071-2099 relative to 1970-1999 | ©National Climate Assessment

p. 50: Point Pelee National Park, Ontario, Canada | ©Michael Murray

p. 53: Saginaw Bay, Michigan, United States | ©Anne Garwood

p. 57: Water control structure – Crow Island State Game Area | ©Michael Murray

Literature Review for Evaluation Criteria and Candidate Best Practices for Michigan Coastal Wetlands Adaptation

October 2014

National Wildlife Federation

Prepared by Melinda Koslow, with research assistance by Ben Schapiro, and additional assistance and editing by Michael Murray, Ph.D.

Prepared as part of project *Best Practices for Climate Change Adaptation: Spotlight on Michigan Coastal Wetlands*, with Great Lakes Commission, and funded by Michigan Coastal Management Program (Project #3210).

Background

Michigan coastal wetlands provide habitat for numerous species of plants and animals, and help maintain water quality for Michigan and the entire Great Lakes basin. Based on the Great Lakes Coastal Wetland Consortium inventory of coastal wetlands, Michigan has approximately 275,748 acres of Great Lakes coastal wetlands.[1] These wetlands are managed by the Department of Environmental Quality (DEQ) and supported by state and federal partnerships. Four aspects of wetland management identified by the state include monitoring, preservation, restoration, and climate change.[2] Given the recognition by the state of the importance of considering climate change adaptation in wetland management, the Michigan Department of Environmental Quality Coastal Management Program awarded the Great Lakes Commission (GLC) a grant to identify, through a collaborative process, best practices for coastal wetland adaptation. The National Wildlife Federation (NWF) was a subcontractor for the project and led the preparation of this literature review, which summarizes the process and associated literature used to develop candidate best practices for climate change adaptation in Michigan wetlands.

Given the many functions and values provided by coastal wetlands, their survival and health is important, including in changing climatic conditions such as warmer air and water temperatures, extreme and variable precipitation patterns and attendant changes in water levels, changing soil conditions, wildlife phenology, and migration patterns.[3] In addition to their importance as habitats, coastal wetlands have other key functions and values as well, including helping to protect water supply, enhancing water quality (e.g., through retaining nutrients), and supporting economic activities such as recreation and tourism. Actual responses of wetlands to climate change will depend on a number of factors, including wetland type and factors affecting runoff and evapotranspiration (e.g., vegetation type and extent, land use).[4]

Concerning climate change adaptation of coastal wetlands, there has been significant work on marine systems, and a number of case studies have been reported.[5] The importance of freshwater coastal wetlands in broader ecosystem health has long been recognized, including in the Great Lakes.[6] However, there have been relatively few efforts at identifying issues specific to coastal wetland adaptation in the Great Lakes, and limited site-specific work, in particular having research components.

Defining what it means to focus on climate change adaptation in a coastal wetland context – and in adaptation in general – requires accounting for multiple issues of scale, complexity, multidisciplinarity, and societal values.[7] Concerning scale, work can include using scientific understanding obtained at a larger scale and applying it at the local level. It requires a general understanding of vulnerabilities to climate change (amongst other stressors) and finding actions that reduce these vulnerabilities. For example, a manager might begin with strategies such as develop restoration projects that are resilient to a wider range of future lake levels and then develop actionable items that are appropriate for a particular location, given the ecological conditions,

specific vulnerabilities, management objectives, and perhaps social constraints on that system. Indeed accounting for plausible future conditions in goal- and objective-setting regarding wetlands management is a key principle characterizing sound climate adaptation in general.[8] In addition, the possibility of significant impacts of future climate change (including beyond recent historic variability) highlights the need for potentially increased human intervention (e.g., in water control, expanded buffer areas, increased protected areas) to ensure particular wetlands can be optimally protected and restored.

This literature review was intended to help identify candidate best practices and criteria by which to evaluate those practices that could be used by the core team (working with the Project Review Committee) ultimately to select those practices which are "best" at supporting adaptation of Michigan's coastal wetlands to climate change. The literature review was not intended to be a comprehensive review of all peer-reviewed and grey literature related to wetlands adaptation, but rather focus on representative work readily available and deemed relevant to adaptation of Michigan coastal wetlands. The effort targeted both peer-reviewed publications (including available through Web of Science) and grey literature (including from government agencies, nongovernmental organizations, and other entities). In addition, solicitation of input from the Project Review Committee was also conducted. For this project, it was understood that coastal wetland adaptation could include both incorporating adaptation considerations into restoration actions as well as altering other practices or actions in the watershed (such as local land use planning, agricultural practices) to reduce vulnerability of particular wetlands to climate change.

Evaluation Criteria

Evaluation criteria were identified to assess the extent to which wetland management programs and practices—candidate best practices—actually enhance the ability of Michigan wetlands to adapt to climate change—are actually "best". Robust criteria will account for uncertainty by embracing multiple principles within adaptive management and scenario planning.[9] After examining a number of criteria and more specific aspects, our team concluded that the criteria we use to evaluate a "best practice" should include measures such as importance, effectiveness, urgency, sustainability, co-benefits and side effects, reversibility, flexibility, resilience, robustness as well as political and cultural acceptability. These measures drew heavily on a technical paper developed to guide adaptation in Europe.[10]In addition, the consideration of optimal measure and criteria specific to Michigan wetlands adaptation drew heavily on earlier drafts of a recently published report reviewing adaptation considerations in the U.S.[11]

Understanding that wetland responses to climate change can be site-specific,[12] we recognized the importance of developing project level (site-specific criteria) for candidate best practices. A key element of effective climate change adaptation is that managers clearly link proposed actions to likely impacts based on some level of analysis or logic model (whether quantitative or conceptual).[13] This approach was carried out in developing the project level criteria.

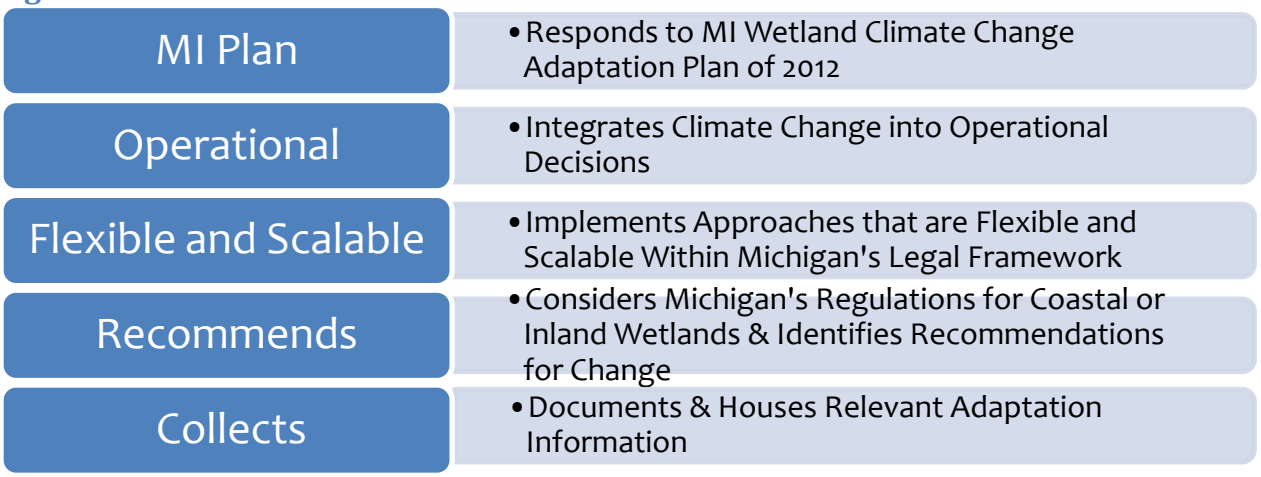
Climate change adaptation will also include addressing programmatic and other institutional constraints and enabling conditions such as existing institutional frameworks, laws and regulations or lack thereof and obsolete or ineffective management or operational procedures (e.g., requirements regarding historical data to inform future decisions).[14] Accordingly, institutional level evaluation criteria were also developed for the potential to enhance governance and institutional capacity around wetlands management to anticipate and respond to climate change. Institutional level evaluation criteria, in this case, were specific to Michigan, but the process also considered local and federal requirements. And it is assumed the types of criteria developed would be applicable in other jurisdictions.

In sum, criteria were developed for evaluating and selecting best practices at both the project/site level as well as the institutional level. We also considered criteria that would enable a determination as to whether a best practice is transferrable to other areas within the Great Lakes region, or other states throughout the country. Figures 1 and 2 summarize the project level and institutional level evaluation criteria used in the end.

Figure 1. Project Level Criteria

Links	• Links Restoration/Management Actions to Climate Impacts/Vulnerability
Decisions	• Integrates Climate Change into Decision-Making Framework
Future Goals	• Develops Goals & Objectives That Learn from Past, Look to Future
Measures and Monitors	• Incorporates Climate Change Into Performance Measures and Monitoring
Broadly Evaluates	• Evaluates Benefits and Impacts at Multiple Spatial Scales
Plans for Variation	• Examines and Plans for Range of Greater Variation or Decision-relevant Uncertainties

Figure 2. Institutional Level Criteria



Candidate Best Practices

In climate change adaptation, "best practices" transpire at multiple levels. Concerning coastal wetland adaptation as envisioned in this project, a best practice can occur at either the project or institutional levels. The project level is site-specific, using the Michigan DEQ definition of site, but expanding out to the adjacent area, migratory pathway, or riverine system, when assessing climate change vulnerability. At the institutional level, best practices are Michigan state-level specific, but as noted above, allow for consideration of local and federal requirements as well.

The term "best practice" generally describes a method or technique that has consistently shown results superior to those achieved with other means. At this point in adaptation of Michigan's wetlands, we do not have enough information to determine whether all individual practices deliver consistent, superior results. Instead, through the literature review (see annotated bibliography at end), and iterative consultations with the Project Review Committee, the team generated a list of "good" or "emerging" practices, or "candidate best practices." Again, some of these are formally cited in the literature while others are suggestions from experience among the PRC members or are inferred in reports that address wetlands or climate change adaptation more generally but not necessarily both. The candidate best practices were evaluated and ranked by PRC members using the selected evaluation criteria described above and a simple numeric scoring system, leading to a shorter list of practices deemed by the group to be most promising in wetland adaptation efforts. Our selected list of "best practices" exemplify different approaches for responding to climate change impacts for various situations. They highlight courses of adaptation actions that are expected to be most efficient and effective by taking into account relevant measures of successful adaptation, as noted above.

Annotated Bibliography

This section highlights references and resources (with citations, summaries, and relevance to criteria and/or individual best practices) identified by core team members and Project Review Committee members during the literature review phase of this project as relevant to coastal wetlands adaptation in Michigan.

Title: Adaptation Collaboratory
Full Citation: University of Notre Dame and The Nature Conservancy, Adaptation Collaboratory, available from https://adapt.nd.edu/.
Summary: The website is a resource for research, education, and collaboration in the area of adaptation and climate change. It incorporates a multitude of tools, which take several forms including modeling, searchable clearinghouses of legal information, and dissemination of emerging opinion from experts on the benefits and challenges with adaptation implementation. These tools can be used individually and in an integrative way to inform decision-making, research, and awareness.
Relevance to Criteria or Best Practices: As with CAKE, this clearinghouse provides publication, tools, and other information relevant to this project, and individual components are relevant to multiple criteria and several best practices in general. However, one issue is the relatively limited number of wetland adaptation case studies compiled to date.

Title: Adaptation of Shoreline Best Management Practices
Full Citation: EOR, Inc. (undated) EOR - Helping to Address Climate Change, available from http://www.eorinc.com/EOR-ClimateChangeGrant.php.
Summary: A multi-agency effort involving EOR, Inc. and the University of Minnesota, with funding from the Minnesota Pollution Control Agency, investigated the impacts of climate change on shoreline processes (including vegetation condition) and how policies and shoreline best management practices (BMPs) can be modified to address climate change. The project was to entail modeling, field experimentation, and monitoring, with results to be made available to local units of government and firms engaged in BMP installation.
Relevance to Criteria or Best Practices: The case study is relevant to several project level criteria as well as several best practices, including consideration of climate in wetland and shoreline restoration.

Title: Adapting to Climate Change: A Planning Guide for State Coastal Managers

Full Citation: 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, available from http://coastalmanagement.noaa.gov/climate/docs/adaptationguide.pdf.

Summary: The guide was developed by NOAA to assist state and territorial coastal managers in developing and implementing adaptation plans to reduce the impacts and consequences of climate change and variability. The guide discusses the planning process, development of a vulnerability assessment, development of an adaptation strategy, and implementation and maintenance of the plan. Appendices include information on federal funding sources, federal laws and executive orders related to climate change, and brief regional climate impact overviews.
Relevance to Criteria or Best Practices: The guide is relevant to several criteria and several best practices, including climate vulnerability assessments.

Title: Building Capacity for Climate-Resilient Communities and Water Conservation in the Huron River Watershed
Full Citation: Gregg, R. M. 2012. (Updated 2013). Building Capacity for Climate-Resilient Communities and Water Conservation in the Huron River Watershed [Case study on a project of the Huron River Watershed Council], available from http://www.cakex.org/case-studies/building-capacity-climate-resilient-communities-and-water-conservation-huron-river.
Summary: This case study involves climate adaptation efforts of the Huron River Watershed Council (HRWC), a nonprofit in Ann Arbor, MI engaged in protecting and sustaining resources in the Huron River Watershed. The HRWC has been engaged in climate change work for some time, including developing an adaptation project entitled Making Climate-Resilient Communities. The project has involved multiple funders and partnership with the Great Lakes Integrated Sciences and Assessment program, and has included multiple workshops with local community members, with work divided among three workgroups: water infrastructure, in-stream flows, and natural infrastructure (with the latter including wetland restoration). A number of strategies have come out of the workshops, including related to water infrastructure improvements, broadening of education and outreach efforts, and incorporating climate change in to regulations and permitting.
Relevance to Criteria or Best Practices: The case study is relevant to several of the criteria in this project (in both project and institutional groups), including around decisionmaking, and informed several best practices related to partnerships, convening workshops, and development of local ordinances considering climate change.

Title: Climate Adaptation Knowledge Exchange (CAKE)
Full Citation: EcoAdapt, Climate Adaptation Knowledge Exchange (CAKE), available from http://www.cakex.org/.
Summary: The Climate Adaptation Knowledge Exchange (CAKE) was founded by EcoAdapt and Island Press in July 2010, and is managed by EcoAdapt. It aims to build a shared knowledge base for managing natural and built systems in the face of rapid climate change. Just as importantly, it is intended to help build an innovative community of practice. It helps users to get beyond the limitations of their time and the unwieldy thicket of books, papers and articles by:

- Vetting and organizing the best information available, including providing summaries of individual efforts,
- Building a community via an interactive online platform,
- Creating a directory of practitioners to share knowledge and strategies, and
- Identifying and explaining data tools and information available from other sites.

Users desiring more information on summarized case studies can go to original source materials, linked from the site.
Relevance to Criteria or Best Practices: Given the numerous case studies (and original research and other work) available in the system, this source in aggregate is relevant to multiple criteria as well as a number of best practices.

Title: Climate Change Adaptation: A Priorities Plan for Canada
Full Citation: Feltmate, B., Thistlethwaite, J., 2012. Climate Change Adaptation: A Priorities Plan for Canada; Report of the Climate Change Adaptation Project (Canada), available from http://uwaterloo.ca/environment/sites/ca.environment/files/uploads/files/CCAP-Report-30May-Final.pdf.
Summary: This project aimed to identify and prioritize solutions to address climate change threats to Canada, in particular around adaptation approaches. The effort entailed examining climate change projections for the country, utilizing experts to identify key climate challenges, utilizing an advisory committee to rank sectors, and utilize experts to identify actions addressing challenges in priority sectors identified. One of the top sectors was freshwater, and the resulting action was to "establish a national priority to identify, preserve, and/or restore wetlands that are 'key capacitors' within watersheds across Canada…" The report notes the importance of wetlands in several Canadian regions, threats they are under, several wetland initiatives underway, and the importance of developing new wetland restoration policies as an adaptation measure.
Relevance to Criteria or Best Practices: The effort overall is relevant to several criteria and several best practices, including regarding partnering with experts, engaging stakeholders, and incorporating climate change in land protection decisions.

Title: Climate Change Adaptation Plan for Coastal and Inland Wetlands in the State of Michigan
Full Citation: Christie, Jeanne, P. Bostwick. 2012. Climate Change Adaptation Plan for Coastal and Inland Wetlands in the State of Michigan. The Association of State Wetland Managers, Inc.: Windham, ME, available from http://www.michigan.gov/documents/deq/Michigan_Wetlands_and_Climate_Change_Report_Final_Final_403251_7.pdf.
Summary: The report presents general information about climate change impacts to Michigan's wetlands, a synthesis of various local workshops on coastal adaptation, state strategic approaches on climate change, case studies of adaptation planning in

other states, and recommendations. The purpose of this plan is to give background information on coastal wetland adaptation in Michigan and to make recommendations for state wetland management in a changing climate. The Handbook also is not intended as legal or environmental advice or as a best practices manual. This handbook is intended to facilitate navigation of a wide array of statutory and regulatory programs, especially those of which that have relevance to adaptation.
Relevance to Criteria or Best Practices:: Because this is a Michigan-focused plan on adaptation, it was highlighted in the form of a separate criterion.

Title: Climate Ready Great Lakes
Full Citation: National Oceanic and Atmospheric Administration, Great Lakes Region, Climate Ready Great Lakes, available from http://www.regions.noaa.gov/great-lakes/index.php/resources/climate-ready-great-lakes/.
Summary: The National Oceanic and Atmospheric Administration (NOAA) Great Lakes Regional Collaboration Team, working with the Great Lakes Sea Grant Network and University of Michigan School of Natural Resources and Environment produced training modules to inform adaptation efforts in the region. The approach consists of three modules, each of which has a slide presentation and supplemental materials (including handouts, worksheets, and evaluation forms). The modules address three aspects of adaptation, including predicted climate impacts in the region (including discussion on variability), approaches to adaptation (including in relation to stormwater management, infrastructure, and ecosystems), and tools to assist in the entire process, including on vulnerability assessments and adaptation planning.
Relevance to Criteria or Best Practices: Because the modules were developed for the Great Lakes region, they are particularly suited to adaptation in Michigan coastal areas, address several of the criteria considered in this process, and also informed several best practices, in particular on continuing education and cross-training.

Title: Climate-Smart Restoration of the Black River.
Full Citation: Inkley, D. 2013. Climate-Smart Restoration of the Black River, National Wildlife Federation. Also see summary in Koslow, M., J. Berrio, P. Glick, J. Hoffman, D. Inkley, A. Kane, M. Murray and K. Reeve. 2014. Restoring the Great Lakes' Coastal Future - Technical Guidance for the Design and Implementation of Climate-Smart Restoration Projects with Seven Case Studies. National Wildlife Federation, Reston, VA and National Oceanic and Atmospheric Administration, Silver Spring, MD, available from http://www.nwf.org/What-We-Do/Energy-and-Climate/Climate-Smart-Conservation/Adaptation-on-the-Ground/Great-Lakes-Projects.aspx.
Summary: As part of a broader project funded by National Oceanic and Atmospheric Administration and the Kresge Foundation to advise on adaptation restoration, NWF was involved in advising restoration efforts in the lower Black River draining to the

central basin of Lake Erie in Ohio. The area saw significant impacts from industrial development, and design addressed several issues, including slag debris removal, streambank stabilization and revegetation, and other habitat restoration. A vulnerability assessment identified several modifications to pursue in the project, including regarding choices of tree species in planting efforts, prioritizing streambank revegetation to address projected variable streamflow conditions, and install variable height fish habitat shelves to better accommodate both low and high river flows.
Relevance to Criteria or Best Practices: The case study entailed work with a number of partners, and is particular relevant to the best practice concerning climate change vulnerability assessments.

Title: Climate-Smart Restoration of Little Rapids
Full Citation: Haven, C. 2013. Climate-Smart Restoration of Little Rapids. National Wildlife Federation, Ann Arbor, MI. Also see summary in Koslow, M., J. Berrio, P. Glick, J. Hoffman, D. Inkley, A. Kane, M. Murray and K. Reeve. 2014. Restoring the Great Lakes' Coastal Future - Technical Guidance for the Design and Implementation of Climate-Smart Restoration Projects with Seven Case Studies. National Wildlife Federation, Reston, VA and National Oceanic and Atmospheric Administration, Silver Spring, MD, available from http://www.nwf.org/What-We-Do/Energy-and-Climate/Climate-Smart-Conservation/Adaptation-on-the-Ground/Great-Lakes-Projects.aspx.
Summary: In another NOAA-funded project, Eastern U.P. Regional Planning & Development Commission led a grant to restore habitat in the Little Rapids area of the St. Mary's River Area of Concern (near Sault Ste. Marie, MI), with NWF advising on climate adaptation. The project entailed hydraulic flow modeling to assess the potential impacts of restoration of 70 acres of habitat and associated ecosystem processes. Potential climate change impacts considered included ensuring consideration of potential regional precipitation changes in modeling, and considering ice formation and other impacts of removal of a causeway in the channel.
Relevance to Criteria or Best Practices: The case study is relevant to several project level criteria, as well as several best practices, including on vulnerability assessments and considering multiple climate scenarios.

Title: Climate-Smart Restoration of the Maumee Area of Concern
Full Citation: Koslow, M. 2013. Climate-Smart Restoration of the Maumee Area of Concern, National Wildlife Federation, Ann Arbor, MI. Also see summary in Koslow, M., J. Berrio, P. Glick, J. Hoffman, D. Inkley, A. Kane, M. Murray and K. Reeve. 2014. Restoring the Great Lakes' Coastal Future - Technical Guidance for the Design and Implementation of Climate-Smart Restoration Projects with Seven Case Studies. National Wildlife Federation, Reston, VA and National Oceanic and Atmospheric Administration, Silver Spring, MD, available from http://www.nwf.org/What-We-

Do/Energy-and-Climate/Climate-Smart-Conservation/Adaptation-on-the-Ground/Great-Lakes-Projects.aspx.
Summary: As part of the same broader NOAA- and Kresge Foundation-funded project, NWF was involved in this ongoing project with an emphasis on wetlands restoration in the Maumee Area of Concern (AOC) in western Lake Erie. The overall project goal was to restore 600 acres of coastal wetlands in four tracts, with separate goals and approaches for each of the sites. NWF involvement included general literature review, working with project partners (including the Nature Conservancy, U.S. Fish and Wildlife Service, and others) to identify key climate drivers in the area, and carrying out a screening level vulnerability assessment. Outcomes of the effort included recommendations on approaches specific to individual restoration sites related to reforestation, fish passage, and wetland restoration.
Relevance to Criteria or Best Practices: The report has relevance to several project criteria as well as informing the selection of the best practices involving partnering with experts on climate change adaptation, conducting climate change vulnerability assessments, and monitoring to establish baseline conditions.

Title: Coastal Change Analysis Program
Full Citation: National Oceanic and Atmospheric Administration, Coastal Change Analysis Program, available from http://coast.noaa.gov/digitalcoast/data/ccapregional; H. Stirratt (NOAA), personal communication.
Summary: NOAA's Coastal Change Analysis Program (C-CAP) has developed a nationally standardized database of land cover and change information for U.S. coastal regions. The land cover maps (including intertidal areas, wetlands, and adjacent uplands) are updated every five years, allowing an assessment of locations and extent of changes occurring with time. The tool has been used to assess changes at Oconto Marsh on lower Green Bay (WI). The program showed that as water levels decreased, new wetlands developed. A related tool, Coastal County Snapshots, is also useful in highlighting and tracking wetland changes with time. Both tools can potentially be useful in the context of wetland mitigation (including in scenarios with wetland loss and gain in the same general region following water level changes.)
Relevance to Criteria or Best Practices: This program is relevant to several project level criteria, and also formed the basis for the best practice on using land cover/land use data to inform wetland planning and management at various jurisdictional levels.

Title: Edgewater Beach Overlay District, St. Joseph, Michigan
Full Citation: Edgewater Beach Overlay District, City of St. Joseph, Michigan, Zoning Ordinance, Section 9.7, available from http://www.sjcity.com/images/departments/planning_zoning/pdfs/Zoning_ordinance_amended_041414_eff_042414.pdf.
Summary: The ordinance, adopted in 2012, had the intent to "preserve the character of the public trust land" along the Lake Michigan shoreline, in particular in light of changing conditions. As noted in the ordinance, periods of low water levels can lead

to sand accretion, and the enlarged beach can be a target for development by local property owners. In contrast, periods of high water levels lead to submergence and erosion, and existing state and federal development standards do not ensure that damages to land during these periods will not occur. In addition, a natural reaction of property owners in such situations often being construction of a seawall, and these types of shore protection structures pose their own problems for public trust and other lands. In response to these types of problems, the ordinance prohibits construction shoreward of a fixed demarcation north of the St. Joseph River, highlighting the benefits that will accrue in both low and high-water situations.
Relevance to Criteria or Best Practices: Though the ordinance does not explicitly reference climate change, key impetus for it is clearly relevant to climate change (and the potential for changes in water level regimes, including extremes), and the ordinance is relevant implicitly to several criteria, and offers lessons for best practices related to zoning decisions in light of climate change (in particular concerning variable water levels).

Title: Flood Protection and Ecosystem Services in the Chehalis River Basin
Full Citation: Batker, D., Kocian M., Lovell, B, & Harrison-Cox, J. 2010. Flood Protection and Ecosystem Services in the Chehalis River Basin, Earth Economics, available from http://www.eartheconomics.org/FileLibrary/file/Reports/Chehalis/Earth_Economics_Report_on_the_Chehalis_River_Basin_compressed.pdf.
Summary: The report was developed to inform decisions on flood policy in the Chehalis River Basin in southwestern Washington, following severe flooding and establishment of the Chehalis River Basin Flood Authority. The study noted climate change projections for the region, noting predicted increases in total precipitation would mostly be in winter months, with the potential for increasing water supply concerns in summer months. The study had an emphasis on quantifying ecosystem services in the river basin, identified the many functions and values provided by wetlands (including regarding water supply), and identified freshwater wetlands as providing the greatest monetary value in the river basin.
Relevance to Criteria or Best Practices: The report is relevant to best practices related to quantifying ecosystem services in support of wetland protection and restoration, as well as potentially the consideration of climate change in wetland and shoreline restoration measures.

Title: Great Lakes Coastal Wetland Communities: Vulnerabilities to Climate Change and Adaptation Strategies
Full Citation: Mortsch, L., J. Ingram, A. Hebb, and S. Doka (eds.). 2006. Great Lakes Coastal Wetland Communities: Vulnerability to Climate Change and Response to Adaptation Strategies. Final report submitted to the Climate Change Impacts and Adaptation Program,
Natural Resources Canada. Environment Canada and the Department of Fisheries and Oceans, Toronto, Ontario. 251 pp. + appendices, available from

http://www.env.uwaterloo.ca/research/aird/aird_pub/Great_Lakes_Coastal_Wetlands_Report_2006.pdf.
Summary: Coastal wetlands in the Great Lakes region will be impacted by climate change. Namely, changes in water level could have dire consequences for existing wetlands and dependent bird and fish communities. This project entailed a review of potential impacts of climate change to Great Lakes coastal wetlands, assessed vulnerabilities, and identified evaluated adaptation options. Their approach included utilizing GIS to analyze shoreline vulnerabilities, develop and apply bird and fish habitat suitability models to projected climate change scenarios, and evaluate feasibility and effectiveness of adaptation strategies.
Relevance to Criteria or Best Practices: The approach is relevant to several criteria and best practices, including on data acquisition, modeling, and vulnerability assessments.

Title: Great Lakes Dashboard Project; Lake Level Viewer: United State Great Lakes
Full Citation: National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineers, Great Lakes Environmental Research Laboratory, Great Lakes Commission, Cooperative Institute for Limnology and Ecological Research, Great Lakes Restoration Initiative, Great Lakes Dashboard Project. Available from http://www.glerl.noaa.gov/data/dashboard/portal.html; National Oceanic and Atmospheric Administration, Digital Coast, Office for Coastal Management (and other collaborators), Lake Level Viewer: United State Great Lakes. Available from http://coast.noaa.gov/digitalcoast/tools/llv.
Summary: National Oceanic and Atmospheric Administration and other partners have been involved in development of tools relevant to coastal wetlands. The Great Lakes Dashboard Project provides graphical display of a number of physical parameters, including water levels (monthly, annual, and period of record averages), wind speed, air and water temperature, ice cover, and other parameters, and output format is customizable (e.g. time scales, vertical axes). The Lake Level Viewer Great Lakes module was recently released, and allows for visualizing changes in lake levels in the lakes (up to six feet below and above historical long-term averages), as well as coastal and shoreline impacts. The tool provides images of each Great Lake, showing areal change in shoreline with user-selected changes in water levels, and also allows examining potential impacts via photographic images at specific locations around the Basin. Other tools are also linked from Lake Level Viewer. Given the importance of lake levels in wetland extent and condition, these tools and others can assist in adaptation planning, in examining impacts of historical changes and potential future changes with climate change.
Relevance to Criteria or Best Practices: These tools are relevant to several criteria and informed the best practice on coastal wetland monitoring.

Title: Lake Superior National Estuarine Research Reserve

Full Citation: National Oceanic and Atmospheric Administration, Lake Superior National Estuarine Research Reserve, available from http://lsnerr.uwex.edu/; B. Schleck (NOAA), personal communication.
Summary: As part of planning efforts at the Lake Superior National Estuarine Research Reserve, near Superior, WI, significant stakeholder work has been carried out. This included outreach with three different focus groups in support of Sentinel Site development at the NERR. Outreach by NOAA staff targeted a diverse audience, including other federal agencies, state and tribal agencies, academic researchers, and others to characterize ongoing monitoring of vegetation and climate parameters in the region, as well as to determine the extent of stakeholder needs in these and related areas.
Relevance to Criteria or Best Practices: The effort is relevant to several project criteria, and also informed the best practice on engaging multiple stakeholders and interest groups.

Title: Metro Beach Metropark and St. John's Marsh
Full Citation: Michigan Sea Grant, 2011. Metro Beach Metropark and St. John's Marsh, available from http://www.miseagrant.umich.edu/explore/restoration/marsh-restoration-project/; L. Vaccaro (MI Sea Grant), personal communication.
Summary: A cooperative effort of Michigan Sea Grant, Michigan Department of Natural Resources, Ducks Unlimited and other partners has been involved in a project to restore coastal marshes in the St. Clair watershed, with an emphasis on this case in controlling invasive *Phragmites*. The invasive plant with the potential to outcompete most other marsh plants is threatening marsh biodiversity in much of Michigan and throughout the region, impairing wildlife habitat, views, and recreational access. Treatment in this case has included herbicide application and controlled burns. Though not explicitly an adaptation measure, controlling *Phragmites* and improving wetland plant biodiversity can contribute to increased resiliency to climate change, and climate change considerations can help inform selection of areas to prioritize for *Phragmites* control.
Relevance to Criteria or Best Practices: The case study is relevant to the first project level criteria, and also the best practice consideration of climate in wetland and shoreline restoration.

Title: Municipal Adaptation & Resiliency Service (MARS)
Full Citation: Great Lakes and St. Lawrence Cities Initiative, Great Lakes & St. Lawrence Cities Initiative Municipal Adaptation & Resiliency Service (MARS), available from https://www.ccadaptation.ca/en/mars.
Summary: The Municipal Adaptation & Resiliency Service (MARS) was created by the Great Lakes & St. Lawrence Cities Initiative, the Ontario Centre for Climate Impacts and Adaptation Resources, and the Climate Action Partnership, with the goal of increasing climate change adaptation and resiliency in the over 100 cities represented in the Cities Initiative. The MARS service includes a "Call to Action" pledge (on adaptation commitments), the provision of adaptation training Webinars, and a

community of practice portal with a number of resources, including reports, case studies, fact sheets, and tools to assist in adaptation project implementation.
Relevance to Criteria or Best Practices: The resource is directly tied to the institutional criterion on collecting information, and informed several best practices, including on continuing education and processes for information access.

Title: New York City Wetlands Strategy
Full Citation: Mayor's Office of Long-Term Planning & Sustainability, 2012. New York City Wetlands Strategy, available from http://www.nyc.gov/html/planyc2030/downloads/pdf/nyc_wetlands_strategy.pdf.
Summary: Like many other parts of the country, the New York City region has seen significant wetlands losses, with over 85% of coastal wetlands and 90% of freshwater wetlands lost through development and other activities. The city Wetlands Strategy was developed to address these losses and ongoing pressures on wetlands, and address issues such as regulatory gaps, information limitations, funding limitations, and threats from climate change. The Strategy proposed work in four areas – protection, mitigation, restoration, and assessment. Individual initiatives were identified in each area, and climate change would be considered across a number of initiatives, including in monitoring and assessing potential impacts of sea level rise, ensuring climate change is considered in further research on wetlands in the area, and incorporating understanding of climate change impacts into local education programs.
Relevance to Criteria or Best Practices: The Strategy has relevance to institutional criteria (in particular related to decisionmaking), and offers lessons concerning regulatory best practices (e.g., compliance/permitting), including in implementation of the Waterfront Revitalization Program (in lieu of any local wetland statutes or regulations).

Title: Pristine Lands Protected at Bete Grise Preserve.
Full Citation: Michigan Office of the Great Lakes, Coastal Zone Management Program, Pristine Lands Protected at Bete Grise Preserve, available from www.michigan.gov/deq/0,4561,7-135-3313_3677_3696-311958--,00.html.
Summary: A multi-phase land purchase project was undertaken to protect wetlands at Bete Grise in Keweenaw County along Lake Superior in Michigan's Upper Peninsula. Funding provided through the Great Lakes Restoration Initiative, the NOAA Coastal and Estuarine Land Conservation Program, and other partners enabled the Houghton-Keweenaw Conservation District to purchase over 1,000 acres of land in 2012-13 adjacent to the existing preserve. Though not explicitly an adaptation effort, partners recognized the increased protected areas should provide benefits in the context of a changing climate (and potential wetland movement).
Relevance to Criteria or Best Practices: This effort is directly related to best practice involving consideration of climate in land protection decisions.

Title: Criteria for Evaluation of Wetland Permits
Full Citation: Michigan Natural Resources and Environmental Protection Act (Act 451) of 1994, Section 30311, as amended.. Available from www.legislature.mi.gov/doc.aspx?mcl-Act-451-of-1994
Summary: This section of Michigan law describes requirements for issuance of a permit under state and federal law. Some provisions that have been needed to protect wetlands from historic or ongoing threats can in some cases hinder restoration efforts, if the broader habitat restoration and enhancement goals are not considered. Additionally, it is important that climate change be considered in permit applications, including to ensure that projects are designed to enhance wetland adaptation.
Relevance to Criteria or Best Practices: These issues are related in particular to several institutional level criteria (including on changes needed to regulations) as well as the wetland permitting best practice.

Title: Rein in the Runoff: Michigan's Spring Lake Stormwater Management Project
Organization: **Publishing Date**: 2013
Citation: Feifel, K. M. 2012. Rein in the Runoff: Michigan's Spring Lake Stormwater Management Project [Case study on a project of Michigan Sea Grant], available from http://www.cakex.org/case-studies/rein-runoff-michigans-spring-lake-stormwater-management-project.
Summary: Over the past few decades, stormwater has increased pollutant loads in Spring Lake, Michigan. In 2007, a collaborative team of researchers began working with the community of Spring Lake to develop an integrated assessment of Best Management Practices (BMPs) to reduce local stormwater impacts. The integrated assessment process involved a detailed assessment of natural, economic, and social issues, future population growth scenarios, and an analysis of potential BMPs. The final report, Rein in the Runoff, was released in 2009 and decision-makers are using it to help guide the development and implementation of local ordinances and structural improvements to reduce stormwater impacts. The current and future state of the Spring Lake watershed was assessed using the following research tools:

- a regional wetlands and shoreline assessment,
- a systematic comparison of potential stormwater solutions (both structural and nonstructural-ordinance based BMPs),
- economic analyses of different BMP alternatives, and
- forecasts of future land use and land cover change related to population growth.

Relevance to Criteria or Best Practices: This project was relevant to several criteria, and though the effort did not have an emphasis on climate change, the scenario planning concerning land use/land cover changes could be expanded to consider impacts of different climate change scenarios.

Title: Soft Shoreline Engineering in the Detroit River and Western Lake Erie

Full Citation: University of Windsor, Soft Shoreline Engineering, available from http://web4.uwindsor.ca/units/stateofthestraight/softs.nsf/inToc/D27D2ED7AB6CBCE48525775F00726983?OpenDocument.
Summary: The Huron-Erie Corridor, including the Detroit River, has witnessed some of the greatest shoreline alterations (in particular hardening) in all the Great Lakes. Through a project involving researchers at the University of Windsor, a number of soft shoreline engineering case studies in the region were compiled. The projects, most located along the Detroit River, included a range of technologies to achieve varying degrees of shoreline softening, including use of flexible plastic revetments; dam removal and standard stream restoration; replacement of concrete shore protection structure with diversity of stone types; and removal of invasive Phragmites and native planting.
Relevance to Criteria or Best Practices: The case studies are relevant to several best practices related to mitigation and restoration, including climate considerations in wetland and shoreline restoration.

Title: South Bay Salt Pond Restoration Project, Adaptive Management Plan
Full Citation: Trulio, L., D. Clark, S. Ritchie, A. Hutzel, and the Science Team, 2007. Science Team Report for the South Bay Salt Pond Restoration Project, Adaptive Management Plan, Final Environmental Impact Statement/Report, Appendix D, available from http://www.southbayrestoration.org/pdf_files/SBSP_EIR_Final/Appendix%20D%20Final%20AMP.pdf. Also, summarized in Kershner, J. 2010. South Bay Salt Pond Restoration Project, case study, available from http://www.cakex.org/case-studies/south-bay-salt-pond-restoration-project.
Summary: The South Bay Salt Pond (SBSP) Restoration Project has been identified as the largest tidal restoration project on the West Coast, with a goal of transforming 15,100 acres of former leveed salt ponds to tidal wetlands and managed pond habitats. In addition, it is anticipated that the restored tidal wetland system will provide a natural buffer against sea level rise, coastal flooding, and erosion, all with potential to increase with climate change. The project included earlier development of an Adaptive Management Plan, with an emphasis on learning from restoration and management actions, and the plan itself being adaptive, with key uncertainties, applies studies, and institutional structure potentially changing over time. Given the numerous uncertainties, managers determined that project activities would be implemented in phases, utilizing adaptive management to determine the extent to which the system can move toward full tidal action (and associated habitats).
Relevance to Criteria or Best Practices: This project is relevant to a number of project level criteria, and in its approach, can offer suggestions relevant to several institutional best practices.

Title: State Hazard Mitigation Plans & Climate Change: Rating the States
Full Citation: Babcock, M., 2013. State Hazard Mitigation Plans & Climate Change: Rating the States. Available from

http://web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Publications/Students/SHMP%20Survey_Final.pdf
Summary: Federal law requires that states can only receive disaster mitigation funding from the federal government if they have an approved hazard mitigation plan in place, though there are no requirements that such plans include discussion of potential climate change implications for natural hazards. A survey was conducted to assess the extents to which state hazard mitigation plans address climate change. The analysis grouped states in four categories, ranging from 1 (no or inaccurate discussion of climate change) to 4 (thorough discussion of potential impacts on hazards and adaptation options). The survey found that coastal states in general were more likely to address climate change. Michigan ranked in group 3, with limited discussion of climate change, but emphasis on the need to more systematically consider it in future plans. The report also noted that lessons from states with some type of consideration of climate change in their plans could potentially be applied to other states.
Relevance to Criteria or Best Practices: This document informed the best practice on including analysis of climate change in state hazard mitigation plans.

Title: Terrestrial Carbon Sequestration Monitoring Networks and Demonstration Sites
Full Citation: Nater, E.A., C. Miller, 2008. Terrestrial Carbon Sequestration Monitoring Networks and Demonstration Sites, Report to the Minnesota Department of Natural Resources. Available from http://files.dnr.state.mn.us/aboutdnr/reports/legislative/terrestrial_carbon.pdf.
Summary: The report summarizes findings on a study carried out by University of Minnesota researchers upon request by the Minnesota State Legislature on the potential of terrestrial carbon sequestration in the state. The request included identification of a network of monitoring sites to measure the large-scale, long-term potential capacity of carbon sequestration of various land types, as well as identify potential demonstration projects to measure the impact of deliberate sequestration practices. Though not focused on wetlands, two of the proposed demonstration project sites included wetland complexes, with proposals to quantify carbon stock changes of conversion from agriculture back to wetlands. The project did not appear to have an emphasis on coastal wetlands, though some lessons learned would presumably be transferable to coastal wetland ecosystems. In addition, if any carbon credit system were developed, carbon sequestration achieved via wetland restoration would presumably be part of such a system.
Relevance to Criteria or Best Practices: The concept is directly related to a potential best practice including consideration of carbon sequestration potential of wetlands restoration projects (as an additional ecosystem service provided by restoration).

Title: Updating the Illinois Wildlife Action Plan: Using a Climate Change Vulnerability Assessment to Inform Conservation Priorities

Full Citation: Kahl, K., Hall, K., Walk, J., Hagen, S., Lange, A., & Doran, P. (2011). Updating the Illinois Wildlife Action Plan: Using a Climate Change Vulnerability Assessment to Inform Conservation Priorities. [Case study on a project of The Nature Conservancy, Ed. Rachel M. Gregg], available from http://www.cakex.org/case-studies/5241.
Summary: The Nature Conservancy's vision of "climate-smart" conservation seeks to anticipate human responses to climate change, and considers the benefits to people that result from our actions to protect and restore nature. One key area for engagement and partnership has been work on state Wildlife Action Plans. This case study describes a vulnerability assessment of 163 species comprising eight taxonomic groups from Illinois' list of "Species in Greatest Need of Conservation" designated in the state's Wildlife Action Plan. High priority action items include: 1) As a strategy for reducing sediment and nutrient loads in waters draining from agricultural and developed areas, engineering standards for constructed wetlands need to be revised to account for more frequent high-precipitation events to avoid failure; 2) Chicago Wilderness' vulnerability assessments, already underway, will help prioritize species and habitat within their regional long term conservation strategies; and 3) Locations for endangered species reintroductions are being reconsidered based on the potential for long-term viability and stewardship, rather than only locations of historical occurrence.
Relevance to Criteria or Best Practices: This plan is relevant to several best practices, in particular climate vulnerability assessments.

Title: Visualizing Coastal Flooding and Lake Level Changes
Full Citation: Stone, J.D., Johnson, S. 2012. Visualizing Coastal Flooding and Lake Level Changes, available from http://greatlakesresilience.org/case-studies/land-use-zoning/visualizing-coastal-flooding-and-lake-level-changes; H. Stirratt (NOAA), personal communication.
Summary: Storm surges and coastal flooding can be issues in the Great Lakes, as was witnessed in Green Bay, WI on several occasions, both during high and low water levels.To help understand and prepare for such events, the NOAA visualization tool CanVis was used in a case study involving Brown County and the City of Green Bay. The tool includes descriptions of the short-term (e.g. wind-driven waves) and long-term factors (e.g. precipitation, ice cover) affecting water levels, and allows users to see potential impacts of different development and water level scenarios. The effort in Brown County and Green Bay is part of a larger effort involving development of an interactive mapping tool to assist public officials and private individuals in understanding coastal flooding hazards and consider management options.
Relevance to Criteria or Best Practices: The case study is relevant to several criteria and best practices, including on vulnerability analysis, land protection decisions, and considering multiple climate scenarios.

Title: Wetland Mitigation Banking

Full Citation: Michigan Department of Environmental Quality, Wetland Mitigation Banking, available from http://www.michigan.gov/deq/0,4561,7-135-3313_3687-10426--,00.html.

Summary: Wetland mitigation is required for many wetland permits issued under state or federal law, with a goal of replacing wetland functions lost as a result of some permitted activity. Wetland mitigation banking provides a mechanism for creating new wetland areas ("banks"), and the resulting "credits" can be sold to permit applicants or used by the bank sponsor to meet wetland permit conditions. In the context of climate change, mitigation banking has the potential to offer some benefits, through for example, by considering the broader area consisting of a number of smaller projects, and integrating mitigation projects with watershed based resource planning.

Relevance to Criteria or Best Practices: The program is potentially relevant to the best practice involving use of purchases and conservation easements in wetland protection and restoration.

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