Maximizing Wetland Restoration Outcomes **for a Changing Climate**

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Wetlands are water resources, and as such are at the heart of many climate-related concerns. The fact that wetlands are by definition an interface between one aquatic system and another, between land and water, often between surface and ground water, and even – in the case of storm systems – between air and land means that wetlands often have a place in the front line of both adaptation and mitigation actions even while wetland ecosystems are themselves under threat (Figure 1). For example, many coastal wetlands are being impacted by sea level rise, but they also have the ability to buffer coastal communities against severe storm events. We know that wetland ecosystems can be severely impacted or even destroyed by drought, but they also provide water storage and often groundwater recharge capacity, contributing to drought management efforts. Wetlands are negatively impacted by increases in contaminated stormwater runoff resulting from intense rainfall patterns, but they can also provide flood storage and filter some pollutants before they reach other waters. Wetland habitats can also be altered by hydrologic changes, and by shifting plant and animal populations following temperature alterations, but at the same time, they can provide migration pathways and refuge for species. And wetlands sequester significant amounts of carbon compared to other ecosystems – estimated at 12 percent of the global carbon pool – and if left undisturbed should continue to do so (Erwin 2009).

Figure 1: Water lilies are a popular wetland plant – they are rooted in soil at the bottom of bodies of water. Photo credit: Jeanne Christie, ASWM.

Sorting out the multiple roles of wetlands in response to climate change – which is likely to suggest increased wetland protection in some instances and more intensive restoration and management in others – will require a clear understanding of the pros and cons of various approaches. The "correct" action will not always be the same everywhere – there is no one-size-fits-all solution. Many, if not most, decisions regarding wetland management will depend on local climate impacts as well as other individual considerations such as regional land use patterns, extent of development, and available adaptation alternatives.

Wetland restoration as a strategy to prepare for and mitigate the impacts of climate change is being employed broadly by nonprofits and government agencies. However, several studies have raised concerns about the ability of restored wetlands to provide the same services of those that were lost. Wetland restoration projects fail to perform as planned for many reasons, including but not limited to: poorly articulated performance criteria (often called "success criteria"), inadequate designs, inadequate collection of baseline conditions, unsuitable site selection, incorrect wetland type selected, inadequate site supervision during construction, inability to adapt wetland restoration plans to new information found during construction, and lack of follow up maintenance, adaptation, and long-term management (Figure 2). Many of these issues have been documented for many years yet they are repeated time and again. An examination of the underlying causes for wetland restoration failure described over 25 years ago in *Wetland Restoration and Creation: Status of the Science* (Kusler and Kentula 1989) includes many of these same issues.

At the same time, there has been progress. Scientific understanding of how wetland ecosystems work has broadened, and monitoring of wetland health has grown into a large body of methods and techniques. Both natural and restored wetlands have been monitored and data about them reported. As a result, there is consensus among many scientists and experienced practitioners that the knowledge base exists to achieve a much higher level of performance across many wetland types. Thus, many of the problems identified can be resolved. In light of the fact that wetland restoration is undertaken by many different types of groups (i.e., agencies, non-profits, private landowners, etc.) and due to the immense diversity of wetland types and restoration goals that drive restoration projects, a "cookbook approach" to wetland restoration is not feasible. Wetlands are complex and dynamic ecosystems, and there are many different wetland types that provide different functions at different levels in different conditions (Figure 3). However, while wetlands exhibit differences based on variables such as hydrogeomorphic (HGM) classification, the region of the U.S in which it located, vegetation classes, or numerous other characteristics, there are features common to all wetlands that should be considered when attempting to restore wetlands.

For the past two years, the Association of State Wetland Managers (ASWM) has been researching the reasons for wetland restoration failure and identifying ways to improve restoration outcomes. With the assistance of a twenty-five member expert work group, ASWM has been offering monthly webinars on how to improve wetland restoration practice and has been developing a white paper to summarize our findings. Below you will find some highlights from the draft white paper that take on particular significance when planning for climate change.

Provide a scientifically objective way to define wetland goals

To measure the ecological progress of a wetland restoration project, specific performance criteria must first be identified. The word "success" is often used subjectively to describe wetland restoration project outcomes and it can be interpreted differently depending on the criteria that different agencies or professionals may use to define "success". All too frequently, quantifiable goals are not identified and/or implemented (Figure 4).

Often mistakes occur at the very beginning as a result of unclear project goals. Vague project goals can lead to inadequate compilation of baseline information that can in turn lead to failure to correctly set hydrology objectives. Inadequate characterization of water quality inputs and existing soil conditions can also lead to design mistakes. Too many projects are judged relying largely on desired plant coverage without looking

Figure 2: Many culverts across the U.S. are poorly maintained and are undersized to manage increasing precipitation volumes, resulting in downcutting and erosion. Photo credit: Jeanne Christie, ASWM.

Figure 3: Mitigation sites that are next to infrastructure such as power lines and roads have unique challenges to overcome and provide unique ecosystem services due to their location. This is an example of one that has met and/or exceeded its performance criteria in Westbrook, Maine. Photo credit: Lisa Cowan, PLA, Studio Verde.

closely enough to determine if the hydrology and soil health are adequate to support the restoration site over a long time frame.

While the number of potential functions and services provided by wetlands is very broad, they can be combined to fall under a small number of categories. This short list can be categorized into the following: hydrologic, soil bio-geochemical, habitat, and landscape. The functions that any wetland restoration provides should be appropriate to the wetland goal(s). A clear statement of known and/or expected functions will lead to a solid set of project goals and objectives. Furthermore, most wetland functions can and should be defined in a watershed context. Wetlands are widely recognized as providing local benefits, but rarely are the benefits of wetland projects presented in terms of clear goals and expected outcomes linking wetlands in a specific watershed position.

Create realistic, adaptive, and quantifiable performance criteria

Existing program regulations and guidelines generally restrict monitoring times to assess wetland restoration "success" to three to five years. For the vast majority of restoration sites, this timeframe is inadequate, particularly for wetland types that develop over a much longer period of time, such forested wetlands, bogs, and fens. In practice, wetland restoration projects can have a finite endpoint, but ecosystem development does not. Project proponents may need a judgment of "in compliance" in order to terminate work, and most will want a judgment of "success" to showcase their projects. Compliance can be judged objectively if there are both clear goals for performance and performance criteria for the level of performance anticipated at the end of the monitoring period. It is important to establish monitoring criteria most likely to indicate whether or not a wetland is on a trajectory for meeting the project goals (Figure 5).

Climate change concerns are leading many efforts to focus wetland restoration designs to meet program goals such as flood-peak attenuation or nonpoint source runoff reduction. Whatever the purpose of the wetland restoration project is, applicable quantifiable performance criteria should be incorporated and monitored over time to determine if it has been met. If not, then adaptive management to address problems should occur.

Figure 4: The word "success" is highly subjective. Joy Zedler, PhD, "Success" quotes from How Restoration Outcomes are Described, Judged and Explained, *September, 2015.*

Figure 5: Monitoring and reporting of performance data is critical to improve outcomes. Monitoring Field Trip on Lake Michigan, Traverse City Michigan during Michigan Wetland Conference 2011. Photo credit: Jeanne Christie, ASWM.

Engage multidisciplinary, integrated teams

It is unrealistic to expect one individual to possess all the various types of expertise needed to carry out wetland restoration projects. In particular, large and/or complex projects require interdisciplinary teams (Figure 6). The absence of one or more types of expertise, (e.g., knowledge about hydric soils or technical understanding of the design, bid, and construction process) can result in a poor design and implementation. Consistent, interdisciplinary coordination, communication, and leadership between many disciplines such as wetland scientists, engineers, soil scientists, hydrologists, ecological landscape architects, and other practitioners throughout the project is needed.

Identify realistic restoration costs and benefits

Restoration costs are frequently underestimated, particularly those costs associated with evaluating baseline conditions, post-implementation monitoring, and long-term management. There is often pressure to further reduce anticipated costs to save money to expedite the release of credits (in the case of mitigation) or because funding resources may be limited (in the case of a voluntary restoration project). There is also very little information available to compare restoration costs from site to site or by wetland type so that reasonable cost estimates may be developed. The lack of accurate budgeting has led to many projects being underfunded and unable to achieve the desired outcomes.

Furthermore, the overall economic benefits of wetland restoration are often either undervalued or not even considered even though they are frequently greater than the cost of the restoration itself. This is primarily because many wetland benefits are difficult to derive a monetary value for and are non-exclusive so there may often be no direct economic benefit to the agency or organization that is paying for the restoration. Rather, the benefits are spread more broadly and are considered a "public good" (e.g., habitat conservation, flood water attenuation, clean water, intrinsic value, etc.) (Figure 7). Developing a comprehensive cost-benefit analysis (particularly for

Figure 6: An interdisciplinary team with diverse expertise and consistent leadership is important for wetland restoration projects. Vernal Pool Creation Project, Wetland Restoration Training, Cape Cod, Massachusetts, May 2013. Photo credit: Jeanne Christie, ASWM.

Figure 7: This tidal wetland provides many ecosystem services such as wildlife habitat, storm surge protection, flood protection, shoreline erosion control, water quality improvement, and recreation. Plum Island, Parker River National Wildlife Refuge, Massachusetts. Photo credit: Jeanne Christie, ASWM.

larger projects) is an important task to accomplish at the beginning and provides an opportunity for those involved to do scenario modeling and analyze economic and ecological trade-offs for various project goals.

Select an appropriate site for the wetland type

Landscapes are dynamic – they have been manipulated and altered by both people and nature throughout human history. Restoration projects that do not anticipate predictable and/or potentially substantial changes in the surrounding landscape are at risk (e.g., demographic changes may create more or less impervious surfaces and/or increases in demand for resources may expand the amount of and type of agriculture or resource extraction activities next to or near the restoration site, etc.). And restoration projects that are sited on a location where a wetland never previously existed are significantly more prone to failure.

Lack of consideration of the historical, current, and projected future context of the proposed restoration site constrains restoration. For example, thousands of miles of drainage tiles are installed beneath the ground across much of the United States. Often wetland restoration designs incorporate water budgets that assess water coming onto a site but lack a thorough understanding of the pathway and volume of the water moving off the site. In order to restore a site's hydrology, it is important for a restoration plan to account for the site's hydrologic budget including the sources and type of water entering a site (surface water? groundwater? both?), how it is retained onsite (for example is there a clay lens that would effectively drain a historic wetland if it were punched through during construction), and how it will exit the site (surface runoff? groundwater? drainage tile?). Similarly soils (on and beneath the surface) need to be analyzed onsite to avoid relying solely on a desktop determination of whether hydric soils are present (Figure 8). While GIS mapping may indicate that hydric soils exist, they may or may not be present at a specific location. In addition they may be compacted, depleted, or contaminated due to extensive farming or other intensive or industrial land uses.

Figure 8: It is important to restore your site's hydrology and soil condition in order to sustain plantings and functions. Vernal Pool Creation, Wetland Restoration Training, Cedar Niles Johnson County Park and Recreation lands, Olathe, Kansas, May 2015. Photo credit: Jeanne Christie ASWM.

Next steps

With shifts in climate patterns already upon us and expanding changes projected for the future, climate change has become an overarching consideration in many aspects of resource management. Wetlands restoration and protection is at the heart of many climate change adaptation and mitigation plans. It is also clear that the scope of climate change is far too great to be addressed by any one entity; rather, we must find ways to integrate our efforts and collectively tailor our work to minimize the causes of and adapt to the consequences of climate alteration. The first half of ASWM's white paper defines the barriers to achieving the goals of wetland restoration and the second half roughly outlines what can be done to overcome many of the identified barriers. Throughout the next year, ASWM and its work group will continue to identify concrete actions that can be taken, as well as who and/or what organization(s) is best suited to implement those actions and how (Figure 9). Entities that have an interest in climate strategies may not be typical stakeholders in wetland policy decisions. They are likely to have diverse needs and goals which may create potential for conflict as decisions are made. Of course, these same diverse interest groups provide significant opportunities for collaboration and knowledge sharing. In many instances the question will not be either/or, but will be one of the extent of acceptable wetland use or alteration, or of managing wetland resources to meet multiple objectives.

Encouraging a positive, collaborative effort will require a thorough and informed analysis on the pros and cons of various adaptation approaches, understanding of the needs and concerns of the various stakeholders, and effective and purposeful communication.

References:

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Erwin, K.L. 2009. Wetlands and global climate change: the role of wetland

Figure 9: Forested wetland/beaver impoundment, Windham, Maine. Photo credit: Jeanne Christie ASWM.

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Kusler J. and M. Kentula (Eds.) 1989. Wetland Creation and Restoration Status of the Science, Volumes I & II, U.S. Environmental Protection Agency.

For more information

ASWM Wetland Restoration Webpages: http://www.aswm.org/wetland-science/wetland-restoration.

ASWM Wetlands & Climate Change Webpages: http://www.aswm.org/wetland-science/wetlands-and-climate-change.

ASWM Improving Wetland Restoration Success Project & Webinar Series: http://www.aswm.org/aswm/aswm-webinarscalls/6773-improving-wetland-restoration-success-project.

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