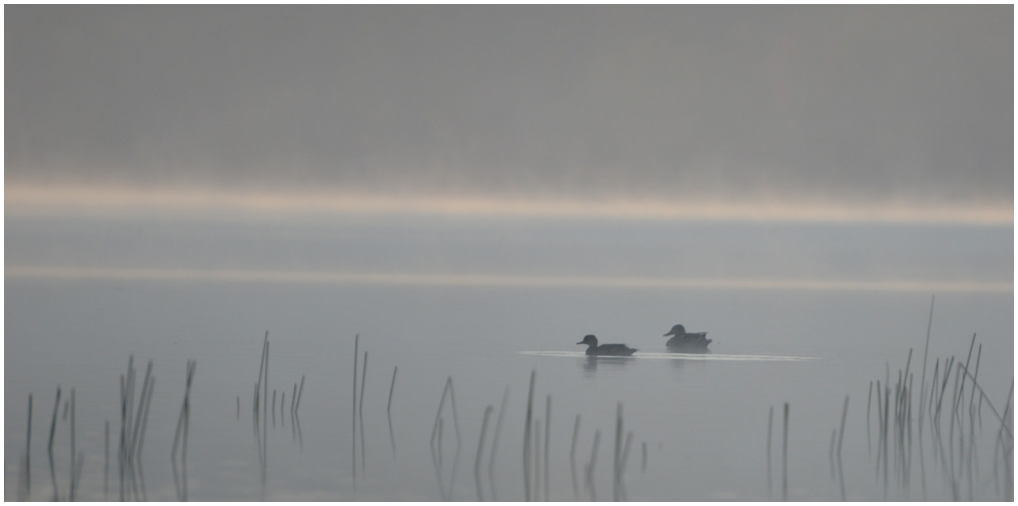
Climate Change Adaptation & Local Planning for Michigan's Coastal Wetland Resources

A White Paper Prepared for the Coastal Zone Management Program Michigan Department of Environmental Quality



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Final Project Report
September 2014

This project was funded, in part, by the Michigan Coastal Zone Management Program, Department of Environmental Quality Office of the Great Lakes, and the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

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As described in the illustrated booklet *Between Land and Lake: Michigan's Great Lakes Coastal Wetlands*, broad coastal marshes (lacustrine wetlands), barrier-protected wetlands and extensive river-mouth wetlands (riverine wetlands) were once common throughout the Great Lakes. Before the European settlement of Michigan, the region featured beds of wild rice within mile-wide swaths of bluejoint grasses and bulrushes teemed with diverse populations of wildlife and fish. But as Dennis Albert so eloquently describes, the coastal wetlands were dredged, filled and converted to other uses as Michigan developed into an industrial state. Rapidly, the seemingly limitless marshes and their connecting channels began to disappear, and today less than half of the state's coastal wetlands remain.[1]

Over the last 50 years or so, the value of services provided by wetlands has been well documented and widely recognized. In addition to critical fish and wildlife habitat, wetlands provide water quality protection and improvement, sediment and erosion control, and flood management — all extremely valuable ecosystem services. Both state and federal governments now protect wetlands - directly and indirectly - through regulation, acquisition, incentives and disincentives. Local governments, private developers and NGOs are fostering the creation and reestablishment of wetlands through voluntary restoration and mitigation programs.

This story of ruin to recovery for Michigan's wetlands is far from over. Though ongoing economic development and land-use pressures continue to threaten wetlands, an even bigger set of challenges lies ahead. Michigan's climate is changing. Increasing average temperatures, more frequent and more intense storms, seasonal changes in precipitation, and decreases in winter snow and ice are well-documented trends — trends that appear to be accelerating. Shifts in temperature and hydrologic regimes are expected to alter the character and ability to function of existing wetlands, but there is a great deal of uncertainty about the specifics. Climate change is arguably the most dramatic wetland management challenge industrialization began over 150 years ago.

Introduction – Project Description

The State of Michigan has a diverse array of coastal wetlands along the shoreline of the Great Lakes. Overall, there are approximately 5.5 million acres of wetlands in Michigan, which amounts to 15% of the total land area in the state.[2] These wetlands are highly productive and essential to the overall health of the surrounding ecosystems and human systems. Therefore, the Coastal Zone Management Program (CZMP) has worked to foster the continued protection and preservation of these critical natural resources.

CZMP's 2012 – 2016 Five-Year Strategy calls for research-based adaptation actions and strategies that can be incorporated into state and local resource management plans. Specifically, CZMP outlined a need for analysis of gaps in wetland adaptation literature, direction for training staff to integrate climate measures into wetland regulation processes, and guidance to develop technical assistance for incorporating climate change adaptation measures into local plans. The white paper *Climate Change Adaptation Plan for Coastal and Inland*

Wetlands in the State of Michigan by Jeanne Christie and Peg Bostwick[3] provided a response to the needs identified, delivering a summary review of the climate change literature and outlining potential impacts of climate change on Michigan's wetlands. The paper offers a series of broad recommendations for how wetlands can be managed to serve both climate change mitigation and adaptation.

LIAA began this project, *Climate Change Adaptation and Local Planning*, to help further address the CZMP's needs. The goal of the project is to reevaluate and assess options for helping Michigan's local governments to preserve and protect coastal wetlands. This project builds on the work of Christie and Bostwick, providing some updated information and a focused assessment of options for local governments to employ to improve wetland preservation and protection efforts in their communities.

As a nonprofit community service organization, LIAA has helped hundreds of cities, townships and villages in Michigan to build civic engagement and develop plans for a more sustainable and resilient communities. In addition to developing municipal plans and land-use regulations, LIAA's planning professionals and technical experts have helped communities design meaningful programs for the protection and preservation of critical cultural and natural resources.

LIAA collected information for the project from primary and secondary sources to obtain up-to-date information on climate change, characterize gaps in the research, and identify climate adaptation strategies for the protection and preservation of wetlands. LIAA completed a review of existing state and local plans that incorporate climate change adaptation strategies and an assessment of all known local wetland ordinances in Michigan. This information was combined with a series of expert interviews to obtain information, examples and opinions about the best options for action at the local level. Finally, we discussed our findings and suggested options for action with select groupings of experts (i.e., focused group discussions).

In general, we found that most identifiable options for wetland preservation and protection in the face of climate change are based on existing, well-known wetland *best management practices* (BMPs). While climate change does present a new set of threats to wetlands and exacerbates the ongoing pressures from local and regional land development, most of the management options are familiar. Ultimately, the majority of experts and research point to a common bottom line: The most effective plans require that we preserve existing wetland hydrology while assuring the connectivity of wetlands and our other natural resources. In fact, the restoration of wetlands and wetland buffers may be one of the most cost-effective techniques available to urban communities for managing the storms of climate change.

This report summarizes key findings taken from the published literature and gathered from Michigan's wetland experts and resource managers. We begin with an overview of recent climate change reports and projected impacts to wetlands. We then review and summarize information compiled from the literature and discussions with experts, including knowledge

gaps and areas for further investigation. Finally, the report provides key recommendations for CZMP concerning local government policies and programs.

Climate Change Trends & Challenges

According to the *Third National Climate Assessment* published in 2014 by the U.S. Global Change Research Program, climate change is no longer a distant consequence. Significant changes in the earth's climate have been observed and thoroughly documented. Warming of the climate system is unequivocal and is demonstrated throughout changes in average air and ocean temperatures, rising sea levels and the melting of ice, and increases in storm severity, with more change expected.[4]

To better understand and predict what the global climate will be like in the coming decades, scientists use three-dimensional computer models of the earth's atmosphere, oceans and land surfaces. These models allow scientists to simulate future climate characteristics with existing levels of greenhouse gas discharges (e.g., carbon dioxide and methane) and scenarios involving increases or decreases of greenhouse gas discharges worldwide. These General Circulation Models (GCM) have been improved and verified over the years, resulting in relatively reliable predictions for climate changes over large regions, including the Midwestern United States. While there are techniques for downscaling the results of these global models, the results at a regional level are somewhat less reliable.

The Great Lakes Integrated Sciences + Assessments project (GLISA) is a consortium of scientists and educators from the University of Michigan and Michigan State University that is helping to provide downscaled climate models for the Great Lakes Region. According to GLISA, the Great Lakes region has experienced a 2.3°F increase in average temperatures from 1968 to 2002. An additional increase of 1.8° to 5.4°F in average temperatures is projected by 2050, largely determined by future levels of greenhouse gas discharges.[5] Temperature increases will in turn drive other changes in our climate, including more precipitation, fewer winter snowfalls, and a greater likelihood of flooding. Regional climate models indicate that extreme heat and rain events will become more frequent and more intense over the coming decades.

According to the *Third National Climate Assessment* (2014), regional climate model projections for the Midwest indicate increased spring precipitation and decreases in summer precipitation, with an overall increase in the frequency and intensity of extreme precipitation events. Reports cited by the *Intergovernmental Panel on Climate Change* (IPCC) state that stormwater runoff could increase by as much as 10-40% in higher latitudes by 2050.[6,7] More frequent extreme storms with high winds and tornadoes are also expected.

Data for Lakes Michigan and Huron show an average summer surface water temperature increase of 4.5°F over the last 27 years. Lake Superior's average water temperature has

increased by more than 5°F since 1985. That rate of increase is about 15% faster than the air above the lake and twice as fast as the rate of warming over nearby land.[8]

Based on temperature change, pollution, and other causes, the chemistry of the Great Lakes will also be changing. The pH of the Great Lakes is – and has been - slightly basic. Because of their limited alkalinity, the Great Lakes have a lower buffering capacity and will respond more to changes in atmospheric carbon dioxide as compared with the ocean. According to the IPCC, the pH of the Great Lakes may decline by 0.30 pH units by 2090, double the rate of change in the ocean.[9] A study in Wisconsin has indicated that this will cause some species to decline significantly.[10] Warmer temperatures are likely to increase the rate of organic matter decomposition and accelerate carbon release to the atmosphere in the form of carbon dioxide. Carbon release from wetlands in the form of methane, a greenhouse gas that is 25 times more potent than carbon dioxide, is predicted to increase with warmer temperatures and higher water levels.[11,12]

Climate Change Impacts on Wetlands

The Christie and Bostwick paper identified and characterized many of the possible impacts of climate change on Michigan's coastal wetlands. The following paragraphs build on the work of that paper, adding information from other references as noted.

The full extent of how climate change will impact Michigan's coastal wetlands is still unknown, but a number of trends have already been observed. For example, the threat of invasive species is heightened. Climate change will stress native plants and animals, providing a window of opportunity for invasive species to become established.[13] Warmer water temperatures will result in a change in species composition, and a likely decrease in biodiversity. Warmer temperatures also cause greater evaporation, potentially resulting in lower lake levels.

Anticipated Climate Impacts on Wetlands

- More variation in water supply, increased drought
- Increased erosion caused by extreme storm flows and surges
- Sedimentation and nutrient overloading
- Increased occurrence of invasive species
- Degradation of water quality
- Disruption of plant and wildlife assemblages
- More frequent fires
- Warmer water temperatures

Recent interpretations of GCM results suggest that Great Lakes water levels may not change significantly. However, changes in the precipitation patterns are likely to alter the water budgets of most wetlands. Further, if Great Lakes water levels do decline, there will be significant impacts on the type and quality of wetlands[14] and a reduction in hydrologic connections to riparian zones and groundwater recharge.[15] Wetland plant species with limited drought tolerance and modes of colonization are the most vulnerable. Native fishes that are most sensitive to water-level changes are those with limited geographic distributions, shallow-

water spawning, and a preference for vegetated habitat. Wetland bird species with nesting and foraging preferences that require specific hydrologic conditions are also highly vulnerable.[16]

As noted, the Midwest is already experiencing more frequent and severe storms, a trend that is predicted to continue. As seen in many places around Michigan, such sudden heavy downpours can create a very large amount of fast-moving runoff, carrying sediment and pollutants from urban areas, farm fields, and other open spaces. Shoreline erosion rates could also increase, causing a subsequent decrease in water quality as more sediment is suspended in the water column.[17] Researchers recently established linkages between a pattern of intense precipitation events induced by climate change and massive algal blooms in the waters of Lake Erie.[18]

Coastal wetlands have always changed and shifted somewhat with the natural cycling of Great Lakes water levels. However, climate change is expected to increase the frequency of storm surges, alter the frequency and duration of storm flows, disrupt seasonal precipitation patterns, and build more erosive force in stream flows. Increased drought also has the potential to reduce wetland habitat and migration corridors. As a result, climate-induced changes to wetlands are widely expected, but there is great uncertainty about the extent and character of these changes to both coastal and inland wetlands.

Literature Review & Summary

In addition to the climate change literature described and summarized above, there is a growing body of technical and popular literature concerning the impacts of climate change on Michigan's wetlands and associated natural resources. The white paper prepared by Christie and Bostwick delivers a concise and comprehensive summary of the climate change and wetlands literature. More importantly, the paper identifies a range of responses to help address climate change adaptation for wetlands. Many of these responses concern broad regional and statewide goals, programs and policies requiring interagency and intersectoral cooperation, such as:

- cooperation in data sharing, collaborative research, resource management;
- collaboration in developing new models for managing shorelines and bottomlands during periods of water level change;
- monitoring and assessment of climate changes, adaptive measures, and changes in wetland flora and fauna;
- coordinated effort to provide real-time tracking of the impacts of climate change on wetlands;
- development of a state geographic information system (GIS) providing analyses of wetland restoration and management for increased ecosystem services and climate change mitigation;
- support for the revision of floodplain plans to support the restoration of wetlands and other aquatic habitats; and

- recommendation to work with the US EPA on the integration of climate change adaptation in the wetland dredge and fill permitting process.

Some of the other recommendations offered by Christie and Bostwick concern policies, programs and projects at the local government level. These recommendations primarily emphasize the update and dissemination of existing information and guidance documents to incorporate climate change concerns into local government plans and actions.

Based on our review, three papers stand out as most directly applicable to the management of Michigan's wetland resources by local units of government. All of these offer specific recommendations for application by municipalities for the preservation and protection of wetlands and related natural resources. While each of these documents would benefit from updates to more specifically address climate change impacts and concerns, the recommendations and options for action presented remain timely, relevant and applicable.

- *Protecting Michigan's Wetlands – A Guide for Local Governments*, edited by Grenetta Thomassey, Ph.D.; published by Tip of the Mitt Watershed Council, 2007.
- *Filling the Gaps: Environmental Protection Options for Local Governments* (2nd Edition), by Katherine Ardizone and Mark Wyckoff; published by the Michigan Department of Natural Resources and Environment, 2010.
- *Planner's Guide to Wetland Buffers for Local Governments*, published by the Environmental Law Institute, 2008.

Several recent publications and reports have served to add a sense of urgency to climate change adaptation efforts while challenging both regulatory officials and resource managers to establish monitoring systems, evaluate alternative management strategies, and disseminate information. For example, the Michigan Department of Natural Resources (MDNR) Wildlife Division report, *Changing Climate, Changing Wildlife* (April 2013), explained and reported on vulnerability assessments completed for 281 animal species and 67 plant species. The authors state that 61% of species of greatest conservation need (SGCN) are likely to experience population decreases due to climate change by 2050. Wetland species appear to be disproportionately affected. One adaptation strategy presented in this report is the protection and restoration of wetlands that provide habitat through drought and flood.

A similar assessment of climate change impacts was published by the US Forest Service in March 2014 titled, *Michigan Forest Ecosystem Vulnerability Assessment and Synthesis*. Though this work focuses primarily on tree species found on the uplands of Michigan's Northern Lower and Upper Peninsulas, the conclusions follow a familiar pattern, including climate-induced losses of numerous trees species, eventual replacement by species common to more southern areas, and increasing vulnerability of forest ecosystems to invasive species. The implications are that lowland forest species are vulnerable.

A report published by the National Wildlife Federation and the National Oceanic and Atmospheric Administration (NOAA) in 2014, *Restoring the Great Lakes' Coastal Future*, offers

practical recommendations for responding and adapting to climate change and adaptation challenges. The technical guide focuses on so-called *climate-smart restoration projects* that address ecosystem concerns, including two projects in Michigan. The authors call for the use of climate change vulnerability assessments in planning species, habitat or ecosystem restoration projects. The assessment process challenges project planners (and all of us) to evaluate the climate sensitivity, exposure characteristics, and adaptive capacity of species, habitats and/or ecosystems in relation to restoration goals. As summarized in the report, climate change adaptation typically involves promoting ecosystem resilience through four strategies:

- prioritizing connectivity of habitat;
- reducing existing stressors;
- protecting key ecosystem features; and
- maintaining biological diversity.

The 2014 publication *Lake Superior Climate Change Impacts and Adaptation*,[19] prepared for the *Lake Superior Lakewide Action and Management Plan*, identifies climate adaptation strategies for the ecosystems surrounding Lake Superior. Specifically, the report tracks the most recent climate science as applied to Lake Superior and outlines recommended responses and future actions. The report focuses on adaptation of ecosystems and does not address impacts related to human infrastructure. Key recommendations that relate specifically to wetland adaptation include:

- conserve and restore ecological connections to facilitate migrations and other transitions caused by climate change;
- upgrade and replace existing infrastructure to handle the volume of runoff associated with potentially more frequent and intense precipitation events;
- construct and/or preserve riparian buffers to manage runoff from non-point source pollution and sediments associated with potentially more frequent and intense precipitation events;
- identify strategies to cope with flow alteration and increased “flashiness” of flows;
- plant seeds or seedlings originating from seed zones that resemble the expected future conditions of the planting site;
- plant shady vegetation to reduce water temperatures; and
- use wind-resistant vegetation to minimize blow-downs and erosion along coastal shorelines.

In many ways, these educational research and guidance documents focus primarily on climate change in relation to natural resources and wetland management. There are, of course, extensive and worldwide efforts to address the impacts of climate change on human communities in urban and suburban settings. Numerous cities, villages, townships and counties throughout the U.S. have developed *Climate Action Plans* (CAPs), master plans and capital improvement plans designed to guide community-wide climate adaptation. While considering a variety of ways to assist social and economic adaptation, urban planners, civil engineers, and a

host of municipal managers have begun to incorporate wetland preservation and restoration into community development (e.g., *green infrastructure*) and capital improvement efforts (e.g., *stormwater wetlands*). While these urban and suburban wetlands may support less biological diversity than desirable, these limitations may be changed with the advance of wetland management science in the face of climate change.

Expert Interviews & Focused Discussions Summary

To better identify, characterize and evaluate wetland preservation and adaptation practices for local governments, LIAA completed 15 expert interviews and convened two group discussions involving 15-20 participants in each. Participants in both the interviews and the discussion groups were selected to represent different areas of expertise related to wetland functions, management and preservation.

The interviews were informally structured as conversations using a framework of ten primary and five secondary questions. However, much of the most valuable information gathered was derived from follow-up questions during these informal interviews. We interviewed a broad mix of policy experts and wetland ecologists as identified in the table below.

Date	Name	Organization	Title
27 Nov 2013	Don Uzarski	CMU Biological Station	Director
8 Jan 2014	Grenetta Thomassey	Tip of the Mitt Watershed Council	Program Director
13 Jan 2014	Anne Garwood	MDEQ	Wetland Ecologist
30 Jan 2014	Elizabeth Riggs	Huron River Watershed Council	Executive Director
30 Jan 2014	Amy Beyer	Conservation Resource Alliance	Director
30 Jan 2014	Anne Vaara	Clinton River Watershed Council	Executive Director
19 Mar 2014	Erin McDonough	Michigan United Conservation Clubs	Executive Director
20 Mar 2014	Brad Garmon	Michigan Environmental Council	Dir. of Conservation and Emerging Issues
18 Apr 2014	John Roda	West Bloomfield Charter Township	Environmental Manager
18 Apr 2014	John Hamlin	Ann Arbor Charter Township	Wetlands Administrator
21 Apr 2014	Alan D. Steinman	Annis Water Resources Institute (GVSU)	Director
25 Apr 2014	Carl R. Ruetz	Annis Water Resources Institute (GVSU)	Professor
2 Jun 2014	Brian Benway	Independence Charter Township	Zoning Administrator
5 Jun 2014	Michael Pennington	MDEQ	Wetlands Mitigation and Banking Specialist
8 Jul 2014	Jeremy Jones	MDEQ	GIS Analyst
8 Jul 2014	Chad Fizzel	MDEQ	Wetlands GIS Specialist

After the interviews were complete, we made use of information collected in the literature review, policy scan, and stakeholder interviews to lead focused discussions with groups of other policy and ecology specialists from around the state. The first discussion group was held in July,

2014 in Traverse City, Michigan, and the second discussion was convened during a session at the Michigan Wetland Managers Annual Conference in Grand Rapids, Michigan in August, 2014. Based on some specific topic questions, we have collected some of the key findings from the interviews and focused group discussions below.

What are the most important actions local governments can take to preserve/restore their coastal wetlands?

Overall, participant answers to this question reflected current knowledge of best practices in preserving and managing wetlands, without special consideration of climate change. Many participants said emphatically that the best thing local governments could do for wetlands is to *preserve the hydrology*. Tip of the Mitt Watershed Council's Grenetta Thomassey simply stated: *leave the wetlands alone*. Giving a specific example of local action, Amy Beyer of Conservation Resource Alliance (CRA) noted that dam removal can positively impact hydrology by connecting rivers and wetlands with high-quality floodplains. A discussion group participant from the MDNR, Chris Hoving, noted culverts under roads are one of the biggest barriers to climate adaptation for wildlife species, including those dependent on wetlands, as culverts are often too small to allow migrating species to pass through.

Interview participants also stressed the importance of taking a watershed-level approach to wetland management. Other responses that came up multiple times included: maintain a strong regulatory regime, build more buy-in from local officials, and improve and expand outreach and education to the public.

Participants noted that there are many different management tools available to local governments, but it is difficult to identify a single list of best management practices because there is so much diversity across the state. For example, Thomassey noted that wetland banking is a tool that communities in northwest Michigan should use more because there is a lot of land available for banking and the tool has not been used much. Similarly, Anne Vaara of the Clinton River Watershed Council cited the local wetland ordinance as a tool that is most commonly used in southeast Michigan, because the majority of the land in that area of the state was once wetlands and there is significant development pressure in much of southeast Michigan. We also heard that restoration of smaller wetlands (less than 5 acres) is more crucial in cities, villages, and urbanized townships. These areas are generally more "built out" and benefit from the flood storage capacity of smaller urban wetlands. On the other hand, undeveloped areas in Michigan's Upper Peninsula are good candidates for preserving large connected areas of wetlands that can support high biodiversity and possibly serve as migration corridors for species shifting north as a result of climate change.

What wetland data collection efforts would prove most useful?

Several of the interview participants were affiliated with the Great Lakes wetland mapping project headed by Don Uzarski of Central Michigan University. The *Great Lakes Coastal Wetland Consortium* project team is tasked with mapping and sampling 1,039 wetlands in the Great Lakes Basin. Interviewees participating in this project were investigating a range of environmental indicators — including biota, water temperatures, dissolved oxygen, pH, and turbidity — to measure overall health of the ecosystem and to serve as a baseline for future monitoring efforts. Professor Uzarski noted that this data is available to local government agencies including tribes. In general, NGOs can receive summarized data. This $10 million project is funded by the Great Lakes Restoration Initiative (GLRI) to fulfill a mandate by the U.S. EPA for standardized testing protocols.

During one of the focused discussions, Doug Marcy (NOAA) emphasized the importance of continuous monitoring to respond to uncertainty and changing climate conditions. He also noted that scale is an important consideration for monitoring in that small wetland areas require more on-the-ground data than what is often available from the state. Another data challenge emphasized in the discussion groups is the location and hydrology of groundwater discharge wetlands known as *fens*. At present, fens are often missing from wetland inventory maps. Additionally, it is often difficult to identify the origin of the groundwater.

MDNR's Chris Hoving said that another data gap is elevation data. This is important especially when evaluating vulnerability to flooding and erosion as well as areas at risk for drying out at times of high drought. Hoving went on to note that another knowledge gap concerns the identification of risk tolerance, as there are very few *risk tolerance calculators*. The importance of planning and modeling using multiple scenarios was also noted, especially when there are significant uncertainties. For example, precipitation trends predicted by downscaled climate models are less certain than temperature trends.

What are some of the climate change impacts of greatest concern?

In discussion groups and during expert interviews, the biologists and ecologists said one of the biggest climate-change challenges is the increase in average water temperatures. Higher average water temperatures are likely to have a significant impact on species persistence and long-term species diversity.

Carl Ruetz (GVSU) believes that fluctuating water levels in the Great Lakes will cause "drying out" of some wetlands and negatively impact fish habitat and reproduction. He said that additional research is needed to look at multiple years of data to identify how important

wetlands are to the recruitment of fish species. Alan Steinman (GVSU) said that as water levels go up and down, experiencing more extreme fluctuations, the sediment exposed to oxygen will undergo chemical changes. He also noted that low water levels allow more room for invasive species to gain a foothold.

Several of the interview participants observed that higher temperatures and increased precipitation have amplified the intensity of algal blooms, impacting water quality and coastal habitats. Professor Steinman has observed that wetlands performing water quality protection services do not always function as high-quality habitat. For example, cattails that thrive in high phosphorus areas assist with phytoremediation to improve water quality, but they do not provide a diverse habitat for native species. Though such wetlands provide valuable ecosystem services such as good flood storage capacity as well as sediment and nutrient capture, they represent poor wildlife habitat with low biodiversity.

What are some of the biggest obstacles to wetland protection and/or restoration?

Many of our interview and discussion group participants agreed that current and potential economic development opportunities limit efforts to protect and/or restore wetlands. They believe that some community leaders fear litigation over efforts to restore wetlands in some areas. Another obstacle cited by Anne Garwood (MDEQ) is the lack of knowledge and experience among state and local elected officials. Due to short election cycles and term limits, elected officials may not have time to become familiar with the long history of wetland losses and evolving efforts to preserve and protect wetlands. Elected officials may not fully understand the wide variety of low-cost ecosystem services offered by wetlands. As a result, efforts to inform and educate state and local officials are required at least every two years.

What roles do public outreach and education play in protecting and restoring wetlands?

Many of our interview and discussion group participants commented on the importance of involving a wide variety of stakeholders at the local level and mentioned a number of different avenues for engagement. Professors Ruetz and Steinman (GVSU) have assisted citizen groups working to improve beneficial use impairments (BUIs) in areas of concern (AOC) designated by the U.S.-Canada Great Lakes Water Quality Agreement.[20] Other interview participants suggested seeking the support of non-traditional stakeholders for wetland preservation and restoration efforts, including architects, engineers and developers. Another suggestion was that communities could better leverage people within their own communities (i.e., social capital) who have wetland knowledge. For example, some communities would find that their emergency managers and floodplain managers have extensive wetland expertise.

Are there special programs or projects that would be particularly helpful?

Interview and discussion group participants strongly endorsed a number of programs and project activities that would help municipalities and communities preserve and/or restore wetlands to ameliorate the impacts of climate change. A primary goal of these experts is the preservation of the functions and character of all existing wetlands. One of the most important programs needed to support this work in Northern Michigan is a wetland bank, according to Ms. Thomassey (Tip of the Mitt Watershed Council). *Wetland banking* offers a particularly useful way of preserving and/or restoring wetlands while accommodating some development pressures. She emphasized the importance of planning now to protect large, high functioning wetlands.

According to discussion group participant John Paskus (Michigan Natural Features Inventory, MNFI), local governments and communities should complete a geographic assessment of all their natural features. Using a GIS and methodologies developed over a decade ago, communities can map their *Potential Conservation Areas* (PCA) at a detailed level, giving each area a rating representing their relative conservation values. The process is both educational and a valuable land-use planning exercise to help guide the planning of future land uses at city, township and village levels.

Discussion group participants Marcy Colclough (Southwest Michigan Planning Commission) and Matt Meersman (Van Buren County Conservation District) have applied the landscape-level *Functional Assessment of Wetlands* to assess areas for their potential in providing significant ecosystem services, wildlife habitat and other wetland functions. The process has successfully identified highly functioning, high-value wetland areas for protective management through the local master planning process. By identifying specific parcels with high total "Functional Units," local officials encourage property owners to get engaged in the planning process. Mr. Meersman explained that they send landowners specialized letters in the mail letting them know that they possess the wetlands with the highest Functional Unit rankings in their township and/or watershed. In their experience, the landowners feel singled out and "special," and are motivated to attend future meetings.

Interview participant Brad Garmon (Michigan Environmental Council, MEC) said that the *Farmland and Open Space Preservation Program* (PA 116) was an important tool for wetland protection because of the tax incentives available for property owners. Referencing that program in terms of climate change adaptation, one discussion group participant suggested that the state could consider shorter time periods for land trust agreements to allow for greater flexibility given the potential changes in resource value characteristics. Mr. Meersman said that the *Wetland Reserve Program* has been a useful program for preserving wetlands. In southeast Michigan, the *Wetland Reserve Program* pays landowners up to $3,000 per acre to give up

rights to developing their land. Oftentimes hunting land is low-hanging fruit in the effort because converting existing wetlands to higher functioning wetlands does not impact the overall quality of the land for hunting purposes.

What are the roles of local planning and land-use regulations in wetland preservation?

We heard from our interviewees and focus group participants that communities need to do a better job of integrating wetland restoration and preservation into all areas of municipal management. For example, Ms. Thomassey believes that drainage districts should be expanded to include areas for wetland restoration. She explained that this should be about changing perceptions. In southeast Michigan, a transition is underway for drain commissioners to be renamed "water resources commissioners." Water resource commissioners could consider expanding the drain easements/drainage districts to include natural wetland areas and potential wetland restoration areas.

Interview participant Anne Vaara (Clinton River Watershed Council) said that her organization and other watershed councils actively assist local governments in developing plans and a wide range of environmental ordinances, including woodland ordinances, erosion control ordinances, steep slope ordinances, and wetland ordinances. All of these ordinances can be used as a parts of a larger climate adaptation strategy to better manage the impacts of extreme rain events, more periods of drought, and higher temperatures.

Another interview participant, Elizabeth Riggs (Huron River Watershed Council), agreed that watershed councils play an important role in assisting local governments with policies concerning water quality and natural resource management. In relation to adapting to climate change, Riggs said a "trifecta" of local ordinances is key, including: (1) riparian buffers, (2) stormwater ordinances, and (3) wetland ordinances. Ms. Garwood (MDEQ) added to these points, stating that larger buffer requirements are good options for local governments in protecting wetlands and water quality — policy options that are not feasible at the state level.

Mr. Garmon (MEC) said critical dune designation and/or areas designated as high risk for erosion are important areas to focus on from a coastal wetland restoration standpoint. These areas are very dynamic and climate change will likely cause significant erosion issues. One concern brought up by a focus group participant is that as lake levels fluctuate, some poorly informed local governments may try to delist high-risk erosion areas, leading to the possibility of development occurring in areas that could eventually become coastal wetlands. Similarly, interdunal wetlands are often at risk, because as development is pushed back away from the shoreline, interdunal wetlands are damaged or filled.

In addition to the interview participants listed above, we spoke with a number of local government officials concerning the wetland ordinances enacted in their municipalities. John Roda, West Bloomfield Charter Township Environmental Manager, said that his township's wetland ordinance dates back to 1979 when community residents pushed for better protection of lakes, rivers and wetlands. Mr. Roda described a number of obstacles to wetland ordinance enforcement, including messaging, the lengthy permitting process, and assuring compliance. The board that oversees compliance with the wetland ordinance is the township's Environmental Council. The local ordinance can be viewed as a climate adaptation strategy because it regulates all wetlands, regardless of their size. One messaging failure is that very few people understand how wetlands are actually regulated. Many members of the public believe all wetlands are protected. They don't understand that wetlands may, in fact, be altered for development purposes.

Are there other issues or concerns about wetland preservation and restoration?

Many interviewees cited the importance of wetlands for the ecosystem services they provide to human settlements. Although the notion that wetlands provide critical ecosystem services is commonly accepted, one discussion group participant noted that "a better cost-benefit estimate for the services wetlands provide is necessary, especially since they will be providing an increasingly important role in flood control." There will be increasing interest in wetland restoration for such purposes.

Ms. Beyer (CRA) brought up a concern about the permitting process for wetland restoration. Apparently, the same process used for granting dredge and fill permits is used for restoration permits. Ms. Beyer suggests that state's wetland permitting program take a different approach with a different perspective when addressing permits for the restoration of wetlands.

In addition to ecosystem services for human populations, the biologists and ecologists we spoke with noted the important role wetlands play in the life cycle of a wide diversity of fish, birds, reptiles, amphibians and plants. One example provided by Professor Ruetz (GVSU) is the yellow perch, which depends on wetlands for the early part of its life cycle. He stressed the importance of explaining to people (and to fishermen in particular) that some wetlands are key to yellow perch and that without wetland protection this important fish species will decline.

When discussing next steps for conserving and restoring wetlands, we heard a number of topics repeated in these expert discussions. One repeated topic of concern is the need for better data. For example, Ms. Riggs (Huron River Watershed Council) said that many engineering departments are still using precipitation tables from the 1970s to design pipes and other stormwater management systems. At the same time, ecologists have little predictive data concerning the characteristics of flora and fauna succession induced by rapid climate change. Mr. Hoving (MDNR) noted that while some species will be able to adapt, some will not.

However, little is known regarding tactics such as translocating species and which species are most able and likely to adapt.

Both interview and discussion group participants emphasized the importance of public education and messaging. Many participants said that in recent history, environmentalists have done a poor job at getting their messages out to the greater public. Furthermore, very few people are familiar with or actually experience wetland ecosystems because they are generally less accessible than upland areas and often impractical for recreation. At least one interview participant stressed the need for more wetland boardwalks to increase accessibility. This point was emphasized by discussion group participants, who agreed that there needs to be better opportunities for human interaction with wetland ecosystems.

Wetland Regulation Basics

In accordance with Part 303, wetlands are regulated if they are any of the following:

- Connected to one of the Great Lakes or Lake St. Clair.
- Located within 1,000 feet of one of the Great Lakes or Lake St. Clair.
- Connected to an inland lake, pond, river, or stream.
- Located within 500 feet of an inland lake, pond, river or stream.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, but are more than 5 acres in size.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5 acres in size, but the DEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner.

The law requires that persons planning to conduct certain activities in regulated wetlands apply for and receive a permit from the state before beginning the activity. A permit is required from the state for the following:

- Deposit or permit the placing of fill material in a wetland.
- Dredge, remove, or permit the removal of soil or minerals from a wetland.
- Construct, operate, or maintain any use or development in a wetland.
- Drain surface water from a wetland.

The DEQ must determine the following before a permit can be issued:

- The permit would be in the public interest.
- The permit would be otherwise lawful.
- The permit is necessary to realize the benefits from the activity.
- No unacceptable disruption to aquatic resources would occur.
- The proposed activity is wetland dependent or no feasible and prudent alternatives exist.

General Wetland-Management Policy Framework

Wetlands are preserved and protected through a number of federal and state regulations. Both the Michigan Department of Natural Resources (MDNR) and Department of Environmental Quality (MDEQ) provide explanations of Michigan's wetland regulations and their application. The statutory basis of these regulations is Part 303, Wetlands Protection, Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). The inset below contains the information published by MDEQ on what wetlands are regulated, the activities regulated, and when permits are granted.

As described, Michigan shares authority over coastal wetlands with the federal government. More specifically, the state and federal government share authority over traditionally navigable waters including the Great Lakes, connecting channels, other waters connected to the Great

Lakes where navigational conditions are maintained, and wetlands directly adjacent to these waters.[21]

Limited Local Control

Michigan's cities, townships and villages are given authority to regulate wetlands by ordinance within their jurisdictions under state law. However, the state requires these local ordinances to meet certain criteria, including:

- A wetland ordinance cannot require a permit for activities exempted from regulation under Part 303.
- A wetland ordinance must use the same wetland definition as in Part 303.
- Local units of government must publish a wetland inventory before adopting a wetland ordinance.
- Local units of government that adopt wetland ordinances must notify the DEQ.

Local governments can regulate wetlands under five acres in size, but if it chooses to regulate wetlands of less than two acres, it must determine that each such wetland is essential to the preservation of the community's natural resources. A sample ordinance for local governments was developed by MDEQ and Huron River Watershed Council many years ago and is available on the state website.[22]

Coastal Wetland Monitoring

Late in 2000, more than 40 organizations — including Canadian and U.S. national agencies, state agencies, academic institutions and nongovernmental organizations (NGOs) — began working together as the *Great Lakes Coastal Wetlands Consortium* (GLCWC), with funding provided by the U.S. EPA's Great Lakes Program Office. According to the group's Fact Sheet, the GLCWC is dedicated to the design and implementation of a regional monitoring program to track and assess the Great Lakes coastal wetlands health to support management decisions." By 2008, the GLCWC had completed pilot studies, an inventory and classification system, and detailed monitoring protocols. A publicly accessible international database was also described. The *Great Lakes Coastal Wetlands Monitoring Plan* was published in March 2008.[23]

In 2010, a consortium of scientists led by Dr. Don Uzarski at Central Michigan University were awarded a $10 million grant through the Great Lakes Restoration Initiative (GLRI) to begin implementing a detailed coastal wetlands monitoring program. The consortium involved scientists working in at least 12 different organizations, including academic institutions, state and national agencies and one NGO. As described by Dr. Alan Steinman (Annis Water Studies Institute, Grand Valley State University), the five-year project "will analyze the plants, birds, amphibians and reptiles to get an idea what their conditions are. These are critical habitats for spawning of our fish for the nurseries and filtering out nutrients. We need to figure out what condition they're in and how to improve them."[24]

Wetland quality information and mapping data is slowly being released for use by other agencies and organizations. A number of new, related projects have also been started, including an effort to standardize methods for monitoring the treatment and control of invasive *phragmites*.[25]

Policy Scan: Michigan's Municipal Wetland Ordinances

MDEQ keeps a list of municipal governments with wetland ordinances on its website. MDEQ staff have confirmed the list was up to date as of February 2014, with a total of 45 governments on the list. Although many of the municipalities are not within Michigan's coastal zone, LIAA reviewed all ordinances in order to gain the best insight into BMPs for ordinance development, adoption, and enforcement.[26]

Methodology: We began the policy scan by reviewing the State of Michigan's *Sample Wetland Ordinance* that was developed in partnership between MDEQ and the Huron River Watershed Council. Next, we identified the wetland ordinance or zoning ordinance for each community, specifically looking for the section of the ordinance containing reference to wetlands. LIAA then created a spreadsheet to track specific details of each local wetland ordinance. The details we tracked included:

- Date ordinance was adopted
- Size of wetland regulated (in acres or square feet)
- Unique exemptions (as compared with the model wetland ordinance for Michigan)
- Mitigation requirements
- Implementation process
- Enforcement criteria and procedures
- Natural buffers (criteria and distance)

This section highlights our key findings as a result of the review of wetland ordinances. In addition to BMPs and the degree to which the ordinances fostered restoration and preservation, we focused on identifying components of ordinances that could be used as climate adaptation strategies.

- ***Wetland Inventory Map:*** The wetland inventory map is intended to be high level and requires site-specific field inspection on a case-by-case basis. In general, the wetlands inventory map is based on the National Wetlands Inventory Map of the U.S. Fish and Wildlife Service, the Michigan Resource Information System Mapping (MIRIS) of the State of Michigan, the soils maps of the Soil Conservation Service, aerial photography, and onsite inspections. Because climate change will require adaptive management to adjust to unpredictable ecosystem changes, an up-to-date detailed wetland inventory will be especially critical. One existing BMP we found that relates to the inventory map is that Orchard Lake Village requires an accurate topographic map of the disturbed areas drawn to scale not less than 1:360. This level of detail ensures the municipality has up to date

detailed information about the wetland type and vegetation coverage, and can also inform a better understanding of wetland functions.

- ***Wetland Ordinance Administration:*** Many communities with wetland ordinances have a Wetland Protection Advisory Committee or Environmental Commission that administers the ordinance and makes recommendations to the township board, city commission or village council regarding permits and mitigation plans. Committees are generally comprised of five or seven individuals. Scio Township requires that at least three members have "knowledge and experience in the areas of botany, soils, geology, hydrology, or natural resources." This language also appears in the model ordinance. Forest Home Township uses an overlay district to administer its wetland ordinance.

- ***Wetland Ordinance Enforcement:*** Many communities with wetland ordinances also have a Wetland Enforcement Officer who conducts necessary field inspections to insure compliance with approved permits. We found that in smaller jurisdictions without an officer, the wetland ordinance is usually enforced through the local Building Department. Most ordinances specify a punishment, such as a fine of up to $500 and/or up to 90 days in jail.

- ***Size:*** MDEQ regulates all wetlands more than five acres in size, as well as all wetlands that meet certain criteria regardless of size. However, the model ordinance recommends protecting wetlands that are two acres or more in size. Added protection for wetlands between two and five acres can provide significant flood storage capacity in urbanized areas where many of the smaller wetlands are located. In our review, we found that most local wetland ordinances regulate wetlands two acres or larger, and some communities regulate wetlands below two acres. For example, Fenton Township protects all wetlands down to one acre in size. The Townships of Williamstown and Grattan regulate all wetlands down to one-half acre in size. Cannon Township regulates wetlands down to one-quarter acre. Delhi Charter Township regulates all the way down to one-sixteenth of an acre. Orchard Township does not have a minimum size, but instead uses a list of criteria to determine the presence of a wetland.

- ***Wetland Mitigation:*** A number of wetland-ordinance municipalities require that each acre of wetland impacted by any manmade change must be mitigated by the establishment of 1.5 acres of new wetland. Many municipalities specifically state "mitigation shall be permissible only where it is determined that if a permit is not issued, there would be no viable use of the property." This language is not stated in the model ordinance.

  Spring Lake Township goes a step further through the incorporation of a Floristic Quality Assessment (FQA), a vegetation-based ecological assessment approach that can be used for wetland quality monitoring and assessment.[27] The Township requires that wetlands determined to have Floristic Quality Index (FQI) values over 25 will be mitigated at a 3:1 ratio, and wetlands with FQI values over 35 will be mitigated with a 10:1 ratio.

There is only one township that makes reference to a wetland mitigation bank in their ordinance: Independence Charter Township. However, when we contacted Independence Charter Township, they deferred us to the local conservation district and did not have any knowledge of a wetland bank.

- ***Wetland Functions:*** Several communities focus on the beneficial functions that various wetlands play and attempt to quantify or identify these functions as part of their ordinance. For example, the Floristic Quality Index used by Spring Lake Township identifies the quality and biodiversity of the wetland. The Rapid Assessment Method (RAM) used by Scio Township is a tool used by MDEQ to quickly identify the functions performed by a given wetland in the field.[28] Finally, Delhi Charter Township identifies "potential conservation areas" as wetland areas that should not be permitted for development regardless of the size of the wetland.

- ***Groundwater/Aquifer Recharge***: The model wetland ordinance suggests that a denial of a wetland permit can be made on the grounds that the site in question provides "groundwater recharge documented by a public agency" or if the site "provides protection of subsurface water resources and provision of valuable watersheds and recharging groundwater supplies."

  Some communities have gone a step further. For example, Delhi Charter Township specifies that wetlands smaller than five acres are protected if they are located in an aquifer recharge area equal to greater than 7.5"/year. Wetlands that drain into the water table are a significant source of recharge to groundwater so it is important to place priority on protecting these wetlands that feed groundwater. The Delhi ordinance also states that a "permit shall be approved unless the site…supports groundwater recharge." Numerous wetland ordinances consider recharge an "essential" service that wetlands provide. The model ordinance specifies that "Non-contiguous wetland areas of less than two (2) acres…shall be analyzed for the purpose of determining whether such areas are essential…and the site provides groundwater recharge documented by a public agency."

- ***Soil Type:*** We found that communities can consider protecting areas with hydric soils as a way of protecting areas that have the potential to be restored as wetlands. For example, the Argentine Township Ordinance identifies wetlands as areas with "poorly drained and very poorly drained soils."

- ***Natural Buffers:*** Most local ordinances employ a vegetative buffer requirement of 25 feet, although some specify 20 feet or as little as 10 feet (such as the Alba Township ordinance). From a wetland adaptation standpoint, buffering natural features like wetlands with a substantial buffer will help to facilitate the functioning of these areas as climate conditions fluctuate.

- ***Ordinary High Water Mark:*** The Michigan model wetland ordinance defines wetlands as "partially or entirely located within five hundred (500) feet of the ordinary high water mark (OHWM) of an inland lake or pond or a river or stream, or within 1,000 feet of the ordinary high watermark of one of the Great Lakes or Lake St. Clair." Most local ordinances also use this language. This can be considered an adaptation strategy because as the climate changes, the lake levels will fluctuate, but the OHWM will remain relatively constant in inland lakes.

- ***Floodplain:*** As flooding events become more severe and more frequent, protecting floodplain areas will be an increasingly important adaptation measure. Numerous local wetland ordinances we reviewed consider floodwater storage as an "essential" service provided by wetlands. The model ordinance specifies that "Non-contiguous wetland areas of less than two (2) acres…shall be analyzed for the purpose of determining whether such areas are essential." The ordinance goes on to state that if the site provides flood and storm control by the hydrologic absorption and storage capacity of the wetland, then it should be deemed essential. The Argentine Township wetland ordinance applies to "lands subject to 100 year flooding." West Bloomfield Charter Township requires mitigation for "impacts to…floodplains." Oakland Charter Township regulates areas within the "Flood Hazard Areas (and the) 100 year frequency flood."

Although there are still measures all local jurisdictions in Michigan can take to make their wetland ordinances better adapted for a changing climate, many of the ordinances we reviewed are on the right track. Overall, it seems that key adaptation elements in local wetland ordinances include a robust wetland inventory, the capacity to administer and enforce the ordinance, and a focus on the functions wetlands provide by regulating floodplains, groundwater recharge, deep vegetative buffers, and hydric soils.

Overall Project Observations

Based on all of the literature reviewed and the comments of the numerous experts and interested parties we contacted for this project, Michigan's coastal wetlands are critically important and extremely valuable natural features that should be preserved and protected wherever possible. Further, wetlands should be restored in many coastal and inland areas. From a biological perspective, wetlands represent many of the state's most diverse and productive ecosystems, providing important habitat, food or breeding areas for wildlife and fish, including many rare and endangered species. From birders and hunters to kayakers and fisher-people, most outdoor enthusiasts benefit in some way from wetland ecosystems. From the perspective of human settlements, wetlands provide flood protection, water quality protection and improvement, and other key services at far less cost than built infrastructure.

Climate Change & Wetland Protection Linkages

While the causes, impacts and advance of climate change have been described in both technical and popular literature for decades, the efforts to link climate adaptation with wetland preservation and restoration are relatively recent. Within the last decade, workshops, publications and research papers focused on Michigan's wetlands have specifically detailed the potential impacts of climate change on wetlands as well as the role wetlands may play in helping communities adapt to climate change.

The Michigan Climate Action Council formed in 2007 (Executive Order 2007-42) and engaged a broad range of technical experts in six working groups to evaluate what was known about climate change and potential options for climate-change mitigation and adaptation. Published in 2009, *Michigan's Climate Action Plan* calls for land-use management that promotes the retention and enhancement of wetlands and promotes permanent vegetative cover in wetland areas to reduce erosion and flooding.[29] Some of the underlying goals for the restoration and preservation of wetlands include:

- Store carbon
- Reduce heat island effect
- Reduce the negative impacts of drought
- Mange flooding and store excess water
- Improve overall water quality
- Recharge groundwater

On June 27, 2008, the University of Michigan and Michigan Sea Grant sponsored a workshop involving 40 representatives of Great Lakes foundations, non-governmental organizations, governmental agencies and universities to examine how to prepare for climate change in our region. Two of the four recommended areas for policy change and development focused on (1) land and zoning authorities of local governments (e.g., low-impact development and green infrastructure); and (2) wetland preservation and restoration. State and regional experiences with climate change impacts in the years since have further emphasized how important these policy and program areas are to the health and well-being of Michigan communities.

In 2010, the Michigan Wetland Association was established "to protect and restore wetlands and associated ecosystems through science-based programs, education and stewardship."[30] The next year, the Association of State Wetlands Managers and MDEQ joined the Michigan Wetland Association in holding a symposium on wetlands and climate change. This symposium was particularly important in fostering a robust and continuing discussion among researchers, wetland managers and others about climate-change adaptation strategies in Michigan. One of the key outcomes was the Christie and Bostwick paper published by the Association of State Wetland Managers in September 2013.[31]

Wetland Preservation & Restoration at the Local Level

While climate change presents significant threats to Michigan's coastal and interior wetlands, recent extreme weather events have helped to emphasize the value of wetland services to the people of Michigan — a value that is difficult to overestimate. Wetlands can be used as powerful tools for combating climate change.[32] Healthy wetlands preserve water quality, slow flooding, reduce the impact of droughts and extreme heat, store carbon, and recharge groundwater.[33, 34] The roles wetlands play or could play in managing the impacts of extreme precipitation events — both flood and pollution control — are becoming increasingly obvious.

To build more climate-resilient communities, municipalities all across the state need to reevaluate the functional roles wetlands play in local and regional watersheds. Funding for drains, pipes and other hardened infrastructure is unlikely to match the increasing need being generated by a rapidly changing climate. Therefore, wetlands and other natural features will play increasingly important roles in controlling flood flows as well as reducing the sediments and pollution that reach rivers, streams and the Great Lakes. We believe that both preservation and restoration of wetlands, wetland buffers, and other natural features need to be incorporated into local master plans, land-use regulations and capital improvement plans in order to for those communities to effectively begin to manage the impacts of the changing climate.

Capacities & Limitations of Michigan's Coastal Municipalities

There are a total of 277 Michigan cities, townships and villages that border on one of the Great Lakes. In many ways, these municipalities control the nature, extent and density of land uses along Michigan's coastline. To paraphrase a statement from *Filling the Gaps* (2nd Edition), these coastal jurisdictions are the last stop for surface pollutants for the entire watershed, serving as the final filtration opportunity before stormwater runoff reaches the Great Lakes.[35]

Most of Michigan's coastal municipalities are relatively small in size, suggesting that they have only limited capacity to inventory, evaluate and manage their wetland resources. The following table shows the total number of cities, townships and villages that border on one of the Great Lakes, grouping them by relative size of population. Clearly, the vast majority of coastal municipalities include relatively small populations. For example, 57 Michigan cities share a border with one of the Great Lakes; the majority of these municipalities have populations of 5,000 people or fewer. Only 18 Michigan cities bordering one of the Great Lakes have populations of over 10,000 people. Of the 196 townships bordering a Great Lake, a total of 167 of them (85%) have populations of 5,000 or fewer people.

Table 1. Relative Size of Coastal Municipalities

	Populations Ranges				
Municipality	**1-2,500**	**2,501-5,000**	**5,001-10,000**	**Over 10,000**	**Totals**
Cities	14	13	12	18	57
Villages	24	0	0	0	24
Townships	129	38	14	15	196
Totals	167	51	26	33	277

As described previously, relatively few of Michigan's municipalities have adopted wetland protection ordinances (less than 3% of all municipalities). Of the 277 coastal municipalities, only four coastal townships and three coastal villages have adopted wetland protection ordinances. None of Michigan's coastal cities have wetland ordinances.

At the same time, *all* but four of the coastal municipalities have some form of wetland within their jurisdictional boundaries (in addition to Great Lakes shoreline). Further, the vast majority of these municipalities contain land areas determined to have high potential for wetland restoration. In other words, all of the coastal townships, 47 of the cities and 18 of the villages include areas of hydric soils that are believed to have had wetlands prior to European settlement.

In summary, it appears that most coastal municipalities have jurisdiction over critical coastal wetland and potential wetland restoration areas, but only limited capacity to manage these resources. To plan and foster climate change adaptation within their communities, these local government leaders may need a good deal of training, technical guidance, and policy support.

Recommendations for Helping Michigan's Coastal Municipalities in Protecting, Preserving and Restoring Wetlands While Adapting to Climate Change

This project was undertaken to identify and evaluate options for helping Michigan's coastal municipalities protect and preserve wetlands in the face of advancing climate change. We have conducted an extensive literature review, numerous expert interviews, and focused discussions with expert groups. We have also completed a policy scan, including a detailed review of planning and regulation options for Michigan's local governments. Finally, we have reflected on LIAA's many experiences in providing direct land-use planning and regulation support to local governments across the state for 20 years and, most recently, under the *Planning for Resilient Coastal Communities Program*. Based on this accumulated information and experience, we have identified a number of ways in which the Coastal Zone Management Program (MDEQ) could join with other organizations to help local governments preserve, protect and restore coastal wetlands a part of their adaptive response to climate change.

Education, Training & Outreach

As described in this report, there are several relatively new methods available to local planning officials for assessing the values and functions of local natural resources. Similarly, there are technical guidance documents to help local officials identify and apply land-use regulations to the preservation and protection of wetlands and other key resources. However, our growing understanding and public acknowledgement of climate change is adding new urgency to wetland preservation and restoration efforts.

- ***Recommendation 1*** – Convene, co-sponsor and/or support community-specific workshops or training programs designed to build local capacity in climate change adaptation options for preserving and protecting wetlands, including options for restoring wetlands to increase community resilience. These workshops could include training and explanations in the use of *Potential Conservation Area* identification techniques to guide local land-use planning; the application of a *Wetland Functional Assessment* to assess options for wetland restoration; guidance on where to find and how to apply for funding for wetland projects; and, regulatory tools for preserving and protecting wetlands.

- ***Recommendation 2*** – Develop an outreach program from MDEQ with the assistance of others to provide "live-person" responses to questions, site visits and direct technical assistance for wetland protection and restoration, and expert advice to municipal planning commissions. This effort might be modeled after the *Wetland Circuit Rider Program* used by Massachusetts' Department of Environmental Quality. Another approach might involve engaging the *Wetland Keepers Program* developed by the Association of State Wetland Managers.

- ***Recommendation 3*** – Revise and update the *Sample Wetland Ordinance* that was developed by MDEQ in cooperation with the Huron River Watershed Council, providing more definitive recommendation that cities, townships and villages adopt some form of this ordinance. In so doing, MDEQ should clearly link wetland protection and restoration to stormwater management and water quality protection.

- ***Recommendation 4*** – Revise and update or completely redevelop the publication, *Protecting Michigan's Wetlands – A Guide for Local Governments* (Tip of the Mitt Watershed Council, 2007). This publication along with several others cited in our literature review should be revisited with climate change adaptation in mind.

Linking Wetland Restoration & Stormwater Management

Climate change will impose a variety of negative impacts on Michigan's coastal and inland wetlands, exacerbating ongoing development pressures. While statewide regulations help assure no net loss of wetlands through mitigation, ongoing land division and development continue to raise concerns over ecosystem fragmentation and the disruption of hydrology.

However, climate change impacts may provide opportunities to increase wetland acreage and rebuild ecosystem connectivity.

Many, if not all, cities and urban areas in Michigan are struggling to manage increasing amounts of stormwater runoff with outdated infrastructure. As one response, urban planners, civil engineers and municipal managers are encouraging the use of green infrastructure, low-impact design (LID) and development alternatives (e.g., porous pavements, green roofs) for more climate-resilient cities. This growing appreciation for green infrastructure, under the duress of climate change, should encourage efforts to restore wetlands that provide key ecosystem services. We suggest that this growing interest in wetland restoration could offer significant opportunities for public education, expanded ecological corridors, and research concerning ecological functions and species succession as the climate changes.

- ***Recommendation 5*** – State and regional wetland managers as well as academics should promote the restoration of wetlands for ecosystem services, even if these projects yield little new habitat value at first. These sites may become key research areas for gaining understanding about species adaptation and replacement as the climate changes. Restored wetlands could contribute to or enhance the connectivity of ecological corridors. Additionally, wetland restoration projects could present opportunities for building a larger, more urban constituency for wetland preservation (e.g., outdoor classrooms, bird-watching venues).

Guidance & Support from State Agencies & Programs

While completing the literature review for this project, we noticed that there is very little discussion about climate change impacts or adaptation to climate change within any of the web pages and instructional materials published by MDEQ and MDNR. Similarly, very few of the published guidance documents (if any) available from the State of Michigan discuss these topics. Climate change is having and will continue to have significant impacts on all of Michigan's natural resources, including coastal wetlands. State guidance and regulatory documents should reflect this reality.

- ***Recommendation 6*** – Encourage and support renewed efforts to review land-use plans and regulations related to wetlands in all coastal municipalities. One approach would be to model the water protection gap analyses completed by the Tip of the Mitt Watershed Council for four counties in 2011. This is a critical starting point for most local units of government.

- ***Recommendation 7*** – Complete a short-term study to better estimate the economic values of Michigan's wetlands as well as cost-benefit ratios for restored wetlands given recent changes in precipitation tables and anticipated climate changes. A possible model for this study is the *Rapid Assessment of the Economic Value of Wisconsin's Wetlands* prepared by Earth Economics for the Wisconsin Wetlands Association.[36]

- ***Recommendation 8*** – Complete Wetland Functional Assessments for all coastal jurisdictions. This landscape-scale functional analysis of wetlands has proven to be a useful watershed planning tool with real meaning and weight for local government officials.

- ***Recommendation 9*** – Provide planning support incentives to coastal communities for incorporating advanced wetland protections into local planning and land-use regulations (e.g., uniform river, lake and wetland setbacks).

Wetland Mapping & Monitoring

Thanks to the Great Lakes Wetlands Coalition and efforts like the Coastal Wetland Monitoring project funded by the GLRI and lead by Dr. Uzarski, there is a growing body of knowledge and expanding capacity to monitor coastal wetland conditions, including types, locations, physical and chemical characteristics, and key indicators. The research community is getting close to providing real-time data on wetland changes. However, it appears that this information is not readily available to everyone. In fact, researchers we contacted were actively limiting who has access to which datasets. While there may good reasons for protecting preliminary, unverified data, selective data distribution that limits access to this data is troubling.

- ***Recommendation 10*** – Provide enhanced access to wetland mapping and monitoring data through the MDEQ Wetland Viewer or some other portal. GIS data files could be provided through the Center for Shared Solutions and Technology Partnerships (Michigan Department of Technology, Management and Budget).

- ***Recommendation 11*** – Work with and support organizations that will interpret and disseminate the wetland monitoring information at some frequency, helping local governments track wetland conditions within their jurisdictions.

- ***Recommendation 12*** – Consider engaging citizens in efforts to monitor changes in wetland flora and fauna at specific locations. Large groups of volunteers have been successfully engaged in surveys of reptile and amphibian populations in the past. Crowdsourcing approaches have also been used effectively in monitoring fundamental environmental changes for years (e.g., pothole reporting, documenting tree locations in Grand Rapids).

Funding for Wetland Preservation & Restoration

As noted above, the vast majority of coastal municipalities have limited resources to support wetland preservation and restoration objectives. Even if the citizens and leadership of these local governments wanted to update their land-use regulations or conduct wetland preservation and restoration work, they are unlikely to have the time and funding to act. Many of these municipalities would benefit from assistance from state agencies and regional community service organizations.

- ***Recommendation 13*** – Work with and support NGOs (e.g., watershed councils, conservation organizations) and regional planning agencies to provide direct assistance to local governments in updating land-use policies and regulations, such as wetland ordinances, setback provisions, and environmental overlay zones.

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