Fresh coast Best coast

Resilient Coastal Communities

Planning Guide

A guide to incorporate local coastal resiliency principles into the community's master plans and ordinances for making wise local development decisions.

EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

MAY 2023

This document was supported through financial assistance provided by the Coastal Zone Management Act of 1972, as amended, administered by the Office of Coastal Management, National Oceanic and Atmospheric Administration.

Water Resources Division
Coastal Management Program

MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

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1. Introduction

Michigan Coastal Management Program

Within the Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division (WRD), the Coastal Management Program Unit (CMPU) administers the Michigan Coastal Management Program (MCMP). The MCMP's mission is to protect, preserve, restore, enhance, and wisely develop the coastal natural resources and cultural heritage on the longest freshwater coastline in the nation. The MCMP was established in 1978 as part of the national Coastal Zone Management Program – a voluntary partnership with the federal government. This national program consists of 34 participating coastal states, islands, and territories in coordination with the National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management (OCM), Stewardship Division, Coastal Communities Program.

The MCMP provides leadership and support for Michigan's coastal communities and their unique ecological resources by offering technical and financial assistance to support environmental stewardship, innovate to address unique coastal challenges, and serve as cooperative partners in economic development. Michigan's coastal communities face unique challenges from erosion, lake level changes, coastal hazards, and seasonal economies. The MCMP assists local decision-makers to plan and implement hazard preparedness systems and supports sustainable, diverse economies.

Planning Guide Purpose

This Guide provides guidance for Michigan's coastal community decision-makers to improve resilience to hazards along Michigan's Great Lakes coast. Long-term planning and zoning are proactive ways to enhance preparedness for the impacts of coastal hazards and account for the variability of the Great Lakes water levels, coastal storms, and changes to our system associated with a changing climate.

On the national scale, NOAA has identified the ability for coastal communities to prepare for and minimize risks to coastal hazards as a national priority. The MCMP seeks to leverage resources and partnerships to build coastal community resilience such that communities are better able to respond and bounce back from the ever-changing conditions of living on Michigan's coast.

***Community resilience* is defined as the sustained ability of a community to understand and use available resources to respond to, withstand, and recover from adverse situations.**

Michigan's state regulations help to reduce impacts to the state's coastal resources, yet local stewardship is essential for a healthy, natural coast. A critical feature for master plans is to adopt resilient principles, identify vulnerable coastal infrastructure, and prioritize areas to target adaptation strategies to protect and preserve those resources. Improved capacity, knowledge, and commitment are needed to increase the number of local master plans and zoning ordinances that directly consider and address local coastal hazard management.

Why Local Action is Necessary

With more than 300 counties, cities, townships, and villages touching a Great Lake or connecting waterway in Michigan (Figure 1) coastal communities have an especially important role to play in protecting Michigan's Great Lakes coast.

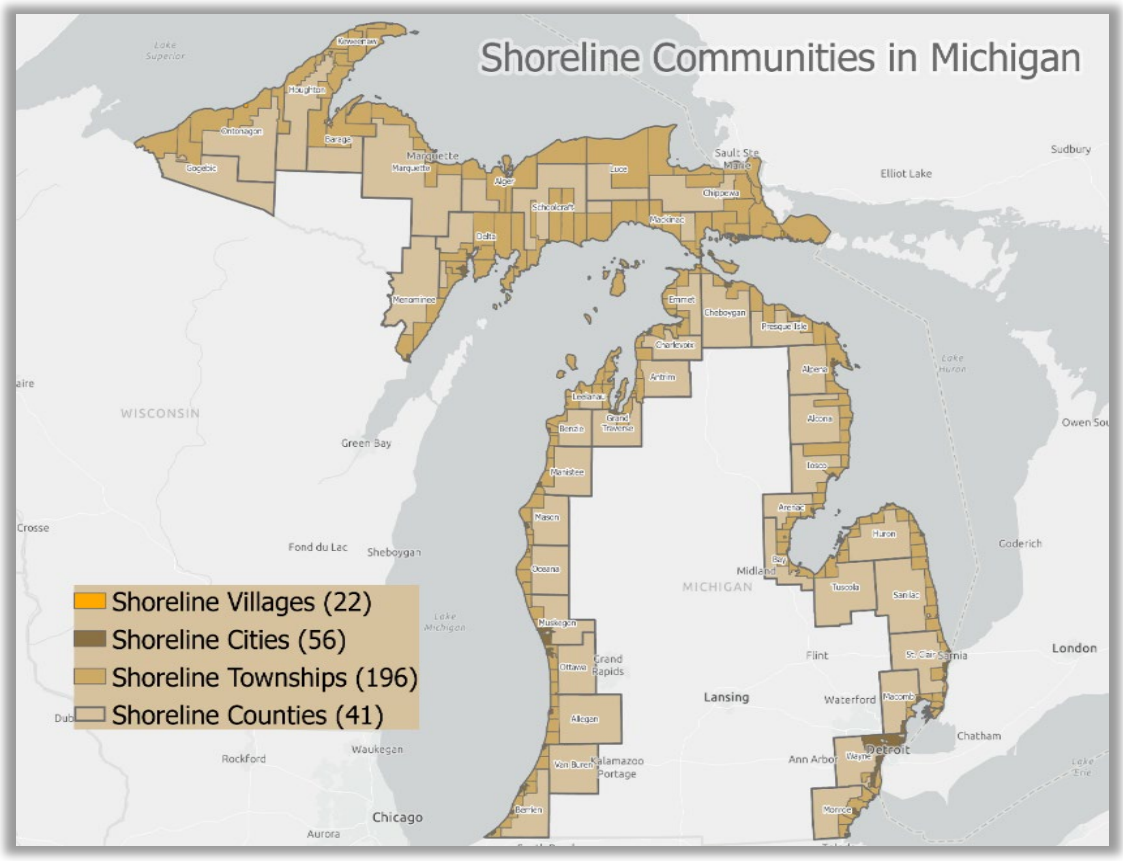

Figure 1. Michigan shoreline communities

The Michigan Planning Enabling Act, Public Act 33 of 2008 (MPEA), and the Michigan Zoning Enabling Act, Public Act 110 of 2006 (MZEA), as amended, give local governments the power to manage land use in their communities. Additionally, providing for public health, safety, and welfare through managing land use in risk-prone coastal areas is a legitimate application of local zoning powers. The MZEA states that local governments can use their zoning authority "…to achieve specific land management objectives and avert or solve specific land use problems, including the regulation of land development and the establishment of districts in areas subject to damage from flooding or beach erosion." (MCL 125.3201(3))

Planning for coastal management and hazards at the local level requires knowledge of both local conditions and state and federal regulations. State and federal programs cannot fully consider local site conditions nor be as informed on the local vision and goals for the coast as can local stakeholders. State and federal programs are also limited in their jurisdictional scope. Therefore, gaps remain that can only be filled through local efforts.

2. Understanding Great Lakes Coastal Processes

Wind-driven waves and currents drive coastal processes along our Great Lakes' coast including the erosion, transport, and deposition of sand and other sediment. Basic understanding of local coastal processes is essential for a community to increase resilience towards coastal hazards. This section provides a high-level overview and access to additional references on coastal processes and hazards.

Great Lakes Water Level Changes through Time

The water level of each Great Lake rises and falls seasonally and changes from year to year. The Great Lakes are connected, yet they do not rise and fall in unison. The lakes have different elevations above sea level with Superior being the highest, followed by Michigan-Huron and Erie. Water generally flows from the high point of Lake Superior down through the lower lakes, and out the St. Lawrence Seaway to the Atlantic Ocean.

Lakes Michigan and Huron are discussed as one lake, with the same elevation measurements because they connect hydrologically at the Straits of Mackinaw. Lake St. Clair is not technically a Great Lake but remains important as a connecting water body between Lake Huron and Lake Erie. Unlike the oceans, daily tidal changes associated with the moon's gravitation pull are not measurable on the Great Lakes.

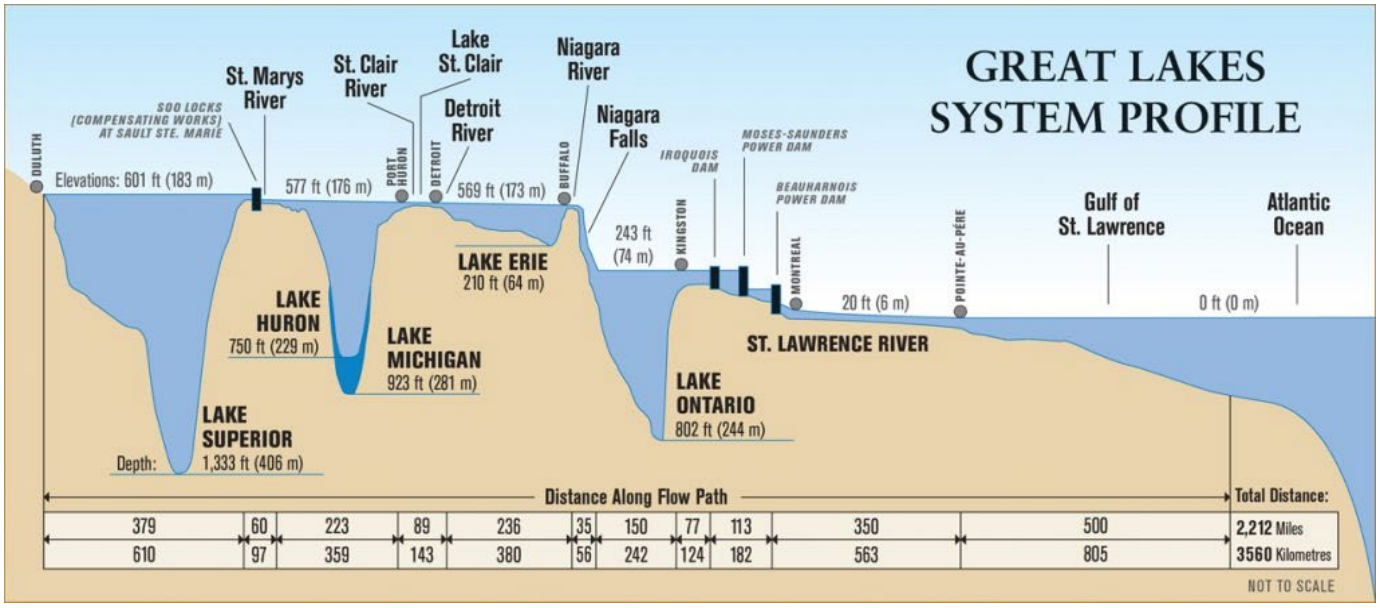

Figure 2. Great Lakes System Profile. (Source: Michigan Sea Grant)

Table 1 shows the range of water levels for each of the Great Lakes and Lake St. Clair that define Michigan. Values shown occurred during the 103-year record of water level observations captured between 1918 and 2021. Notice how the variability in water level ranges for the lakes. Communities along Lake Superior must develop the coast in a way that accommodates approximately 4 feet of change between high and low, while Lake St. Clair communities must deal with more than 7 feet of change. Understand for now that the only constant for lake levels at your local coast is that it will change.

Lake	Minimum Water Level (feet)	Maximum Water Level (feet)	Difference (feet)
Superior	599.5	603.4	3.9
Michigan-Huron	576.0	582.4	6.4
St. Clair	570.5	577.6	7.1
Erie	568.2	574.6	6.4

Table 1: Minimum, maximum, and range of water levels for Michigan's Great Lakes.

The climate is changing in the Great Lakes region. Average temperatures are increasing along with total precipitation and the number of heavy precipitation events or storms. A wealth of regional climate change information is available from the Great Lakes Integrated Sciences and Assessments (GLISA). GLISA is one of 11 regional centers funded by the NOAA. Its role is to build the Great Lakes' capacity to manage risks from climate change.

Consensus among climate experts is that we will experience more intense storms in the region and a higher number of storms. Greater frequency of storms will result in more waves impacting our coasts and more intense storms mean we should also anticipate larger and therefore stronger waves. Rapid changes between extreme high and low water levels in the Great Lakes represent the new normal due to climate change.

How Waves Shape the Coast

Wave interactions with the lakebed near the shore drives local currents. Waves and currents move sand and other beach sediments both along the shoreline and across the shore. Visit a Great Lakes beach regularly and you are sure to notice that vast changes take place both within seasons and over the years. Beaches can change overnight under certain conditions.

Waves may be constructive (beach-building) or destructive (beach-eroding), and the type of wave at a location will change as weather conditions change. Sandy beaches adapt to these changing wave and water level conditions. Beach profiles, the shape of the beach as viewed from intersecting a vertical plane perpendicular to the shoreline, are constantly working to reach an equilibrium where they are in harmony with the forces acting upon the beach. Since the Great Lakes' wave and water conditions are almost constantly changing, the profile is unable to reach such equilibrium for any significant length of time. When beaches are changing shape, they are adapting to the conditions, and by doing so are becoming more effective at dissipating wave energy. Local officials should be aware that sandy beaches are likely to have distinct summer and winter beach profiles. Summer wave conditions tend to be constructive, moving sand onto the beach and tending to form wider recreational beaches. Winter storm waves tend to be more destructive with larger, more destructive waves causing erosion of the recreational beach. The sand that is eroded is typically deposited in the nearshore in the form of submerged sand bars. These sand bars can trip waves moving onshore.

High-energy waves cause many of the impacts to Michigan's Great Lakes coast. Passing storm systems cause water to impact higher up the beach from a combination of wave setup and wave runup. Wave setup is the increased height of the water level that results from high winds essentially pushing and piling water up on the beach. Wind-generated waves moving onshore on top of this setup further increases the height on the beach where waves can impart their power.

As the wave breaks on the beach, the momentum of the water is carried up the beach face. The distance of this runup is largely controlled by the speed and the height of the wave as well as the slope of the beach. The runup height is the elevation up the beach face that the wave can reach.

Beach response to high-energy waves is shown in Figure 3. A natural beach will adjust to high energy waves by flattening so that sediment moves lakeward to form nearshore bars. Once formed, these sandbars can trip incoming waves, reducing the amount of energy impacting the beach. A beach's natural ability to adapt to changing wave conditions is why beaches are the best shore protection. When a beach is starved of sand, or a seawall or other coastal armoring structure is installed, this natural defense mechanism is destroyed.

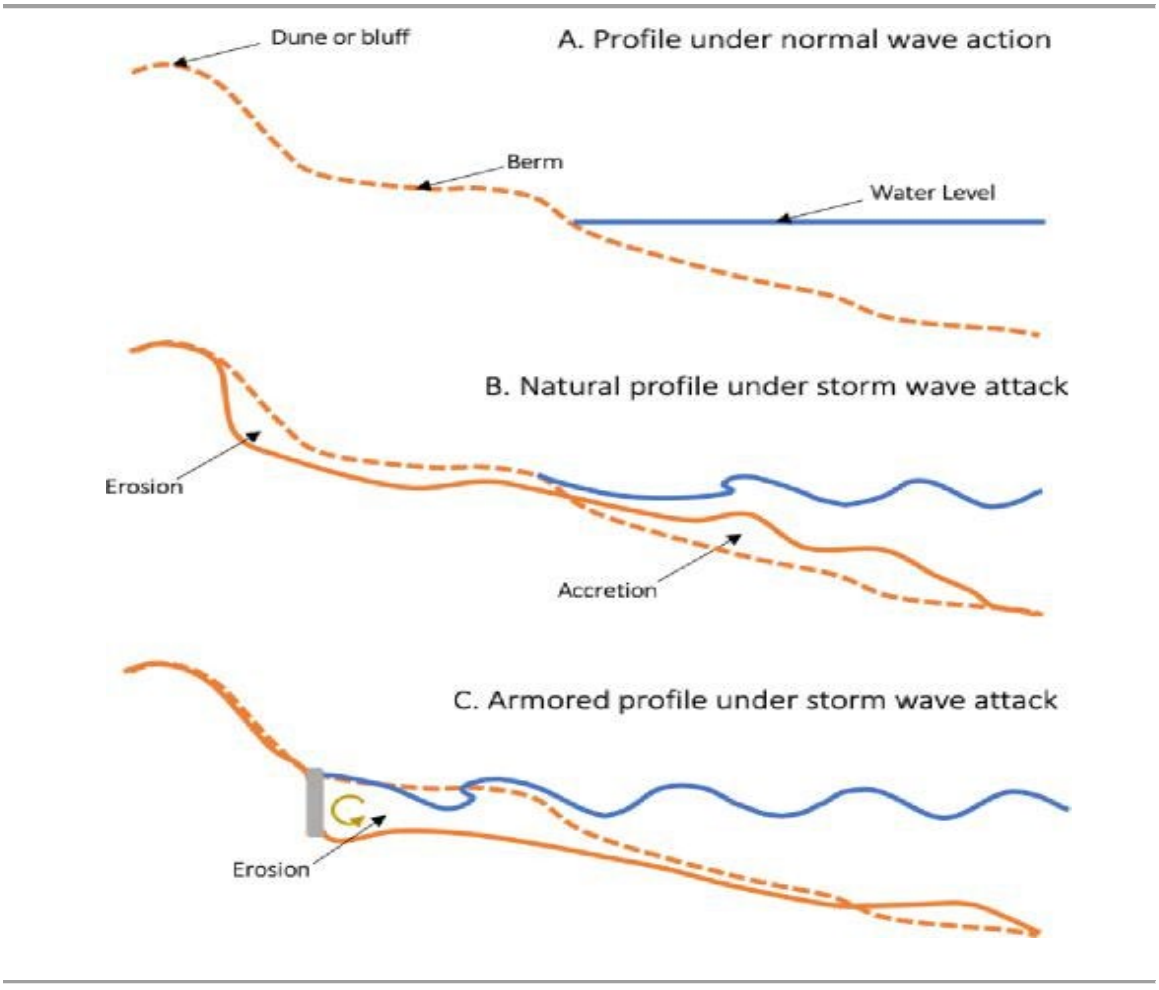

Figure 3. Profile response for natural and armored beaches

Recent advances in how we measure the Great Lakes' wave characteristics can help local coastal management efforts. A map showing average and maximum wave heights show local officials what level of wave energy to expect along their coast and it compares to other areas in Michigan. Maps of average and maximum wave heights are easily viewed in the Great Lakes Aquatic Habitat Framework's Data Explorer (GLAHF). Both maximum and mean wave height data are located under the Mechanical Energy heading in the Data Explorer's list of layers.

Beach nourishment – the adding of sand onto or directly next to an eroding beach.

Longshore drift – sand is transported along the coast parallel to the shoreline. waves approaching the beach at an angle drive the currents and move sand in a zig-zag pattern along the coast.

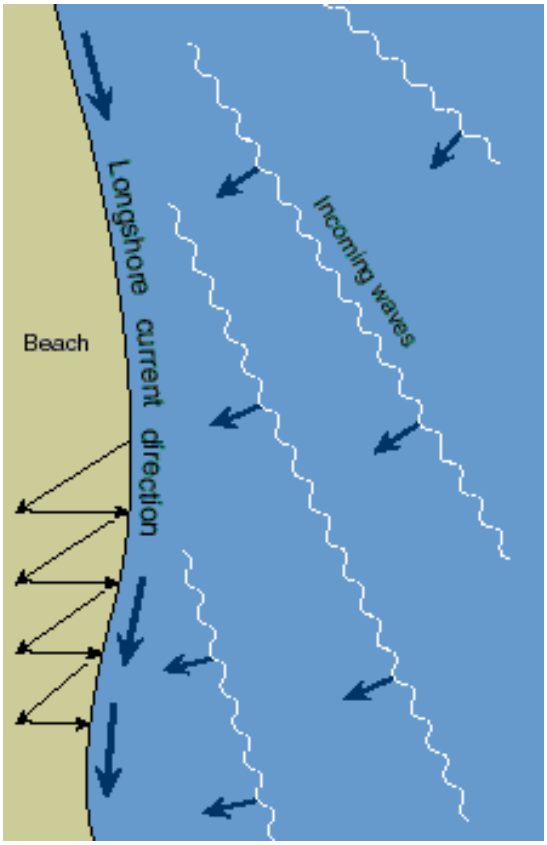

Figure 4. Longshore drift process.
Source: USGS

Littoral cell – a geographic stretch of coast that is self-contained. littoral cells are typically bounded by rock headlands or other structures.

Many offshore buoys collect information at numerous locations in the lakes. Where buoys do not exist, Great Lakes scientists have developed computer models that fill in the gaps such that we can obtain both long-term views of a local wave climate, along with shorter term forecasts of waves expected to impact the coast.Detailed wave data is available from the U.S. Army Corps of Enineers (USACE) and NOAA. The USACE Wave Information Study data is a free dataset that provides high-resolution, comprehensive wave data in a downloadable table format. Local officials are unlikely to directly utilize this data; however, knowledge of its availability may be helpful in determining what level of information consultants are able to provide for site review packages or other local coastal process analyses. Similarly, NOAA's National Data Buoy Center provides free wave data for wave characteristics collected at the system of offshore buoys in the Great Lakes. Data includes minimum, maximum, and mean wave heights.

Growing Beaches vs. Shrinking Beaches

A beach is the gently sloping area of sand and other sediments at the land and water interface. We can all envision our ideal recreational beach with a wide expanse of sugar-sand. While we do have some spectacular recreational beaches in Michigan, the descriptions and mapping of coast types clearly shows much of our coast is not characterized by these wide, sugar-sand beaches. Such beaches exist along Michigan's coast only where there is enough sand to sustain those beaches. These primarily exist in the areas mapped as "Sandy Beach / Dune."

Lake Michigan is home to the largest percentage of such beaches with smaller pockets along Lake Huron and Lake Superior.

Sediment sources to our Great Lakes beaches include:

- Material transported from connected rivers (mostly fine-grained).
- Sediment (gravel, sand, clay) eroded from coastal bluffs and dunes.
- Sediment eroded from the lakebed in the nearshore and transported onto the beach.
- Beach nourishment.
- Longshore drift into the littoral cell.

Beaches lose sediments from the following:

- Transport into deep water from wave or ice action
- Sand trapped by harbor jetties (retained in other littoral cells).
- Sand trapped behind shoreline armoring.

Many of Michigan's beaches are generally starved for beach sediment, meaning they are losing more sand than they are gaining. Factors such as the extent of shoreline armoring, breakwaters, and other structures that interrupt the natural flow of sediment along the shoreline can affect erosion and accretion along the shoreline. Movement of sand across the shore – from the bluff, beach, or dune into the nearshore waters - and in some cases back onto the beach - is important as is the movement of sand along the shoreline. Depth of closure is a key concept for local officials to understand, and one that will play into any coastal sediment budget studies. Depth of closure is the depth of the lake in the nearshore beyond which waves cannot act on the lakebed to mobilize and move sediments towards the beach. Beach sediments that move beyond the depth of closure no longer have the potential to be naturally redeposited on the beach. They are lost to the beach system forever.

Geology Matters - The Importance of Knowing your Community's Shore Type

Michigan's Great Lakes coast has almost every type of shoreline imaginable, from the rock cliffs along the Keweenaw Peninsula to the perched sand dunes along northeastern Lake Michigan, to the low-lying wetland coasts in Saginaw Bay on Lake Huron. This diversity adds interest and beauty but also affects coastal processes and how we should manage hazards. Local geology determines how water level changes and waves are affected as they arrive at the shoreline and shore type and geology directly affect which coastal impacts will occur and need to be managed for any given stretch of coast.

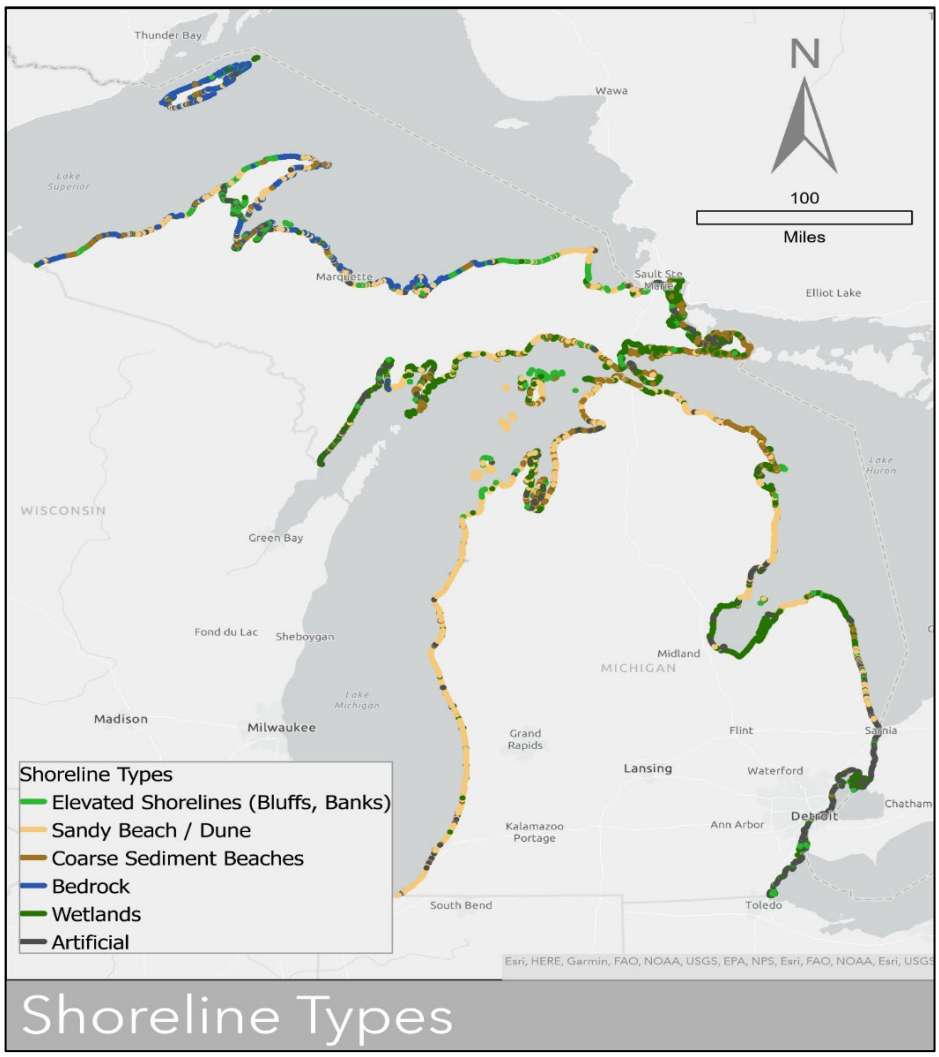

Figure 5. Shoreline types along Michigan's Great Lakes Coast. Source: NOAA Great Lakes Hardened Shorelines Data.

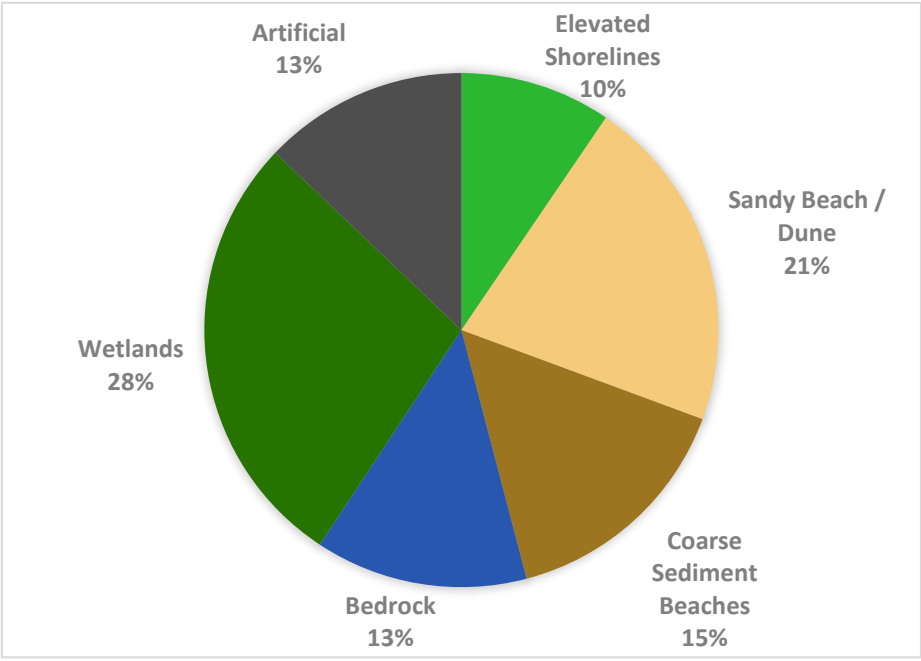

Figure 6. Michigan's Great Lakes Shore Types by Percentage. Values are derived from NOAA's Great Lakes Hardened Shorelines Data.

Elevated Shorelines: Elevated shorelines as mapped in Figure 5 includes high bluff and low bank coasts. The geology in both cases is dominated by deposits from the last glaciation. A wide range of sediment sizes and relatively low amount of sand means that these coasts will tend to be more erosive. The lower volumes of sand results in generally narrow beaches that tend not to widen significantly, even during low-water periods. Development along these coasts have less concern about flooding; however, erosion may be a critical concern for development near the bluff edge.

Sandy Beach / Dunes: Approximately 21% of Michigan's coast is sandy beach or dune. Most are along Lake Michigan. Sandy beaches, such as those that typify the western Lower Peninsula coast, are considered "intermediate" in nature. Between one and three rows of submerged sand bars typically exist just offshore. These sand bars, especially those closer to shore, tend to migrate and will "weld" to the beach at times. Sandy beaches have more shallow slopes than gravel or cobble shores; however, are not as gentle as the silt and mud-dominated "dissipative" beaches of wetland coasts.

Coarse Sediment Beaches: Gravel or cobble beaches are steeply sloping with relatively deep water near the shoreline. Shoreline position is fairly stable through time and will not change as much as sandy or wetland beaches when water levels change. Examples exist near Seven Mile Point along the Keweenaw County coast of Lake Superior.

Bedrock Coasts: Bedrock coasts may still erode or flood depending on the type of rock and elevation of the coast but are relatively stable compared to other shore types. Approximately 13% of Michigan's coast is bedrock – mostly along Lake Superior in the Upper Peninsula.

Wetland Coasts: The most common shore type, wetland coasts are said to be "dissipative" as they are wide and flat with very gentle slopes. Incoming waves tend to break far from the shoreline. Flooding and inundation are the largest management concern. A foot of water level rise may cause the shoreline to move landward hundreds of feet due to the gentle slope. Wetland coasts provide critical habitat and ecosystem services which should be incorporated into coastal management planning efforts.

Artificial: Approximately 13% of Michigan's coast is artificial, meaning that it has been altered by the addition of structures in an attempt to prevent erosion or flooding. Armoring takes different forms, may utilize different materials (including rock, wood, and steel), and is applied along different geologies. Therefore, effects and management considerations are quite variable. Deep water near the shoreline of steeply sloped or armored coasts allow higher wave energies to impact the shoreline, because the waves do not lose energy until they are nearly at the shoreline. The existence of artificial shorelines often indicates areas where significant erosion has occurred and/or development has occurred too close to the water.

3. Data and Tools for Making Informed Decisions

For local coastal community officials to address coastal conditions in their planning efforts, information must be readily accessible with clearly stated steps for use, because each community has different needs and capacity levels. This section provides a range of tools and data sources that can serve all coastal communities.

Great Lakes Water Levels

Discussion and information on water level changes through time should be considered an essential part of coastal communities' planning-related education and public engagement efforts.

Local water level changes should be directly incorporated into the master plan text. The Northwest Lower Michigan Coastal Resilience Atlas includes sample text that is easily tailored and updated for inclusion in any coastal community's master plan. Chapter 2 has a sample master plan chapter to give communities an idea of what sort of content is recommended for a resilient master plan.

Water level data and charts from the USACE, Detroit District are included in the sample plan language. Communities can easily access the USACE Water Levels Information to gather the following key items:

- Historic minimum and maximum water levels.
- Recent trends (e.g., past year, 5-year, 10-year periods).
- Projections – only project out six months, so while interesting will likely have limited value for long term planning.

The Great Lakes Dashboard provided by NOAA's Great Lakes Environmental Research Laboratory (GLERL) is available for communities wanting to explore water level variations in greater detail. This interactive tool allows the user to focus on a specific lake and interactively change the time period of data being reviewed. This makes it easy to focus on a specified past time period and identify trends. Additional Great Lakes hydro-climate information such as ice cover, wind speed, water temperatures, and other climate variables can be pulled from the dashboard for more detailed analyses.

The Great Lakes Lake Level Viewer provides users with an easy-to-use tool for visualizing potential coastal flooding through a range of water levels. The viewer should be used only as a screening level tool for management decisions as it does not account for erosion, subsidence, or future construction. Water levels are shown as they would appear during calm conditions and do not include storm-driven increases in water level or wave impacts. The tool serves as an excellent discussion-starter and high-level planning tool to identify sections of the coast that are prone to flooding. An easy-to-access view of the nearshore bathymetry and topography of the coast is provided through the tool.

The NOAA GLERL has a Water Levels in the Great Lakes StoryMap with detailed information on changing water levels in the Great Lakes. This tool provides good insight on the history of changing water levels and the impact of human influence.

While there are no long-term prediction tools for wind and wave action, the Great Lakes Portal contains information for current wind and wave heights and forecasts a week into the future. Used in tandem with the Great Lakes Lake Level Viewer, this data can paint a better picture of potential erosion and flooding concerns by combining lake levels with the speed and direction of the wind and height of the waves.

Coastal Erosion

Understanding how much, and along what specific stretches, the local shoreline has eroded provides valuable insight on erosion that may be expected in the future.

Michigan Technological University, with support from the MCMP, developed the Great Lakes Shorelines Through Time Coastal Change Viewer. The easy-to-use web-based viewer includes coastal aerial photography dating back as far as 1938. Historic shoreline and bluff line location data from 1938, 1980, 2009, 2016, 2018, and 2020 are available in most locations. More imagery may be added in the future.

Full coverage for the Lake Michigan and Lake Huron coasts is available, while Lake Superior is a work in progress. Lake Erie and St. Clair coverage may be available in the future depending on additional funding. Oblique aerial photographs are also available for most of the Lake Superior and Lake Michigan coasts. While this tool does not predict where the shoreline will be in 10 years, a review of where the shoreline has been over the past century will help inform the community on where the coastline might be during a high-water period or a low-water period.

Some parts of the Michigan coastline fall into the category of High-Risk Erosion Areas (HREAs). The HREA program is administered by the state under Part 323 of the Natural Resources and Environmental Protection Act (NREPA), 1994, Public Act 451, as amended (Act 451), and the purpose is to prevent structural property loss in areas of the shoreland receding at a rate greater than one foot per year. Construction projects require a permit in these areas. Local units of government may adopt a zoning ordinance in HREAs to assume administration of permitting in their jurisdiction. HREA regulations apply to about 8% of Michigan's Great Lakes Coast. In places where HREAs are not present, local governments can implement coastal construction setbacks through local zoning authorities.

For those with access to ArcGIS, the NOAA Office for Coastal Management Digital Coast has a U.S. Great Lakes Hardened Shorelines Classification dataset. This dataset is a useful delineation of the type of shoreline found around the State of Michigan. As some types of shorelines are more prone to erosion, this can be a useful tool to find areas of your local coastline that might be more susceptible to erosion or flooding.

Coastal Flooding

The GLAHF site provides both geospatial data sets as well as an online map viewer allowing easy viewing of Great Lakes habitat and information on the natural physical processes. Detailed data sets such as Great Lakes bottom substrate, fetch, and wave action are available for use and incorporation into a local GIS for communities wanting to conduct a more detailed analysis.

Communities looking for quick and easy insight should use the GLAHF Explorer. The GLAHF Explorer is a web-based map viewer that includes coastal hazards information such as a shoreline classification, lake depths, and maximum and average wave height maps. This tool contains coastal inundation area scenarios, which include high-lake level and estimated wave run-up scenarios.

NOAA Digital Coast offers a Coastal Flood Exposure Mapper that provides the user with information on coastal flood zones and FEMA flood zones. The map offers tools for the user to determine societal and/or infrastructure exposure and inform users on what populations or critical infrastructure would be at-risk in the case of coastal flooding.

The Federal Emergency Management Agency (FEMA) offers coastal floodplain mapping that communities may find useful. This tool provides information on flood zones, Base Flood Elevations, and Special Flood Hazard Areas. Flood zone information can help communities identify which areas are more prone to flood risks and prioritize those areas for action.

EGLE Water Resources Division has a Wetlands Map Viewer that the public can use for quick and easy access to wetland spatial data. This data allows the user to view, print, and export wetland mapping data, which communities may find useful to locate areas that could be more prone to flooding.

Coastal Dunes and Habitat

The Michigan Natural Features Inventory, with MCMP support, developed coastal dune and historic shoreline classification data resources that communities might find useful in conducting vulnerability analyses.

Coastal dunes generally lower the vulnerability from coastal hazards along a coast by acting as a significant source of sand to the beach and nearshore systems and increasing elevations along the coast. Flooding is less likely along these elevated coasts, and wave runup and surge is mitigated by these increased elevations.

Local Vulnerability Assessments may incorporate coastal dune data including the state-regulated Critical Dunes Areas and more holistic coastal dune inventories such as that developed by Michigan State University Extension, Michigan Natural Features Inventory.

Geospatial data sets are available at:

Critical Dune Areas (State of Michigan – EGLE)
Dunes regulated under the State's Critical Dune Act

Coastal Dunes of Michigan (Michigan Natural Features Inventory)
Non-regulatory inventory of coastal dunes. Includes dune classification and health scorecard.

4. Resilient Planning and Zoning

Local Planning and Zoning

Michigan's communities have a great opportunity to exercise their planning and zoning authority towards improved coastal management. Realizing a future coast that aligns with the vision of residents and reducing impacts from coastal erosion and flooding is possible using these powers. In fact, such action is explicitly endorsed in the MZEA as it states, "*A local unit of government may provide under the zoning ordinance for the regulation of land development… including the regulation of land development and the establishment of districts in areas subject to damage from flooding or beach erosion* (MCL 125.3201(3))."

Community resilience begins with a well-crafted, thoughtful master plan that creates a vision for what the community aspires to be in the future. Despite the myriad of issues associated with living on the coast, many of Michigan's coastal communities fail to consider their coastal areas in their master planning or to adopt policies to manage coastal areas. To improve resilience from coastal erosion or flooding, a community can use their master plan to map and analyze these hazards at the local level and set the stage for action.

A community can implement its master plan through a variety of methods, including policy changes, zoning ordinance amendments, permit and plan review requirements, infrastructure investments, and land acquisition. Zoning techniques can be used to mitigate the impacts of coastal flooding, coastal erosion, and other hazards, such as risks of building too close to coastal bluffs and steep slopes by creating location-specific building placement standards.

The MPEA requires local units of government to adopt a master plan as a basis for their zoning ordinance. The Act also requires that the municipality review its master plan at least every five years to evaluate whether to amend, readopt, or replace the plan. This evaluation is a perfect time to use the tools below to identify the hazards faced by the community and update the master plan to support actions that will make the community more resilient.

Scenario-based Planning

Great Lakes water levels fluctuate over the course of years and decades, which produces uncertainty for long-term planning. Scenario-based planning is an important part of resilient coastal planning because it helps tackle this uncertainty by producing several different "scenarios" that can be used to determine the possible benefits and risks to the community from coastal development occurring in high-risk or high-value settings. The American Planning Association describes scenario-based planning as "a process to support decision-making that

helps urban and rural planners navigate the uncertainty of the future in the short and long term. A scenario planning process considers the current reality, forecasts, and internal & external factors to develop a set of plausible potential futures." This type of planning involves developing analyses for three types of climate future scenarios: Lucky, Expected, and Perfect Storm (Figure 7).

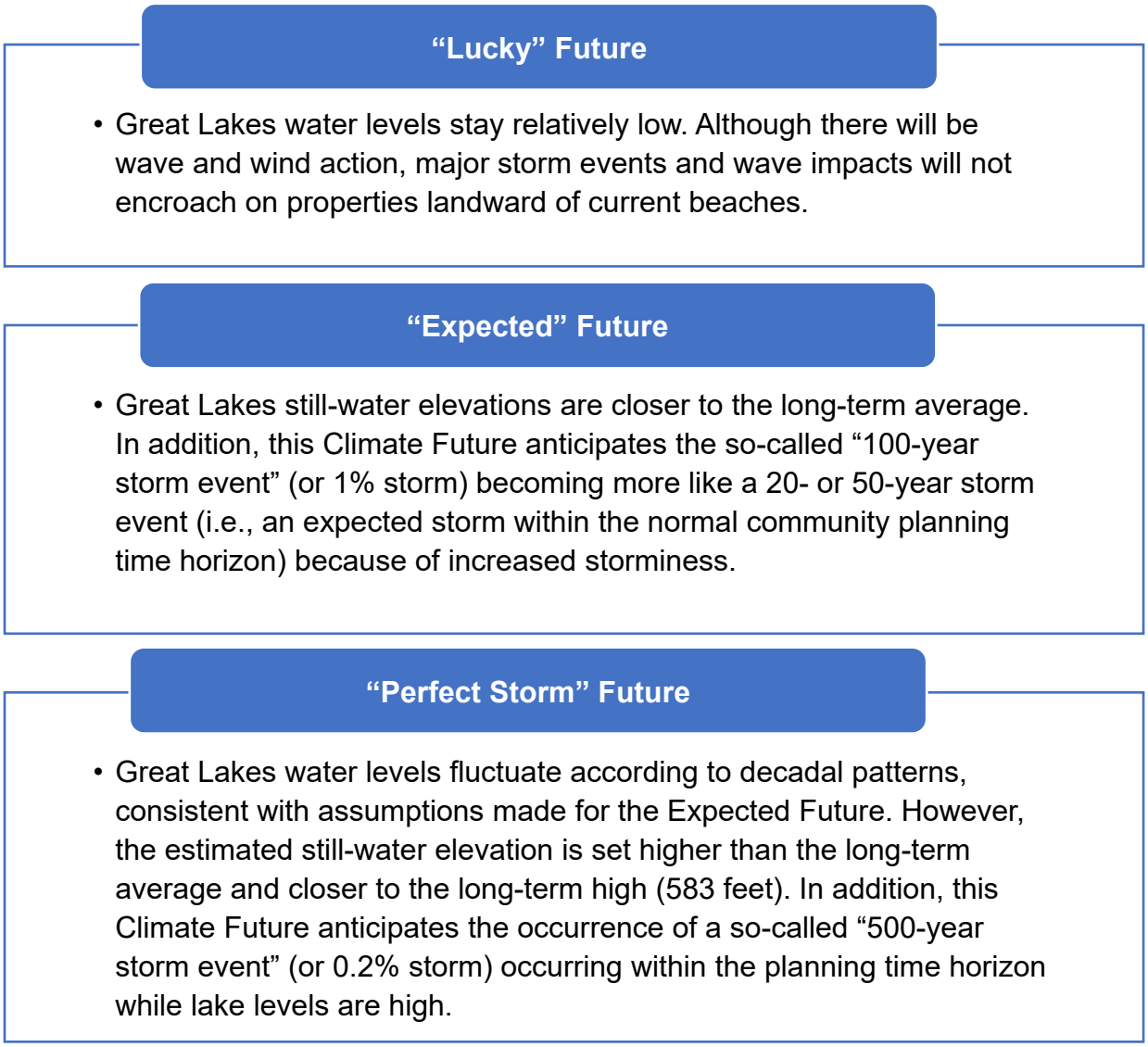

Figure 7. Climate futures for coastal flooding scenarios.

Ranging from best case to worst case, these scenarios represent physical conditions that might be experienced by a coastal community in the future, particularly in coastal shoreline areas. To forecast community needs under these scenarios, a community needs to account for a few things, including:

- Fluctuations in standing lake water levels.
- Unique characteristics of its shoreline areas.
- Current levels of buildout and current opportunities for additional buildout.
- The community's collective vision on how to balance economic vitality and the environment.

The MCMP funded extensive efforts by partners at the University of Michigan to develop methods of analysis for scenario-based planning. The Resilient Great Lakes Coast website contains step-by-step instructions to develop maps showing future local coastal flooding scenarios, such as that shown in Figure 8.

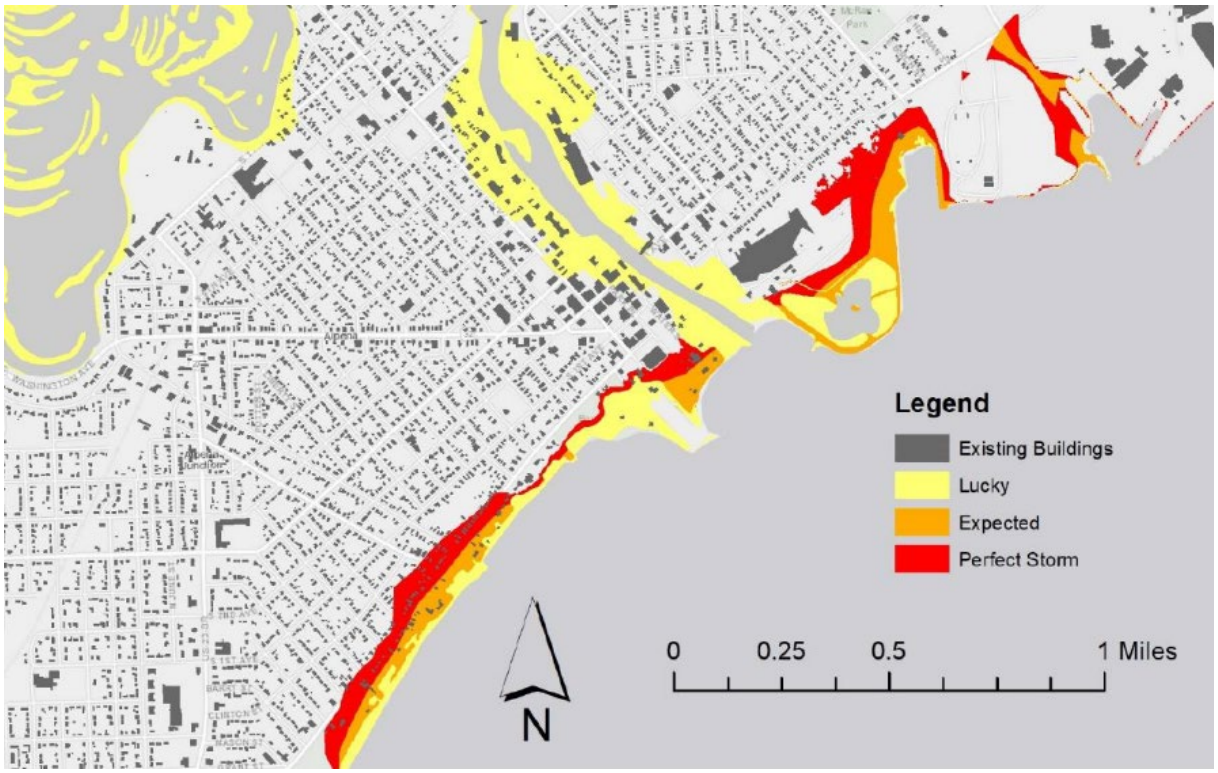

Figure 8. Sample map showing coastal flood scenarios in Alpena, Michigan.

Scenario-based planning analysis and mapping can be developed using maps and tools available to most communities. Local staff and/or consultants will need access to standard GIS technology and readily available data including standard digital elevation model data from the U.S. Geological Survey and floodplain maps developed by FEMA. The resulting maps will show decision-makers the land areas potentially affected under different climate futures, the number of parcels affected, and the number of existing and potential structures that might be directly impacted by coastal flooding under each scenario. The community can use these maps to pursue resilient planning and zoning options that reduce flooding impacts to structures, becoming resilient to the uncertain coastal conditions along the shoreline.

Sustainability Assessment Tool

Through collaboration with the MCMP, the Land Information Access Association (LIAA) developed the Community Sustainability Self-Assessment Tool, which helps Michigan coastal communities identify areas in their master plans and zoning practices to consider updating with resilient principles. Sections on economic, social, coastal, and environmental sustainability help local leaders benchmark their sustainability status across 39 sustainability topics with 254 specific indicators. Using the tool involves working through a series of questions to help the community identify gaps that can be further explored and pursued to increase local resilience.

Communities wishing to focus on enhancing resilience to coastal hazards may want to begin with the Coastal Sustainability portion of the assessment, which includes the elements shown below.

Coastal Sustainability - Self Assessment Elements

- Data gathering and mapping
- Zoning regulations
- Structural design near dunes and bluffs
- House siting
- Critical facilities and infrastructure
- Distaster preparedness
- Bluff and ravine protection
- Professional training
- Hazard planning

Understanding Local Vulnerability

To protect citizens and investments from coastal hazards, a community must first have a good understanding of the people and places in harm's way.

Vulnerability = Exposure + Sensitivity

A Vulnerability Assessment helps identify and prioritize adaptation strategies in the community planning process. "Exposure" refers to the extent or degree to which a natural hazard is likely to affect the natural or built environment. "Sensitivity" refers to how well the resource will fare when exposed to the hazard. Each community's physical location on the coast, geology, and development affect vulnerability. Vulnerability Assessments described here focus on community infrastructure such as roads and publicly owned buildings; commercial land uses; as well as privately-owned houses and other buildings. A good protocol for conducting a Coastal Hazards Vulnerability Assessment along the Great Lakes remains a work in progress. However, scenario-based planning can help identify infrastructure within a community that could be more susceptible to flooding exposure depending on coastal conditions.

The Planning Process

There are three key components of any successful resilient planning process, which include education, community input, and data. For coastal hazards planning, education should include the basics of coastal processes, including the role of floodplains and wetlands, coastal geomorphology, assessment of vulnerable coastal areas, and the role of sand supply & management in sustaining beaches. The community should pull together a technical advisory team including economists, planners, GIS experts, land use attorneys, civil engineers, and

coastal dynamics experts if available, to review the master plan. It may also help to include public works departments and emergency managers. If you do not have the needed expertise in-house, consider seeking help of outside resources such as local universities, nonprofit organizations, regional commissions, or consultants. After this technical advisory team conducts an initial review of the master plan, it is important to engage the community and get comments from local citizens, usually through a citizens advisory committee. It is important to give coastal private landowners, including commercial, industrial, and residential, a chance to provide input and help shape the master plan.

Resilient Master Planning

A master planning process is a unique opportunity in local government to look forward in a holistic way, rather than reacting to coastal hazards as they happen. No one master plan will look the same for every community, but there are some common themes that should be found in any resilient master plan. The inclusion of data on local climate and water level trends is an important section in resilient master plans. Using this data as a framework, a community master plan should include an understanding of its sustainability and any potential threats to its resiliency.

The MPEA requires that a master plan address the general location, character, and extent of waterways and waterfront developments as well as facilities for flood prevention, drainage, pollution prevention, and maintenance of water levels. Resilient master plans should include the following coastal resiliency analysis items:

1. Identification of constraints on building within coastal areas.
2. Identification of High-Risk Erosion areas and other areas subject to erosion.
3. Identification of mapped floodplains and other areas subject to flooding.
4. Identification of coastal natural resource features, such as wetlands, dunes, and beaches.

Identification of these areas and features will give the community an idea of what types of policy items should be considered to help increase the community's resiliency. This forms the basis of a land-use plan which is grounded in spatial data. In turn, the master plan then lays out the policies from which zoning regulations are developed, as required by the MZEA. In this way, zoning controls help development accommodate a community's physical conditions, including its unique coast.

Two specific parts of the master plan that play an important role in this spatial analysis and regulation are the Future Land Use Map and the Zoning Plan. The Future Land Use Map shows the general intended use of each area of the community, which may or may not be consistent with the current use. Where communities wish to reduce the intensity of coastal land use or implement a specialized coastal zoning district, this map lays the policy foundation, connected to supporting text and data in the master plan. The Zoning Plan is then required by the MPEA to explain how each land use category relates to the community's zoning districts and to spell out the changes to the zoning ordinance that would bring it into alignment with the desired future.

Engaging the community needs to be part of the resilient master planning process, as with all master planning updates. A resilient master plan will strive to involve questions that revolve around coastal resiliency.

How is the community resilient? What does the community value and how can resiliency be introduced within these values? Using community input and the assessment of local threats to resiliency, a community master plan should detail a series of goals and objectives that will lead the community to a more resilient future. This definition of goals and objectives should lead to an implementation schedule, created by the planning team, which outlines the who, what, where, and when of the community goals. Progress towards these goals should be measured through annual review of the master plan.

A community may have invested in other planning efforts that address coastal issues and property, such as a Park and Recreation Plan, a Waterfront Redevelopment Plan, or a Watershed Management Plan. In addition, county and local hazard mitigation plans may provide coastal-specific land use recommendations. These are valuable guidance documents and should inform land use decision-making. Because the master plan is the legal document on which land use controls must be based, it is advisable to substantially incorporate their findings into it, whether by reference or by adopting portions of the other plans directly into the master plan.

Implementation of the master plan coastal resilience goals and objectives can be accomplished through the creation or update of zoning ordinances, site development standards and local policies, as well as specific construction projects. In addition, a community's Capital Improvements Plan, which guides public expenditures in infrastructure, is another tool to implement resiliency projects targeted for public lands or transportation networks.

The MCMP has engaged with communities to help develop a resilient master plan update or add a resilient chapter to an existing master plan. The city of Bridgman updated their entire master plan and added a chapter dedicated to resiliency. The counties of Alpena, Emmet, and St. Clair each added a resilient chapter through the Resilient Michigan Collaborative to their existing master plans. All these plans and chapters provide information on Great Lake processes, coastal hazards, and discuss local vulnerability. A resilient master plan will include a few goals dedicated to increasing community resiliency. The city of Bridgman plan outlines four goals dedicated to this concept.

City of Bridgman Goals and Action Strategies for Resiliency

1. The city will be a resource for Bridgman residents on the importance of developing and maintaining a resilient community.
2. Bridgman will be prepared for natural disasters.
3. All residents will have access to affordable, locally sourced foods.
4. The sensitive natural landscapes that distinguish the Bridgman landscape will be protected as context-sensitive development and carefully permitted.

Some Michigan communities possess little or no natural shoreline. Many coastlines on Lake St. Clair and Lake Erie are industrial or artificial. Communities in this situation will find waterfront redevelopment plans more useful. This type of plan focuses specifically on the community's waterfront, crafting a vision statement and goals for the waterfront district. In 2014, the MCMP funded Harrison Charter Township to develop a waterfront redevelopment plan.

At the core of this plan is a Future Land Use Map that incorporates the creation of a mixed-use, walkable downtown with environmental protections along the Clinton River Spillway. These types of plans can help Michigan communities create resilient, vibrant waterfront districts that highlight the local waterbody and create a sense of place.

Resilient Zoning Ordinances

There is no "one size fits all" when it comes to resilient zoning ordinances in Michigan coastal communities. The coastline of Michigan is unique, ranging from long sandy beaches and dunes to high clay bluffs to low lying wetlands. However, there are a few zoning options that a community could consider when striving for coastal resiliency.

Coastal Shoreland District Overlay

A district overlay involves several considerations that a community should study, ideally during the development of the master plan supporting this regulation. First, a tightly defined intent statement for the district needs to be crafted, identifying the unique character and public benefit of the overlay area. Then, the spatial boundaries of the ordinance will need to be established. This can involve a standard distance from the shoreline (e.g., 1000 feet) or a community can use a point based on anticipated erosion distance or area of potential inundation. Second, a dynamic shoreline setback should be considered in the overlay district (see more on this below). Third, the ordinance should consider requirements or restrictions in development and use within the overlay district.

For example, an ordinance could require lakefront lots to extend a substantial distance away from the shoreline to provide ample space for movement of structures landward in the future. Fourth, the district should establish structural requirements to minimize risks to structures from erosion, flooding, and/or heavy storms. Finally, an overlay district could establish provisions to ensure the conservation of environmental conditions like coastal habitats and water quality.

An ordinance could require or incentivize the use of native landscaping and nature-based shorelines in lieu of hard armoring structures and impermeable pavement. Overall, there are several different ways a shoreline overlay district could look, and coastal communities should strive for an ordinance that best serves coastal resiliency in their area.

Coastal Shoreline Setback

Shoreline setbacks involve limiting the distance between development and the coastal shoreline. The community needs to establish the appropriate shoreline features from which to benchmark the setback. This includes features like the water's edge, the Ordinary High-Water Mark (OHWM), coastal property boundary lines, etc. Setback ordinances traditionally rely on set benchmarks like the OHWM or the 100-year flood elevation line. The purpose of a setback is to protect the property from coastal erosion, protect the waterbody from polluted runoff, and to help maintain the natural appearance of the coastline and preserve natural features and local beaches. Given the dynamism of coastlines, some communities may be interested in pursuing a dynamic shoreline setback. This type of setback is not set on a fixed point but can shift depending on where the shoreline moves. Communities should be cautious in crafting dynamic shoreline setbacks as interpretation issues can arise, leading to the potential for a court to find the regulation arbitrary.

Resilient Ordinance Examples

The city of St. Joseph developed ordinance language to acknowledge the detrimental impact of seawalls and other shore protection structures constructed in response to erosion. The city established a Floodplain Overlay District to protect property adjacent to floodplains and an Edgewater Beach Overlay District to prevent damage to the public trust beach and private property. The ordinance can be found in Zoning Ordinance IX Section 9.5, 9.6, and 9.7.

The city of Manistee established a setback from any natural or human-made water feature. The ordinance, found in Zoning Ordinance Article 5, Sections 505, requires additional setback from bluff lines to mitigate or prevent erosion.

The city of Grand Haven implemented two ordinances, a Sensitive Areas Overlay District and a Beach Overlay District. These ordinances are designed to limit development/redevelopment in floodplains and along the shoreline as well as limit armoring of the shoreline. The ordinance can be found in Zoning Ordinance Article IV, Sections 40-422.02 – 40-422.06.

While a full overlay zoning district is the most comprehensive coastal land use regulation, other standard natural feature protections can also support coastal management. These include wetland protection ordinances, floodplain management ordinances, and preservation-focused zoning districts for undeveloped areas. Communities should keep in mind that the development of zoning ordinances should be grounded in the community's master plan and zoning plan.

5. State and Local Regulatory Considerations

State and local regulations have a part to play in management options on Michigan Great Lakes coasts. This section is dedicated to covering important coastal regulations and laws.

EGLE Resource Program Regulations

State regulations are in place along Michigan's Great Lakes coast to protect our natural resources, public trust interests, and infrastructure. Michigan's environmental acts, including those related to coastal resources, were consolidated into the NREPA. EGLE's Water Resources Division administers the following Parts along with associated administrative rules, where applicable:

- Part 325, Great Lakes Submerged Lands
- Part 353, Sand Dunes Protection and Management
- Part 323, Shorelands Protection and Management
- Part 301, Inland Lakes and Streams
- Part 31, Water Resource Protection, and the National Flood Insurance Program
- Part 303, Wetlands Protection

Public participation is an important part of the permitting process. Public notices are issued by EGLE for projects that involve Wetlands, Inland Lakes and Streams, and Great Lakes Bottomlands when a proposed project might negatively affect public trust resources or when the scope and scale of a proposed project requires special consideration. The public notice is sent to neighboring property owners and the local unit of government. It provides an opportunity for individuals with proper standing to weigh in on the proposed project and use of public trust resources. A public hearing may also be held depending on relevant regulatory Part, project characteristics, and level of public interest.

Local governments in Michigan have the option to locally-administer the state's Critical Dune Areas Program, High-Risk Erosion Area, and Wetlands Programs. Doing so requires creation of a local ordinance that meets all the state's requirements, along with prior approval by the state. By playing an active role in implementing state regulations the local unit of government can apply their local knowledge towards coastal resource management and potentially streamline the permitting process for residents.

Great Lakes Submerged Lands

The Great Lakes Submerged Lands Program regulates construction activities along 3,288 miles of Great Lakes shoreline and over 38,000 square miles of Great Lakes bottomlands. It regulates a wide variety of activities, extending from the middle of Michigan's Great Lakes, along our boundaries with adjoining states and the international boundary with Ontario, Canada. State jurisdiction extends up the beach to the respective Elevation-Based High-Water Mark (E-OHWM). The E-OHWM is the landward extent for state permitting of regulated activities on the shoreline or on Great Lakes bottomlands.

These elevations are based on the USACE International Great Lakes Datum of 1985, and are as follows: Lake Superior, 602.6 ft.; Lake Michigan-Huron, 580.5 ft.; Lake St. Clair, 575.3 ft.; and Lake Erie, 572.2 ft.

Typical projects regulated include filling, dredging, and structural alterations lakeward of the E-OHWM. Most shore armoring structures such as seawalls, revetments, sandbags, and groins are regulated under this program, which have major implications for coastal resilience planning.

The state has jurisdiction and provides protections under the Submerged Lands Act from the E-OHWM out to the middle of the lakes. Two significant challenges arise from the use of the E-OHWM: (1) projects might be conducted higher up the beach, outside of the state's regulatory authority, that still adversely impact the beach, and (2) although the specified elevations in Part 325 don't change, the position of the E-OHWM moves over time as the beach changes in shape due to erosion and other coastal processes. Fluctuating lake levels on a seasonal, annual, and decadal time period together with changes in beach widths and elevations from erosion and other processes means that the jurisdictional line may move landward or lakeward hundreds of feet in the matter of months to a few years.

The limited landward extent of the E-OHWM and associated state jurisdiction, along with the extent to which this line shifts position over time creates jurisdictional gaps in the state's ability to preserve dynamic beaches. Coastal communities have the authority through local planning and zoning to fill these gaps.

Critical Dune Areas

The Critical Dune Areas Program provides protection for approximately 74,000 acres of Michigan's 230,000 acres of coastal dunes. Coastal dunes exist on Lakes Superior, Michigan, and Huron. In 1989 the Michigan Legislature identified the dunes to be protected in the atlas of critical dune areas. The dunes protected are along the coasts of Lake Michigan and Lake Superior. Typically, the protected dunes are closest to the shoreline, meet specific criteria, or represent a special plant community. The regulated area includes the beaches to the water's edge. Regulation within a critical dune area strives to ensure that proposed projects do not increase erosion, decrease stability, or diminish the diversity, quality, functions, and values of the dunes.

An EGLE permit is required for development, silvicultural or recreational projects that propose to alter the physical characteristics of the dune or changes to the contour of the land. Typical projects include: the construction of a new house, an addition to an existing house, installation of a deck, construction of a revetment to address an eroding shoreline, or moving sand that has buried a driveway.

Local units of government may assume administration of the state's Critical Dune Area Program by passing an ordinance; however, the ordinance cannot be more restrictive than state law. Currently there are four local governments with authority to administer the state's Critical Dune Area Program. EGLE periodically reviews the local programs to ensure their administration is consistent with state law.

High-Risk Erosion Areas

The High-Risk Erosion Areas Program determines setbacks on eroding shorelines for the purpose of protecting structures from falling in the lakes. When structures are setback a safe distance from the eroding shoreline the natural coastal processes continue building and maintaining beaches. The expense and maintenance of shore protection is not necessary. This is a savings for the property owner and a benefit for the shoreline. Coastal construction setbacks are implemented for those shorelines with long-term coastal recession rates averaging one foot per year or more. The setbacks are based on local historic recession rates, so those stretches of coast that have eroded relatively fast in the past will have larger required setbacks. Approximately 250 miles of Michigan's shoreline is currently designated as being in a high-risk erosion area. Erosion of the shoreline is a natural coastal process necessary for providing the sand and sediment to build and maintain Great Lakes beaches.

An EGLE permit is required for construction of a permanent structure proposed anywhere on a property in a designated high-risk erosion area. New houses, additions to existing houses, garages, outbuildings, swimming pools or decks with a roof or walls, and septic systems all require permits. Two required setback distances are identified on each designated property. A 30-year setback applies to structures built to specific criteria allowing them to be easily moved if threatened by erosion. The 60-year setback applies to larger structures and septic systems.

Like the Critical Dune Area Program, local units of government may adopt an ordinance and receive EGLE approval to administer the High-Risk Erosion Area Program locally. Benefits of local implementation include the ability to apply more protective setbacks that reflect the community's values and shoreline characteristics. Coastal communities may also implement coastal construction setbacks outside of the state's high-risk erosion areas, through their zoning ordinances. An ordinance with setbacks that reflect the local community's sense of place, economy and citizens will set the framework for a healthy and thriving shoreline.

Inland Lakes and Streams

The Inland Lakes and Streams Program protects the natural resources and public trust interests for Michigan's inland lakes and streams. State permits are required prior to activities such as dredging, filling, constructing structures, building a marina, or interfering with the natural flow of water on an inland lake or stream at or below the OHWM. The OHWM on inland waterbodies is identified on-site by the presence of a distinct change in the character of the land.

While the name references inland lakes, the program remains relevant to coastal resilience because regulated water bodies under this act include many of the Great Lakes' connecting waterways such as the St. Mary's, St. Clair, and Detroit Rivers. Great Lakes estuaries, often referred to as the drowned river mouths, such as Lake Macatawa, Muskegon Lake, Lake Charlevoix, and Lac La Belle are also protected under the Inland Lakes and Streams Program. Great Lakes water level changes directly affect the water bodies listed above even though they are regulated as "inland lakes."

During the recent episode of high Great Lakes water levels, many of the significant flood impacts were felt along the shores of the Part 301 estuaries. These estuaries often serve as the heart of development, business, and tourism in our coastal communities. Therefore, flooding potential along these coasts is of great interest and is a primary focus within the scenario-based mapping and planning presented later in this guidance document.

Coastal communities may enhance inland lake and stream protections provided for by the state program through implementing local ordinance provisions. Additional information and options for local protection are provided in: Protecting Michigan's Inland Lakes: A Guide for Local Governments. Communities may also promote the use of natural and nature-based shoreline protection projects. Knowledge and options for implementing such projects on inland lakes have been advanced in recent years – in large part through efforts of the Michigan Natural Shoreline Partnership.

Floodplain Management & the National Flood Insurance Program

Approximately 300 miles of Michigan's Great Lakes mainland is subject to coastal flooding. All mapped floodplains, including those along the Great Lakes coast, are regulated by the local communities under the State Building Code. The current building code in Michigan requires that new construction or substantially improved buildings within the 100-year floodplain have the lowest floor, elevated at least one-foot above the 100-year flood elevation.

The requirements and standards for flood-resistant construction within the building code result in every Michigan community having floodplain construction regulations which are considered by FEMA to comply with the minimum National Flood Insurance Program (NFIP) regulatory construction criteria. In addition, permits are required for certain construction, fill or alteration activities within the floodplain under Part 31, Water Resources Protection and Part 323, Shorelands Protection and Management, of the NREPA.

Michigan also participates in the NFIP, with coordination at the state level housed within EGLE's Water Resources Division. NFIP regulations require that the most recently published Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) be used as the basis for regulation. FEMA's Great Lakes Coastal Flood Study is producing updated Digital Flood Insurance Rate Maps (DFIRMs) for coastal counties around the Great Lakes. The updated Coastal Flood Study will provide a better estimate of coastal flood hazards and risks for much of Michigan's Great Lakes. The FIRMs produced by FEMA, including updated DFIRMs, through the Great Lakes Coastal Flood Study will serve as the controlling maps identifying areas managed under the state's building code and regulations when they are made effective. Local communities are required to update local ordinances to incorporate the updated flood maps once they are made effective.

Wetlands

Michigan's Wetlands Protection Act defines a wetland as: "a land or water feature, commonly referred to as a bog, swamp, or marsh, inundated or saturated by water at a frequency and duration sufficient to support, and that under normal circumstances does support, hydric soils and a predominance of wetland vegetation or aquatic life." Wetlands play a vital role in recreation, tourism, and the economy in Michigan, and therefore their protection is of interest to coastal communities.

Important functions and values provided by wetlands include water storage that can help prevent flooding, providing valuable habitat, purifying storm water as it runs off the land, and helping reduce erosion along low-energy shorelines. According to state wetlands law, 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 more than 5 acres in size.
- Has the documented presence of an endangered or threatened species under Part 365 of the Endangered Species Act of 1973, Public Law 93-205.
- Is a water of the United States as that term is used in section 502(7) of the Federal Water Pollution Control Act, 33 USC 1362.
- Is a rare and imperiled wetland.

A state permit is required prior to performing certain activities in regulated wetlands including the following:

- Placing of fill material in a wetland.
- Dredging or removing soil or minerals from a wetland.
- Constructing, operating, or maintaining any use or development in a wetland.
- Draining surface water from a wetland.

Surface water and ground water levels are of critical importance to wetlands and as such directly impact the nature and location of those wetlands. It follows that wetlands along the Great Lakes coast are affected as the Great Lakes rise and fall. Providing adequate space and setting back development so these wetlands can maintain their dynamic nature and migrate with water level variations is of great importance.

A local unit of government can regulate wetlands by ordinance, in addition to state regulation, if certain criteria are met. Advantages of implementing local wetland protections include the ability to protect small, isolated wetlands not covered by state or federal regulations. Local wetland protection can take many forms. Some communities integrate wetland protection provisions into their site plan review process while other communities maintain comprehensive, stand-alone ordinances. Additional information, including a Wetland Protection Guide for Local Governments and Sample Local Wetland Ordinances, is available at EGLE's Local Wetland Protection web site.

Public Trust Doctrine in the Great Lakes

The Public Trust Doctrine is a common-law doctrine that establishes public rights in navigable waters and along our Great Lakes' beaches. Coastal waters, bottomlands, and shorelands have historically been used as common areas for food, travel, and commerce. Based on this fact, the Public Trust Doctrine balances public and private rights, interests, and uses. Public Trust Doctrine concepts date back at least to the Roman Empire and were also recognized in English common-law. Early American colonial courts generally followed English common-law.

As the United States of America grew, each state further refined the doctrine through its Legislatures and courts to best fit their unique circumstances and societal needs. Given the importance on the shipping of goods, colonial and early state Legislatures encouraged the development of the shoreline for commerce and industry.

A coastal property owner typically holds title down to the water's edge. However, the state retains public trust interest for the portion of the beach landward of the water's edge and lakeward of the N-OHWM. Essentially, there is overlapping ownership interests between the coastal property owner and the public at the beach for certain uses such as beach walking.

Decades of development eventually led to cumulative impacts that reshaped the coastal environment. In response, to preserve and protect navigation, federal and state governments began to regulate the construction of wharfs and piers. More recently, increased development pressures of private, residential ownership on the shoreline have had similar detrimental effects. In the case with private property, states can no longer assume public access to the shore, and are being forced to consider public trust responsibilities differently.

Regardless of ownership, the Great Lakes' navigable waters and the lands beneath are subject to a public easement under the Public Trust Doctrine. However, the public's ability to access these public trust lands is not limited to the location of the Elevation-Based Ordinary High-Water Mark (E-OWHM), which is the jurisdictional line under the Great Lakes Submerged Lands Act. Rather, a second OHWM is defined through case law and tailored for the public's use of public trust lands at the coast. The public trust OHWM is identified based on natural conditions observed on the shoreline and is referred to as the Natural Ordinary High-Water Mark (N-OHWM). The N-OHWM determines where the public may access and recreate on coastal

public trust resources -- mainly beaches. When identifying the N-OHWM, certain physical characteristics must be considered, such as changes in soil composition or stratification, evidence of persistent wave action, and vegetation changes.

When natural forces cause accretion, erosion, or reliction for coastal property, the title of the littoral owner follows the shoreline under a “moveable freehold.” In Michigan, moveable freehold interest refers to the recognition that the boundary line at a Great Lakes’ shore separating the state’s property interest in bottomlands, and conversely a littoral property owner’s property interest in uplands, moves lakeward and landward over time as the shoreline itself moves in response to natural processes. Figure 9 is a simplified visualization of the spatial relationship between coastal lands under public trust and littoral private ownership in Michigan and as compared to other Great Lakes states.

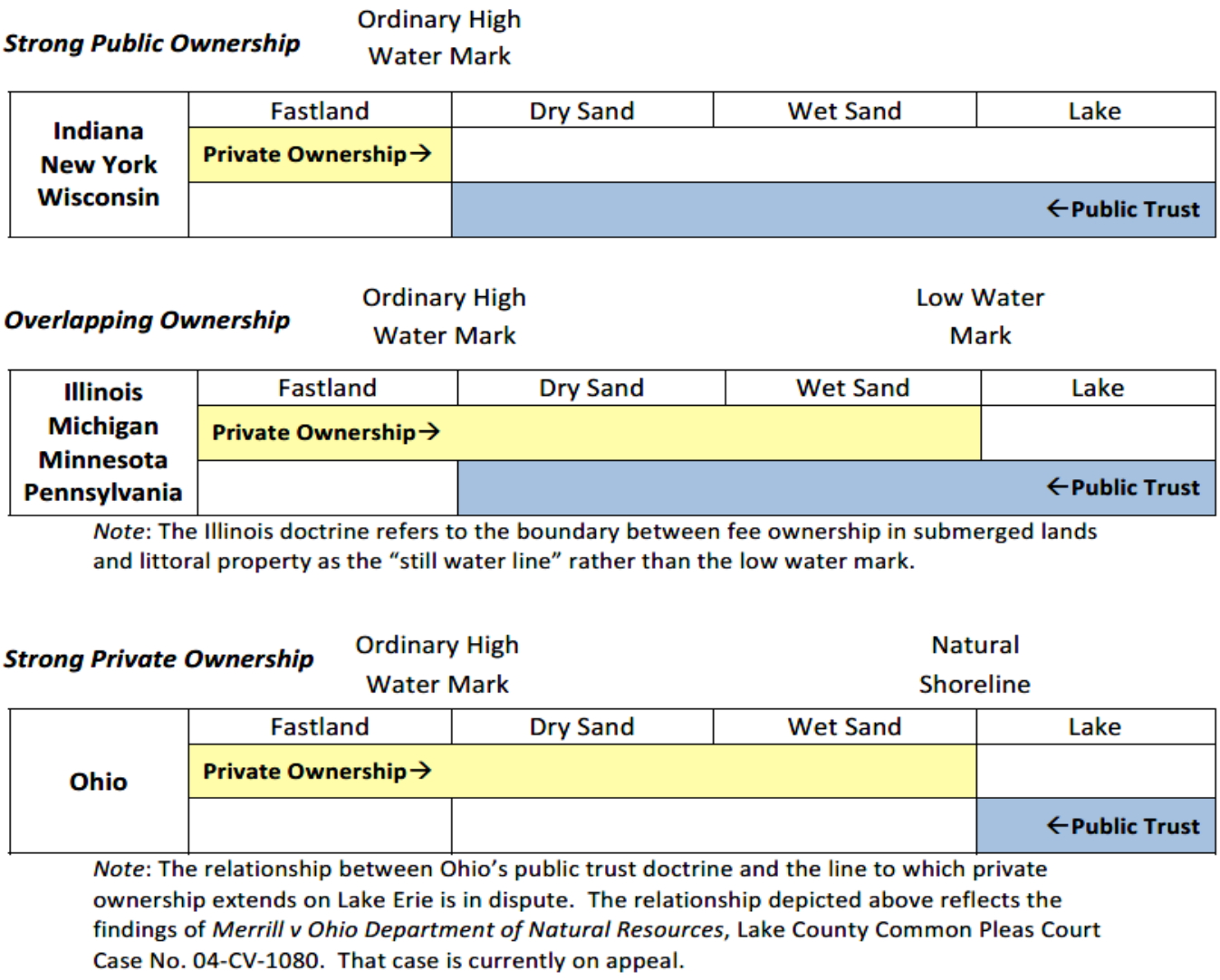

Figure 9. Schematic diagram illustrating the public trust and littoral property ownership boundaries in the Great Lakes states. Fastland, also called upland, refers to land that is high and dry near water (From Norton et. al., 2009, Lake Level Dynamics in Michigan’s Great Lakes: Implications for Shoreline Management Policy and Law).

Balancing the publics' interest in public trust resources with the rights of private property owners continues to be a contentious issue in coastal management in Michigan and nationally. While the state is responsible for protection of the public trust along Michigan's Great Lakes coast, the nature of public trust uses is in part dictated by land use decisions at the local level and individual property owners.

6. Creating a Pathway to Resilience

Resilient Communities are those that are prepared to withstand and recover from Great Lakes coastal erosion and flooding events. Through resilient planning, coastal communities can prepare to absorb and adapt to changes in Great Lakes water levels, coastal storms, and floods; manage social and environmental changes; and build a better and more reliable local economy. With technical and financial assistance from the MCMP, Michigan's coastal communities can achieve resiliency goals that will help them respond and recover from coastal hazards.

Living along the Great Lakes coastline comes with an abundance of natural hazards ranging from Great Lakes' high-water levels increasing coastal flooding and erosion while low water levels threaten the navigability of harbors. The MCMP is working to help build and sustain community preparedness and promote resiliency to mitigate the impacts of coastal hazards through increased knowledge of the risks, wise planning and zoning practices, and capacity building. The Pathway to Resilience is a strategy that focuses efforts to enhance community preparedness and promote resiliency to mitigate the impacts of coastal hazards. The following outlines actions a community can take to become more resilient to coastal hazards:

1. Participate in a MCMP Coastal Leadership Academy (CLA) training module.
2. Conduct a sustainability assessment of the community master plan to identify gaps in resiliency approaches.
3. Update the master plan with a Resilient Chapter and formally adopted via Michigan Law.
4. Adopt resilient policies and ordinances such as setback and no build zones.
5. Install resilience adaptation strategies such as nature-based alternatives to traditional hardened shore practices that respect riparian rights and protects public trust.

The CLA is a free technical training offered by the MCMP and available to coastal communities as the first step in developing coastal resilience. Developed with the help of the Michigan Association of Planning, the purpose of the CLA is to bring community leaders together to share the coastal resilience challenges they are experiencing throughout their communities and learn strategies that can help address those challenges. The CLA is currently comprised of three training modules:

- Scenario-Based Planning and Zoning.
- Nature-based Solutions to Reduce Coastal Risks.
- Adaptation Strategies for Coastal Hazards (to be launched in 2025).

This planning guide along with the Building Coastal Resilience Video Series found on the MCMP's Michigan Resilient Coast webpage provide the foundation for resiliency principles promoted throughout the CLA.

Resilience Adaptation Strategies

The MCMP is developing a toolkit of adaptation strategies to increase knowledge on resilient policies, nature-based solutions, and prudent alternatives to hardened shoreline structures. As part of the toolkit, a technical guidance document will describe natural coastal processes along Michigan's varied coastline. It will provide communities a deeper understanding of how various types of shorelines respond to forces of wind and waves, as well as how sediment moves along the coast. Communities along the coast face various risks from the natural hazards of coastal erosion, flooding, stormwater management, and urban heat. Together, the technical guidance document and adaptation strategies will enable communities to identify appropriate actions based on their specific shoreline type and hazard.

Both community-wide and site-specific strategies will be addressed. Solutions will focus on zoning and ordinance options, as well as nature-based solutions and softer shoreline techniques. Additional strategies such as relocation of assets, shoreline restoration, and removal of failed hardened structures will be explored.

The toolkit will expand on the role that local communities play in protecting natural coastal features, guiding prudent development, and limiting shoreline hardening. Though water levels are receding, now is the best time to plan for the next Great Lakes high water cycle. More than 2,000 permits for shore armoring were issued along Michigan's Great Lakes coast in 2020.

Communities have the difficult task of finding a balance between protecting private property rights, upholding the public trust, and preserving the natural shorelines that define Michigan's coastal communities. The toolkit will provide a backdrop for local communities to begin these conversations as they envision what they wish to see as they walk down their shorelines 20, 30, or 50 years from now.

Benefit of Nature-Based Solutions

Nature-based solutions refer to best practices that are supported by nature and offer environmental, economic, and social benefits while increasing resiliency. Nature-based solutions are sometimes also referred to as natural or green infrastructure practices. The impacts of coastal hazards can be reduced by using nature-based solutions. They allow communities to prepare for rather than react to coastal hazard events leading to improved community resilience.

Examples of Nature-Based Approaches

- Rain gardens or bioswales
- Street trees
- Living shorelines
- Dune Restoration
- Wetland creation for flood control and to slow the flow of stormwater

Nature-based solutions are not yet widely used along Michigan's Great Lakes coast. Improved understanding about designs suitable for our Great Lakes setting are needed along with education and social acceptance.

Funding Opportunities

Impacts from coastal hazards have negative financial impacts on citizens and communities. Therefore, increased community resilience from those hazards has financial value. The challenge is that increasing resilience is not free. The good news is that planning, and visioning can plant the seeds for implementation projects that make real difference on the ground. Inaction is not a good option, as research has shown that with respect to preventative hazard mitigation, the cost of inaction is much greater than the cost of implementing resilience measures.

The MCMP offers an annual grant funding opportunity with a call for proposals in the fall of each year. Consider seeking an MCMP grant to help fund a community coastal resilience plan or to incorporate resilience principles into your community's master plan. Importantly, this funding opportunity includes development of local coastal resilience planning efforts as an eligible activity.

NOAA provides a quick reference guide called Funding and Financing: Options and Considerations for Coastal Resilience Projects containing information about various types of funding and financing for coastal resilience projects. "Funding" refers to money that pays for a resilience effort but does not have to be repaid while "financing" includes an obligation to repay the money (along with interest in most instances).

Another excellent resource is the National Association of County's (NACo) Local Government Guide to Coastal Resilience Funding. The NACo guide is especially helpful for identifying funding and financing for implementation activities such as adaption, mitigation, and recovery efforts. Like the NOAA Funding and Financing Reference, the NACo guide informs about tools such as taxes and fees, bonds, and grants. Specific grant program opportunities available at the federal level such as NOAA's National Coastal Resilience Fund are detailed as are Foundation and Corporate grants such as the National Fish and Wildlife Foundation's National Coastal Resilience Fund.

Visit Michigan.gov/CoastalManagement to learn more about the MCMP.

Visit Michigan.gov/ResilientCoast for program contacts, resilient resources, the Building Coastal Resilience video series, as well as other training resources.