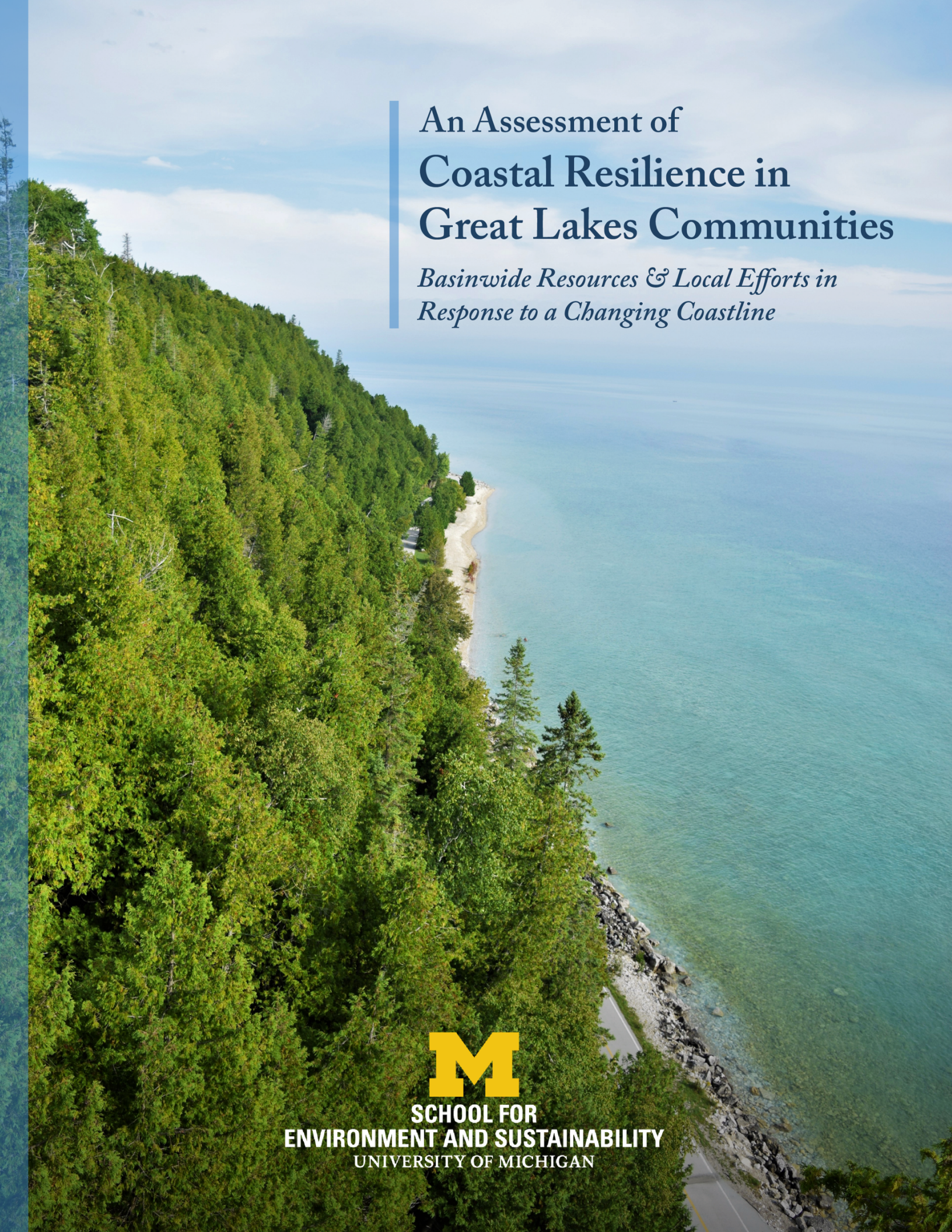

An Assessment of Coastal Resilience in Great Lakes Communities

Basinwide Resources & Local Efforts in Response to a Changing Coastline

SCHOOL FOR ENVIRONMENT AND SUSTAINABILITY
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Executive Summary

As the largest freshwater system in the world, the Laurentian Great Lakes and St. Lawrence River watershed is an essential resource that drives the cultural, ecological, and economic well-being of Central Canada and the Midwestern United States. However, climate change threatens the way of life, ecosystem health, and economic prosperity of the Great Lakes region. Sustained high water levels from 2017 to 2020, unusually low water levels in 2013 and 2014, and a noticeable increase in storm magnitude and frequency have alerted Great Lakes government officials of the high risks for coastal communities due to climate change.

High water levels and increased storms have piqued interest and inspired action on shoreline protection and management across the Great Lakes region. While some municipalities began implementing measures, such as improving stormwater management and installing shoreline armoring, many communities face barriers in assessing risk, choosing appropriate projects, obtaining funding, implementing plans, and collaborating with other coastal communities. Resource providers and organizations supporting local coastal efforts also struggle to effectively assist communities.

To better understand these challenges we employed two research methods: digital research and interviews. This involved the compilation of two libraries - a resources library with over 1100 sources of resilience-focused information and a funding library with 130 available funding opportunities. We conducted interviews with 41 Great Lakes basin municipalities on the status and challenges of resilience work along their shorelines and 11 interviews and two focus groups with resource providers. This research highlighted existing gaps and identified potential approaches to improve implementation of coastal resiliency measures at a local scale.

Municipal interviews revealed the obstacles many communities face. Residents influence their local government's response to changing shoreline conditions by supporting or stifling action depending on the recency of catastrophic events and personal values and experiences. As a result, decision-makers are faced with the possibility of incurring debt and a short window of opportunity before coastal resilience is no longer urgent to community members and the impetus to make change disappears. Confusion over potential climate change impacts and whose responsibility or authority it was to implement shoreline protection was also shared with us. Interviews revealed an equity disconnect; municipal staff could identify the vulnerable members of the community but did not recognize it as an equity issue. Coastal municipalities also struggled to carry out resilience actions due to a lack of staff capacity to identify funding, evaluate resource options, and prepare effective applications. The relationships municipal staff formed with resource providers and funders, other communities, outside contractors, and with other

department staff influenced their ability to successfully apply to grants, collaborate with other communities, and develop comprehensive plans and grant proposals. Balancing many responsibilities, municipal staff often do not have the time, energy, nor training required to properly manage coastal projects. Other constraining factors included information overload - municipal staff not knowing what resources to use or who to contact for assistance - and the siloing of information across different agencies in the Great Lakes basin. Both prevented information sharing, which hindered actions or produced redundancies.

The resources assembled covered a variety of topics but mostly focused on adaptation planning, flood mitigation, and educational materials on climate impacts on coastal systems. The number of state-specific resources was relative to the length of their coastlines, with Michigan and Wisconsin possessing the most resources. The majority of resources were in English, and only one-fifth of resources mentioned social equity. Federal and state/provincial agencies created over 50 percent of the available resources, which were often for use by elected officials and staff, specifically planners.

Due to the variability and unpredictability of climate change, there is an immediate need to address these issues and support binational Great Lakes coastal communities. The Infrastructure Investment and Jobs Act is a once-in-a-generation opportunity to utilize federal infrastructure spending to implement critical shoreline protection measures such as green infrastructure. Various federal and state-level agencies and regional non-profits may be uniquely positioned to provide outreach and aid to local communities through technical knowledge, project management, and financial assistance. Drawing upon this research, we propose recommendations to incorporate equity into projects, conduct long-term planning and monitoring to improve the reactions and responses of decision-makers, utilize a hub to disseminate available resources, and educate communities on coastal processes and solutions. Overall, improving access to funding and information on financing options, educating staff on grant writing, and encouraging the collaboration amongst municipalities on projects would increase successful implementation. Finally, to overcome limitations of capacity, resource providers can improve access to technical assistance and assist in fostering relationships across boundaries and the Great Lakes basin to enhance communication and information sharing.

Land Acknowledgement

Over the course of time, more than 120 First Nations and Native American nations and people have called the Great Lakes and St. Lawrence River basin home ("Native Peoples of the Great Lakes Region", no date). This has included the ancestral, traditional, and contemporary lands of the Anishinabewaki (Ojibwe), Menominee, Očhéthi Šakówiŋ, Bodéwadmiké (Potawatomi), Odawa, Hoocąk (Ho-Chunk), Niúachi, oθaakiiwaki·hina·ki (Sauk), Meškwahkiašahina (Fox), Wyandot (Anderdon), Kiikaapoi (Kickapoo), Kaskaskia, Peoria, Myaamia (Miami), Erie, Ho-de-no-sau-nee-ga (Haudenosaunee), Onundagaonoga (Onondaga), Odǫhwęja:deˀ (Cayuga), Onöndowa'ga' (Seneca), Onʌyote'a•ka (Oneida), Wenrohronon, Michif Piyii (Métis), Mississauga, Attiwonderonk (Neutral), Petun, Mississaugas of the Credit First Nation, Wendake-Nionwentsïo, Caldwell First Nation, Cree, Kanien'kehá꞉ka (Mohawk), Omàmìwininìwag (Algonquin), Nitaskinan (Atikamekw), Wabanaki (Dawnland Confederacy), Wolastoqiyik (Maliseet), Abenaki / Abénaquis, Arosaguntacook, and Mi'kma'k. Their lands were taken forcibly through unfair treaties and forced removal by white settlers in both Canada and the United States.

We also acknowledge the University of Michigan's origins through an 1817 land transfer from the Anishinaabek, the Three Fires People: the Odawa, Ojibwe, and Potawatomi as well as Fox, Peoria and Wyandot. We acknowledge that our research at the School for Environment and Sustainability has benefited and continues to benefit from access to this land originally gained through the exploitation of others.

We, the authors, recognize that this acknowledgement is solely the beginning of the work that must be done. Simply knowing the land's history does not undo the past, but understanding and acknowledging the history, culture, and impacts of colonial practices is the first step. Beyond this project, we will be committed to this work for all future endeavors. By writing this, we hope that this report and any outcomes influenced by it will encourage Great Lakes and St. Lawrence River communities to actively work towards an equitable, sustainable, and resilient future.

Source: (NativeLand.Ca, no date)

Acknowledgements

We would like to thank Dr. Paul Seelbach for his invaluable advice, guidance, and knowledge through every phase of this 16-month project. His patient and attentive mentorship has prepared our team for thoughtful careers in the environment and beyond.

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We would like to thank the University of Michigan School for Environment and Sustainability for the opportunity to conduct this research as part of our master's capstone project.

The extent of our research would not have been possible without funding from the Great Lakes Restoration Initiative, which supported our summer research efforts.

Lastly, we are greatly appreciative of the time and effort contributed by municipalities and organizations across the Great Lakes and St. Lawrence River as we conducted our research. Thank you.

Acronyms & Definitions

CMP: State Coastal Management Program

Equity: The fair treatment and involvement of all people and communities—regardless of race, gender, national origin, or income level—in the development, implementation, and enforcement of environmental laws, regulations, and policies (The U.S. Federal Government 2016).

FEMA: Federal Emergency Management Agency

GLSLCI: Great Lakes and St. Lawrence Cities Initiative

NFIP: National Flood Insurance Program

NOAA OCM: National Oceanic and Atmospheric Administration Office for Coastal Management

Resilience: The ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events (National Academies 2022)**.**

UM SEAS: University of Michigan School for Environment and Sustainability

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Introduction

The combined watersheds of lakes Superior, Michigan, Huron, Erie, and Ontario and the St. Lawrence River comprise the Great Lakes and St. Lawrence River basin (hereinafter referred to as the Great Lakes basin or basin). This term is all encompassing of the shoreline, water, and the coastal communities that reside within the watershed delineation. As the largest freshwater system in the world, this region is an essential resource that drives the cultural, ecological, and economic well-being of Central Canada and the Midwestern United States (SOM 2014). Spanning over 94,000 square miles, the Great Lakes basin encompasses eight U.S. states: Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin and two Canadian provinces, Ontario and Quebec (Michigan Sea Grant 2022). Binationally, the Great Lakes basin is home to over 120 indigenous communities, 34 million residents, and 3,500 species of plants of animals, including over 170 fish species (Michigan Sea Grant 2022).

The Great Lakes basin houses a massive freshwater system; the daily discharge rate from the St. Lawrence River is the second highest outflow rate of any river in the United States, with only the Mississippi River discharging more water per day (U.S. Geological Survey 2020). This flow is managed through a series of locks and dams upstream that carefully control outflow in response to lake water levels influenced by climate patterns. The health of these lakes and rivers has been long understood to have direct impacts on the quality and quantity of water that flows out of the St. Lawrence River and into the Atlantic Ocean, with consequences for pollution, sediment transport, harmful algal blooms, water temperatures, and coastal marine ecosystem function (Drinkwater 1986; Twiss et al. 2022).

Between 2017 and 2020, the Great Lakes region experienced high precipitation and river inflow leading to record high lake water levels (Gronewold and Rood 2019b;USACE 2021; Environment and Climate Change Canada and U.S. National Oceanic and Atmospheric Administration 2021). These high water levels led to coastal flooding and erosion, damaging critical coastal infrastructure and disrupting shipping and recreational use of the lakes (Environment and Climate Change Canada and U.S. National Oceanic and Atmospheric Administration 2021).

The upper Great Lakes water levels generally follow a 13-year cycle, which may be prompting many local officials to view higher water levels as expected, inhibiting plans to prepare for physical damage to homes and properties during high water (Watras et al. 2014; Vega and Warner 2020). This lack of planning for cyclical water events is enabled by local zoning codes and regulations, which often are not regularly updated to reflect trends in water level cycles (Norton and Meadows 2014). Thus, resilience planning at the local level depends on both private and local governmental forethought, which can be dependent on recent hydrological cycle conditions and their impacts on residents and local officials.

Before these events, there was a general concern for protecting both nearshore private and public property from coastal hazards but little impetus to act (Norton and Meadows 2014). The events of 2017-2020 spurred a renewed interest in lake levels and in property protection for many coastal communities and managers. Many property owners urgently sought to protect their properties with revetments and shoreline armoring practices that can disrupt the nearshore ecology and the physical processes that form beaches and dunes (Norton et al. 2018). While some coastal municipalities tried to regulate armoring efforts and provide zoning regulations, some homeowners were resistant (Norton et al. 2018).

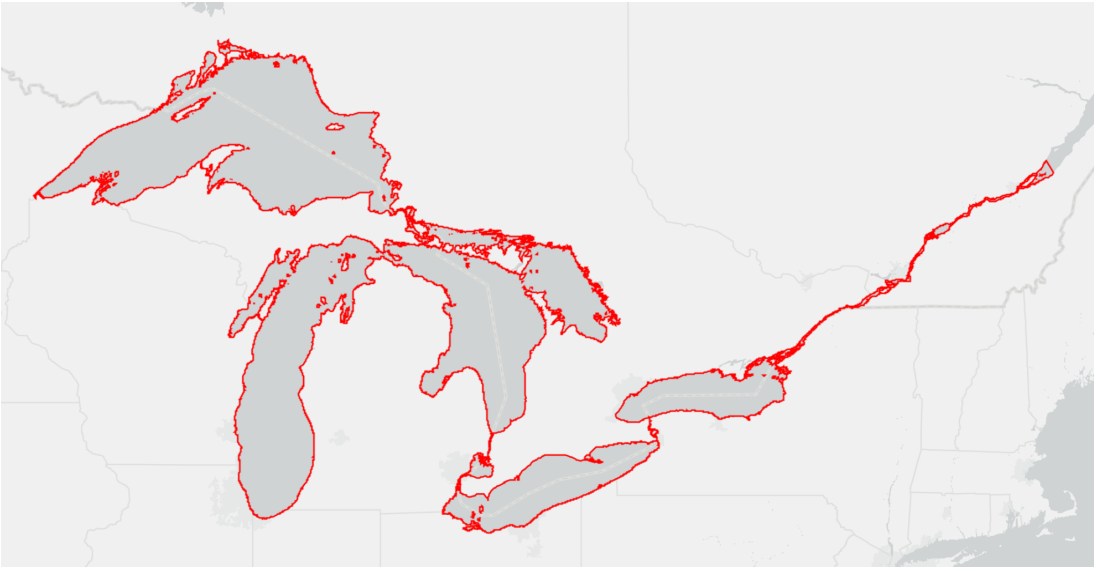

Figure 1: A map depicting the coastal community study area of this report.

Given the wealth of natural resources and large geographic area, the Great Lakes basin powers a robust economy of $3 trillion in annual GDP while supporting 30 million residents (National Oceanic and Atmospheric Administration, Office for Coastal Management, no date). If considered a country, the binational basin would be the third largest economy in the world (CIGLR 2018). An array of industries including manufacturing, agriculture, and mining rely on the basin's waters for shipping and transport, irrigation, and hydropower (SOM 2014; CIGLR 2018). Several of these sectors have negative impacts on the lakes, such as industrial uses and agriculture. However, other industries, like tourism, recreation, and municipal water services, depend on the ecological stability of the lakes, but have little impact on the lakes themselves (Campbell et al. 2015).

Many experts speculate that some cities in the Midwest and Great Lakes basin could face increased populations and economic activity as people relocate from other regions of the U.S. facing more intense effects of climate change (Blue, no date; Pierre-Louis 2019; Steuteville 2022). The abundant water-related resources and industries and history of binational trade also make the Great Lakes region attractive to businesses. Most recently, a meta-analysis by the Place Initiative conducted an assessment of flood and climate risk exposure with infrastructure factors in the Great Lakes basin, suggesting this area may be well-suited to accommodate incoming climate migrants (2022). Projections from the 2019 EPA and Environment Canada annual report show populations have already been increasing along Lake Michigan, Lake Huron, and Lake Ontario (EPA, Environment and Climate Change Canada). Many

cities like Pittsburgh, Duluth, Buffalo, and Cleveland have been profiled in the media as self-branded "climate havens" or "receiver-cities," in hopes of attracting potential migrants to boost their economy (Pierre-Louis 2019). However, the region still faces difficulties due to deindustrialization and institutional factors that may pose challenges in the event of an influx of climate migrants (Sullivan and Jacobson 2021). Additionally, the Great Lakes region may not become the climate refugia it is predicted to be if it cannot address its own climate issues.

As water and air temperatures, storm severity, and frost-free season length increase due to climate change, the way of life, health of ecosystems, and prosperity of economies within the Great Lakes basin are threatened (Mason et al. 2016). When compared to the rest of the United States, the basin has seen more intense average temperature increases over the last 60 years (Mason et al. 2016; Wuebbles et al. 2019). Moreover, the frequency and intensity of severe storms has increased, resulting in higher precipitation over the Great Lakes basin (GLISA 2019). The increase in storm intensity and frequency has the potential to greatly stress coastal community budgets as they become stretched to meet the staggering costs of repairing inadequate and damaged coastal infrastructure (USGCRP 2017). The area is expected to continue to see wetter winters and drier summers and reduced lake ice coverage (GLISA 2019). On top of the natural decadal cycle of lake water levels inherent in the Great Lakes and St. Lawrence River system, variability in water levels is increasing with more frequent swings between highs and lows (Gronewold and Rood 2019a). These hydrologic disruptions will be of the utmost importance to continue tracking to inform coastal management decisions.

Climate change adaptation and resilience have become increasingly popular topics of research and guidance (Sietsma et al. 2021). The wealth of existing knowledge and data on climate change and resilience should be useful in supporting strategies and decisions about coastal resilience at local, regional, and national levels. However, many municipalities find this abundance of information overwhelming and struggle to find information that is meaningful to inform decision-making. Many agencies agree that climate data and community knowledge are critical assets in finding solutions to resilience problems (Kiker et al. 2011).

Though there are many resources available to local municipalities, many lack the organizational capacity to access and utilize this information to develop resilience plans of their own or incorporate resilience measures into their existing comprehensive and resilience plans (Norton et al. 2018). A lack of coordination at the local level and across government levels adds to this problem. Further, physical climate systems and government systems rarely share boundaries. This can be especially challenging in the basin where climate resilience efforts require coordination between eight U.S. states and two Canadian provinces (Vega and Warner 2020)

Many states delegate planning for coastal resilience to local governments, often at the municipal level (Norton and Meadows 2014). Without higher level guidance, local governments vary in the extent to which they actually address coastal resilience, creating a heterogeneous pattern of involvement and interest. This patchwork action is unlikely to come together at the scale needed to really address resilience issues across the entire basin. Without coordinated action, punctuated action along the shoreline will push wave action to neighboring municipalities and will leave other communities vulnerable (Gittman et al. 2016; Posts et al. 2021).

Though municipalities may currently lack capacity to implement coastal resilience measures, funding from the recent infrastructure bill, the U.S. Infrastructure Investment and Jobs Act of 2021, may help

provide financial support. It provides millions of dollars for infrastructure including roads, water systems, and electrical grids to U.S. communities (Infrastructure Investment and Jobs Act of 2021). One of the bill's objectives is to make U.S. infrastructure resilient to climate change and extreme weather events such as floods, droughts, and wildfires. The bill also increases funding to FEMA's Building Resilient Infrastructure and Communities (BRIC) Program and the State Clean Water Revolving Funds. In the bill, the House Committee on Natural Resources allotted $25.6 billion in environmental conservation and climate mitigation measures, including $9 billion for coastal and Great Lakes restoration and climate resiliency projects. ***The bill has the potential to provide once-in-a-generation federal funding for resilience projects, such as green infrastructure, and may finally facilitate long-term municipal resilience planning.***

Social equity is also often overlooked in coastal resilience programs. Planning and resource distribution for hazard events and the immediate impacts of erosion and flooding typically benefit some groups over others (Hemmerling et al. 2020). Planning and implementation decisions are often made without the full participation or consideration of those most affected or those who lack adequate representation in decision-making processes. Thus decisions often have unintended consequences, overlook essential knowledge that could be useful in finding the best solutions, and perpetuate or worsen conditions for poorly represented groups (Yumagulova 2011; Hemmerling et al. 2020).

PROJECT OBJECTIVES

To address the challenges and opportunities in Great Lakes coastal resilience, we explored existing resources, examined the current state of coastal resilience programs in the Great Lakes, and identified barriers to implementation. Our objectives were to:

Objective 1: Compile and assess existing coastal resiliency information resources and funding opportunities.

To understand the breadth of current resources available and assess their usefulness to practitioners, we will compile accessible resource and funding libraries for municipal coastal resilience practitioners.

Objective 2: Identify enabling and constraining factors (e.g., regarding communication, funding, or focus) of local coastal resilience work in the Great Lakes and St. Lawrence River basin.

To capture practitioners' understanding and view of coastal resilience programs and needs, we will conduct interviews and focus groups with representative practitioners across the basin.

To further understand and identify how equity is addressed in existing coastal resilience work, we will incorporate diverse perspectives in our interviews and focus groups. We will also explore how equity is incorporated in local resilience programs.

Objective 3: Make recommendations to local governments and Great Lakes and St. Lawrence River practitioners for how to effectively and collaboratively advance future coastal resilience work.

To combine our collected knowledge about existing resources for coastal resilience and the perspectives of coastal resilience practitioners, we will provide a set of recommendations to federal, state, and other governmental agencies and organizations regarding effective implementation of coastal resilience programs.

Methods

The data we collected fall into two broad categories: (1) data provided by federal, state, regional, and local agencies and organizations, referred to as "resource provider" data; and (2) data provided by local government staff, referred to as "implementation" data. Resource provider data highlight the experiences of individuals and organizations generating and disseminating technical, financial, and programmatic resources to support implementation efforts. Implementation data capture local coastal resilience measures, challenges faced by local coastal managers, and impacts of lakeshore coastal dynamics and coastal flooding across the Great Lakes basin.

COMPREHENSIVE RESOURCES LIBRARY | *OBJECTIVE 1*

We compiled a comprehensive library of information resources on coastal management and coastal resilience decision support tools. Two researchers identified over 130 relevant U.S. and Canadian organizations as potential sources of informational resources (Appendix A). The organizations consisted of, but were not limited to, federal agencies, state and provincial agencies, local governments, non-profits, think tanks, academic institutions, consulting firms, and planning agencies from the United States and Canada. We reviewed the organizations' web pages, toolkits, documents, and existing resource libraries to collect relevant resources for inclusion. Recommended resources were also received during our interviews (see below).

Upon selection, each resource was cataloged and characterized using 22 attributes (Appendix B). Several attributes provided objective information including: name, organization, language, access instructions, and date created. We also created several subjective attributes, including: time investment required to use the resources, reading level, and the resource's consideration of other relevant topics (e.g., climate change and social equity). We also identified the primary and secondary topics addressed by each resource using the coastal resiliency topics established in Question 9 of the Cities Initiative's coastal resilience needs assessment survey (Appendix C).

Following the compilation of resources, we used Google Sheets to conduct a quantitative analysis of the resource library. We used the 22 attributes to describe and evaluate the ecosystem of coastal resilience informational resources in the Great Lakes and St. Lawrence River basin, including an assessment of gaps and needs.

RECOMMENDED RESOURCES LIBRARY | *OBJECTIVE 1*

We created the recommended resource library by distilling the over 1100 resources collected in the comprehensive resources library into a more useful, external-facing resource for municipalities and other coastal resilience implementers. We organized the recommended resources library based on selected coastal resilience topics of interest. We created spreadsheet tabs for resources that correspond to these topics of interest. As with the main resource library, these topics mirror the topics from Question 9 of the needs assessment survey. We subsetted resources by their primary topic of focus identified in the main resources library.

We used several evaluation criteria to distill recommended resources from the larger resource library. Resources were selected for inclusion based on:

- ***Usability:*** Selected resources are easily accessible to users, with no apparent paywall or other barriers to access. These resources engage various mediums, including text, visuals, or design, to effectively organize the presented information. They identify best practices for applications of the presented information by on-the-ground practitioners.
- ***Quality:*** Selected resources are produced by organizations or institutions with reputability or excellence in evaluating or addressing relevant topics of interest. Authors and collaborators holistically cover existing or emerging information.
- ***Relevance:*** Selected resources are applicable to recent coastal resilience issues, integrate the latest information, and are routinely updated to reflect current and evolving understanding of the topics of interest. These resources can be applicable to a wide range of potential users or have a specific focus on the Great Lakes and St. Lawrence basin.

For the recommended resources library, we narrowed the resource attributes from 22 to 12 that provide a digestible characterization of the recommended resources. Selected attributes and recommended resources were determined based on client feedback and insight from interviews. Recommended resource library attributes included: name, organization, delivery method, date created or updated, URL, access restrictions and navigation, topic, location covered, Great Lakes application, target audience, consideration of equity, and summary of each included resource (see asterisks in Appendix B).

FUNDING LIBRARY | *OBJECTIVE 1*

We created a library of the most relevant and up-to-date funding opportunities for coastal resilience in the basin to understand the coastal resilience funding ecosystem. To compile relevant funding opportunities, we conducted digital research and participated in virtual trainings and webinars held by different entities across the basin. In total, we attended over 12 virtual trainings and webinars on relevant funding and financing topics and opportunities. We observed and recorded funding and financing challenges and successes expressed by other attendees. Many challenges facing municipalities were acknowledged and understood by the presenting agency.

We compiled existing digital funding information to use as the foundation for development of the funding library. Relevant financing and funding opportunities were cataloged into a Google Sheet and characterized using 35 attributes. Some attributes were based on the structure developed for the resource

library, including: geographic region covered, topic/problem addressed, and time investment required to apply for funding. The remaining attributes assessed the criteria and requirements for the cataloged funding and financing opportunities (Appendix D); e.g., funding type, application requirements, project lifespan, total appropriated funds, match requirements, and eligibility description.

We were highly selective when developing the funding library and did not aim to be comprehensive. There are many databases for government funding options; e.g., organized by state, coastline, or other geographic criteria. Rather, our process was meant to emphasize opportunities that were published in FY2019, FY2020 or FY2021 to reflect the most up to date information on topics that pertain most closely to coastal resiliency in the Great Lakes basin. These most recent grants are also most likely to reflect federal agency priorities and application criteria. We emphasized inclusion of well-established programs that offer funding and financing on a regular cycle. Because of this more selective approach to resource compilation, we did not conduct a quantitative analysis as was done for the resources library. Our goal was to share practical knowledge, so a qualitative analysis was conducted and translated into practical tools. These tools include tabs that outline federal grant programs and their associated application portals, registration requirements, state and federal program liaison contact information, existing database URLs, funding and financing training and educational materials, and pilot projects.

IMPLEMENTATION INTERVIEWS | *OBJECTIVE 2*

Coastal Resilience Needs Assessment Survey and Preliminary Data Collection

In spring 2021, the Cities Initiative collaborated with researchers at the University of Illinois Urbana-Champaign to develop and disseminate a coastal resilience needs assessment survey of Great Lakes and St. Lawrence River local governments (Appendix C). This survey was widely distributed to mayors, local government staff, and municipal leagues across the Great Lakes basin coastal areas. This survey collected information on: existing coastal management challenges, predicted costs of coastal resilience efforts, and challenges to implementing coastal resilience projects. As part of the survey, respondents were asked if they would be interested in participating in a follow-up interview to discuss their responses. We facilitated these follow-up interviews as outlined below.

Interviewee Selection

We identified implementation interviewees in two phases, initially through the coastal needs assessment survey respondents and then by identifying gaps in our interviewee demographics. First, the Cities Initiative facilitated contact between our team and their survey respondents who answered "yes" or "maybe" to a follow-up interview. This process created a list of potential interviewees. We reached out to these individuals and interviewed those that expressed further interest. Second, after holding interviews with most of the interested interviewees, we assessed the extent to which the range of municipalities in the Great Lakes and St. Lawrence River basin were represented. We found a lack of perspectives from New York, Quebec, and Tribal governments. This was a result of fewer initial survey respondents from these demographics. Noticing this gap, our clients referred us to specific contacts to fill these gaps. We conducted at least one additional interview in each missing demographic.

Interview Design

We structured interview questions to address ten themes discerned from the needs assessment survey results and literature review (Appendix E). The themes were: community, impacts, response, funding and financing, knowledge base and capacity, resources, communication of outside information, equity, long-term planning, and success. Each theme was addressed using one to two leading questions, with potential follow-up questions depending on the interviewee's responses (Appendix E). Our use of questions was customizable based on the interviewee's needs assessment survey response and pre-interview research. The questions and interview methods were reviewed by the University of Michigan's Institutional Review Board, and the application was then classified as unregulated.

Interview Process

We conducted 41 interviews with 44 individuals with municipal staff in coastal communities in the Great Lakes watershed (see Figure 2). Interviews were conducted by two researchers: an interviewer and a notetaker. Once the date had been selected, the interviewee was sent a consent form detailing our data management protocols, including plans to record the interview. The interviewer conducted pre-interview research on the interviewee and their corresponding local entity's coastal resilience activities and used this research and the interviewee's needs assessment survey to select appropriate interview questions. Interviews took place over video conference software (Zoom, San Jose, California) for approximately one hour and were recorded to the interviewer's computer as audio files. The audio files were then transcribed and edited using audio transcription service (Otter.ai, Palo Alto, California). A final transcript was then uploaded to Atlas.ti, a qualitative data analysis software (Scientific Software Development GmbH, Berlin).

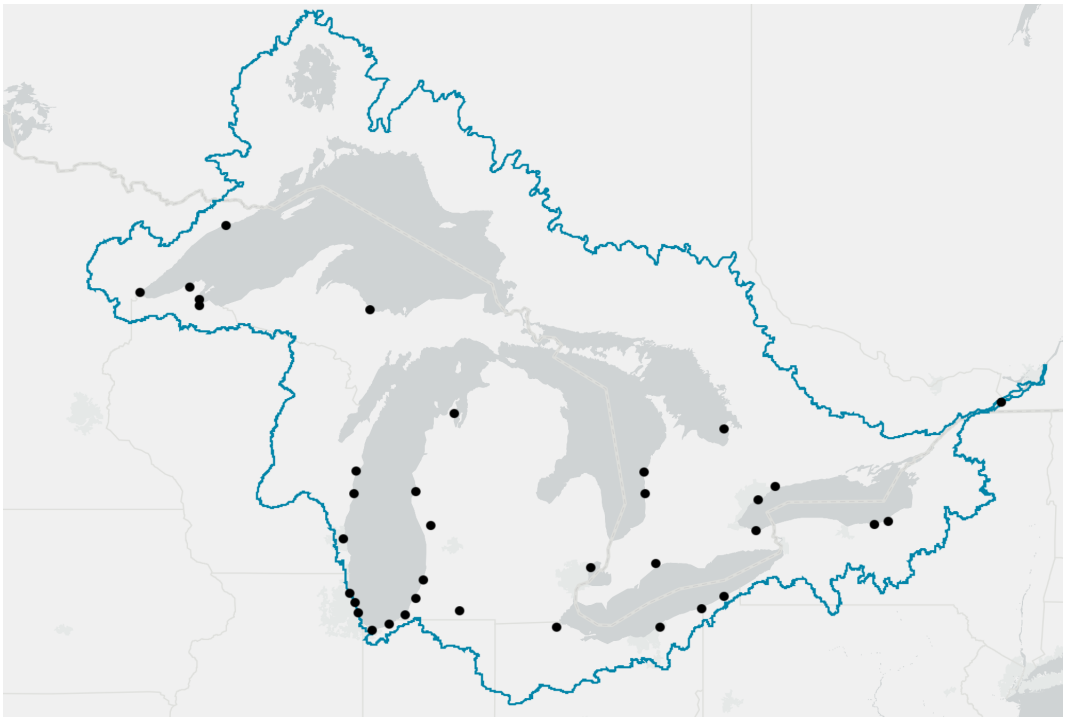

Figure 2: A map of implementation interviewees as indicated by the black points. The blue line represents the Great Lakes watershed boundary.

RESOURCE PROVIDER INTERVIEWS | *OBJECTIVE 2*

Interviewee Selection

We conducted web research to identify existing coastal resilience practitioners and capacity-building organizations in the Great Lakes basin. We identified: government agencies, non-profit organizations, academic institutions, communities of practice, and other organizations with missions and project work that support, fund, and/or educate local coastal resilience efforts in the Great Lakes, the broader United States, and Canada. We identified the most applicable staff member or representative through additional web research and conversations with organizational staff. Interviewee selection was also informed by input and insights from the project clients. From this group, we conducted 11 individual interviews. Five previously completed implementation interviews were recategorized as resource provider interviews due to the organization type and content of work conducted, bringing the total number of resource provider interviews to 16.

Interview Design

Our interviews explored how these organizations support the work of local entities in the Great Lakes through: research, data management, technical support, public education and engagement, and training. Our interview questions examined organizational perceptions of gaps and needs in the Great Lakes and St. Lawrence coastal resilience arena, with a focus on local and municipal efforts. We developed a bank of approximately 40 questions (see Appendix F) using the preexisting implementation interview questions as a guide. We reframed, rewrote, or struck questions based on our research objectives for resource provider interviews. We organized questions into nine thematic sections, including: general, organizational, planning and strategy, implementation and delivery, impact and program evaluation, partnerships, equity, future, and other. We based these themes on our implementation interview question themes, as well as client input. As with the implementation interviews, the resource provider questions and interview methods were reviewed by the University of Michigan's Institutional Review Board and then classified as unregulated.

Interview Process

We conducted the resource provider interviews using a process similar to that for implementation interviews. Two researchers conducted each interview. One served as the interviewer and facilitator and the other as the notetaker. The interviewer asked questions and kept the interview to time, and the notetaker recorded notes and provided suggestions for follow-up questions and clarifications to the interviewer. Once the date was selected, we sent the interviewee a consent form detailing the project's data management protocols. Once the team received the signed consent form, a project team member also signed it. We conducted pre-interview research on the existing coastal resilience work of the organization, which was used to inform the questions asked during the interview. Interviews were conducted using Zoom (San Jose, California) video conferencing and lasted approximately one hour. The interviews were recorded with the interviewee's consent to assist with transcription and analysis. We edited and reprocessed the autogenerated Zoom audio transcriptions using Otter.ai audio transcription service (Palo Alto, California) then uploaded the final transcript to Atlas.ti software (Berlin) for further analysis.

RESOURCE PROVIDER FOCUS GROUPS | *OBJECTIVE 2*

Participant Selection

We used a focus group format to collect responses from the Great Lakes Sea Grant Network (Sea Grant) and state Coastal Management Programs (CMPs) in the United States Great Lakes basin. This format enabled us to more effectively interview a larger number of participants and to coalesce intra-organizational responses. Sea Grant and CMP coordinators helped us identify participants by providing applicable contact information for staff members compatible with our project's interest and geographic scope. We sent invitation emails and calendar invites to participants to initiate engagement in the focus groups and reminder emails prior to the scheduled focus groups.

Focus Group Design

Given the large number of participants and limited time available, we selected 5-6 research questions (see Appendix G) from the resource provider interview questions. Questions focused on assessing existing activities and extent of coastal resilience support, as well as organizational and basin-wide barriers and successes related to coastal resilience in the Great Lakes basin.

Focus Group Process

We conducted two virtual 60-minute focus groups, one for Sea Grant practitioners and one for CMP practitioners. Each focus group had 10-15 attendees and was conducted by two researchers. One team member served as the facilitator for the session and the other as the notetaker. The facilitator asked questions and prompted and moderated responses as necessary. The focus groups used Zoom video conferencing and virtual whiteboard (Google Jamboard) to conduct the sessions and collect responses, respectively (San Jose, California). For each question, session participants were given between three to five minutes to first provide written responses in the Google Jamboard and then were provided an additional three to five minutes to verbally answer or share more information related to written answers. In the Google Jamboard, participants could also provide plus mark icons next to other participants' answers to indicate agreement. Participants opted into the session, with their attendance providing implied consent for responses to be recorded and used for research purposes. Interviewees were provided briefing materials in advance about the project but were not provided interview questions prior to the session.

INTERVIEW DATA ANALYSIS | *OBJECTIVE 2, OBJECTIVE 3*

Processing

We processed and analyzed the implementation interviews, resource provider interviews, and focus groups using the same methods. Following interviews, the relevant digital materials were promptly prepared for data analysis. The recorded audio was transcribed using Otter.ai audio transcription service (Palo Alto, California). The initial transcription was edited for accuracy and requested confidentiality. The finalized transcript was then uploaded to the project drive. The interview notes were not prepared for analysis as they only served as backup data collection in case the recording failed, or audio was corrupted. Focus group Google Jamboard responses were manually typed into word documents.

Coding

A codebook (Appendix H), or a list of critical themes identified in the data and their definitions, was developed throughout the interview process and finalized after the completion of data collection. After the initial implementation interviews, we created the first draft codebook based on the recurring themes in interviews, areas of interest, and interview question structure. This draft served as a record of the implementation interviewing team's thoughts midway through data collection. The initial draft was refined and expanded following the completion of implementation interviews, resource provider interviews, and the literature review utilizing all sources of data collection (not just implementation interviews). Thus, the codebook became a way to organize the interviews based on broad themes, which included code groups with some more specific codes added for certain topics.

We coded the interview transcript and Google Jamboard data using Atlas.ti software (Berlin). Our coding goal was to categorize interview data, not to auto-analyze our data as this program is commonly used for. The guiding rationale behind our coding and data analysis process was to use researchers' critical thinking as the centers of analysis, rather than qualitative data analysis software. Two researchers coded the data over a two-week period. Throughout the coding process, each researcher checked the other's work to ensure consistency.

Analysis and Categorization of Themes

Discerning central themes from coded interview data occurred in three phases. Each researcher was responsible for analyzing one to three code groups (e.g., data/resources, funding, or responses/solutions). In the first phase, data from implementation interviews and resource provider interviews were analyzed separately for each code group. Team members assessed each group of interviews for: key takeaways, common themes, further lines of analysis, potential connections to other parts of the project, and specific interviews worth diving into. The second phase involved comparing within-code groups across interview types. All researchers compared how implementers and resource providers discussed the same issues to assess similarities or disconnects between the two. We also looked for issues discussed in one group but not the other. Finally, we used a macro-level analysis to pull out broader conclusions. Each researcher presented findings to the team; the team then discussed and compared to find connections, meta-issues, and themes.

BIASES

Implementation Interviews

We utilized the clients' professional networks to find potential interviewees, which created several biases that echoed throughout the interview and analysis process. Similarly, the needs assessment survey was distributed through the Cities Initiative's communication channels to their member mayors and other municipal leagues, coalitions, and relevant organizations. The clients leveraged specific relationships to help fill interviewee gaps. Our potential interviewee pool was limited to municipalities who were currently plugged into coastal work at least some level. By nature of our methods, we could not reach municipalities that are detached from the larger coastal work ecosystem. Potential interviews from the Cities Initiative's needs assessment Survey skewed toward the United States, Lake Michigan, and small municipalities (sub 2,500 people). As a result, our interviewees also skewed towards these. Efforts were made to mitigate this

in the second round of potential interviewee contact, but we were unable to fully address this bias. Our work captured all provinces, states, lakes, and connecting channels, but the report lacks a roundness of perspective on Quebec and New York experiences. Additionally, while we interviewed a few individuals who work with tribal governments, these were certainly not representative of the great diversity of tribal nation experiences.

Resource Provider Interviews

Since our resource provider interview questions were based on those from the implementation interviews, the focus of our resource provider interview data was constrained. Our questions focused on examining the work of local entities and municipalities, leading to shortcomings in the degree of assessment conducted on the organizations and resource provider institutions. In addition, many organizations were unable to provide evaluatory comments during their interviews, resulting in limitations to intra-organizational assessments. The resource provider interviews also lacked equal representation from all eight Great Lakes states and two Canadian provinces. We interviewed largely United States-based organizations.

Resource Provider Focus Groups

Our use of Google Jamboards during the resource provider focus group sessions resulted in some technical difficulties in collecting responses. Some virtual response sticky notes were accidentally deleted by participants, which may have impacted the data produced. Focus groups also were limited in time duration, leaving many individuals unable to actively contribute beyond written Google Jamboard comments.

Interview Analysis

We develop our codebook based on the structure of the implementation interview questions plus our initial impressions of the implementation interview content. It was later supplemented with other team member input and refined to suit our data analysis needs, but it was biased towards the initial assessment. Ultimately, we decided that this bias was acceptable as coding served to organize interviews, not analyze them.

Resources Library and Recommended Resources Library

Some attributes within the resources library and recommended resources library, including time investment and readability, were produced based on subjective evaluations by the project sub-team rather than objective quantitative methods. This process resulted in biases in this attribution. The designation of a "recommended resource" was also a product of team evaluation and judgment, as previously outlined. We did not document reasoning and merits for individual resource inclusion in the recommended resources library.

Funding Library

We primarily found funding resources through NOAA and NOAA-affiliated partners like state agencies associated with Sea Grant and Coastal Zone Management programs. We emphasized federal and state-level grant opportunities for two reasons: they are well-documented and highly advertised, and the intent of the funding library was to have it be relevant for as long as possible. A specific challenge we

encountered was that existing compilations of resources that include ephemeral funding types tend to become out of date quickly, and thus are short-lived.

Results | *Objective 1*

> *"Most people find that the internet is extremely difficult to navigate to actually get to information. The internet is functionally useless if you don't know what you don't know. We face a serious challenge to take all of the myriad data sources and convert them into something useful for an actual practitioner on the ground."*
>
> Executive Director, American Society of Adaptation Professionals

COMPREHENSIVE RESOURCE LIBRARY

The coastal resilience resources library contains 1,117 resources relevant to coastal resilience in the Great Lakes and St. Lawrence River basin. The resources are information-based, typically available online, and include maps, webinars, reports, and toolkits. This library does not include funding options or contact information of relevant agencies or their personnel.

We categorized the resource materials into 32 topics, with the most common being: adaptation planning (12.8%), flooding/high water levels (12.8%), mitigation planning (8.0%), and general climate change (7.7%). Flooding and high water levels are viewed as one of the most impactful problems caused by climate change. This view was reflected in the number of resources on that topic.

The most common resource-content type is text-based (65.2%), typically delivered using websites, reports, or factsheets. Some of the most common resources are interactive maps (11.4%), planning guides (20.1%), and toolkits (10.2%). Webinars (9.4%) are the most common video-based resource delivery method. The least frequent content types are audio (<1%) and images (<1%).

Equity Considerations

Most resources do not consider equity (see Figure 3) in resilience planning (78.2%). Of the resources that include equity, 24.9% are not specific in which equity concern is considered. Among equity concerns, social vulnerability (15.1%) and socioeconomic status (12.8%) are the most commonly named within the subset. The extent to which a resource considers equity is divided into three categories (Yes, No, Somewhat). We define "somewhat" as noting the importance of equity considerations but lacking specific parameters for projects or management to address stated considerations. NGOs and Communities of Practice consider equity significantly more than other resource providers in the resource library. The American Planning Association does exceedingly well at including specific and frequent mentions of

equity in their resources. The resources that do not consider equity are generally distributed evenly among the remaining organization types.

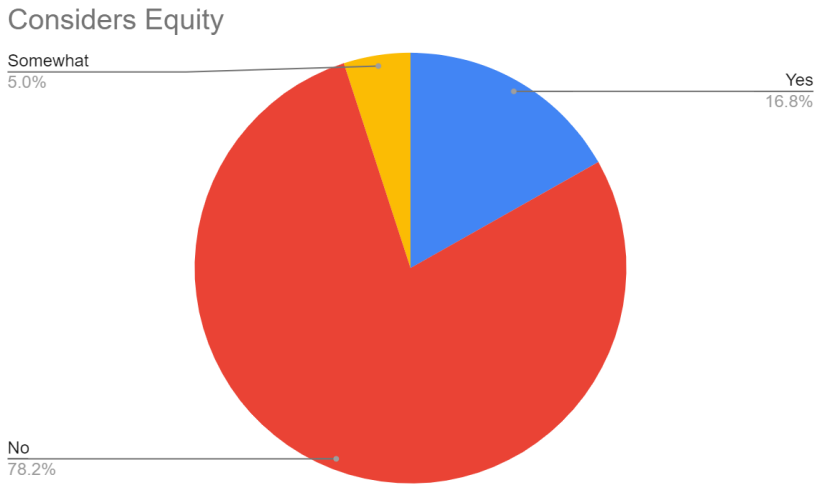

Figure 3: A diagram indicating resources in the comprehensive resource library that included equity throughout (Yes), considered it somewhat, or not at all (No).

Timely Information

Many resources (43.2%), do not provide a creation date. Most without these dates are interactive maps or technical reports, whereas policy guides and factsheets more consistently provide dates. It is assumed that interactive web interfaces are maintained regularly, more than print or PDF format reports where dates need to be specified. The resources that include creation and update timelines have been recently created since 2014 (43.5%), and only 182 are older. Many updated resources are data-driven (55.7%), including interactive maps and databases. Many of the remaining resources are shorter toolkits and fact sheets that include updates beyond their original creation date (18.9%).

Geographic Coverage

Resources are predominantly created for the whole United States (34.8%), followed by specific focus on the Great Lakes basin (15.8%). Only 7.6% of resources were specific to Canada. When looking at a subset of the data relevant to the Great Lakes states and provinces, Wisconsin (23.4%) and Michigan (19.5%) make up nearly half the available resources; this parallels the relative proportion of the Great Lakes coastline these states comprise. Canadian users have far fewer relevant resources overall, and many of the Canadian websites we accessed linked to resources from United States-based agencies. Ontario (8.2%) and Quebec (4.5%) do not reach a third of this subset despite having nearly the same amount of coastline as the United States. Resources covering the Great Lakes basin encompass 44.7 percent of the library and generally focus on the whole system (32.7%) rather than a specific body of water or coastline. ***While the St. Lawrence River is part of the Great Lakes basin, it is rarely mentioned in resources, with only 14 resources (1.1%) explicitly focused on the St. Lawrence River.***

Source Agency

Federal agencies (35.1%) are the predominant resource-generating organization type (see Figure 4). Other substantial contributions to this library are state and provincial agencies (18.6%) and collaborative organizations (16.8%). Resources produced by these state and provincial governments are more tailored and relevant to the Great Lakes than resources produced by federal agencies. The National Oceanic and Atmospheric Administration (NOAA) has the most well-established presence in the Great Lakes as a resource provider, contributing 11.1 percent of resources. All resources created or supported by NOAA (e.g., Sea Grant, CMP, NOAA Offices, etc.) encompass 19 percent of the comprehensive resource library. State Sea Grant organizations make up 36.7 percent of resources from collaborative organizations, indicating NOAA's connection to various organization types. Natural resources departments are the largest state/provincial resource provider organization, with the highest resource contributions from Wisconsin (14.5%), Michigan (10.6%), Ohio (13.5%), and New York (9.7%).Ontario led Canadian resource contributions (3.9%), but lag compared the U.S. states.

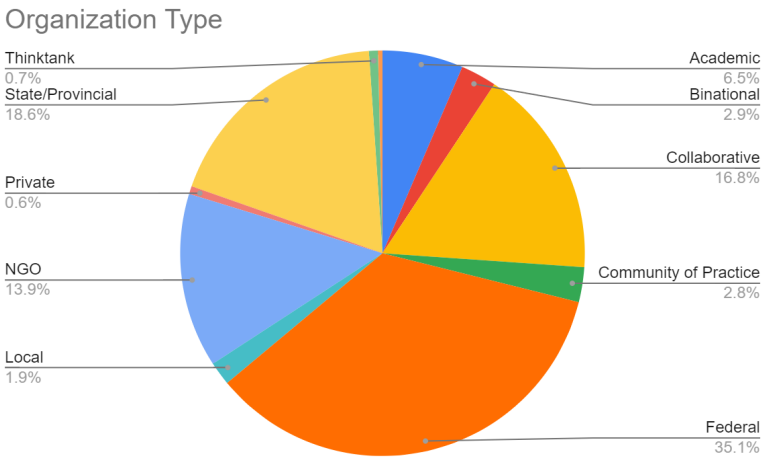

Figure 4: A diagram indicating resource contributors by organization type.

User Base

Most resources have a specified target audience (70.4%). Resources typically target municipal employees or elected municipal officials (42.4%) and, to a lesser extent, planners (26.5%). The audiences least targeted are farmers (<1%), emergency managers (1.5%), and engineers (2%).

While many resources target specific audiences, they can be understood by the general public with only a few exceptions that require specialized knowledge (8.9%). Half of the resources available are evaluated to be moderate (50.2%) in their reading difficulty and followed closely by simple (40.9%) entries. The list of accessible resources would suggest that decision-makers in the Great Lakes with some college education can understand 90 percent of the library. Many (40.9%) of the resources compiled can also be understood by the general public and applicable to a broad range of users.

Time Investment

The time investment, or the length of time needed to use or process a resource, averages 1.3 hours. The time investment varies based on readability, with simple resources requiring an average of 40 minutes, 1.7

hours for moderate resources, and 2.3 hours for complex resources. Some resources, such as maps or databases, are not provided with quantified time investment and were listed as dependent on interest (34.9%).

Language

Most resources are only available in English (93.8%), while French speakers only have access to 69 resources (6.2%). In addition, all French resources are sourced from Canada, particularly from Quebec organizations. A few resources compiled were available in Spanish, but this was not recorded and was only available for general United States resources.

Accessibility

We found the accessibility of information to be very wide-ranging, though generally, most adults with some post-secondary education and an internet connection can access and understand most resources compiled. The majority of resources (98.4%) are only available in a single form, making access to online resources difficult; potentially problematic without a strong Wi-Fi connection if joining webinars or other bandwidth-intensive delivery types. Only 66 resources have some sort of access restriction (5.9%), such as payment, association membership, or login credentials, and only 16 of these require payment (1.4%).

We encountered many "404 pages" during our search, indicating the resource was unavailable, is no longer maintained by the publishing entity, or no longer exists. The resources we cataloged might also become 404 pages in the future. Like the NOAA Digital Coast program, some resource providers have overcome technical barriers, including 404 pages and others, by providing one-on-one assistance or even delivering hard drives of relevant data to users.

Interviewing resource providers allowed us to understand how resources are written, updated, and evaluated. We found that formal evaluation is uncommon. Interviewees suggested that funding typically covered the project or resource development but not assessment or evaluation. Interviewees mentioned that funders are shifting to require evaluation, but this is not yet common practice. Existing evaluation is typically informally derived, e.g., through asking for feedback from users during conferences, webinars, or one-on-one consultations. One instance where evaluation feedback was incorporated practically was by NOAA's Great Lakes Water Level Dashboard. Based on user feedback, NOAA and New York Sea Grant improved the scale of the Dashboard to allow home and business owners to view their properties' flooding potential at a higher resolution.

RECOMMENDED RESOURCE LIBRARY

The recommended resource library subset includes 188 resources (16.8%) from the comprehensive list. The resource categorizations are simplified or combined into 11 categories. Adaptation planning has the most entries covering 33.5 percent of the subset, while low water levels have the least, with only six entries (3.2%). The most common delivery methods are toolkits (19.7%), webinars (10.6%), and factsheets (9%). Databases (1.1%) and engineering guides (<1%) are the least prevalent delivery methods. Podcasts, briefing papers, and white papers are not in the recommended list but are in the complete list. Most of the resources are open access (93.1%), and the remaining do not require payment but rather account creation (4.8%) or waiting for the next scheduled release (2.1%). Nearly half of the recommended list considers

equity at least somewhat (45.2%), and social vulnerability (12.8%) is the most common variable. Like the full list, the target audience for most resources is municipal staff (50%), and the least targeted includes emergency managers (1.1%). Federal organizations created the most resources (35.6%) that are in the recommended list, followed by collaboratives (21.3%), while private organizations contributed only one resource (<1%). NOAA and its Sea Grant partners are the most present organizations (22.9%), similar to the comprehensive resource library.

FUNDING RESOURCE LIBRARY

The funding library contains 128 funding and financing opportunities for coastal resilience planning and implementation efforts in the Great Lakes. These grants, loans, or match dollars are available through federal, state, regional, and private sources.

We found the most funding opportunities are available for the state of Minnesota (27) and Canada (Ontario and Quebec) (9), followed by Ohio (6). This was due to Minnesota's additional state revenue through the Legacy Amendment, a publicly led and supported state sales tax of 0.38 percent that is appropriated into the Clean Water Fund, Outdoor Heritage Fund, Arts and Culture Fund, and the Parks and Trails Fund. This funding has totaled over $1232.8 million into the Clean Water Fund alone since the tax was enacted in 2009. Minnesota is the only Great Lakes state to have a tax with this structure that supports clean water projects.

We looked for pre-existing databases and individual grant programs. Indiana has the most comprehensive pre-existing funding database. This database was created by a NOAA grant to the Indiana Lake Michigan Coastal Program in 2021. It was most difficult to find funding sources for the state of New York, which used a centralized application for all state grants. These grants were not advertised individually and only appeared through the New York State website. We found that Pennsylvania and Indiana had the least state-specific funding opportunities.

We found very few of these resources to be explicitly intended for coastal resilience work. In general, the term 'resilience' is not widely used in the names and descriptions of grants and loans that do in fact support efforts to become more resilient. This term was found in only three of the documented grants (National Coastal Resilience Fund, Southeastern WI Coastal Resilience program, and Five Star and Urban Waters Restoration Grant Program). While there are likely others that do name 'resilience,' it is clear that this term and mindset are not yet widespread in funding opportunities. We also found very few grants to incentivize green infrastructure and nature-based solutions. There are many grants that incentivize habitat restoration and preservation, which can have the same effect in preserving the natural capacity of an environment to withstand changes by supporting its natural composition and functions (i.e. resilience).

The most well-established state-level funding programs are the CMPs and Sea Grant programs. NOAA's Office for Coastal Management supports state Coastal Zone Management Programs, while Sea Grants are a partnership between Universities and NOAA for research, extension, and outreach-based programming. Each state's coastal zone management program is administered through different state agencies, supported by NOAA (Table 1). These state websites are a primary channel through which funding for community resilience is advertised.

Table 1: A table of Coastal Zone Management Programs in the Great Lakes and their NOAA Sea Grant and University Partners.

State	State Agency Administering Coastal Management Program	Sea Grant University Partners
Illinois	Department of Natural Resources	Illinois-Indiana Sea Grant, University of Illinois
Indiana	Department of Natural Resources	Illinois-Indiana Sea Grant, Purdue University
Ohio	Department of Natural Resources	Ohio Sea Grant, Ohio State University
Michigan	Department of Environment, Energy, and the Great Lakes	Michigan Sea Grant, University of Michigan, Michigan State University
Minnesota	Department of Natural Resources	Minnesota Sea Grant, University of Minnesota-Duluth
New York	Department of State	New York Sea Grant, Stony Brook University, Cornell University
Pennsylvania	Department of Environmental Protection	Pennsylvania Sea Grant, Penn State University
Wisconsin	Department of Administration	Wisconsin Sea Grant, University of Wisconsin-Madison

The authority and responsibility to manage coastal areas are spread across different state and regional agencies. It might be intuitive to assume coastal management work is carried out by a state's Department of Natural Resources. Wisconsin houses its very small Coastal Management program under the Department of Administration. New York houses their Coastal Management Program in the Department of State. This lack of continuity across departments complicated how municipalities seek informational and financial support. Interviews with several municipalities revealed perceptions that certain departments or agencies have more capacity to support municipal decision-makers than others. This perception is enough to prevent local governments from reaching out and successfully getting support from the appropriate agency. For example, Wisconsin's CMP serves as a collaborative meeting ground for stakeholders, and utilizes a council structure for relationship-building and co-production. Michigan's CMP is administered by EGLE (Department of Environment, Energy, and Great Lakes) and has permitting authority and acts in a regulatory capacity, which can inhibit the ways in which municipalities reach out for assistance.

Another issue with discontinuous naming conventions is evident in smaller-scale agencies that provide technical and financial expertise. A range of names show that seeking out a support agency is not as straightforward as it should be. Regional planning commissions are named "regional development organizations," "economic development organizations," and "councils of government." In Ontario, regional environmental planning occurs at the watershed level through Conservation Authorities, who offer technical expertise and project management assistance to municipalities and have authority over natural resource management and community development.

Results | *Objective 2*

We found that the enabling and constraining factors of local coastal resilience work in the Great Lakes and St. Lawrence River basin were often two sides of the same coin. We grouped the results around six key factors: community, confusion, control, capital, capacity, and connection.

COMMUNITY

"Preserving the public access of your water and preserving that has got to be the most important thing. The more access the public loses to the water, you'll never get it back. Right? Once it's gone, it's likely gone forever. So I think, to preserve what we have, protect what we have, and grow, that going forward is probably one of the most important things [we] can do."

Director of Public Works, Muskegon, MI

"Well, the flooding issue, I think, speaks for itself. It's an economic problem. It's a social problem. We're up here, where it's a tourism driven economy. And in particular, on our coast, when we have our major thoroughfares closed, because you know, [if we] get 6 feet of standing water on the highway, we can't get people in or out. And not only can't we conduct tourism, we cannot conduct commerce. So our businesses are taking a hit on both sides."

Deputy Director, Northwest Regional Planning Commission, WI

"In order for us to actually be prepared for any future, but especially a future where there could be an opportunity for equitable, just growth in the Great Lakes Region, addressing our current inequalities, and the current failure of our infrastructure and social systems is critical. We will not get to a period of growth and security without addressing the past and reconciling that with who we are today and who we want to be."

Executive Director, American Society of Adaptation Professionals

One is on waterfront property. It's common for older homes to be purchased, bulldozed and rebuilt at a much larger scale. There are neighborhoods in our community that were platted in the 1920s, when we were a cottage destination for Detroit. So folks bought a 50 foot lot and built small cottages for fishing and duck hunting, that sort of thing. But

> *as time has gone on, we now have a million dollar home on that same 50 foot lot, and its built to the FEMA or NFIP requirements, outside of the floodplain. Unfortunately, some residents are in still in homes built many years ago, and some are stuck between two brand new homes. As a result, the flooding that was experienced 30 years ago is twice as bad now because that high water just flows to the lowest point. So in some neighborhoods, we see a significant impact from high water at a residential level.*
>
> Supervisor, Harrison Township, MI

Coastal communities in the Great Lakes and St. Lawrence basin face unique and dramatic climate change impacts due to their vulnerable positions on the coast. Factors beyond the bounds of municipal government had significant impacts on coastal projects. Municipal leaders needed to consider how climate change applied pressure to both public and privately owned properties. The attitudes of community members influenced municipalities' abilities and willingness to act in response to impacts. Municipalities' economies were affected by changing coastal conditions. Residents' memory of coastal impacts was short-lived which created small opportunity windows for municipal action. Coastal inequities exacerbated systemic inequities, but there was a disconnect in municipal staff between identifying vulnerable populations, addressing problems, and recognizing the work as equity-related.

Municipalities were experiencing many climate change impacts. The variability of weather, especially the change in frequency and severity of storms and high-water cycles, caused infrastructure damage on public and private properties alike. Flooding and erosion of lakeside areas and at tributary mouths were common problems. The flooding of roads could cut off access to sections of communities, depriving them of access to their homes and necessary services such as health care. In addition, low water levels threatened critical infrastructure such as water mains, which provided water for the city or region, and water treatment plants. Municipalities were also concerned with the interaction of climate change and other impacts like invasive species, algal blooms, and pollution.

Communities' actions could exacerbate shoreline impacts for neighboring communities as well. When a community took measures to harden or restore their shoreline, wave energies could be deflected and pushed down the shoreline, creating more intense impacts for neighboring communities. This also played out at individual property owner-scale, where a homeowner's revetment would worsen erosion of their neighbors' property.

Municipal officials were concerned about shoreline access, safety, and additional climate-related impacts on their coastal areas. When asked about what coastal resilience would look like in their communities, many interviewees emphasized that ensuring public access to the waterfront was of the utmost importance. Both shoreline degradation (i.e., erosion) or preservation (i.e., revetments) prevented residents from accessing and enjoying the beach when lake levels were high. Although when shorelines are held in the public trust for public use, shoreline access can still be limited by private property if there are no public access points. Related to access, safety was a community concern as the shifting weather patterns and water levels posed public safety concerns.

We found that municipal officials had observed that residents of these coastal communities felt a strong sense of pride and connection to the Great Lakes shorelines and waterfront areas. This sense of place was a strong factor in uniting the community, and the lakes and lakeshore were the main attraction for

residents and tourists alike. Therefore, protecting the ability to recreate and connect with the water was at the core of many municipal staff's long-term goals.

Private property experienced the same impacts as public shoreline; however, we found the ability of property owners to respond proactively or reactively depended on a variety of factors. Wealthy lakeshore owners possessed the financial capital to seek out professional assistance and install structures to protect their local shoreline, which often came at a high cost. Low- and medium-income residents, who may have lived on the coast for decades or inherited property from family, may not have had the means to implement effective solutions. As older properties were redeveloped and new structures built on higher land or to new standards for flooding, remaining legacy homeowners could have experienced worsening impacts of flooding as their homes were not built to the same standards. New buildings could be built larger and with higher elevation than older properties and protected by new revetments, which caused storm and floodwaters to deflect and flow toward older properties, amplifying the issues. Year-round locals and seasonal residents may be affected by coastal impacts differently as locals face additional winter storms, and seasonal residents may feel less financial impact from property damage. Their responses could also vary in the actions they took and whether they supported municipal response. We found that residents were getting information on coastal issues from a variety of sources, and they were often influenced by their neighbors and local politicians. This prevented them from fully understanding the range of options available for coastal management.

Coastal issues directly impacted coastal industries- including shipping, fishing, and tourism - which were already exposed to shifts in changing global economies. Many localities were in the process of transitioning away from industrial economies and exploring other markets, specifically tourism, as main sources of revenue. We found that municipalities needed to make decisions about vestigial industrial infrastructure – such as ore docks, seawalls, and contaminated sediments. We found that maintaining recreation services was a priority for municipal officials as these generate revenue and attract tourists. The changing shorelines were threatening these opportunities and potentially harming tourism, which was a keystone industry for many communities. The effect on tourism extended to businesses along the water's edge, in the port, or at the river's mouth, where flooding and storms could wreak havoc on the physical structures of shops and the number of days they remain open for business.

Municipalities' ability to respond to impacts could be determined by community members' attitudes towards coastal issues. Acceptance or denial of climate change played a part in how communities perceived and responded to changes along their coasts. However, we found that the most important factor in shaping coastal resilience response was the extent to which a community was dealing with the direct, tangible impacts, often crises, of climate change, regardless of their perceptions of climate change science. We found that municipal officials ranged in their level of support and interest for climate resilience measures such as green infrastructure, based on their openness to new ideas and prior exposure to green infrastructure. Community members' aesthetic preferences and willingness to imagine alternative shorelines influenced people's attitudes about coastal resilience measures also play a key role in choosing the best course of action. Some community members did not prefer green infrastructure projects, such as large scale rain gardens or bioswales, compared to hard armoring approaches. They perceived green infrastructure features to look like underutilized or unkempt land. Municipal officials perceived that long-time residents often did not want the shoreline to change from what they are used to. We also found a general lack of willingness to take drastic measures such as demolishing or moving at-risk homes or allowing the shoreline to erode naturally.

A significant barrier to community action was the short-term memory of residents and decision-makers, and that action was further thwarted by the timing of issues and their varying perceived urgency. ***Residents and decision-makers could be spurred to action after high-water levels or a storm surge, but any lag in the adoption of coastal resilience measures could later hinder response.*** Many projects took years to design, plan, secure funding, and construct; during that time, residents could lose interest in supporting or paying for costly mitigation measures. As time passed, other issues could come to take precedence as coastal issues dwindle in urgency. Short-term memory exacerbated issues with timing. The time it took for legislation to pass or emergency funds to be approved influenced when communities could obtain funding and implement actions.

Despite the challenges associated with involving residents in municipal coastal work, municipal officials continuously reiterated the importance of communication, transparency, and listening to the wants and needs of residents. Officials reported that projects went smoother in the long term when residents were informed early and often of municipal work. They also elevated transparency as a perpetual goal of their work as municipal officials. Ultimately, municipal officials were public servants, and serving the needs of their residents was a core tenet of their profession.

Equity played a significant but often silent role in a community's ability to implement coastal resilience measures. We saw larger municipalities and cities attempt to navigate the effects of systemic racism in their coastal work. We found that smaller, racially homogenous municipalities, some who do have serious economic inequities, tended to not view equity as an issue for their community. For them, equity was solely about racial equity, and economic inequities were not considered even when it had been discussed in other portions of the interview. In these other sections, municipal officials perceived that elderly and long-term, often less wealthy residents may lack the financial, informational, and social capacities to find information and invest in coastal resilience solutions. Encampments of houseless people and mobile home park residents were often mentioned as other groups at greater risk of flooding impacts as they lived on the shoreline with little to no capacity to respond.

CONFUSION

> *"If we don't understand it, we avoid it. We don't confront it. When we [finally] have to confront it is when we have a disaster."*
>
> Mayor, Saint-Anicet, QB

> *"A huge part of the problem has been to educate local officials about the natural systems that they're dealing with and about the legal authorities that they have to act. What we found, again, is that many of them don't really understand the shoreline dynamics over*

the long term and many think they are much more constrained in what they can do than what they actually are."

Professor, University of Michigan - Ann Arbor

"The only thing that is more difficult to talk about than climate change is lake level variability. So figuring out the legal approaches to things like land use management, zoning codes, tenure, in light of variability is a huge challenge."

Executive Director, American Society of Adaptation Professionals

Confusion was a common theme among interviews. Misinformation, information excess, and unpredictability of climate change could overwhelm community members and local decision-makers. Private property owners and municipalities endeavor to decipher available information on coastal dynamics and resilience, and are unsure about who may be best to turn to and to believe. Perception of municipal struggles by the higher levels of government play a role in response by preventing federal, state, and provincial governments from seeing community-level solutions rather than solely the big picture.

The ambiguity around climate change impacts in the basin influenced several elements of coastal resilience. Many interviewees stated that they believed in climate change but did not understand how their municipality would be impacted. Climate change misinformation infrequently appeared among our interviewees. When mentioned, it was often coupled with climate change denial. However, climate skepticism from a municipal official did not predict community action on coastal issues. The degree of property damage and shoreline degradation had a more significant influence on action. Understanding the particulars of how and when climate change impacts their coastline is more difficult to discern for municipalities due to complicated technical programs and the general unpredictability of climate change. Resource providers and communities flagged a lack of continuous monitoring such as of lake levels as a barrier to determining future impacts of climate change.

We found a general lack of understanding of complex shoreline dynamics among municipal officials. Knowledge of shoreline dynamics was not always common for local engineering firms, who are often the technical guides for municipalities. This stymied decision-making about which coastal resilience measures to adopt. Decision-makers could not turn to their usual consulting firm for help and had to seek out new expertise.

"Our interviews revealed that the massive amount of information about coastal planning and resilience overwhelmed municipal staff."

Municipal officials reported varying levels of literacy about coastal issues among their residents. Residents did not appreciate the true burden on their leaders of assisting the community in recovery and mitigation efforts. New property owners did not recognize flood mitigation measures on their own property such as flood water control pumps and sometimes dismantled or disengaged these measures.

Faced with the perplexity of coastal problems, municipalities found themselves confounded by innumerable information sources and confused about who to contact at state and federal agencies.

Municipal governments are constrained by their existing, incomplete understanding of the urgency of coastal issues and lack of appropriate information to be able to adopt forward-looking projects. ***Our interviews revealed that the massive amount of information about coastal planning and resilience overwhelmed municipal staff.*** This experience was echoed in our own digital data collection experience. The sheer number of resources and broken internet links made determining the most useful resources difficult. Resource providers stated that the internet was a useless search tool unless you already knew what you were looking for. Municipal officials reported that identifying the most effective and applicable federal or state agency to contact for assistance is also cumbersome. Not all municipal workers were aware of what entities provide assistance, programming, or funding for coastal resilience efforts.

We found that governmental perception of local coastal challenges could impede progress. In Quebec, we saw a relative lack of agency interest in Great Lakes issues as they saw the St. Lawrence River as a separate entity. We spoke to some municipalities who were pursuing inventive solutions to coastal challenges who felt relatively unsupported by higher-level agencies, as the agencies attention and monies were focused on more tried and true methods. Focused on the bigger picture, larger agencies search for solutions that enable multiple communities to benefit. This zoomed out approach prevents agencies from supporting innovative or tailored solutions for individual communities. Communities are more likely to advance independent solutions such as using police power ordinances to ban additional shoreline armoring or collaborate with neighboring communities on funding.

CONTROL

> *"The easiest thing that you can do right now is revisit your insurance policy and make sure it includes resiliency and flood related language. Make sure that you have really strong insurance coverage because the Great Lakes are going to win. Mother Nature is stronger than all of us. From a long-term recommendation, coastal resiliency must be part of your asset reinvestment strategy. Otherwise, the cycle of damage to and costly remediation of port infrastructure will be never ending."*
>
> Port Director, Milwaukee, WI

> *"It's hard because you might make, you know, two steps forward and then you'll get new city council members or somebody new, and three steps back and so it's trying to get more solidified plans in place for climate resilience."*
>
> Cook County SWCD District Manager, Cook County, MN

> *"We are quite lucky in our jurisdiction, where a lot of the shoreline areas are publicly owned and there's not a whole lot of privately owned areas along the shoreline, such as residences and things like that. So we're quite lucky in that respect and we are able to*

work with our municipal partners on coordinated projects that will enhance the lake shore."

Manager, Flood Emergency Management
Toronto and Region Conservation Authority

"We are very reactive. But we would be better served in the long run by being more proactive in a lot of those things and coming up with a 20 year plan instead of a week long plan."

Director of Public Works, Muskegon, MI

Municipal coastal resilience work was significantly impacted by the degree of control municipal governments had over the process. The degree of control often determined the starting point of projects, possible funding sources, and potential partners.

We found that shoreline ownership impacted the amount of and type of coastal work municipalities could advance. The more shoreline municipalities owned, the greater opportunity and control they had over the whole of the community's coastal resilience trajectory. Those municipalities with more shoreline could implement projects on a larger scale and worry less about a patchwork of coastal management approaches. Municipalities that owned a smaller percentage of the coastline were limited in possible avenues to address current and future impacts. There was little precedent for spending public monies on private shoreline and limited legal mechanisms for controlling private shoreline owners' actions and mitigating negative impacts of past shoreline projects (e.g., deteriorating seawalls).

Municipalities were constrained by their legal authority to regulate the shoreline and conduct projects. If municipalities wanted to control the actions of private shoreline owners, they primarily utilized zoning ordinances to regulate building setbacks, property severances, or septic systems. Municipalities also used educational efforts, such as town halls and printed materials, to influence private coastline owners' coastal management actions.

We found that the form of municipal government could restrict municipalities' ability to do coastal work. For example, we repeatedly saw general-law townships in Michigan significantly limited in their ability to advance coastal management strategies. The townships were limited in their legal authority to dedicate revenue streams to support coastal work, and they had limited jurisdiction over the land and roads. Therefore, even when township officials could see the impacts of changing coastal conditions on their communities, they needed to build partnerships with organizations with authority to act to address the impacts, such as county road commissions, sewer districts, or non-township municipalities.

Finally, we found that municipal planning documents (e.g., comprehensive plans, climate action plans, capital improvement plans, hazard mitigation plans) could restrict or enable local coastal work. While most of these documents did not include statutory requirements, i.e., the municipality did not have to do what was in them; municipalities aimed to follow the plan as well as possible. Therefore, if coastal resilience was not a priority of the community's planning documents, then coastal resilience work would likely not happen without significant external disturbance or pressure. Municipal officials recommended aligning planning documents with coastal resilience goals as a critical first step in improving coastal programs. Additionally, some funding sources required this alignment to be eligible for support. In particular, FEMA requires a FEMA Hazard Mitigation Plan in order to obtain FEMA funding.

CAPITAL

> *"Mother Nature is very hard to manage with legislation or with stormwater piping improvements. It's much more and beyond that. There's very little funding available for it. So either cities like us have to pay out of pocket or find other creative strategies to help out."*
>
> Mayor, Willoughby, OH

> *"It is super competitive. And, you know, everybody's vying for what seemingly seems to be a small pot of money for these projects that are really expensive. And, beyond the knowledge of opportunities, competition is just crazy."*
>
> Director of Community Development, Marquette, MI

> *"I'm the only person that does a lot of this work, so I really could use an awesome team. It's not just legacy cities or minority cities, I would say most municipalities that lack the capacity to write grants. Some funders make it really challenging for us to apply for grant funds, and we're the ones that need the resources most. And I just believe there must be some alternative means to these competitive grant processes."*
>
> Director/MS4 Coordinator, Gary, IN

Whether or not a community is able to fund and carry out their resilience efforts is a highly complex and nuanced question and is intertwined with "capacity" and "connection." We identified three components of capital that determine a community's ability to advance coastal resilience: (1) knowledge, (2) cash, and (3) relationships. Knowledge includes an understanding of funding timeline, process, and sources of funding opportunities. Cash refers to the amount of money available for various project types or at each level of government (i.e., how much is available per state, for only green infrastructure projects, or only for erosion mitigation). Relationships refer to connections to other communities, collaborative partnerships, and working relationships with state offices or other funding agencies.

Knowledge

Knowledge or information availability and accessibility was a key determinant of successful financial planning. This knowledge lived within people, typically a grant writer or financial expert, and contributed to institutional knowledge that is less likely to be lost through staff turnover. Staffing a grant writer or financial planner created capacity within local governments to establish municipal funding priorities, learn more about alternative funding options, and submit more competitive applications. By having a dedicated grant writer or staff member well-trained in grant writing, a community was also often required to get specific with their priority projects, ability to manage awards, and desired outcomes. Once these priorities had been established or there was a process established to regularly determine these priorities, it was easier for communities to align with relevant funding and financing opportunities. Additionally, when a grant writer spent time stewarding relationships with funding and financing agencies outside of application periods, they better understood the underlying motivations of the program, picked up on language and key phrases used by the agency, and established a relationship with staff who could be reviewing submitted applications. This relationship allowed municipalities to understand which funding

and financing options aligned with their goals, further allowing for municipalities' time and energy to be aimed at fewer, higher-quality application packages with higher success rates.

We noticed that municipal staff were not always aware of major federal and state grant and loan programs. In instances where staff were aware of these programs, many staff still did not put their limited resources towards these applications. The technical and complex application process and perceived limitations to how funds could be used discouraged municipalities from applying. In particular, FEMA's Building Resilient Infrastructure and Communities (BRIC) program was named as inaccessible and difficult to apply to. Further, some federal funding applications had incredibly scientifically complicated portions of their application (e.g., stormwater runoff calculations) that necessitated a degree of expertise not readily available within most municipalities.

Another common challenge was understanding the general grant writing process, including how to maximize the grant cycle cadence. Grant writers made very significant contributions to the municipalities for which they worked. They had expertise and experience in the grant application process, which enabled application success. They were able to steward relationships with grant agencies and collect information on potential grant prospects. In one case, a single grant writer was able to bring in $40 million for a variety of projects, not limited to coastal resiliency.

We found that municipalities were often overwhelmed by the amount of information available, which made it difficult to sort through the immense amount of available funding and financing information. We found this issue was exacerbated in communities that lack a grant writer or financial specialist that can expertly navigate available information. Online funding and financing databases were abundant but often became irrelevant within a few years after creation, or one to two funding cycles with changes to requests for applications. We also identified that municipalities often discovered funding opportunities in their application "sweet spot" (i.e., manageable award amount, relevant project type, and others outlined in Appendix I) through professional connections and networks. These networks and personal recommendations cut through the noise of information overwhelm and more directly linked municipalities to money they were able to use.

Cash

Among grant and loan opportunities, funding models tended to emphasize project-based funding (discretionary) over capacity-building or general operating (non-discretionary) funding. The project-based approach locked municipalities into short-term and nearsighted projects that reacted to the most immediate threats. Project-based funding incentivized spending on certain types of projects like green infrastructure, leaving municipalities unable to use those awards to address ongoing issues. Ongoing projects or updates to aging infrastructure also tended to be extremely high cost and were not covered by many grant programs. When grants were designed at mid-range award levels and as project-based funding, background or ongoing issues like updating aging water infrastructure lost their priority on municipal to-do lists.

Cash availability was constrained by the slow pace and changing priorities of federal administrations. It was common for federal spending priorities to be established but then not reflected in spending patterns for a few years. We heard an example from practitioners in the U.S. Army Corps of Engineers who described a Great Lakes Summit Meeting in Chicago 2016, where budget requests were outlined to emphasize coastal resilience for the next three years. This was eventually recognized in the federal budget for FY2022.

"Finally, when municipalities did find an appropriate funding source, substantial match dollar requirements often prevented them from qualifying as applicants."

While municipalities acknowledged that it was not possible to obtain every grant that they applied for, many felt that they were systematically losing out to the municipalities that had greater capacity, influence, or need. Interviewees noted high competition between small and mid-sized communities along the same shorelines. These communities also noted competition from small and mid-sized communities against large cities like Chicago, who often outcompeted their smaller counterparts for grants. Interestingly, we noted a general feeling that Great Lakes communities were outcompeted by salt coast communities for federal funding. Despite the competitive nature of the funding process, the literature indicates the Great Lakes basin was experiencing a wave of awareness and action for resilience planning and research.

We found municipalities mentioning the increase in high-value property residents and visitors during the summer season having significant impacts on the community's income via local sales and recreation. Communities benefit financially from seasonal income. When local revenue is subject to drastic seasonal swings, it can be difficult to plan ahead for high-cost resilience projects.

Finally, when municipalities did find an appropriate funding source, substantial match dollar requirements often prevented them from qualifying as applicants. This was particularly challenging for unanticipated or emergency issues that needed to be addressed immediately. Most municipalities did not have cash on hand for unexpected matching funds. Finding match dollars has been known to stall project progress and limit the scope of grants that best support a community's needs. Based on interviews with both resource providers and municipal staff and the process of compiling funding and financing opportunities, it is important to consider the extent to which a grant fits the needs of the applicant. Match dollar requirements are a primary excluding factor when determining goodness of fit.

Relationships

A significant indicator of success in financial planning could be attributed to relationships. Professional networks that connected municipalities to state and federal agencies, private funders, regional planning commissions, and other communities with similar resilience concerns were often the antidote to other constraining factors. This report will further investigate relationships in the Connection section.

CAPACITY

> *"But our village is quite small. The entire Town (township) has fewer than 300 registered voters. We have very limited resources and are basically at the mercy of Mother Nature. I would say what we need to do more of is learning how to live with the changes rather than trying to change anything."*
>
> Chairman, Town of Bell, Bayfield County, WI

> *"I wish that there was a way for the city to better capture some of the knowledge retention. I mentioned that I leaned on the former DPW Director a lot. And that helped me a lot. But if that wasn't there, all of his knowledge is lost somehow. And you know, it. He knew what to do. He knew where the problems were going to be because he lived through him before, right? And I'm going to be the same way 20 years from now, or whenever that is, and how do I make sure the next person is ready for that? Whether I'm here to tell him that or not."*
>
> Director of Public Works, Muskegon, MI

> *"Again, that comes back to dollars, having dollars to pay consultants to develop solutions, and then the dollars to implement those solutions, whether it be through private money or government money or a cost share process."*
>
> Drainage Superintendent, Dutton Dunwich, ON

> *"Many municipalities don't bother to apply for grants because of the matching funds requirements. So, it's not that we don't have the water quality issues to address. We simply lack the capacity with existing staff and the necessary resources to compete for grant opportunities."*
>
> Director/MS4 Coordinator, Gary, IN

If there was one thing consistently on the minds of those doing local coastal resilience work, it was their limited capacity. We found that many challenges and successes could be traced back to this. Capacity can broadly be broken into staff capacity and funding capacity, but the two are often deeply intertwined. Capacity is an enabling and constraining factor that is easy to understand; when there was capacity, work could be done; when there was not capacity, work could not be done. ***The challenge was that there never was enough capacity anywhere, at any level or size of government.***

Staff Capacity

The staff supporting local coastal work often wore multiple hats and juggled various commitments, and as a result, these officials were stretched thin. They did not necessarily have the time and energy to devote to emerging coastal challenges while attending to their core job responsibilities. We found that time constraints limited staff's ability to absorb new information, attend trainings, build communities of practice, or engage with support agencies. A prime example of this were municipal floodplain managers. This duty was often assigned in addition to their primary, full-time responsibilities, which left little time to adequately fulfill the added responsibilities. Additionally, staff dealt with timing issues as they strived to complete projects within the same election cycle before a new official could switch priorities. Low staff capacity also limited the organization's ability to identify and apply for grant funds.

> **"The challenge was that there never was enough capacity anywhere, at any level or size of government."**

Coastal work capacity challenges were not solely an issue of expertise on coastal issues. Capacity was needed at multiple areas of municipal government to execute projects successfully. Projects also required expertise in administration, legal, engineering, purchasing, and beyond. Municipal officials reported that the myriad administrative tasks could make a grant "not worth it," discouraging them from applying.

While capacity challenges existed at every size and type of municipal government, small municipalities (i.e., <1,000 residents) had significant capacity issues. Small municipalities had a few full-time staff focused on immediate municipal services like street maintenance. Therefore coastal work fell to elected officials with an interest in coastal issues; there was no employee with coastal work as part of their job responsibilities. In addition, resources providers stated that small municipalities did not have the technical capacity to utilize data to understand their community's situation.

Municipalities often turned to outside organizations like consultants and resource provider agencies to bridge capacity gaps, but this also brought added capacity challenges. Resource provider agencies had their own staffing capacity issues, limiting the amount of support they could provide municipalities. For example, if resource providers took on some of the responsibility of running a municipal project, they would need to hire a new person to do so or decrease an existing staff member's responsibilities. Additionally, resource providers commented that it still takes a local champion to see projects through even with substantial provider support; therefore, outsourced capacity still requires a base level of local capacity. Similar issues existed with consultant work, as there still needed to be a point person on the project.

Knowledge and staff capacity were tightly bound together. Institutional knowledge was key to local coastal resiliency work, which resided in people. Therefore individuals leaving positions could create massive information loss. While some of that knowledge could be preserved and passed on, there were some things one could only know after significant time in a local position. Similarly, if the new employee did not have a background in coastal resilience, they were less likely to know where to begin in collecting information and building relationships. While information could be preserved in protocols and documents, relationships were the most difficult to pass down; high turnover rates made it difficult to build trust

between resource providers and municipalities. While municipalities could turn to consultants to fill knowledge gaps, consultants had their own knowledge gaps and institutional knowledge challenges.

A few municipalities reported that residents filled in capacity gaps. One municipality utilized the skills of a retired grant writer to support their grant applications. Another municipality was able to leverage the connections and knowledge of a former FEMA contractor during a time of intense crisis. Individual residents and community groups also played vital roles in educating people on coastal issues — often being champions of a cause. These individuals filled critical gaps in their communities' coastal work, volunteering time and expertise, and they speak to the commitment of many residents to the coastal resilience of their communities. However, these were the exception, not the rule, and the connection between these residents and municipal officials often occurred by chance.

As there were never enough people for coastal work, communities may not have the capacity to look beyond reacting to immediate challenges. This lack of capacity led to a lack of long-term planning and proactive solutions. Over the long term, this could create more coastal work than if initial long-term planning was completed.

We did find that elected official priorities could overcome some capacity issues. If mayors or council members were knowledgeable on coastal issues and invested in coastal resilience, they could use their political influence to devote funds and staff toward local coastal work. However, this attention was not a permanent solution as elected officials' priorities could shift, or they could get voted out of office.

Funding Capacity

Staff capacity always came back to funding: to hire staff, hire consultants, or work with partner agencies. Increased staff capacity could only be achieved through new funding sources. Municipalities needed funding to contract with consultants. Agencies need funding to support the staff position necessary for supporting local coastal work.

Municipalities needed staff capacity to obtain and manage grants. Staff needed the knowledge and time to navigate potential funding sources, apply for the grant, and then administer it once received. When municipalities had a grant writer on staff, they were more effective at obtaining and managing grants for coastal projects and other work. However, not all municipalities have the funding capacity to support a grant writer.

One aspect of funding capacity that was not directly tied to staff capacity was match dollars. Communities needed to commit a certain amount of money to obtain grants. If they could not provide match dollars, they would not apply for the grant, perpetuating their capacity issues.

CONNECTION

> *"It is always a very important thing to get to know those people that you'll need to talk to during an emergency before the emergency happens. So networking and making sure you know the right people to call beforehand is also very critical."*
>
> Manager, Flood Emergency Management
> Toronto and Region Conservation Authority

> *"And adaptation is all local. So the tribes have to have a good relationship with the municipalities particularly already. A lot of times that's strained. A lot of times it's siloed where the tribes are doing their thing and municipalities are doing their thing. And sometimes they're working together. But often they're working at cross purposes. Or they do the same thing, not even realizing that each other are working on the same projects that could be done jointly and maybe more efficiently and over a bigger area. [...] And that's something that relationship building needs to help address. I think the potential is certainly there for it. But I think everybody has to be at the table together at the same time for that to happen."*
>
> Climate Change Program Coordinator
> Great Lakes Indian Fish & Wildlife Commission

What was immediately evident in the interviews was that connections are integral to responding to Great Lakes issues, and a lack thereof is detrimental to communities' resilience. The web of influential relationships includes other municipalities, non-governmental organizations, state and federal agencies, and communities of practice.

We found that the most significant gap was what we call the "Missing Middle Person." Municipalities seemed lost on whom to contact at larger supportive agencies. ***From requesting help with grant applications to deciphering technical information, communities reiterated that many of their struggles with planning, funding, and implementing could be solved with consistent guidance from a person or organization.*** Someone with applicable relationships and knowledge could improve communities' ability to address coastal challenges by connecting their municipality with the best available grant programs, assisting with demanding applications, breaking down scientific or technical information, or simply being their go-to contact. Interviewees' preferences for whether this individual needed years of experience in the basin and well-established relationships varied. Whether or not the position had to be filled by someone in the government or a non-profit was also up for discussion.

We found that some boundary organizations, including governmental partnerships and non-governmental organizations (NGOs), had already successfully filled these gaps. Local and regional organizations, such as Sea Grant, could clarify data, assist with applications, help with matching funds, educate community members, and collaborate on projects. We found several successful examples of collaborations between NGOs and municipalities during our interviews. Organizations provided municipalities with necessary studies to support future action or connected them with the appropriate agency staff on an issue. Academic institutions also could provide necessary support or technical assistance, but they were not frequently cited as a source of support.

Municipal officials expressed frustration over a lack of connectivity between state agencies. This created overlaps in work being done and priorities that did not align with each other. Additionally, when municipalities were implementing a project that involved multiple agencies, they found themselves submitting the same information over and over, which they viewed as an ineffective use of time.

Municipalities who had professional relationships with state program contacts or administrators had greater success in securing grants. These relationships enabled information sharing on new grant opportunities and a level of familiarity and trust between municipalities and granting organizations. Another benefit of professional relationships is an understanding and tailoring to the core values and motivations of the lending organization.

Relationships with partners like regional planning commissions, environmental engineering groups, or consulting firms could strengthen an application amd facilitate project success. Adding a professional partner as a project manager gave legitimacy to projects, particularly new and innovative projects that are emerging to strengthen coastal resilience.

A municipality's relationships with other municipalities, especially those with similar concerns and resources, also proved important in their coastal work. Municipalities shared contact information for state and federal agencies, provided general advice based on their own experiences with coastal resilience work, and even gave tours of finished projects. In addition, staff and elected officials shared success stories and challenges with each other. Often, these intermunicipal relationships formed between nearby communities or those who experienced similar issues. These connections started with personnel reaching out or through existing municipal networking groups. Through partnerships and collaborations, communities could share the cost of projects that benefit a greater area of shoreline for mutual gains, such as creating a Special Improvement District to assist private property owners with erosion control measures. Lastly, communities across the Great Lakes basin could share ideas for pilot projects and give credibility to more innovative nature-based solutions. Local governments felt more comfortable taking a risk on a new type of project when they had seen it in action and working successfully.

We found that personal connections were at the heart of these relationships. Staff and elected officials' relationships with community members affected the community's response to issues, especially when advising on shoreline protection. As mentioned in the first section, a personal connection with someone in a supporting agency improved the community's ability to respond to and carry out necessary steps such as filling out applications or receiving advice. Interviewees mentioned the importance of knowing the right person to call to answer questions. This increased the likelihood that interviewees would reference a specific agency they worked with in the past. One very successful community-recommended sending a staff person to lectures and talks on coastal issues to connect with experts and agency staff and to then leverage those connections when applying for grants, even if it required traveling hundreds of miles.

Last, we found that municipalities benefited from having strong relationships with their legislators at the state and federal levels. Inviting representatives to view damaged property or eroding shorelines strengthened this relationship and made representatives more aware of the issues communities face, even if the representatives could not immediately provide help. This was especially important for small rural communities who may have been overlooked or forgotten. The same community mentioned in the last paragraph also recommended monthly meetings with state representatives to exchange information on the current state of the community and potentially be briefed on any upcoming funding opportunities that

could soon be available through state or federal legislatures. As a result, municipal officials were able to plan further in advance for projects.

Discussion

Direct experiences, attitudes, and beliefs play important roles in how community leaders respond to coastal issues. It is clear that experience with coastal impacts (e.g., flooding, erosion) inspires communities to act, whether or not climate change is acknowledged as the source (Druckman and McGrath 2019; Sambrook et al. 2021). We all seek information that confirms what we already believe; people often interpret their experiences as confirmation for preexisting beliefs. This is an important consideration in understanding local-level action towards climate resilience, and it plays a role in how Great Lakes communities perceive coastal impacts. Previous studies have found that climate change messaging that focuses on the intrinsic value of nature, the impact on the environment, and the ways the environment supports our health and enjoyment could be effective strategies to inspire environmental stewardship (Marshall et al. 2019). The roles experience and perception play in shaping beliefs will likely continue to be investigated as coastal communities increasingly encounter climate change impacts.

Current decision-making processes are out of alignment with the environmental values supported by the culture and pride of living on the Great Lakes coastline. ***Municipalities often make reactive, short-term decisions about implementation of coastal resilience measures***, though many resilience practitioners emphasize a long-term and value-based approach for more sustainable outcomes. Despite being constrained by short-term project options, community-level interviewees said they greatly value public access to the lakes and nearshore areas, and preserving these areas for the future is a priority. Two causes of reactive decision-making are the short-term memories of residents and local decision-makers lacking capacity to plan for the future (Kiker et al. 2011; Norton and Meadows 2014; Norton et al. 2018). This study finds another cause to be project-based funding and financing options, addressed later. A common short-term project and oft-recommended solution in the past has been shoreline hardening by installing seawalls or other gray infrastructure, which has the effect of reducing public access and recreational use of nearshore areas. These engineering solutions do not absorb wave action but rather push the energy carried by the waves to other stretches of shoreline without hardened protection. The effect is a concentration of erosive wave power on a few stretches of shoreline, cutting away sand and reducing area that can be publicly accessed in un-hardened areas (Posts et al. 2021).

"Municipalities often make reactive, short-term decisions about implementation of coastal resilience measures"

Municipalities who included coastal resilience in their long-term plans were more likely to act on their coastal resilience strategies, but municipal planning was dependent on having organizational capacity. Our conclusions that coastal resilience is dependent on capacity (both staff and funding), knowledge of coastal issues, and commitment are also themes in other coastal resilience planning research (Norton et al. 2018). Norton et al. (2018) found that municipalities that address coastal issues in plans had: higher home values which represent a financial measure of capacity; dedicated planning staff, which represents knowledge and capacity; and development pressure which represents commitment (resulting from urgency) and capacity. We find political will and public support to be an important factor in successful incorporation of coastal resilience into comprehensive plans. Local officials received support for resilience projects if constituents considered local resilience a priority, relating to themes of environmental values discussed above. In-house knowledge of coastal issues was also important; it made it easier for officials to envision and start coastal resilience projects.

Resilience planning is executed at the local scale (i.e., city, county) with technical assistance, project management, and funding from federal and state agencies. However, it can be difficult to ensure that local municipalities adopt planning tools and guidance offered by higher levels of government. Each Great Lakes state has a Coastal Management Program (CMP), funded and supported by the Coastal Zone Management Act of 1972, and administered by NOAA's Office for Coastal Management. These programs do not mandate management, but they do offer decision-making support (Norton and Meadows 2014). At present, few local U.S. coastal areas are influenced by federal and state regulations. For instance, only 8 percent of Michigan's coastline are designated as erosion hazard zones, meaning that over 90 percent of houses or buildings may not be reviewed for erosion hazard (Norton and Meadows 2014; Vega and Warner 2020). At the local level, there is a heterogeneous spread of coastal planning efforts along the Great Lakes coasts (Norton et al. 2018). We also found that coastal resilience planning should incorporate hazard planning based on advice from resilience practitioners.

Our interviews reveal that local coastal planning and zoning have benefits and costs that complicate discussions about standardizing coastal resilience planning and implementation at regional or state scales. Having less local regulation allows for more flexibility to adopt resilience solutions relevant to municipalities' specific context. However, less local regulation may also result in coastal resilience being excluded from planning or zoning if municipalities do not view coastal resilience as a priority. If standardized planning from the state or federal level is adopted, the specified measures may not be tailored to a community's specific needs and priorities. These benefits and costs create some tension in considering what the best practices would be for standardizing plans and regulations or if standardization is a good idea.

Though local U.S. municipalities face challenges in implementing resilience projects and plans, the recent 1 trillion-dollar infrastructure bill, the Infrastructure Investment and Jobs Act of 2021, may provide even more support for resilient infrastructure from the federal government. The bill includes $47 billion in resilient infrastructure investments and $55 billion for resilient drinking water investments (Pita 2021; Infrastructure Investment and Jobs Act of 2022). Funding from the bill will last for five years, which may help U.S. local and state governments adopt a long-term perspective on resilience planning and projects and catalyze future change (Pita 2021). It will still be important to consider how to incorporate equity into the distributions of this money. Green infrastructure projects and other resilient infrastructure are often used to address historic effects of inequitable resource distribution, but it is also important to consider how

these proposed projects will interact with current inequities and disparities in the communities they are built in (Derickson et al. 2021).

Academics have identified an opportunity to expand existing binational agreements like the Great Lakes Water Quality Agreement and the Great Lakes Restoration Initiative (GLRI) to cement consistent funding for water and environmental coastal resilience planning (Gallagher et al. 2020). Using binational agreements to further protect the Great Lakes from climate change and other environmental stressors will allow federal, state, and regional governments to formally collaborate and better support resilience planning at the local level.

Investing financially in a coastal and climate literate coastal management culture will play a key role in shifting the approach to meet current and future coastal management challenges. Federal and state aid could support increased literacy. Recent events, like the COVID-19 pandemic, have further highlighted the need for informed decision-making regarding coastal management and public health. Beaches and outdoor spaces became important social hubs during the pandemic, resulting in increased usage. However, these beaches also faced environmental challenges during the pandemic, like cyclones, severe storms, and increased plastic pollution (Perillo et al. 2021). We also found that Great Lakes coastal and beach areas served as important public gathering spaces during the pandemic, but environmental issues, like algal blooms, excessive erosion, and high bacterial levels caused closures — reducing their usability as safe outdoor gathering spaces.

Over the past decade, with increased attention and effort on climate adaptation and resilience, municipalities have been overwhelmed by the array of climate and resilience resources and how to integrate these in their decision-making processes. We refer to this phenomenon as "information overwhelm." ***The inability for municipalities to gather and understand climate information and remaining uncertainty of localized future climate effects have made municipalities feel less confident in their decisions.*** Kiker et al. (2011) similarly identified the lack of adequate information and comprehension as barriers to adaptation. Knowing what information is relevant and knowing how to incorporate it into decision-making is perhaps the most important reason for effective science translation.

A missing middle person - someone to facilitate relationships and information exchange between federal and state agencies and municipalities - is needed to ensure successful collaboration and communication. At present, the use of data and research-backed science in local coastal resilience decision-making processes is low (Lemos and Kirchhoff 2016). We see an additional "middle person" or liaison between CMPs or another agency as an opportunity to close this gap. The effect of a middle person can be filled in many other ways. Municipalities reach out to each other for information, ideas, and advice. Sometimes non-profits and academic organizations fill the middle person role, too. These groups often provide data and science communicators that serve to connect local governments with data to inform coastal resilience action. The Cities Initiative connects local municipalities across international borders, facilitating intergovernmental collaboration (Norton and Meadows 2014). ***The role of the missing middle person may be just as important as the physical and engineering solutions to coastal hazards*** (Kiker et al. 2011). This finding is also supported by Lemos and Kirchoff (2016), who concluded that the biggest influence on how science is incorporated into policy is the quality of the relationships between the science-generators and decision-makers.

Low resource and socially vulnerable communities are often the least insulated from climate change impacts. This vulnerability is compounded for communities that are located in higher risk areas for

natural hazards, like low-lying coastal areas (Yumagulova 2011). Communities like Duluth, Milwaukee, Chicago, Detroit, Cleveland, and Toronto were built at the mouth of major rivers to take advantage of ecosystem services provided in these areas (Larson 2013; NOAA 2019). As lake water levels become more variable and more frequent severe storms, these urban areas will be increasingly more susceptible to flooding (Wuebbles et al. 2019). These increasingly frequent flooding and other climate impacts disproportionately affect urban communities of color due to red and yellow-lining ("A Racist Past, a Flooded Future" 2021; Capps and Cannon, no date). Areas that were historically redlined in large cities like Sacramento, California and Detroit, Michigan face higher flood risks due to decreased infrastructure development and sustained disinvestment in these areas. Due to close proximity to the shoreline, communities of color in Detroit who live in previously redlined neighborhoods may also face higher risks of flooding as water levels become more variable and the effects of climate change reach further inland.

The primary source of funding for current coastal management projects in the Great Lakes is the Great Lakes Restoration Initiative (GLRI). Established under the Obama administration in 2010, this legislation provides increased funding to sixteen federal agencies who manage natural resources and human well-being in the Great Lakes basin. These agencies use GLRI funds to carry out five main foci identified most recently in the GLRI Action Plan III for 2020-2024: (1) toxic substances and areas of concern, (2) invasive species, (3) nonpoint source pollution impacts on nearshore health, (4) habitats and species, and (5) foundations for future restoration actions. These five themes are represented in the funding opportunities offered through the sixteen federal agency partners as pass-through grants to state and local managers and municipalities. A notable update to these priorities in version III from previous Action Plans is the addition of foundations for future restoration projects, signaling the importance of preparing and training the next generation of coastal managers who are likely to approach these challenges in innovative ways.

"The use of innovative funding models could be a new tool in the arsenals of local governments feeling constrained by traditional funding and financing options."

Flood and disaster insurance, primarily offered through FEMA, brings mixed results. Recent studies by Norton et al. (2018) and Kiker et al. (2011) suggest that FEMA's individual flood insurance and disaster assistance is a barrier to implementing coastal resilience. Flood insurance can lead to inaction, as the insured know they will be compensated in the event of flooding. As a result, they see long-term planning and adaptation measures as unnecessary. FEMA has also been long criticized for structural inequalities in their programs, leaving low-income and BIPOC renters and communities without the direct assistance in the event of a disaster or flood (Billings et al. 2019; Howell and Elliott 2019). Their 50 percent appraisal rule means that low-value homes need to show very significant damage, likely to the point of evacuation or tearing down their home, rendering insurance pay-outs to undervalue damage and become essentially useless (Staebler 2017). A review of FEMA's internal documents revealed that the lowest-income renters were 23 percent less likely than higher-income renters to get personal disaster relief in the event of a flood (Rott 2021). Still, other studies showed that when implemented as part of a broader resilience plan, community-based flood and catastrophe insurance will be a key part of climate preparedness (Kousky 2019).

The use of innovative funding models could be a new tool in the arsenals of local governments feeling constrained by traditional funding and financing options. Residents of Great Lakes coastal communities face many similar challenges to communities in other coastal areas and thus can learn from and model successful resilience efforts from these areas. In Hampton, Virginia, environmental impact bonds allow a private venture capital firm to invest in municipal green infrastructure and other projects that have been on the city's to-do list for decades (NOAA Digital Coast 2021). This model outlines an outcomes based pay-out plan, where investors see a return on their investments if the project successfully meets its evaluation targets, like increasing stormwater storage capacity. Another pilot funding model is event-based catastrophe insurance for coral reefs in Mexico. This approach aims to combine risk transfer (insurance) with risk reduction (hazard mitigation) for disaster risk management (Reguero et al. 2020). These mechanisms have been considered separately in most insurance models, though combining them would open the door to public and private alignment and investment in nature-based solutions. In California, some counties are using a revolving loan program to purchase homes and properties at risk of flooding (Rott 2021). This works to shift the burden of flood damage costs onto the county or public and off of homeowners, incentivizing homeowners to consider relocating further from the shoreline. The county or community can then rent out the property, sometimes to the original homeowners, until the loan has been paid back. Some state governments are getting involved in financing these efforts in other ways, including the addition of state sales taxes (Minnesota, Montana) or lottery sales (Colorado, Minnesota) to fund natural resource management and climate resilience projects (Clark 2016).

Philanthropy may be a novel approach to funding but has some drawbacks. Some agencies suggest that "green" philanthropy is a growing and largely underutilized source of funds (NOAA Digital Coast 2021). However, just one municipality among forty interviewed mentioned green philanthropy as a significant funding source. Private funding may be a viable alternative to project-based funding but is unlikely to replace base funding. We do not recommend that municipalities redirect efforts from federal funds in favor of green philanthropy. Much like government sourced funding, there is still a competitive application process where well-developed and high-urgency projects go unfunded. Changing course toward private funds does not address the underlying structural issues within government funded programming (grant cycles, limited awards, high match dollars, limited technical support) that are pushing municipalities to find creative funding methods. A potential challenge in seeking green private funding is to find a lender that trusts their recipient and allows for funds to be spent on general operating expenses, including paying salaries and wages to expand staff capacity. This is a common limitation of federal funding uses as well. Thus, to successfully use private investment, a positive relationship between lenders and borrowers must be built on trust. Without this, a community may be better suited to apply for public funding programs.

Limitations

IMPLEMENTATION INTERVIEWS

Our findings from implementation interviews apply to many different Great Lakes basin communities in the United States. Still, Canada is not well represented in our findings and subsequent recommendations. Quebec's participation in the needs assessment survey and our implementation interviews was limited. While many of our study's recommendations could apply broadly, considering the recommendations in a Canadian context is provisory. In the United States, while comparable communities in other states were interviewed, readers may find recommendations helpful but limited for New York, where our coverage was limited. The applicability of our findings and recommendations are even more limited for use by Indigenous Nations. We had so few interviews with Indigenous communities and agencies that our recommendations do not claim to reflect the diverse perspectives and needs of Indigenous Nations. Our interviews also lacked perspective from other minority ethnic or racial communities, particularly in urban coastal cities, suggesting a gap in the applicability for these populations.

RESOURCE PROVIDER INTERVIEWS

Our resource provider interviews were more limited, with fewer interviews overall, providing a less comprehensive understanding from the provider's perspective. We had fewer opportunities to talk with Canadian, Quebec, or tribal agencies and organizations; similar to implementation interviews. Because questions focused on the interplay between interviewed organizations and municipalities they support, our recommendations generally focus on how agencies can most directly support municipalities. This focus generally leaves out the improvements providers could make amongst themselves to improve resilience efforts.

RESOURCE PROVIDER FOCUS GROUPS

Only two focus groups were conducted, limiting the information that could be compared across different organization types. Because of this, we cannot compare questions directly between focus groups and standard interviews. The focus group model restricts the number of questions that can be asked. Therefore, the breadth of results would be limited compared to the resource provider interviews but provide more context due to communication between interviewees.

COMPREHENSIVE RESOURCES LIBRARY AND RECOMMENDED RESOURCES LIBRARY

Both resource libraries are limited to those we could access. Broken links, 404 pages, and paywalls likely resulted in missing resources, suggesting that our findings relating to the libraries may be incomplete. Even for the resources that we could access, it took time to jump through many subpages to access some resources. The library could closely resemble the available resources in the basin but not all may be easily accessed, resulting in a library that may not represent resources that users could find.

FUNDING LIBRARY

The funding library has limited applications due to funding and financing opportunities aging out of relevance after 1-3 years. It captures a snapshot in time. Because of these frequent changes, our funding library would be best used as a reference guide to the most considerable grant opportunities available in the basin from 2018 to 2022, rather than a comprehensive list. We attempted to overcome this short lifespan by adding supplemental information on state liaison contact information, grant training modules, relevant webinars, and general application information to aid future grant finding.

The library also emphasizes federal- and state-administered funding programs and does not fully represent private and philanthropic opportunities. This is because sometimes, obscure search terms are required to find funding and financing opportunities. Even if private opportunities are open to funding green infrastructure and nature-based solutions, their descriptions may more broadly ask for applications that emphasize the health and well-being of people and the environment in the Great Lakes and thus may not be returned in a search. Private opportunities are also not as widely advertised and may be primarily shared through private channels posted exclusively on the foundation's webpage.

FUTURE RESEARCH

Understanding how disparities across social demographics will be exacerbated or affected by climate change, with specific focus on access to technical and funding support across the Great Lakes, is a suggested topic for future research. Another opportunity is to investigate how state-level funding management differs by state and how this compares to the context of their major resilience concerns, urgency and risk of coastal dynamics in a particular geographic location, and stratification of local and regional support organizations. This project was able to capture general, high level information to place a municipality within the context of their unique assets, resources, and challenges but does not aim to be a community-based skills assessment. Spending more time with local municipal staff and mayors would allow for more tailored suggested action depending on the 'starting point' of their coastal resilience work. The recommendations below could be used as a more comprehensive list from which tailored recommendations could be developed to best fit a specific case.

Recommendations

This section fulfills research Objective 3. We offer the following suite of recommendations based on our understanding of the current literature, interviews with stakeholders from across the Great Lakes basin, and assessments of coastal resilience resources and funding and financing options. Recommendations are not listed in a prioritized order. While tailored to our clients, the Cities Initiative and NOAA OCM, our recommendations also integrate general recommendations for municipalities and other relevant actors in the basin. The nine recommendations below are built off perceived challenges from our research and each is followed by a suite of potential strategies and actions. Each strategy has recommended actors provided in brackets.

Challenge 1 - Communities are constrained by a range of institutional structures that favor short-term, reactive projects.

Recommendation 1 - Initiate long-term planning and monitoring to drive sustained action, despite changing conditions and decision-makers.

Coastal resilience action in the Great Lakes basin is predominantly driven by changing coastal conditions and election cycles. When water levels swing, local interest in coastal resilience piques and political will heightens. This inspires reactionary measures to mitigate short-term effects and damage but fails to consider long-term dynamics and consequences. Municipalities must embody a long-term view by developing (and prioritizing funding for) future-oriented plans to manage their coast and prepare for hazards. This approach ensures communities are proactively cultivating their capacity to prepare for, adapt to, and recover from changing coastal conditions.

Recommendation 1 Strategies

1. Support development of local coastal management plans; with considerations and maximization of varying priorities, cultures, and capacities among federal, state, and local leadership (see the Michigan Department of Environment, Great Lakes, and Energy's Coastal Leadership Academy). [NOAA, GLSLCI, CMPs, State Agencies, Sea Grant, Conservation Authorities]
2. Invest in sustained regional and local coastal data monitoring, modeling, and analysis. Improve scale and resolution of data to the degree possible. [NOAA, Municipalities]
3. Integrate projections from long-term data and coastal modeling into local planning and decision-making. [NOAA, Municipalities]
4. Identify and prioritize potential local coastal management projects, and ensure their inclusion in capital improvement plans (if applicable). Develop shovel-ready designs. [Municipalities]

Challenge 2 - Information and expertise are siloed across the Great Lakes basin; stifling communication, collaboration, and comprehension and resulting in duplicative (or lacking) efforts and programming.

Recommendation 2 - Intentionally facilitate binational, basinwide communication, relationship-building, and information-sharing on coastal resilience.

Relationships are the linchpin to local success on coastal resilience. However, establishing reciprocal and lasting relationships takes time, communication, and trust. Both implementers and resource providers can more proactively foster relationships and establish lines of communication before urgent situations arise. Establishing forums, hubs, and events to build relationships can lead to quicker action, more effective distribution of resources, and increased collaboration.

Recommendation 2 Strategies

1. Establish a designated staff person at a non-regulatory organization to serve as a conduit or liaison between local entities and government agencies. [GLSLCI, NOAA, CMPs, Sea Grant, Conservation Authorities, Regional Planning Agencies]
2. Proactively establish two-way communication between communities and government agencies before emergencies occur. [NOAA, GLSLCI, Municipalities]
3. Build basinwide and statewide communities of practice on coastal resilience hosted by boundary organizations or statewide organizations. [GLSLCI, CMPs, Sea Grant, Conservation Authorities]
4. Hold a regular sub-basin or basinwide summit or conference on coastal resilience to synergize efforts, foster relationships, and share successes and challenges. [NOAA, GLSLCI]
5. Integrate coastal resilience best practices into GLSLCI's Best Practices Library and overhaul the platform to facilitate more inter-municipal information-sharing and collaboration. [GLSLCI]

Challenge 3 - Stakeholders face an overwhelming number of resources and actors involved with coastal resilience and are uncertain about how to effectively seek information and help.

Recommendation 3 - Identify a primary hub for coastal resilience resources and build capacity of existing sub-hubs.

The wave of interest and momentum in coastal resilience following the 2017 and 2019 high water level events spurred the creation of resources to support local action on this topic. Organization and curation of this wealth of resources into a more user-friendly, centralized hub will guide stakeholders to resources most compatible to their needs and skill level. Creating additional resources, information, clearinghouses, and hubs could further confuse stakeholders and dilute the impact of existing resources. Instead, efforts should be invested in improving the capacity and usability of the existing resources based on user feedback and recent data.

Recommendation 3 Strategies

1. Identify a binational, boundary organization to host, manage, and update a centralized coastal resilience resources hub and provide guidance to users. [GLSLCI]
2. Improve usability and searchability of existing resource sub-hubs, and refrain from creating additional dispersed platforms (see Gulf Tree as a model for a usable hub). [NOAA, GLSLCI]
3. Sunset underutilized resource hubs. Identify a focal hub for binational resource compilation efforts. [NOAA, GLSLCI, Resource Providers]
4. Incentivize co-production of science-informed management strategies through collaboratives with university partners. [Municipalities, GLSLCI]
5. Develop a strategy for branding, marketing, and onboarding the resource hub to on-the-ground users in the United States and Canada. [NOAA, GLSLCI]
6. Consult with target users during resource development and provide opportunities for their input during resource evaluation; ensure usability of resources and data for decision-making support. [NOAA, GLSLCI, Resource Providers]
7. Conduct social survey research (e.g., surveys, listening sessions, or focus groups) to better understand current and potential use of specific resources and hubs; identify areas for improved information delivery and topics for future resource development. [NOAA, GLSLCI, Resource Providers]
8. Survey municipalities and coastal managers regarding resource needs in the next iteration of the coastal needs assessment survey to better identify topical needs for resources. [GLSLCI]

Challenge 4 - Coastal decision-makers and residents remain confused about coastal and climate processes and potential resilience solutions.

Recommendation 4 - Educate coastal communities about coastal and climate processes and potential resilience solutions, and include residents in local coastal management planning and decision-making.

Without awareness and understanding of coastal and climate processes and resilience solutions, municipal coastal resilience efforts will continue to lack public support and broad adoption of residential resilience solutions. Effective coastal resilience requires public engagement to ensure solutions are relevant, broadly applicable, and supported. Education of decision-makers and residents can improve understanding of the drivers of coastal variability and potential coastal management solutions. By establishing grassroots stewardship programs, communities can cultivate local champions to maintain momentum towards coastal resilience and expand implementation beyond city-owned properties.

Recommendation 4 Strategies

1. Work with Sea Grant programs, Conservation Authorities, or university extension programs to provide workshops and training for residents on coastal and climate processes and resilience solutions. [Municipalities, State Agencies, NOAA]
2. Launch and maintain a robust train-the-trainer coastal stewards ambassador program to empower shoreline residents to promote coastal resilience within their communities and grow a network of on-the-ground coastal stewards (see Michigan Natural Shoreline Partnership's Michigan Shoreland Stewards Ambassador Program). [NOAA, CMPs, State Agencies, Sea Grant, Conservation Authorities]
3. Diversify communication strategies and language around climate change to ensure outreach is compatible with residents' capacities and perspectives. [State Agencies, Sea Grant, Conservation Authorities]
4. Provide opportunities for residents to co-create coastal management projects with municipalities and share input on proposed plans. [Municipalities]

Challenge 5 - Municipalities lack time and staff to digest information, apply for grants, and oversee coastal resilience projects.

Recommendation 5 - Invest in regional scale grant writing expertise and capacity to support local coastal resilience.

Financial information and other coastal resilience resources are not effectively incorporated into local coastal planning. This is due to limited staff capacity and underutilization of existing intermediate agencies like Regional Planning Agencies, Conservation Authorities, and state Coastal Zone Management Programs. With competing demands, few employees, and staff turnover, efforts to bolster in-house capacity often fall short, especially in small municipalities. Rather than continuously relearning the latest science, technology, and funding opportunities when acute high water levels occur, municipalities are better served by third-party experts for guidance on grants and engineering. These agencies can invest in expertise to remain a valuable tool for municipal resilience planning and management.

Recommendation 5 Strategies

1. Increase state- and regional-level staff expertise in leading data science and financial information to inform management decisions. [Regional Planning Agencies, Conservation Authorities, CMPs]
2. Identify a designated staff person within a support agency or boundary organization to provide accessible technical assistance to help municipalities digest, process, and use data and technical information. [NOAA, GLSLCI, Resource Providers]
3. Set up a designated organizational email helpline or virtual help center to support municipal requests. [NOAA]
4. Develop a centralized list of contacts to support coastal resilience efforts, including contractors, data scientists, grant managers, and other resource providers. [GLSLCI]
5. Partner with an external organization (e.g., non-profit organization, Conservation Authority, Regional Planning Agencies) on projects; allow the external partner organization to manage and administer projects. [Municipalities]
6. Foster inter-municipal communication and information sharing. Provide platforms for municipalities to learn from each other's challenges and successes. [NOAA, GLSLCI]
7. Create positions for post-master's or post-doctoral graduates to bring funding knowledge, technical expertise, and interest in social science to local municipalities in support of coastal resilience work. [NOAA, CMPs]

Challenge 6 - Many municipal governments are at the beginning of their coastal resilience journeys and require assistance with project planning, grant seeking, and aligning coastal resilience goals across municipal departments.

Recommendation 6 - Familiarize municipal staff with general funding and financing procedures, to improve self reliance in the absence of a grant writer.

Improving in-house knowledge base on funding and project management leads to stronger applications. While there are agencies that provide assistance, it is key that municipalities have their own tools to get started on coastal resilience projects. Teaching municipal employees the basics on strategic applications will concentrate efforts and lead to more successful grant applications.

Recommendation 6 Strategies

1. Coach municipalities and other local fund-seeking entities on how to apply for opportunities in their "sweet spot" as outlined in "Funding 101" (Appendix J). [NOAA, GLSLCI]
2. Include more general funding knowledge in webinars and informational materials aimed at local municipalities and coastal management professionals. [NOAA, GLSLCI]
3. When possible, hire a grant writer with a holistic understanding of the funding process outside of the application cycle. [Municipalities]
4. Train staff with grant writing responsibilities on the full process of funding procurement outside of the application cycle. [Municipalities]
5. Encourage municipalities to participate and register with major federal grant programs before they are interested in a specific grant. [GLSLCI]

Challenge 7 - Funding application processes and high match requirements create barriers to access for low-resource communities.

Recommendation 7 - Improve accessibility to funding and financing opportunities for low-resource communities.

Many funding and financing options exclude applicant groups that need it most. Existing funding programs should strive to attract a wider range of applicants and improve grant success rates among disadvantaged applicants. This can be done by: providing technical assistance for grant applications, reducing match dollars, and directing applicants to project management partners that can strengthen an application.

Recommendation 7 Strategies

1. Provide more direct funding application support to municipalities to help low-income and disadvantaged communities access funds, especially the Infrastructure Investment and Jobs Act funding. [Funders, NOAA, GLSLCI]
2. Remove match and other cost-sharing requirements for disadvantaged communities. [Funders, NOAA]
3. Favor, or more heavily weight, applications that directly address social and climate equity. [Funders, NOAA]
4. More heavily weight or favor applications from underrepresented groups. [Funders, NOAA]
5. Widen project eligibility for NOAA Coastal Management Grants. [NOAA]
6. Provide regional-level technical support in grant writing to small communities to decrease the disparity between those communities and large cities with more access to resources and staff. [Funders, NOAA, CMPs, Conservation Authorities, Regional Planning Agencies]

Challenge 8 - Limited grant opportunities create competition between small- and mid-sized communities, and between larger and all other communities.

Recommendation 8 - Encourage and facilitate collaboration across municipalities along the same shoreline to maximize effectiveness of available dollars.

By pooling resources across municipalities, more money becomes available to take on higher-cost and larger-scale projects. Collaboration along the shoreline allows for coastal resilience projects to cover more area and prevents negative climate change impacts from getting pushed to the neighboring municipality. Implementing nature-based solutions over gray infrastructure is a sustainable and low-cost option that eludes mainstream practice but is more likely to gain popularity in a collaborative environment where successes are communicated and shared.

Recommendation 8 Strategies

1. Prioritize providing education on nature-based solutions to local decision-makers and municipal staff. [NOAA, GLSLCI]
2. Continue providing education on alternative funding sources (e.g., green bonds and philanthropic donations) that break the cycle of project-based, reactive funding. [NOAA, GLSLCI]
3. Prioritize and highlight pilot projects that successfully demonstrate collaboration and partnerships along shorelines. [NOAA, GLSLCI]
4. Continue to facilitate cooperation, collaboration, and knowledge sharing across jurisdictions. [NOAA, GLSLCI]

Challenge 9 - Consideration of marginalized or minority stakeholders (e.g., tribes, BIPOC communities, and French speakers) is not universally prioritized when advancing coastal resilience strategies and developing resources to support these strategies.

Recommendation 9 - Integrate equity considerations during the project development stage.

There is an opportunity for increased intentionality related to equity and inclusion within coastal resilience programs. Existing shortcomings in equity consideration create segregation of resources based on language, culture, or border; leading to disjointed efforts and perpetuated barriers for marginalized or minority communities in accessing information and resources. Despite an organization's geographic scope (NOAA) or membership (GLSLCI), equity consideration on a basinwide scale can lead to wider-reaching coastal resilience solutions and more inclusive implementation.

Recommendation 9 Strategies

1. Increase French translation of basinwide resources and technical support to remove barriers to information access for Quebec stakeholders. [NOAA, GLSLCI]
2. Consult with tribes and other marginalized (i.e., BIPOC) communities early and often during project development and implementation. Be aware of, and adhere to, cultural norms or practices during collaboration. Provide dedicated time to listen, learn, and build relationships. Integrate consideration of Traditional Ecological Knowledge (TEK) into project ideation. [NOAA, GLSLCI, Municipalities]
3. Consider Canadian perspectives and seek feedback from Canadian stakeholders during the development of basinwide resources to mitigate United States bias in coastal resilience resources. [NOAA, US-Based Organizations]
4. Make resources and data publicly available in multiple different delivery formats to promote universal access and easy delivery. [NOAA, GLSLCI]

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Appendices

APPENDIX A: RESOURCE LIBRARY ORGANIZATIONS OF ANALYSIS

Adaptation Clearinghouse
American Planning Association
American Society of Adaptation Professionals
Army Corp of Engineers
Association of State Floodplain Managers
Atlantic Climate Adaptation Solutions Association
Buffalo Niagara Waterkeeper
Canadian Coast Guard
Canadian Institute of Planners
Center for Indigenous Environmental Resources
Chamber of Marine Commerce
Climate Risk Institute
Coastal Hazards of Superior
Coastal Restoration Toolkit
Coastal States Organization
Community Resilience Action Network of Erie
Conservation Ontario
Consortium on Regional Climatology and Adaptation to Climate Change
Council of the Great Lakes Region
Ducks Unlimited
EcoAdapt
Environment and Climate Change Canada
Environmental Law and Policy Center
Environmental Law Institute
Environmental Protection Agency
Federal Emergency Management Agency
Federation of Canadian Municipalities
Federation of Ontario Cottagers' Associations
Fisheries and Oceans Canada
Flood Mitigation Industry Association
Freshwater Future
Georgian Bay Forever
Great Lakes & St. Lawrence Cities Initiative
Great Lakes Commission
Great Lakes Indian Fish & Wildlife Commission
Great Lakes Integrated Sciences and Assessments Center
Great Lakes Observing System
Green Communities Canada
Green Infrastructure Ontario Coalition
H2Ohio
ICLEI – Local Governments for Sustainability
Illinois Association for Floodplain and Stormwater Management
Illinois Coastal Management Program

Illinois Department of Natural Resources
Illinois Environmental Protection Agency
Illinois Floodplain Management Program
Illinois-Indiana Sea Grant
Indiana Department of Environmental Management
Indiana Floodplain Management Program
Indiana Lake Michigan Coastal Program
Indiana Metropolitan Planning Organization
Institute for Local Government
Intact Center on Climate Adaptation at the University of Waterloo
International Joint Commission
Lake Carriers' Association
Lake Huron Center for Coastal Conservation
Lake Ontario Resiliency and Economic Development Initiative
Land Information Access Association
Metropolitan Planning Council
Michigan Association of Planning
Michigan Center for Geographic Information
Michigan Coastal Zone Management Program
Michigan Department of Environment, Great Lakes, and Energy
Michigan Department of Natural Resources
Michigan Floodplain Management Program
Michigan Natural Shoreline Partnership
Michigan Sea Grant
Michigan State University
Michigan State University Extension
Michigan Transportation Planning Association
Mid-Ohio Regional Planning Commission
Midwestern Regional Climate Center
Minnesota Department of Natural Resources
Minnesota Floodplain Management
Minnesota Geospatial Information Office
Minnesota Pollution Control Agency
Minnesota Sea Grant
National Association of Counties
National Oceanic and Atmospheric Administration Office for Coastal Management
National States Geographic Information Council
National Wildlife Federation
National Working Waterfronts Network
Natural Resources Canada
New Buffalo Shoreline Alliance
New York Coastal Management Program
New York Floodplain Management Program
New York Sea Grant
New York State Department of Environmental Conservation
Ohio Coastal Management Program
Ohio Department of Natural Resources
Ohio Environmental Council
Ohio Environmental Protection Agency
Ohio Floodplain Management Program
Ohio Sea Grant

Ohio State University
Ontario Centre for Climate Impacts and Adaptation Resources
Ontario Climate Consortium
Ontario Ministry of Infrastructure
Ontario Ministry of Natural Resources and Forestry
Ontario Ministry of the Environment, Conservation and Parks
Pennsylvania Coastal Resource Management Program
Pennsylvania Department of Conservation and Natural Resources
Pennsylvania Department of Environmental Protection
Pennsylvania Floodplain Management Program
Pennsylvania Geospatial Technology Operations Office
Pennsylvania Sea Grant
Public Safety Canada - Emergency Management
Quebec Ministry of Energy and Natural Resources
Quebec Ministry of Sustainable Development, Environment, and Fight Against Climate Change
Resilient Michigan
RISC Solutions
Southeast Michigan Council of Governments
Southeastern Wisconsin Coastal Resilience
Southeastern Wisconsin Regional Planning Commission,
Southern Wisconsin Coastal Resilience
St. Lawrence River Institute
SUNY
Superior Watershed Partnership and Land Conservancy
The Nature Conservancy - Great Lakes
Transport Canada
United States Coast Guard
United States Department of Agriculture
United States Department of Transportation
United States Department of Interior - Fish and Wildlife Service
United States Department of Interior - United States Geological Survey
United States Department of Interior - National Park Service
United States Saint Lawrence Seaway Development Corporation
University of Michigan
University of Minnesota
University of Wisconsin
University of Wisconsin Extension
Urban Sustainability Directors Network
Wisconsin Coastal Management Program
Wisconsin Department of Natural Resources
Wisconsin Floodplain Management Program
Wisconsin Geographic Information Office
Wisconsin Sea Grant

APPENDIX B: RESOURCE LIBRARY ANALYSIS METADATA

Attribute Name	Description
Resource Name*	Title or name of resource
Organization Name*	Provider of resource
Organization Type	Type of organization structure
Department/Program	Subgroup of provider
Language	What language is the resource available as?
URL*	URL for resource access
Navigation to File	File access if not a direct URL
Date Created*	Date originally released
Date Updated*	Most recent update of resource
Update Timeline	How often is this resource updated?
Delivery Method*	Interactive map/report/brief/webinar/presentation/etc.
Content Type	data/text/audio/video/GIS shapefile/storymap/map/model
Target Audience*	Who is the intended audience for the resource?
Access Restrictions*	Open access? Paid access or view restrictions?
Topic/Problem Addressed*	Portion of resiliency categorized by survey responses and other important topics
Geographic Region Covered*	Resources intended use by area or location of case study
Great Lakes Specific*	Was this intended for the Great Lakes basin?
What Waterway?	Which Great Lake/river does this resource focus on?
Readability	Reading level and degree of language complexity
Time Investment (raw)	Time required to use/read resource
Time Investment (hours)	Time required to use/read resource
Time Investment (minutes)	Time required to use/read resource
Time Investment (Hours/Minutes)	Time required to use/read resource
Considers Equity*	Consideration of equity and justice in content of resource
Equity Type	Variables and elements of equity and justice considered by resource
Considers Climate Change	Consideration of climate change in the content of resource
Recommend Resource	Indicates a high-quality resource recommended by the review team. High-quality resources indicate resources with high usability and information transfer into on-the-ground municipal decision-making and planning
Summary*	Brief description of resource content
French Summary	Original wording for resource summaries in French

* = Indicates attribute is included in recommended resource library

APPENDIX C: COASTAL RESILIENCE NEEDS ASSESSMENT SURVEY OF GREAT LAKES & ST. LAWRENCE RIVER LOCAL GOVERNMENTS

Administered by the Great Lakes and St. Lawrence Cities Initiative and the University of Illinois Urbana-Champaign

Survey Purpose

The purpose of this survey is to assess needs facing U.S. and Canadian local and tribal governments on the Great Lakes and St. Lawrence River related to coastal management and resilience to coastal impacts such as erosion from changing water levels, flooding, and severe storm events. The survey results will help guide future activities to strengthen the ability of local and tribal governments to safeguard social, economic and environmental resources in coastal areas.

Coastal Resilience

For our purposes, coastal resilience is defined as the ability of local and tribal governments to plan for, withstand, adapt to, and recover from impacts (e.g., severe storm events) and changing conditions (e.g., changing water levels) in coastal areas to ensure the well being of residents and community resources and infrastructure. Due to the variety of accepted definitions for the term resilience, the terms coastal issues and coastal impacts will be used for clarity from here forward.

Who Should Complete the Survey

The survey is intended for both elected officials and staff in local units of government, as well as Tribal Authorities and First Nations, with authority for coastal areas along the Great Lakes and the St. Lawrence River in the United States and Canada. This includes cities, villages, counties, townships, regional planning agencies, port authorities, park districts or other entities with government or tribal authority in coastal areas. We encourage multiple respondents from a single jurisdiction, including elected officials (mayors, county supervisors) and staff working on coastal issues (city managers, planning directors, stormwater managers, park directors, port directors, etc).

Release of Survey Results

Only aggregated results and summary information will be shared publicly. Unless specifically requested, individual survey responses will not be shared outside the project team.

Survey Sponsors

The survey is being coordinated by the Great Lakes and St. Lawrence Cities Initiative in collaboration with the Great Lakes Commission, Coastal States Organization, National Association of Counties, Association of State Floodplain Managers, and the Illinois Applied Research Institute at the University of Illinois at Urbana-Champaign.

Demographics and Background Information

1. Your Name:
2. Your Position:
   [ ] Elected official
   [ ] Appointed administrator
   [ ] Staff
   [ ] Other
3. Name of Jurisdiction:
4. Type of Jurisdiction:
   [ ] City
   [ ] Village
   [ ] Township
   [ ] County
   [ ] Region
   [ ] Park District
   [ ] Port Authority
   [ ] Regional Planning Organization
   [ ] US Tribal Authority
   [ ] First Nations
   [ ] Other
5. Location of Jurisdiction:
6. Great Lakes or Connecting Channel:
7. Estimated Population of Jurisdiction:

Scope and Scale of Coastal Issues

8. How would you characterize the level of concern in your jurisdiction today about coastal issues?
   [ ] Low Concern
   [ ] Moderate Concern
   [ ] High Concern
9. Select and rank the following coastal issues by dragging them to the appropriate category, with a rank of 1 in the High Priority box being the highest priority, and a rank of 1 in the Low Priority box being the lowest priority. If you have no opinion or an item is not applicable, you may leave those items unsorted.
   Shoreline/bluff erosion
   Flooding/high water levels
   Low water levels
   Storm frequency and severity
   Algal blooms
   Beach maintenance
   Infrastructure damage
   Residential development
   Business development
   Economic impacts
   Exacerbating inequalities within jurisdiction
   Other
10. How concerned is your jurisdiction about the impact coastal issues have on the following areas within your jurisdiction?
    [ ] No concern
    [ ] Somewhat concerned

[ ] Very concerned
Roads
Parks
Public beaches
Natural coastal features
Water infrastructure (e.g. drinking water, storm, sewer)
Other utilities (e.g. gas, electric)
Ports/Marinas
Privately owned shoreline property
Socially and economically vulnerable populations

11. Estimate the overall costs incurred over the past two years (2019, 2020) from coastal impacts in your jurisdiction in USD.
12. Of the costs incurred over the past two years (2019, 2020) due to coastal impacts, approximate the percentage allocated to each of the following in your jurisdiction. Estimates are acceptable, total should equal 100.
    Roads
    Parks
    Public beaches
    Natural coastal features
    Water infrastructure (e.g. drinking water, storm, sewer)
    Other utilities (e.g. gas, electric)
    Ports/Marinas
    Privately owned shoreline property
    Socially and economically vulnerable populations
13. Estimate the future expenditures anticipated to mitigate coastal impacts over the next two years (2021, 2022) in USD.
14. Estimate the future expenditures anticipated to mitigate coastal impacts over the next five years (2021 through 2025) in USD.
15. Of the future costs you anticipate to mitigate coastal impacts, approximate the percentage that will be allocated to each of the following in your jurisdiction. Estimates are acceptable, total should equal 100.
    Roads
    Parks
    Public beaches
    Natural coastal features
    Water infrastructure (e.g. drinking water, storm, sewer)
    Other utilities (e.g. gas, electric)
    Ports/Marinas
    Privately owned shoreline property
    Socially and economically vulnerable populations

Existing Knowledge, Capacity and Planning Activities to Address Coastal Issues

16. Rate the general level of knowledge the staff in your jurisdiction have regarding coastal issues.
    [ ] Low level of knowledge
    [ ] Moderate level of knowledge
    [ ] High level of knowledge
17. Rate your jurisdiction's capacity to plan for and respond to coastal issues.
    [ ] Low level of capacity
    [ ] Moderate level of capacity
    [ ] High level of capacity

18. What types of coastal resilience planning are completed or underway in your jurisdiction?
    [ ] No current action
    [ ] Underway
    [ ] Completed
    [ ] Not applicable
    Comprehensive planning update
    Climate action plan
    Policy updates
    Data collection to inform decision-making
    Vulnerability assessment(s)
    Coastal resilience projects or practices
    Planning/zoning code and ordinance updates
    Monitoring effectiveness of resilience actions
    Public education on resilience issues and best practices
    Other
19. Does your jurisdiction have a current FEMA-approved All-Hazard Mitigation Plan?
    [ ] Yes
    [ ] No
    [ ] In development
    [ ] Not sure
    [ ] Not applicable
20. Does your jurisdiction have a plan for land use that makes recommendations to reduce coastal hazard vulnerability?
    [ ] Yes
    [ ] No
    [ ] In development
    [ ] Not sure
    [ ] Not applicable
21. Is your jurisdiction active in the National Flood Insurance Program's Community Rating System?
    [ ] Yes
    [ ] No
    [ ] In development
    [ ] Not sure
    [ ] Not applicable
22. Does your jurisdiction's long-term planning incorporate strategies to anticipate, accommodate, and adapt to changing coastal conditions?
    [ ] Yes
    [ ] No
    [ ] In development
    [ ] Not sure
    [ ] Not applicable
23. How likely is your jurisdiction to prioritize sustainable or environmentally friendly mitigation responses to coastal impacts, even if it increases cost?
    [ ] Not likely
    [ ] Moderately likely
    [ ] Highly likely

Resources and Information Sources Used for Coastal Response Activities

24. How likely is your jurisdiction to work with the following entities on coastal planning?
    [ ] Not likely
    [ ] Moderately likely
    [ ] Highly likely
    Federal agency
    State agency
    County
    Regional planning organization
    Consultant and/or contractor
    Professional association
    Non-profit organization
    Community-based organization
    Other
25. Rate the importance of the following to your jurisdiction's work on coastal planning.
    [ ] Not important at all
    [ ] Somewhat important
    [ ] Very important
    [ ] Not applicable
    Water level and flooding forecasts
    Model planning and zoning codes
    Training and engineering assistance
    Public education, homeowner assistance materials
    Meteorological data
    Sediment management/shoreline dynamic data
    Other
26. Indicate how important the following are to your jurisdiction's efforts to respond to coastal issues.
    [ ] Not important at all
    [ ] Somewhat important
    [ ] Very important
    Staffing
    Support from state agencies
    Support from federal agencies
    Funding for planning
    Funding for mitigation projects
    Local political support
    Local planning policies
    Other
27. Which of the following are barriers to your jurisdiction accessing federal or provincial funding for coastal issues? Please select all that apply, if any.
    [ ] Staff capacity
    [ ] Low awareness of opportunities
    [ ] Application difficulties
    [ ] Cost-share requirements
    [ ] Lack of public support
    [ ] Opportunities not relevant/applicable
    [ ] Other
28. Has there been a change in your constituents' level of interest towards addressing coastal issues?

[ ] Yes, decreasing interest
[ ] No change
[ ] Yes, increasing interest

29. Identify your top three preferred ways to receive information related to coastal issues by dragging them to the box.
    [ ] Websites and newsletters
    [ ] Reports/studies
    [ ] In-person training (post-COVID)
    [ ] Virtual training
    [ ] Workshops/conferences
    [ ] Continuing education courses
    [ ] Professional network
    [ ] Other
30. Are you interested in future training, capacity building, or partnership development opportunities related to coastal management?
    [ ] Yes
    [ ] Maybe
    [ ] No
31. Is there any other information you'd like us to know? (If none, please skip)
32. Are you willing to participate in a follow-up interview, focus group, or related activity to further understand coastal issues facing local jurisdictions and develop ways to assist them?
    [ ] Yes
    [ ] Maybe
    [ ] No

APPENDIX D: FUNDING LIBRARY ANALYSIS METADATA

Attribute Name	Description
Resource Provider	Name of organization or government agency offering program
Organization Type	Type of agency providing resource
Name of Funding Opportunity	Name of grant or loan program
Host URL	URL to specific funding opportunity page when possible, or link to homepage of grant provider
Year	Most recent year that funds are offered. Asterix (*) indicates the grant is offered in the current fiscal year, or will be available in the next fiscal year.
Navigation to File (where applicable)	Directions to file when not a direct URL
Brief Description	Wording copied directly from the website or supporting documentation. Shows general purpose of funding opportunity.
Entity Eligible for Funding	Entities that are eligible for this funding option
Eligibility Description	Full list of eligible entities; criteria-based eligibility
Factsheet/ Request for Proposals/ Notice of Funding Opportunities	Hyperlinked one-page fact sheets, detailed Request for Proposal, or Notice of Funding Opportunity
Primary Posting Location	Website where opportunity is advertised
Research or Implementation Opportunity	Classification of opportunity as research *or* project planning, risk assessment, and other implementation phase
Funding	Refers to money raised and spent with no need for repayment*
Funding Type: Tax Proceeds	Taxes collected and paid into a general fund to be used toward resilience projects*
Funding Type: Fees	Funds raised through through charging fees for services or permits (or in-lieu fees for compensatory mitigation)*
Funding Type: Grants	Funds provided by state or federal governments, or philanthropic organizations.*
Funding Type: Public-Private Partnerships	A cooperation between a public-sector agency and a private-sector entity*
Funding Type: Voluntary Surcharge	A small voluntary charge or fee added to a customer's retail, hospitality, or lodging bill*
Financing	Money that is borrowed, spent, and repaid*
Funding Type: Loans	Money borrowed from either a private banking or philanthropic source or from the government (state or federal) for a specific purpose*
Funding Type: State Revolving Funds	Federal funds allocated annually to state governments to be granted as loans*
Funding Type: Municipal Bonds	Issued by local governments to finance capital projects in the form of (1) revenue bonds, secured by future revenue to be generated by project, (2) general obligation bonds, secured by the government and its future tax revenue
Funding Type: Environmental Impact Bonds	Tool that uses a pay-for-success method where investors are paid back at rates that depend upon achievement of a specified environmental outcome*
Funding Type: Green Bonds	Similar to municipal bonds but labeled for environmentally beneficial

	projects*
Funding Type: Resilience Bonds	A bond designed to expand financial protections in the event of a disaster by linking insurance coverage with capital investments in resilient projects that will decrease risk*
Funding Type: Event-Based Insurance	Insurance pays out based on previously agreed-upon parameters, consisting of a trigger, such as a type of hazard event that could generate negative or catastrophic impact, over a defined area*
Amount Appropriated	Total dollar amount in grant program
Match Fund Requirements (%) or Interest Rates	Cost-sharing required for grants; interest rates on loan if finance opportunity
App Due Date	Due date of first application component, often a letter of interest or pre-proposal; green indicates application is currently open based on today's date
Project Lifespan or Funding Cycle	Supported Project Length or general application cycle cadence
Application Materials Required	Application components or forms where specified on host url/factsheets
URL To Application Materials or templates	File access to application
Project Eligibility (Prerequisites criteria)	Specific characteristics of application, applicant or project type to access application
Follow - Up Requirements	Post-project monitoring or other evaluation metrics
Geographic Region Covered	Area or region covered by program
Waterway or Lake	Name of surface waterway or groundwater
Keywords	Project topics Covered by Grant/Loan Program
Topic/Problem Addressed	Specifies Category (36) of Topic that are continuous across Resource Library
Explicit Emphasis on Climate Change	Mentions the phrase "climate change" in materials
Social Equity Considerations	Program addresses social equity considerations, or program gives special consideration to underrepresented applicants
Information Access Restrictions	Describes if researcher was able to find details of application without creating account, profile, or completing registration
Time Investment Required by Applicant	Subjective estimate of time investment required to complete application package. Low =10-20 hours, Med=20-40 hours, High = 40+ hours
Background Knowledge to Complete Application	Categorizations are "Most local government staff could complete," "Most academic faculty could complete," or "Specialized Knowledge Required" based on technical background information required to complete application.
Level of Supporting Materials	Subjective categorizations are "low," "medium," and "high" noting if opportunities have associated application or program support tools (i.e tip sheets, FAQ sheets, Webinar series, list of example applications, scoring rubrics).
Recommended Resource	Indicates a high-quality resource recommended by the review team. High-quality resources indicate funding or financing opportunities with clearly outlined application expectations, lists of past grantees, relevance to most sought after coastal resilience projects, and sufficient supporting information.
Connection to Great Lakes Resiliency	Description of relevance to coastal resilience efforts

Summary	Description of funding or financing opportunity
Other Notes	Additional relevant information
Past Grantees	List of past awardees and projects
Supporting Legislation	Legislation supporting government appropriated funds
Primary Contact Information	Program staff contact
Secondary Contact Information	Program lead contact

* = Indicates attribute definitions adapted from Quick Reference: Funding and Financing Coastal Resilience (NOAA Office for Coastal Management, Digital Coast, 2021).

APPENDIX E: INTERVIEW QUESTIONS - IMPLEMENTATION

General

Leading Questions

1. What is your name, position, how long have you been working in this jurisdiction and how long have you been working on coastal issues?
2. How does coastal resilience fit into the priorities of your position as [position] and within [your department]?

Potential Follow Up Questions

1. How have the priorities changed?
2. Do you see that changing in the future?

Community

Leading Questions

1. Who is impacted by coastal issues in your community? Why?

Potential Follow Up Questions

2. What is important to know about your community? What makes it special?
3. Who is the most vocal on coastal issues in your community?
4. What does this look like in action?
5. What fraction of your shoreline is hardened and/or privately owned?

Impacts

Leading Questions

1. You listed [X] as high priority issues, can you discuss these further?
2. Why are they high priority?
3. Are these impacts different based on the season?

Potential Follow Up Questions

1. What issues do you think will be high priority in the future?
2. Are there issues that you think should have higher priority?
3. What other departments work on these issues?
4. [If discrepancy between high priority issues and areas of spending] - Why are these high priority issues not receiving the bulk of your budgetary dollars?

Response

Leading Questions

1. [If completed actions] - Your jurisdiction is undertaking [completed action] in the form of [program/project], do you feel that the effort was worthwhile?
2. [If ongoing/planned actions] - Your jurisdiction is undertaking [action] in the form of [program/project], can you elaborate on the effort?
3. [If no action has been taken] - Your jurisdiction has not begun any specific effort, can you elaborate why?

Potential Follow Up Questions

1. How was this action chosen or prioritized over other options?
2. Can you elaborate on the challenges you've described?
3. What do you think enabled these successes?
4. What would you have done differently?
5. What would you recommend other municipalities to embark on the same or similar planning exercise?
6. [If no action has been taken] - Is there a project you would like to see undertaken in your jurisdiction?
7. Is there a program that you are particularly excited about?
8. You answered that your community is not likely to prioritize sustainable or environmentally friendly mitigation responses to coastal impacts, even if it increases cost, can you elaborate on why that is?

Funding and Financing

Leading Questions

1. You list [X] as barriers to accessing funding, can you elaborate on how specifically these challenge you?
2. Have you used or considered using financing for coastal resilience projects (e.g., environmental impact bonds, public-private partnerships, philanthropic investments, event-based insurance, state-revolving funds)? Why or why not?
3. [If needs are met or not seeking funds] - Did you access or utilize funds or financing for any coastal resilience efforts?

Potential Follow Up Questions

1. Are these barriers unique to your work on coastal resilience?
2. Do you encounter these challenges ubiquitously or do you face certain challenges with different funding and financing sources?
3. What is the nature of this barrier? Legislative backing? Hard to meet definitions?
4. Are there particular barriers to financing?

5. [If needs are met or not seeking funds] - What were some of the keys to successfully accessing those funds or financing options?

Knowledge Base and Capacity

Leading Questions

1. [For low/moderate capacity] - You marked [low/moderate] for your capacity to plan for and respond to coastal issues, what would help take you to the next level?
2. [For high capacity] - Could you elaborate on why you marked high for your capacity to plan for and respond to coastal issues?

Potential Follow Up Questions

1. Where are the knowledge gaps in your jurisdiction?
2. How would you plan to bridge the knowledge gaps in your department?
3. Why are those areas of knowledge or resources important to your jurisdiction?
4. Can you expand upon your answer to training topics or educational/technical assistance from?
5. [For high staff knowledge] - How do you learn about coastal resilience challenges and solutions?

Resources

Leading Questions

1. How do you engage with outside planning and implementation resources?
2. [If needs not met] - In your survey you responded that your needs were not met by federal/state/ provincial agencies. What needs are not being met and what do you think these agencies could do to help you?

Potential Follow Up Questions

1. At what stage of resource searching, or applying to implementation do you use or need assistance?
2. Of the resources you are familiar with, have they been helpful? Why or why not?
3. How have the resources been most beneficial?
4. Was the delivery of the resource helpful?

Communication of Outside Information

Leading Questions

1. Are there any challenges or roadblocks you face when gathering the information you need to make decisions or run programs? What are they?

Potential Follow Up Questions

2. How do you think these challenges could be addressed?
3. Is there particular data that would aid in your decision-making processes?
4. Do you share local coastal data with larger organizations?

5. Do you think larger organizations that operate across the basin have an understanding of your local conditions?

Outside Networks

Leading Questions

1. In your survey response you listed [X] as the entities your jurisdiction is most likely to work with, why? What are some examples of collaboration?
2. Do you work with your state coastal management programs?

Potential Follow Up Questions

1. Do you go to these types of organizations for all issues or does it depend on what you are trying to accomplish?
2. You listed [X] as the types of organizations your jurisdiction is least likely to work with, why?
3. Are there barriers to working with [X]? How do you think they could be addressed?
4. Do you feel connected to neighboring municipalities?
5. Given the interconnectedness of neighboring shoreline communities and funding limitations, do you collaborate with nearby municipalities or others in similar positions on broader coastal issues?
6. What benefit [does/would] your community see from working with neighboring municipalities?

Equity

Leading Questions

1. Does social equity factor into your jurisdiction's work on coastal resiliency?

Potential Follow Up Questions

2. [If yes, and unable to answer what via pre-interview research] - How? Do you include physical or social vulnerability? Metrics, guiding principles?
3. [If yes, and some info available in pre-interview research] - We found that your jurisdiction states that it does [X], how is that working in practice? Have you seen changes in your work after its implementation?
4. [If no] - Why? Is equity incorporated into other areas of government? Are there plans to incorporate it in the future?
5. Do you find resources that support your jurisdiction's environmental justice goals?
6. How would you see equity fitting into your future plans? Do you feel like there are resources that could help you successfully incorporate equity? What would they be?

Long-Term Planning

Leading Questions

1. [If engaging in long-term planning] - Your survey response and our research indicates that your jurisdiction undertakes [X], can you take us through what that has looked like so far?

2. [If no long-term planning] - You indicated that [X] is a barrier to your ability to incorporate coastal resiliency into your long-term planning, can you elaborate on this challenge?

Potential Follow Up Questions

1. When was coastal resilience incorporated into long-term planning?
2. How far in advance is long-term for your jurisdiction?
3. Who advocated for its inclusion?
4. How has it impacted your work?
5. Has including it in long-term planning made it easier to implement coastal resilience projects?
6. Are these barriers unique to your work on coastal resilience?
7. How do you think they could be overcome?
8. Were there any other barriers not mentioned in the survey?

Success

Leading Questions

1. What would long-term coastal resilience look like for your community?
2. Are there any successes that you would like to share?

Potential Follow Up Questions

1. Do you think your current and planned measures will address the issues you highlighted and achieve long-term success?
2. What would make achieving this easier, outside of funding?
3. What tools and resources would you recommend to others?

Other

Leading Questions

1. Are there any questions you wish we asked? Any topics you'd like to discuss?
2. If a neighboring municipality approached you today and said they were trying to accomplish and sustain an actionable change, what advice would you give them?

Potential Follow Up Questions

1. Who else should we talk to?

APPENDIX F: INTERVIEW QUESTIONS - RESOURCE PROVIDER

General

Leading Questions

2. Can you state your name, organization, and position title?
3. How long have you been in this position and what are your primary responsibilities?
4. What is the mission and geographic scope of your organization's work?
5. Which aspects of coastal resilience does your organization work on?

Organizational

Leading Questions

1. How does coastal resilience fit into the priorities of your organization?
2. For how long has your organization been working on coastal resilience?
3. What is the geographic scope of your organization's work on coastal resilience?
4. What guides your organization's work on coastal resilience?

Potential Follow Up Questions

1. Is there an event or community input that led to this being a priority for your organization?
2. What determines the geographic scope of your work?

Planning and Strategy

Leading Questions

1. What are your organization's goals/desired outcomes related to coastal resilience?
2. What do you perceive as today's priority issues related to coastal resilience?
3. How did you and your organization come to identify these as issues?
4. What do you perceive as priority needs for municipalities' efforts on coastal resilience?

Implementation and Delivery

Leading Questions

1. How does your organization currently support municipalities in their coastal resilience efforts?
2. What resources have been created to support municipalities and local stakeholders' coastal resilience efforts?

3. When developing coastal resilience support tools and resources, who specifically is the target audience?
4. Where would your target audience find your resources?
5. What format are your resources primarily distributed?
6. What are notable outcomes or successes tied to the resources you've developed on coastal resilience?
7. What are some challenges you've faced with delivery of resources to local stakeholders?
8. How do you think these challenges could be addressed?
9. To effectively utilize your resources, what is the required knowledge base of the user?

Potential Follow Up Questions

1. Have you found your resources to be used by groups outside of this target audience?
2. If so, why do you think this might be?
3. To what extent are the end users involved in the creation of your resources on coastal resilience?
4. Can you elaborate on the challenges you've described?

Impact and Program Evaluation

Leading Questions

1. How do you evaluate the effectiveness of your efforts on coastal resilience?
2. For support tools and resources, how do you evaluate their use and effectiveness?
3. What feedback have you received from users about the resources you've developed?
4. What communications and outreach methods (for example, webinars, reports, factsheets, training) have been the most effective in delivering resources to communities?
5. On the flip side, what delivery methods have not been effective?
6. How do insights from program/project evaluation inform future efforts?

Potential Follow Up Questions

1. How often is the tool updated?
2. To what extent are the end users involved in refining and updating this tool?
3. Are there any challenges or roadblocks you face when gathering the information you need to make decisions or run programs? What are they?

Partnerships

Leading Questions

1. How do you coordinate your efforts with the work of other agencies and organizations across the Great Lakes?
2. What partnerships have been instrumental to your organization's work on coastal resilience and why?
3. What successes, if any, has your organization had when partnering with municipalities?
4. What challenges, if any, has your organization had when partnering with municipalities?

Potential Follow Up Questions

1. Can you explain the role that each partner plays in supporting this resource?
2. Who maintains/ annually updates the goals and informational website of this resource?

Equity

Leading Questions

1. In what ways have you considered social equity and marginalized populations in your work on coastal resilience?
2. How do you ensure your resources and efforts reach the most vulnerable populations?
3. How have you engaged marginalized populations, such as rural communities, socio-economically disadvantaged communities, tribes, and communities of color, in your coastal resilience work?
4. Are any of your resources or efforts particularly focused on any of these groups?

Potential Follow Up Questions

1. [If no] - Why? Are there plans to incorporate it in the future?

Future

Leading Questions

2. What issues around coastal resiliency in the Great Lakes need additional support?
3. Over the next 10 years, what do you forecast as the largest challenges towards achieving Great Lakes coastal resiliency?
4. What is your vision for long-term coastal resilience in the Great Lakes region?
5. What advice would you give to municipalities trying to make actionable progress on coastal resilience?

6. What advice would you give to municipalities who want to work with you and engage with your resources?

Other

Leading Questions

1. Are there additional resources from your organization or work on coastal resilience that we haven't considered and you'd like to touch on?
2. Are there resources from any organization on any coastal resilience topic that you think are particularly great or exciting?
3. Do you have any recommendations on other people to talk with?
4. Is there anything else you'd like to share or discuss?

APPENDIX G: FOCUS GROUP QUESTIONS

1. How does your organization currently support local coastal resilience efforts, such as funding opportunities or resources?
2. What are the biggest challenges your organization faces in advancing coastal resilience in your state? And, what are notable successes of your coastal resilience work?
3. What coastal resilience issues and/or stakeholders in the Great Lakes need additional support and resources?
4. What advice would you give to local entities trying to make progress on coastal resilience?
5. Is there anything else you'd like to share or discuss?

APPENDIX H: CODEBOOK

Code Group Name	Definition, Related Topics
Advice	Guidance, recommendations, best practices
Attitude	Strong feelings, points of view, opinions
Barriers-Determinants	Constraining factors, enabling factors, capacity, climate change, collaboration, connective relationships, knowledge, politics, relationships
Community-Public	Residents, stakeholders, private property, public access, local business, local culture
Data/Resources	Information, education, resources, data, research, clearinghouses, user support, monitoring
Equity	Marginalized communities, accessibility, inclusion, diversity, socioeconomic status, race, power dynamics
Evaluation	Review, assessment, quality assurance, stakeholder evaluation/engagement
Funding/Finance	Grants, loans, environmental impact bonds, philanthropic donations, insurance, funding organizations, FEMA, legislation, match funds, municipal bonds, COVID relief funds, municipal bonds, public-private partnerships, reimbursements
Future, Long-Term Planning	Land use planning, comprehensive plans, coastal resilience plans, climate action plans, future actions, objectives, goals, visions
Impacts	Erosion, flooding, property damage, high water levels, low water levels, economic/business damage
Response	Emergency response, projects, construction, design, green infrastructure, gray infrastructure, nature-based solutions, past/current actions
Solutions	Ideas, staffing, coordination, knowledge sharing, technical assistance, opportunities
Uses/Benefits	Applications, priorities, tourism, public use/recreation, ecological benefits, fishing, cultural uses

APPENDIX I: FACTSHEET - COMMUNITY RESILIENCE FUNDING 101

The Grant Writing Process

1. Research the Grant
2. Steward the Relationship with the Funding Agency
3. Apply
4. Accept the Award or Ask for Application Feedback
5. Manage the Award
6. Close out the Grant

Researching Grants

1. There are hundreds of grant and loan opportunities. Begin narrowing your search by finding a grant in the "sweet spot," defined here as (1) in alignment with applicants' goals and needs (2) applicant has capacity to manage project scope and award amount.
    a. Does the funding agency and grant RFP support my community's mission or objectives?
        i. Is my mission well-developed and clear?
        ii. Is the project I am trying to fund the best project to meet the needs of the community?
        iii. Is it furthering my resilience goals to implement this project?
        iv. Consider if it is more advantageous to get a short-term vs. long-term project funded
        v. Consider high award value vs. low award value projects
    b. Consider the limitations to how grant money can be spent. A common limitation is that funds may not be used to hire staff.
    c. Do I have the capacity to manage this money?
        i. Do I have the capacity to implement a high award-value project?
        ii. Do I have the capacity to implement a long-term project?
        iii. Do I have the capacity to raise match dollars?
2. Read the Request for Proposal or Notice of Funding Opportunity
3. Read it again to understand the technical specifications required.
4. Do I have the knowledge or experience (or access to people who have the knowledge or experience) to manage this project?

Steward the Relationship with the Funding Agency

1. Invest in relationships with grant program administrators outside of the funding cycle.
    a. Understand their mission and purpose.

b. Based on their mission, determine if they are more interested in your data or stories of communities that could benefit from this project, or both. Understanding their underlying motivations will help you better curate a competitive application.

c. You may hear about funding opportunities that are not widely advertised.

2. For private or foundational donors, review their 990 Form to understand the types of projects they fund.

3. For government lenders, review posted information about past grantees.

Writing the Application:

1. Tell a compelling story. The reviewers will read many applications, make yours stand out.

    a. Federal applications may be more interested in how data and research supports your project, rather than a compelling narrative. Be sure to speak with a program liaison to understand the type of narrative that is best suited to an application.

    b. If you have difficulty crafting a compelling story, speak with affected community members or stakeholders for additional perspectives.

2. Use SMARTIE Goals (The Management Center, 2020) for specific and measurable goals that can be tracked and reported on later. Often, application packages outline the evaluation metrics for you.

3. Have more than one person working on a grant when possible.

4. Tie all components of the application together. Be sure the budget matches the project description, and all components support the mission of your organization or municipality.

Close out the Grant

1. Which evaluation metrics do you need to track so you can report successes and progress to the funding agency?

2. Report your outputs to the lending organization or government agency.

General Components you will be asked for when writing your grant application:

1. Executive Summary

2. Organization Description

3. Problem/Statement of Need

4. Project/Program Description

5. Goals/Objectives

6. Key Personnel

    a. Contractors and Partners

7. Evaluation

    a. What are your metrics for success? How will you know your project is performing well? Use SMARTIE model to set goals:

        i. Strategic, Measurable, Ambitious, Realistic, Time-Bound, Inclusive, Equitable (from The Management Center, 2020)

8. Sustainability
    a. How will you sustain this program beyond this grant?
    b. How will you continue to pay staff members?
    c. Does this project require maintenance?
    d. Does this project generate revenue?
9. Budget Narrative/Justification
    a. Write a brief but informative line-by-line description of your budget.
10. Include a Project Timeline when possible
    a. A Gantt chart is an excellent way to illustrate the life and length of your project, and supplement the budget narrative.