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PLANNING FOR CLIMATE CHANGE IN THE LAURENTIAN GREAT LAKES BASIN -- A NOAA Needs Assessment - Final Report

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This report summarizes the results of a regional assessment to gauge the knowledge, skills, interest, attitudes, and abilities of Great Lakes coastal community planners, stormwater managers, and natural resource managers, in order to design effective training that increases the ability of these groups to confront and adapt to the impacts of climate change.

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Ohio Coastal Training Program at Old Woman Creek National Estuarine Research Reserve
Ohio Department of Natural Resources Division of Wildlife
Ohio Coastal Management Program
Lake Superior National Estuarine Research Reserve
Great Lakes Environmental Research Laboratory
Great Lakes Sea Grant Network

This report is a companion document to [NOAA Technical Memorandum 153](#), and the planning needs assessment counterpart to the science needs assessment summarized in [NOAA Technical Memorandum 147](#).

NOAA TM-153. 2011. "Laurentian Great Lakes Basin Climate Change Adaptation" available at: <http://www.glerl.noaa.gov/pubs/techrept.html>.

NOAA TM-147. 2009. "Impact of Climate Change on the Great Lakes Ecosystem a NOAA Science Needs Assessment Workshop to Meet Emerging Challenges – Summary Report" available at: <http://www.glerl.noaa.gov/pubs/techrept.html>.

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NOAA's Mission Goals:

- Protect, restore and manage the use of coastal and ocean resources through an ecosystem approach to management
- Understand climate variability and change to enhance society's ability to plan and respond
- Serve society's needs for weather and water information
- Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation
- Provide critical support for NOAA's Mission

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Planning for Climate Change in the Laurentian Great Lakes Basin A NOAA Needs Assessment - Final Report

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1. EXECUTIVE SUMMARY

The NOAA Great Lakes Regional Collaboration Team, Old Woman Creek National Estuarine Research Reserve and Great Lakes Sea Grant Network, and in collaboration with the Great Lakes and Saint Lawrence Cities Initiative, have worked collaboratively to determine what is needed to increase adaptive capacity in Great Lakes communities to anticipated changes in climate. The primary objective for conducting this study is to increase adaptive capacity by informing and developing climate change adaptation training workshops. To ensure that training meets priority needs and provides accessible and applicable tools and resources, these organizations have collaborated to conduct a needs assessment: a comprehensive front-end evaluation of the climate change adaptation training and information needs of Great Lakes coastal communities. Presented here are the results of a needs assessment completed in 2011, engaging nearly 700 stakeholders across the Basin through interviews, focus groups, and an online survey.

The goal of this needs assessment was to collect sufficient information about the knowledge, skills, interest, attitudes, and/or abilities of Great Lakes coastal community planners, stormwater managers, and natural resource managers to design effective training that increases the ability of these groups to confront and adapt to the impacts of climate change. This study was conducted in two phases with funding from the NOAA Sea Grant Climate Engagement Project for Phase I, a synthesis of existing literature which served to inform the development of the *Climate Ready Great Lakes* training modules¹, as well as a pilot “Train-the-Trainer” workshop held in Michigan for Great Lakes State Sea Grant Extension Agents. Funding from the Great Lakes Restoration Initiative² was utilized for Phase II. This report contains the results of Phase II, a comprehensive data collection coordinated by Old Woman Creek National Estuarine Research Reserve. Study results have informed the development and implementation of specialized training to build the capacity of Great Lakes coastal communities to adapt to the impacts of climate change, with pilot workshops taking place in Ohio, Wisconsin, and Minnesota. Outcomes and evaluation of these workshops are also included in this report.

Study results and recommendations have informed the development of NOAA’s Great Lakes Climate Science and Service Plan³, and will guide future investments by NOAA and other agencies in Great Lakes research, training and decision support services. Training could address issues such as climate change research; long-term forecasts for climate change impacts in the Great Lakes region; processes by which community leaders can identify and consider management responses necessary to respond to forecasted changes; and decision tools and science-based resources that are available to make coastal development, resource protection, and infrastructure decisions today that sustain communities for the next 50-100 years.

¹ NOAA/Sea Grant. 2011. “Climate Ready Great Lakes” training modules are available at: http://www.regions.noaa.gov/great-lakes/?page_id=395.

² Great Lakes Restoration Initiative website: <http://greatlakesrestoration.us>

³ NOAA Great Lakes Climate Science and Service Plan. Personal communication, H. Stirratt, Sept. 7, 2012.

2. LITERATURE REVIEW

2.1 Synthesis of Documented Needs

An initial synthesis of existing literature served to inform data collection, as well as the development of the Great Lakes NOAA/Sea Grant climate adaptation training modules *Climate Ready Great Lakes* (2011)⁴. The literature synthesis is available in the NOAA technical memorandum *Laurentian Great Lakes Basin Climate Change Adaptation* (2011)⁵, and is a companion document to this report. Over 300 needs were culled from existing literature and grouped into five key coastal management issue areas:

- Infrastructure: Ports and Regional Planning
- Water Infrastructure
- Ecosystem Based Management
- Coastal Planning and Management
- Hazard Resilience and Disaster Preparedness

The needs from the 2011 report were further condensed into ten overarching needs, and then revised again once the data collection and analysis were completed to reflect the new information found in the data. This resulted in having a ranked list of the top ten needs for Great Lakes communities to be able to adapt to climate change. This top ten list can be found in this report in the methods section 3.3 and in the results summary chapter, as well as in the NOAA Climate Science and Service Plan for the Great Lakes Region.⁶

3. METHODS

3.1 Data Collection

A three-tier approach for data collection was used to identify information and training needs. Beginning with in-person and telephone interviews, this information influenced the second and third tier of data collection. The second tier included focus groups, and the third tier was an online survey during the months of January and February of 2011.

Data collection for interviews and focus groups took place from July through September 2010. Potential participants for interviews and focus groups were identified through the Ohio Coastal Training Program contact database, the NOAA Sea Grant Extension Agent Network and other NOAA partners. In-person and telephone interviews were conducted across the Great Lakes States, as well as two focus groups in Ohio. Fifteen interviews were conducted in August and September. Focus group participation consisted of one group of four and one group of five. Content analysis of the interviews yielded a ranked list of ten main issue categories, which should be distinguished from the top ten needs list. Detailed results from the interviews and focus groups are supplemental documents to this report, and available on the *Planning*

⁴ NOAA/Sea Grant. 2011. "Climate Ready Great Lakes" training modules are available at: http://www.regions.noaa.gov/great-lakes/?page_id=395.

⁵ NOAA TM-153. 2011. "Laurentian Great Lakes Basin Climate Change Adaptation" available at: <http://www.glerl.noaa.gov/pubs/techrept.html>

⁶ NOAA Great Lakes climate Science and Service Plan. Personal communication, H. Stirratt, Sept. 7, 2012.

for *Climate Change* workshop website.⁷ The top ten needs list was determined from the outcomes of the entire assessment, and is included in the methods section 3.3 and in the results summary chapter of this report.

In January 2011, a web-based survey was constructed to further characterize climate training, information, and data needs identified through literature review, interviews, and focus groups. The survey was designed by a project team including staff from Old Woman Creek and Lake Superior National Estuarine Research Reserves, Ohio Sea Grant College Program, the Great Lakes Saint Lawrence Cities Initiative, and the NOAA Great Lakes Regional Team with technical guidance from social scientists at the NOAA Hollings Marine Laboratory, NOAA Coastal Services Center and professional staff of the Ohio and New York Coastal Management Programs. The project team utilized other needs assessment surveys designed to identify climate training and information needs of municipal officials throughout the country as prototypes (Angell, 2008; Auermuller, 2011; Tribbia and Moser, 2008, Krum and Feurt 2002, Pollack and Szivak, 2007). The survey consisted of 22 questions designed to assess:

- Self-reported awareness of climate change causes, impacts, mitigation and adaptation options
- Trusted sources of climate information
- Perceived impact of climate change on work or decision-making
- Climate planning initiatives underway
- Perceived acceptance of climate-related terms among peers or colleagues
- Perceived barriers to and benefits of climate planning
- Need for information and tools

The survey was disseminated by e-mail to a target population of Great Lakes decision-makers through NOAA state partner program networks including mailing lists of the Old Woman Creek and Lake Superior National Estuarine Research Reserves, Minnesota, Pennsylvania and Ohio Sea Grant Programs; and Ohio, Michigan, New York, and Wisconsin Coastal Management Programs. Professional associations were also asked to assist with survey dissemination.

Survey results were analyzed by the Great Lakes Environmental Finance Center at Cleveland State University. The survey results are discussed in detail in the report “Climate Change Needs Assessment Survey Analysis”, including an evaluation of variability among respondent subgroups by State, sector, and planning stages.⁸ All five Lake basins are represented in the study results. Key variations in data are noted where applicable (i.e., by sector or geographic region).

This document contains survey results for a benchmark group of respondents that identified themselves as working within one or more Great Lakes Watersheds. This group of respondents is referred to as the *Great Lakes Benchmark Group*. In the detailed analysis, a t-test was used to compare mean values for subgroups determined by geography or sector to the remainder of the Great Lakes Benchmark Group. For that analysis, alpha levels for the t-test were converted into descriptive wording as follows: statistical

⁷ All needs assessment and workshop materials are available at: <http://nerrs.noaa.gov/CTPIndex.aspx?ID=663>

⁸ The Great Lakes Environmental Finance Center. Maxine Good an Levin College of Urban Affairs Cleveland State University, 2011. “Climate Change Needs Assessment Survey Analysis” Principal Author: Charlie Post. Available at: <http://nerrs.noaa.gov/CTPIndex.aspx?ID=663>.

significance at the 0.1 level is termed “somewhat different”, at the 0.05 level it is termed “different”, and at the .01 level it is termed “extremely different”. A total of 785 people started the survey, and 609 completed it. Incomplete surveys were included in this analysis and therefore the sample size for statistical analysis varies by question. The Great Lakes benchmark group ranged in size from 530 to 669 across all questions in the survey.

3.2 Target Population

The target population was professional planners, stormwater managers, natural resource managers, public health officials, and emergency managers working in Great Lakes coastal counties or watersheds. There are 158 coastal US counties, 121 watersheds, and thirteen major urban areas in the Great Lakes basin.⁹ A breakdown of specific professional roles targeted for this survey is detailed in the following section.

Planners

- Professional Planner - land use, transportation, ports, energy, water infrastructure
- Sustainability Director
- Zoning Director/Administrator
- Director of Housing and Business Development
- Energy Procurement Manager

Stormwater Managers

- Public Works Director
- Engineer
- Public Service Director
- Permitting Authorities
- Municipal Separate Storm Sewer System (MS4) Program Coordinators
- Stormwater Plan Reviewers

Natural Resource Managers

- Parks and recreation directors
- City Forester
- Park and protected area managers at the local, state, and federal levels

Policy-Makers

- City Council members
- Township Trustees
- Mayors
- County Commissioners
- State Representatives
- Representatives and Staff on State Legislature Natural Resource and Environment committees
- Staff on State Departments of Natural Resources and Environmental Quality Protection

Emergency Managers

- County Agency Director

⁹ NOAA’s State of the Coast. The U.S. Population Living in Coastal Counties: Available at: <http://stateofthecoast.noaa.gov/population/welcome.html>.

- Municipal Manager
- Water Manager
- Emergency Management Director
- Public Health and Safety Director

3.3 Developing the Top Ten Needs List

Drawing from the review of literature, as well as from the insights of almost 700 Great Lakes coastal community decision-makers, it was possible to develop a prioritized list of the top ten needs for Great Lakes communities to be able to adapt to climate change. The ranking of these ten needs was developed by grouping the over 300 needs identified in the literature review¹⁰ into ten overall categories.¹¹ These categories were then prioritized based on the number of times they appeared in the literature review. This prioritization of needs documented in existing literature was then updated, enhanced, and expanded in descriptive detail to incorporate new information gathered on regional needs through interviews, focus groups, and an online survey, resulting in the final prioritized list presented on the next page.

4. DECISION-MAKER'S BRIEF

4.1 Awareness, Attitudes and Adaptation Activities

Awareness of climate change and impacts varied across the basin. While it is often assumed that public awareness of climate change is low, several participants exhibited high-level awareness. Many participants felt well informed on climate change issues and were able to speak knowledgeably about perceived impacts, as well as identify specific tool and information needs, whether for professionals, the public, or policy-makers, in order to effectively anticipate and adapt to climate impacts. However it should be noted that within the survey population there was a small group of respondents that indicated that they think climate change is unproven. Another small group (which may overlap the first one) believed that it is important to distinguish between natural and human causes of climate change. This group seemed to acknowledge that climate change is occurring, but that it isn't caused by humans.

Participants felt that education for decision-makers was a priority need and having high-level advocacy for climate change issues would enable and facilitate effective planning at all scales. Uncertainty about climate impacts and how to communicate impacts to the public was listed as a potential barrier, with the potential to instill or increase mistrust of government officials.

Having near and far term trend reports for lake level fluctuation and changes in weather patterns could be used to inform planning and decision-making. Understanding how the natural system has behaved historically and how the natural systems are changing from historical trends can be achieved by maintaining monitoring systems that inform regionally specific climate and hydrological model outputs. Participants believed that having this type of information would be very helpful to justify decisions and actions.

¹⁰NOAA TM-153. 2011. "Laurentian Great Lakes Basin Climate Change Adaptation" available at: <http://www.glerl.noaa.gov/pubs/techrept.html>

¹¹ Credit for this work is given to contributing author Brent Schleck, who analyzed the literature synthesis and developed an initial list of the top ten needs. The final list of needs presented in this report is shaped by the work performed to develop the overall prioritization and structure of categories.

Top Ten Needs (detailed list)

1. Increase climate change literacy through research that addresses decision-maker needs, comprehensive science education throughout all grade levels, community outreach, ensuring ecological awareness through youth programs as well as training students in scientific field methods, tribal engagement, increased communication with stakeholders, and end-user/public participation. Build climate literacy within NOAA, strengthen internal agency capacity to deliver climate services, and develop public awareness of NOAA climate services.
2. Regional needs coordination and relationship building between organizations at the federal, state, and local levels for the sake of efficient knowledge exchange through improved communication, decreased redundancy, and reduced regulatory/cross-jurisdictional conflicts.
3. Financial support, as well as political guidance and resource leverage for local climate adaptation efforts / projects.
4. Management, coordination, and adjustment of maps, models, and collected data to incorporate new information and to allow for regional, as well as downscaled forecasting, analysis, and assessment of climate change related events.
5. Research and implementation of resilient land use and physical planning/design that incorporates local economic drivers, infrastructure management/monitoring, transportation, and land-sea interactions. Document implementation challenges and successes to support diffusion of knowledge and adaptive planning and management across the region.
6. Engage states, municipalities, and managers (e.g. land use planners, emergency managers, and extension agents) in collaborative research to generate current, comprehensible, near-term, and regionally relevant climate change data to inform decision-making (e.g. drafting ordinances, master plans, and evacuation plans).
7. Engineering, design, and social research as it applies to data collection methods, modeling, forecast uncertainty, extreme event attribution, and community resiliency.
8. Decision maker trainings revolving around utilizing sector-specific, as well as general tools/strategies to implement clear and flexible ecosystem-based management programs that properly manage/protect resources (e.g. forests, fisheries, beaches, floodplains).
9. Assessing the impacts of climate change on natural resource demands / budgets, and how those impacts will affect different sectors of the economy.
10. Biological/ecological research, assessment, and monitoring, as well as prioritization of ecosystem preservation, in order to mitigate environmental stressors and monitor ecosystem health.

In the survey, 70% of Great Lakes benchmark respondents perceived planning and policy guidance as a barrier to climate planning. The most significant benefit of climate planning for the Great Lakes benchmark survey group was improved quality of life for future generations, which was seen as a significant benefit by 70 percent of the respondents. Improved environmental quality and a more secure water supply were perceived as the next most significant benefits of climate planning. Additionally, perceived benefits included increased opportunities for renewable energy, and a more pleasant climate for the region. With this understanding, having a comprehensive social and ecological picture of possible climate scenarios could enable communities and policy-makers to more fully recognize and actualize opportunities and to mitigate impacts.

4.2 Top Ten Needs

Top Ten Needs in Brief

1. **Climate Literacy.** Increase climate change literacy through research that addresses decision-maker needs, comprehensive science education throughout all grade levels, and informal science education for the public.
2. **Regional Needs Coordination.** Build relationships between organizations at the federal, state, and local levels for the sake of efficient knowledge exchange.
3. **Financial Resources and Guidance.** Resource leverage for climate adaptation.
4. **Information Tools.** Management, coordination, and adjustment of maps, models, and collected data to incorporate new information and to allow for regional forecasting, analysis, and assessment of climate change related events.
5. **Resilient Land Use Planning.** Research and implementation of resilient land use and physical planning/design that incorporates local economic drivers, infrastructure management/monitoring, transportation, and land-sea interactions.
6. **Climate Change Data.** States, municipalities, and managers need current, comprehensible, near-term, and regionally relevant climate change data to incorporate into decision-making (e.g. drafting ordinances, master plans, and evacuation plans).
7. **Social and Ecological Research and Community Resiliency.** Engineering, design, and social research as it applies to data collection methods, modeling, forecast uncertainty, extreme event attribution, and community resiliency.
8. **Decision-maker Trainings.** Trainings utilizing sector-specific and general strategies to implement clear and flexible ecosystem-based management programs.
9. **Understanding Climate Impacts.** Assessing the impacts of climate change on natural resource demands and budgets, including differential impacts across sectors.
10. **Ecosystem Research and Monitoring.** Biological and ecological research, assessment, and monitoring, as well as prioritization of ecosystem preservation, in order to mitigate environmental stressors and monitor ecosystem health.

4.3 Needs Fulfillment: NOAA Projects

The Ohio Coastal Training Program at Old Woman Creek National Estuarine Research Reserve and the Lake Superior National Estuarine Research Reserve coordinated a regional project to customize *Planning for Climate Change*, a one-day training workshop to address Great Lakes issues and the needs of planners and other professionals working on land use, public health, stormwater, emergency preparedness, and natural resource management issues across the region.

Old Woman Creek and Lake Superior National Estuarine Research Reserves convened three planning teams which used the results of this assessment in concert with local knowledge of needs and climate resources to customize a NERRS *Planning for Climate Change* workshop to meet the needs of Great Lakes professionals and decision-makers. The one day training increases participant understanding of climate science and regional vulnerabilities and builds local capacity for adaptation including awareness of best available local and regional data, planning process, resources, and adaptation strategies, and tools for stakeholder engagement.

Along with the *Planning for Climate Change* workshops, NOAA and Sea Grant have also developed training modules to assist communities in planning for and adapting to climate change. The *Climate Ready Great Lakes* ‘train the trainer’ training modules¹² include three modules that can be presented as single modules, or as a group. The first module, “*What am I adapting to?*” addresses climate impacts and explains the science of climate change. The second module, “*What is an adaptation plan?*” instructs trainers on how they can engage the community to develop a tailored plan for adapting to climate change. The third module, “*What tools are available to me?*” includes a review of available tools to assist in decision-making. Each of these modules are customizable and come with supplemental materials for trainers to use.

In addition, the NOAA Coastal Services Center has developed *Climate Adaptation for Coastal Communities*, a three-day course that builds participant understanding and skills related to climate science and impacts; community vulnerability assessment; effective communication; identification and implementation of adaptation strategies. Opportunities for local collaboration and next steps for adaptation planning and implementation are emphasized through discussion, participant activities, and incorporation of local speakers and examples. The course is designed for program administrators, land use planners, public works staff members, floodplain managers, hazard mitigation planners, emergency managers, community groups, members of civic organizations, and coastal resource managers.

Additionally, NOAA provides operational support for two climate centers located in the Great Lakes region including the Midwestern Regional Climate Center (MRCC) and the Northeast Regional Climate Center (NRCC). The MRCC and the NRCC provide services and outreach to their regions to better explain climate impacts, provide practical solutions to climate problems, and to develop climate information regarding regionally significant sectors that climate change will affect (e.g. agriculture, energy, environment, public health, transportation, and water resources). In total there are six Regional Climate Centers operating nation-wide.

NOAA’s Regional Climate Centers (RCCs) are a federal-state cooperative effort. The RCC Program is managed by the NOAA’s National Climatic Data Center (NCDC). NCDC’s Regional Climate Centers support a three-tiered national climate services support program in partnership with other agencies including the [National Weather Service](#) and [State Climate Offices](#)¹³

4.4 Priority Recommendations

Whereas many of the top ten needs are being addressed by current projects, there still remain unmet needs that can, in part, be addressed by making the following recommendations a priority for decision-making:

- Continue and expand delivery of climate adaptation training at the community level throughout the Great Lakes region. Engage end users in collaborative research and climate service development to leverage the wealth of knowledge and local expertise across the region.

¹²The “Climate Ready Great Lakes” training modules are available at: http://www.regions.noaa.gov/great-lakes/?page_id=395.

¹³Midwestern Regional Climate Center website <http://mcc.sws.uiuc.edu/overview/overview.htm> and NCDC Website <http://www.ncdc.noaa.gov/oa/climate/regionalclimatecenters.html>

- Develop educational tools and resources to increase understanding of climate impact scenarios that include modeling output and anticipated trends for natural, social, and economic systems. Having a comprehensive social and ecological picture of possible climate scenarios will enable the public and policy-makers to more fully recognize, anticipate, and actualize opportunities and mitigate hazards. Determine regionally specific ‘no-regrets’ policy options for each of the Great Lakes, and as a collective.
- Increase capacity for local and regional monitoring of the Great Lakes, as well as the coastal watersheds. Develop partnerships to collect and analyze data. Further develop and strengthen regionally coordinated efforts to maintain monitoring systems. Educate policy-makers on the need for funding the implementation and maintenance of large lake observation systems.
- Develop partnerships and regionally coordinated efforts to leverage funding for large-scale projects. Strengthen communication with policy-makers and include specific cost-benefit analyses for anticipated improvements.

5. ADAPTATION ACTIVITIES

5.1 Climate Planning Status

About 25 percent of respondents in the Great Lakes benchmark group indicated that planning was at least underway in their community or organization: 21% indicated that planning was underway, 1% indicated that planning is complete, and 3% indicated that planning is complete and implementation is underway. Within the other 75%, 32% indicated that planning was not underway but conversations have begun, and 43% indicated that nothing has happened. The top three steps taken were “initiated public discussion,” “conducted background research,” and “convened working group.” At least two of these three steps were also among the top three for most subgroups. Other steps which ranked in the top three for individual subgroups were “contacted specialist for information/assistance,” “participated in clean energy initiatives,” “assessed climate change impacts on ecosystems,” and “climate change impacts have been addressed through the existing planning process” and “assessed climate change impacts on infrastructure.”

The following entities’ climate planning efforts were identified as models:

- Cities: Ann Arbor, Michigan; Cincinnati, Ohio; Cleveland, Ohio; Chicago; East Lansing, Michigan; New York City; Portland and Seattle (state not indicated); Portland, Oregon; and Town of Sandy Creek
- States: Arizona, California (mentioned four times), Delaware, Maryland, Michigan (mentioned twice), New Jersey; Wisconsin (mentioned twice), and “other states” (mentioned three times)
- Centers for Disease Control and Prevention (CDC) Climate Ready States and Cities Initiative, Corps of Engineers partnering with other agencies (National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey, U.S. Environmental Protection Agency, etc.), Department of Interior, Federal Highway Administration, All Great Lakes Coastal Management programs, National Park Service, and NOAA.
- Universities: Penn State, University of Wisconsin
- Others: Chicago Climate Action Plan; Chicago Wilderness Adaptation planning process; Delaware Valley Regional Planning Commission, Philadelphia, Pennsylvania (mentioned twice); Forest

Service; MGA; Michigan Climate Coalition; Nature Conservancy; Northeast States for Coordinated Air Use Management/Regional Greenhouse Gas Initiative (NESCAUM/RGGI); Federal: American Association of State Highway and Transportation Officials (AASHTO), public utility commissions, including California; Sustainable Twin Ports group (based on Natural Step program from Sweden); Toledo Metropolitan Area Council of Governments; and Wisconsin Initiative on Climate Change Impacts (mentioned twice).

A small subset noted elements of their organization’s climate planning that they felt were exceptional. Responses generally fell into the following categories:

- Thirteen cited their efforts to reduce greenhouse gases and develop alternative energy sources.
- Eight pointed to their work on storm water management plans, wetlands and/or coastal areas, or other water-related issues.
- Seven cited their work in habitat preservation or restoration, and/or mitigation of the impact of climate change on species.
- Other answers included collaborative work with other agencies or community groups, implementation of statewide recommendations or action plans, and the protection of human health through adaptation.

Some respondents noted that their community or organization is conducting research or monitoring related to climate change including monitoring of water systems, researching the effects of climate change on local species, and studying energy issues and greenhouse gas emissions. Some respondents noted that they relied on or contracted with other entities to provide research on the impact of climate change and others cited the integration of their data into regional networks.

5.2 Barriers to and Benefits of Climate Planning

For the Great Lakes benchmark group, the most significant barrier to climate planning was funding, which was seen as a significant barrier by 78% of the respondents. Next was staff time, which was seen as a significant barrier by 60%, and then political support (58%). The highest percent response for “not a barrier” was for technical capabilities (12%), followed by facilitation assistance (11%), and access to data and information (10%).

The most significant benefit of climate planning was improved quality of life for future generations, which was seen as a significant benefit by 70% of Great Lakes respondents. Next was improved environmental quality, which was seen as a significant benefit by 66%, and then a more secure water supply (64%). The highest percent response for “not a benefit” was for compliance with federal and state mandates (15%), followed by job creation (14%), and meeting political and public demand (12%) (Figures 1 and 2).

6. DISCUSSION: TOP TEN NEEDS

6.1 Climate Literacy (Need 1)

Awareness of climate change and impacts varied across the basin. While it is often assumed that public awareness of climate change is low, several participants exhibited high-level awareness. Many participants felt well informed on climate change issues and were able to speak knowledgeably about perceived impacts, as well as identify specific tool and information needs, whether for professionals, the public, or policy-makers, in order to effectively anticipate and adapt to climate impacts.

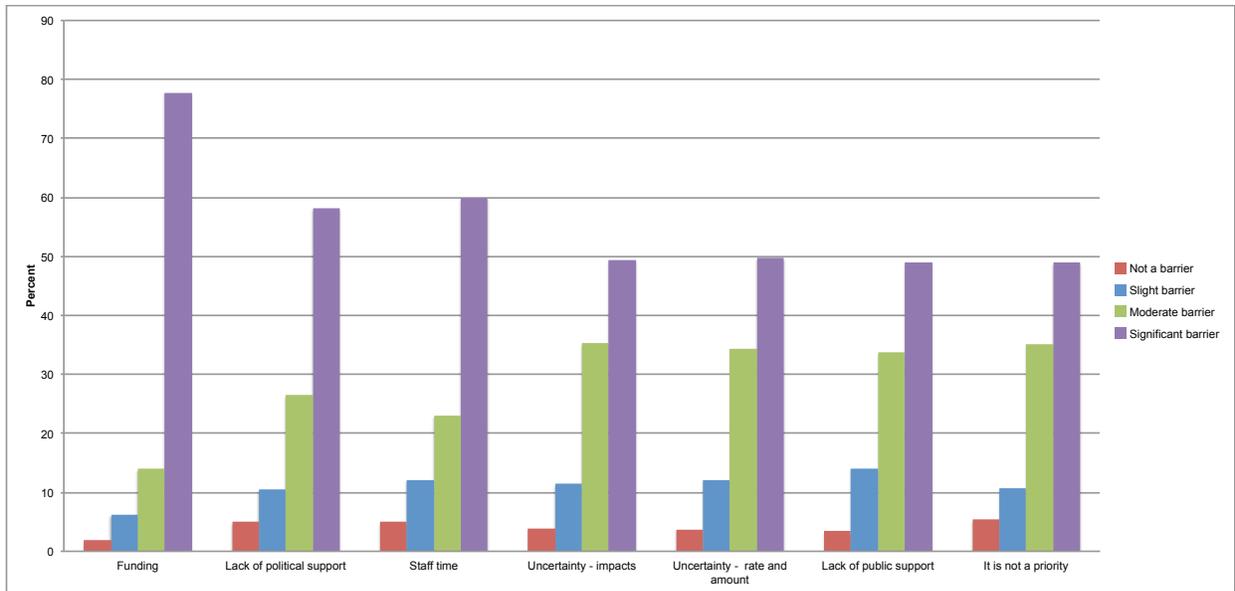


Figure 1. Highest-rated barriers to climate planning.

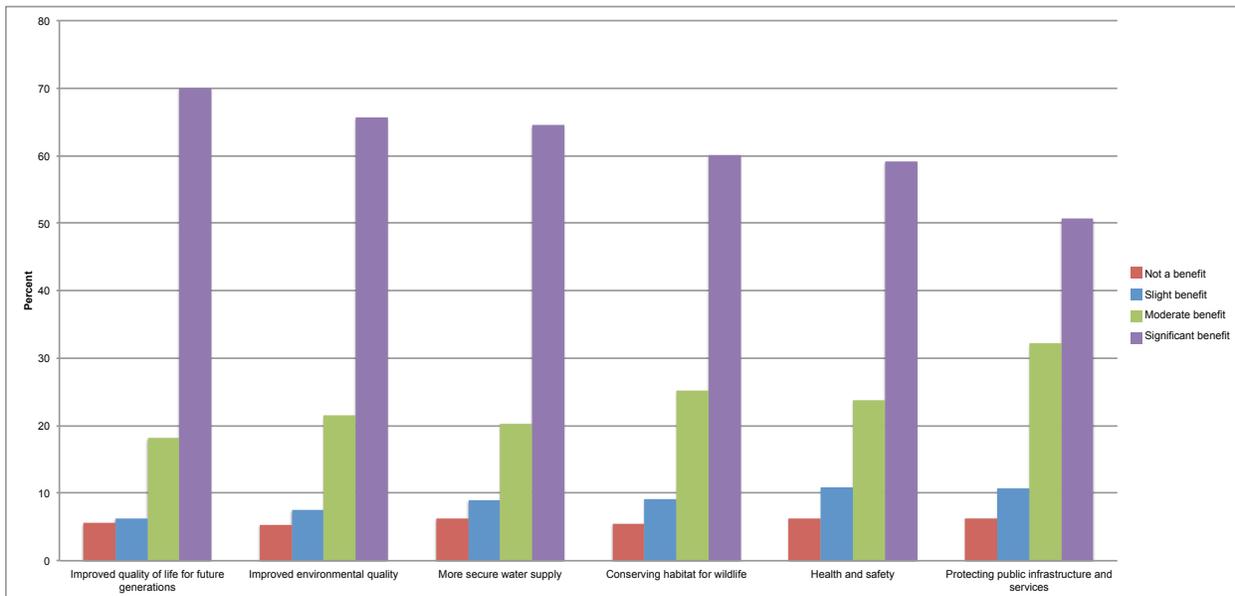


Figure 2. Highest-rated benefits of climate planning.

Participants who felt that they were not very well informed were able to identify more general types of information they needed, such as changes in rates of precipitation and anticipated climate scenarios, in order to make decisions with more certainty.

In the interview data, uncertainty about climate impacts and how to communicate impacts to the public was listed as a potential barrier, with the potential to instill/increase mistrust of government officials. Participants felt that education for decision-makers was a priority need and having high-level advocacy for climate change issues would enable and facilitate effective planning at all scales. Interview data also showed that public education and comprehensive science education was regarded as a priority need and ranked fifth in the ten issue categories.

Participants in the focus groups were able to speak very specifically to concerns about flooding as it impacts water infrastructure, as well as personal property and coastal development. Often mentioned was the need for public education on fluctuating lake levels and long-term coastal impacts, as well as water flow to the lake from onshore systems. A big concern across the two groups was effectively communicating about climate impacts, as discussion about climate change is not socially acceptable in many communities. Strategies for communicating about uncertainty in climate change were identified as an important need in each focus group, as well as in several of the interviews. Other topics identified for public education were stormwater management, water treatment, sanitary sewers, rain gardens and barrels, swales, stormwater basin retrofits and maintenance, and stream restoration.

However, as mentioned previously, it should be noted that within the survey population there was a small group of respondents that indicated that they think climate change, or at least human-caused climate change, is unproven.

6.1.1 Self-Assessed Knowledge and Perceived Impact on Work or Decision-Making

Twenty four percent of Great Lakes benchmark group respondents to the survey indicated they were “very well” informed about the *causes of climate change*, 20% about *ways to reduce climate change*, 17% about *climate change* in their region. Eleven percent were “very well” informed about *ways to prepare for the impacts of climate change*. The highest percent response for “not at all informed” was for ways to prepare for the impacts of climate change (5%), while the rates for the other three topics were all under 2% (Figure 3).

About 70% responded that climate change will impact their job either “a great deal” or “moderate amount” with about 26% responding a “great deal” and approximately 13% indicated “not at all” (Figure 4).

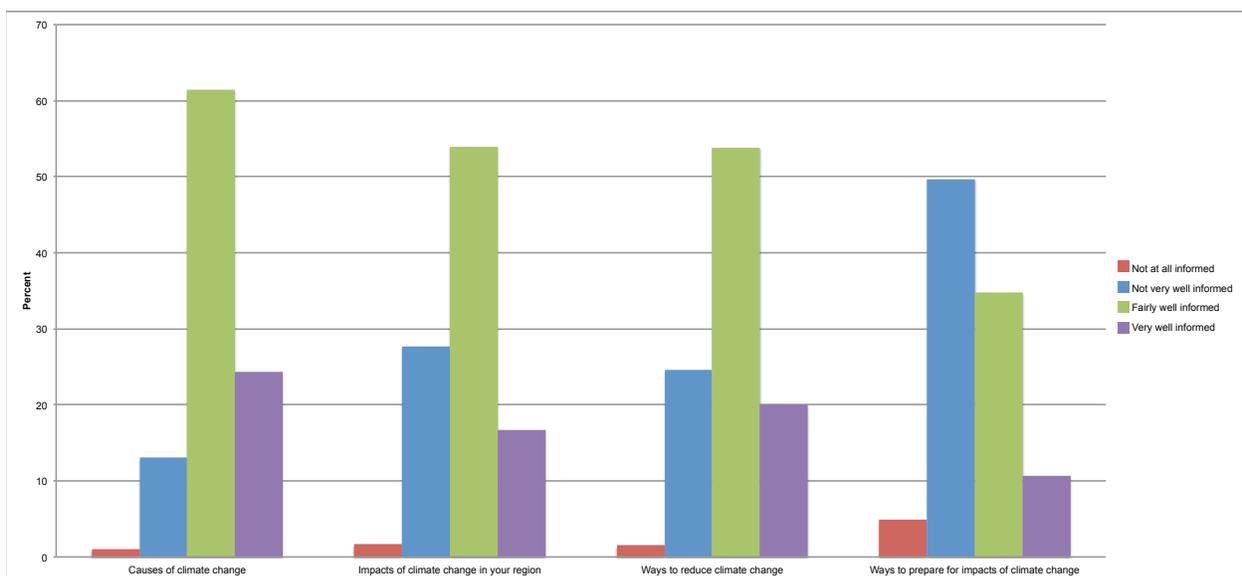


Figure 3. Degree to which respondents felt informed about climate change issues.

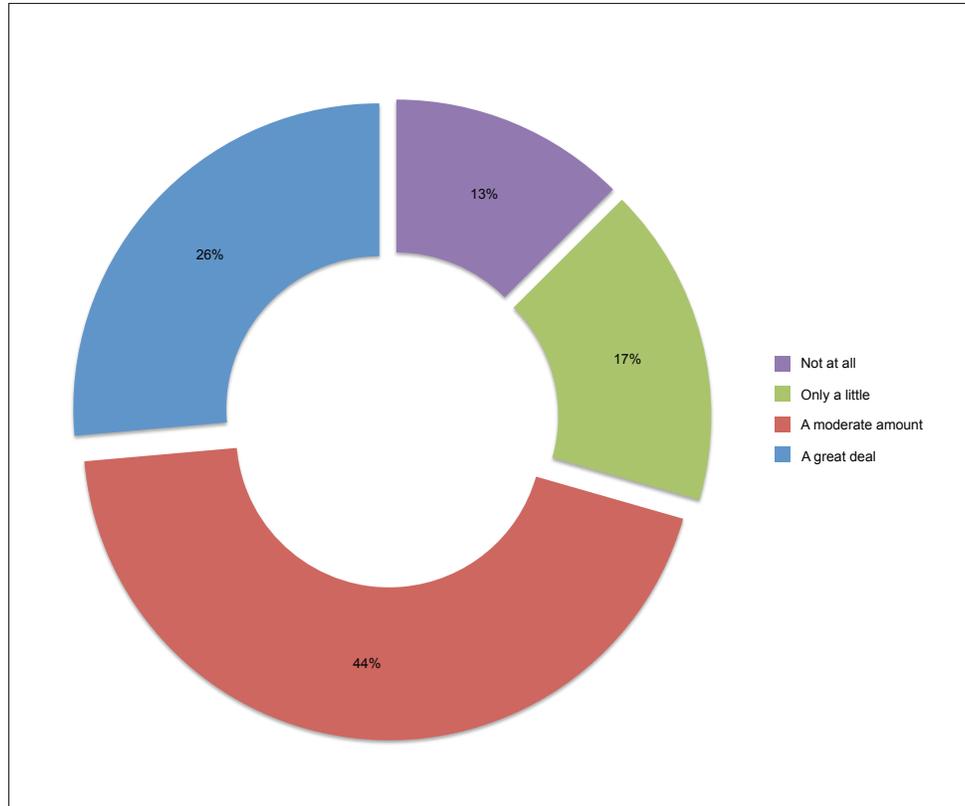


Figure 4. Degree to which respondents thought climate change would impact their jobs.

6.1.2 Trusted Information Sources

The three most “strongly trusted” sources were peer reviewed journals (54.4%), university scientists (52.0%), and conferences and symposiums (34.1%) The three most “strongly distrusted” sources were television (19.1% of respondents), radio (14.4%), and (tie) internet (13.4%) and newspapers (13.4%) (Figure 5).

6.1.3 Community Acceptance of Climate Terminology

The term “climate change” was “highly accepted” by 14 percent of respondents, “community sustainability” by 10%, “hazard mitigation” and “global warming” by 7%, and other climate change related terms were highly accepted by less than 4%. The highest percent response for “highly unaccepted” was for “global warming” (7%), and the next highest was for “climate change” (4%).

6.1.4 Barriers that Building Climate Literacy Could Address

Eighty five percent of Great Lakes benchmark respondents identified lack of political support as a barrier to climate planning. Eight two percent identified lack of public support as a barrier, and 81% indicated that denial that climate change is happening or a problem is also a barrier. Sixty seven percent identified lack of agency/organizational support. About eight survey respondents indicated that they would like better information that is easier to present to and be understood by the general public, and tailored to the specific (often local or regional) audience.

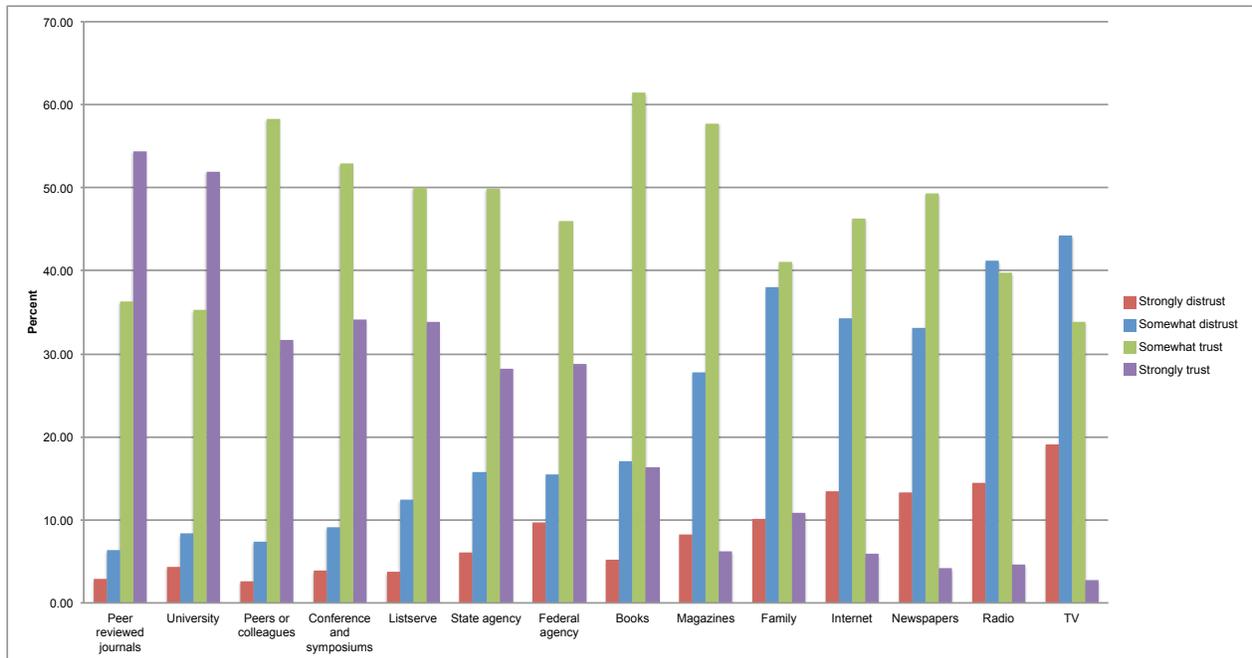


Figure 5. Trust in climate information sources.

6.2 Communication, Coordination, and Collaboration (Need 2)

The need for improved coordination between levels of government and with other agencies, and specifically across jurisdictional boundaries, ranked second in the ten issue categories identified in the interview phase of the needs assessment. Fragmentation in government was seen as a significant barrier, along with mistrust of officials. Strategies for communicating about uncertainty in climate change were identified as an important need in each focus group, as well as in several of the interviews. Other coordination issues identified were information accessibility and distribution at the community scale, and the need for demonstrated leadership at all levels. For example, one participant spoke of the changes in public health agencies after September 11, 2001. After this tragedy occurred, public health departments and related agencies improved service and response time through more integrated coordination that recognized public health agencies as *the lead agency*. This emphasizes the need to have clear understanding of which agency is in the lead of a coordinated effort for the effort to be most effective. Additionally, lack of regional coordination across city or county boundaries can make it difficult to address flooding issues for a watershed system in its entirety. Participants in each focus group identified the need for regional coordination, as well as the barriers to coordination. Participants believed that municipalities are often hesitant to yield decision-making authority to regional water sewer district service management as the trade-off for a regional water system. However, the value of a regional stormwater utility was regarded as a beneficial improvement.

“People have their missions and they’re just following it down without realizing that they can get more of their missions accomplished by helping other people to accomplish their missions, if we are all working together – whether it’s federal, state, or local level.”

– County Agency Director (from interviews)

In the survey, 67% of Great Lakes benchmark respondents identified lack of cooperation and coordination between agencies and organization as a barrier to climate planning. Respondents in the Federal

Government, Regional Government, and All Great Lakes subgroups were significantly less likely to identify cooperation and coordination as a barrier. Sixty three percent saw lack of facilitation assistance as a barrier to climate planning.

6.3 Financial Resources and Guidance (Need 3)

In the survey, financial assistance and/or incentives for adapting to climate change was most frequently identified by Great Lakes benchmark respondents as an area where they need ‘a lot more information’ (57%). About 92% responded that funding is either a “moderate barrier” or a “significant barrier,” including 78% as “significant.” The Federal Government and All Great Lakes subgroups were less likely to see funding as a significant barrier to climate planning.

The most frequently identified factor limiting access to tools for climate planning was staff time (74%), followed by funding (68%), knowledge about tools (63%), technical capacity (49%), and access to data (35%). Use of tools for climate planning was relatively low for the Great Lakes benchmark group. Sixty three percent indicated that they do not use decision support tools, 62% do not use forecast models, 59% do not use stakeholder engagement processes, 53% do not use database management, 41% do not use GIS, and 39% do not use maps. Respondents were most likely to draw on outside expertise for forecast models (23%), and least likely for stakeholder engagement processes (14%).

Focus group discussion about water infrastructure improvements highlighted the need to leverage resources for large-scale, expensive projects with very local implications. Such expensive projects often leads to inaction and failing infrastructure, as participants talked about the difficulty in justifying budgets with perceptions of uncertainty in climate planning. Several city officials discussed the magnitude of the issue:

“Typically several million dollars of work annually, on the average in ..., doing sewer separation projects, separating storm and sanitary sewers, trying to reduce inflow and infiltration, reduce, we have very big basement flooding problems in our city.”

–Municipal Engineer (during focus group)

“We have some water lines or sewer lines that are 100 years old or more and never planned for any replacement. When you approach the people, the people want the replacement, but the city has not set aside funds so it’s either people have to be assessed, and no one wants to be assessed or they expect the city to pay for it, which would mean grants. It’s a gigantic problem.”

– City Mayor (during focus group)

Concerning funding for ecological restoration projects, interview participants perceived lack of funding as a barrier, although this barrier was somewhat mitigated by having near and long term planning goals and scoped projects already identified on paper, which can be undertaken as soon as funding becomes available. Interviewees also believed having decision support for program budgeting was needed.

6.4 Maps, Models, Data and Forecasting (Need 4)

In the focus groups, there was general awareness of changes in precipitation as something associated with climate change. Descriptions of heavy and/or torrential rain as a more regular occurrence, and the consequent impacts on water infrastructure generated discussion on stormwater management and methods

for managing increased amounts of water, such as with retention basins or with green infrastructure and low impact development. Participants identified rain barrels, rain gardens, and other GI/LID strategies as possible solutions. Also mentioned were the increasing costs incurred by cities for maintenance and/or emergency services. There was very clear awareness of precise changes in precipitation patterns based on long-term personal observations. Specific concern was expressed for the need for weather gauges and monitoring stations locally, as discussion centered on how dramatically different microclimates can be within close proximity of each other. For example, one infrastructure manager stated that:

“We’re gathering long-term control plan data right now, and even in our little tiny area we put up 3 rain gauges. So in 5 square miles we decided we might have 3 distinct weather patterns.”

– Municipal Water Infrastructure Manager (during focus group)

Similarly, more consistent collection of stream data was mentioned as needed to inform stream models, and especially urban streams. This was mentioned in both the focus groups and in several of the interviews.

“What’s hard is that people are going to ask the inevitable question what am I planning for? More rain? Less rain? More snow? less snow?”

–Stormwater manager (during focus group)

In the survey, 85% of the Great Lakes benchmark group indicated that the level of uncertainty about the impacts of climate change was a barrier to climate planning, 84% uncertainty about the rate and amount of climate change, 83% uncertainty about adaptation options, and 82% regarding uncertainty about mitigation options.

6.5 Resilient Land Use Planning (Need 5)

As mentioned in the previous section, there was general awareness of changes in precipitation as something associated with climate change among focus group participants. Descriptions of heavy and/or torrential rain as a more regular occurrence, and the consequent impacts on water infrastructure generated discussion on stormwater management and methods for managing increased amounts of water, such as with retention basins. Also mentioned were the increasing costs incurred by cities for maintenance and/or emergency services. It was noted that it is problematic to deal with issues as costly emergencies, rather than to anticipate the issue and manage it before it occurs. One city forester talked about how much it costs the city to deal with downed trees after a storm, when it would be much less if there were routine maintenance for trimming tree branches. Discussion on flooding as it impacts personal property was considered an important issue and challenging problem. Flooding was talked about as a major concern for property owners, as well as a challenge for regional coordination, as discussed previously in section 6.2. In the interview data, both water quantity and quality ranked high on the issue list, along with the need for ecosystem-based management strategies for habitat and natural area preservation. Coastal planning for lake level changes and resilient coastal infrastructure was discussed across nearly all of the interviews. The need for decision support resources that identify and characterize anticipated climate impacts was discussed in the context of understanding the implications for development projects. Being able to address issues on a watershed scale was also a concern.

In the survey, “Lessons learned from communities that have taken action” and “Examples of how Great Lakes and other communities are preparing for climate change” ranked second and third among 22 issue areas in which Great Lakes benchmark respondents need “a lot more information” to effectively do their jobs. 83% of survey respondents perceived protecting public infrastructure and services as a benefit of climate planning.

6.6 Regional and Local Climate Data (Need 6)

Participants in both focus groups and interviews talked about the need for updated precipitation data that reflect trends from recent years and forecasted rates. Having information on storm classifications was also mentioned, as well as guidance documents on anticipated climate impacts. Several engineers felt that having design standards based on current precipitation data and forecasts of future rates is critical to design stormwater infrastructure at an effective scale that can handle any anticipated increases in the intensity of rainfall. Several participants believed that strengthening professional networks and intranet communication systems would facilitate the exchange of knowledge and information, and that local information should be made accessible and distributed at the community scale. In the survey, 61% of the Great Lakes benchmark respondents perceived access to data as a barrier to climate planning.

6.7 Social and Ecological Research and Community Resiliency (Need 7)

There was also discussion on how water levels might be affected from engineered systems, such as dams, and how this might complicate anticipating water level changes. Focus group participants regarded having information about regionally relevant engineered systems as an important piece to understand lake level fluctuation. Additionally, modeling potential shifts in shipping activity based on anticipated lake levels and the estimated ability to maintain ports and harbors (e.g., dredging) could assist communities in making long term plans and decisions that may mitigate economic losses.

Concerns about water temperature increase and resulting consequences on ecosystems and duration of ice cover were identified in several of the interviews. Economic concerns included potential impacts from aquatic invasive species on food webs and commercial and recreational fishing that could detrimentally affect current fishing practices, and that beach health hazards and fish kills could compromise the quality of beaches and deter tourists. Changes in shipping seasons, capacity, and navigation were discussed across several of the interviews as having potentially severe implications for local and regional economies, as well as presenting financial challenges for management of navigation channels and dredging projects. Participants felt that not being able to maintain ports, harbors and marinas could result in economic loss from reduced shipping activity regionally and from international import and export, as well as from impacts on recreational boating.

In the survey, 70% of Great Lakes benchmark respondents perceive planning and policy guidance as a barrier to climate planning. The most significant benefit of climate planning for the Great Lakes benchmark survey group was improved quality of life for future generations, which was seen as a significant benefit by 70% of the respondents. Next was improved environmental quality, which was seen as a significant benefit by 66 percent, and then a more secure water supply (64%).

6.8 Decision-maker Trainings (Need 8)

Leadership training, as well as improved coordination across jurisdictional and sectoral boundaries, was seen as an important priority across many of the interviewees and in the focus groups. Fragmentation in government was considered one of the most significant barriers to development of policies or plans for

climate change. Uncertainty about climate impacts and how to communicate impacts to the public was identified as a potential barrier, with the potential to instill or increase mistrust of government officials. Participants felt that education for decision-makers and having high-level advocacy for climate change issues would enable and facilitate effective planning at all scales.

In the survey, 45% of Great Lakes benchmark respondents were “very interested” in obtaining climate change knowledge and planning skills in a fact sheet format, 44% through one day intermediate training workshops, and 40% through websites. The format for which the highest percentage of respondents were “not interested at all” was multi-day advanced training courses (29%).

Of 22 issue areas, Great Lakes respondents most frequently identified financial assistance and/or incentives for adapting to climate change as an area where they need ‘a lot more information’ (57%). Next was lessons learned from communities that have taken action, which was selected by just over 53%, and then examples of how Great Lakes and other communities are preparing for climate change (just under 53%). The highest percent response for “do not need any information” was for the science of climate change (20%), followed by scientific projections of climate change phenomena such as temperature rise, precipitation, and lake level - nationally (18%), and potential impacts of climate change - nationally (16%) (Figure 6).

Of 25 potential climate change impacts, respondents most frequently selected impacts on the economy as an area where they need “a lot more” information (31%). Next was ecosystem restoration, creation, and enhancement, which was selected by 30%, and then ecosystem protection and management (29%).

6.9 Understanding Climate Impacts (Need 9)

Reduced uncertainty regarding anticipated impacts was a primary concern across focus groups and interviews. Many participants felt that it is extremely difficult to justify budgeting resources to address potential issues without having more certainty about projected impacts. Having near and far term trend reports for lake level fluctuation and changes in weather patterns could be used to inform planning and decision-making. Understanding how the natural system has behaved historically and translating climate and hydrological model outputs of how the natural systems are changing can include a companion layer of analysis of social and economic trends. Participants believed that having this type of information would be very helpful to justify decisions and actions. Additionally, perceived benefits of climate change included increased opportunities for renewable energy, and a more pleasant climate for the region. Having a comprehensive social ecological picture of possible climate scenarios could enable communities to more fully recognize and actualize opportunities, as well as mitigate risks.

Concerns about water temperature increase and consequences for ecosystems and duration of ice cover were identified in several of the interviews. Water management issues concerning both quantity and quality ranked high on the issue list, along with the need for ecosystem based management strategies for habitat and natural area preservation. Coastal planning for lake level changes and resilient coastal infrastructure was discussed across nearly all of the interviews. A related concern was the need for decision support resources that identify and characterize anticipated climate impacts, and understanding the implications for development projects. Being able to address issues on a watershed scale (across jurisdictional boundaries) was also a concern. Notably, some impacts may only affect a subset of the population, as some groups are more vulnerable to certain climate impacts. A specific example of this is the impact of water level fluctuation on the yield of wild rice, and the consequences of the loss of a major

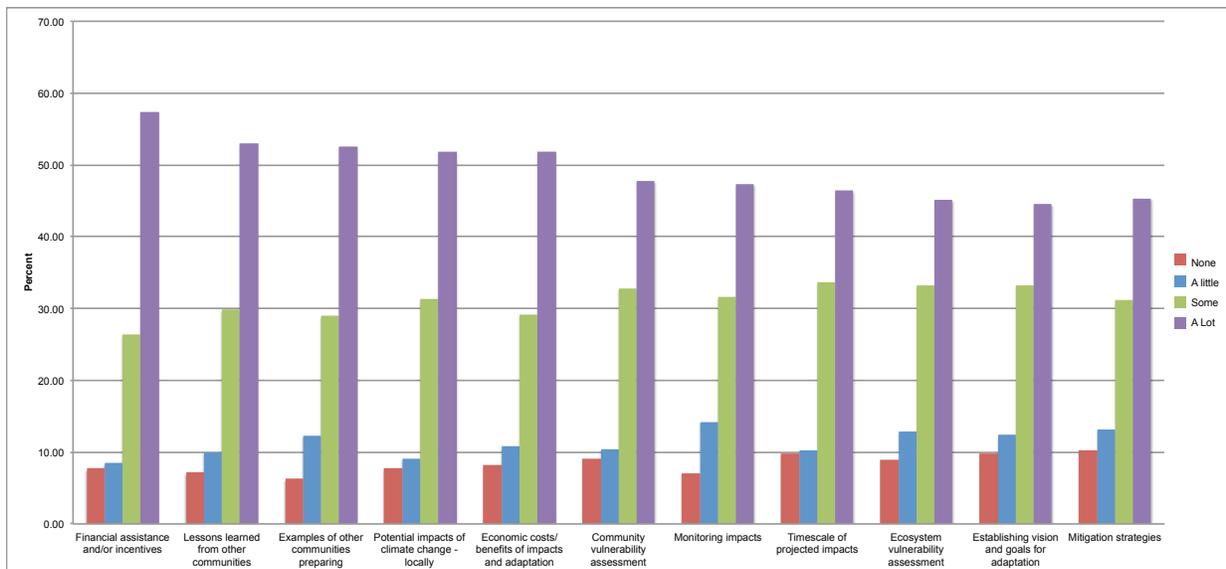


Figure 6. Highest-rated information needs – climate planning.

food source for Tribes and First Nations. Similarly, changes in the aquatic food web may detrimentally impact subsistence fishing, with disparate impact on different groups. Uncertainty about climate impacts and how to communicate impacts to the public was identified as a potential barrier, with the potential to instill or increase mistrust of government officials. Fragmentation in government was considered one of the most significant barriers to develop policies or plan for climate change. Participants felt that education for decision-makers and having high-level advocacy for climate change issues would enable and facilitate effective planning at all scales.

In the survey, Great Lakes benchmark group respondents most frequently said they need “a lot more” information regarding climate change impacts on the economy (31%) among a list of 25 potential impacts. Next was ecosystem restoration, creation, and enhancement, which was selected by 30%, and then ecosystem protection and management (29%) (Figure 7).

6.10 Ecosystem Research and Monitoring (Need 10)

In the focus groups, concerns about public health were often discussed in context of having relevant environmental information about health hazards, such as real-time forecasting of beach conditions and awareness of harmful algal blooms (HABs). Some focus group participants described the need for local monitoring systems, given differences in microclimates and precipitation trends even in small geographical areas. More consistent collection of stream data was mentioned as needed to inform stream models, especially for urban streams.

In the interview data, ecosystem-based management strategies were identified as a priority for habitat, natural areas, and softshore preservation and restoration, as well as wildlife protection and species preservation. Participants emphasized the need for water quality monitoring for beach quality, drinking water quality, and wastewater treatment. Being able to address issues on a watershed scale was also a concern.

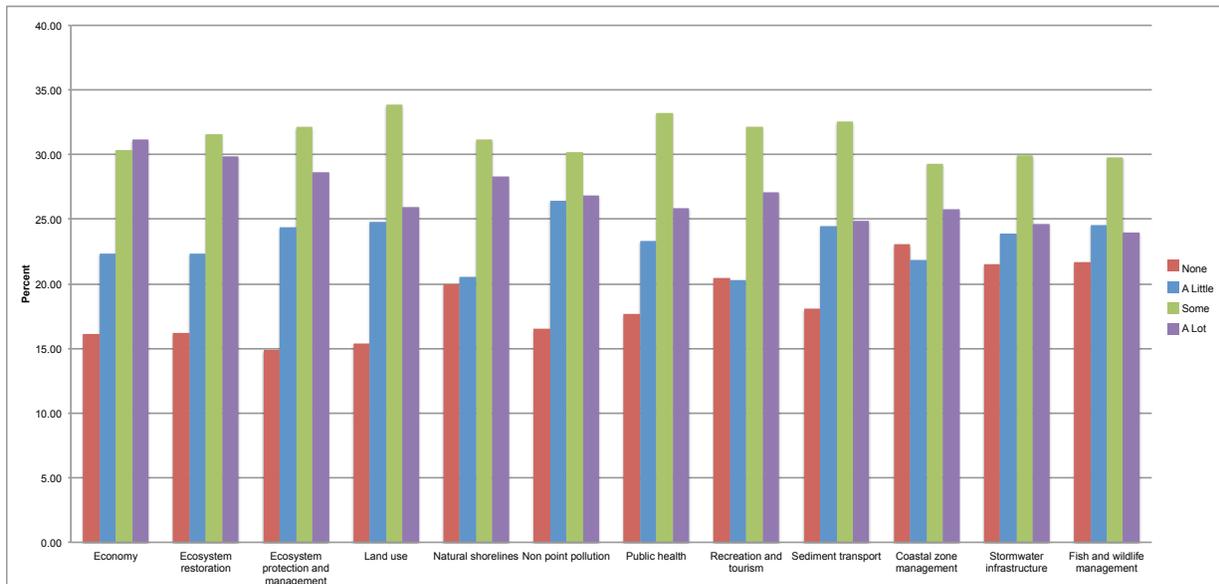


Figure 7. Highest-rated information needs – climate impacts.

Impacts from increasing water temperature and aquatic invasive species on aquatic food webs, as well as changes in duration of ice cover and lake level changes were discussed across nearly all of the interviews. Again, some impacts may only affect a subset of the population, as some groups are more vulnerable to certain climate impacts. As discussed in the previous section, a specific example of this is the impact of water level fluctuation on the yield of wild rice, and the consequences of the loss of a major food source for Tribes and First Nations. Similarly, changes in the aquatic food web may detrimentally impact subsistence fishing, with disparate impact on different groups.

Eighty five percent of Great Lakes benchmark respondents see conserving habitat as a benefit of climate planning. Thirty percent of survey respondents indicated that they need “a lot more information” regarding climate change impacts on ecosystem restoration, creation, and enhancement and 29% regarding ecosystem protection and management.

7. NEEDS FULFILLED BY NOAA AND PARTNERS

Highlighted here are results of the climate adaptation workshops as a primary outcome of this needs assessment.

7.1 PCC Workshops¹⁴

The Ohio Coastal Training Program at Old Woman Creek National Estuarine Research Reserve and the Lake Superior National Estuarine Research Reserve coordinated a regional project to customize *Planning for Climate Change*, a one-day training workshop to address Great Lakes issues and the needs of planners and other professionals working on land use, public health, stormwater, emergency preparedness, and natural resource management issues across the region. This project was developed to address the need for decision-maker trainings (Need 8).

¹⁴ The Planning for Climate Impacts Workshop Evaluation Report is available on the Workshop website at: <http://nerss.noaa.gov/CTPIndex.aspx?ID=663>

7.1.1 Workshop Development

The *Planning for Climate Change* workshop was originally developed by the National Estuarine Research Reserve (NERR) System through its Coastal Training Program with funding from the NOAA Coastal Service Center. The workshop lays a foundation in science and targets actions that can be taken to prepare and adapt to the anticipated impacts of climate change. The course was piloted in Washington State and has been offered in several coastal states.

For this project, Great Lakes region workshops were developed for Cleveland, Ohio; Duluth, Minnesota; and Green Bay, Wisconsin and held in late summer 2011. Staff of the Old Woman Creek and Lake Superior National Estuarine Research Reserves convened three planning teams, one associated with each workshop, which used the results of this assessment in concert with local knowledge of needs and climate resources to customize the NERRS *Planning for Climate Change* workshop for the Great Lakes region. Planning teams identified the target audience for all three workshops as professionals involved in planning and decision-making related to land use, public health, stormwater, emergency preparedness, and natural resource management. The teams also agreed upon a set of learning objectives described below:

- (1) Increase participant understanding of the following:
 - (a) Basic climate science principles
 - (b) Best available local and regional data related to climate projections
 - (c) Potential impacts from climate change
 - (d) Planning processes, resources, and actions that can help communities prepare for and adapt to climate change impacts
 - (e) Potential barriers to climate change adaptation and tools and resources to overcome these barriers
 - (f) Potential benefits of climate change adaptation
- (2) Create opportunities for networking and dialogue related to potential climate change adaptation strategies and regional examples of climate planning and adaptation

Planning teams developed regionally tailored messages and products to market the course. The course title *Planning for Climate Change* was adjusted to *Planning for Climate Impacts* and a phrase localizing the title was added:

- *Planning for Climate Impacts in Northern Ohio*
- *Planning for Climate Impacts in the Western Lake Superior Region*
- *Planning for Climate Impacts in Northeast Wisconsin Communities*

The tag lines ‘Safeguarding our economy, environment, and quality of life’ and ‘capacity building workshop’ were also utilized. The Ohio Department of Natural Resources Office of Coastal Management developed a save the date flyer in consultation with workshop planning teams that featured graphics of the Lake Superior, Michigan, and Erie coasts; images of the lakes and recreational uses; and a National Climate Assessment report graphic illustrating sectors affected by climate change. Sponsors and collaborating partners were included on the flyer.

Over 240 planners, stormwater professionals, natural resource managers, public health professionals, emergency preparedness staff, and private industry representatives participated in the training¹⁵. Most participants were affiliated with universities (19%), state government (18%), non-profit organizations (15%), or local government (13%). The remaining participants were affiliated with county government, private industry, federal government agencies, regional government agencies, and tribal governments. Nine members of the American Institute of Certified Planners earned six certification maintenance credits for participating in the Cleveland workshop.

Each workshop began with an overview of climate change science and regional impacts. The existence of downscaled climate information applicable to Western Lake Superior and Northeast Wisconsin allowed for further localization of the content for these two workshops. All three trainings also covered fundamental concepts in climate planning, provided a review of available tools and resources to aid in climate planning, and included an interactive activity through which participants identified and discussed potential adaptation strategies for vulnerabilities in their communities. Depending on local needs and interests, regional case studies of climate planning, the economics of adaptation, and public health impacts were also covered in one or more workshops.

In addition to the Old Woman Creek and Lake Superior National Estuarine Research Reserves, workshop sponsors included the Ohio Department of Natural Resources Division of Wildlife, the University of Wisconsin Extension, University of Wisconsin Environmental Resources Center, NOAA Coastal Services Center, Green City Blue Lake Institute at the Cleveland Museum of Natural History, Ohio Lake Erie Commission, Ohio Coastal Management Program, Great Lakes Sea Grant Network, United States Environmental Protection Agency, and the Cofrin Center for Biodiversity at the University of Wisconsin Green Bay. Workshops were funded by the Great Lakes Restoration Initiative and Old Woman Creek National Estuarine Research Reserve.

Collaborating partners¹⁶ that provided input on training design through local planning teams included Great Lakes Sea Grant and Coastal Zone Management Programs and a wide array of other local, state, and federal agencies such as EPA, U.S. Fish and Wildlife Service, tribal governments, universities, community leaders, ICLEI Local Governments for Sustainability, local chapters of the American Planners Association, The Nature Conservancy, and other conservation NGOs.

7.1.2 Evaluation Surveys and Outcomes

*“There will be no more hesitation on my part in saying that the climate has and is changing. The science based historical data presented for Wisconsin and Minnesota on changes in temperatures, dew points, storms, rainfall levels and stormwater runoff and the consequences and impacts on health, natural resources, the economy, water levels and temperature is valuable and important proof that climate change is real. Now, I can speak to this subject with or without addressing the man-made contribution to climate change. **The workshop was the first opportunity that I have had to consider adaptation as a proactive activity.** The research, analysis and presentation of adaptation topics, strategies and the processes to adapt to climate change presented at the workshop are all new information for me.”*
– Training workshop participant (emphasis added)

¹⁵ Agendas and workshop presentations are posted at: <http://nerrs.noaa.gov/CTPIndex.aspx?ID=663>

¹⁶ A complete list of collaborating partners can be found at the end of this document.

The workshop was the first opportunity that I have had to consider adaptation as a proactive activity. Sixty-four percent of participants completed an online survey immediately following the workshop. Thirty-nine percent of respondents strongly agreed and 48% percent agreed that participating in this event was a good use of their time. Participants reported large knowledge increases related to climate adaptation. Ninety-one percent of evaluation respondents said the workshop increased their knowledge of climate adaptation “some,” “a lot,” or “a great deal.” Several participants said that they had little prior knowledge of adaptation planning approaches or strategies and some indicated that they knew little about the science. Others indicated that they came to the workshop with some understanding but that the experience took their knowledge to the next level. Seventy-two percent of respondents indicated they learned something new that they will apply in their work or future decisions. Participants in the Green Bay and Duluth workshops reported knowledge gains relative to all workshop objectives in post versus pre workshop surveys.

Most useful aspects of training

Several participants indicated that the sharing of climate science, information regarding regional impacts, adaptation basics, and local adaptation case studies were the most useful aspects of the workshop. Others found the roundtable discussions and the vulnerability assessment activity to be the most valuable aspect of the training. For the Cleveland workshop, several participants noted that sessions covering the economics of adaptation and public health impacts of climate change were most useful.

Opportunities for improvement

Participants in all three workshops identified similar opportunities to improve the workshop. Several suggest that the workshop would be improved by incorporating more case studies, reducing lecture time, and more opportunities for interactive, engaged learning. Some wanted more details regarding adaptation strategies and examples, including hands on examples and demonstration of tools. In Duluth and Wisconsin there was a desire for more mapping information. Some participants thought the training should be longer and several provided suggestions regarding improvements to presentation style and technical logistics. Quotes from respondents related to potential improvements included the following:

- *Build a model community and have participants identify and implement changes. It's easy to “make changes” but there are trade offs. I think adding this piece to the discussion will begin to identify additional topics.*
- *Topics were great but need to be framed in a format where participants play an active role and are engaged in learning and in putting what they learn into action.*
- *Have breakout sessions with in-depth info about how to do adaptation related to impacts like increased stormwater, flooding.*

Respondents cited a number of obstacles to applying what they learned at the conference including lack of public, political, and agency support; low levels of climate literacy among the general public and key decision-makers; perception that climate change will impact others far into the future and in other places; fiscal constraints; and scientific uncertainty regarding impacts.

Participants indicated that additional training could assist them in overcoming obstacles, particularly if the training focuses on the science related to regional impacts, specific adaptation options and local adaptation case studies. Education of elected officials was mentioned by several respondents as an

important need as was economic analyses of impacts and adaptation options. Quotes from respondents related to additional training or assistance that would help address obstacles included the following:

- o “Continuing to provide examples of how climate change is specifically impacting the natural resources, agriculture, infrastructure and the economy. Hold regular forums on local case studies to help build a bridge for planners, engineers, administrators and legislators on how the environment is changing and what needs to be done.”
- o “Workshops like these, events or outreach/information programs that can effectively take the climate change concept and translate it to formats that are more readily understood and accepted, like public health and safety, flooding, and stormwater concerns.”
- o “Intensive facilitated discussion that brings regional groups to consensus on adaptation strategies that they can jointly work on; as well as individual community actions that they can take right away.”
- o “Promoting climate adaptation as best practices and having an economic pay-off - in the way the Brookings Institution promoted Great Lakes restoration - help us message and sell this to decision makers. I imagine there is an important role for assistance for municipalities to help them address building climate change resilience into limited budgets and show city leaders why they must address it.”

Future training needs

There was a great deal of consistency across the three workshops in terms of what participants identified as future training needs. Future needs include:

- Specific practices, policies, codes, and ordinances that address adaptation
- More examples of adaptation programs
- Economic costs of climate change and cost benefit analysis of adaptation options
- Local examples of impacts including phenology change, stormwater impacts, mapping of habitat impacts, emergency preparedness implications, invasive species, water withdrawals (Great Lakes Compact), and ground water supplies
- Education of elected officials and more specific target audiences
- Collaboration
- Funding
- Legislative work
- Climate science
- Accessible data and tools
- Messaging

7.1.3 Vulnerabilities and Adaptation Options Identified in Workshops

During an interactive exercise, participants identified key vulnerabilities to climate change, discussed potential adaptation strategies, brainstormed key stakeholders, action time frames, next steps that can be taken locally, and barriers to implementation. Across all three workshops and particularly in Cleveland, participants identified the impacts of increased runoff on stormwater infrastructure as a key vulnerability. Robust discussion on the barriers to and benefits of adapting to increased stormwater runoff revealed awareness of vulnerabilities across a spectrum of sectors, and workshop participants were aware of appropriate response strategies, all of which were consistent with findings from the needs assessment.

Changes in species composition resulting from range changes, invasive species impacts, loss of vulnerable species, and loss of habitat were identified as key vulnerabilities for the region's natural resources. Other key vulnerabilities discussed included heat related stress, impacts on drinking water quality, loss of fisheries and recreational opportunities, loss of tourism revenue, and impacts on shipping. Potential strategies that participants identified to reduce impacts on infrastructure, ecosystems, and communities included (but not limited to): strengthening local policy and planning regulations, separating combined sewer systems and employing green infrastructure design, restoring and protecting wetlands, and educating engineers, infrastructure managers, and public on the value of storage and infiltration of water rather than conveyance.

Workshop participants identified several barriers to and benefits of adaptation actions, many of which were consistent with those identified through the needs assessment. Barriers included lack of funding, guidance, political will, cooperation, and knowledge of vulnerabilities and adaptation options. Benefits included increased quality of life, improved water quality, reduced flooding and property damage, improved property values, lower incidence of waterborne disease, and lower energy costs. Full discussion of the results from the vulnerability exercise are available in the workshop evaluation report.¹⁷

7.1.4 Outcomes: Information Sharing, Application to Decision-Making and Management

In June 2012, 76 participants who had agreed to be contacted after the workshops were surveyed to assess whether and how they have applied information gained through the training. Of the 28 who responded, almost all (93%) have shared information from the workshop with others such as professional colleagues and organizational partners. Eighty-six percent said they are using the information in their current work or decision-making. Some indicated that they have integrated the information into regional adaptation plans and multi-hazard mitigation planning processes to address flooding problems, others have used it on websites, to write grant proposals, provide technical guidance for development projects, or to develop education programs for community leaders, citizens, and students.

Seventy-one percent said they have encountered obstacles to applying the information including lack of agency acceptance that climate change is occurring, limited staff time and funding, need for better information about adaptation options, and lack of political and public acceptance. Forty-three percent think that follow up technical assistance with selecting adaptation strategies, communicating with stakeholders, conducting vulnerability assessment or with using visualization or other decision support tools would help them to overcome these obstacles.

When asked what they think is the most critical vulnerability to climate change in the community or ecosystem they plan for or manage, several cited ecosystem and infrastructure vulnerabilities to more frequent intense storms including flooding, erosion, nonpoint source pollution, and harmful algal blooms. Others saw migration of pests and species loss, impacts to local economies, lack of funding, absence of state policies that incentivize adaptation and mitigation, low public awareness and support, and low understanding of potential health impacts as key vulnerabilities.

Several respondents said they have changed their planning or management in response to knowledge gained at the workshops. Some are considering climate change impacts when developing natural resource management plans, and others have integrated the information into education programs and watershed

¹⁷ Available at: <http://nerrs.noaa.gov/CTPIndex.aspx?ID=663>

action planning. One community implemented a sustainable zoning code that includes adaptation strategies, and another is using the information to review proposed local zoning policies.

7.2 NOAA and Partners

A major outcome for this needs assessment has been to inform the development of a regional climate science and service plan. While NOAA has developed several programs to meet information and training needs, this does not preclude others outside of NOAA addressing these needs, where they are uniquely suited to do so. Many agencies throughout the region are engaged in climate planning, and the challenge is to ensure that climate work is effectively coordinated so that efforts are complementary and building on one another.

Issue areas that present opportunities for needs fulfillment include, but are not limited to, the following: considering natural habitat complexity as a key feature to enhance resilience; adapting forest management to assist species migration and redistribution, establishing new protected forests, and allowing natural regeneration after disturbances. Improving tracking and monitoring of invasive species and ecosystem conditions in order to evaluate existing prevention measures and future threats in the context of climate change, as well as utilizing parks as long-term integrated monitoring sites for climate change. Identify representative Great Lakes ecosystem locations to serve as Sentinel Sites for the impacts of climate change, such as the Lake Superior and Old Woman Creek National Estuarine Research Reserves. Finally, having financial support, political guidance, and resource leverage for local climate adaptation efforts is an ongoing need in all Great Lakes communities, and in various capacities.

8. RECOMMENDATIONS AND NEXT STEPS

Throughout this assessment, the need for collaborative research and learning has been explored from multiple perspectives. The National Research Council (2009) recommends that decision support services should engage an interdisciplinary structure (p. 67), as well as using an analytic and iterative approach for decision-making (p. 78-84). Furthermore, focusing on user needs and skills is an essential component for developing effective climate services (National Research Council, 2010:168-169). Given these considerations, it is possible that requiring engagement of end-users in collaborative research, learning, and implementation projects in requests for proposals (RFPs) could expedite implementation of this approach across the region. Additionally, the wealth of information regarding regional needs gathered in this assessment, and other assessments in recent years, could be synthesized and communicated to a broader audience through forums and symposiums and mapped to available resources that address these needs. The survey data revealed this type of delivery mechanism to be among the most trusted sources for information. Other recommendations include:

- I. Develop and expand educational tools and resources to increase understanding of climate impact scenarios that include modeling output and anticipated trends for natural, social, and economic systems. Having a comprehensive social and ecological picture of possible climate scenarios will enable the public and policy-makers to more fully recognize, anticipate, and actualize opportunities and mitigate hazards. Determine regionally specific ‘no-regrets’ policy options for each of the Great Lakes, and as a collective.
- II. Increase capacity for local and regional monitoring of the Great Lakes, as well as the coastal watersheds. Develop public-private and citizen science partnerships to collect and analyze

data. Further develop and strengthen regionally coordinated efforts to maintain monitoring systems. Educate policy-makers on the need and justification for funding the implementation and maintenance of large lake monitoring systems.

- III. Develop partnerships and regionally coordinated efforts to leverage funding for large-scale projects. Strengthen communication with policy-makers and include specific cost-benefit analyses for anticipated improvements.
- IV. Pursue research of the social and economic impacts from climate change currently and longitudinally. Perform analyses that couple social and ecological systems, and engage high school and college students in the research.
- V. Generate near and far term trend reports for lake level fluctuation and changes in weather patterns to inform planning for fishing and tourism seasons. Include social and economic trends analysis in climate change research and modeling to illustrate how natural system changes affect decision-making for local communities and tourists.
- VI. Conduct assessments that identify additional gaps and needs for particular sectors, demographic and professional groups, and geographies.
- VII. Conduct and fund research that quantifies the current and future benefits of adaptation for environmental quality and public health to help support adaptation actions.
- VIII. Develop training in use of appropriate social science methods and application for climate change adaptation.
- IX. Develop leadership training and climate literacy programs that engage working professionals, as well as high school and college students.
- X. Develop climate services that engage end-users and incorporate the wealth of knowledge and local expertise across the region. Engage end-users in collaborative research whenever possible. Require this approach in requests for proposals to expedite implementation across the region.
- XI. Develop effective communication between agencies and the public. Develop and refine contextualization regarding uncertainty and ongoing investment to improve models and forecasts.
- XII. Continue and expand delivery of climate adaptation training at the community level throughout the Great Lakes. Build capacity, funding mechanisms, and train-the-trainer support for delivery of local training within NOAA and more broadly in the region.
- XIII. Host symposiums to synthesize and communicate findings from this study, as well as other assessments that have been conducted in recent years. This type of forum could be held annually, to strengthen awareness and understanding across the region.

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