PRIORITIES IN CLIMATE ADAPTATION PLANS 2011-2016

Provided by Central Upper Peninsula Planning and Development in Cooperation with the Superior Watershed Partnership
EXECUTIVE SUMMARY

This project brings together the climate change adaptation planning work done in the Upper Peninsula since 2011 with the Master Plan revisions and updates that take place on a regular basis. It is organized in order to answer three common questions:

What was found to be important for the Central Upper Peninsula in planning for climate change?

See 1.1 Priorities in Climate Adaptation Plans 2011-2016

I’m planning for the future of the Central Upper Peninsula. How do I easily find concrete ideas to address climate change?

See 1.2 Climate Adaptation Strategies by Master Plan Chapters.

The chapters are:

- Economic profile/local economy
- Housing
- Public and community facilities
- Natural features and resources
- Recreation
- Transportation, and
- Land use and zoning

What is known about how climate change will impact the Central Upper Peninsula?

See 1.3 Climate Change Indicators Report.

Use their table of contents as a guide to finding the topics covered. Each document contains links to specific actions, policies or data to support local decision makers.

Why Master Plans Were Chosen as the Organizing Structure.

The Central Upper Peninsula Planning and Development Regional Commission (CUPPAD) contracted with the Superior Watershed Partnership to create these documents in 2016 through the Regional Prosperity Initiative, supported by the State of Michigan. The work resulted in:

- A summary and table showing how priorities in existing climate adaptation plans could be applied to master plans and zoning plans. See Chapter 1.1
- Identification of strategies to bring climate adaptation into the revising, adopting and writing of master plans. See Chapter 1.2
- An annotated list of resources and prioritized set of actions for CUPPAD planners to take in order to apply climate adaptation lens to the revising, adopting and writing of master plans. See Chapter 1.2
- Identification of issues and locations where climate change adaptation are important threats, weaknesses or opportunities in zoning, economic development, recreation, or land use planning and provide table of topics including citations/references where to get more information. See Chapter 1.3
1.1 Priorities in Climate Adaptation Plans 2011-2016

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Priorities in Existing Plans

Since 2011, six climate adaptation plans and a climate resilience workshop have been developed in the CUPPAD region. To read the full report online, click on title to be taken to the website. The Executive Summary of the workshop is included at the end of this document.

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<th>Page</th>
<th>Document</th>
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<td>2011 Climate Adaptation and Mitigation Plan for Alger County</td>
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<td>7</td>
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<td>4</td>
<td>2015 Climate Resilience Toolkit Marquette County workshop (Appendix A)</td>
</tr>
</tbody>
</table>

Consistent Priorities in all of the Plans

The presentation of the priorities varies according to the methodology used in the document. While there are differences in the priorities arising from the geography and economies of the different regions of the plans, several issues are consistent. They are:

- Water resources – drinking water availability, flooding and erosion, habitat health of lakes and rivers - are the primary concern.
- The increase in the amount of, and severity of, extreme weather is a new challenge.
- Maintaining the health and integrity of forest ecosystems is highly valued.
- Both drought and increased rainfall are threats to infrastructure, ecosystems and social health and welfare.
- Taking action begins with education and outreach on local climate change impacts and how to mitigate and adapt to it.
### Ranking Priorities Using Risk and Vulnerability

A standard practice in developing climate adaptation plans is to identify possible climate change impacts and then rank those issues according to two criteria: risk and vulnerability. (See US Environmental Protection Agency [Adapting to Climate Change](https://www.epa.gov/climate-adapt) and NOAA [Climate Resilience Toolkit](https://coast.noaa.gov/climate-resilience/).) The 2013 [Lake Superior Watershed Climate Adaptation Plan](https://www.epa.gov/cmis/business-human-environment/climate-adaptation) states that (emphasis in original):

“In order to determine appropriate adaptation goals and actions for this Plan, it was necessary to assess the level of **Risk** climate change is likely to bring to both natural resources and the human experience. In the following tables, **Risk** conveys both the **probability** and the **impact** of the occurrence. Once the **risk** was determined, it was necessary to assess the **ability to cope** with these impacts when and where they occur. The ability to cope is referred to as **Vulnerability**.”

Three climate adaptation plans completed for the Upper Peninsula used this methodology: the [Alger County](https://www.epa.gov/region5/), [Lake Superior Watershed](https://www.epa.gov/region5/lake-superior-watershed), and [Marquette County](https://www.epa.gov/region5/marquette-county). The results are below.

<table>
<thead>
<tr>
<th>Projected Climate Changes</th>
<th>Medium Risk</th>
<th>High Risk</th>
</tr>
</thead>
</table>
| **High Vulnerability** (less able to cope) | - Increase in severe weather events  
- Warming water temperatures  
- Less ice on Great Lakes  
- Less ice on inland lakes  
- Drought and changes to soil conditions | Habitats likely to shift |

<table>
<thead>
<tr>
<th>Impacts to Natural Resources</th>
<th>Medium Risk</th>
<th>High Risk</th>
</tr>
</thead>
</table>
| **High Vulnerability** (less able to cope) | - More flooding due to increased rain  
- Drier conditions increase number/severity of wildfires | Threats to wetlands due to lack of zoning or management plans  
Habitat for endangered species will be threatened |

<table>
<thead>
<tr>
<th>Impacts to Human Populations</th>
<th>Medium Risk</th>
<th>High Risk</th>
</tr>
</thead>
</table>
| **High Vulnerability** (less able to cope) | - Increased disruptions from severe weather  
- Diminished cold water fishery harms sport/commercial fishing  
- Drier conditions threaten water supplies and increase fire dangers | Winter culture/tourism events will lack cold/snow conditions  
Changes in tree populations, especially fewer Sugar Maples, harm timber, syrup and tourism industries/traditions |
At the October 2015 Climate Resilience Toolkit workshop, “participants learned how to use the Climate Resilience Toolkit and the five step process by identifying local concerns related to extreme weather event hazards and climate change adaption planning.” The thirty people attending “agreed upon three key issues influencing Marquette County’s resilience to a changing climate: 1) the municipal water supply and drought, 2) our municipal water infrastructure, especially during “freeze and thaw” weather events, and 3) shoreline erosion along Lake Superior.”

For each of the three issues identified, the workshop participants listed numerous vulnerabilities, or potential for harm. Workshop participants used “dots” to vote for the vulnerabilities that they believed were most worrisome.

### Table 1. Top Three Assets and Associated Vulnerabilities

<table>
<thead>
<tr>
<th>Asset</th>
<th>Threat</th>
<th>Indicator - Potential Consequence</th>
<th>Stressors that Contribute to Threat</th>
<th>Projected Change in Threats &amp; Stressors</th>
<th>Degree of Sensitivity / Impact</th>
<th>Adaptive Capacity</th>
<th>Critical Threshold</th>
<th>Vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Municipal Water Supply</strong></td>
<td>Drought</td>
<td>Inability to Meet Demand</td>
<td>Extended Periods</td>
<td>Increasing</td>
<td>Varied</td>
<td>Low</td>
<td>No</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Municipal Water Infrastructure</strong></td>
<td>Extreme Cold Snaps</td>
<td>Frozen Water Lines; Loss of Drinking Water</td>
<td>Variability</td>
<td>Continuing</td>
<td>Widespread</td>
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<tr>
<td><strong>Lake Superior Shoreline</strong></td>
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<td>Road Closure</td>
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<td>Widespread</td>
<td></td>
<td></td>
<td>High</td>
</tr>
</tbody>
</table>

Prioritized actions supporting climate adaptation in Alger County, Marquette County and the Lake Superior watershed of Michigan’s Upper Peninsula

From these rankings, an action plan was developed specific to the region (Alger County, Marquette County and the Lake Superior watershed of Michigan's Upper Peninsula). They can be read at the links on Page 3. Section 1.2 of the Climate Adaptation Planning Series also contains the recommended actions, organized by master plan chapter.

**Priorities - City of Marquette 2013 Climate Adaptation Plan**

The City of Marquette 2013 Climate Adaptation Plan was developed through a series of public meetings, input from key stakeholders and in alignment with the Lake Superior Watershed Climate Adaptation Plan mentioned above. The primary concerns identified by City of Marquette community members were *water resources, food and agriculture, and land use and development*. The City of Marquette included an appendix on climate change in its 2015 Master Plan. It is available online [here](#). Its climate change recommendations follow the regional goals identified in the [Lake Superior Watershed Climate Adaptation Plan](#). Those goals are:
Priorities in Climate Adaptation Plans 2011-2016

- Protect the Lake Superior shoreline from damage due to fluctuating lake levels, increased storm action, habitat loss and poorly regulated human development.
- Increase the ability of wetlands to withstand climate changes such as flooding, drought and intense storm events through on-the-ground projects and effective watershed management. Protect habitat for cold-water stream fish. Minimize damage from invasive aquatic species.
- Maintain forest ecosystem integrity, overall health and resilience. Protect habitat for specific endangered and vulnerable plant and animal species, and minimize damage from invasive species.
- Promote public education and awareness of the effects of climate change and the benefits of taking action through adaptation and mitigation strategies.
- Assist communities to prepare their infrastructure, built environment, health and human services for predicted climate changes.
- Strengthen the region’s main economic bases, tourism and timber, by helping communities minimize negative climate change impacts on these industries, and take advantage of positive opportunities.

Priorities - 2012 Forest and Water Climate Adaptation: A Plan for Delta County, Michigan

In the 2012 Forest and Water Climate Adaptation: A Plan for Delta County, Michigan, the planning team considered risks to the County’s economy and forest and water resources. They found that:

- “Water was the greatest concern,” as the probability of its impact on the economy from tourism and on a cultural level for fishing will be high and not easily adaptable.
- Forestry risks have already been experienced and are of concern, but the group felt that there is a higher likelihood that we will be able to adapt to them from an economic standpoint.
- Economic risks were also considered, but our ability to adapt was once again ranked high for most of them.”

Six goals were identified to assist Delta County in adapting to climate change:

- Goal 1: Promote public education and awareness of climate change and its possible effects in Delta County.
- Goal 2: Create a group of community leaders who meet regularly to discuss and implement
- Goal 3: Preserve quality of water resources in Delta County.
- Goal 4: Maintain diverse and healthy forests.
- Goal 5: Improve local infrastructure to meet needs of adapting to climate change.
- Goal 6: Keep Delta County economically viable.
Priorities - Menominee County 2015 Climate Adaptation Plan

The Menominee County 2015 Climate Adaptation Plan used an Ecosystems Services Checklist to identify all of the risks that “need to be addressed for Menominee County to adapt and become resilient in the face of climate change”.

From this list of risks, seven goals were identified to adapt and mitigate their impacts:

Goal 1: Integrate climate resilience provisions into planning processes and documents for at least three high priority Menominee County plans. Addressing the lack of planning in major Menominee County documents this goal will help ensure residents have proper zoning, are prepared for possible natural disasters, and have a pathway to follow toward a resilient future.

Goal 2: Provide support for an ongoing timber-based economy while maintaining the health and integrity of forest ecosystems (highest value use of forest resources). Providing support for the timber industry through education, cost share and incentive programs, technical support, as well as access to information and services allows foresters, loggers, and landowners to be less vulnerable to impacts of a changing climate.

Goal 3: Provide support for an ongoing agriculture-based economy with climate resilient farming practices that preserve ecological, social, and economic values. Education, cost share and incentive programs, and access to information and services addresses the agriculture industry’s need to adapt to climate change.

Goal 4: Develop policies and practices that reduce invasive and slow new introductions. Invasive species reduce habitat for native species. Technical assistance, education and outreach, cost share and incentive programs, new policies, and practices are required to slow their spread.

<table>
<thead>
<tr>
<th>Non-Climate Risks</th>
<th>Climate Risks</th>
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<tbody>
<tr>
<td>Non-sustainable forest harvesting</td>
<td>Increased precipitation</td>
</tr>
<tr>
<td>Conversion of forest land to agriculture</td>
<td>Northern species shift</td>
</tr>
<tr>
<td>Natural tree regeneration failure</td>
<td>New pests &amp; disease</td>
</tr>
<tr>
<td>Invasive species</td>
<td>Invasive species</td>
</tr>
<tr>
<td>Cattle in wetlands</td>
<td>Drought</td>
</tr>
<tr>
<td>Proposed mine along river</td>
<td>Seasonal shift</td>
</tr>
<tr>
<td></td>
<td>Severe weather events</td>
</tr>
</tbody>
</table>
Goal 5: **Promote ecological integrity of our native habitat and ecosystems.** A variety of risks affect habitat and ecosystems: flood, drought, invasive species, land conversion, pests and disease. Residents of Menominee County highly value their outdoor recreation as well as the tourism income it generates. Monitoring, planning, proper management techniques and education are key in this goal.

Goal 6: **Research and identify specific adaptation strategies for water cycle impacts with focus on shifting precipitation patterns including wet springs, drought, floods, storms, etc.** The greatest amount of uncertainty in this plan was found in the water assessment. Increased research and partnerships like Great Lakes Integrated Science Assessment and MSU Extension will allow for additional risks to be identified and solutions found.

Goal 7: **Promote and manage implementation of adaptation strategies through collaborative fundraising and project management, including monitoring and outcome reporting.**
Executive Summary
The Marquette County Community Resilience Workshop brought together more than 30 elected officials, managers and planners to discuss and develop proactive strategies for becoming more resilient and effective when dealing with the negative consequences of unusual and extreme weather events. This was a training-style workshop designed to introduce participants to the U.S. Climate Resilience Toolkit (https://toolkit.climate.gov/) created by an interagency task force. Members of the website's national development team, including David Herring (NOAA), Jim Fox (National Environmental Modeling & Analysis Center), Nancy Beller-Sims (NOAA), and Daniel Brown (UMich-GLISA) traveled to Marquette to lead the workshop. The workshop focused on specific adaptation planning and hazard mitigation concerns related to 1) municipal water supply, 2) municipal water infrastructure and 3) Lake Superior shoreline erosion.

The web-based toolkit provides scientific tools, information and expertise to help people understand climate-related risks and opportunities for building resilience to extreme events. The site was designed to serve interested citizens, communities, businesses, resource managers, planners, and policy leaders at all levels of government. The workshop facilitators introduced the Toolkit's five-step process designed to help communities initiate, plan and implement projects to become more resilient. The Toolkit includes several additional resources, including:

- **Taking Action Stories** - Case studies describing climate-related risks and opportunities that communities and businesses face, steps they're taking to plan and respond, and tools and techniques they're using to improve resilience
- **A Catalog of Freely Available Tools** for accessing and analyzing climate data, generating visualizations, exploring climate projections, estimating hazards, and engaging stakeholders in resilience-building efforts
- **Climate Explorer** - A visualization tool that offers maps of climate stressors and impacts as well as interactive graphs showing daily observations and long-term averages from thousands of weather stations
- **Topic Narratives** that explain how climate variability and change can impact particular regions of the country and sectors of society
- **Free, Federally Developed Training Courses** that can build skills for using climate tools and data
- **Maps** highlighting the locations of centers where federal and state agencies can provide regional climate information
- **Advanced Search Engine**. Search the entire federal government's climate science domain and filter results according to your interests
Workshop Results

Workshop participants learned how to use the Climate Resilience Toolkit and the five-step process by identifying local concerns related to extreme weather event hazards and climate change adaptation planning.

Step 1: Identify the Problem. Workshop participants agreed upon three key issues influencing Marquette County’s resilience to a changing climate: 1) the municipal water supply and drought, 2) our municipal water infrastructure, especially during “freeze and thaw” weather events, and 3) shoreline erosion along Lake Superior.

Step 2: Determine Vulnerabilities. For each of the three issues identified, the workshop participants listed numerous vulnerabilities, or potential for harm. Workshop participants used “dots” to vote for the vulnerabilities that they believed were most worrisome.

Table 1. Top Three Assets and Associated Vulnerabilities

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Step 3. Investigate Options. Based on the vulnerabilities that were most threatening, the group brainstormed a list of parameters for solutions – identifying numerous ideas to reduce vulnerability and increase resilience for each of the three issues. Table 2 lists the top ranked options for increased resilience.

Step 4. Evaluate Risks & Costs. The facilitators helped the workshop participants be consistent in comparing the possible options and ultimately prioritize the most feasible solutions. This step included very open, full-group discussions about what the County wants, needs and would be able to implement. On Day 3, workshop participants engaged in a lengthy conversation about Marquette County’s resilience in relationship to the three key assets, their vulnerabilities and options for resilience.
Step 5. Take Action. The workshop participants were trained to use the five-step process and Climate Resilience Toolkit. The “Take Action” step included a small-group skill-building session, where one team member taught the other about the Toolkit website and showed them how to navigate it. They traded roles and then reflected on what works, what doesn't and what might be useful for their day-to-day work. This training “action” wasn’t directly related to the three issues and vulnerabilities, but it provided an opportunity to end the workshop with an action.

Next Steps
CATF is developing a network of “ambassadors” to promote awareness and use of the Climate Resilience Toolkit. This team is developing mini-workshops designed around key climate related questions and challenges that different planners, managers, business leaders and the climate-interested public could attend. Currently members of CATF are writing grants and seeking funding to support these activities, which includes an UP-version of the Toolkit, live demos, webinars and half-day professional development training sessions.

The October workshop was sponsored by Marquette County’s Climate Adaptation Task Force (CATF) with support provided by the County of Marquette, the Superior Watershed Partnership (SWP), Northern Michigan University (NMU), the National Oceanic and Atmospheric Administration (NOAA) and the Great Lakes Integrated Science and Assessment Center (GLISA).

For additional information contact Robert Kulisheck, Chair – Marquette County Climate Adaptation Task Force: rkulishe@nmu.edu or 906-226-2372.
http://superiorwatersheds.org/catf.html

Table 2. Options for Increased Resilience

<table>
<thead>
<tr>
<th>Options for Assets</th>
<th>Ability to Increase Resilience</th>
<th>Economic Feasibility</th>
<th>Low Environmental Impact</th>
<th>Able to Implement in our County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement plan to move road and restore natural features (e.g., green infrastructure) $\leq$ $10$ million</td>
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<td>🟢 🟢 🟢 🟢 🟢</td>
<td>🟢 🟢 🟢 🟢 🟢 🟢 🟢</td>
<td>🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢</td>
</tr>
<tr>
<td>Form a multi-jurisdictional water authority (e.g., address interconnectivity and Lake water vs. pumped water)</td>
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<td>🟢 🟢 🟢 🟢 🟢</td>
<td>🟢 🟢 🟢 🟢 🟢 🟢 🟢</td>
<td>🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢</td>
</tr>
<tr>
<td>Mine water in terms of developing alternative sources of water (e.g., drill more wells, pump from Lake).</td>
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<td>🟢 🟢 🟢 🟢 🟢</td>
<td>🟢 🟢 🟢 🟢 🟢 🟢 🟢</td>
<td>🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢 🟢</td>
</tr>
<tr>
<td>Funding for mapping of the mains (e.g. using GIS)</td>
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<td>🟢 🟢 🟢 🟢 🟢</td>
<td>🟢 🟢 🟢 🟢 🟢 🟢 🟢</td>
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<tr>
<td>Map the mains for improved emergency response (e.g., utility crews responding during freeze events)</td>
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CLIMATE ADAPTATION STRATEGIES
BY
MASTER PLAN CHAPTERS

Provided by Central Upper Peninsula Planning and Development in Cooperation with the Superior Watershed Partnership
PURPOSE – Why create this climate adaptation reference manual?

Master plans serve as guidance documents for land use, economic and other development for Michigan communities. As extreme weather events cause increasing disruptions, how to plan for them is a critical question. For example, the winter of 2013-14 contained the longest continuous cold spell in Michigan Upper Peninsula (UP) history, causing significant damage to water infrastructure and reducing tourism, an important economic engine. Those costs drove increases in water and sewer rates in many communities in the following year and even into 2016, three years later. In 2016, Michigan's Upper Peninsula experienced six tornadoes and record-breaking flooding that damaged major roads, some of which will not be repaired until 2017. Since these threats have multi-year impacts on the region’s economy and environment, the master plan process is a valuable opportunity to address these potential threats to the growth and sustainability of the region.

This reference manual provides a tested set of climate adaptation tools to local decision makers. It combines the climate change adaptation planning work done in the Upper Peninsula since 2011 with relevant best practices from around the country. The tools are organized by the topics commonly found in master plans:

- Economic profile/local economy
- Housing
- Public and community facilities
- Natural features and resources
- Recreation
- Transportation
- Land use and zoning

Reference Manual Chapters – Priorities, Tools and Impacts

The Central Upper Peninsula Planning and Development Regional Commission (CUPPAD) contracted with the Superior Watershed Partnership to create this document in 2016 as part of the Regional Prosperity Initiative, supported by the State of Michigan. The project consisted of:

Chapter 1 - A summary and table showing how priorities in existing climate adaptation plans could be applied to master plans and zoning plans. It answers the question, “What was found to be important for the Central Upper Peninsula in planning for climate change?”

Chapter 2 - Identification of tools and strategies to bring climate adaptation into the revising, adopting and writing of master plans. I'm planning for the future of the Central Upper Peninsula. It answers the question, “How do I easily find concrete ideas to address climate change?”

Chapter 3 - Identification of issues and locations where climate change adaptation are important threats, weaknesses or opportunities in zoning, economic development, recreation, or land use planning and provide table of topics including citations/references where to get more information. It answers the question, “What is known about how climate change will impact the Central Upper Peninsula?”

HOW TO FIND INFORMATION IN EACH CHAPTER

Use the Table of Contents for each chapter to find the topics covered. Within each topic, there are links to specific actions, policies or data to support local decision makers.
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Upper Peninsula’s Economy and Changing Climate

The 2013 Lake Superior Climate Change Adaptation Plan (link above goes to relevant section) includes climate change impacts to timber industry:

- Reduce non-climate stresses on forests, and maintain forest health through invasive plant management, reduced frequency of harvests, etc.
- Require sustainable forest management plans for all commercial logging.
- Create a ban on clear-cutting existing forested areas for building lots and create standards for preparing a forested site for development.
- Maintain or improve forest connectivity.
- Protect forest species diversity by retaining biological legacies during harvest, using intermediate treatments that enhance stand health and diversity, and allowing for appropriate recovery periods between regeneration harvests.
- Include climate change adaptation strategies in long-term and annual forest management plans.
- Preserve urban forest canopies, which filter air pollutants, absorb water to alleviate stormwater pollution, and moderate urban temperatures.

Northern Institute of Applied Climate Science

On the website link above:
“The Northern Institute of Applied Climate Science (NIACS) has been designed as a collaborative effort among the Forest Service, universities, and forest industry to provide information on managing forests for climate change adaptation, enhanced carbon sequestration, and sustainable production of bioenergy and materials.

The global climate is warming and will continue to do so for at least several decades. Although the distribution and extent of future warming is uncertain at a regional scale, it is expected that additional impacts will occur as a result of higher temperatures, changing precipitation patterns, and more frequent storms, droughts, and wildfires. This concept of uncertain but changing climate, with the attendant range of ecosystem responses to changing climate, will need to be incorporated into management, policy, and planning. NIACS is working to help land managers and others respond to these impacts by enhancing the ability of forests to adapt to changing climate conditions, as well as to mitigate increased levels of greenhouse gases that are responsible for climate change:

- Climate Change Response Framework
- Training in Advanced Climate Change Topics
- Climate Change Resource Center
- Forest Management for an Uncertain Climate Future

The NIACS and US Forest Service Northern Research Station have released an updated and expanded edition of Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers. The new edition serves the entire Midwest and Northeast and contains additional resources to support the development of vulnerability assessments as well as adaptation in urban forests.”
**Michigan Dept. of Natural Resources - Northwoods Climate Change Response Framework**

On the website link above: “The DNR has been involved in the Northwoods Climate Change Response Framework since 2010. Executive staff in the DNR have helped shape the course of the Northwoods Framework as part of the Regional Coordinating Group, with other State Foresters and regional organizations. The DNR is working closely with NIACS and other partners on an Ecosystem Vulnerability Assessment and Synthesis for Michigan's forests, contributing information as well as staff expertise.

**Climate Change Vulnerabilities within the Forestry Sector for the Midwestern United States** states that

“A planned, measured approach to climate change adaptation might ultimately depend on having a vibrant forest industry, because it will require considerable management intervention to actively influence the course of ecosystem adaptation and avoid catastrophic, unplanned outcomes. A key point is that climate change adaptation will be best pursued as a proactive, rather than reactive, course of action (Seppälä, Buck, and Katila 2009). Forest managers will need to be prepared to encourage resilience or facilitate ecosystem transitions through management operations, and an agile industry can take advantage of these management opportunities to produce desired goods and services. “

**Implementing Forest and Water Climate Adaptation Solutions to Build the Resilience of Two Northwoods Communities: Menominee County, MI and Red Lake Band of Chippewa in MN**

**Specific Actions**

1. **Reduce non-climate stresses on forests, and maintain forest health through invasive plant management, reduced frequency of harvests, etc.**
   - Co-operative Weed Management Areas of the Upper Peninsula, organized by county, can be found here. This large network has many resources to address this specific challenge.

2. **Require sustainable forest management plans**
   Include climate change adaptation strategies in long-term and annual forest management plans. The Michigan Department of Natural Resources offers three programs to support private landowners in achieving these goals:
   - **Forest Stewardship Program** The purpose of this Program is to encourage long-term stewardship of family forest land by providing professional planning and technical assistance to private landowners. Participation in the program is voluntary, and forest landowners can obtain information and cost-share assistance throughout the year.
   - **Commercial Forest Program** This program provides a significant property tax reduction to private landowners as an incentive to retain and manage their forest land for long-term timber production in support of the state's forest products industry. Landowners pay a specific tax (currently $1.25 per acre) in property taxes in exchange for managing their land as a productive commercial forest. Commercial Forest lands are open to the public for foot access for hunting and fishing.
• **Forest Legacy Program**  The Forest Legacy Program seeks to protect privately owned and environmentally significant forest land from being converted to non-forest uses. It is a strictly voluntary program and involves the acquisition of land in fee ownership or rights in land through a conservation easement. If a conservation easement is acquired, the land remains in private ownership but does provide for public access. The Forest Legacy Program encourages partnerships with local governments and land trusts, recognizing the important contributions that private landowners, local communities, and environmental organizations make to forest conservation efforts.

• **Assistance from Foresters at Conservation Districts.** The Michigan Department of Agriculture and Rural Development (MDARD) awards grants to Conservation Districts (CD) across the state to provide education and one-on-one technical assistance to private land owners and to communities regarding local forest health issues. Professional foresters working out of 20 District offices provide coverage for 49 counties in the upper and lower peninsulas in Michigan.

3. **Create standards for preparing a forested site for development**

• **Better Designs for Development in Michigan: Putting Conservation into Local Land Use Regulation.** This article reviews conservation design principals for development. Approaches such as clustering and open space preservation, through use of Planned Unit Development and Michigan Land Division Act tools are explained.

• **Community Strategies for Vermont’s Forests and Wildlife** includes examples of
  - Purpose Statements for a Forest District
  - Standards for Avoiding Fragmentation of Forest Resources and Productive Forestland through zoning and forestry management.

• **Implementing conservation zoning** provides landowners a menu of options for splitting rural parcels, and may give incentives for permanently reserving large parcels:
  - Country estate option, which allows property to be split into large 25 to 40 acre pieces.
  - “Sliding scale,” lets owners split off a relatively limited number of 1 to 2 acre parcels, keeping the parent parcel large. The original parcel size dictates the number of permitted splits.
  - Conservation subdivision, permits greater parcel density, arranged in a way that keeps most of the property as permanently – dedicated open space that can be reserved as natural area, or as more intensively managed forest or agricultural land.
  - There are many other techniques for reducing forestland fragmentation including very large (greater than 20 acres) minimum parcel sizes, exclusive forestry districts, fixed and sliding scale formulas for limiting development, special use permits for non-forestry uses and combinations of these approaches. Contact [Brad Neumann at MSU Extension Marquette County](mailto:brad.neumann@msu.edu).
4. Preserve urban forest canopies, which filter air pollutants, absorb water to alleviate stormwater pollution, and moderate urban temperatures.

- Michigan Department of Natural Resources Urban & Community Forestry Program. The staff of the Urban & Community Forestry Program advises and assists local units of government (city/village/township/county), community-based organizations, volunteers and individuals in developing and implementing community forestry activities, including:
  - Proper tree selection, planting and maintenance.
  - Community involvement.
  - Tree ordinance development.
  - Public awareness and education.
  - Insect and disease management.
  - Tree inventories and management planning
1.2 Climate Adaptation Strategies by Master Plan Chapters

Table 1: Lake Superior Watershed Climate Adaptation Plan P. 24

<table>
<thead>
<tr>
<th>Sector</th>
<th>Goals</th>
<th>Actions</th>
<th>Time Frame</th>
<th>Action Type</th>
<th>Applies to Region</th>
<th>Applies to County</th>
<th>Applies to Town</th>
</tr>
</thead>
</table>
| Forests | Maintain forest ecosystem integrity, overall health, and resilience. Protect habitat for specific endangered and vulnerable plant and animal species, and minimize damage from invasive species. | • Develop working relationships with state and federal land-use agencies and other interested groups to identify forest adaptation projects to fund/support.  
• Hold meetings with interested timber industry leaders to discuss predicted climate change impacts on infrastructure as it will affect the timber industry.  
• Create comprehensive mapping and inventory of region’s forested land, focusing on location of microhabitats at risk, rare plants, fragmentation, migration corridors, etc.  
• Form a temporary working group among interested stakeholders to create a five-year collaborative plan to address issues of forest fragmentation, deer management, invasive species and pest infestations.  
• Expand existing programs and create new programs to eradicate and restrict spread of invasive species and forest pests. Involve the public in on-the-ground projects.  
• Incorporate climate change considerations in all habitat restoration projects and forest management plans.  
• Require sustainable forest management plans for all commercial logging.  
• Institute a ban on clear-cutting on existing forested areas for building lots and create standards for preparing a forested site for development. | ST | Outreach | ✓ | ✓ | ✓ |
|       |       |         | ST | Outreach | ✓ | ✓ | ✓ |
|       |       |         | ST | Research | ✓ | ✓ | ✓ |
|       |       |         | ST | Policy | ✓ | | |
|       |       |         | ST | Action | ✓ | ✓ | ✓ |
|       |       |         | LT | Policy | ✓ | | |
|       |       |         | LT | Policy | ✓ | ✓ | ✓ |
|       |       |         | LT | Policy | ✓ | | |
Tourism
Impacts and Contacts for Assistance

Upper Peninsula’s Economy and Changing Climate

2013 Lake Superior Climate Change Adaptation Plan (link above) identified the following issues. Resources, contacts and specific actions are provided for each topic.

“Winter recreation and tourism are likely to suffer due to reduced snow cover and shorter winters.”

- Climate Impacts on Winter Tourism Report includes tourism and economic data
  - Actions to address this change
    - National Hockey League Sustainability Initiative
    - Skiing Industry Campaign Protect Our Winters
    - Snowmobiling Economic impact on Vermont snowmobiling

Increasing summer temperatures and a longer summer season

- More warmth and longer warm seasons may increase demand for beaches, but possible increased lake contamination (warmer surface waters amplify the risk of toxic algal blooms) and decreasing lake levels may lead to less desirable shorelines.
  - Excess phosphorus in Green Bay September 16, 2016 news article
  - City of Marquette closed beaches in 2012 due to e. coli bacteria contamina-
  - See Water Resources Section for actions to reduce water pollution.

Many coldwater species of fish important to recreation are likely to decline while populations of warmwater species grow.

- Sturgeon River Watershed Stream Flow Monitoring Project (Dickinson County)
- Ojibwe Lifeways: Fishing includes impacts of climate change on fishing in region
- Specific actions to protect cold water resources
  - Chocolay Township Shoreline District Specialized zoning in coastal areas.
- Natural Shoreline Buffers: A UP community, Curtis, which restored natural shoreline.
- Stormwater Best Management Practices (BMP) recommended for cold water fisheries include:
  - Vegetated filter strips
  - Bio-retention areas and rain gardens
  - Dry and wet swales (swales must be lined if used for pretreatment
  - Infiltration basins
  - Leaching catch basins (if pretreatment is provided and pretreatment
    standards are met)
  - Drainage channels
- Stormwater BMPs that are not recommended for cold water fisheries include:
  - Constructed stormwater wetlands
  - Dry detention basins
  - Wet basins (wet retention ponds)
• Draft/adopt a local wetlands or other bylaw that subject stormwater discharges into coldwater streams to a higher level of scrutiny or mitigation than under state law/regs/guidance. **Examples:**
  o Require greater than 80% Total Suspended Solids removal and/or treatment of more than 1” of runoff
  o Incorporate Best Management Practices for streams into local bylaws

• Work with planning and/or other municipal boards to help adopt zoning and subdivision bylaws implementing smart growth/low impact development (LID) techniques that steer new development and other potentially harmful land use practices away from coldwater stream habitats. **Examples:**
  o zoning overlay districts along coldwater stream corridors
  o open space residential development (“cluster”) bylaws
  o subdivision regulations limiting lot clearing/lawn creation where coldwater streams are present

• **Assert jurisdiction over any activities that may “alter” coldwater stream habitat** and/or harm other sensitive aquatic species, such as:
  o condition the operation of flow control points at the outlet of lakes and ponds, water supply reservoirs, etc. where coldwater species and habitat in the stream reach below the flow control point may be harmed (by lake drawdown/refill)
  o condition the operation of irrigation withdrawals that may deplete streamflow in coldwater streams
### Objectives and Strategies

**Objective 5.1:** Engage economic development organizations and tourism-dependent business in developing an economic development plan specific to tourism with specific goals to help local business minimize economic loss and take advantage of increased tourism opportunities.

<table>
<thead>
<tr>
<th>Strategy: Focus on climate change predictions that will be beneficial for tourism, for example; longer shoulder seasons, more aquatic based recreation and more property rental opportunities.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actions</strong></td>
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<tr>
<td>Meet with community and business leaders to initiate discussion and awareness of shifts in tourism with relation to shifts in climate</td>
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<tr>
<td>Appoint a member to devise a plan based on discussions and concerns</td>
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<tr>
<td>Promote tourism activities that are likely to increase</td>
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</table>

**Objective 5.2:** Invest in optimal harbor improvement/adaptations to maintain access to water resources.

<table>
<thead>
<tr>
<th>Strategy: Promote the importance of water based recreation within the County</th>
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<tr>
<td><strong>Actions</strong></td>
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<tr>
<td>Prioritize high use water recreation</td>
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</tbody>
</table>
Strategy: Promote the importance of water based recreation within the County

<table>
<thead>
<tr>
<th>Actions</th>
<th>Timing (S,M,L)</th>
<th>Resources Needed</th>
<th>Responsible Parties</th>
<th>Deliverable</th>
<th>Success Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>areas in need of repairs</td>
<td></td>
<td>ramps, dams, etc.</td>
<td>MDNR</td>
<td>areas in need of repairs/improvements</td>
<td>for water enthusiasts</td>
</tr>
<tr>
<td>Secure funding for future repairs or improvements of water resources</td>
<td>M-L</td>
<td>Funding</td>
<td>MDNR</td>
<td>Money set aside specifically to address water based resources</td>
<td>Same as the deliverable</td>
</tr>
<tr>
<td>Initiate a state wide campaign to promote tourists to consider</td>
<td>M</td>
<td>Funding Marketing team</td>
<td>Michigan tourism council County of Marquette</td>
<td>Marketing techniques (video, photo, radio) promoting the recreational opportunities</td>
<td>Increased water based tourism within the County</td>
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<tr>
<td>Marquette County as a destination due to its water based recreation</td>
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<tr>
<td>opportunities</td>
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</table>

Objective 5.3: Strengthen connectivity between coastal and non-coastal recreational areas to improve resiliency of tourism.

Strategy: Gather county recreation organizations to initiate the objective

<table>
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<tr>
<th>Actions</th>
<th>Timing (S,M,L)</th>
<th>Resources Needed</th>
<th>Responsible Parties</th>
<th>Deliverable</th>
<th>Success Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiate a cost reduction program for customers who utilize different recreational areas</td>
<td>M</td>
<td></td>
<td>Recreational organizations</td>
<td>Coupons/monetary reduction in different recreational uses</td>
<td>More diverse recreational areas throughout the County</td>
</tr>
</tbody>
</table>
**Agriculture/Commercial Fishing**

**Impacts identified in the 2013 Lake Superior Climate Adaptation Plan**

- Earlier warm spells, coupled with variability in spring freezes, may result in more freeze damage early in the growing season.
- A longer growing season will positively impact some crop yields through mid-century.
- By the end of the century, more frequent and intense severe weather, more flooding and drought risks, as well as more pests and pathogens will likely reduce crop yields.
- Water availability and quality will likely pose challenges for agriculture.

**Specific Actions**

- Best practices education and stewardship through the Michigan Agriculture Environmental Assurance Program.
  - The Farmstead System applies to all farms and addresses environmental risks of the entire farmstead, from water wells and septic system management, safe handling of fuels to the proper storage of fertilizers and pesticides.
  - The Cropping System focuses on field-related environmental issues, such as irrigation and water use, soil and water conservation practices, and nutrient and pest management.
  - The Livestock System focuses on environmental issues related to livestock activities, including manure handling, storage and field application, as well as conservation practices to protect water and prevent soil erosion. Mortality and odor management and emergency management are also included.
  - The Forest, Wetlands & Habitat System includes sustainable forestry, compliance with laws, protecting special sites, reforestation and afforestation, air, water and soil protection, habitat restoration and development, forest aesthetics and forest product harvesting and other management activities.

- Animal Agriculture in Michigan and Climate Change. MSU Extension fact sheet explains the effects of climate change to animal agriculture to allow farmers to adjust management practices and implement technologies to maintain profitability.

- Climate Change and Agriculture webinar: Changes in precipitation patterns, temperature, and extreme events have direct and indirect effects on Michigan’s field crops. Learn how Michigan farmers are experiencing these changes and actions they are taking in response.

- Support local food initiatives through existing initiatives and state purchasing efforts.

  **UP Food Exchange** The U.P. Food Exchange (UPFE) is a Food Hub being led by the Marquette Food Co-op and MSU Extension in conjunction with the Western UP Health Department. UPFE serves as a resource portal for farmers, businesses, and individuals looking to connect with and actively participate in their local food system.

- Develop a food security plan and increase local food production by working with farmers, protecting soils, and encouraging farmer’s markets and food co-ops.
A strong local food system offers multiple benefits to Marquette County including, but not limited to, an improved local economy, health, access to fresh food, and food security. A necessary step in strengthening our local food system is to evaluate policies and regulations to ensure that they are “local food friendly”.

- **Marquette County Food Plan.** (September 2013) A strong local food system offers multiple benefits to Marquette County including, but not limited to, an improved local economy, health, access to fresh food, and food security. A necessary step in strengthening our local food system is to evaluate policies and regulations to ensure that they are “local food friendly”.

- **Community Food Systems Guide** - A guide to engaging in with the local food system and local units of government

- Decision making tool - [Climate Change Implications for Lake Whitefish](#)
  Currently, the Great Lakes lake whitefish fishery is the most economically valuable commercial fishery in the upper Great Lakes. The decision-support tool will help ensure that the fish, the fishery and the livelihoods dependent upon them remain sustainable in the face of climate change.

- Identify and protect prime agricultural soils through ordinance, conservation measures, or other protections. MSU [North Farm Research and Extension Center](#).

- More severe storms may have a negative economic impact due to resulting damages and increased costs of preparation, clean up, and business disruption.
  - Michigan Department of Agriculture and Rural Development [Emergency Management for Farms](#).
### 1.2 Climate Adaptation Strategies by Master Plan Chapters

#### Table 2: Lake Superior Climate Adaptation Plan P. 28

<table>
<thead>
<tr>
<th>Sector</th>
<th>Goals</th>
<th>Actions</th>
<th>Time Frame</th>
<th>Action Type</th>
<th>Applies to…</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Economy</strong></td>
<td>• Hold meetings with local business leaders to initiate discussion and awareness of specific climate change concerns in each sector.</td>
<td>ST</td>
<td>Outreach</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td><strong>Strengthen the region’s main economic bases, tourism and timber, by</strong></td>
<td>• Track economic trends for the region for a specific time period to gather important economic data that currently does not exist.</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td><strong>helping communities minimize negative climate change impacts on</strong></td>
<td>• Identify vulnerable breeding grounds for cold-water fish such as brook trout. Obtain funding for and conduct habitat improvement activities where appropriate.</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td><strong>these industries, and take advantage of positive opportunities.</strong></td>
<td>• Secure funding for and conduct feasibility studies on using locally and sustainably produced forest byproducts, creating new products and technology, and other methods to promote the local timber industry.</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
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<tr>
<td></td>
<td></td>
<td>• Research potential for bringing new investors in green technology, manufacturing, alternative energy or eco-friendly retail businesses into the region.</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
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<tr>
<td></td>
<td></td>
<td>• Based on community discussion, develop a five-year plan and specific goals to help local businesses minimize economic losses and take advantage of increased tourism opportunities.</td>
<td>LT</td>
<td>Policy</td>
<td>✓</td>
</tr>
</tbody>
</table>

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<th>REGION</th>
<th>COUNTY</th>
<th>TOWNS</th>
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<td>✓</td>
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<td>✓</td>
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<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>
HOUSING

Impacts
From the White House Advancing Resilience through Building Codes and Standards

“Building codes set the baseline for the safe design and construction of our homes, schools, and workplaces, providing the minimum requirements to adequately safeguard the health, safety and welfare of building occupants. Building codes and standards also influence the design of buildings and their ability to withstand natural disasters and the impacts of climate change— including hotter temperatures, more extreme weather, flood, and drought.

How can we ensure that buildings will perform under the impacts of climate change such as rising sea levels, extreme heat conditions, and more intense storms? Compounding this challenge, infrastructure in many cities has exceeded its design life, increasing our vulnerability. What has guided design choices in the past—average temperatures, return intervals of certain heavy precipitation events, and stationary sea levels—can no longer safely guide us in our building choices.

By incorporating resilience and the impacts of climate change into the building code and standards development process, we can help ensure that our homes, schools, and workplaces can better withstand climate impacts and position our communities to recover more quickly when disasters happen. As the Hurricane Sandy Rebuilding Strategy stated “Using disaster-resistant local building codes is the most effective method to ensure new and rebuilt structures are designed and constructed to a more resilient standard.”

Specific Actions
Michigan building codes are set at the state level and compliance enforced at the local level. Local officials can be aware of Green Building Council LEED standards as suggested higher objectives for buildings. LEED, or Leadership in Energy and Environmental Design, is the most widely used third-party verification for green buildings, with around 1.85 million square feet being certified daily.

The LEED standards now include climate resilience, as outlined in this post on the Resilient Design website.

LEED ND Neighborhood Development Guide applies to new land development projects or redevelopment projects containing residential uses, non-residential uses, or a mix. Projects can be at any stage of the development process, from conceptual planning to construction.
### 1.2 Climate Adaptation Applied to Master Plans and Zoning Plans

#### Table 3: Lake Superior Watershed Climate Adaptation Plan P. 25

<table>
<thead>
<tr>
<th>Sector</th>
<th>Goals</th>
<th>Actions</th>
<th>Time Frame</th>
<th>Action Type</th>
<th>Apply to Region</th>
<th>Apply to Counties</th>
<th>Apply to Towns</th>
</tr>
</thead>
</table>
| Built Environment | Assist communities to prepare their infrastructure, built environment, health and human services for predicted climate changes. | - Identify and prioritize communities in the region that would be in most need of assistance.  
- Inventory areas of infrastructure (roads, bridges, culverts, etc.) vulnerable to climate change impacts. See case study on how Vermont rebuilt culverts after Hurricane Irene.  
- Research roadway materials that are more tolerant to quick changes in hot or cold weather in order to decrease repair costs, enhance safety, and increase longevity of road surfaces.  
- Study design standards for buildings that currently handle weather conditions similar to those forecast for the Lake Superior Watershed (to help develop future building codes).  
- Identify low-risk areas that would allow for the safe burial of existing power lines to avoid power interruption from extreme weather events.  
- Continue to expand regional energy-efficiency programs for both residential and commercial buildings.  
- Adopt building design standards that better reflect future climate conditions.  
- Promote pitched roofs and incorporate design standards that consider snow stacking and ice falling zones.  
- Incorporate building materials that improve the longevity of construction into building code requirements.  
- Revise design standards for hydraulic structures like culverts and drainage systems.  
- Improve existing energy conservation standards by a minimum of 25% through implementation of appropriate codes for commercial and residential development. | ST          | Research       | ✓              | ✓                | ✓                |
|                |                                                                       |                                                                                                                                                                                                                                                                                                                                     | ST          | Research       | ✓              | ✓                | ✓                |
|                |                                                                       |                                                                                                                                                                                                                                                                                                                                     | ST          | Research       | ✓              | ✓                | ✓                |
|                |                                                                       |                                                                                                                                                                                                                                                                                                                                     | ST          | Research       | ✓              | ✓                | ✓                |
|                |                                                                       |                                                                                                                                                                                                                                                                                                                                     | ST          | Action         | ✓              | ✓                | ✓                |
|                |                                                                       |                                                                                                                                                                                                                                                                                                                                     | LT          | Policy         | ✓              | ✓                | ✓                |
|                |                                                                       |                                                                                                                                                                                                                                                                                                                                     | LT          | Policy         | ✓              | ✓                | ✓                |
|                |                                                                       |                                                                                                                                                                                                                                                                                                                                     | LT          | Policy         | ✓              | ✓                | ✓                |
|                |                                                                       |                                                                                                                                                                                                                                                                                                                                     | LT          | Policy         | ✓              | ✓                | ✓                |
The American Council for an Energy-Efficient Economy prepared a two-page Fact Sheet. It explains:

“Local policies related to energy efficiency—those implemented at the scale of a municipality, county, or metropolitan region—can improve community self-reliance, save consumers and citizens money, create local “main street” jobs, catalyze local economic investment, and help protect the environment. The responsibilities of local governments give them large influence over energy use in their communities through land use and zoning, building requirements, property taxes and transfers, transportation investment decisions, economic and workforce development, and, in many cases, the provision of utility services such as water, natural gas, and electricity. Additionally, local governments can lead by example by improving the energy efficiency of their own facilities and operations.”

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<thead>
<tr>
<th>Policy or Strategy Type</th>
<th>Economic Sector</th>
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<tbody>
<tr>
<td></td>
<td>Buildings</td>
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<tr>
<td>Public Investments &amp; Government Operations “Leading by Example”</td>
<td>Government operations &amp; procurement</td>
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<td>Public investments &amp; Infrastructure</td>
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<td>Public Investments &amp; Government Operations “Leading by Example”</td>
<td>Public Investments &amp; Infrastructure</td>
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<td>Regulation &amp; Revenue</td>
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<td>Incentives</td>
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The ACEEE Local Technical Assistance Toolkit includes:
- Local Energy Planning
- Local Government Lead by Example
- Local Government-Utility Partnership Strategies
- Community Resilience Planning
- Local Energy Efficiency Policy Calculator (LEEP-C)
Brownfields

The US Environmental Protection Agency Brownfield program now includes climate change resilience in its grant making criteria. See How to Address Changing Climate Concerns in an Analysis of Brownfield Cleanup Alternatives (ABCA) which states:

“To ensure that cleanups remain effective as the climate changes, EPA has added a new term and condition starting in the FY13 Cleanup and Revolving Loan Fund (RLF) grants that requires recipients to “evaluate the resilience of the remedial options in light of reasonably foreseeable changing climate conditions (e.g., sea level rise, increased frequency and intensity of flooding and/or extreme weather events, etc.).”

An Analysis of Brownfield Cleanup Alternatives (ABCA) typically includes sections describing the background and current conditions of the site (maps, previous uses, assessment findings, reuse goals), applicable regulations and cleanup standards, an evaluation of cleanup alternatives and a recommended remedial action. The evaluation of cleanup alternatives is based on the effectiveness, ease of implementation and cost of each remedial action.

As directed under EPA’s Climate Change Adaptation Plan, the ABCA must also include a discussion of observed and forecasted climate change conditions for the area of the project and the associated site-specific risk factors. Examples of changing climate conditions include, but are not limited to:

- Increased/decreased temperatures
- Increased/decreased precipitation
- Extreme weather events (e.g., storms of unusual intensity, increased frequency and intensity of localized flooding events)
- Increased risk of wildfires
- Changing dates for ground thaw/freezing
- Rising sea level
- Changing flood zones
- Changing environmental/ecological zones
- Increased salt water intrusion
- Higher/lower groundwater tables

Note: EPA does not expect grant recipients to generate new site-specific climate change measurements to complete this analysis. Through the ABCA, grant recipients must demonstrate they have reviewed available current and authoritative information for the cleanup analysis. The level of analysis expected depends on the complexity of the project and the degree of risk involved given the feasible remedial options and targeted reuse of the site.”
Energy Efficiency for Michigan K-12 Schools

From 2009-2011, the Michigan Renewable Schools Program provided comprehensive energy efficiency assistance to selected Michigan K-12 schools. Sixty-seven school facilities participated in the initial pilot and currently save over $400,000 annually as a result of the program.

The Ecology Center in partnership with the Michigan School Business Officials and Michigan Saves, funded through the C.S. Mott Foundation, is pleased to announce that this program is recommencing and new resources are being allocated for K-12 school energy efficiency projects. The program provides the experience and resources to support K-12 facility efforts to save money, reduce operating expenses, and improve classroom environments. For more information, contact: Jason Bing, RA LEED AP.

Design/Location of Community Facilities

The Climate Resilience Toolkit: Built Environment section identified:

- The impacts of extreme weather, climate, and other hazardous events are felt particularly acutely in cities and towns.
- Ensuring the resilience of built environment systems takes collaboration among all interested stakeholders before, during, and after extreme events and disasters.
- Stressors such as economic inequality and environmental degradation, coupled with deteriorating public infrastructure, can make some communities more vulnerable to extreme weather and climate change than others.
- Building resilience by investing in physical adaptation efforts and/or utilizing nature-based solutions can provide co-benefits for a range of challenges, including climate mitigation.

When decision makers integrate strategies that improve the resilience of physical, social, and natural systems, they may find effective ways to reduce systematic vulnerabilities in the built environment. Relevant themes in the 2014 Third National Climate Assessment include:

- **Infrastructure System Security**: Essential infrastructure systems—such as water, energy supply, and transportation—will be increasingly compromised by interrelated climate change impacts. The nation's economy, security, and culture all depend on the resilience of urban infrastructure systems.
- **Interrelated Infrastructure Systems**: In urban settings, climate-related disruptions of services in one infrastructure system will almost always result in disruptions in one or more other infrastructure systems.
- **Social Vulnerability**: Climate vulnerability and the adaptive capacity of urban residents and communities are influenced by pronounced social and economic inequalities that reflect age, ethnicity, gender, income, health, and (dis)ability differences.
- **Planning Now for Tomorrow**: Local, state, and federal agencies and organizations are at a crucial early stage in developing resilience and adaptation planning. To be successful, these planning efforts require cooperative action by and between the public and private sectors.
These themes can guide the efforts of regional stakeholders as they collaborate to understand their vulnerabilities and identify their risks; define their social, economic, and environmental capacities; and integrate various forms of resilience. Working across physical, natural, and social considerations of the built environment, stakeholders can holistically address a variety of risks and identify an equal variety of benefits.

**Specific Actions**

*Smart growth strategies could help communities adapt to climate change,* as well as natural disasters, economic changes like volatile energy prices, and other challenges that could arise regardless of climate change. The link goes to the US Environmental Protection Agency website that has the following strategies to consider:

- **Determine which areas are both well-connected to existing development and less vulnerable to current and projected climate change impacts** such as wildfires, sea level rise and higher storm surges, and riverine flooding, and encourage growth in these areas.

- **Discourage building in areas that are currently or are projected to be more vulnerable to climate change-related impacts.** Making it easier to build in safer areas can help relieve pressure to develop in more vulnerable areas.

- **Preserve large, contiguous areas of open space to better protect ecosystems that might be under pressure from the changing climate.** Open space preserved along water bodies can also absorb flood waters and reduce flooding in developed areas.

- **Coordinate land use and transportation infrastructure decisions, and incorporate climate change projections into these decisions.** For example, the Langston-Brown School and Community Center in Arlington, Virginia, is an energy-efficient building that includes passive survivability techniques, such as operable windows and passive shading to keep the structure cool if the power goes out. It also has two cisterns that collect rainwater from the roof to reuse for nonpotable uses.

- **Encourage water- and energy-efficient buildings and land use patterns** so that communities can continue to thrive if energy prices rise. This strategy can also help communities better cope with drought and extreme heat.

- **Upgrade stormwater systems to better manage heavier storm flows, and consider using green infrastructure** to reduce the amount of runoff from paved surfaces.

- **Encourage green roofs, parks, street trees, and other elements that can reduce ambient air temperatures and filter pollutants from stormwater runoff and the air.**

- **Design buildings with adaptation and resilience in mind.** For example:
  - Modular buildings can more easily be moved, renovated, and deconstructed as a community or tenant’s needs change and as climate-related impacts change. Strategies include using exposed mechanical fasteners, disentangling utilities from the structure, using moveable walls and ramps, using standard-sized modular building components and assemblies, and providing easy-to-understand information on construction drawings and documents.
Buildings designed for passive survivability – meaning they remain habitable if they lose external power for an extended period – can help ensure that even if the power goes out, the building will stay at a safe temperature. Because passive survivability techniques such as better insulation and operable windows often save energy as well, they can also save occupants money on energy bills.

**Water Sector**

*Rural Water Quality Protection: A Planning & Zoning Guidebook for Local Officials.* (December 2012). This manual specifically addresses rural water quality, with concrete tasks for local officials.

- The Guidebook is 116 pages in length and divided into four chapters *(Introduction, Understanding Watersheds, the Umbrella of Protection for the Watershed, and Best Management Practices in Rural Areas)* and features two appendices *(Appendix A: Master Plan and Zoning Ordinance Sample Language, and Appendix B: Local Planning and Zoning Assessment Tool)*. Chapter 4 and Appendix A comprise the bulk of this Guidebook, and are organized to include a description of each major low impact development category, along with a description of the category, a list of best management practices addressed within the category, and “Good,” “Better,” and “Best tables for that category.

**Urban Tree Canopy**

The Marquette County Climate Adaptation Plan Goal #4 is to maintain forest ecosystem integrity, overall health, and resilience. Objective 4.2 relates to urban trees: Adopt a *County-wide urban canopy goal of a minimum of 40% and implement a program that monitors documented resiliency values* delivered by a diverse, healthy urban tree canopy such as heat island effect and air quality.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Timing (S,M,L)</th>
<th>Resources Needed</th>
<th>Responsible Parties</th>
<th>Deliverable</th>
<th>Success Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop effective language for inclusion into master plan addressing urban tree canopy goals</td>
<td>M</td>
<td>Model climate resiliency plan from other communities that include urban forestry City/County urban tree canopy details</td>
<td>SWP Staff County Forester City/County planners</td>
<td>Draft master plan language</td>
<td>Inclusion into master plan</td>
</tr>
</tbody>
</table>

The City of Burlington, Vermont has 3-page case study/report on urban tree canopy in small, northern community.
LAND USE AND ZONING

In 2012, the Great Lakes Integrated Science Assessment Center found that "Increased risk of droughts, severe storms, and flooding events may increase erosion, sewage overflow, lead to more interference with transportation, and other damage. Future changes in land use could add to a far greater impact on water quality than climate change alone. The coupling of climate change and land use change could therefore result in even stronger effects in some areas."

Case Study and Contacts for Assistance
https://toolkit.climate.gov/case-studies/using-demonstration-storms-prepare-extreme-rainfall

GOAL: Prepare for flooding from more intense rain storms (it will be more likely to have 1” per hour or higher rain storms) in order to lower damages.

TARGET: Identify regions that would flood during high intensity storms using risk and vulnerability rankings

ACTION: Work with National Weather Service, MDOT, universities, emergency management to collect data and run modeling tools to identify where and how long flood levels would be when infrastructure is overwhelmed by a large amount of water in a short time.

INDICATOR: INCREASED FLOOD RISK
Flooding is impacted by land use patterns and building material choices. To understand if and how flooding will impact a building, road, community, need to know what risk is upstream and rain fall probabilities.

Land Use: Green infrastructure allows water to be held back for gradual release into ground or slowed to reduce erosion and damage. DEQ holds annual Green Infrastructure conferences to share best practices. See past proceedings/presentations here and here.

Buildings: Use materials that are durable, water-resistant, less susceptible to water intrusion, and relatively inexpensive and easy to replace. More here.

Recovery: Resilience is not just about preventing harm. Planning will need to be done for the inevitable cleanup and to ensure business, government and social continuity.
Specific Planning Actions - 2013 Lake Superior Climate Adaptation Plan

- Establish a comprehensive planning and zoning policy, considering projected water level changes and flooding impacts:
  - Establish and enforce shoreline setback requirements
  - Place limits on density and infrastructure in coastal and transitional zones
  - Site and design all future public works projects with these projections in mind

- Adopt smart growth principles in the community’s comprehensive master plan.
  - Revise conservation subdivision regulations to create incentives for developers to provide greater densities and community services, while achieving open space conservation/recreation in areas that might be flooded.

- Establish policies that set new infrastructure further back from water bodies and retain naturally vegetated buffers to protect the infrastructure from the predicted higher frequency and magnitude of flooding and lake level fluctuations.

- Establish new street grade and building first floor elevation requirements and infrastructure elevation that exceed current town, state and FEMA standards.
  - Local governments enact floodplain regulations in conformance with the National Flood Insurance Program (NFIP) requirements and maps.
  - Communities that choose to can also participate in the NFIP’s Community Rating System (CRS), which is designed to encourage local governments to enact floodplain standards above the NFIP’s minimums. Communities that participate can earn insurance discounts for their property owners. The CRS includes some elements that could be implemented using building codes.

- Increase building “free board” (the height of the watertight portion of a building or other construction) above base flood elevation.

- Protect land from development to preserve vegetation, retain hydrologic features, and ecological services through:
  - Land acquisition through purchase
  - Conservation easements
  - Purchasing development rights

- Establishing overlay zones, which apply additional regulations to development within the zone, such as setbacks, lot sizes and impervious surface.
  - Promote wetland protection through:
    - Evaluating existing wetland restoration policies and programs
    - Targeted wetland restoration
    - Dam removal or management

- Adopt net-zero runoff site plan requirements.

- Provide technical assistance and incentives for habitat management to landowners.

- Remove structures that harden coastlines, impede natural regeneration of sediments, and prevent natural inland migration of sand and vegetation.
Marquette County Climate Adaptation Plan Goal #1: Assist communities to create water resource resiliency with infrastructure and built environment.

Objective 1.1: Revise conservation subdivision regulations to create incentives for developers to provide greater densities and community services, while achieving open space conservation.

Strategy: Partner with the City and County of Marquette, St Lawrence Cities Initiative, and other interested regional planning entities to research subdivision regulations and coordinate updates.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Timing (S,M,L)</th>
<th>Resources Needed</th>
<th>Responsible Parties</th>
<th>Deliverable</th>
<th>Success Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyze governance tables for opportunities to update subdivision regulations</td>
<td>S</td>
<td>Staff Time</td>
<td>Superior Watershed Partnership</td>
<td>Timetable for subdivision modifications</td>
<td>A calendar of when communities will have updates to their zoning policy and regulations</td>
</tr>
<tr>
<td>Identify model subdivision regulations to recommend to communities</td>
<td>S</td>
<td>Staff time</td>
<td>Superior Watershed Partnership</td>
<td>Compiled portfolio of model plans/codes</td>
<td>A reference document including highlighted plans in action that work</td>
</tr>
<tr>
<td>Integration into county plan update</td>
<td>S-M</td>
<td>Cooperation from County</td>
<td>Dave Stensaas (City of Marquette Planner)</td>
<td>Updated plan with updated subdivision regulations</td>
<td>New county master plan.</td>
</tr>
<tr>
<td>Integrations into municipal regulation updates</td>
<td>S-M</td>
<td>Cooperation from cities</td>
<td>Dave Stensaas (City of Marquette Planner)</td>
<td>Revised subdivision regulations</td>
<td>New subdivision regulations</td>
</tr>
</tbody>
</table>
Objective 1.2: Protect critical watershed features with enhanced land use including planning, zoning, acquisitions and easements especially river corridors and floodplains to preserve vegetation, retain hydraulic features, and ecological services

<table>
<thead>
<tr>
<th>Actions</th>
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<th>Resources Needed</th>
<th>Responsible Parties</th>
<th>Deliverable</th>
<th>Success Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational session about plan with county planning commission</td>
<td>S</td>
<td>Presentation, Literature/handouts on the topic</td>
<td>SWP Staff</td>
<td>Presentation and Recommendations</td>
<td>Favorable Response, Request for more Information</td>
</tr>
<tr>
<td>Determine calendar for planning and zoning updates</td>
<td>S</td>
<td>Maps of the area, A clear outline of The revision process</td>
<td>SWP Staff, County Commission</td>
<td>Calendar</td>
<td>Agreement for goal date to start</td>
</tr>
<tr>
<td>Model zoning language and examples for the region</td>
<td>S-M</td>
<td>GIS layers/data for riparian delineation County/City of Marquette land development code</td>
<td>SWP Staff, County/City planner</td>
<td>SWP’s model riparian buffer ordinance</td>
<td>Integration of SWP’s model riparian buffer ordinance into county/city zoning documents</td>
</tr>
<tr>
<td>Determine available riparian lands for fee simple purchase and/or purchase of development rights</td>
<td>L</td>
<td>County land ownership GIS Layers, Land cover/use GIS layers</td>
<td>SWP Staff, County/City planner</td>
<td>Prioritized list of available lands within the County</td>
<td>Acquire land or development rights for riparian zones</td>
</tr>
</tbody>
</table>
Objective 1.3: Promote green storm water management.

**Strategy:** Incentivize residential private property storm water management.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Timing (S,M,L)</th>
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<th>Responsible Parties</th>
<th>Deliverable</th>
<th>Success Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educate community about personal property storm water management strategies/incentives</td>
<td>S</td>
<td>Advertisements, Brochures, other marketing resources regarding storm water treatment</td>
<td>SWP Staff</td>
<td>Presentation and Recommendations</td>
<td>Interested property owners</td>
</tr>
<tr>
<td>Develop a tiered storm water rate structure based on a property’s amount of impervious surface</td>
<td>M-L</td>
<td>A model storm water rate system (ie Ann Arbor, MI)</td>
<td>SWP Staff, City/County Planners</td>
<td>A document outlining the tiered rate structure</td>
<td>Passage of the rate structure through the city/county commission</td>
</tr>
<tr>
<td>Quantify and map city and county impervious surface in contrast to pervious surface</td>
<td>M</td>
<td>CIR imagery for the County Land owner layers</td>
<td>City Planners</td>
<td>Map showing county wide pervious and impervious lands</td>
<td>Integration of maps/data into current planning documents</td>
</tr>
<tr>
<td>Develop a storm water management code for all new development with impervious areas greater than 200 feet</td>
<td>L</td>
<td>Working model codes from other communities (ie Ann Arbor)</td>
<td>SWP Staff, City/County Planners</td>
<td>A document showing standards and codes for new development</td>
<td>Increase in pervious land throughout the County</td>
</tr>
</tbody>
</table>
Objective 1.4: Adopt shoreline adaptation measures for habitat and infrastructure protection.

**Strategy:** Develop policy and recommendations to further protect and enhance existing shoreline.

<table>
<thead>
<tr>
<th>Actions</th>
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<th>Resources Needed</th>
<th>Responsible Parties</th>
<th>Deliverable</th>
<th>Success Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID and map critical habitat for entire Marquette County</td>
<td>S-M</td>
<td>GIS Layers/Data Historical Maps</td>
<td>SWP Staff City/County Planners</td>
<td>Mapped areas with critically impaired habitat</td>
<td>Map in hand</td>
</tr>
<tr>
<td>Establish shoreline protection zone for new development (including set back requirements)</td>
<td>M-L</td>
<td>Model shoreline protection ordinance</td>
<td>SWP Staff</td>
<td>Fully executable shoreline protection plan for Marquette County</td>
<td>Adoption of plan by county commission</td>
</tr>
<tr>
<td>Restore impaired dune complex along shoreline</td>
<td>S</td>
<td>Funding Volunteers Prioritized list of critical areas in need of restoration</td>
<td>SWP Staff</td>
<td>Map of protected areas</td>
<td>Protected shoreline</td>
</tr>
</tbody>
</table>
### 1.2 Climate Adaptation Applied to Master Plans and Zoning Plans

**GOAL:** Assist communities to prepare their infrastructure, built environment, health and human services for predicted climate changes. *ST = short term, LT = long term*

Table 4: Lake Superior Climate Adaptation Plan Page 25

<table>
<thead>
<tr>
<th>Actions</th>
<th>Time Frame</th>
<th>Action Type</th>
<th>Applies to Region</th>
<th>Applies to Counties</th>
<th>Applies to Towns</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Identify and prioritize communities in the region that would be in most need of assistance.</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Inventory areas of infrastructure (roads, bridges, culverts, etc.) vulnerable to climate change impacts.</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Research roadway materials that are more tolerant to quick changes in hot or cold weather in order to decrease repair costs, enhance safety, and increase longevity of road surfaces.</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Study design standards for buildings that currently handle weather conditions similar to those forecast for the Lake Superior Watershed (to help develop future building codes).</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Identify low-risk areas that would allow for the safe burial of existing power lines to avoid power interruption from extreme weather events.</td>
<td>ST</td>
<td>Research</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Continue to expand regional energy-efficiency programs for both residential and commercial buildings.</td>
<td>ST</td>
<td>Action</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- “Lead by example” in government buildings by demonstrating how to reduce building energy demand to reduce peak electricity loads during extreme temperatures. This can be done through passive design, new building materials, improved insulation, etc.</td>
<td>ST</td>
<td>Action</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
1.2 Climate Adaptation Applied to Master Plans and Zoning Plans

<table>
<thead>
<tr>
<th>Actions</th>
<th>Time Frame</th>
<th>Action Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourage development green infrastructure such as green roofs, rain barrels, rain gardens, permeable paving, swales, and water retention ponds.</td>
<td>ST</td>
<td>Action</td>
</tr>
<tr>
<td>Promote green stormwater management, such as through a utility fee rate structure where rates are determined by the amount of impervious area on a property (e.g., Ann Arbor, MI).</td>
<td>LT</td>
<td>Policy</td>
</tr>
<tr>
<td>Adopt building design standards that better reflect future climate conditions.</td>
<td>LT</td>
<td>Policy</td>
</tr>
<tr>
<td>Promote pitched roofs and incorporate design standards that consider snow stacking and ice falling zones.</td>
<td>LT</td>
<td>Policy</td>
</tr>
<tr>
<td>Incorporate building materials that improve the longevity of construction into building code requirements.</td>
<td>LT</td>
<td>Policy</td>
</tr>
<tr>
<td>Revise design standards for hydraulic structures like culverts and drainage systems.</td>
<td>LT</td>
<td>Policy</td>
</tr>
<tr>
<td>Improve existing energy conservation standards by a minimum of 25% through implementation of appropriate codes for commercial and residential development.</td>
<td>LT</td>
<td>Policy</td>
</tr>
<tr>
<td>Utilize more climate-friendly roadway materials in infrastructure projects.</td>
<td>LT</td>
<td>Action</td>
</tr>
</tbody>
</table>
**NATURAL FEATURES AND RESOURCES**

**Wildfire**
- 2015 Marquette County Wildfire Protection Plan
- **2011 Eastern Delta County Wildfire Protection Plan.** Includes Bay De Noc, Ensign, Masonville, Nahma, & Garden Townships. It is cited in the 2015 Delta County Hazard Management Plan.
- **State Line Community Wildfire Protection Plan** (Ottawa National Forest)
- **Whitefish Township (Chippewa County).** Explains how planning was done in rural community: “This plan is organized to function as a handbook to guide the community through the steps taken during the planning process. It is intended to provide a framework for understanding the context of the decisions that were made in the community's wildfire protection plan. Each section builds upon the prior sections and content grows progressively complex. It is intended to follow a logical flow and provide understanding for the decision making process.”

**Great Lakes’ Issues**
From the [Great Lakes Coastal Resilience Planning Guide](http://example.com):

**Impacts**
- Lake temperatures have been increasing faster than surrounding air temperatures
- Warmer temperatures and higher evaporation rates may be partially responsible for declining lake levels.
- While most models show long-term declines in lake levels, in the near future, variations will remain large, with periods of high lake levels.

**Resources and Specific Actions**
- The Great Lakes Environmental Research Laboratory's Great Lakes Water Level Dashboard provides a way to visualize and examine historic lake levels and future projection comparisons at a variety of user-designated time scales. Options are available for customizing output graphs in addition to time scale.
- The Nature Conservancy's Climate Wizard allows users to explore future climate scenarios (change in temperature and precipitation under different future carbon emissions) for specific regions. This information can be used to inform a community's planning goals, resource management, and investment decisions.
- The Association of State Floodplain Managers Great Lakes Coastal Resilience Planning Guide provides resources for mapping, analyzing, reporting, and visualizing specific coastal hazards. State and local officials engaged in coastal management, planning, and development can examine how trends in short-and long-term climate conditions affect hazards and their impacts on land, water, and resources and explore how different management types respond to changing conditions.
**Inland Lakes**

*Impacts*
- Lake temperatures have been increasing faster than surrounding air temperatures
- Warmer temperatures and higher evaporation rates may be partially responsible for declining lake levels.
- Land use and lake regulations also affect lake levels, though no major management changes have occurred since 2000.
- While most models show long-term declines in lake levels, in the near future, variations will remain large, with periods of high lake levels.

*Specific Actions*
- [Protecting Michigan's Inland Lakes: A Guide for Local Governments](#)
- [MiCorps’ Cooperative Lakes Monitoring Program](#) provides technical assistance, training, and other support to volunteer lake monitors in Michigan.

**Forests (also see Timber Economy Section above)**

*Impacts*
- Changing temperature and precipitation will force many forest ecosystems northward, but many tree species will be unable to migrate fast enough to keep up with the pace of climate change.
- With warmer temperatures and increasing CO2, forest productivity will likely increase until other impacts of climate change, such as increased drought, fire, and invasive species present additional stressors to forests.
- Climate change impacts on forests will impair the ability of many forested watersheds to produce reliable supplies of clean water and other forest products.
- Climate change will alter cultural and recreational connections to forest ecosystems.

*Specific Resources and Actions*
- The NIACS and US Forest Service Northern Research Station have released an updated and expanded edition of [Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers](#). The new edition serves the entire Midwest and Northeast and contains additional resources to support the development of vulnerability assessments as well as adaptation in urban forests. “
- [Michigan Dept. of Natural Resources - Northwoods Climate Change Response Framework](#)

Create standards for preparing a forested site for development
- [Community Strategies for Vermont’s Forests and Wildlife](#). Includes examples of
  - Purpose Statements for a Forest District, Conservation District, Natural Resources Overlay Districts
  - [Examples of Standards for Avoiding Fragmentation of Forest Resources and Productive Forestland through Zoning and forestry management](#).
Fish and Wildlife

Impacts

- Coldwater fish populations (trout/salmon) will likely decline in population as warm water fish populations (bass/pike) become more abundant.
- Wildlife populations better adapted to cold temperatures will continue to decline in the UP as competing species migrate into the region from the south with rising temperatures. Many animal species will need to migrate north to adapt to rising temperatures.
- Lake stratification and an increased frequency of low oxygen conditions will reduce overall biomass productivity in lakes and waterways.
- Increased evaporation rates will decrease the total wetland area in the region, creating additional stresses on species.
- The rate of warming may outpace the rate at which ecosystems are able to migrate and adapt.

Specific Resources and Actions (also see Tourism Section above)

- Sample Standards: Promoting Wildlife Connectivity, Wildlife Habitat, and Wildlife Crossing Areas
- Draft Michigan Northern Pike Management Plan

Wetlands Protection

- Protecting Michigan’s Wetlands: A Guide for Local Governments
## 1.2 Climate Adaptation Applied to Master Plans and Zoning Plans

**Table 5: 2013 Lake Superior Climate Adaptation Plan Page 22-24**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Goals</th>
<th>Actions</th>
<th>Time Frame</th>
<th>Action Type</th>
<th>In Region</th>
<th>In Counties</th>
<th>In Towns</th>
</tr>
</thead>
</table>
| Lake Superior Lake Michigan (and other water bodies) | Protect shorelines from damage due to fluctuating lake levels, increased lake storm action, habitat loss, and poorly regulated human development. | - Determine projected changes in water levels and storm surge extents in the area.  
- Identify and map critical habitat to be protected along the Lake Superior shoreline.  
- Identify beach/dune areas along shore in need of habitat restoration and resilience work.  
- Expand existing and create new programs to restrict spread of invasive species, including zebra and quagga mussels, sea lamprey, and spiny waterflea.  
- Implement at least one habitat restoration project in each county, incorporating climate change impacts.  
- Re-establish and maintain physical stability of streams. Protect river corridors and floodplains to accommodate river adjustment and floodplain processes.  
- Remove barriers to aquatic organism passage.  
- Devise grey water storage and reuse systems to recycle and utilize water resources more efficiently.  
- Research current setback ordinances and other zoning standards regarding shoreline development. Present recommendations to appropriate governing boards.  
- Establish shoreline protection zones for new development.  
- Establish and enforce shoreline setback requirements.  
- Place limits on density and infrastructure in coastal and transitional zones.  
- Establish new street grade and building first floor elevation requirements that exceed current town, state, and FEMA standards. | ST | Research | ✓ | ✓ | ✓ | LT | Policy | ✓ | ✓ | ✓ |
### 1.2 Climate Adaptation Applied to Master Plans and Zoning Plans

<table>
<thead>
<tr>
<th>Sector</th>
<th>Goals</th>
<th>Actions</th>
<th>Time Frame</th>
<th>Action Type</th>
<th>In Region</th>
<th>In Counties</th>
<th>In Towns</th>
</tr>
</thead>
</table>
| Great Lakes, inland lakes and rivers | Protect shorelines from damage due to fluctuating lake levels, increased lake storm action, habitat loss, and poorly regulated human development. | • Increase building “free board” above base flood elevation.  
• Institute conservation rate pricing for water.  
• Adopt net-zero runoff site plan requirements.  
• Establish policies that set new infrastructure farther back from water bodies and retain naturally vegetated buffers.  
• Develop State of Michigan-approved watershed management plans for priority watersheds in each county.  
• Remove structures that harden coastlines, impede natural regeneration of sediments, and prevent natural inland migration of sand and vegetation. | LT | Policy | ✓ | ✓ | ✓ |
| Wetlands | Increase the ability of wetland to withstand climate changes such as flooding, drought and intense storm events through on-the-ground projects and effective watershed management. | • Develop working relationships with land-use agency staff and identify wetland adaptation projects on public lands to support and/or fund.  
• Identify, map and prioritize wetland areas most vulnerable to flooding, erosion, siltation, degradation and invasive species.  
• Assess status of current watershed plans in region and work with partners to update them to reflect climate change considerations.  
• Incorporate climate change considerations into all habitat restoration planning.  
• Expand existing and create new programs to restrict spread of invasive aquatic plant and animal species in both Lake Superior and inland wetlands. Involve the public in on-the-ground projects.  
• Conduct targeted wetland restoration. | ST | Outreach | ✓ | ✓ | ✓ |
| | | | | | | | |

CLIMATE CHANGE IMPACTS IN THE UPPER PENINSULA

Provided by Central Upper Peninsula Planning and Development in Cooperation with the Superior Watershed Partnership
1.3 Climate Change Impacts in the Upper Peninsula

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Executive Summary

This project brings together the climate change adaptation planning work done in the Upper Peninsula since 2011 with the Master Plan revisions and updates that take place on a regular basis. It is organized in order to answer three common questions:

What was found to be important for the Central Upper Peninsula in planning for climate change?
See 1.1 Priorities in Climate Adaptation Plans 2011-2016

I’m planning for the future of the Central Upper Peninsula. How do I easily find concrete ideas to address climate change?
See 1.2 Climate Adaptation Strategies by Master Plan Chapters.
The chapters are:
- Economic profile/local economy
- Housing
- Public and community facilities
- Natural features and resources
- Recreation
- Transportation, and
- Land use and zoning.

What is known about how climate change will impact the Central Upper Peninsula?
See 1.3 Climate Change Indicators Report.
Use their table of contents as a guide to finding the topics covered. Each document contains links to specific actions, policies or data to support local decision makers.

Why Master Plans Were Chosen as the Organizing Structure.

The Central Upper Peninsula Planning and Development Regional Commission (CUPPAD) contracted with the Superior Watershed Partnership to create these documents in 2016 as part of the Regional Prosperity Initiative, supported by the State of Michigan. The work would result in:
- A summary and table showing how priorities in existing climate adaptation plans could be applied to master plans and zoning plans. See Chapter 1.1.
- Identification of strategies to bring climate adaptation into the revising, adopting and writing of master plans. See Chapter 1.2.
- An annotated list of resources and prioritized set of actions for CUPPAD planners to take in order to apply climate adaptation lens to the revising, adopting and writing of master plans. See Chapter 1.2.
- Identification of issues and locations where climate change adaptation are important threats, weaknesses or opportunities in zoning, economic development, recreation, or land use planning and provide table of topics including citations/references where to get more information. See Chapter 1.
Understanding and Preparing for Climate Change in the Upper Peninsula

This report is the third in a series of reference guides created for local government officials and land use planners to assist them in making recommendations and decisions while taking climate change into account. The other two documents are 1.1 Priorities in Climate Change Adaptation Reports 2011-2015 and 1.2 Climate Adaptation Strategies by Master Plan Chapter.

The information below was gathered from the US Environmental Protection Agency’s website on climate indicators and from the Great Lakes Integrated Science Assessment Center. The wording in some instances has been changed. These changes were made to make the information more accessible to the public.

Climate Change Indicators

The Earth’s climate is changing. Temperatures are rising, snow and rainfall patterns are shifting, and more extreme climate events – like heavy rainstorms and record high temperatures – are already happening. Many of these observed changes are linked to the rising levels of carbon dioxide and other greenhouse gases in our atmosphere, caused by human activities.

EPA partners with more than 40 data contributors from various government agencies, academic institutions, and other organizations to compile a key set of indicators related to the causes and effects of climate change.

Greenhouse Gases
- Greenhouse Gases Summary
- U.S. Greenhouse Gas Emissions
- Global Greenhouse Gas Emissions
- Atmospheric Concentrations of Greenhouse Gases
- Climate Forcing

Weather and Climate
- Weather and Climate Summary
- U.S. and Global Temperature
- High and Low Temperatures
- U.S. and Global Precipitation
- Heavy Precipitation
- Tropical Cyclone Activity
- River Flooding*
- Drought

Oceans
- Oceans Summary
- Ocean Heat
- Sea Surface Temperature
- Sea Level
- Coastal Flooding*
- Ocean Acidity
Climate Change Indicators (continued from previous page)

Snow and Ice
- Snow and Ice Summary
- Arctic Sea Ice
- Antarctic Sea Ice*
- Glaciers
- Lake Ice
- Snowfall
- Snow Cover
- Snowpack

Health and Society
- Health and Society Summary
- Heat-Related Deaths
- Heat-Related Illnesses*
- Heating and Cooling Degree Days
- Lyme Disease
- West Nile Virus*
- Length of Growing Season
- Ragweed Pollen Season

Ecosystems
- Ecosystems Summary
- Wildfires
- Streamflow
- Stream Temperature*
- Great Lakes Water Levels and Temperatures
- Bird Wintering Ranges
- Marine Species Distribution*
- Leaf and Bloom Dates
Climate Change in the Great Lakes Region by GLISA

http://glisa.umich.edu/media/files/GLISA_climate_change_summary.pdf

Temperature »
- Since 1900, average temperatures have increased by 2.0°F (1.1°C) in the U.S. Great Lakes region.
- By 2050, average air temperatures are projected to increase by 1.8 to 5.4°F (1 to 3°C).
- By 2100, average air temperatures are projected to increase by 3.6 to 11.2 °F (2 to 6.2°C).
- Winter temperatures have been rising faster than temperatures during other seasons.

Precipitation »
- Since 1900, total annual precipitation has increased by 11% in the U.S. Great Lakes region, and is expected to continue to increase.
- Total annual precipitation will likely continue to increase, but projections of future precipitation vary.
- Summer precipitation may decline or increase less than precipitation in other seasons.
- Warmer temperatures will lead to less precipitation falling as snow, and more falling as rain.
- Lake-effect precipitation may continue to increase in some areas.

Extreme Weather »
- The frequency and intensity of severe storms has increased. This trend will likely continue as the effects of climate change become more pronounced.
- The amount of precipitation falling in the heaviest 1% of storms increased by 37% in the Midwest from 1958 to 2012.
- Heavier storms are projected to increase in frequency at a faster rate than storms that are less intense.
- More severe storms may have a negative economic impact due to resulting damages and increased costs of preparation, clean up, and business disruption.

Water Quality and Stormwater Management
- Increased risk of droughts, severe storms, and flooding events may increase the risk of erosion, sewage overflow, lead to more interference with transportation, and more flood damage.
- Future changes in land use could have a far greater impact on water quality than climate change (more pavement/buildings decreases water quality). Adding climate change to land use change could result in even stronger effects in some areas.
Climate Change in the Great Lakes Region by GLISA

Groundwater Availability »
- Despite increasing precipitation, land surfaces in the Great Lakes region are expected to become drier overall due to increasing temperatures and evaporation rates.
- More frequent summer droughts could affect soil moisture, surface waters, and groundwater supply.
- The seasonal distribution of water availability will likely change. Warmer temperatures may lead to more winter rain and earlier peak streamflows.

Great Lakes Ice Coverage »
- From 1975 through 2004, the number of days with land snow cover decreased by 15 days, and the average snow depth decreased by 2 inches.
- Snow and ice levels on the Great Lakes and on land will likely continue to decrease.
- Reduced lake freezing will result in more exposed water that could increase lake-effect precipitation.

Algal Blooms (more in Lake Michigan than Superior) »
- The Great Lakes have warmed faster than nearby air temperatures, leading to longer warm seasons and prolonged stratification.
- More total and intense precipitation is increasing runoff and combined sewer discharge, leading to greater nutrient loads in the lakes.
- Warmer temperatures, prolonged stratification, and increased nutrient loading combine to increase the occurrence of harmful algal blooms.
- Hypoxic "dead zones" can result when algal blooms sink, decompose, and reduce dissolved oxygen concentrations. A greater risk of algal blooms may increase the incidence of hypoxia and fish kills.

Fish and Wildlife »
- Coldwater fish populations (trout/salmon) will likely decline in population as warm water fish populations (bass/pike) become more abundant.
- Wildlife populations better adapted to cold temperatures will continue to decline in the UP as competing species migrate into the region from the south with rising temperatures. Many animal species will need to migrate north to adapt to rising temperatures.
- Lake stratification and an increased frequency of low oxygen conditions will reduce overall biomass productivity in lakes and waterways.
- Increased evaporation rates will decrease the total wetland area in the region, creating additional stresses on species.

The rate of warming may outpace the rate at which ecosystems are able to migrate and adapt.
Forests

- Changing temperature and precipitation will force many forest ecosystems northward, but many tree species will be unable to migrate fast enough to keep up with the pace of climate change.
- With warmer temperatures and increasing CO2, forest productivity will likely increase until other impacts of climate change, such as increased drought, fire, and invasive species present additional stressors to forests.
- Climate change impacts on forests will impair the ability of many forested watersheds to produce reliable supplies of clean water and other forest-products.
- Climate change will alter cultural and recreational connections to forest ecosystems.

Lake Levels

- Lake temperatures have been increasing faster than surrounding air temperatures.
- Warmer temperatures and higher evaporation rates may be partially responsible for declining lake levels.
- Land use and lake regulations also affect lake levels, though no major management changes have occurred since 2000.
- While most models show long-term declines in lake levels, in the near future, variations will remain large, with periods of high lake levels.

Agriculture

- Earlier warm spells, coupled with variability in spring freezes, may result in more freeze damage early in the growing season.
- A longer growing season will positively impact some crop yields through mid-century.
- By the end of the century, more frequent and intense severe weather, more flooding and drought risks, as well as more pests and pathogens will likely reduce crop yields.
- Water availability and quality will likely pose challenges for agriculture.

Public Health

- Increased risk of heat waves and increased humidity may increase the number of heat-related deaths and illnesses.
- More storm activity and flooding will increase the risk of harm and water contamination while warmer surface waters amplify the risk of toxic algal blooms and fish contamination.
- Diseases such as West Nile virus and Lyme disease may become more widespread since carrier insects will be more likely to survive milder winters.
- The mosquitoes that carry the Zika virus cannot live in the cold so will not likely live in the Upper Peninsula.
Climate Change Impacts in the Upper Peninsula

Climate Change in the Great Lakes Region by GLISA

Transportation

- More extreme heat may increase the risk of damage to pavement and rails.
- More extreme precipitation may compromise transportation routes and damage infrastructure.
- Shipping lanes will likely be open earlier and longer due to reduced ice cover on the Great Lakes.
- Lower lake levels lead to decreased depth of navigation channels and a reduction in the maximum loads carried by vessels. For each inch of lost draft, the average 1,000-foot freighter loses $30,000 per transit.

Tourism and Recreation

- Winter recreation and tourism are likely to suffer due to reduced snow cover and shorter winters.
- Increasing summer temperatures and a longer summer season may increase demand for beaches, but possible increased lake contamination (warmer surface waters amplify the risk of toxic algal blooms) and decreasing lake levels may lead to less desirable shorelines.
- Overall, summer tourism may grow before temperatures rise become unfavorable for many recreational activities.
- Many coldwater species of fish important to recreation are likely to decline while populations of warmwater species grow.

Energy and Industry

- Reduced summer water availability may interfere with some industrial operations.
- Warmer temperatures and more frequent heat waves will likely increase electricity demands, particularly in urban areas and during the summer months.
- Increased storm intensity could put transmission lines/pipelines at risk from falling trees and flooding.

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1. https://www.epa.gov/climate-indicators/great-lakes
2. https://www3.epa.gov/climatechange/