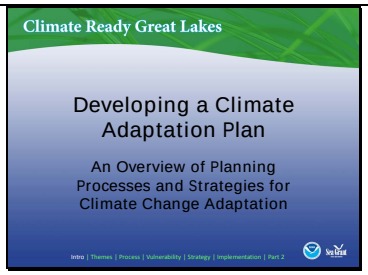
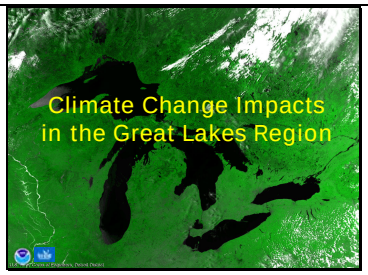
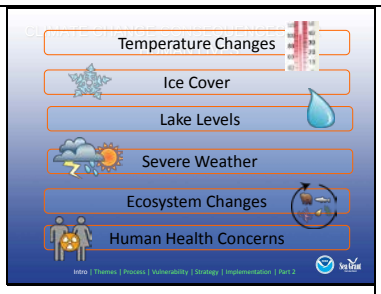
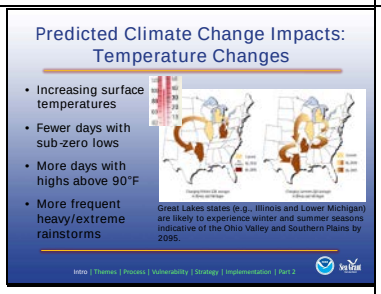
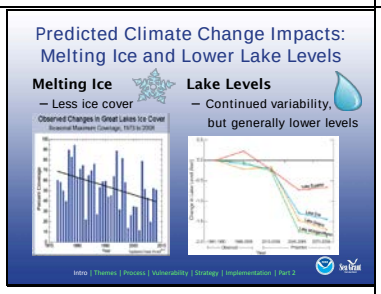
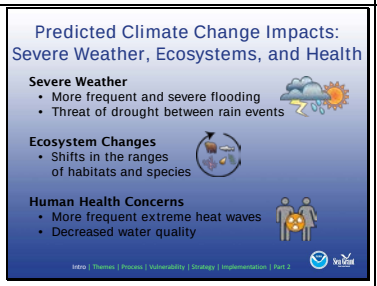
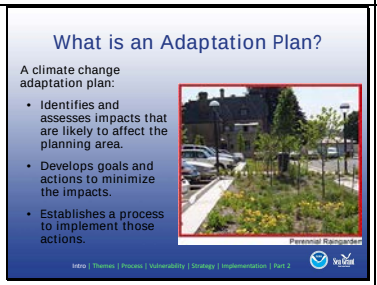
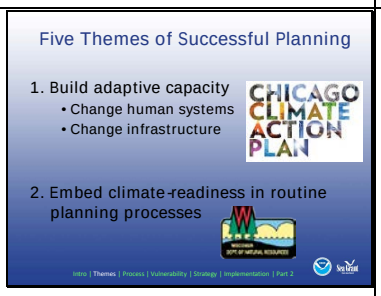
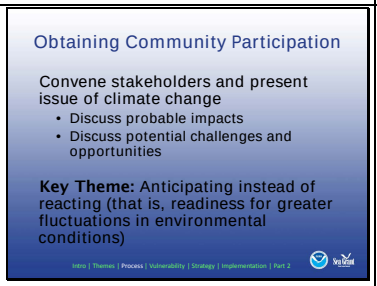
Slide 1		Welcome to this training on “Climate Ready Great Lakes!” This presentation features content that was developed on behalf of the NOAA Great Lakes Regional Collaboration Team and the Great Lakes Sea Grant Network.
Slide 2		This is the second of three modules developed to help people and communities in the Great Lakes region become more “climate ready.” This module provides an introduction to developing a climate adaptation plan.
Slide 3		This presentation has two parts: 1) The first part describes a planning process focused on developing a plan for climate adaptation. This is based on the process used in Chicago, but it is adaptable to different communities. Part 1 will include insights from real world case studies. 2) The second part describes some of the strategies that can be incorporated into an adaptation plan to address specific topics related to the predicted impacts of climate change for the Great Lakes region. This includes a final section on incentives and resources related to policies at community, state, and federal levels.
Slide 4		The following slides provide a brief review of the predicted impacts of climate change in the Great Lakes Region.

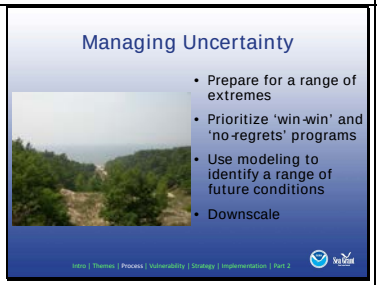
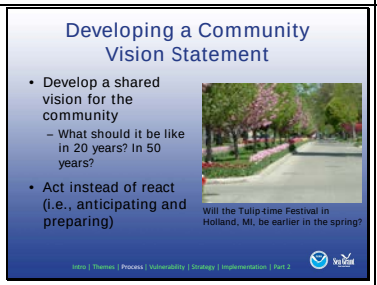
Slide 5		Climate change is a global phenomenon, but its effects are seen at a regional scale. There is a wealth of knowledge about climate systems, but regional-scale systems are still under development and require improvements in scale and certainty. However, it is clear that… **Climate change will have consequences for the Earth system and human lives.**
Slide 6		• Over the next century, wintertime surface temperatures are likely to increase 6–13°F, while summertime surface temperatures are likely to increase 8–18°F. The largest increases will likely occur over western portions of the Great Lakes region. • The number of days with sub-zero lows is likely to drop by 50% or more, while the number of very hot days (highs > 90°F) is likely to double or even triple. For example, by 2095, Detroit may annually have 35–50 days with highs above 90 degrees, including several days over 97 degrees. • Extreme or heavy rainstorms are likely to become 50–100% more frequent by 2095, making flash flooding a real possibility. The figure depicts what Illinois' and Lower Michigan's climate systems (both winter and summer) might look like by 2095 AD. Figure credit: Union of Concerned Scientists (UCSUSA) http://www.ucsusa.org/assets/documents/global_warming/color_figures.pdf
Slide 7		As ice sheets and glaciers melt and seawater thermally expands (as the oceans warm), it is causing the sea level to rise globally. Although there are no ice sheets or glaciers in the Great Lakes, a reduction in seasonal ice cover is a predicted impact of rising temperatures. The black line on the graph of Great Lakes' ice cover shows a clear decrease in the extent of ice cover since the 1970s, even though there are large year-to-year variations. Higher temperatures cause more evaporation, which will likely result in reduced water levels in the Great Lakes. In winter, reduced amounts of lake ice also increases evaporation and contributes to the water level decline. Under a lower emissions

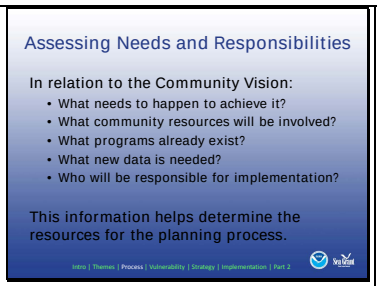
		scenario, water levels in the Great Lakes are projected to fall no more than 1 foot by the end of the century; however, they are projected to fall 1–2 feet in a higher emissions scenario. The greater the temperature rise, the higher the likelihood of a larger decrease in lake levels. Climate factors like temperature, wind speed, evaporation, precipitation, humidity, and solar radiation cause Great Lakes water levels to naturally fluctuate. Current models show that by the end of the century lake levels are much more likely to be lower, although the models also indicate a high degree of uncertainty. Source citation: United States Global Change Research Program. *Global Change Impacts in the United States, Midwest Report.* http://www.globalchange.gov/images/cir/pdf/midwest.pdf
Slide 8		In the United States, extreme weather events have made up a disproportionate share of the observed increases in total precipitation. For example, the number of days with precipitation greater than two inches has increased (Karl, T.R., R.W. Knight, D.R. Easterling, and R.G. Quayle. 1996. "Indices of climate change for the United States." *Bulletin of the American Meteorological Association* 77 (2): 279-292). Increases in precipitation accumulations have been the greatest in the Great Lakes, Southwest, and Midwest regions (IJC. 2003. *Climate Change and Water Quality in the Great Lakes Basin*.) High amounts of precipitation within a short period of time are considered *extreme precipitation events*. These events create risks for flooding, erosion, water quality deterioration (e.g., entrainment of pollutants and sewer overflow), and human health concerns (e.g., more frequent outbreaks of water-borne diseases, especially in rural areas). Even though extreme precipitation events may occur more frequently, the threat of drought may also increase in the Great Lakes region due to warmer temperatures and increased evaporation between rain events. As temperatures increase, the loss of soil moisture between rain events due to evaporation could be more significant than increases in rainfall.

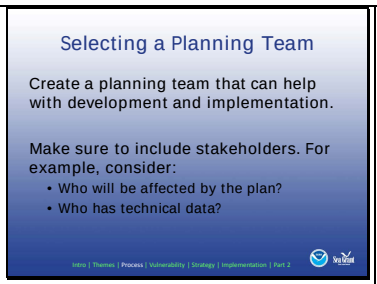
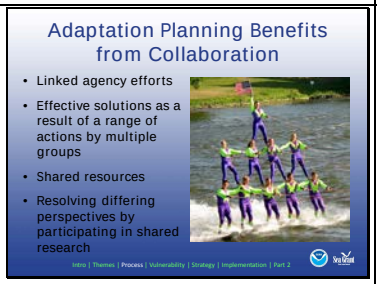
		The Great Lakes region includes numerous ecosystems and habitats (such as coastal wetlands, northern hardwood and coniferous forests, beaches, and dunes). Many of these habitats have been stressed or altered by human activities over time. Additionally, relatively small changes in temperature or water levels can have a cascading impact throughout the system: as habitats become drier, species will shift locations to remain in their preferred temperature range. These shifts can alter the relationships between species and how they use their habitats. One of the major impacts of rising temperatures in the Great Lakes region will be territorial shifts as species expand to the north. Numerous studies are documenting movements by species as they seek out the best conditions for their survival. More frequent extreme heat events are also expected over the next century as a result of climate change. More frequent extreme precipitation events could affect water quality by causing increased runoff into streams and lakes and an increased chance of combined sewer overflows.
Slide 9		"While an adaptation plan … may stand alone, planning to adapt to climate change should be incorporated to varying degrees in all statewide planning efforts (as well as regional and local planning efforts)." The ultimate goal is "coastal states and communities that are organized to take action, have the tools to take action, and are taking action to plan for and adapt to the impacts of climate change." (Definition of Adaptation Plan from NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers*.)
Slide 10		Chicago has worked extensively to prepare for climate adaptation, including documenting the planning process they used. Chicago is making the results of its research available for other communities to use in their own planning efforts. Although rural and smaller towns will need some different kinds of information, there are currently very few cases of climate adaptation planning from small towns on which to draw.

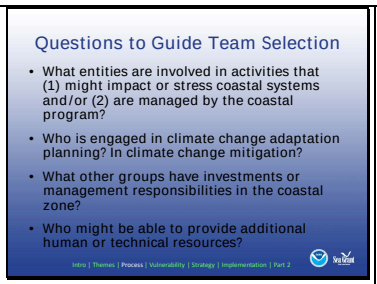
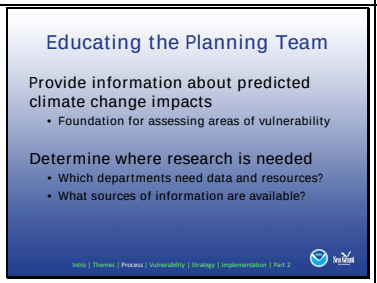
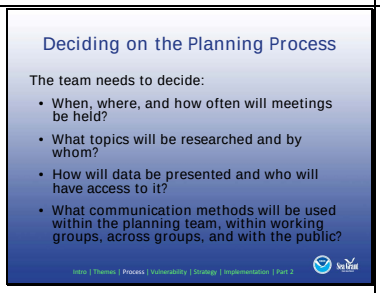
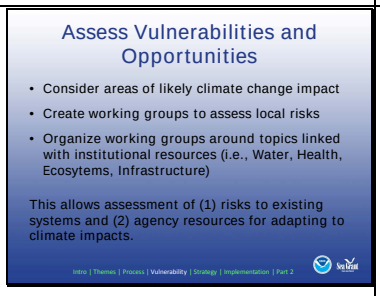
		The *Chicago Climate Action Plan* includes five themes for successful planning that are useful for all planners to keep in mind: 2) "[B]uilding adaptive capacity is the putting in place of support systems, data collection, evaluation processes, awareness-raising, and policy framework(s) which will encourage, allow or require individual businesses and regions to undertake adaptation. Only when such work has been undertaken in a particular organization or sector can the work of delivering adaptation actions begin." 3) Climate change will affect elements of community infrastructure and life that are already addressed by municipal planners and existing organizational structures. Planning for climate change is not about starting from scratch; it is about adding climate considerations to the existing short- and long-term community plans. 4) Planning processes identify future organizational, operational, equipment, or infrastructure needs involving procuring new goods, services and/or products or building new infrastructure that must function under a new set of climate conditions. To manage risk, planning processes should be modified to account for potential impacts of climate changes." For example, New Zealand has issued guidelines for local authorities that include specific questions to be asked when drawing up individual plans, including: • Does the risk management analysis take into account changes due to climate change? • Do the effects of climate change reflect the current level of uncertainty in the region and should a cautious approach be adopted as a result? If not, is this explained? • Does the plan include a specific commitment to keep up to date with changing understanding of climate change and its implications (including any relevant local monitoring or liaison)? *Chicago Quick Guide to Climate Change Preparation* p. 6.

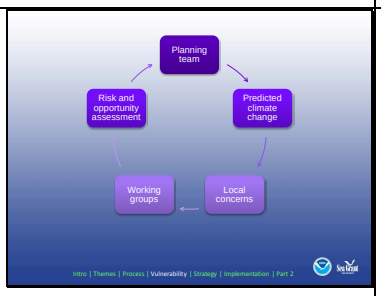
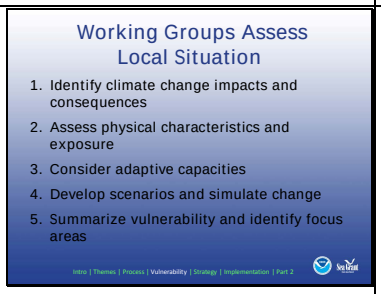
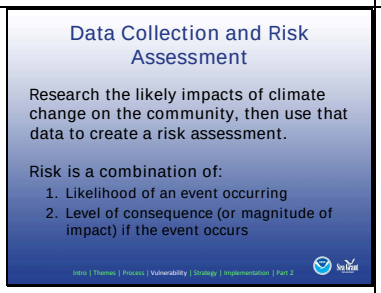
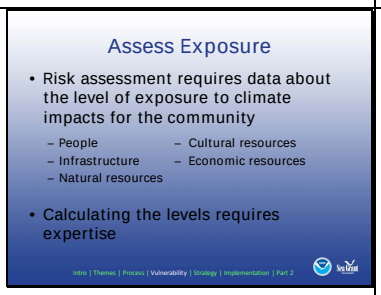
Slide 11		5) Adaptation measures almost always have multiple benefits (such as reduced energy costs, improved aesthetics, and reduced air and water pollution). These should be considered to assess the overall benefit of the measures that may be taken—especially when the co-benefits either save money or outweigh the costs of the measures. *Chicago Quick Guide to Climate Change Preparation*
Slide 12		6) Incremental steps (rather than large actions) keep options open so that plans can be adjusted as new data develops. Phased projects can help communities avoid getting locked into trajectories that may not be compatible with future climate risks. Phased projects are also easier to incorporate into existing community plans and are less politically difficult. Also, distributed infrastructure can be more flexible in responding to change than large, centralized systems. 7) "The paradox of process planning is the intermixed integration of past, present, and future. We plan for the future, do so in the present, and use data from the past." To plan for climate change, new data must be continually incorporated and decisions reassessed. *Chicago Quick Guide to Climate Change Preparation*
Slide 13		This adaptation planning process is from NOAA's *Adapting to Climate Change: A Planning Guide.* Taking time to define the planning process helps clarify and streamline planning. It also promotes appropriate representation of stakeholders, inclusion of decision makers, and access to resources.
Slide 14		Every community is unique, so it is necessary to start by determining what your community needs/wants to do. Use NOAA's Module 1 to present information on the predicted impacts of climate change for the Great Lakes and the science involved in developing these predictions. *Readiness* means anticipating and planning to avoid potential future impacts and conflicts. For example,

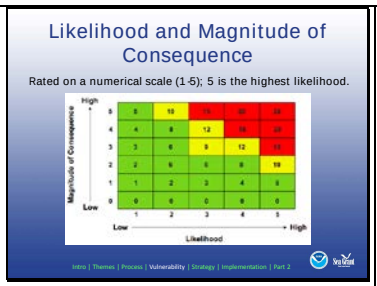
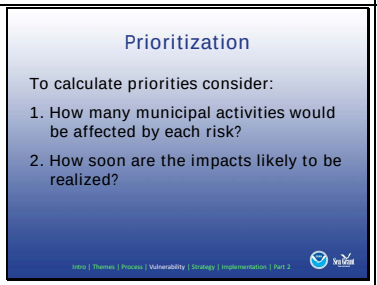
		• Preparing strategies for competition for water in dry years • Avoiding land use/development with problematic consequences • Preventing development in shorelines exposed by low water
Slide 15		Waiting until information is completely certain increases risk, so climate change planning requires action and planning with imperfect information. Cities and municipalities already make other plans and decisions based on uncertain information. For example, population growth, natural disasters, flood insurance programs, and disease control are all based on uncertainty.
Slide 16		Even though plans need to be made based on imperfect information, there are ways to manage the uncertainty: • Prepare for a range of extremes, but revise plans as information improves. • Prioritize and focus on 'win-win' and 'no-regrets' programs (such as ecosystem conservation and energy reduction programs). • Use modeling to help identify a range for future conditions—as well as significant uncertainties. • Downscale to reduce the amount of uncertainty (such as measuring water availability in a city). PPT: David MacNeil – Sea Grant PowerPoint
Slide 17		Having a clearly defined goal is important for the success of plan development. Including public voices in the visioning process builds ownership, which facilitates implementation of a plan. *Anticipating* includes planning to avoid potential future conflicts, such as: • Competition for water in dry years • Land use/development with problematic consequences • Development in shorelines exposed by low water • Future shoreline ownership issues

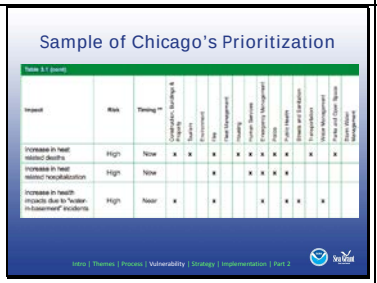
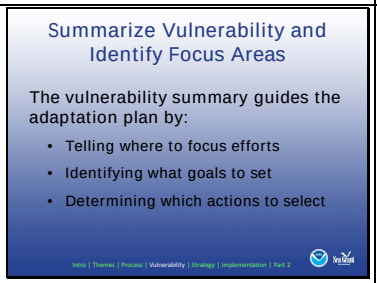
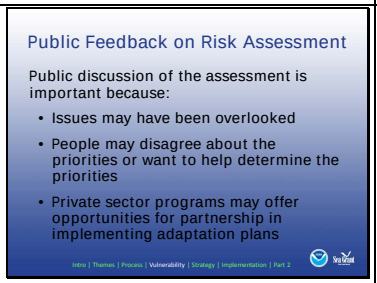
Slide 18		It is important to be clear about (1) what the plan aims to accomplish and (2) who needs to be included in the process in order to accomplish it. Figuring this out at the beginning of the process saves trouble later. For example, Chicago began its planning process with the idea that the Department of Environment's Climate Task Force would issue the plan. However, part way through the planning process, it was decided that the City had to have ownership of the plan and be responsible for presenting the plan to the citizens. "In this way, the plan could provide a blueprint for action that had the full support of city government and accountability for implementation." If they had started with this idea, they would have included more of the municipal decision makers in the planning process from the beginning. Julia Parzen. July 2009. *Lessons Learned: Creating the Chicago Climate Action Plan.* www.chicagoclimateaction.org
Slide 19		Having a designated person (and/or a couple of part-time workers) to keep track of the process is important. It provides consistency as the process shifts from phase to phase and other participants move in and out of the process. Without a coordinator, the process is not likely to succeed. In Chicago, a commissioner from the mayor's office oversaw the process, but he had part-time help from staff in the Department of Environment and a representative from a city philanthropic organization. Whether to select the planning team or the planning coordinator first depends on the community. Although it may be ideal to start with a team, a successful planning process usually requires a "champion" to set things in motion and keep up the momentum. Thus, setting up leadership may be a necessary first step.

Slide 20		The planning team should be diverse, including representatives of agencies that will have to deal with infrastructure and municipal services affected by climate change, business owners, local college researchers, state environmental departments, and elected officials. The team could also include representatives from neighborhood associations or community organizations. If these community voices are not included on the team, they need to be brought into the process through public adaptation meetings. It may not be necessary to create a new, stand-alone climate change program. Communities may have (1) existing programs that already address many areas affected by climate change or (2) sustainability plans that can be expanded to include climate change. "Plans in your state that may relate to climate change adaptation include, but are not limited to, hazard mitigation, watershed management, wildlife, emergency operations, transportation, economic development, and growth plans."(NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers.)*
Slide 21		Collaboration is appropriate for climate adaptation planning processes. Implementation of the plan will require cooperation across agencies and authority parameters; perceived ownership of the issues and resources is an important motivation for participation. Stakeholders prefer to have a role in making decisions (instead of feeling like they are suffering under an imposed mandate). Some of the differing perspectives about climate change may be resolved by including agnostics in the research process; however, full-scale deniers are not likely to change their opinions. Of course, collaboration cannot work if the parties involved do not want to collaborate. Information on when collaboration is appropriate derived from *Making Collaboration Work* by Julia Wondolleck and Steven Yaffee.

Slide 22		From NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers.*
Slide 23		The team needs knowledge about the predicted local impacts of climate change in order to determine what topics need to be researched further.
Slide 24		Having a regular schedule for meetings creates momentum and improves group dynamics. Establishing guidelines for communication is vital to preventing misunderstandings. There should be a clearly defined method for sharing data within the planning committee so all have access. Designating a channel for interaction with the public helps avoid miscommunication and damage from rumors.
Slide 25		This adaptation planning process is from NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers.*
Slide 26		When considering areas of likely climate change impact, Chicago used four themes (Water, Health, Ecosystems, and Infrastructure) and then identified subthemes within each group. The city wanted to know how climate change would impact each of these areas. For example, • Water's subthemes included precipitation, river flow, and Lake Michigan. • Health's subthemes included heat, air quality, and vector-borne diseases. • Ecosystems' subthemes included natural vegetation, animals, invasive species, and

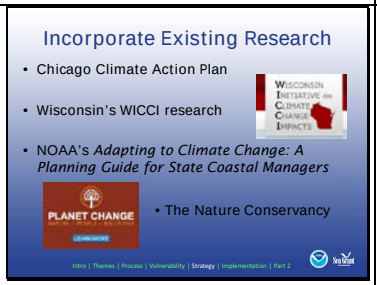
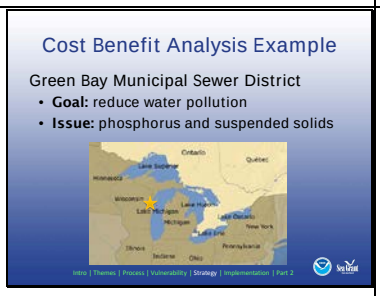
		agriculture. • Infrastructure's subthemes included heating and cooling, operation and maintenance, labor, and other. Although the primary focus of adaptation planning is on risks, climate change may also create new opportunities for a community. Including this concept in the research gives a more complete picture that is useful in determining the best local actions.
Slide 27		The planning team starts with information on predicted climate change, examines how that will affect the local community, and then selects working groups to pursue information about what risks and opportunities are likely. The research reports from the working groups will provide the basis for developing an appropriate adaptation plan.
Slide 28		From NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers*.
Slide 29		Examples of the level of consequence include number of deaths, infrastructure damage, and business disruptions. This sample of a way to quantify risk comes from the *Chicago Climate Action Plan*.
Slide 30		The data that the working groups collect will provide this assessment. Module 3 describes tools and resources to help calculate the levels of exposure.

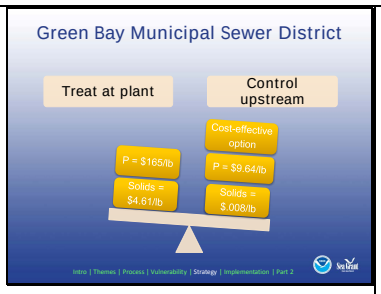
Slide 31		This chart is an example of a way to visualize a risk assessment used by Chicago. The use of 0 on the consequence scale to indicate beneficial impacts did not prove useful. Other communities might want to create a separate measure for benefits/opportunities related to climate change impacts. Knowing about these might affect the way a community allocates some resources. For example, rebates or low-interest loans could be targeted to offset irrigation equipment so that farmers can take advantage of a longer—but drier—growing season. Likelihood scale: • 1 = unlikely • 2 = somewhat likely • 3 = likely • 4 = very likely • 5 = occurring now Consequence scale (infrastructure costs): • 0 = benefit (no cost) • 1 = low cost • 2 = moderate cost • 3 = high cost • 4 = very high cost (significant health effects and high costs) • 5 = catastrophic cost (major loss of life)
Slide 32		8) Examples of municipal activities/services include construction, street maintenance, public safety, public health, tourism, business, and schools. Knowing what activities will be affected can help determine how widely the impacts will be felt in the community, what agencies may need to be brought into the planning process, and where adaptation resources may be available. 9) When considering the timeline for impacts, think about now, 10 years from now, 30 years from now, and 50 years from now. Knowing the level of the risk, the extent of its impact on a municipality, and the immediacy of the threat, the planning team can set priorities for allocation of resources. It is important to retain some flexibility in this prioritization. As the community explores adaptation options, discovery of opportunities to

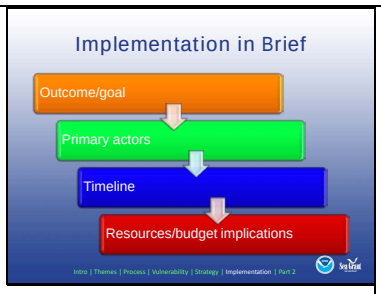
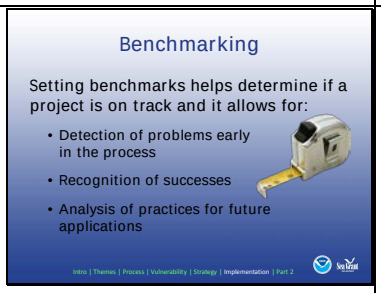
		address impacts that are lower on the priority list may appear. For instance, these could be tied to current development or government grants that will expire shortly. Cases like these will have to be evaluated on an *ad hoc* basis.
Slide 33		** Timing categories: Now = 2010, Near = 2010-2039, and Mid = 2040-2069. Notice how many categories of municipal activity are being affected by the impact of increased heat.
Slide 34		The gathered data is combined into a summary of vulnerability that ranks issues according to the magnitude of their impact on the community and how soon the impacts will be felt. This summary will guide the development of the adaptation plan. The summary identifies what impacts need to to be mitigated soonest in order to reduce the costs of climate change; how to do this most effectively will be the subject of the actual adaptation plan. Questions to help prioritize focus areas: • What locations along the coast are most vulnerable to climate change impacts? • What environments (natural, built) are most vulnerable to climate change impacts? • What assets are most important to your state's coastal values, identity, culture, and economy? • Which climate change impacts are likely to inflict the greatest losses (economically, socially, environmentally, etc)? From NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers.*
Slide 35		Successful adaptation requires community-wide planning; it is vital to bring all parties together to share information and ideas so that widespread implementation will be possible. Once there is a summary report on the risks climate change poses for an area, this report can be presented to the wider community. • This can help make sure that no community concerns were overlooked. • If people have a chance to take part in the

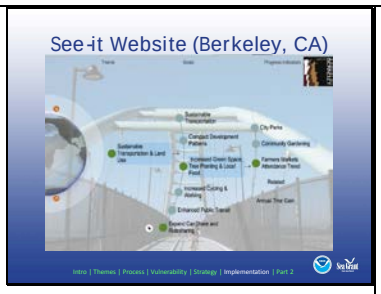
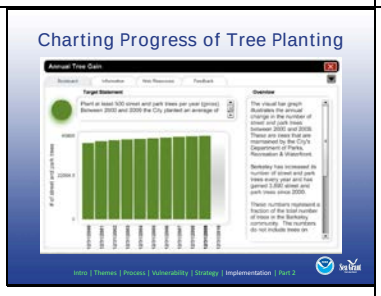
		process and feel that the resulting priorities are valid, they will be more likely to support the adaptation plans. • There may be small-scale programs within the private sector that offer opportunity for partnership in implementing adaptation plans.
Slide 36		This adaptation planning process is from NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers.*
Slide 37		10) Set formal goals that address the areas that will be affected by climate change. (See the accompanying handout for samples.) Reviewing plans from other communities can be helpful goal setting, even if they are not adaptation plans. (Useful plans may include topics such as hazard mitigation, emergency operations, environmental preservation, economic development, resource management, and transportation.) Involve stakeholders in the goal setting: this keeps them engaged and increases support for implementing the plan. 11) Once the team has (a) determined community climate impacts and (b) prioritized those issues, then working groups can be designated to research available solutions that will be incorporated into the adaptation plan. 12) Resource limitations are a significant challenge for adaptation planning. Governments are already juggling multiple issues and have to meet current obligations, so finding resources for new projects is not easy. However, since climate change will exacerbate many existing management concerns, it needs to be included in current planning. Integrating climate concerns into current planning gives access to existing financial, technical, and institutional resources. An example of this can be seen in the case study about a countywide sustainability plan on the following slide. 13) The highest priorities have already been

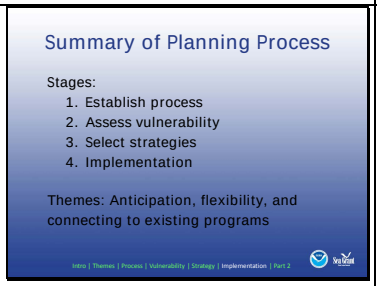
		determined by the vulnerability assessment. These can be grouped if they (a) result from similar climate change impacts (such as effects caused by heavier precipitation) or (b) relate to the same municipal departments (for example, water management may be related to both flood and drought). 14) Brainstorm a wide array of strategies, then sort them for best options. • Consider where they overlap so agencies might be able to combine resources. • Look for "win-wins" that deal with multiple impacts or may add value to the community in the process of reducing climate impacts (like increasing green space or redeveloping brownfields in floodplains). • Choose strategies that build off of existing municipal programs and initiatives if at all possible. Strategies that do not fit into the municipality's programs will be difficult to implement—there will be no resources available and they will be in competition with existing programs. The best mix of actions will depend on local needs and local resources. A cost-benefit analysis helps determine the most effective use of limited resources. Giving priority to lower cost options that can be accomplished quickly can help build momentum by showing the community that progress is being made.
Slide 38		This example concerns a Marin County's sustainability plan, but the creative solutions can be transferred to adaptation planning. By making sustainability a theme of Marin County's regularly scheduled countywide plan, there were already budget and staff allocations. Supplemental funds came from • Grants related to energy efficiency and hazard preparation. • State funds available for planning how to fulfill state mandates at the county level. • Fees for some building permits and land use.

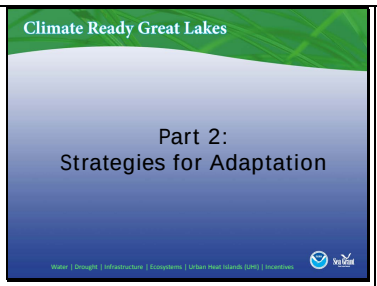
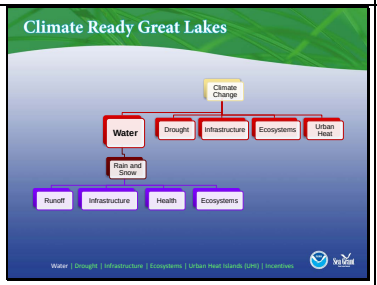
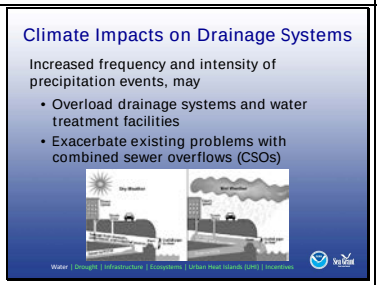
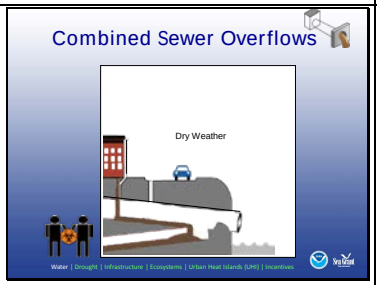
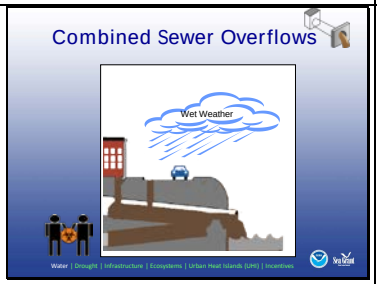
		Connecting to an existing planning processes allowed for the use of existing staff. Note that two part-time workers can be assigned to manage a planning process if it is not possible to have one person be full time, and that paid and unpaid interns can also be useful. For additional resources, consider partnering with universities and local businesses, which may have stakes in the outcomes of the planning process and be willing to donate labor, knowledge, and tools.
Slide 39		Smaller communities face a lack of resources for doing climate research, but they can make use of resources from big cities and government sources. Valuable resources can be found in the research reports from the Chicago Climate Action Plan and the Wisconsin Initiative on Climate Change Impacts (WICCI). These are the most advanced and thorough climate adaptation plans in the Great Lakes region at this time. Most of the reports that informed Chicago's climate plans are already on the city's website. The reports from WICCI are just being completed and placed on the website so some topics may not yet be available. Resources are also available from NOAA, FEMA, EPA, and The Nature Conservancy.
Slide 40		The Green Bay Municipal Sewer District did an analysis of the sources of phosphorus and suspended solids (two major pollutants in the river water that were affecting the city and the bay). A research company developed a computer model to determine the sources and analyze the most cost-effective locations for pollution reduction. The phosphorous and suspended solids came from agricultural regions upstream in the Fox River watershed and accumulated as they flowed downstream to Green Bay. White, David, Paul Baumgart, and Bruce Johnson, eds. 1995. "Toward a Cost-Effective Approach to Water Resource Management in the Fox-Wolf River Basin: A First Cut Analysis." Green Bay: Northeast Wisconsin Water of Tomorrow.

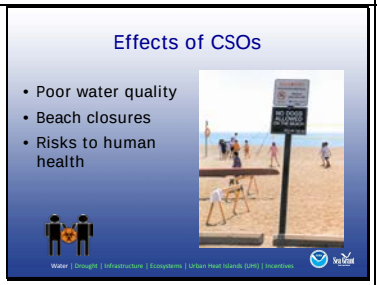
Slide 41		Economic analysis of control options: • Reduce phosphorus in municipal water through technology at treatment plant = $165/lb • Control phosphorus releases upstream = $9.64/lb • Remove suspended solids at treatment plant = $4.61/lb • Prevent suspended solids entering stream at outlet to watershed= $.008/lb The most cost-effective option was determined to be controlling the pollutants upstream rather than treating them at a plant downstream. Low-cost reductions could be achieved through planting vegetative buffers along river banks to minimize erosion, encouraging more efficient use of fertilizers and pesticides, setting up zoning and livestock exclusion ordinances to minimize animal access to streams, and improving management of animal wastes. The state's Department of Natural Resources has pursued these goals by hosting educational outreach programs directed at changing farming practices, providing technical assistance, and partially subsidizing the costs of new, non-point source controls. The major weakness of such a source-reduction process is that changing human behavior can be slow, whereas changing technology has a clearly defined timeframe. There are lots of context-specific details that affect a cost-benefit analysis, so these numbers will not be the same for other communities. But the study shows that such analyses are possible. White, David, Paul Baumgart, and Bruce Johnson, eds. 1995. "Toward a Cost-Effective Approach to Water Resource Management in the Fox-Wolf River Basin: A First Cut Analysis." Green Bay: Northeast Wisconsin Water of Tomorrow.
Slide 42		Once a community has determined what adaptation actions are most appropriate for its local needs and resources, it is time to design a process for implementing the action plan. From NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers.*

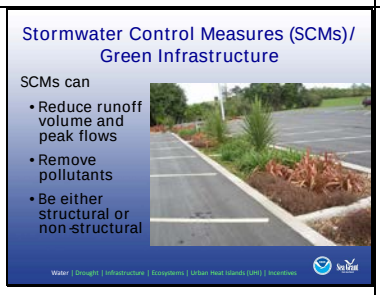
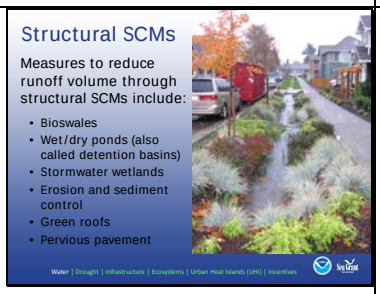
Slide 43		An implementation plan describes what the goals are, who has responsibility for achieving which goals, timing and benchmarks for achieving the goals, and what resources are going to be used to accomplish the goals. These can be determined by asking the following questions: • What is the desired outcome? • Who (agencies, departments, organizations, etc.) is responsible for achieving that outcome? • How will results be achieved? For example, changes to regulations, retrofitting structures, or zoning. Examples of strategies for achieving results will be included in Part 2 of this presentation. • What resources (e.g., funds, staff, events, and materials) will be used to achieve the result? • How will success be measured? For example, number of trees planted or buildings insulated, completion of a drought plan or updating of flood maps. • How will evaluation of progress be made accessible? For example, website, published reports, and public meetings.
Slide 44		Trying to determine why something is working well (or not) can be useful for improving efforts in other areas. Evaluating whether a program is meeting its benchmarks also helps determine if the strategy is cost-effective and if more resources are needed for successful implementation. Continuous assessment is especially important for climate adaptation, because of the uncertainties in the long-range predictions. As information improves and new data develops, plans will need to be updated. Benchmarks can set specific timelines for making these updates.

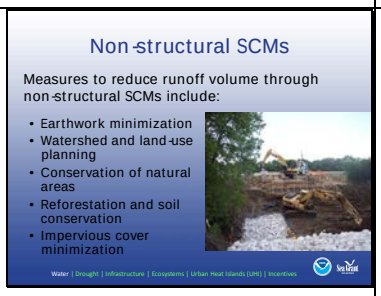
Slide 45		Here is an example of a system for keeping the public up to date on benchmarks. The City of Berkeley created a sustainability plan and developed a website called “See-it” to inform people about the plan. The inner circle shows themes like transportation and land use, the middle ring of the circle shows the goals of the city plan, and the outer ring shows indicators of how well the city is doing in achieving the goals. Clicking on a green dot takes you to a page that includes more data about the goals, actors, and current measures of progress. It will also explain whether the city is on track or not—and what variables are affecting this progress. **NOTE: Berkeley, CA has updated their climate plan web materials and now uses pdf reports to describe progress toward meeting sustainability goals. Although, the “See-It” website is no longer there, it is still a good example of how interactive, easily navigated communication tools can be formatted into a tool that facilitates public outreach.**
Slide 46		Here, for example, is the See-it page (now in pdf report forms) describing the city’s progress toward its target goal of planting 500 new trees per year. The scorecard tab shows the city’s progress: although the city has planted nearly 4,000 trees over 9 years, this is slightly below the target. Other tabs provide information about the goals and the reasons for wanting to increase the number of trees, web resources, and a method to provide feedback to the city planners. Benchmark pages can also explain why a goal is not being met. For example, Berkeley has a target for reducing greenhouse gas emissions from utilities; however, a drought caused a reduction in hydropower and an increase in coal-based electricity use, so the city is not on track to meet that target.

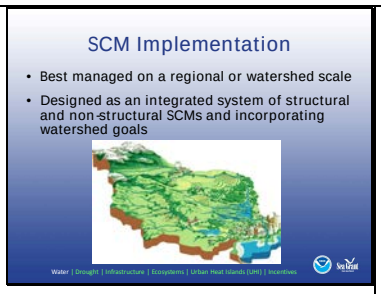
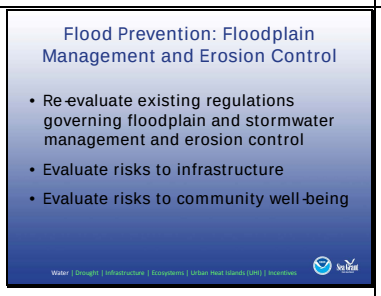
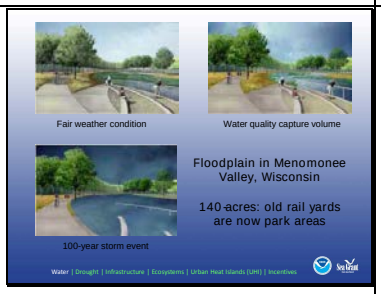
		Tree planting programs have proven particularly successful for cities. Citizens like trees and it is easy to show that benchmarks are being met since there is clearly visible evidence of progress.
Slide 47		Climate adaptation plans require regular re-evaluation and updating. This is true for all municipal plans, but it is especially important with climate change. The exact impacts of climate change involve many uncertainties, so the plans need to be flexible; new science and technologies may change recommendations for best practices. Building regular assessment and adjustment into the plan from the beginning will make it easier to update the plans. Even though many communities may not be able to implement a full range of adaptation strategies immediately, it is still worthwhile to create a comprehensive plan. The community can set priorities and begin with some of the simpler measures—or target a specific area for early adoption and phase in other measures as resources allow. Resource limitations are quite real. Communities will have to decide that adaptation will pay off. It helps to remember that federal (and state) government funding is growing in this area. If a community develops a plan now, then they will be ready to take advantage of funds as they become available and will be in a better position to compete for these new resources. Center for Science in the Earth System (The Climate Impacts Group); Joint Institute for the Study of the Atmosphere and Ocean; ICLEI – Local Governments for Sustainability. *Preparing for Climate Change: A Guidebook for Local Regional, and State Governments.* pp 28-31.
Slide 48		

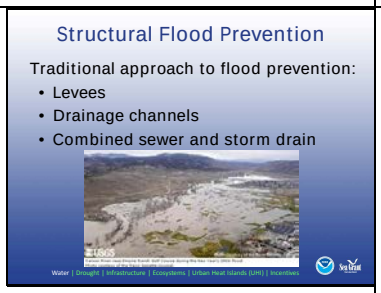
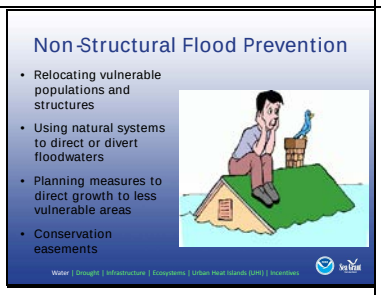
Slide 49		
Slide 50		Climate Change adaptation strategies are broken out here into water, drought, infrastructure, ecosystems, urban heat, and incentives. Let's first look at strategies for water. Climate change will increase the number of extreme weather events. Rain and melting snow increase runoff and affect infrastructure, health, and ecosystems. Management strategies aim to prevent harm to life and property.
Slide 51		The frequency of heavy rain events will increase with climate change, which can pose problems for communities with combined sewer overflow systems (CSOs). In CSOs, the same pipes collect rainwater runoff, sewage, and industrial water. Normally, the CSO can handle the whole load and direct it all for treatment. However, during heavy storms, the wastewater treatment plants can't handle the increased volume of water, and the systems overflow into local rivers and lakes. Figure credit: EPA
Slide 52		
Slide 53		

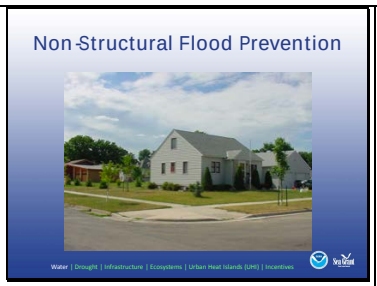
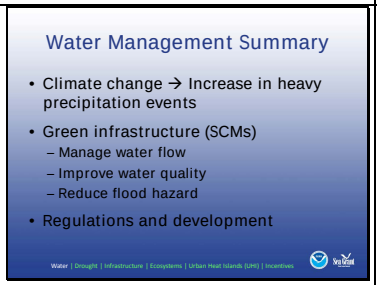
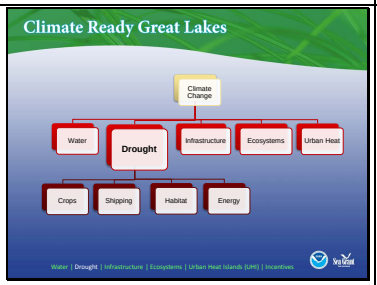
Slide 54		When over a billion gallons of sewage is released into our rivers and lakes from CSOs during heavy rains, water quality diminishes and beaches are closed. CSOs can also negatively affect human health, since waterborne diseases in drinking water can be more prevalent after heavy storm events. For example, in 1993, an outbreak of a parasitic disease (called *Cryptosporidium*) occurred in Milwaukee right after a large storm, causing 400,000 people to fall ill with diarrhea.
Slide 55		One of the most effective ways to address the CSO problem is for a city to undertake a sewer separation project—that is, build a second piping system for all (or part) of the community. However, high capital costs or physical limitations may preclude this as an option for most communities. Another solution is to build a CSO storage facility (such as a tunnel) that can store flow from many sewer connections. Storage tunnels store combined sewage, but do not treat it. When the storm is over, the flows are pumped out of the tunnel and sent to a wastewater treatment plant. Installing retention treatment basins is another option. These large, concrete tanks store and treat combined sewage by (1) sending the most polluted water (from the first part of a storm) to the wastewater treatment plant after the storm and (2) treating the later flows with bleach. Screening and disinfection, or flow-through, facilities treat CSO without ever storing it. They use fine screens to remove solids and sanitary trash from the combined sewage, and inject disinfectant into the flows. All of the materials removed by the screens are then sent to a wastewater treatment plant.

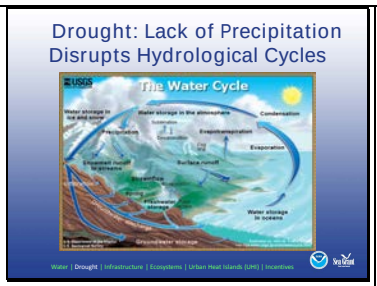
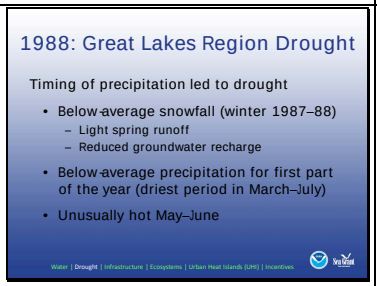
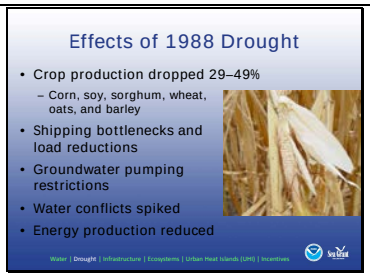
		Finally, one of the least expensive options for dealing with CSOs is to reduce the amount of stormwater runoff created in the first place by using stormwater control measures.
Slide 56		Stormwater Control Measures (also known as Green Infrastructure) attempt to mimic natural hydrology to manage stormwater runoff closer to its source. SMCs reduce runoff volume by allowing stormwater to infiltrate the ground or evaporate after a storm, instead of piping the water offsite. For example, in this photo, water from an impervious surface (the concrete parking lot) flows into a vegetated bioswale, where it is allowed to seep into the ground. This helps to both reduce peak flows and remove pollutants from rainwater. SCMs can be both structural (such as the bioswale) or non-structural (conservation on natural areas). Picture source: http://www.landcareresearch.co.nz/research/built/liudd/casestudies/case_manukau.asp
Slide 57		**Note: Participants can turn to the Stormwater Control Measures handout to follow along with the next 2 slides.** Structural/engineered SCMs help capture and retain stormwater near where it first falls. These SMCs serve multiple functions (such as preventing streambank erosion, flood control, and large-scale habitat provision). Examples of structural SCMs include: • **Bioswales**: a swaled drainage course with gently sloped sides, filled with vegetation, compost, and/or riprap. The swale is designed to remove silt and pollution from surface runoff water and allow water to drain. • **Wet/dry ponds (also called detention basins)**: wet or dry areas sunk into the ground that are designed to collect runoff during rain events. • **Stormwater wetlands**: wetlands constructed to absorb excess runoff from storm events. • **Green roofs**: a roof that is partially or completely covered with vegetation (planted over a waterproofing membrane) that absorbs rainwater as it falls.

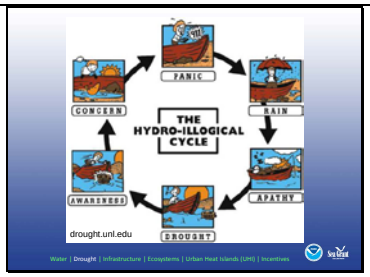
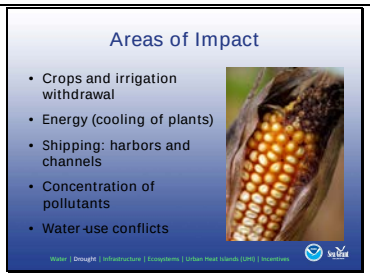
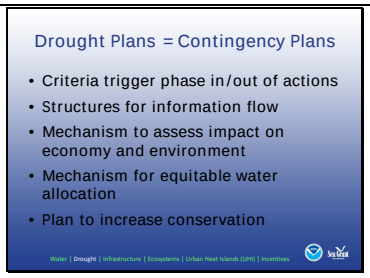
		• **Pervious pavement**: a special type of concrete with a high porosity that allows water from precipitation events to pass through the pavement. Source: NRC Stormwater Report Picture source: http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/BMPs/Bioswale.htm
Slide 58		Another way of dealing with stormwater runoff is by using non-structural SCMs. Non-structural SCMs are generally longer-term and lower-maintenance solutions than structural SCMs, and can also greatly reduce the need for and/or increase the effectiveness of structural SCMs. Examples of nonstructural SCMs include: • **Earthwork minimization**: limiting the degree of clearing and grading on a development site in order to prevent compaction, conserve soils, and prevent erosion from steep slopes. • **Watershed and land-use planning**: making land-use decisions that change the location or quantity of impervious cover created by new development through zoning, watershed plans, comprehensive land-use plans, or Smart Growth. • **Conservation of natural areas**: protecting natural features and environmental resources that help maintain the pre-development hydrology of a site by reducing runoff, promoting infiltration, and preventing soil erosion. • **Reforestation and soil conservation**: improving the quality of native vegetation and soils present at a site by planting trees and plants, tilling, and amending compacted soils to improve their hydrologic properties. • **Impervious cover minimization**: reducing the amount of impervious cover through practices such as reducing street, driveway, and parking lot areas; using permeable pavement; and installing swales and other bio-retention areas near impervious surfaces. Source: NRC Stormwater Report Photo source: http://www.mwvetcon.com/4.html

Slide 59		Stormwater is best managed on a regional or watershed basis (as opposed to relying solely on a site-by-site basis), due to the complexity of both the hydrologic and pollutant processes and their effect on habitat and stream quality. Therefore, SCM implementation is ideally designed as a system, integrating structural and non-structural SCMs and incorporating watershed goals, site characteristics, development land use, construction erosion and sediment controls, aesthetics, monitoring, and maintenance. Source: NRC Stormwater Report, Summary Picture source: http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1187635073613&lang=eng
Slide 60		Communities may need to • Re-evaluate existing regulations governing floodplain and stormwater management and erosion control. For example, even recently updated Flood Insurance Rate Maps (FIRMs) are probably based on historically-derived assumptions and may not account for potential climate change impacts. FEMA has just issued new flood maps and these will help with efforts to update regulations. • Evaluate risks to infrastructure (such as buildings, roads, public services, and energy). • Evaluate risks to community well-being, such as health and water supplies. Often water supplies and waste-water treatment are located in flood-prone areas.
Slide 61		The Menomonee Valley Redevelopment Project is an example of planning ahead to reduce costs of climate change (in this case from more frequent heavy rain events) rather than waiting to react afterwards. This 140-acre redevelopment of abandoned railyards illustrates how a Brownfield site within an existing floodplain can be redeveloped using both onsite and consolidated treatment. Consolidated treatment is incorporated into park areas, which provide recreation for adjacent neighborhoods and also serve as a centerpiece for a developing light industrial area that provides jobs to surrounding neighborhoods. The volume of water that, by regulation, must be captured and treated on individual sites is conveyed through a conventional

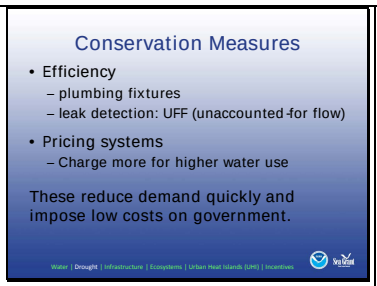
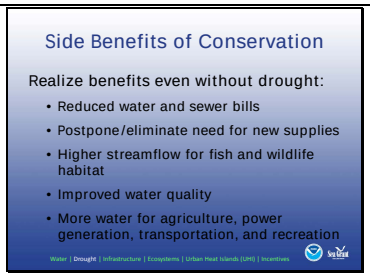
		subsurface system for treatment in park areas. This park area also prevents development in a floodplain and reduces the potential costs of damage during 100-year storm events.
Slide 62		Structural flood prevention is still important. However, regulations may need to be adjusted (such as larger pipe diameters or different configurations of drainage channels). These changes can be incorporated into regularly scheduled maintenance. Picture source: nevada.usgs.gov
Slide 63		Climate change will increase heavy precipitation events and may cause flooding in areas that have not been at risk in the past. Doing an analysis of flood risks using the new FEMA flood maps can help prevent development in areas that may become vulnerable in the future. Anticipating and preventing damage is much easier than restoration afterwards. Setting aside flood-prone areas can have additional benefits. Often areas that are vulnerable to flooding, erosion, storm surge, and other climate change threats have scenic value that contributes positively to community character. Areas that are difficult to serve efficiently (rural, mountainous, or rocky) may also be scenic. Focusing conservation efforts in these areas can reduce risks to human populations while supporting quality of life, economic development, and infrastructure efficiencies. Such conservation can also create buffer zones to minimize climate change stresses on community resources. Wetlands have many important functions including floodplain management. The technical literature on the subject of wetlands management plans developed by the U.S. Army Corps of Engineers and others is quite large, and there are a number of examples of Comprehensive Wetlands Management Plans (CWMPs) available online. Source: APA. *Planning for a New Climate and Energy Future*. pp 69. Picture source: http://www.themoneyalert.com/WhentheWaterRisesArticle.html

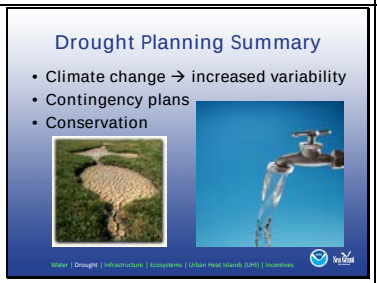
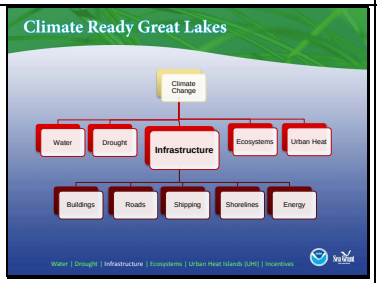
Slide 64		Non-structural flood prevention has gained popularity in regions that have experienced frequent flooding. Often there are FEMA funds that can help with relocation after a major event. For example, flooding has been a frequent problem in Austin, Minnesota, on the banks of the Cedar River. In 1993, flooding damaged 450 homes and the city used buyouts to reduce the number of people in the floodplain. Funded under FEMA's Hazard Mitigation Grant Program and the Minnesota Department of Natural Resources, the acquisition project was administered through the Minnesota Division of Emergency Management. Some residents took advantage of an offer to help them move their homes to higher ground, but they faced the problem of finding vacant land for the houses. Fortunately, the Board of Education had just torn down an old elementary school, and the city purchased the land and gave flood victims preference in buying the lots. In 1994, five homes from a flooded area were then moved to the school land, which also had the added benefit of keeping neighbors together. (The picture shows the homes that were relocated to a higher elevation.)
Slide 65		
Slide 66		Droughts are: • Unpredictable. Consider the 1988 drought, which occurred shortly after 1985's record high precipitation that led to historic high water levels on 4 of the 5 Great Lakes (11/85 – 10/86). The abrupt reversal caught people by surprise. • Difficult to manage. Drought is a gradual phenomenon that has no defined beginning or end; droughts have varying severity and thus affect society differently. • A normal part of North American climate patterns. However, climate change is predicted to make them more frequent in the Great Lakes region.

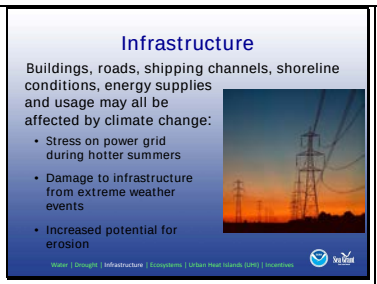
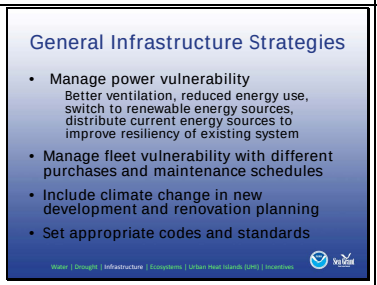
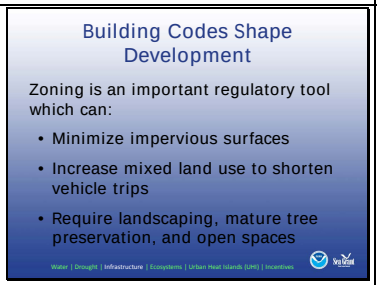
Slide 67		Hydrological cycles normally move water from lakes, oceans, and other bodies of water to the atmosphere by means of evaporation. Water also moves to the atmosphere out of soil and plants through evapotranspiration. Water is then returned to the earth through precipitation (rain and snow). Some of this water runs off into streams, rivers, lakes, and oceans—and some percolates through the soil into the groundwater system. Continuing precipitation shortages eventually lead to reduced groundwater levels, reduced streamflows, and lowered lake levels. Great Lakes Commission. 1989. *Guide to Drought Planning, Management, and Water Level Changes in the Great Lakes*.
Slide 68		In a year with "normal" rainfall totals, the timing of precipitation led to the drought. • Precipitation for the first 7 months of 1988 was 19% below normal. The driest period was March–July, which affected crop planting and root development. • Moreover, an unusually hot May–June led to increased evaporation from lakes, reservoirs, and wetlands. This caused higher water demand in rural and urban areas (for example, as people watered their lawns). This sequence of events caused increased demand at the same time that water resources were decreasing, which hastened the reductions in streamflow and groundwater. August and December had precipitation 33% above normal, so the total for the year ended up "average." Great Lakes Commission. 1988. *Guide to Drought Planning*.
Slide 69		• The impact on crops varied by crop and by state. States experienced large revenue losses (for example, $1.3 billion in Wisconsin). • Low river levels meant shipping bottlenecks on the Ohio and Mississippi rivers. Ships were diverted to Lake Michigan instead of using the canal to the Mississippi River. Ohio River barges carried 40% less cargo in June and revenue dropped 25%. • Water conflicts developed between towns using wells, between rural and urban areas, and between agriculture and residential users. • Electric generation in the Great Lakes relies on lake and stream water for cooling. As lake levels and stream flows drop, intake pipes are

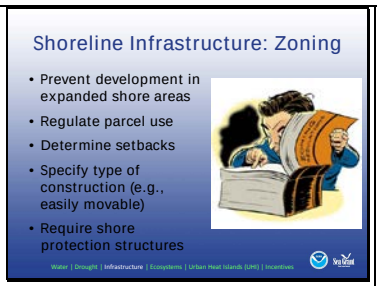
		not able to draw in enough water. Ontario hydroelectric production was reduced by low water levels just as high heat increased demand. Photo source: http://drought.unl.edu/gallery/2003/Missouri/droughtcorn.htm
Slide 70		The greatest barrier to drought planning is human nature—but planning ahead is the key to mitigating drought. It is much easier to get a community to agree to appropriate contingency plans when they are not actually in a panic.
Slide 71		• Crops will require more irrigation. • Power plants may not be able to draw as much water for cooling and will have to reduce capacity. • Shipping channels and harbors may require more frequent dredging. Weight load will need adjustment to reduce draft depth. • Exposed soils may have high levels of pollutants. Soils displaced by dredging may also be contaminated. • Water users will compete and conflicts will increase.
Slide 72		A drought plan is a contingency plan: specific actions will be triggered by defined measurements of drought severity. Implementation requires an organized flow of information among agencies, from agencies to the media, and from agencies to organizations that need to implement actions. It is best to utilize existing state or local water resources for planning and management. The plan should: • Outline actions required for individual citizens, industry, agriculture, and government. Establishing these ahead of time reduces impacts and conflicts when drought occurs. • Include mechanisms to assess how drought impacts the economy and environment, which helps determine priorities for water use when supplies are scarce. This helps in the equitable allocation of water. • Consider increased conservation. Conservation is the first line of defense against drought.

		Educating people about conservation ahead of time can help a community respond quickly, which can be the fastest way to mitigate the impacts—especially if the drought does not last too long.
Slide 73		The U.S. Drought Monitor synthesizes data from multiple sources and provides weekly updates, including a map of conditions for the entire United States. It draws much of its information from USDA, NOAA, and state climatologists. Information about drought planning is available from the National Integrated Drought Information System (NIDIS).
Slide 74		Calculation of drought in Indiana is based on precipitation, streamflow, reservoir levels, groundwater levels, and soil moisture. When the index of these reaches designated levels, the plan recommends specific actions. **Level 1: Watch.** Increase monitoring of water levels. Encourage voluntary conservation (reduced yard watering, outside pressure washing, and car washing; sewer and hydrant flushing; industries encouraged to use recycled water, irrigate less, and reduce employee water usage). **Level 2: Warning.** Voluntary reductions in same areas as Level 1. Adds efforts to reduce irrigation water usage for agriculture, landscaping, nurseries, golf courses, recreation, and gardens. **Level 3: Emergency.** Promote voluntary elimination of all non-essential water use. 15% reduction in agricultural irrigation and shifting of water withdrawals to off-peak hours. Indiana Department of Natural Resources, Water Division. 2009. *Indiana's Water Shortage Plan*. Indiana's plan is not very strict, since it only recommends voluntary compliance at each level of drought. This requires outreach and education to the public and industries who must join the effort. Climate change may require that states develop more stringent plans.

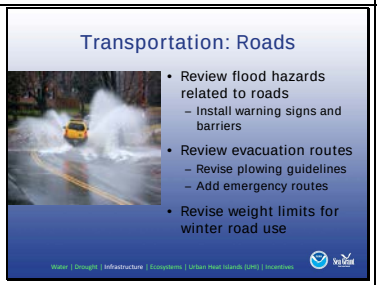
Slide 75		Conservation is the least costly and easiest drought mitigation measure. This can be a first level of response. Leaks or "unaccounted-for flow" (UFF) can cause significant water waste, especially in cities like Chicago that have century-old infrastructure. Illinois now requires municipalities to have a UFF below 8% to get a Lake Michigan water allocation permit. The average UFF in the Great Lakes basin is around 15-16%. Leakage control—water conservation by water suppliers—is a drought management strategy that supports water conservation by water users. Also, there is a big push in northeast Illinois for water metering (rather than per connection or per household flat charges), which also helps give water users direct feedback on their conservation practices. In 1988, communities reduced use by ~25% (for example, by reducing lawn watering and car washing). The Great Lakes Commission study of the 1988 drought found that most of the impacts could have been mitigated by conservation.
Slide 76		Poster source: www.nelsonmandelabay.gov.za
Slide 77		Conservation also raises community awareness of water issues, so that people are more likely to respond to other measures if conditions get worse.

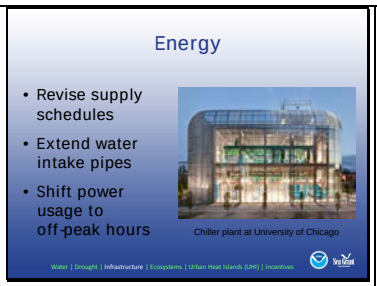
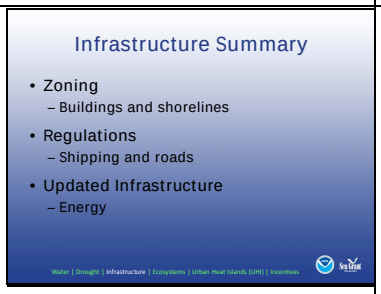
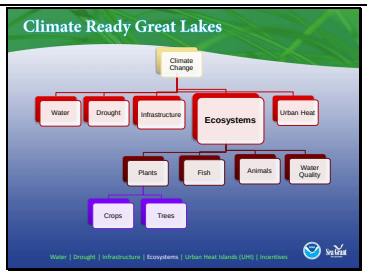
Slide 78		Quakertown, Pennsylvania, relies on wells for its municipal water supply. However, in 1980, the water table was low and the wells were not producing enough water to meet demands. The city developed a conservation ordinance with support from the Pennsylvania Department of Environmental Resources. The ordinance required installation of efficient fixtures in all new construction and in all remodels. This was easy to enforce through the existing permitting process, which also included inspections of the permitted work. The municipality engaged in a public information campaign about the water shortage and the reasons for the new rules through news releases, informational brochures, displays of equipment that would meet the new guidelines, and advertising for new product lines in the stores. The ordinance has reduced water usage so that the well system is able to meet community water needs. The longer the ordinance is in place, the more buildings have efficient fixtures—so it offsets increases in population. Source: Drought Management, 1989 and Quakertown, PA, water department webpage. http://www.quakertownboro.com/water.html
Slide 79		Photo sources: http://www.greenzer.com/blog/tag/charity-water http://www.emd.wa.gov/preparedness/prep_infocus_summerhaz_schoolprep2009.shtml
Slide 80		All of these areas of infrastructure will be affected by climate change, but there are ways to prepare.

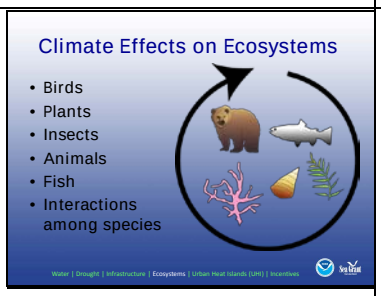
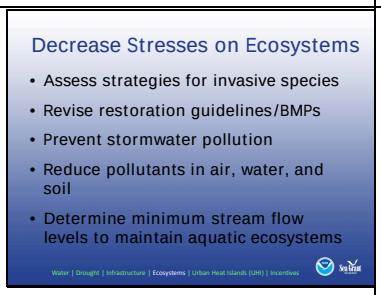
Slide 81		Buildings, roads, shipping channels, shoreline conditions, and energy supplies and usage may all be affected by climate change. Examples of infrastructure impacts include: • Stress on the power grid due to more summer heat waves • Increased annual energy costs due to probable need for additional air conditioning/cooling during summer • Need to get greater penetration of A/C to residential units (particularly in areas of high risk resident populations) • Increased vehicle-fleet replacement and maintenance costs • Damage to key infrastructure (pump stations, electrical distribution equipment, etc.) caused by extreme weather events (temperature and/or precipitation) • Increased wear on buildings due to heat and weather extremes • Increased potential for shoreline erosion/storm damage Photo source: http://home.uchicago.edu/~slaho/stephClass.html
Slide 82		Source: Chicago Climate Action Plan.
Slide 83		Zoning is an important regulatory tool that can: • Minimize impervious surfaces to reduce heat island effects and water runoff. • Increase mixed land use to shorten vehicle trips, which reduces road surface and repair and the need for parking. This also reduces paved land use and preserves natural areas. • Require landscaping, mature tree preservation, open spaces, and other types of “green infrastructure” that help manage stormwater, reduce the heat index, and improve air and water quality.

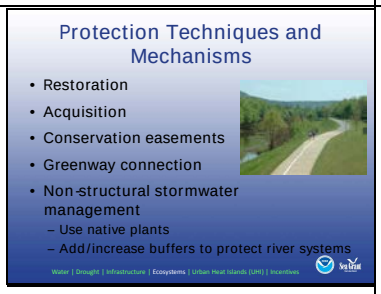
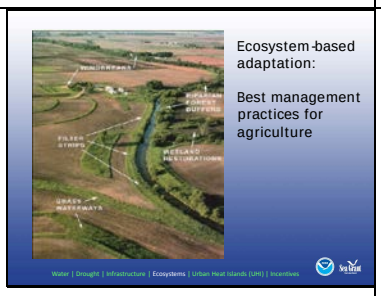
Slide 84		Lower lake levels may increase shore area. Policies for protecting these areas from development should be established beforehand, because preventing development will reduce costs if lake levels fluctuate. Picture source: http://uhelgato.com/2010/06/zoning-in-on-zoning-laws/
Slide 85		Note that although this program is not designated as a climate adaptation program, all the goals help with climate adaptation needs. This is a good example of existing programs that can be linked to adaptation planning. A model ordinance and *Creating an Effective Shoreland Zoning Ordinance: A Summary of Wisconsin Shoreland Zoning Ordinances* are available online at http://dnr.wi.gov/org/water/wm/dsfm/shore/local.htm. NOAA, Planning Guide
Slide 86		If water levels drop, loading/unloading polices may need to be adjusted to require shallower draft boats in ports. Draft depths will need to be monitored to determine when warnings should be sent to shipping companies. Remember the coal ship that ran aground on a sand bar in Lake Michigan a few years ago? Dredging is handled by the federal government. Transport shipping needs take precedence over recreational boating areas. Communities with recreational and tourist harbors may need to start their own dredging funds. Photo source: http://www.greencar.com/articles/plans-improve-air-quality-california-ports.php
Slide 87		Floating docks easily adjust for fluctuating lake levels. This type of infrastructure (common on the salty coast where tides create regular shifts in water level) can be utilized on the lakes to reduce the costs of adapting to lake-level fluctuations. Sea Grant's Clean Marina program is designed to improve management of marinas so that they do not add stress to ecosystems. This protects the

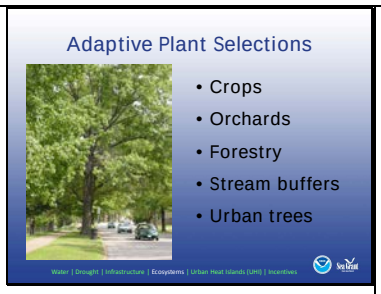
		marine resources that attract the boaters to the water, so they strengthen the basis for this important element of the local economy. **Clean Marina Program** As participants in the Michigan Clean Marina Program, marinas voluntarily pledge to maintain and improve Michigan's waterways by reducing or eliminating releases of harmful substances and phasing out practices that can damage aquatic environments. To date, there are nearly 80 program participants—more than 40 marinas have pledged to work toward certification and more than 30 marinas have been awarded certification. In 2010, 13 marinas were awarded certification and 7 were re-certified. **Achieving Clean Marina Status** In order to receive official certification as a Michigan Clean Marina, participants need to complete a 10-step process, including training, a self-evaluation checklist, and a site visit. Certified marinas strive for continuous improvement in daily environmental stewardship practices. Some of the benefits to becoming a certified Clean Marina include: • Reducing pollution and improving water quality in the Great Lakes • Protecting fish and wildlife habitat • Enhancing public image by promoting environmentally sound practices • Reducing costs by adopting best management practices • Completing Clean Marina training online Marina owners and operators have a resource they can access 24/7 to assist in the certification process: The Clean Marina Classroom. This self-paced, online course includes details on recommended and mandatory practices of the Clean Marina Program. It includes photos and videos of best practices, nine units, and a review of relevant laws and regulations. The text about the Clean Marina Program is from the Sea Grant website at http://www.miseagrant.umich.edu/cmp/index.html.

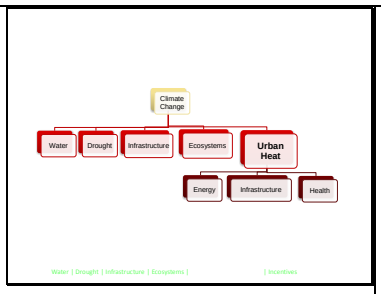
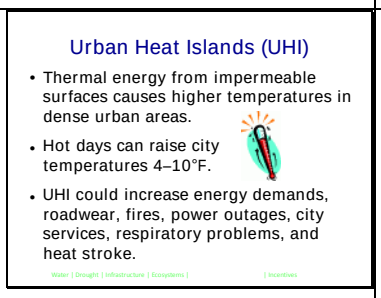
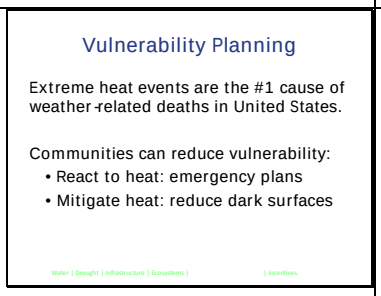
Slide 88		Shore protection structures include walls and jetties that keep sediment in place. Photo source: http://www.merchantcircle.com/blogs/Shoreline.Design.LLC.410-956-4662/2008/5/Living-Shorelines/85824
Slide 89		Beach nourishment makes the beach higher and wider, in order to provide a buffer against wave action and flooding and/or to improve the recreational value of the beach. Sand dunes serve as buffers against erosion and flood, by trapping windblown sand, storing excess beach sand, and protecting inland areas against wave runup and overwash. Sand dunes also provide habitat for wildlife. (NOAA, Planning Guide) Michigan uses “a permit program that regulates earthmoving, vegetation removal, and construction activities within legally defined critical dune areas.”
Slide 90		Any Regional Sediment Management (RSM) plan should include an emphasis on the beneficial use of dredged material. A sediment management program that (1) recognizes sediment as a valuable resource and (2) links needs with appropriate opportunities will be the most effective at reducing economic and environmental losses associated with climate change. (NOAA, Planning Guide) Photo source: http://seacoastdocks.com/dredging.html
Slide 91		• Permanent, remotely activated warning signs free up personnel to focus on higher priority actions during an emergency. • Housing areas that have only one entry road may need to add emergency secondary access roads. This can be added to development regulations. • Dirt roads used for industrial transport (such as logging) often have higher weight limits during the winter, when freezing makes the roads firmer. These may need to be revised.

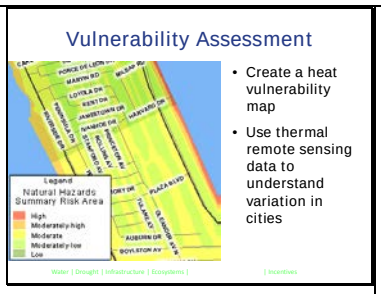
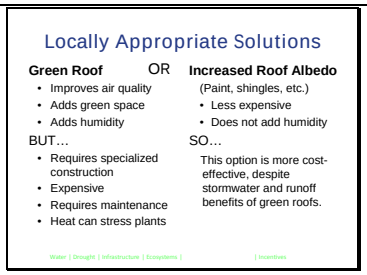
Slide 92		• Plants may have to adjust shipping schedules, because shallower draft means lighter loads of fuel arriving at power plants by ship. • If lake levels drop, extending water intake pipes can help maintain cooling. • Shifting power usage can redistribute energy loads. For example, shift large energy usage to night hours. Consumers Energy provided Kalamazoo College with a $150,000 rebate to install the ice storage part of a chiller plant. The plant draws electricity during the night to create ice and uses the melting ice water to cool the campus during the day. The rebate funded about 75% of the cost of ice storage. The utility saves by being able to serve increasing loads without having to build extra generating capacity. The college saves by buying power during off-peak hours when it is cheaper. A much larger scale example of demand shifting with direct utility involvement is Consumers Energy's pumped storage facility in Ludington, where water is pumped from Lake Michigan by electric pumps during low-demand periods. This water is stored in a reservoir, which is then drained through pumps/turbines to produce electricity during the peak periods of use.
Slide 93		
Slide 94		Climate change is increasing stresses on ecosystems. Reducing other causes of stress promotes resilience.

Slide 95		Definition source:Climate Change Great Lakes report and the IPCC Glossary of Terms (Annex B) http://www.ipcc.ch/pdf/glossary/tar-ipcc-terms-en.pdf Photo source: http://www.kayanase.ca/ECO.html
Slide 96		Climate change will touch all aspects of ecosystems, affecting: • Bird ranges, migrations, food supply, and diseases • Plant ranges, growth patterns, water needs, pollinator relationships, and diseases • Insect lifecycles and ranges • Animal ranges, habitat health, and availability • Fish ranges and habitat quality • Interactions among species
Slide 97		
Slide 98		Reduce the impacts of ecological stressors that constrain the ability of native species to persist as they become stressed by changes in climate. Note that the idea of "invasive species" is in flux. With climate change, indigenous American species are shifting their ranges; so are the native species considered invasive species when they move to a new area? This issue is made more complicated by climate change. • Revise restoration guidelines to address new data. For example, should species of plants and fish being reintroduced be adjusted? • Reduce stresses from human pollutants. • Determine minimum steam flow levels needed to maintain aquatic ecosystems. Reduced precipitation will increase competition for water; setting regulations before this becomes a problem may reduce future conflicts. This is why it is important to study an ecosystem's stream flow requirements and to incorporate these into groundwater regulations.

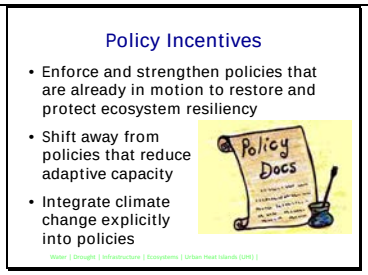
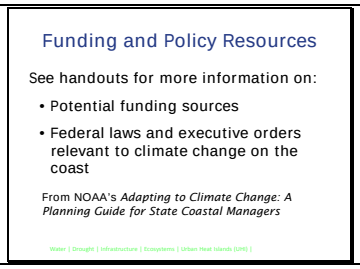
Slide 99		Larger landscapes and waterscapes for biodiversity with internal redundancy and connectivity. Preserve designs need to be able to withstand disruptions in species dispersal and shifting microenvironments. Consider most/least harm to ecosystem when planning for future development.
Slide 100		• Restoration reduces stresses and increases resilience. • Acquisition efforts focus on locating lands that are important for ecosystem health and protects these from development. The value of the ecosystem services (such as protecting water quality, reducing flood and drought risks, and increasing green space for recreation) outweighs the value of development. • Conservation easements restrict changes in land use. These can be adjusted to permit continued farming or timber production, but prevent urbanization and impervious land cover. • Non-structural stormwater management (using green infrastructure) can also improve ecosystem resilience. Using native plants and stream buffers are particularly good win-wins for both stormwater and ecosystems. TNC's Active Rivers model can help determine needed buffer size. These measures can be incorporated into land-use and development guidelines. Photo source: http://www.hsvcity.com/gis/greenways/aldridge.htm
Slide 101		• Setting up buffers along streams that run through agricultural land protects the water from pollutants, while also providing habitat and connective corridors for wildlife. • Trees and vegetation used in the buffers can be selected from native plants with wide ranges of temperature tolerances to ensure greatest resilience. • Some plants are especially good at absorbing pollutants—these could be utilized in areas with urban runoff concerns. • Trees play an important role in ecosystem adaptation because their shade helps cool streams, which reduces stress on aquatic ecosystems.

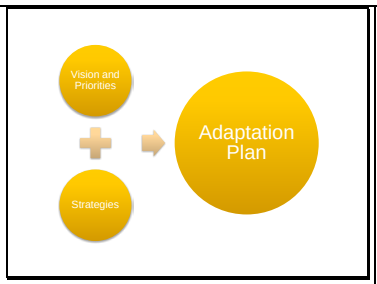
Slide 102		Adaptation planning includes making appropriate plant selections. • **Crops:** Farmers may need to choose varieties of seed that fit new climate patterns. • **Trees:** Trees can't quickly be exchanged for new varieties, so advance planning is important. This is another example of anticipation being easier and more effective than reaction. • **Orchards:** Farmers may need to increase the varieties of fruits they grow, so they have a mix of earlier and later bloom times and a range of harvest cycles. This will help ensure that weather fluctuations from year to year will not eliminate entire crops. • **Forestry:** State forestry programs are already taking climate into consideration in their tree planting programs by adjusting the mix of species they use. • **Urban trees:** Cities need to consider long-term climate predictions when deciding what species to plant along streets and in parks. Most cities have lists of approved trees for urban planting, so these need to be updated.
Slide 103		Land trusts are "non-profit organizations that work with landowners and the community to conserve land by acquiring conservation easements or providing stewardship on the land" (www.landtrustalliance.org/conserve/about-land-trusts). Valuable lands are those with most potential to aid with adaptation. **Case Study: Milwaukee, Wisconsin** Milwaukee Metropolitan Sewerage District partnered with the Conservation Fund to manage floodplains in the Milwaukee watershed. The plan identifies undeveloped private properties that could provide future flood prevention benefits, but that are at risk for development. The Conservation Fund then works to acquire properties through conservation easements or outright purchase. Photo source: http://flooksolutions.com/id4.html

Slide 104		
Slide 105		
Slide 106		
Slide 107		Emergency response plans are activated when heat rises above a specified level. These plans may include sending out requests for neighbors to check on each other, setting up cooling centers and providing transportation to bring people to spend the day, providing free public transit to city swimming pools, and distributing fans. Mitigation involves reducing the dark surfaces that transform light into heat and raise the temperature. This can be achieved by changing roof colors and adding green space.

Slide 108		Identifying the hottest areas helps a city target its emergency response plans. Thermal data can be combined with neighborhood information about types of buildings, income levels, and ages of residents. Low-income areas with older building are less likely to have air conditioning, and senior citizens are susceptible to heat-related health problems. These high risk areas may also have less green space and limited access to transportation. Module 3 describes tools that can help with thermal remote sensing data.
Slide 109		
Slide 110		This picture of a park area along Lake Shore Drive in Chicago shows a tree barrier. • Tall trees and banks of trees that are parallel to the shoreline can block the flow of wind as it shifts directions throughout the day. • Alleyways of trees perpendicular to the shore let more wind flow through and are more effective for reducing heat. Shorter trees let more air through, but still provide park shade. Photo source: travel.webshots.com
Slide 111		There may be cases where a green roof is the best choice. For example, a large city may benefit from increasing green space since that adds outdoor space, improves air quality, and can increase humidity. However, green roofs are more expensive and are probably not appropriate for smaller towns—especially if humidity is already high.

Slide 112	**Summary of Urban Heat** Emergency planning: • Cooling centers • Transit to pools Reduce dark surfaces: • Lighten roofs • Increase green space Water | Drought | Infrastructure | Ecosystems | | Incentives	
Slide 113	**Financial and Regulatory Incentives** Use of Policies and Regulations to Promote Adaptation Water | Drought | Infrastructure | Ecosystems | Urban Heat Islands (UHI) |	This section provides an overview of resources that can help with implementation of adaptation measures
Slide 114	**Financing Approaches** • Most existing financing approaches for adaptation are reactive. • A more effective approach would be having an adaptation financing structure built-in to local policies. Water | Drought | Infrastructure | Ecosystems | Urban Heat Islands (UHI) |	Most financing approaches for adaptation are reactive—responding to a crisis instead of trying to prevent one. Shifting to an approach that has an adaptation financing structure built-in to local policies would give communities more flexibility to respond to climate change challenges as they happen. Source: Preparing for Climate Change in the Great Lakes Region, Sea Grant and UM Photo source: http://www.usm.edu/aredjournal/archive_ared/archives_pages/topically_archives_home.html
Slide 115	 **Fiscal Incentives** • Use finances to discourage damage to ecological resiliency and encourage increased adaptive capacity • Adjust existing financing mechanisms to support activities that increase adaptive capacity Water | Drought | Infrastructure | Ecosystems | Urban Heat Islands (UHI) |	Communities can use fiscal incentives (such as tax structure, subsidies, and funding opportunities) to discourage actions that damage ecological resiliency and encourage those that increase adaptive capacity. For example, communities could charge for actions that reduce ecological resiliency, such as developing a wetland. This could create a pool of funding for restoration and adaptation measures—such as providing subsidies for actions that increase resiliency (for example, wetland restoration). Additionally, existing financing mechanisms could be tweaked to support activities that increase adaptive capacity. For example, the Clean Water State Revolving Fund is a low-interest loan financing program that assists municipalities with funding water quality projects. This fund currently

		supports grey infrastructure projects (i.e., bricks and mortar construction), but could shift to focus on green infrastructure (such as constructing green roofs or bioswales). Source: Preparing for Climate Change in the Great Lakes Region, Sea Grant and UM Photo source: http://www.dnrec.delaware.gov/Admin/DelawareWetlands/Pages/DelawareWetlandsConservationStrategy.aspx
Slide 116		Communities could also enforce and strengthen policies that are already in motion to restore and protect ecosystem resiliency, as well as shifting away from policies that reduce adaptive capacity. One example would be phasing out perverse subsidies (such as insurance programs that encourage development in floodplains and vulnerable coastal zones). Communities could also explicitly integrate climate change into existing and new policies, such as shoreline ownership and pollution permitting. One example of this would be updating floodplain permits to align with the new FEMA flood maps that have recently been released.
Slide 117		Local governments can create their own incentives to promote climate resiliency such as: • Expedite plan review and other financial incentives for projects that meet or exceed climate objectives • Waive permit fees for projects that enhance ecosystem resiliency and/or adaptive capacity • Give rebate and trade-in incentives for home and business upgrades on environmentally-friendly products • Provide technical assistance to help developers meet new goals and standards—and give financial incentives to developers whose projects meet predetermined standards • Offer community financing mechanisms to offset start-up costs for green infrastructure projects
Slide 118		

Slide 119		The planning process outlined in the first part of this presentation sets the framework for assessing what climate impacts are most likely to affect a specific community. With this background, people can evaluate strategies for climate adaptation that are locally appropriate. Samples of such strategies were covered in the second part of the presentation, but there are many more ideas than could be included here. Hopefully, this introduction to adaptation planning and adaptive measures has given you a sense of what is possible—so that you have a place from which to start developing a climate adaptation plan.