

Adapting to Climate Change in Minnesota

*Preliminary Report of the Interagency
Climate Adaptation Team*



Minnesota Pollution Control Agency

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Background

A changing climate has the potential to cause disruptions in ecological, economic and social systems. Adapting to changes in climate includes developing strategies, initiatives and measures to help natural and human systems thrive as our climate changes. Adapting effectively can limit damage, reduce costs, and ease the transition to a changing regional climate. It makes sense to plan ahead to be better prepared to deal with the result of those changes.

In July, 2009, an Interagency Climate Adaptation Team (ICAT) began to explore the potential effects of climate change in Minnesota and develop an adaptation plan for the state. The ICAT includes representatives from the Departments of Agriculture, Commerce (Office of Energy Security), Health, Natural Resources, Public Safety (Division of Homeland Security and Emergency Management) and Transportation, and the Pollution Control Agency. This report, the first work product of the team, is a preliminary assessment of how climate change may affect Minnesota and a framework for future planning, investigation and action.

It is important to note that the ICAT efforts are focused solely on adapting to the effects of a changing climate in Minnesota. Efforts to mitigate – i.e., reduce greenhouse gas (GHG) emissions – are entirely different than efforts to adapt. See www.state.mn.us/mn/externalDocs/Commerce/Greenhouse_Gas_Emissions_Reduction_Report_2009_011510030930_GreenhouseGasEmissions2009.pdf for information about GHG reductions goals and efforts in Minnesota. Also note that the ICAT is not considering why the climate is changing, only how to adapt to a changing climate. In a parallel effort, the University of Minnesota Water Resources Institute is facilitating communication within Minnesota's scientific and academic communities. This effort is called the Climate Change Adaptation Working Group. Their focus is research and education. Together, these efforts should position Minnesota well to begin addressing this challenge. A small but growing number of states have initiated climate change adaptation activities. States that are farthest along in adaptation planning generally have coastal population centers and are concerned about rising sea levels and/or are relatively arid and have limited freshwater supplies. Most state efforts are currently focused on refining climate change forecasts and assessing potential risks.

In the Midwest, Wisconsin has the most robust adaptation effort underway. There are potential opportunities for collaboration with Wisconsin, particularly in the area of regional climate change forecasting. Regional collaboration and partnerships will play an increasingly important role as Minnesota develops and evaluates adaptation strategies to address ecological and public health impacts.

Minnesota's Climate is Changing

The issue of climate change is currently the subject of intense political controversy and debate. Foremost in this debate is the question of whether and how to go about reducing the emissions of greenhouse gases. Intertwined are the issues of whether the climate is changing at all, the degree to which human activity is responsible, and what the future climate will be. In Minnesota,

extensive weather observations recorded over decades have led scientists to conclude that the climate in this region is changing. Dr. Mark W. Seeley, Professor in the College of Food, Agriculture and Natural Resource Sciences at the University of Minnesota states:

“During the three most recent decades, the Minnesota climate has shown four very significant trends, all of which have had many observable impacts. These four trends are statistically detectable in the data of most – though not all – of the state’s climate stations: (1) warm winters, during which higher temperatures have been both persistent and substantial; (2) higher minimum temperatures; (3) increased episodes of high summer dew points; and (4) greater annual precipitation, most profoundly in seasonal snowfall and thunderstorm rainfall. ...it appears these climate trends are not about to reverse themselves.”¹

The impact of warmer winters results in a reduction in the duration and depth of soil freezing; a change in the onset, thickness and duration of ice cover on lakes; and greater over-winter survivability of microbes, insects and pathogens. Warmer winters and higher minimum temperatures can also lead to a longer freeze-free growing season and construction season, and reduced consumption of energy for heating. Higher dew points result in more high heat index days, potentially causing heat stress on plants, animals and humans. Greater snowfall generally leads to greater spring runoff and flooding potential. Finally, increased thunderstorm intensity and frequency stresses water-related infrastructure and increases the chance of flash flooding. There are many other issues of potential significance that can result from the four basic climate changes discussed here. ICAT will continue to rely on Minnesota climate and weather experts to guide and refine our efforts.

Potential Impacts of Climate Change in Minnesota

- More spring flooding events
- More frequent flash flooding events
- Increased threat of waterborne disease due to more overflows from coupled sanitary and storm sewer systems
- More invasive species, with accompanying impacts to ecosystems and economy (e.g. agriculture, tourism)
- Accelerating extinction or extirpation (i.e., no longer found locally) of plant and animal species
- Longer growing seasons may increase yields of some crops
- Changes in duration of allergy season and pollen loads and types; increased impacts on respiratory illness associated with aero-allergens
- Chemical and biological changes to lakes and streams
- Increased periods of drought
- More wildfire events
- More extreme heat events, increasing the potential for heat-related illness or death (e.g. heat stroke, heat exhaustion, acute dehydration)
- Changing spatial patterns and incidence of vector-borne and zoonotic diseases (e.g. Lyme disease); possible emergence of new disease vectors

¹ Seeley, Mark W. *Minnesota Weather Almanac*. Minnesota Historical Society Press, 2006.

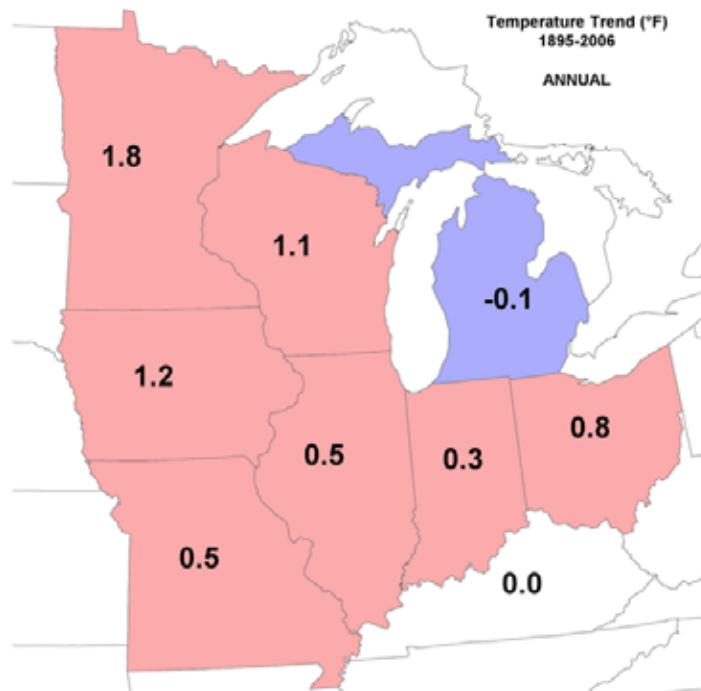
- Changes in established outdoor recreational opportunities
- Lower water levels and changing shorelines on Lake Superior
- Degradation in air quality and visibility, with possible increased illness and death due to increased ambient fine-particle and ozone concentrations
- Changes in energy usage: less heating in cold season but more cooling in warm season
- Increased spending on infrastructure, as some of Minnesota's built infrastructure is not adequate to deal with these potential changes.

Summary of Climate Change Data

While trends in long-term climatic conditions will always be subject to some uncertainty, the general consensus is that the state of Minnesota is in the midst of a long-term warming trend. The observed 100-year surface warming trend is generally between 1.5 and 2 degrees Fahrenheit.

Minnesota isn't the only Midwestern state whose surface climate is warming. The long-term warming estimated by the Midwestern Regional Climatic Center is shown for Minnesota and other Midwestern states in Figure 1. The warming over Minnesota since 1895 is possibly the most intense in the region, perhaps twice or even three times the rate of warming in other Midwestern states.

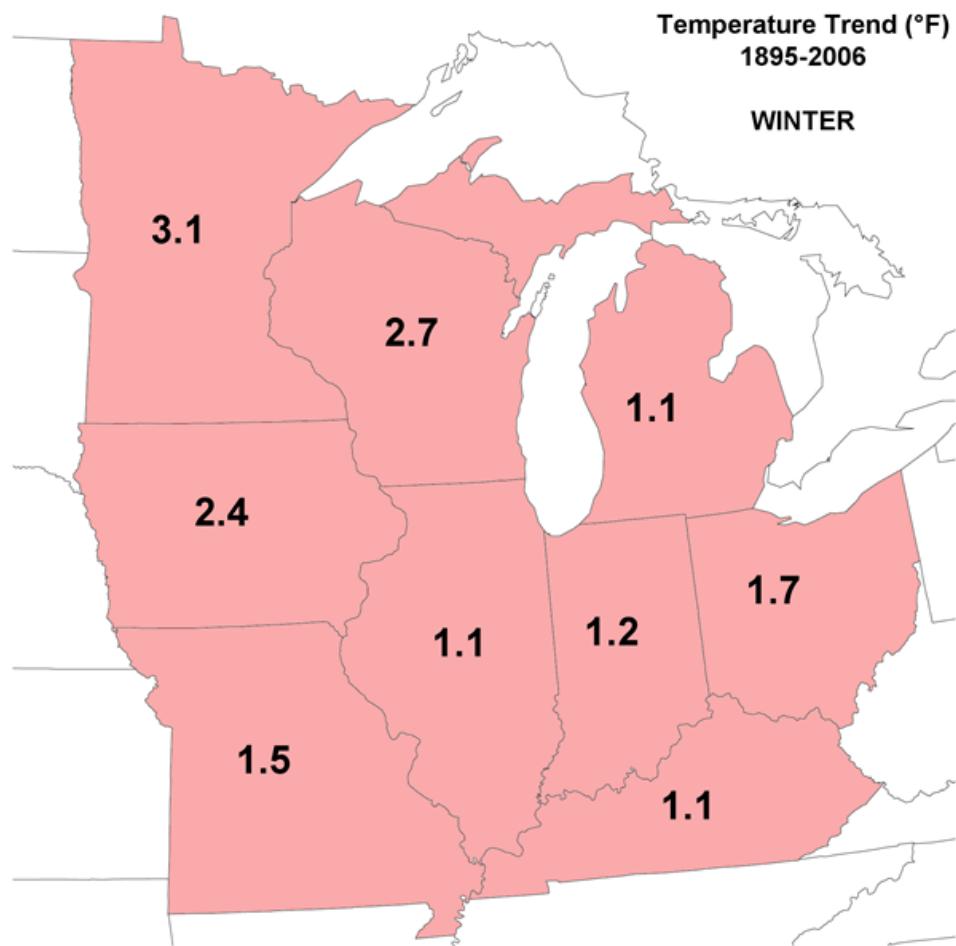
Figure 1. Annual average change in temperature, 1895-2006 (°F)



http://mcc.sws.uiuc.edu/climate_midwest/mwclimate_change.htm#

The surface warming over Minnesota appears to have been more intense in the northern two-thirds of the state and most intense during winter and at nighttime. Based on the analysis developed by the Midwestern Regional Climatic Center, Minnesota winter surface temperature may be three degrees Fahrenheit warmer now than in 1900, and may be warming at a rate perhaps double or triple that for Midwestern states to our east or south (See Figure 2).

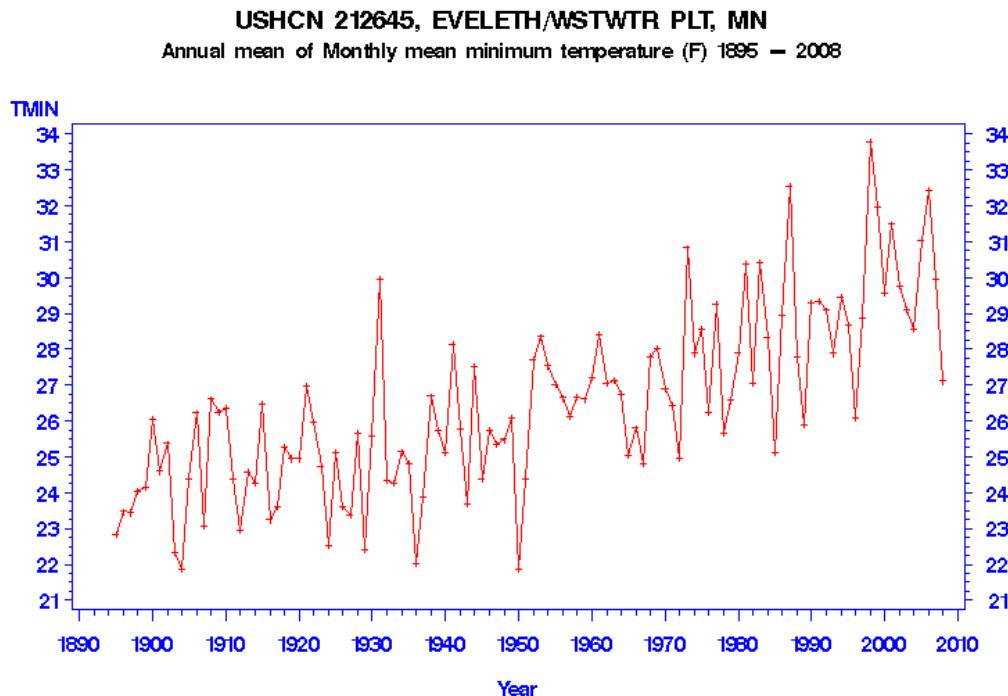
Figure 2. Average annual temperature change -- winter, 1895-2006 (°F)



http://mcc.sws.uiuc.edu/climate_midwest/mwclimate_change.htm#

Much of this warming appears to have resulted from an increase of daily low temperature, which is generally experienced at nighttime, rather than an increase in daily maximum temperature. The trend in monthly mean minimum temperatures for Eveleth, Minnesota, is shown in Figure 3 (next page). The trend at this location is generally suggestive of the larger trend in monthly mean minimum temperature throughout much of Minnesota -- if not in degree, in direction. As the Eveleth trend suggests, a good part of the surface warming that has been observed since 1895 is probably the result of a persistent rise in daily low temperatures.

Figure 3. Annual mean monthly temperature, 1895-2005, Eveleth (°F)



Source: MJ Menne, CN Williams Jr., RS Vose, NOAA, National Climatic Data Center, Asheville, NC

http://cdiac.ornl.gov/epubs/ndp/ushcn/monthly_doc.html

Finally, the data support the conclusion that Minnesota's climate is wetter now than 100 years ago (See Figure 4, next page). The observed increase in wetness has been across all seasons and probably represents about an average 10% increase since 1900 in annual wetness. Trends in the frequency of extreme storm events appear to be following these larger wetness trends.

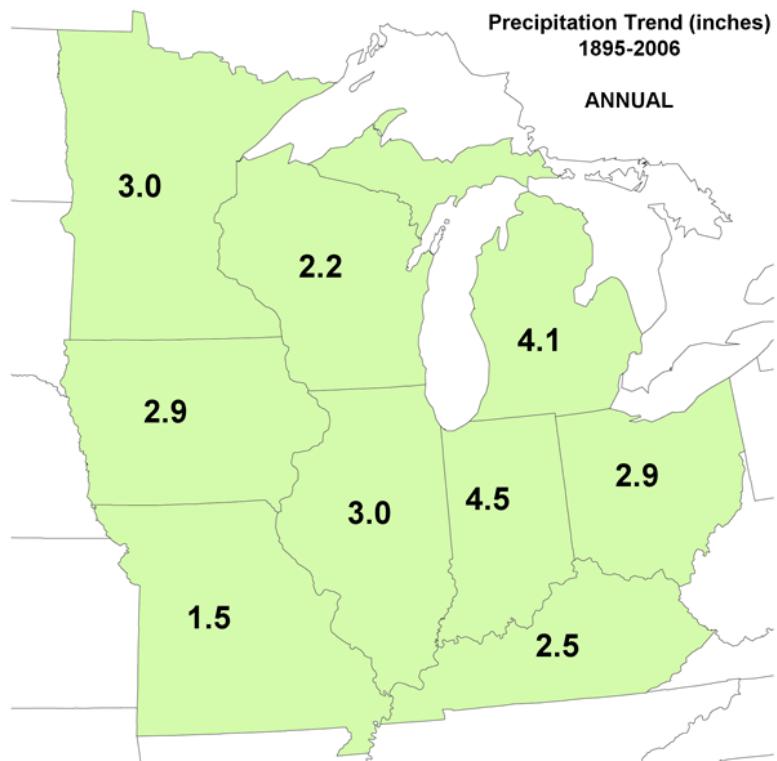
Current and Proposed State Department Adaptation Efforts and Actions

Minnesotans, through various mechanisms, are already taking numerous actions to reduce traditional energy use and reduce greenhouse gas emissions. Less emphasis and attention has been given to actions being taken to begin adapting to a changing regional climate. The efforts listed below highlight a few of those already underway at key state departments to prepare for a changing climate in Minnesota.

Minnesota Department of Agriculture

- Working on cover crops for mainstream cropping systems (i.e., aerial seeding in corn and soybeans, cover crops after silage, cover crops after canning crops).

Figure 4. Annual precipitation trend, 1895-2006 (inches)



http://mcc.sws.uiuc.edu/climate_midwest/mwclimate_change.htm#

- Initiated biological control work on weeds, pest identification and integrated pest management education for fruit growers, and an increase in noxious weed education.
- Applied for USDA Federal-State Marketing Improvement Program grant to develop marketing materials that address climate change challenges and opportunities for agriculture producers (grant was not awarded).
- Established an internal Air Quality Team to ensure better coordination and communication of climate change and other air quality-related activities.
- Administering the Agricultural Land Preservation Program through work with various local units of government.
- Providing technical land-use planning expertise to various local units of government.
- Tracking efforts by the federal government to gain expertise regarding how climate change information can be utilized during the land protection planning process.

Minnesota Department of Commerce - Office of Energy Security

- Aggressively promote Minnesota's Renewable Portfolio Standards to increase the percent of renewable energy capacity.

- Actively pursue the reduction of greenhouse gases and expand the role of energy conservation via energy efficiency efforts as codified in the 2007 Minnesota Next Generation Act.
- Collaborate with other state agencies to develop specific data in similarly affected areas.
- Monitor utilities' short- and long-term generation, transmission and distribution plans.
- Maintain an annually updated "Minnesota Resource Assessment."
- Continually interact with other states, provinces and regional entities (specifically, Midwest Independent Transmission System Operators).
- Establish and refine analytical tools to model long-term energy needs under changing seasonal and annual consumption patterns.

Minnesota Department of Health

- A Climate Change Adaptation Workgroup that includes program staff and managers throughout MDH and local public health representatives is developing a five-year climate change adaptation strategic plan for the agency.
- *Public Health Impacts of Climate Change*, a white paper including background on climate change, public health impacts and response, resources, and health outcome indicators was written and disseminated in 2008.
- A 2009-10 grant from the Association of State and Territorial Health Organizations was received for an initial assessment of MDH capacity to address the public health consequences of climate change.
- A subgroup of the Climate Change Adaptation Workgroup was formed and a coordinator hired to complete the grant requirements.
- MDH staff were surveyed regarding their knowledge of climate change and public health impacts.
- Based on the survey results, an introductory training for public health staff is being developed and will be disseminated by summer 2010 via Webinar on four topics: basic climate change science, vector-borne disease, extreme heat and weather, and vulnerable populations.
- The Workgroup is actively seeking additional federal funding.
- A project for mapping vulnerable populations for flooding and other extreme weather events is currently underway.
- Program level work regarding climate change adaptation is occurring around the following public health activities: environmental public health tracking of climate change indicators, infectious disease and vector borne disease, asthma, children with special needs, emergency preparedness, health risk assessment, drinking-water protection and well management, food safety, licensed facility health and safety, and chronic disease.
- MDH is actively participating in national and state initiatives to develop environmental health indicators of climate change (i.e., development of indicators of heat-related morbidity and mortality through the Minnesota Environmental Public Health Tracking Program). These indicators may be used to develop training for public health professionals, target education and outreach (i.e., emergency response planning for extreme weather events), and evaluate the effectiveness of policy actions to protect public health.

Minnesota Department of Natural Resources

Over the past 10 years, DNR has taken numerous actions to address climate change. Actions can be grouped into several categories:

1) Awareness building

- Hosted a forum for DNR senior managers to learn from experts about climate change and its implications for natural resources management (2006).
- Organized a climate change symposium at major state natural resource professionals' conference (2010).
- Planning to develop a communications and education plan for Department staff (2010).

2) Analysis and capacity building

- Began implementing recommendations from a preliminary assessment of climate change implications for DNR's Section of Wildlife (2009).
- Managing and analyzing climate data, and providing public access to climate information by State Climatology Office (administered by DNR) in conjunction with Extension Climatology (U of M) (ongoing).
- Enhanced lake monitoring through the Sustaining Lakes in a Changing Environment and MPCA partnerships (ongoing).
- Assessing the needs for climate downscaling for vulnerability assessments and other uses (2010).
- Conducting vulnerability assessments to determine the species, key habitats, resources, and operational activities most vulnerable to climate change (2010-2011).
- Developing agency-wide climate change adaptation strategies and management guidance based on vulnerability assessments and other sources (2010-2011).
- Coordinating with our federal partners (Geological Survey and Fish and Wildlife Service) on the development and implementation of the new National Climate Change and Wildlife Science Center, Landscape Conservation Cooperatives, and the National Fish and Wildlife Climate Adaptation Strategy (2008-present).

3) Planning and policy development

- Established climate change mitigation and adaptation as one of eight agency strategic priorities in DNR's *Strategic Conservation Agenda* (2009).
- Established a Climate and Renewable Energy Steering Team, and four supporting sub-teams, to advance the adaptation and mitigation priorities (2009).
- Convened the Moose Advisory Committee to evaluate the population status of Minnesota's moose and develop expert and stakeholder-driven recommendations (2009).
- Organized a DNR staff Climate Change Adaptation Scoping Discussion to begin to identify approaches and organization needs for reviewing and developing adaptation strategies (2009).
- Developing an agency-wide strategic guidance framework.

Minnesota Pollution Control Agency

- Water quality monitoring:
 - Initiated a watershed-focused monitoring design to help provide better spatial resolution of stressors.
 - Initiated a statewide random monitoring program to develop long-term trends on a large scale.
 - Integrate biological, physical and chemical monitoring to develop relationships between environmental factors (including climate) and aquatic life.
- Developed biological indices for fish and invertebrates to measure response.
- Developed approaches to reduce stormwater runoff through low impact development.
- Continued monitoring for climate-influenced air pollutants.

Minnesota Department of Public Safety - Division of Homeland Security and Emergency Management

- Continue collaboration and information sharing with stakeholders.
- Develop climate adaptation goals, strategies and action plans for inclusion in the 2011 State All Hazard Mitigation Plan update.

Minnesota Department of Transportation

- Participate in the Interagency Climate Change Adaptation Team, working with other state agencies on the issues of adapting to a changing climate in Minnesota.
- Continue to stay informed on transportation-related climate adaptation strategies, through participation in Federal Highway Administration, American Association of State Highway and Transportation Officials, Transportation Research Board and other climate adaptation education opportunities.
- Continue participation in the pooled fund study entitled “U.S. Precipitation Frequency Estimates for the Midwestern Region” to update flood hydrographs. This will assist with determining needed design changes of hydraulic structures to adapt to changing runoff conditions caused by the stressors of increased frequency and intensity of rainfall events.
- Organize a cross-functional group within the Department that will review how climate change stressors will affect current design standards, maintenance and construction operations, determine if changes may be necessary, and how implementation will occur.

Information Gaps/Research Priorities

In December 2009, a Summit was held between key academic researchers and state department staff to discuss what is currently known about climate change in Minnesota and the surrounding region. Through that effort and others underway at the departments, a preliminary identification of critical data and information needs was developed. Further work and collaboration with the academic community and others will be needed to better develop and prioritize research needs, and this work will continue into the future.

Common to all state departments is the need for better tools to project future climate response (temperature, precipitation and drought) at relevant scales and to assess uncertainty in these

projections. Current output from global climate models, while extremely useful, does not provide the geographic resolution needed to develop comprehensive and effective response plans.

Department-specific needs and activities are listed below:

Minnesota Department of Agriculture

- Research on possible positive interactions between cover crops, conservation tillage, and manure as they relate to northern agricultural systems.
- Research on weed and pest control impacts (potential staffing needs/changes).
- Research on livestock feed and health impacts (potential staffing needs/changes).
- Data on predicted commodity price impacts, research on how domestic and international clients/partners may respond, information on whether producers of similar commodities in other regions and countries will face same problems or will potentially take over Minnesota market opportunities.
- Understanding of federal climate change regulations and legislation.

Minnesota Department of Commerce - Office of Energy Security

- There is the need for more detailed flood plain data for rivers on which electric generation facilities are located.

Minnesota Department of Health

- Periodic updates by agencies about programs/actions or new information in their areas.
- Conduct a gap analysis of climate change impacts on Minnesota's food security system regarding food-borne and waterborne diseases.
- Expand current food safety and protection collaboration between MDH and MDA to include those food supply issues that may present as a result of climate change.
- Determine the public health threat from waterborne diseases spread by overflowing combined sanitary and storm sewers.
- Research vulnerabilities of specific populations to public health impacts of climate change and develop adaptation strategies to resolve the issues.
- Research climate change impacts of vector-borne and zoonotic disease in Minnesota.
- Research the impact of increased allergens such as pollen on public health.
- Conduct a gaps analysis regarding the implementation of the MDH climate change strategic plan.
- Build upon NDH climate change adaption activities to assist local public health workers with training and outreach.
- Developing and disseminating information about environmental health indicators of climate change to inform strategic planning, training, and education.

Minnesota Department of Natural Resources

- Comprehensive, spatially explicit vulnerability assessments to determine the species, key habitats, resources and operational activities most vulnerable to climate change.

- A survey to assess DNR staff understanding of climate change and its impacts, and associated DNR staff training needs.
- Better understanding of stakeholders' and the public's knowledge and attitudes regarding climate change and its potential impacts on Minnesota.
- Strategies that maximize resilience of Minnesota's natural resources to climate change.
- Improved information exchange among researchers, managers, and stakeholders.
- Improved monitoring and database infrastructure to rapidly detect natural resource changes and inform appropriate management and policy responses.
- Staff training on formal methods for making the best decisions in the face of uncertainty.

Minnesota Pollution Control Agency

- Need to continue following ongoing studies to better understand the effects of climate change on fine particle and ozone concentrations.
- Estimates of the ranges of variability and extremes that we are likely to encounter, so that these can be factored into manure storage-area design.
- Relationship between temperature and mercury methylation rate.
- Evaluation of biological and chemical rate coefficient changes with temperature increases.
- Bioassessment tools that consider climate change as a potential stressor and attempt to incorporate potential differences in response and sensitivity to climate change among aquatic habitat types.
- The MPCA will work to meet strategic plan goals, adjust guidelines and standards accordingly, and continue to develop the watershed integration system. MPCA would like to develop a more complete perspective on biological and chemical rate changes, and expand thermal monitoring of aquatic systems.

Minnesota Department of Public Safety- Division of Homeland Security and Emergency Management

- Need more concrete data about climate change (temperature, precipitation, drought).
- Identify effects of co-stressors (population, future land use).
- Continue collaboration with other agencies.
- Participate in information sharing.

Public Safety will continue collaboration and information sharing with stakeholders and develop climate adaptation goals, strategies and actions plans for inclusion in the upcoming State All Hazard Mitigation Plan, update due in April, 2011.

Minnesota Department of Transportation

- Updated hydrograph information (being addressed in the pooled fund research study).
- Risk analysis (routine maintenance versus retrofits).
- Availability of funding.

Conclusion

The Interagency Climate Adaptation Team will continue to coordinate activities among state departments and will collaborate with the University of Minnesota Climate Adaptation Working Group on climate adaptation research priorities. The Team will also begin developing a long-term strategic plan including goals and objectives. As that planning effort proceeds, the Team has identified some key priorities for the next year.

- Existing regional climate change forecasts are imprecise and efforts should be made to improve their accuracy and resolution.
- Current efforts to coordinate and expand the collection of benchmark environmental data should be leveraged to build a climate monitoring infrastructure capable of detecting climate change impacts and informing appropriate management and policy responses.
- Initial review of potential risks suggests increased spring flooding and flash flooding are of most near-term concern. Refined assessment of flooding potential should be a priority.

Next Steps

- Work with the Climate Change Adaptation workgroup at the University of Minnesota and others to refine and downscale climate change forecast models for the region as a basis for vulnerability assessments. (Lead MDNR State Climatology Office)
- Explore federal funding opportunities. (ICAT)
- Adapt environmental monitoring for climate adaptation needs. (MDNR/MPCA)
- Begin assessing public awareness and concern about adaptation. (MDNR)
- Assess existing efforts and engage communication and outreach with local units of government and other stakeholders. (ICAT)
- Identify appropriate steps to further assess vulnerabilities from extreme weather events.
- Identify opportunities for interagency collaboration on climate adaptation. (ICAT)
- Inventory existing state climate data sources.