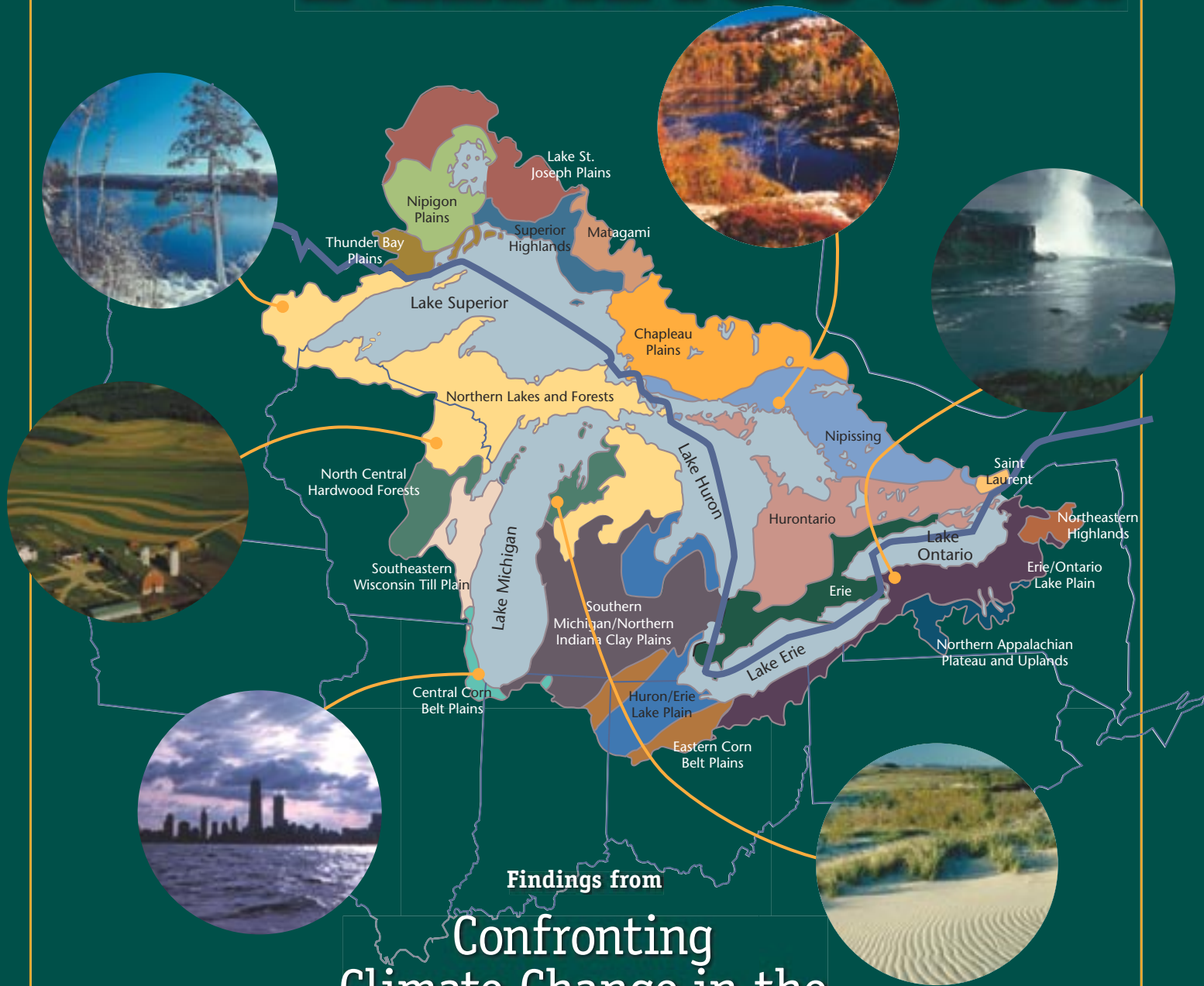


Minnesota



Findings from

Confronting Climate Change in the Great Lakes Region

Impacts on Minnesota Communities
and Ecosystems

Climate Change in the Land of 10,000 Lakes

Much of Minnesota's character is defined by water, from Lake Superior to the thousands of inland lakes to the headwaters of the Mississippi River. This summary highlights the potential impacts of climate change on Minnesota's economy, its people, and the places they love.

Scientists are now convinced that human activity, primarily burning fossil fuels to produce electricity and drive our cars, is changing our climate. These activities emit gases, principally carbon dioxide (CO₂), that blanket the planet and trap heat. Already, we are seeing signs of climate change throughout the Great Lakes region: average annual temperatures are increasing; severe rainstorms have become more frequent; winters are getting shorter; and the duration of lake ice cover is decreasing.

Climate Projections

The latest, most reliable projections of future climate change combine 100 years of historical data for Minnesota with the most up-to-date general circulation models of the Earth's climate system. In general, Minnesota's climate will grow considerably warmer and probably drier during this century, especially in summer.

- **Temperature:** By the end of the 21st century, temperatures are projected to rise 6–10°F in winter and 7–16°F in summer. This dramatic warming is roughly the same as the warming since the last ice age. Overall, extreme heat will be more common and the growing season could be 3–6 weeks longer.

- **Precipitation:** While annual *average* precipitation may not change much, the state may grow drier overall because rainfall cannot compensate for the drying effects of a warmer climate, especially in the summer. Seasonal precipitation in the state is likely to change, increasing in winter by 15–40% and decreasing in summer by up to 15%. Minnesota, then, may well see drier soils and perhaps more droughts.

- **Extreme events:** The frequency of heavy rainstorms, both 24-hour and multiday, will continue to increase, and could be 50–100% higher than today.

- **Ice cover:** Declines in ice cover on the Great Lakes and inland lakes have been recorded during the past 100–150 years and are expected to continue.

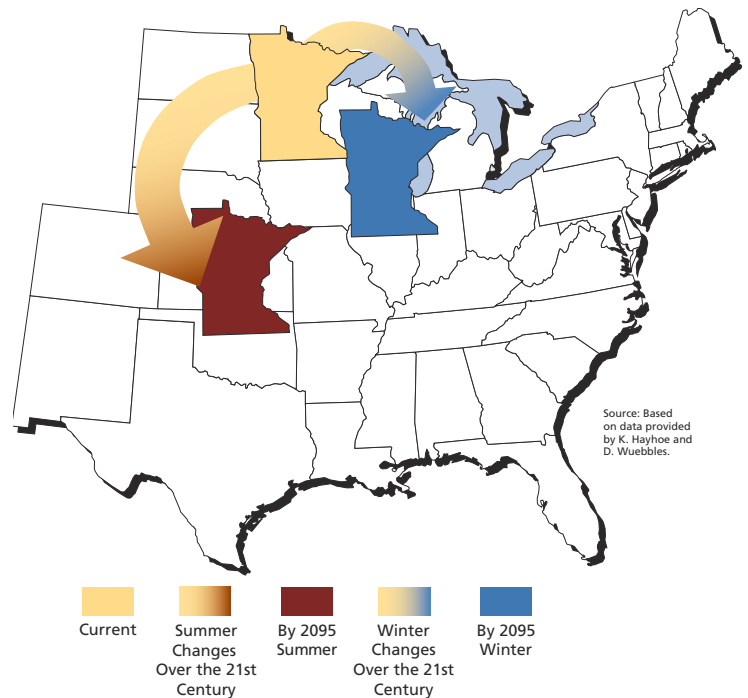
How the Climate Will Feel

These changes will dramatically affect how the climate feels to us. By the end of the century, the Minnesota summer climate will generally resemble that of current-day Kansas, and winters may be like those in current-day Wisconsin.

Potential Impacts from Climate Change

Water Supply and Pollution

Minnesota depends heavily on groundwater, on fresh water from lakes and the Mississippi River, and on rainfall for agriculture, drinking, and industrial uses. As the state's popula-



tion grows from currently five to nearly six million by 2025, projected changes in rainfall, evaporation, and groundwater recharge rates will affect all freshwater users.

- Reduced summer water levels are likely to diminish the recharge of groundwater, cause small streams to dry up, and reduce the area of wetlands, resulting in poorer water quality and less wildlife habitat.

- Lake levels are expected to decline in both inland lakes and the Great Lakes, as more moisture evaporates due to warmer temperatures and less ice cover.

- Pressure to increase water extraction from the Great Lakes will grow, exacerbating an already contentious debate in the region.

- Development and climate change will degrade the flood-absorbing capacities of wetlands and floodplains, resulting in increased erosion, flooding, and runoff polluted with nutrients, pesticides, and other toxins.

Agriculture

Corn and soybeans are major crops in Minnesota, with more than one billion dollars in sales from these crops in 2001. The state is also a dairy and livestock leader. There are likely to be some positive impacts for agriculture from a warmer climate, although current evidence suggests that the negative consequences could outweigh the positive. In general, however, regional development, technological advances, and market fluctuations have as much influence on farmers as the climate.

Overall, optimal weather conditions are expected to shift northward and eastward in the region. Minnesota agriculture may benefit from warmer temperatures and a longer growing season, but may be constrained by declining soil moisture and thin and acidic soils. Climate variability will likely pose greater risk for smaller farms and may thus reinforce the trend toward increasing farm size and industrialization of agriculture in the region. These changes will affect local farming communities, and, in turn, change the character of rural landscapes across the state.

- Increased atmospheric CO₂ and nitrogen as well as a longer growing season could boost yields of some crops, such as soybeans, corn, and wheat.

- Severe rainstorms and flooding during planting and harvest seasons will likely depress productivity. Similarly, hotter and drier conditions during the main growing season also disrupt production and may require irrigation of currently rain-fed crops.

- Higher ozone concentrations can damage soybeans and horticultural crops, countering positive impacts of a warmer climate.

- Increased soil erosion and runoff of agricultural wastes are likely if the frequency of flooding increases.

- Several climate changes combine to create more favorable conditions for a number of pests and pathogens. The bean leaf beetle, which eats soybeans, and the European corn borer may expand northward.

- Warmer summer temperatures suppress appetite and decrease weight gain in livestock; warmer winters and less snow cover likely will reduce the quantity and quality of spring forage, and thus, milk quality.

Human Health

Climate projections suggest that extreme heat periods are likely to become more common in a warmer climate, as will severe storm events.

- Winter cold-related morbidity or mortality will decrease, while summer heat-related morbidity or mortality is likely to increase. The number of hot days is projected to increase, with years later in the century experiencing 40 or more days exceeding 90°F. Of even greater concern is the projected increase in extreme heat days (exceeding 97°F). By 2080–2100, Minnesota may experience 10–25 such days annually. Minneapolis/St. Paul will be particularly vulnerable because extremely high temperatures are now rare. These extremes will require improved warning systems and preparation to avoid severe health impacts.

- Higher temperatures and more electricity generation for air conditioning increase the formation of ground-level ozone, likely exacerbating asthma and other respiratory diseases.

- Some waterborne infectious diseases such as *cryptosporidiosis* or *giardiasis* may become more frequent or widespread if extreme rainstorms occur more often.

- The occurrence of many infectious diseases is strongly seasonal, suggesting that climate plays a role in influencing transmission. Some diseases carried by insects such as Lyme disease

(ticks) or, more recently, West Nile encephalitis (mosquitoes) have expanded across the region. While this spread is attributed largely to land-use changes, future changes in rainfall or temperatures could encourage greater reproduction or survival of the disease-carrying insects.

Property and Infrastructure

Cities are particularly vulnerable to the risks of climate extremes, incurring direct economic losses or requiring costly adaptations.

- More frequent extreme storms and floods, such as the Red River flood shown below, will be exacerbated by stream channeling and more paved surfaces. These climate and land-use changes result in greater property damage, place heavier burdens on emergency management, increase cleanup and rebuilding costs, and exact a financial toll on businesses and homeowners.

- Municipalities in Minnesota will have to upgrade water-related infrastructure including levees, sewer pipes, and wastewater treatment plants in anticipation of more frequent extreme downpours.

- Lower lake levels have costly implications for shipping on Lake Superior, requiring more frequent dredging of channels and harbors and adjusting docks, water intake pipes, and other infrastructure. On the other hand, a longer ice-free season will extend the shipping season.

Minneapolis/St. Paul will be particularly vulnerable because extremely high temperatures are now rare.

Lakes, Streams, and Fish

Minnesota's famous waters draw millions of visitors each year. Native aquatic plant and animal species will differ widely in their responses to changing water temperature and hydrology.

- Cold-water species such as lake trout, brook trout, and whitefish may decline dramatically as cool-water species such as muskie and walleye along with warm-water species such as bluegill and smallmouth bass expand their ranges northward.

- These disruptions will likely be compounded by invasions of nonnative organisms such as the common carp and zebra mussels, fundamentally changing native fish communities.

- In all lakes, the duration of summer stratification will increase, adding to the risk of oxygen depletion and formation of deep-water "dead zones" for fish and other organisms, although "winterkill" in shallow lakes will likely decrease.

- Lower water levels coupled with warmer water temperatures may accelerate the accumulation of mercury and other contaminants in the aquatic food chain.

Wetlands and Shorebirds

Earlier spring runoff, more intense flooding, and lower summer water levels generally translate into growing challenges for Minnesota bogs and wetlands and the species that depend on them. Development and agriculture have already reduced wetland habitat significantly.

- The combined pressures of development and climate change will degrade the flood-absorbing capacities of wetlands and



Dave Saville, courtesy of FEMA

floodplains, potentially resulting in increased erosion, additional water pollution, and delayed recovery from acid rain.

- Wetland losses and changes in flood pulses will likely reduce safe breeding sites for amphibians, migratory shorebirds including some warblers, and waterfowl such as canvasbacks, and may cause many migratory species such as Canada geese to winter further north.

- Increased evaporation will likely shrink wetland habitat and dry up prairie potholes. New wetlands, however, may be created along lake edges as water levels drop.

- Warmer temperatures are likely to accelerate CO₂ and methane release from peat lands.

Recreation and Tourism

Tourism is one of Minnesota's top income-producing industries. Birders, boaters, hikers, hunters, and winter sports enthusiasts bring nearly \$10 billion into the state annually.

- Millions of anglers will be affected by range shifts, loss of habitat, and increases or declines of their preferred catch, both on Lake Superior and inland lakes.

- Loss of habitat or food resources for migratory songbirds, shorebirds, and waterfowl will affect Minnesota's multimillion-dollar birdwatching and hunting industries.

- Warmer winters mean trouble for states such as Minnesota, where winter recreation has long been an integral part of people's sense of place. Communities and businesses dependent on revenues from cross-country or downhill skiing, snowmobiling, and, especially, ice fishing, could be hard-hit.

- The summer recreation season will likely expand as temperatures warm further, but extreme heat, heavy downpours, elevated ozone levels, and possible increases in risk from insect- and waterborne diseases may dampen outdoor enthusiasm.

Forests and Terrestrial Wildlife

Northern Minnesota is still dominated by forests of spruce, hemlock, and fir, and forestry is locally important in the state. Factors other than climate are important drivers of change in forest ecosystems and the forestry sector, but climate change may exacerbate existing stresses.

- Warmer temperatures will likely cause boreal forests (pictured above) to shrink and other forest species to move northward unless hindered by barriers.

- Increasing atmospheric CO₂ and nitrogen will likely spur forest growth in the short term, but higher concentrations of ground-level ozone, more frequent droughts and forest fires, and a greater risk from insect pests could damage long-term forest health.



Larry Ricker, LHR Images

- Resident birds such as northern cardinals and chickadees might be able to breed earlier and raise more broods. Bigger resident bird populations, however, could reduce the food available for migratory songbirds.

- Climate warming may benefit some resident mammals such as raccoons, skunks, and the already prolific white-tailed deer, while moose could be negatively affected by warming and more deer-carried parasites.

Climate Change Solutions

Minnesota residents, business leaders, and policymakers can help reduce the potential impacts from climate change by pursuing three necessary and complementary strategies:

- **Reducing heat-trapping gas emissions** by increasing energy efficiency in buildings, investing more heavily in renewable energy sources such as wind and bioenergy, and enhancing clean transportation choices. Minnesota is already the nation's third largest wind power producer and has the potential to do more.

- **Minimizing pressures on the environment** by improving air quality, protecting the quality and supply of water resources, protecting habitat, and limiting sprawl.

- **Preparing for those impacts from global warming that cannot be avoided** through better planning and emergency preparedness, adaptations in agriculture and shipping, strengthening public health response, and adjusting infrastructure.

With smart planning and a commitment to responsible management, Minnesota can continue to lead the region in designing effective climate solutions, acting as an exemplary steward of its rich environment and resources in the face of climate change.



This fact sheet is based on the findings of *Confronting Climate Change in the Great Lakes Region*, a report published in April 2003 by the Union of Concerned Scientists and the Ecological Society of America. The report was written by regional experts under the leadership of George Kling (University of Michigan). Experts from Minnesota included Lucinda Johnson (U-MN, Natural Resources Research Institute) and Stephen Polasky (University of Minnesota).

Dr. Lucinda Johnson (218) 720-4251 • Dr. Stephen Polasky (612) 625-9213

The full report is available from UCS at www.ucsusa.org/greatlakes or call (617) 547-5552.