An Unfamiliar State

How Global Warming Could Change Natural Wisconsin

Wisconsin Environment
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Executive Summary

Wisconsin residents have a strong connection with the outdoors. Our natural environment provides us with a wide range of recreational and economic opportunities, inspires us with its beauty, and is a big part of Wisconsin's cultural identity.

Global warming threatens to change much of what we know and love about natural Wisconsin. Indeed, Wisconsin's climate is already changing, with less ice cover on lakes, the earlier arrival of spring, and more frequent heavy rainstorms.

To prevent the worst impacts of global warming, Wisconsin must do its share to reduce emissions of global warming pollution.

Global warming is already occurring worldwide, Wisconsin's climate is changing, and Wisconsin is a significant contributor to the problem.

- Average temperatures worldwide have increased by 1.3° F over the last century, and temperatures in the last half of the 20th century were likely the highest in at least the last 1,300 years. The Intergovernmental Panel on Climate Change, the world's leading scientific body evaluating global warming, recently concluded that most of the recent warming is likely due to human activities—particularly the burning of fossil fuels.
- In Wisconsin, average temperatures increased by 0.7° F during the 20th century, extreme rainfall events have become more common, the duration of ice cover on Wisconsin lakes has declined, and springtime events—such as the blooming of plants and the return of migratory birds—are happening earlier in the year.
- Wisconsin is a significant contributor to global warming. Emissions of carbon dioxide—the leading global warming pollutant—increased by 25 percent in the state between 1990 and 2004. Were Wisconsin its own country, it would rank 38th in the world for carbon dioxide emissions, ahead of such nations as Romania, Austria, Sweden and Israel.
- Should emissions of global warming pollutants continue to increase, global average temperatures could increase by another 2° to 11.5° F by the end of this

century (depending on future emission trends), bringing with them increases in sea level, changes in precipitation patterns, more frequent heat waves, and shifts in the distribution of species around the globe.

Global warming poses severe threats to the future of natural Wisconsin.

Water

- Global warming could leave the Great Lakes smaller, shallower and less able to sustain healthy populations of fish and aquatic life. As of spring 2007, water levels in Lake Superior and Lake Michigan were well below long-term averages.
- Ice cover on the Great Lakes and inland lakes is projected to decline and water temperatures are expected to increase. These changes could harm fisheries by increasing the potential for oxygen-depleted "dead zones" to appear in the lakes during the summer months. Lake Superior's average summer surface temperature has increased by 4° F in the last 25 years—a rate of warming much faster than the surrounding air.
- Rivers and streams could experience greater flows during parts of the year as a result of more precipitation, especially in large storm events, thus increasing the risk of flooding. Wisconsin has recently suffered through a string of severe flooding events and eastern Wisconsin has experienced an increasing number of extreme rainfall events.

Forests

- Global warming could reduce or eliminate the Wisconsin habitat of several key tree species—such as the balsam fir, paper birch, white spruce, jack pine and red pine—threatening the state's pulp and paper and softwood lumber industries. While other species would likely thrive in a warmer Wisconsin, the change may not happen overnight, with a period of forest "dieback" possible before new species can establish themselves.
- Higher temperatures, coupled with other ecosystem changes, could increase the risk of forest fires and pest infestation in Wisconsin forests.

Natural Recreation

- Global warming could reduce or eliminate several popular winter pastimes in Wisconsin—including ice fishing and snowmobiling. In recent years, several winter recreational events—including ice-fishing events and cross-country ski races—have been forced to cancel or alter their plans due to lack of snow or ice. Warmer temperatures could also reduce the length of downhill skiing seasons.
- Hunting and fishing opportunities in Wisconsin will also be affected by global warming. Populations of several game birds, including ducks, ruffed grouse and ring-necked pheasants are likely to see their ranges shifted northward, and some may have their populations in the state significantly reduced. Cold-water fish species, such as brook trout, brown trout and rainbow trout will lose habitat and perhaps disappear from all but the deepest lakes, due to warmer water temperatures, while cool-water fish species like walleye and perch could find it harder to live in streams and shallow inland lakes.
- Bird and wildlife watchers will experience a changing mix of species. Birds are particularly sensitive to the impacts of climate change and at least three dozen species could be forced from Wisconsin entirely as a result of global warming. Some changes are already taking place: the territory

of warblers has been found to have shifted northward over the past two decades.

Farming

Most studies suggest that crop yields will increase in the United States as a result of global warming. But global warming will present a series of new threats and headaches to Wisconsin farmers, including:

- Increased risk of heat stress to cattle, which can reduce production of milk, Wisconsin's number one farm product. Wisconsin dairy farmers already lose approximately $60 million annually as a result of heat stress.
- Increased risk of drought as a result of higher summer temperatures that increase evaporation of moisture from farm soils. Wisconsin experienced significant drought in 2003 and again in 2006.
- Increased erosion of farm soils, due to heavy precipitation events.
- Increased risk from aggressive weeds and insect pests that could expand their range northward into Wisconsin.

To prevent the worst impacts of global warming, Wisconsin, the United States and the world must act. Wisconsin must work to stabilize global warming emissions at or below today's levels by the end of the decade, reduce emissions by at least 15 to 20 percent by 2020, and reduce emissions by at least 80 percent by 2050.

There is still time to prevent the worst impacts of global warming, but we must act quickly. Wisconsin should:

- Adopt a cap on global warming pollution within the state that will reduce Wisconsin's emissions by 20 percent by 2020 and 80 percent by 2050.
- Increase our use of renewable energy. Among the steps we can take are:
  - Requiring 25 percent of transportation fuel in Wisconsin to come from renewable sources by 2025, while reducing per-mile global warming pollution from vehicles by adopting vehicle emission standards for carbon dioxide and supporting a strengthening of federal fuel economy standards.
  - Requiring 25 percent of our electricity to come from clean, homegrown sources such as wind and solar power by 2025.
- Make Wisconsin's economy more energy efficient. Among the steps we can take are:
  - Setting energy efficiency standards that will reduce electricity and natural gas consumption in Wisconsin by 10 percent by 2015.
  - Encouraging public and private investments in energy efficiency and renewable energy technologies.

Introduction

Living in Wisconsin, there are always a few things you can count on: trout fishing in the spring, boating or beaching on the Great Lakes during the summer, vibrant fall foliage, and plenty of snow, ice and cold in the winter.

At least until recently. Lately, things haven't been quite the same. Spring is coming earlier. Lakes are freezing later and thawing sooner. "Fifty-year" floods seem to come with increasing regularity.

More changes are in store. Global warming threatens to alter much of what we know and love about natural Wisconsin— from the types of trees in our forests to the types of fish in our streams.

The changes that are in store for Wisconsin aren't as dramatic as the melting glaciers, rising sea levels, or more powerful hurricanes that capture the attention of the national news media. But to Wisconsin residents, the steady loss of pine forests, trout streams, and winter pastimes like ice fishing—as well as increasing threats to important economic engines like agriculture and shipping—cut just as close to the bone.

There is good news, however. We still have time to prevent the worst impacts of global warming—in Wisconsin and around the world. Doing so won't be easy, but it is possible if we move quickly to reduce our use of fossil fuels through improving the energy efficiency of Wisconsin's economy and increasing our use of clean, renewable energy.

Citizens, business leaders and government officials across the country have begun to take action to reduce pollution that causes global warming, and Wisconsin is no exception. Gov. Jim Doyle, for example, is convening a global warming task force to examine the impacts of global warming on Wisconsin and to propose solutions.

By adopting a mandatory limit on global warming pollution from the Wisconsin economy—coupled with policies to improve energy efficiency and expand production of homegrown renewable energy—the state can take the lead in addressing the serious challenges posed by global warming, and help ensure that future generations are able to enjoy the benefits of natural Wisconsin.

Understanding Global Warming

Global warming threatens massive changes across the globe in the coming decades. Many of those changes have already begun to take place. Burning fossil fuels is the primary contributor to global warming and Wisconsin is a large emitter of global warming pollution. By reducing Wisconsin's emissions of global warming pollution, we can do our share to address the problem.

Global Warming Is Happening Now

The first signs of global warming are beginning to appear in Wisconsin and throughout the world. Global temperatures and sea level are on the rise. The timing of the seasons is also changing, part of a profound series of ecological changes that are happening throughout the world.

Rising Global Temperatures

Over the last century, global average temperatures have increased by 1.3° F.[1] Scientists believe that temperatures in the last half of the 20th century were likely the highest in the last 1300 years.[2] Most of the recent warming is likely due to human-caused releases of global warming pollutants, primarily carbon dioxide.[3]

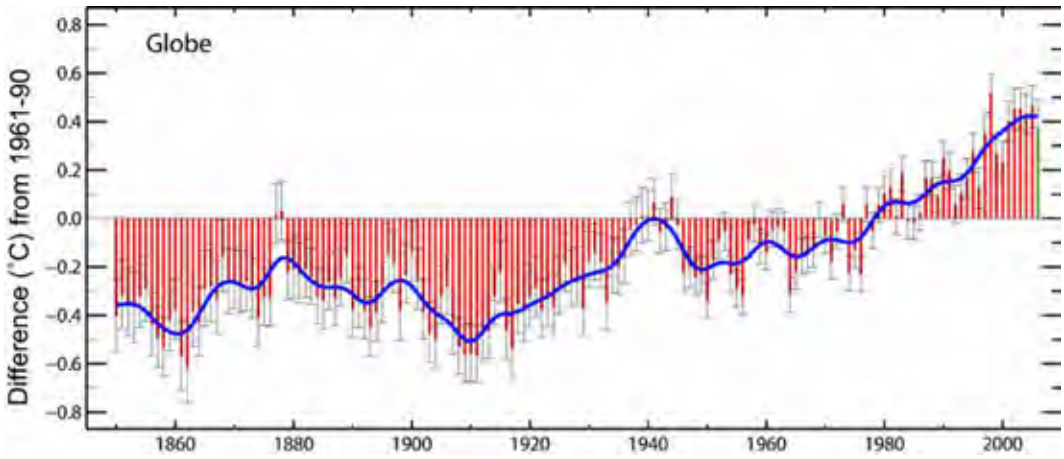
Global warming appears to have intensified in recent years. In 2006, scientists at the National Aeronautics and Space Administration (NASA) reported that, since 1975, temperatures have been increasing at a rate of about 0.36° F per decade.[4] Worldwide, 11 of the last 12 years (1995 to 2006) rank among the 12 warmest years on record, with 2006 likely the warmest year in the United States since record-keeping began in 1895.[5] (See Fig. 1, next page.)

While temperatures have increased on average, patterns of extreme temperatures have also changed. According to the recent IPCC report, "Cold days, cold nights and frost have become less frequent, while hot days, hot nights and heat waves have become more frequent."[7]

Rising Sea Level

Over the course of the 20th century, average sea level increased by approximately 6.7 inches worldwide.[8] Sea level has risen more quickly in recent years.

Fig. 1. Global Average Temperatures, Difference from 1961-1990 Average (in degrees Celsius)[6]



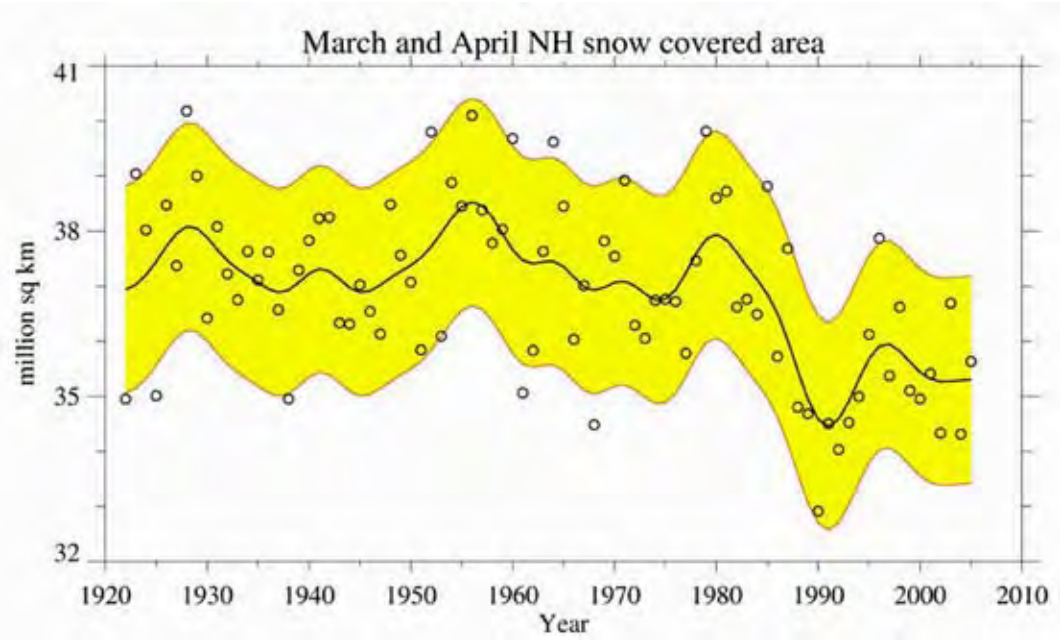
Less Snow and Ice

Snow cover in the Northern Hemisphere has declined over the last several decades, dropping by 5 percent during the 1980s.[9] (See Fig. 2.) Glaciers are retreating around the globe and the annual extent of Arctic sea ice has declined by 2.7 percent per decade since 1978.[10]

Shifting Seasons and Species on the Move

Worldwide, spring events—such as leaf unfolding, egg laying and bird migration—are occurring earlier in the year. In addition, numerous species of plants and animals appear to be moving toward the poles in response to rising temperatures.[12]

Fig. 2. Trends in Northern Hemisphere Snow Cover[11]



More Intense Storms

Heavy precipitation events have become more common in much of the world.[13] In addition, hurricanes have become more powerful and more destructive over the last three decades, a phenomenon that some researchers link to increasing global temperatures.[14]

Changes in Wisconsin

Changes consistent with these global trends have emerged in Wisconsin. Specifically:

- Average temperatures in Wisconsin increased by 0.7° F during the 20th century.[15]
- Extreme rainfall events became more common in the latter two-thirds of the 20th century, particularly in eastern Wisconsin.[16]
- The duration of winter ice cover on lakes has decreased.
- Changes have been observed in the blooming of plants and the return of migratory birds, indicating that springtime events are occurring sooner than they did earlier this century.[17]

Human Activities Are Causing Global Warming

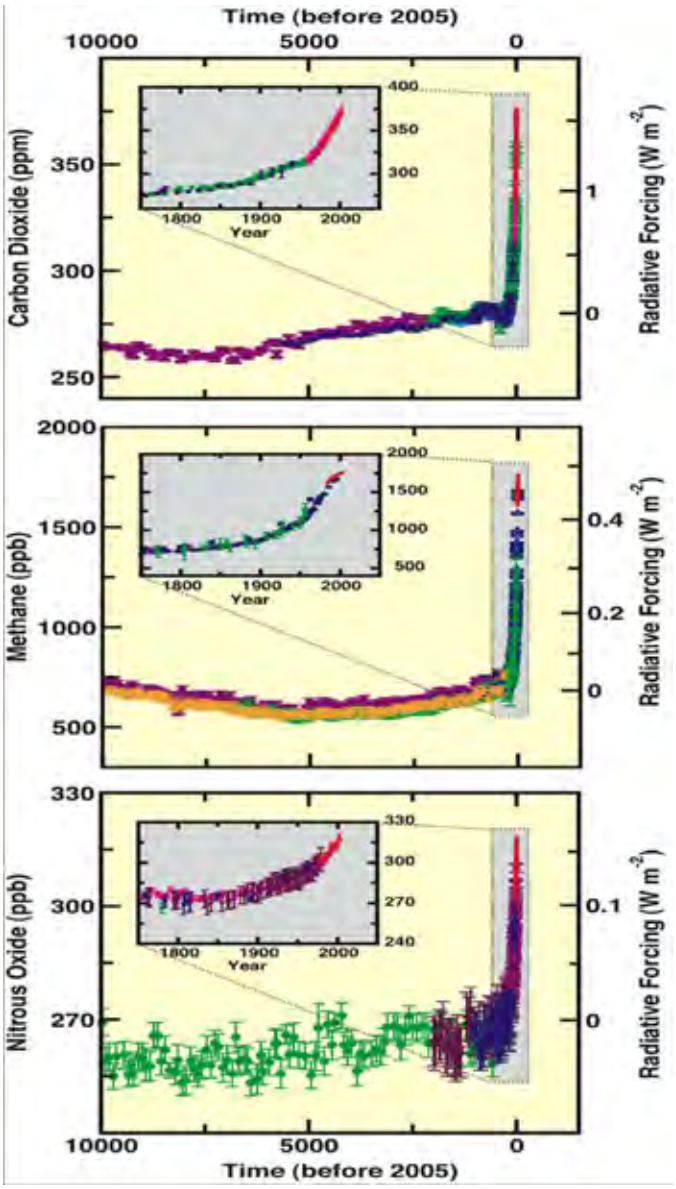
There is broad scientific consensus that human activities—and particularly the burning of fossil fuels—are responsible for most of the global warming that has occurred over the last half-century.[18]

The Greenhouse Effect

Global warming is caused by human exacerbation of the greenhouse effect. The greenhouse effect is a natural phenomenon in which gases in the earth's atmosphere, including water vapor and carbon dioxide, trap heat near the planet's surface. The greenhouse effect is necessary for the survival of life; without it, temperatures on earth would be too cold for humans and other life forms to survive.

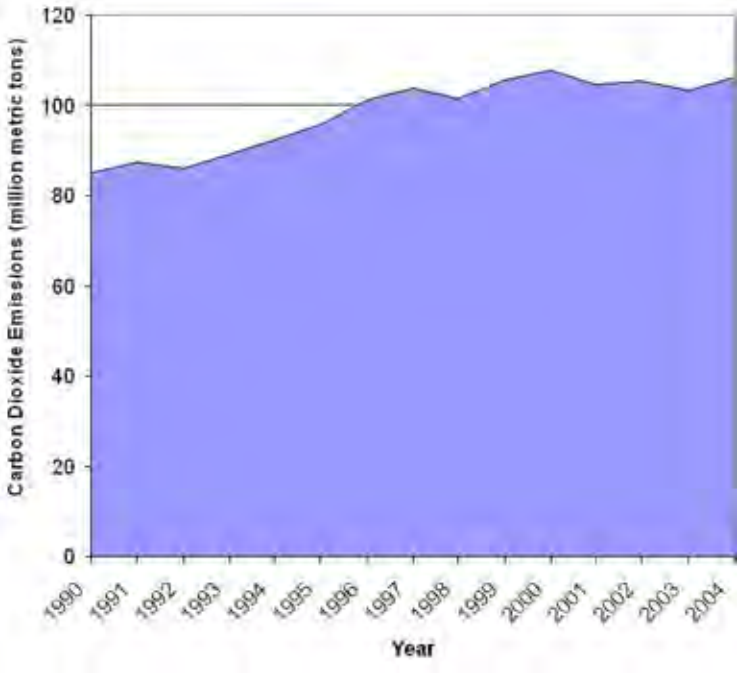
But human activities have altered the

Fig. 3. Atmospheric Concentrations of Global Warming Pollutants[20]



ppb=parts per billion; radiative forcing=A measure of the change in the balance between radiation entering into the atmosphere and radiation leaving it. An increase in radiative forcing indicates that more radiation is retained within the earth's atmosphere, thus contributing to global warming.

Fig. 4. Wisconsin Emissions of Carbon Dioxide from Energy Use, 1990-2004



composition of the atmosphere in ways that intensify the greenhouse effect. Concentrations of carbon dioxide—the leading global warming pollutant—in the atmosphere have increased by more than one third since the beginning of the industrial age, and concentrations of other global warming pollutants have increased as well. (See Fig. 3, page 11.) The concentration of carbon dioxide is higher now than it has been in the last 650,000 years.[19]

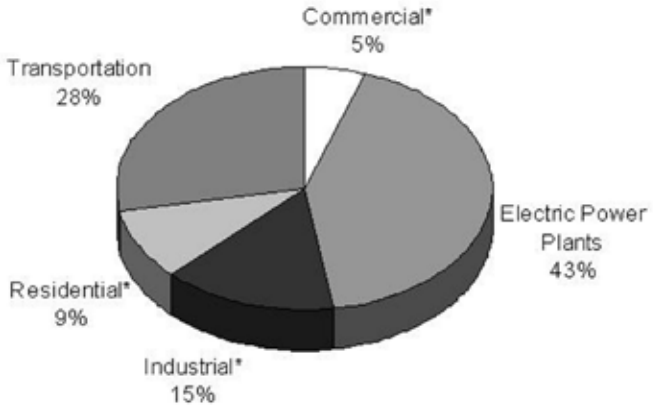
Wisconsin's Contribution to Global Warming

In 2004, Wisconsin emitted approximately 106 million metric tons of carbon dioxide from energy use.[21] Carbon dioxide is the most important global warming pollutant, accounting for approximately 83 percent of the U.S.'s contribution to global warming in 2005 (not counting black carbon emissions and emissions leading to the formation of tropospheric ozone).[22] Wisconsin's emissions of carbon dioxide increased by approximately 25 percent between 1990 and 2004, a rate of increase greater than that of the nation as a whole.[23] (See Fig. 4.)

Wisconsin ranked 20th in the nation for carbon dioxide emissions in 2004.[24] Were the Badger State its own country, it would have ranked 38th in the world for carbon dioxide emissions, ahead of such nations as Romania, Austria, Sweden and Israel.[25]

The bulk of Wisconsin's carbon dioxide emissions come from two sources: electric power plants (primarily those powered with high-polluting coal) and transportation, with the majority of transportation emissions coming from cars and light trucks. (See Fig. 5.)

Fig. 5. Wisconsin Emissions of Carbon Dioxide by Sector[26]



* Does not include emissions resulting from consumption of electricity in homes, businesses or industry. These emissions are accounted for under "Electric Power Plants."

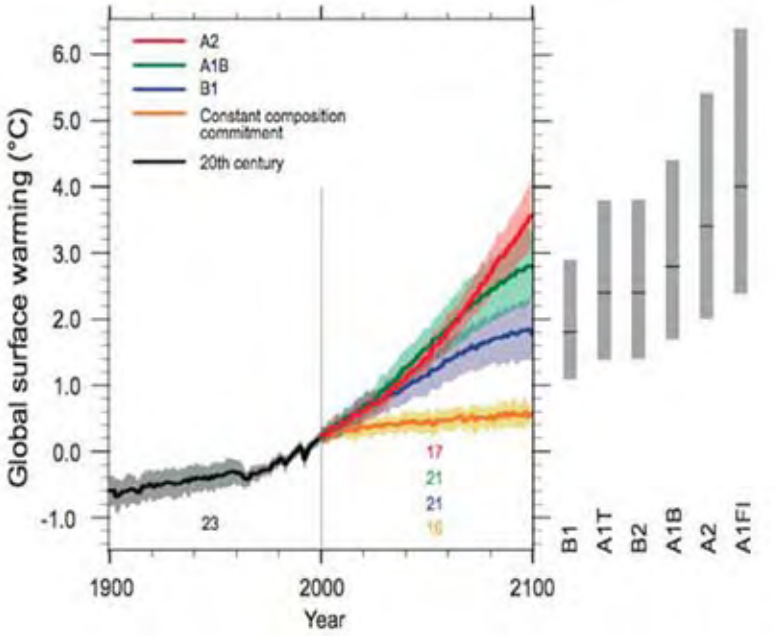
What the Future Holds

Should emissions of global warming pollutants continue to increase, the world will experience dramatic warming over the next century and beyond, with major impacts on the environment, the economy and on human health.

The Intergovernmental Panel on Climate Change (IPCC), the world's leading authority on the science of global warming, recently updated its projections about the future course of global warming. Among the findings:

- Global average temperatures will continue to increase at a rate of 0.36° F per decade over the next two decades. About half of this increase in temperature is essentially "locked in" as a result of the lingering effects of pollution already emitted.
- Temperatures could increase by another 2 to 11.5° F above late 20th century levels by the end of this century, with the size of the increase depending on future emissions of global warming pollutants.[27] (See Fig. 6.)

Fig. 6. Projected Global Average Temperature Increases Under a Variety of Future Emissions Scenarios (see footnote for explanation of graphic)*



* Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis: Summary for Policymakers*, February 2007. Nominal temperature increases in this graphic reflect increases versus a 1980-1999 baseline and do not include increases caused by global warming prior to that period. The IPCC projects future global warming impacts based on a series of scenarios for future global development. The projections in the chart above reflect the following scenarios: "Constant Concentration Commitment" assumes that concentrations of global warming pollutants in the atmosphere remain constant at 2000 levels over time. This scenario assumes that emissions are reduced dramatically and immediately, and is a very unlikely scenario for future emission trends. The remaining scenarios assume different paths for global development and global warming emissions. The scenarios assume roughly these levels of global warming pollutant concentrations in the atmosphere (in carbon dioxide equivalent): B1, 600 parts per million (ppm); A1T, 700 ppm; B2, 800 ppm; A1B, 850 ppm; A2, 1250 ppm; A1F1, 1550 ppm. By contrast, pre-industrial concentrations of carbon dioxide are estimated at approximately 280 ppm and current concentrations are at approximately 379 ppm. The gray error bars to the right of the graph indicate the range of estimates of future temperature increases, with the horizontal line in the center of each bar indicating the "best estimate" of future increase in global average temperature.

- Sea level could be expected to rise by another 7 to 23 inches over the next century, with the level of rise again dependent on future emissions. These estimates do not include the potential for accelerated breakup of the Greenland or Antarctic ice sheets, which would cause a more dramatic rise in sea level.[28]
- Snow and ice cover will continue to contract, heat waves will become more frequent and severe, and hurricanes will likely become stronger.

Summary

Global warming poses a severe threat to the future of the world's environment, its economy, and human health and welfare. Global warming has already begun to affect life around the world, including Wisconsin. At a global scale, scientific evidence continues to mount that global warming is happening, is primarily caused by humans, and will result in higher temperatures, rising seas, and more intense storms in the future.

Global Warming and Natural Wisconsin

Wisconsin's natural resources—its air, water, land, plants and wildlife—are the source of much of our state's beauty, its special identity, and its economic prosperity. Global warming threatens significant changes to much of "natural Wisconsin."

Water

Wisconsin is defined by water—literally. Three of North America's signature waterways—the Mississippi River, Lake Superior and Lake Michigan—define the bulk of our state's border and have helped drive Wisconsin's economic development. Our inland lakes are the sites of some of Wisconsin's favorite winter pastimes, such as ice fishing and skating. And our rivers and streams provide clean water, habitat for fish and other wildlife, and many other important values to state residents.

Global warming will have significant impacts on Wisconsin's water resources, leaving many of them irreparably changed.

Just how those changes will unfold is difficult to predict. Wisconsin's rivers and lakes are part of a complex hydrological system that will be altered in various ways by global warming. If temperatures rise dramatically in Wisconsin, as scientists predict, increased evaporation could reduce the levels of lakes and dry out soils. On the other hand, scientists also predict increased annual precipitation, with more of it coming in large storm events that could cause flooding. In addition, they predict changing annual patterns of precipitation, with more rain and snow in the wintertime and less precipitation in summer. The risk of extremely wet springs and extremely dry summers is also expected to increase over time.[29]

These changes may be hard to discern at times from the natural pattern of climate variability in Wisconsin. Wisconsin is characterized by brutally cold winters and often blisteringly hot summers. But wintertime thaws and periods of relatively cool summer temperatures aren't unheard of. Waterways like the Mississippi River can experience wide swings in water levels from one year to the next. The state is no stranger to flooding and is well-acquainted with drought. As a result, it can be hard to separate the impacts of global warming from the "noise" of natural climate variability.

Nonetheless, scientists have developed complex models that simulate the condition

of waterways under a variety of climate scenarios. While not all of those models agree, a rough picture is emerging of how global warming will affect Wisconsin's waterways.

Great Lakes

Global warming could leave Wisconsin's Great Lakes smaller, shallower and less able to sustain healthy populations of fish and other aquatic life, threatening the public's enjoyment of the lakes and our state's economy.

Wisconsin's Lake Michigan and Lake Superior shorelines provide a wealth of resources to the state. From the beaches of Door County to the working ports of Milwaukee, Green Bay and Duluth-Superior, the state's Great Lakes are a source of recreation, transportation, drinking water and economic activity to Wisconsin.

Declining Water Levels

Most (but not all) scientific models predict that water levels in the Great Lakes will decline as a result of global warming.[30] Global warming is expected to increase evaporation of water from the lakes and reduce runoff from rivers and streams, causing water levels to fall. Estimates of the decline in lake levels vary, but some believe that significant declines—on the order of 1.5 to 3 feet—could occur by 2030.[31] Over the next century, water level in Lake Michigan could decline by 5 feet, or possibly more.[32]

Wisconsin residents don't need to use their imaginations to see the impact of lower water levels on the Great Lakes—they can simply head out to their nearest beach or harbor. As of spring 2007, the water level in Lake Superior was near its historic low and the level in Lake Michigan was well below average.[33] Lake Michigan's water level has dropped by approximately 4 feet since 1998.[34] (See Fig. 7 and Fig. 8.)

Low lake levels create many practical problems. Shipping firms must reduce the weight of their cargo in order to navigate shallower waterways, thus reducing their revenue and prompting calls for expensive and potentially damaging dredging operations.[37] Shoreline infrastructure, such as marinas and breakwaters, may need to be rebuilt or relocated. A severe drop in lake levels could make it harder for communities that use the lakes for drinking water to draw in water through their current intake pipes.

The environmental and wildlife impacts of lower water levels in the Great Lakes are less clear. Water levels in the Great Lakes have fluctuated by as much as 6.5 feet in the past, and such changes are normal and even beneficial to the Great Lakes

Fig. 7. Water Levels in Lake Superior at Duluth, Minnesota (meters)[35]

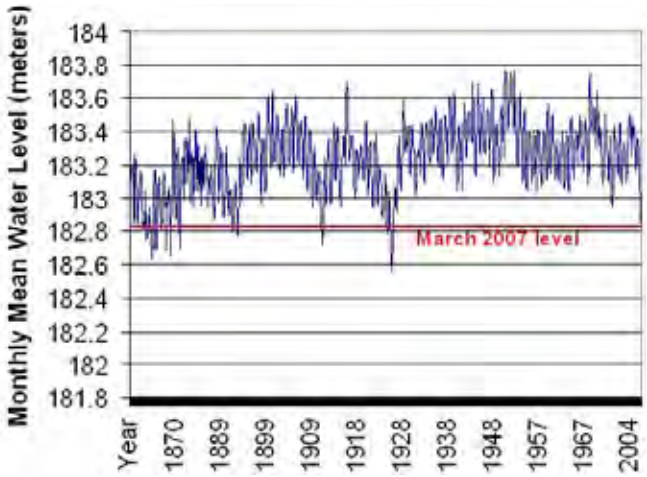
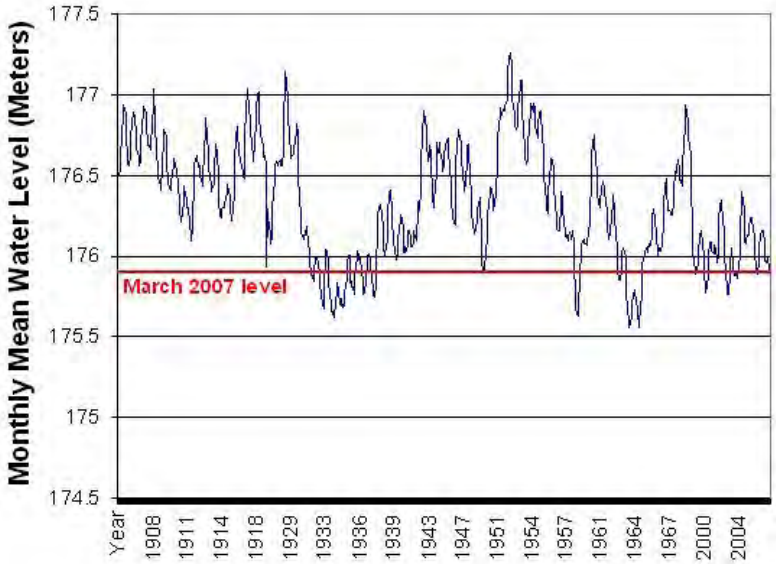


Fig. 8. Water Levels in Lake Michigan at Sturgeon Bay Canal, Wisconsin (meters)[36]



ecosystem.[38] Coastal wetlands, in particular, benefit from the natural stresses caused by shifting water levels.[39] However, a long-term shift toward shallower, smaller Great Lakes could dry up wetlands for longer periods of time, potentially preventing fish from using those wetlands to spawn. About 120 species of Great Lakes fish, for example, spawn in waters less than 1 meter deep.[40]

Rising Temperatures and Decreasing Ice Cover

Not only could the Great Lakes become smaller and shallower as a result of global warming, but they are also very likely to become warmer and experience less ice cover.

Lake Superior and Lake Michigan have both experienced lower water levels in recent years. Scientists project that lake levels will decline over the next several decades as a result of global warming. Credit: NOAA

These trends are already playing out on Lake Superior. Average ice cover during the period from 1998 to 2001 was the lowest on record up to that time, and similar trends have been observed on Lake Michigan.[41]

Ice cover plays an important role in maintaining water levels in the Great Lakes and sustaining a healthy ecosystem. The lakes lose the most water to evaporation during the fall and early winter, when cold air from the north crosses the relatively warm waters of the lakes, sucking up moisture from the lakes and depositing it on nearby shores as lake-effect snow.[42] As the lakes freeze, less open water is exposed, evaporation decreases, and more water is retained within the lakes. Longer periods without ice cover (coupled with warmer lake temperatures) could extend the period during which rapid evaporation occurs.[43]

Declining ice cover also contributes to the warming of the Great Lakes. Recent research has found that Lake Superior is warming at a rate faster than the warming of the surrounding air—with average summer surface temperatures having increased by about 4° F in the last 25 years.[44] Researchers believe part of the cause may be declining ice cover in the lake. Ice provides a bright

surface that reflects sunlight, while open waters absorb it, causing temperatures to rise.[45]

Rising lake temperatures and decreasing ice cover may create problems for fish and other aquatic life in the lakes. Twice each year, in the spring and the fall, the Great Lakes experience thorough mixing of waters from top to bottom, ensuring that oxygen and nutrients are available throughout the lakes. During the summer months, however, the lake stratifies into a warm layer at the surface and cool waters below, preventing deeper waters from receiving fresh supplies of oxygen.[46] Typically, enough oxygen remains in the cool layer to sustain a healthy mix of organisms until the next mixing occurs. But less ice, combined with warmer surface temperatures during the summer, could extend the period of stratification, increasing the likelihood that oxygen will run out in the deep waters of the lakes, creating an oxygen-depleted "dead zone."

In Lake Superior, the date of summer stratification has already moved up by approximately two weeks.[47] And in Lake Erie, a dead zone reappeared during the mid-1990s, with a combination of nutrient loading, invasive species and climate change suspected as the causes.[48] Research suggests that extended stratification in Lake Michigan could cause significant damage to the lake's fishery by the end of the century.[49]

In short, a warming world could leave Wisconsin's Great Lakes smaller, shallower and less able to sustain healthy populations of fish and other aquatic life in the future, threatening the public's enjoyment of the lakes and our state's economy.

Runoff and Beach Closings

Too little water may be the predominant issue facing the Great Lakes in a warming world. But too much water too fast—in the form of extreme rain events that overload sewer systems and carry runoff into the lakes—could also be a problem, particularly for those who swim or boat in Great Lakes waters.

Scientists predict that heavy rain events will become more common in future years, and such events are already occurring with increasing frequency in eastern Wisconsin.[50] Heavy rain can cause sanitary and combined sewer systems to overflow, carrying raw sewage directly into waterways. In addition, heavy rain carries runoff from farm fields, parking lots and urban areas into waterways. Both sewage and stormwater runoff can be contaminated with pathogens that can make beach-goers and others exposed to Great Lakes waters sick.

In 2005, approximately 16 percent of all water quality samples taken at Wisconsin Great Lakes beaches exceeded state standards for presence of *e. coli* bacteria. To protect the public, local health authorities issued daily beach closings or advisories more than 900 times during 2005, with most of those closings and advisories resulting from high bacteria counts.[51]

More heavy rain events could increase the potential for sewer overflows and major runoff events that contaminate beaches—thus reducing Wisconsin residents' ability to enjoy their Great Lakes beaches.

Rivers, Streams and Inland Lakes

Global warming could cause more floods like those that have destroyed property and damaged crops in Wisconsin over the past decade. At the same time, hotter, drier summers could cause some small streams to dry up during the summertime, while adding to the ecological stresses felt by fish and other wildlife in the state's rivers and inland lakes.

Wisconsin's rivers, streams and inland lakes provide habitat for fish and other wildlife, as well as important sources of clean water for homes, farms and industry.

The most straightforward impact of global warming is that inland waterways can be expected to get warmer.[52] Many fish species are very sensitive to water temperatures, and Wisconsin could cease to provide habitat to a variety of cold-water fish, including brook trout, brown trout and rainbow trout.[53] (See "Natural Recreation: Fishing," page 23.) Cool-water fish species like walleye and perch could find it harder to live in streams and shallow inland lakes. And all fish could face other threats including increased potential for oxygen depletion in waterways and possibly pollution-related impacts.

Inland lakes and rivers will also experience reduced ice cover. A recent study of historical ice cover records in the Great Lakes region shows that not only are water bodies freezing later and thawing earlier than in years past, but that the rate of decline in ice cover has accelerated in recent decades. The number of ice cover days on these waterways was found to be declining at the rate of 5.3 days per decade on average since the mid-1970s—a rate of decline far faster than over the period 1846-1995.[54]

Changing precipitation patterns will also alter the flow of rivers and streams. There is some uncertainty about whether annual streamflow in Wisconsin waterways will increase or decrease with global warming.[55] At issue, among other things, is the question of whether increased annual precipitation (particularly in the winter and spring) will outweigh the impacts of increased evaporation resulting from higher temperatures. Since 1970, groundwater levels and stream baseflow have increased in many parts of Wisconsin. Some researchers, however, expect this trend to reverse as global warming continues.[56]

Devastating floods—such as this 1969 flood of the Mississippi River at Prairie du Chien—could become more common as the number of extreme rainfall events increases. Credit: L.J. Maher

It is quite likely, however, that the timing of river and stream flows will be very different than today, and that has important consequences for all types of inland waterways.

Warmer and wetter winters could result in increased streamflows during the springtime. Coupled with scientists' predictions of an increase in extreme rain events, this could result in an increase in flooding on rivers, streams and lakes, causing erosion, water quality damage from runoff and sewer overflows, and damage to crops and property.[57] (See "Recent Major Floods in Wisconsin," next page.)

On the other hand, hotter, drier summers could cause rapid evaporation of water from soils and waterways, causing small, headwaters streams to dry up completely, starving crops of needed moisture, and lowering groundwater tables and the water levels of inland lakes.[58] Declining water levels could also lead to increased concentrations

of water pollutants during parts of the year, making it harder to achieve water quality goals.[59] In addition, inland lakes will experience many of the same stresses as the Great Lakes, with reduced ice cover and warmer and shallower waters increasing the risk of oxygen depletion and damage to fish and other aquatic life.

Recent Major Floods in Wisconsin[60]

Wisconsin has experienced a series of major floods over the last decade. The National Oceanic and Atmospheric Administration's (NOAA) database of extreme weather events documents the impact of some of those floods on life and property in the Badger State.

June 17, 1996 – Heavy rain caused rural flooding in Dane County, inflicting $10 million in crop damage, as well as urban flooding in the Madison area. The urban flash flood in Madison was described by emergency personnel as the worst in 30 years, with 4.5 inches of rain falling at the Madison airport, the rainiest June day on record. The following day, flooding caused by a line of thunderstorms damaged 1,000 homes in Port Washington, one-third of the city's houses. In Green County, the waters of Smock Creek flooded Highway 11 for the first time in 60 years, while flood waters caused serious farm erosion and crop damage.

June 21, 1997 – Nearly 10 inches of rain fell over a 30-hour period, causing flash floods in Milwaukee County. The flash flooding was greater than a "100-year rainfall." Approximately 9,600 homes were damaged, with total property damage from the floods in the county estimated at more than $78 million. Raw sewage from sanitary sewers backed up into homes and flowed into Lake Michigan.

August 6, 1998 – For the second consecutive year, massive flash floods swept through Milwaukee and Waukesha counties. In Waukesha County, the flash flooding was the worst of the century, resulting in the deaths of two young boys. The floods damaged 2,680 homes in the county and 30 businesses.

June 1, 2000 – It was described as a day of "all hell breaking loose," with tornadoes, flash floods, hurricane-force winds, hail and lightning strikes in south-central and southeast Wisconsin. Madison experienced its worst flooding in 50 years, and the storms destroyed roads, uprooted trees, eroded farm soils, and caused serious damage in at least eight counties.

April 10, 2001 – Heavy rains and snowmelt drove water levels on the Mississippi River to heights not seen since the all-time record flood of 1965. Waters remained above flood stage until early May, causing about $6.5 million in property damage in a number of western Wisconsin counties.

June 2004 – Southeastern Wisconsin was hit with flooding yet again, causing a massive $216 million in crop damage. Flooding damaged corn, soybean and alfalfa crops and delayed planting of others. Private property damage was estimated at $35 million. Twenty Wisconsin counties were declared federal disaster areas.

July 27, 2006 – Another "100-year" flash flood occurred, this time in Madison, when a line of slow-moving thunderstorms dumped 3 to 5 inches of rain on the city within an hour-and-a-half. The University of Wisconsin-Madison campus was hit particularly hard, with damage to more than 60 campus buildings.[61]

The Mississippi River is of special importance to Wisconsin and the economy of the larger Midwest region. As the river that ultimately receives runoff from the western half of the state, one can expect that the impacts of climate change will be magnified on the Mississippi. Indeed, research on the region's ancient climate suggests that extreme flooding events—of the kind that have occurred on the Mississippi in the past few decades—were more common during periods of climate change than during periods of more stable climate.[62]

Overall, scientific models suggest that average annual runoff in the Upper Mississippi basin could increase significantly by the end of the century (though there is some disagreement, particularly about the shorter-term impact of climate change on flows to the Mississippi).[63] Again, more of that runoff is projected to occur during the winter and spring months and less of it in the summer, leading to the possibility of more events like the 1993, 1997 and 2001 Mississippi River floods, punctuated by periods of low flow that could affect navigation on the river.

In short, in a warming world, Wisconsin could experience more devastating floods like those that have destroyed property and damaged crops over the past decade. At the same time, hotter, drier summers could cause some small streams to dry up during the summertime, while adding to the ecological stresses felt by fish and other wildlife in the state's rivers and lakes.

Several tree species common to Wisconsin, such as the white spruce (above), could be confined to smaller ranges or forced out of the state entirely as a result of global warming. Credit: Bill Cook, Michigan State University, www.forestryimages.org

Forests

Global warming will cause significant shifts in the composition of Wisconsin's forests. Several species of trees will be forced northward as the climate warms, with some disappearing from Wisconsin entirely. While new tree species will expand to replace them, the transition will not necessarily be smooth. In addition, the state's forests could become more susceptible to fire and pests.

Forests cover nearly half of Wisconsin's land area, providing homes to wildlife, recreational opportunities to hikers, skiers, snowmobilers and hunters, and a key economic engine for the state.[64] Unfortunately, global warming promises dramatic changes for Wisconsin's forests.

As temperatures increase in Wisconsin over the coming decades, tree species that had once thrived in the state will find their territories shifted to the north. Wisconsin could lose at least five species of trees—balsam fir, paper birch, white spruce, jack pine and red pine—by the end of the next century given anticipated levels of warming.[65] Quaking aspens, which provide important habitat for deer as well as brilliant golden foliage in fall, could be limited to the northern part of the state or have greater difficulty thriving.[66]

Even the sugar maple, Wisconsin's state tree, could decline within the state as a

result of global warming, although there is some disagreement among scientists.[67] A decline in the number of sugar maples would impact the state's maple syrup industry, which is the fourth largest in the United States.[68]

Climate change will eventually bring new tree species into the state and cause some forest types to expand their range within Wisconsin. Scientists predict that black walnut and black cherry would expand their ranges northward, as would the oak-hickory forests that currently thrive in southern and central Wisconsin.[69]

The key word, however, is *eventually*. The forests of Wisconsin and other Great Lakes states have undergone gradual changes in species composition for centuries, and have been gradually recovering from the massive deforestation of the late 19th and early 20th centuries. But global warming is anticipated to change the climate with unprecedented speed, meaning that new tree species may not be able to move in immediately to replace those driven out by warmer temperatures. Some researchers anticipate that there will be a period of "dieback" in which the total amount of biomass in some forests declines significantly.[70] In time, as new species move in, vigorous forest growth is expected to return. But Wisconsin's forests will invariably be different in character from those that preceded them.

Warmer temperatures could also exacerbate two other threats to Wisconsin's forests: fire and pests. Fire is a natural part of forest ecosystems, but hotter, drier summers could make forest fires more frequent and severe.[71] In addition, global warming-induced shifts in bird populations could increase forests' susceptibility to pests. Birds act as predators for various species of forest pests, including gypsy moths, tent caterpillars and eastern spruce budworms.[72] Warblers, for example, play a key role in reducing populations of eastern spruce budworms.[73] However, the territory for many types of warblers (along with other birds) has been shifting northward over the last several decades and they may be forced out of Wisconsin entirely as a result of global warming.

With the loss of several tree species, the character of Wisconsin's vast north woods will be changed forever. Wisconsin's northern forests provide habitat for a variety of rare and exceptional species, including the gray wolf, the Canadian lynx and the bald eagle, as well as many species of birds, mammals and other wildlife.[74] Nicolet National Forest is considered a Globally Important Bird Area, with more than 170 species of birds having been observed in the forest over the last two decades—about a quarter of which, including the eastern kingbird, golden-winged warbler and Baltimore oriole, have recently shown signs of decline in the area.[75] (See, "Natural Recreation: Birding," below.)

Wisconsin's forests also support vigorous tourism and forestry industries. (For more information on tourism, see "Natural Recreation," page 23.) Forestry in Wisconsin employs about 70,000 workers and accounts for annual sales of $18 billion annually, with many of those jobs and much of that income coming from the pulp and paper industry.[76] The loss of key softwood tree species such as pines could devastate the state's softwood lumber and pulp and paper industries, which depend upon the state's current mix of forests for their feedstocks.

A changing climate will also affect the pattern of seasons in Wisconsin's forests. The timing of seasons affects everything from bird migration patterns to maple syrup production to the state's vibrant fall foliage displays. Observations of wildlife migration patterns at the home of famed naturalist Aldo Leopold show that many species of birds—including Canada geese, cardinals and robins—now return from their annual migrations earlier than they did in the 1930s and 1940s.[77]

In short, global warming will leave Wisconsin's forests far different than they are today. Some species of trees will be driven out of the state entirely, while

others may face greater struggles to survive. Forests are resilient and will eventually regenerate, but the state could experience a period of "dieback" before full recovery occurs and the forests that result will be far different than those of today. In the meantime, Wisconsin's forestry industry, wildlife, and the thousands of state residents who use the forests for recreation, could suffer.

Natural Recreation

Global warming will change the way Wisconsin residents enjoy the outdoors. Wisconsin residents will have fewer opportunities to fish for trout, snowmobile, ski and partake in ice fishing. Changes in temperature and forest ecosystems will reduce some popular species of wild and game birds.

Wisconsin residents love to get out and enjoy the natural beauty of our state. Visitors from other states love it, too—traveling long distances and spending millions of dollars in our economy to take advantage of the opportunities Wisconsin offers to hunt, fish, hike and enjoy winter recreation. Tourists spent nearly $12 billion in Wisconsin in 2005, helping to sustain more than 300,000 jobs.[78]

Natural recreation is also part of Wisconsin's identity—part of what makes us who we are. Traditions like ice fishing and winter festivals are a part of Wisconsin's cultural fabric; the Badger State just simply wouldn't be the same without them.

Unfortunately, global warming threatens much of the natural beauty that visitors travel to Wisconsin to see. From shorter ski seasons to changing patterns of bird migration, global warming poses many threats to recreation in natural Wisconsin.

Fishing

Sport fishing in Wisconsin is a $2.3 billion business.[79] As noted above, global warming will likely cause changes in the types of fish that call Wisconsin home, as well as the health of some fisheries. Wisconsin is an attractive state for anglers in part because of the diversity of fish species and fishing experiences available.

Global warming will have significant impacts on Wisconsin fisheries, including the likely loss of the state's inland cold-water fishery. Scientists project that cold-water species—such as brook trout, brown trout and rainbow trout—will lose habitat, and perhaps disappear from the state entirely, due to warmer water temperatures.[80] With more than 8,000 miles of trout streams, the loss of cold-water fish species would be a blow to Wisconsin anglers, as well as to businesses that serve them.[81] Cool-water fish species—such as walleye, perch, northern pike and suckers—could find it harder to survive in streams and shallow inland lakes.[82]

At the same time, other threats—ranging from climate-related oxygen depletion of waterways to the growth of invasive species—could pose challenges to Wisconsin fisheries in the future.

Winter Recreation

Wisconsin residents know how to make the most of the state's long winters. Winter recreational activities—including downhill and cross-country skiing, snowmobiling, ice fishing and winter carnivals—attract tourists from the Midwest and beyond and are important parts of the state's cultural tradition. Winter tourists spend more than $2 billion in the Wisconsin economy each year.[83]

Unfortunately, many of these forms of winter recreation are threatened by climate change. Indeed, some forms of winter recreation are already feeling the effects of warmer and more erratic winter weather.

Skiing

Skiing—of both the downhill and cross-country varieties—is a popular pastime in Wisconsin and a boon to local economies. Downhill skiing is the most popular outdoor

activity cited by winter visitors to Wisconsin.[84] The state has 64 downhill skiing areas and 3,589 miles of cross-country ski trails.[85] It is home to North America's largest cross-country skiing marathon, the American Birkebeiner in Cable and Hayward, which draws thousands of skiers and spectators each year.

Warmer winter temperatures could have a serious impact on the ski industry in Wisconsin. Winter temperatures in the Great Lakes region could increase by 5 to 12° F by the end of this century.[86] While the region could receive more precipitation during the wintertime, more of that precipitation is likely to fall in the form of rain, rather than snow.

Downhill ski areas are better able to adapt to climate change due to their snowmaking capability, but extremely warm winter temperatures can still impact downhill skiing and can be devastating to cross-country enthusiasts. In December 2006, for example, temperatures in La Crosse were 9 degrees above normal—the warmest December since 1931.[87] Poor snow conditions hampered winter recreation throughout Wisconsin. The American Birkebeiner cross-country race, for example, had to be run on a short course in 2007; the third time in the last 10 years that poor snow conditions have affected the race.[88]

Snowmobiling

Just as poor snow conditions can put a damper on skiing, they can also prevent snowmobiling. In 2000-2001, snowmobilers spent nearly $250 million in the Wisconsin economy.[89] But a recent string of erratic winters in northern Wisconsin has caused many snowmobilers to look elsewhere for places to practice their hobby and erratic winter weather has put a crimp in the sport nationwide. Snowmobile sales in the U.S. have fallen in every year but one since 1997.[90]

The lack of reliable snowfall in recent years has caused some northern Wisconsin

Ice fishing could be a threatened pastime in Wisconsin if current trends toward reduced ice cover on the state's lakes continue as a result of global warming. Credit: stock.xchnge

tourism businesses, which have traditionally relied on snowmobilers and cross-country skiers for income, to focus on other forms of recreation.[91] Snowmobiling conditions are only projected to become worse over time; by the 2050s, reliable snowmobiling seasons are expected to disappear throughout most of the eastern United States.[92]

Ice Fishing

No ice on Wisconsin lakes means no ice fishing. And in recent years, winters in which lake ice forms late—or doesn't form at all—have happened with disturbing regularity. In Madison, for example, the winter of 2007 saw the second-latest freeze-over date for Lake Mendota and Lake Monona in 152 years.[93] The number of days during which the two lakes have been completely frozen has been below the long-term median in 18 of the last 21 years.[94]

The lack of lake ice has wreaked havoc on ice fishing. In neighboring Minnesota, warm winters caused the cancellation of the Golden Rainbow ice fishing competition north of St. Paul three out of five years. The contest is being moved further north in 2008.[95]

As noted above, not only are inland waterways in the Great Lakes region freezing later and thawing earlier than they did a century ago, but the rate of decline in ice cover is also accelerating. A recent study found that the number of ice cover days on Great Lakes waterways has been declining at the rate of 5.3 days per decade on average since the mid-1970s—a rate of decline far faster than over the period 1846-1995.[96] Further declines in lake ice cover, as would result from the projected warmer winters that will come with global warming, would further reduce the amount of ice fishing opportunities available to Wisconsin anglers.

Hunting

Hunting in Wisconsin depends, at its root, on healthy ecosystems. Global warming will inevitably have impacts on the types of animals available for Wisconsin sportsmen and sportswomen to hunt.

Mallards and other species of duck could see their numbers reduced in Wisconsin as a result of global warming, dealing a blow to Wisconsin duck hunters. Credit: PGC Photo/Joe Kosack

Deer hunting is both big business in Wisconsin (with $233 million in annual spending) and a fall tradition in much of the state.[97] Global warming might actually help populations of white-tailed deer by enabling more of them to survive and remain healthy through the winter months.[98] But Wisconsin, along with other states, already has an overabundant deer population whose browsing has the potential to damage forest ecosystems.[99] Despite record and near-record deer harvests in recent years, the state believes that deer populations remain above their target levels.[100] While abundant deer populations may mean good news for hunters, they are not necessarily good news for the overall health of Wisconsin's forests.

Other forms of hunting could suffer in Wisconsin. Duck hunting opportunities, for example, could become more scarce as duck populations in the Great Lakes region are projected to decline by 19 to 39 percent over the next several decades.[101] Blue-winged teals and mallards are among the species that could see their numbers significantly reduced in a warming Wisconsin.[102] Populations of ruffed grouse are projected to move north or disappear from the Great Lakes entirely following reductions in the number of paper birches in the region, whose buds provide an important part of

the bird's diet.[103] Ring-necked pheasants would likely become more common in northern Wisconsin and less common in southern Wisconsin.[104]

Birding and Wildlife Watching

Hunters aren't the only Wisconsin residents and visitors who enjoy interacting with wildlife in the outdoors. Birders and wildlife watchers spent nearly $3.5 billion in the upper Great Lakes economy in 1996.[105] And to many Wisconsin residents, the presence of birds and wildlife in their natural environment is an important part of what it means to live in the Badger State.

Birds, in particular, are very sensitive to the impacts of climate change. Warming temperatures are already thought to have altered the migratory patterns of many bird species in recent decades. And climate changes can affect the timing of other seasonal changes—such as leafing-out and fruit production in trees—that can affect the health and welfare of bird populations.

There is strong evidence that global warming will cause significant changes in bird populations in Wisconsin. The territory of warblers has already been shown to have moved north over the past two decades, part of a worldwide pattern of species shifting their territories toward the poles.[106] Nearly three dozen species of birds could be forced from Wisconsin as a result of global warming, and many others could see their summer territory in the state reduced.[107] Wood warblers would be among the most severely affected type of birds, with approximately two-thirds of species expected to be eliminated from Wisconsin.[108] Several other species of birds—including the Carolina chickadee and Carolina wren—could find their territory expand to include Wisconsin.

In short, global warming will likely change the way Wisconsin residents enjoy the outdoors in all seasons of the year, with winter recreation opportunities particularly constrained.

Farming

Global warming presents both opportunities and threats to Wisconsin agriculture. On the positive side, scientists project longer growing seasons and increased farm yields. However, climate change also creates a series of threats—such as increased risk of heat stress to cattle, the spread of farm pests, increased erosion, and more frequent drought—that could hamper Wisconsin farmers in the decades to come.

Global warming is often seen as a "good news" story for agriculture—at least in northern states like Wisconsin. The recent report of the Intergovernmental Panel on Climate Change (IPCC) found that climate change in the early years of this century could increase the productivity of rain-fed agriculture by 5 to 20 percent on average.[109] Growing seasons are already getting longer in the Great Lakes region and will likely be extended further in a warming world.[110]

But global warming won't help all types of farmers, and it could have negative impacts at certain times and places. Global warming will also pose new threats that could give Wisconsin farmers plenty to worry about in the next few decades.

Heat Stress

Dairy farming is the mainstay of Wisconsin's agricultural economy, with milk production accounting for more than half of all revenue for Wisconsin farmers. Wisconsin also ranks proudly as the nation's number one producer of cheese.[111] As a result, any threat to the future of dairy farming is of central importance to Wisconsin agriculture.

Rising summer temperatures increase the risk of heat stress to livestock. Above 77° F, cows need to use energy to cool themselves. Temperatures of higher than 90° F can cause significant reductions in milk production—up to 20 to 30 percent. Exposure to high temperatures can also cause serious health problems requiring extended care.[112] Heat stress is already a

Dairy farmers in Wisconsin could be forced to take greater steps to protect their herds from heat stress, should summer temperatures increase as projected by climate scientists. Credit: stock.xchnge

significant issue for Wisconsin dairy farmers; one study estimated the impact of heat stress to the state's dairy industry at $60 million per year.[113]

In a warming world, the number of days of extreme heat in Wisconsin is expected to increase dramatically. By the end of the century, the state could experience as many as 20 days of 97° F temperatures each summer.[114] There are many ways dairy farmers can reduce heat stress—including provision of adequate shade, cooling, and adjustments in water and feed provision. But higher temperatures will present a new issue farmers must face in keeping their herds healthy and productive.

Drought

Higher summer temperatures are projected to increase evaporation of water from farm soils, thus leading to increased potential for drought. Unlike the wetter winters projected for Wisconsin, precipitation in summer is expected to decline.[115] Summer droughts could have significant negative impacts on Wisconsin's agricultural economy—for example, the state's 2003 drought caused an estimated $25 million in crop damage in Pierce County alone.[116]

Much of Wisconsin experienced drought conditions beginning in the summer of 2006 that persisted through at least the early part of 2007. Northwestern Wisconsin was particularly hard hit. Parts of the state were considered in a state of extreme drought leading Gov. Doyle to declare a drought emergency in the state.[117] Such events could become more common in a warming world.

Soil Erosion

The flip side of Wisconsin's increased susceptibility to summer drought is the potential for increased soil erosion caused

by heavy storm events. Scientists predict that heavy rainstorms will become more frequent and could double in frequency by the end of the century.[118] Increases in heavy precipitation events—combined, possibly, with changes in the composition of crops—could lead to dramatic increases in soil loss by mid-century, particularly in eastern and southwestern Wisconsin.[119]

Pests

While increased carbon dioxide levels may encourage the growth of crops, they may—especially when combined with higher temperatures—also encourage the growth of weeds. Several aggressive weed species that are common in the southern United States could find their ranges extended further north as a result of higher temperatures.[120] Warmer winters could also allow several insect pests to expand their ranges northward and longer warm seasons could allow insects to increase their populations.

Global warming, therefore, may have some positive impacts on agriculture in Wisconsin. But it also increases a variety of risks to Wisconsin farmers.

Responding to Global Warming

Global warming threatens to change the character of natural Wisconsin forever. The first wave of changes already appears to be taking place, with warmer winters, later springs and more frequent severe rain events possibly acting as a harbinger of greater changes yet to come.

The good news is that Wisconsin has the tools to reduce our emissions of global warming pollutants and play our part in global efforts to prevent the worst impacts of global warming.

What the World Must Do

The severity of the likely impacts of global warming depends on how much global warming pollution the world emits in the years to come. If the world continues to burn fossil fuels at an ever-increasing rate, temperatures are likely to rise dramatically, causing severe and irrevocable damage to the world's ecosystems and its people.

But if we begin to reduce emissions now—and achieve steep reductions in global warming pollution in the years ahead—we can still avoid the worst impacts of global warming.

The European Union and others have come to accept a 2° Celsius (3.6°F) rise in global average temperatures over pre-industrial levels as a rough threshold beyond which dangerous impacts from global warming will become inevitable.[121] Even if the rise in temperatures is held below 3.6°F, global warming will have significant—and in some places, severe—impacts, due to higher temperatures, shifts in species, changes in precipitation patterns, and increases in sea level caused by melting ice and expansion of the ocean as it warms. But beyond 3.6°F, the impacts of global warming become much more dramatic, including:

- Eventual loss of the Greenland ice sheet, triggering a sea-level rise of 7 meters over the next millennium (and possibly much faster)[122];
- A further increase in the intensity of hurricanes;
- Loss of 97 percent of the world's coral reefs;
- Displacement of tens of millions of people due to sea level rise;
- Total loss of Arctic summer sea ice;

- Expansion of insect-borne disease;
- Greater risk of positive feedback effects—such as the release of methane stored in permafrost—that could lead to even greater warming in the future.[123]

At temperature increases of 3 to 4° C (5.4 to 7.2° F), far more dramatic shifts would take place, including all of the above changes, plus:

- Increased potential for melting of the West Antarctic ice sheet, triggering an additional 5 to 6 meter rise in sea level;
- Major crop failures in many parts of the world;
- Extreme disruptions to ecosystems. [124]

Science suggests that, to have a reasonable chance of keeping global temperature rise below 3.6°F, the world must stabilize concentrations of global warming pollutants at or below 450 parts per million (ppm) carbon dioxide-equivalent. Even by achieving this stabilization level, the probability of keeping temperature rise below 3.6°F is about 50-50.[125] Thus, reducing global warming emissions sufficient to maintain global warming pollutant concentrations at or below 450 ppm is the minimum action necessary, as indicated by current science, to prevent dangerous, human-caused climate change.[126]

To stabilize greenhouse gas concentrations at or below 450 ppm, the world must stop the growth in carbon dioxide emissions by about the end of this decade, reduce emissions to 1990 levels by the 2030s, and reduce emissions by one third below 1990 levels by 2050.[127]

The United States, as the world's leading emitter of global warming pollutants (and the last Western industrialized country, other than Australia, to make a national commitment to reduce global warming emissions), has a disproportionate responsibility to achieve emission reductions. To do its "fair share" to reduce emissions, the United States must:

- stabilize emissions at or below today's levels by the end of this decade
- reduce emissions by at least 15 to 20 percent below today's levels by 2020, and
- reduce emissions by at least 80 percent by 2050.

These reduction levels assume similarly aggressive efforts to reduce emissions by other Western countries, along with action by developing nations such as China and India. In other words, should the United States fail to achieve global warming emission reductions at or beyond these levels, the chances of preventing dangerous, human-caused global warming will be much reduced.

What Wisconsin Must Do

Wisconsin has the opportunity and the tools to reduce our own emissions of global warming pollution and to set a positive example for other Midwestern states in the fight against global warming.

With the Bush administration strongly resisting any serious efforts to reduce global warming pollution, states have taken the lead in recent years in taking strong action against global warming. Among those actions:

- Ten northeastern states—from Maine to Maryland—have created a program to cap carbon dioxide emissions from power plants starting in 2009 and reduce them by 10 percent by 2019. Several western states are considering a similar program.
- Eleven states have adopted standards to reduce global warming emissions from cars and light trucks.
- California has enacted the nation's first statewide cap on global warming pollution, committing to reducing its global warming emissions to 1990 levels by 2020.

- More than 20 states (including Wisconsin) have committed to obtaining a share of their electricity from clean, renewable sources.
- In addition, a number of state governors have made commitments to significant global warming emission reductions and many of those states have developed climate action plans that include specific measures they can take to reduce emissions.

These and other actions have increased momentum in Washington, D.C. to develop a national response to global warming. A variety of proposals are now circulating in Congress to address the problem, with the best proposals calling for reducing emissions by at least 80 percent below 1990 levels by 2050.

Wisconsin is also beginning to take action. In April 2007, Gov. Jim Doyle issued an executive order creating a task force on global warming that will develop a state plan of action to reduce Wisconsin's contribution to global warming. The governor also set ambitious goals for the use of renewable energy in Wisconsin's economy.

Policy Recommendations

Wisconsin should take a series of aggressive actions to reduce our emissions of global warming pollution. Specifically:

- The state should adopt a cap on global warming emissions that will reduce Wisconsin's global warming emissions by 20 percent by 2020 and 80 percent by 2050.
- Wisconsin should increase our use of renewable energy. Among the steps we can take are:
  - o Requiring 25 percent of transportation fuel in Wisconsin to come from renewable sources by 2025, while reducing per-mile global warming pollution from vehicles by adopting vehicle emission standards for carbon dioxide and supporting a strengthening of federal fuel economy standards.
  - o Requiring 25 percent of our electricity to come from clean, homegrown sources such as wind and solar power by 2025.
- Wisconsin's economy should become more energy efficient. Among the steps we can take are:
  - o Setting energy efficiency standards that will reduce electricity and natural gas consumption in Wisconsin by 10 percent by 2015.
  - o Encouraging public and private investments in energy efficiency and renewable energy technologies.

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