Odd-ball Winter Weather: Global Warming's Wake-Up Call for the Northern United States

NATIONAL WILDLIFE FEDERATION 2010

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Global warming is having a seemingly peculiar effect on winter weather in the northern United States. Winter is becoming milder and shorter on average; spring arrives 10 to 14 days earlier than it did just 20 years ago. But most snowbelt areas are still experiencing extremely heavy snowstorms. Some places are even expected to have more heavy snowfall events as storm tracks shift northward and as reduced ice cover on the Great Lakes increases lake-effect snowfalls. Even as global warming slowly changes the character of winter, we will still experience significant year-to-year variability in snowfall and temperature because many different factors are at play.

Milder winters disrupt ecosystems in some surprising ways. Bitter cold temperatures naturally limit the spread of pests, diseases, and invasive species. The absence of extreme winter cold across the mountainous West has enabled an explosion of mountain pine beetles and caused a massive die-off of pine forests. Some important plants—for example, walnuts, peaches, and cherries—require a certain exposure to cold in order to flourish. Plants and animals also can be caught unawares when milder conditions are punctuated by severe winter weather. Across the Great Plains and Southeast United States, a cold snap in early April 2007 caused more than $2 billion in crop losses after an unusually warm March led to premature crop growth.

Large economic uncertainty and potential losses are in store for many communities, especially in regions where winter recreation provides significant tourism revenue. Many ski resorts will see shorter, rainier seasons, which will negatively impact the $66 billion dollar industry and the tens of millions of Americans who ski each year. Lakes across the Midwest are freezing later and have thinner ice, often leading to ice conditions too dangerous for safe ice fishing. Roadway snow removal and wintertime flood management also will be complicated by more erratic winter weather; government agencies may have to account for much more year-to-year variability.

We can keep winters cool and safeguard communities and nature. Curbing global warming pollution as much and as quickly as possible is an essential first step. At the same time, we need to take steps to help communities, winter-dependent industries, and wildlife prepare for some of the changes that we can not avoid. We can no longer plan based on the climate we used to have.

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CONFRONTING GLOBAL WARMING

Report

Global Warming Makes Winter Weather More Erratic


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Global warming is having a seemingly peculiar effect on winter in the continental United States. On one hand, increasing temperatures have led to milder and shorter winters in most areas. On the other, we are still getting big snowstorms, especially in the northern part of the country.

Scientists project that the next few decades will bring both more unusually warm winters and record-breaking snow storms. Projecting how global warming will affect winter in specific locations is complicated because winter temperatures are often close to the freezing point of water: just a small amount of warming can make a big difference when it comes to snow. If no steps are taken to reduce global warming pollution and it gets much warmer, snowfall will become less and less common after midcentury for many parts of the country.

Even as global warming is slowly changing the character of winter in the United States, we will still experience familiar year-to-year variability. Because many different variables affect winter conditions—including temperature, moisture availability, storm tracks, and natural climate oscillations—and because global warming affects these variables in different ways, scientists do not expect a steady progression to less wintery conditions. We are beginning to understand how large climate oscillations, such as those associated with El Niño conditions, affect winter weather. For example, El Niños typically bring milder, less snowy winters to the Pacific Northwest.[1]

MILDER WINTERS ON AVERAGE

Wintertime temperatures have been increasing across the northern United States. Since the 1970's December-February temperature increases have ranged from 1 to 2 degrees Fahrenheit in the Pacific Northwest to about 4 degrees Fahrenheit in the Northeast[2] to more than 6 degrees Fahrenheit in Alaska.[3] Winters are getting shorter, too. Spring arrives 10 to 14 days earlier than it did just 20 years ago.[4] In addition, the date that rivers and lakes freeze over is later and spring-ice breakup is happening earlier.[5]

The spatial extent of snow cover across the Northern Hemisphere has decreased by approximately 3 to 9 percent since 1978, with especially rapid declines in the western United States.[6] In North America, the largest declines have occurred during the spring.[7] At the same time, the last few decades have brought fewer seasons with extremely abundant snowfall and more seasons with extreme low total snowfall in most parts of the country.[8] These trends are expected to continue. For example, by the end of the century, most of the Northeast is projected to lose 10 to 15 snow-covered days each month during winter, particularly across the central part of the region. Even the northern part of the region, which is currently snow-covered for the majority of winter months, could lose up to half of its snow-covered days.[9]

In lieu of snow, many areas are now getting increased precipitation from rain because of the warmer temperatures. The proportion of wintertime precipitation falling as snow has declined by 9 percent since 1949 in the Western United States[10] and by 23 percent in the Northeast.[11] This shift means less hassle with snow removal, but also an increase in flooding risk. One area of concern is flooding from the combined rainfall and snow melt, so-called rain-on-snow events, like several recent major flooding events in the Pacific Northwest. Some higher elevation areas in the West, where winter temperatures typically remain low enough to maintain snowpack, have seen a trend toward more rain-on-snow events, perhaps reflecting the increased likelihood of mid-winter rainfall events. Lower elevation areas in the West are seeing fewer rain-on-snow events because there is less snowfall overall.[12]


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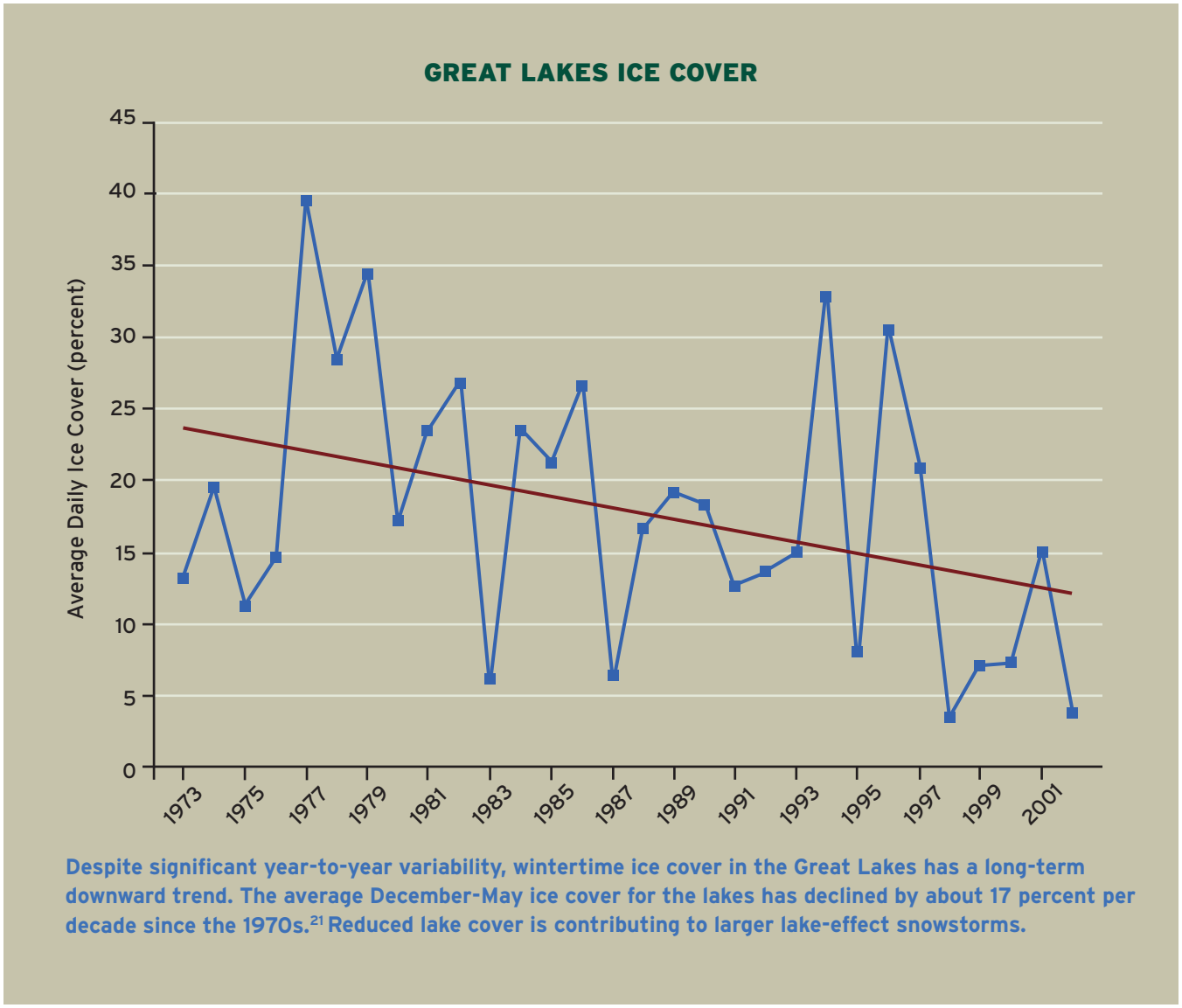


Despite significant year-to-year variability, wintertime ice cover in the Great Lakes has a long-term downward trend. The average December-May ice cover for the lakes has declined by about 17 percent per decade since the 1970s.[21] Reduced lake cover is contributing to larger lake-effect snowstorms.

BIG WINTER STORMS

Global warming is bringing a clear trend toward heavier precipitation events for the simple reason that warmer air can hold more water. Even with a greater fraction of precipitation falling as rain, many areas are still seeing big and intense snowstorms,[13] especially in the upper Midwest and Northeast, where temperatures typically remain below freezing in winter.[14] At the same time, global warming is shifting storm tracks northward.[15] The last few years have brought several unusually heavy snowstorms as warmer and moister air over southern states has penetrated further north, colliding with bitter cold air masses. Indeed, areas from the Dakotas eastward to northern Michigan have seen a trend toward more years with heavy snowfall.[16]

Some areas bordering the Great Lakes are also experiencing more lake-effect snow. Because the lakes are less likely to freeze over or are freezing later, surface water evaporation is recharging the atmosphere with moisture, which subsequently precipitates as more snow as it moves ashore.[17] For example, western New York state had a dramatic lake-effect snowstorm in February 2007, when the largely ice-free Great Lakes contributed to snow accumulation of more than 10 feet over a 10-day stretch.[18] Lake-effect snow is expected to continue increasing over the next few decades and then eventually decline as rising wintertime temperatures lead to rain instead of snow.[19]

Alaska's extensive coastline and coastal population are especially vulnerable to increasing storm activity. The Pacific storm tracks are expected to shift northward, bringing more storms to Alaska. At the same time, warmer surface ocean waters and reduced sea-ice cover are projected to make more heat and moisture available for storms, further increasing the frequency and intensity of storms.[20]

RECENT ODD-BALL WINTER EVENTS

October 2004: Hurricane-strength storm originating in the Bering Sea caused $20 million in damages. The loss of protective sea-ice and melting permafrost weakening coastal infrastructure exacerbated the damages.

March 2009: The Red River bordering North Dakota and Minnesota had its worst flood on record, with the river cresting in Fargo, North Dakota at 40.8 feet. Heavy rainfall the previous fall, large seasonal snow accumulation, ice jams, and a late winter snow-storm all contributed to flood conditions.

March 2008: Madison, Wisconsin reaches 100 inches of seasonal snow accumulation, smashing the previous record of 76 inches. Roadway snow removal costs for the state doubled compared to the previous 5 years.

Winter 2005-2006: Unusually mild conditions caused Canada geese to overwinter as far north as Prince Edward Island.

March 2002: Iditarod starting line moved more than 200 miles north because of inadequate snowcover and encroaching development. The change was made permanent in 2008.

January 2009: Up to 10 inches of rain fell over 2 days, which combined with snow-melt to cause extensive and costly flooding across western Washington State.

February 2007: 10-day lake-effect snow event dumped more than 10 feet in western New York state.

March 2007: Temperatures about 6 degrees F warmer than average from the Great Plains to the Southeast caused premature growth for plants and trees. Record cold temperatures in early April caused more than $2 billion in crop losses.

December 2009: Record snowfall of nearly 2 feet in Washington, DC. Falling on the final weekend before Christmas, it is estimated that local retailers lost about $2 billion in business.

Spring 2007: Colorado snowpack about 50 percent below normal.
Spring 2008: Colorado snowpack about 80 percent above normal.

March 2009: New 24-hour snow records set in Kansas, Oklahoma, and Texas.

January 2007: Unusually warm temperatures in December and early January were followed by a severe ice storm affecting areas from Texas and the Carolinas up to Canada. Missouri was hit especially hard with $352.9 million in damages and 14 deaths.

Several odd-ball winter events over the last few years are characteristic of what we expect global warming could bring.

SOURCES: National Oceanic and Atmospheric Administration, National Geographic News, Wisconsin Department of Transportation,

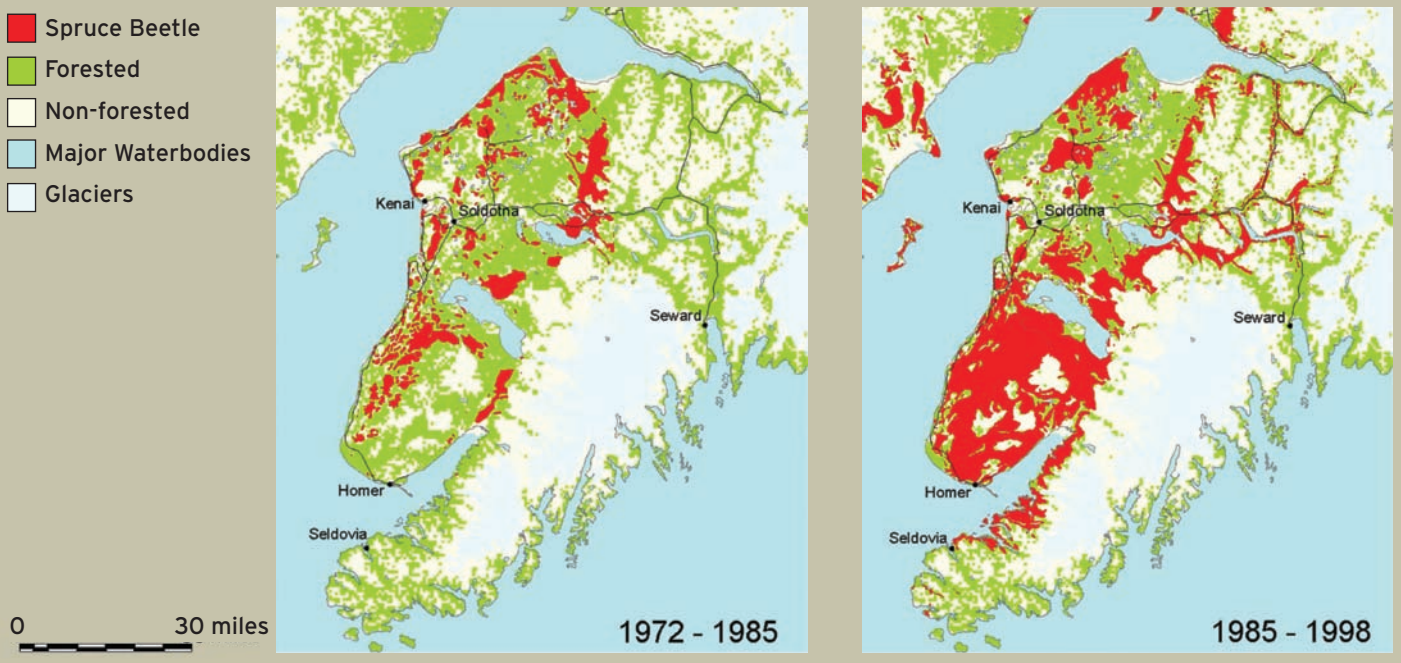
Wildlife and Habitats Disrupted by Changing Winter Weather

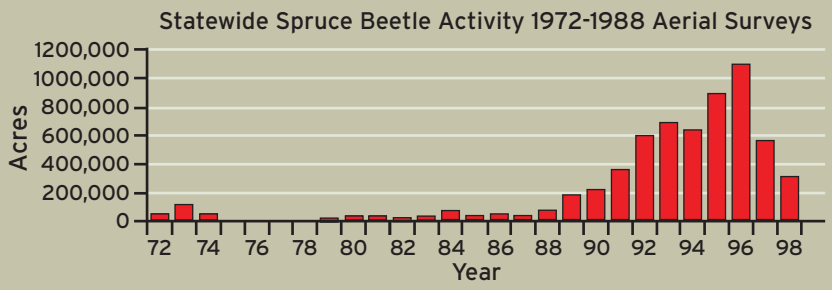
At first glance, milder winters seem like a boon for plants and wildlife. Indeed, many species will benefit from longer growing seasons and the ability to expand their range upslope or further north. A close inspection, however, reveals that global warming can affect wintertime behavior of species in ways that throw ecosystems out of balance, especially if natural controls on pests, diseases, and harmful invasive species are eroded. Furthermore, as wintertime weather becomes more erratic, plants and animals lulled into a sense of security by milder conditions in some years will face the harsh reality of more severe conditions in other years.

LOSS OF NATURAL CHECKS AND BALANCES

Many nasty pests—from invasive species to disease vectors—are expanding further north or are no longer being kept in check by frosts or sufficiently cold temperatures. The ticks responsible for carrying Lyme disease are one example of projected range expansion as winters become milder. Lyme disease causes a range of debilitating symptoms for humans, from fever and headaches to chronic impacts on the joints and central nervous system if it is not caught early. Average minimum temperatures below about 19 degrees Fahrenheit in winter are necessary to prevent the ticks from establishing a stable population. Larger areas of the United States and Canada are projected to be conducive for winter tick survival by later this century if global warming continues unabated.[22]

In some cases, entire ecosystems can be rapidly degraded. For example, millions of acres of pine forests across the Western United States, Alaska, and Canada have been decimated by pine bark beetle infestations in recent





Alaska spruce beetle infestation on the Kenai Peninsula expanded dramatically from 1972 to 1998, destroying over 5 million acres of forests.[24] Warmer conditions allowed beetles to survive over the winter and to complete their life cycle in one year instead of the normal two years.[25]

SOURCE: USGCRP (2009)


Tri-State Bird Rescue

In January 2010, a flock of brown pelicans, that historically would overwinter further south, were stranded in eastern Maryland and had to be moved indoors to protect them from cold temperatures.[27]


Flickr: AR Nature Gal

years. Although the beetles occur naturally in these forests, higher temperatures have increased winter survival of the beetle larvae, facilitating summer population explosions.[23] Once the beetles have ravaged the pines, the forest becomes more susceptible to wildfires, which further damage the ecosystem and put people in harm's way.

WINTERTIME SURPRISES

Numerous anecdotes have been reported of waterfowl, such as Canada geese, tundra swans, and canvasbacks, delaying migration due to the later onset of fall, or stopping short of their usual wintering grounds when they find suitable wintering areas farther north. For example, in the unusually mild winter of 2005-2006, Canada geese were observed for the first time ever spending the winter as far north as Prince Edward Island, on the Atlantic coast north of Nova Scotia. There is concern that waterfowl wintering further north, although less vulnerable to the stresses of migration, may be harmed by the sudden onset of severe winter weather that they would normally avoid if wintering further south.[26]

Plants are also affected by recent changes in winter weather. Milder winters and earlier onset of spring conditions have caused many plants to sprout and bloom unusually early. For example, in Spring 2007 an exceptionally warm March extending from the Great Plains to the Southeast United States led to premature growth and blooming for plants and trees.[28] But, a week of record and near-record cold temperatures in early April wrought more than $2 billion in crop losses and extensive damage to natural ecosystems.[29]

Winter Recreation Opportunities More Fickle

As our calendars turn to the New Year, many of us make plans for special winter getaways. We pull our sweaters out of storage, wax up the skis, or tune up the snowmobile. Lately, though, some unusually mild winters have made people begin to wonder—will we need to trade in our skis for golf clubs? All the more confusing, the next winter might bring several huge snowstorms. This increased variability in winter weather projected by scientists will mean large economic uncertainty and potential losses for many communities and regions where winter recreation is a significant part of overall tourism.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IMPACTS ON SKIING

If the thought of having to ride the chair lift back down the ski hill because of lack of snow makes you shudder, then you will not want to hear what scientists say global warming will mean for many of America's ski areas and the estimated $66 billion contributed to the U.S. economy from downhill skiing, snowboarding, cross-country skiing, and snowshoeing.[30]

- A number of Northeastern ski areas are likely to see a 25 to 45% decline in the length of their ski season by the 2070s.[31]
- Storied destinations such as Colorado's Aspen Mountain and Utah's Park City could see a 2,400-foot rise in the snowline (the elevation below which seasonal snowpack will not develop) before the century is out, leaving many base areas without snow.[32]
- In the Pacific Northwest, warmer, rainier winters are expected to become much more common at popular resorts such as the Summit at Snoqualmie.[33]

This is not good news for the more than 57 million people who flocked to the slopes for the 2008-09 season—the third busiest year ever for America's ski industry.[34]

Major ski resorts may be able to cope with the effects of climate change by increasing their snowmaking capacity, at least in the short term. Increases in snowmaking capabilities since the 1980s have dramatically increased the average downhill ski season length across the country, even during relatively warm winters. However, snowmaking does not come without costs. Smaller resorts may not be able to realize an economic benefit from increased snowmaking, particularly if temperatures rise enough that they cannot make snow efficiently.[35] Furthermore, snowmaking requires a significant supply of water, which will be in even greater demand for other uses in the years ahead, and electricity.

IMPACTS ON ICE FISHING

On a given day in winter, lakes throughout the upper-Midwest and New England can be populated with hundreds of ice-fishing houses. In 2006, ice fishermen spent more than $100 million on equipment alone. However, global warming threatens this cherished pastime. Lakes and rivers throughout the northern hemisphere are now freezing an average of six days later than they did 100 years ago.[36] Some lakes that


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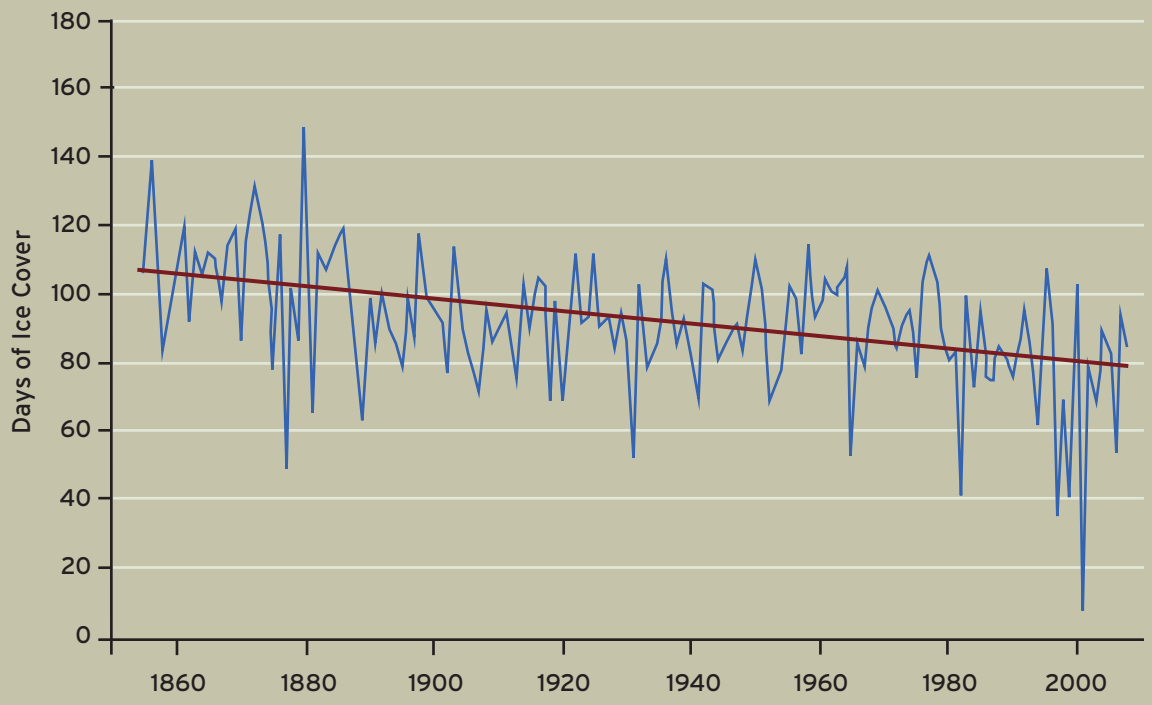
LAKE MENDOTA, WISCONSIN ICE COVER



Representative of many small lakes across the northern United States, for the past 150 years the average period of ice cover on Lake Mendota in Wisconsin has shortened by one day every five years, now averaging a full month less than historic average.[38]

tended to freeze completely in the winter now often remain at least partially open. Continued reductions in lake ice cover would reduce ice-fishing opportunities across the Great Lakes and New England, and increase risks to fishermen. In February 2009, for example, more than 130 fishermen were stranded on an ice floe in Lake Erie when the ice on which they were fishing broke apart.[37] The potential decline of ice fishing could cause a ripple effect on local economies dependent upon fishing activities, as well as state fish and wildlife agencies that rely on revenue from the sale of fishing licenses.

The 2006-2007 ice fishing season in Minnesota portends a grim future for this popular winter activity across much of the northern United States. Facing the cancellation of the popular Golden Rainbow Tournament for the fourth straight year due to poor ice conditions associated with warmer weather, the sponsoring local Jaycees declared in 2007 that it would no longer sponsor the annual event. Numerous other ice-fishing tournaments were cancelled that winter as many lakes across the northern states never froze or froze so late in the season that the ice fishing season was much shorter.

IMPACTS ON SNOWMOBILING

Snowmobiling is a popular winter sport in many parts of the country. The United States has more than 1.6 million snowmobiles registered nationwide, and industry experts estimate the average economic impact of snowmobiling at $22 billion annually.[39] Unfortunately, warmer winters are causing shorter periods of adequate snow cover, meaning those snow-


Flickr: tkellyphoto

mobiles will be spending a lot more time in the garage than on the trails. For example, much of the Northeast is projected to lose more than 50 percent of its snowmobiling season before 2040. Snowmobiling may be even more vulnerable to climate change than alpine skiing because it relies largely on natural snow.[40]

Societal Impacts of Patchy Winter Weather

Changing winter conditions will bring a mix of positive and negative impacts to communities in the United States. Less snowfall on average will likely reduce transportation hazards, the costs of snow removal, and the potential for roof and building damage. In addition, there should be a small decrease in wintertime mortality as we have fewer extremely cold days, although this will be offset by increased summertime mortality from more severe heat waves.[41]

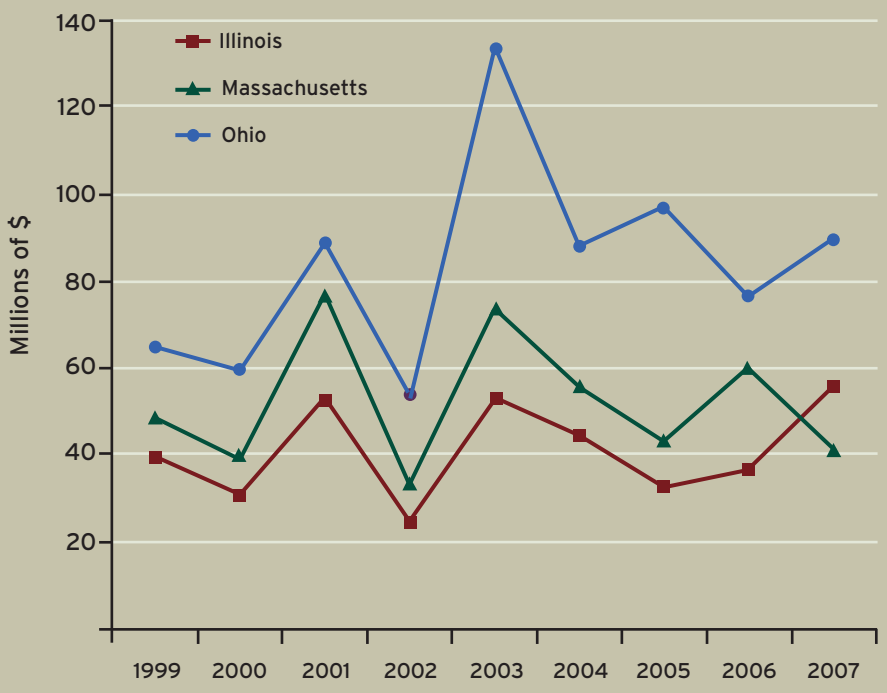
But, the trend toward more heavy snowstorm and rainfall events is likely to put a growing strain on communities across the country, particularly as they plan for snow removal and flood protection. In times of limited budgets and generally milder conditions, governments might tend to devote fewer resources to these services and then find themselves unprepared when big storms arrive. Farmers, foresters, and gardeners are also wrestling with how to plan for the combination of milder winters and the potential for heavy storms and cold snaps after springlike weather has begun.

TRANSPORTATION IMPACTS

Removing snow and ice from our roadways cost states more than $1.2 billion each year on average from 1998 to 2007.[42] The actual expenditures in each state can differ dramatically from year to year due to many factors, including annual snowfall amounts, changes in road maintenance practices, and other budget constraints. This variability makes it difficult for states and municipalities to plan for the future. As winters become milder on average, but punctuated by more heavy snowstorms in some locations, this variability in snow-removal needs will complicate planning even further.

Even the timing of a storm can wreak financial havoc. For example, the record-setting snowstorm that hit the Mid-Atlantic in mid December 2009 fell on a weekend, requiring significant overtime pay for crews to clear the roads. For this single storm, Maryland spent $27 million on snow removal, exceeding the $26 million it had budgeted for this season and the $21 million it typically budgets.[43] In fact, many major snowfall events early in the 2009-2010 season have left cities and states across the region worried about their rapidly dwindling snow removal budgets.[44]

Both Interstates 29 and 94 were shut down in South Dakota and North Dakota following a storm that slammed the Midwest and Great Plains on December 24, 2009.



State snow removal budgets for Illinois, Massachusetts, and Ohio illustrate how variable these expenses can be for states.[45] The year-to-year values can change by as much as a factor of two, reflecting differences in snowfall amounts, changes in road maintenance practices, and even other budget constraints.


U.S. Air Force

MORE EXTREME WINTERTIME FLOODS

Snowstorms are often accompanied by damaging floods. A study of the 155 most damaging snowstorms in the United States since 1948 found that floods accompanied 42 percent of them.[46] Changes in precipitation patterns are also expected to contribute to increased winter flooding in some areas. Already, the increase in average winter temperatures across the western United States during the 20th century has resulted in substantial increases in flood risks as more winter precipitation fell as rain rather than snow.[47] In January 2009, heavy rainfall caused extensive and costly flooding across western Washington State, destroying hundreds of homes and leading to the evacuation of tens of thousands of residents.[48] The flooding caused the closure of Interstate 5, the region's major North-South transportation corridor, for the fourth time since 1990 and the second time in three years.

Global warming also could create conditions ripe for ice-jam floods.[49] Regions where rivers freeze over in winter can have major floods when heavy rainfall or upstream melting raises the stream stage to the point of breaking up the ice cover.[50] If it piles up on bridge piers or other channel obstructions, the ice can create dams that cause flooding behind it. Once the ice jam breaks up, downstream areas are vulnerable to flash floods. The increasing possibility of mid-winter thaws and heavy rainfall events could increase the risk of sudden ice break-up. Flooding can be further exacerbated if the ground is still frozen and unable to soak up rainwater. The 2009 floods on the Red River in North Dakota exemplified this situation.[51]

AGRICULTURE THROWN FOR A LOOP

The United States is already seeing a trend toward fewer frost days, an earlier date of last-spring freeze, a later date of the first-fall frost, and less snow cover.[52] Shorter winters will benefit some forms of agriculture, especially by extending the growing season. However, these changes are also having negative impacts on some crops, sometimes in surprising ways. For example, winter wheat crops and trees can be more vulnerable to frost damage when there is no snow cover. While some farmers can easily switch from one crop to another, for others this transition can be prohibitively expensive.

Many of the economically important fruit and nut species grown in the U.S. require exposure to a certain amount of "winter chill" (periods with average temperatures between 32 and 45 degrees) to successfully break dormancy and resume growth in spring. For example, apples, cherries, and pears require a minimum of 1000 chill hours.[53] With global warming, the length of winter chill periods in some areas is projected to decline significantly. A recent study in California found that by the end of the 21st century, the Central Valley might no longer be suitable for growing walnuts, pistachios, peaches, apricots, plums, and cherries—some of the most economically important agricultural products in the state.[54]

Some exotic pest insects are also likely to benefit from global warming, at the expense of agriculture and beloved garden plants. One consequence of an earlier growing season in Ohio, for example, has been the emergence timing of the black vine weevil, a highly damaging nursery pest. Adults have been emerging 3 weeks earlier, on average, than they did in the 1970s, corresponding with the blooming of black locust.[55]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A MIXED BAG FOR VULNERABLE POPULATIONS


Flickr: brownpau

Changing winter weather will be a mixed blessing for vulnerable populations. Milder conditions are expected to reduce mortality caused by exposure to extreme cold, to which the homeless and other low-income people, the elderly, and those with health conditions are most vulnerable.[56] On the other hand, the trend towards heavier snowstorms in some locations will disproportionately impact the poor, elderly, and those living on tribal lands, especially when roadways are compromised during major snowfall events. The potential loss of work opportunities due to impassable roads combined with higher costs for heating can strain the budgets for households already struggling to get by, especially if recent mild conditions have caused some not to plan for severe weather. The elderly who already have limited mobility can be stranded for days if snow removal is slow. Tribes often have even more limited resources available for snow removal. For example, the Pine Ridge Indian Reservation in South Dakota was hit especially hard by the 2009 Christmas Eve storm: many residents ran out of propane for heating their homes before the roads could be cleared.[57]

Solutions

The most important thing we can do to reduce the potential impact of changing winter weather is to reduce our global warming pollution as much and as soon as possible. At the same time, we need to take steps to help communities, winter-dependent industries, and wildlife prepare for the winter weather changes that we can not avoid. We can no longer plan based on the climate we used to have. In particular, we must take the following important actions.

REDUCE GLOBAL WARMING POLLUTION

Policy makers, industry, and individuals must work together to reduce emissions from the burning of coal, oil, and gas by at least 80 percent below today's levels by 2050. This target is achievable with technologies either available or under development, but we must take aggressive action now to avoid the worst impacts. It is imperative that Congress pass comprehensive climate change legislation mandating reductions in greenhouse gas emissions.

SAFEGUARD WILDLIFE

Targeted habitat restoration and wildlife management approaches can help wildlife endure the changing winter weather. For example, reducing other stressors on wildlife—such as habitat loss, disturbance and degradation—should help wildlife better endure the stresses imposed by climate change. It is important that Congress include dedicated funding in climate change legislation to help safeguard wildlife and other natural resources in a changing climate.

PLAN ACCORDINGLY

Cities and states must account for greater variability in winter weather as they plan their snow removal and flood management programs. Those who depend on winter weather for their livelihood—from ski resort managers and snow mobile manufacturers to farmers and foresters—will need to adjust their business plans for the new climate realities.

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