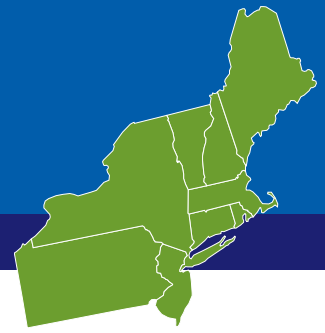




Maine

Confronting Climate Change in the U.S. Northeast



From towering Mount Katahdin to the sandy beaches of York, the climate of Maine is changing. Records show that spring is arriving earlier, summers are growing hotter, and winters are becoming warmer and less snowy. These changes are consistent with global warming, an increasingly urgent phenomenon driven by heat-trapping emissions from human activities. New state-of-the-art research shows that if global warming emissions continue to grow unabated, Maine can expect dramatic changes in climate over the course of this century, with substantial impacts on vital aspects of the state's economy and character. If the rate of emissions is lowered, however, projections show that many of the changes will be far less dramatic. Emissions choices we make today—in Maine, the Northeast, and worldwide—will help determine the climate our children and grandchildren inherit, and shape the consequences for their economy, environment, and quality of life.

The research summarized here describes how climate change may affect Maine and other Northeast states under two different emissions scenarios. The higher-emissions scenario assumes continued heavy reliance on fossil fuels, causing heat-trapping emissions to rise rapidly over the course of the century. The lower-emissions scenario assumes a shift away from fossil fuels in favor of clean energy technologies, causing emissions to decline by mid-century.

The research also explores actions that individual households, businesses, and governments in the Northeast can take today to reduce emissions to levels consistent with staying *below* the lower-emissions scenario, and to adapt to the

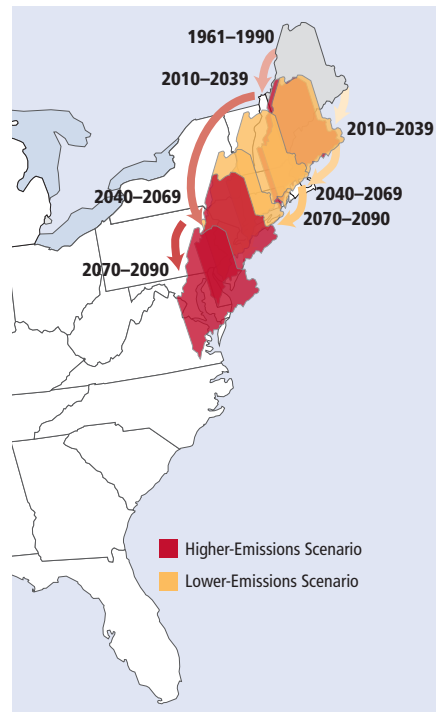
unavoidable changes that past emissions have already set in motion.

MAINE'S CHANGING CLIMATE

Temperature. Average temperatures across the Northeast have risen more than 1.5 degrees Fahrenheit (°F) since 1970, with winters warming most rapidly—4°F between 1970 and 2000. If higher emissions prevail, seasonal average temperatures across Maine are projected to rise 10°F to 13°F above historic levels in winter and 7°F to 13°F in summer by late-century, while lower emissions would cause roughly half this warming.

Precipitation and winter snow. The Northeast region is projected to see an increase in winter precipitation on the order of 20 to 30 percent. Slightly greater increases are projected under the higher-emissions scenario, which would also feature less winter precipitation falling as snow and more as rain.

Snow is nearly synonymous with winter in Maine and an integral part of many favorite winter activities and traditions. If higher emissions



Migrating State Climate

Changes in average summer heat index—a measure of how hot it actually feels, given temperature and humidity—could strongly affect Mainer's quality of life in the future. Red arrows track what summers could feel like over the course of the century under the higher-emissions scenario; yellow arrows track what summers in the state could feel like under the lower-emissions scenario.

prevail, much of Maine—historically snow-covered for most of the winter—would see its snow season shrink by roughly half by late-century. Under the lower-emissions scenario, however, the state is expected to retain a substantial snow season—between two and four weeks of snow cover per winter month.

Heavy, damaging rainfall events have already increased measurably across the Northeast in recent decades. Intense spring rains struck the region in both 2006 and 2007, for example, causing widespread flooding. The frequency and severity of heavy rainfall events is expected to rise further under either emissions scenario.

Drought and stream flow. In this historically water-rich state, rising summer temperatures coupled with little change in summer rainfall are projected to increase the frequency of short-term (one- to three-month) droughts and decrease summer stream flow, particularly if higher emissions prevail. By late-century, for example, short-term droughts are projected to occur annually under the higher-emissions scenario (compared with once every two to three years, on average, historically), while summertime conditions of low stream flow (detrimental to native fish such as the Atlantic salmon) are projected to last an additional month, increasing stress on both natural and managed ecosystems. By contrast, little change in either drought or stream flow is expected under the lower-emissions scenario.

Sea-level rise. Global warming affects sea levels by causing ocean water to expand as it warms, and by melting land-based ice. Under the higher-emissions scenario, global sea level is projected to rise between 10 inches and two feet by the end of the century (7 to 14 inches under the lower-emissions scenario). These projections do not account for the recent observed melting of the world's major ice sheets—nor the potential for accelerated melting—and may



AP Photo/Robert F. Bukaty

A decline in spruce/fir forests would greatly exacerbate existing stresses on Maine's economically important pulp and paper industry.

therefore be conservative. However, even under these projections, Maine's coast faces substantial increases in the extent and frequency of coastal flooding, erosion, and property damage.

IMPACTS ON FORESTS

Forests cover 90 percent of Maine, providing timber and firewood, plant and wildlife habitat, and terrain for hiking, snowmobiling, snowshoeing, fishing, and birding. In addition, the forestry industry provides the state with more than 19,000 jobs.

As temperatures climb, the character of Maine's forests is expected to change—particularly its spruce/fir forests, which are vital to the state's nearly \$1.4 billion pulp and paper industry and treasured for their scenic and recreational value. Spruce and fir species provide 50 percent of all sawlogs (used for lumber) and 20 percent of all pulpwood (used for paper production) harvested in Maine.

Climate conditions suitable for these forests are expected to decline in Maine by late-century under both emis-

sions scenarios, with the steepest losses under the higher-emissions scenario. Losses in spruce/fir forests will eventually affect the animal species dependent on them, such as the Canada lynx, snowshoe hare, and Bicknell's thrush. Under the lower-emissions scenario, patches of the high-elevation spruce/fir habitat required by the Bicknell's thrush could persist in the mountains of Maine, but under the higher-emissions scenario this bird's distinctive song could eventually be muted across the entire region as its suitable habitat gradually disappears.

Warm winters interfere with traditional timber harvesting practices in the region, which rely on frozen soil conditions to minimize damage caused by heavy equipment. With projected winter warming, the trend toward an earlier or intermittent "mud season" is expected to continue.

Long-lived trees may persist for some time even as the climate becomes unsuitable for them; however, they may also become more vulnerable to competition from better-suited species and

other stresses such as pests and disease. Maine's hemlock trees (which shade streams, providing cool conditions required by native brook trout and other fish) face both shrinking suitable habitat and the northward march of the hemlock woolly adelgid, an invasive insect that has already destroyed hemlock stands from Georgia to Connecticut. With warmer winters projected under the higher-emissions scenario, the adelgid is poised to infest hemlocks as far north as the Canadian border by late-century, but would be prevented from spreading into northern Maine this century under the lower-emissions scenario.

IMPACTS ON WINTER RECREATION

The Pine Tree State has a long-established reputation as a winter getaway. But Maine winters have already changed and, over the course of the century, may look and feel profoundly different.

Snowmobiling. Maine is part of a six-state network of snowmobile trails totaling 40,500 miles and contributing \$3 billion a year to the regional economy. Snowmobiling, like cross-country skiing and snowshoeing, relies almost entirely on natural snowfall because of the impracticality of snowmaking on such a vast system of trails. This fact, combined with projected losses in natural snow cover, means that Maine's snowmobiling season could be cut substantially by mid-century. Under the higher-emissions scenario the average season length across Maine is projected to shrink to roughly 30 days by late-century—a nearly 70 percent decline below recent levels—and to roughly 50 days under the lower-emissions scenario (a 40 percent decline).

Skiing. Maine's 17 ski areas contribute \$300 million a year to the state's economy, providing recreation for Mainers and visitors. Milder winters are

expected to shorten the average ski season, increase snowmaking requirements, and drive up operating costs in an industry that has already contracted in recent years. Under the higher-emissions scenario, western Maine is projected to be the only area in the entire Northeast able to support viable ski operations by late-century. However, in order to stay open, resorts in this area would require substantial increases in snowmaking capacity and, therefore, operating costs.

Lake ice. Ice fishing and pond hockey are winter favorites in Maine. However, global warming will render lake ice cover increasingly thin and shorten its duration; ice cover duration on Sebago Lake has already declined by two weeks over the past several decades. Combined with fewer opportunities for sledging, snowshoeing, and other favorite outdoor activities, winter recreation as it is now known in Maine is at great risk.

MARINE IMPACTS

A regional icon, Maine's coastal fishing villages contribute \$393 million to the state economy each year. Commercial fish and shellfish, including cod and lobster, have water-temperature thresholds that define the conditions required for their survival, growth, and reproduction. By increasing the region's water temperatures, global warming is expected to bring more changes to a sector that has already been transformed over the past several decades.

Lobster. In 2005 Mainers landed 70 million pounds of lobster—more than half of the annual U.S. catch. As the Gulf of Maine warms this century, deeper waters and coastal areas of Downeast Maine may become increasingly suitable for lobster habitation. However, these waters may also become more hospitable to diseases such as lobster-shell disease, which is now observed



AP Photo/Robert F. Bukaty

From skiing and snowboarding to snowmobiling, ice fishing, and sledging, many residents of Maine embrace winter recreation. But the state's winters are warming. Over the course of this century more winter precipitation is projected to fall as rain, and snow and lake ice are expected to melt more quickly, reducing opportunities for popular winter activities.

only at low levels in Maine waters but has damaged the fishery farther south.

Cod. Maine's cod landings, valued at \$3 million in 2005, continue to derive mostly from the Gulf of Maine and neighboring Georges Bank. The Gulf of Maine is projected to continue to support adult cod under either scenario but, as temperatures rise, these waters are expected to become too warm to support the growth and survival of young cod later this century—a critical factor in the long-term viability of this fishery. This change would likely occur more rapidly under the higher-emissions scenario.

IMPACTS ON COASTAL COMMUNITIES

From Kittery to Quoddy Head, climate change threatens the extensive Maine coast and its communities. Rising sea levels caused by global warming are projected to increase the frequency and severity of storm surges and coastal flooding. Favorite beaches and popular tourist destinations, such as Old Orchard Beach, could experience increased beach erosion and flood-related property damage this century. The state's coastal wetlands (which provide critical nursery habitat for commercial fish and important stopover sites for migratory and other birds) would be at great risk of permanent inundation as sea levels rise.

Maine is currently the only state in the nation that has implemented shoreline regulations that take potential sea-level rise into account. Further strengthening and adequate funding of these regulations can help protect the state's coast as the climate changes.

IMPACTS ON AGRICULTURE

Maine's farms are not only an idyllic symbol of its heritage, but also a mainstay of the state economy, generating \$1.2 billion every year. Global warming will present both opportunities and challenges to Maine's growers and pro-

ducers in the coming decades; for example, increases in the frequency of short-term drought (see p.2) could necessitate increased irrigation (e.g., of the blueberry barrens) and operational costs, while a longer growing season could benefit farmers seeking to invest in warmer-weather crops that are currently hard to grow in Maine.

Crops. Maine's fruit and vegetable crops generate approximately \$160 million annually. The state produces more wild blueberries than any other place in the world and ranks sixth in the nation for potato production. Increasing summer temperatures and heat stress could depress the yields of economically important crops, including certain apple varieties and potatoes, by late-century under the higher-emissions scenario. Northward expansion of agricultural pests and weeds could further impede crop production during the course of the century and pressure farmers to increase their herbicide and pesticide use. Under the lower-emissions scenario most of these impacts are expected to be relatively minor.

IMPACTS ON HUMAN HEALTH

Air quality. Air quality is a serious concern in Maine, where 1 in 10 people suffer from asthma. While the state has reduced ozone concentrations in recent years, global warming is expected to worsen air quality in the region, putting more stress on people with asthma and other respiratory diseases. In the absence of more stringent controls on ozone-forming pollutants, the number of poor air-quality days in cities like Augusta could roughly quadruple under

the higher-emissions scenario by late this century. Under the lower-emissions scenario such days could increase by half.

Higher temperatures and increasing levels of plant-stimulating carbon dioxide (CO₂) in the air are also expected to accelerate seasonal pollen production in plants over the next several decades



Ting Li Wang/The New York Times/Redux

Maine's landings of American lobster, the state's highest-value commercial catch, were valued at more than \$300 million in 2005. The industry also supported more than 7,000 commercial harvesters in Maine in 2006. As waters warm and lobster ranges shift, lobstermen will need to adapt to the changes and manage the remaining stocks in a sustainable manner.

under the higher-emissions scenario. This could extend the allergy season, increase asthma risks, and exacerbate symptoms for asthma sufferers.

Vector-borne disease. Mosquitoes and ticks carry West Nile virus (WNV) and Lyme disease-causing bacteria, respectively, and spread them to animals or people. Factors affecting the spread of such vector-borne diseases are complex; however, projections for the Northeast of warmer winters, hotter summers, and more frequent summer dry periods punctuated by heavy rainstorms can set the stage for more frequent WNV outbreaks.

WHAT WE CAN DO

We have an opportunity to help protect our children and grandchildren from the most severe consequences of global warming by reducing emissions today. At the same time, effective adaptation strategies are needed to help reduce the vulnerability of Maine's residents, ecosystems, and economies to those changes that are now unavoidable.

Here in Maine, and across the world, there is growing momentum to meet the climate challenge. Of course our actions alone will not be sufficient to avoid dangerous climate change. But with its reputation as a state of sensible and resourceful people and a history of national leadership in environmental policy, Maine (along with the rest of the Northeast) is well positioned to drive national and international action.

Concerted, sustained efforts to reduce emissions in the region—on the order of 80 percent below 2000 levels by mid-century, and just over 3 percent per year on average over the next several decades—can help pull global emissions below the lower-emissions scenario described here.

State and municipal governments have a rich array of strategies and policies at their disposal to meet the climate challenge in partnership with other states, businesses, civic institutions, and the public. These strategies and policies would reduce emissions in the following sectors:

Electric power. As a participant in the Regional Greenhouse Gas Initiative, Maine can reap substantial energy cost savings, promote economic development, and reduce emissions by auctioning 100 percent of the emissions credits created under the initiative and investing the proceeds in energy efficiency and renewable energy development. Governor Baldacci's Task Force on Wind Power Development can help Maine capitalize on its wind resources (largest among New England states) by



New England Futures/Maine DOT

The *Downeaster* is a 116-mile Amtrak train route from Boston to Portland, Maine. In fiscal year 2006, it was Amtrak's fastest-growing service, with overall ridership up 23 percent from the previous year.

ensuring that the state has an efficient and balanced process for evaluating projects and setting targets for substantially increasing new wind generation over the coming decades.

Buildings. Maine's relatively old stock of residential, commercial, and industrial buildings offers substantial opportunities to reduce emissions associated with water and space heating. The state already requires all state building projects to achieve the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification; local governments could follow suit and also amend zoning laws to encourage and/or require private projects to attain LEED certification and/or designation as a U.S. Environmental Protection Agency (EPA) Energy Star Building. Significant emissions reductions and energy cost savings could be achieved by eliminating Maine's distinction as the only New England state without a residential building energy code.

Transportation. Cars and trucks account for nearly 40 percent of Maine's total heat-trapping emissions. The

state has adopted California's tailpipe emissions standards, which require reductions of approximately 30 percent below 2002 levels by 2016, beginning with the 2009 model year (implementation is contingent upon a ruling expected from the EPA). Vehicle emissions can be further reduced through increased investment in public transportation, incentives to purchase low-emissions vehicles, and incentives and regulations that promote "smart growth" strategies such as concentrating development near existing infrastructure and downtowns. In addition, Maine can adopt standards to reduce the carbon content of fuels.

Industries and large institutions can reduce emissions while lowering energy costs and enhancing their energy security by installing combined-heat-and-power (CHP) and on-site renewable energy systems. For example, Eastern Maine Medical Center in Bangor commissioned a CHP system in 2006 that will save the facility \$1 million per year.

Forestry and agriculture policies in Maine can be refined to promote man-

agement practices and systems that cost-effectively reduce emissions. Opportunities for capturing carbon or avoiding CO₂ emissions from forests include protection, reduced-impact timber harvesting, reforestation, and bioenergy production—provided the latter is done in a sustainable manner.

CONCLUSION

Global warming represents an enormous challenge, but the solutions are within reach if we act swiftly. The emissions choices we make today in Maine, the Northeast, and globally will shape the climate our children and grandchildren inherit. The time to act is now.



DOE/NREL/Judy Forsythe

A Citizen's Guide to Reducing Emissions

1. **Become carbon-conscious.** The problem of global warming stems from a previous lack of awareness of our “carbon footprint” and its effect on climate. Individuals and families can start by using one of several publicly available carbon-footprint calculators that will help you understand which choices make the biggest difference.
2. **Drive change.** For most people, choosing a vehicle (and how much they should drive it) is the single biggest opportunity to slash personal carbon emissions. Each gallon of gas used is responsible for 25 pounds of heat-trapping emissions.
3. **Look for the Energy Star label.** When it comes time to replace household appliances, look for the Energy Star label on new models (refrigerators, freezers, furnaces, air conditioners, and water heaters use the most energy).
4. **Choose clean power.** Consumers in Maine can purchase electricity from local utilities generated from renewable resources that produce no carbon emissions. If your local utility does not offer a “green” option, consider purchasing renewable energy certificates.
5. **Unplug an underutilized freezer or refrigerator.** One of the quickest ways to reduce your global warming impact is to unplug a rarely used refrigerator or freezer. This can lower the typical family's CO₂ emissions nearly 10 percent.
6. **Get a home energy audit.** Take advantage of the free home energy audits offered by many utilities. Even simple measures (such as installing a programmable thermostat) can each reduce a typical family's CO₂ emissions about 5 percent.
7. **Lightbulbs matter.** If every U.S. household replaced one incandescent lightbulb with an energy-saving compact fluorescent lightbulb (CFL), we could reduce global warming pollution by more than 90 billion pounds over the life of the bulbs.
8. **Buy good wood.** When buying wood products, check for labels that indicate the source of the timber. Forests managed in a sustainable way are more likely to store carbon effectively—thus helping to slow global warming.
9. **Spread the word and help others.** A growing movement across the country seeks to reduce individual, family, business, and community emissions while inspiring and assisting others to do the same.
10. **Let policy makers know you are concerned about global warming.** Elected officials and candidates for public office at every level need to hear from citizens. Urge them to support policies and funding choices that will accelerate the shift to a low-emissions future.



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For more information on our changing Northeast climate and what you can do, or to download a copy of the full report and additional state summaries, visit www.climatechoices.org.

