

# 2010

## Climate Change and Public Health

*Understanding the Role for Public Health and Health Care Practitioners*



**Maple Hill Farm  
April 7, 2010**

*Sponsors: New England Alliance for Public Health Workforce Development, Harvard University School of Public Health, University of New England Center for Community and Public Health, Maine Center for Disease Control and Prevention*

*Supporters: Maine Department of Environmental Protection, Maine Center for Public Health, American Lung Association of New England, Maine Medical Association, Physicians for Social Responsibility*

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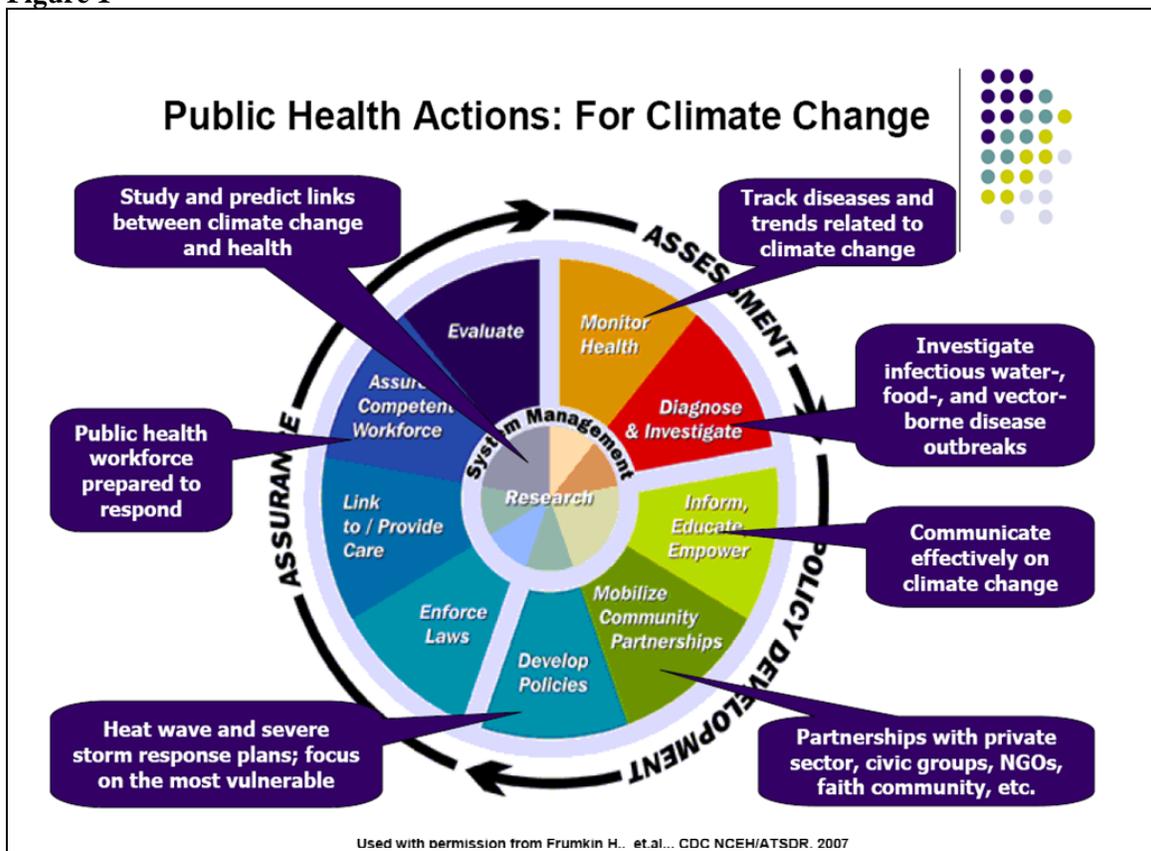
## Introduction

Over the past two decades, there has been an increasing sound of alarm from the international scientific community regarding the health and environmental consequences of climate change. This alarm has been underscored by the realization that human activity is having a significant contribution to our emerging climate crisis and that this crisis will not be reversed in the near term. As a result, we need to start planning how we will adapt to this changing climate, including how we will adapt to Maine's changing climate.

The Harvard Prevention Research Center, in partnership with the University of New England and the Maine Center for Disease Control and Prevention, convened a conference in April, 2010, to address this emerging public health challenge. The conference focused on two major objectives: 1) to educate Maine's public health community on the current state of knowledge regarding the health impacts of climate change: and 2) to use this educational forum as the foundation for establishing climate change as a public health priority in the state.

This document is a summary of the key educational messages delivered during this conference. Collectively, these messages provide the foundation for how Maine's public health community must organize itself around a comprehensive set of public health practices (see below).

Figure 1



## The Public Health Response to Climate Challenge

Michael McGeehin, PhD, MSPH

Director, Division of Environmental Hazards and Health Effects

National Center for Environmental Health

U.S. Centers for Disease Control & Prevention (CDC)

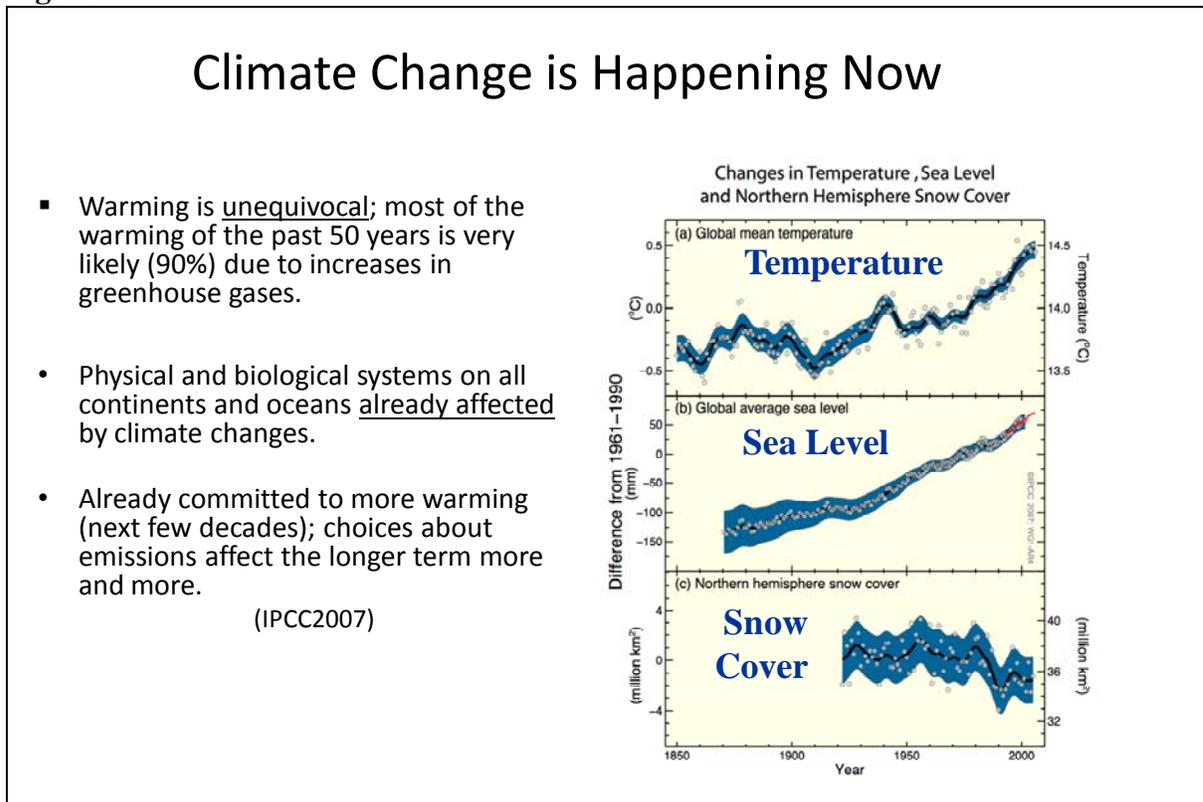
### Key Messages:

- There is a consensus based on good evidence that the climate is changing.
- Climate change causes a wide variety of effects, some of which we have begun to see and others that we will see in the future.
- Many of these effects have health implications.
- Climate change is a public health issue and public health practitioners must be at the table when mitigation and adaptation are discussed.

### Evidence that the climate is changing

Dr. McGeehin began his talk with a summary of the evidence that the climate is changing. Among the most noticeable changes is evidence of an increase in temperature and sea level, along with a decrease in snow cover (Figure 1).

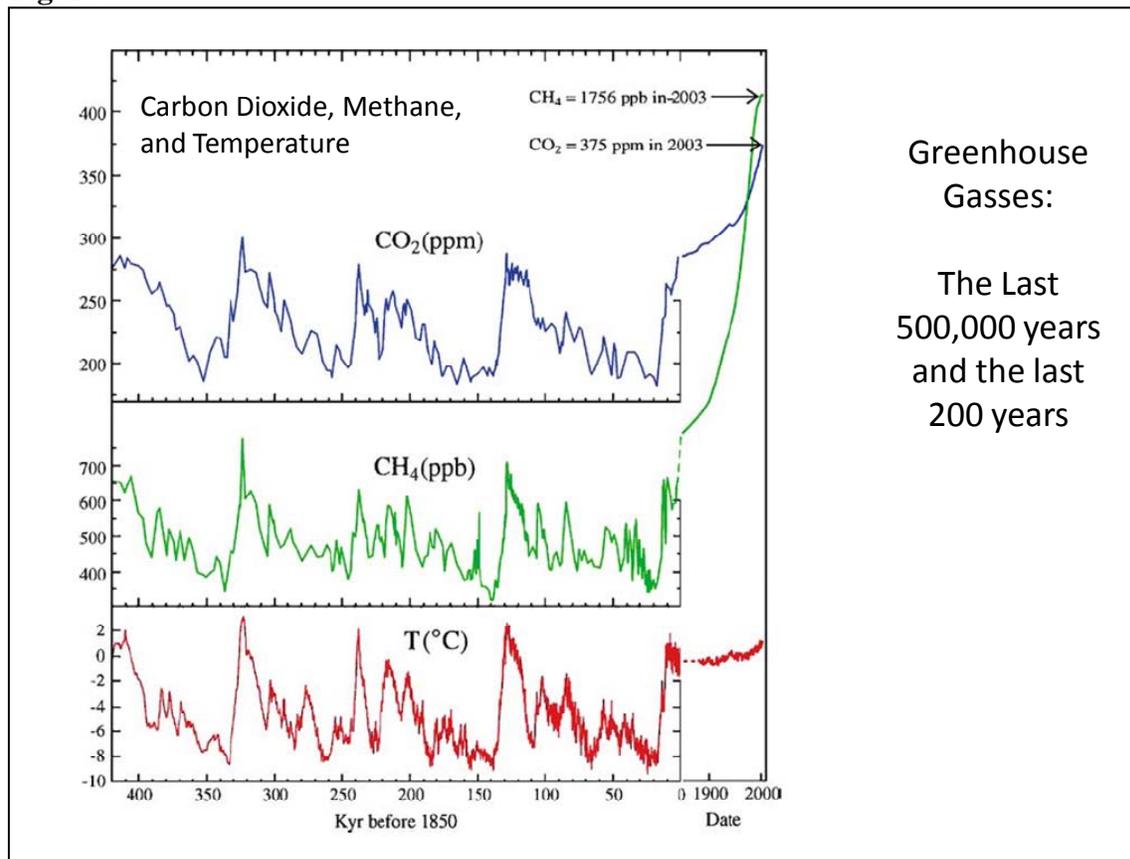
Figure 2



He then cited the Intergovernmental Panel on Climate Change's 2007 report, which not only stated that most of the warming over the past 50 years was caused by increased greenhouse gas emissions, but also that the planet is committed to further warming over the next few decades as a consequence of long lived greenhouse gases already in our atmosphere.

Next, he discussed the similarities in the increases of CO<sub>2</sub> and CH<sub>4</sub> and temperature in the atmosphere, particularly over the past 200 years (Figure 2).<sup>1</sup> It is widely acknowledged, said Dr. McGeehin, that global surface temperatures have risen approximately 1.2 degrees Fahrenheit (0.65° C) from pre-industrial times.

**Figure 3**

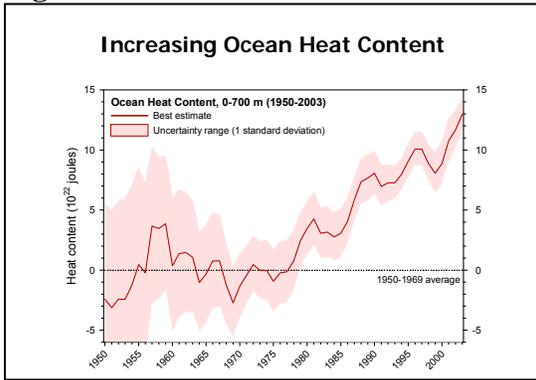


He presented compelling evidence of the worldwide effects of global warming (Figures 3-7). Surface ocean heat content is estimated to have risen by over  $10^{23}$  joules. Sea level rise has been accelerating over this time as well and currently estimated to be approximately 3.2 millimeters per year. The synchronous global retreat of glaciers has also been documented.<sup>2</sup>

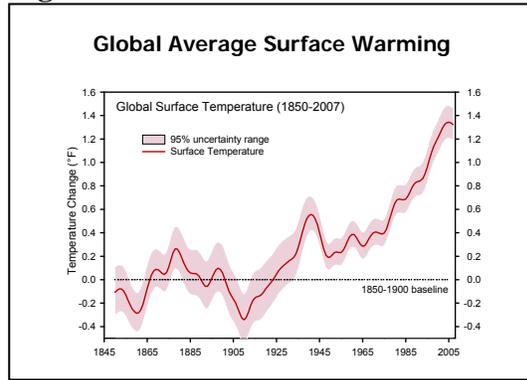
<sup>1</sup> Editor's note. Citing data obtained from ice core samples, some climate skeptics have made the argument that temperature increases have actually come before increases in carbon dioxide. While this is true, it is important to point out that this temperature-CO<sub>2</sub> pattern occurred early in the warming period; following this initial phase, carbon dioxide sustained and enhanced temperatures throughout the warming period.

<sup>2</sup> Editors note. The retreat of the glaciers provides one example of how inter-related the impacts of climate change are. Glaciers are vitally important to our global water supplies. In addition, the loss of snow cover increases the absorption of radiant energy, further adding to global warming.

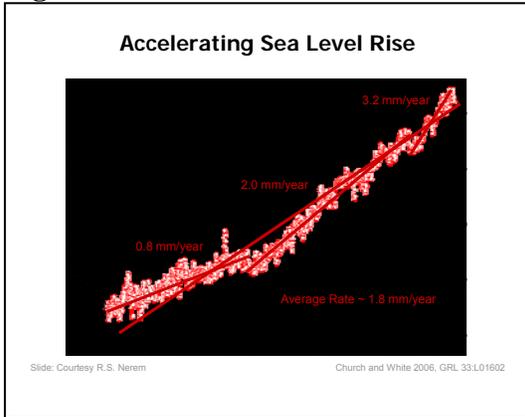
**Figure 4**



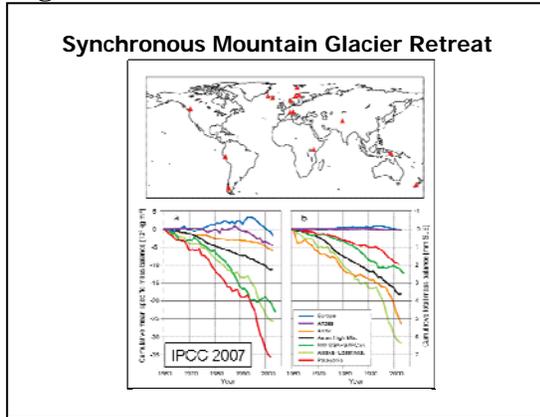
**Figure 5**



**Figure 6**



**Figure 7**



**Figure 8**

**Worldwide Effects of Global Warming**

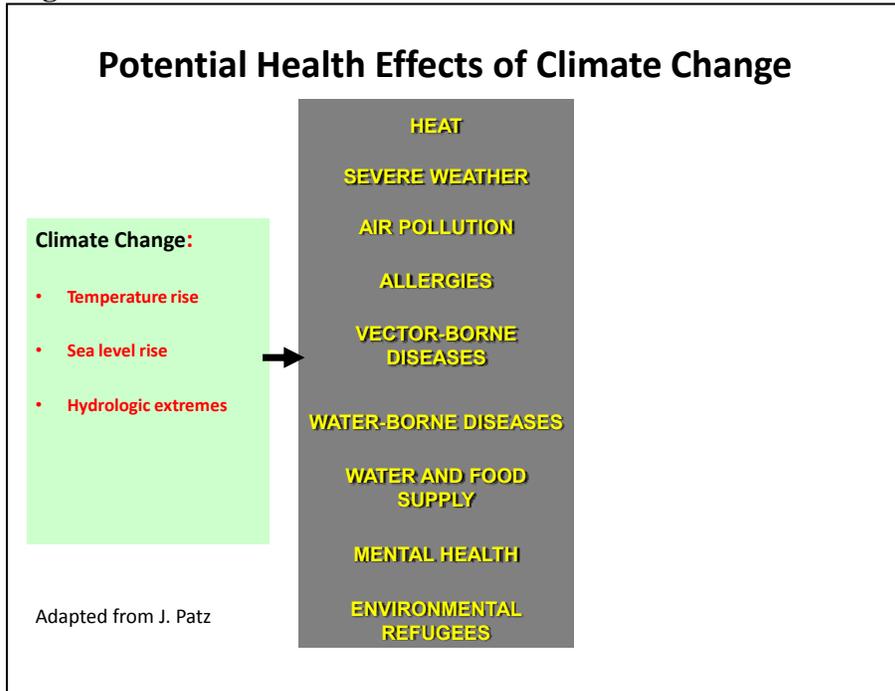
❖ Evidence of global destabilization of natural systems:

- Ice cap & glacier melting
- Early arrival of Spring
- Oceans warming
- Rising sea levels
- Extreme weather patterns
- Coral reef disintegration



Dr. McGeehin said that by causing increases in sea level rise, temperature, and hydrologic extremes, greenhouse gas emissions are magnifying public health impacts in a wide array of areas. These impacts include heat waves, air pollution episodes and allergies, vector borne and waterborne diseases, along with threats to water and food supplies. They also include secondary impacts such as population displacement, civil conflict and mental health issues (Figure 9).

**Figure 9**



### Effects of Climate Change

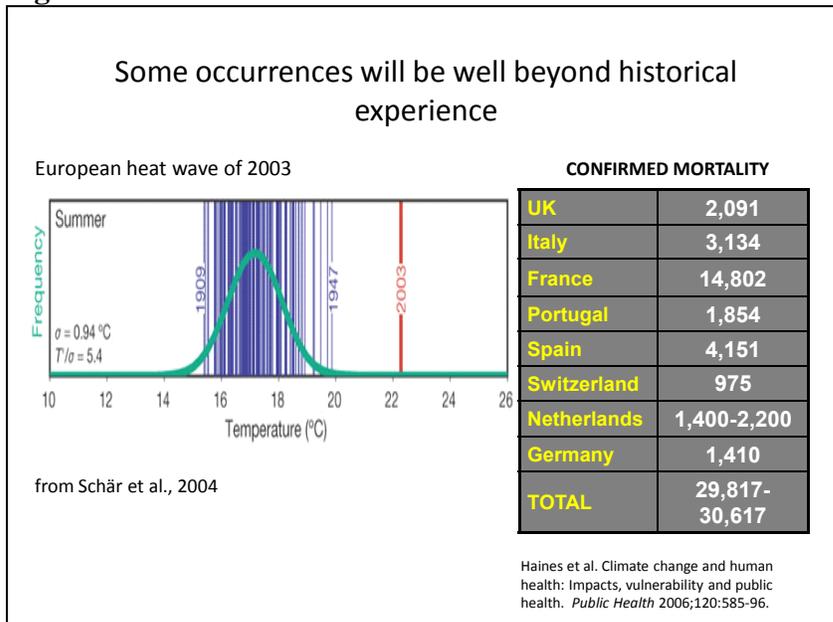
Dr. McGeehin then discussed the IPCC predictions of percent likelihood regarding certain events. He believes that we need to carefully consider these predictions as public health practitioners. They indicate that there will be more extreme weather events often in areas that have never seen extreme weather such as hurricanes and heat waves. What happens if, he wondered, due to a warmer ocean we get intense hurricanes in northern areas that have never experienced them before? Dr. McGeehin noted that based on historical evidence, these places are unlikely to have evacuation plans. Usually, places don't have plans until they have experienced a disaster. He mentioned that places like Chicago, Philadelphia and St. Louis have had heat waves, and now they have plans, but before the disaster, they did not.

According to Dr. McGeehin, all areas of the United States are predicted to experience warming, though not evenly and with varying degrees of uncertainty. In general, though, the more northern latitudes (such as Alaska) will experience the most warming.<sup>3</sup> He emphasized, however, that the major public health concern is not warmer weather,

<sup>3</sup> Editors note. This consistent with the relatively large increases in temperature in the circumpolar regions of Canada.

but that the extremes in weather (very hot and very cold weather, along with heavier precipitation events). For example, the 2003 European heat wave was well beyond historical experience (Figure 10).

**Figure 10**



In addition to these climate factors that have a potential to cause public health disasters, Dr. McGeehin believes that some of our contributions to the built environments can increase the potential impact of climate change. He argued that cities and climate are coevolving in a manner that will place more populations at risk; more than half of the world's population lives in cities, many of whom are over 65 years of age, and urban heat islands created by a city's design can intensify heat waves.

### **Health related impacts of temperature increase:**

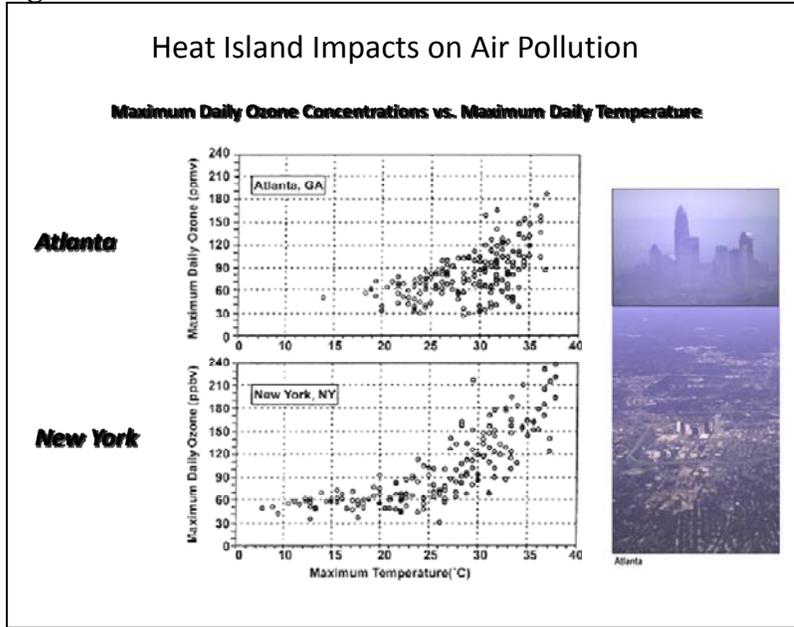
**Heat waves:** Dr. McGeehin pointed out that each year we lose 600 people to heat waves. He called this a public health failure because those that die, who are the isolated, elderly and poor, are exactly those who public health exists to protect. He predicted that these events will increase in frequency as the climate changes.

**Air Pollution:** On days with higher temperatures, there is more ozone in the air.<sup>4</sup> Dr. McGeehin told a story about his own inability to play tennis for very long on high ozone days to illustrate that clearly, the increased pollution in the atmosphere is not only a problem for people with chronic respiratory or cardiovascular diseases (Figure 11).<sup>5</sup>

<sup>4</sup> Editors note. Ozone is not emitted directly, but rather is formed through the photochemical interaction of sunlight with directly emitted air pollutants, a process that accelerates with increasing temperatures,

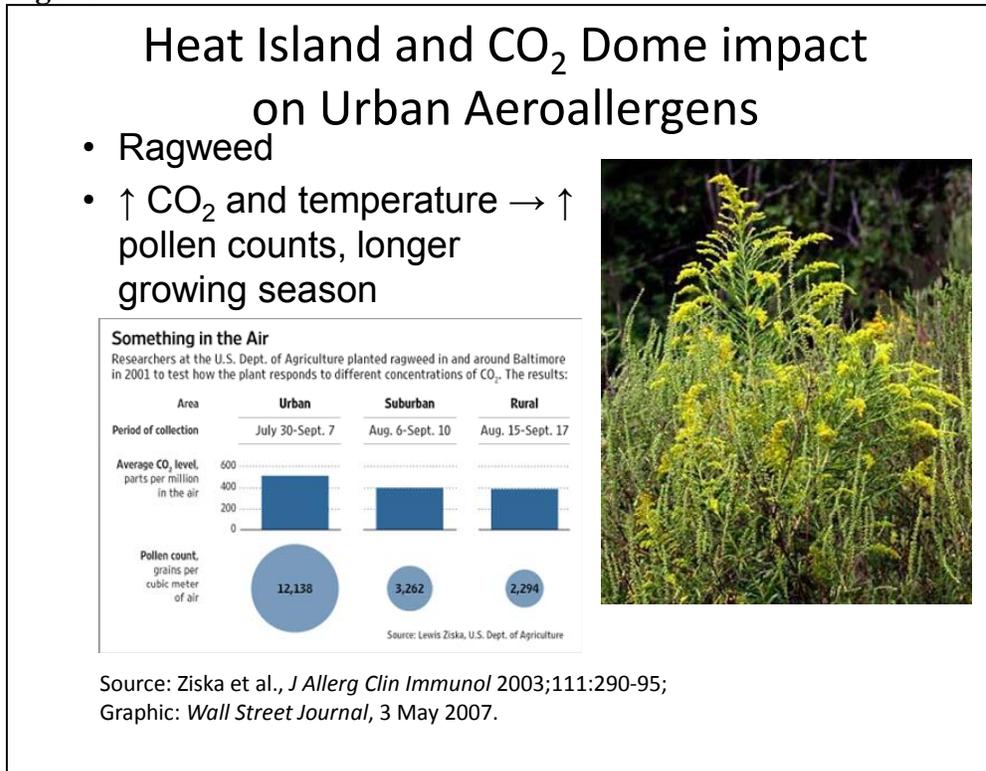
<sup>5</sup> Editors Note: this association between higher temperatures and higher ozone levels may not consistently hold for Maine. Much of our air pollution is generated from upwind states and provinces, and the degree of air pollution experienced in Maine depends largely on regional meteorological conditions.

**Figure 11**



**Ragweed:** Ragweed grows better in higher temperature and at higher CO<sub>2</sub> levels. Dr. McGeehin said that more people now have allergies, possibly due to an increase in ragweed, and therefore as the growing season lengthens, this problem could worsen (Figure 12).

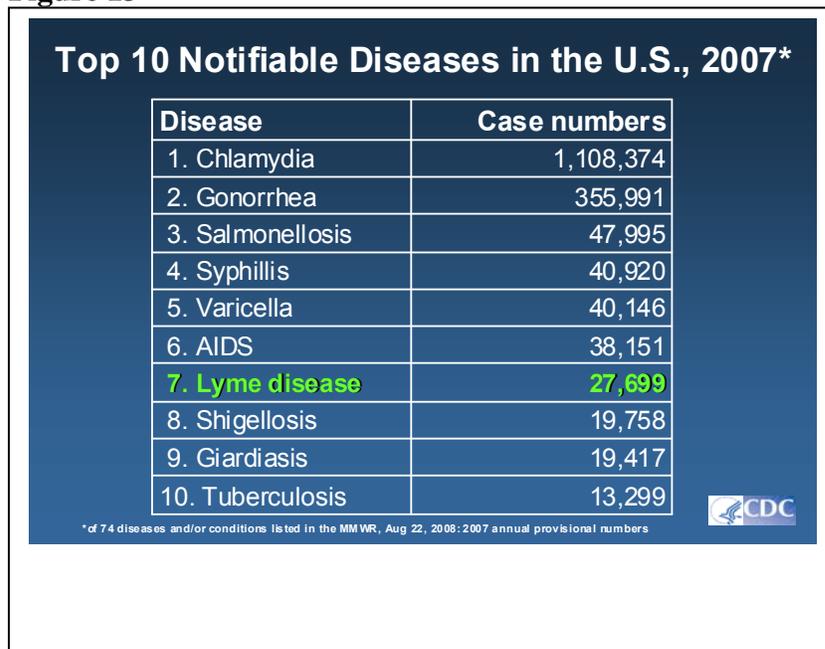
**Figure 12**



**Vector borne disease:** Dr. McGeehin said that climate change will increase the livable range of vector borne diseases, as a general pattern increasing their range both in latitude and altitude. He noted that thus far, there has been little success addressing disease threats such as dengue fever in developing countries, and as these diseases move into areas with people without immunity and less preparedness, it could be a huge problem. Diseases are already being found in new places. *Cryptococcus gati*, Dr. McGeehin pointed out, was once only found in the tropics, but in 1999 it was found in Vancouver. And the prevalence of Lyme disease has increased, which Dr. McGeehin attributed to social, ecological, and climate related factors (Figure 13).

**Harmful algal blooms:** Harmful algal blooms increase with increasing temperatures and nutrient loading.<sup>6</sup> Dr. McGeehin added that in Florida, the many outbreaks of algal blooms have led to respiratory problems in lifeguards, and caused visitors to leave the beach. A further consequence of harmful algal blooms is the ingestion of ciguatoxin in dinoflagellates<sup>7</sup> by predatory fish (such as snapper and grouper), and their subsequent ingestion by humans, which can lead to poisoning.

**Figure 13**

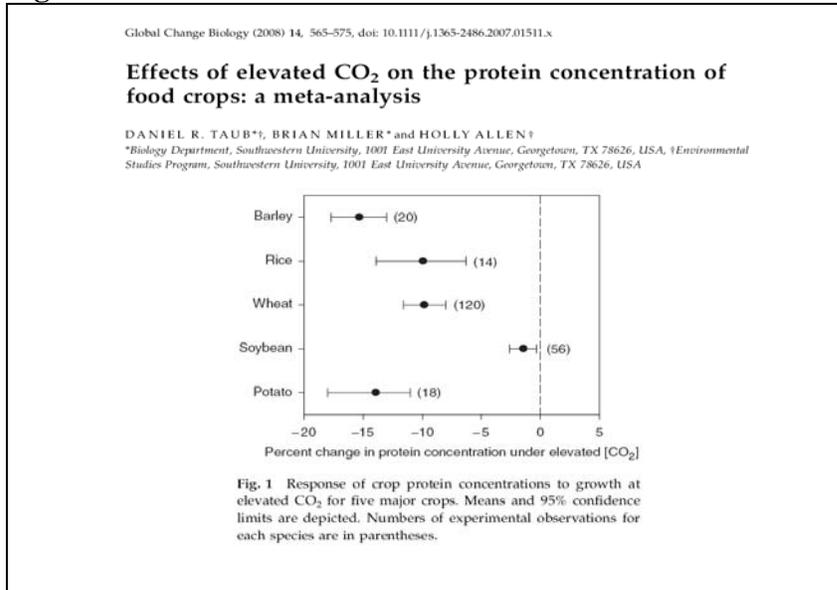


**Food security:** As the carbon dioxide in the atmosphere increases the protein in food decreases, said Dr. McGeehin. Of particular note, he added, is that the protein concentrations in potatoes, an important food crop in Maine, experience one of the highest reductions of all the major food crops (approximately 15%). Herbicides are also less effective at higher carbon dioxide levels (Figure 14).

<sup>6</sup> Editor's note. Harmful algal blooms are most commonly associated with red tides that have occurred with increasing frequency throughout the world. They are also associated with freshwater sources, including lakes and rivers in Maine.

<sup>7</sup> Editor's note. Here is another example of the complex nature of climate nature and its interaction with other causes of environmental degradation, as growth of dinoflagellates is promoted by the destruction of coral reefs.

## Figure 14

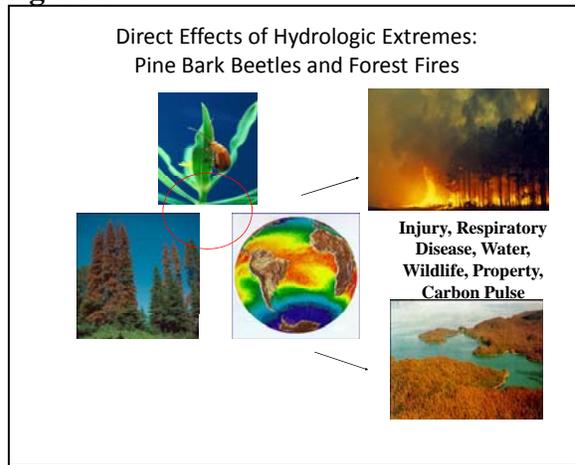


**Climate change related increases in extreme weather, both heavy rain and drought, will likely lead to health related problems:**

**Waterborne disease after extreme precipitation and flooding:** Dr. McGeehin described how big floods can overwhelm sanitation systems and expose the public to disease. In the United States, he said, two-thirds of water-borne disease outbreaks in recent decades have been preceded by precipitation above the 80<sup>th</sup> percentile; 50 percent of outbreaks occurred when precipitation was above the 90<sup>th</sup> percentile. For example, the widely publicized 1993 *Cryptosporidium* outbreak in Milwaukee was preceded by its largest rainfall in 50 years.

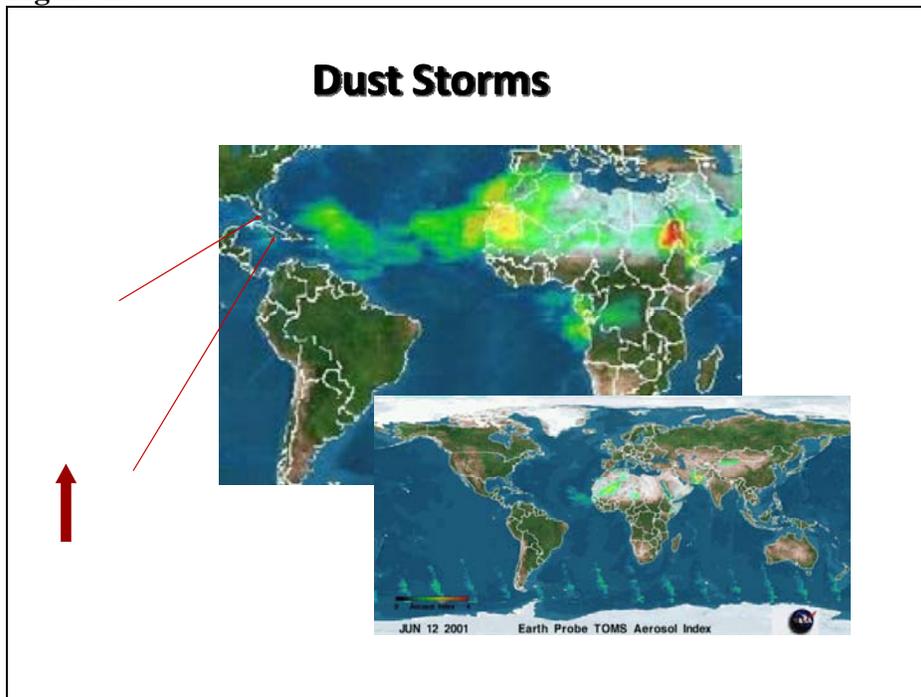
**Forest Fires, Pine bark beetles and drought:** The consistent drought conditions in the West combined with the fuel created by trees killed by the beetles results in a perfect situation for forest fires, said Dr. McGeehin. The impacts, he added, may be disproportionately severe for rural populations, where our forest resources are located. The burning material causes indoor air pollution which can lead to chronic respiratory disease.

**Figure 15**



**Dust storms in Africa:** The dust travels across the Atlantic and contributes to asthma. Dr. McGeehin pointed out that dust storms are an example of how we have to think globally from a public health standpoint, as national borders, and even oceans don't matter in many of these situations.

**Figure 16**



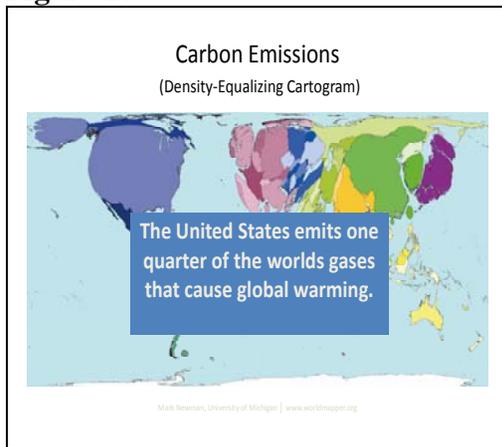
**Hurricanes:** Though the correlation between warmer ocean temperature and the frequency of hurricanes is controversial, Dr. McGeehin argued that we can't wait to see who is right. Larger hurricanes, and hurricanes that occur in areas that do not normally see them, could be devastating.

## The case for public health intervention in climate change

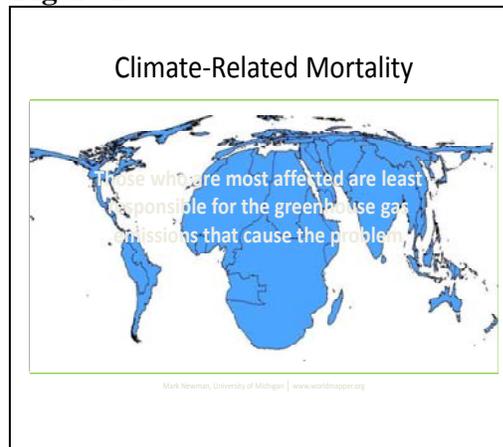
Dr. McGeehin concluded by explaining the relationship between climate change and public health. Thus far, he said public health has not been at the table regarding climate change, but we are moving quickly now. The two main arguments for public health involvement in climate change, according to Dr. McGeehin, are that 1) it is about environmental justice; and 2) addressing climate change is ultimately about changing people's behaviors.

Environmental justice is related to both climate change and public health argued Dr. McGeehin (Figures 17 and 18). Climate change will affect the poorest countries and people the most, while wealthier nations and individuals will adapt better. Further, he added, those who are most affected are least responsible.

**Figure 17**



**Figure 18**



Dr. McGeehin said that in this country, those least likely to adapt to climate change, including low income populations and racial minorities, are also most likely to experience the more severe impacts, as our sad experience with Hurricane Katrina has demonstrated. He stated that public health exists to help people that can do the least to help themselves, and emphasized environmental justice as core public health value. Dr. McGeehin also argued that climate change is a public health issue because the bottom line is that we need to provide sufficient motivations for people to change their behaviors. No matter how good our science is, he said, if our communication isn't good, we haven't done much. Dr McGeehin emphasized the importance of not appearing alarmist and to be mindful of how the science of climate change can be misrepresented in the popular press. While sensationalist messages of 150 foot sea level rises are popular, they are not helpful in bringing about a sustainable response to climate change. Another important risk communication concern involves the impacts of such messaging on children, and that as adults we need to be especially mindful of the mental health implications (Figure 19).

**Figure 19**

## Mental health: Anticipatory

**washingtonpost.com**

**Climate Change Scenarios Scare, and Motivate, Kids**

*By Darraugh Johnson*  
Washington Post Staff Writer  
Monday, April 16, 2007, Page A01

The boy has drawn, in his third-grade class, a global warming timeline that is his equivalent of the mushroom cloud.

"That's the Earth now," the 9-year-old says, pointing to a dark shape at the bottom. "And then," he says, tracing the progressively lighter stripes across the page, "it's just starting to fade away."

**The Boston Globe**

HOME / LIFESTYLE / GREEN LIVING

**BIG NEWS**

Last Updated: Tuesday, November 14, 2006 11:15 GMT  
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**Climate change is kids' top fear**



How we're damaging the environment is more of a worry to you than getting a girl or boyfriend, says a survey.

The results showed three quarters of 11 to 14-year-olds worry about climate change, compared to 41% who are worried about going out with someone.

Looks like you lot aren't just all talk - 63% turn off

He also noted that a public health framework for climate change should recognize the co-benefits and synergies between healthy behaviors and reducing our carbon footprint (Figure 20).

**Figure 20**

<b>Climate Change Synergies</b>	
<b>Heat wave plans using "buddy systems"</b>	↑ social capital, ↑ community resiliency
↓ vehicular travel	↓ car crashes, ↓ air pollution
↑ fuel efficiency	↓ air pollution
<b>Locally grown food</b>	↓ pesticide loading, ↓ fuel
<b>Energy-efficient buildings</b>	↓ operating costs
<b>Alternative energy sources</b>	Business opportunities

In motivating people to change their behaviors, Dr. McGeehin noted that some strategies that have worked in the past will have to be adapted for climate change. He pointed out that such strategies often appeal to people's self interest. It was easy to say don't smoke, wear a seatbelt, or use a condom because we could say that this directly benefited the individual. With regards to climate change, he noted, a person can drive a Prius, grow his own food, buy solar panels, and do everything right, all without producing any specific benefit that he can personally realize. Thus, appealing to a person's self interest will not work; however, Dr. McGeehin said that he didn't know yet what the message should be.

He said that basic guidance is available that we can use, such as making sure that we can convey a sense of urgency while at the same time have the messages positive and able to motivate effective action.

Effective Messages in Health Marketing:

- Appeal to "Market Segments"
- Be Relevant
- Convey Urgency
- Appeal to Self Interest
- Appeal to Values
- Convey a Positive Message
- Be Actionable (Popular, Convenient)

The image of the polar bear on the shrinking iceberg has worked thus far to make people aware of climate change, but, said Dr. McGeehin, the question is now: can we reframe climate change around children with asthma (Figure 21)?

**Figure 21**



## Conclusions

In conclusion, Dr. McGeehin emphasized that climate change is a major issue and it must be framed as a public health issue. It impacts public health as much as any risk the public health community is facing. He urged the audience to go back to the ten essential public health services and promote good surveillance, good studies, good communication, and have public health at the table when we decide to attempt any mitigations or adaptations.

## **Questions and answer**

During the question and answer session, Dr. McGeehin first addressed a question regarding addressing the problem of urban heat bubbles. He suggested that to mitigate the problem we design, and redesign cities with more trees, as was done in Chicago after their heat wave. In other areas, we have to adapt by being prepared and having good data about which areas will be more likely to have high rates of morbidity and mortality. In answer to another question about age changes in populations, Dr. McGeehin reinforced the idea that we need to adapt to changing populations as well as the changing environment.

Another question concerned addressing climate change impacts in rural areas. Dr. McGeehin noted that rural health has been ignored, in part due to the larger number of people means that you can affect more people in a smaller space. He also said that we have not spent enough time on rural issues, and there may even be some consequences of climate change that affect rural areas more than urban areas.

The final questioner asked where the climate change and public health fields could work together. Dr. McGeehin answered by suggesting that state health departments need a locus of expertise on climate change that keeps up on literature to which questions can be directed.

## **Biography:**

Dr. McGeehin has been a scientist with the CDC for over 28 years and has spent most of that time working on environmental health issues including lead poisoning in children, asthma, drinking water contamination, air pollution, radiation exposures, environmental health tracking, cancer clusters, and morbidity and mortality related to heat waves, hypothermia and extreme weather events. Dr. McGeehin also served as co-chair of the Human Health Sector for the U.S. National Assessment Team, responsible for assessing the possible human health effects on the U.S. population resulting from global climate change.

## Addressing Climate change in Maine: Overview of Maine's Activities

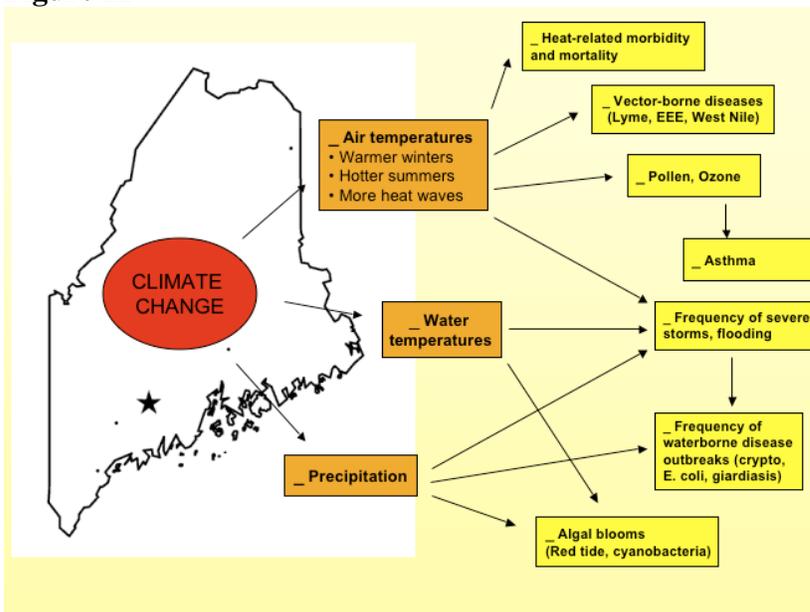
Dora Anne Mills, MD, MPH, Director, Maine CDC

### Key Messages:

- Lyme disease has been increasing both in terms of disease burden and geographical spread in Maine: it has increased from a handful of cases in York County in 1990 to over 900 cases a year across the state for the past few years.
- Creating a surveillance system for heat related morbidity is a current project of the Maine CDC.
- After the Ice Storm in 1998, the Maine CDC developed a response system for storms that can serve as a model for other climate change related emergency situations.
- In 2010, there have been widespread and severe harmful algal blooms, resulting in the closure of many shellfish harvesting areas.
- The Maine CDC's key focus is tracking key environmental and health outcomes because that is the basis for determining how to implement the other services through public health infrastructure.

In her talk, Dr. Dora Mills focused on what the Maine CDC has currently identified as public health issues related to climate change, and the extent of its current capacity to track these diseases. Dr. Mills noted that many of the likely effects of climate change in Maine are those described by Dr. McGeehin: more heat events, more algal blooms, more vector-borne disease, among others. Because of the need to know the impacts of climate change in order to prepare and adapt to its impacts, environmental public health tracking is a key focus of ME CDC's initial work in this area.

**Figure 22**



## Lyme Disease:

Dr. Mills explained that Lyme disease in Maine has been increasing both in terms of disease burden and geographical spread and has now been reported in every county. She noted that we have an existing ability to track trends of Lyme disease over time so we know that the number of cases has increased from a handful of cases in York County in 1996 to over 900 per year for the past two or three.



Figure 23

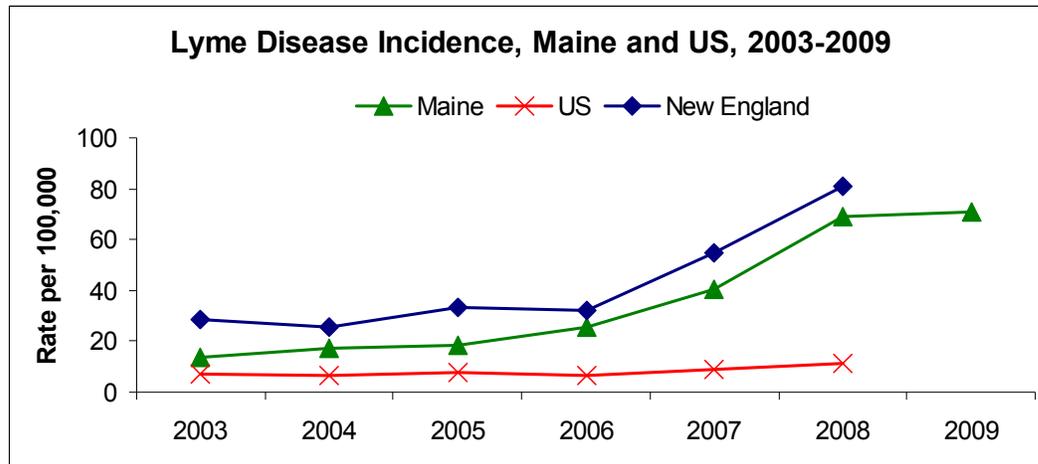
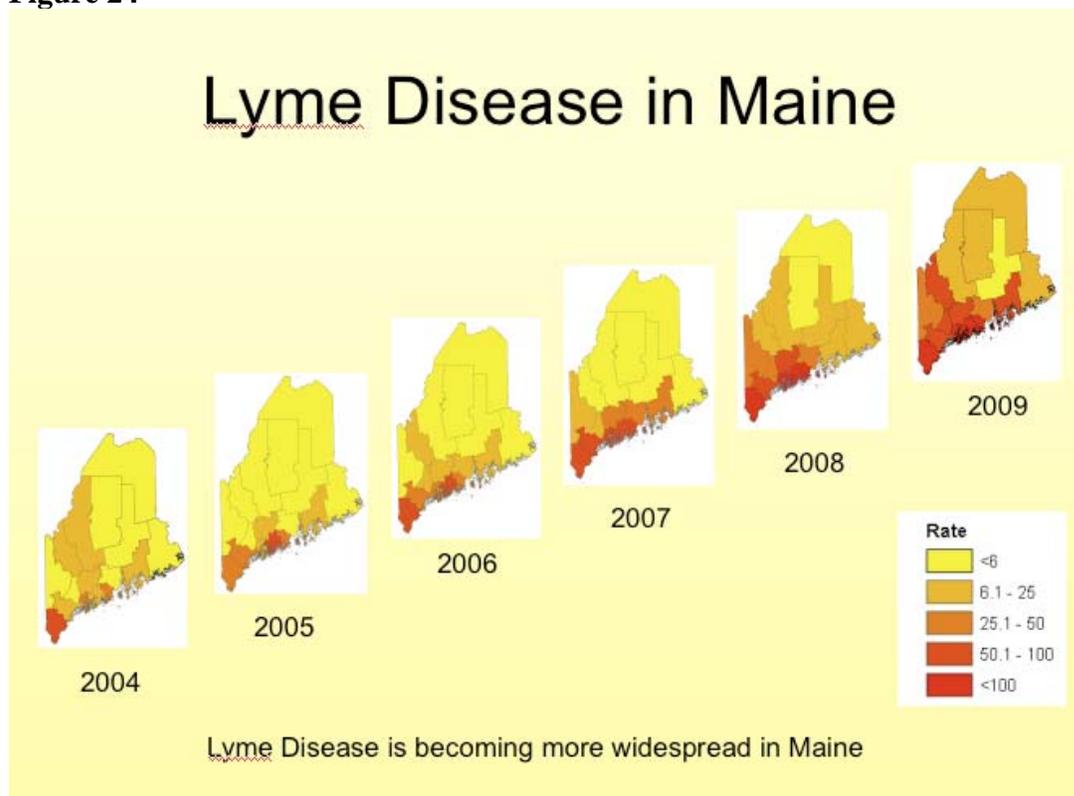


Figure 24



## Eastern Equine Encephalitis (EEE):

Dr. Mills then moved on to discuss tracking of Eastern equine encephalitis (EEE), a mosquito borne disease, in Maine. She said that the CDC is concerned because, due to its high mortality rate, EEE is one of the most severe mosquito-borne diseases in the United States. At the same time, however, it is more difficult to track than Lyme disease. Surveillance for EEE includes

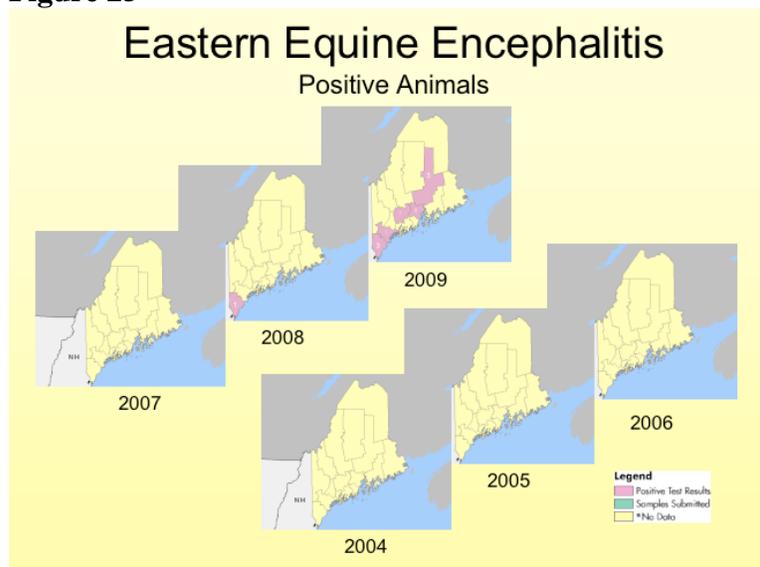


routine testing of mosquitoes, plus testing animals for the disease at the request of an epidemiologist or the state veterinarian. Dr. Mills noted that currently there has been one horse death and one human death in Maine, though it is unclear whether or not that person was infected in Maine. The CDC has noted infected animals in more and more counties. In 2009, EEE was detected in areas of the state where it had never been seen before. Curiously, the virus was detected in animal monitoring, but not in mosquito monitoring.

Dr. Mills expressed concern that we will see much more EEE in 2010, especially due to the warm, wet winter.

One consequence of studying these vector borne diseases mentioned by Dr. Mills is that health professionals need to understand ecology and entomology. One might think that because there are no mosquitoes in the winter, the disease would disappear, but of course it doesn't work that way. Instead, birds and mammals are the long-term carriers, while mosquitoes transmit the disease between animals by biting twice. If a mosquito bites an infected bird, and then an uninfected bird, it can transmit the disease, but the birds don't die (even though the mosquito does). Therefore the disease can amplify without us knowing it. And when it is warm and birds and mosquitoes come earlier, Dr. Mills suggested that we could have more EEE in the state.

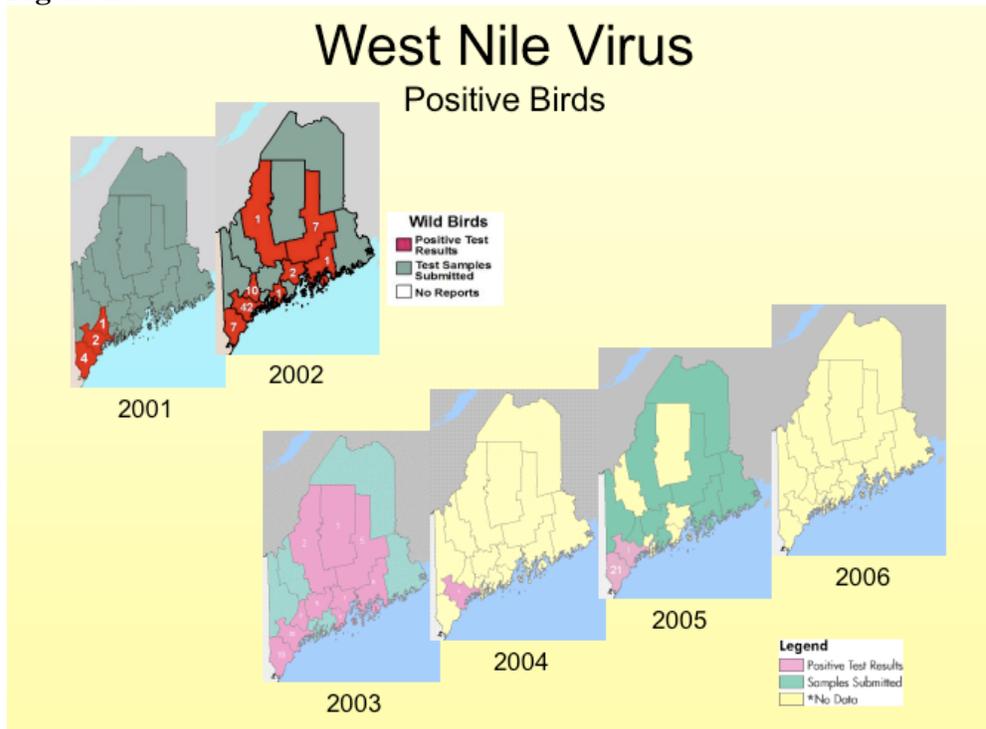
**Figure 25**



## West Nile Virus:

West Nile virus is a common mosquito borne disease in the US, but Dr. Mills reported that there have been no cases have been detected in Maine residents. Cases have been detected in New England and she assumes it is in Maine, but there has been no laboratory evidence of acute illness. Dr. Mills said that the CDC did bird monitoring for West Nile from 2000-2007 and currently there is a surveillance system to test mosquitoes. This surveillance has not resulted in any apparent trends over time. She reported only one positive mosquito test in 2009, but higher numbers of positive bird and mosquito tests between 2001 and 2005.

Figure 26



## Heat Related Morbidity:

Dr. Mills noted that although most people have seen what they would call heat waves, we do not have good tracking on heat related morbidity and mortality. Creating this kind of surveillance is a current project of the Maine CDC (which will be discussed later). Dr. Mills also pointed out that the young and the elderly are among those most affected by heat, and currently we do not have assistance for those groups. She suggested that we could try to turn warming centers into cooling centers, but the lack of air conditioning in Maine would make this a challenge.

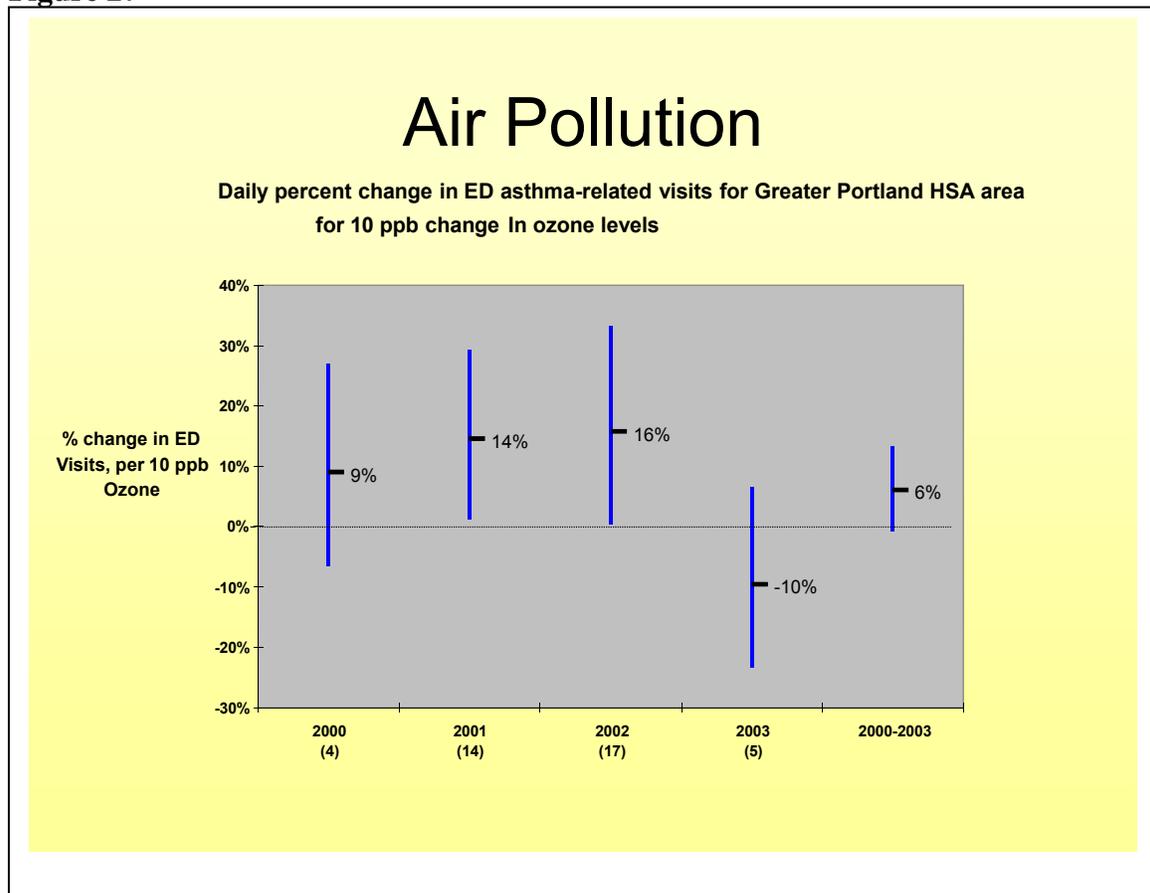


**"Maine has one of the highest rates of asthma in the U.S."**

Another consequence of heat that Dr. Mills discussed is higher ozone levels, which are known to aggravate asthma. Maine has one of the highest rates of asthma in the United States, which Dr. Mills suggested places our population at increased risk from the impacts of pollutants from areas to the south and west of us. One way that Department of Environmental Protection has tried to address asthma morbidity is by issuing Air Quality Alerts.

Dr. Mills then illustrated the tracking that the ME CDC has done to measure asthma morbidity attributable to ozone and track it over time. She showed a graph that looked at asthma related Emergency Department visits in the Portland hospital service area. The figure shows the estimated percent change in ED asthma-related visits for a given change in ozone levels for the years 2000-2003. Dr. Mills said that this kind of data is useful because it allows us to look at how ozone may be influencing asthma morbidity in Maine, and whether efforts to reduce such morbidity by interventions are working.

**Figure 27**



## Storms and flooding:

In discussing tracking of storms, Dr. Mills looked back at the ice storm in 1998 to describe the beginnings of one important storm related surveillance system. During the storm and the accompanying power outages, there was an outbreak of carbon monoxide poisoning. Now the Maine CDC has an active case-based surveillance system for carbon monoxide poisoning, radio public service announcements (PSAs) developed and ready to be released prior to or during major power outages. It also has email and text alerts for press releases and the Health Alert Network, the latter of which is rapidly disseminated to health care providers throughout the state. Dr. Mills described this as a model for a way to prepare for climate change. Thus, by understanding the key environmental conditions responsible for carbon monoxide poisoning, we can alert Maine people when these conditions occur through public service announcements and educational materials.



## Algal Blooms

Dr. Mills said that 1972 was the first time Maine saw a large number of deaths and hospitalizations related to red tide. The result was a shellfish monitoring system run by the Maine Department of Marine Resources that determines what areas are open to clamming and seafood harvesting. This system prevented related deaths or illnesses for over 30 years, but in 2008 Dr. Mills reported that there was a case of paralytic shellfish poisoning. Recently, Dr. Mills said, there have been widespread severe algal blooms resulting in extensive and prolonged closures. In 2010 the first red tide closure happened in March, the earliest closure ever.

## Conclusion:

Dr. Mills closed by reminding the audience that tracking and response, and the ten essential public health services are critical parts of addressing climate change. She re-emphasized her earlier point that the Maine CDC's key focus is tracking because that is the basis for determining how to implement the other services through public health infrastructure. In Maine, she explained, the public health infrastructure is composed of eight public health districts plus the tribal districts. This structure was effective for H1N1 and Dr. Mills said that they plan to use it to address climate change as well.

## Question and Answer:

In the question and answer session, Dr. Mills described in more detail what the Maine CDC is doing to prevent an outbreak of EEE. She said that they are working carefully with epidemiologists because they are facing new challenges in surveillance. There is no more funding to test birds, and horses are now vaccinated, whereas before they could test horses to find out if there were vectors in the state. Spraying for mosquitoes is impractical in a state where much of the state is wetlands, though populated areas like Deering Oaks Park might be worthy of consideration. Dr. Mills said that the ME CDC

has been focusing on educating people with some of the same messages as Lyme disease: cover up and use insect repellent.

### **Biography**

Dr. Mills is a native of Maine. She was raised in Farmington, graduating from Mt. Blue High School and Bowdoin College. Before returning to Maine in 1992, she graduated from the University of Vermont College of Medicine, completed her internship and residency at the Children's Hospital of Los Angeles, and traveled and worked in Tanzania, Ivory Coast, Nepal, and India. While practicing pediatrics in her hometown in the early to mid 1990s, she commuted to Boston to earn a master of public health (MPH) from Harvard University.

She was appointed to her current position in 1996. During her tenure as Maine's public health director, she has worked on various issues, including tobacco, obesity, infectious disease control, public health emergency preparedness, and public health infrastructure. She also has written a myriad of articles, including "Public Health and Foreign Policy", the featured article in the 2006 *Bowdoin Forum Journal of International Affairs*, various articles for the *Maine Policy Review*, and opinion pieces for Maine newspapers. She has received the highest honors from the Maine Public Health Association and the Maine Medical Association, as well as the prestigious Nathan Davis Award for Outstanding Government Service from the American Medical Association. She is married to Michael Fiori, has two young children, and enjoys skiing, hiking, and lake activities with them.

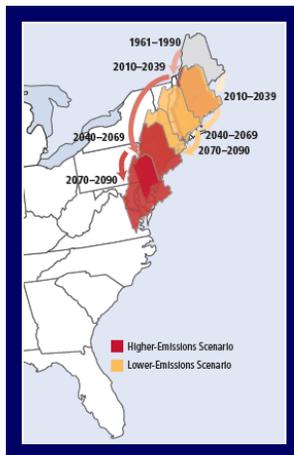
## Addressing Climate Change in Maine

*David Littell, Commissioner, Maine Department of Environmental Protection*

### Key Messages

- A working group of over 100 stakeholders gathered in 2009 to create an Adaptation Plan for Maine and has recently published a 2010 Climate Adaptation Interim Report.
- Maine was one of the first states to put together a climate change action plan, which, among other goals, set out steps to reach 1990 levels of greenhouse gas emissions by 2010. Currently, the state is set to meet that goal.

Mr. Littell reviewed the current indications of climate change in the state and the relation to public health. He then discussed the state of climate change research in Maine, and current efforts in the state to mitigate the effects and adapt to the changes.



Commissioner Littell said that recent changes in attitudes towards climate change have allowed adaptation efforts to take place. After a 2009 Legislative Resolve, a working group of over 100 stakeholders plans to put out an Adaptation Plan for Maine and has recently published a 2010 Climate Adaptation Interim Report. The report emphasized several key inter-connected areas to which the people of Maine must respond with shared solutions. These include: 1) agriculture; 2) health and social aspects; 3) the natural environment; 4) economic sustainability; and 5) infrastructure.

The stakeholders group included significant contributions from the Maine CDC and non-governmental organizations. The latter included the Maine Chapter of Physicians for Social Responsibility, Maine Medical Association, and the Maine Council of Churches. In addition to the physical health aspects described earlier, the stakeholders' group also emphasized the importance of mental health concerns, including the resiliency of individuals and communities to severe weather events. These stakeholders also drew attention to broader health and social concerns, such as disasters occurring globally could lead to massive migrations, possibly to Maine.

Commissioner Littell went on to stress the necessary complement to climate adaptation, namely greenhouse gas mitigation. He noted that Maine was one of the first states to put together a climate change action plan, which, among other goals, set out steps to reach 1990 levels of greenhouse gas emissions by 2010. Currently, the state is set to meet that goal and Commissioner Littell stated that these multifaceted efforts to reduce greenhouse gas emissions and increase carbon sequestering has a positive impact on the health of Maine residents by creating cleaner air, building more biking and walking trails, and planting more trees. Commissioner Littell pointed out that other health threats aside from climate change are also associated with fossil fuel combustion and are within the purview of the Maine DEP. These include regional air quality problems of ozone and fine particulate air pollution, along with acid and mercury deposition.

### **Biography**

As Commissioner of Maine's D.E.P David heads an agency of 410 scientists, engineers, biologists, and environmental specialists who protect Maine's water, land and air resources. He implemented far-reaching initiatives like Maine's Climate Action Plan, protections for threatened high-value wildlife habitats, and controlling toxics in consumer products. During his tenure, DEP has focused on internal innovation to lower costs in processing more than 4,000 permits annually while increasing environmental protections.

He represents Maine on emerging environmental issues as:

- Chairman of the RGGI Inc. board of directors, which is running the first greenhouse gas cap and trade system in the U.S.
- An executive member of The Climate Registry Board; he attended the COP-15 talks in Copenhagen as a member of this delegation
- Co-chair of the New England Governors/Eastern Canadian Premiers Environment Committee and chair of the New England Governor's Committee on the Environment (2007–2008)
- Chairman of the Mid-Atlantic Northeast Visibility Union representing 14 states and Indian tribes which established a regional plan to reduce visibility impairing pollutants under the Clean Air Act since 2006
- Chair of the Cross Media Committee of the Environmental Council of the States (2008-2009)

With family ties to five generations of Aroostook County farmers, David spent summers on a northern Maine farm with his grandparents and uncle. In 1992, he began practicing law with Pierce Atwood, and left in 2003 to join Governor Baldacci's Administration. David lives in Portland with his wife Penny and two daughters, Brickley, and Georgia.

## Maine's Climate Future

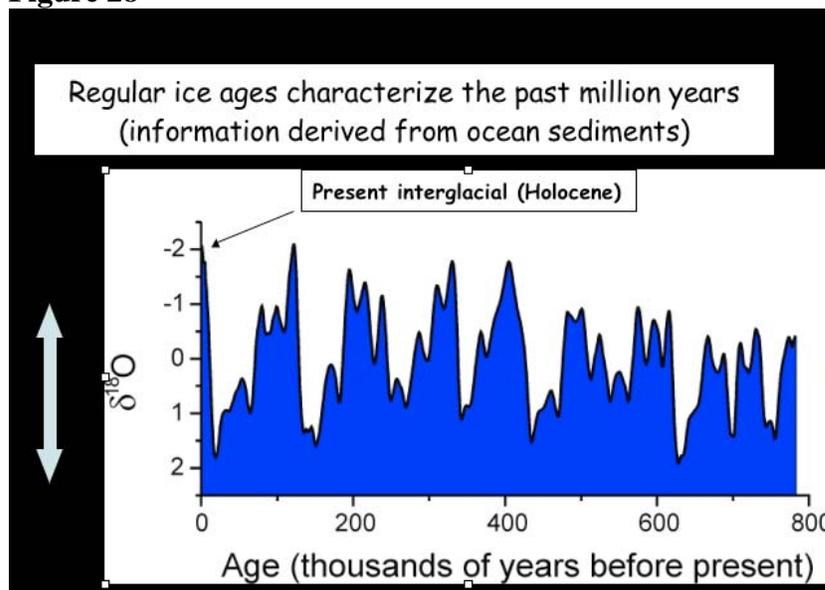
George Jacobson, PhD, State Climatologist,  
University of Maine Climate Change Institute

### Key Messages:

- Currently, we are at the warmer part of the Earth's natural climate cycle, and we are moving outside the Earth's natural climate variability.
- The projections from a report produced by the University of Maine called "Maine's Climate Future," are that Maine will become warmer and wetter in all regions

George Jacobson, the State Climatologist, placed the recent climate change and temperature differences in the context of a much larger time scale. As a member of the Climate Change Institute at the University of Maine, Dr. Jacobson works with scholars in a variety of disciplines to understand the natural variability of the Earth's climate and the underlying mechanisms that prompt changes. The reason to study natural variability is, according to Dr. Jacobson, so that we can put the current change in context and know if it is normal variability or something that hasn't happened before.

**Figure 28**



Dr. Jacobson pointed out that according to the graph of climate fluctuations of the last 800,000 years, we are currently at the warmer part of the cycle. Yet, Dr. Jacobson also noted that in the last hundred years, humans have drastically changed the composition of the atmosphere in a manner that largely mirrors the explosive growth in population. In addition to greenhouse gas concentrations, levels of radio nuclides, heavy metals, and sulfates have also been increasing exponentially.

Figure 29

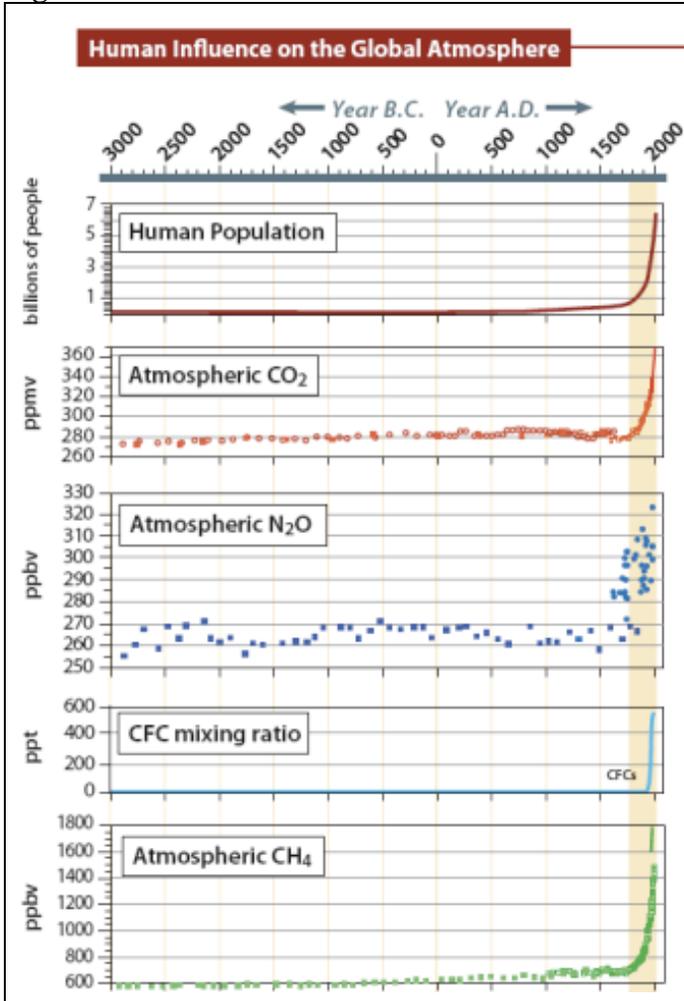
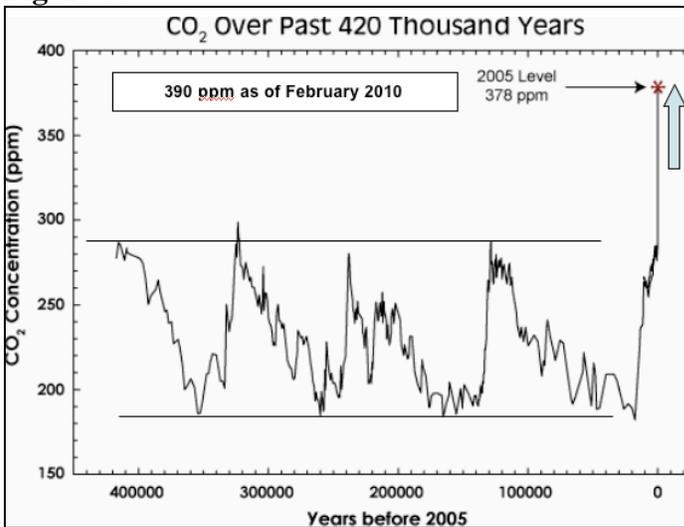


Figure 30

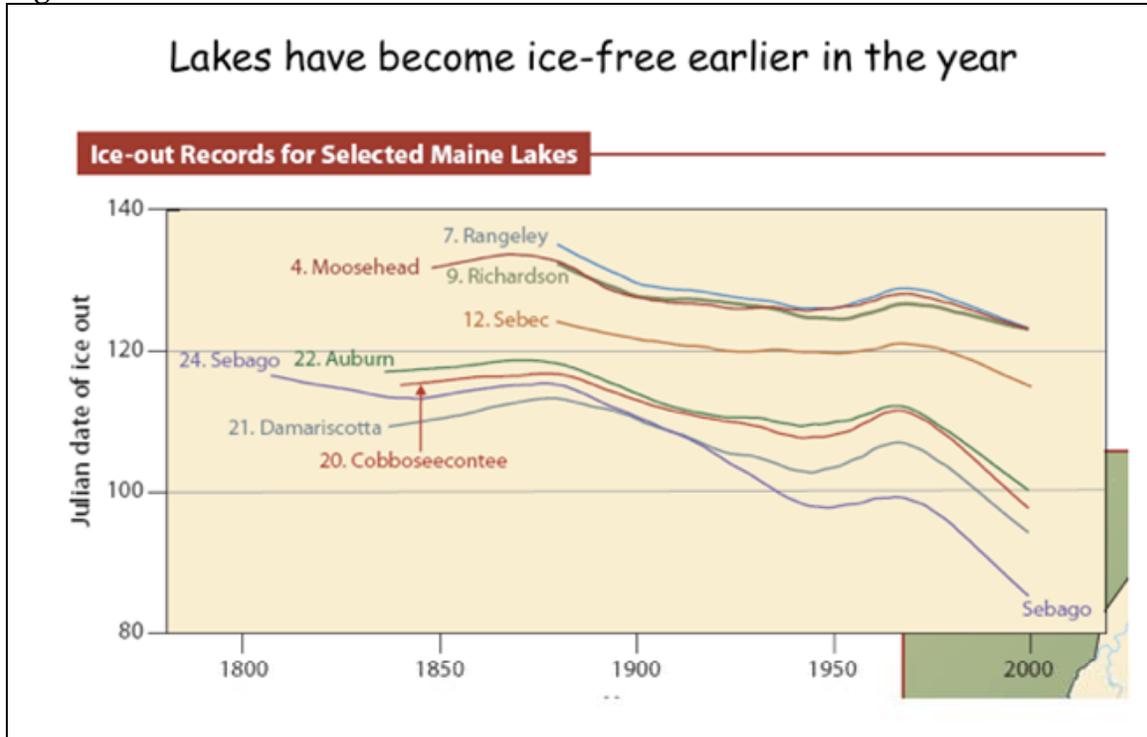


Another point discussed by Dr. Jacobson is the difference between weather and climate. Despite the fact that this winter was cold in the south, climatologists have to be aware that this was an El Niño year, which often results in cold winters in the South and mild

winters in the North. Also, despite the warmth of the winter, Caribou experienced the coldest recorded temperature in history for that location in January<sup>8</sup>; Therefore, Dr. Jacobson cautioned that until these data are placed in a greater context, no one can make conclusions about climate change based on current weather conditions.

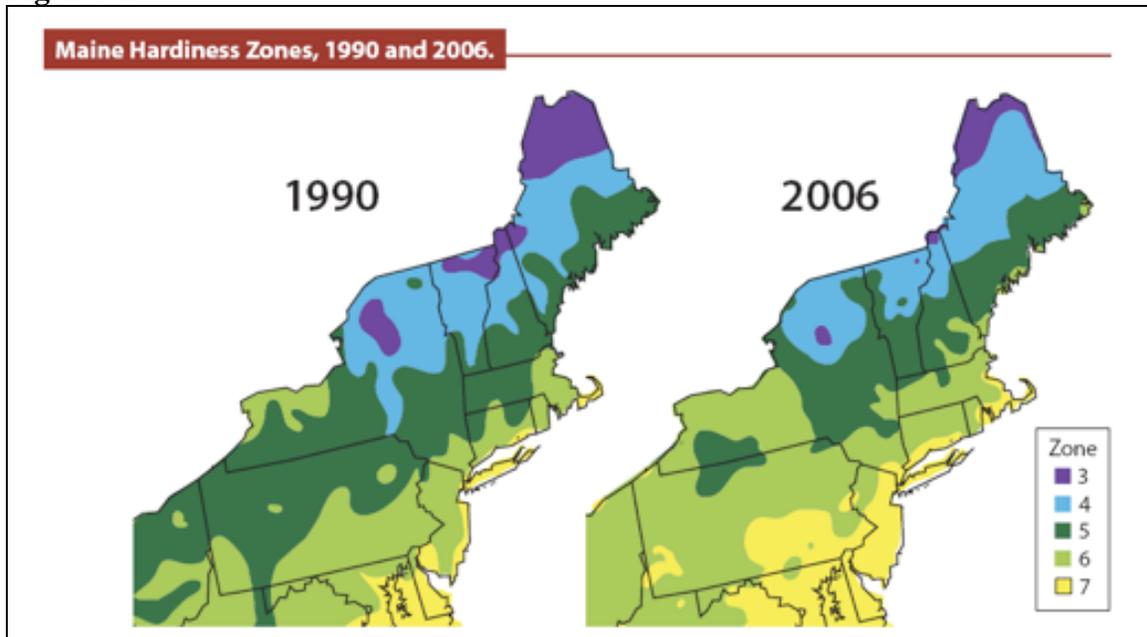
Dr Jacobson also said that the projections from a report produced by the University of Maine called “Maine’s Climate Future,” are that Maine will become warmer and wetter in all regions. Some of the important findings are that ice-out days are earlier, deer ticks have spread to a wider range and changes in forest cover have occurred.

**Figure 31**



<sup>8</sup> Editors note. Underscoring the earlier point made by Dr. McGeehin that climate change is likely to be more evident in extreme fluctuations in weather than in steadily rising temperatures, the temperature in Caribou, Maine during the day of the conference (April 7, 2010) was 82°F.

**Figure 32**



### Questions and Answers:

In the questions and answers section, Dr. Jacobson answered questions about the Institute's attempts to make more specific predictions about climate change for each climate region of Maine and about the likelihood of a return to an ice age. Dr. Jacobson responded that climatologists don't believe that global warming will stop ice ages, but the next ice age will not be for some thousand years from now. But, he added, because we are on the outside the natural variability of our climate, it is difficult to predict.

### Biography

Professor Emeritus of Biology, Ecology, and Climate Change, University of Maine. Since his arrival in Maine in 1979, Dr. Jacobson has been a member of the Climate Change Institute, and he was Director of the Institute for nearly a decade. He currently serves as the Maine State Climatologist. At the request of Governor Baldacci, he and his colleagues recently prepared a report entitled *Maine's Climate Future*, an assessment of 21<sup>st</sup> Century climate change and its implications for our state.

His research has focused on long-term climate variability and specifically on forest responses to climate changes during the past 60,000 years. His projects have included sites in North America, South America, and Europe. During the 1990s he chaired the Scientific Advisory Panel for the NOAA Paleoclimate Program, and for the past five years he has chaired a similar Scientific Advisory Panel for the European Science Foundation, the scientific arm of the European Union. In addition, he recently served as an advisor to the Finnish Academy of Sciences in their development of a paleoclimate research program.

Professor Jacobson joined the faculty of the University of Maine in 1979 after three years working in the United States Senate in Washington, D.C., first as a Congressional

Science Fellow of the American Association for the Advancement of Science, and then as a staff scientist for the U.S. Senate Committee on Environment and Public Works. He was born in Rapid City, South Dakota, and earned a B.A. in 1968 from Carleton College, and a Ph.D. in 1975 from the University of Minnesota. From 1968-1970 he served as a medical specialist in the United States Army.

## **Data & Surveillance**

*Andrew Smith, SM, ScD, State Toxicologist, Maine CDC*

*Rebecca Lincoln, Toxicologist, Maine CDC*

### **Key Messages:**

- Tracking is a key part of addressing climate change because: 1) we can't plan adaptations and mitigations before we know how the climate is changing, and 2) we need to be able to justify and support actions with compelling data.
- The Maine CDC has been working on a pilot project to develop a national system of climate change indicators based on the consensus document developed by the Council of State and Territorial Epidemiologists (CSTE).
- Heat waves are an important place to begin tracking because they clearly affect people's health and kill more people in the United States than all other weather events combined.
- There are many challenges in collecting good data to track heat related morbidity.

Andrew Smith, the State Toxicologist, and Rebecca Lincoln discussed the current efforts to measure and monitor climate related health effects. Dr. Smith began by explaining why tracking matters. He pointed out that we need consistent ways to measure what is happening, that we can't plan adaptations and mitigations before we know how the climate is changing, and we need to be able to justify and support actions with compelling data.

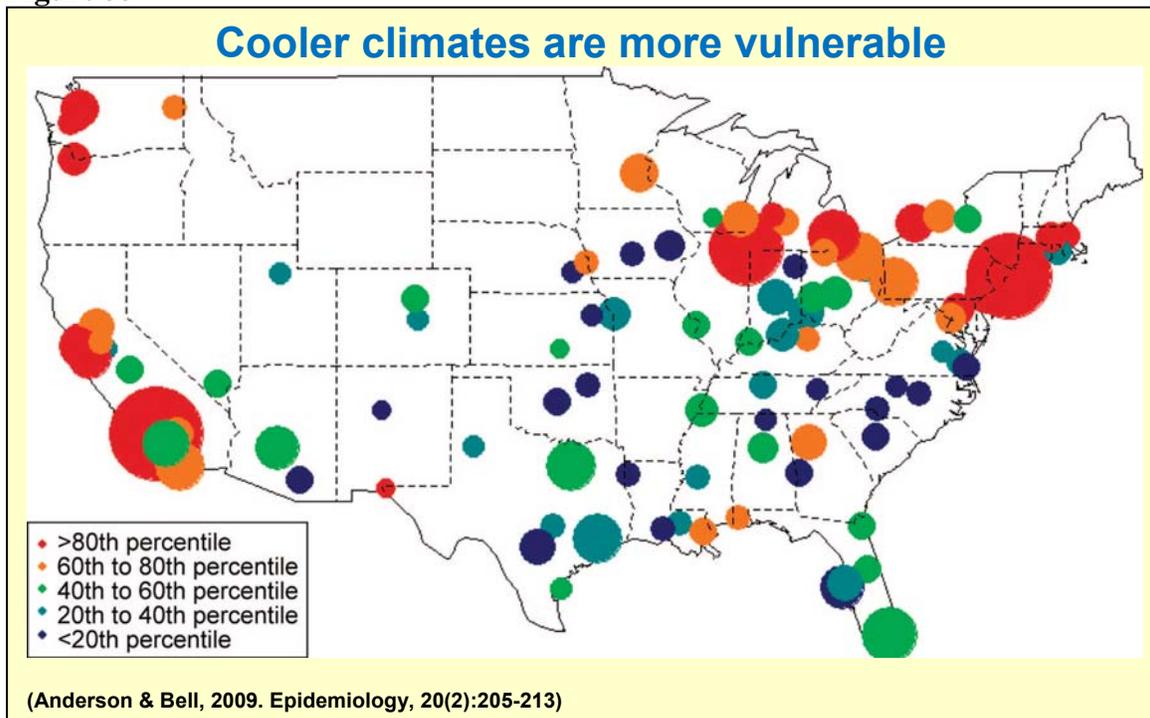
As an example of the importance of tracking, Dr. Smith described his program's work on tracking asthma related emergency department visits on high ozone days. He said that his group found that there were more Emergency Department (ED) visits on high ozone days. Surprisingly, they found that the people most likely to end up in the ED were 18-34 year olds (although the focus of public health attention on this issue is on children). This important identification of an unlikely vulnerable population was made possible by good surveillance.

Dr. Smith described the national framework for doing environmental public health tracking, of which Maine has been a participant since the initiative began in 2002. Recently, the Maine CDC has been working on a pilot project to develop a national system of climate change indicators based on the consensus document developed by the Council of State and Territorial Epidemiologists (CSTE). This group is working to develop, pilot and implement tracking systems and improve existing systems. These activities will allow public health practitioners to better characterize vulnerable populations and identify strategies for adaptation to climate change. The initial focus of this study is to develop nationally consistent methods to measure the impact of heat waves, one of the most likely weather events predicted to increase in frequency and severity due to climate change.

## Heat Waves: A Tracking Case Study

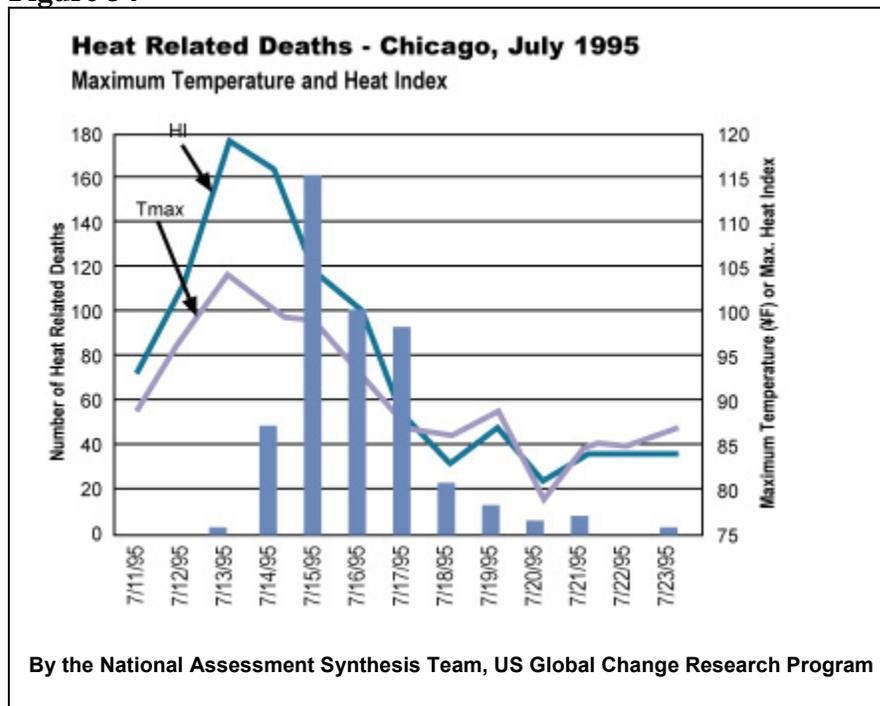
Next, Rebecca Lincoln, the lead scientist at the Maine CDC on climate change, described the state's work on heat related health tracking. Ms. Lincoln explained that heat waves are an important place to begin tracking because they clearly affect people's health and kill more people in the United States than all other weather events combined. She also added that heat-related deaths nationally are predicted to increase from 700 per year to between 3000 and 5000 by 2050. In order to combat this problem and understand vulnerable populations in such a short time frame, it is important to start a system for gathering and analyzing data now.

**Figure 33**



Ms. Lincoln then explained why heat events matter in Maine, though Maine is considered a cool climate. She stated that in fact, cooler climates are more vulnerable to heat waves than hotter areas and have more deaths when the temperature is high. These cooler areas, she explained, lack air-conditioning and people are not adapted to situations in which the weather is suddenly much hotter than normal. Maine also has a high proportion of vulnerable populations compared to the country as a whole: elderly living alone, people with chronic diseases, and people living in rural areas. She added that we do not have a good understanding of why the relative percentage of heat-related deaths is higher in rural areas than urban areas, so more study is certainly needed to address this problem.

**Figure 34**



Ms. Lincoln then explained how researchers measure the effects of heat waves using the 1995 Chicago heat wave as an example, where there were 700 excess deaths during the heat wave. The first question, she said, is how do researchers define a heat wave? In the case of Chicago, it was pretty clear, as there was a sharp peak in temperature and heat index, and then those lines drop off. The bars on the graph represent daily heat-related deaths, which, Ms. Lincoln noted, lag behind the heat peak by a day or two because heat morbidity is a result of a protracted physiological response, so there is a lag before there is a strong increase in heat-related deaths. Ms. Lincoln also pointed out that there is a dip in deaths after the heat wave, a phenomenon called ‘mortality displacement;’ people who are frail and sick that would have died shortly after the heat wave die sooner, during the heat wave. The consequence is that death rates may be artificially low directly after a heat wave.

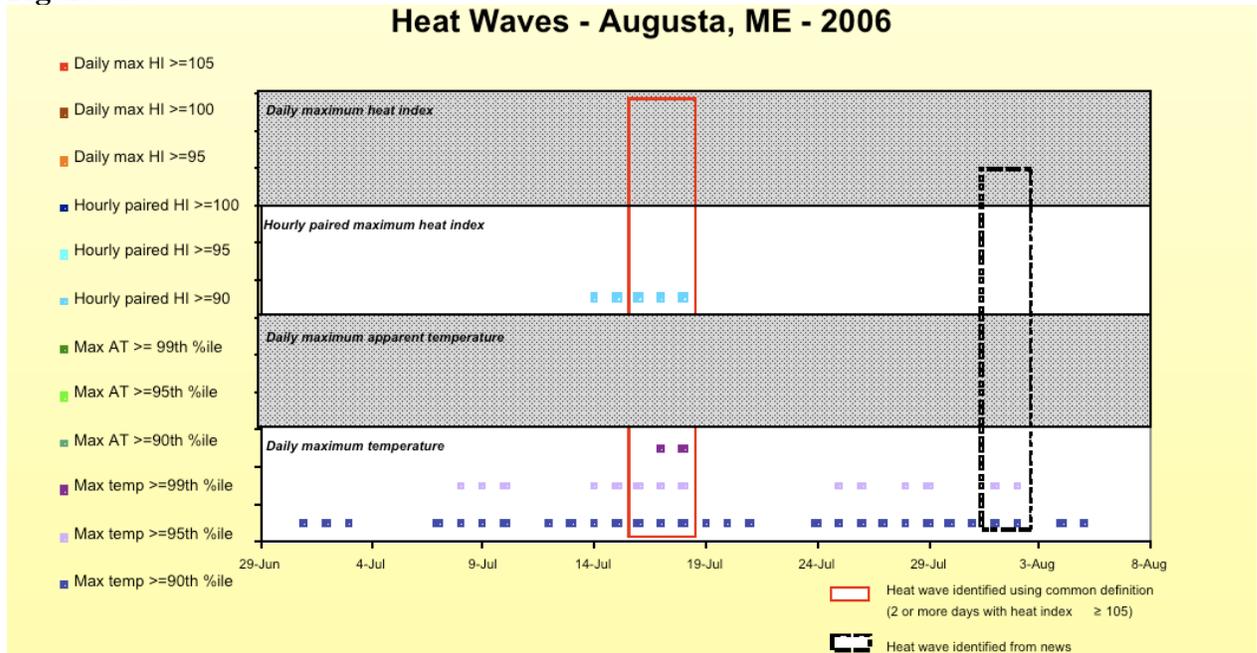
Next Ms. Lincoln described the challenges of replicating this type of analysis. First she further explored the problems of defining a heat wave for situations less extreme than Chicago in 1995 or Europe in 2003. Ms. Lincoln said that there is no consistent definition of a heat wave—how hot it has to be and how long it has to last. One definition is “a prolonged period of excessively hot weather” but Ms. Lincoln noted that this definition is extremely vague and it is difficult to work with. And, she added, even defining ‘hot’ is difficult from a health tracking perspective. One could use maximum or minimum temperature, or heat index (a measure that combines temperature and humidity). The National Weather Service uses the heat index to issue health-based warnings but they use a threshold of 105 as a heat wave cut off, a heat index that we almost never reach in Maine.

Regarding mortality, there are challenges depending on which deaths are determined to be heat-related and how increases in mortality above background rates are assessed.

While it seems like researchers could simply count deaths where heat is listed as a contributing cause, physician coding is not consistent and this method has been shown to undercount heat wave related deaths. Another approach, added Ms. Lincoln, is to count deaths from either all causes, or all non-accidental causes, and compare these numbers to deaths during a non-heat wave period. The challenge with this latter approach is that there is much variability in all cause mortality, or even in mortality from particular mortality conditions such as cardiopulmonary disease. This variability might mask effects associated with heat events unless more in depth studies are conducted.

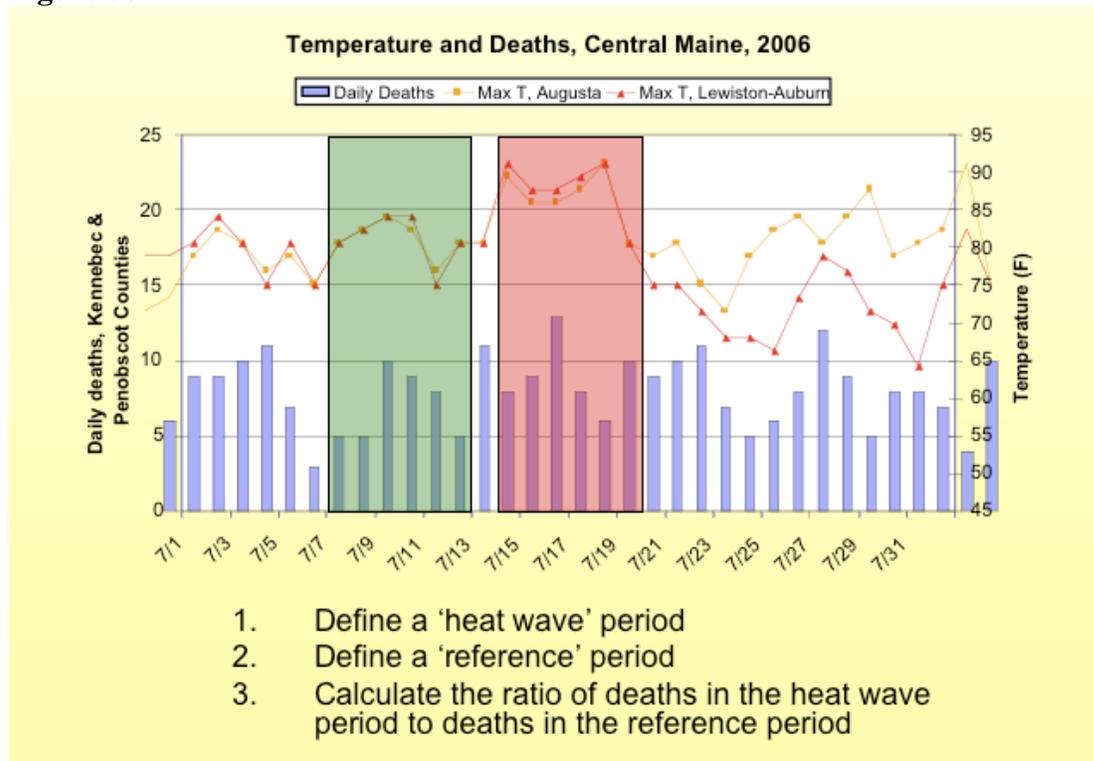
Next, Ms. Lincoln described the initial phase of Maine’s participation in nation-wide pilot project on heat related morbidity and mortality that focused on identifying a heat wave in Maine. She said they looked at 2006 because there was record-breaking heat on the east coast and showed a graph (Figure 35) that marks heat wave days that were identified using a variety of methods.

**Figure 35**



Ms. Lincoln then showed a graph with the daily maximum temperature in Augusta and Lewiston-Auburn and the daily deaths in Kennebec and Penobscot counties (Figure 36). She acknowledged that nothing obvious was on the graph, differentiating the situation from the Chicago graph she showed earlier, and then she explained the statistics. After identifying the heat wave as July 14-19, she noted that they chose a reference period, based on well defined protocol including same length, same days of the week, and close to the heat wave but not directly after to avoid the effect of mortality displacement.

**Figure 36**



According to this protocol, deaths were compared in the two periods. There were 54 deaths during the heat wave period, across both counties, and 42 deaths during the reference period. The mortality rate ratio is 1.29, or a 29% increase in daily mortality rate during the heat wave period. The confidence interval does include 1, so this is not a statistically significant result, given that the numbers are so small, but the numbers are probably suggestive. She also mentioned that she checked another reference period a few weeks after the heat wave and found almost the same number of deaths as the earlier reference period. She said that she also looked at this same time period for the entire state. She did not find a heat wave in coastal and northern areas of the state. When she ran the same calculation for deaths across the whole state, the ratio was not elevated.

## Conclusion

In closing, Ms. Lincoln described some of the future hopes for using data. She said that the Maine CDC is planning to assess all of the mortality and morbidity data and look at daily association with heat an entire season, which would avoid some of the problems associated with a heat wave analysis. Such a season long analysis would also address the problems associated with defining a threshold for heat related morbidity and mortality. It

could also help identify regions of the state that may be most at risk from heat related health impacts, thereby guiding future adaptation planning.

### **Question and Answer**

In the question and answer session, many questions were focused on getting better information out of the data. Ms. Lincoln explained some research decisions, including the choice of using temperature instead of heat index. In this case they were basically analogous, and temperature is easier for people to understand. She also expressed a need to use more powerful analysis tools with more data in the future to determine who the vulnerable populations are, and how the combined impacts of both high heat and high temperature could affect public health planning and assessment.

### **Biographies**

Dr. Smith obtained his master's and doctorate of science degrees in environmental health from the Harvard School of Public Health. Andy began his science career in oceanography, working in the waters of the Antarctic, Caribbean, Sargasso Sea, Peruvian upwelling waters in the Pacific, and Gulf of Maine. He has published in the fields of oceanography, toxicology, epidemiology and environmental health. He is the principal investigator on Maine's Environmental Public Health Tracking cooperative agreement with the U.S. CDC, and it is in this capacity that his group has begun to investigate and pilot indicators for health impacts of climate change.

Rebecca Lincoln is a Toxicologist with the Maine Center for Disease Control, and is currently completing her doctorate in Environmental Health at the Harvard School of Public Health. Her research has focused on the use of novel biomarkers for measuring prenatal exposure to heavy metals, and other research interests include exposure assessment, biomonitoring and the health effects of climate change. She has collaborated with researchers at the Harvard Graduate School of Education and the Harvard Medical School on several climate change projects, including publications on the challenges of climate change education and the impacts of climate change on water and health. She holds a BA in Geology from Oberlin College.

## Effective Change at the Community Level

Barbara MacKinnon, Ph.D.

New Brunswick Lung Association

### Key Message:

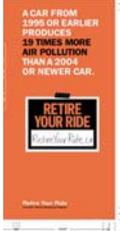
- Existing research on societal behavior change and community based social marketing for *greenhouse gas mitigation* could provide a basis for interventions on climate adaptation.

Dr. MacKinnon picked up on the threads of discussion Dr. McGeehin identified at the beginning of the conference regarding the importance of effective communication and education as crucial elements in our collective response to the health challenges of climate change. She recognized the relatively recent emergence of climate change adaptation as a public health issue, and consequently the lack of health promotion and education materials on this subject. Nonetheless, she emphasized the fact that the existing research on societal behavior change and community based social marketing for *greenhouse gas mitigation* could provide a basis for interventions on climate adaptation. Throughout the presentation, she referenced the extensive work of her colleague Douglas Mackenzie-Mohr on this subject.

Dr. MacKinnon identified the major challenges involved with changing behavior, as the old behavior typically has more perceived benefits and fewer perceived barriers than the new behavior. Consequently, it is important for interventions to have a clear idea of who the audience is, what behavior change is to be promoted, and how we can overcome existing barriers to behavior change. Two major components of this strategy are: 1) effective communication, and 2) a commitment on the part of the public to make visible commitments, however small, towards positive behavior change.

**Communication- The art of persuasion**

- Use captivating information
- Know your audience
- Use credible information
- Frame your message (messages which emphasize losses due to inaction are more persuasive than messages that emphasize savings as a result of action)
- Fear messages must be combined with solutions
- Model the behavior
- Provide feedback



**Commitments**

- Obtain small commitment
- Obtain larger commitment
- Recognize commitment in public
- Obtain commitment in groups, in writing
- Use commitments of a champion (block leader)
- Commitments must be voluntary
- Involve the person making the commitment
- Follow up



Dr. MacKinnon stressed that ultimately, the goal of such social marketing approaches is to create new norms of social behavior. Furthermore, fostering new norms can positively affect society at multiple levels: promoting increased bicycle/pedestrian use and green spaces can help with greenhouse gas mitigation strategies, individual health promotion, and overall community cohesion. These norms can be promoted by various types of

rewards or incentives (such as a bottle deposit). One must be careful, however, to consider the possibility that behaviors conditioned on rewards might disappear once those incentives are no longer available. Ideally, people will internalize or habitualize these norms, making external rewards and penalties no longer necessary (such as is largely the case with smoking prohibitions in public indoor spaces in Maine).

### **Biography**

Over the past nine years, Dr. MacKinnon has participated in a number of national committees relating to standards, legislation and public engagement relating to air quality and climate change issues.

Priorities of the New Brunswick Lung Association include advocacy and public education programs which reduce the health risks of indoor and outdoor air contaminants, actions to mitigate and adapt to climate change, and strategies for tobacco use reduction.

She was a member of two research teams spearheaded by the New Brunswick Lung Association to conduct the first-even study of indoor air quality in First Nations housing, and the first Canadian study of the exposure of children to diesel exhaust from school buses.

### **Concluding Panel: Next Steps**

Norman Anderson, M.S.P.H., Maine CDC, moderator

Kellie Miller, M.S., Maine Medical Association

Paul Santomenna, Maine Chapter, Physicians for Social Responsibility

### **Key Message:**

- Organizations such as the Maine Medical Association and Physicians for Social Responsibility are beginning to organize around addressing climate change through a public health perspective.

The concluding panel of the conference highlighted the ways in which Maine's public health community is organizing itself around the emerging challenges of adapting to a changing climate. Mr. Anderson re-emphasized the Maine CDC's continuing and expanding commitment to the state's preparedness and capacity to respond to Maine's changing climate. This commitment includes increased collaboration among ME CDC divisions and district liaisons regarding the issuance of heat alerts, as well as in furthering its understanding of vector borne diseases (such as Lyme disease) within the context of climate change. It also includes expanded collaboration with other governmental organizations such as the Maine DEP, the Maine Emergency Management Agency, and the National Weather Service.

Ms. Miller emphasized the growing commitment of its organization to addressing climate change. She described Maine Medical Association's (MMA's) recent Resolve on Climate Change that outlined its planned work on education, training, and collaboration with Maine's public health community. She also distributed materials regarding an upcoming MMA educational seminar on climate change and health, funded through the American Medical Association.

Mr. Santomenna concluded the discussion with an overview of Physicians for Social Responsibility's (PSR's) abundant body of work relative to climate change assessment and public policy. Currently, the Maine PSR coordinates MESHNet, a network of environmental champions within Maine hospitals who are improving their institutions' environmental sustainability and climate change mitigation efforts. Through mechanisms such as MESHNet, as well as its monthly e-newsletter, Maine PSR will build a network of individuals and organizations interested in moving forward a climate change adaptation agenda in Maine. This network will start with individuals from this conference, as well as the pending MMA conference, who have expressed interest in working collaboratively. For more information on this developing network, readers are encouraged to visit the PSR Maine website (<http://www.psr.org/chapters/maine/>) or to contact Mr. Santomenna ([psantomenna@psr.org](mailto:psantomenna@psr.org)).

## Climate Change and Public Health Resource List

### **Web Sites/Reports**

U.S. Centers for Disease Control and Prevention

[www.cdc.gov/climatechange/](http://www.cdc.gov/climatechange/)

Intergovernmental Panel on Climate Change

[www.ipcc.ch/index.htm](http://www.ipcc.ch/index.htm)

U.S. Environmental Protection Agency

[www.epa.gov/climatechange/](http://www.epa.gov/climatechange/)

National Oceanic and Atmospheric Administration

[www.climate.gov/#climateWatch](http://www.climate.gov/#climateWatch)

U.S. Climate Change Science Program

[www.climatechange.gov/default.php](http://www.climatechange.gov/default.php)

Association of State and Territorial Health Officials

[www.astho.org](http://www.astho.org)

National Association of County and City Health Officials

[www.naccho.org/topics/environmental/climatechange/index.cfm](http://www.naccho.org/topics/environmental/climatechange/index.cfm)

Trust for America's Health Climate Change Report

<http://healthyamericans.org/reports/environment/>

American Public Health Association

[www.apha.org/advocacy/priorities/issues/GlobalClimateChange.htm](http://www.apha.org/advocacy/priorities/issues/GlobalClimateChange.htm)

### **Maine**

Maine Center for Disease Control and Prevention

<https://tracking.publichealth.maine.gov/> (Environmental Health Tracking)

[www.maine.gov/dhhs/boh/ddc/](http://www.maine.gov/dhhs/boh/ddc/) (Infectious Disease)

Maine Department of Environmental Protection

[www.maine.gov/dep/oc/adapt/](http://www.maine.gov/dep/oc/adapt/) (Adaptation Report)

[www.maine.gov/dep/air/ozone/](http://www.maine.gov/dep/air/ozone/)

Maine Climate Action Plan

<http://www.maine.gov/dep/air/greenhouse/>

The University of Maine Climate Change Institute

[www.climatechange.umaine.edu](http://www.climatechange.umaine.edu)

Physicians for Social Responsibility

[www.psr.org/chapters/maine/climate-change.html](http://www.psr.org/chapters/maine/climate-change.html)

Natural Resources Council of Maine

[www.nrcm.org/issue\\_globalwarming.asp](http://www.nrcm.org/issue_globalwarming.asp)

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