



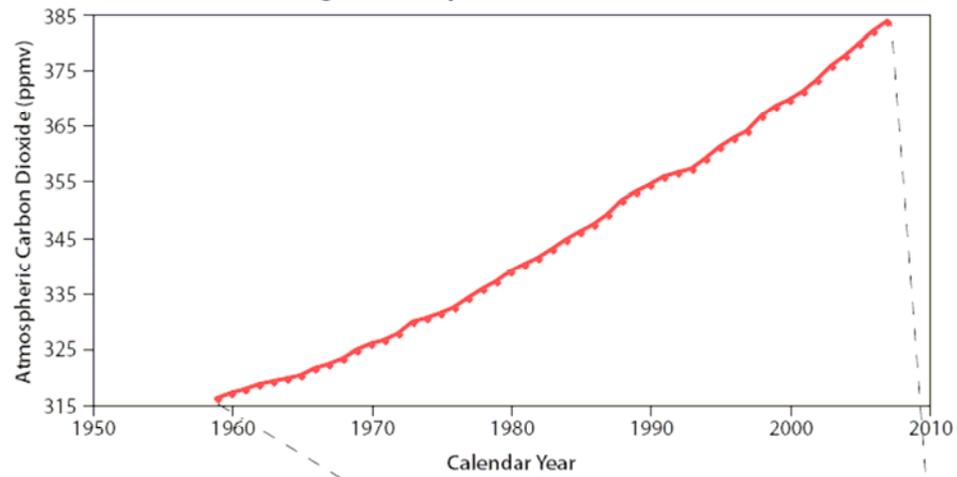
# Confronting Climate Change in Boston and New England

Peter C. Frumhoff  
Union of Concerned Scientists

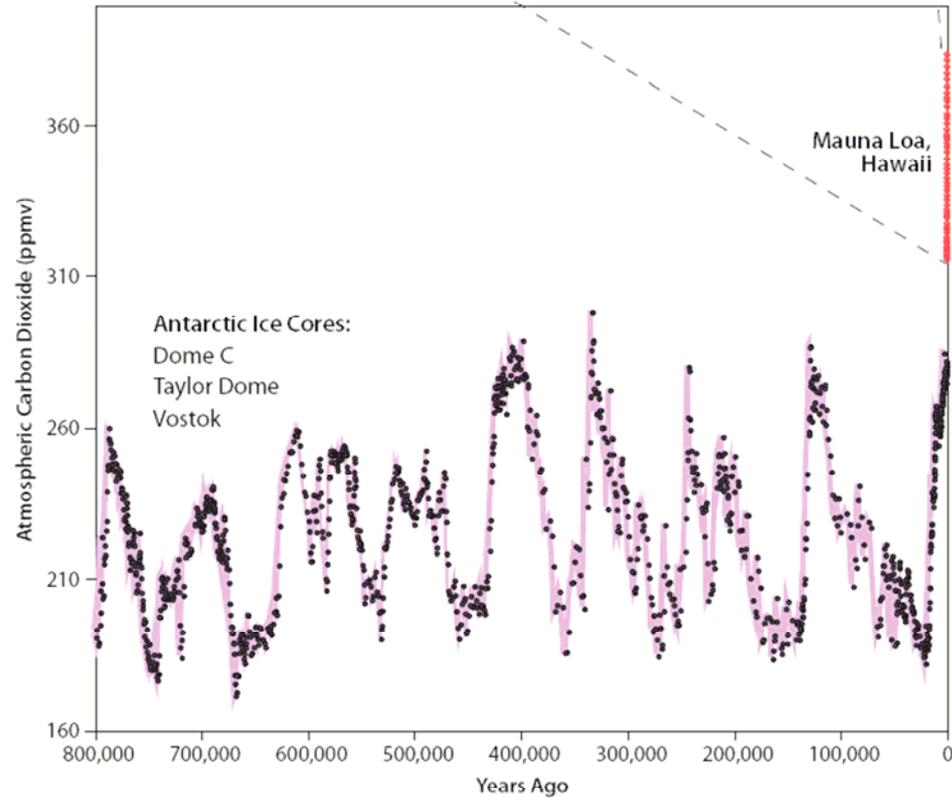
Mayor Menino's Climate Action  
Leadership Committee

26 May 2009

**Annual Average Atmospheric CO2 at Mauna Loa Hawaii**



**Atmospheric Carbon Dioxide Over Past 800,000 Years**



Source: [cdiac.ornl.gov](http://cdiac.ornl.gov);  
Lüthi et al. 2008.

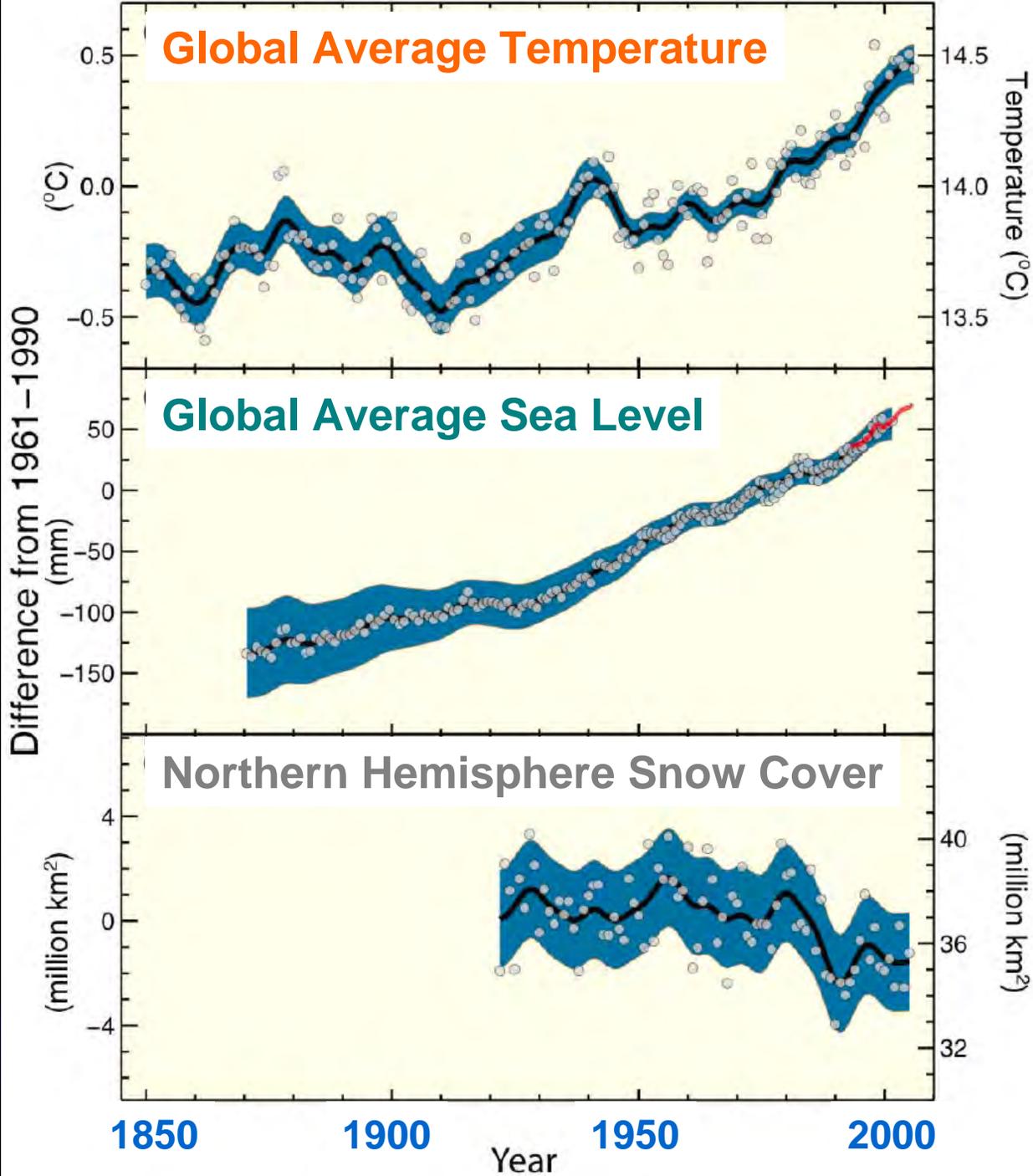
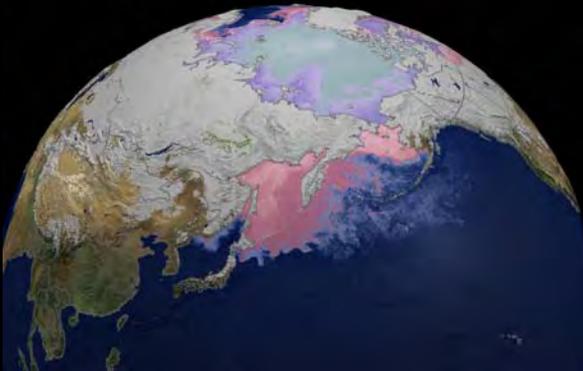
Washington Post



NOAA

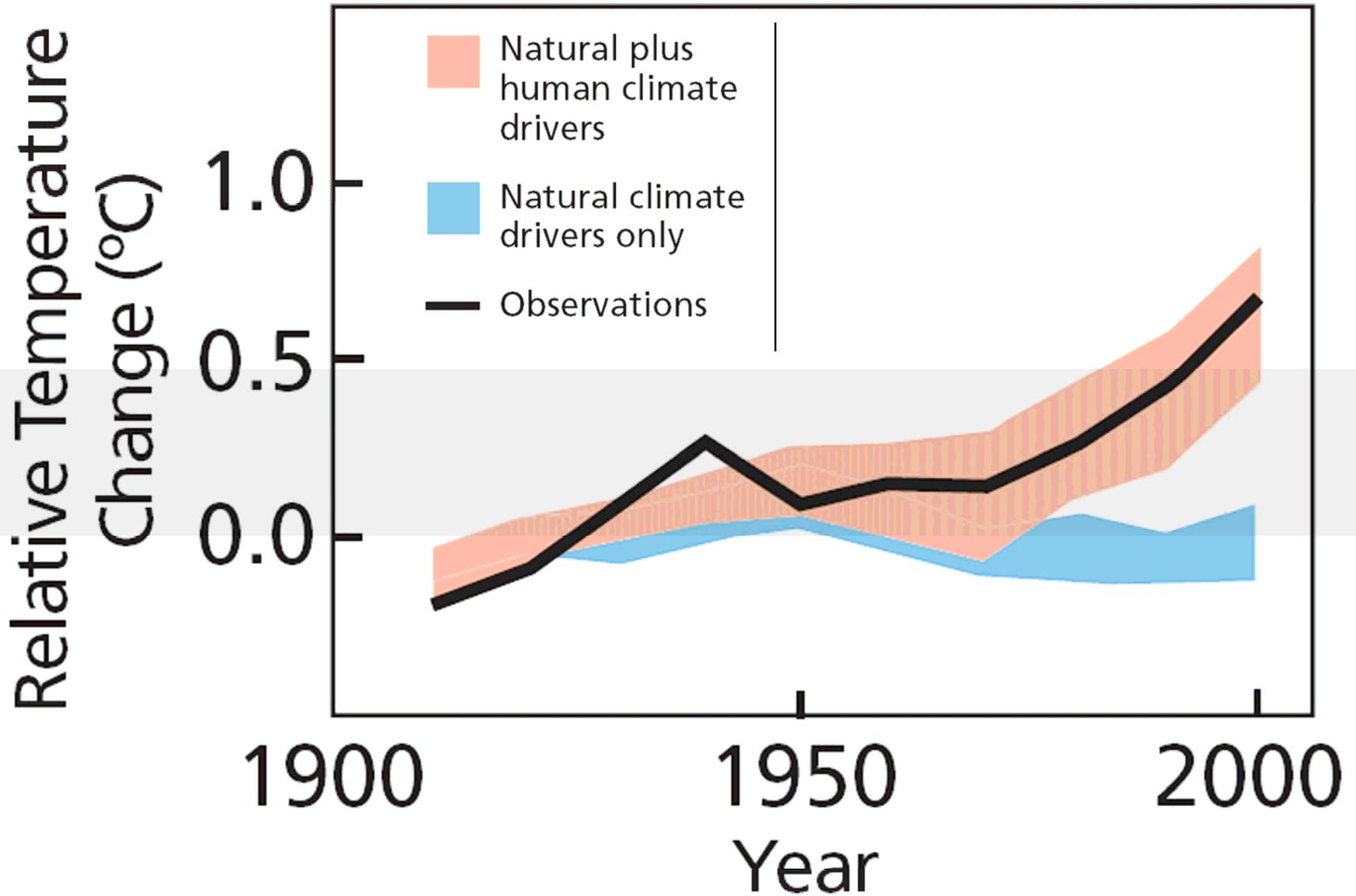


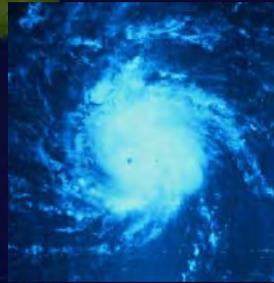
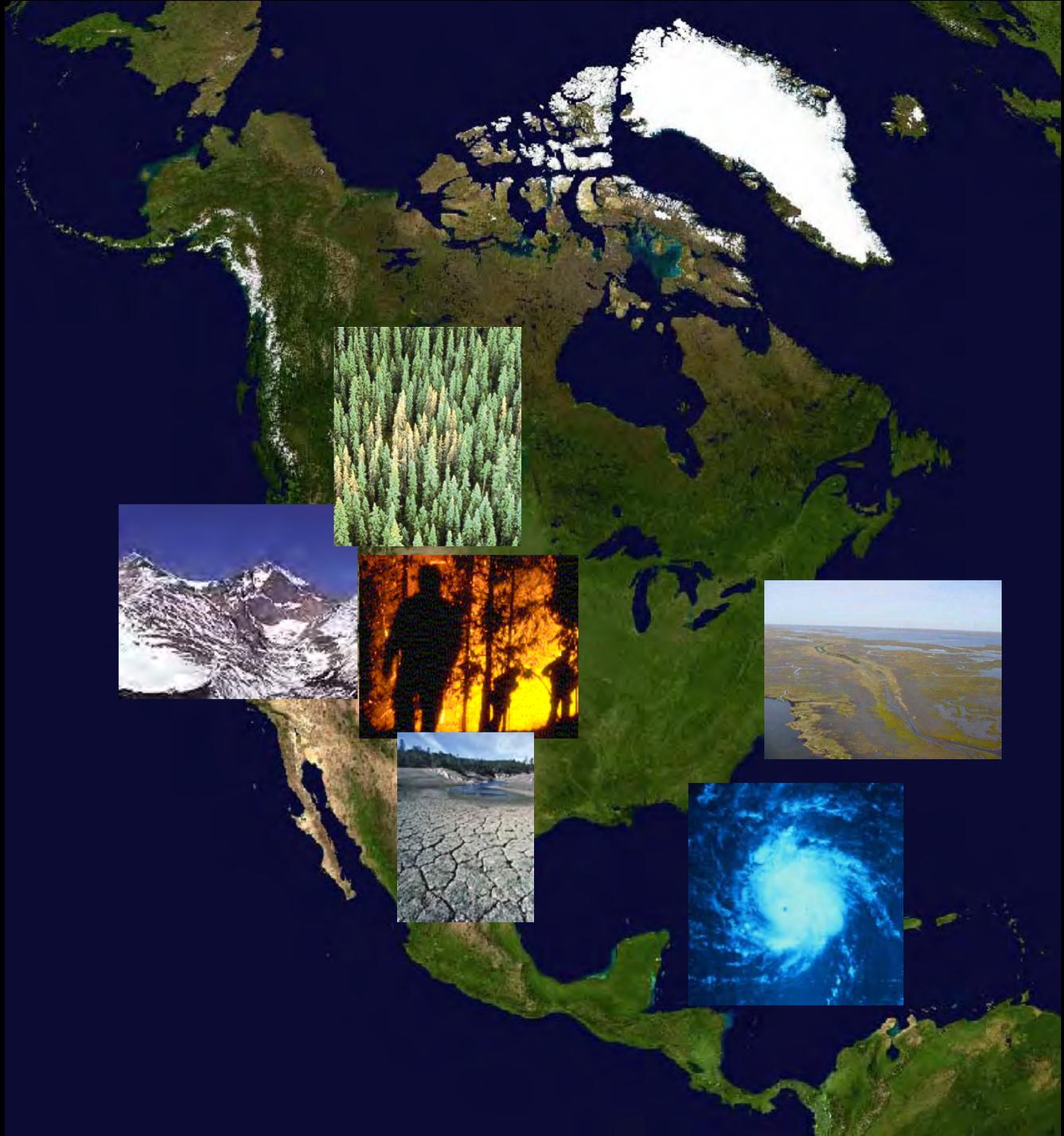
NASA



Source: IPCC *Climate Change 2007: The Physical Science Basis—Summary for Policymakers.* →

# Global Average Surface Temperature

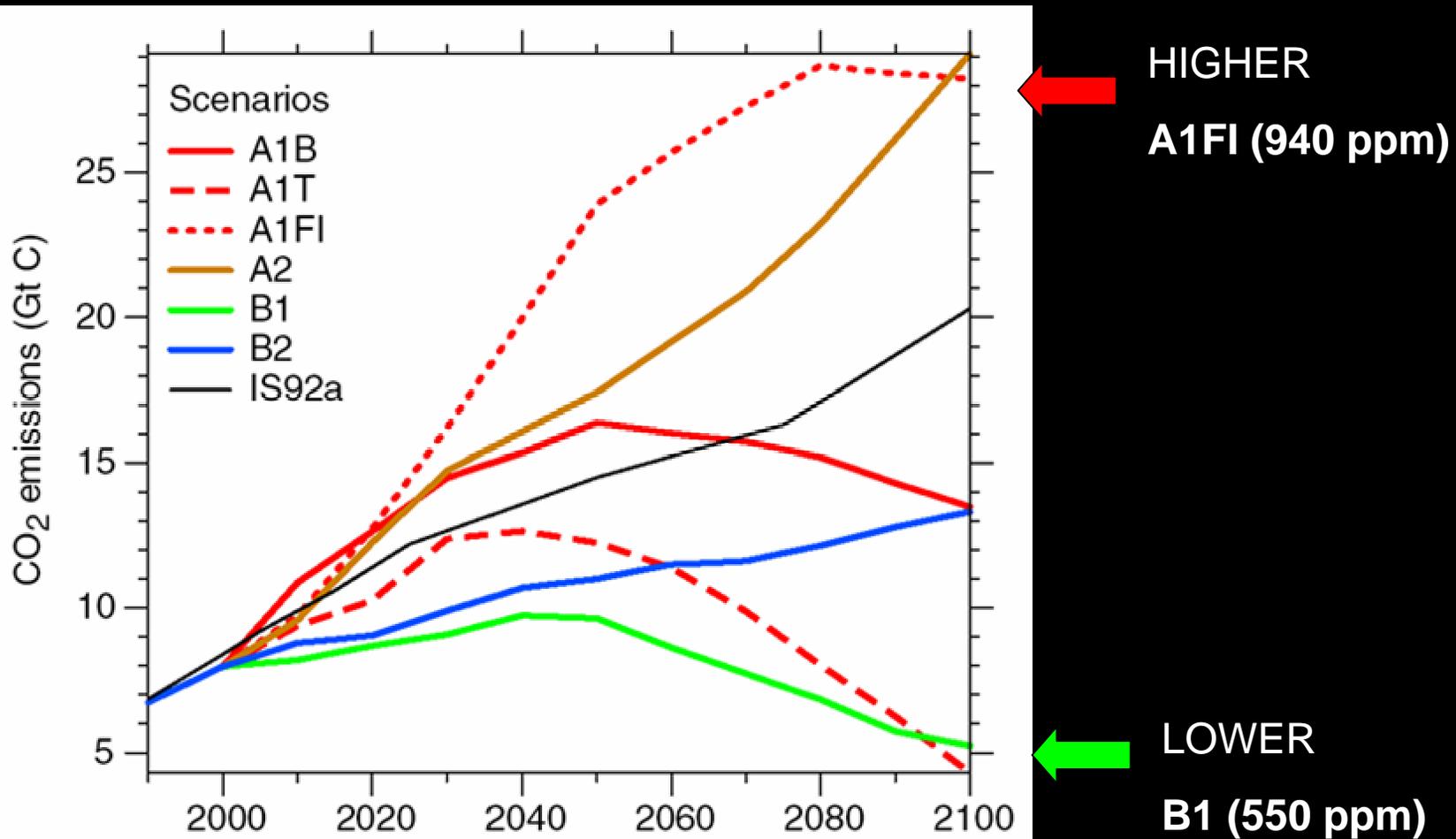




# Climate across the Northeast is also changing

- Annual temperatures have warmed ~ 2°F since 1970
- Winters have been warming fastest, ~ 4°F since 1970
- Winter snowpack is decreasing
- Plants are flowering earlier in the spring
- More frequent extreme heat days in summer
- Rising sea surface temperature (1°F since 1900)

# Further warming depends on our emissions choices



# Confronting Climate Change in the U.S. Northeast



## SCIENCE, IMPACTS, AND SOLUTIONS

JULY 2007

### Pennsylvania

Confronting Climate Change in the U.S. Northeast

From the Liberty Bell to the Pocono... big post rapidly... FT between 1970 and 2000.

### New Hampshire

Confronting Climate Change in the U.S. Northeast

From the White Mountains to the Seacoast... NEW HAMPSHIRE'S CHANGING CLIMATE

### New York

Confronting Climate Change in the U.S. Northeast

From the Adirondack Park to the City... Other Northeast States under two different skies.

### Massachusetts

Confronting Climate Change in the U.S. Northeast

From the Berkshires to the Cape... MASSACHUSETTS' CHANGING CLIMATE

Temperature. Average temperatures across the Northeast have risen more than 1.5 degrees Fahrenheit (19 to 2000) with winter warming most rapidly—4°F between 1970 and 2000. If higher-emissions' global average temperatures across the state are projected to rise 3°F to 5°F by summer by late-century, while lower emissions' would raise roughly half the warming. Under the higher-emissions scenario Massachusetts cities can expect a dramatic increase in the number of days over 100°F. See the figures on p.2 and the section on health impacts.

Regional and sectoral risks. 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 include less winter precipitation falling as snow and more as rain.

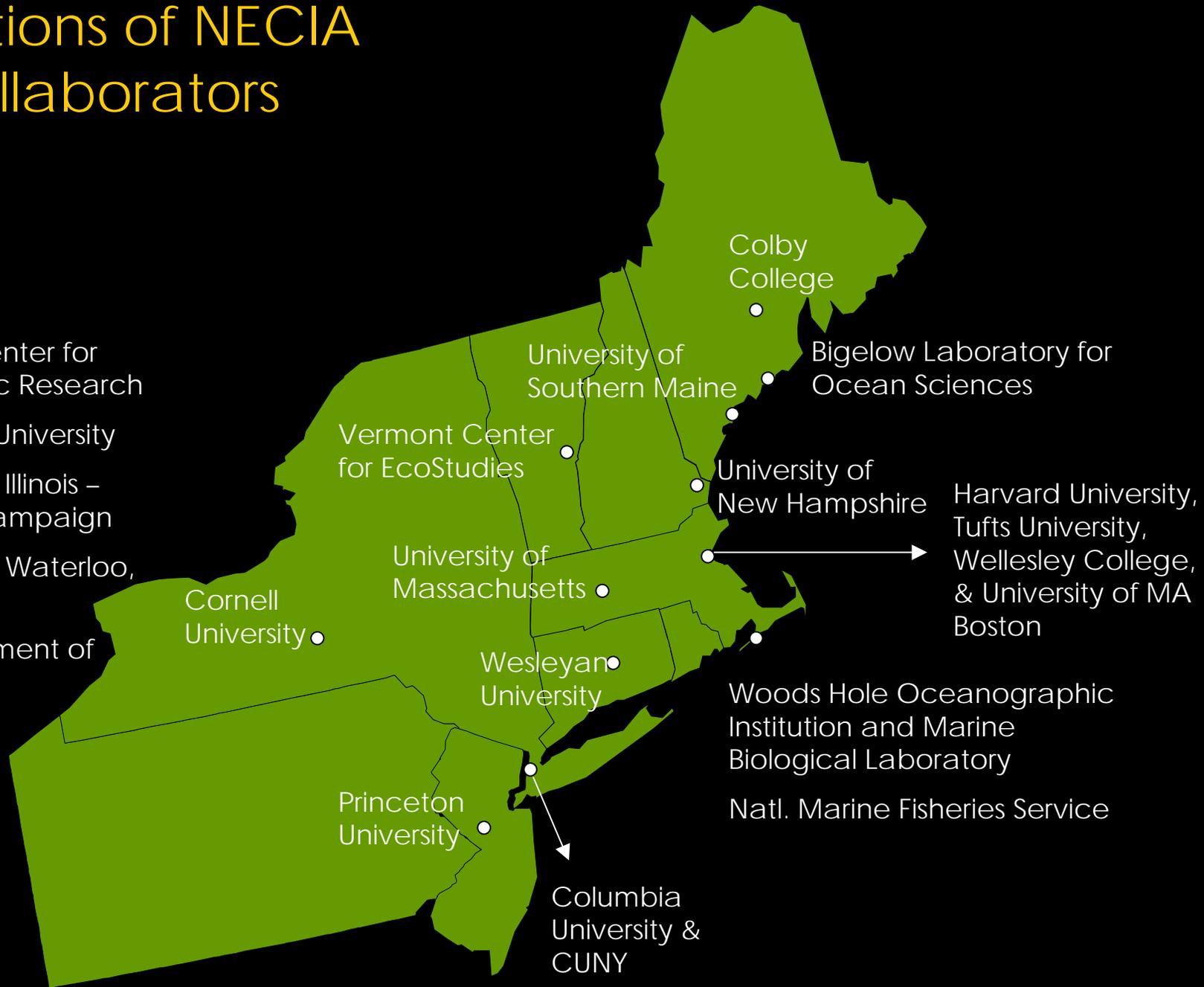
Some of the most characteristic of new long, hot winters—part and parcel of many favorite winter activities. Minus that, Massachusetts has

Changes in average temperature have a noticeable influence on the lives of people and animals—on the quality of the air we breathe, on the crops we grow, on the water we drink, and on the way we live. The Northeast has experienced a number of extreme weather events in recent years, including a major ice storm in 2003, a major flood in 2004, and a major drought in 2006. These events have caused significant damage and loss of life and property. The Northeast is projected to experience more frequent and severe extreme weather events in the future, with the highest emissions scenario showing the most dramatic increases in the number of days with extreme heat and cold.

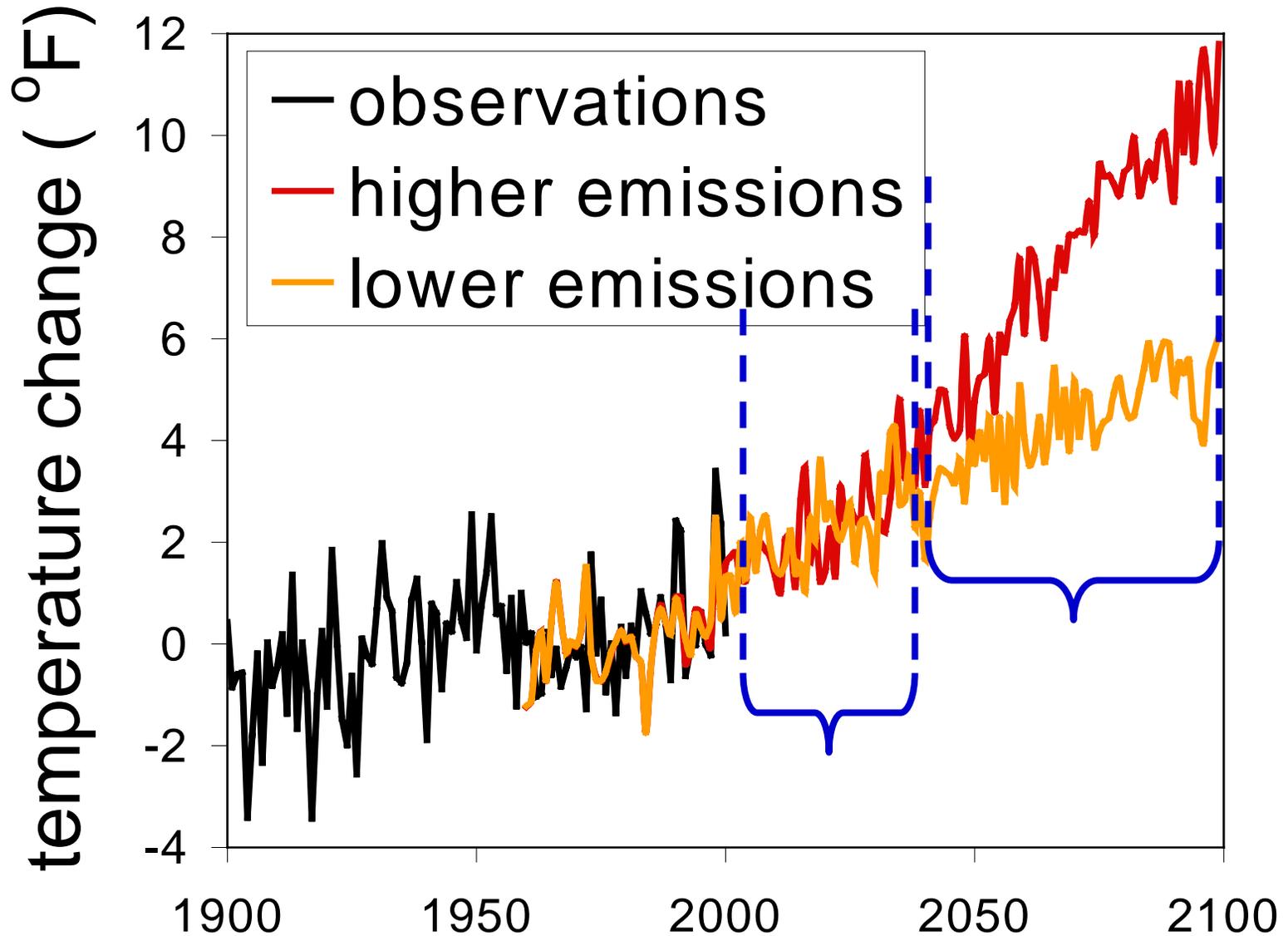
The research also explores actions that individual households, businesses, and governments across the Northeast can take today to reduce emissions to levels consistent with staying below the two-degree Celsius scenario and reduce the unavoidable changes that past emissions have already set in motion.

Home of the Original Buffalo Chicken Wings

# Institutions of NECIA Collaborators

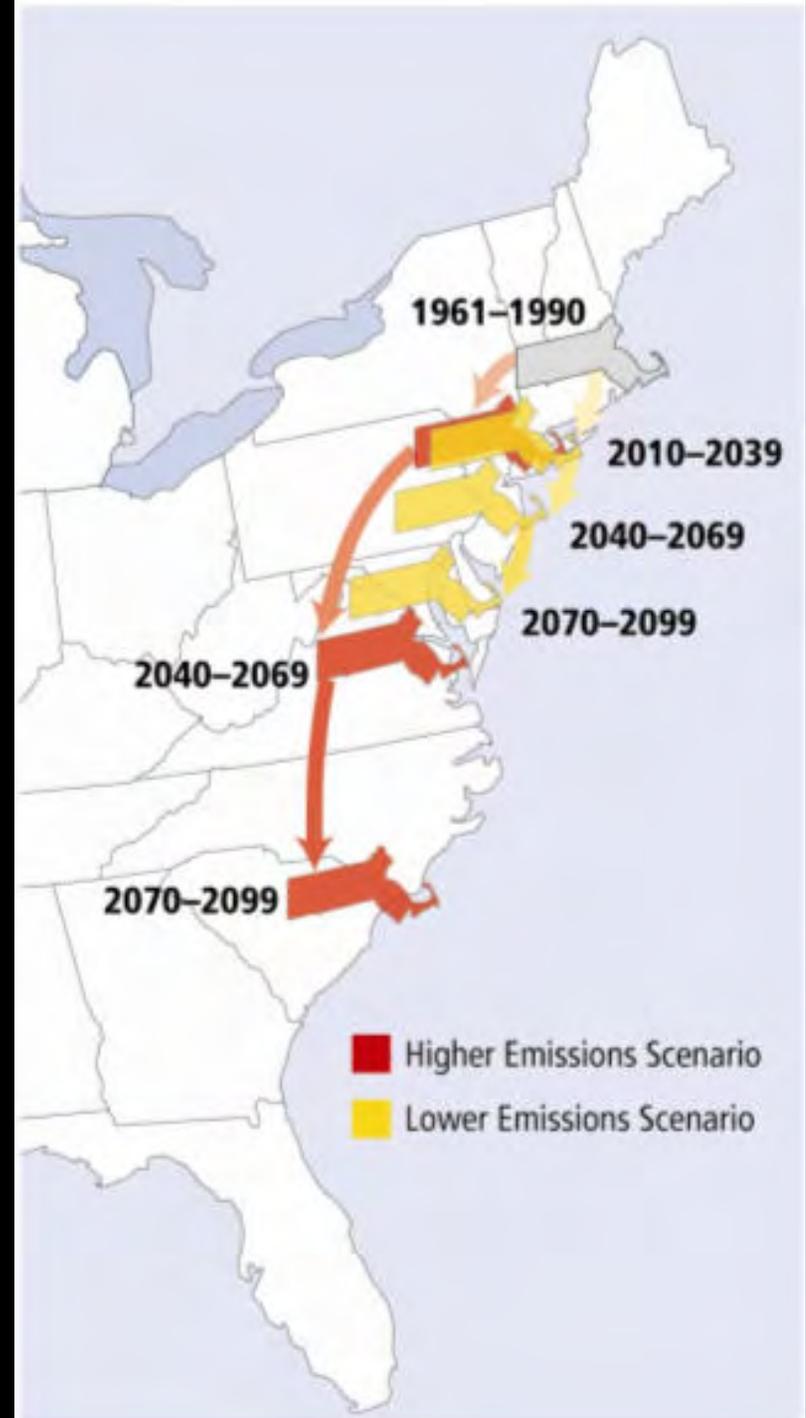


# NE Average Annual Temperatures



Heat index:

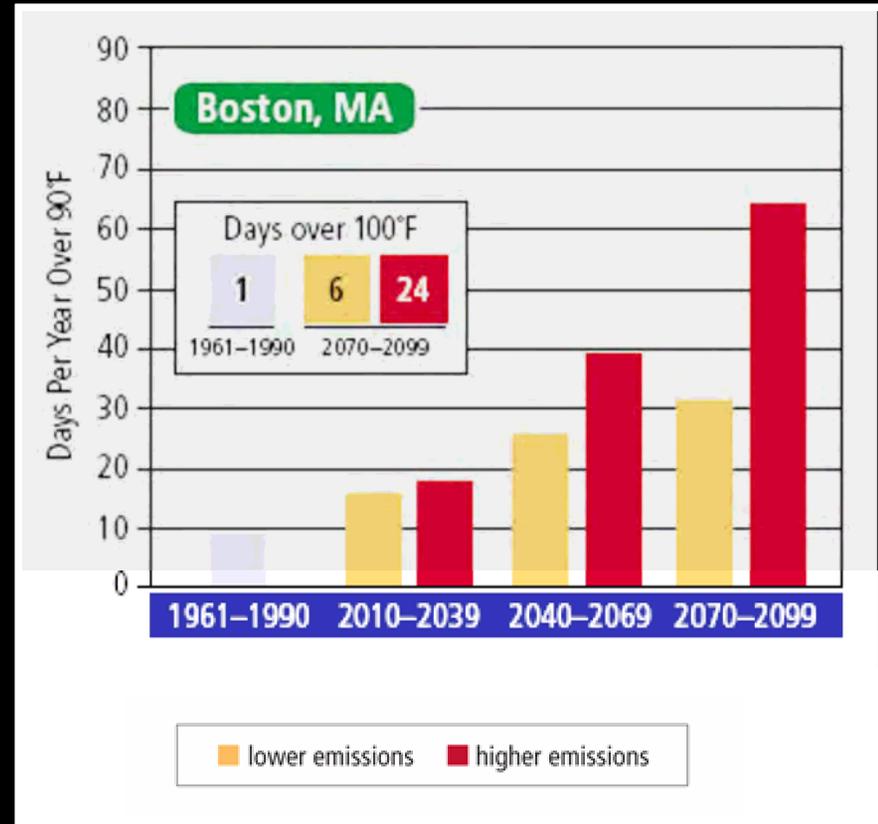
How hot will  
a summer day in  
Massachusetts feel?



# Increasing Frequency of Extreme Heat



AP Photo/Michael Dwyer



Many fruit crops  
require cold winters



# Changing Precipitation

- Increasing winter precipitation (more rain, less snow)
- More frequent and intense periods of heavy rainfall



# Managing Water Resources

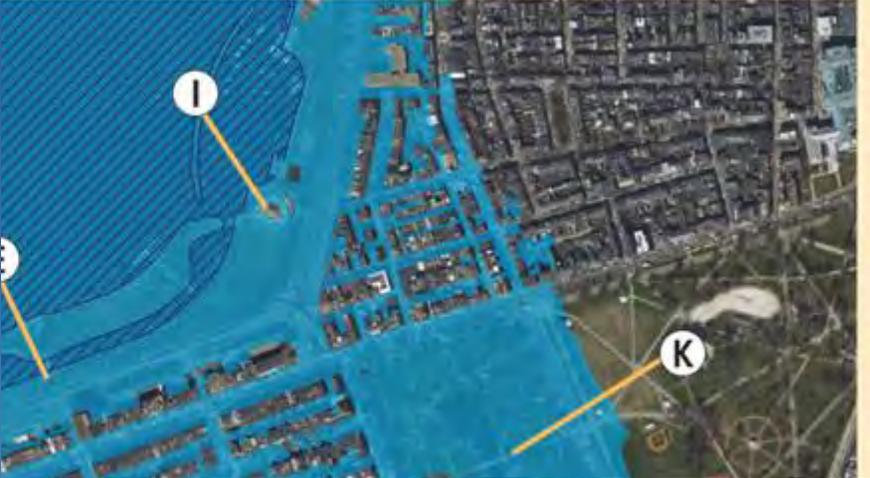


# Boston: The Future 100-Year Flood under the Higher-Emissions Scenario

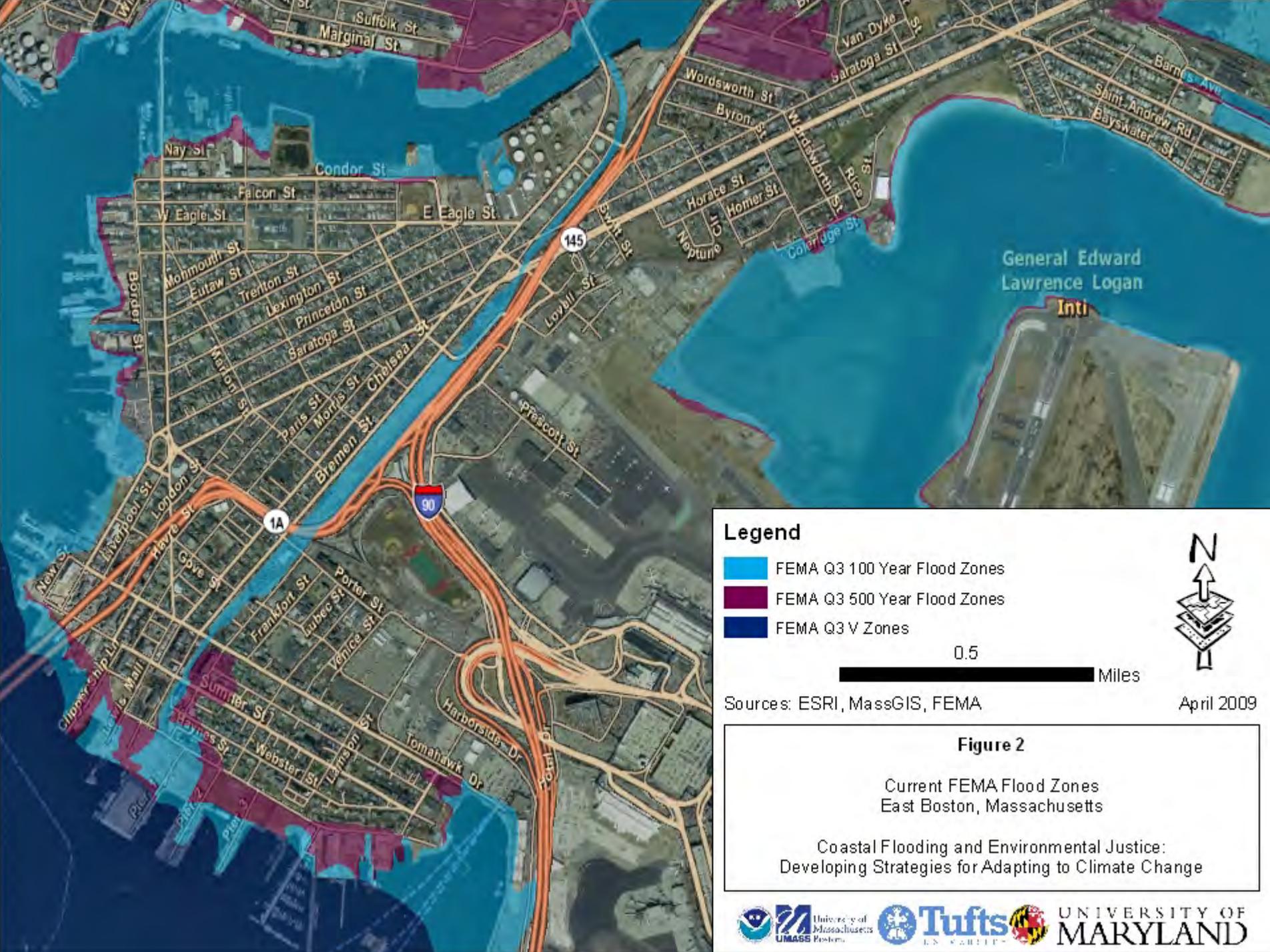


Projected 100-year flooded area (higher-emissions scenario)

# Boston: The Future 100-Year Flood under the Higher-Emissions Scenario

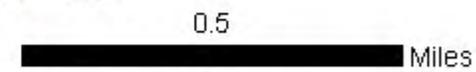


Edward Giardina



**Legend**

- FEMA Q3 100 Year Flood Zones
- FEMA Q3 500 Year Flood Zones
- FEMA Q3 V Zones

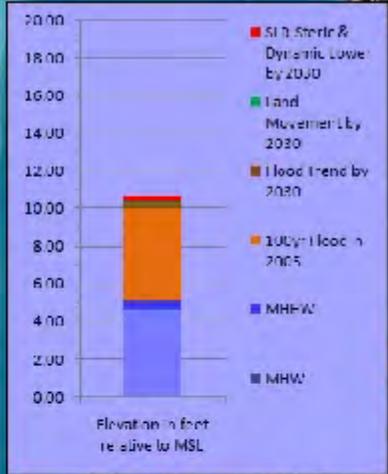
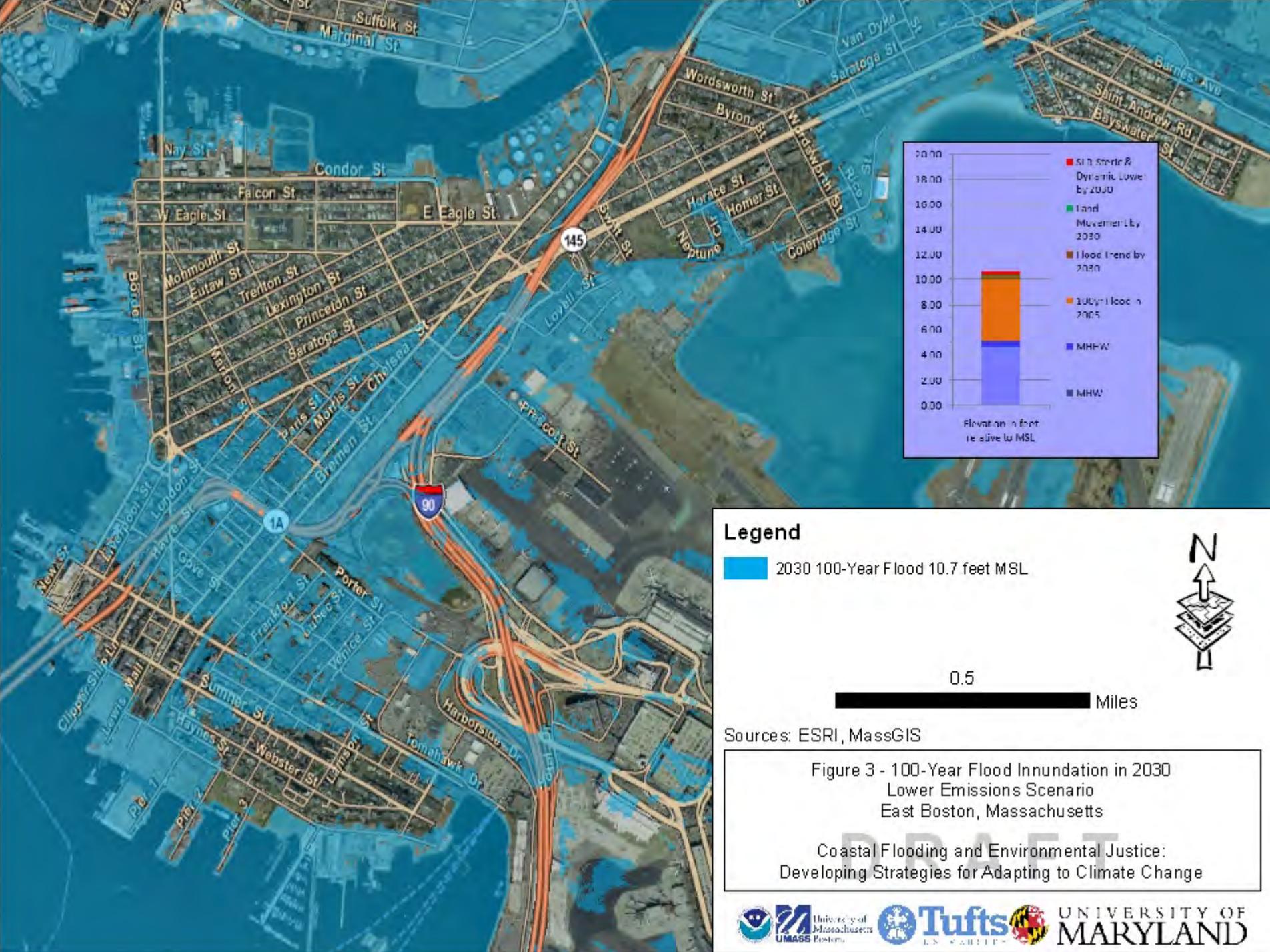


Sources: ESRI, MassGIS, FEMA

April 2009

**Figure 2**  
 Current FEMA Flood Zones  
 East Boston, Massachusetts

Coastal Flooding and Environmental Justice:  
 Developing Strategies for Adapting to Climate Change



**Legend**

2030 100-Year Flood 10.7 feet MSL



0.5

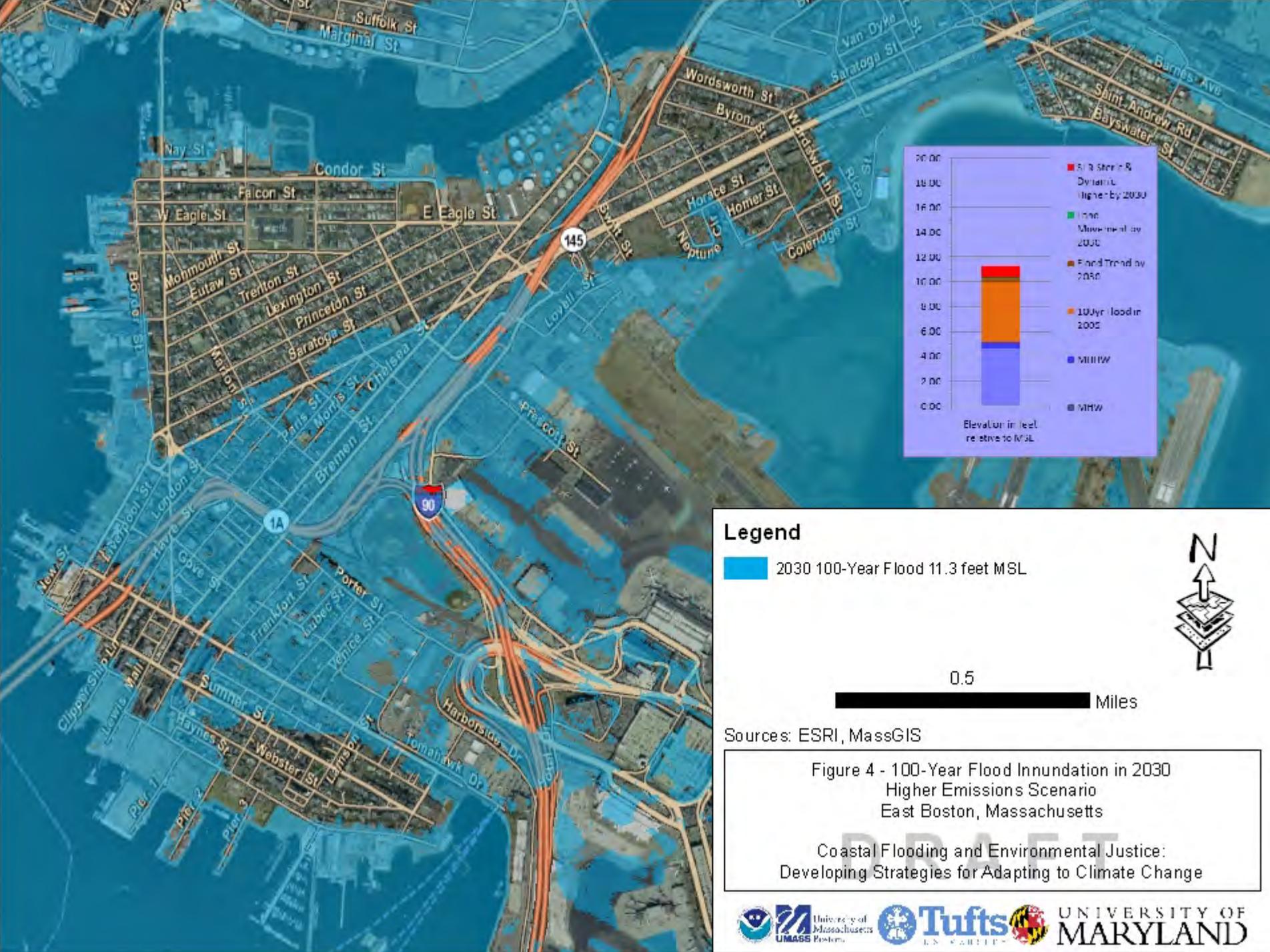
Miles

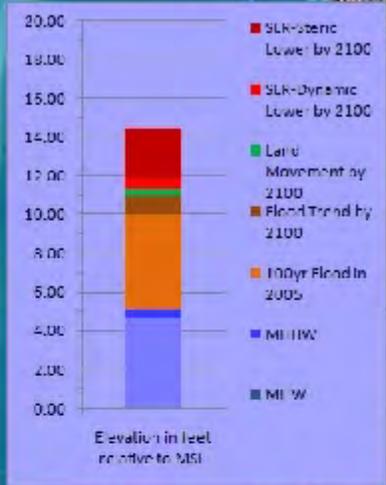
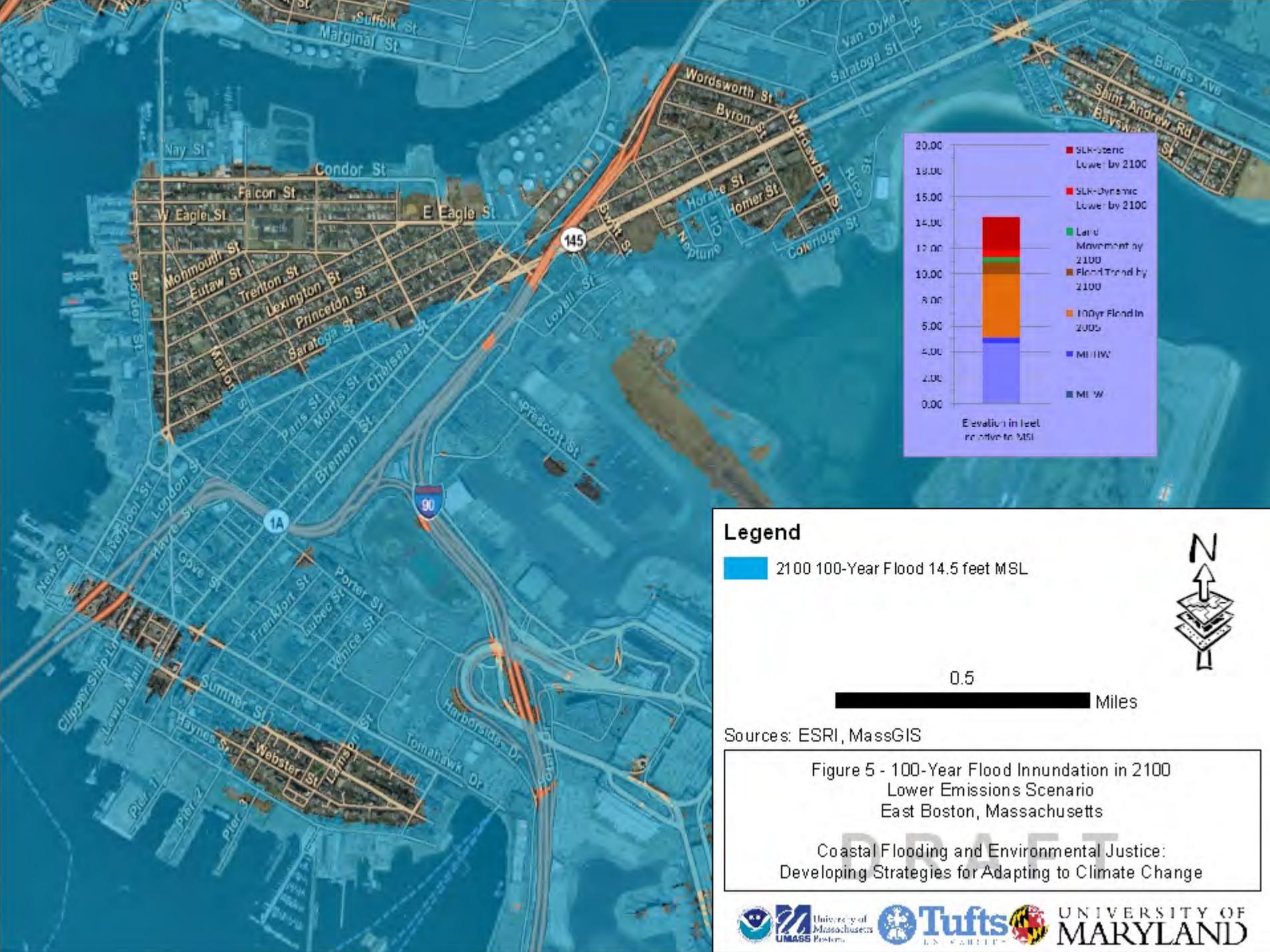
Sources: ESRI, MassGIS

Figure 3 - 100-Year Flood Inundation in 2030  
 Lower Emissions Scenario  
 East Boston, Massachusetts

**DRAFT**

Coastal Flooding and Environmental Justice:  
 Developing Strategies for Adapting to Climate Change





**Legend**

2100 100-Year Flood 14.5 feet MSL



0.5

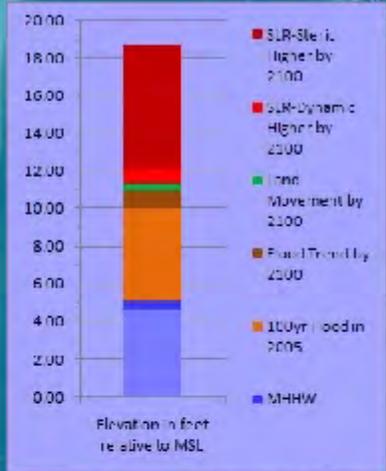
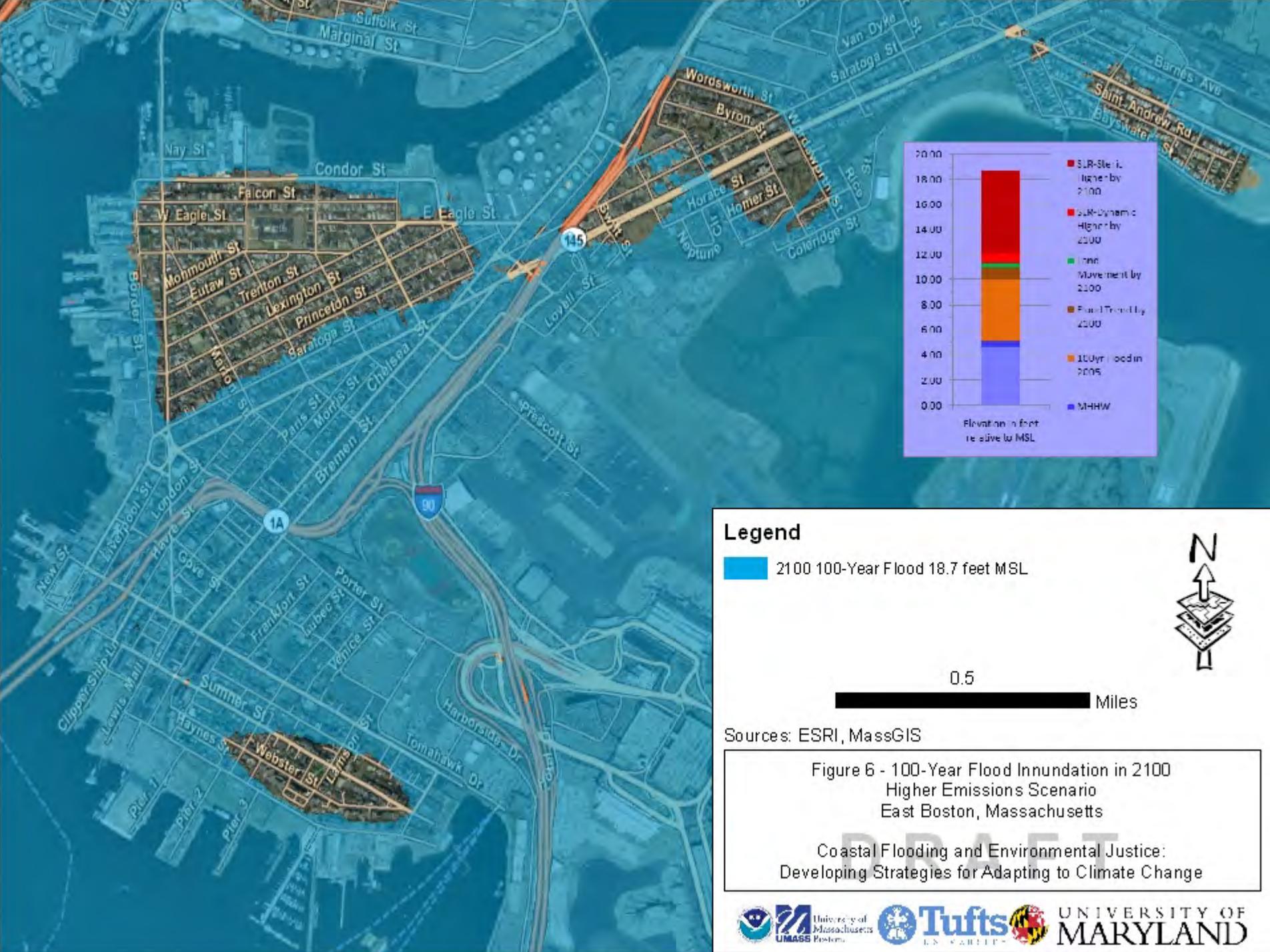
Miles

Sources: ESRI, MassGIS

Figure 5 - 100-Year Flood Inundation in 2100  
Lower Emissions Scenario  
East Boston, Massachusetts

DRAFT

Coastal Flooding and Environmental Justice:  
Developing Strategies for Adapting to Climate Change



**Legend**

2100 100-Year Flood 18.7 feet MSL



0.5

Miles

Sources: ESRI, MassGIS

Figure 6 - 100-Year Flood Inundation in 2100  
Higher Emissions Scenario  
East Boston, Massachusetts

DRAFT

Coastal Flooding and Environmental Justice:  
Developing Strategies for Adapting to Climate Change



# Confronting Climate Change in California

Ecological Impacts on the Golden State

1999

# Confronting Climate Change in the Gulf Coast Region

Prospects for Sustaining Our Ecological Heritage

2001

# Confronting Climate Change in the Great Lakes Region

Impacts on Our Communities and Ecosystems

2003

# Climate Change in California: Choosing Our Future

2004

# Climate Change in the U.S. Northeast

2006

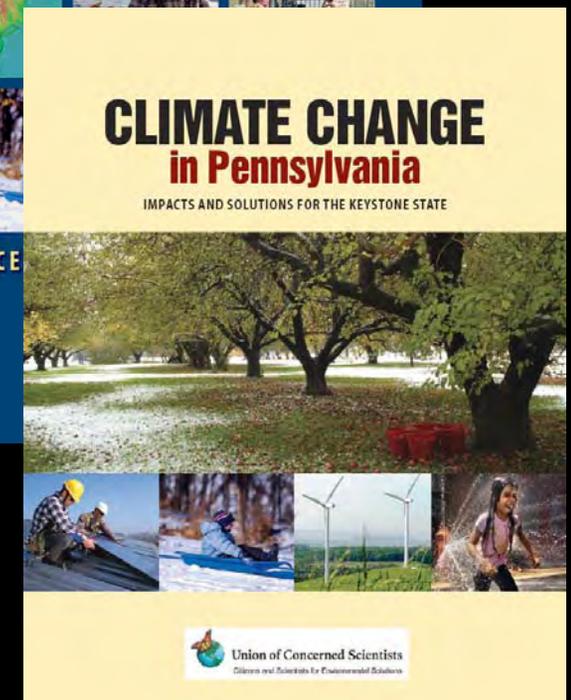
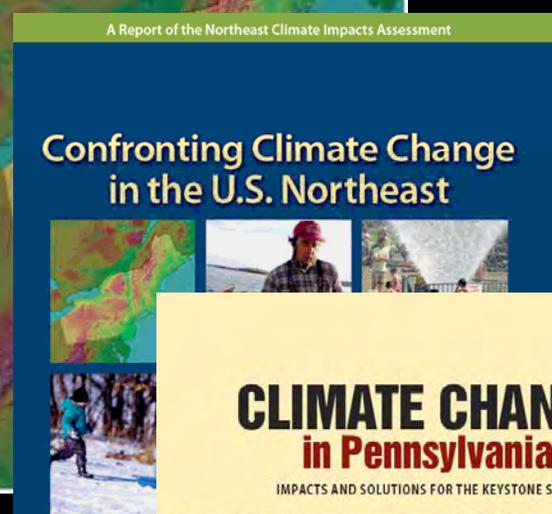
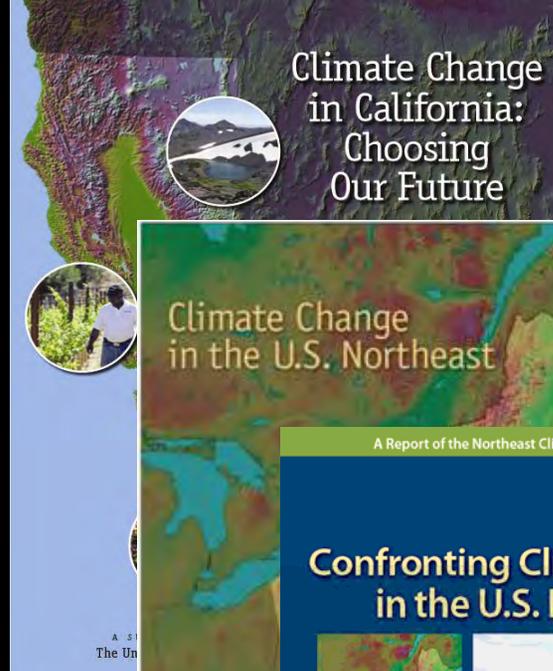
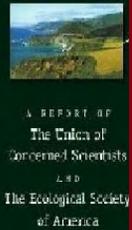
# Confronting Climate Change in the U.S. Northeast

2007

# CLIMATE CHANGE in Pennsylvania

IMPACTS AND SOLUTIONS FOR THE KEYSTONE STATE

2008



A REPORT OF  
The Union of Concerned Scientists  
AND  
The Ecological Society of America

A REPORT OF  
The Union of Concerned Scientists  
AND  
The Ecological Society of America

A REPORT OF  
The Union of Concerned Scientists  
AND  
The Ecological Society of America

SCIENCE

Union of Concerned Scientists  
Citizens and Scientists for Environmental Solutions

# For more information

- About the NECIA

[www.climatechoices.org/ne](http://www.climatechoices.org/ne)

- About UCS

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



# Adaptation Principles in Action

- Act swiftly to reduce emissions



PPM Energy



AscensionTechnology, Inc



New England Futures/Maine DOT

# Adaptation Principles in Action

- Consider the most vulnerable first
- Take the long view

AP Photo/Candice Choi



James Estrin/NYTimes/Redux



Vera Bogaerts

# Adaptation Principles in Action

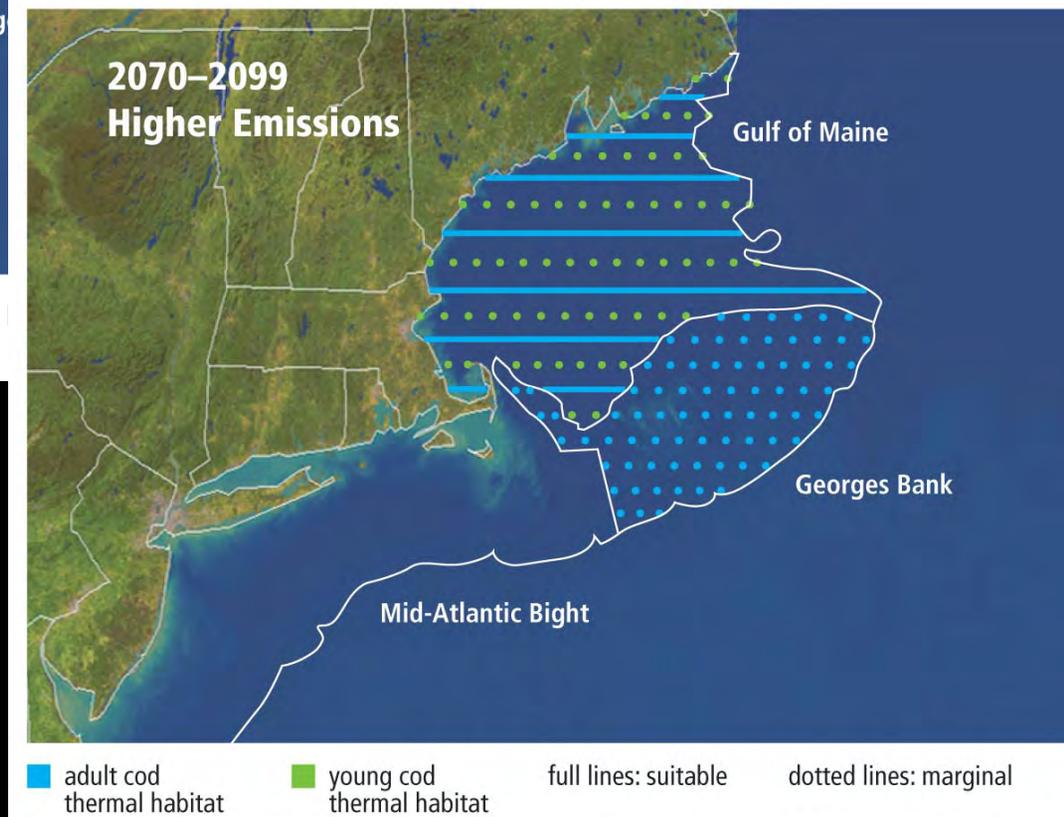
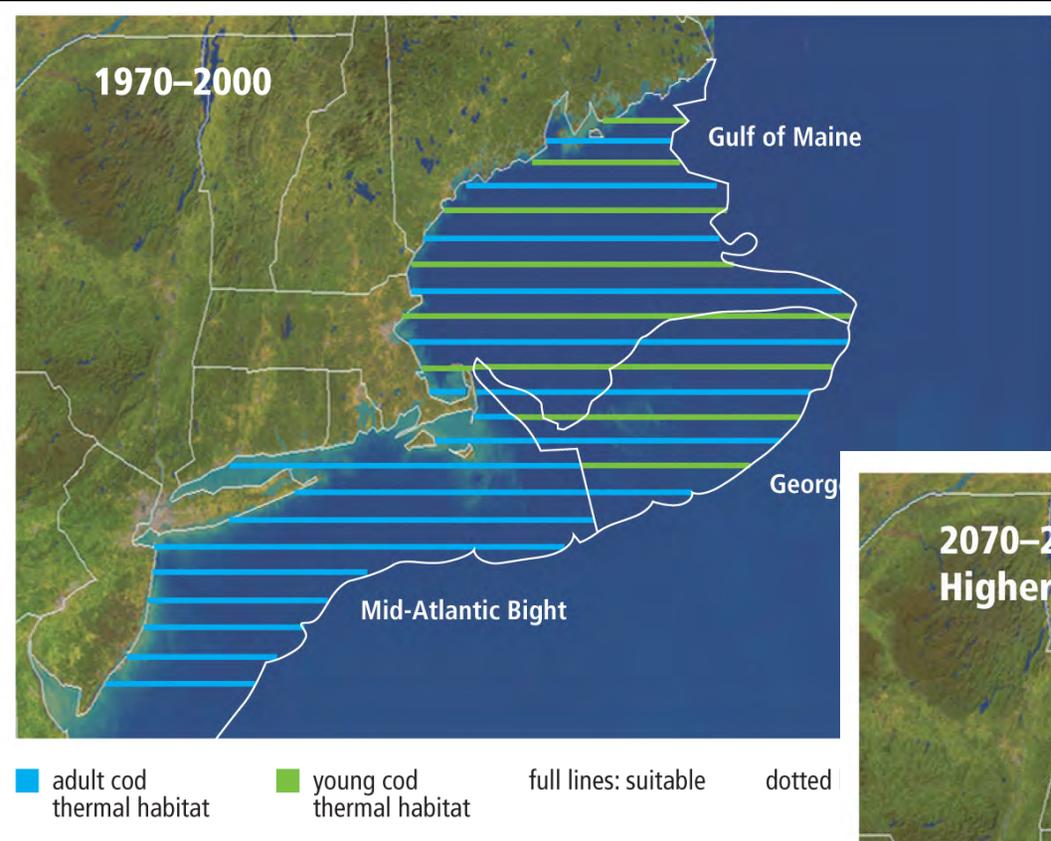
- Monitor the changing environment



- Improve communication and public engagement



# Emissions Choices May Redefine Waters Suitable for Cod

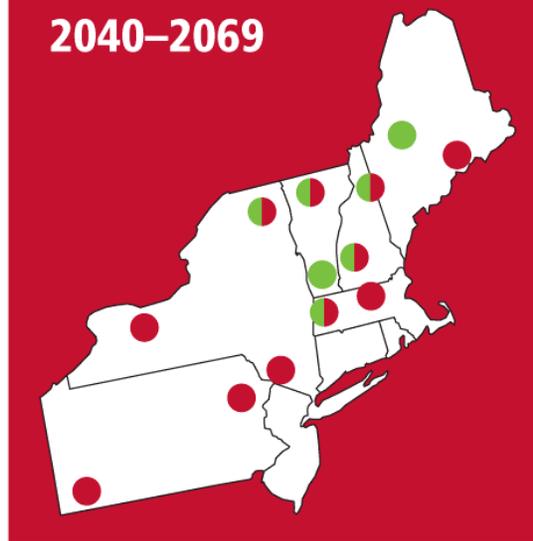


# Vulnerability of Ski Resorts to Climate Change

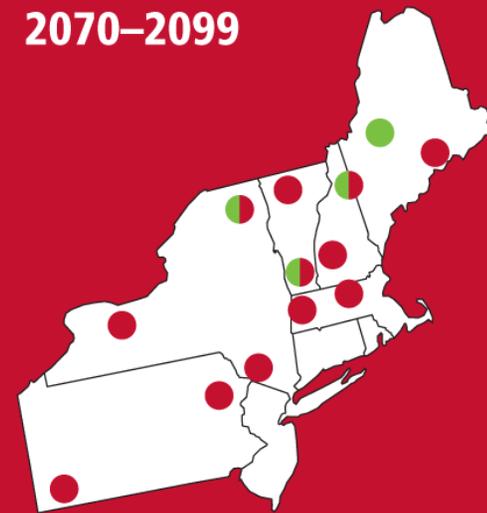
2010–2039



2040–2069

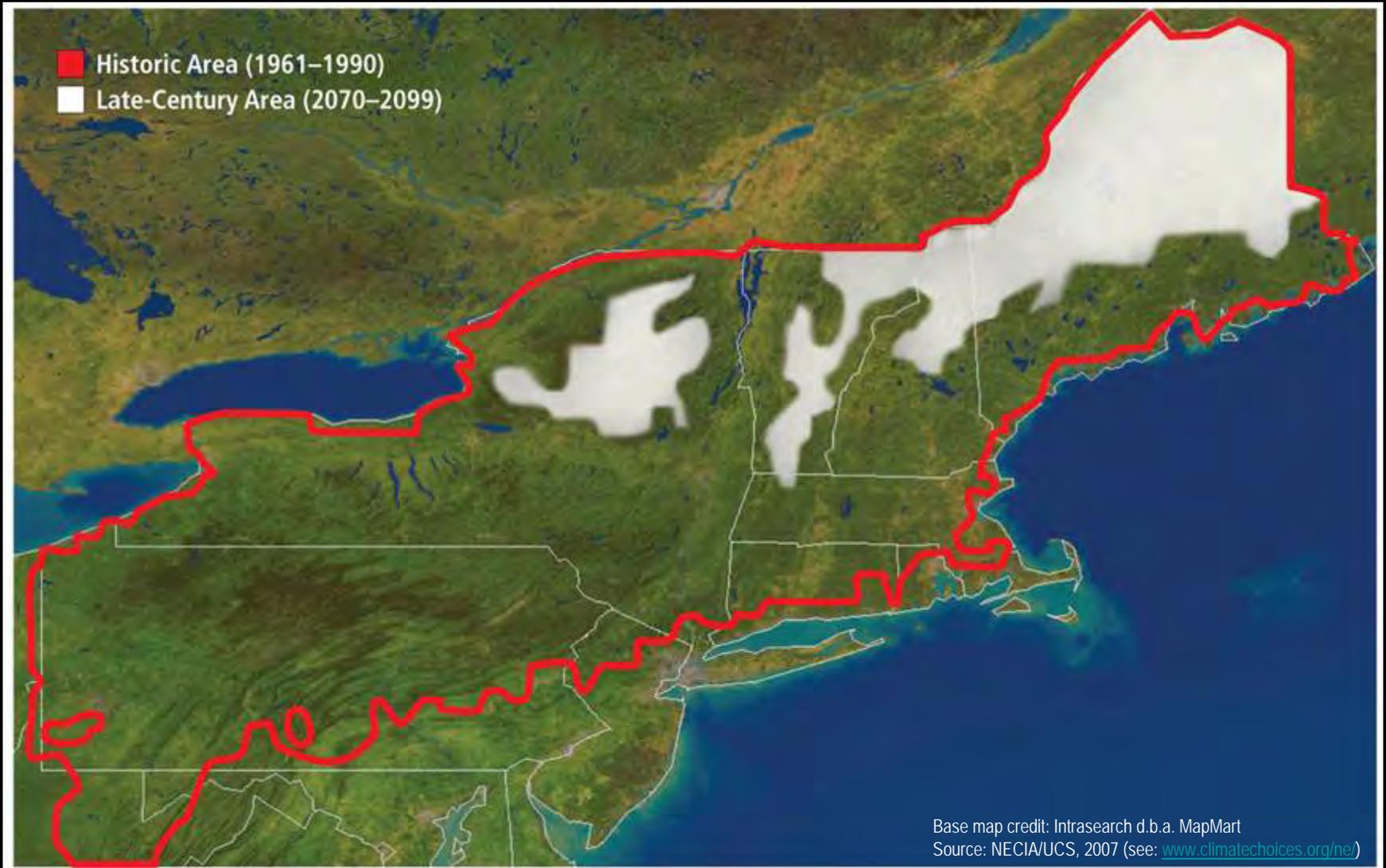


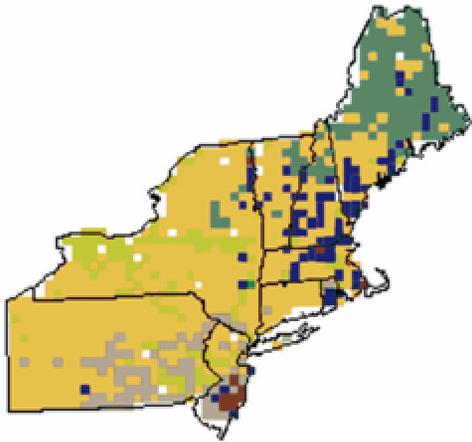
2070–2099



- highly vulnerable
- vulnerable
- viable

# Declining Snow Cover





Current



Spruce/Fir



Maple/Beech/Birch



Oak/Hickory



Elm/Ash/Cottonwood



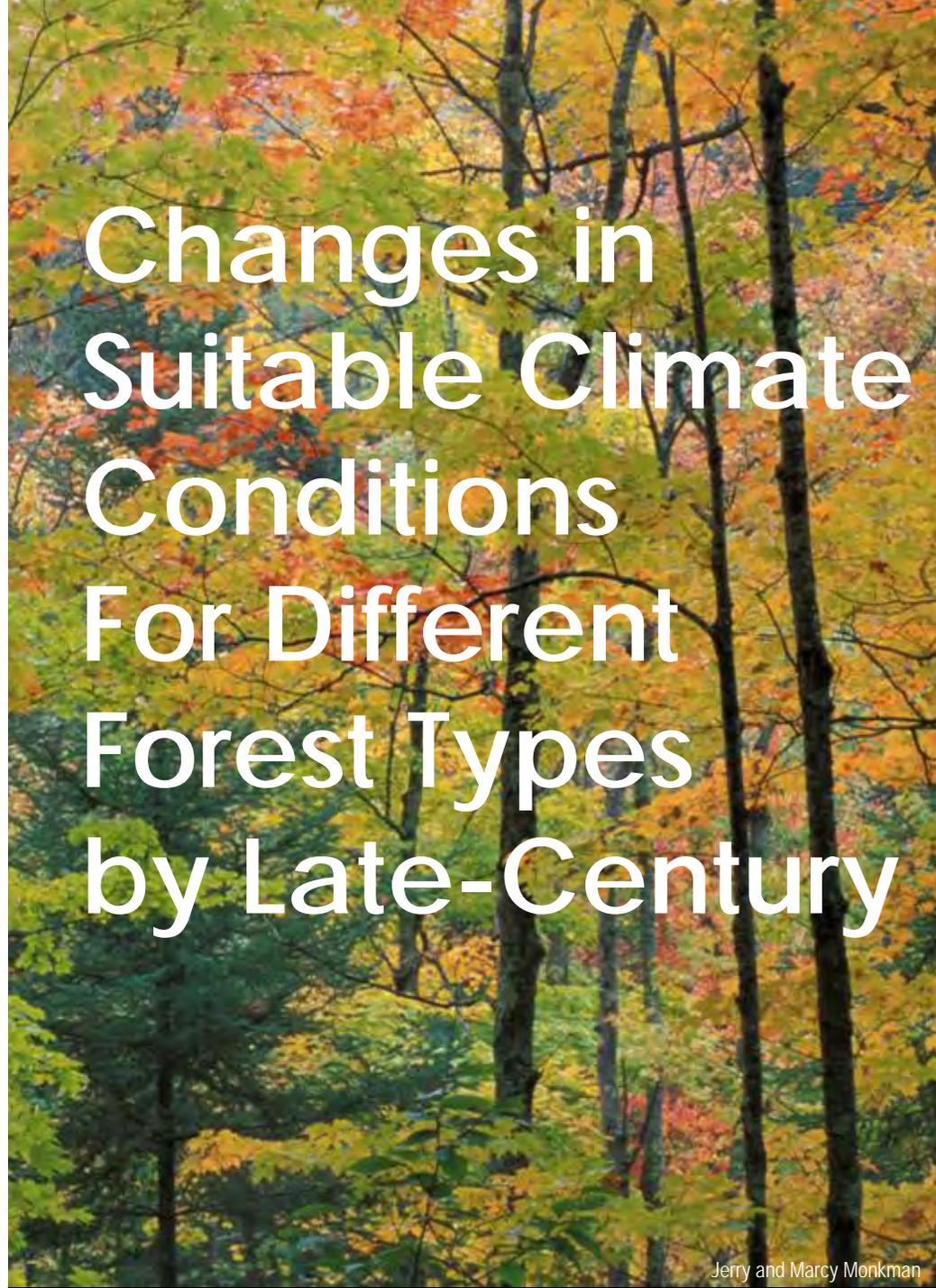
Loblolly/Shortleaf Pine



Other



No Data



# Changes in Suitable Climate Conditions For Different Forest Types by Late-Century

spruce/fir: Anastasiya Maksymenko; maple: Birthe Lunau; oak: Dave White; ash: Chad Davis; loblolly: Kentucky Division of Forestry. Source: NECIA, 2007 (see: [www.climatechoices.org/ne/](http://www.climatechoices.org/ne/)).

# Preparing to Adapt

Significant changes are now unavoidable.



# Increasing Summer Drought

Short-term drought (1-3 months)



- Hotter summers increase evaporation rates and reduce soil moisture
- With higher emissions, project annual short-term droughts across much of the Northeast by end-of-century.