



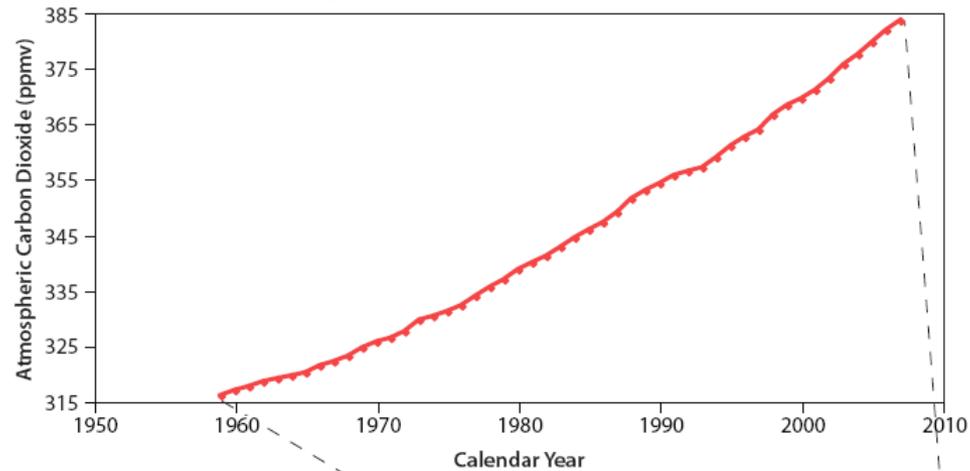
Confronting Climate Change in Boston and New England

Peter C. Frumhoff
Union of Concerned Scientists

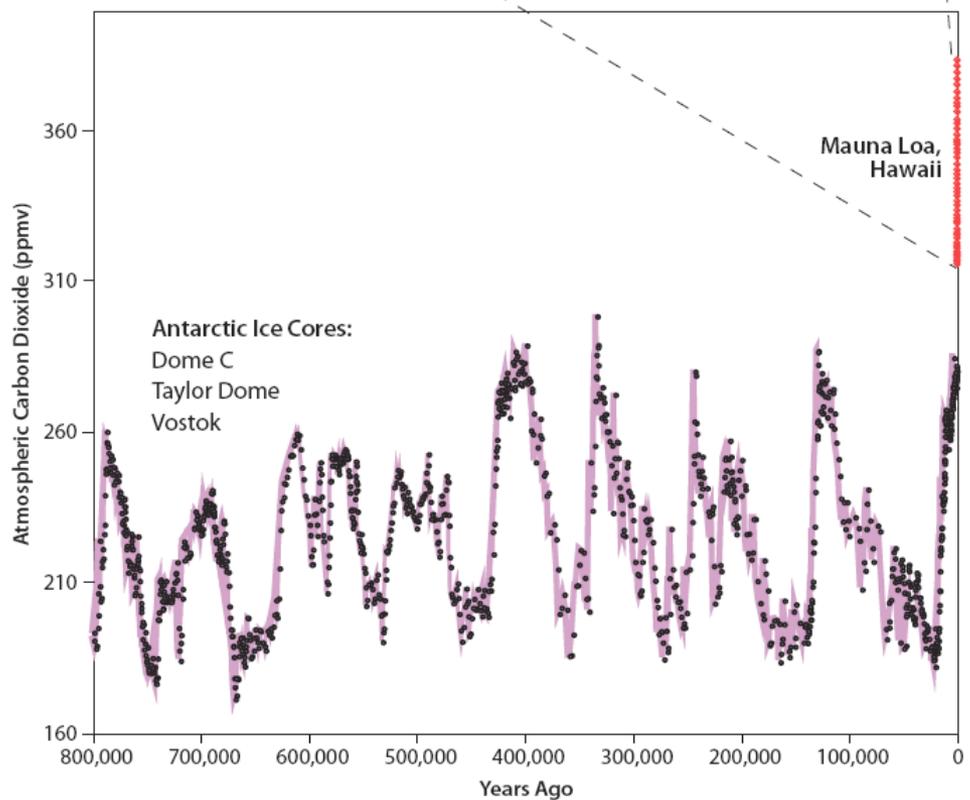
Mayor Menino's Climate Action
Leadership Committee

26 May 2009

Annual Average Atmospheric CO2 at Mauna Loa Hawaii



Atmospheric Carbon Dioxide Over Past 800,000 Years



Source: cdiac.ornl.gov;
Lüthi et al. 2008.

Washington Post



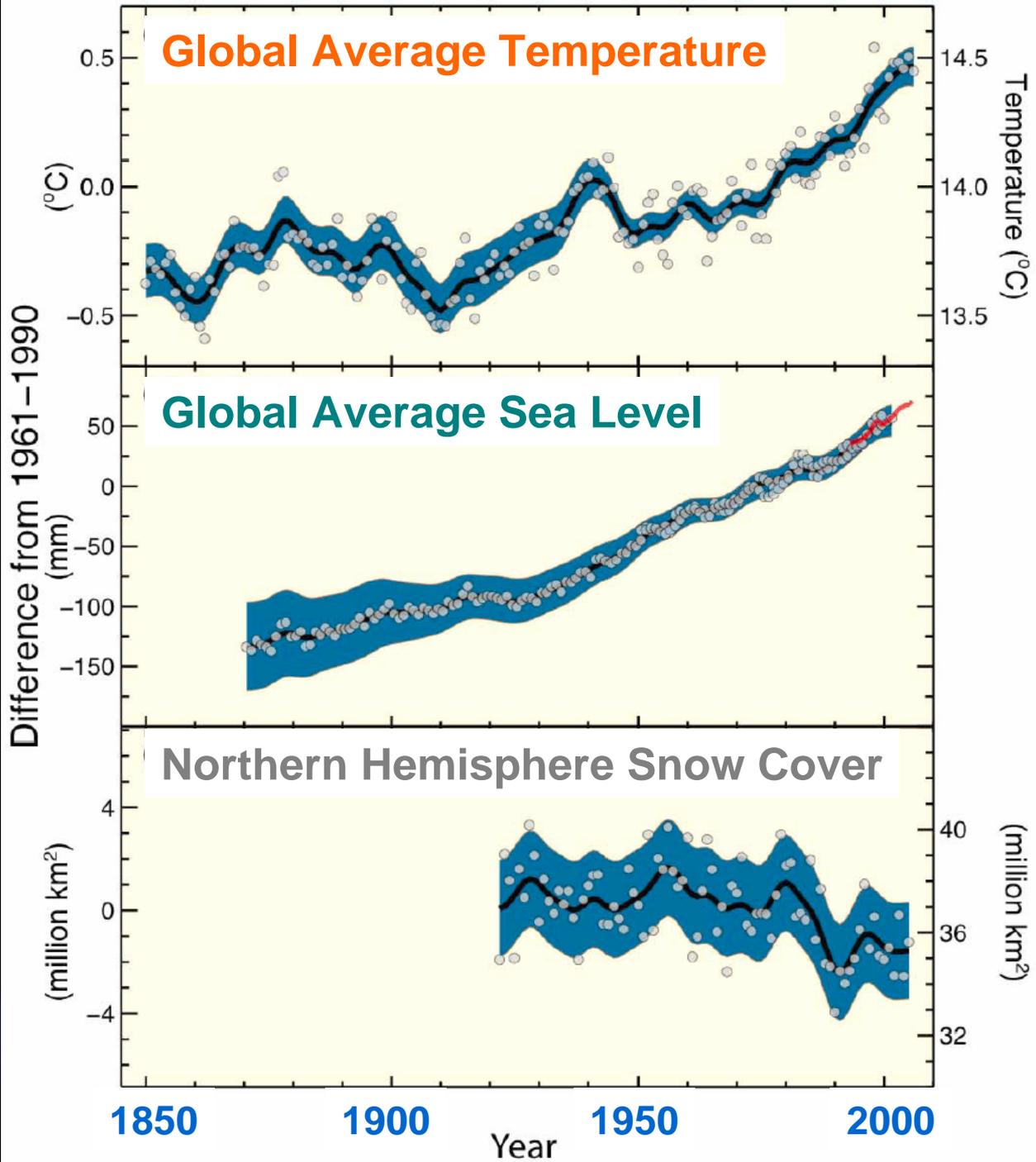
NOAA



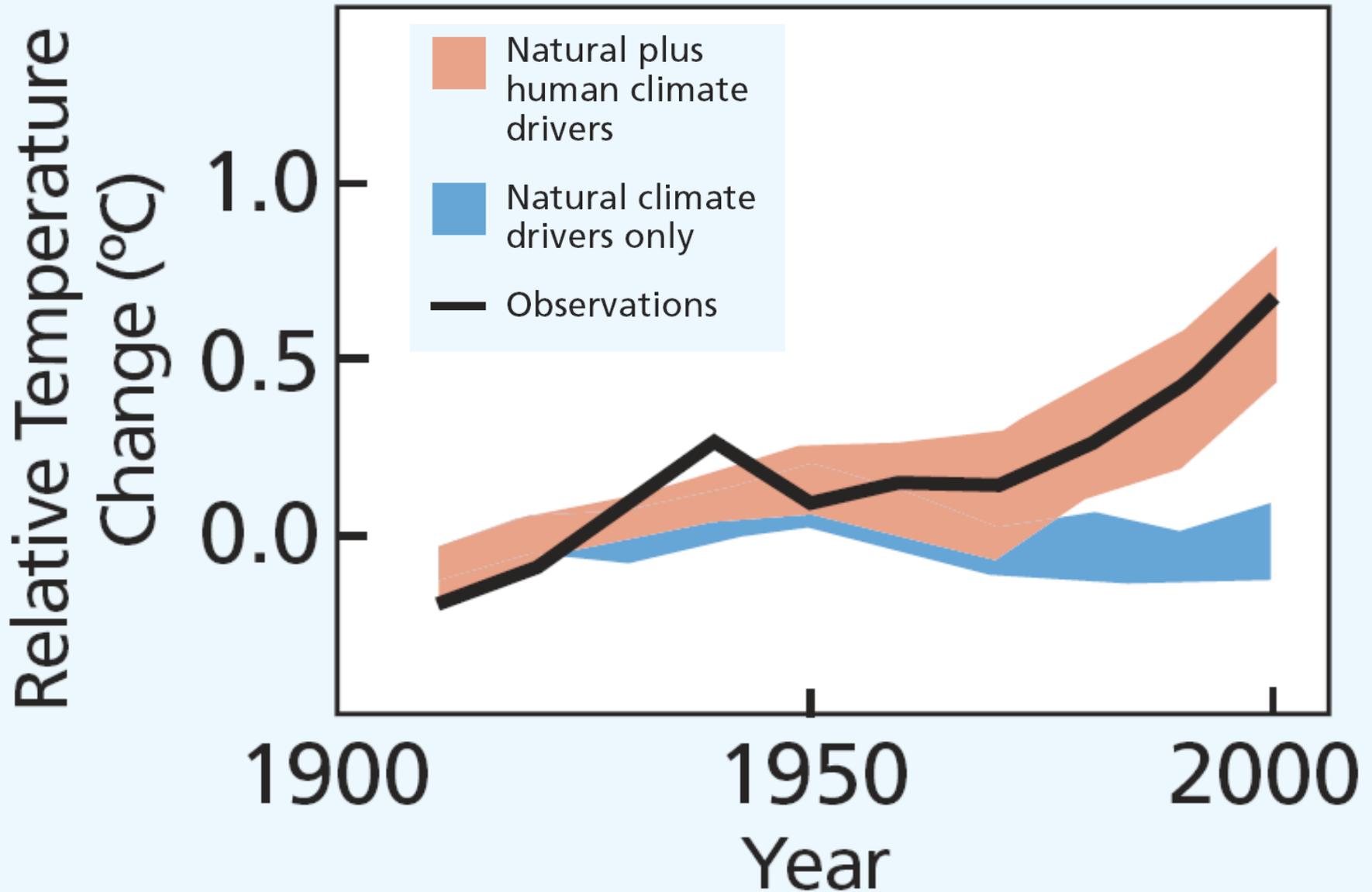
NASA

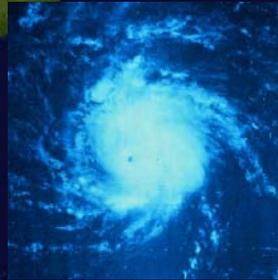
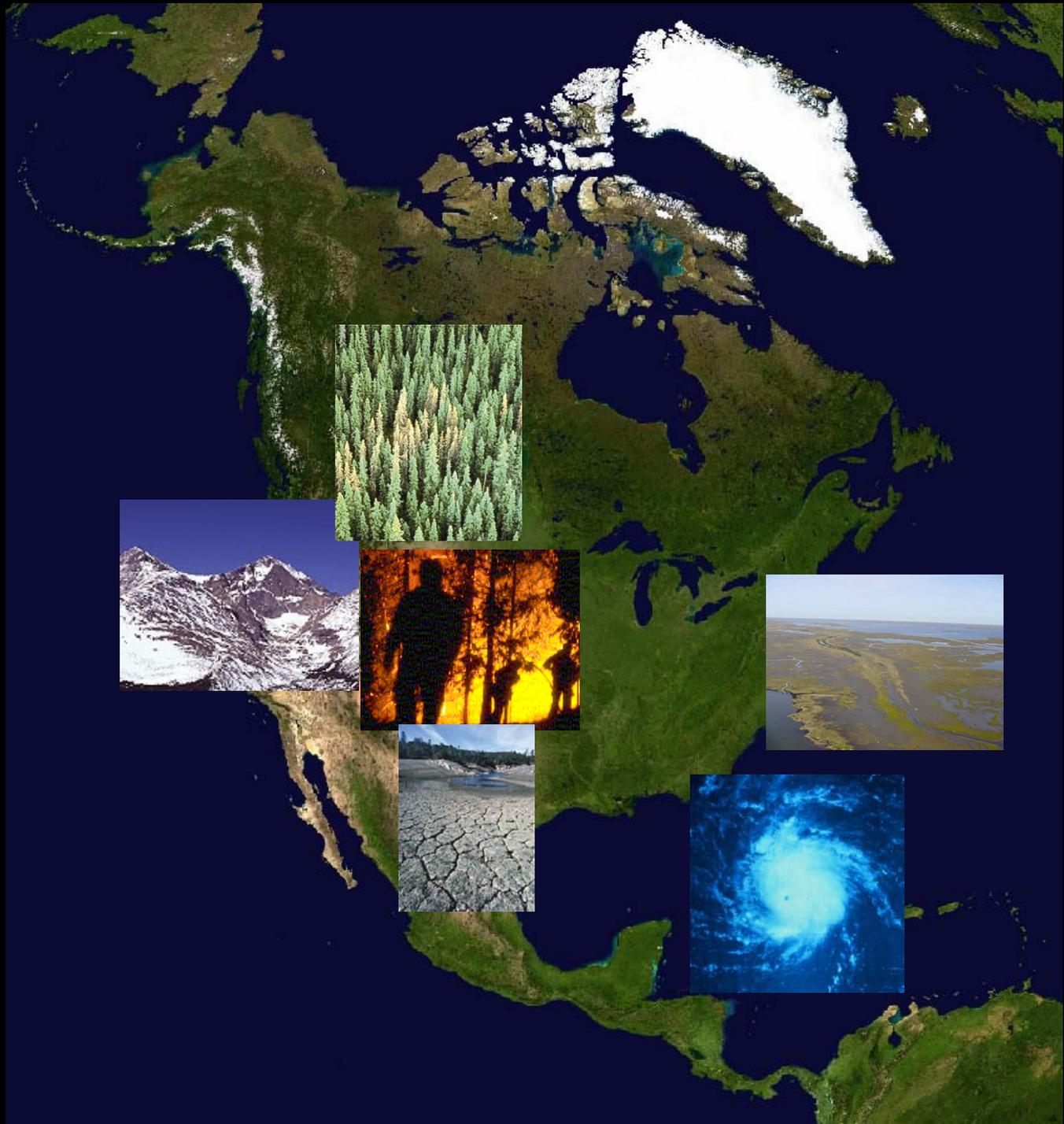


Source: IPCC *Climate Change 2007: The Physical Science Basis—Summary for Policymakers.* →



Global Average Surface Temperature

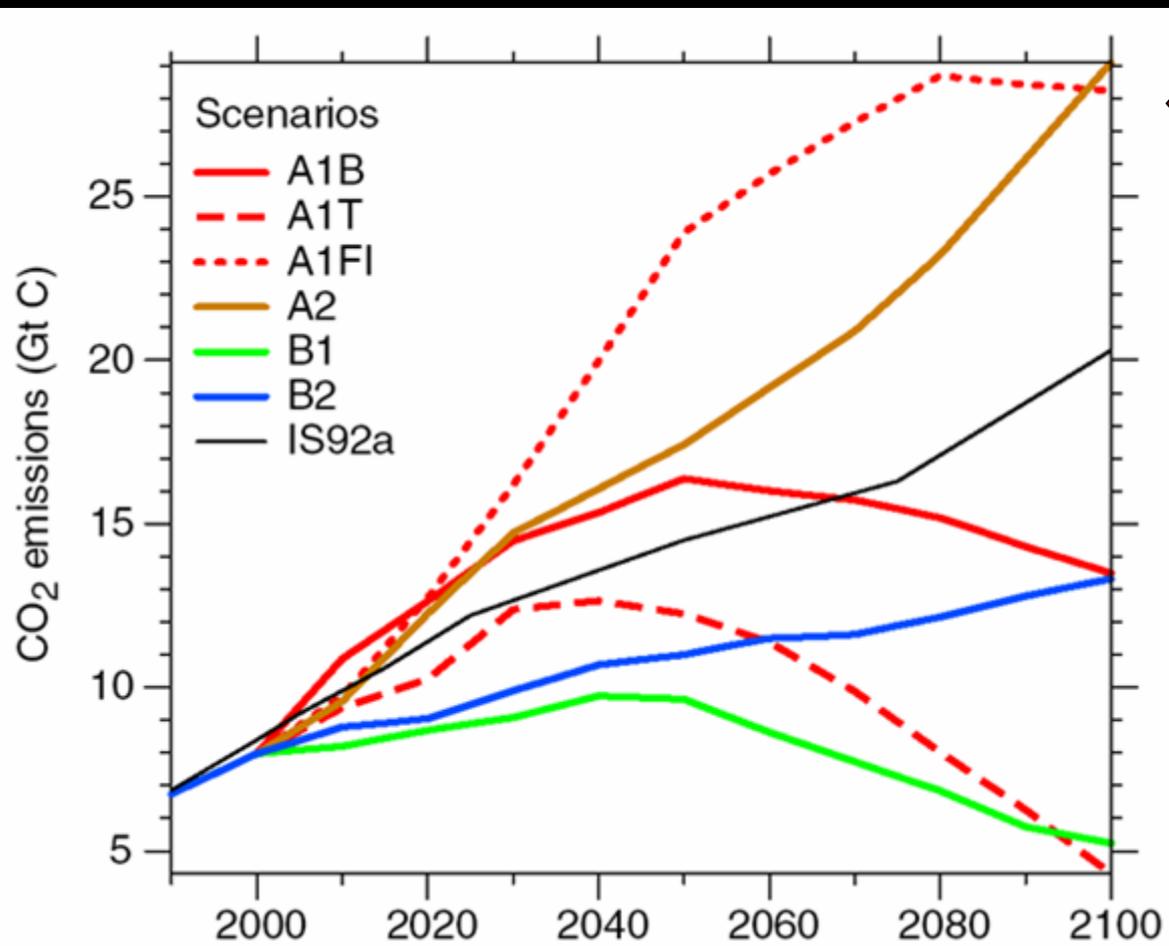




Climate across the Northeast is also changing

- 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



HIGHER
A1FI (940 ppm)

LOWER
B1 (550 ppm)

Confronting Climate Change in the U.S. Northeast



SCIENCE, IMPACTS, AND SOLUTIONS

JULY 2007

Pennsylvania
Confronting Climate Change in the U.S. Northeast

New Hampshire
Confronting Climate Change in the U.S. Northeast

New York
Confronting Climate Change in the U.S. Northeast

Massachusetts
Confronting Climate Change in the U.S. Northeast

MASSACHUSETTS' CHANGING CLIMATE

From the Chesapeake Bay to the sandy Cape Cod shore, the climate of Massachusetts is changing. Records show that spring is ending earlier, summers are getting hotter and winters are becoming milder and less snowy. These changes are consistent with global warming, an increasingly urgent phenomenon driven by heat-trapping emissions from human activities.

Two state-of-the-art research reports that if global warming continues to grow unabated, Massachusetts will see significant changes in climate over the course of this century, with substantial impacts on key sectors and the state's 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 Massachusetts, the Northeast, and worldwide—will help determine the climate our children and grandchildren inherit, and shape the consequences for their wellbeing, environment, and quality of life.

The research summarized here describes how climate change may affect Massachusetts and other Northeast states under two different emissions scenarios. The higher emissions scenario is consistent with the current rate of fossil fuel burning, 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, reducing emissions to decline by mid-century.

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 lower emissions scenario and reduce the undesirable changes that global warming has already set in motion.

Changes in average summer temperatures—a measure of the hot-hot extremes that, given longer and warmer seasons, could affect quality of life in the future for residents of the Northeast. Red arrows track what summers could be like in Massachusetts over the course of the century under the higher emissions scenario. Yellow arrows track what summers could be like under the lower emissions scenario.

Institutions of NECIA Collaborators

National Center for Atmospheric Research

Texas Tech University

University of Illinois – Urbana-Champaign

University of Waterloo, Canada

U.S. Department of Agriculture

Cornell University

Vermont Center for EcoStudies

University of Massachusetts

Wesleyan University

Princeton University

University of Southern Maine

Colby College

Bigelow Laboratory for Ocean Sciences

University of New Hampshire

Harvard University, Tufts University, Wellesley College, & University of MA Boston

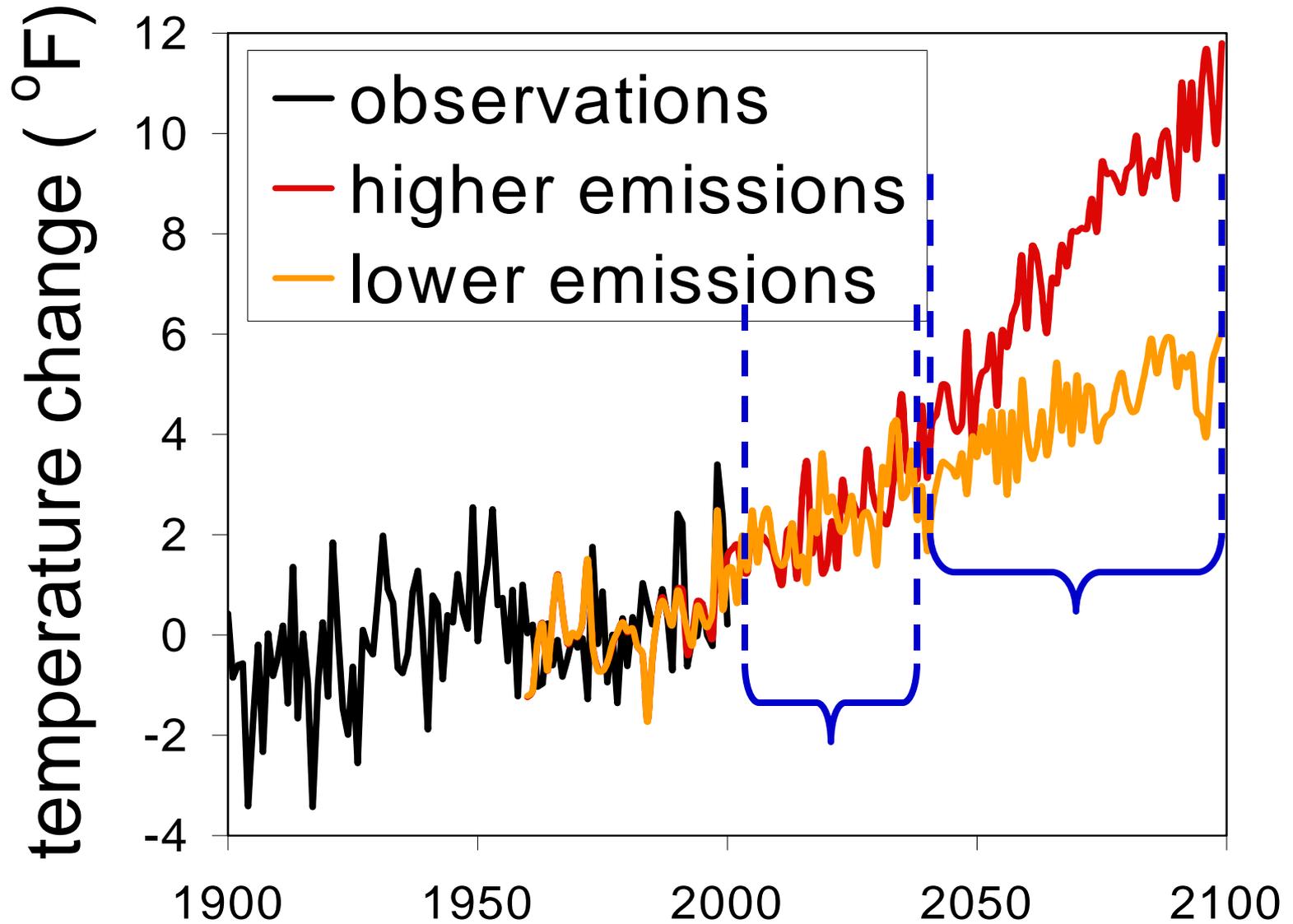
Woods Hole Oceanographic Institution and Marine Biological Laboratory

Natl. Marine Fisheries Service

Columbia University & CUNY

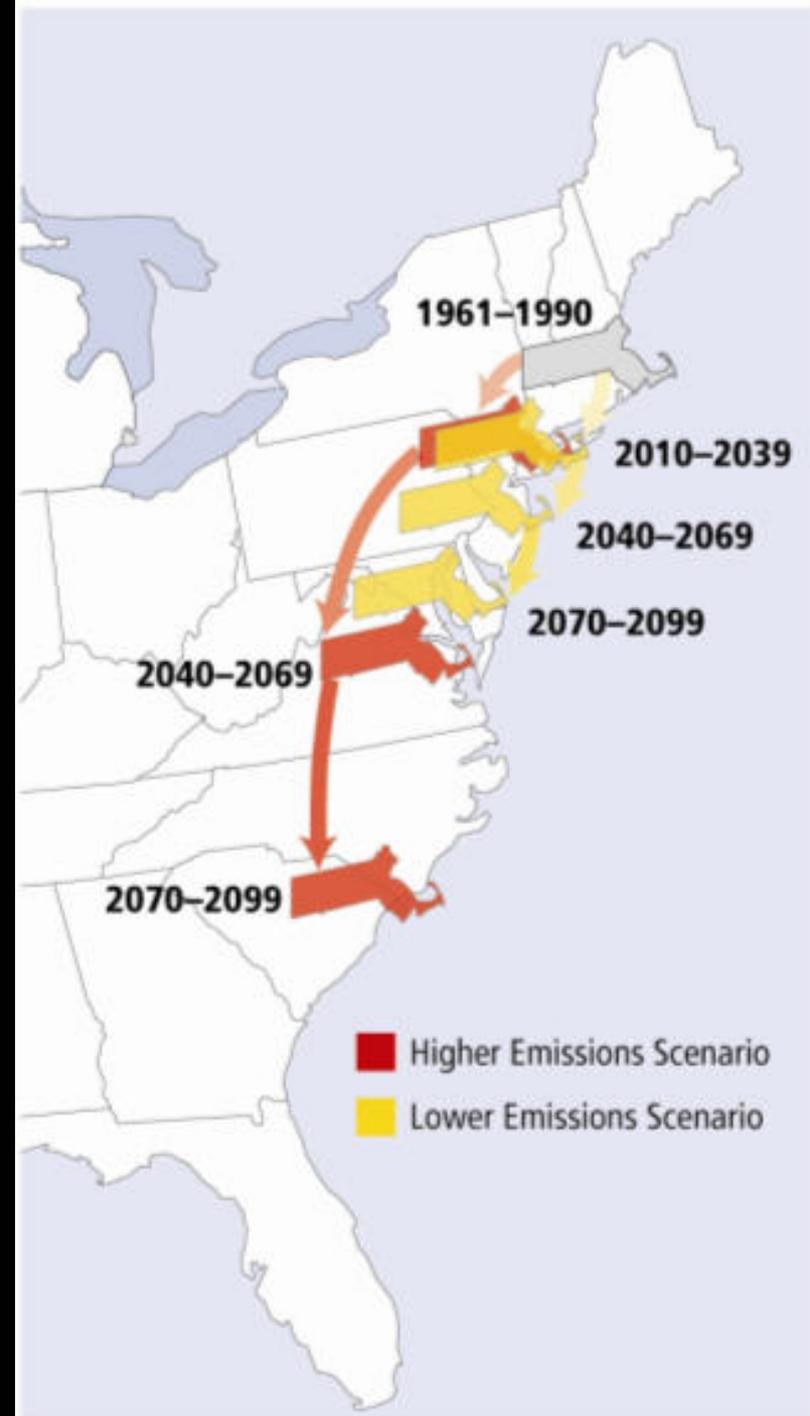


NE Average Annual Temperatures

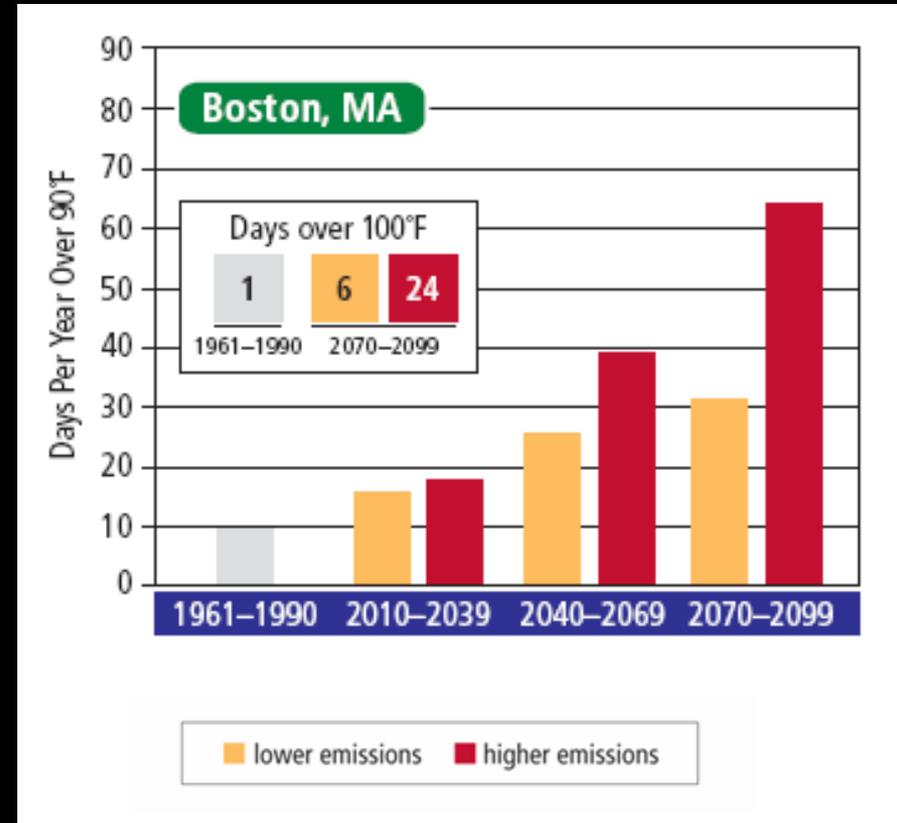


Heat index:

How hot will
a summer day in
Massachusetts feel?



Increasing Frequency of Extreme Heat



Many fruit crops
require cold winters



Changing Precipitation

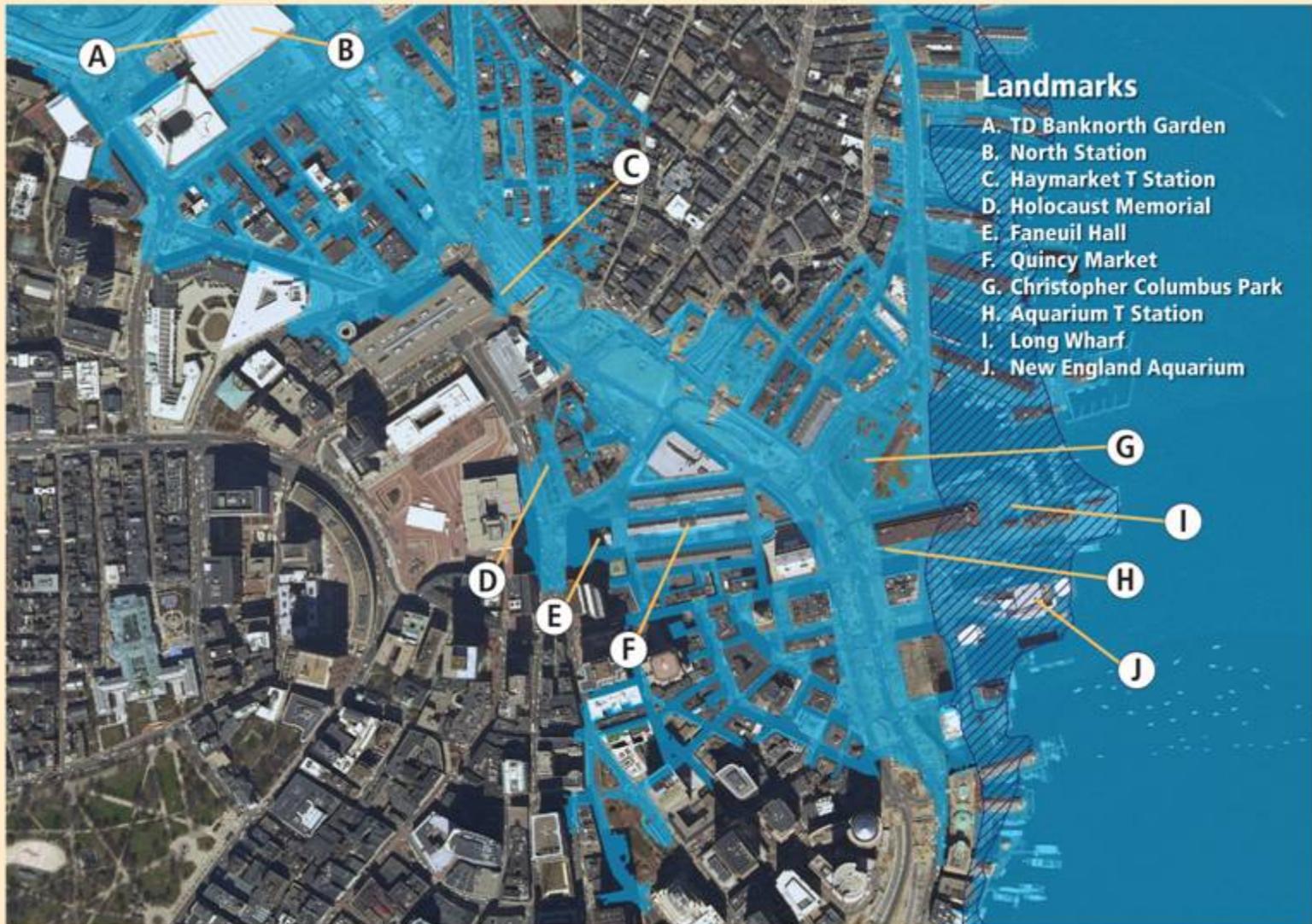
- Increasing winter precipitation (more rain, less snow)
- More frequent and intense periods of heavy rainfall



Managing Water Resources



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



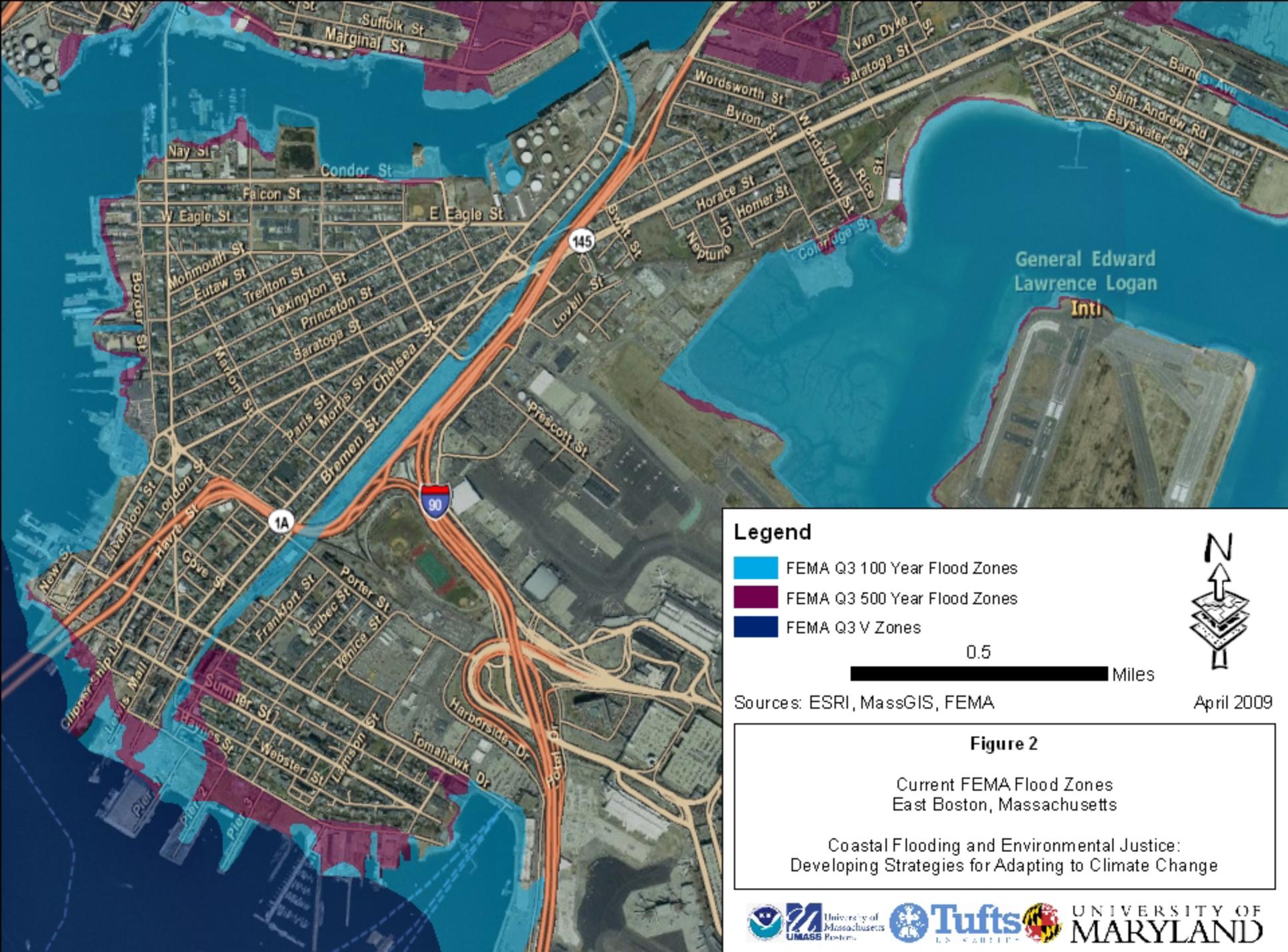
■ Current 100-year flood zone
■ Projected 100-year flooded area (higher-emissions scenario)

Source: NECIA/UCS, 2007 (see: www.climatechoices.org/ne/)

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



■ Current 100-year flood zone
■ Projected 100-year flooded area (higher-emissions scenario)



Legend

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

0.5
 Miles

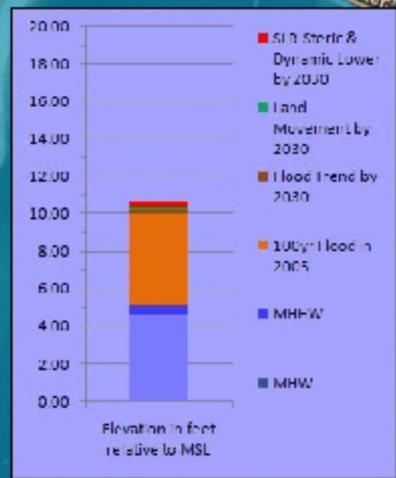
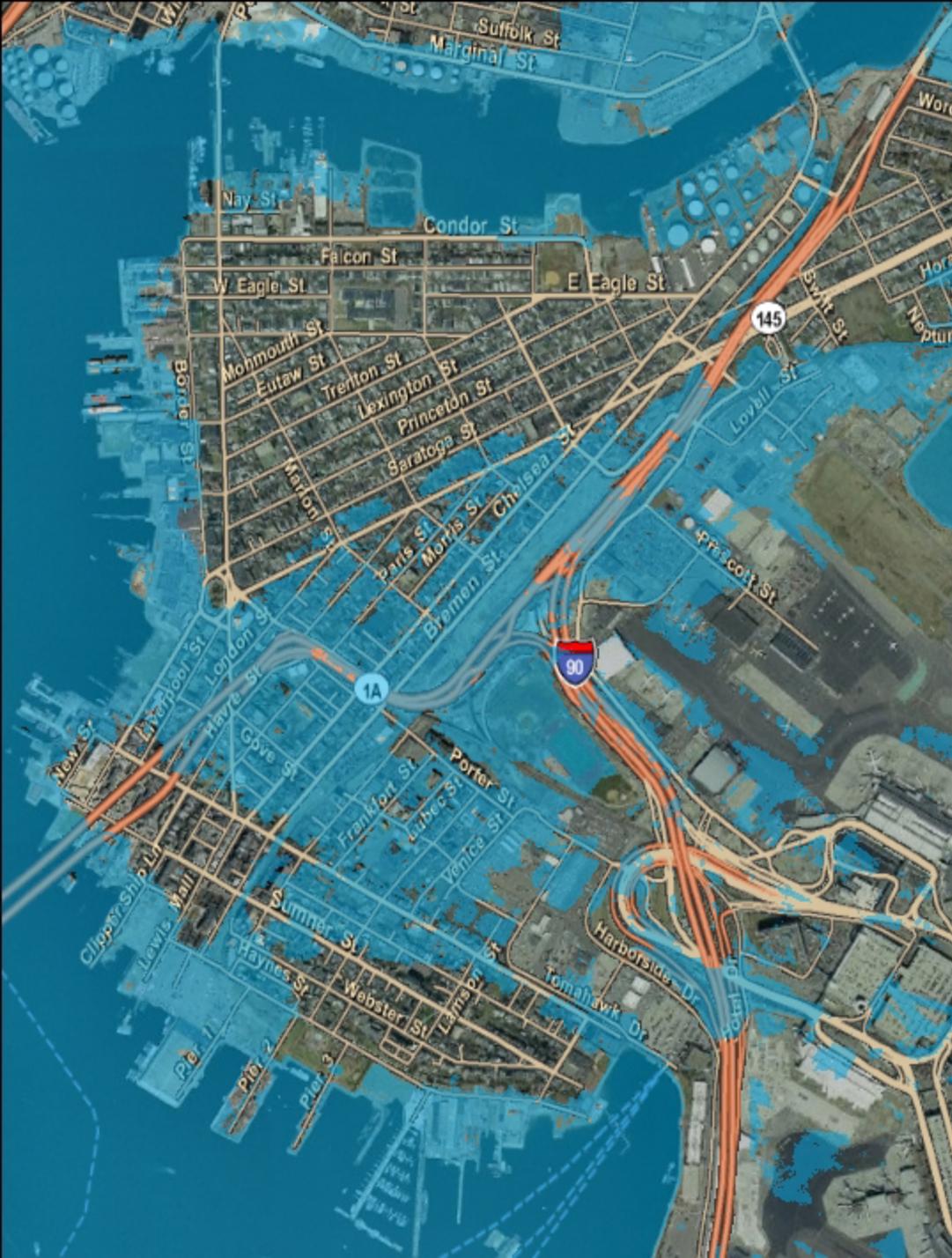


Sources: ESRI, MassGIS, FEMA

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



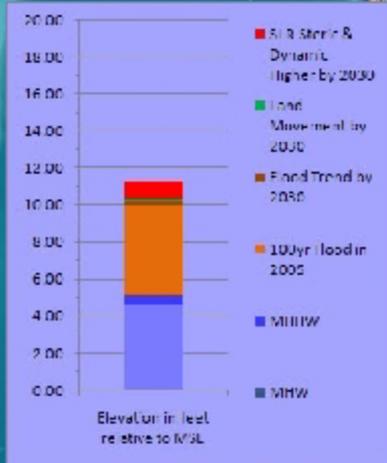
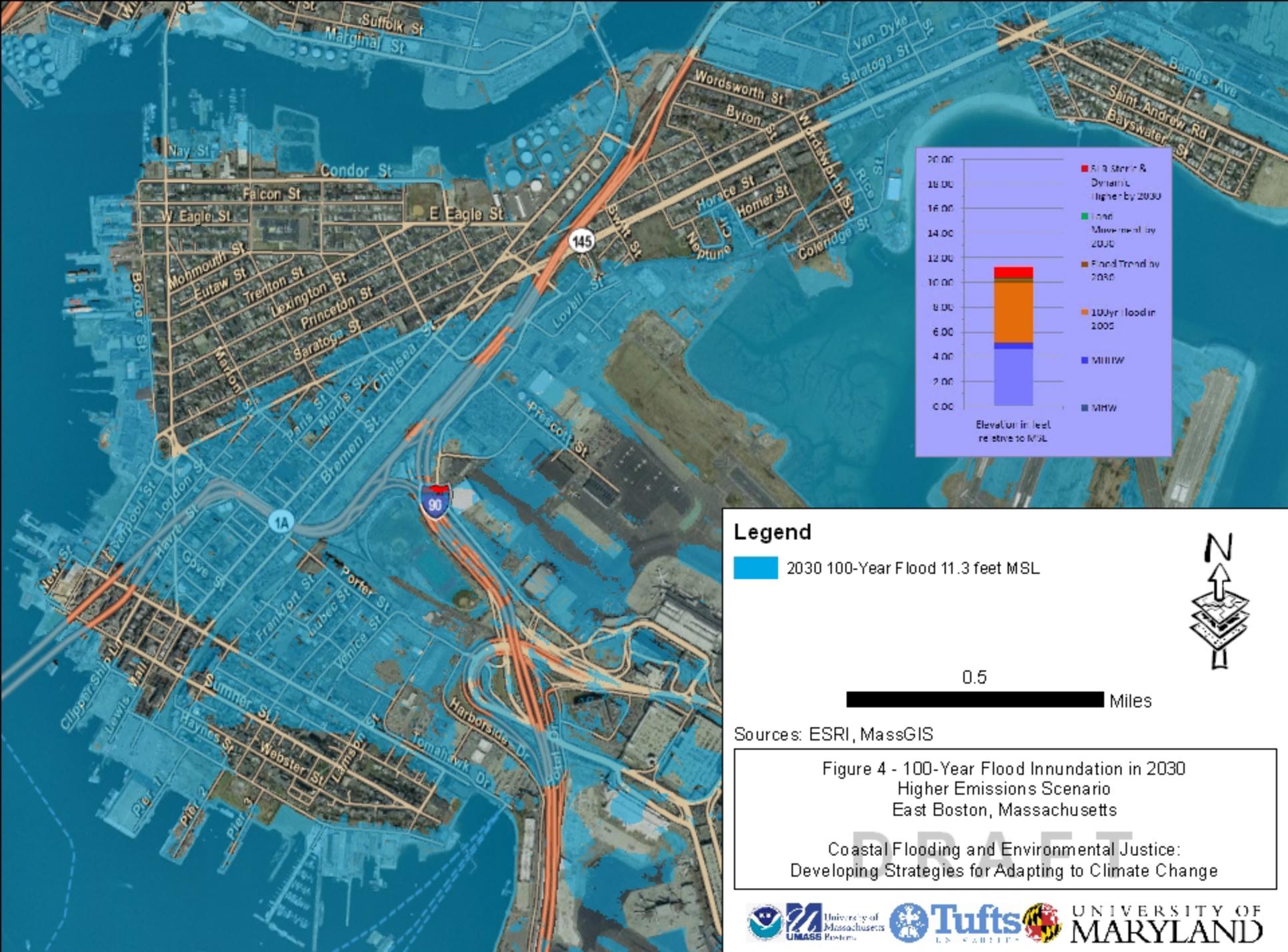
0.5
 Miles

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

■ 2030 100-Year Flood 11.3 feet MSL



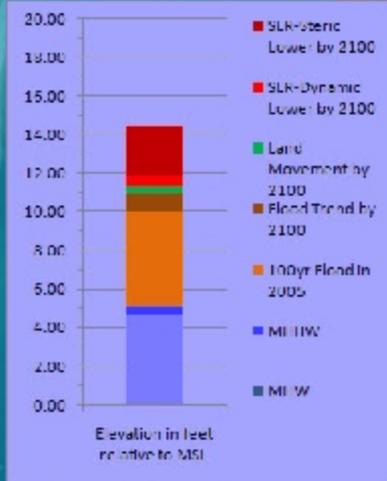
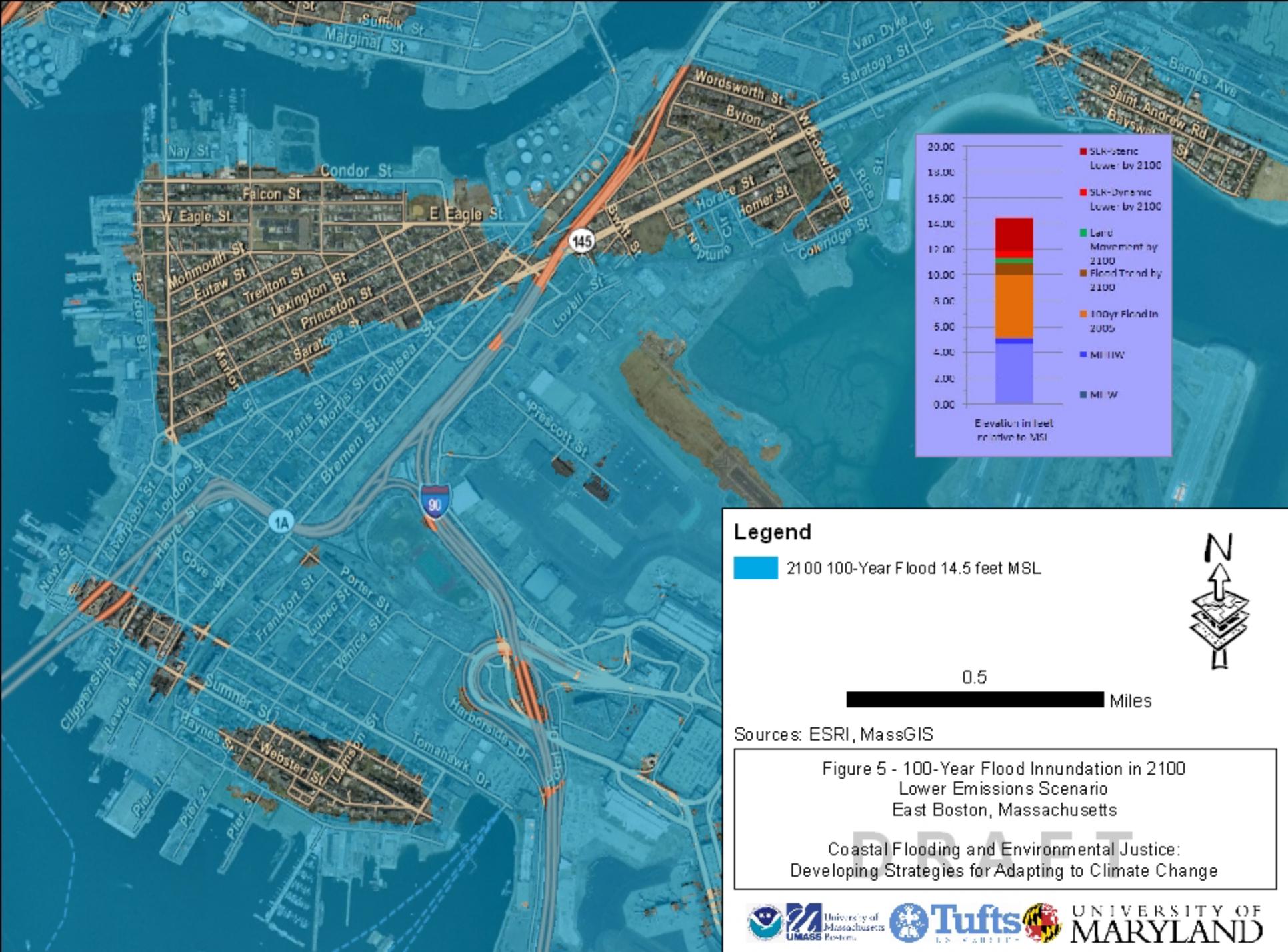
0.5
Miles

Sources: ESRI, MassGIS

Figure 4 - 100-Year Flood Inundation in 2030
Higher 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



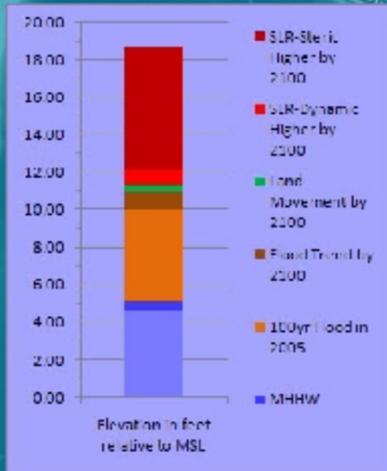
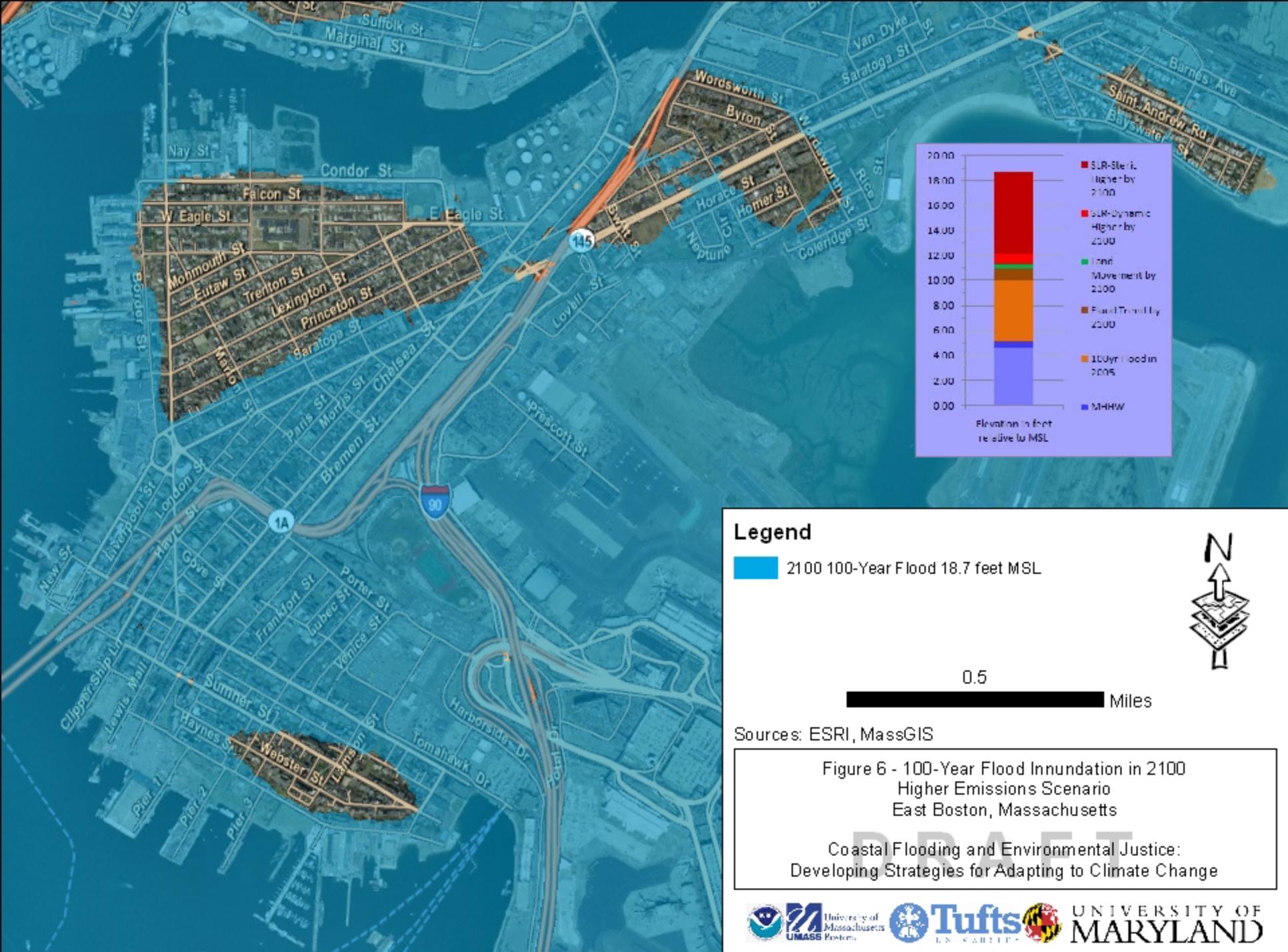
0.5
 Miles

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

Worcestershire, ASAC
California Air Resources Board

1999

Climate Change in California: Choosing Our Future

2004

Confronting Climate Change in the Gulf Coast Region

Prospects for Sustaining Our Ecological Heritage

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

2001

Climate Change in the U.S. Northeast

2006

A Report of the Northeast Climate Impacts Assessment

Confronting Climate Change in the U.S. Northeast

2007

Confronting Climate Change in the Great Lakes Region

Impacts on Our Communities and Ecosystems

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

2003

CLIMATE CHANGE in Pennsylvania

IMPACTS AND SOLUTIONS FOR THE KEYSTONE STATE

SCIENCE

2008

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

For more information

- About the NECIA

www.climatechoices.org/ne

- About UCS

www.ucsusa.org



Adaptation Principles in Action

- Act swiftly to reduce emissions



PPM Energy



AscensionTechnology, Inc



New England Futures/Maine DOT

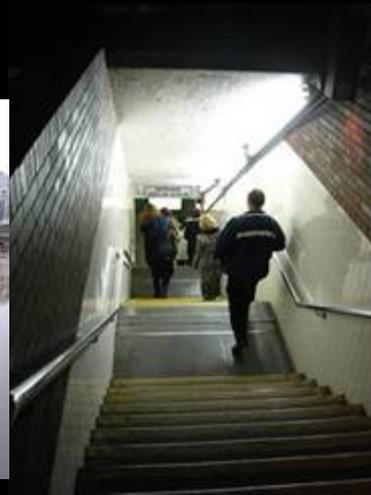
Adaptation Principles in Action

- Consider the most vulnerable first
- Take the long view

AP Photo/Candice Choi



James Estrin/NYTimes/Redux



Vera Bogaerts

Adaptation Principles in Action

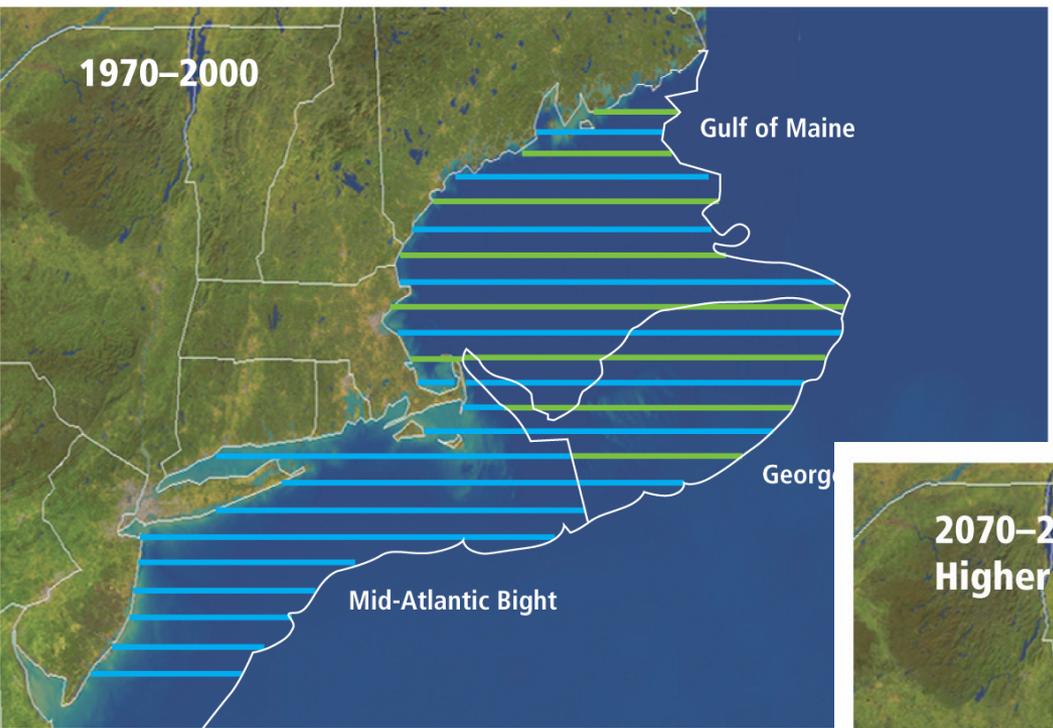
- Monitor the changing environment



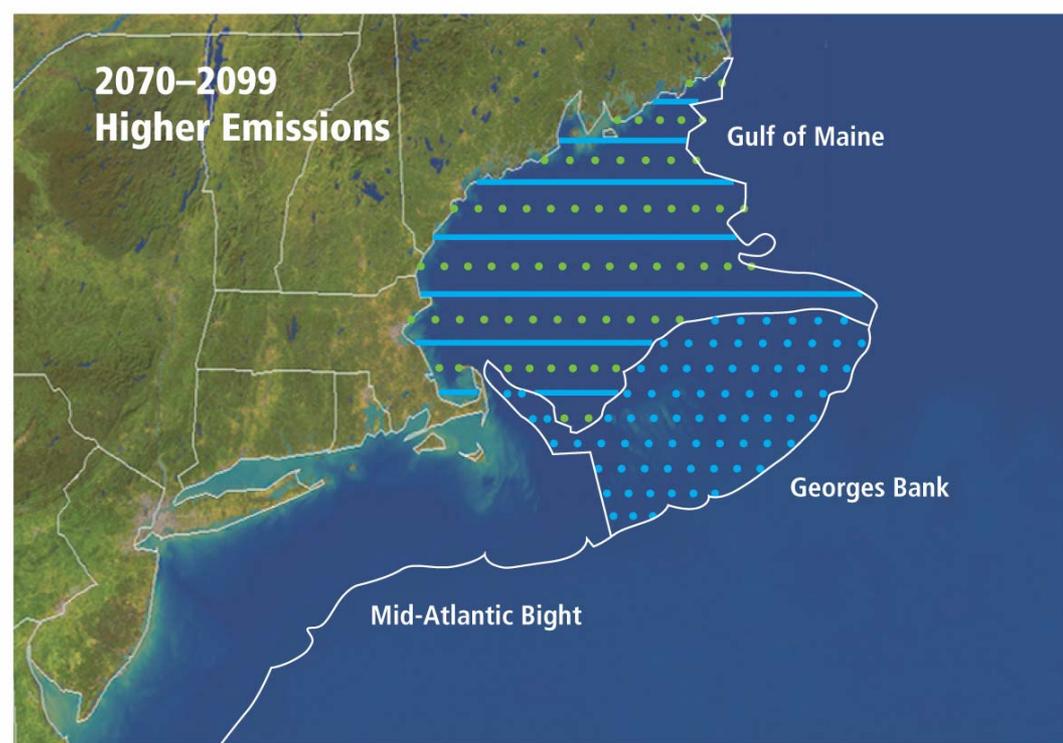
- Improve communication and public engagement



Emissions Choices May Redefine Waters Suitable for Cod



■ adult cod thermal habitat ■ young cod thermal habitat full lines: suitable dotted lines: marginal

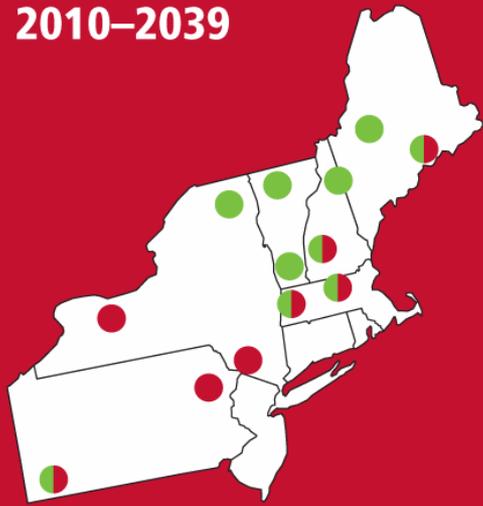


■ adult cod thermal habitat ■ young cod thermal habitat full lines: suitable dotted lines: marginal

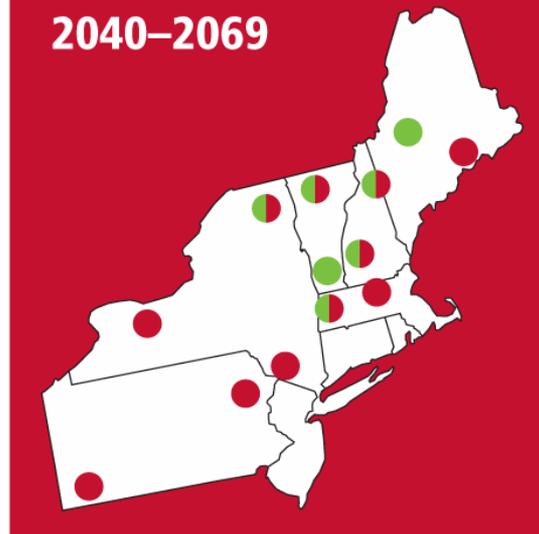
Source: NECA/JCs, 2007 (see: www.climatechoices.org/ne/)

Vulnerability of Ski Resorts to Climate Change

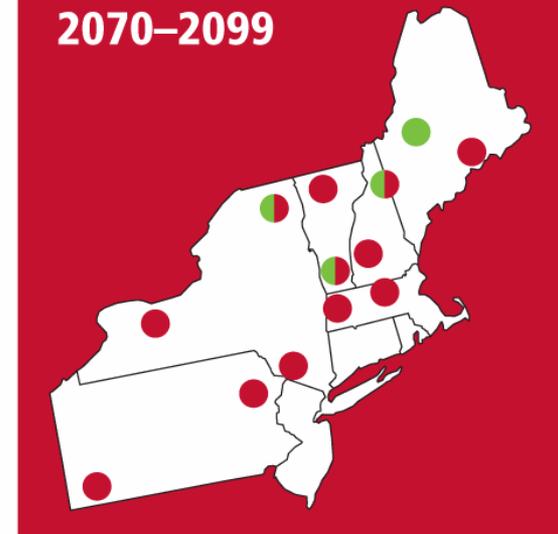
2010–2039



2040–2069

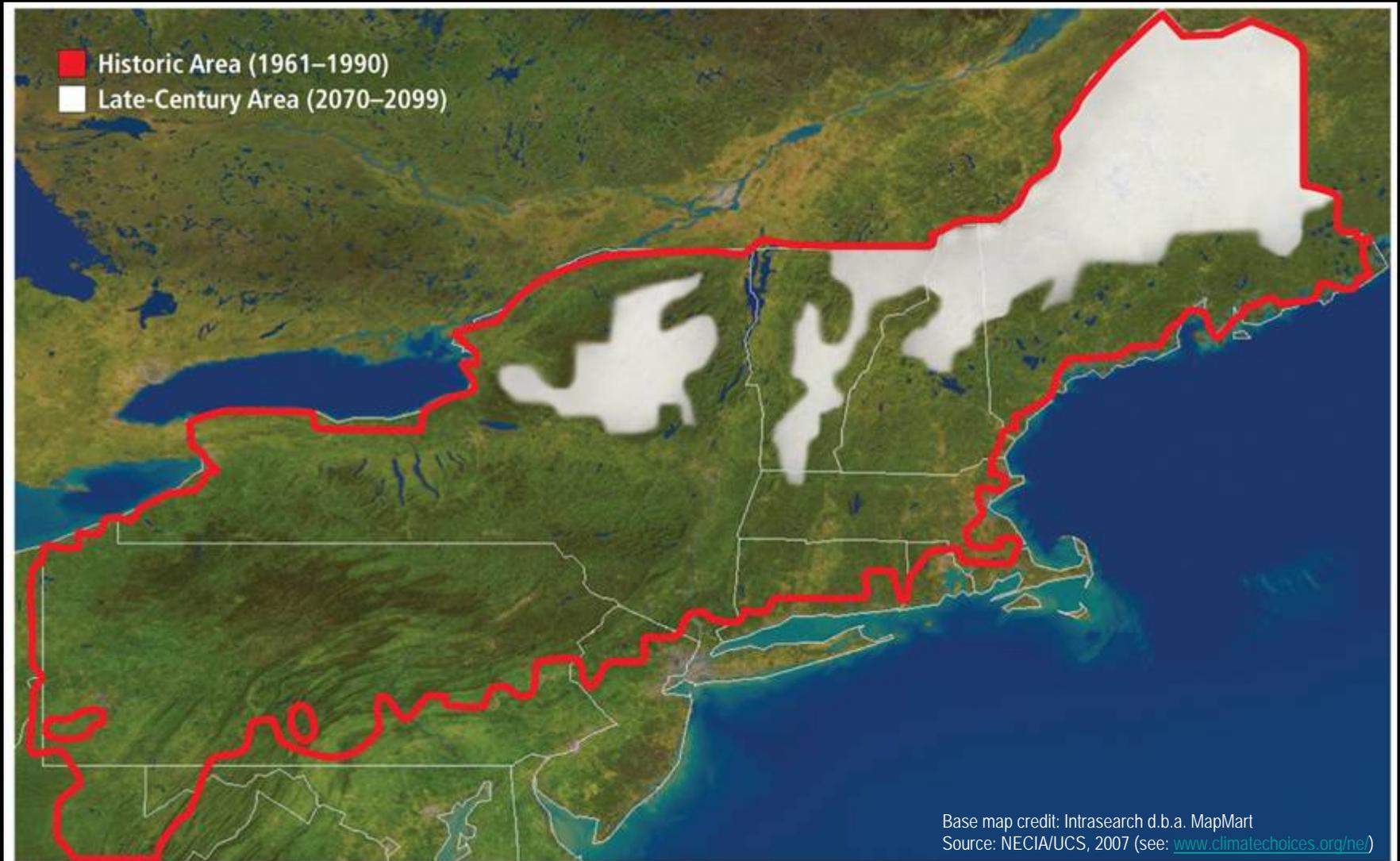


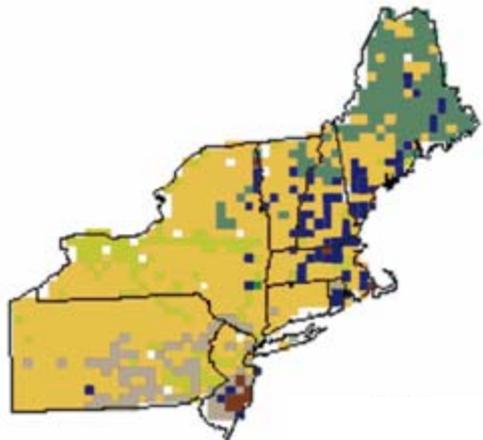
2070–2099



- highly vulnerable
- vulnerable
- viable

Declining Snow Cover





Current



Spruce/Fir



Maple/Beech/Birch



Oak/Hickory



Elm/Ash/Cottonwood



Loblolly/Shortleaf Pine

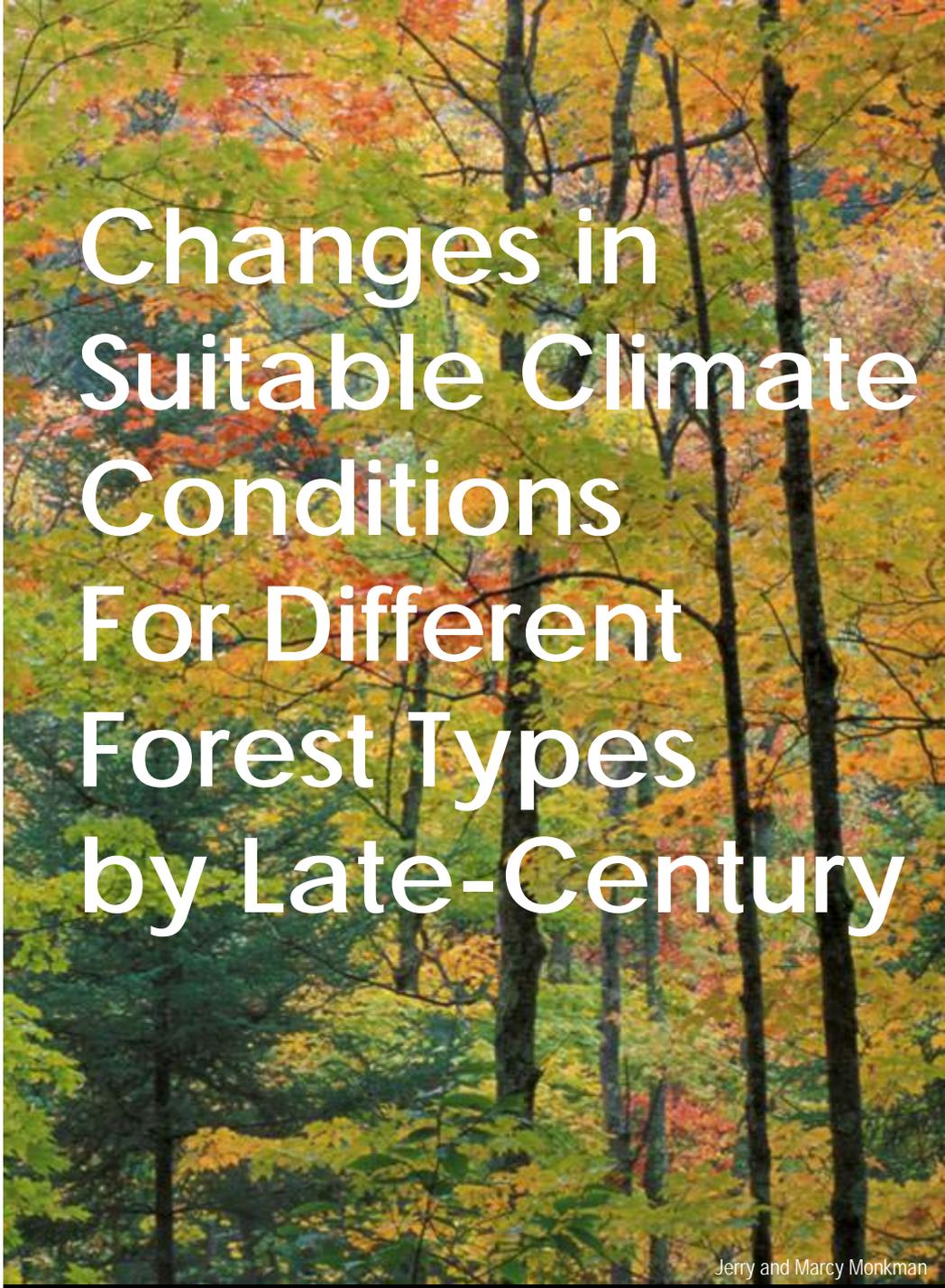


Other



No Data

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



Preparing to Adapt

Significant changes are now unavoidable.



Short-term drought (1-3 months)

Increasing Summer Drought



- 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.