

# CLIMATE CHANGE IN MASSACHUSETTS – ECOLOGICAL IMPACTS AND ADAPTATION

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# CLIMATE CHANGE IN MASSACHUSETTS – ECOLOGICAL IMPACTS AND ADAPTATION

1. How will the climate change over the next century?
2. What effects might this have on Massachusetts ecosystems?
3. What can we do about it – adaptation?

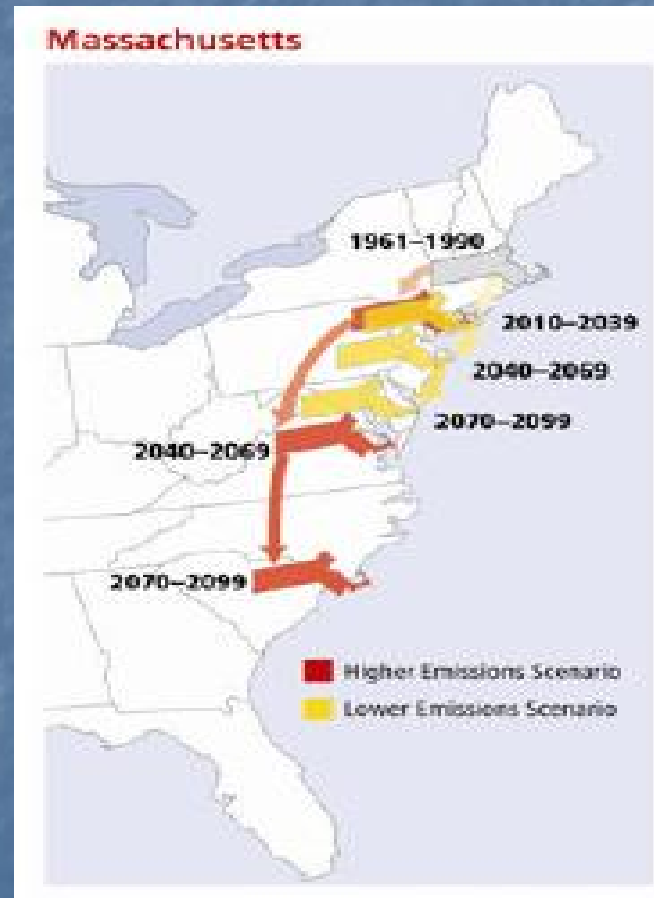
# FUTURE CLIMATE CHANGE IN MASSACHUSETTS

- Most recent modeling by Hayhoe *et al.* 2006
- Projected T, precipitation, etc, for next few decades, until mid-century, until 2100 under:
  - Low emissions scenario (B1). Doubling of CO<sub>2</sub>
  - High emissions scenario (A1F1). Tripling of CO<sub>2</sub>

# RESULTS OF GCM/EMISSIONS MODELING - TEMPERATURE

<b>Projected Temperature Change (°F)</b>			
	<b>2030</b>	<b>2050</b>	<b>2100</b>
<b>Winter:</b>			
<b>Low emissions</b>	<b>+2.5-4.0</b>	<b>+4.0-5.0</b>	<b>+5.0-8.0</b>
<b>High emissions</b>	<b>+2.5-4.0</b>	<b>+4.0-7.0</b>	<b>+8.0-12.0</b>
<b>Summer:</b>			
<b>Low emissions</b>	<b>+1.5-3.5</b>	<b>+2.0-5.0</b>	<b>+3.0-7.0</b>
<b>High emissions</b>	<b>+1.5-3.5</b>	<b>+4.0-5.0</b>	<b>+6.0-14.0</b>

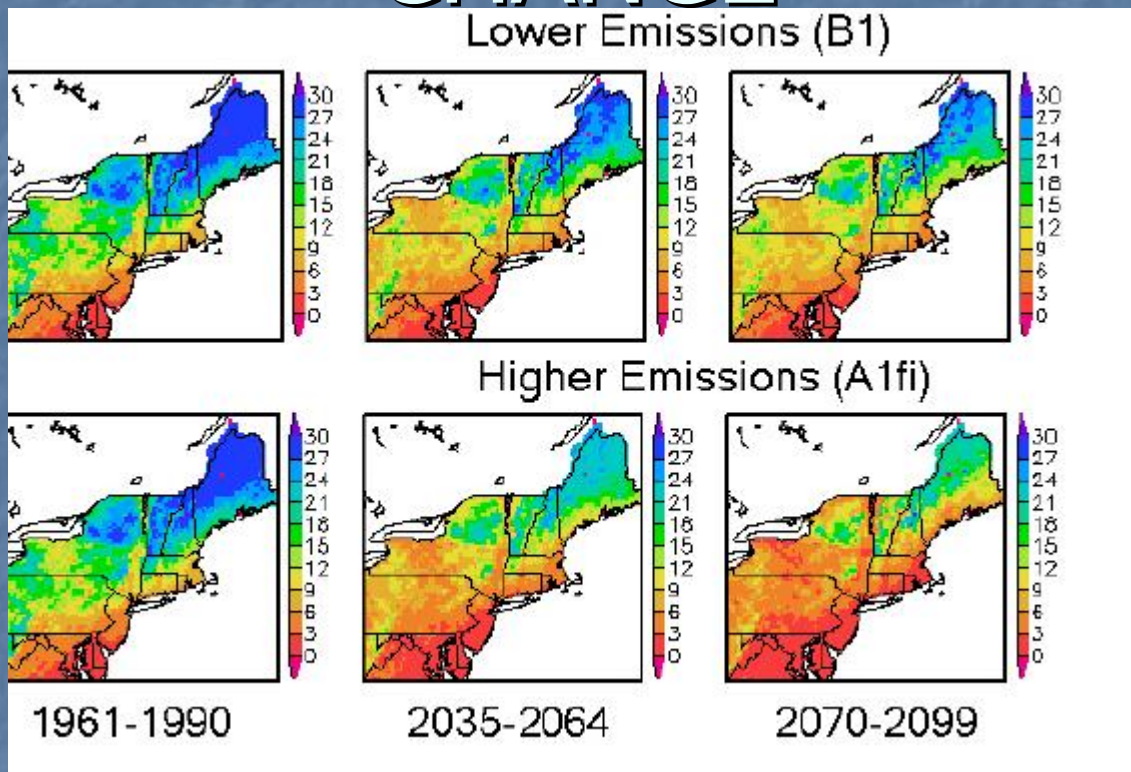
# MIGRATION OF CLIMATE INDEX



# RESULTS OF GCM/EMISSIONS MODELING - PRECIPITATION

- Under both scenarios: +10% annual increase
- Projections for summer – variable, but probably little change (implications for evapotranspiration)
- Projections for winter - +20-30%
- Less winter snow precip. More rain

# SNOW-DAYS UNDER CLIMATE CHANGE



UCS, 2007

# SNOW-DAYS UNDER CLIMATE CHANGE

FIGURE 3: The Changing Face of Winter

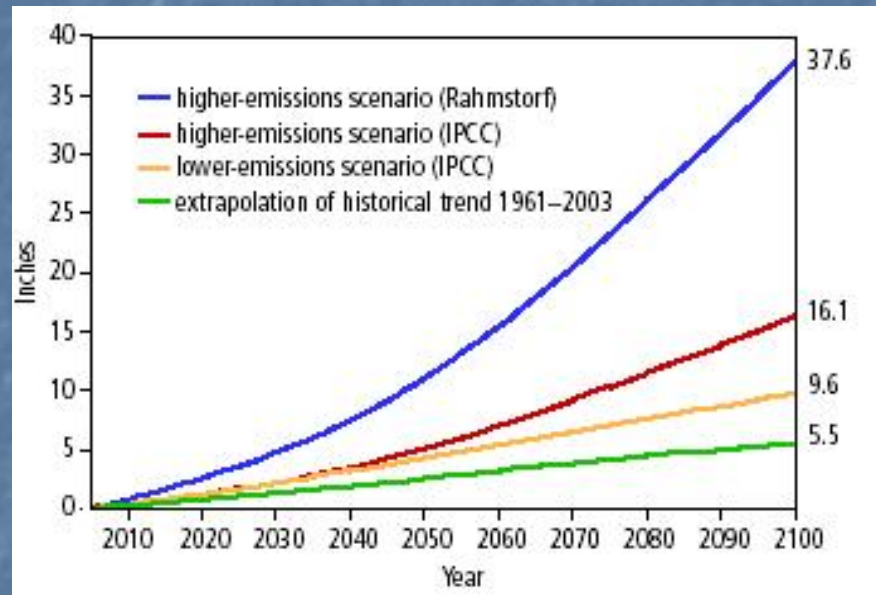


If higher emissions prevail, a typical snow season may become increasingly rare in much of the Northeast toward the end of the century. The red line in the map captures the area of the northeastern United States that, historically, has had at least a dusting of snow on the ground for at least 30 days in the average year. The white area shows the projected retreat of this snow cover by late-century to higher altitudes and latitudes, suggesting a significant change in the character of a Northeast winter.

UCS (2007)



# GLOBAL SEA LEVEL RISE



More recent analyses project 2-4.5 feet by 2100 under HES

# ECOLOGICAL RESPONSES: WHAT TYPES OF EFFECTS MIGHT OCCUR?

- Distribution shifts:
  - ❖ Elevation
  - ❖ Latitude
- Shifts in timing of events (e.g., migration)
- Changes in communities
- Extinctions (5-37%)

Is there evidence that such changes are already occurring in northeast?

# BIRDS MOVING NORTHWARD IN NEW ENGLAND

- At least 20 species have extended breeding ranges north (by up to 200 miles) in last 50 years.
- Greatest range expansions in last 30 years (also period when climate change accelerated in North America)

# BIRDS MOVING NORTHWARD IN NEW ENGLAND

Black vulture

Turkey vulture

Red-bellied woodpecker

Acadian flycatcher

Tufted titmouse

Carolina wren

Blue-gray gnat.

Mockingbird

Pine warbler

Cardinal

Orchard oriole

# NORTHWARD RANGE CONTRACTIONS

Rusty blackbird

Olive-sided flycatcher

Blackpoll warbler

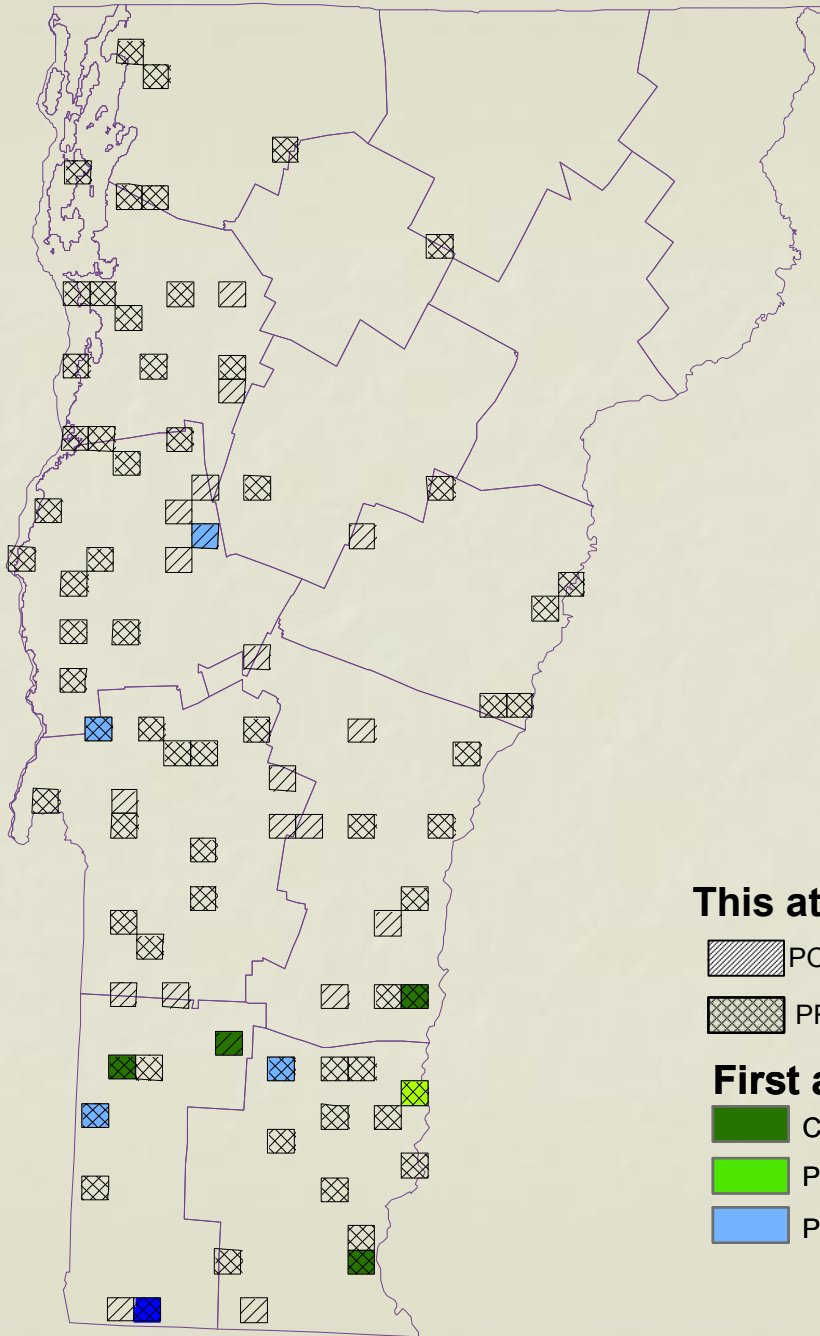
Bicknell's thrush

Cape May warbler

Bay-breasted warbler

Tennessee warbler

# TUFTED TITMOUSE



## This atlas 2003- 2007



POSSIBLE



PROBABLE OR CONFIRMED

## First atlas 1977 -1981



CONFIRMED



PROBABLE



POSSIBLE

# RED-BELLIED WOODPECKER



## This atlas 2003- 2007



POSSIBLE



PROBABLE OR CONFIRMED

## First atlas 1977 -1981



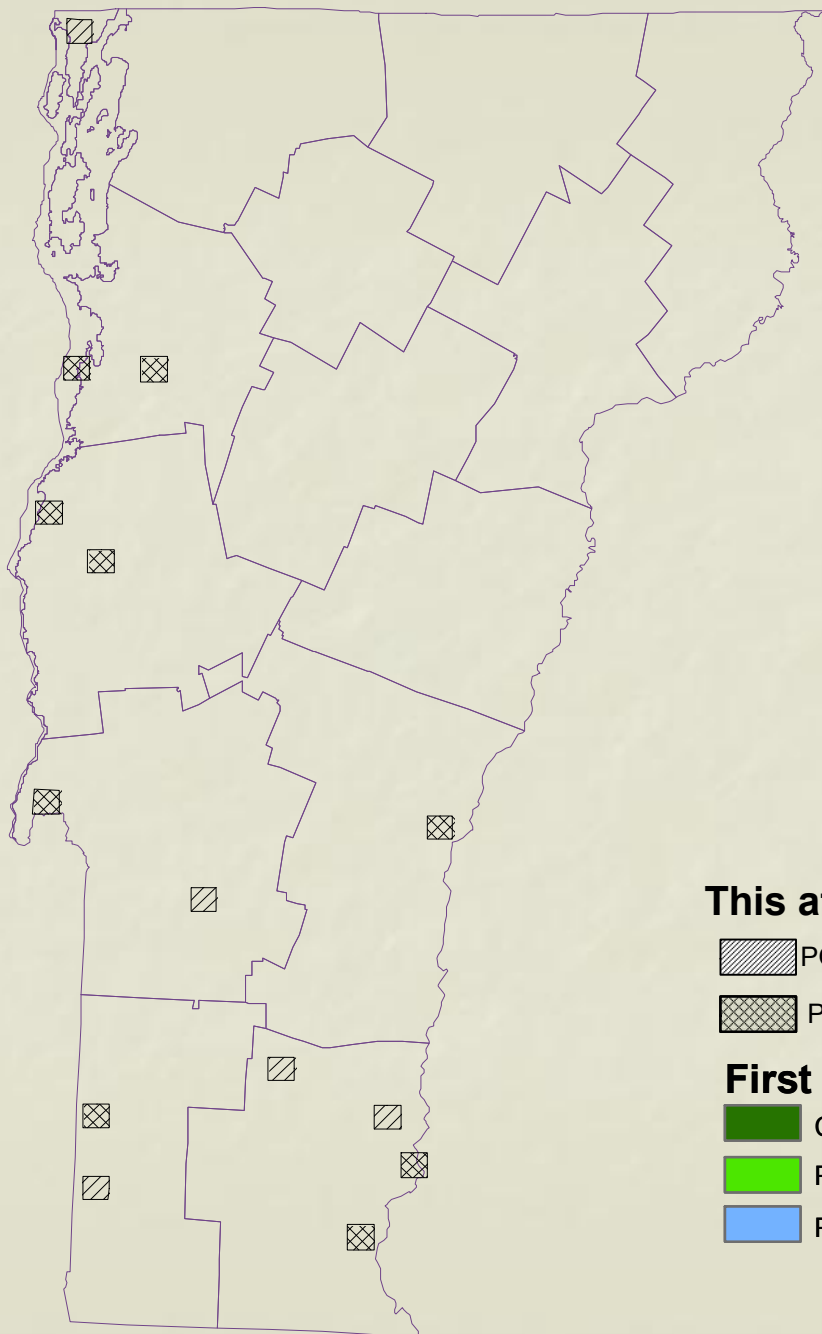
CONFIRMED



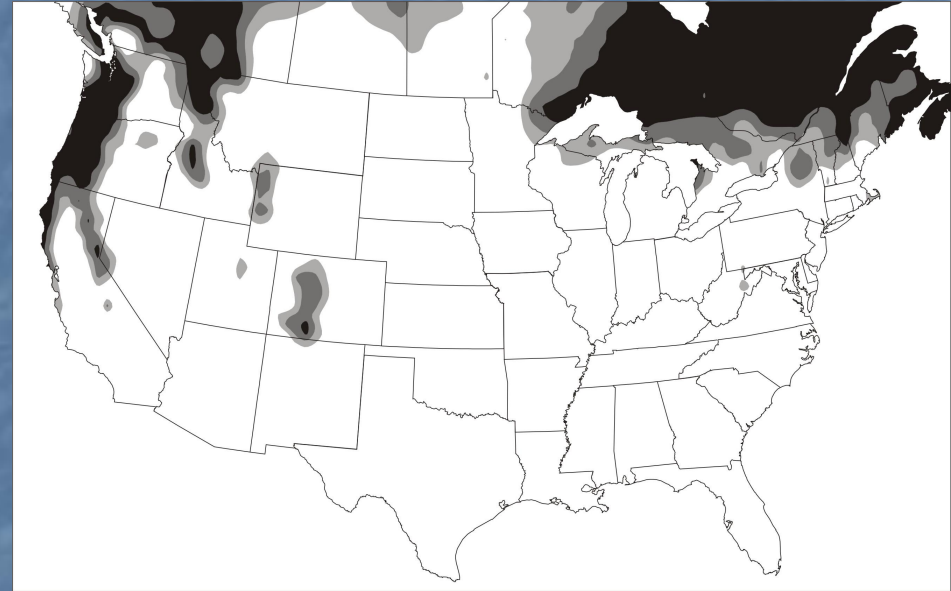
PROBABLE



POSSIBLE

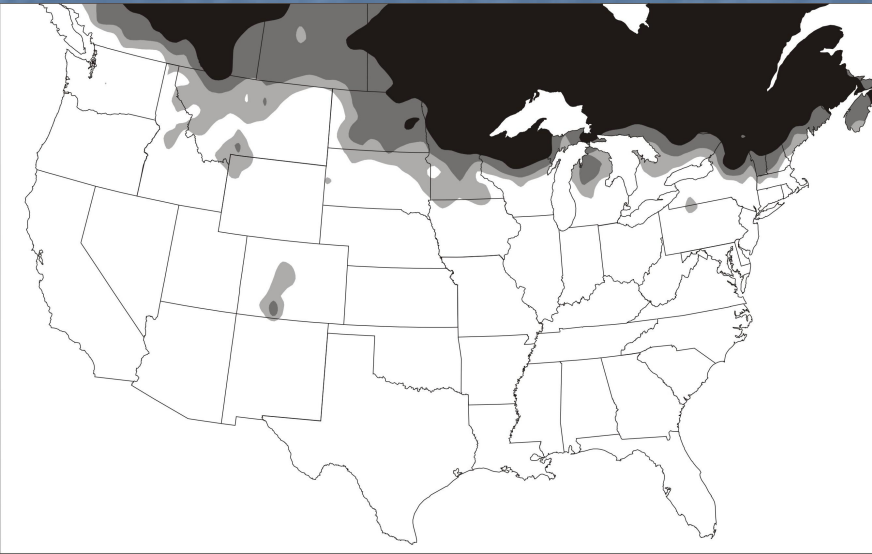


# TREE SWALLOW MOVES NORTH

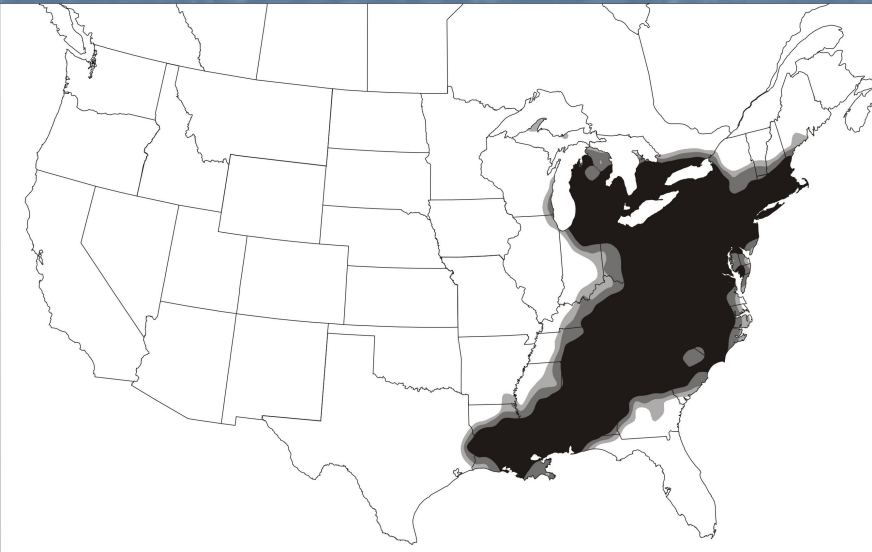




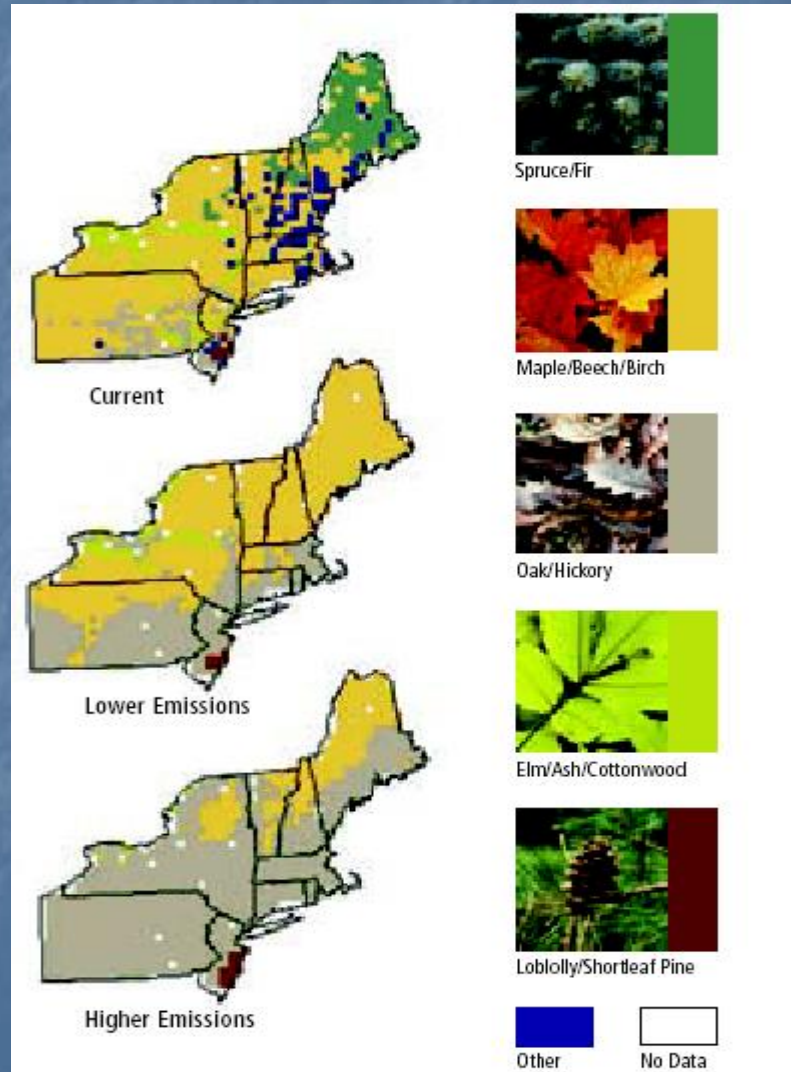
# BLACK-CAPPED CHICKADEE IN TROUBLE



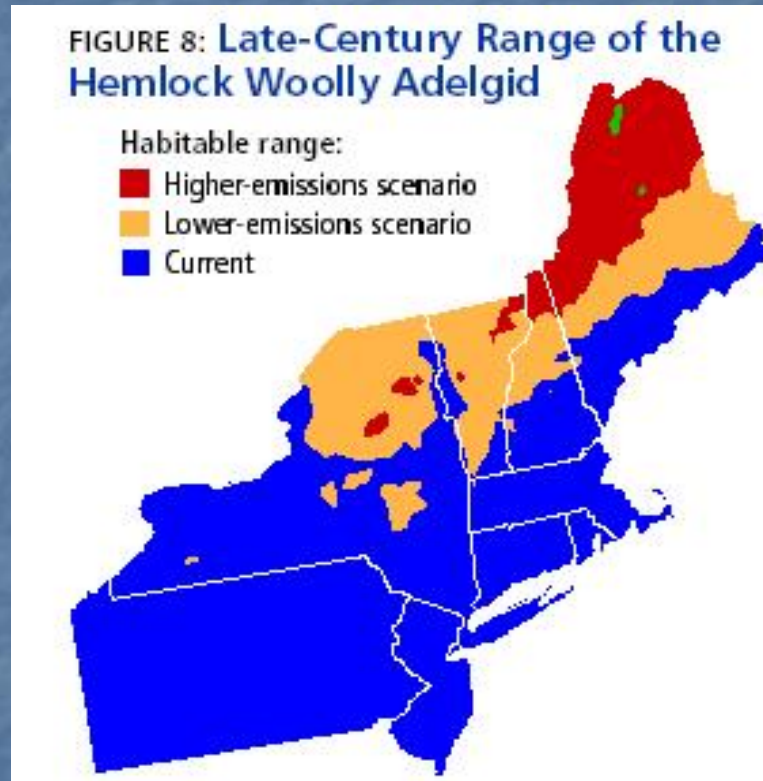
# CAROLINA CHICKADEE MOVES NORTH



# PROJECTED FOREST CHANGES



# WOOLY ADELGID UNDER CLIMATE CHANGE



# CLIMATE CHANGE – WHAT WE KNOW

- The climate is changing
- Climate change is already affecting ecological systems:
  - ❖ range shifts
  - ❖ phenologies
  - ❖ population and community changes
  - ❖ extinctions (5-37%)
- All this with less than 1 degree C change
- Projections over next century are for 3-5 degree increase (based on doubling of CO<sub>2</sub> from pre-industrial levels)

# COMMITMENT TO WARMING AND ADAPTATION

- CTW = continued warming over next few decades
- Most scientists recognize that +2 degrees will bring about beginning of major ecological change (we already have had +0.7 degrees)
- Mitigation (emissions control) is not the entire solution – we need to adapt!

# ADAPTATION QUESTIONS

- Which ecosystems/species/sites are more or less vulnerable to cc and how should we allocate scarce resources?
- Ecological trajectories under climate change?
- Interaction with other stressors?
- How well will traditional conservation tools work in climate changed future?
- How do we avoid cures as bad as the illness?

# ADAPTATION

Going to describe two studies aimed at addressing these questions:

- Sea level rise, coastal ecosystems, and shorebirds – USEPA funding
- Manomet, DFW, TNC collaborative adaptation project in Massachusetts – Doris Duke funding



# SHOREBIRDS AND SEA LEVEL RISE

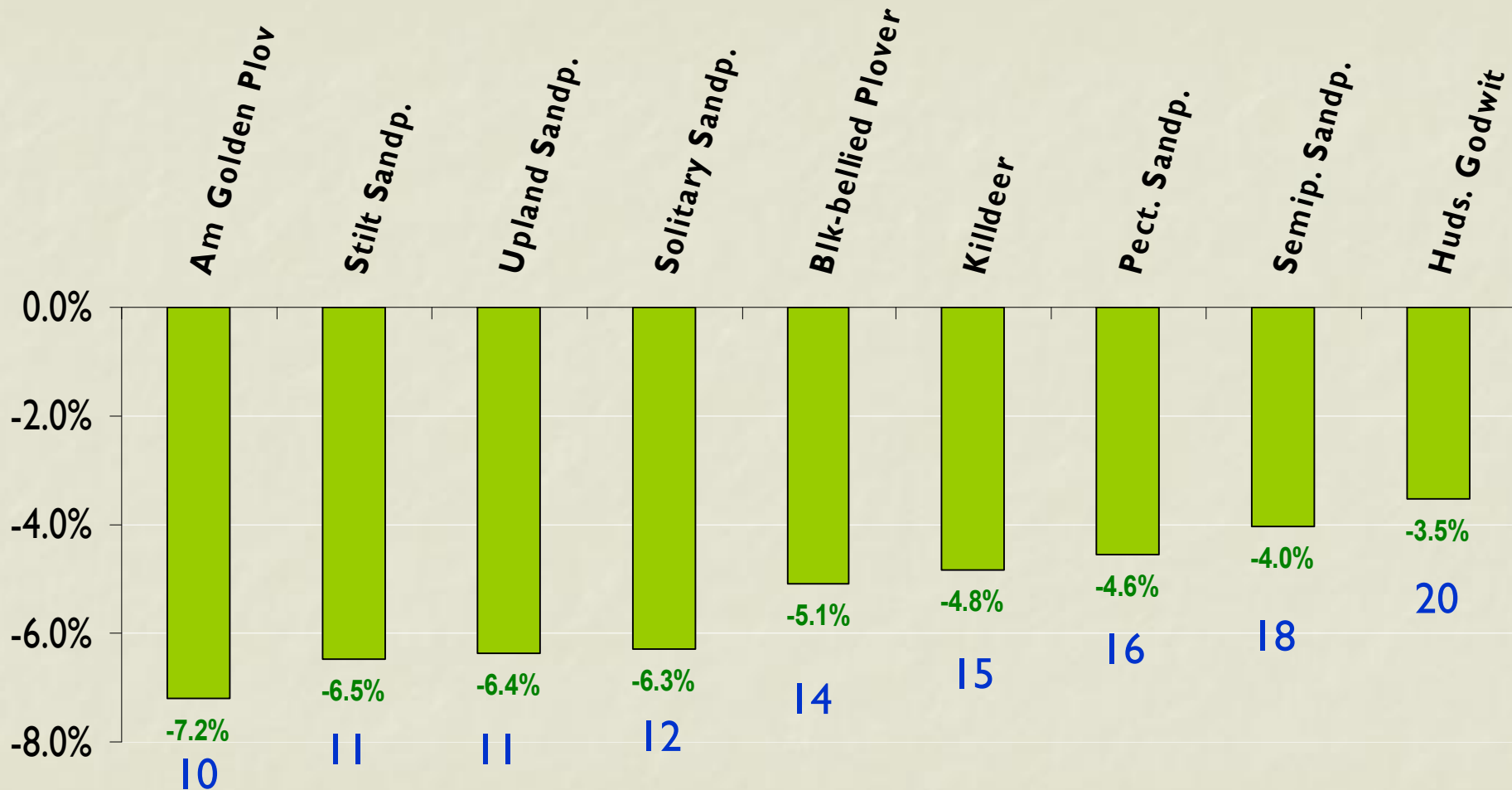


# SHOREBIRDS AND SEA LEVEL RISE

- Shorebird populations are declining – rapidly
- They are particularly vulnerable to climate change:
  - sea level rise and habitat loss
  - they breed at high latitudes
  - they are dependent on wind patterns for migration strategies
  - ecological synchronicities are important



# Annual Change in Shorebird Populations



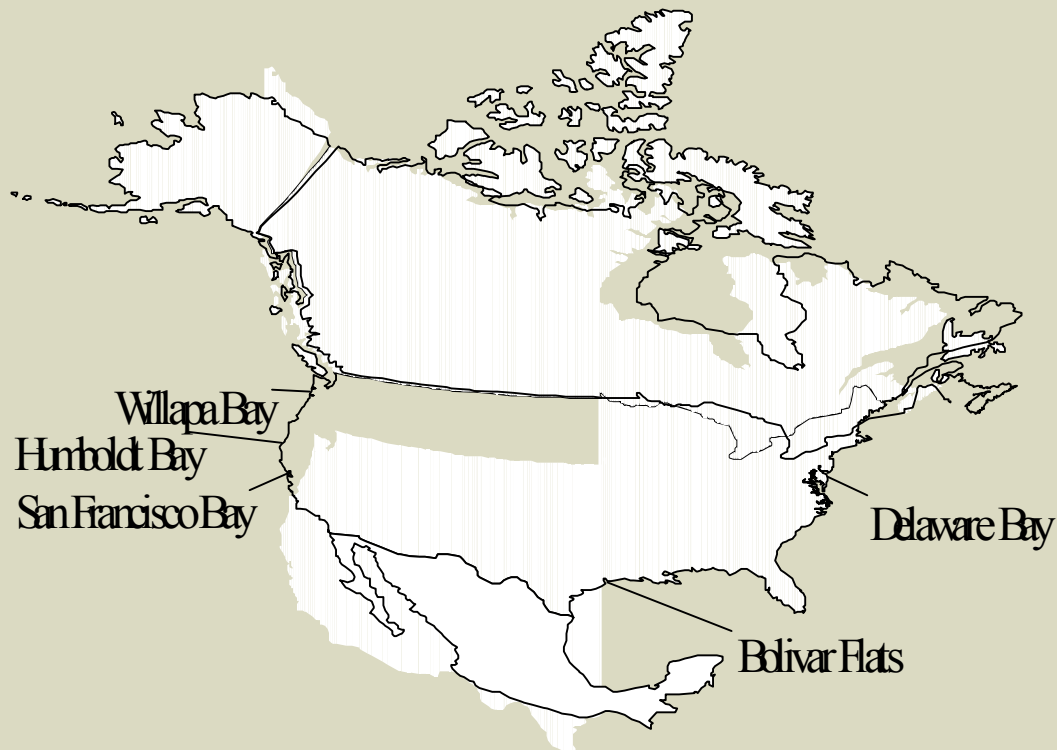
Based on migration counts in eastern N. America; Bart et al 2007. *J Av. Biol*

# SHOREBIRDS AND SEA LEVEL RISE

- Objectives
  - Evaluate potential effects of sea level rise on shorebird habitat
  - Estimate future ability of sites to support existing shorebird populations.

Funded by USEPA ORD





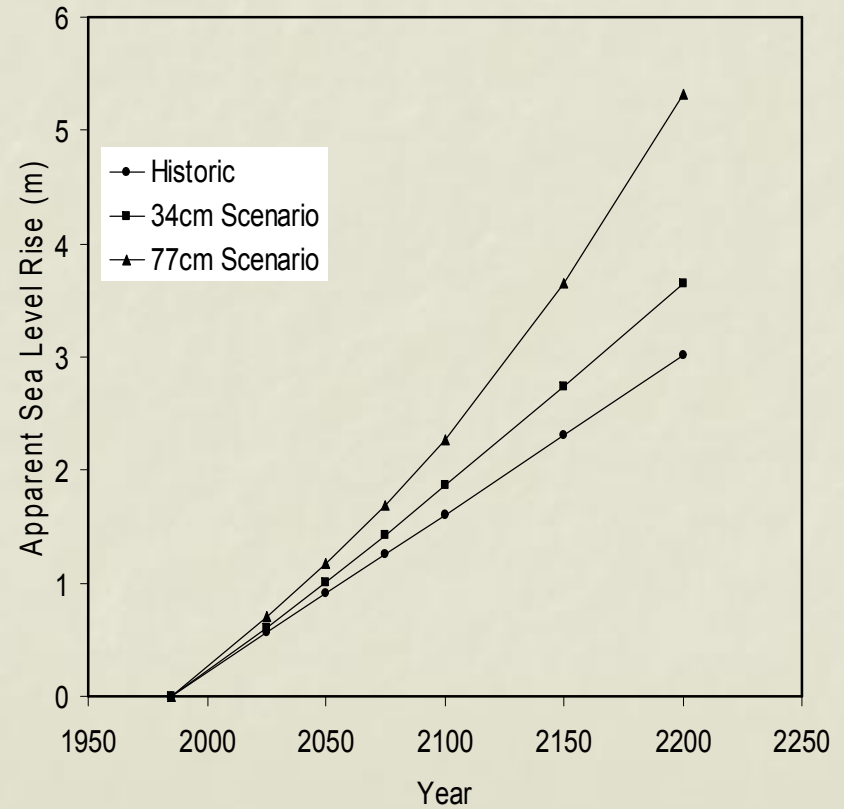
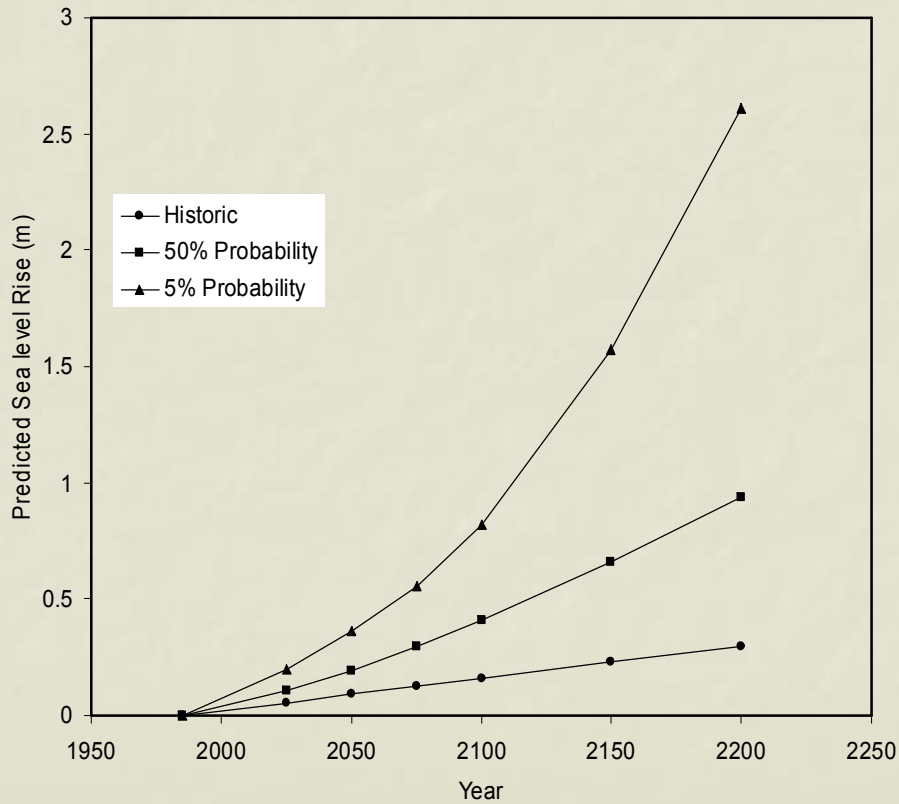
Study Sites

# SAN FRANCISCO BAY SHOREBIRDS

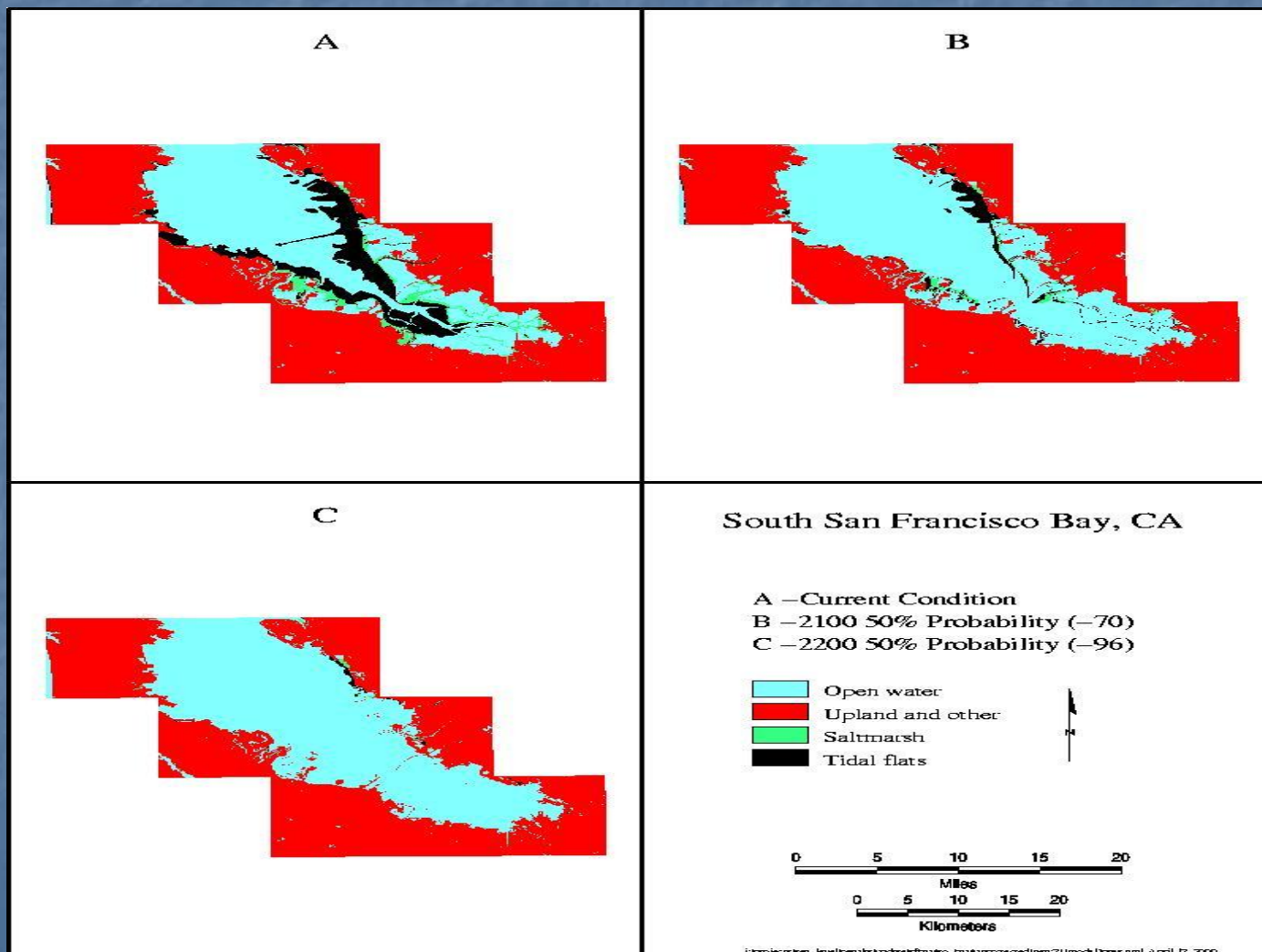
- One of most important North American staging sites
- About one million birds per season



# Future Sea Level Rise at North (left) and South (right) San Francisco Bays



# SOUTH SAN FRANCISCO BAY – CO<sub>2</sub> DOUBLING





# HOW WOULD BUILDING DIKES AFFECT HABITAT LOSS?

- Modeled potential effects of building dikes at Bolivar Flats
- Assumed that all built-up areas would be protected
- Intertidal habitat loss exacerbated by about 20%



# SHOREBIRDS AND SEA LEVEL RISE

Two important adaptation messages:

- Climate-schlimate! Road to reducing impacts may go through mitigation of non-climate stressors
- Don't do anything too dumb in response to climate change!

# CONSERVATION PLANNING - MASSACHUSETTS

- “Title” - Planning and implementing adaptation to climate change in Massachusetts
- Collaborative project – Manomet, DFW, TNC, etc.
- Funding – Doris Duke Foundation through Wildlife Conservation Society
- Duration - 18 months
- Begins – April, 2008
- Similar projects being funded by DD in NM and Mid-Atlantic states

# CONSERVATION PLANNING - MASSACHUSETTS

- State has already developed (2005) Wildlife Action Plan (CWCS) – “roadmap” for future conservation of wildlife and habitat
- Identifies 22 critical habitat types and 257 animals in “greatest conservation need”
- Priority strategy – Proactive Habitat Protection
- CWCS acknowledges that climate change is likely to be major stressor – goes little further
- MA is way ahead of the game – most SWAPS do not address implications of CC

# CONSERVATION PLANNING - MASSACHUSETTS

## Questions:

1. Which of focal areas, target habitats will be most affected by CC?
2. How will conservation values of protected areas change under CC?
3. How will CC affect future land acquisition priorities?
4. How effective will conservation approaches be under CC?
5. How should we modify our tools and approaches?

# CONSERVATION PLANNING - MASSACHUSETTS

## Objectives:

- Develop tools to evaluate relative vulnerabilities of habitats, focal areas, species under CC
- Project impacts on protected areas under CC
- Provide information to focus habitat acquisition priorities
- Evaluate effectiveness of conservation approaches/strategies for most vulnerable resources under CC
- Develop alternative approaches/strategies to enhance resilience

# ADAPTATION – LAST WORDS

- Nothing is for sure – we need to remain flexible, creative, and practice adaptive management
- Face up to tough choices – what gets thrown off the raft?
- Seek win-win solutions

# ADAPTATION – LAST WORDS

- We already practice lots of valuable approaches – intensify!
- Effective monitoring is crucial - indicators
- We already have lots of important baseline info. – use it!
- Bottom-up approaches needed