The Future Ain't What it Used to Be

Assessing Vulnerability to Climate Change

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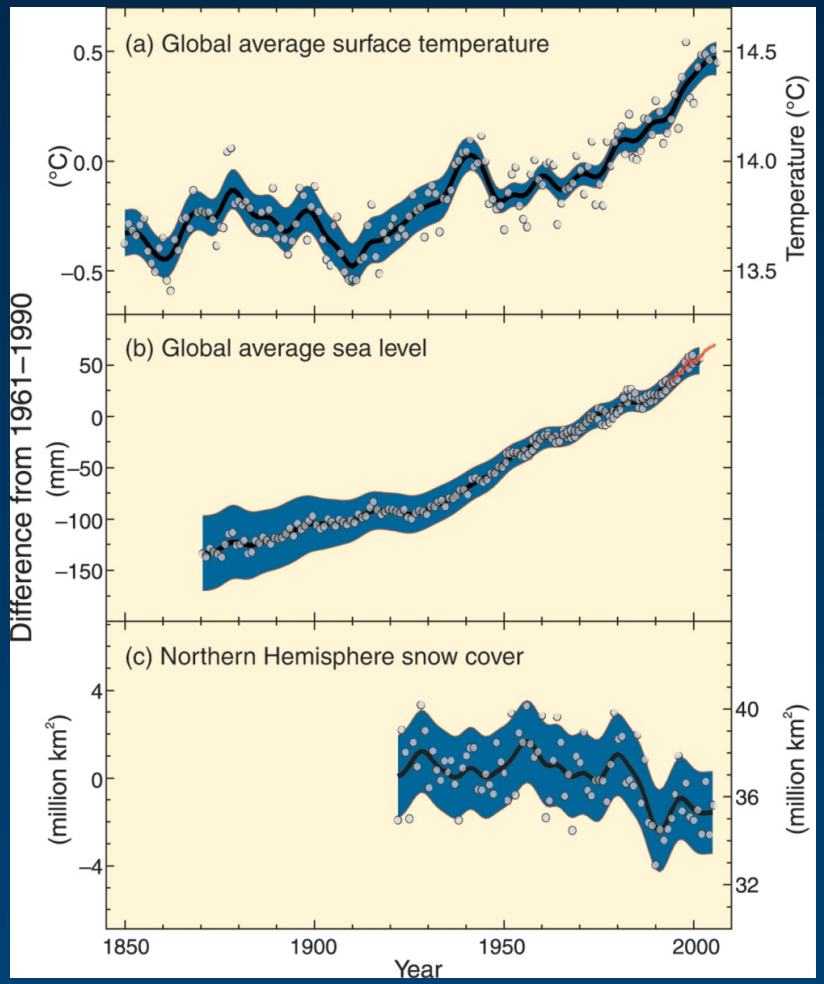
Climate Change is Unequivocal

Observed Changes

Global Ave. Surface Temperature

Global Ave. Sea Level

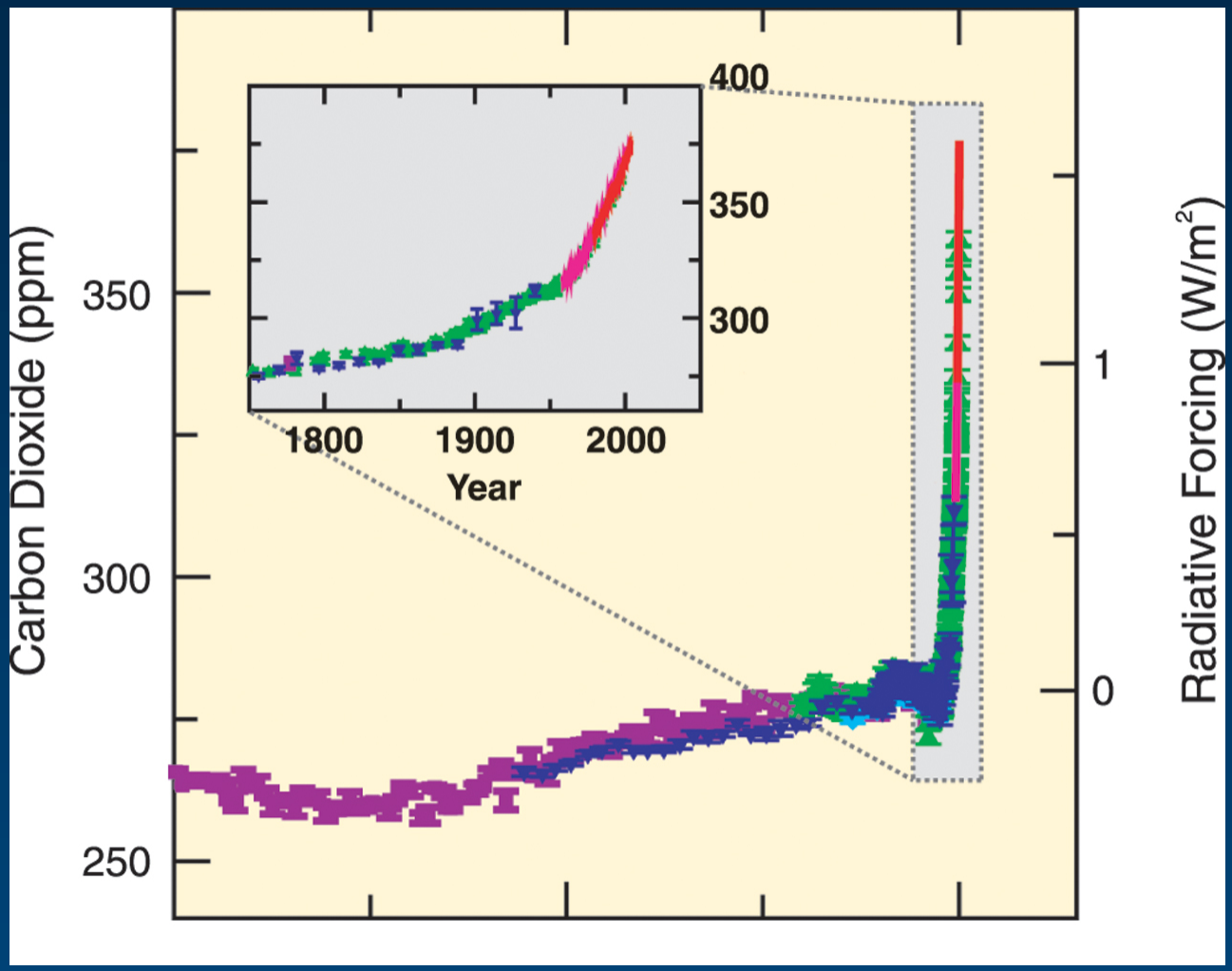
Northern Hemisphere Snow Cover



Last decade the warmest on record; 2009 2nd warmest year

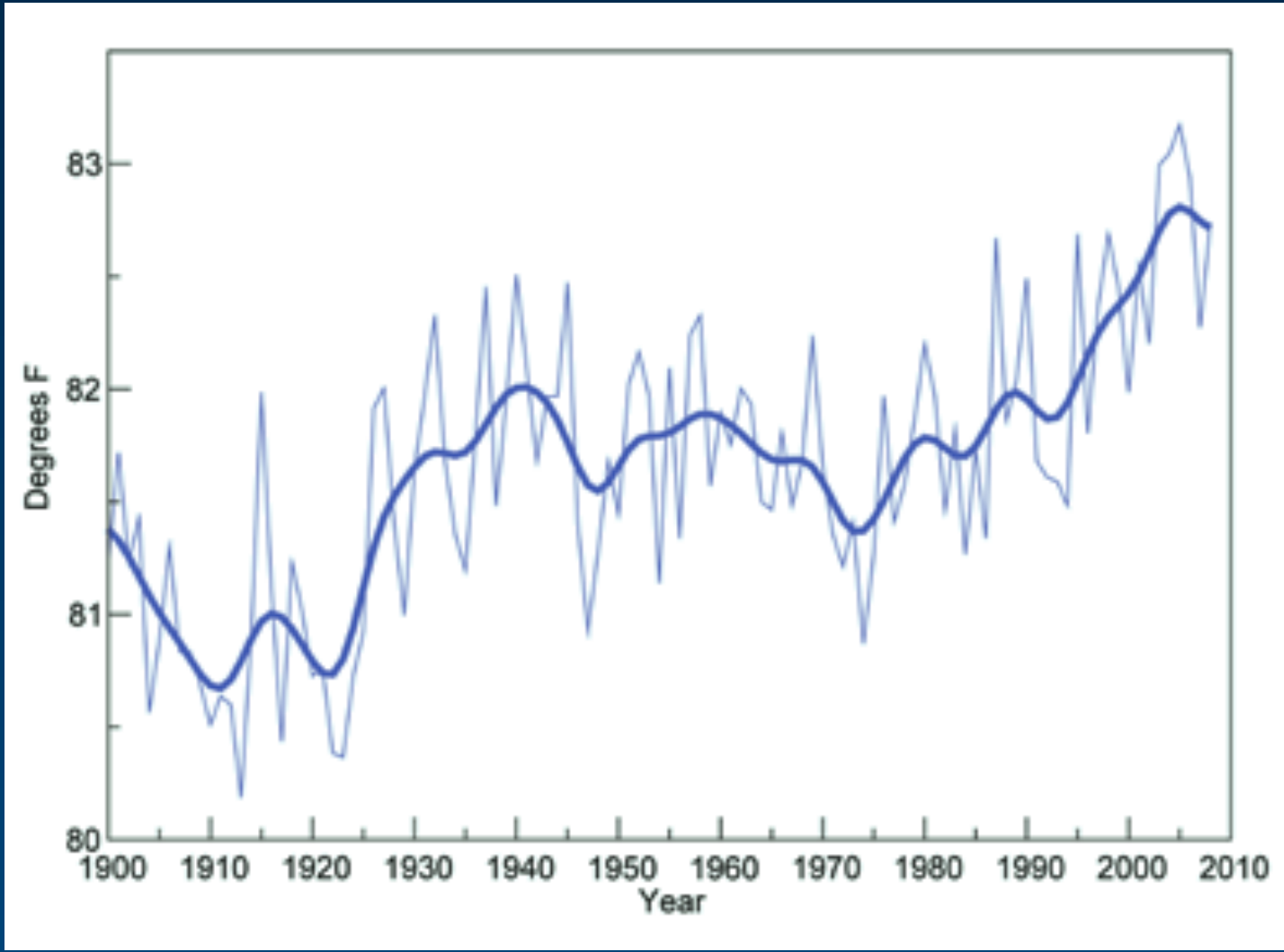
Atmospheric Carbon Dioxide

Over last 10,000 years

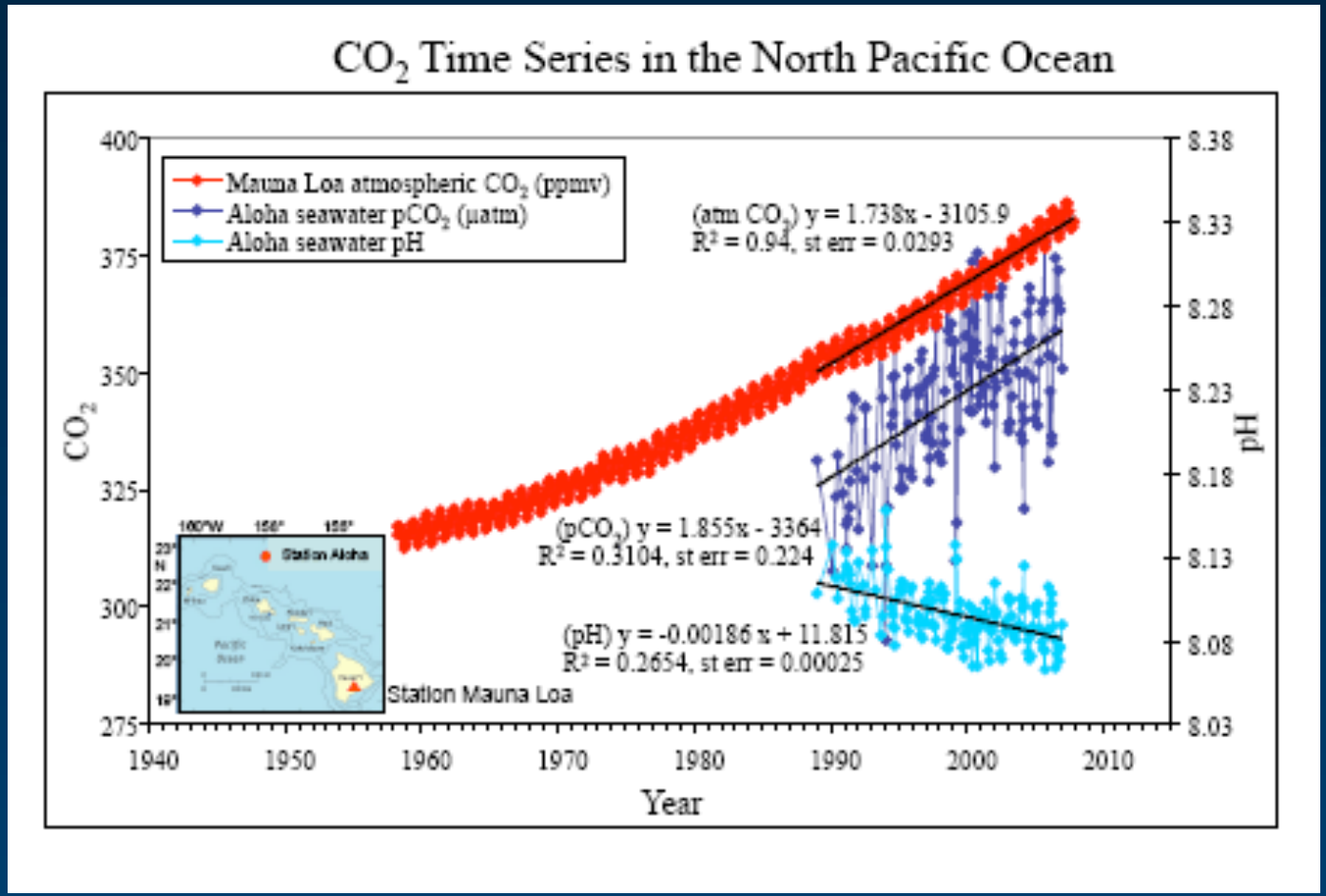


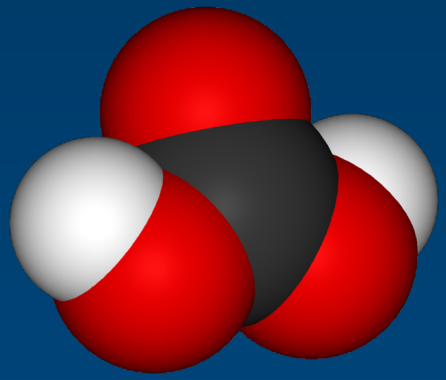
Sea Surface Temperature

During Hurricane Season

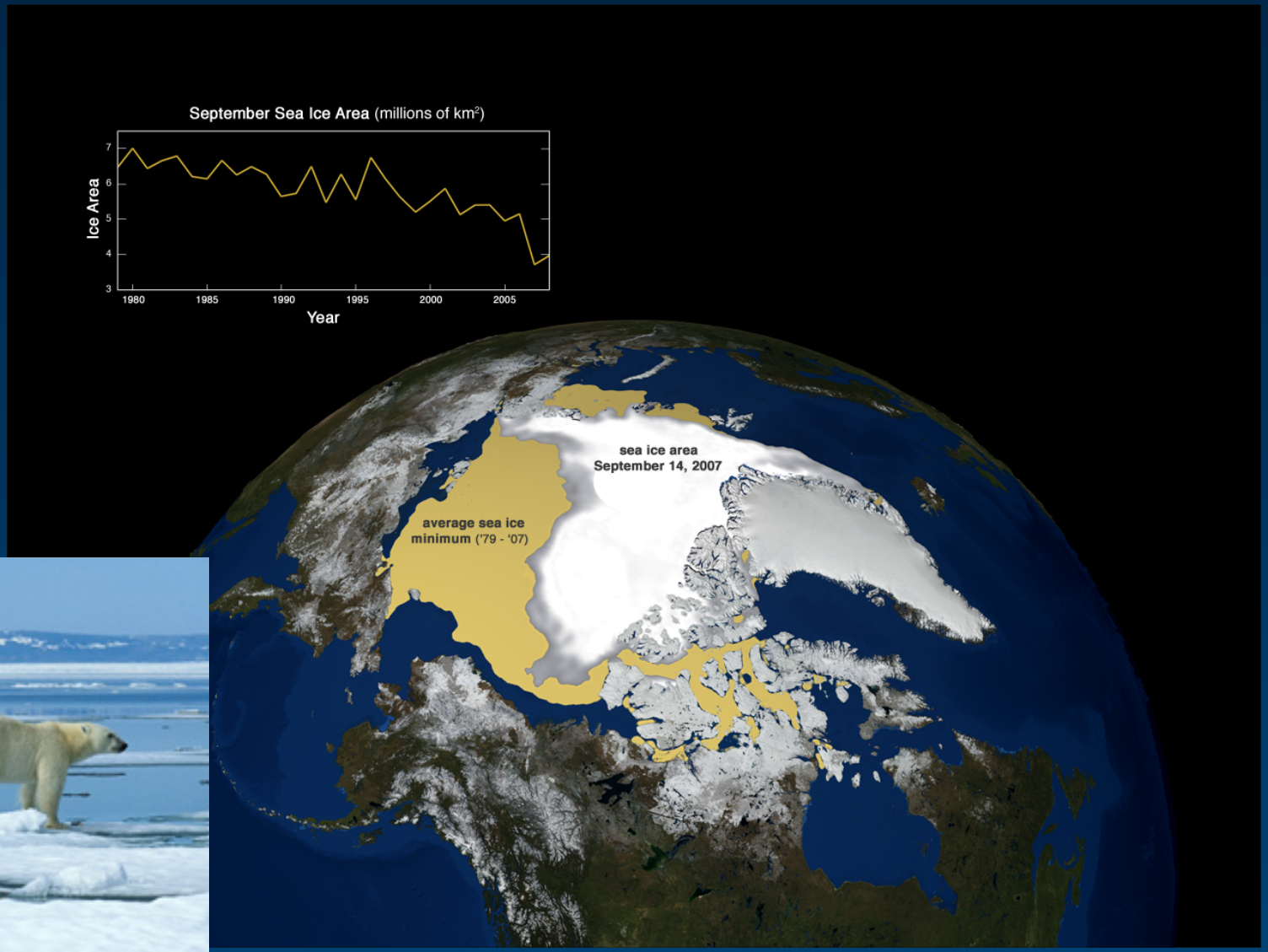


Ocean Acidification



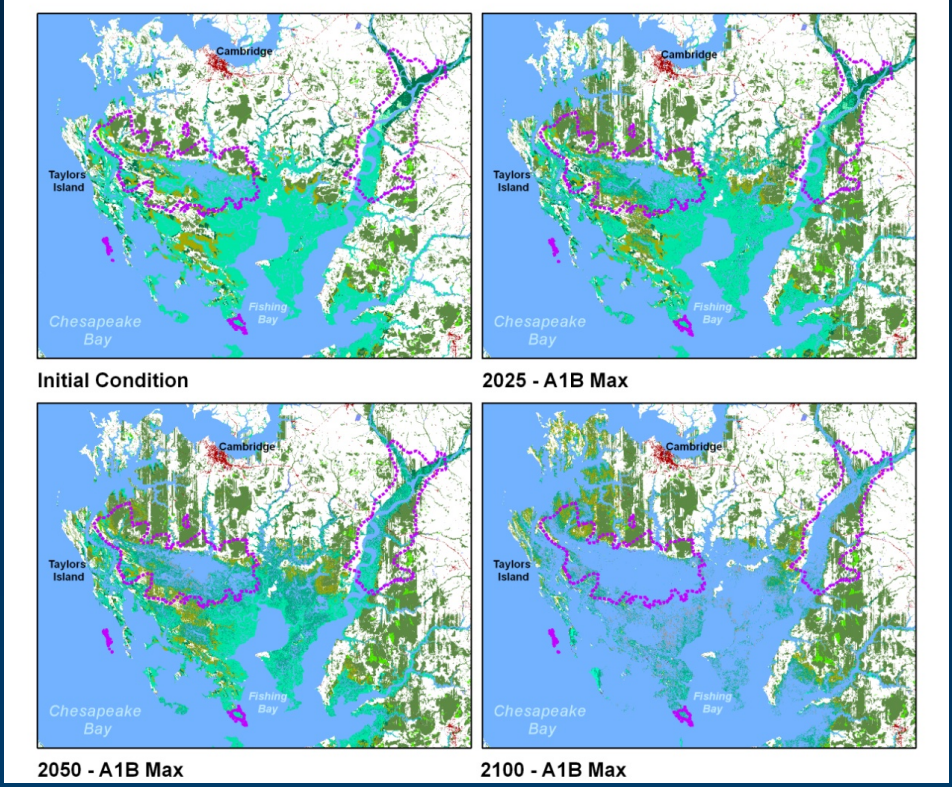


Loss of Sea Ice



Arctic summer sea ice, Sept. 2007. Source: NASA

Rising Sea Levels



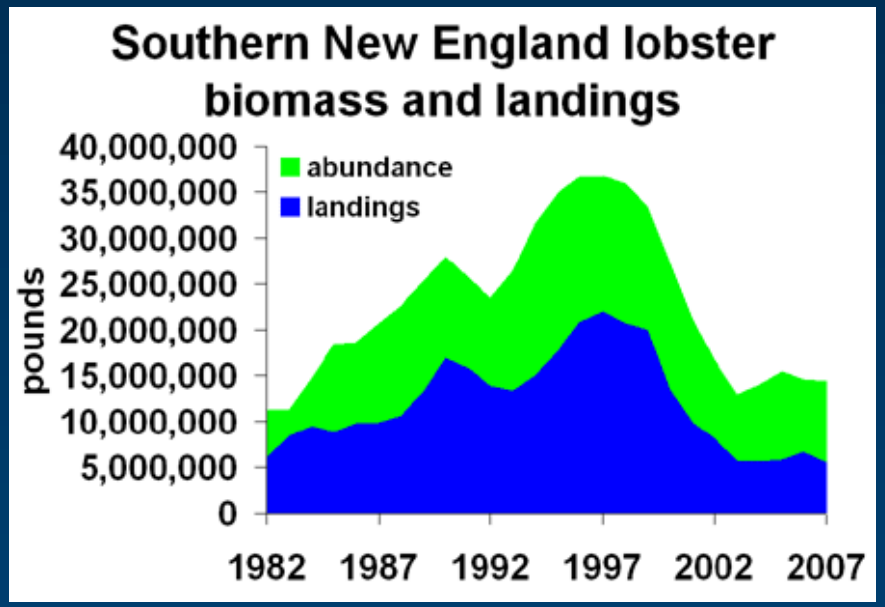
Blackwater National Wildlife Refuge
Source: NWF SLAMM Projections

Wye Island erosion

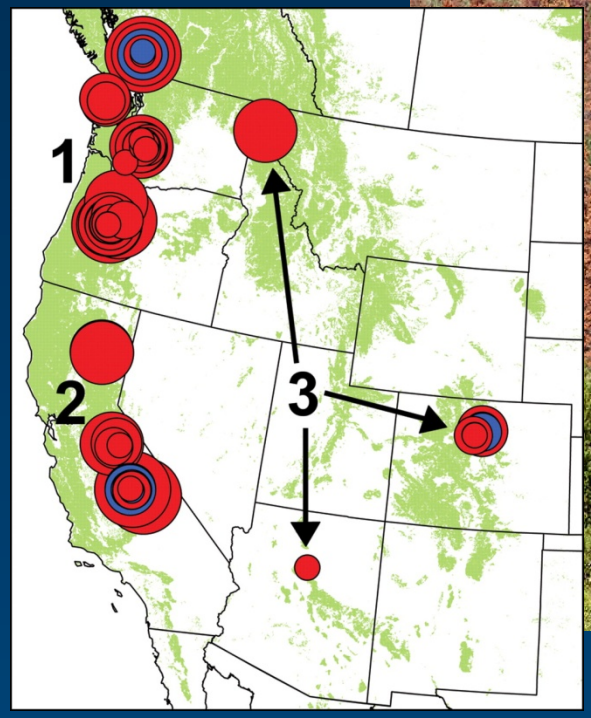
Extreme Weather Events

Hurricane Katrina

Warming Waters



Ecosystem Disruptions

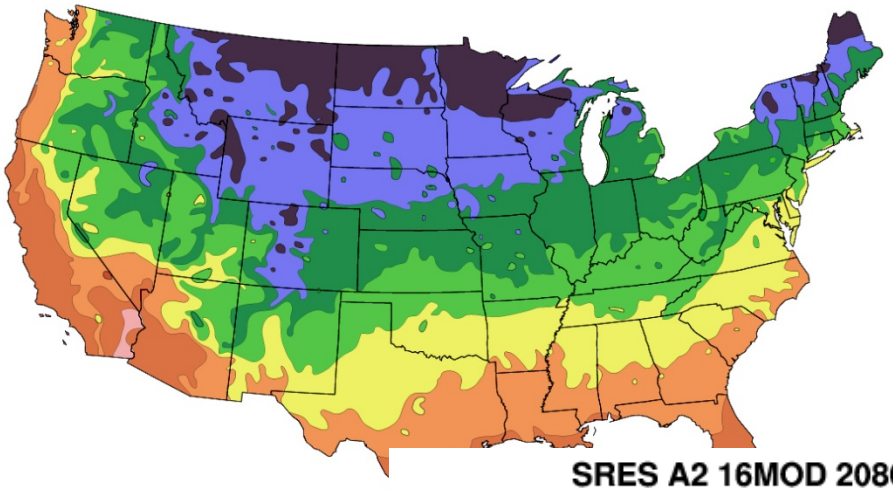


Old Growth Tree Mortality
van Mantgem et al. (2009)

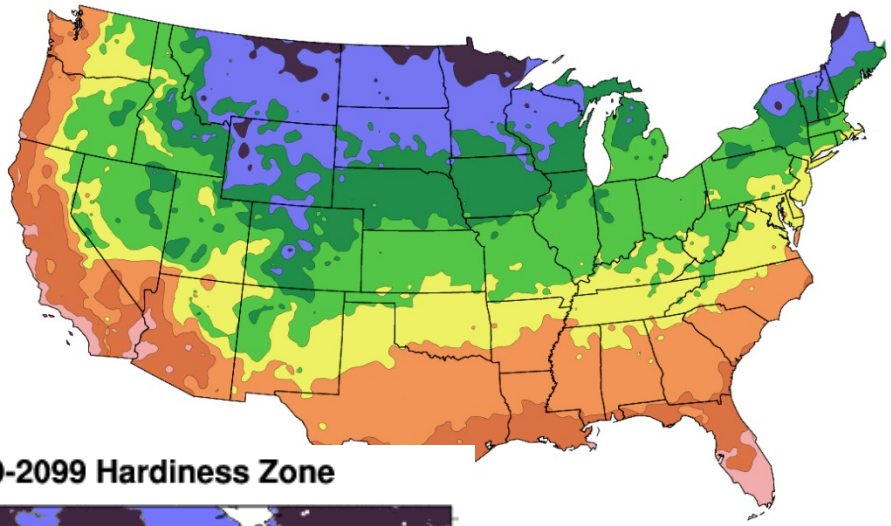
Mountain Pine Beetle Damage, Colorado
Photo: Allen L. Thornton

Shifting plant hardiness zones

1990 Map



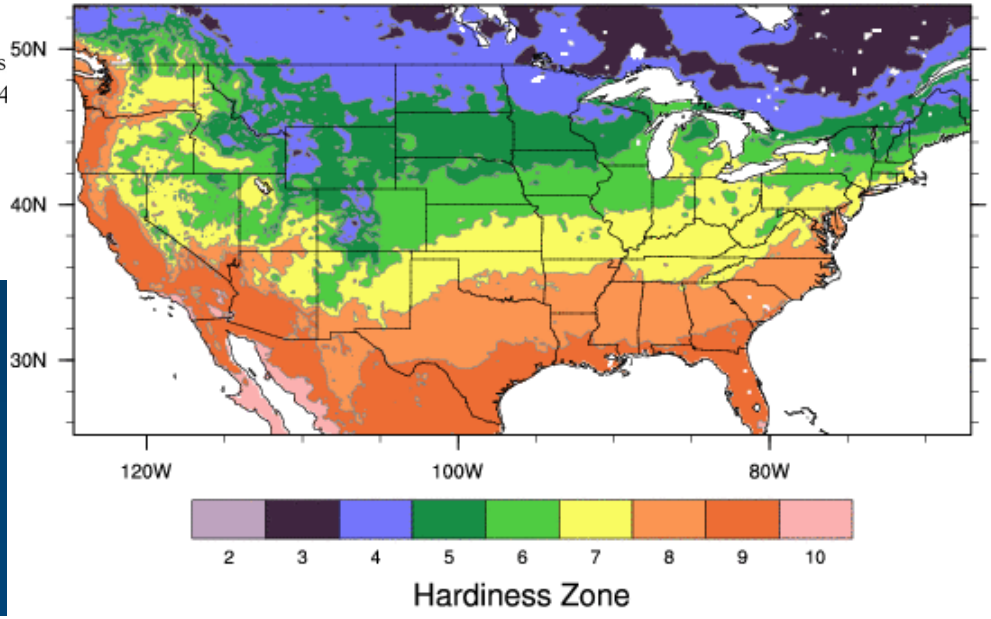
2006 Map



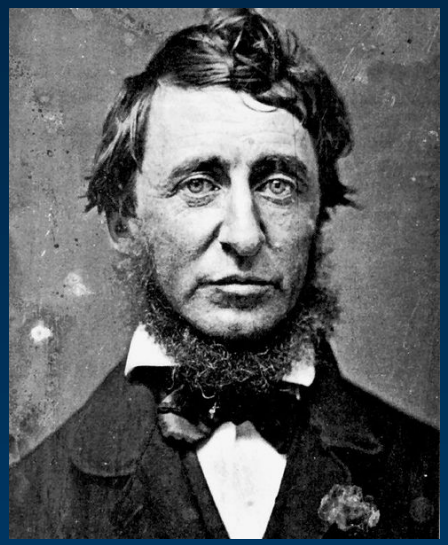
After USDA Plant Hardiness
Publication No. 14

Plant Hardiness Zone Map
2006.

SRES A2 16MOD 2080-2099 Hardiness Zone



Shifts in Flowering Time



Average temperature at Thoreau's Pond has increased by approximately 2.4° C since 1852. On average flowering times have advanced by 7 days since Thoreau's time.

Non-native species appear to have adapted to these shifts more readily than natives

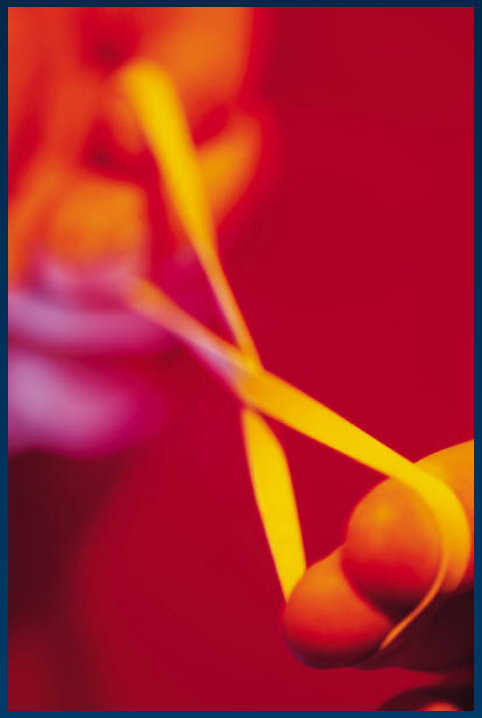
Human Responses to Global Warming

- Mitigation
  - Addresses causes of global warming
  - Focus on reducing greenhouse gas emissions

- Adaptation
  - Addresses impacts of global warming pollution on people and ecosystems
  - Focus on safeguards or coping strategies

Adaptation – What Is It?

Initiatives and measures designed to reduce the vulnerability of natural and human systems against actual or expected climate changes



- Resilience and Resistance
- Anticipatory and Reactive Measures
- Human and Natural Systems
- Facilitating Change, Embracing Uncertainty

Adaptation Planning

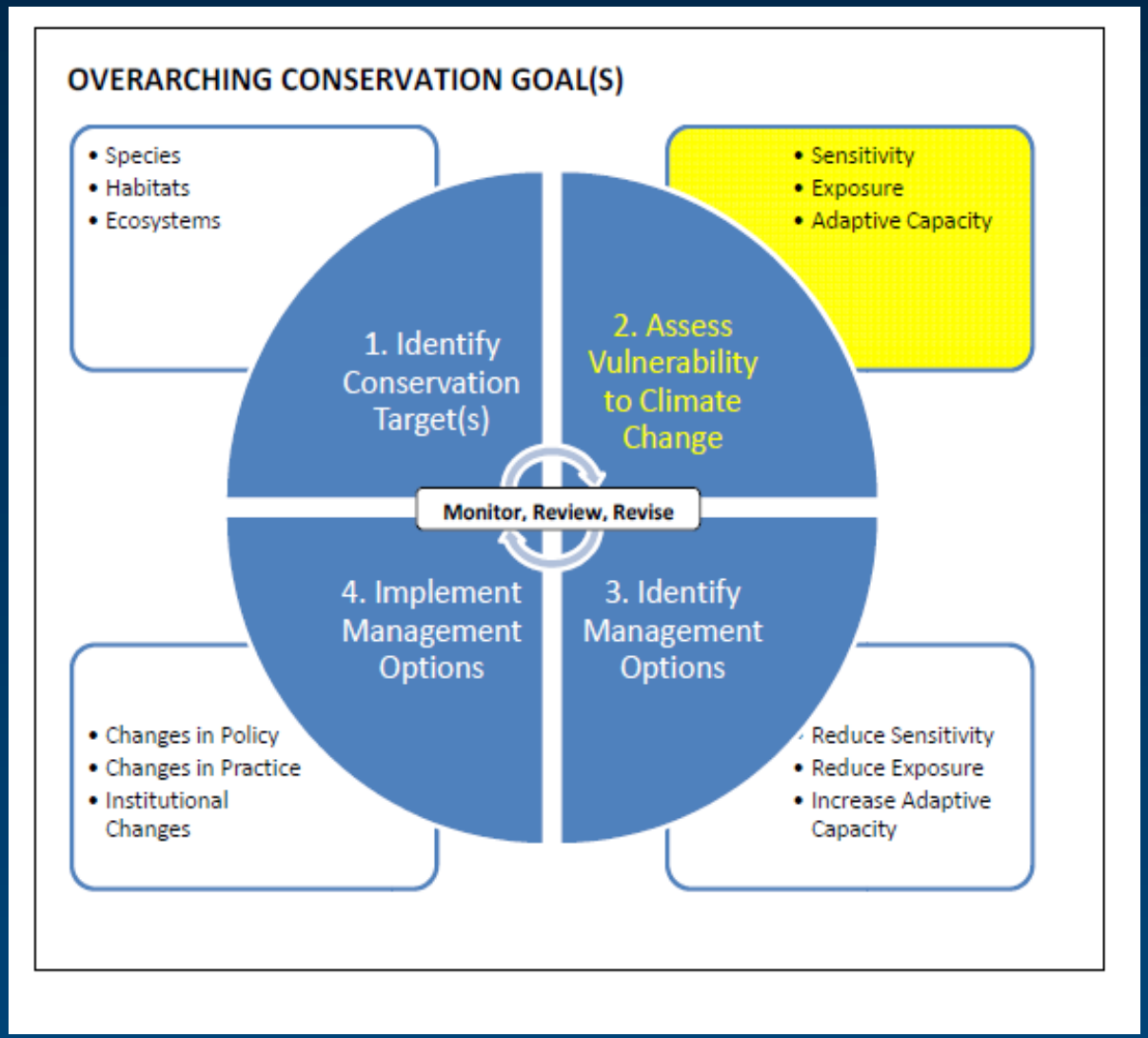
"I skate to where the puck is going to be, not where it has been."

--- Wayne Gretsky

Coastal Adaptation

- Protect and restore marshes and other coastal habitats
- Preserve the ability of habitats to migrate inland as sea levels rise (e.g., use of rolling easements)
- Facilitate replenishment of sediments in coastal wetlands and beaches
- Use ecosystem-based management to improve coastal resilience
- Eliminate public subsidies for development in high risk coastal zones

Adaptation Planning Cycle



"Climate-Smart" Conservation

- Science and practice of adaptation still in early stages of development
- Essential to be able to answer :
  - What should we be doing differently?
  - What continues to make sense?
- Need to guard against relabeling/justifying all existing projects as adaptation
  - Must go through climate-specific analyses
- Vulnerability assessments key to determining what is "climate-smart"

What is Vulnerability?

The likelihood that climate-induced shifts will have an adverse impact on a given species, habitat, or ecosystem.

Louisiana coastal wetland, Photo NRCS

American pika, Photo Alan Wilson

Why Carry Out Vulnerability Assessments?

- Identify species and systems most in need of conservation actions due to climate change
- Develop adaptation strategies tailored for managing species and habitats in greatest need
- Foster collaboration by providing a shared understanding of impacts and management options
- Efficient allocation of scarce resources for wildlife adaptation

Guidance on Vulnerability Assessment

Experts Working Group

SCANNING THE
CONSERVATION HORIZON

A Guide to Climate Change Vulnerability Assessment

NATIONAL WILDLIFE FEDERATION

DRAFT
May 2010

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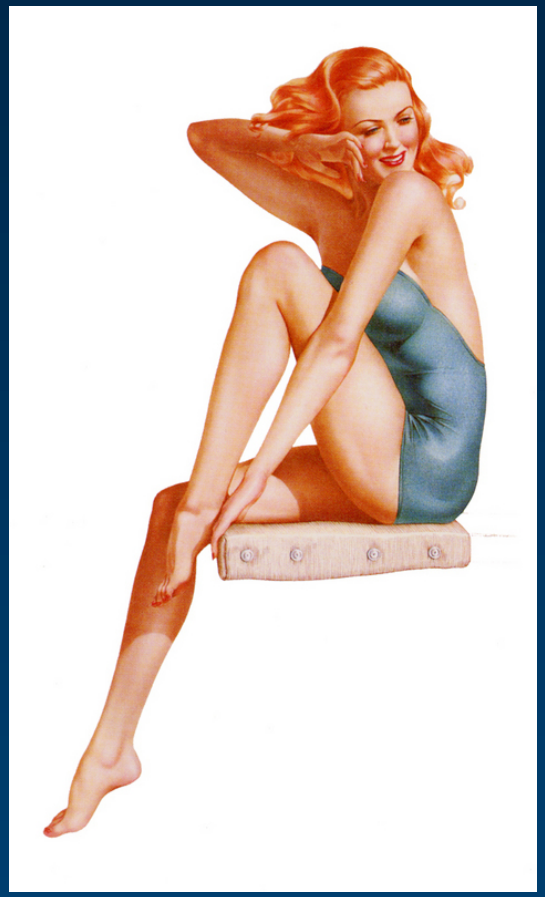
Components of Vulnerability

- Sensitivity
- Exposure
- Capacity to Adapt

Sensitivity

- Measure of whether and how a species or system is likely to be affected by a given change in climate.
  - For sunburn, amount of melanin in skin is key physiological factor
  - Melanin absorbs UV rays, which cause sunburn
  - Skin with lower melanin levels is more sensitive to sunburn

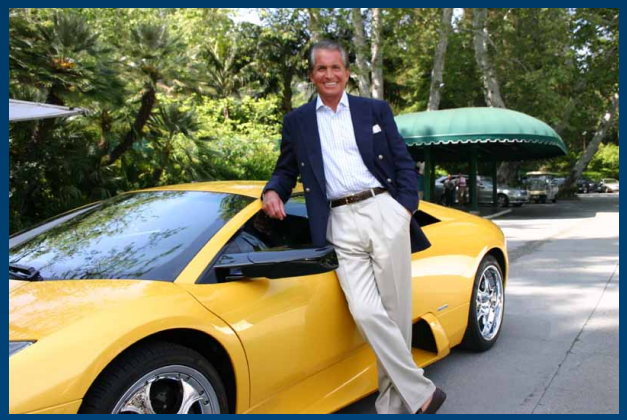


Exposure

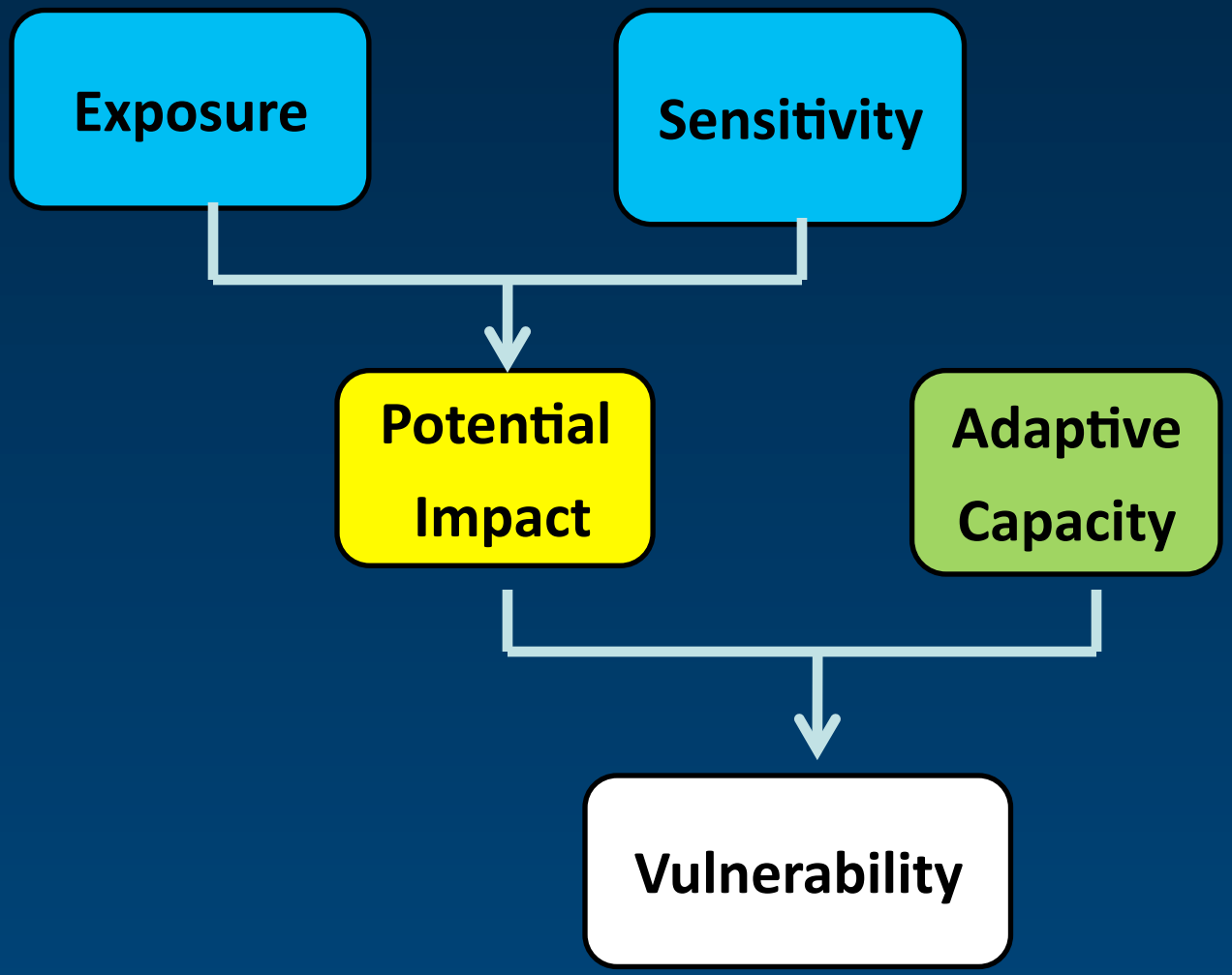
- Measure of how much of a change in climate or other environmental factor a species or system is likely to experience
  - For sunburn, the amount of UV rays determines exposure
  - Strength of rays depends on latitude, season & weather
  - With enough exposure, most anybody can burn

Adaptive Capacity

- Ability to accommodate or cope with climate change impacts with minimal disruption.
  - Can be intrinsic (reduce sensitivity) or extrinsic (reduce exposure)
  - For sunburn, extrinsic adaptations includes sunblock, protective clothes, shelter
  - Intrinsic adaptations include UV-induced increase in melanin production (i.e., tanning)



Vulnerability Assessment Framework



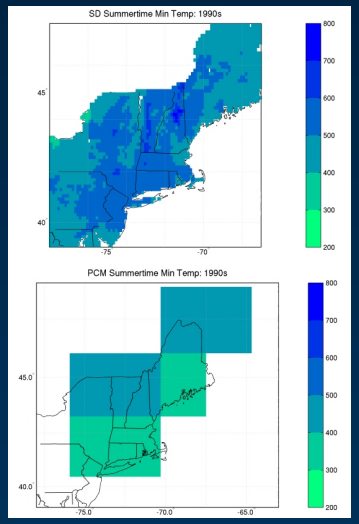
Assessing Sensitivity

Focus on Intrinsic Factors

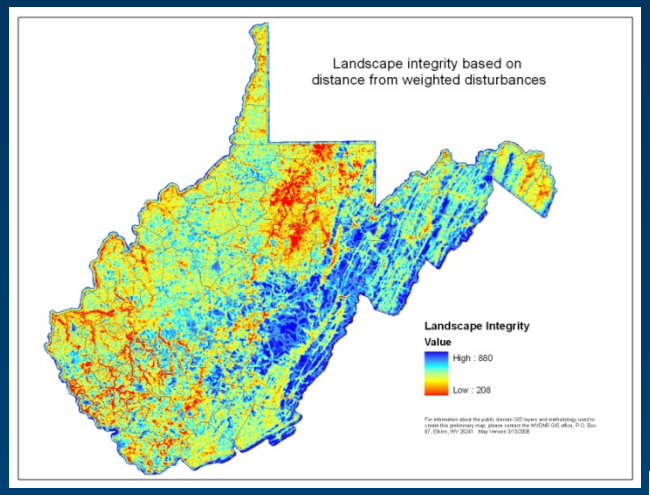
- Specialized habitat or microhabitat requirements
- Narrow environmental tolerances or physiological thresholds
- Dependence on specific environmental triggers
- Dependence on interactions with other species
- Poor dispersal ability

Assessing Exposure
Focus on Extrinsic Factors

- Climate models
  - shifts in temperature, precipitation
  - Increasing availability of finer scale data (e.g., downscaling)
- Ecological response models
  - Climate related vegetation shifts
  - Landscape impediments to dispersal



Downscaled climate data



Landscape integrity

Overarching Considerations for Vulnerability Assessment

- User needs, decision processes
- Conservation targets
  - Species, habitats, ecosystem, ecosystem service
- Spatial scale, level of specificity required
- Available data and expertise
- Levels of confidence/uncertainty
- Cost and time available

Various approaches available:
No one-size fits all

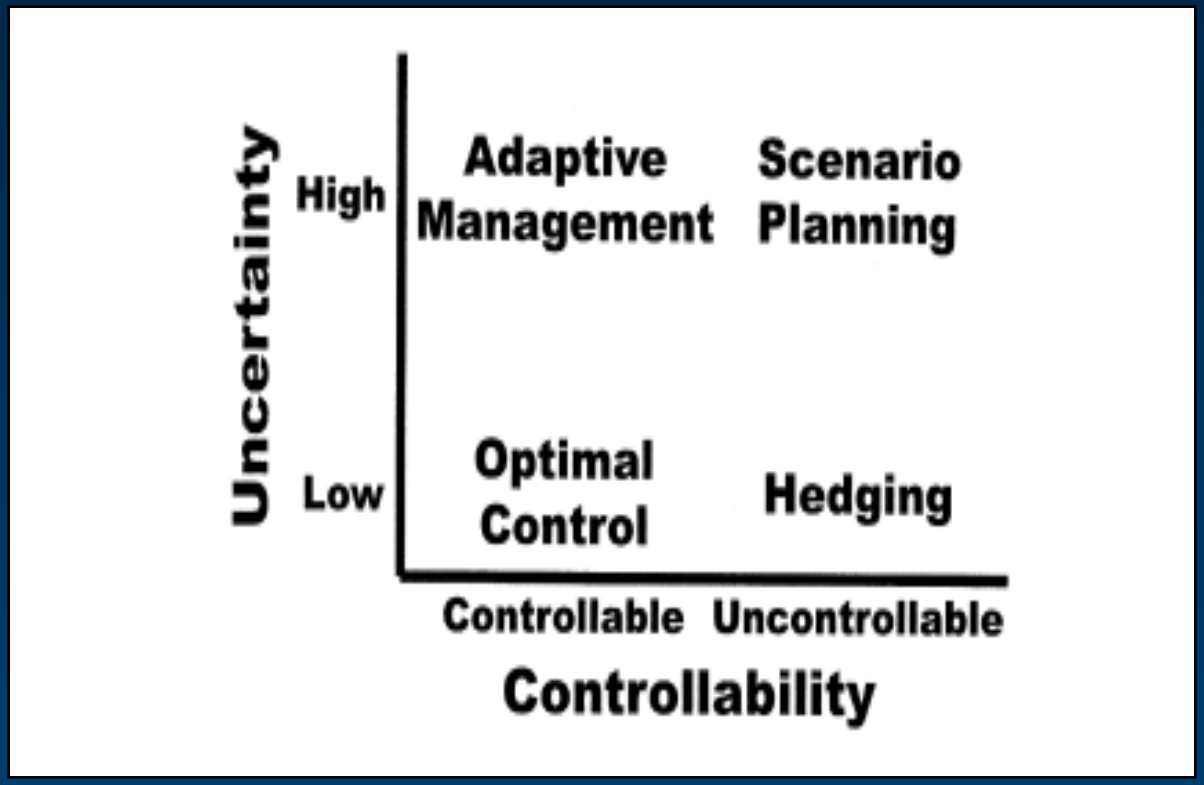
Major Approaches

- Expert opinion
  - usually based on literature, existing data products, prior knowledge
  - often use delphi-type processes
  - can be relatively rapid; often has broad stakeholder engagement
- Model-based
  - computationally and data intensive
  - often use climate envelope-type models or other ecological response models
  - often produces spatially explicit outputs
  - can require substantial expertise, time, and cost

Addressing Confidence

- Three types of uncertainty
  - Climate predictions
  - Ecological responses
  - Management effectiveness
- Uncertainty is common in many things
  - Oftentimes too much focus on uncertainty
  - Need to distinguish between directionality and magnitude of change

Managing Under Uncertainty



From Peterson et al. 2003

Adaptive Management

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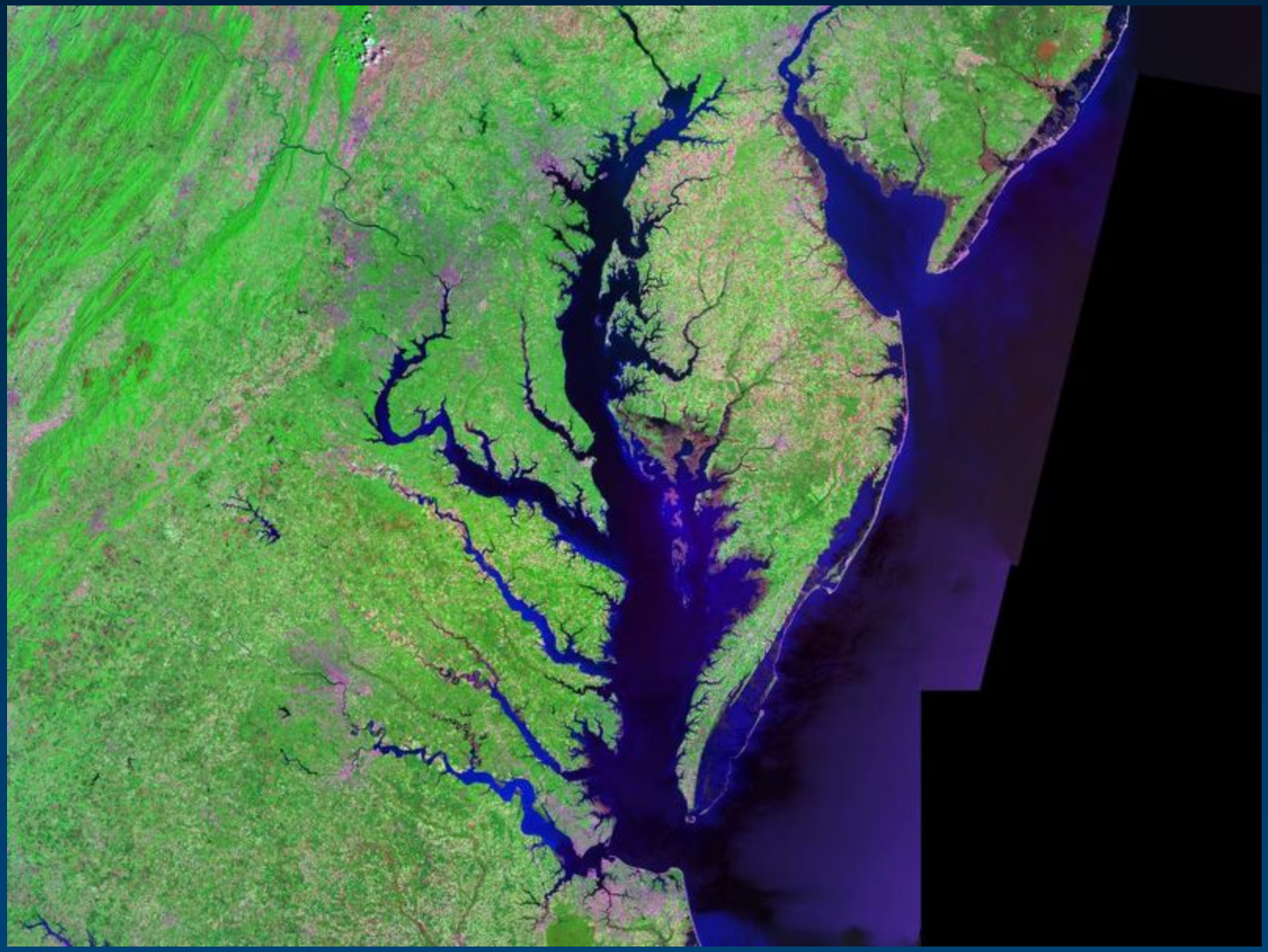
Adaptation

Key Steps for Assessing Vulnerability

- Determine objectives and scope
- Gather relevant data and expertise
- Assess components of vulnerability
- Apply assessment in adaptation planning

Guess Who's Coming to Dinner?

- Traditional conservation focus on maintaining/ restoring to historical condition
- Tendency to focus on what sites will lose in the face of climate change
- Will be important to look towards what ecological value site may have in future