Vulnerability Assessment

Components and Overview
Talk Goals

• Introduce climate change adaptation and the role of vulnerability assessment
• Unpack the concept of vulnerability
• Summarize key assessment steps
Adaptation Planning Framework

Overarching Conservation Goal(s)

1. Identify Conservation Target(s)
   - Species
   - Habitats
   - Ecosystems

2. Assess Vulnerability to Climate Change
   - Sensitivity
   - Exposure
   - Adaptive Capacity

3. Identify Management Options
   - Reduce Sensitivity
   - Reduce Exposure
   - Increase Adaptive Capacity

4. Implement Management Options

Monitor, Review, Revise

From Glick et al. 2011 Scanning the Conservation Horizon
Defining Vulnerability

Climate change vulnerability refers to the extent to which a species, habitat, or ecosystem process is susceptible to harm from climate change impacts.

- **What** things are most vulnerable
- **Why** they are vulnerable
Why Assess Vulnerability?

Vulnerability assessments **can help**:

- Prioritize species and systems for management actions
- Develop management strategies to address climate change
- Efficiently allocate resources

What vulnerability assessments **cannot do**:

- Make a conservation decision for you
Key Steps for Undertaking a Vulnerability Assessment

1. Determine objectives and scope
2. Gather relevant data and expertise
3. Assess the components of vulnerability
4. Apply assessment results in adaptation planning
Steps 1 and 2

1. **Determine objectives and scope**
   - Audience/user needs
   - Goals and objectives
   - Assessment targets (species, habitats, ecosystems)
   - Scale (temporal and spatial)
   - Appropriate approach (no “one size fits all”)

2. **Gather relevant data and expertise**
   - Review existing literature
   - Reach out to experts
   - Obtain/develop climate and ecological response projections

**Can find information through:**
- California Climate Commons
- TACCIMO
- Data Basin
3. Assess components of vulnerability
   – Assess sensitivity, exposure, and adaptive capacity
   – Estimate overall vulnerability
   – Document confidence levels and uncertainties
Assessing Sensitivity

Factors affecting sensitivity of species, habitats, ecosystems:

- Specialized habitat or microhabitat requirements
- Narrow environmental tolerances or physiological thresholds
- Dependence on interactions with other species
Assessing Exposure

Measure of how much of a change in climate or other environmental factor a species or system is likely to experience

Factors to consider when assessing exposure:

- **Climate models**
  - Shifts in temperature, precipitation
  - Increasing availability of finer scale data (e.g., downscaling)

- **Ecological response models**
  - Sea level inundation
  - Climate related vegetation shifts
  - Landscape impediments to dispersal
  - Hydrologic projections
Assessing Adaptive Capacity

Ability to accommodate or cope with climate change impacts with minimal disruption

Factors that can influence amount of adaptive capacity of your species or system:

• **Intrinsic factors**
  – “Plasticity”
  – Dispersal abilities
  – Evolutionary potential

• **Extrinsic factors**
  – Existence of barriers to habitat migration
  – Institutional capabilities
Putting the Pieces Together: How to Assess Vulnerability Components

- **Detailed modeling efforts**
  - In-house or commissioned
  - Mark Schwartz, UC Davis

- **Vulnerability indices**
  - e.g., NatureServe Index
  - Rodney Siegel, IBP

- **Expert elicitation**
  - Supplement and/or supplant modeling
Example Expert Elicitation VA: MA Fish & Wildlife

- Developed draft assessment narrative for each habitat type
- Met with experts to review draft
- Revised draft; Back to experts
- Experts asked vulnerability questions; assigned ranking, confidence value

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<th>Forested Habitats</th>
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<td>Spruce-Fir Forest</td>
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<td>Northern Hardwood Forest</td>
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<td>Southern/Central Hardwood Forest</td>
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<td>Pitch Pine-Scrub Oak Community</td>
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<td>Warm-water Ponds, Lakes, and Rivers</td>
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<td>Coldwater Kettle Ponds</td>
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<td>Connecticut and Merrimack Mainstems</td>
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<td>Spruce-fir Boreal Swamp</td>
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<td>Atlantic White Cedar Swamp</td>
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<td>Riparian Forest</td>
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<td>Saltmarsh</td>
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<td>Brackish Marsh</td>
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MA Fish & Wildlife Expert Elicitation

Five Vulnerability Categories:
1. Critically vulnerable
2. Vulnerable
3. Less Vulnerable
4. Likely to Benefit
5. Likely to Greatly Benefit

Three Confidence Rankings:
1. High
2. Moderate
3. Low

Figure 1. Structure of the NEAFWA Habitat Vulnerability Model.
MA Fish & Wildlife
Vulnerability Rankings

Habitat Vulnerability to Climate Change

Vulnerability score

Habitat

Spruce-fir forest
Northern hardwood forest
Southern hardwood forest
Pitch pine-scrub oak forest
Cold water rivers, streams
Large cold water lakes
Smaller cold water lakes, ponds
Kettle ponds
Warm water rivers, lakes, ponds
Connecticut and Merrick mainstems
Atlantic white cedar swamp
Shrub swamp
Vernal pools
Boreal swamp
Hardwood swamp
PITCH PINE-SCRUB OAK VULNERABILITY EVALUATION

NTWHCS category: Northeastern Interior Pine Barrens/North Atlantic Coastal Plain Pitch Pine barrens

State ranking S2

Vulnerability score 4 (both emissions scenarios)

Confidence evaluation Low

Rationale

Its range extending south to New Jersey and Maryland, this community type reaches its northern limit on sandy, nutrient-poor, drought-prone soils in southern Maine, on Cape Cod, in the southern part of the Massachusetts coastal plain, and in the Connecticut River Valley (see Massachusetts Natural Heritage and Endangered Species Program map below). It is therefore a southern community type that extends into southern and central New England. Its canopy is dominated by Pitch Pine, with an understory of Scrub Oak, Huckleberry, and Lowbush Blueberry. The system is fire-maintained and will revert to White Pine or oak-dominated forest in the absence of fire (NHESP, 2007).

Figure 1. Distribution of Pitch pine-scrub oak communities in Massachusetts.

Pitch pine-scrub oak occurs in significantly warmer climates to the south in New Jersey and Maryland. If the only determinant of its distribution were climate, it would be likely that its distribution in Massachusetts would extend under a warming climate. However, non-climatic factors, mainly the distribution of sandy, nutrient-poor soils; fire frequency; and development, are also important factors. These are likely to be the main limiting factors in any future spread of pitch pine barrens, not climate change. Based on this, a vulnerability score of 4 (extent of habitat may not change appreciably under climate change) has been assigned for both scenarios. The confidence score that we assign for this community type is Low. This is because its future distribution is dependent on uncertain human settlement patterns and responses to climate change. Urban development is already a major fragmenting factor affecting this forest type and it is unlikely that this pressure will ease over the next few decades. Also, as the summers warm and droughts become more frequent and prolonged, fire outbreaks may become more frequent and/or intense. How humans respond to this is a major uncertainty. If the societal response is increased fire suppression (to protect property and lives), it could result in further loss and fragmentation of this habitat type.
Step 4

4. Apply assessment results in adaptation planning

- **Reduce Sensitivity**
  - Example: Actively plant drought-tolerant species in an area projected to get drier

- **Reduce Exposure**
  - Example: Identify and protect cold-water refugia

- **Enhance Adaptive Capacity**
  - Example: Remove coastal armoring to facilitate wetland accretion
Addressing Uncertainty

- Natural resource management has always faced uncertainty
  - Anxiety about uncertainty often leads to “analysis paralysis”
  - Don’t deny it, embrace it
- Document where/why there is uncertainty
- Three types of uncertainty
  - Climate predictions
  - Ecological responses
  - Management effectiveness
- Distinguish between uncertainty in trend vs. rate and magnitude
Up Next: Intro to Assessing Sensitivity