Need to incorporate climate change into near-, medium-, and long-term planning

- Minimize risk of wasting time, money, and effort
- Maximize likelihood of success

“A society grows great when old men plant trees whose shade they know they shall never sit in.” Greek Proverb
Mitigation is what we do to decrease the potential of climate change itself.

Adaptation is how we prepare for and respond to the changes that we are already experiencing/expected to experience.
5. Monitor, Review, Revise

4. Implement Adaptation Options

3. Identify Adaptation Strategies and Actions

2. Assess Vulnerability to Climate Change

1. Define Goals and Identify Priorities

- Changes in management
- Cooperation across organizations

- Define goals
- Identify focal resources

- Reduce vulnerability (↓ S and E)
- Increase adaptive capacity

- Sensitivity
- Exposure
- Adaptive capacity
- Non-climate stressors

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

Climate change vulnerability refers to the degree to which a resource is susceptible to, and unable to cope with adverse impacts of climate change.
Vulnerability is the degree to which a resource is susceptible to, and unable to cope with adverse impacts of climate change.
Vulnerability is the degree to which a resource is susceptible to, and unable to cope with adverse impacts of climate change.

Degree of change a resource is likely to experience

+1°C vs. +5°C
Assessing Exposure

<table>
<thead>
<tr>
<th>Climate Variable</th>
<th>Projected Future Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air temperature</td>
<td>↑ annual temperature</td>
</tr>
<tr>
<td>Extreme heat events</td>
<td>↑ frequency</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Variable</td>
</tr>
<tr>
<td>Drought</td>
<td>↑ frequency; ↑ risk of multi-year drought</td>
</tr>
<tr>
<td>Snowpack</td>
<td>↓ annual depth</td>
</tr>
<tr>
<td>Timing of snowmelt</td>
<td>Shift ~10-30 days earlier by 2100</td>
</tr>
<tr>
<td>Wildfire</td>
<td>↑ total area burned</td>
</tr>
</tbody>
</table>

Factors to consider when assessing exposure:

- **Climate models**
  - Shifts in temperature, precipitation

- **Ecological response models**
  - Climate related vegetation shifts
  - Hydrologic projections

Measure of how much of a change in climate or other environmental factor(s) a resource is likely to experience.
Defining Vulnerability

Vulnerability is the degree to which a resource is susceptible to, and unable to cope with adverse impacts of climate change.

**IPCC 2007**

Sensitivity

Whether and how a resource reacts to climate change

*E.g., does an increase in temperature matter?*
Assessing Sensitivity

Measure of whether and how a resource is likely to be affected by a given change in climate

Factors affecting sensitivity of species, habitats:

- Narrow environmental tolerances
- Specialized habitat or microhabitat requirements
- Impacts of non-climate stressors
Vulnerability is the degree to which a resource is susceptible to, and unable to cope with adverse impacts of climate change.

**Defining Vulnerability**

**IPCC 2007**

Ability of a resource to accommodate or cope with climate impacts
Assessing Adaptive Capacity

Ability of a resource to accommodate or cope with climate change impacts with minimal disruption

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

- **Intrinsic factors**
  - “Plasticity”
  - Ability to resist or recover from stressors

- **Extrinsic factors**
  - Barriers to dispersal/migration
  - Institutional capabilities
Assessing Vulnerability
(Should I take my umbrella?)

**Exposure**: What is the likelihood of rain today?

**Sensitivity**: Will it be detrimental if I get wet?

**Adaptive Capacity**: Can I get out of the rain?
Vulnerability is the degree to which a resource is susceptible to, and unable to cope with adverse impacts of climate change.

Purpose of a vulnerability assessment:
Identify what resources are most vulnerable and why
Climate Adaptation Framework

1. Define Goals and Identify Priorities
   - Define goals
   - Identify focal resources

2. Assess Vulnerability to Climate Change
   - Sensitivity
   - Exposure
   - Adaptive capacity
   - Non-climate stressors

3. Identify Adaptation Strategies and Actions
   - Changes in management
   - Cooperation across organizations
   - Reduce vulnerability (↓ S and E)
   - Increase adaptive capacity

4. Implement Adaptation Options

5. Monitor, Review, Revise

From Glick et al. 2011 *Scanning the Conservation Horizon*
Defining Adaptation

Climate change adaptation refers to natural or human adjustments in an ecosystem in response to changing climate conditions.

Adaptation strategies attempt to reduce the negative effects of or respond to climate change.
Climate adaptation actions reflect the **intentional** integration of climate change

- **Current/same actions** – now even more important!
- **New/different actions**
- **Modifications to current actions**

Swanstom et al. 2017
Applying Vulnerability Assessment Results in Adaptation Planning

Vulnerability = Exposure * Sensitivity - Adaptive Capacity

↓ Exposure

↓ Sensitivity

↑ Adaptive capacity
Applying Vulnerability Assessment Results in Adaptation Planning

\[
\text{Vulnerability} = \text{Exposure} \times \text{Sensitivity} - \text{Adaptive Capacity}
\]

\[\downarrow \text{Exposure}\]

*Example*: Protect resources and infrastructure from flood damage
Applying Vulnerability Assessment Results in Adaptation Planning

Vulnerability = Exposure * Sensitivity
- Adaptive Capacity

\[ \downarrow \text{Sensitivity} \]

*Example:* Reduce or eliminate invasive species that outcompete native species
Applying Vulnerability Assessment Results in Adaptation Planning

Vulnerability = Exposure * Sensitivity
- Adaptive Capacity

↑ Adaptive capacity

Example: Adjust recreation timing or route of access
Adaptation Strategies

Resistance

Resilience

Response

Knowledge

Collaboration
Resistance Strategies

**Prevent** the effects of climate change from reaching or affecting you.

**Examples:**
- Increase proactive management to prevent invasive weeds
- Reduce erosion potential to protect municipal water supplies and sensitive aquatic habitats
- Identify and protect aquifer recharge zones
- Focus thinning activities in areas where fire is most likely to carry up from neighboring habitats
Resilience Strategies

*Weather* the impacts of climate change by avoiding the effects of or recovering from changes.

**Examples:**

- Remove or modify infrastructure to allow channel migration within the floodplain
- Promote native genotypes and adapted genotypes of native species
- Employ a risk-diversification approach to forest management and silvicultural practices
Response Strategies

Intentionally accommodate change and enable resources to adaptively respond to changing and new conditions.

Examples:

- Facilitate change to desired species assemblages
- Promote connected landscapes that can facilitate species migration along climatic gradients
- Identify and protect refugia
- Accept loss of recreation sites and/or adjust the timing or route of access
Gather more information about climate changes, impacts, or the effectiveness of management actions in addressing climate change.

Examples:

- Map water sources and aquifers to improve understanding about spatial and temporal connections between surface flows and groundwater
- Learn more about fire return intervals in subalpine habitat and the effects of fire suppression
- Research and identify regional drought-adapted ecotypes
Collaboration Strategies

Coordinate efforts and/or capacity across jurisdictional and political boundaries to create holistic approaches to adaptation.

Examples:

- Coordinate management actions across land management designations to meet mutual goals for conifer habitats
- Implement a landscape-scale monitoring program designed to increase the identification, detection, and prediction of insect and disease outbreaks
- Coordinate invasive species management, funding, and support between agencies
Adaptation planning **can help:**

- Shift the *way* you are implementing current actions
- Identify new approaches to management or new actions
- Prioritize no-regrets actions with high likelihood of success/impact
- Identify cross-resource opportunities that:
  - Accomplish objectives across a range of resources
  - Can be used to leverage funding, partnerships, etc.
Key Considerations

**Context**
- Focus on what you manage and what you can do

**Creativity**
- Think outside the box!

**Collaboration**
- Work with traditional and non-traditional partners to develop and implement solutions

**Awareness**
- Be aware of unintended consequences/impacts on other sectors and resources

**Flexibility**
- Embrace flexibility to make changes as needed

**Planning Horizon**
- Consider short-, medium-, and long-term time frames within a portfolio of adaptation strategies
Questions?

1990
SO, THIS CLIMATE CHANGE THING COULD BE A PROBLEM...

1995
CLIMATE CHANGE: DEFINITELY A PROBLEM.

2001
YEP, WE SHOULD REALLY BE GETTING ON WITH SORTING THIS OUT PRETTY SOON...

2007
LOOK, SORRY TO SOUND LIKE A BROKEN RECORD HERE...

2013
WE REALLY HAVE CHECKED AND WE'RE NOT MAKING THIS UP.

2019
IS THIS THING ON?

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