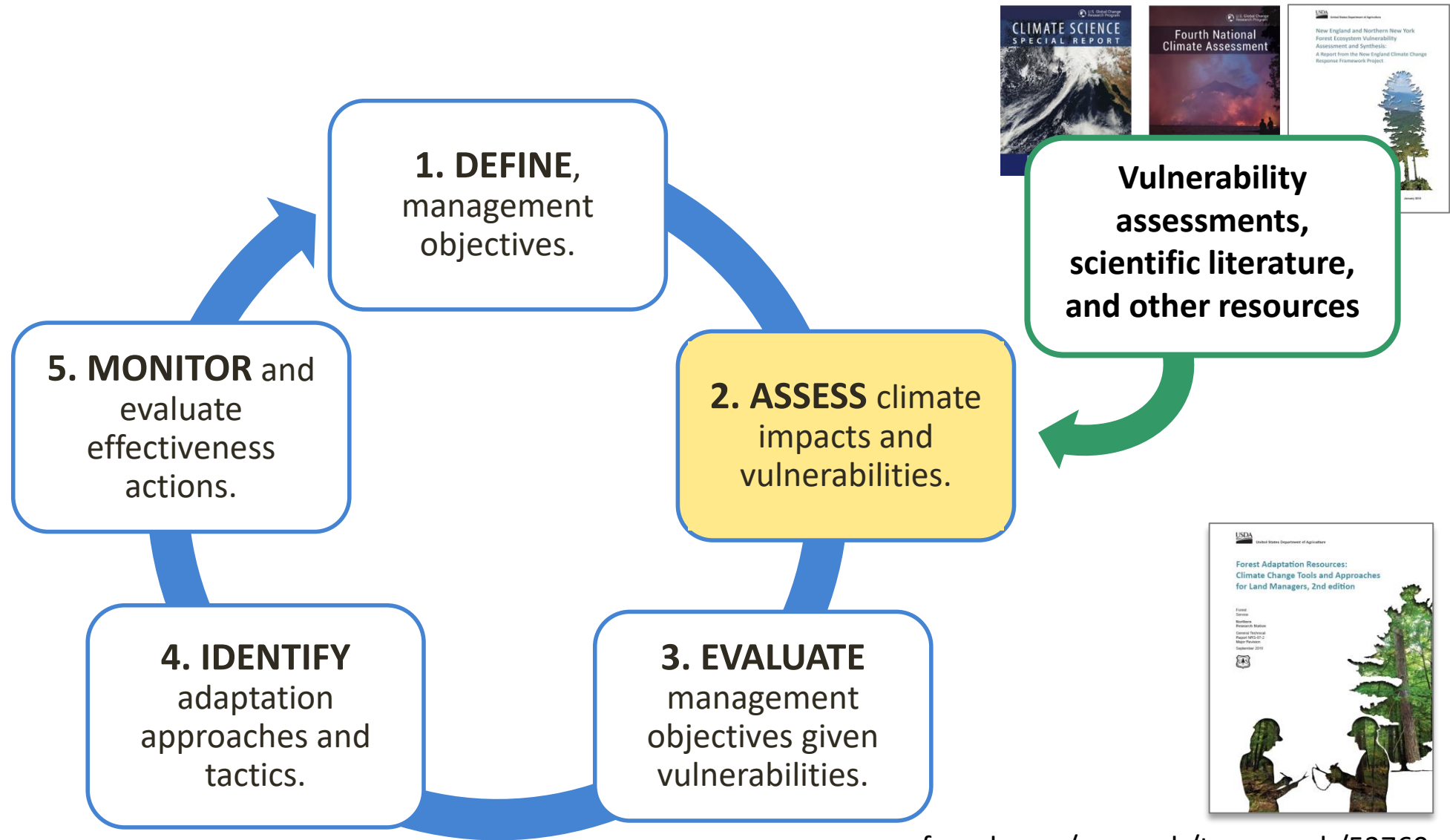


# Climate Change Impacts: Northern New England & New York



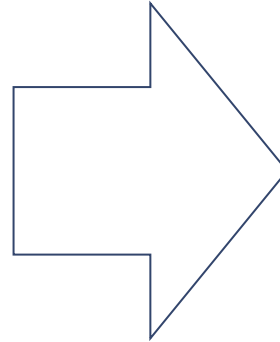
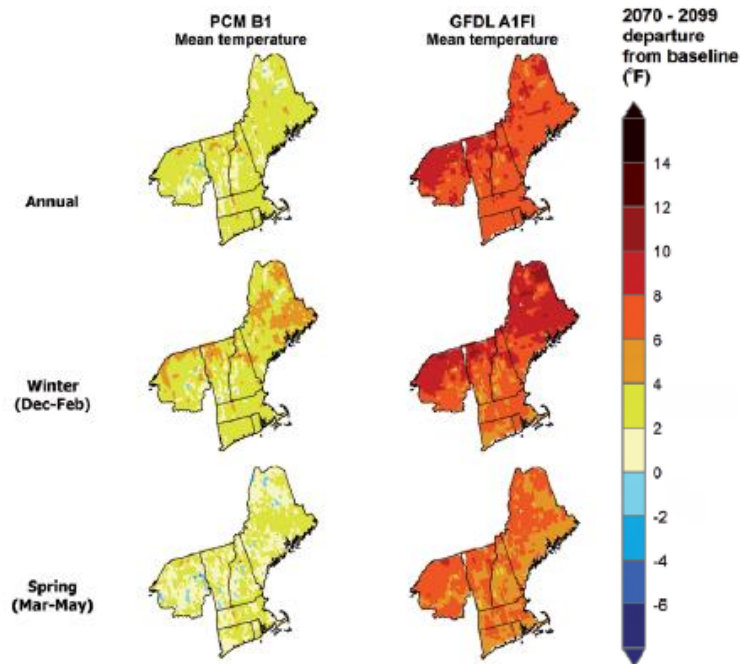
# Adaptation Workbook: Decision-support tool



# Step 2: ASSESS climate change impacts and vulnerabilities

## Regional Climate Impacts

Based on regional resources



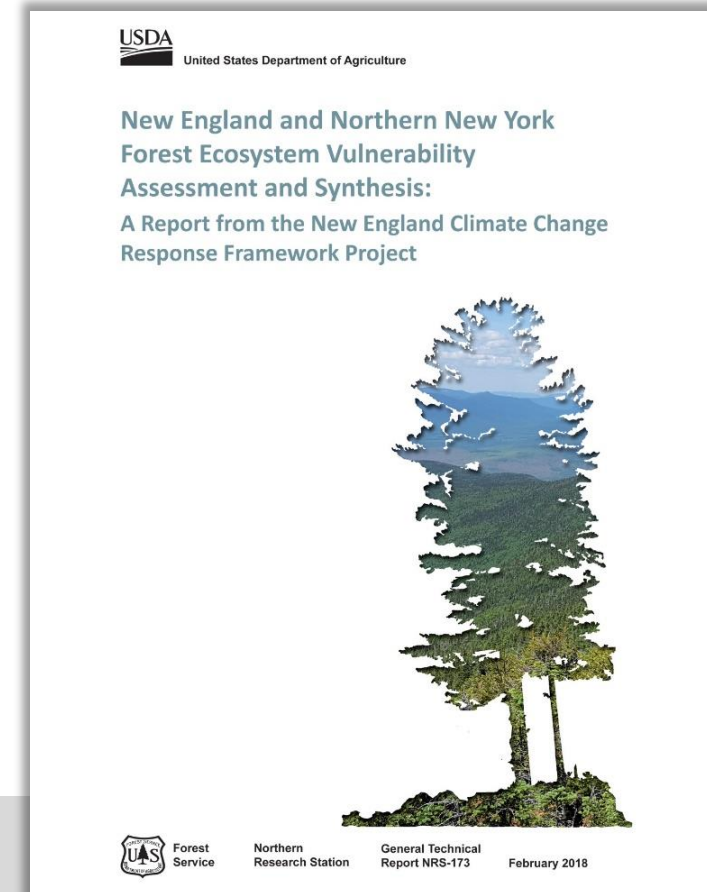
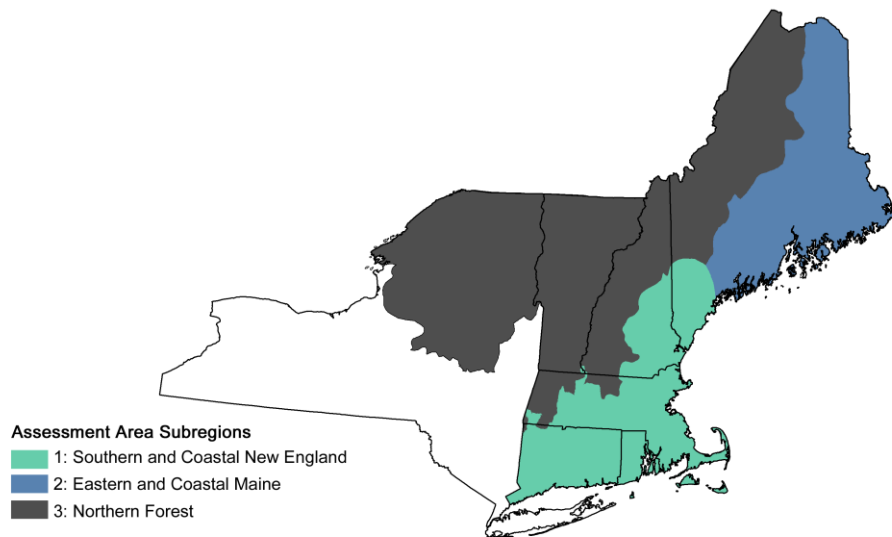
## Site-specific Impacts

Based on your expertise



# New England Vulnerability Assessment

- Report, primarily for **natural resource professionals**
- Focus on **tree species and forest ecosystems**
- Examine a **range** of future climates
- Evaluate **key ecosystem vulnerabilities** to climate change under a range of future climate uncertainty using existing models and information
- Does **not make recommendations** or assess vulnerability to changes in management, land use, or policy



Vulnerability assessment:

[www.fs.usda.gov/research/treesearch/52760](http://www.fs.usda.gov/research/treesearch/52760)

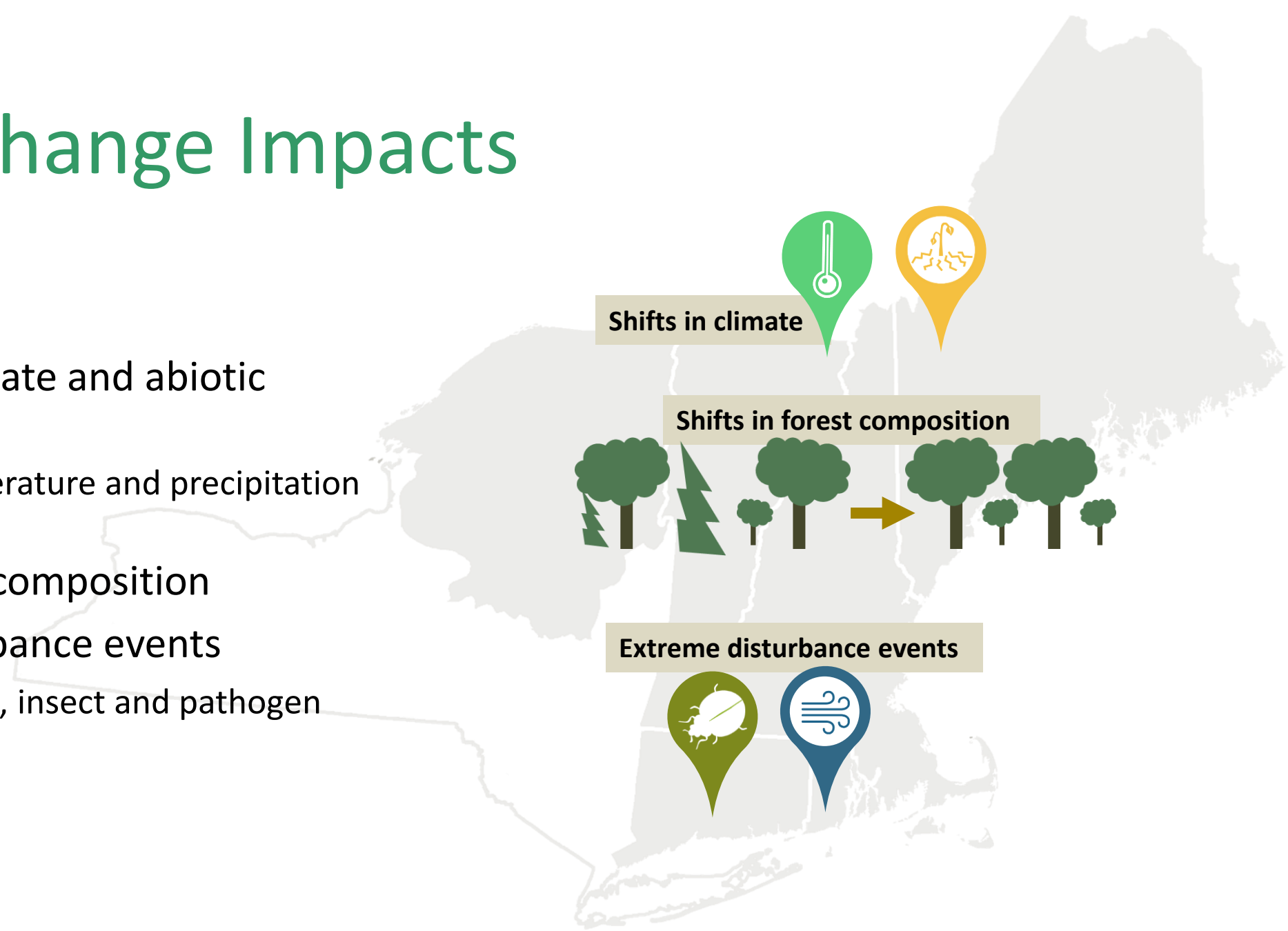
Additional resources & story map:

[www.forestadaptation.org/new-england](http://www.forestadaptation.org/new-england)

# Climate Change Impacts

## Three buckets:

- Changes in climate and abiotic conditions
  - Altered temperature and precipitation patterns
- Shifts in forest composition
- Extreme disturbance events
  - Severe storms, insect and pathogen outbreaks



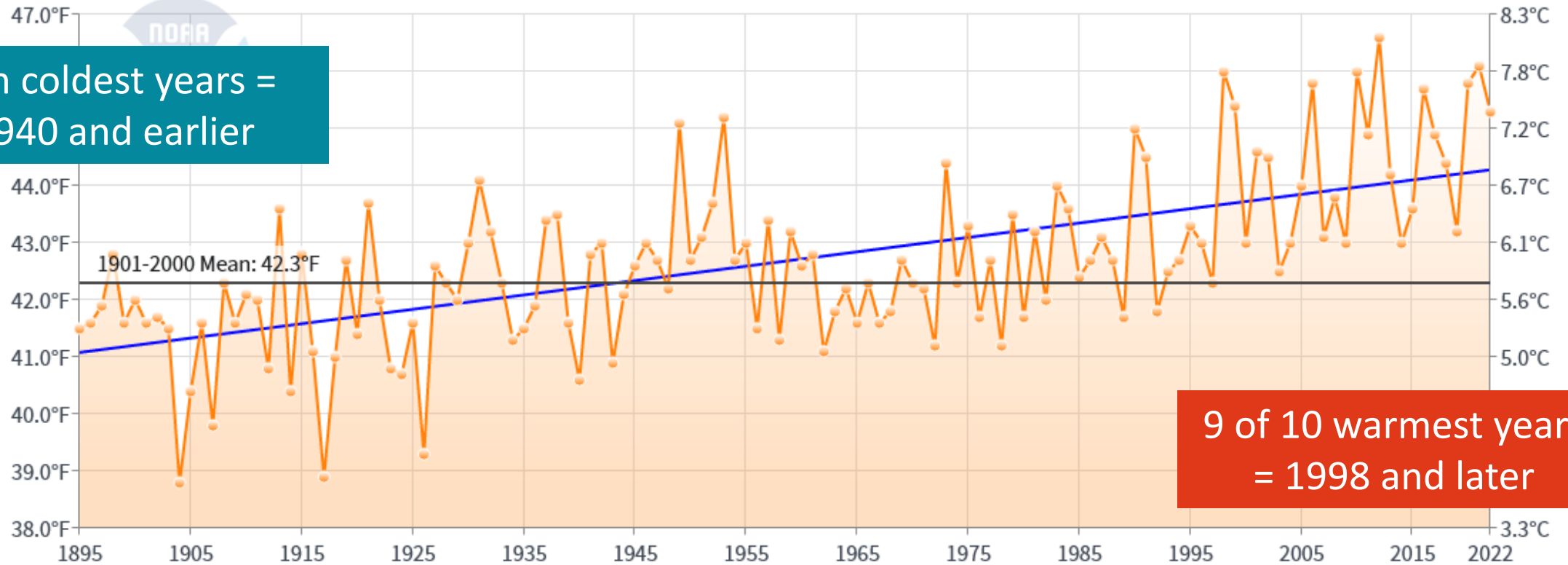
# Observed Changes in Climate (NH)

Temperatures have risen  $>2^{\circ}\text{F}$  since turn of last century.

**New Hampshire Average Temperature**  
January-December

— 1895-2022 Trend  
( $+2.5^{\circ}\text{F}/\text{Century}$ )

Ten coldest years =  
1940 and earlier



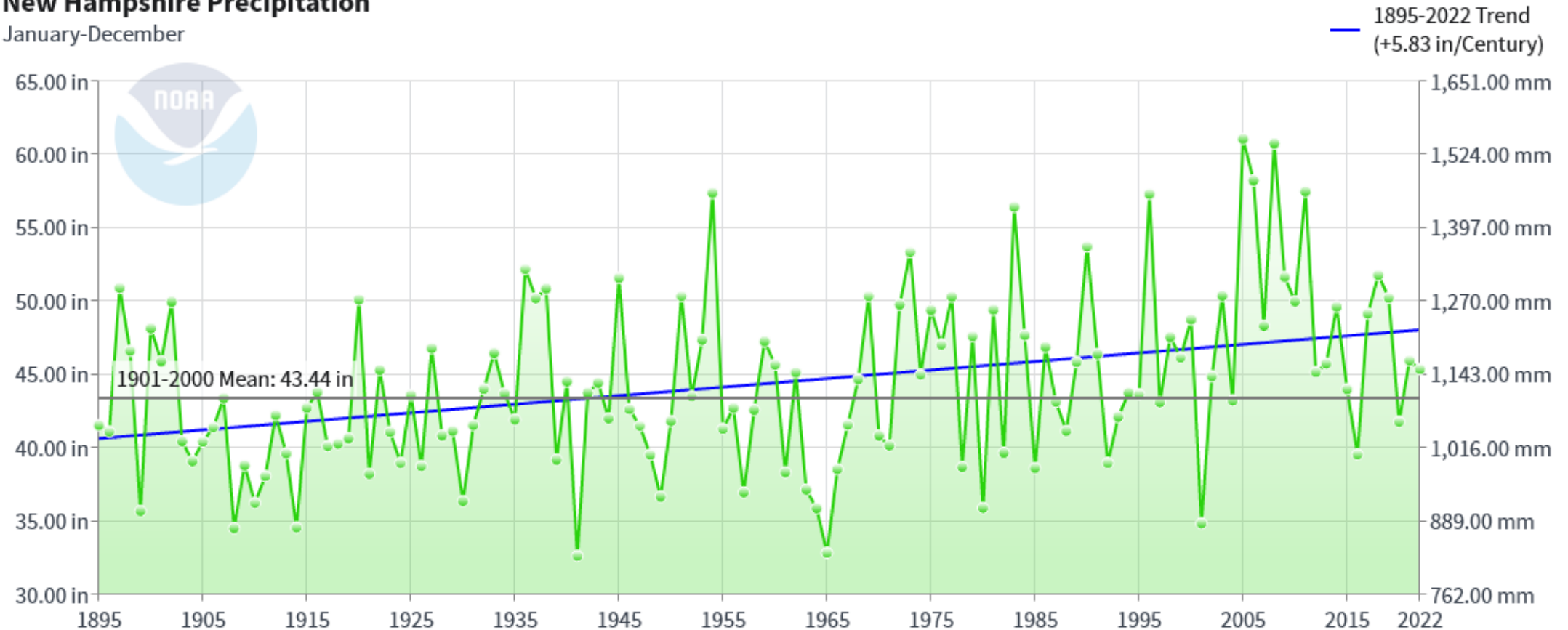
9 of 10 warmest years  
= 1998 and later

# Observed Changes in Climate (NH)

Annual precipitation has increased about 5.8 inches.

## New Hampshire Precipitation

January-December



# Not Just Warmer Temps

- Extreme rain events
- Extreme storms
- Sea-level rise
- Coastal flooding

NOAA



Dan Turner, Cambridge Fire Dept.



NY DEC



VTRANS/VT ANR

# Future Changes in Climate

Anticipated Change in Climate	Evidence	Confidence
<b>Warmer temperatures</b> increasing another 3.5 to 8.5 °F	● ● ●	● ● ●
<b>Longer growing season</b> increasing another 20+ days	● ● ●	● ● ●
<b>Shorter, warmer winters</b> with less snow fall and snow cover	● ● ●	● ● ●
<b>Sea levels rising</b> by another 7 to 23 inches	● ● ●	● ● ●
<b>Altered precipitation patterns</b> with increased annual rainfall	● ● ●	● ● ●
<b>Intense precipitation events</b> that are more frequent and severe	● ● ●	● ● ●
<b>Altered soil moisture</b> potentially both wetter and drier	● ●	● ● ●
<b>Increased risk of drought stress</b> during the growing season	● ●	● ●

● ● ● = *robust/high*  
 ● ● = *medium*

# Warmer Winter (Less Snow)

## Projected decreases in snow fall, cover, and depth

- 30-70% decreases in snowfall
- Greatest loss in December/January

## Decreased snowpack

- Increased soil freeze-thaw cycles can damage roots and alter soil processes

Area with some snow on ground for 30 days per year



Red = historic

White = high emissions

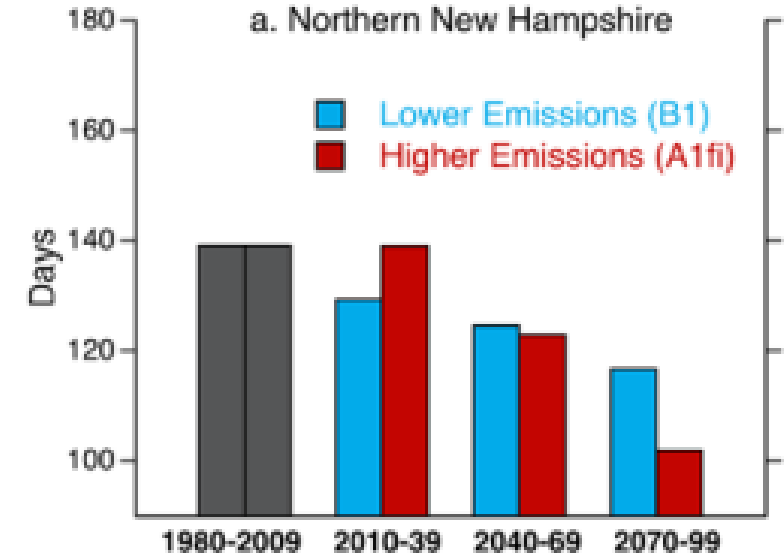
# Warmer Winter (Less Snow)

## Projected decreases in snow fall, cover, and depth

- 30-70% decreases in snowfall
- Greatest loss in December/January

## Decreased snowpack

- Increased soil freeze-thaw cycles can damage roots and alter soil processes



*Number of snow-covered days*

# Warmer Winter (Less Snow, More Rain)

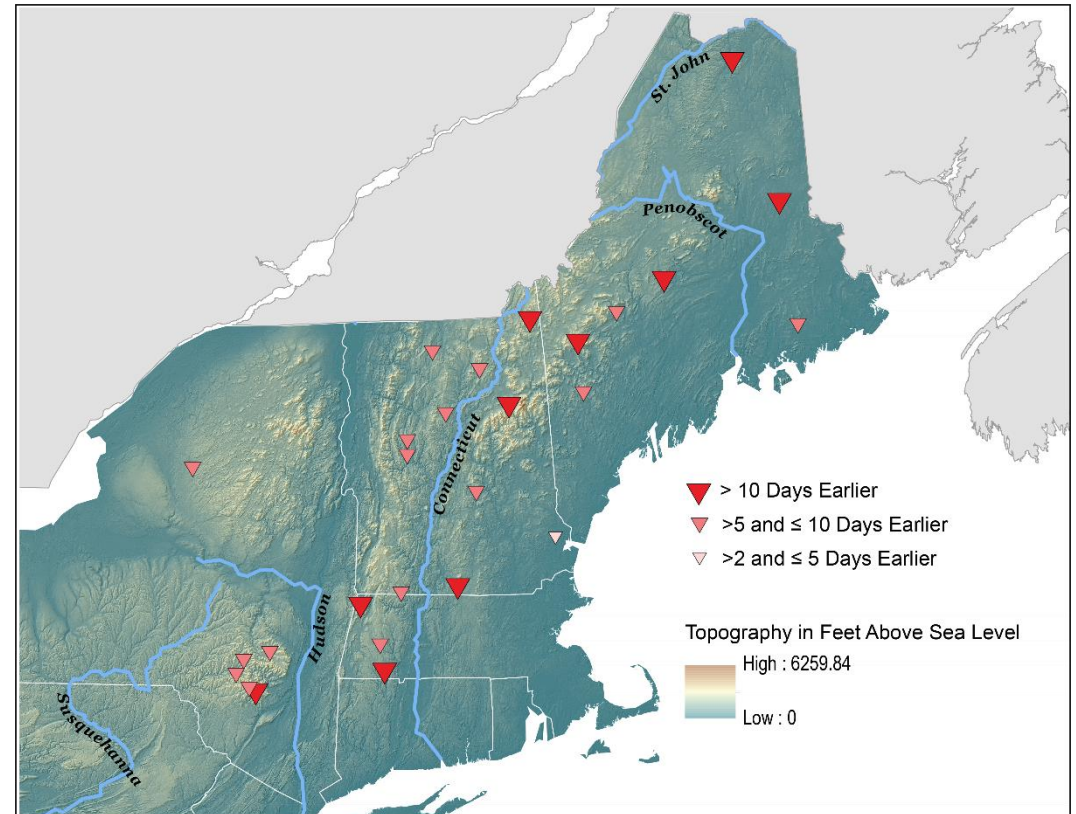
## More rain

- Warmer temperatures
- Increased precipitation
- Extreme rain events

## Earlier peak stream flows

- Flashiness and episodic high flows may increase

**What may be at risk:** Increased erosion or sedimentation on susceptible sites; culvert washouts and road damage from extreme events; aquatic habitats and species



*Historical changes in the timing of snowmelt-related streamflow (1960-2014)*

# Longer Growing Season

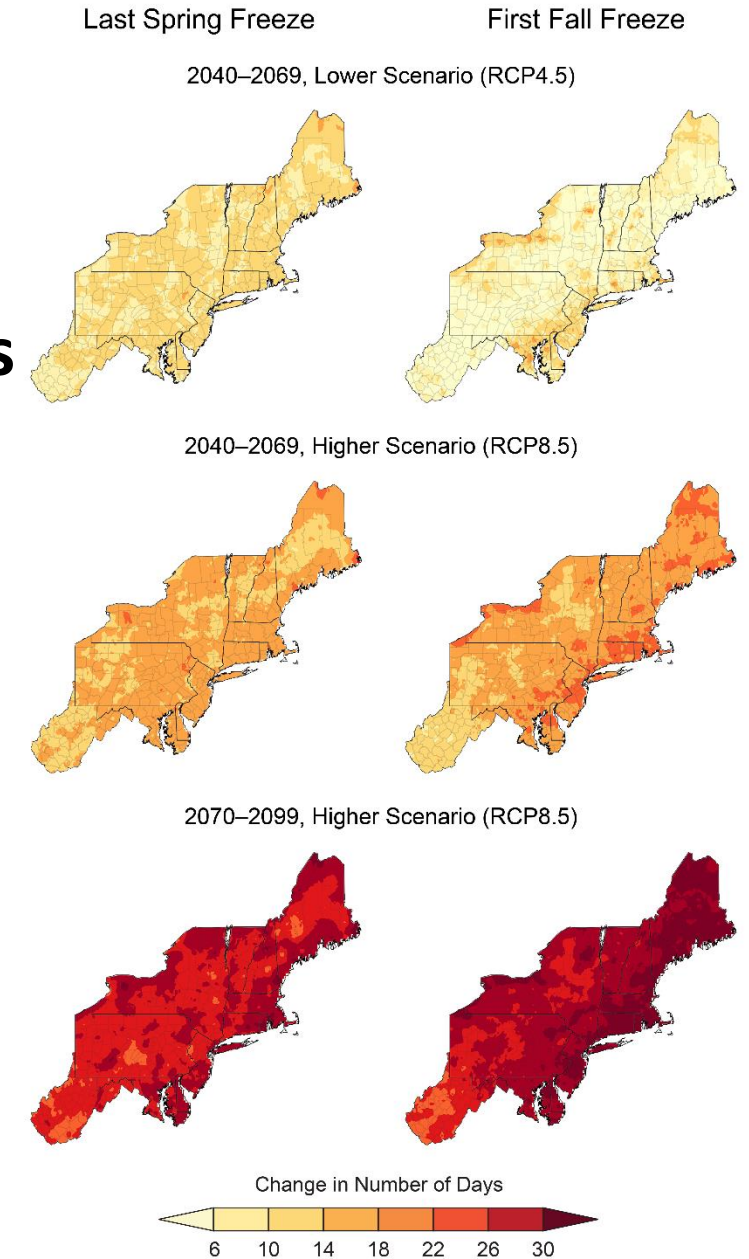
**Warmer temps result in longer growing seasons**

- Evidence of phenological shifts
- Projected to increase 3-7+ more weeks

**Longer period for plant growth**

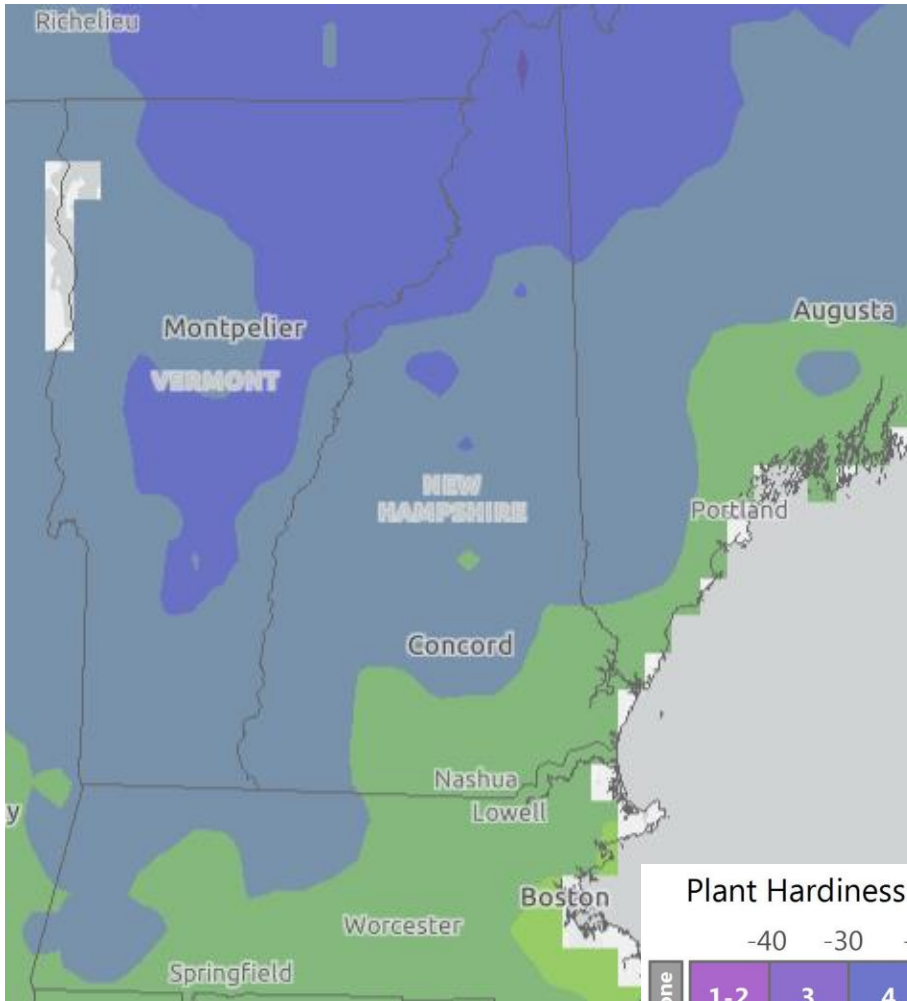
**Phenological changes/mismatches**

- Early bud break and frost damage spring freezing.

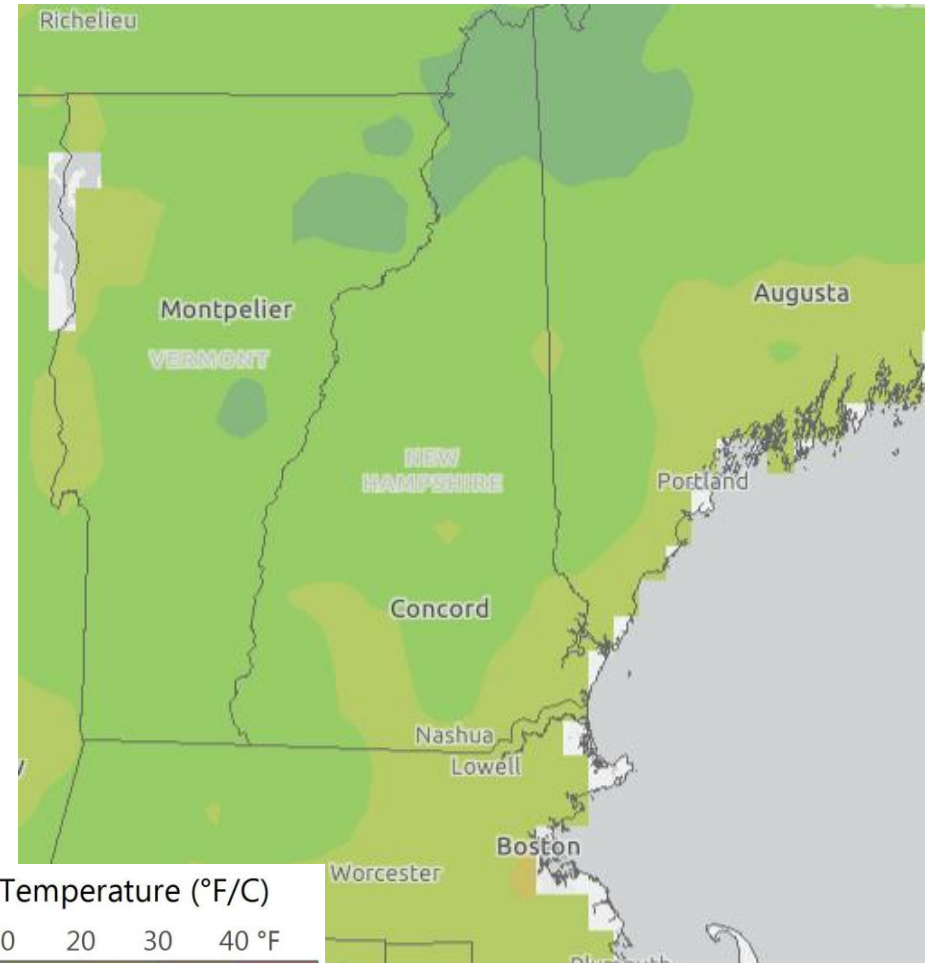


# Longer Growing Season/Warmer Winter

1980-2009



2070-2099 (RCP 8.5)

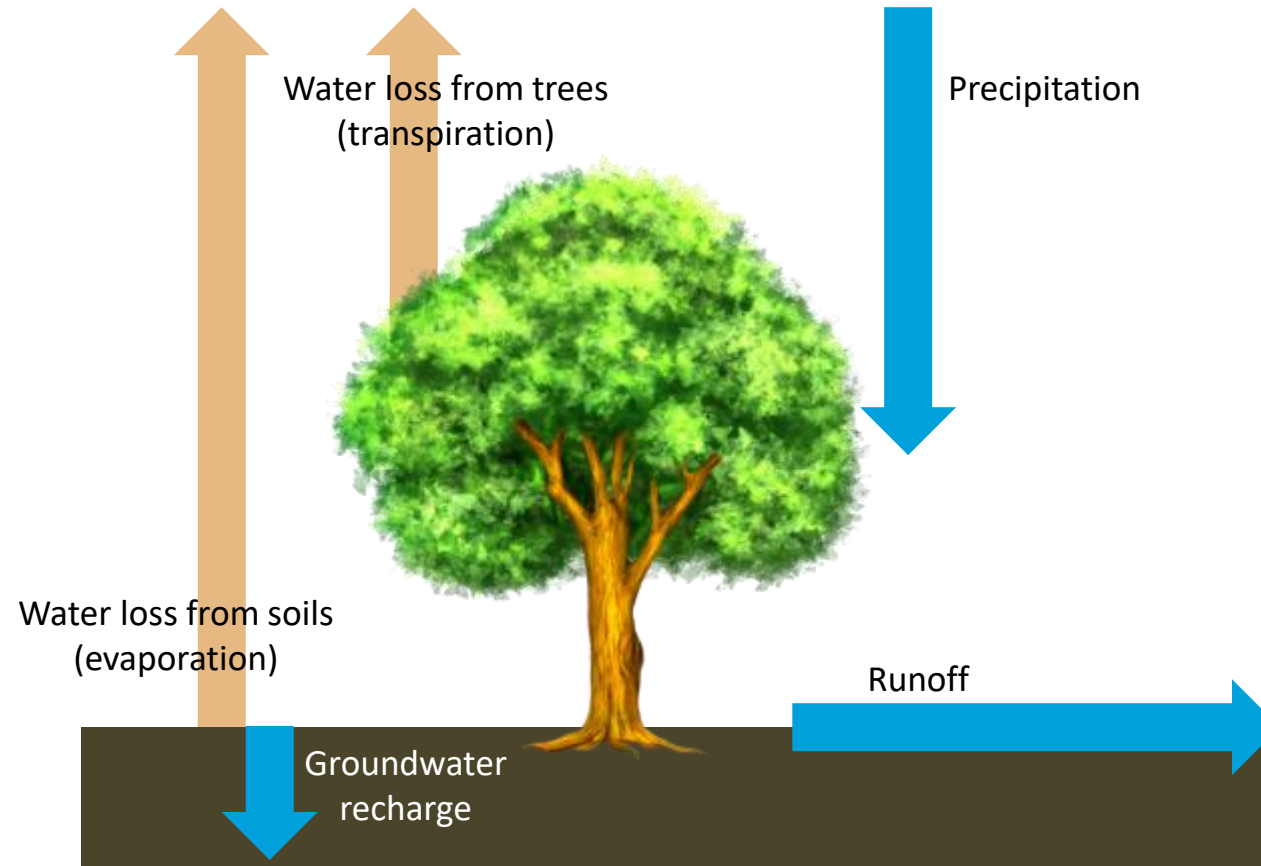


Plant Hardiness Zones: Minimum Temperature (°F/C)



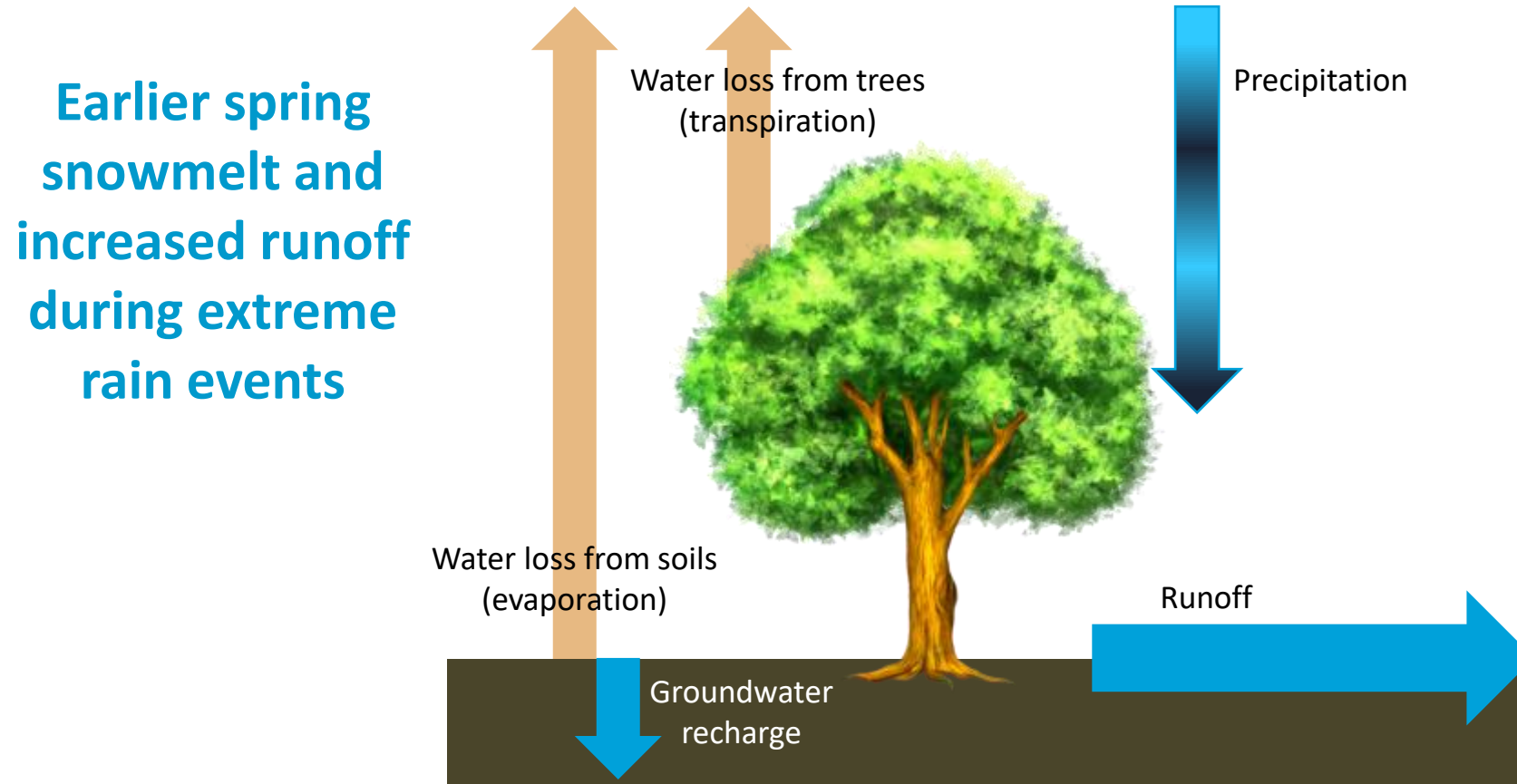
# Increased Risk of Moisture Stress

Longer and warmer growing seasons may lead to drier conditions during the growing season.



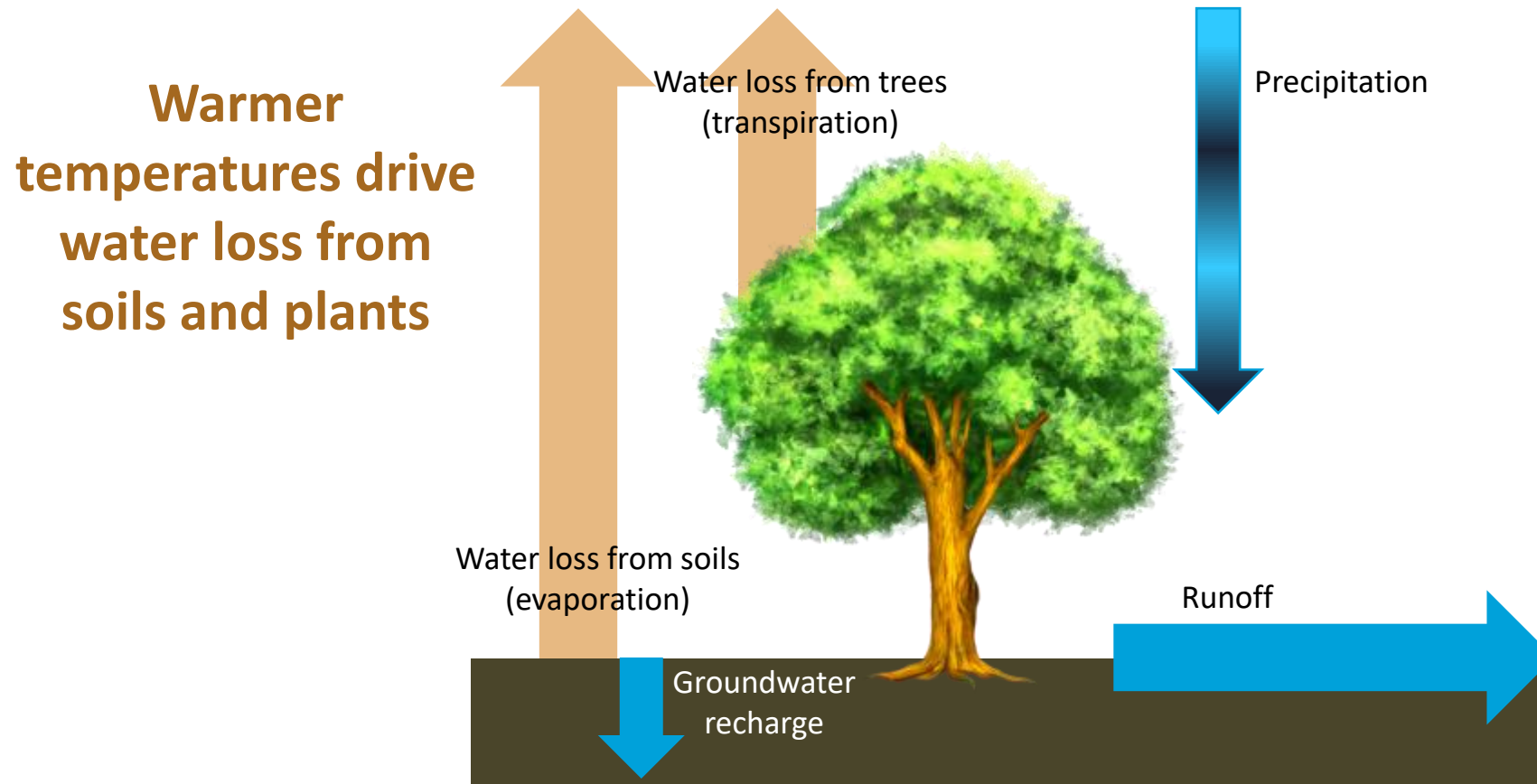
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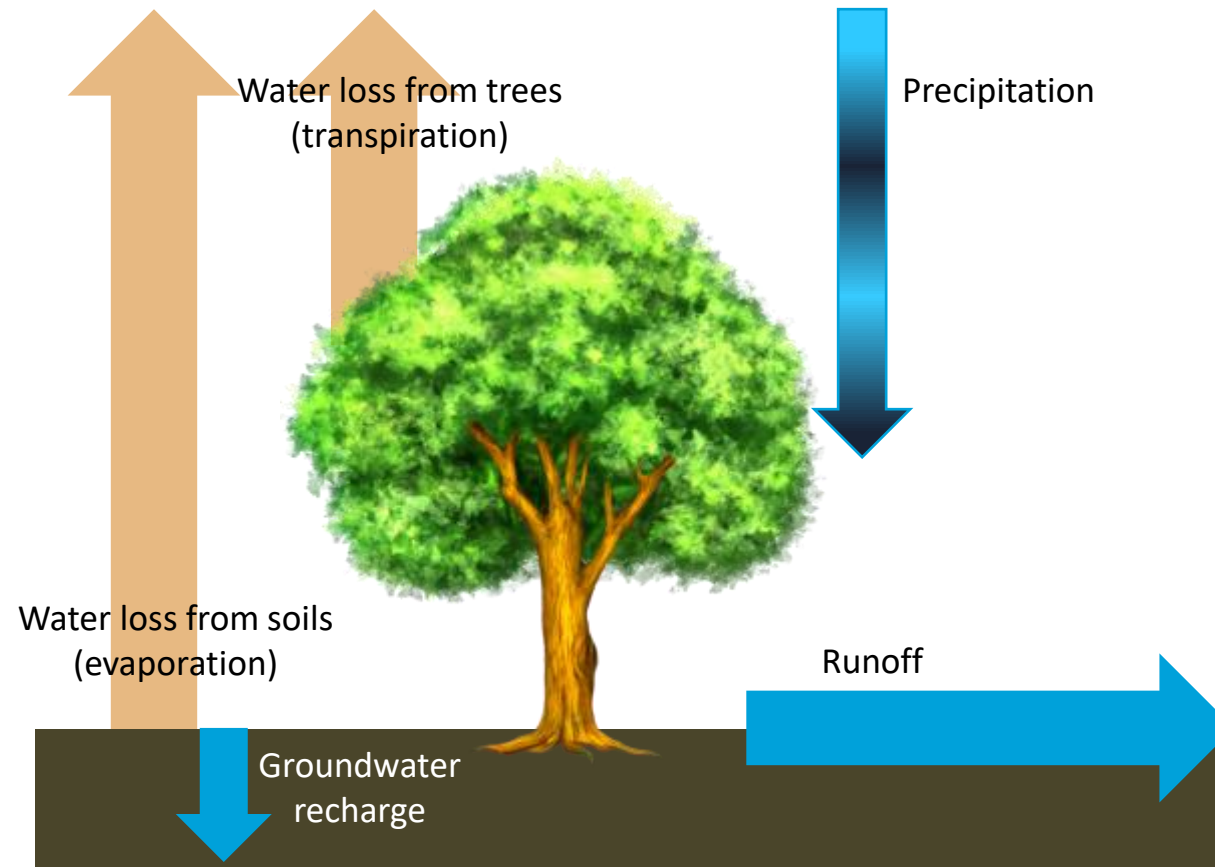


# Increased Risk of Moisture Stress

Longer and warmer growing seasons may lead to drier conditions during the growing season.

## Risk may be greatest:

- Sites with drought-prone or shallow soils
- South-facing ridges
- Mesic species on drier sites (marginal sites or off-site)



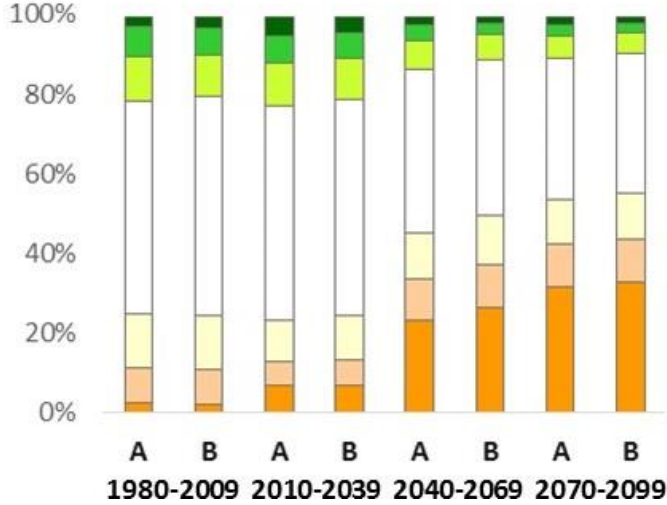
# Drought?

Palmer Drought Severity Index (PDSI) for the Northeast under two greenhouse gas emissions scenarios

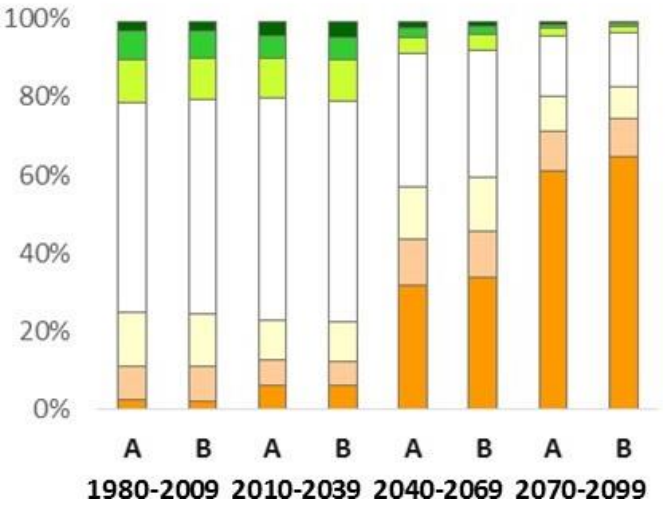
Northeast



## RCP 4.5

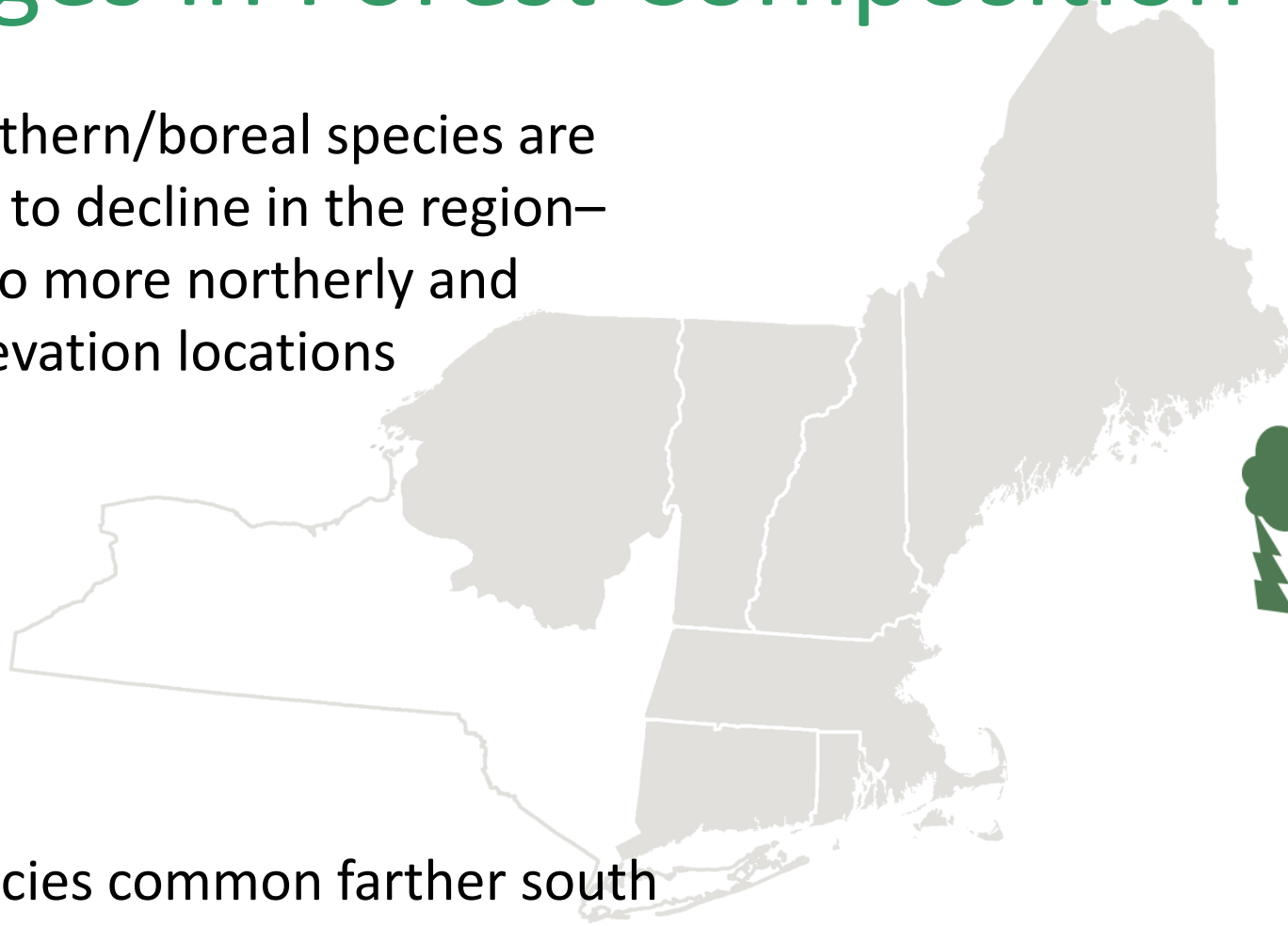


## RCP 8.5



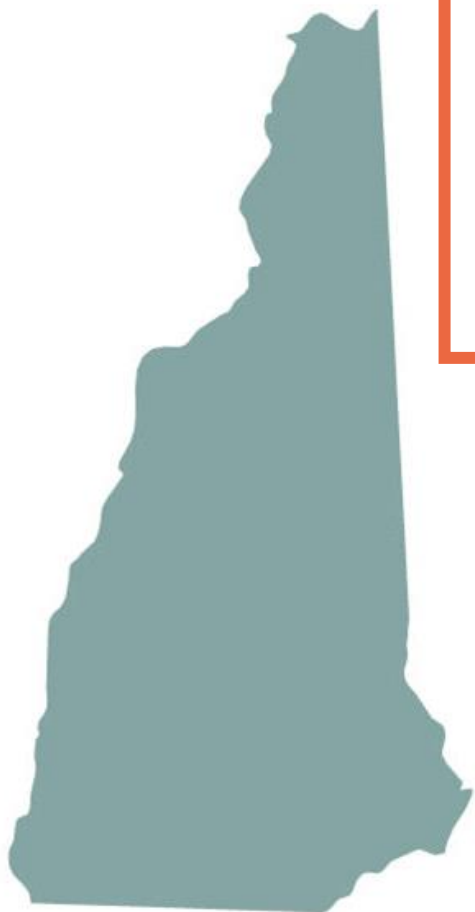
# Changes in Forest Composition

Many northern/boreal species are projected to decline in the region—contract to more northerly and higher-elevation locations



Many species common farther south are expected to see increased and new habitat within the region.

# Changes in Forest Composition



## Declining Habitat

- Black spruce
- Red pine
- Red spruce
- White spruce
- Tamarack
- Black ash

## Likely to Persist (Fair/Good Capability)

- American beech
- American elm
- Bitternut hickory
- Black walnut
- Eastern white pine
- Eastern hemlock
- Northern red oak
- Northern white-cedar
- Paper birch
- Red maple
- Sugar maple
- Yellow birch

## Increasing Habitat

- American basswood
- Bigtooth aspen
- Black oak
- Black cherry
- Northern red oak
- Scarlet oak
- Shagbark hickory
- White oak

## New habitat

- Black hickory
- Eastern redbud
- Loblolly pine
- Shortleaf pine
- Southern red oak
- Sycamore
- Yellow-poplar
- Virginia pine

# Changes in Forest Composition

- Many common tree species are projected to have reduced suitability in the future
- Changes will occur slowly—not instant dieback
- Mature and established trees should fare better
- Immense lags to occupy habitats
- Critical factors: competition, management, & disturbance

## **Risk may be greatest:**

- Location is relatively near the southern extent of species range
- Trees are projected to decline and located on a marginal site
- Forest is composed of few species, esp. those projected to decline
- Other factors reduce system function or add stress

# Extreme Events

Extreme events may become more frequent or severe

- Heavy precipitation
- Heat waves/droughts
- Wind storms
- Hurricanes
- **“Events” are not well modeled**



# Wildfire

Future climate conditions suggest increased risk of weather conducive to fire.

## **Wildfire may increase:**

- Warmer/drier summers
- Increased tree stress or mortality
- Shift toward fire-associated species like oaks and pines

## **Wildfire may not change:**

- Spring/early summer moisture
- Current regeneration of more mesic species
- Spatial patterns of land use and fragmentation
- Fire suppression



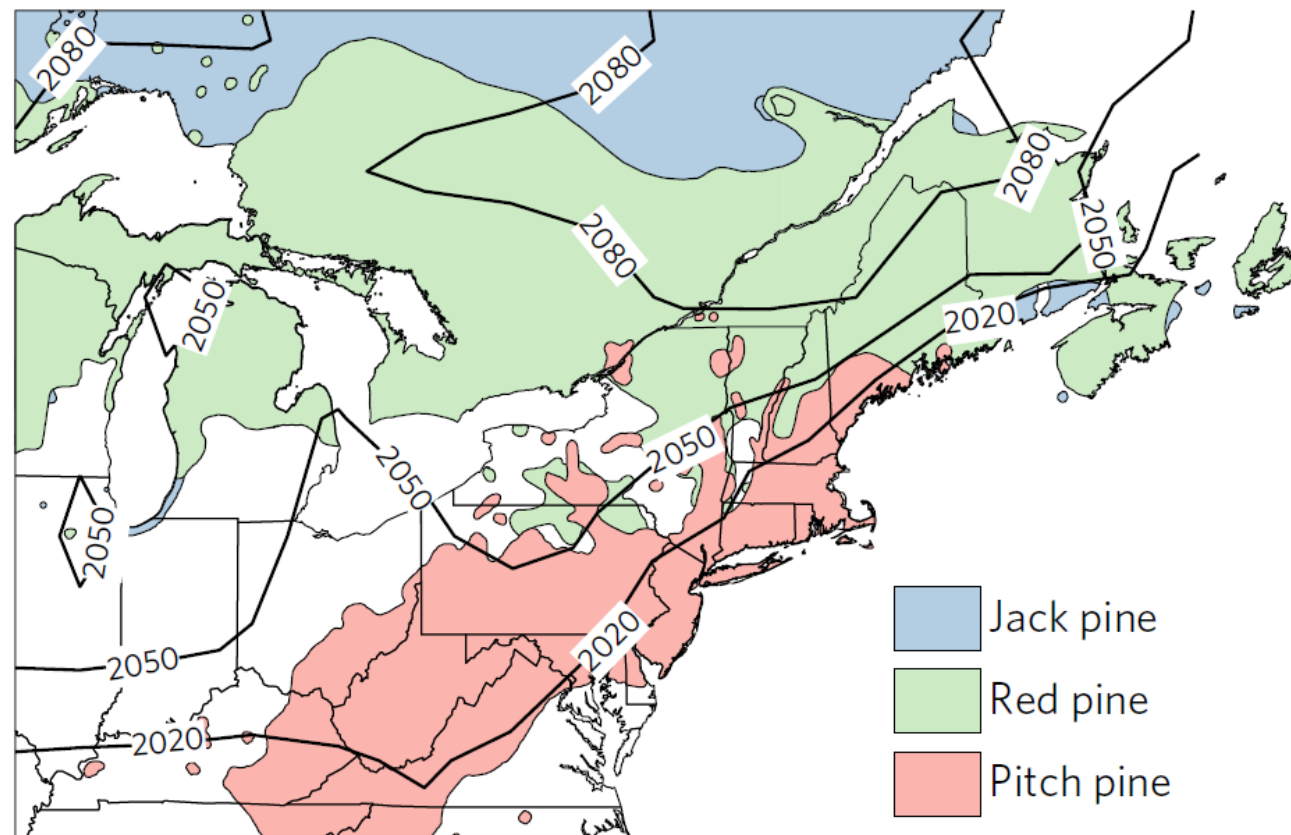
# Insects and Diseases

Increased damage from forest insects & diseases

**Indirect:** Stress from other impacts increases susceptibility

**Direct:**

- Pests migrating northward
- Decreased probability of cold lethal temperatures
- Accelerated lifecycles



Projected southern pine beetle expansion into ranges of forest types with suitable dominant pine species (Lesk et al. 2017)

# Invasive Plants

Increased habitat for many noxious plants

**Indirect:** Stress or disturbance from other impacts can affect the potential for invasion or success

**Direct:**

Expanded ranges under warmer conditions

Increased competitiveness from ability of some plants to take advantage of elevated CO<sub>2</sub>



# Deer Herbivory

Here to stay.

Deer populations likely to be maintained or increase:

- More overwinter survival & better condition due to warmer conditions
- Population expansions near northern edge of range.

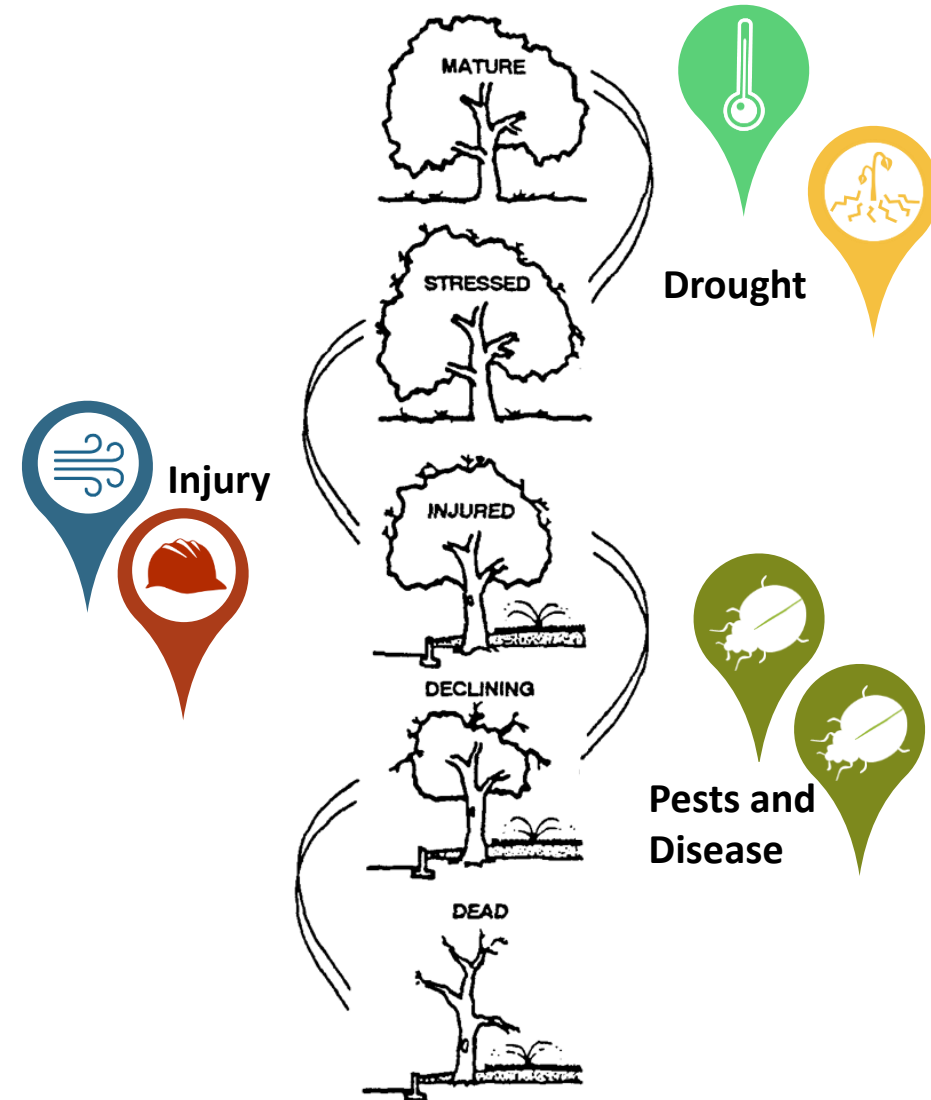


# Interactions are Critical

**Climate change is a “threat multiplier”**

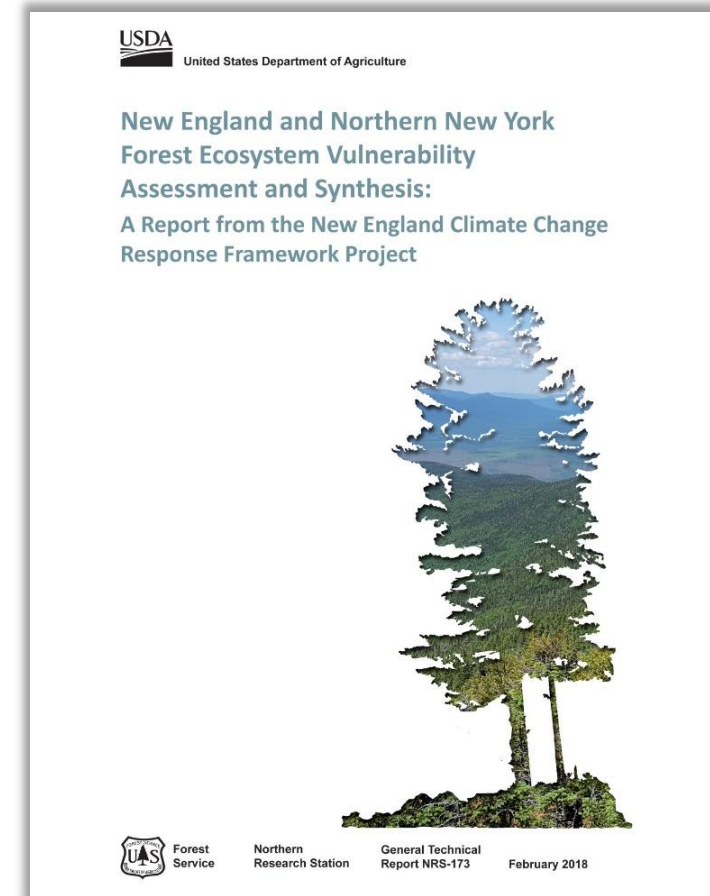
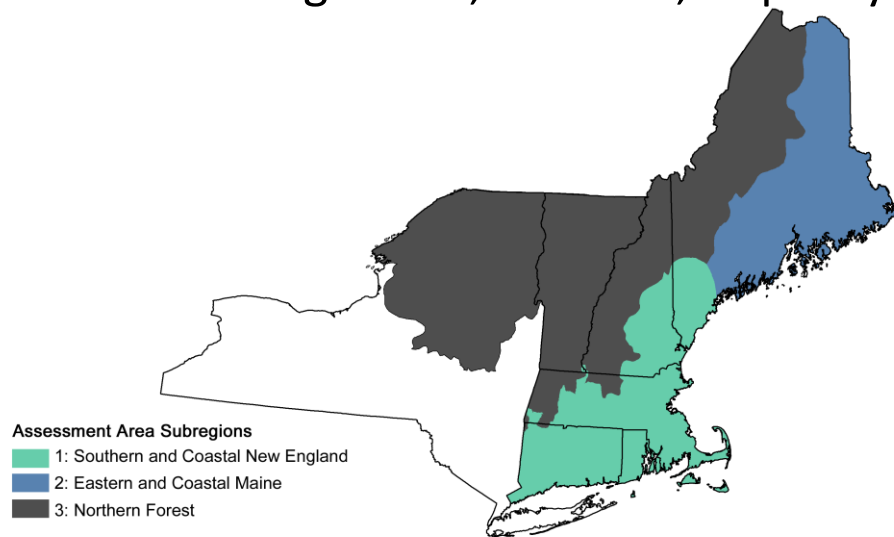
- Chronic stress
- Disturbances
- Insect pests
- Forest diseases
- Invasive species

**Interactions make all the difference.**



# New England Vulnerability Assessment

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# Other Resources

- New England Vulnerability Assessment
  - [forestadaptation.org/new-england](https://forestadaptation.org/new-england)
- USDA Forest Service Climate Change Tree atlas
  - <https://www.fs.usda.gov/nrs/atlas/>
- New England Tree Species Lists
  - <https://forestadaptation.org/learn/resource-finder/climate-change-projections-individual-tree-species-new-england-and-northern>
- New Hampshire reports:
  - [New Hampshire State Climate Summary](#) (NOAA/Runkle et al.: 2017)
  - [Climate Change in Northern New Hampshire: Past, Present and Future](#) (Wake et al 2014)