

Climate Change & Regional Forests

This presentation will describe:

- Observed climate trends
- Projected changes in climate
- Impacts to tree species & forest ecosystems

More resources are available at:

www.forestadaptation.org and
www.forestadaptation.org/new-england

The screenshot shows a webpage titled "New England Forest Vulnerability" under the "CLIMATE CHANGE RESPONSE FRAMEWORK" header. The page includes a navigation menu with options like "Who we are", "Assess", "Adapt", "Learn", "Focus", and "Contact". The main content area features a large landscape photograph of a forested mountain range. Below the photo is a section titled "New England and Northern New York" with a descriptive paragraph about the region's forests and their vulnerability to climate change. To the right of this text is a map of the New England region, highlighting the states of Maine (ME), New Hampshire (NH), Vermont (VT), Massachusetts (MA), Connecticut (CT), and Rhode Island (RI). Below the map is a section titled "Vulnerability Assessment" with a paragraph explaining the assessment process and two buttons: "Download the Assessment" and "View the Story Map". At the bottom of the page, there is a section titled "Work with us" with a paragraph about the assessment's role in the framework.

CLIMATE CHANGE
RESPONSE FRAMEWORK

Who we are ▾ Assess ▾ Adapt ▾ Learn ▾ Focus ▾ Contact 🔍

New England Forest Vulnerability

Home » Assess » Ecosystem Vulnerability » New England Forest Vulnerability

New England and Northern New York

Stretching from the coast of the Atlantic Ocean to the peaks of the Appalachian Mountains, this region covers more than 50 million acres. Regional forests and natural ecosystems provide numerous cultural, economic, and environmental benefits, and are facing increasing threats from a changing climate. Warmer and more variable conditions are already having an impact on the region's forests, increasing damage from extreme precipitation events and insect pests. Future changes could dramatically alter the landscape that characterizes the region.

Vulnerability Assessment

We developed a vulnerability assessment for this region that describes climate change risks and opportunities for forests. Two global climate models, three forest impact models, hundreds of scientific papers, and forest manager expertise were combined to assess the effects of climate change on forest ecosystems. More than 30 scientists and forest managers contributed to the assessment.

➤ Download the Assessment

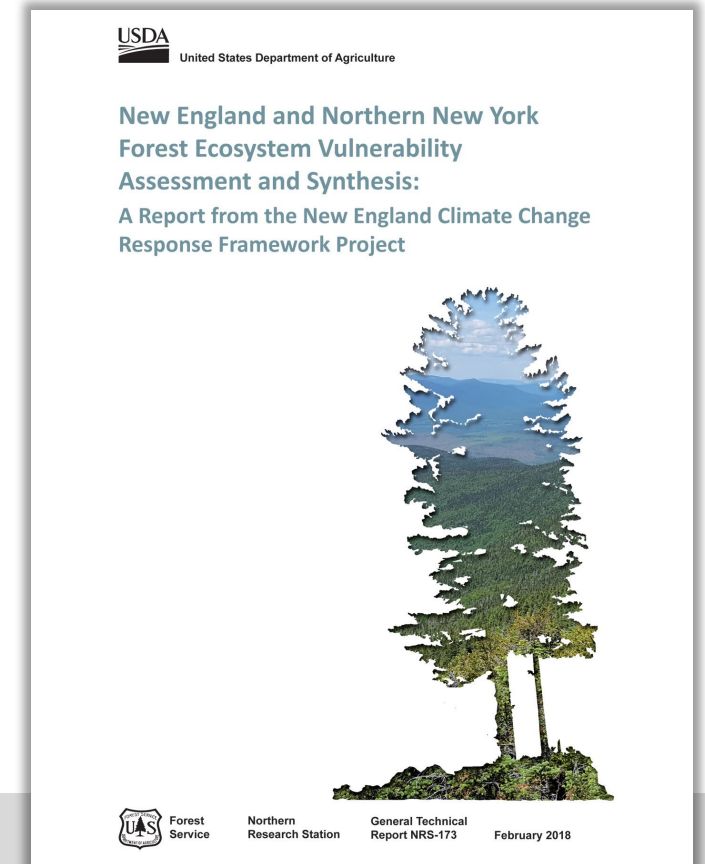
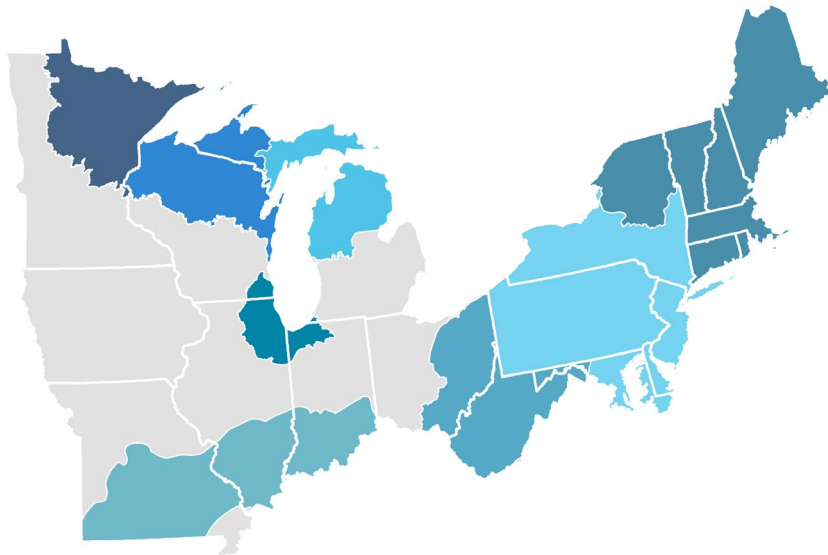
➤ View the Story Map

Work with us

The vulnerability assessment provides critical information about how climate change is expected to affect this region and serves as a starting point for other Framework activities.

Vulnerability Assessment & Synthesis

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



Vulnerability assessment:
www.nrs.fs.fed.us/pubs/55635

Additional resources & story map:
www.forestadaptation.org/new-england

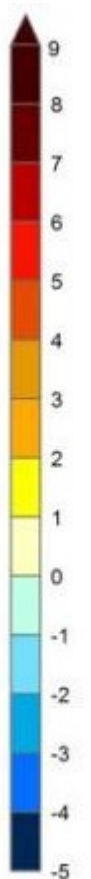
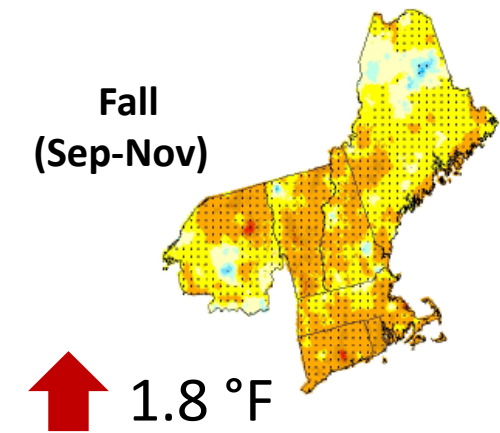
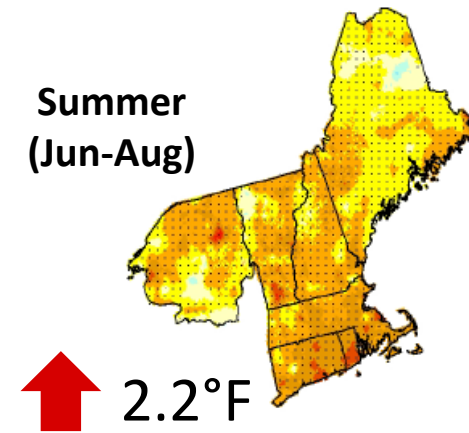
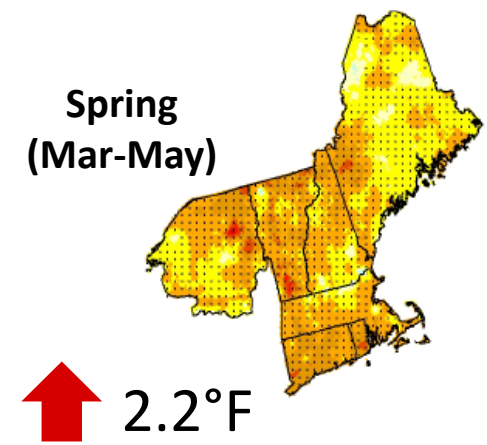
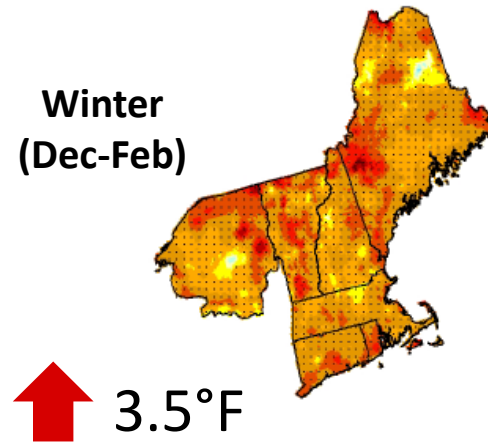
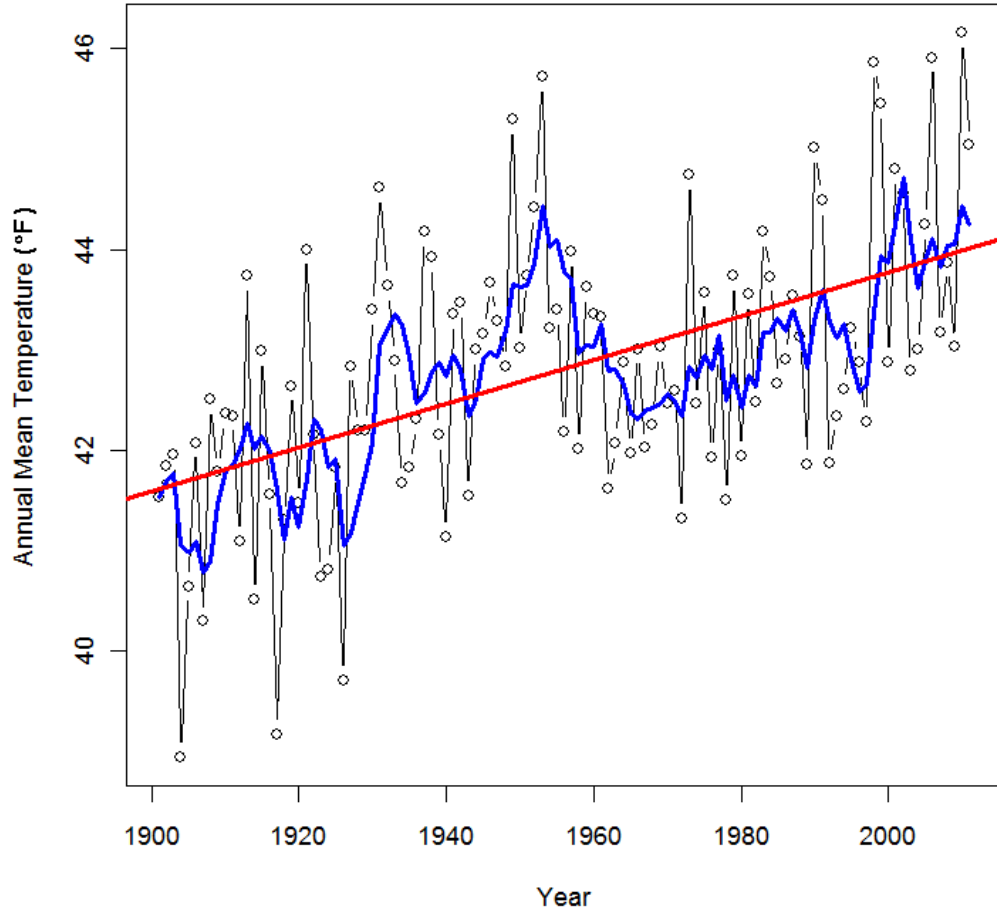
Future Changes in Climate

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

● ● ● = robust/high
 ● ● = medium

Observed Temperature Changes

Observed annual temperature change (1901-2011)



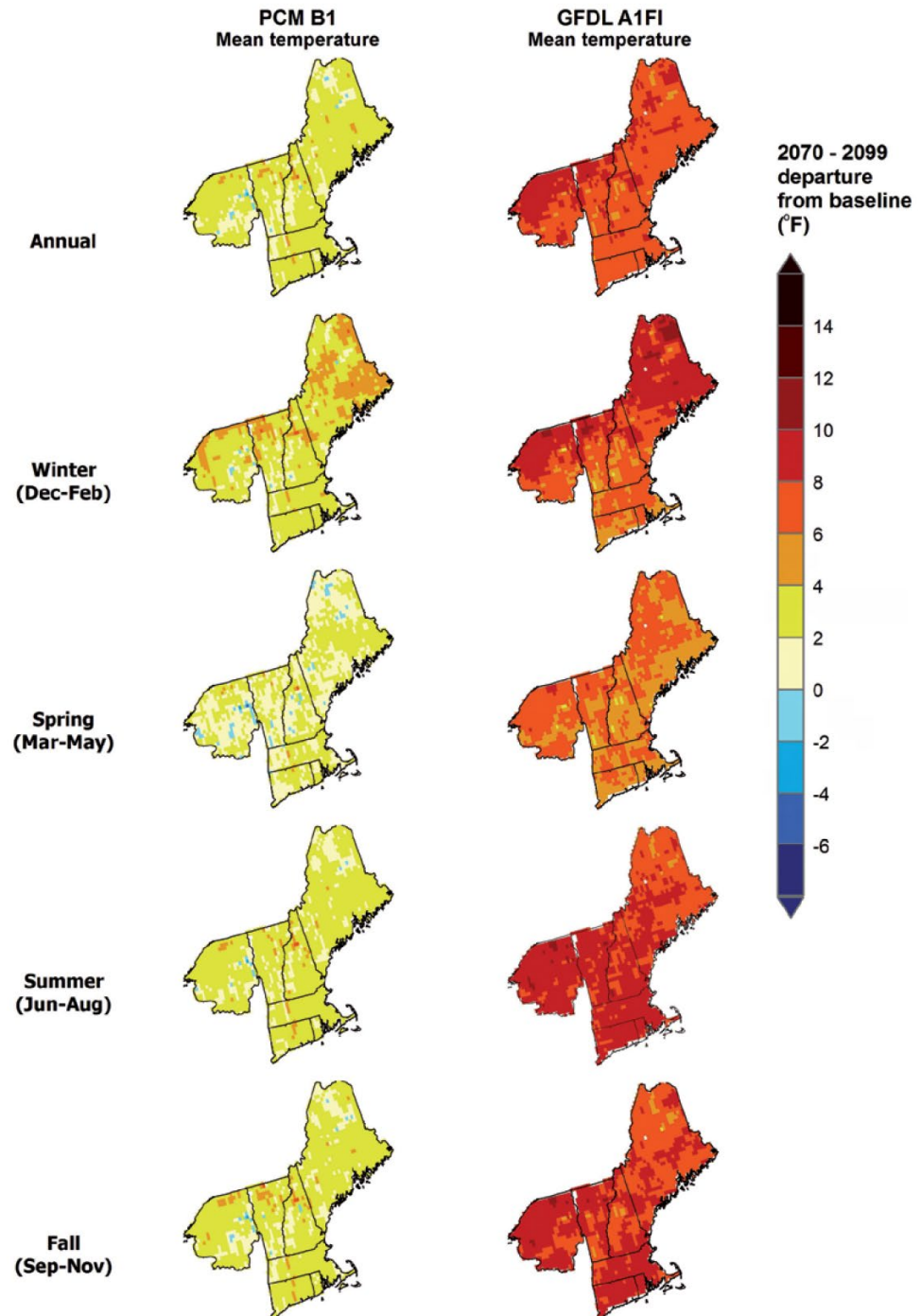
Statistically significant trend
P-value < 0.1

Projected Change in Temperature

PCM B1 – Lowest change
(insensitive model, low emissions)

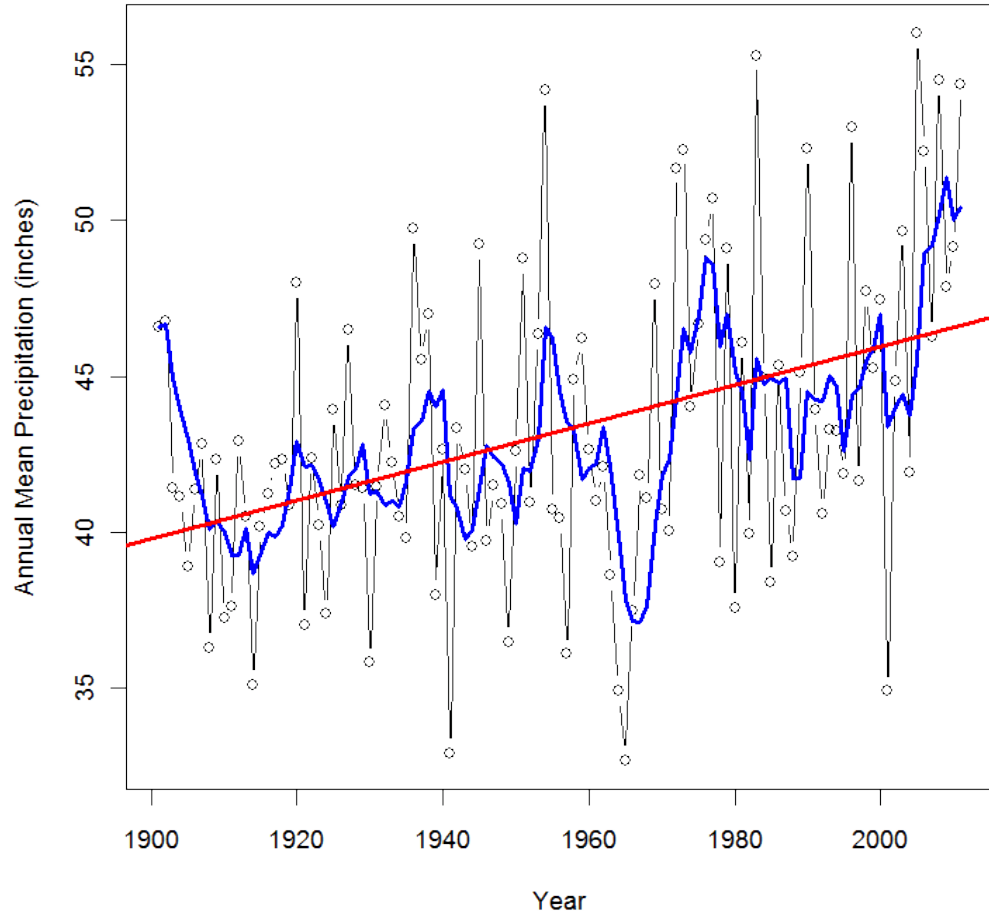
GFDL A1FI – Greatest change
(sensitive model, high emissions)

Baseline is average 1971-2000

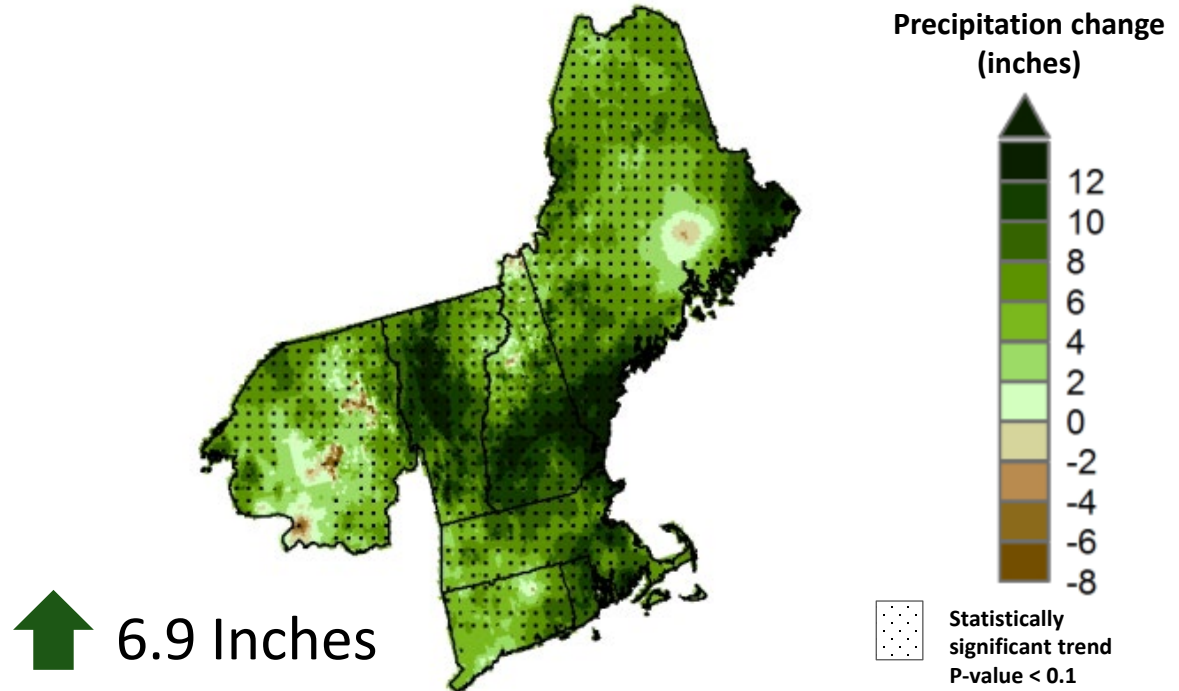


Not Just Warmer Temps: Precipitation

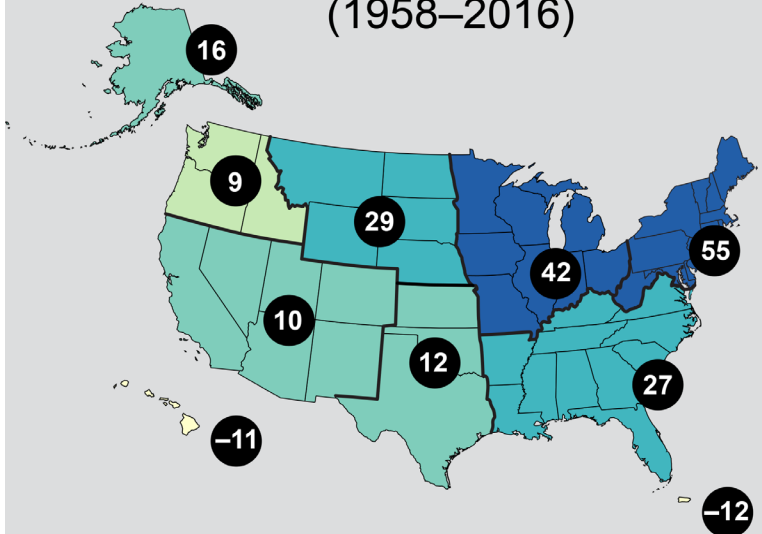
Observed annual precipitation change (1901-2011)



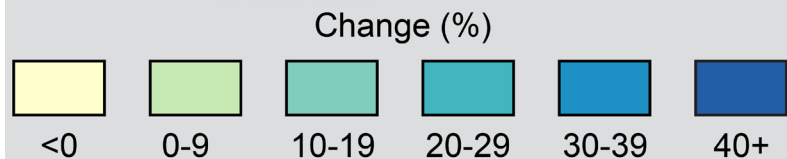
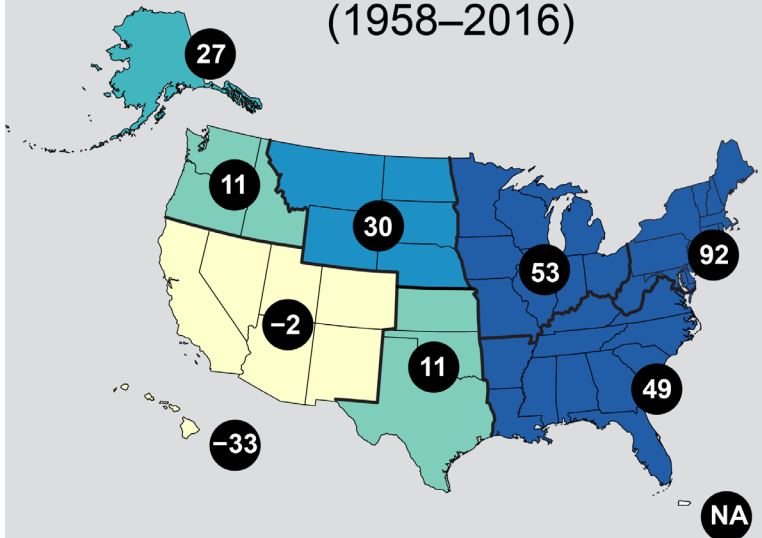
- Several more inches of rain per year
- More extreme rain events
- Greater variability throughout year



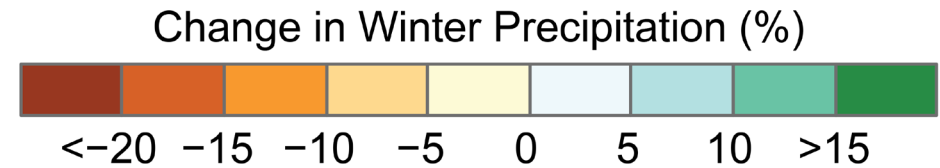
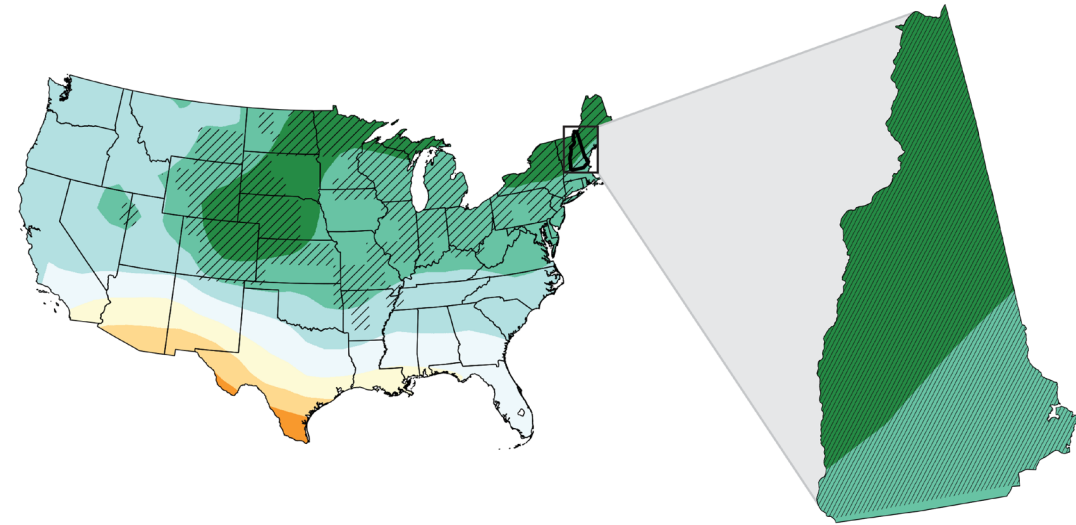
99th Percentile Precipitation (1958–2016)



Number of 5-yr, 2 Day Events (1958–2016)



Projected Change in Winter Precipitation



Left: Climate Science Special Report (USGCRP 2017)

Right: NOAA State Climate Summaries

[statesummaries.ncics.org/chapter/nh/]

Shorter Winter (Less Snow)

Projected decreases in snow fall, cover, and depth

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

Area with some snow on ground for 30 days per year



Red = historic

White = high emissions

Shorter 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

What may be at risk: The ability to do winter timber harvest when it is preferred to prevent damage to forest soils and residual forest; tree species sensitive to soil freeze-thaw



Red = historic

White = high emissions

Shorter Winter (Less Snow, More Rain)

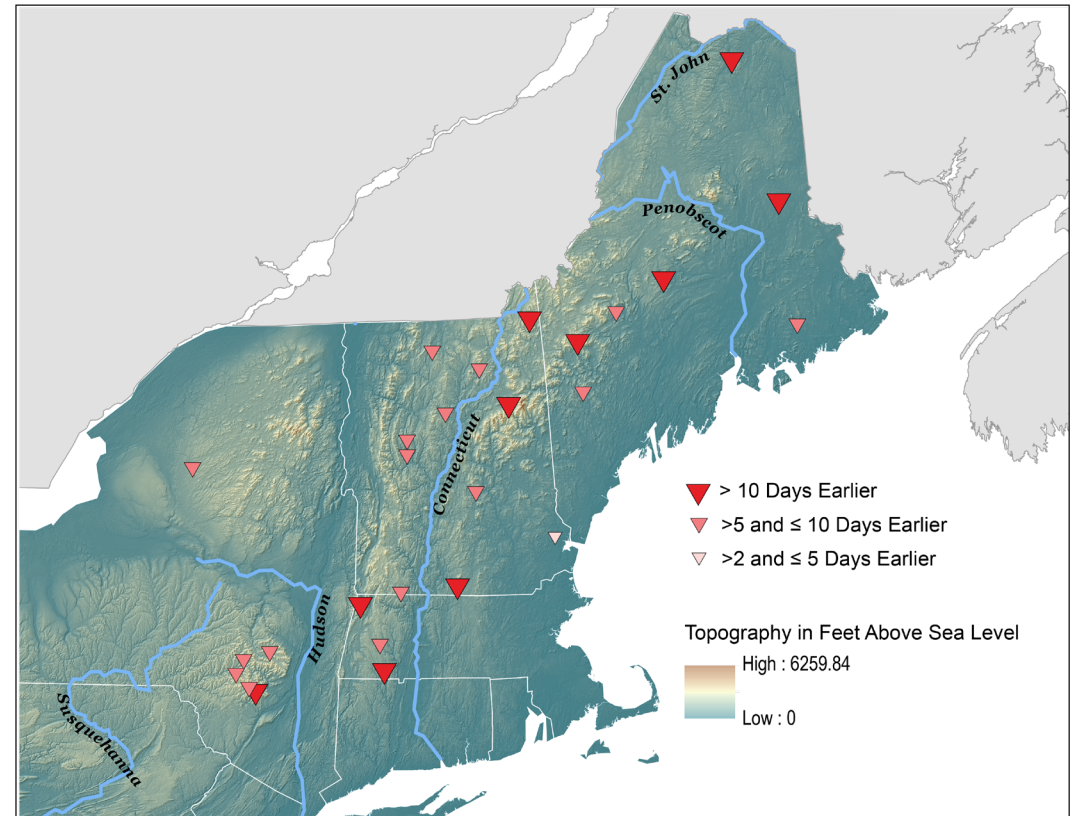
More rain

- 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

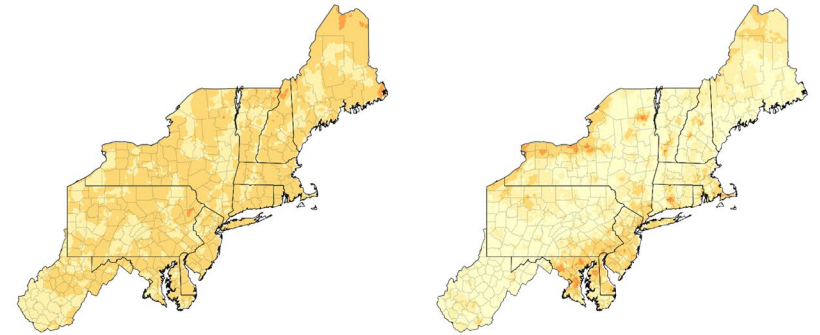
Phenological changes/mismatches

- Early bud break and frost damage freezing.

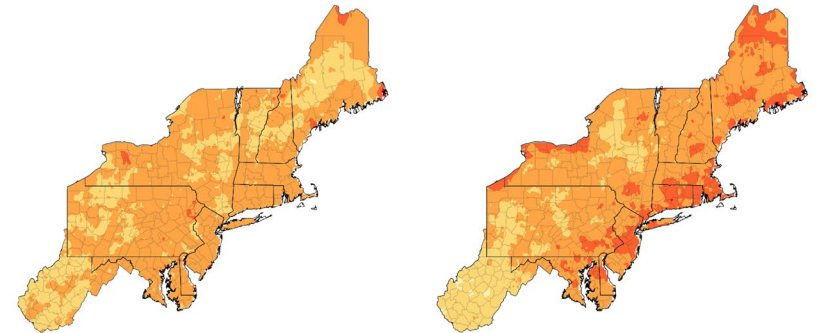
Last Spring Freeze

First Fall Freeze

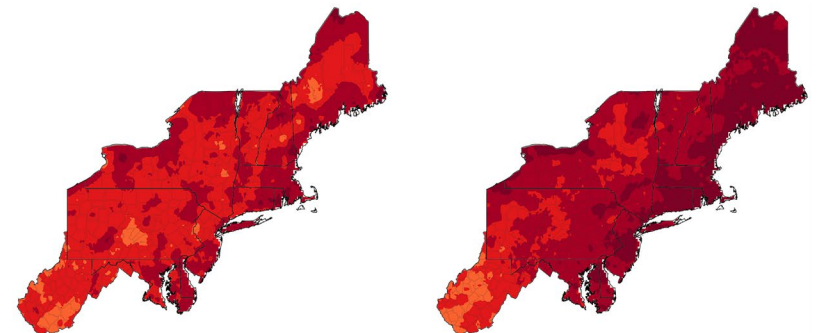
2040–2069, Lower Scenario (RCP4.5)



2040–2069, Higher Scenario (RCP8.5)



2070–2099, Higher Scenario (RCP8.5)



Change in Number of Days

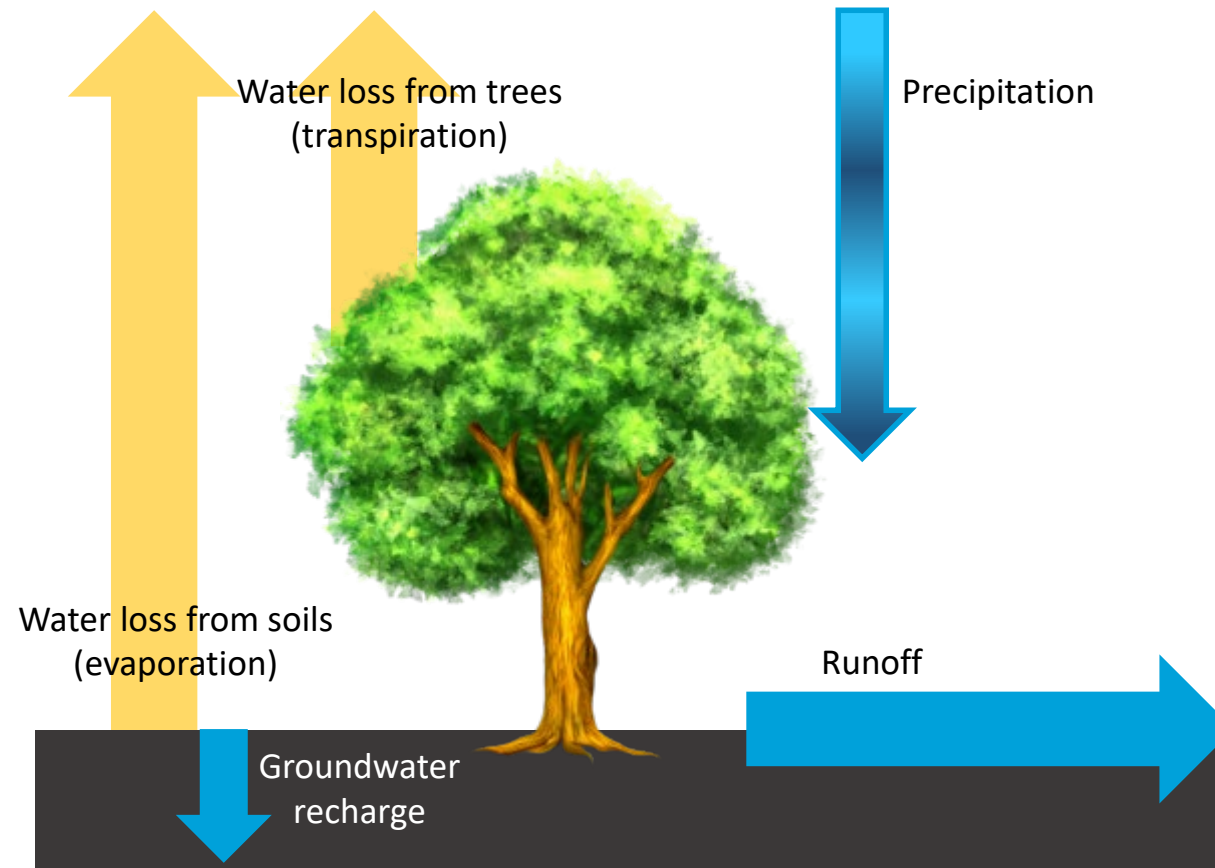


Increased Risk of Moisture Stress

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

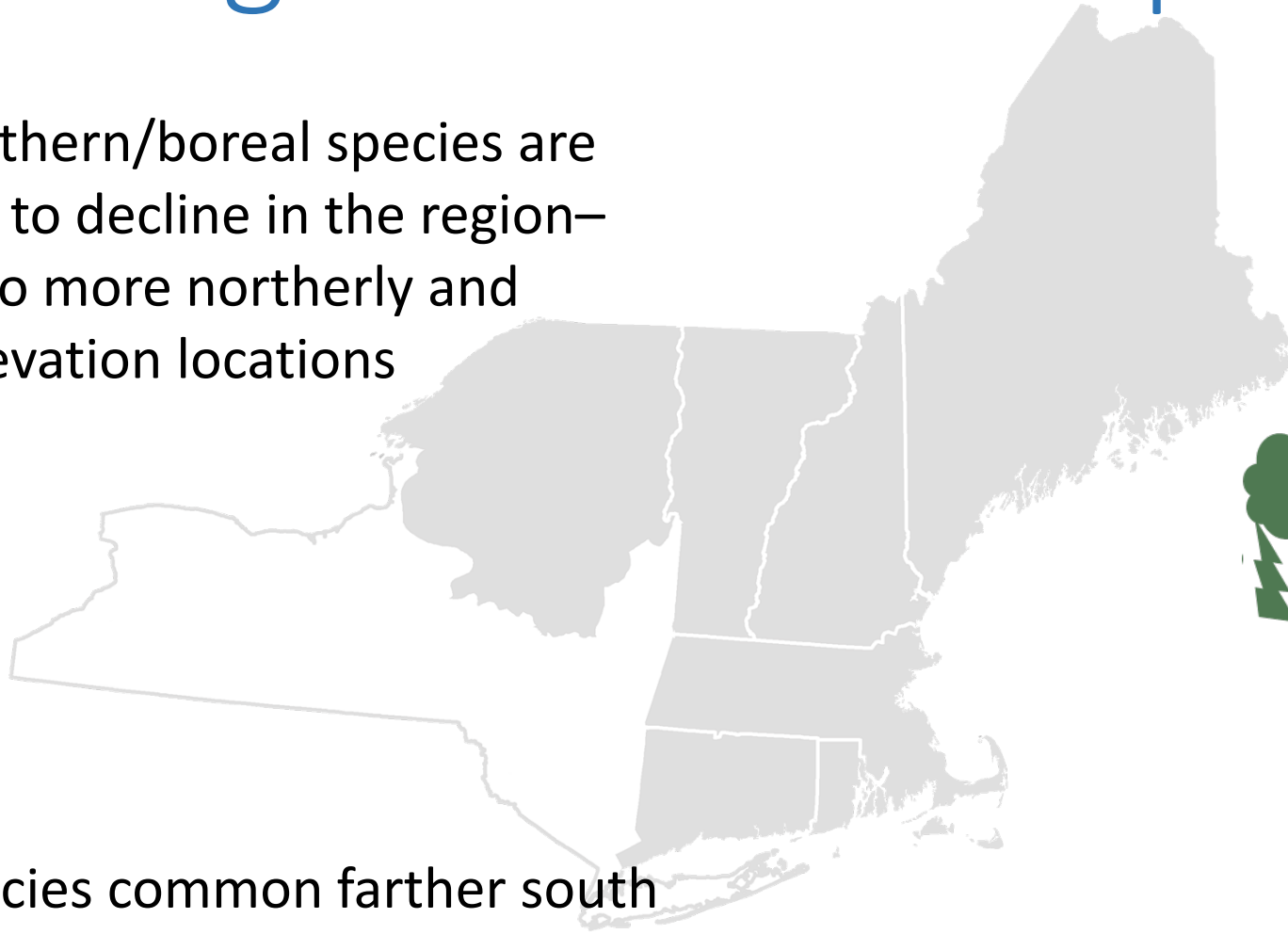
Risk may be greatest:

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



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.



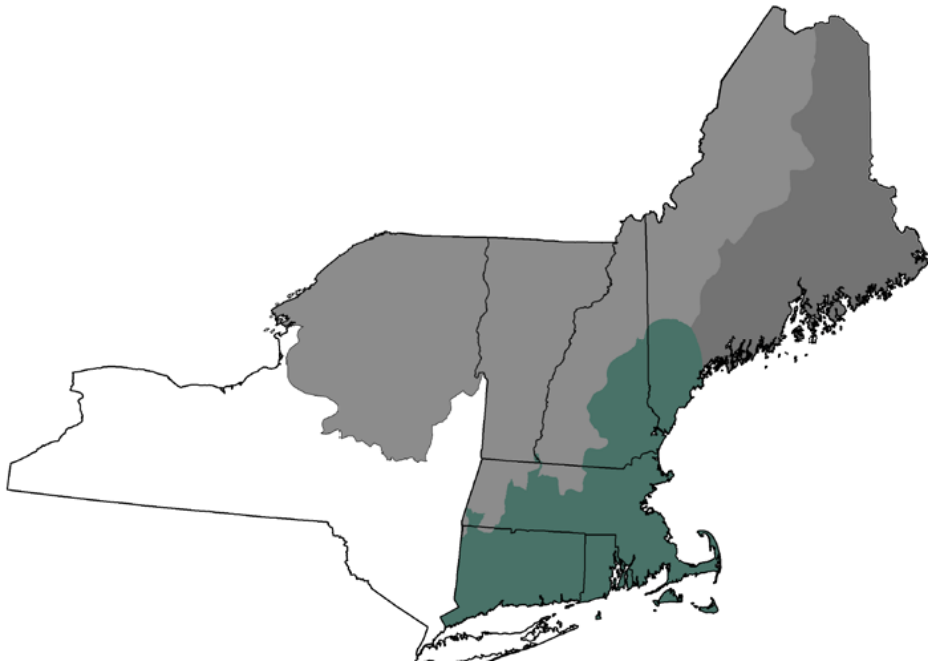
Changes in Forest Composition

Likely to decline

- Balsam fir
- Black, red, & white spruce*
- Northern white-cedar*
- Gray birch^
- Black ash
- Paper birch*
- White pine*
- Tamarack

Mixed model results

- American beech^
- Eastern hemlock
- Northern white cedar^
- Yellow birch*



Potential “winners”

- American basswood
- Blackgum
- Black cherry
- Mockernut/ Pignut hickory
- Northern red oak
- Sugar/ red maple
- Sweet birch^
- White oak
- White pine^
- Yellow poplar*

New habitat (esp. south)

- Water hickory*
- Chinkapin oak
- Common persimmon^
- Loblolly/ Shortleaf pine*
- Virginia pine
- Osage-orange^
- Pin oak^
- Southern red oak
- Sweetgum^

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



Photo: Joe Klementovich, HBRF

What may be at risk: Depends greatly on site conditions and susceptibility to different types of disturbance

Interactions: Insects and Disease

Increased damage from forest insects & diseases

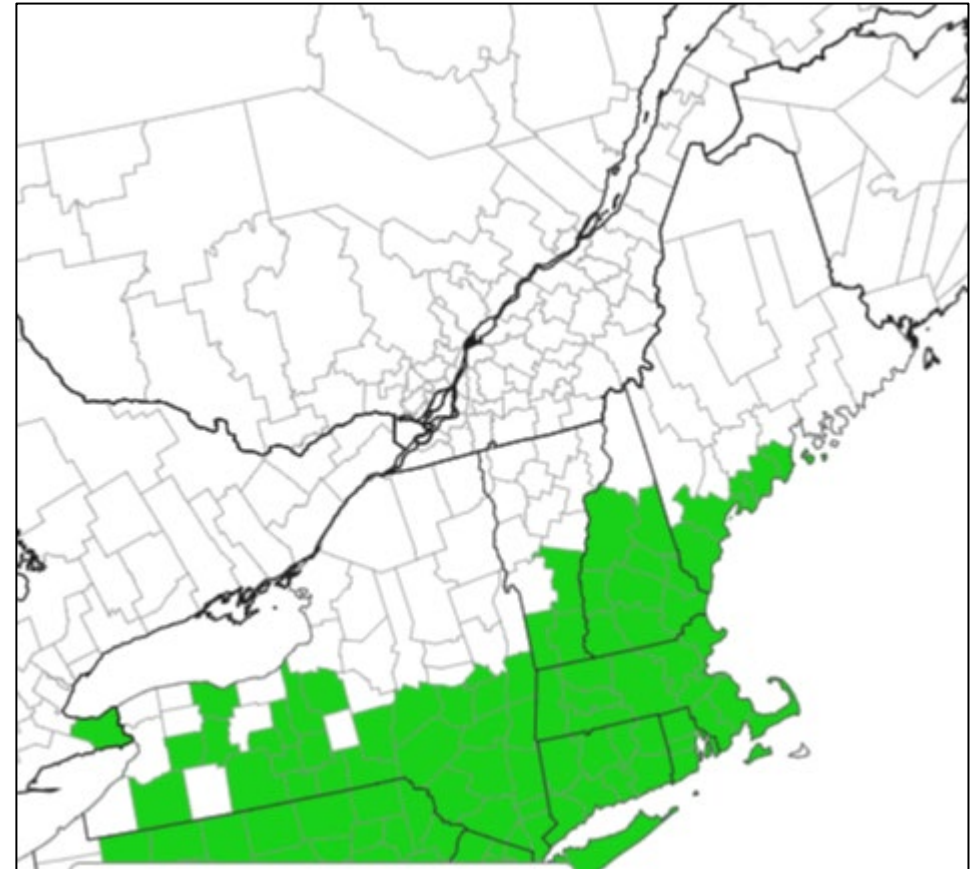
Indirect: Stress from other impacts increases susceptibility

Direct:

- Pests migrating northward from decreased lethal cold temps
- Accelerated lifecycles

Risk may be greatest: Presence of host species; pest is nearby; other factors reduce that forest vigor

Hemlock woolly adelgid incidence by county, 2022
(EDDMaps.org)



Ayres and Lombardero 2000, Parmesan 2006, Dukes et al. 2009, Weed et al. 2013, Sturrock et al. 2011, USFS 2019

Interactions: 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 CO₂

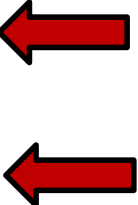


Risk may be greatest: Presence of invasive species nearby; other factors that reduce forest/understory vigor

Vulnerability: *Forest Communities*

Forest communities will be affected differently

| Forest system | Potential impacts | Adaptive capacity | Vulnerability |
|---------------------------|-----------------------|-------------------|---------------|
| Central hardwood-pine | Neutral-Positive | Moderate-High | Low |
| Low-elevation spruce-fir | Neutral-Negative | Moderate | Moderate-High |
| Lowland/riparian hardwood | Positive and Negative | Moderate-High | Moderate |
| Lowland mixed conifer | Neutral-Negative | Low-Moderate | Moderate-High |
| Montane spruce-fir | Neutral-Negative | Moderate | Moderate-High |
| Northern hardwood | Positive and Negative | Moderate-High | Low-Moderate |
| Pitch pine-scrub oak | Neutral-Positive | Moderate | Low |
| Transition hardwood | Positive and Negative | Moderate-High | Low-Moderate |



Effects on Forests

Climate change is a “threat multiplier”

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

Interactions can compound stress.

