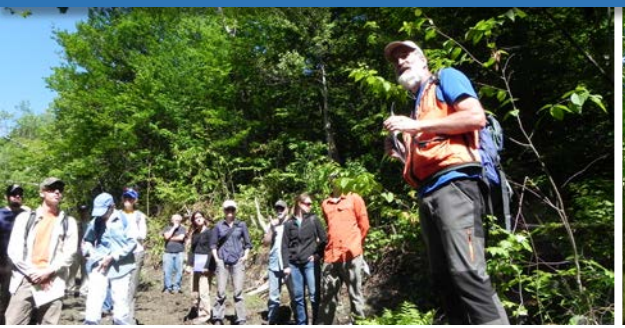
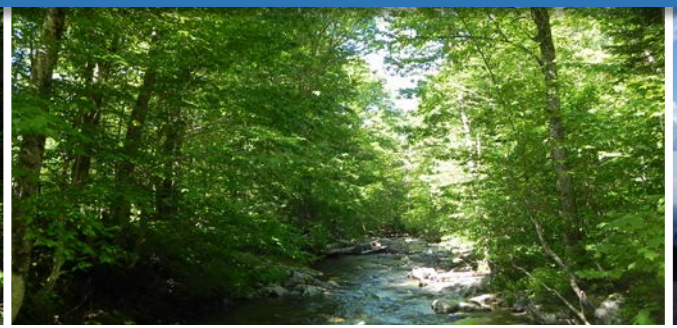
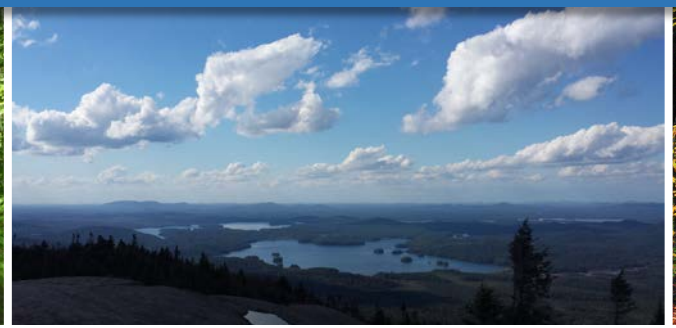
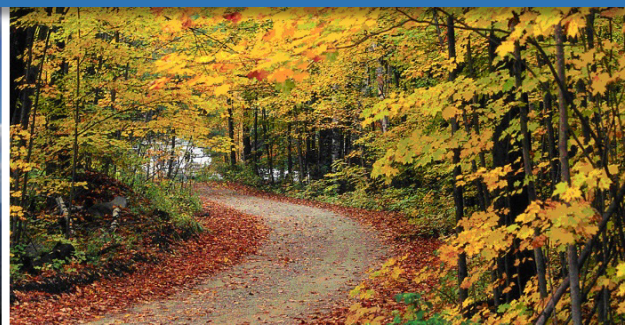
Southern New England Forests and Climate Change

Maria Janowiak

Northern Institute of Applied Climate Science

www.niacs.org / www.forestadaptation.org

Northern Institute of Applied Climate Science (aka NIACS)

Climate

Carbon

NIACS
Northern Institute of Applied Climate Science

Chartered by USDA Forest Service, universities, non-profit and tribal conservation organizations

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

Michigan Technological University
1885

Great Lakes Indian Fish & Wildlife Commission

The University of Vermont

University of Minnesota

American Forests

NCASI

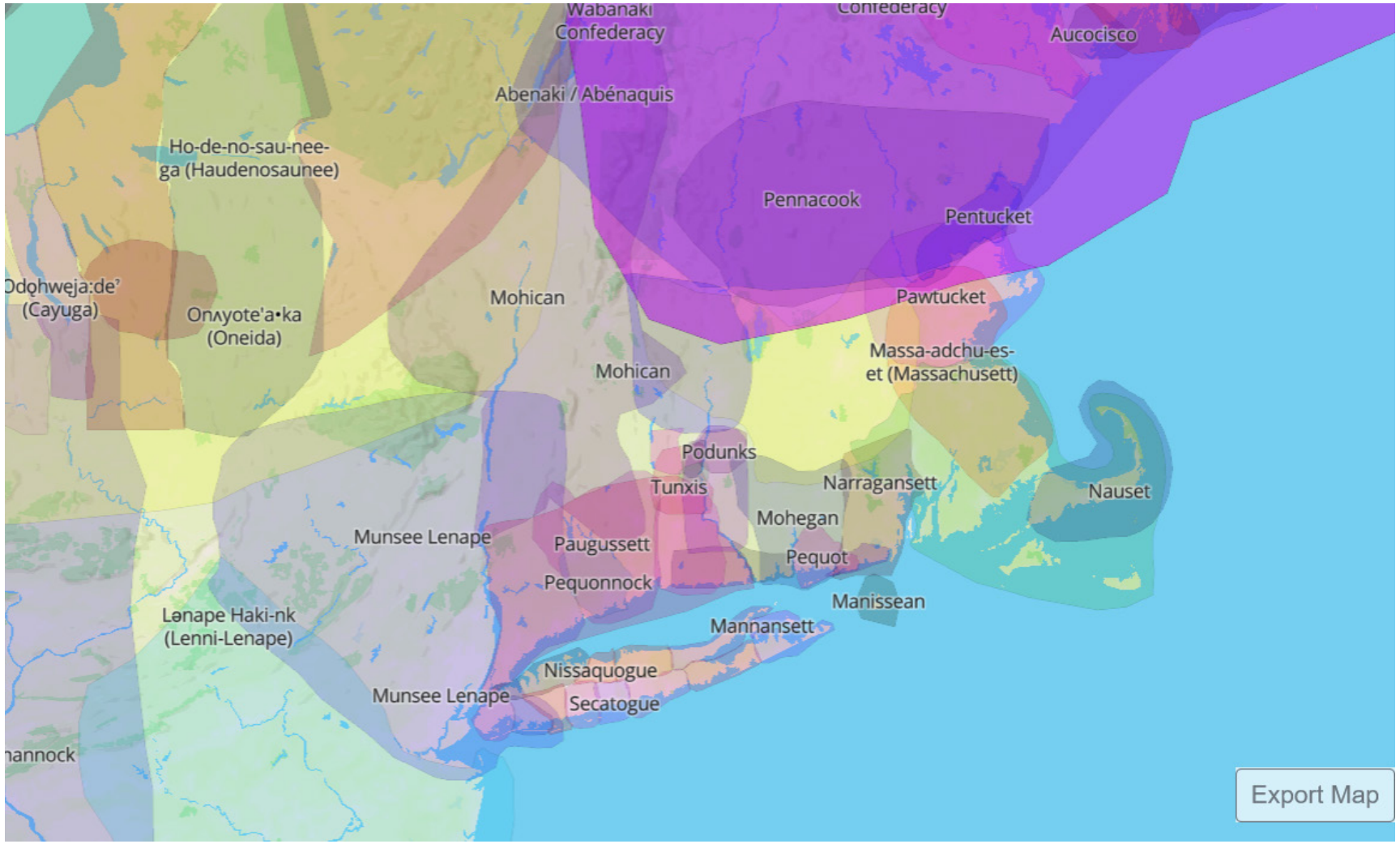

What’s your
favorite tree?

Summary: New England Forests and Climate Change

- Forest composition has changed over time in response to environmental changes, including climate and disturbance.
- Humans have been part of the southern New England landscape and influencing its forests for at least 8,000 years.
- The forests we see today are largely the result of interacting human disturbances over several centuries.
- Climate change will continue to alter forest ecosystems in new (and likely surprising) ways.
- We have a role to play in assisting forest adaptation to future conditions, to maintain healthy forest ecosystems and the benefits they provide.

Land Acknowledgement

- Mohegan
- Mashantucket Pequot
- Eastern Pequot
- Schaghticoke
- Golden Hill Paugussett
- Nipmuc
- Lenape



Map: https://native-land.ca/ CT Tribal names: https://diversity.uconn.edu

What is a forest?

- A vegetation community composed of trees
- An assemblage of plants, animals, and fungi species with complex inter-relationships (i.e., an ecosystem)

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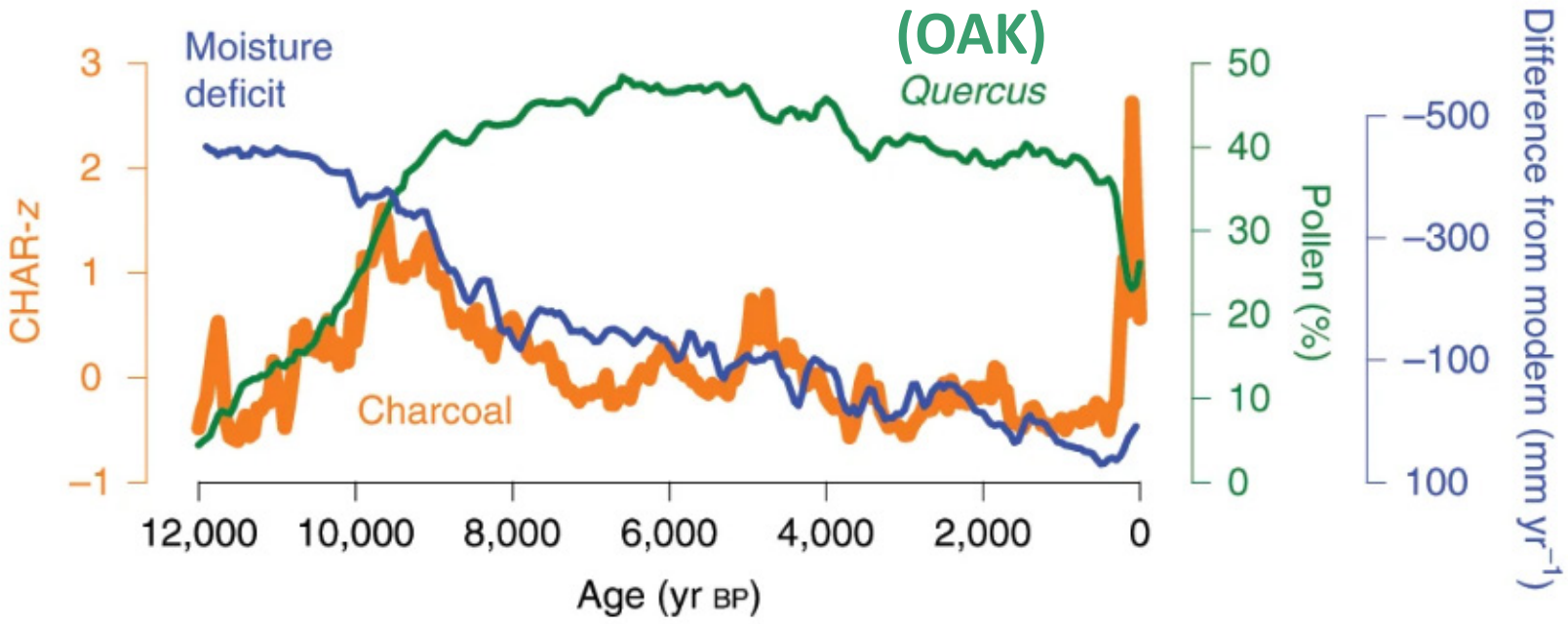
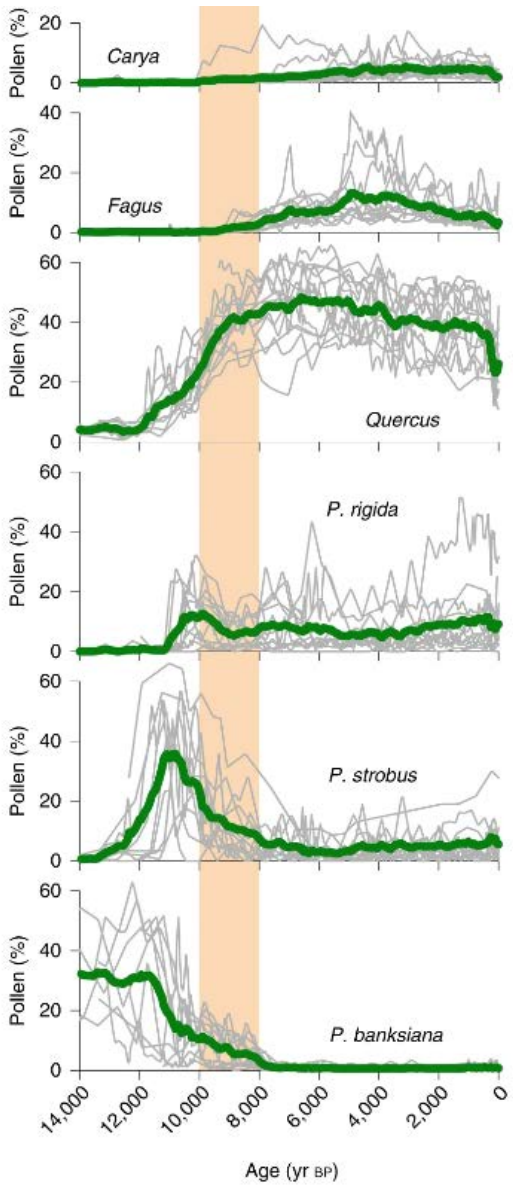
- **Climate:** averages and extremes in temperatures and precipitation, microclimate, …
- **Landform:** slope, aspect, shape. …
- **Soils:** texture (rocky, sandy, clayey), nutrients
- **Water:** availability and interaction with landform, soils, and vegetation, …
- **Vegetation:** seed source, species, abundance, …
- **Natural Disturbance:** fire, storms, …
- **Human Disturbance**: land use change, …

Past Forest Change



Other tree species:

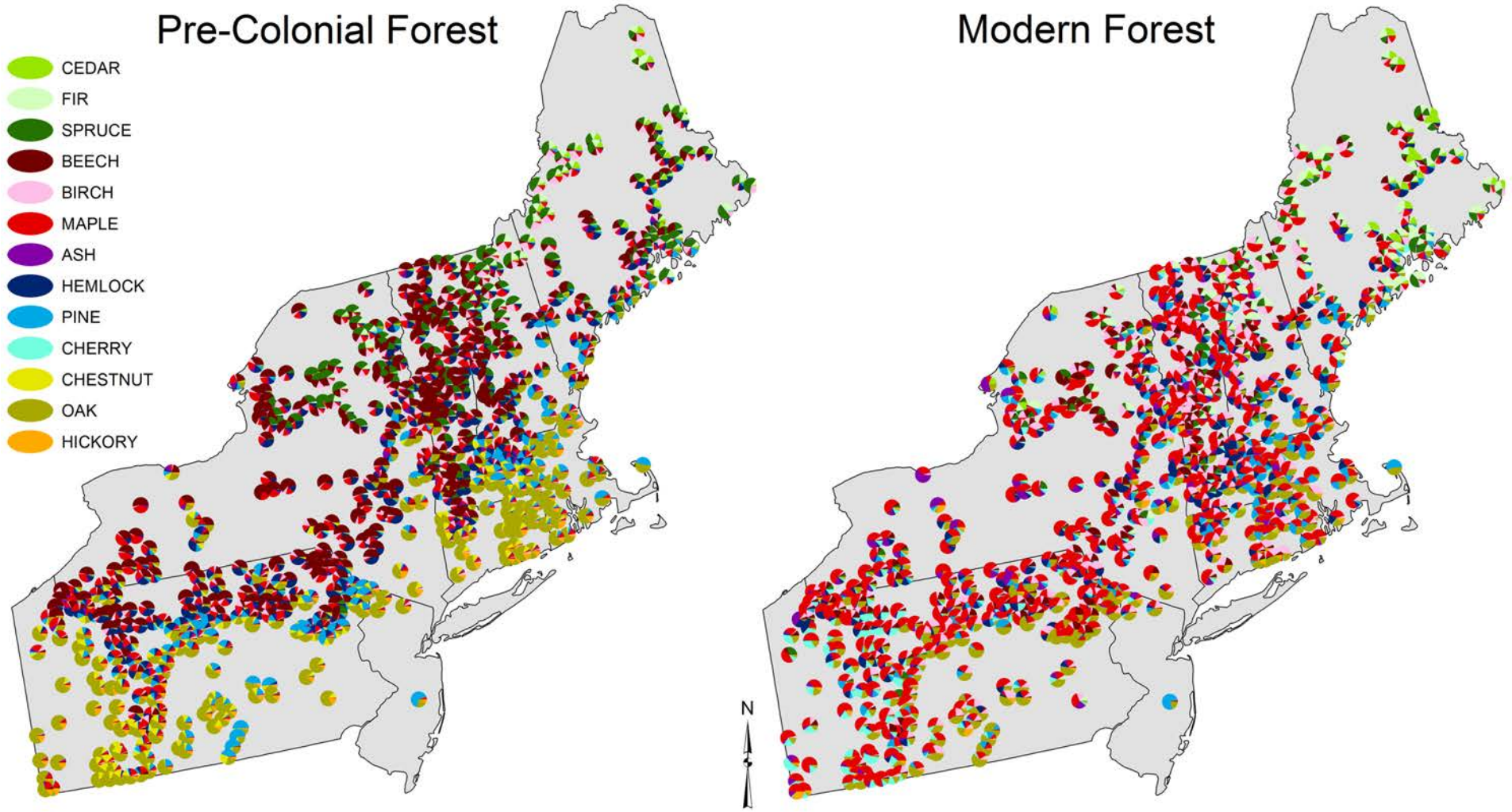


Oswald et al. 2020: https://doi.org/10.1038/s41893-019-0466-0

Past Forest Change

Harvard Forest Dioramas: https://harvardforest.fas.harvard.edu/dioramas

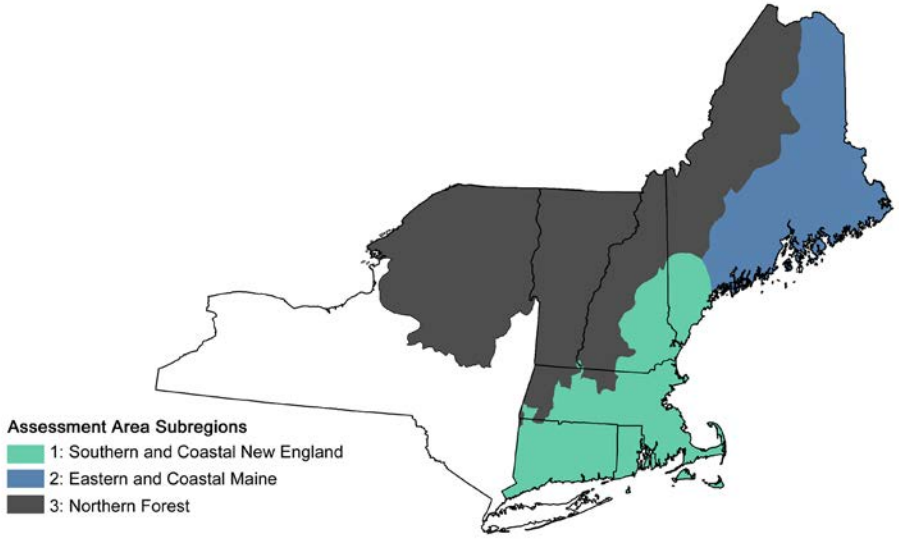
Past Forest Change

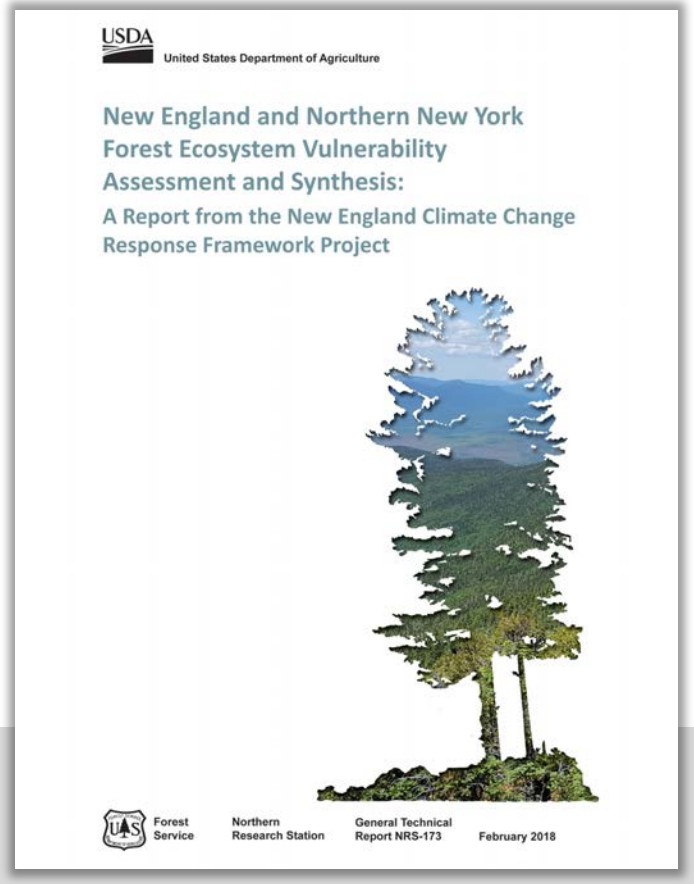


Thompson et al. 2013: https://doi.org/10.1371/journal.pone.0072540

Climate Change

- 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
- Does **not make recommendations** or assess vulnerability to changes in management, land use, or policy





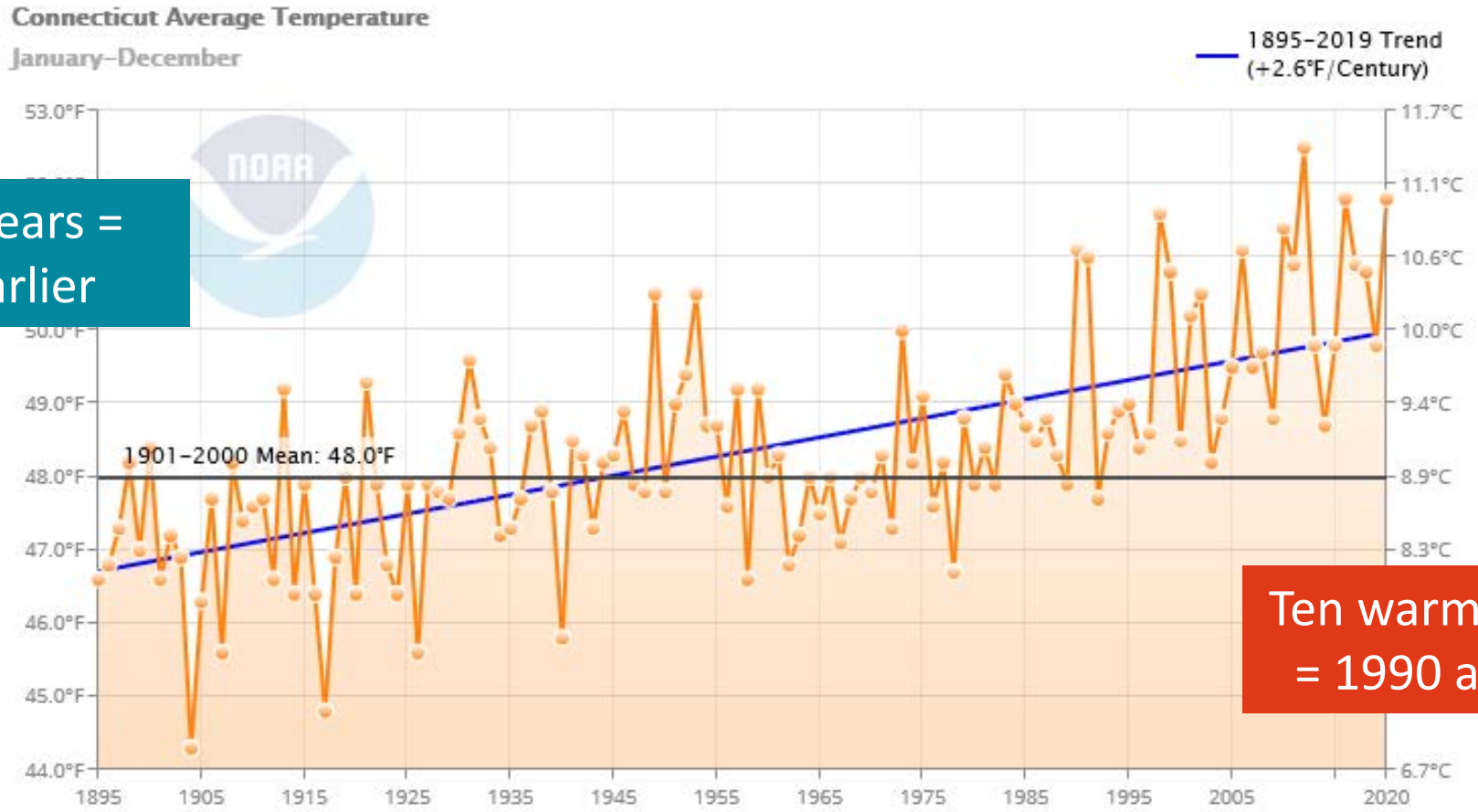
Vulnerability assessment:
www.nrs.fs.fed.us/pubs/55635

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

Observed Changes in Climate (CT)

Temperatures have risen 3.2°F since turn of last century.

Ten coldest years = 1940 and earlier

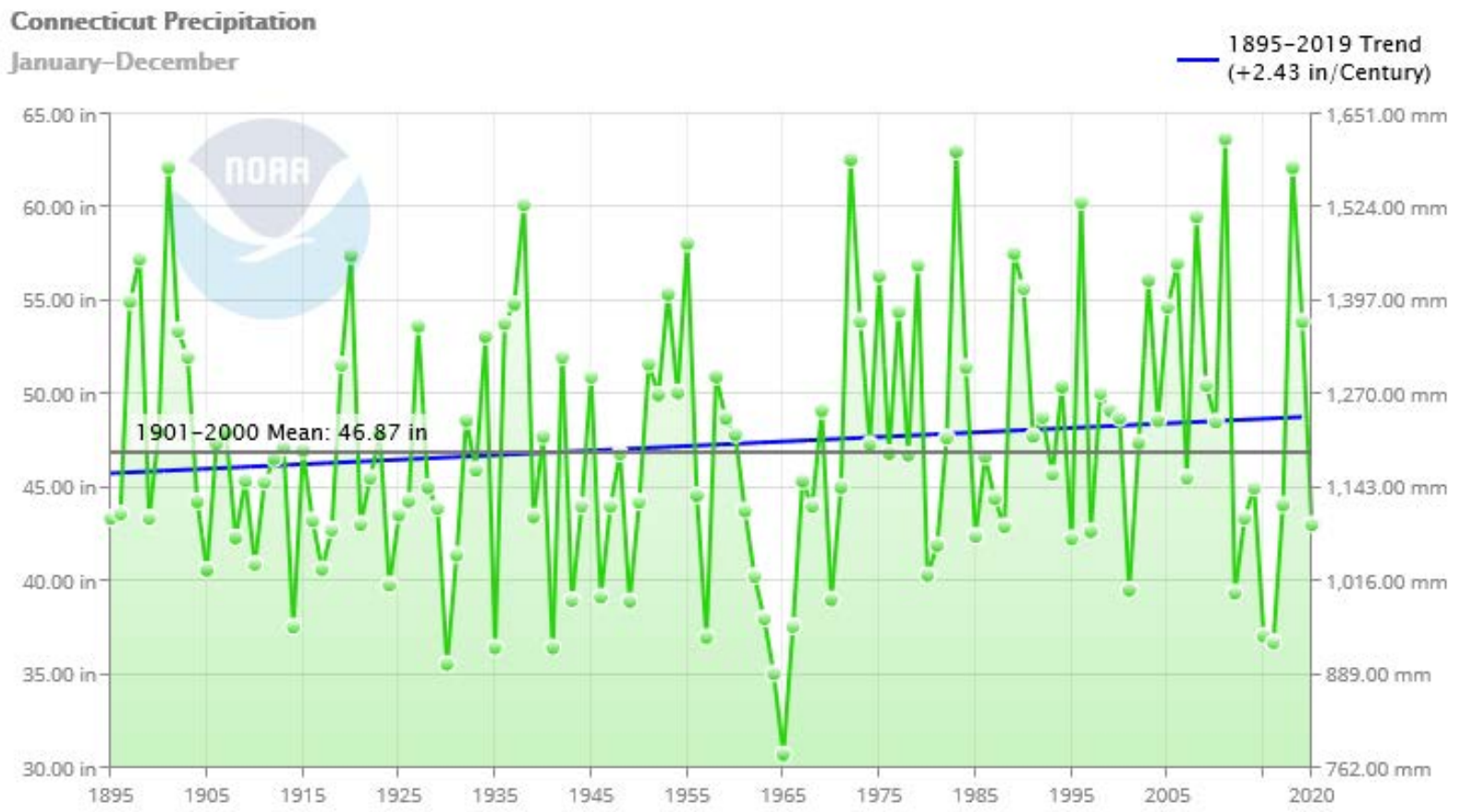


Ten warmest years = 1990 and later

NOAA Climate-at-a-Glance Tool

Observed Changes in Climate (CT)

Annual precipitation has increased about 2.6 inches (~4%).



NOAA Climate-at-a-Glance Tool

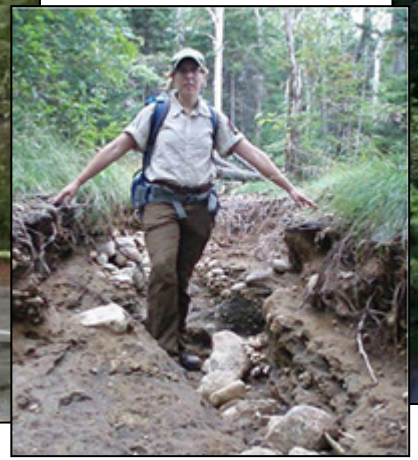
Not Just Warmer Temps

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

NOAA

VTRANS/VT ANR

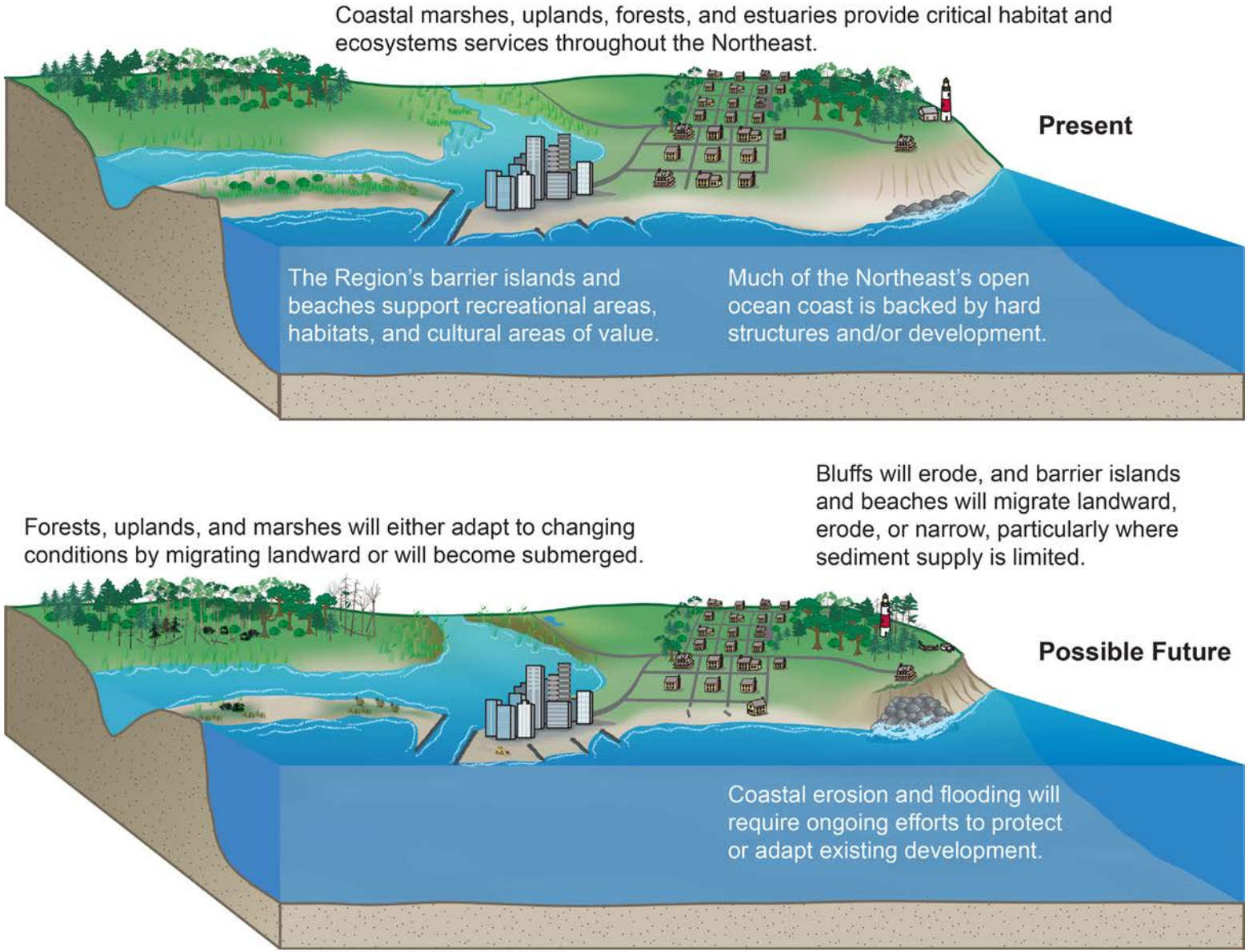
Dan Turner, Cambridge Fire Dept.



NY DEC

Sea-level Rise

- Sea level rose about 1 foot since 1900
- Projections of additional 12 to 23” or more by end of century
- Increases in coastal flooding



NCA 2018

Longer Growing Season

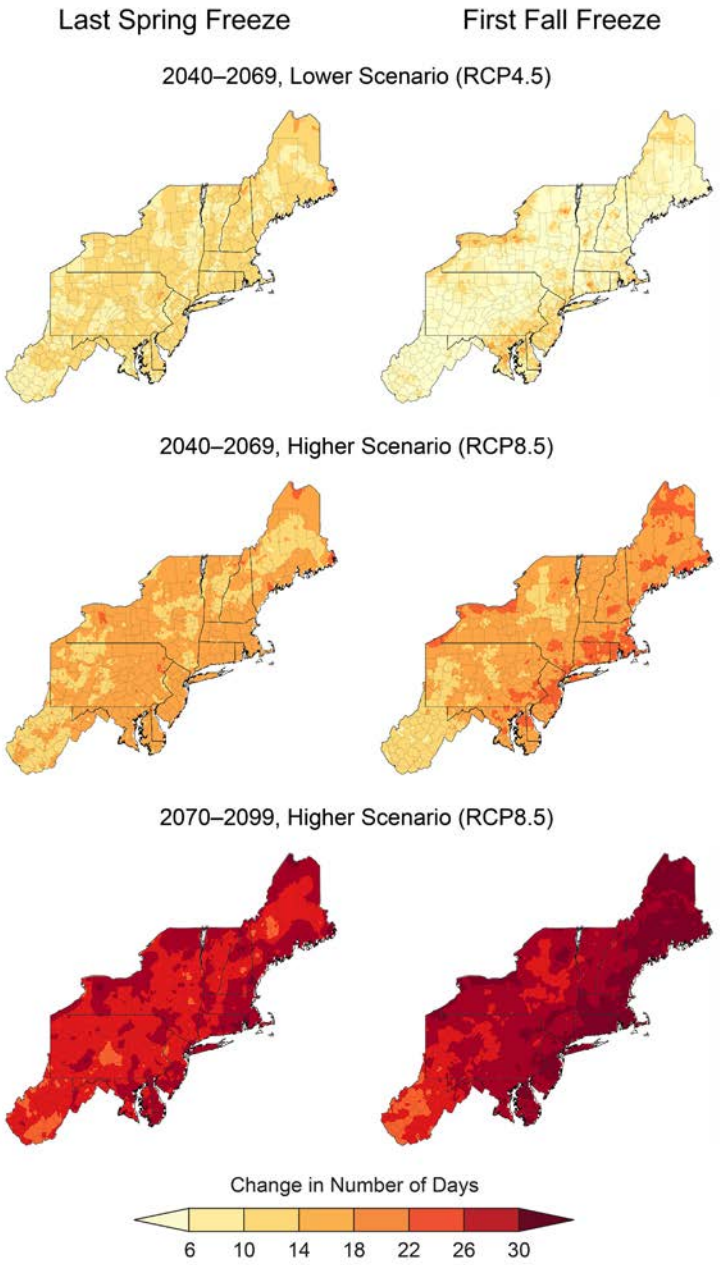
Warmer temps result in longer growing seasons

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

Longer period for plant growth

Phenological changes/mismatches

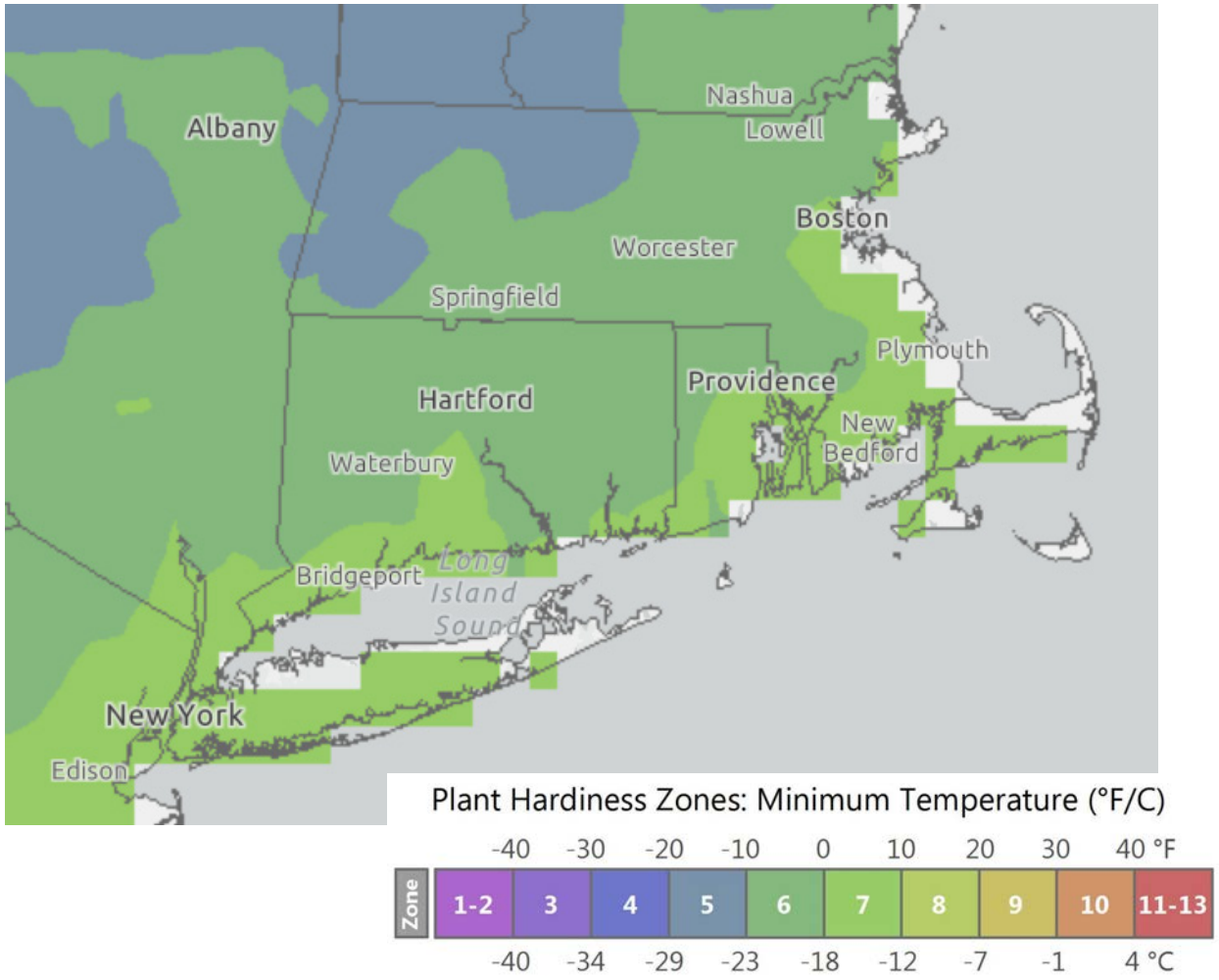
- Early bud break and frost damage freezing.



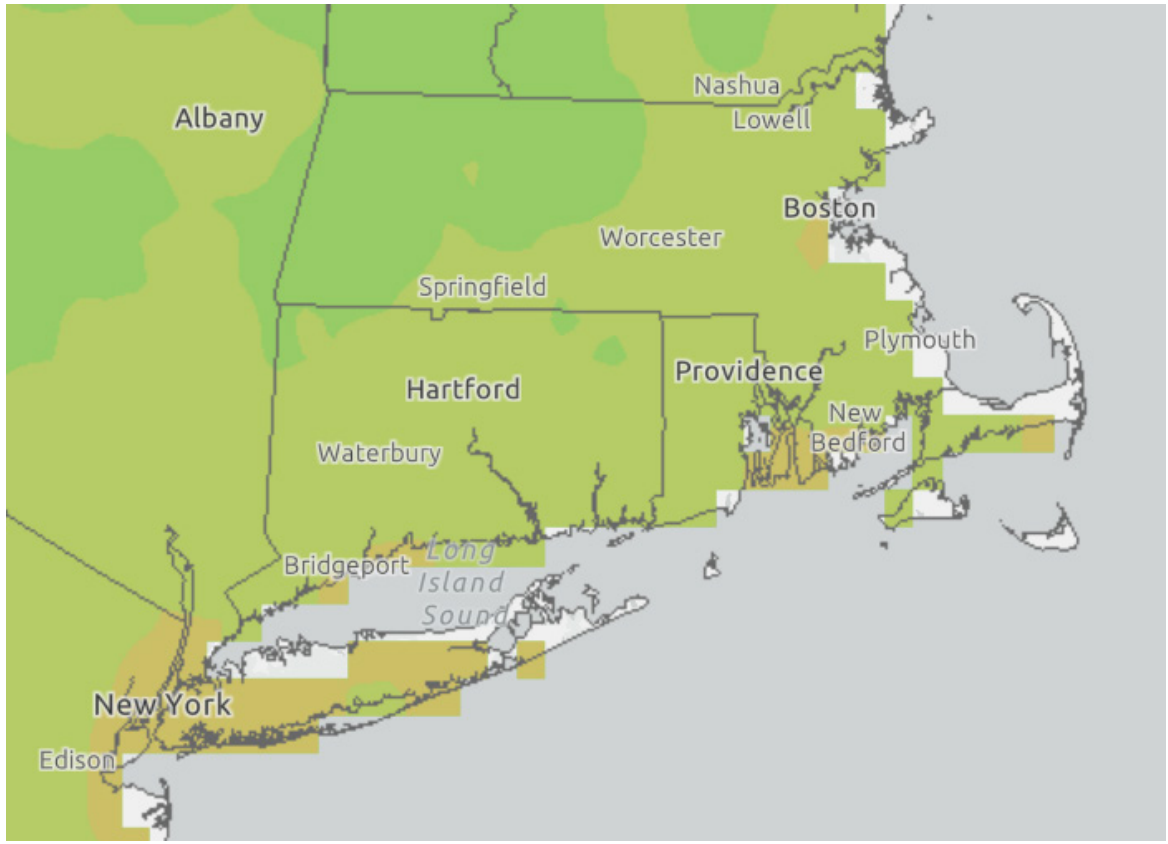
Melillo et al. 2014, Nelson Center 2014, NCA 2018

Longer Growing Season/Warmer Winter

1980-2009



2070-2099 (RCP 8.5)



Matthews et al. 2018

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

Notaro et al. 2014, Figure: Frumhoff et al. 2007

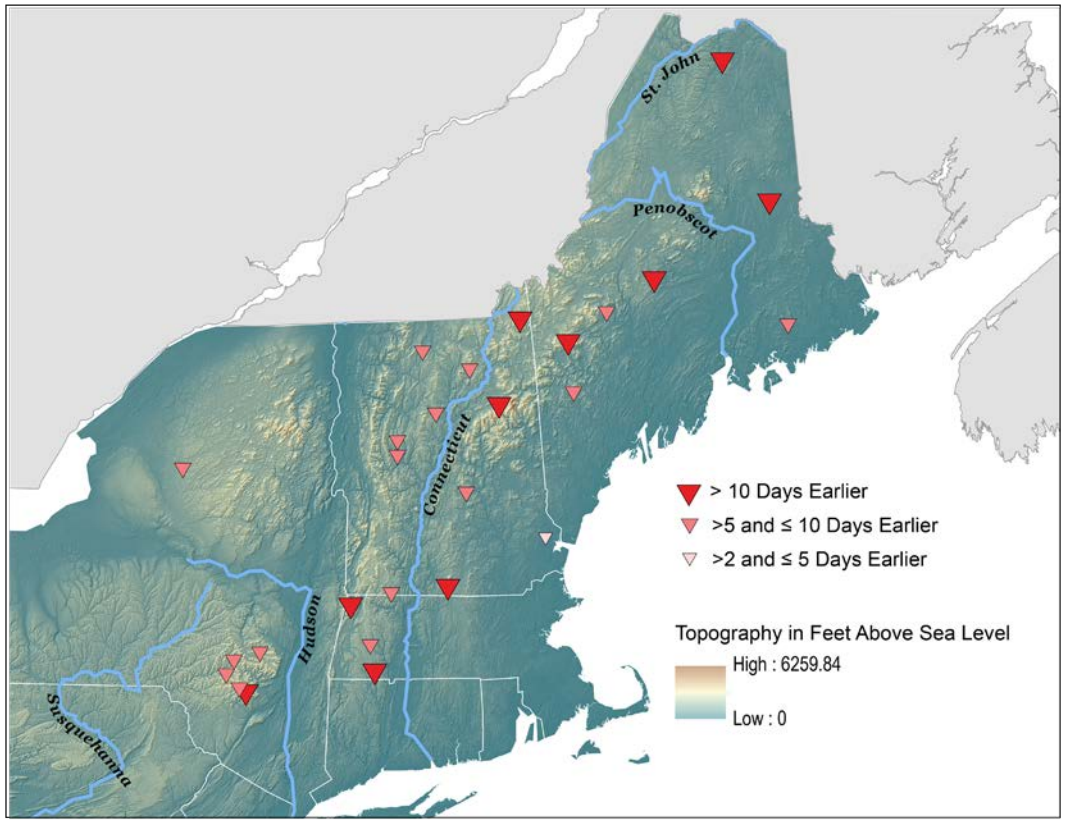
Warmer Winter (Less Snow, More Rain)

More rain

- Warmer temperatures
- Increased precipitation
- Extreme rain events

Earlier peak stream flows

- Flashiness and episodic high flows may increase



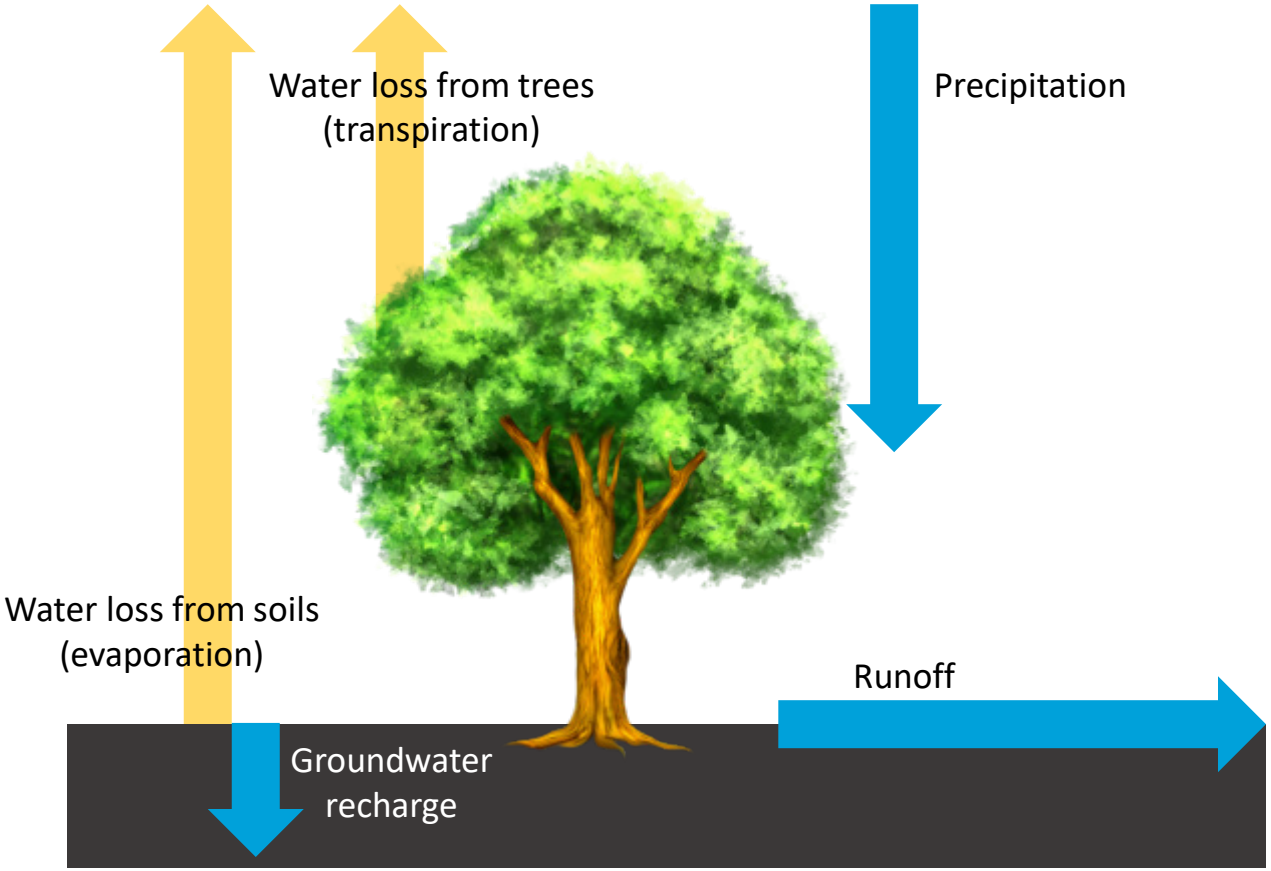
Historical changes in the timing of snowmelt-related streamflow (1960-2014)

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

Dale et al 2001, Huntingon 2004, Parmesan 2006, NCA 2018

Increased Risk of Moisture Stress

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



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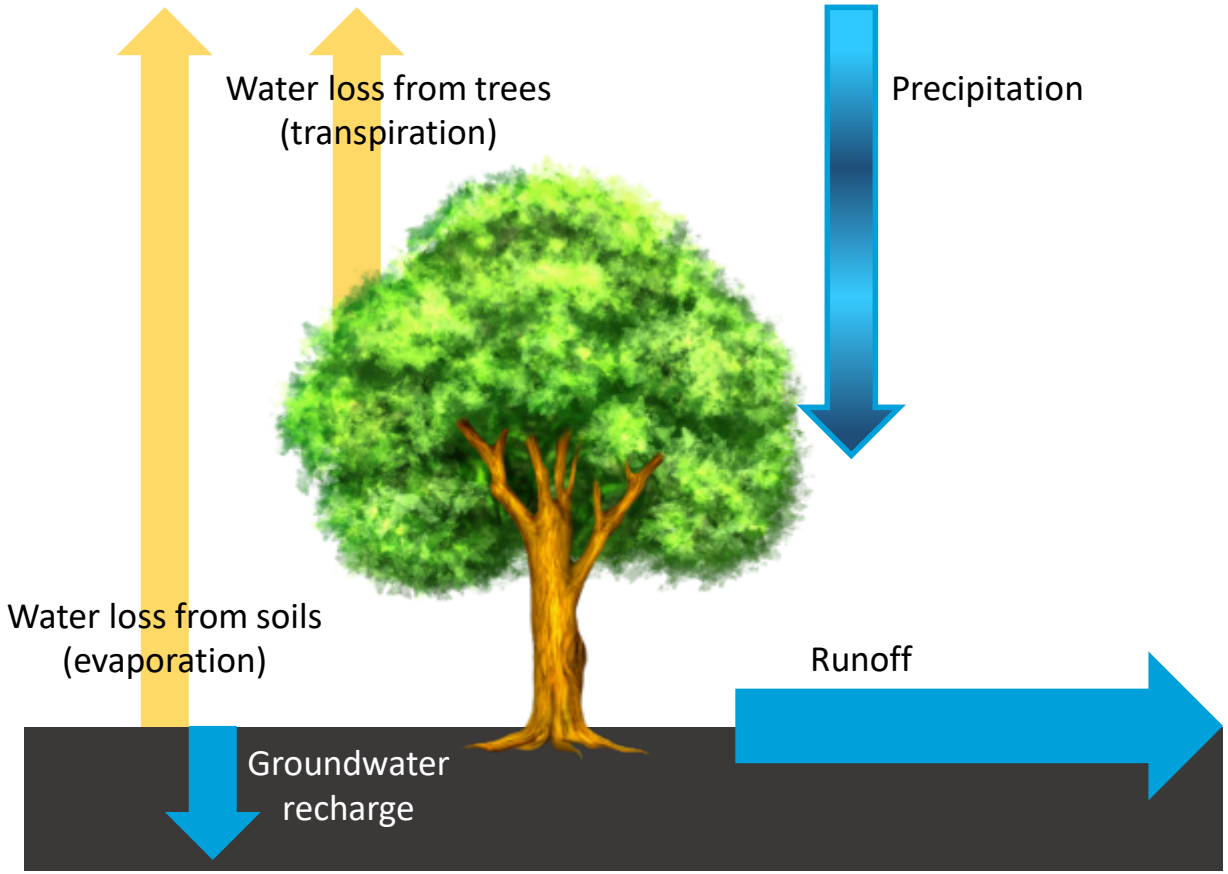
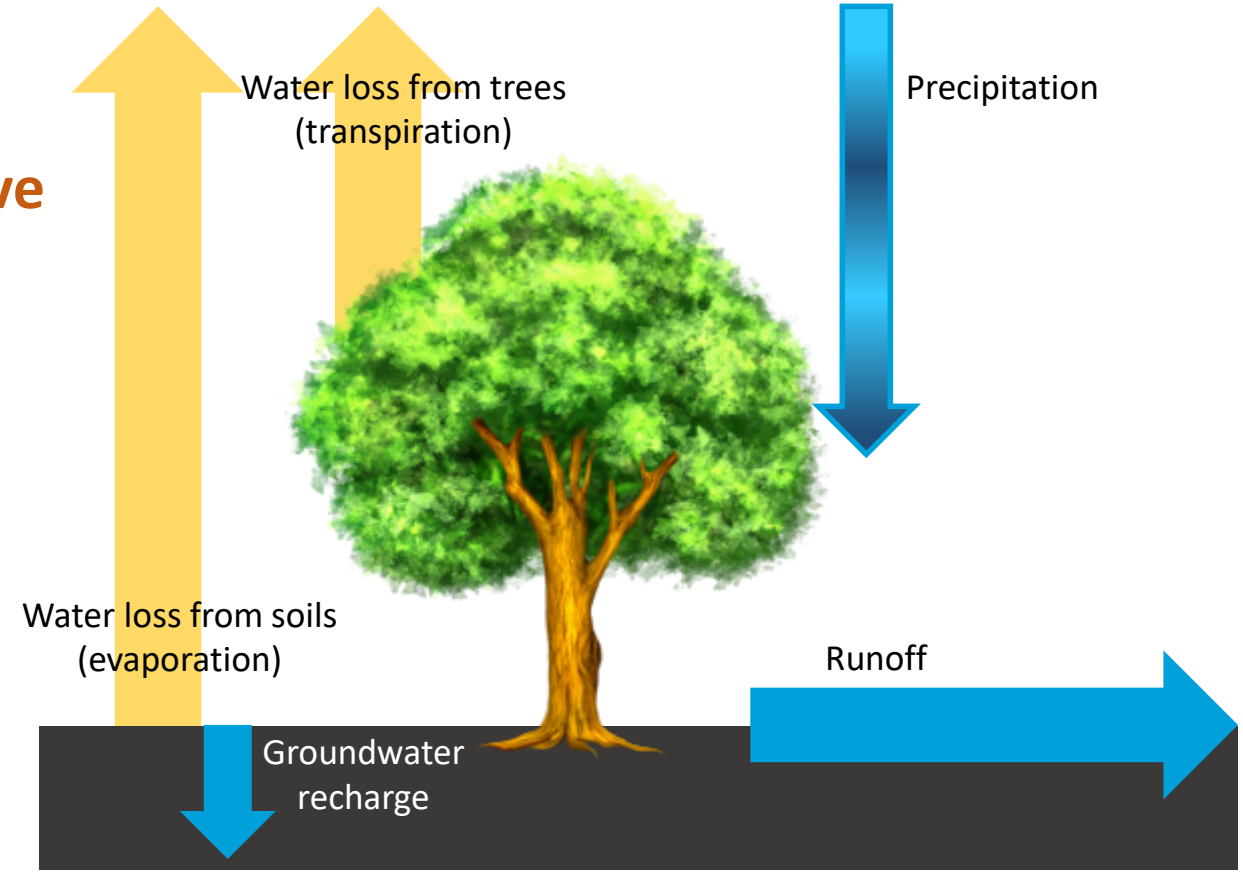
Earlier spring runoff and increased runoff during extreme rain events



Increased Risk of Moisture Stress

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

Warmer temperatures drive water loss from soils and plants

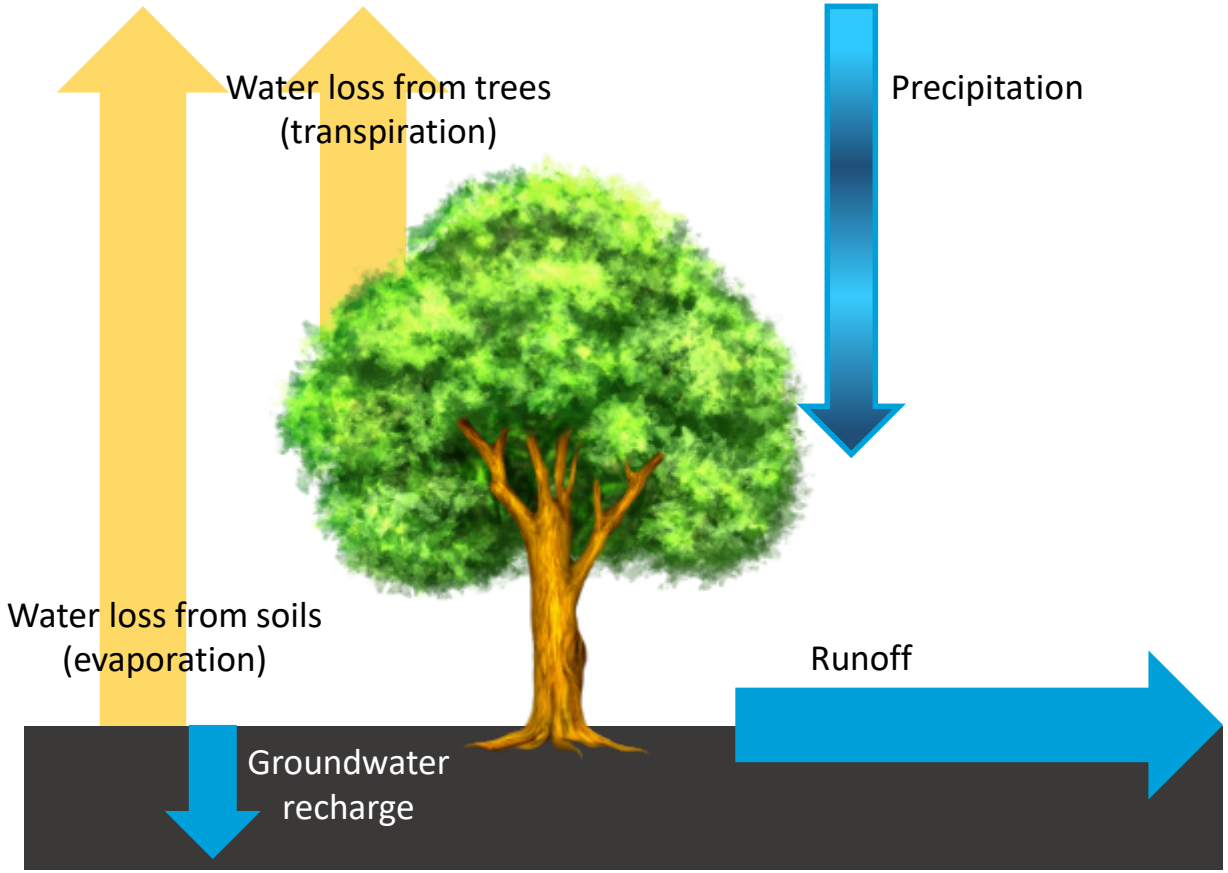


Increased Risk of Moisture Stress

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

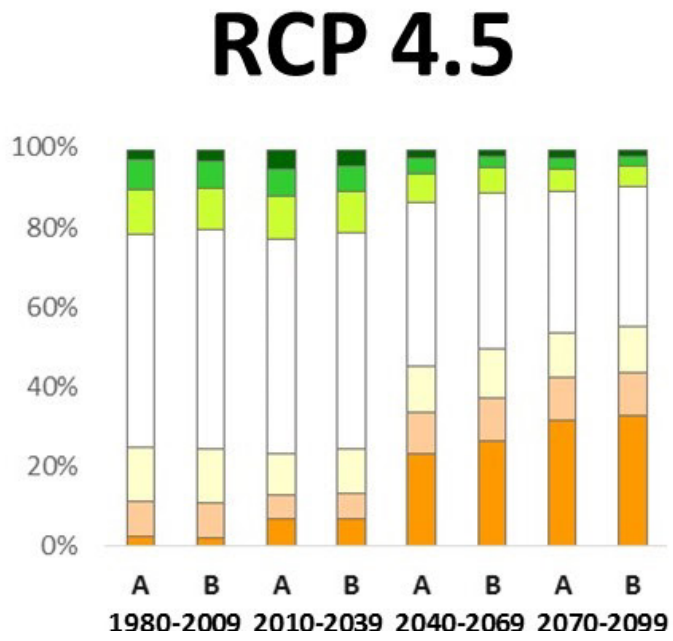
Risk may be greatest:

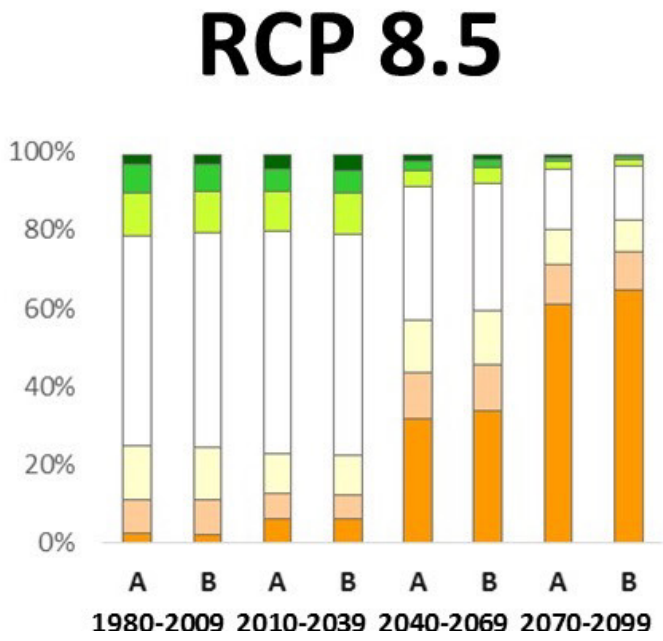
- Sites with drought-prone or shallow soils
- South-facing ridges
- Mesic species on drier sites (marginal sites or off-site)



Drought?

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



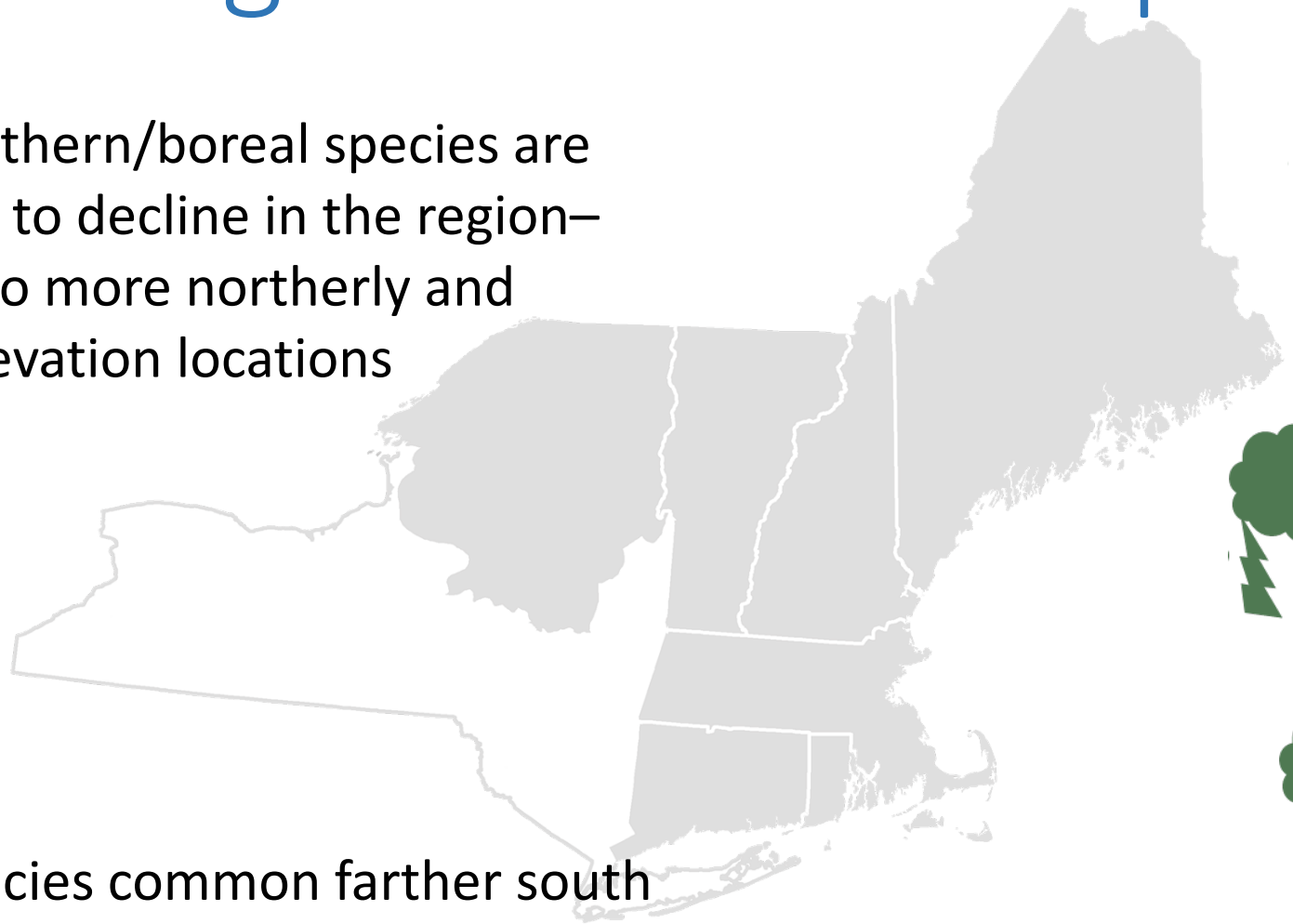


Extreme Drought | Severe Drought | Moderate Drought | Near Normal | Unusual Moist Spell | Very Moist Spell | Extremely Moist

Asbjornsen et al. 2019; ; Image: Matt Peters

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.

Effects on Forests

SHIFTING SEASONS | **SHIFTING SPECIES** | SHIFTING STRESSORS

Declining Habitat

- Balsam fir
- Black ash
- Striped maple
- Sycamore

Persisting Habitat

- American basswood
- Atlantic white cedar
- Bitternut hickory
- Black locust
- Eastern cottonwood
- Eastern redcedar
- Gray birch
- Northern red oak
- Pitch pine
- Sassafras
- Shagbark hickory
- Sugar maple
- Scarlett oak
- Yellow birch
- White oak

Increasing Habitat

- American beech
- Blackgum
- Black cherry
- Black oak
- Chestnut oak
- Pignut hickory
- Yellow-poplar

New habitat

- Bald cypress
- Black hickory
- Chinkapin oak
- Eastern redbud
- Loblolly pine
- Shortleaf pine
- Southern red oak
- Virginia pine

New DISTRIB-II data; www.fs.fed.us/nrs/atlas; www.forestadaptation.org/new-england

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**

October 2020 News:

New England Sees First 'Derecho' Storm In Quarter-Century

Wildfire

Future climate conditions suggest increased risk of 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

Clark et al. 2014, Guyette et al. 2014. Photo: Matthew Duveneck

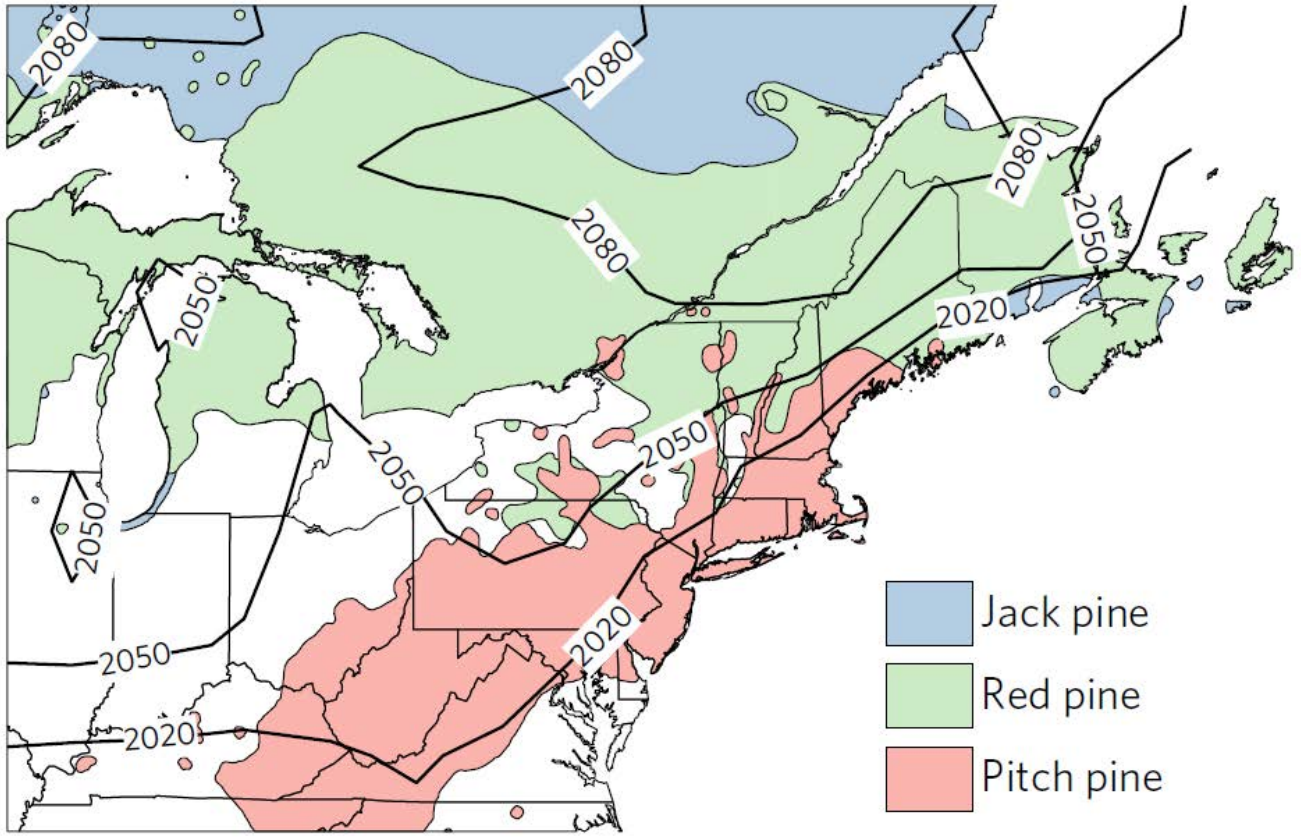
Insects and Diseases

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)

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

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_2

Dukes et al. 2009, Hellman et al. 2008; Images: www.eddmaps.org)

Deer Herbivory

Here to stay.

Deer populations likely to be maintained or increase:

- More overwinter survival & better condition due to warmer conditions
- Potential increase in some diseases affecting deer?
- Effect much greater near northern edge of range.

Weiskopf et al. 2019, Image: Norcross Wildlife Foundation

Interactions are Critical

Climate change is a "threat multiplier"

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

Interactions make all the difference.

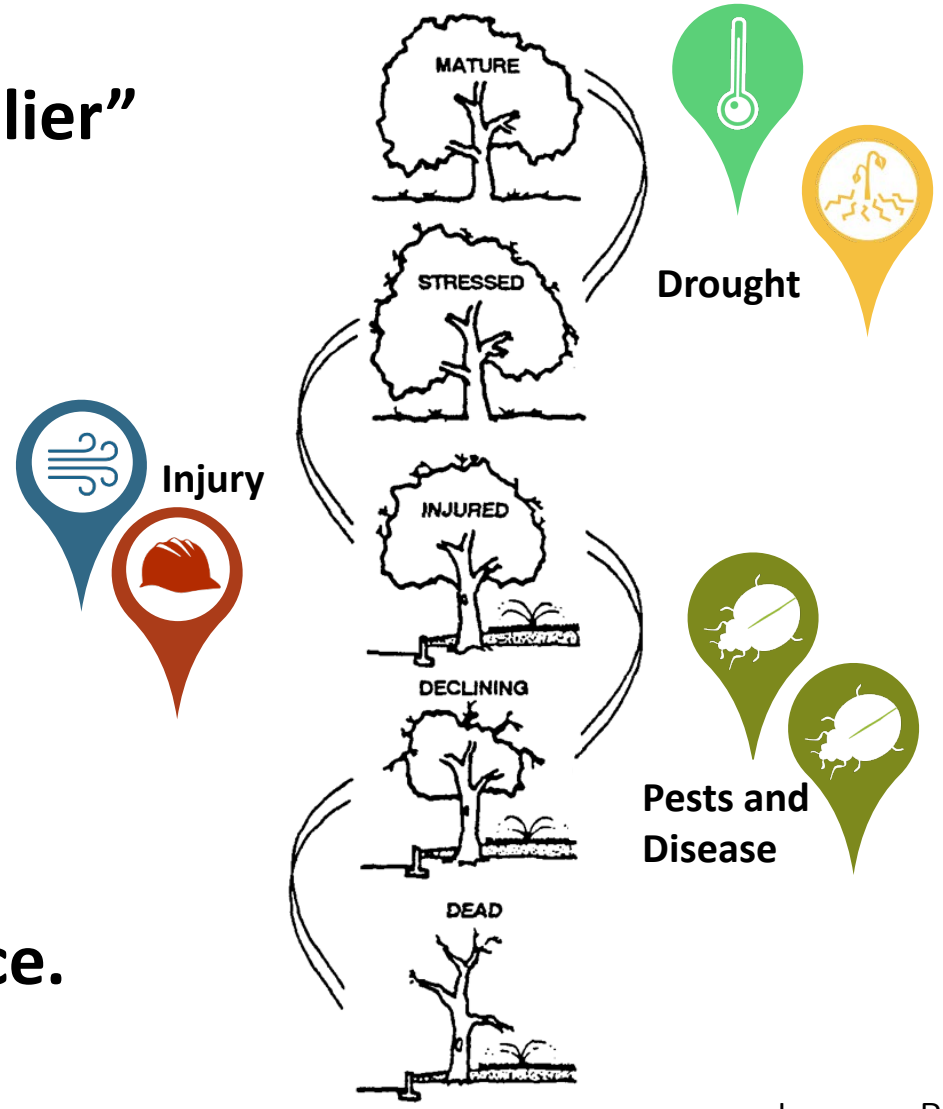


Image: Bartlett Tree Experts

How can we respond to climate change?

If you want a single “answer” for how to respond to climate change, it’s

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If you want a single “answer” for how to respond to climate change, it’s

“It depends”

It depends on **where** you are working and **what** you’re trying to achieve.

Adapting Forests to Climate Change

1) **Avoid forest loss:** Connecticut forest loss to other land uses is ~4,000 ac/year, which removes forests habitats and the benefits they provide, and reduces opportunities for plants and animals to move across the landscape.
2) **Reduce stressors:** Pro-actively reducing stress on forests can support the inherent adaptive capacity (resilience) of systems to cope with disturbance and change.
3) **Support ecosystem functions:** Use passive and active management to provide a wide array of forest benefits, including carbon sequestration, clean water and air, wildlife habitat, nature connection, and wood products.

Finding the Right Trees for the Right Time

Wednesday, April 14. 1-2pm

- **Forest Management for Carbon Sequestration and Climate Adaptation**
- Presented By Dr. Todd Ontl, Northern Institute of Applied Climate Science

Wednesday, May 12. 1-2pm

- **Experimenting with Climate-Adaptive Forestry Practices: Challenges and Opportunities**
- Presented By Christopher Riely, Sweet Birch Consulting, LLC

Wednesday, June 9. 1-2pm

- **Brave New Worlds for Trees: Assisted Migration and the Study of Hoffman Preserve Date**
- Presented By Dr. Juliana Barrett, Connecticut Sea Grant and UConn Extension

https://clear.uconn.edu/webinars/schedule.htm

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- Humans have been part of the southern New England landscape and influencing its forests for at least 8,000 years.
- The forests we see today are largely the result of interacting human disturbances over several centuries.
- Climate change will continue to alter forest ecosystems in new (and likely surprising) ways.
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