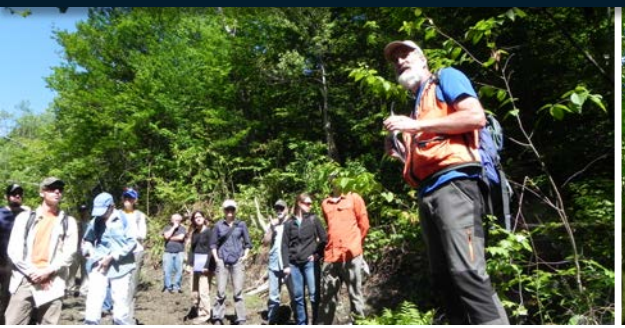
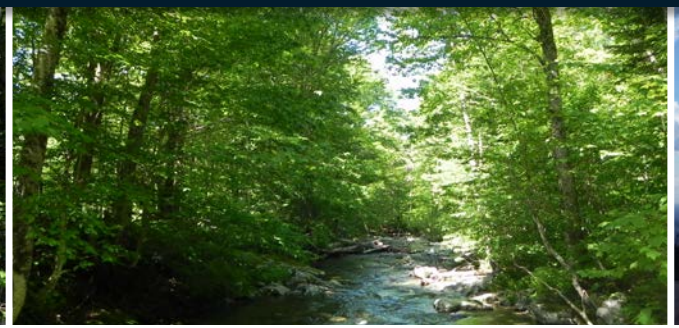
Climate Change & Oak Forests

in Southern New England

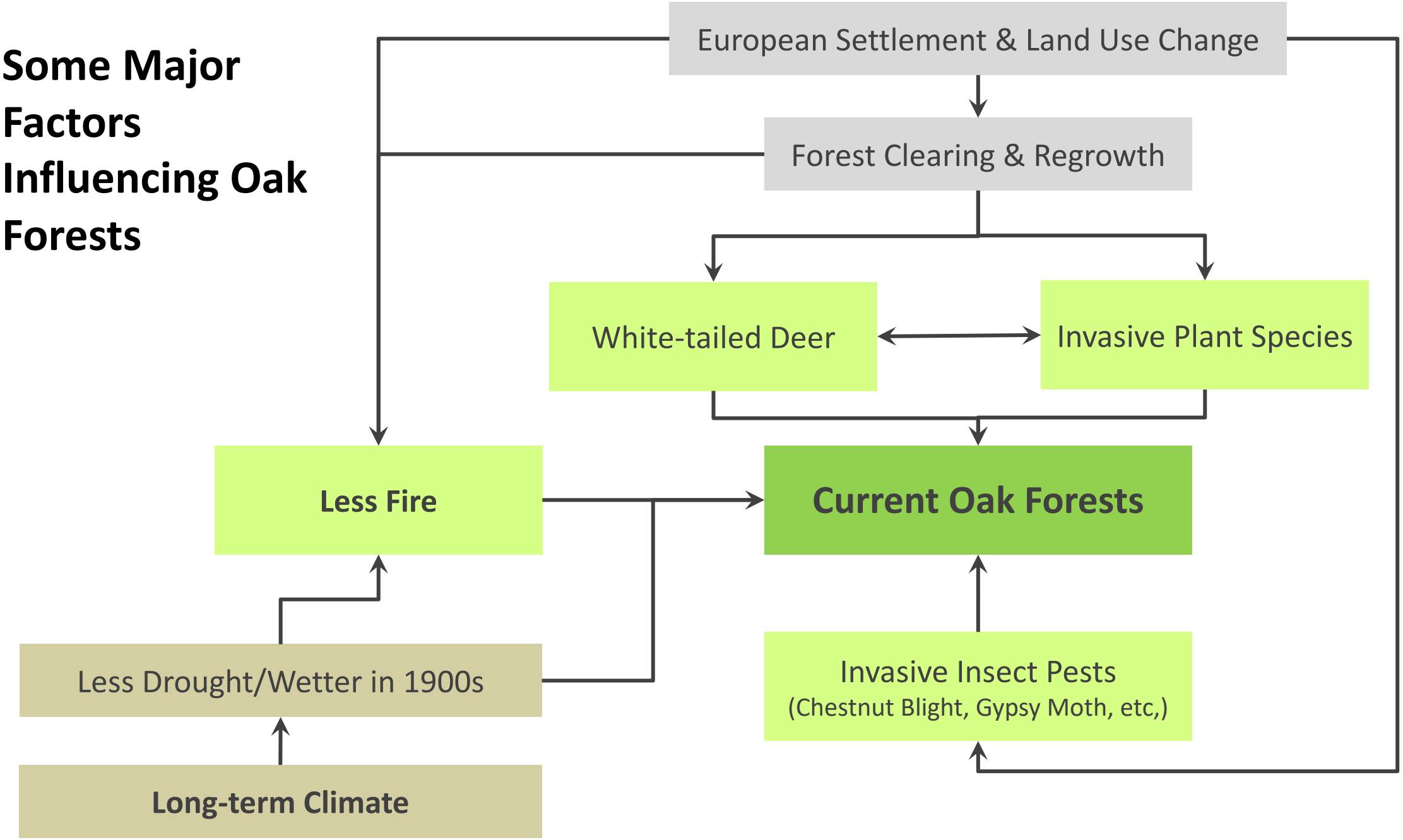



Maria Janowiak

Northern Institute of Applied Climate Science

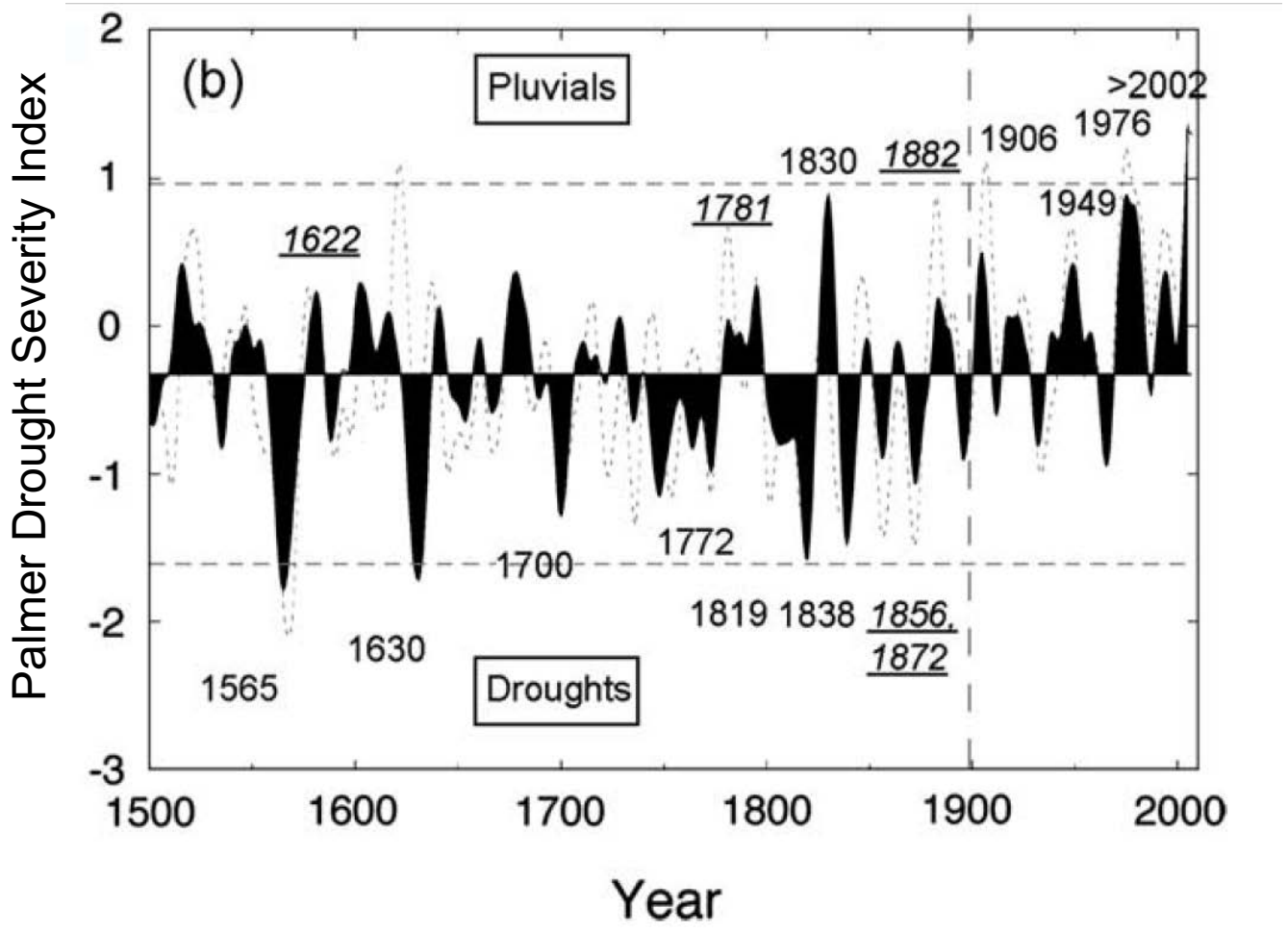
www.niacs.org / www.forestadaptation.org

Some Major Factors Influencing Oak Forests



Factors drawn from: McEwan et al. 2011

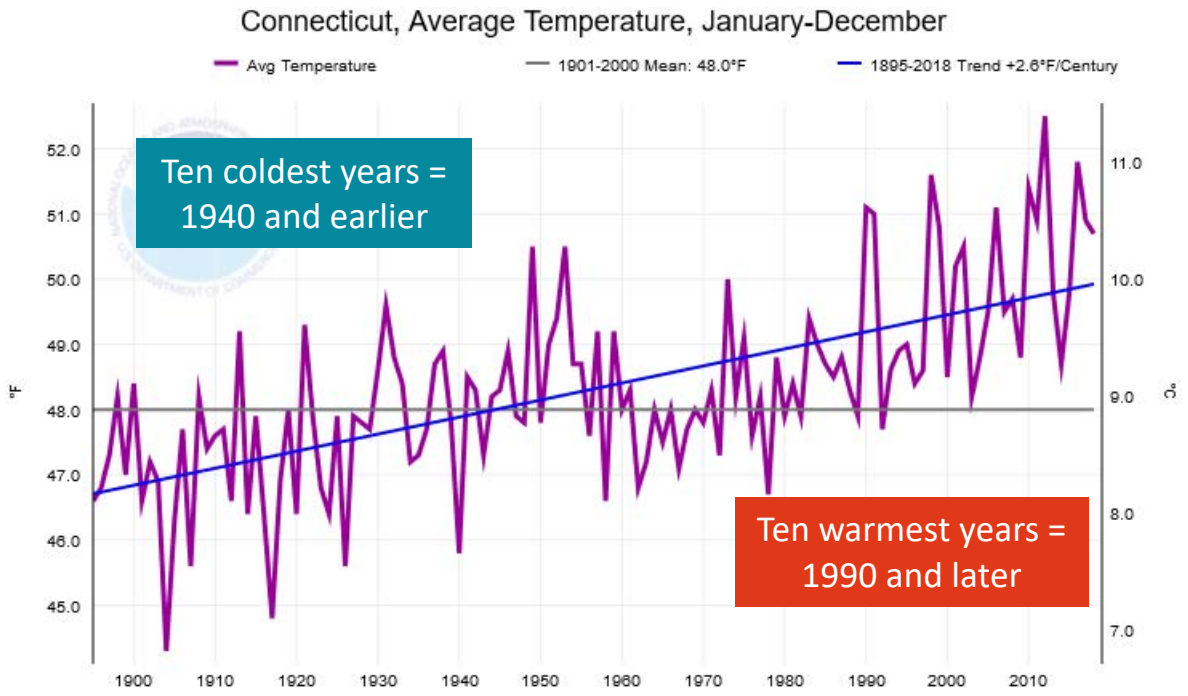
Drought History Across Eastern Oak Forest Since 1500



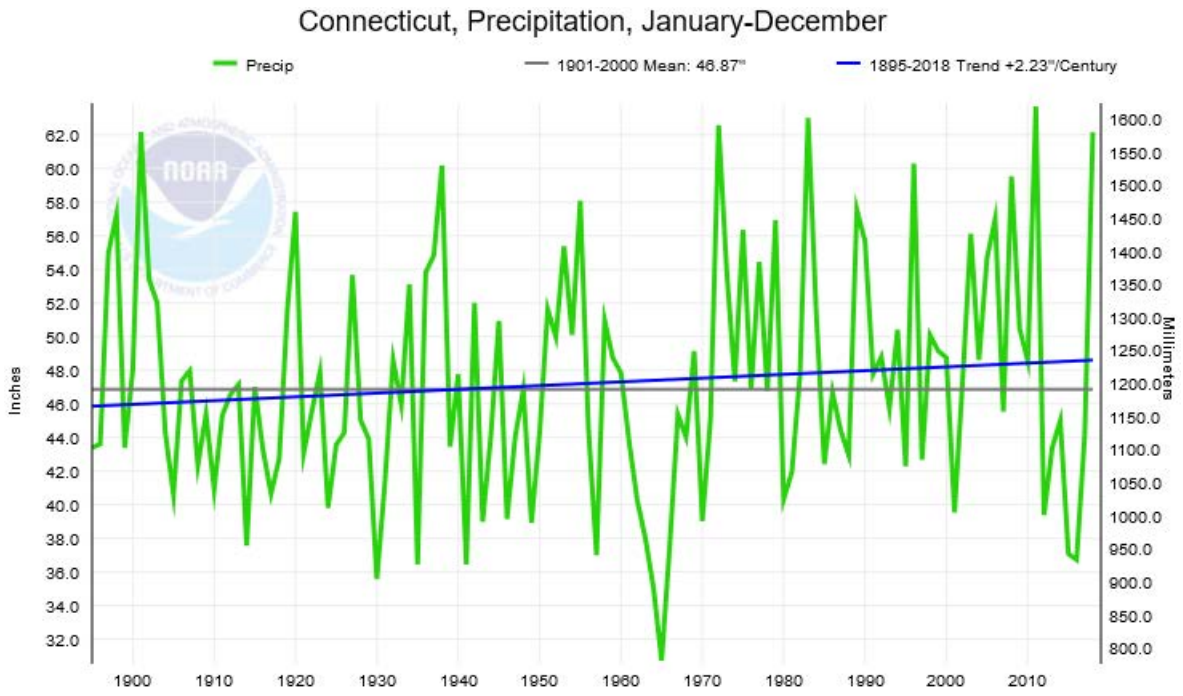
McEwan et al. 2011

Observed Changes in Climate (CT)

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



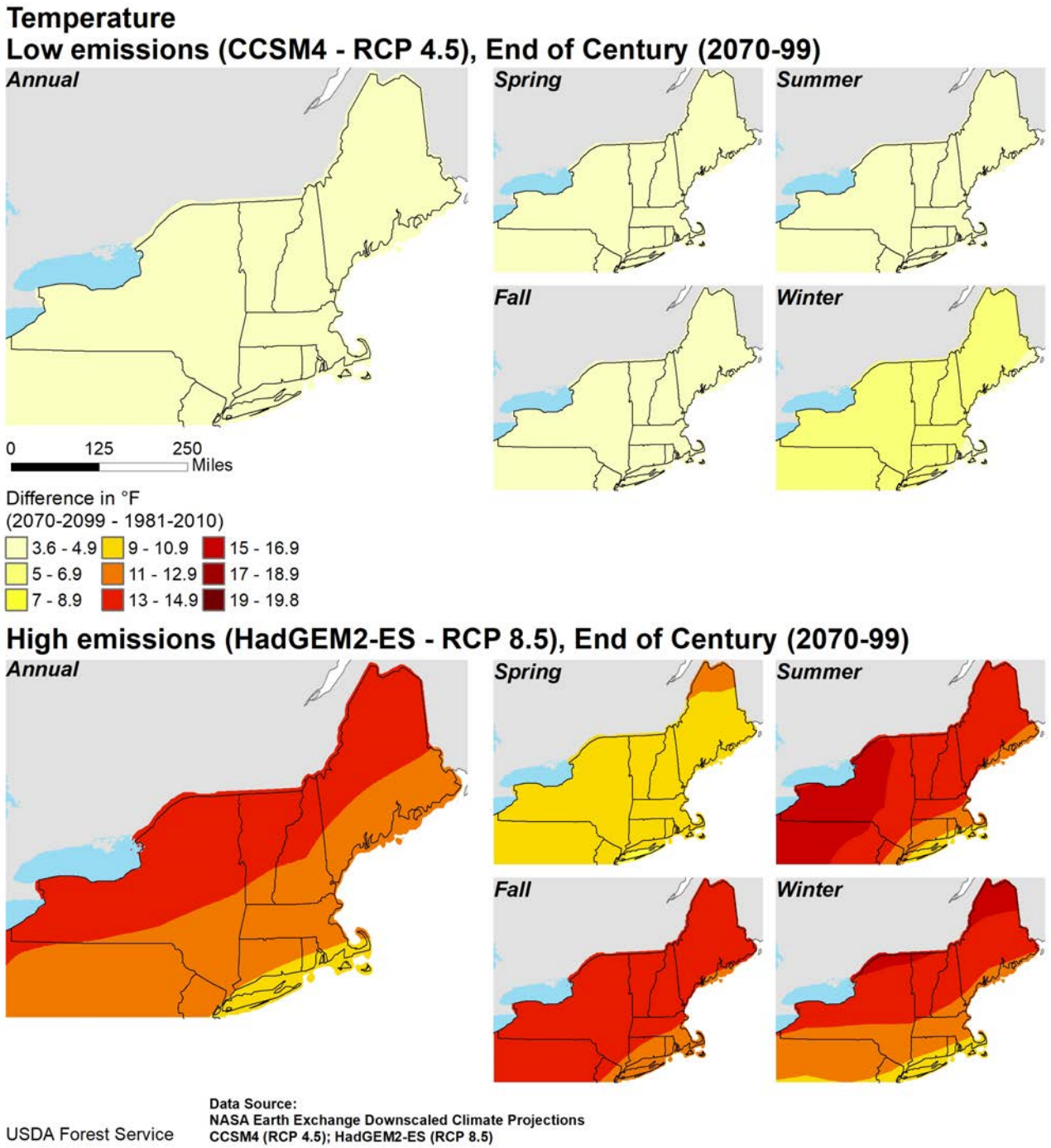
Annual precipitation has increased about 2.6 inches (~4%).



NOAA Climate-at-a-Glance Tool

3.6-4.9°F more warming (all seasons)

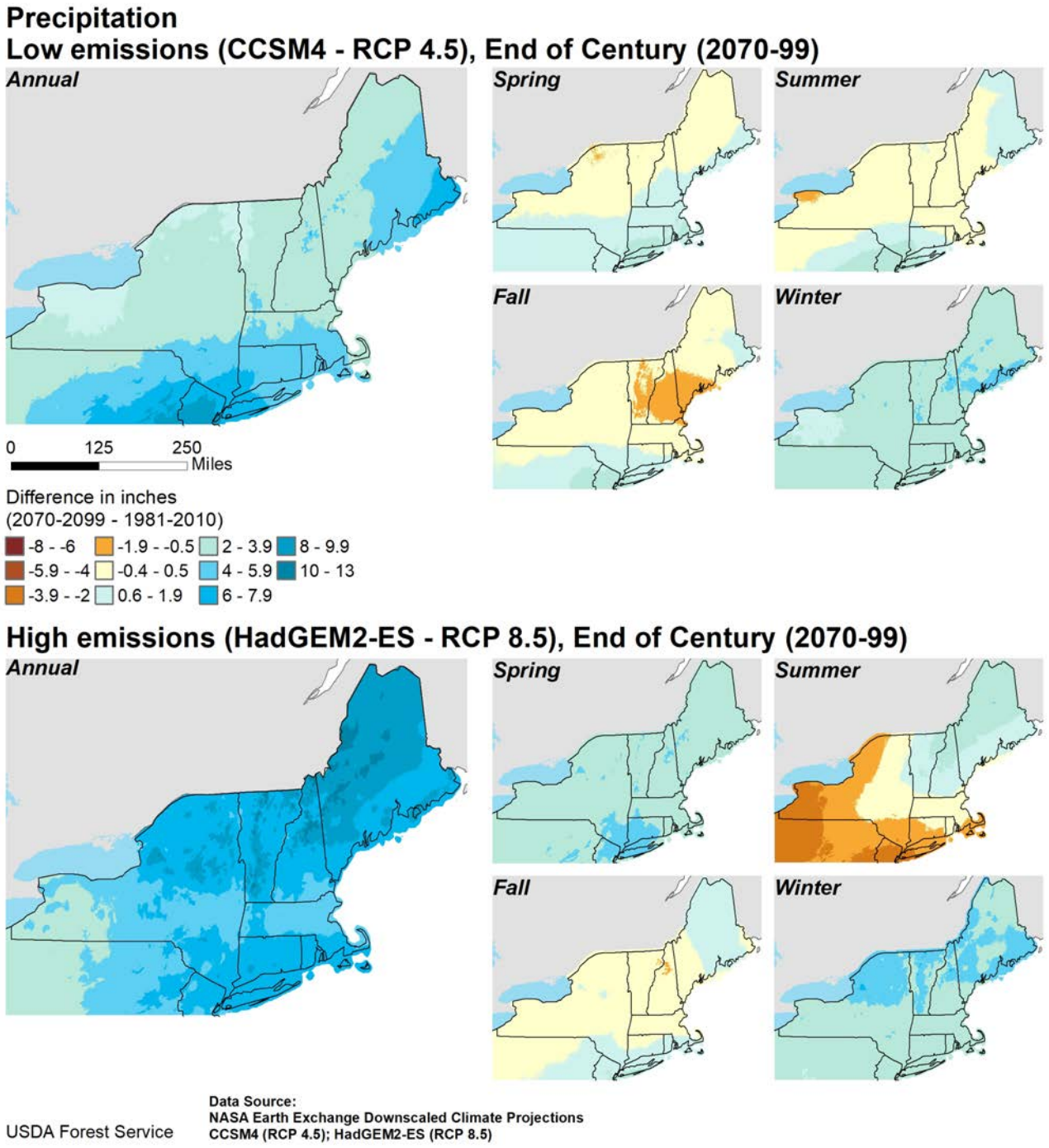
9-12.9°F more warming (all seasons)



Map: USDA Forest Service
Other studies project same trends: Lorenz et al., Lynch et al.

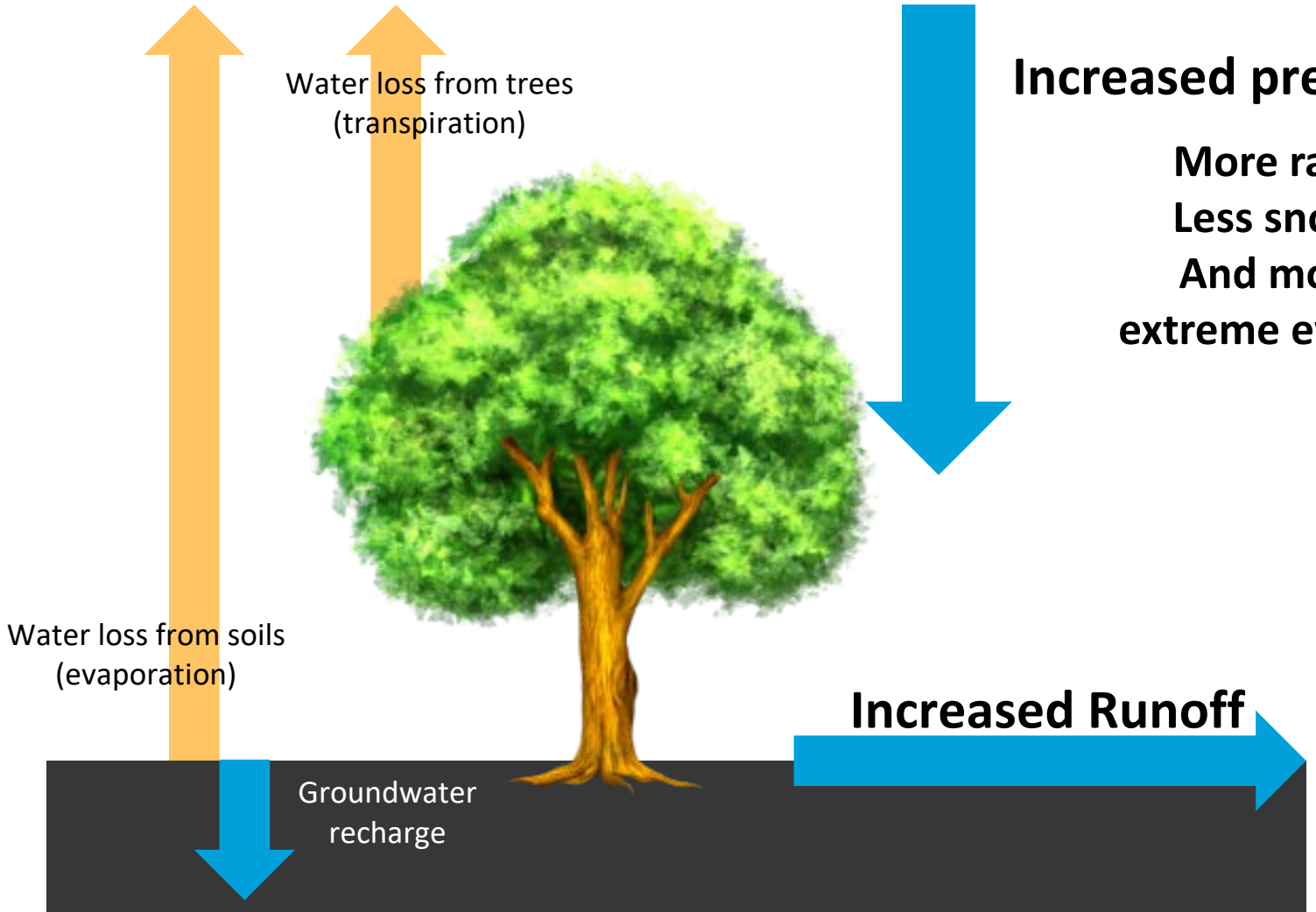
4-5.9” more precipitation
Wetter in winter/spring
Little change summer/fall

6-7.9” more precipitation
Wetter in winter/spring
Little change summer/fall



Map: USDA Forest Service
Other studies project same trends: Lorenz et al., Lynch et al.

Wetter Winters & Springs?

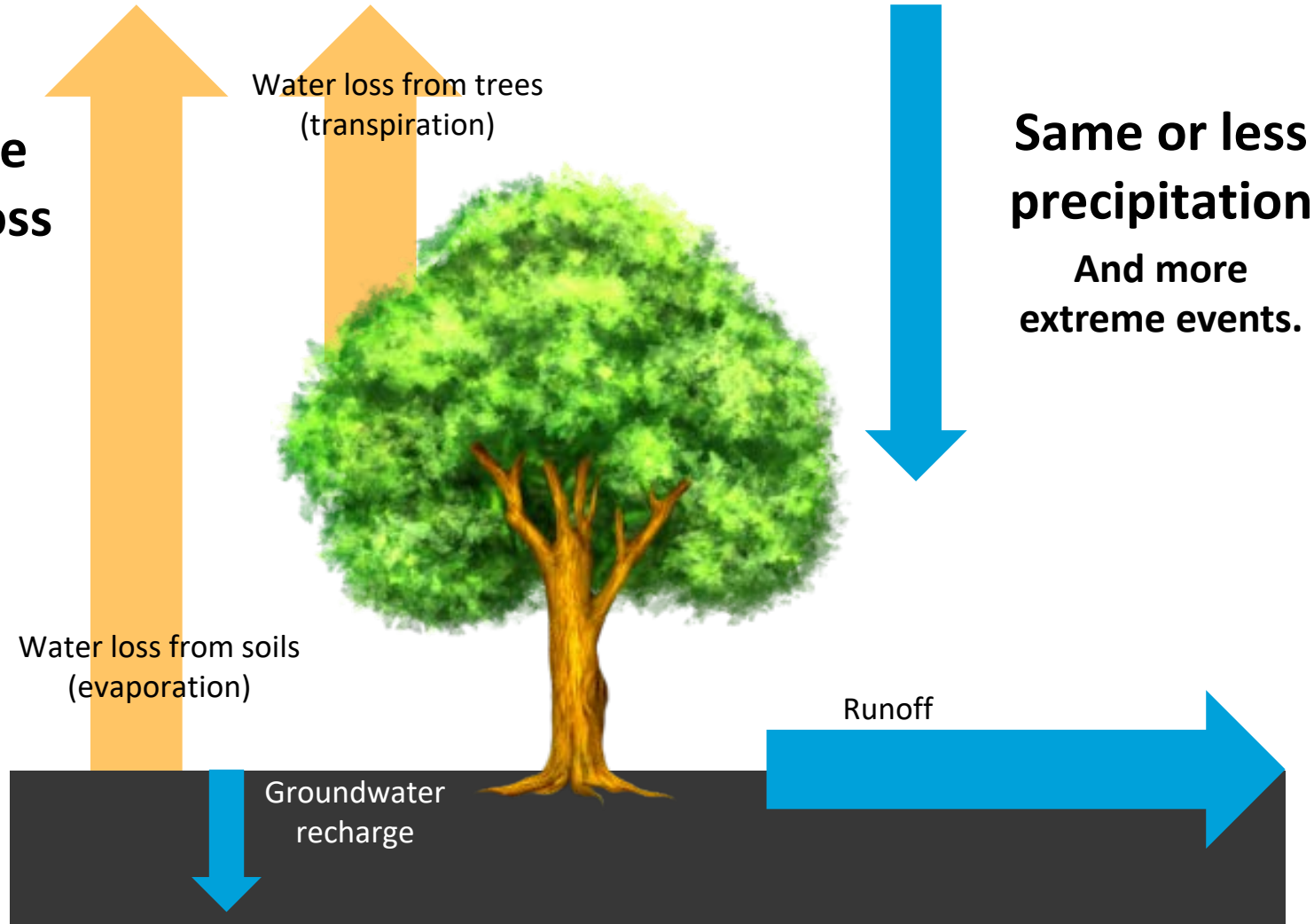


Increased precipitation

More rain.
Less snow.
And more
extreme events.

Drier Summers?

Greater evaporative demand & water loss

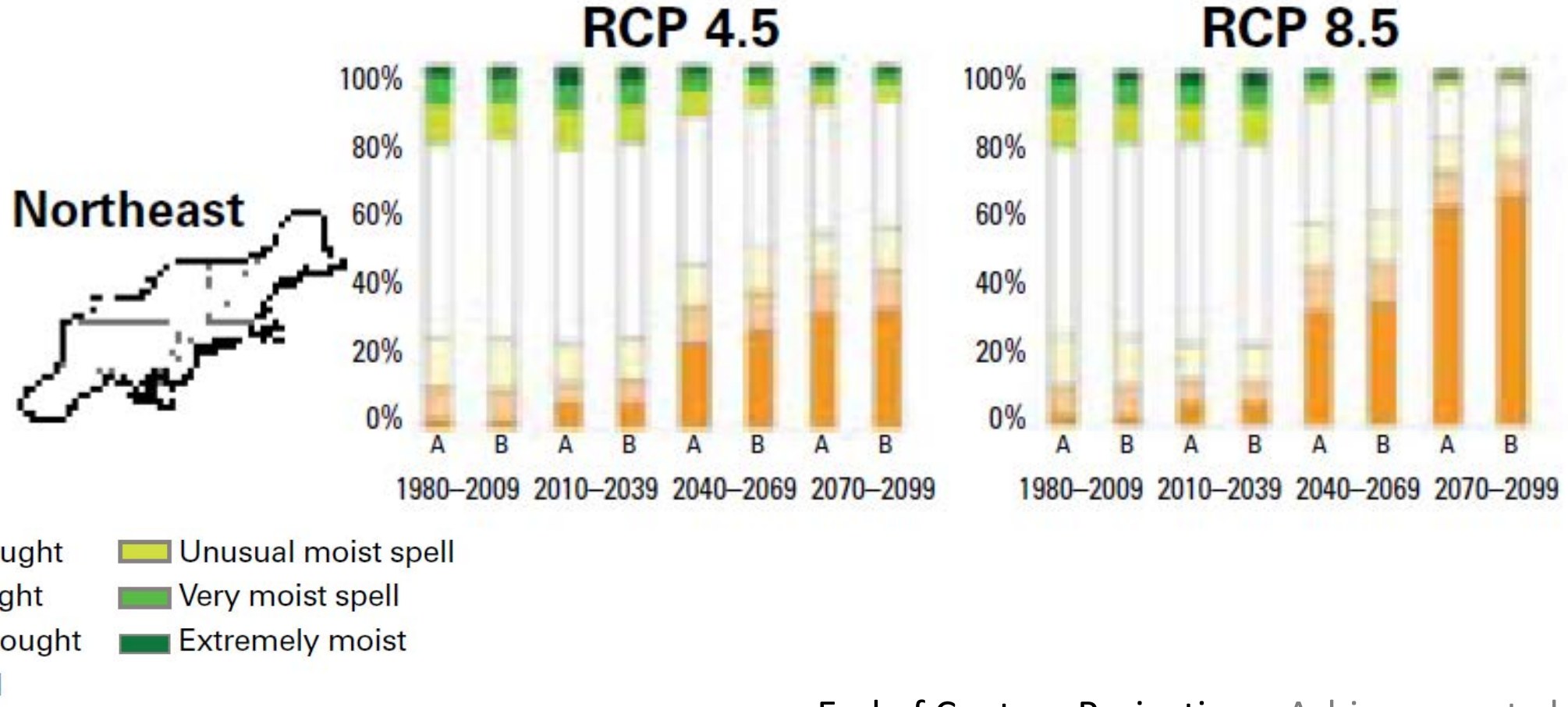


Same or less precipitation

And more extreme events.

Drought?

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



End of Century Projections. Asbjornsen et al. 2019

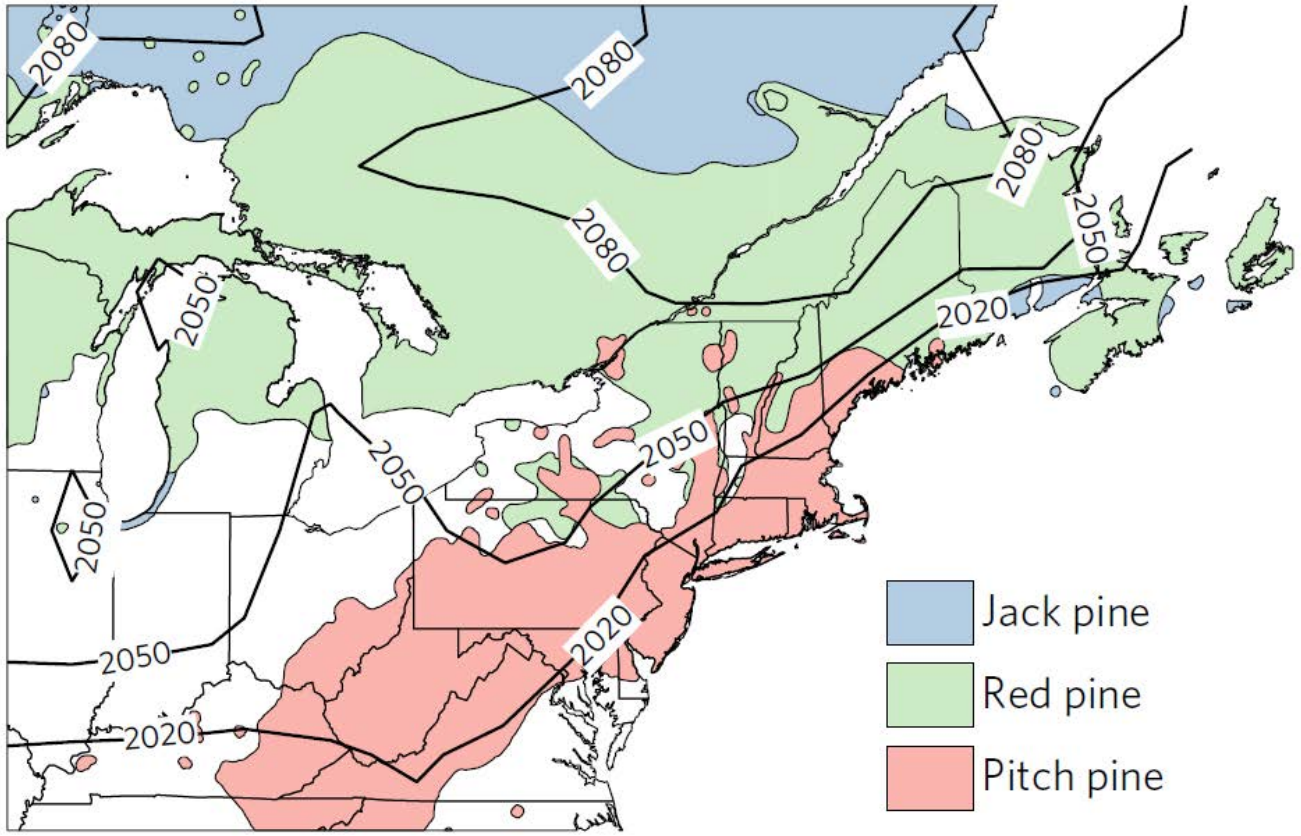
Insects and Diseases

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

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

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

Wildfire

Future climate conditions suggest increased risk of fire.

Wildfire may increase:

- Warmer/drier summers
- Increased stress or mortality from less suitable conditions
- Shift toward fire-associated species like oaks and pines

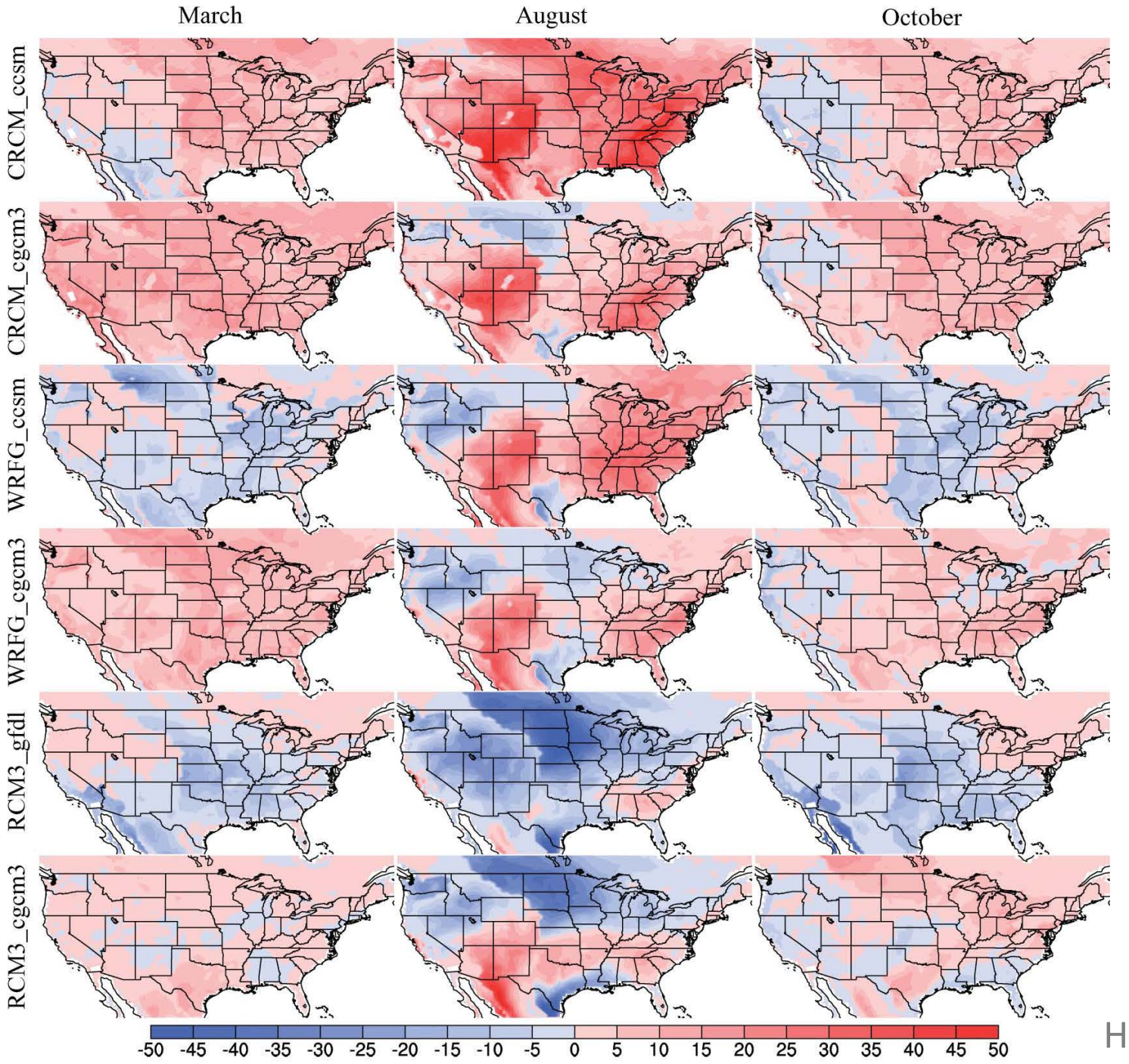
Wildfire may not change:

- 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

Wildfire

Potential Increase in Fire Weather



Percentage change in days with HI ≥5. The Haines Index (HI) is a measure of how conducive the atmosphere is to potential extreme or erratic fire behavior based on atmospheric stability and moisture

Tang et al. 2015
Heilman et al 2015

Changes in Forest Composition

Habitat based on:

Temperature

Precipitation

Elevation

Latitude

Soils

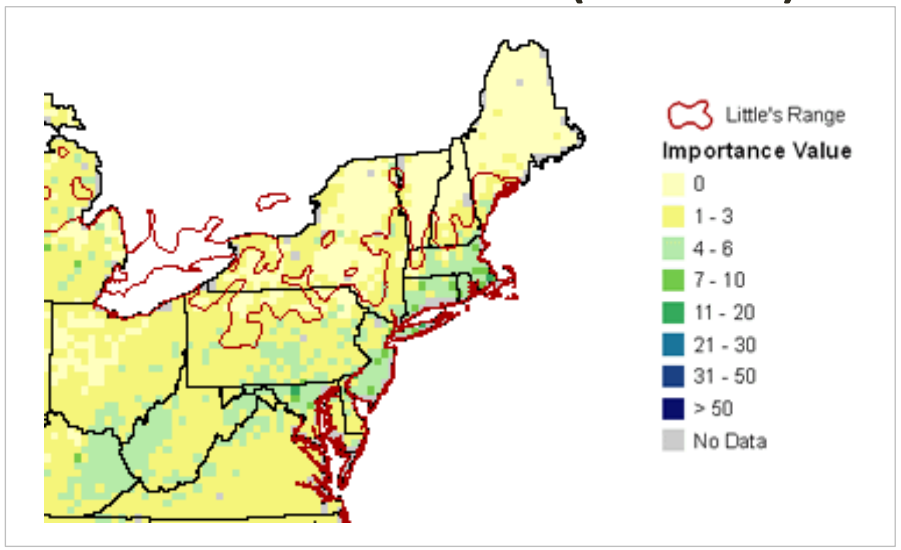
Slope & Aspect

Land use

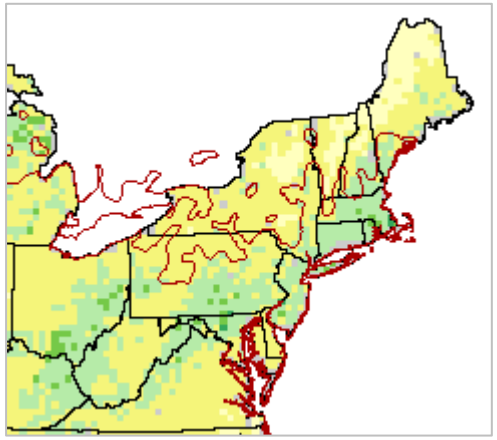
Competition

Management

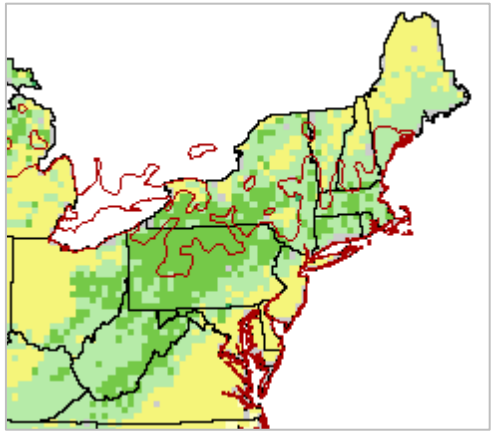
Black Oak: Current Habitat (modeled)



PCM B1 (Less Change)



GFDL A1FI (More Change)



Iverson et al. 2008; Atlas website: www.fs.fed.us/nrs/atlas/

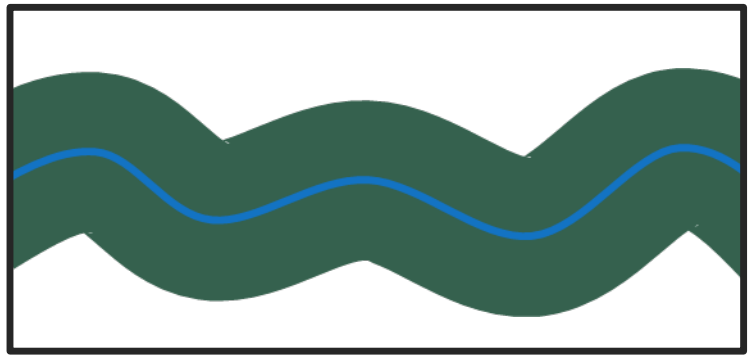
Tree Atlas Projections – end of century (CT)

Common Name	Scientific Name	Adaptability	Abundance	Habitat Suitability (RCP 4.5)	Capability (RCP 4.5)	Habitat Suitability (RCP 8.5)	Capability (RCP 8.5)
American beech	Fagus grandifolia	Medium	Common	Sm. inc.	Good	Sm. inc.	Good
bitternut hickory*	Carya cordiformis	High	Rare	No change	Fair	No change	Fair
black oak	Quercus velutina	Medium	Abundant	Sm. inc.	Very Good	Sm. inc.	Very Good
eastern hemlock	Tsuga canadensis	Low	Abundant	Sm. dec.	Fair	Lg. dec.	Poor
eastern white pine	Pinus strobus	Low	Abundant	Sm. dec.	Fair	Sm. dec.	Fair
gray birch*	Betula populifolia	Medium	Rare	Sm. dec.	Very Poor	No change	Poor
mockernut hickory	Carya alba	High	Common	Lg. inc.	Very Good	Lg. inc.	Very Good
northern red oak	Quercus rubra	High	Abundant	No change	Very Good	Sm. dec.	Good
pignut hickory	Carya glabra	Medium	Common	Sm. inc.	Good	Sm. inc.	Good
pitch pine	Pinus rigida	Medium	Rare	Sm. dec.	Very Poor	Sm. dec.	Very Poor
red maple	Acer rubrum	High	Abundant	Sm. dec.	Good	Sm. dec.	Good
shagbark hickory	Carya ovata	Medium	Common	No change	Fair	No change	Fair
shellbark hickory*	Carya laciniosa	Medium	Rare	Very Lg. dec.	Lost	Very Lg. dec.	Lost
sugar maple	Acer saccharum	High	Abundant	Sm. inc.	Very Good	No change	Very Good
sweet birch	Betula lenta	Low	Abundant	Sm. dec.	Fair	Sm. dec.	Fair
white ash	Fraxinus americana	Low	Abundant	No change	Fair	No change	Fair
white oak	Quercus alba	High	Abundant	Sm. inc.	Very Good	Sm. inc.	Very Good
yellow birch	Betula alleghaniensis	Medium	Common	Sm. inc.	Good	Sm. inc.	Good

*species where the habitat suitability model has low model reliability

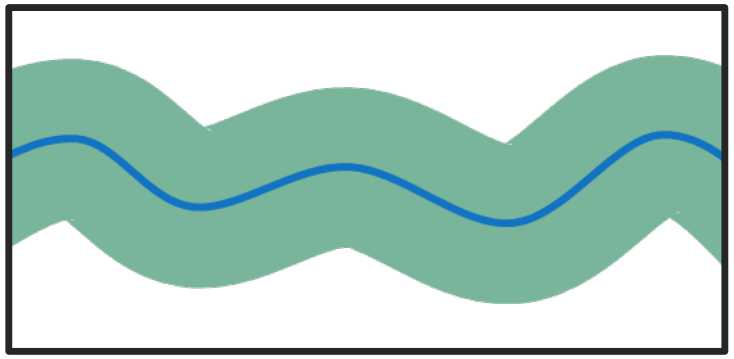
Iverson et al. 2020

Changes in Forest Composition

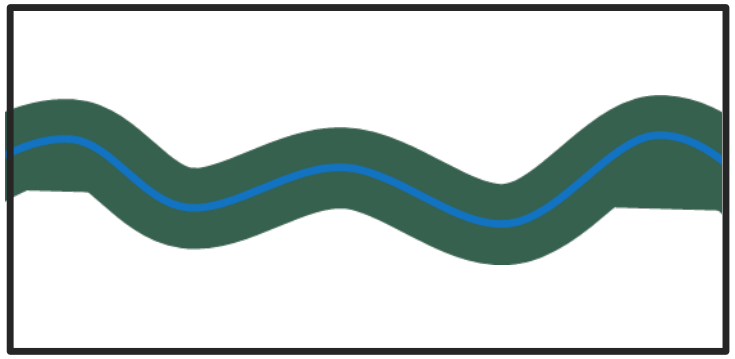


= species X quality habitat

50% Reduction in Habitat:



Habitat reduced equally



Best habitats remain

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

Summary of Impacts

Anticipated Change in Climate	Ecosystem Impact?
More variable precipitation and soil moisture – potentially both wetter and drier	**Variable**
Drought stress potentially increased during the growing season	**Supportive**
Fire weather potentially increased during some parts of the year	**Supportive**
White-tailed deer populations and impacts unchanged or increase	**Disruptive**
Invasive plant species increase (enhanced disturbance and non-climate impacts)	**Disruptive**
Insect pests and pathogens become more problematic in general	**Disruptive**
Southern pine beetle expands northward	**Disruptive?**
Gypsy moth (and fungus) change uncertain	**Uncertain**
Extreme disturbance events becoming more frequent and severe	**Variable**
Tree species composition favoring oak and associate species	**Supportive**
Interactions among all the above	**Complex!**

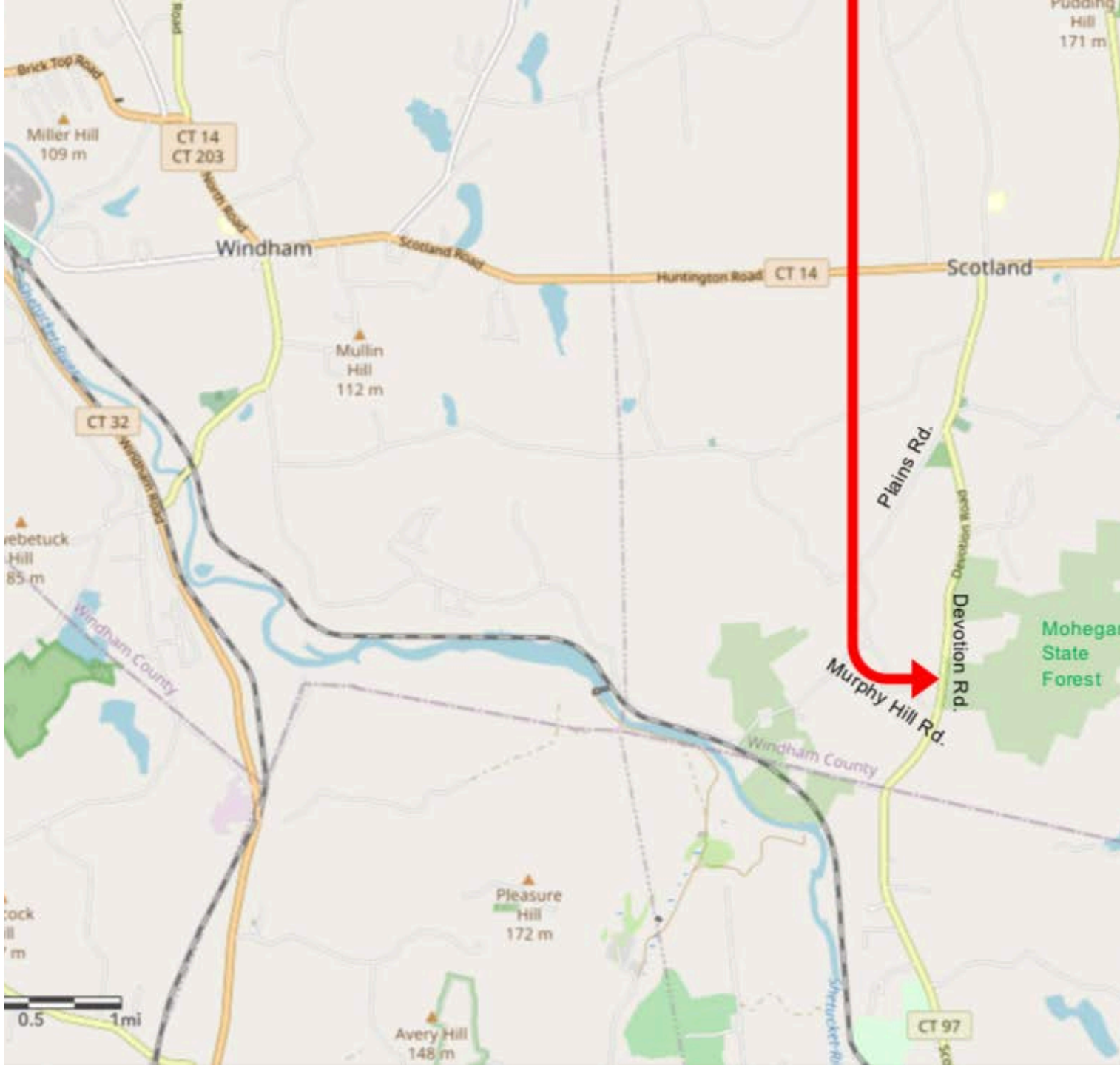
Activity A: Climate Change Considerations for Forest Management

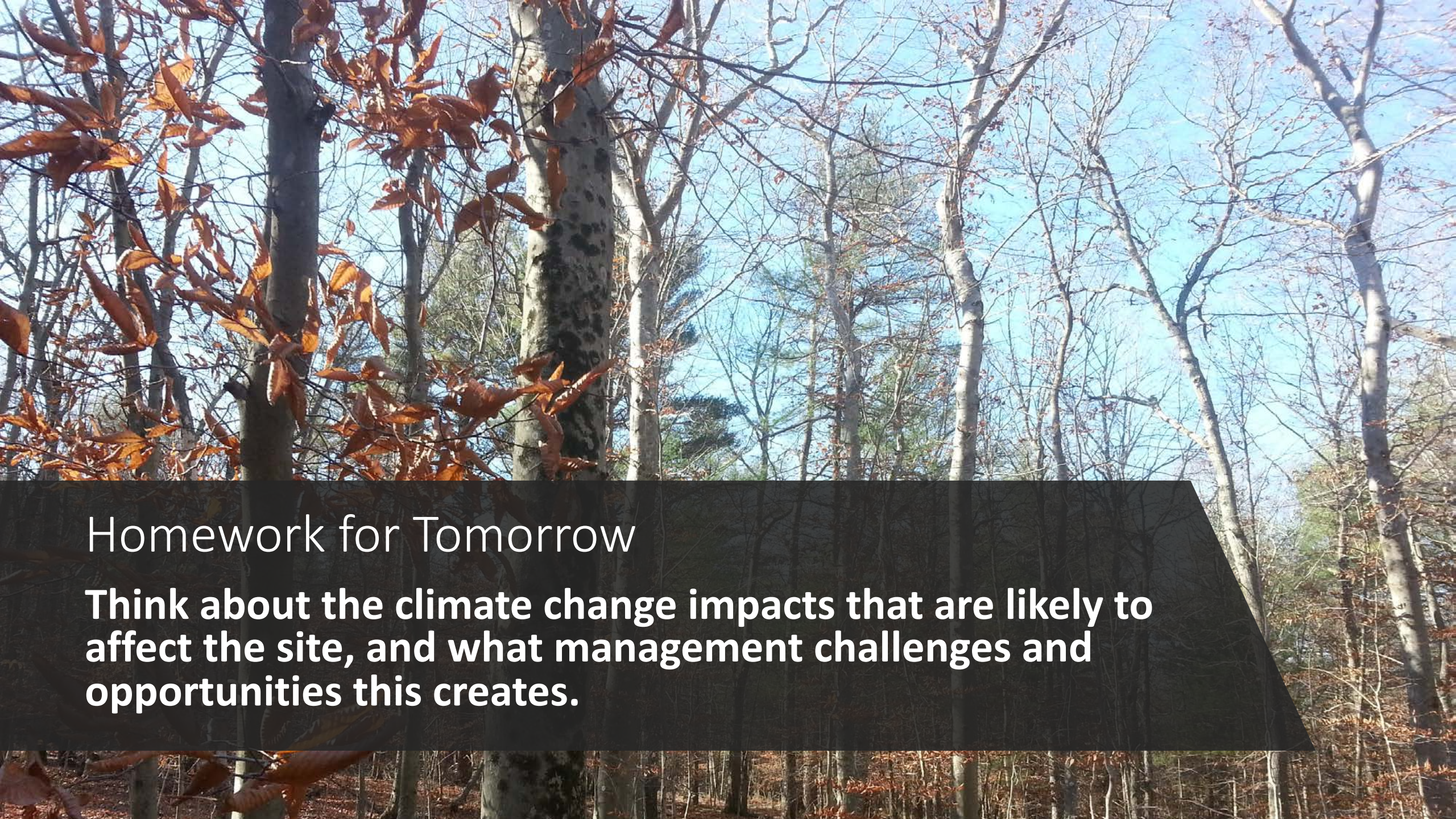
What new or different considerations do we need to think about when managing forests in the face of a changing climate?

Google Jamboard!

Field Tour Logistics

- Meet on Devotion Road at 1:00 p.m.
- Please wear a face covering and do your best to maintain a distance of 6 ft.
- Virtual discussion at 2:00 p.m.
- Check-out the StoryMap





Homework for Tomorrow

Think about the climate change impacts that are likely to affect the site, and what management challenges and opportunities this creates.