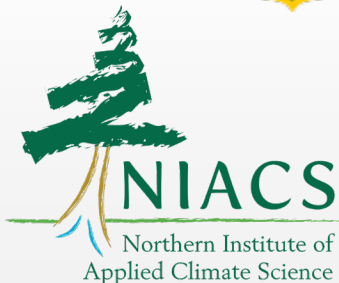
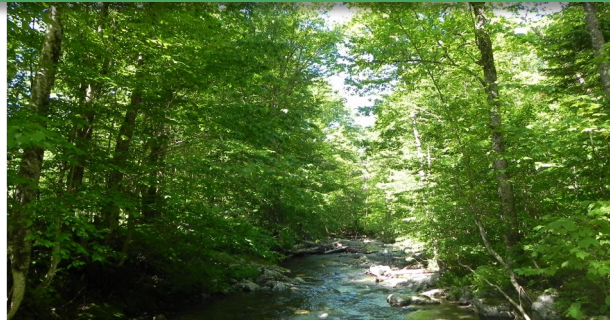


Climate Change and Forests Northeast U.S.

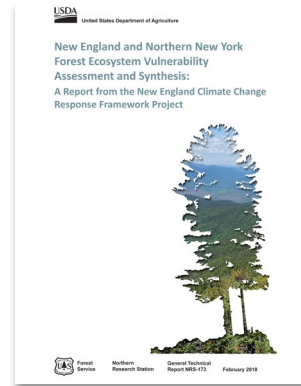
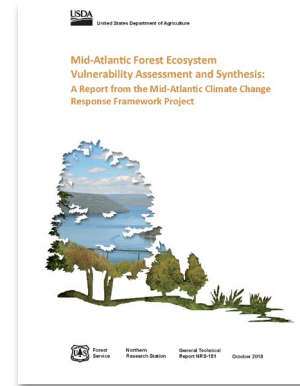
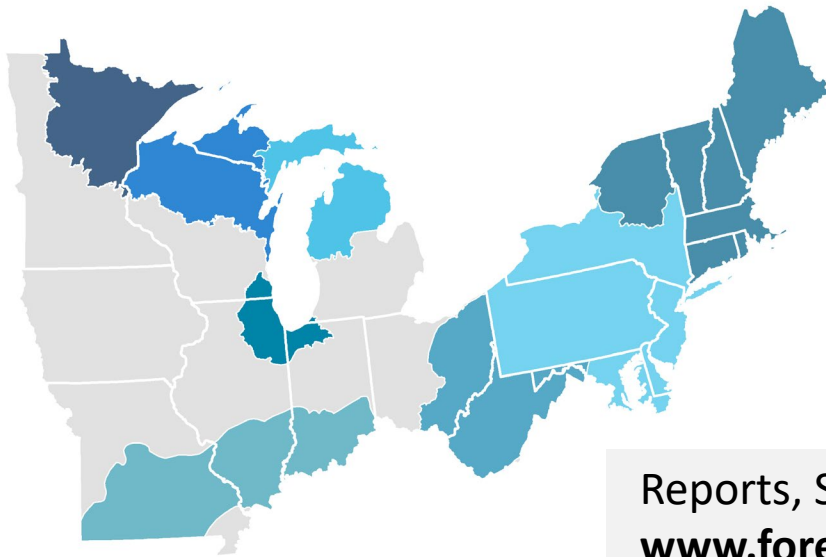


Maria Janowiak maria.janowiak@usda.gov
Northern Institute of Applied Climate Science
USDA Forest Service

Climate Change Response Framework
www.forestadaptation.org

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 mgmt., land use, policy



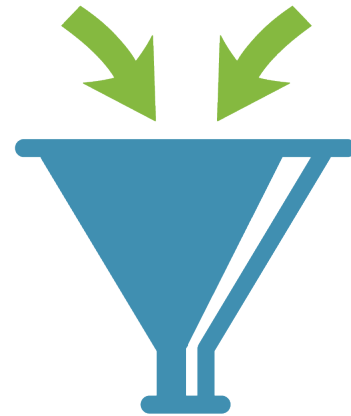
Reports, Summaries and StoryMaps:
www.forestadaptation.org/vulnerability-assessment

This presentation...

I'll talk about...

Shifting seasonality
Extreme Events
Disturbance
Sea-level rise
Wildfire Risk
Interacting stressors
Forest pests and disease
Altered precipitation
Tree species changes
Invasive Plants

You think about...



**What's at risk in
YOUR forest?**

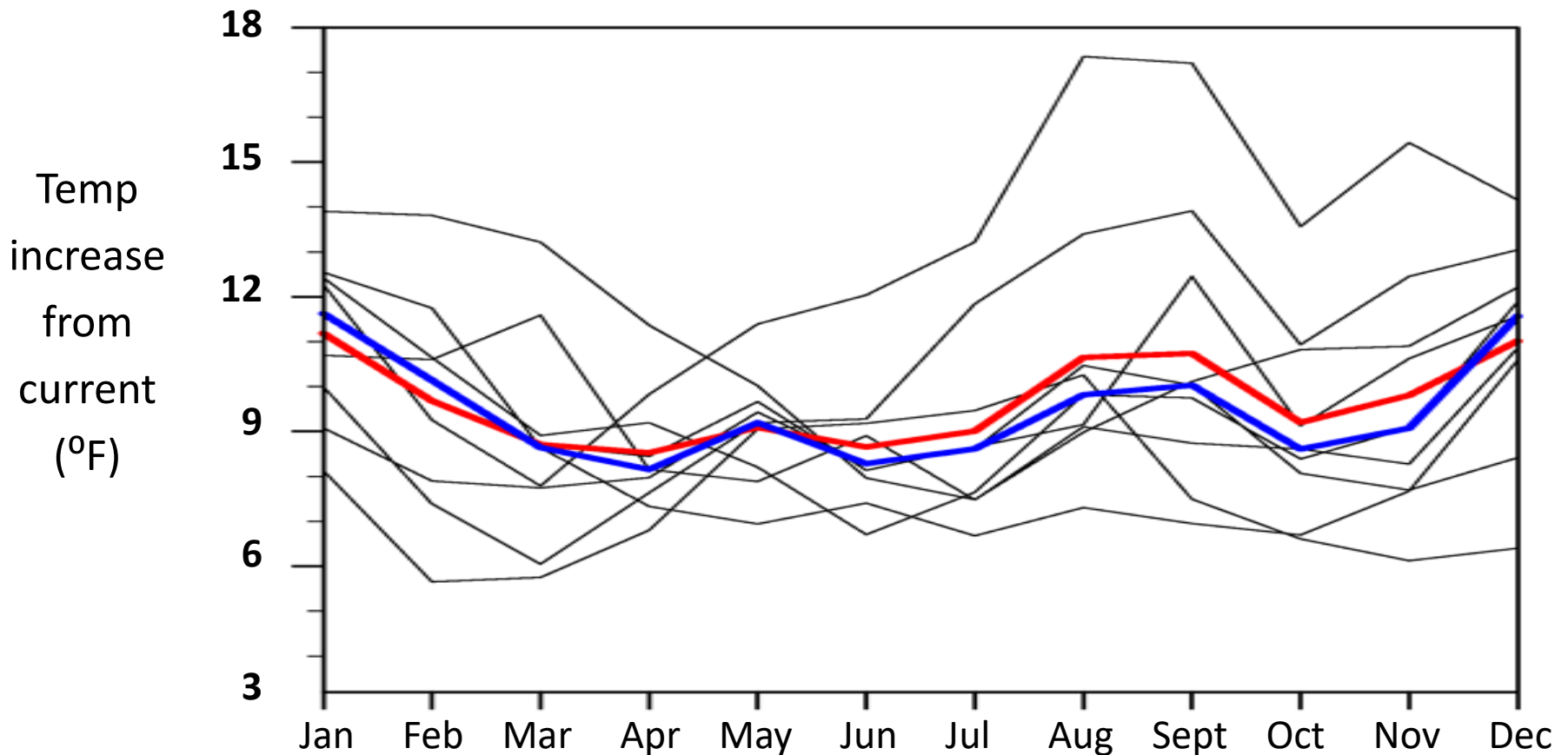
All models project increased temperatures.

All models project warming during all months.

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All models project warming during all months.

Temperature (°F) change 2081-2100 from 1961-2000 (higher emissions, A2)



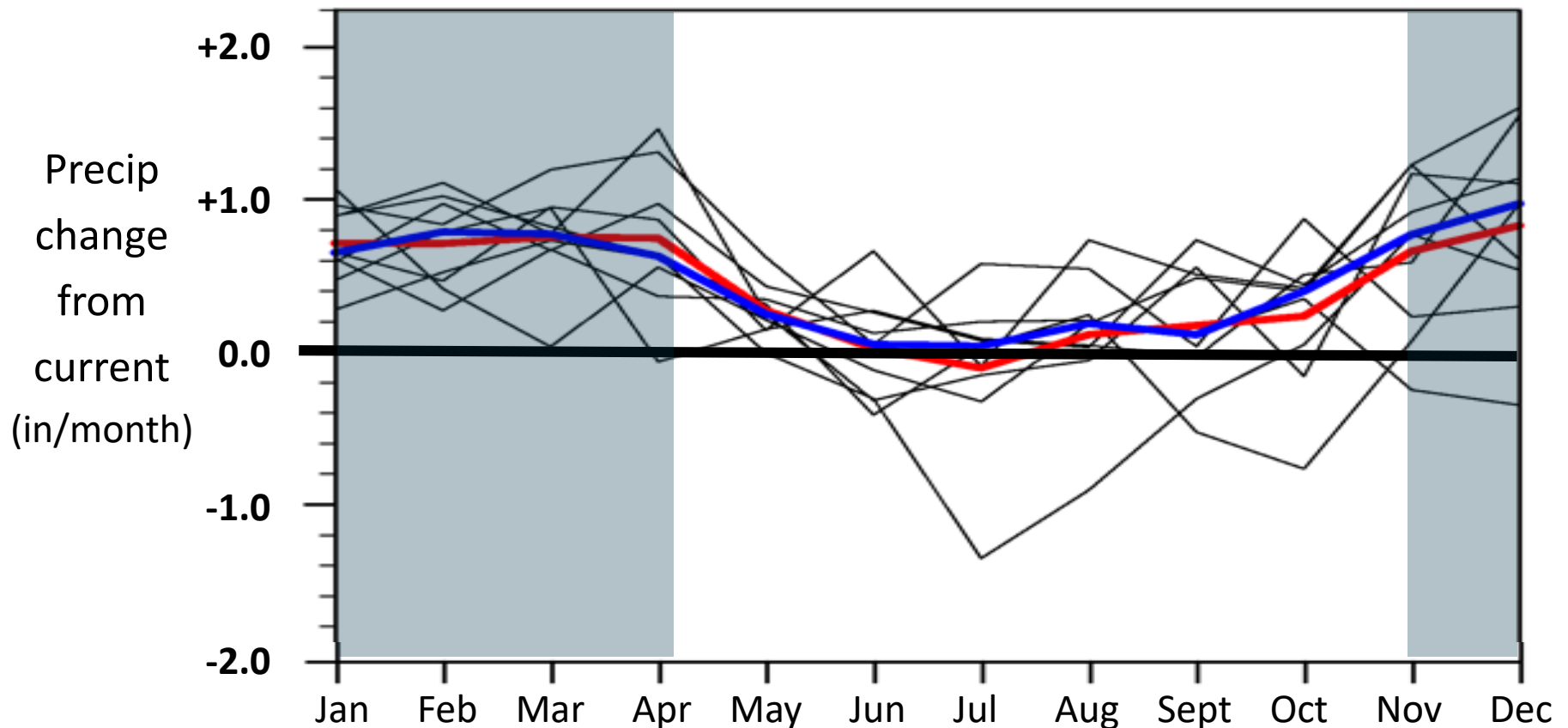
Each line = one climate model projection (16 total); Red = mean; Blue = median

Lorenz et al.

Models project seasonal changes in precipitation.

Models consistently project wetter conditions during the colder months.

Precipitation (in/month) change 2081-2100 compared to 1961-2000 =



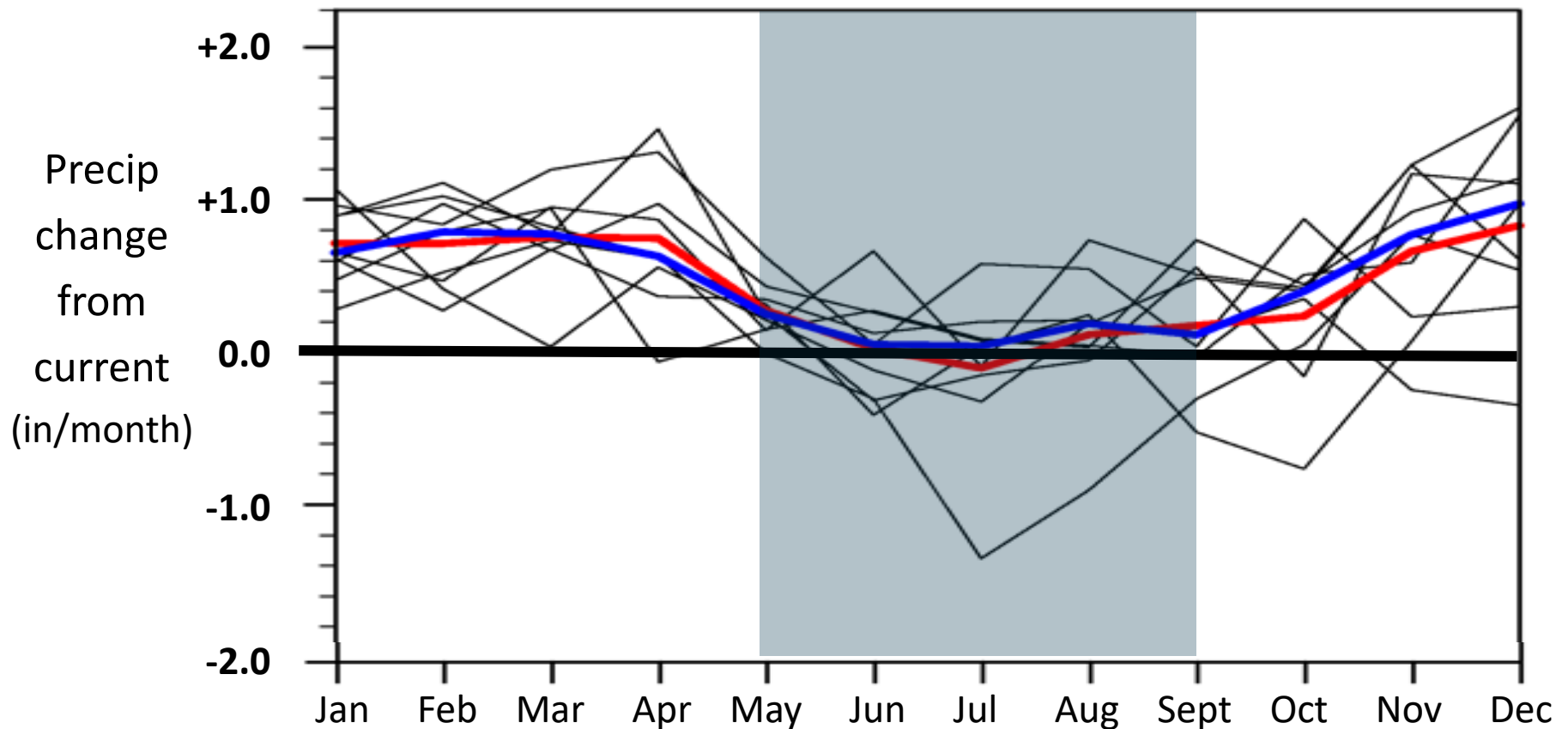
Each line = one climate model projection (9 total); Red = mean; Blue = median

Lorenz et al.

Models project seasonal changes in precipitation.

Models project relatively unchanged precipitation during the growing season.

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Lorenz et al.

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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

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



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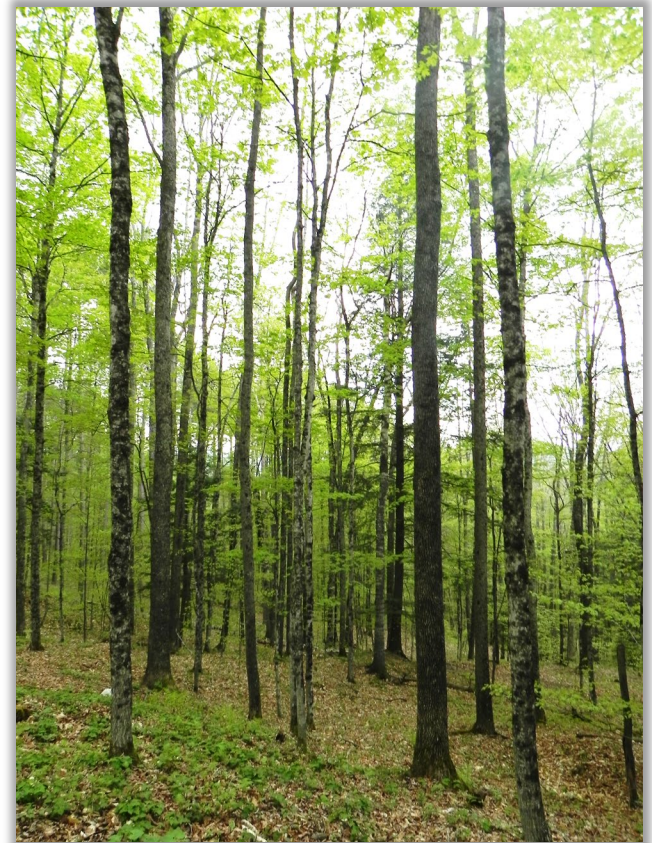
What may be at risk: Increased erosion/sedimentation on susceptible sites; culvert washouts and road damage from extreme events; aquatic habitats and species

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



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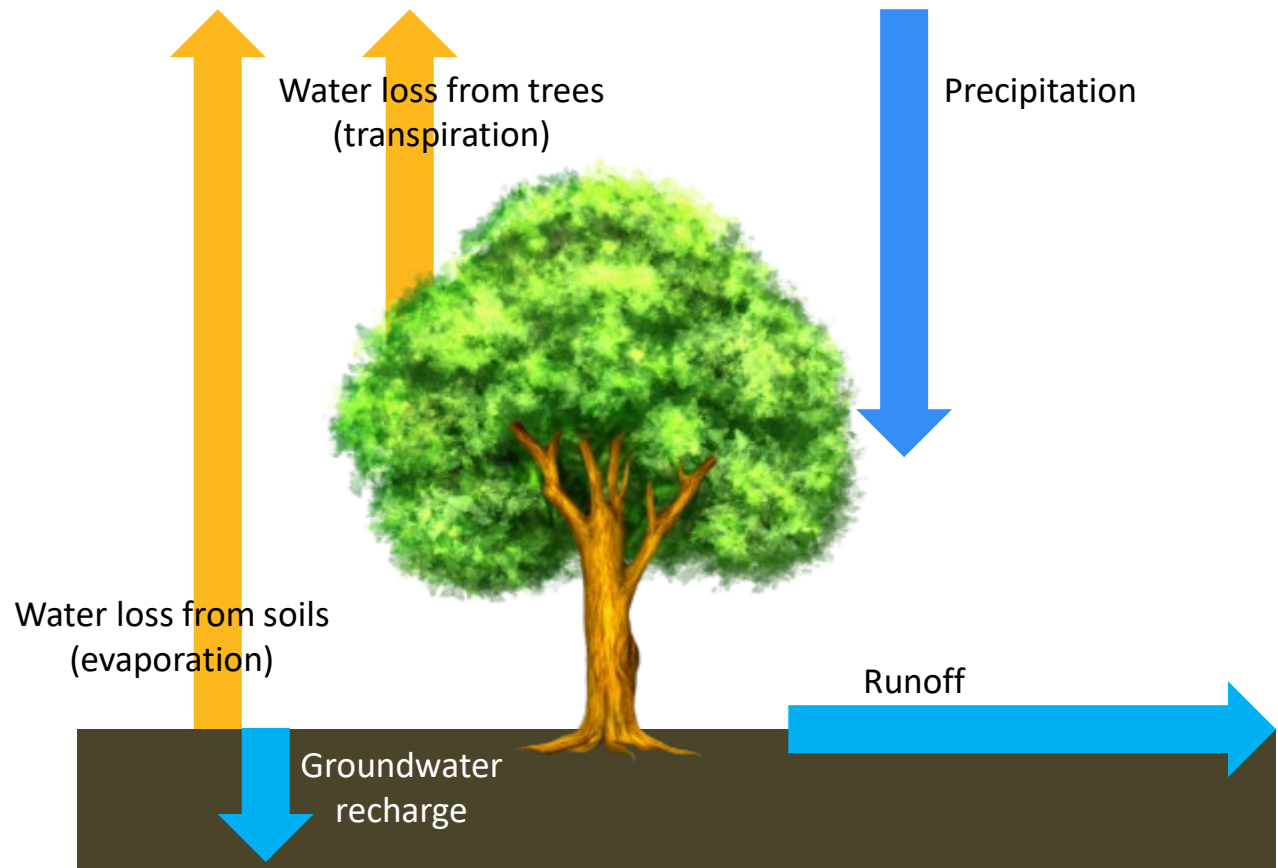
Phenological changes/mismatches

- Early bud break and frost damage from late spring freezing.



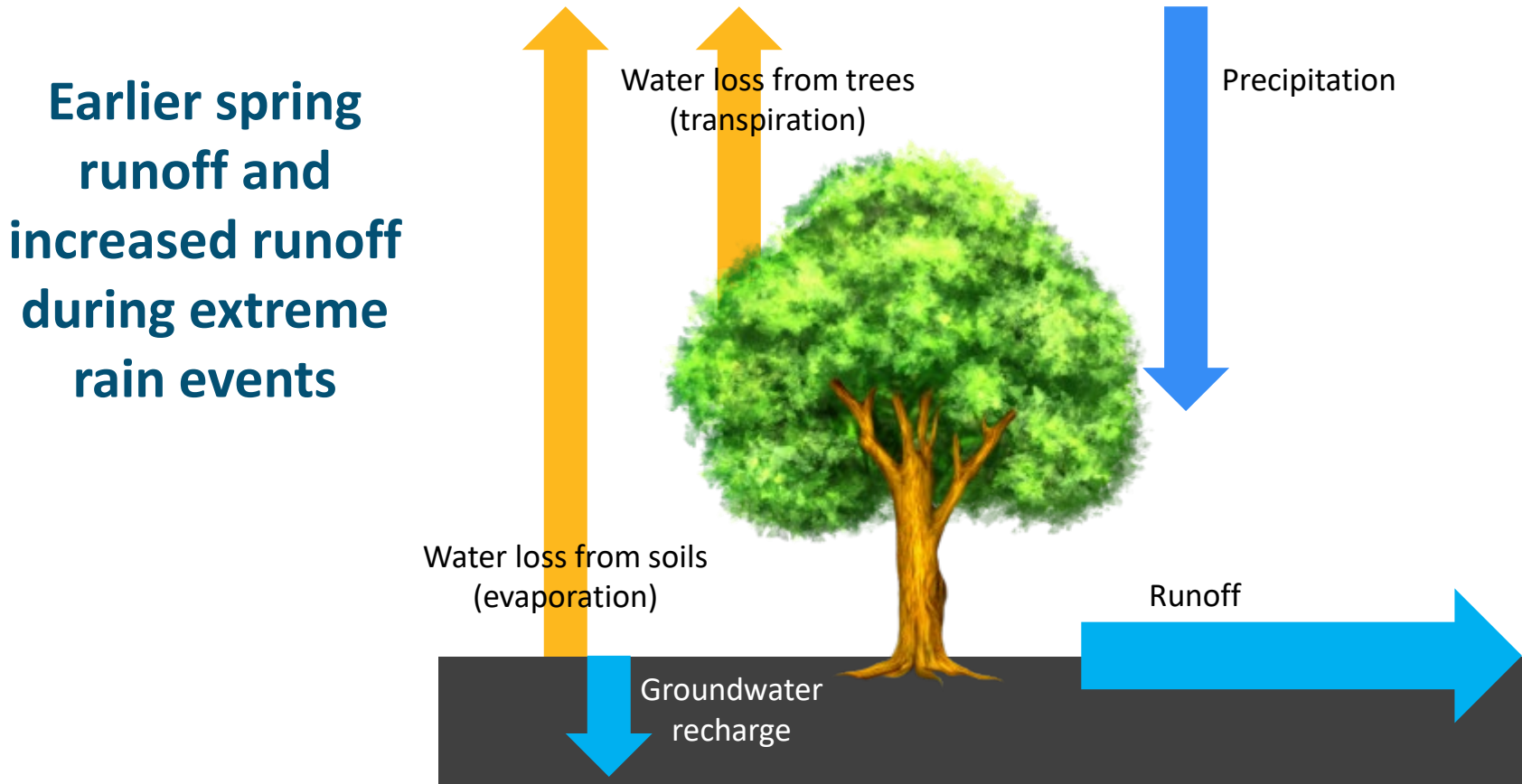
Increased Risk of Moisture Stress

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



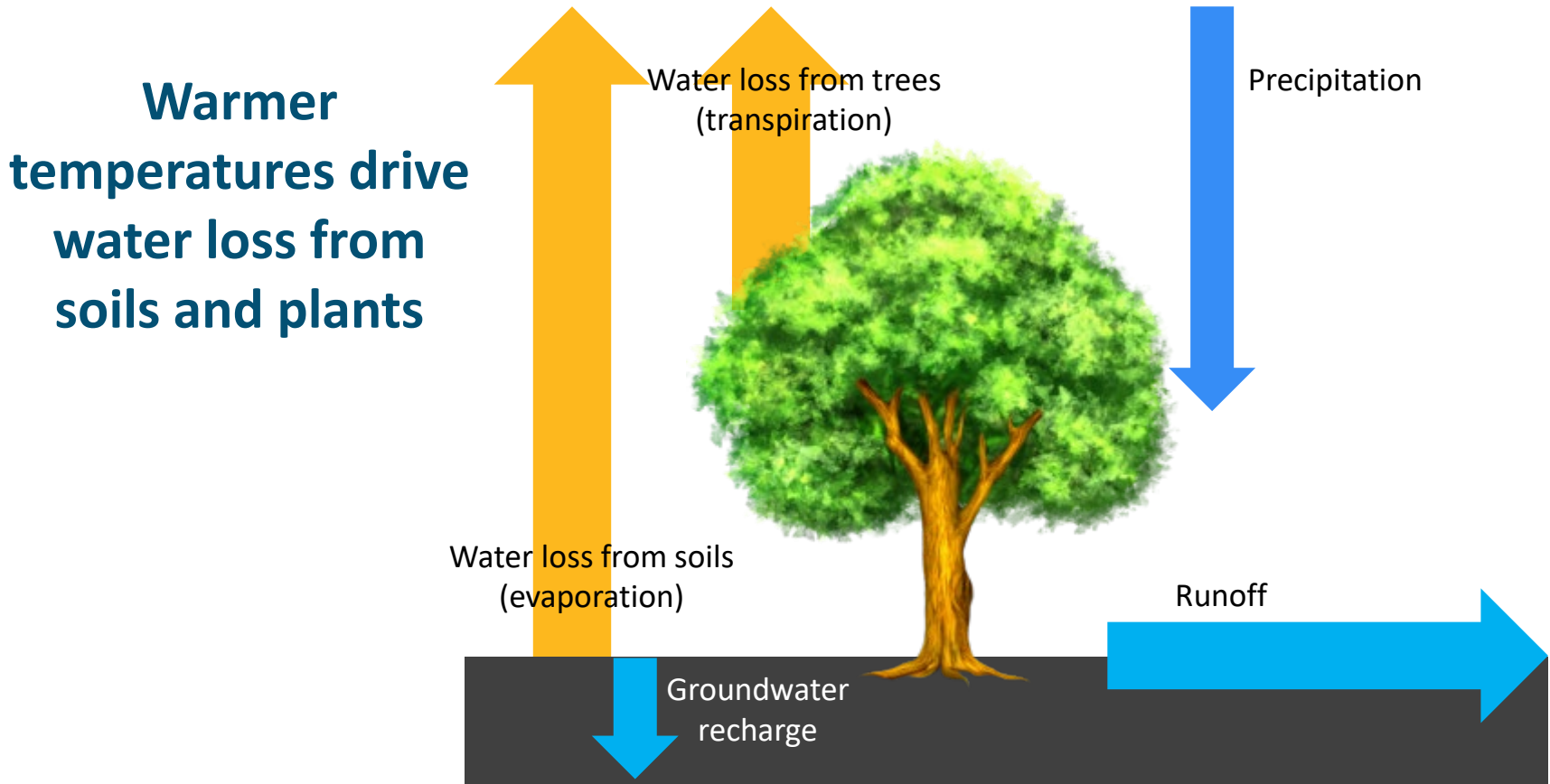
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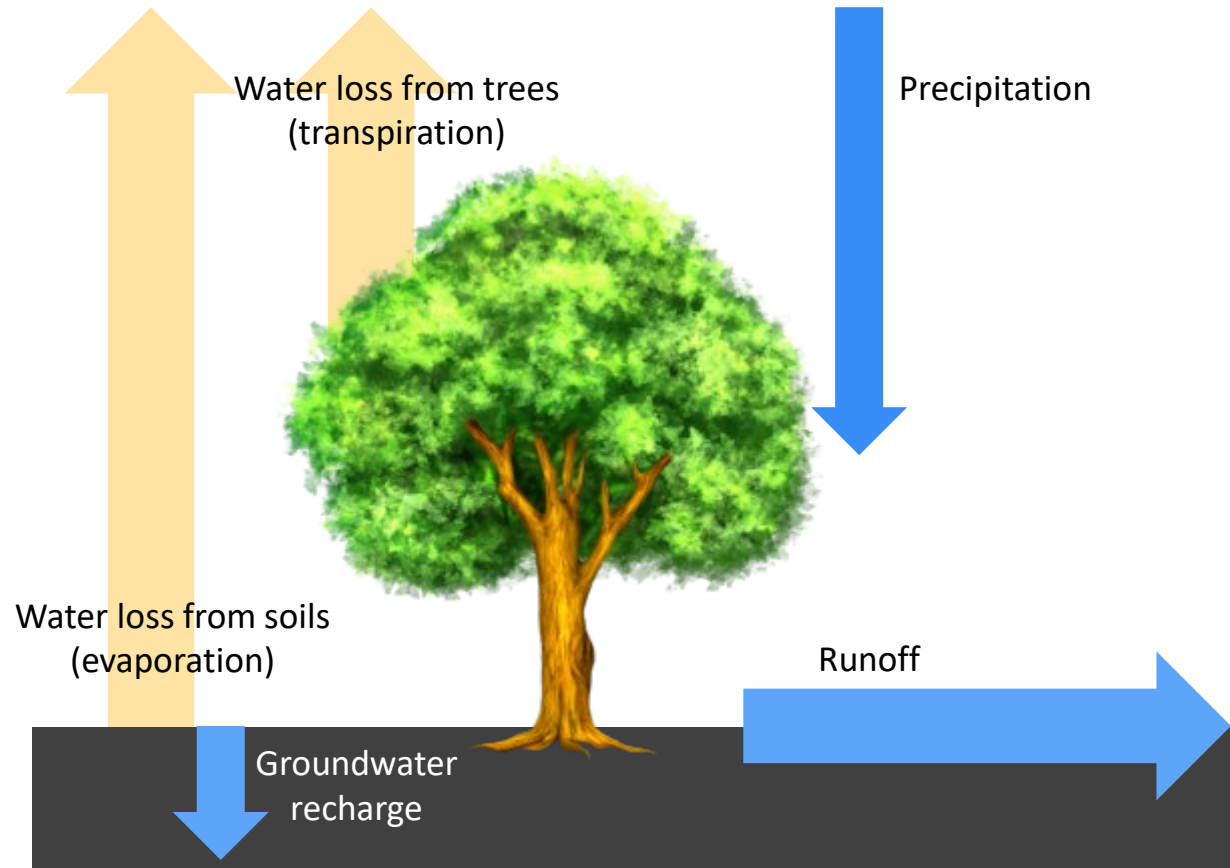


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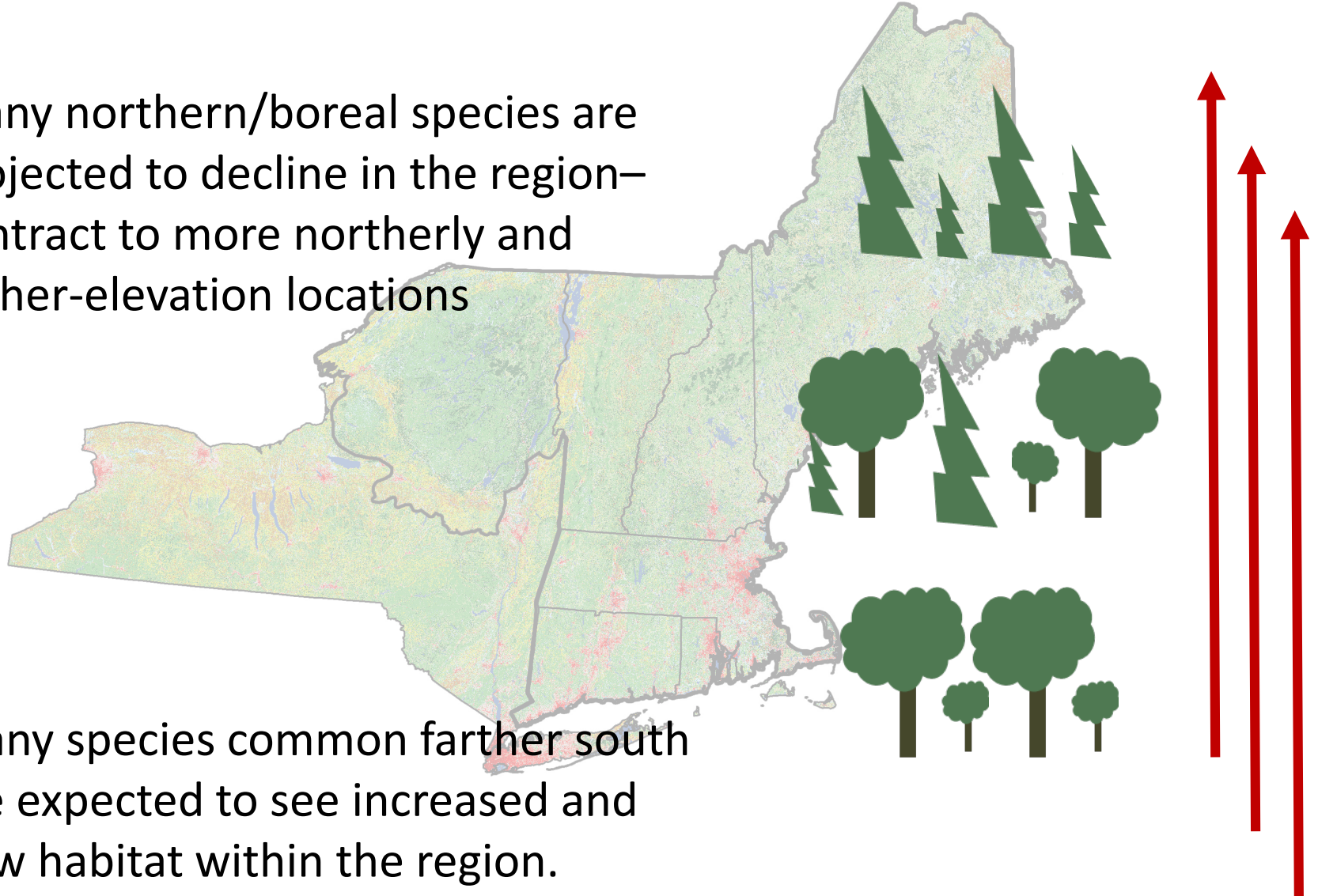
Risk may be greatest:

- 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.

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**



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

Interactions: 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

What may be at risk: Fire-dependent forests or areas of tree mortality when fire is not suppressed.

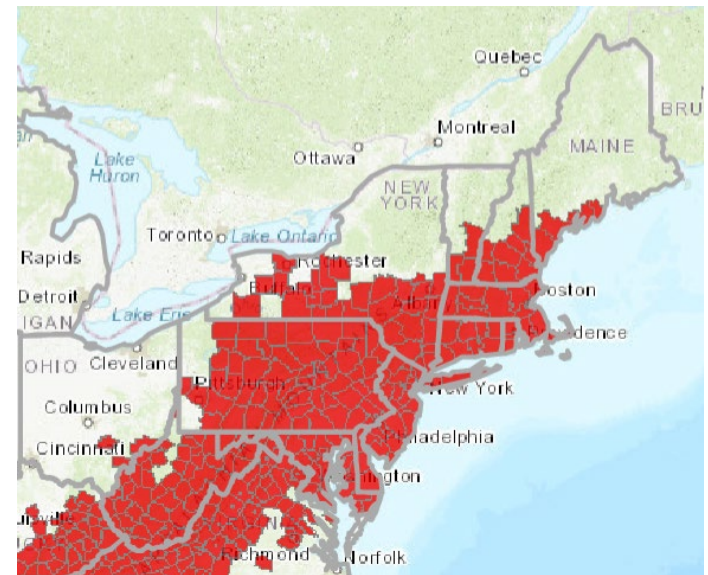
Interactions: Insects and Disease

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



Hemlock woolly adelgid incidence ~2015

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

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

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



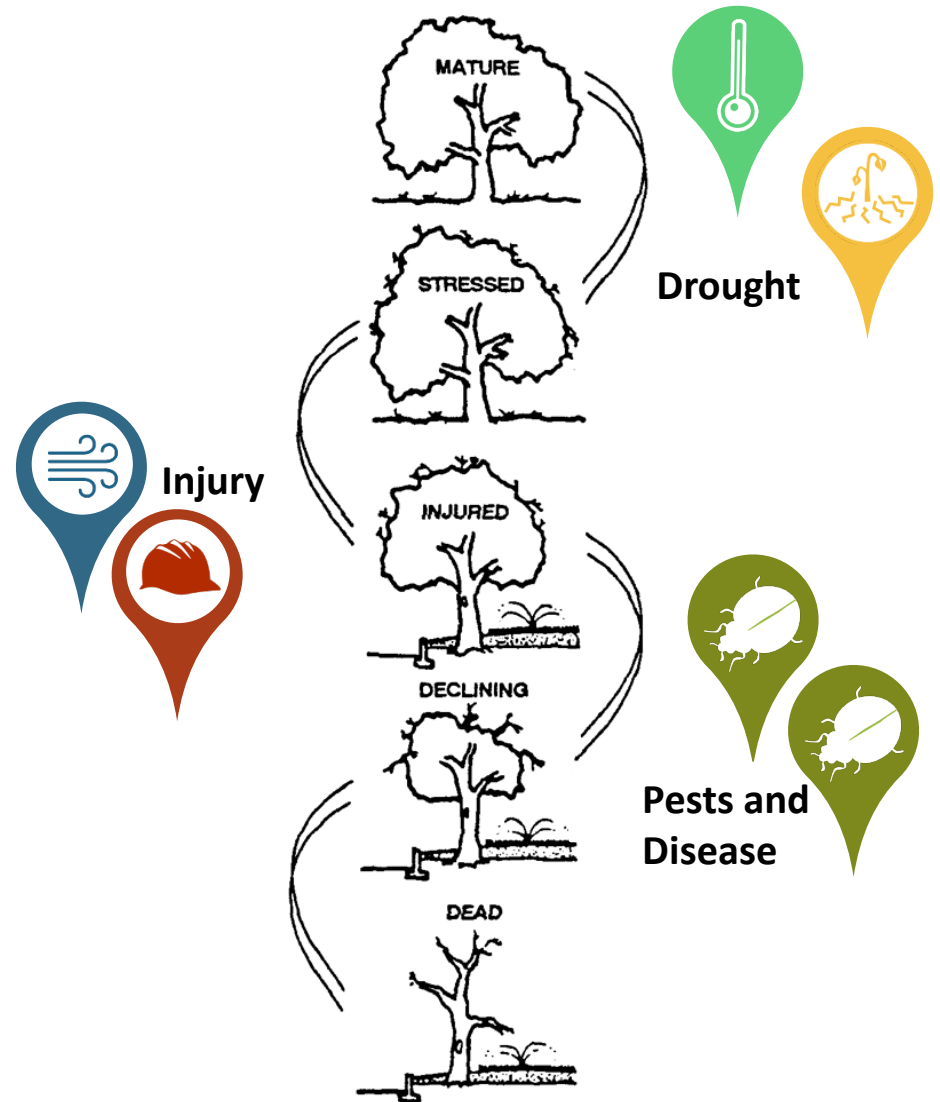
Risk may be greatest: Presence of invasive species nearby; other factors that reduce forest/understory vigor

Dukes et al. 2009, Hellman et al. 2008; Images: Invasives Plants Atlas of New England (www.eddmaps.org)

Climate change is a “threat multiplier”

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

Interactions make all the difference.



Drawing: Bartlett Tree Experts

