

VIRTUAL WORKSHOP

Managing West Virginia's Forests in a Changing Climate

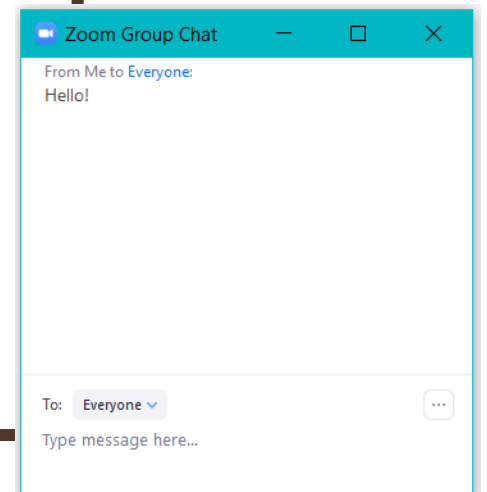
Welcome!

This workshop has been approved for 3.5 CFE credits!

Icebreaker!

Use the chat box to introduce yourself:

*Name, Title, Organization or Location
(and certificate no. for SAF credit!)*



Agenda

- 8:00 Welcome, Introductions, and Overview of the Climate Change Response Framework
- 8:30 Climate Change Impacts on West Virginia Forests
- 9:00 Insect Pests and Pathogens in a Changing Climate
- 9:15 Oak, Fire, and Climate Change: The Profound Effect of Changing Conditions on the Oak Resource
- 10:15 Break
- 10:30 Climate Change & Forest Hydrology
- 11:15 TNC's Climate Resiliency Science, Strategies, and Planning
- 11:45 Overview of the Monongahela National Forest's Deer Creek Project
- 12:00 Adjourn

This workshop is organized by the Northern Institute of Applied Climate Science, USDA Northern Forests Climate Hub, and US Forest Service, Monongahela National Forest.



Northern Forests Climate Hub
U.S. DEPARTMENT OF AGRICULTURE



Presenters are being recorded*



All recordings will be posted on our YouTube page!

We will send a follow up email with a link!

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United States Department of Agriculture
Northern Forests Climate Hub

VIRTUAL WORKSHOP

Climate Change Impacts on West Virginia Forests



*Managing West Virginia's
Forests in a Changing Climate
(Virtual) September 15, 2021*

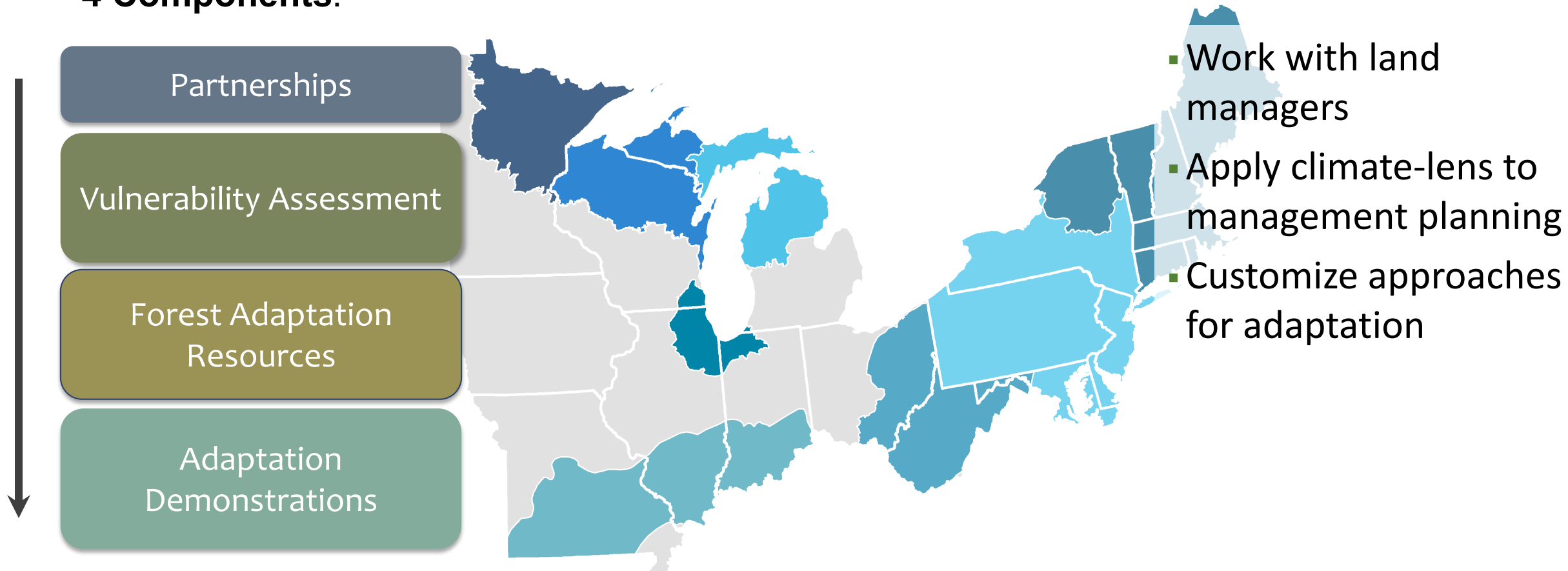
New

Patricia Leopold pleopold@mtu.edu
Northern Institute of Applied Climate Science

Climate Change Response Framework
www.forestadaptation.org

Climate Change Response Framework

4 Components:



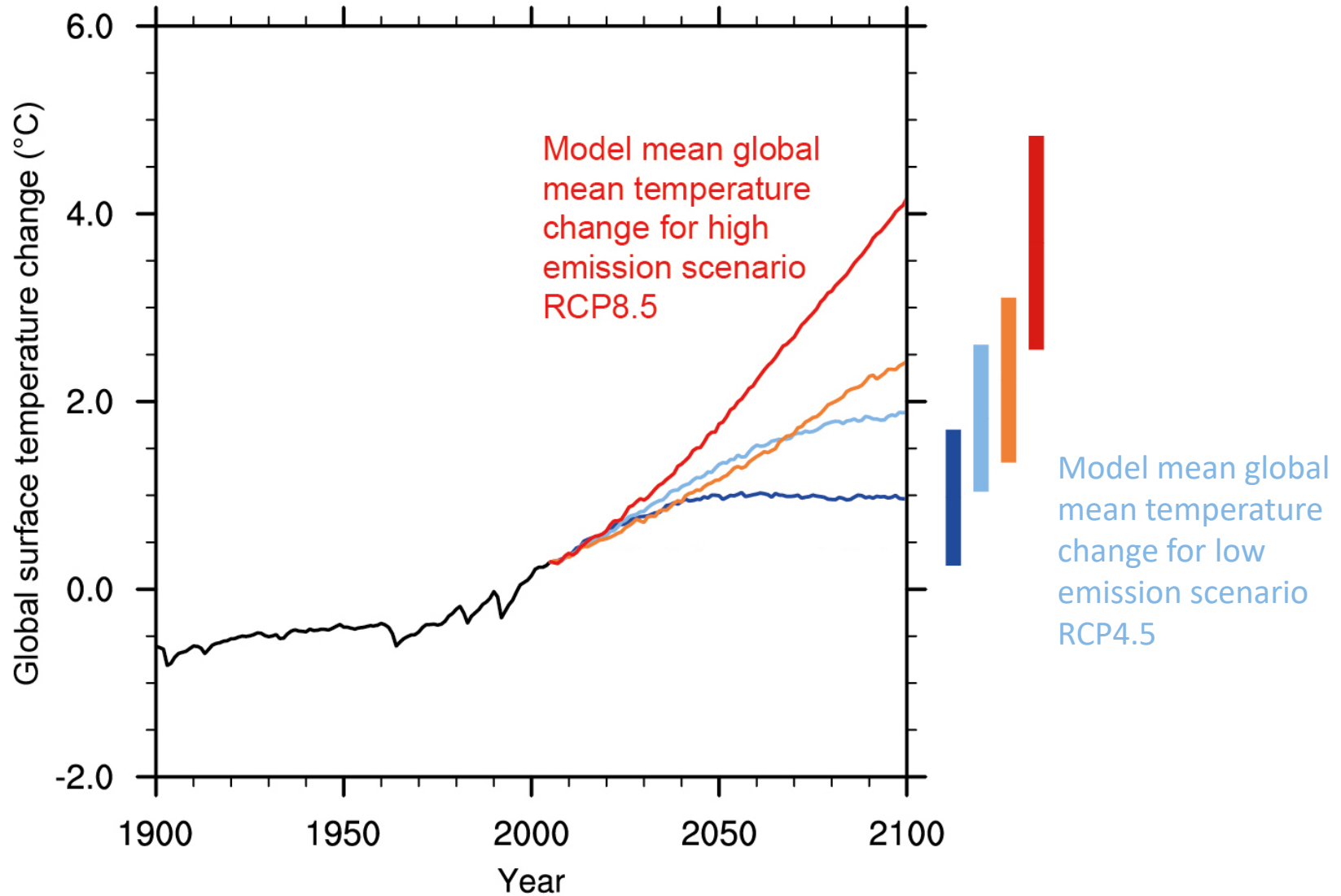
Vulnerability Assessment & Synthesis

- 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, or policy



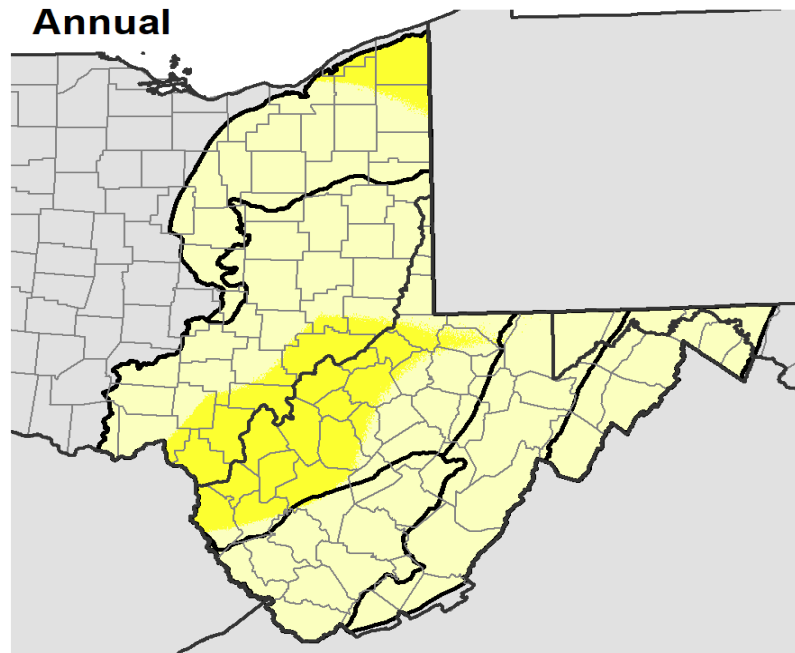
How is the climate changing?

Future changes

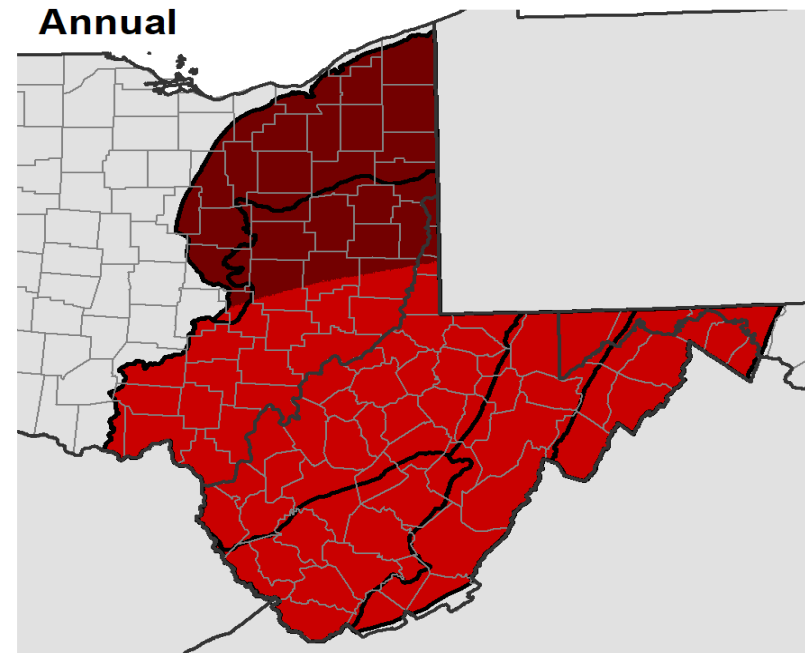


Projected Changes in Annual Temperature

**Low emissions
CCSM4 – RCP 4.5**



**High emissions
HadGEM2-ES – RCP 8.5**



Legend

- Counties
- Ecological Sections

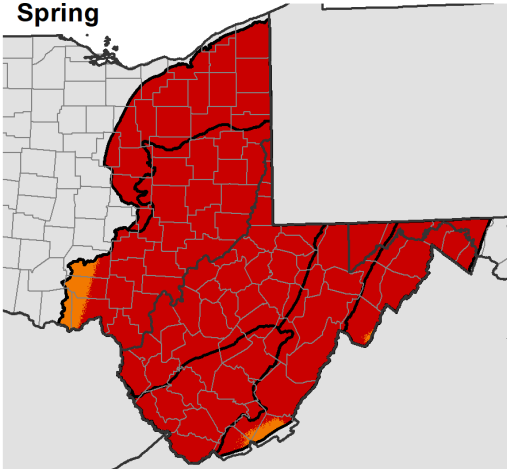
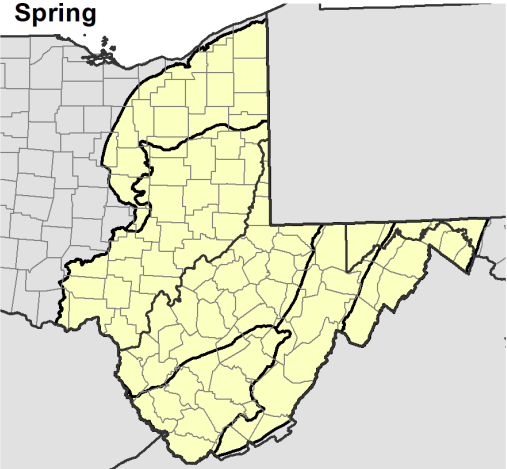
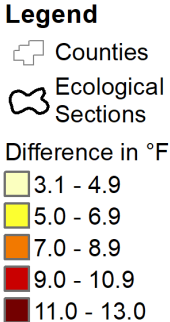
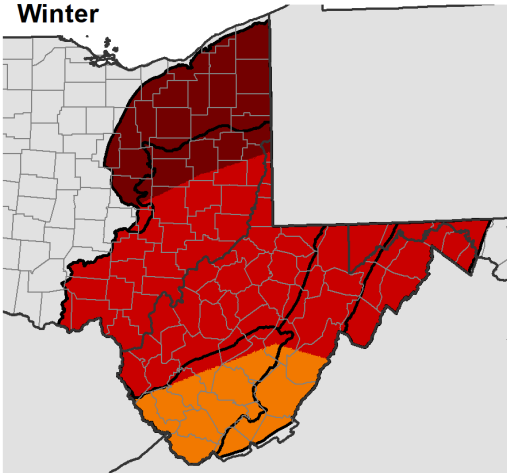
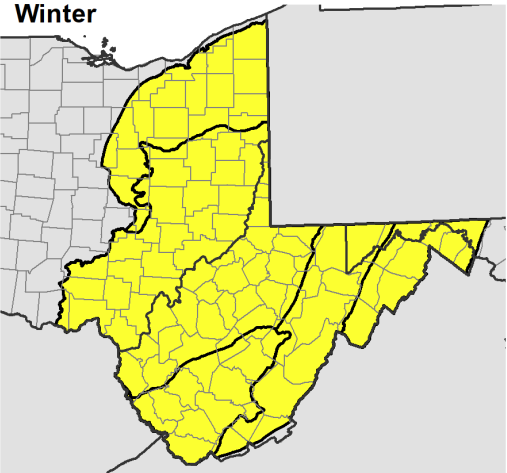
Difference in °F

- 4.1 - 4.5
- 4.6 - 7.6
- 7.7 - 11.0
- 11.1 - 12.4
- 12.5 - 13.1

Projected Changes in Seasonal Temperature

**Low emissions
CCSM4 – RCP 4.5**

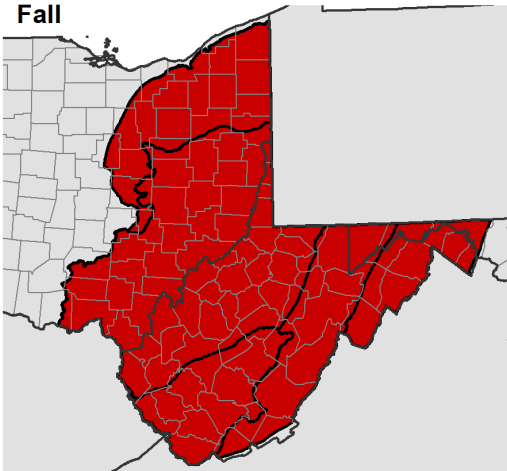
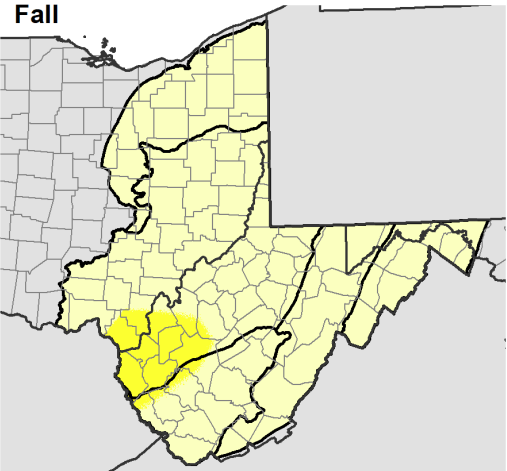
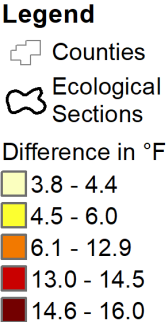
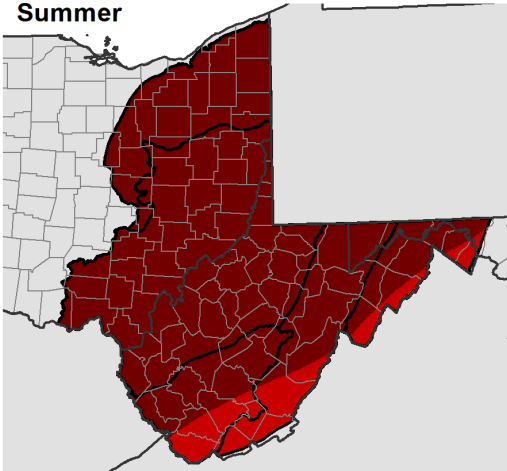
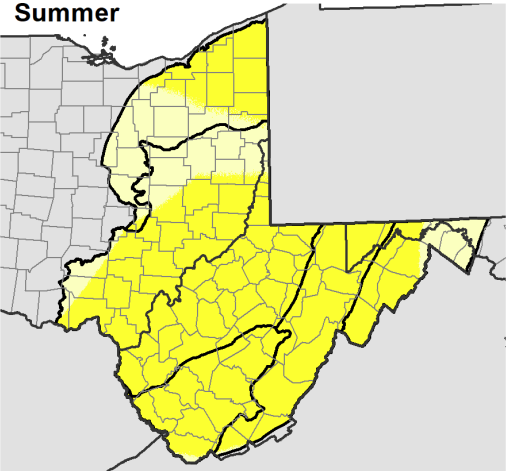
**High emissions
HadGEM2-ES – RCP 8.5**



Projected Changes in Seasonal Temperature

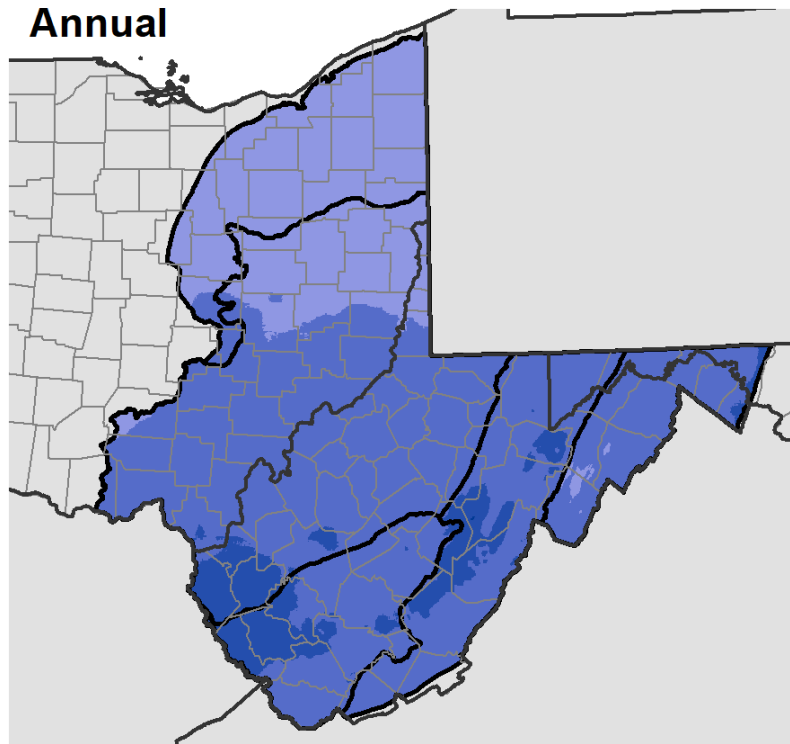
**Low emissions
CCSM4 – RCP 4.5**

**High emissions
HadGEM2-ES – RCP 8.5**

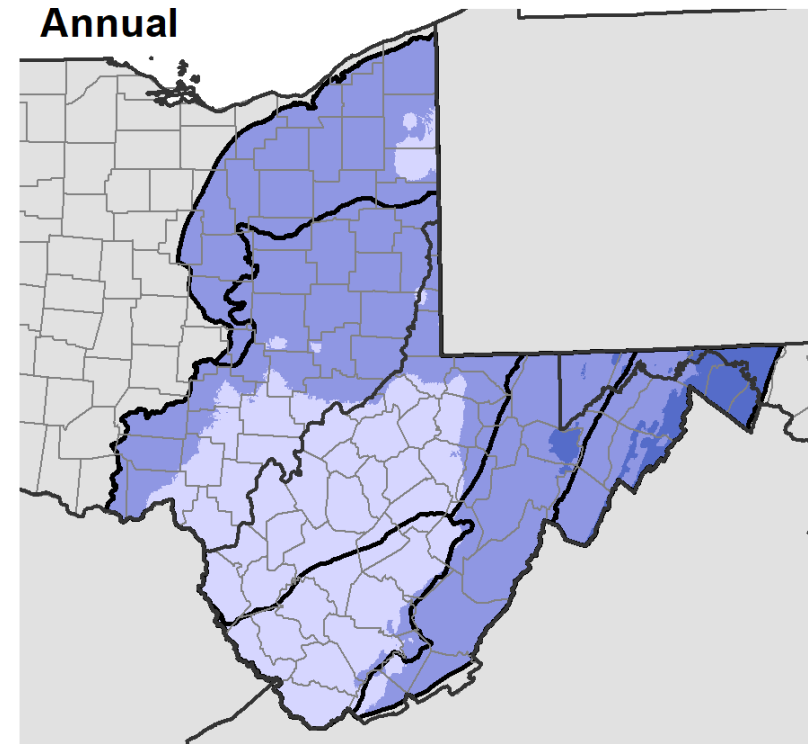


Projected Changes in Annual Precipitation

**Low emissions
CCSM4 – RCP 4.5**



**High emissions
HadGEM2-ES – RCP 8.5**

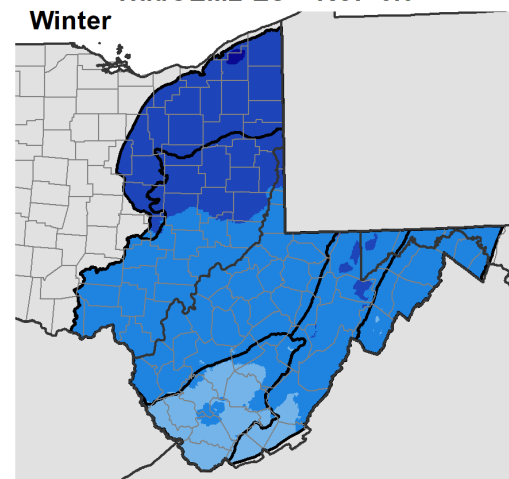
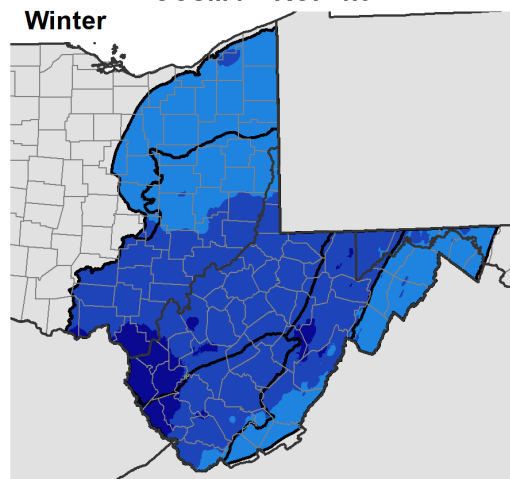


Data source: NASA Earth Exchange Downscaled Climate Projections

Projected Changes in Seasonal Precipitation

**Low emissions
CCSM4 – RCP 4.5**

**High emissions
HadGEM2-ES – RCP 8.5**

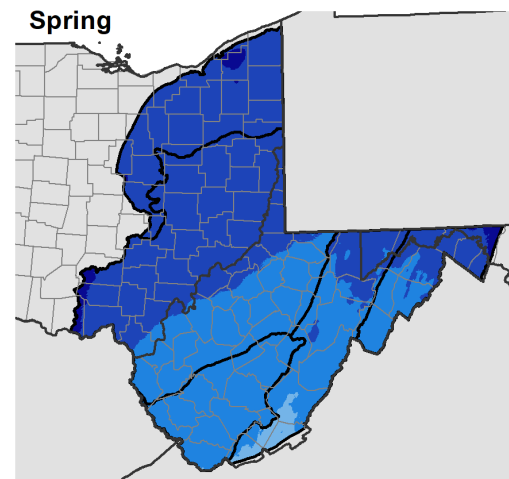
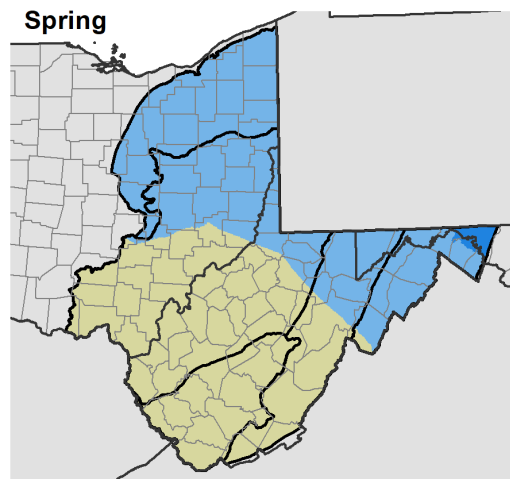


Legend

- Counties
- Ecological Sections

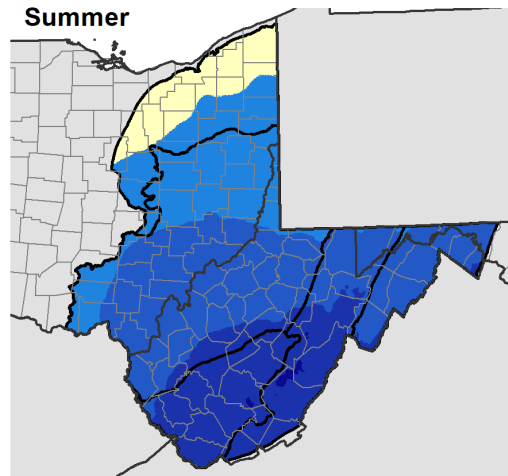
Difference
in inches

- 0.9 - 0
- 0.1 - 0.9
- 1 - 1.9
- 2 - 2.9
- 3 - 3.9

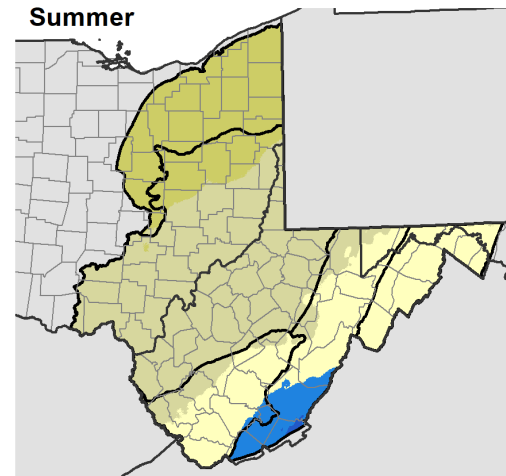


Projected Changes in Seasonal Precipitation

Low emissions
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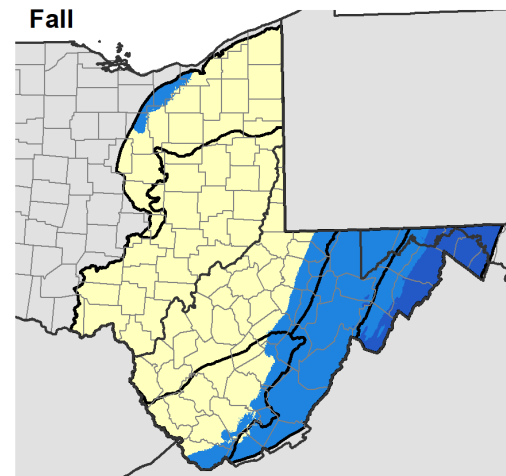
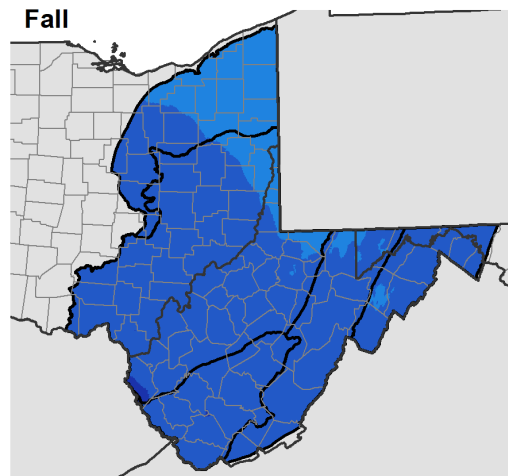


Legend

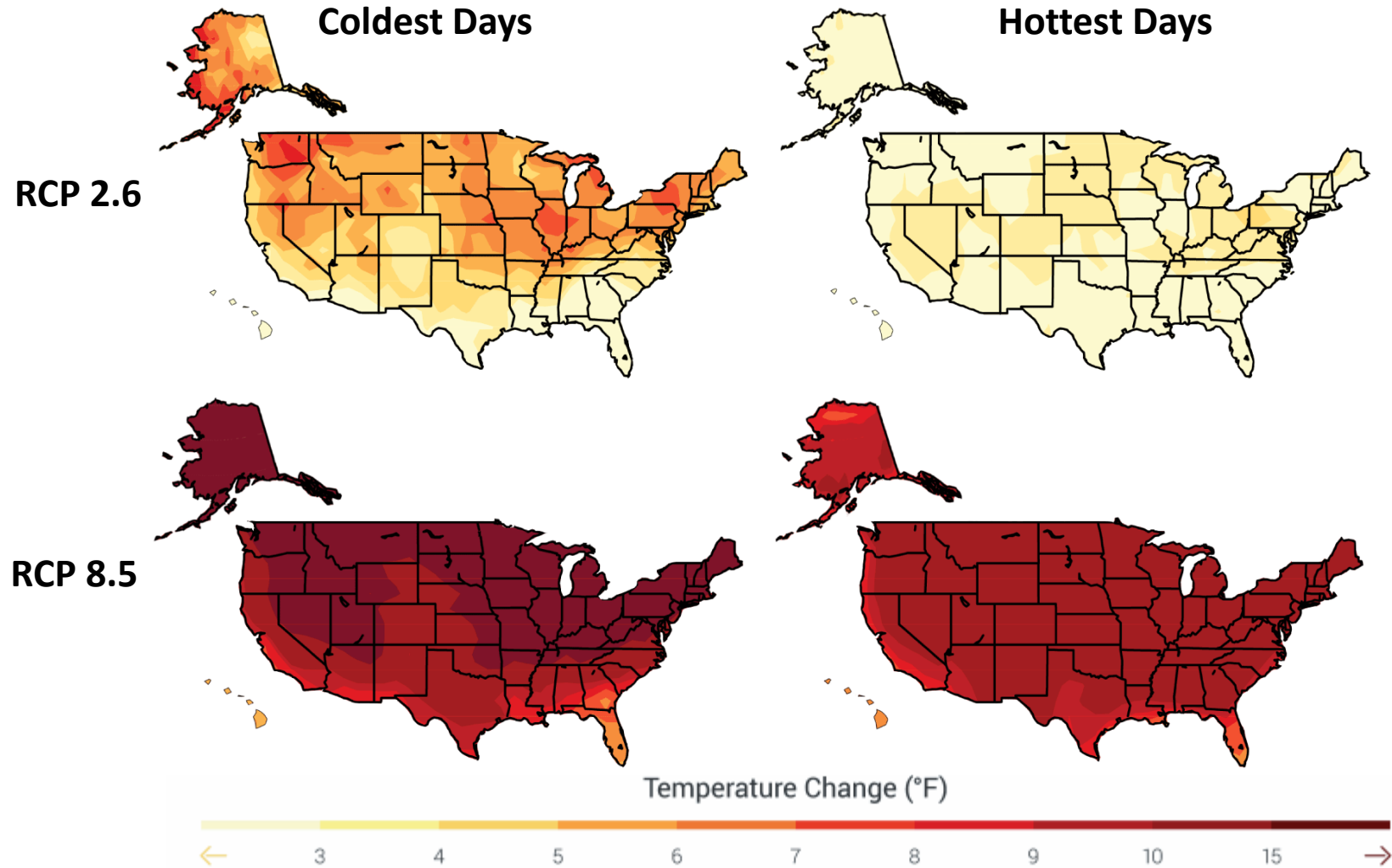
- Counties
- Ecological Sections

Difference
in inches

- 2.8 - -2
- 1.9 - -1
- 0.9 - 0
- 0.1 - 0.9
- 1 - 1.9
- 2 - 2.9
- 3 - 3.2



Extreme Temperatures



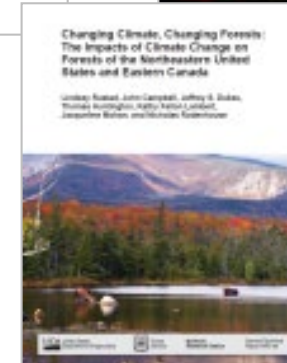
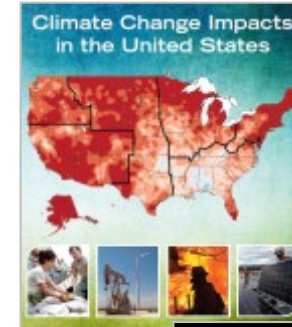
7 WAYS THAT CLIMATE CHANGE WILL AFFECT FORESTS

A Synthesis of Anticipated Impacts in
West Virginia and the Central
Appalachians Region



Climate Change Impacts

- 1) Longer Growing Season
- 2) Shorter Winters
- 3) Increased Risk of Moisture Stress
- 4) CO₂ Fertilization
- 5) Changes in Suitable Habitat
- 6) Extreme Events
- 7) Invasive Plants



Climate Change Impacts

- 1) Longer Growing Season
- 2) Shorter Winters
- 3) Increased Risk of Moisture Stress
- 4) CO₂ Fertilization
- 5) Changes in Suitable Habitat
- 6) Extreme Events
- 7) Invasive Plants



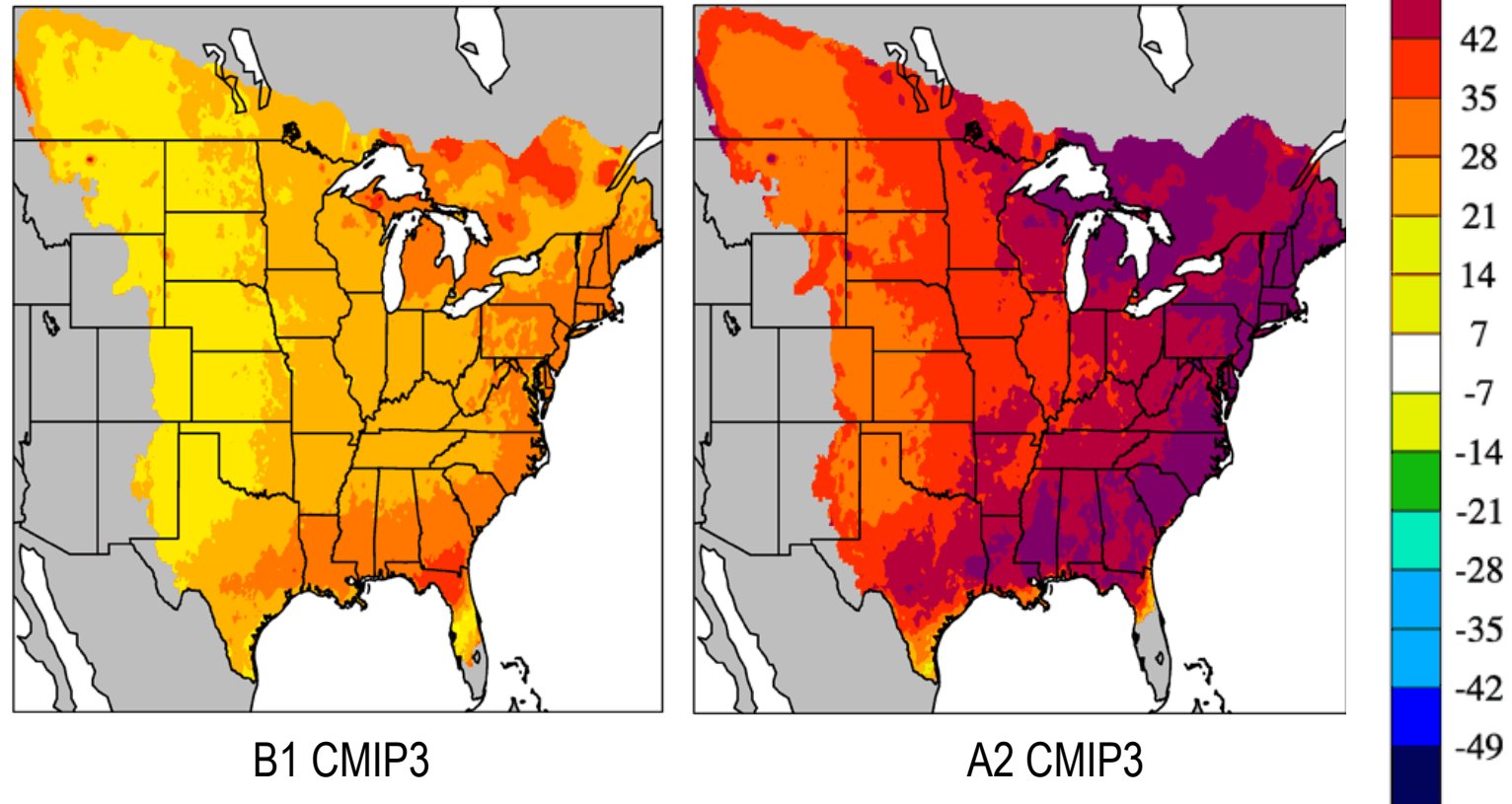
1) Longer Growing Season

Warmer temps result in longer growing seasons

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

Longer period for plant growth

Change in Growing Season Length (Days) 2080-2100



1) Longer Growing Season

Warmer temps result in longer growing seasons

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

Longer period for plant growth

Phenological changes

- Early bud break and frost damage

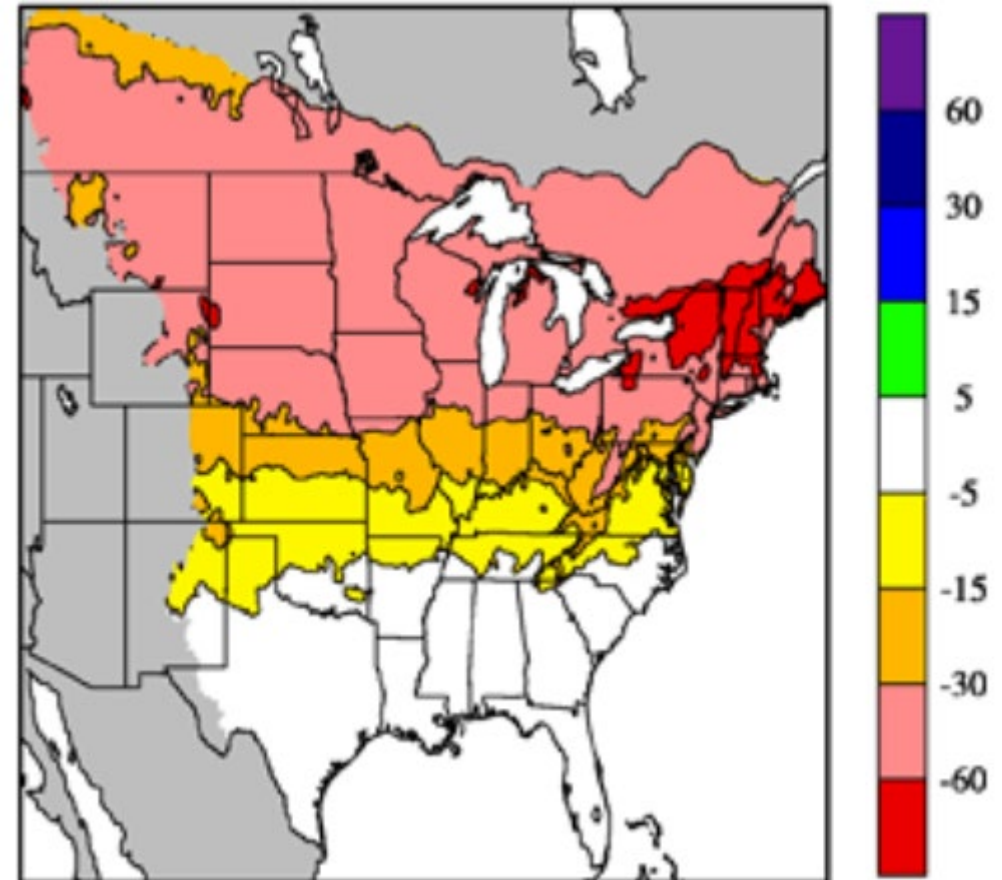


2) Shorter Winters (Less Snow)

Projected decreases in snow fall, cover, and depth

- 30-70% decreases in snowfall
- Greatest loss in December/January
- 15 to 60 fewer days with snow cover

Change in Snowpack Days (A2 CMIP3) 2080-2100



2) Shorter Winters (Less Snow)

Projected decreases in snow fall, cover, and depth

- 30-70% decreases in snowfall
- Greatest loss in December/January
- Up to 30 fewer days with snow cover

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

2) Shorter Winters (Less Snow, More Rain)

More rain

- Warmer temperatures
- Increased precipitation
- Extreme rain events

Earlier peak stream flows

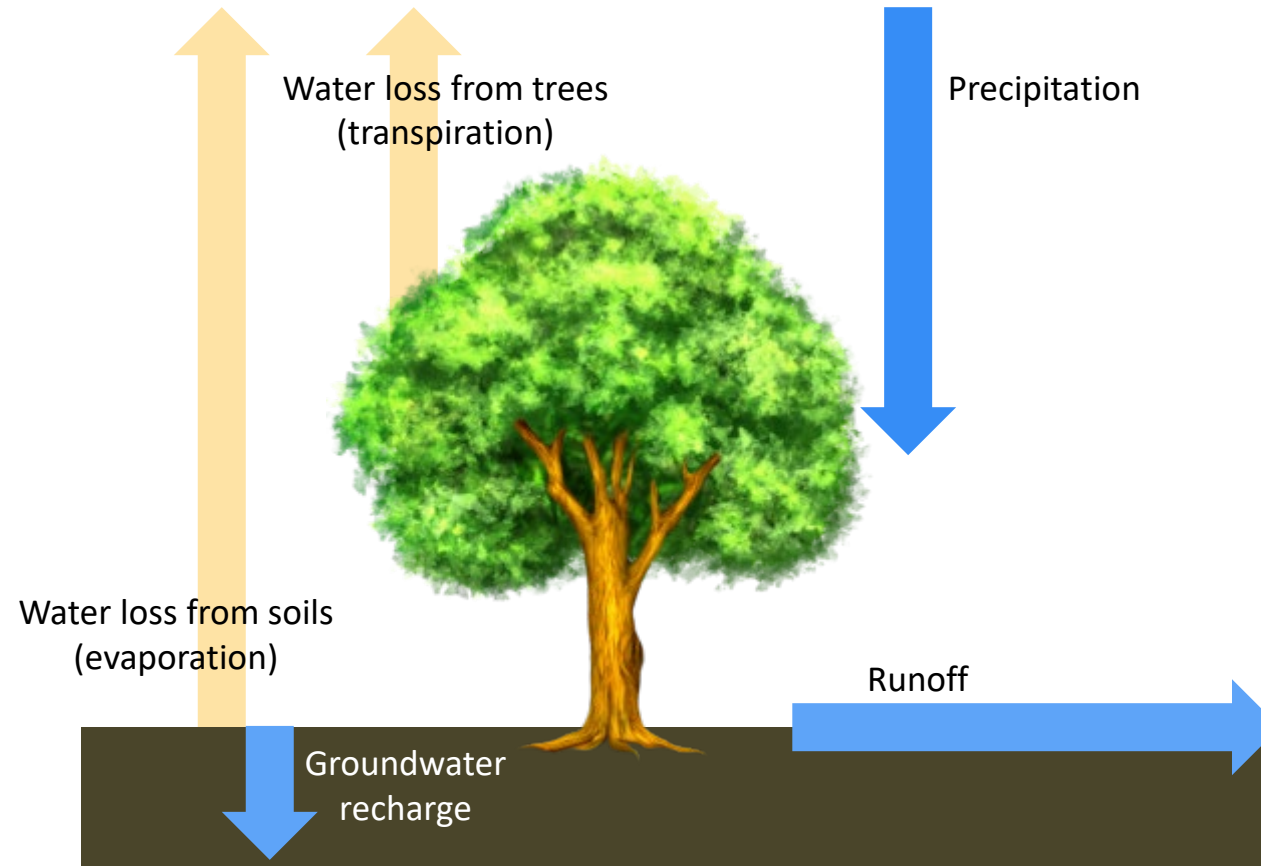
- Flashiness and episodic high flows may increase

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



3) Increased Risk of Moisture Stress

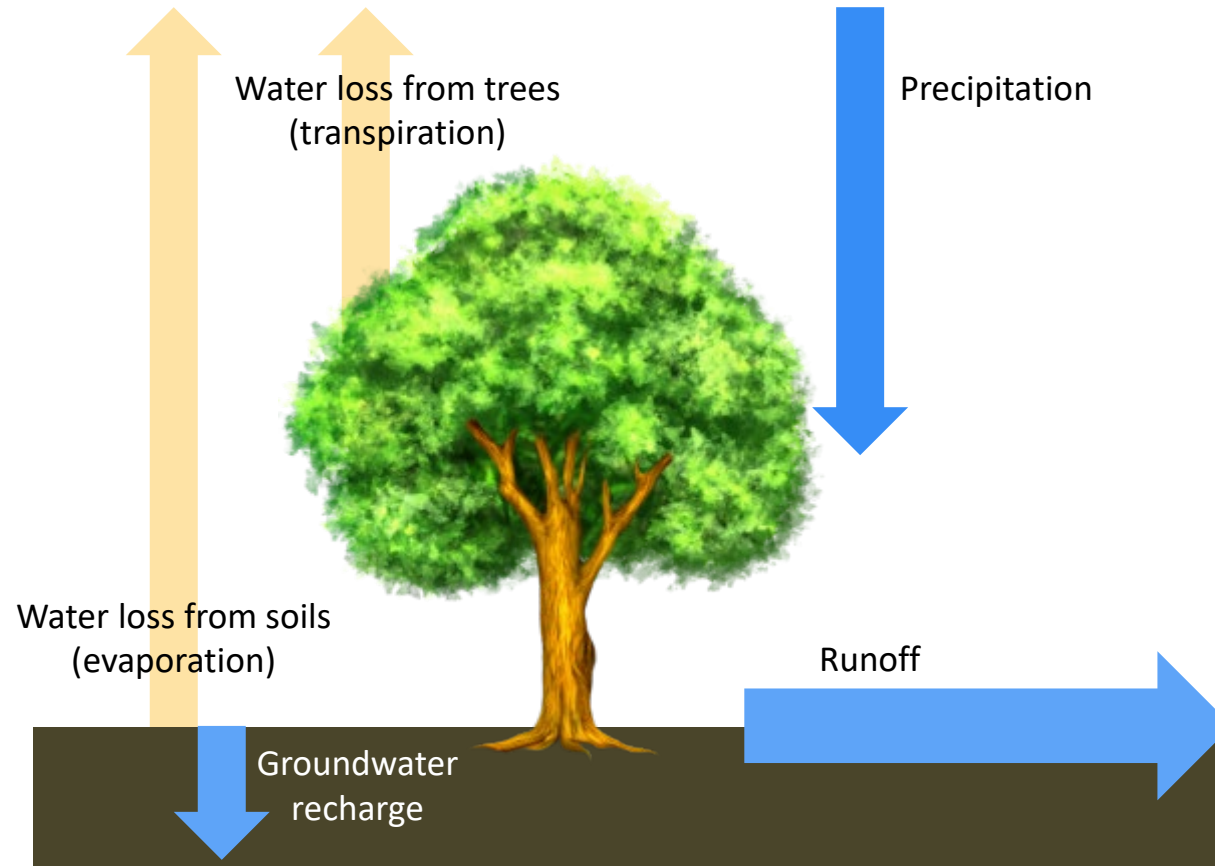
Longer and warmer growing seasons may lead to drier conditions during the growing season.



3) Increased Risk of Moisture Stress

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

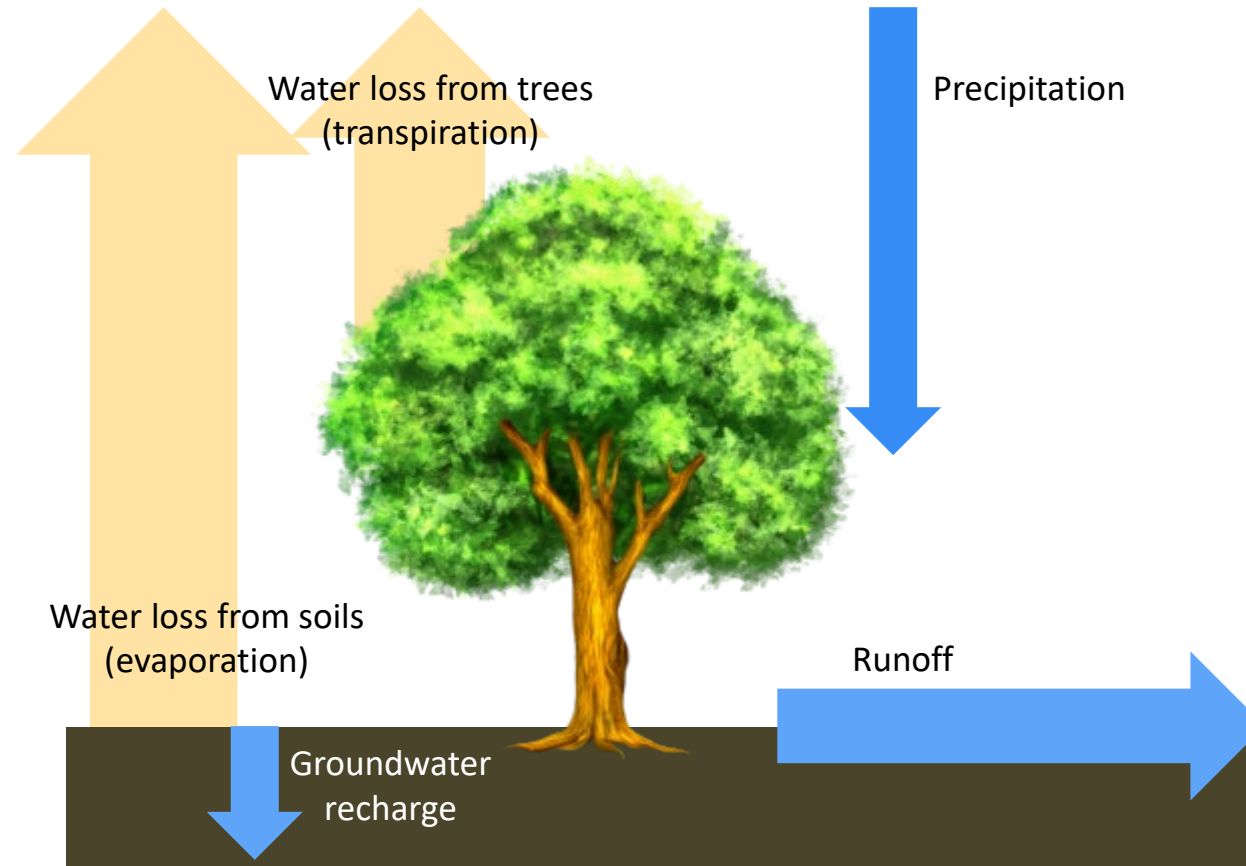
Earlier spring runoff and increased runoff during extreme rain events



3) Increased Risk of Moisture Stress

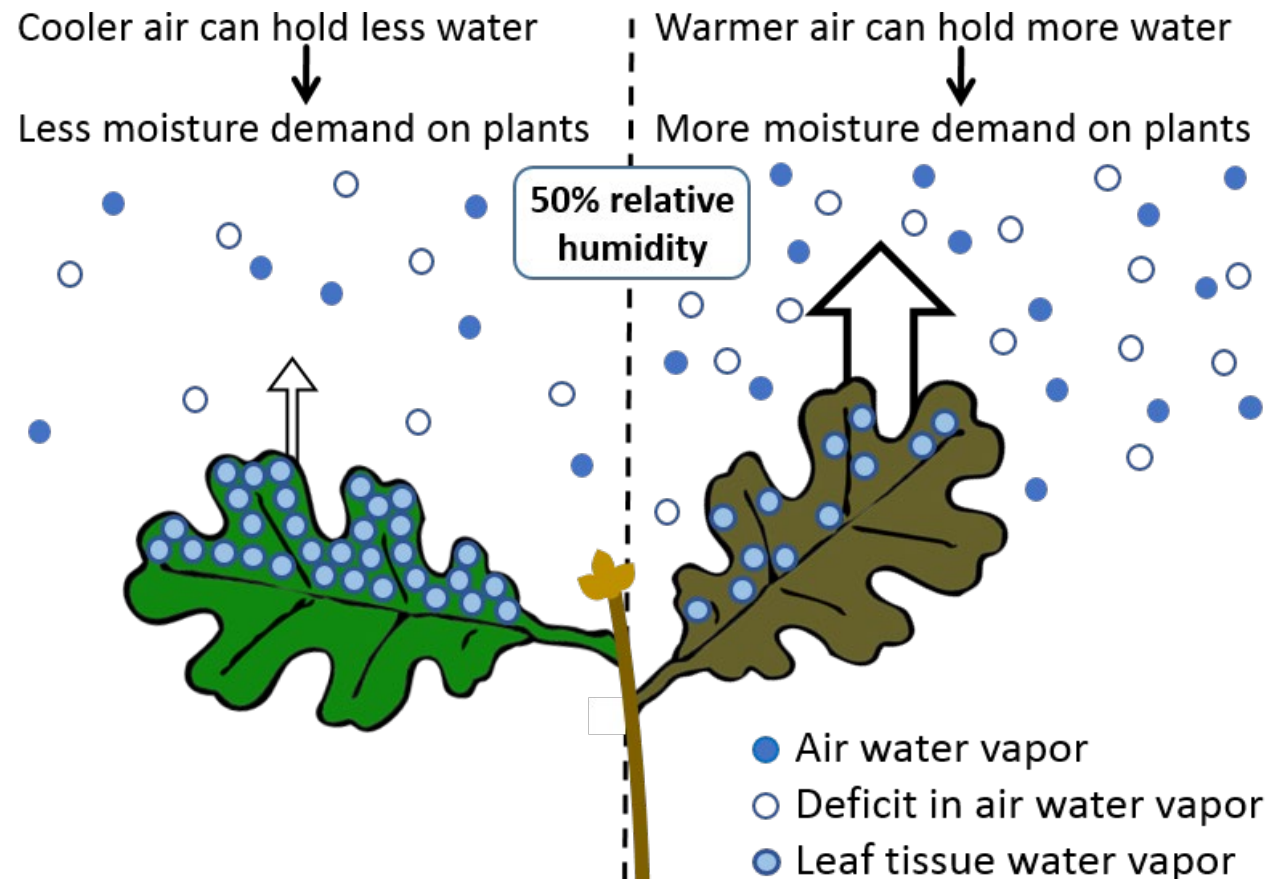
Longer and warmer growing seasons may lead to drier conditions during the growing season.

Warmer temperatures drive greater water loss from soils and plants



Warmer temperatures = ↑ vapor pressure deficit (VPD)

- More evaporation from soils & open water
- More transpiration from plants

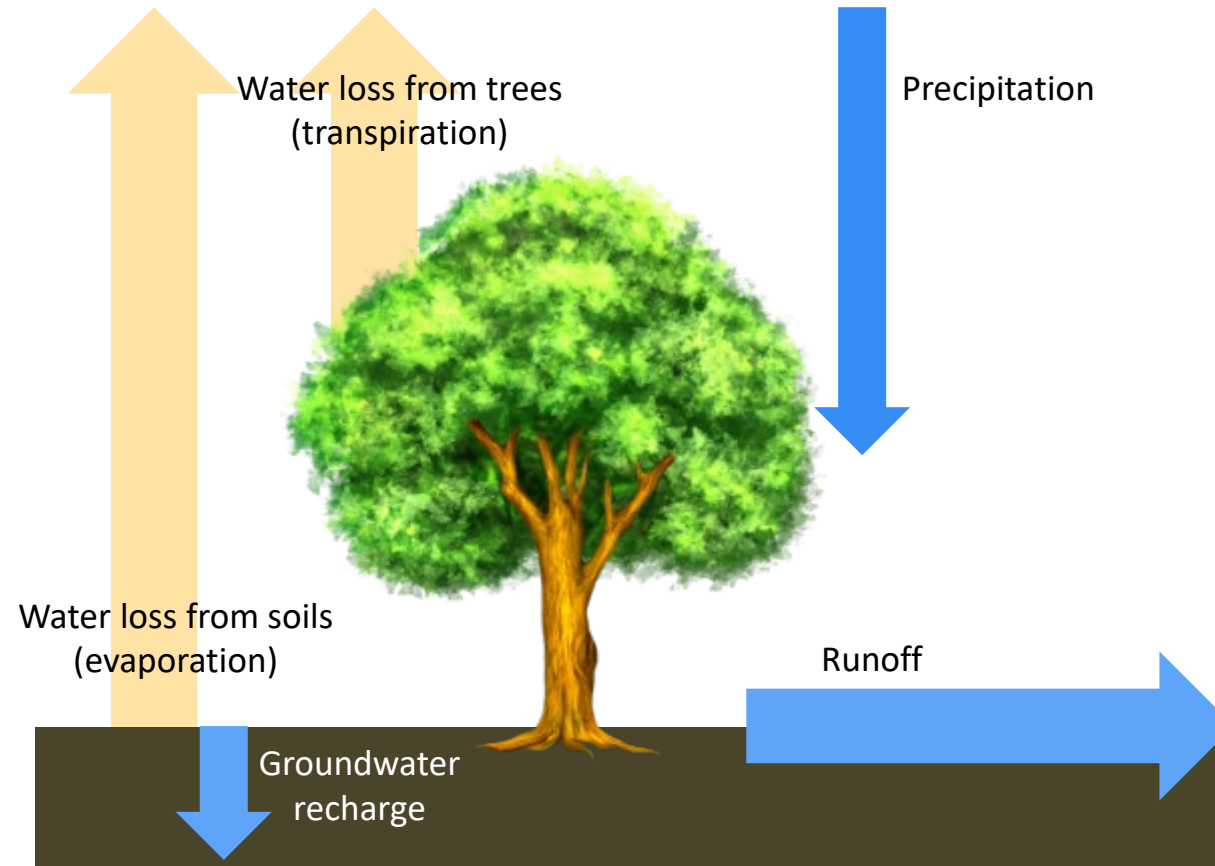


3) Increased Risk of Moisture Stress

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

Risk may be greatest:

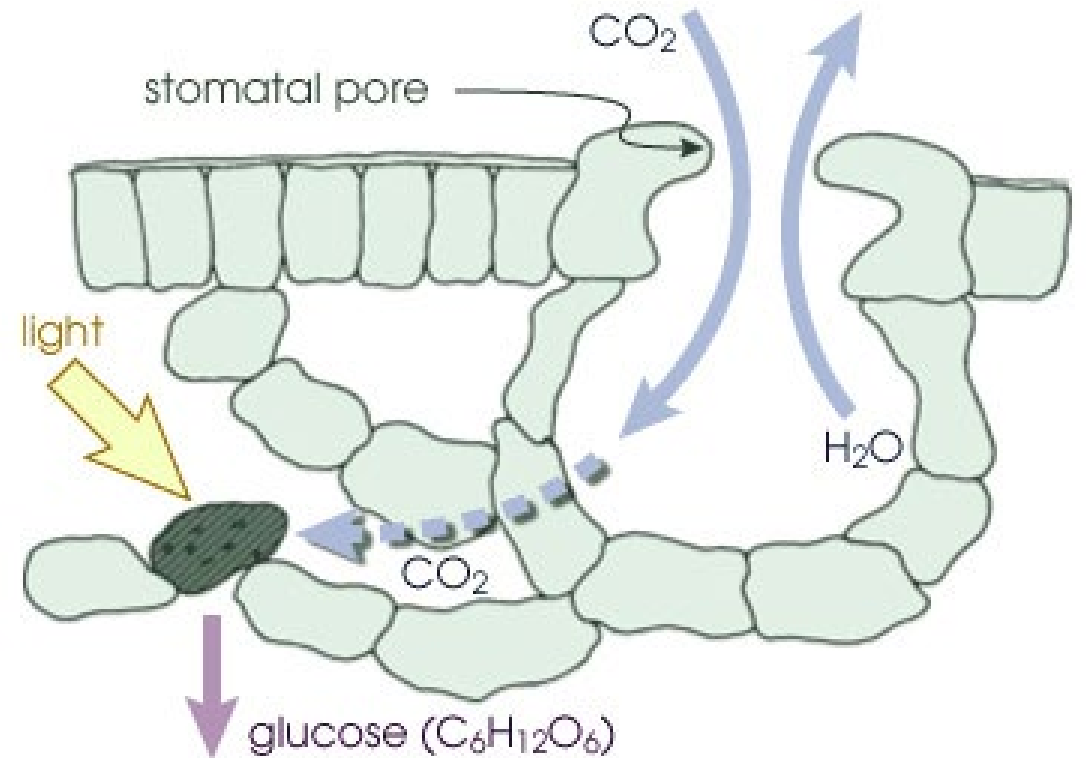
- Sites with drought-prone or shallow soils
- South-facing ridges
- Mesic species on drier sites (marginal sites or off-site)
- Crowded stands that compete for water



4) CO₂ Fertilization

Benefits

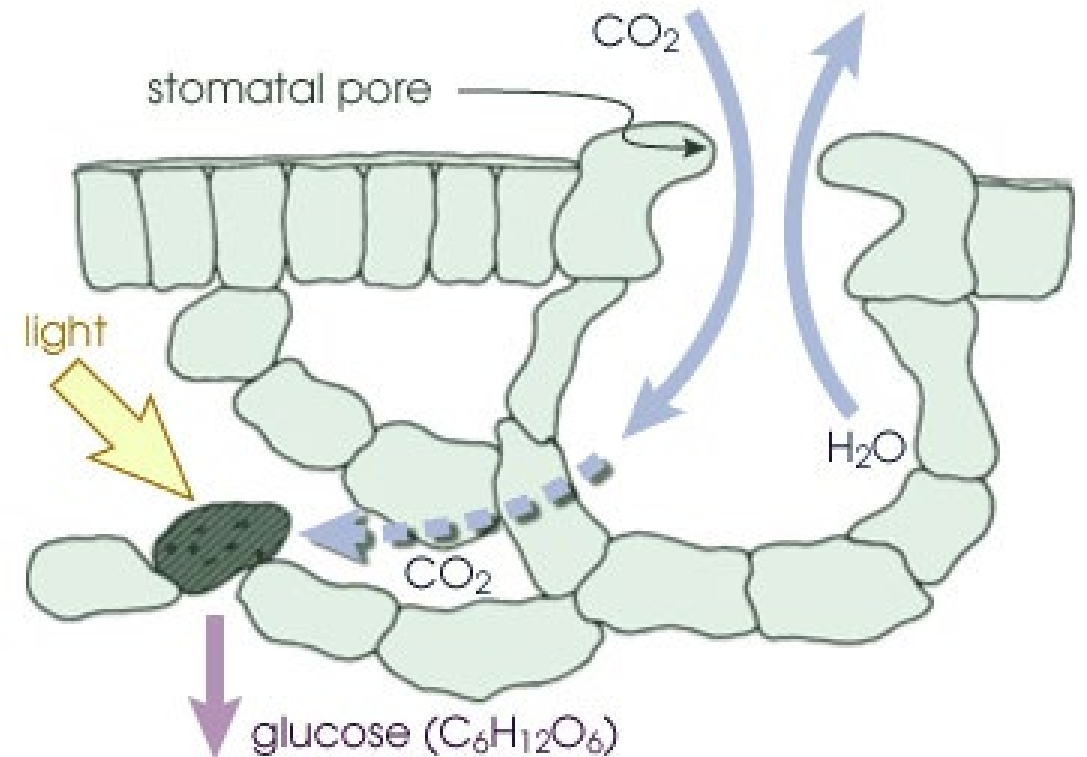
- Increased photosynthesis
- Increased water use efficiency



4) CO₂ Fertilization

Limits to CO₂ fertilization

- Varies by species and site
- Nutrient deficiencies (especially N)
- Sensitive to ozone pollution
- Limited sink strength
- Limited evidence of long-term sequestration
- Any productivity increases may be offset by reductions from increased drought stress or disturbance



5) Changes in Suitable Habitat

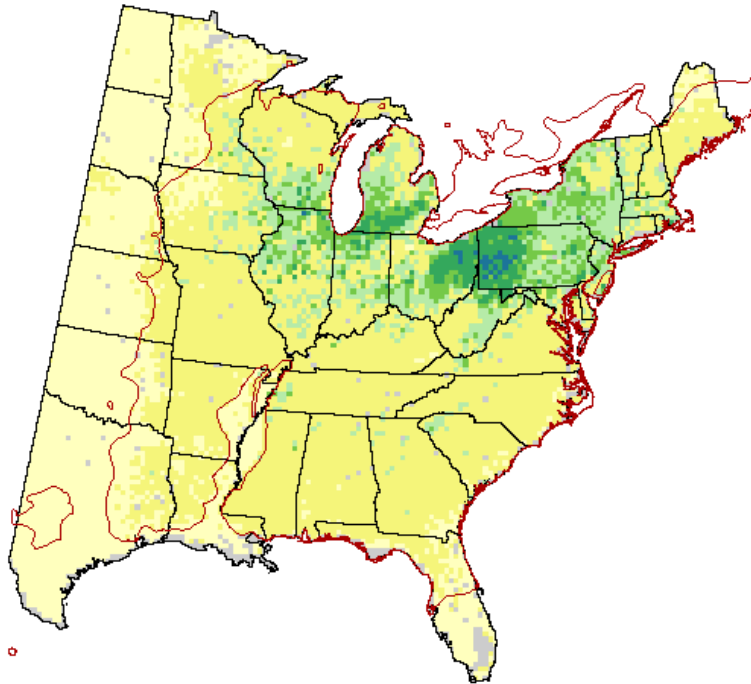
Black Cherry habitat

Current (present day, based on USFS FIA)

Importance
Value

Low

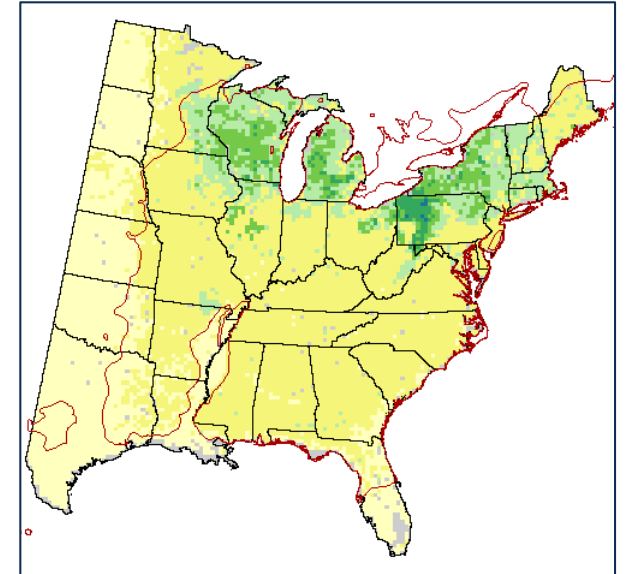
High



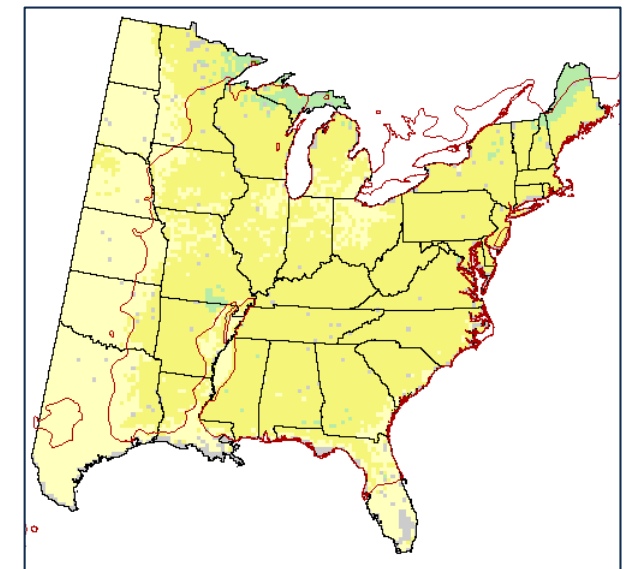
Low emissions (less warming)

High emissions (very warm)

2070-2100 Low (RCP4.5)



2070-2100 High (RCP8.5)



5) Changes in Suitable Habitat

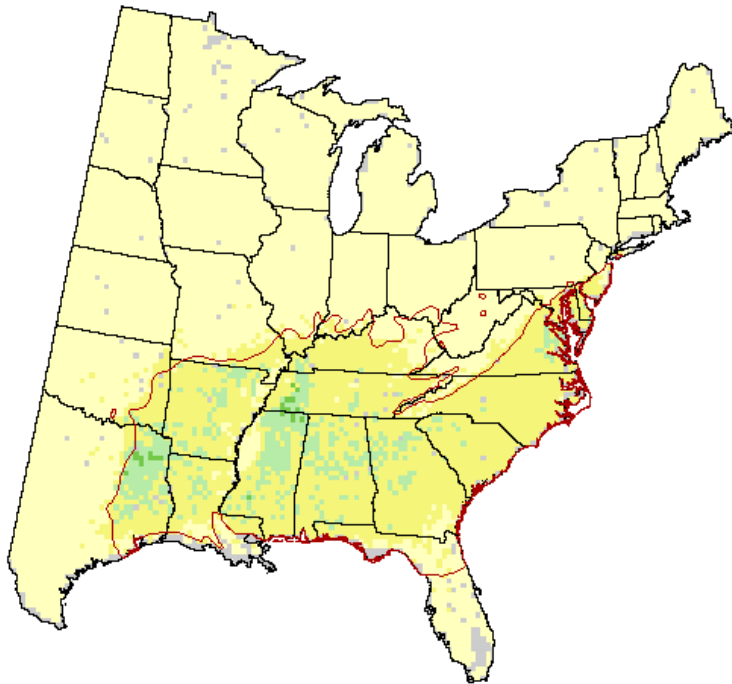
Southern Red Oak habitat

Current (present day, based on USFS FIA)

Importance
Value

Low

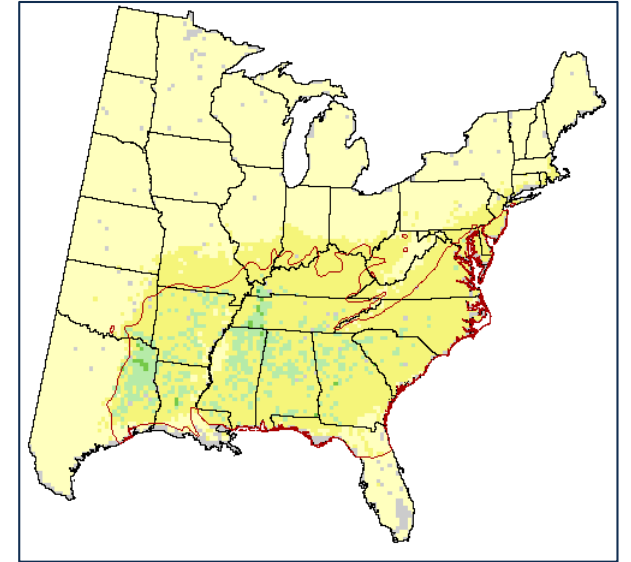
High



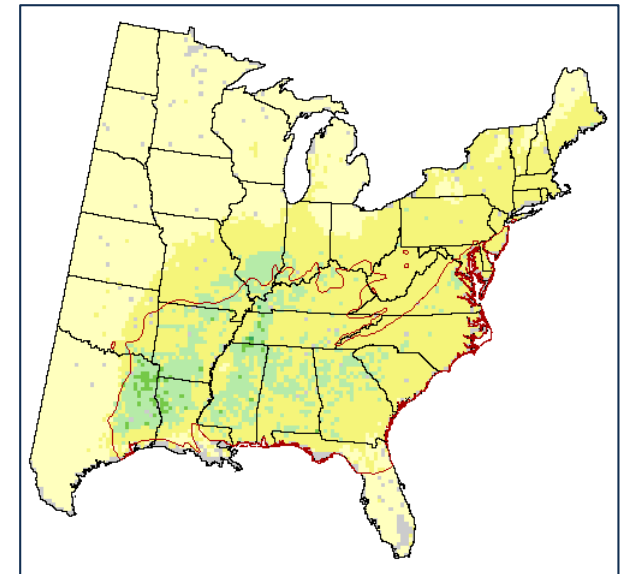
Low emissions (less warming)

High emissions (very warm)

2070-2100 Low (less warming)




2070-2100 High (very warm)



5) Changes in Suitable Habitat

Subregions in WV...

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES CENTRAL APPALACHIANS



This region's forests will be affected by a changing climate and other stressors during this century. A team of managers and researchers created an assessment that describes the vulnerability of forests in the region (Bullard et al., 2015). This report includes information on observed and future climate trends, and also summarizes key vulnerabilities for forested natural communities. The Landscape Change Research Group recently updated the Climate Change Atlas, and this handout summarizes that information. Full Tree Atlas results are available online at www.fs.fed.us/nrs/atlas/. Two climate scenarios are presented to "bracket" a range of possible futures. These future climate projections (2070 to 2099) provide information about how individual tree species may respond to a changing climate. Results for "low" and "high" emissions scenarios can be compared on the reverse side of this handout.

The updated Tree Atlas presents additional information helpful to interpret tree species changes:

- Suitable habitat - calculated based on 39 variables that explain where optimum conditions exist for a species, including soils, landforms, and climate variables.
- Adaptability - based on life-history traits that might increase or decrease tolerance of expected changes, such as the ability to withstand different forms of disturbance.
- Capability - a rating of the species' ability to cope or persist with climate change in this region based on suitable habitat change (statistical modeling), adaptability (literature review and expert opinion), and abundance (FIA data). The capability rating is modified by abundance information; ratings are downgraded for rare species and upgraded for abundant species.
- Migration Potential Model - when combined with habitat suitability, an estimate of a species' colonization likelihood for new habitats. This rating can be helpful for assisted migration or focused management (see the table section: "New Habitat with Migration Potential").

Remember that models are just tools, and they're not perfect. Model projections can't account for all factors that influence future species success. If a species is rare or confined to a small area, model results may be less reliable. These factors, and others, could cause a particular species to perform better or worse than a model projects. Human choices will also continue to influence forest distribution, especially for tree species that are projected to increase. Planting programs may assist the movement of future-adapted species, but this will depend on management decisions. Despite these limits, models provide useful information about future expectations. It's perhaps best to think of these projections as indicators of possibility and potential change.

CLIMATE CHANGE CAPABILITY

POOR CAPABILITY

| | |
|--------------------|-----------------|
| American basswood | Quaking aspen |
| American holly | Red pine |
| Bald cypress | Red spruce |
| Balsam fir | River birch |
| Bigtooth aspen | Serviceberry |
| Black ash | Shingle oak |
| Black willow | Striped maple |
| Bur oak | Swamp white oak |
| Eastern cottonwood | Sweet birch |
| Eastern hemlock | White ash |
| Eastern white pine | Yellow birch |
| Pin oak | Yellow buckeye |
| Pitch pine | |

FAIR CAPABILITY

| | |
|---------------|------------------|
| Black cherry | Scarlet oak |
| Black locust | Shagbark hickory |
| Cucumber tree | |

GOOD CAPABILITY


| | |
|---------------------|------------------|
| American elm | Osage-orange |
| Bitternut hickory | Pignut hickory |
| Black oak | Post oak |
| Black walnut | Red maple |
| Black gum | Sassafras |
| Blackjack oak | Shortleaf pine |
| Boxelder | Silver maple |
| Chestnut oak | Slippery elm |
| Chinkapin oak | Sourwood |
| Eastern hophornbeam | Southern red oak |
| Eastern redbud | Sugar maple |
| Eastern redcedar | Sugarberry |
| Flowering dogwood | Sweetgum |
| Green ash | Sycamore |
| Hackberry | Virginia pine |
| Loblolly pine | White oak |
| Mockernut hickory | Yellow-poplar |
| Northern red oak | |

NEW HABITAT WITH MIGRATION POTENTIAL

| | |
|----------------|------------|
| Cherrybark oak | Water oak |
| Longleaf pine | Winged elm |
| Slash pine | |

SOURCE: This handout summarizes the full model results for the Central Appalachians region, available at www.fs.fed.us/nrs/atlas/combined/resources/summaries. More information on vulnerability and adaptation in the Central Appalachians region can be found at www.forestadaptation.org/central-appalachians. A full description of the models and variables are provided in Hanson et al. 2019 (<https://www.fs.fed.us/nrs/atlas/combined/resources/summaries>) and www.fs.fed.us/nrs/atlas/combined/resources/summaries and www.fs.fed.us/nrs/atlas/combined/resources/summaries.

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ADAPTABILITY: Life-history factors, such as the ability to respond favorably to disturbance, that are not included in the Tree Atlas model and may make a species more or less able to adapt to future stressors.

- + HIGH Species may perform better than modeled
- MEDIUM
- LOW Species may perform worse than modeled

HABITAT CHANGE: Projected change in suitable habitat between current and potential future conditions.

- ▲ INCREASE: Projected increase of >20% by 2100
- NO CHANGE: Projected change of <20% by 2100
- ▼ DECREASE: Projected decrease of >20% by 2100
- * NEW HABITAT: Tree Atlas projects new habitat for species not currently present

ABUNDANCE: Based on Forest Inventory Analysis (FIA) summed Importance Value data, calibrated to a standard geographic area.

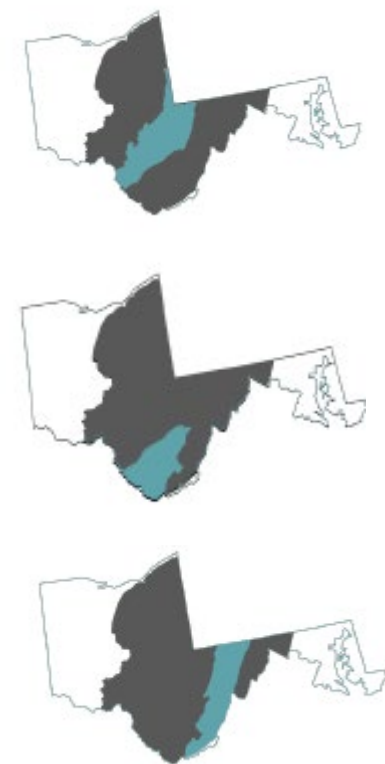
- + ABUNDANT
- COMMON
- RARE

CAPABILITY: An overall rating that describes a species' ability to cope or persist with climate change based on suitable habitat change class (statistical modeling), adaptability (literature review and expert opinion), and abundance within this region.

- ▲ GOOD: Increasing suitable habitat, medium or high adaptability, and common or abundant
- FAIR: Mixed combinations, such as a rare species with increasing suitable habitat and medium adaptability
- ▼ POOR: Decreasing suitable habitat, medium or low adaptability, and uncommon or rare

| SPECIES | LOW CLIMATE CHANGE (RCP 4.5) | | | HIGH CLIMATE CHANGE (RCP 8.5) | | | SPECIES | LOW CLIMATE CHANGE (RCP 4.5) | | | HIGH CLIMATE CHANGE (RCP 8.5) | | |
|-----------------------|------------------------------|------|---------------------------|-------------------------------|------|---------------------------|------------------|------------------------------|------|---------------------------|-------------------------------|------|---------------------------|
| | ADAPT | ABUN | HABITAT CHANGE CAPABILITY | ADAPT | ABUN | HABITAT CHANGE CAPABILITY | | ADAPT | ABUN | HABITAT CHANGE CAPABILITY | ADAPT | ABUN | HABITAT CHANGE CAPABILITY |
| American basswood | - | - | ▼ | ▼ | ▼ | ▼ | Osage-orange | + | - | ● | ▲ | ▲ | ▲ |
| American beech | - | - | ● | ● | ● | ▼ | Pignut hickory | - | - | ▲ | ▲ | ▲ | ▲ |
| American elm | + | - | ● | ● | ▲ | ▲ | Pin oak* | - | - | ● | ▲ | ▲ | ▲ |
| American holly | - | - | ▼ | ▼ | ▼ | ▼ | Pitch pine | - | - | ▼ | ▼ | ▼ | ▼ |
| American hophornbeam* | - | - | ▼ | ▼ | ▲ | ● | Post oak | + | - | ▲ | ▲ | ▲ | ▲ |
| Bald cypress | - | - | ▼ | ▼ | ▼ | ▼ | Quaking aspen | - | - | ▼ | ▼ | ▼ | ▼ |
| Balsam fir | - | - | ▼ | ▼ | ▼ | ▼ | Red maple | + | + | ▼ | ▲ | ▲ | ▲ |
| Bigtooth aspen | - | - | ▼ | ▼ | ▼ | ▼ | Red pine | - | - | ▼ | ▼ | ▼ | ▼ |
| Bitternut hickory* | + | - | ▲ | ▲ | ▲ | ▲ | Red spruce | - | - | ▼ | ▼ | ▼ | ▼ |
| Black ash | - | - | ▼ | ▼ | ▼ | ▼ | River birch* | - | - | ▼ | ▼ | ▼ | ▼ |
| Black cherry | - | + | ▼ | ● | ▼ | ● | Sassafras* | - | - | ▲ | ▲ | ▲ | ▲ |
| Black locust* | - | - | ▲ | ▲ | ● | ● | Scarlet oak | - | - | ▲ | ▲ | ▲ | ● |
| Black oak | - | - | ▲ | ▲ | ▲ | ▲ | Serviceberry* | - | - | ▼ | ▼ | ▼ | ▼ |
| Black walnut* | - | - | ▲ | ▲ | ▲ | ▲ | Shagbark hickory | - | - | ● | ● | ● | ● |
| Black willow* | - | - | ▼ | ▼ | ▼ | ▼ | Shingle oak | - | - | ● | ▼ | ▼ | ▼ |
| Blackgum | + | - | ▲ | ▲ | ▲ | ▲ | Shortleaf pine | - | - | ▲ | ▲ | ▲ | ▲ |
| Blackjack oak | + | - | ▲ | ▲ | ▲ | ▲ | Silver maple* | + | - | ● | ▲ | ▲ | ▲ |
| Boxelder* | + | - | ▲ | ▲ | ▲ | ▲ | Slash pine | - | - | + | + | + | + |
| Bur oak | + | - | ▼ | ▼ | ▼ | ▼ | Slippery elm* | - | - | ● | ▲ | ▲ | ▲ |
| Cherrybark oak | - | - | + | + | + | + | Sourwood | + | - | ▲ | ▲ | ▲ | ▲ |
| Chestnut oak | + | + | ● | ▲ | ▲ | ▲ | Southern red oak | + | - | ▲ | ▲ | ▲ | ▲ |
| Chinkapin oak | - | - | ▲ | ▲ | ▲ | ▲ | Striped maple | - | - | ● | ▼ | ▼ | ▼ |
| Cucumber tree* | - | - | ▼ | ▼ | ▼ | ▼ | Sugar maple | + | + | ▲ | ▲ | ▲ | ▲ |
| Eastern cottonwood* | - | - | ▼ | ▼ | ▼ | ▼ | Sugarberry | - | - | ▲ | ▲ | ▲ | ▲ |
| Eastern hemlock | - | - | ▼ | ▼ | ▼ | ▼ | Swamp white oak* | - | - | ▼ | ▼ | ▼ | ▼ |
| Eastern hophornbeam* | + | - | ● | ● | ▲ | ▲ | Sweet birch | - | - | ▼ | ▼ | ▼ | ▼ |
| Eastern redbud* | - | - | ▲ | ▲ | ▲ | ▲ | Sweetgum | - | - | ▲ | ▲ | ▲ | ▲ |
| Eastern redcedar | - | - | ▲ | ▲ | ▲ | ▲ | Sycamore* | - | - | ▲ | ▲ | ▲ | ▲ |
| Eastern white pine | - | - | ▲ | ▲ | ▲ | ▲ | Virginia pine | - | - | ▲ | ▲ | ▲ | ▲ |
| Flowering dogwood | - | - | ▲ | ▲ | ▲ | ▲ | Water oak | - | - | + | + | + | + |
| Green ash* | - | - | ▲ | ▲ | ▲ | ▲ | White ash | - | - | ▼ | ▼ | ▼ | ▼ |
| Hackberry | + | - | ● | ● | ▲ | ▲ | White oak | + | + | ▲ | ▲ | ▲ | ▲ |
| Loblolly pine | - | - | ▲ | ▲ | ▲ | ▲ | Winged elm | - | - | + | + | + | + |
| Longleaf pine | - | - | + | + | + | + | Yellow birch | - | - | ▼ | ▼ | ▼ | ▼ |
| Mockernut hickory | + | - | ▲ | ▲ | ▲ | ▲ | Yellow buckeye* | - | - | ▼ | ▼ | ▼ | ▼ |
| Northern red oak | + | - | ▲ | ▲ | ▲ | ▲ | Yellow-poplar | + | + | ▲ | ▲ | ▲ | ▲ |

*Species with low model reliability based on five statistical metrics of the habitat models that affect change class. See maps and tables for more information (www.fs.fed.us/nrs/atlas/combined/resources/summaries). Updated April 2021.



5) Changes in Suitable Habitat

Good Capability

- American elm
- Bitternut hickory
- Black oak
- Black walnut
- Blackgum
- Blackjack oak
- Boxelder
- Chestnut oak
- Chinkapin oak
- Eastern redcedar
- Loblolly pine
- Mockernut hickory
- Northern red oak
- Pignut hickory
- Post oak
- Red maple
- Shortleaf pine
- Southern red oak
- Sugar maple
- Sweetgum
- Virginia pine
- White oak
- Yellow-poplar
-and more!

Poor Capability

- Bald cypress
- Balsam fir
- Basswood
- Bigtooth aspen
- Black ash
- Bur oak
- Eastern hemlock
- Eastern white pine
- Pin oak
- Pitch pine
- Quaking aspen
- Red pine
- Red spruce
- River birch
- Shingle oak
- Striped maple
- Yellow birch
- ...and more!

New Habitat with Migration Potential

- Cherrybark oak
- Longleaf pin
- Slash pine
- Water oak
- Winged elm

6) 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



Photo: Route 72 in Preston County

7) 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

honeysuckle



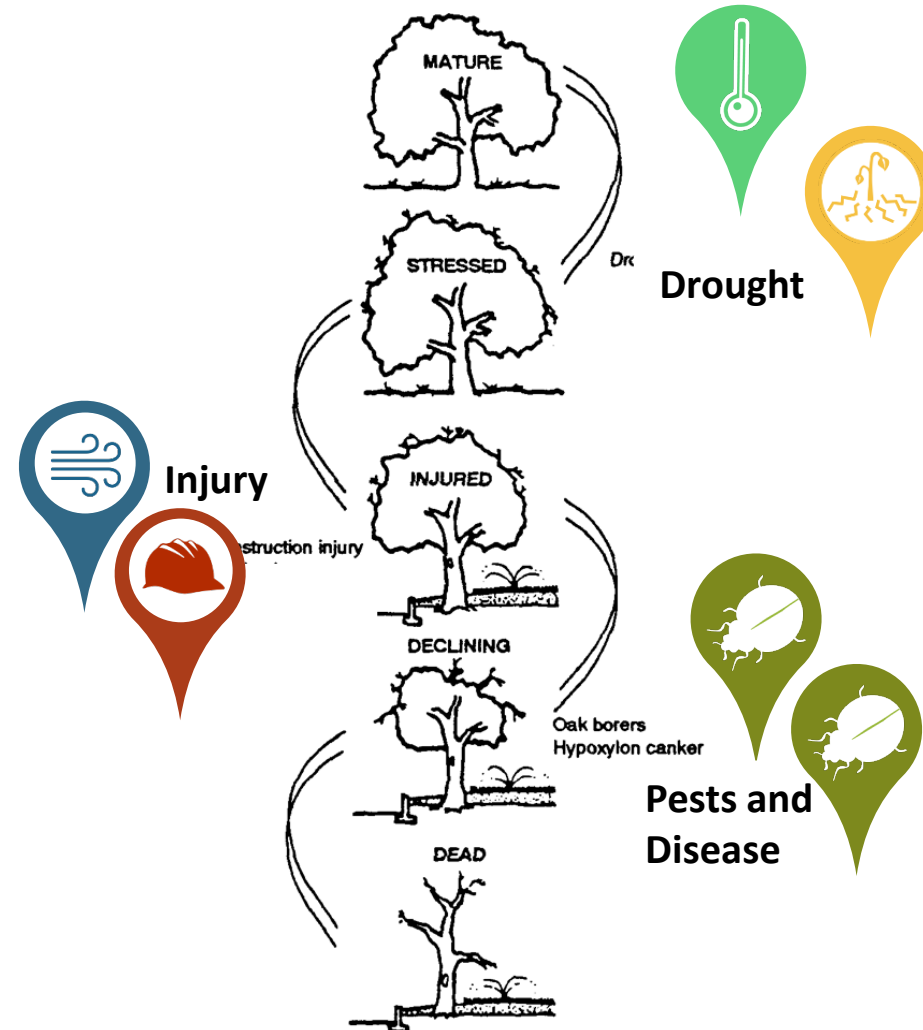
autumn olive



Climate change is a “threat multiplier”

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

Interactions make all the difference.

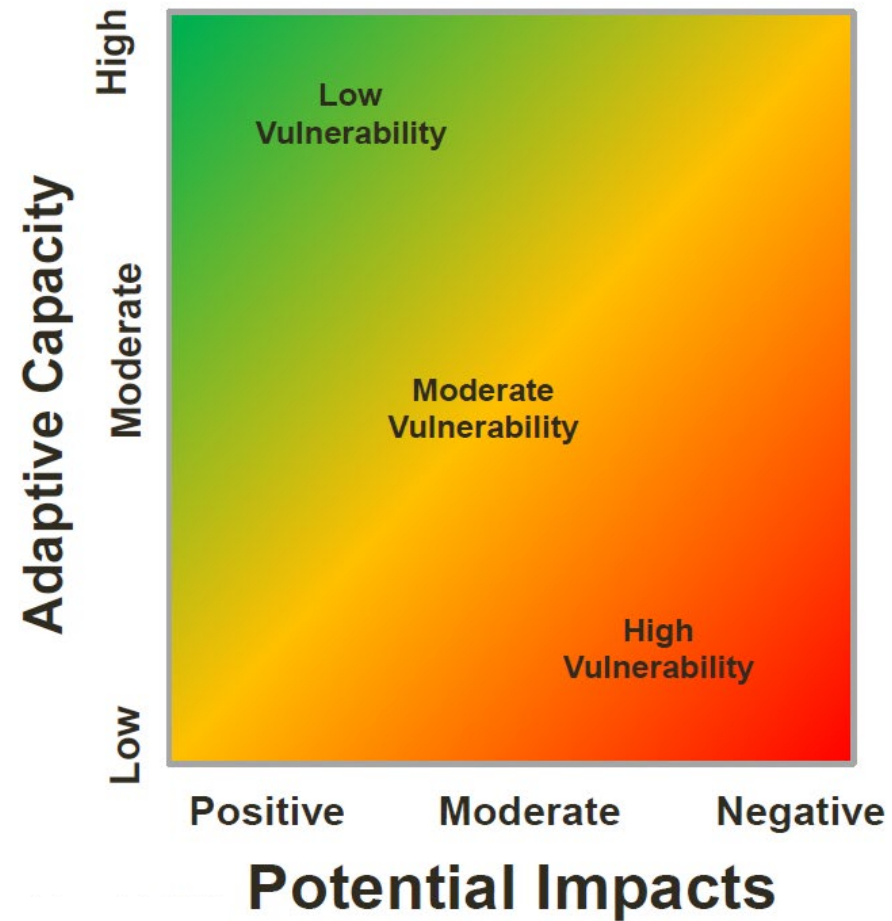


Vulnerability Assessment Process



Place-based, model-informed, expert driven, transparent

Vulnerability



Vulnerability Ratings

| Forest Ecosystem | Potential Impacts | Adaptive Capacity | Vulnerability |
|---|-------------------|-------------------|---------------|
| Appalachian (Hemlock)- Northern Hardwood | Negative | Low-Moderate | High |
| Dry Calcareous | Neutral-Negative | Low-Moderate | Moderate-High |
| Dry Oak & Pine-Oak | Positive | Moderate-High | Low |
| Dry/Mesic Oak | Positive-Neutral | High | Low-Moderate |
| Large Stream Floodplain and Riparian | Negative | Low | High |
| Mixed Mesophytic and Cove | Neutral-Negative | Moderate-High | Moderate |
| North-Central Interior Maple-Beech | Neutral | Moderate | Moderate |
| Small Stream Riparian | Negative | Moderate | Moderate-High |
| Spruce-Fir | Negative | Moderate | High |

Vulnerability: Spruce-Fir

High Vulnerability

DRIVERS:

Increasing temperatures, decreased snow cover, decreased soil moisture

DOMINANT SPECIES:

red spruce, balsam fir, yellow birch, eastern hemlock, red maple, sweet birch, black ash.....

STRESSORS:

Acid deposition, pests and diseases, disturbance

ADAPTIVE CAPACITY:

geographically limited, species already declining from pests, currently expanding to former range, highest elevations may be somewhat buffered from most severe changes



Vulnerability: Northern Hardwoods

High Vulnerability

DRIVERS:

Decreasing precipitation, increasing temperatures:
reduced soil moisture during summer and fall

DOMINANT SPECIES:

American beech, eastern hemlock (keystone where occurs), sugar maple, tulip tree, black cherry, white ash, red spruce

STRESSORS:

Increased drought, pests and diseases, disturbance

ADAPTIVE CAPACITY:

High diversity, geographically limited, combined effects of acid deposition, increased temperatures and drought



Vulnerability: Dry-Mesic Oak Forest

Low-Moderate Vulnerability

Drivers:

Dry to mesic soils, gap-phase dynamics, fire was historically important

Dominant Species:

Pignut hickory, white oak, mockernut hickory, shagbark hickory, chestnut oak, scarlet oak, black oak

Stressors:

Increased drought, pests and diseases, Ailanthus and other invasive plants

Adaptive Capacity:

Past shift to mesic species (sugar maple, beech, etc. wide distribution, variety of habitat conditions, increased fire could help oak regen.



Location, Location, Location

Research and assessments describe broad trends but local conditions and management make the difference.



Thank you!

**More information and
resources at:**

Forestadaptation.org

Patricia Leopold
pleopold@mtu.edu



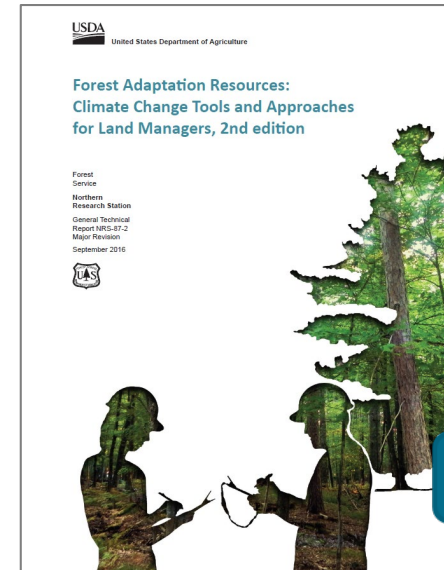
15 minutes

Break
TIME

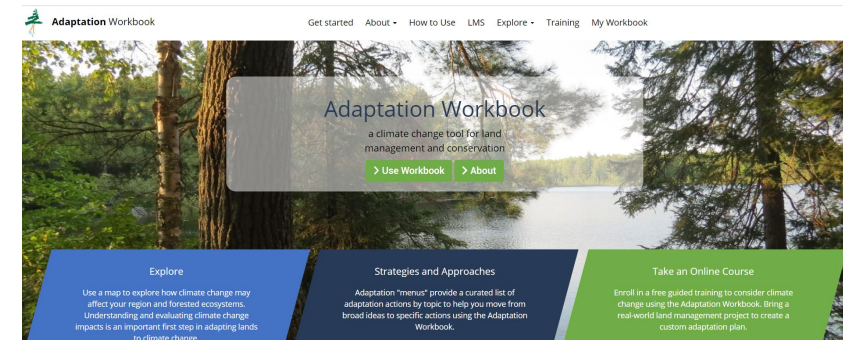
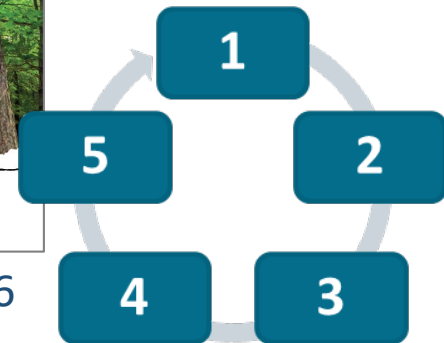
Come back at 10:30!

Climate Adaptation Workbook & Adaptation Strategies

- Flexible workbook designed for a variety of land owners with diverse goals
- Works at project-level
- Centers around manager's expertise, and judgement
- Adaptation resources to help you create **clear rationale** for your actions by connecting them to **broader adaptation ideas**.
- **Does not make recommendations**



Swanston et al. 2016
(2nd edition)



NIACS is here to help

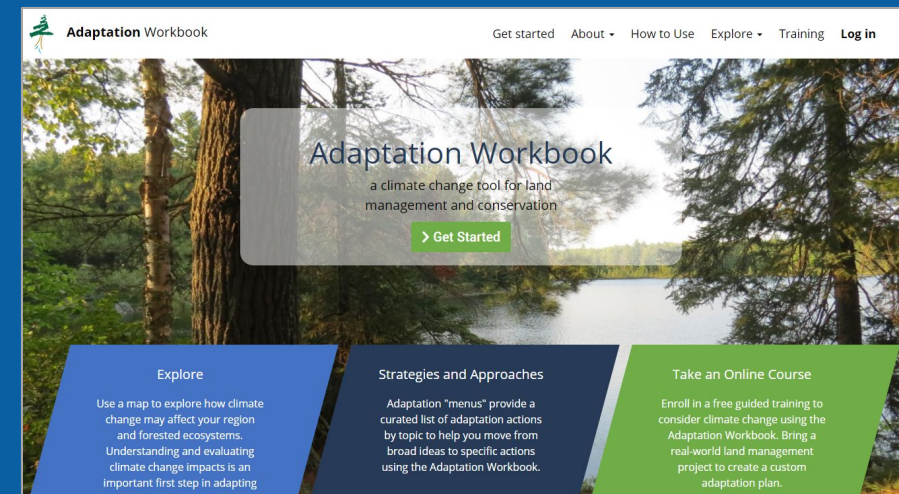
Consultation

- Adaptation considerations and planning
- Large-scale or property-level planning
- Just get in touch – this is our job!
- Technical assistance by regional experts



Course

- FREE distance learning course
- Develop a custom plan with your own project
- 8 weeks, 1 session per week
- Continuing ed credits
- www.forestadaptation.org/training



Adaptationworkbook.org

Monongahela National Forest

Next Steps

Reminder:

*Use the chat box to provide your name and certificate no.
for SAF credit or email pleopold@mtu.edu.*

