



Mid-Atlantic Climate Change Vulnerability Assessment: Climate Change Effects on Forest Ecosystems



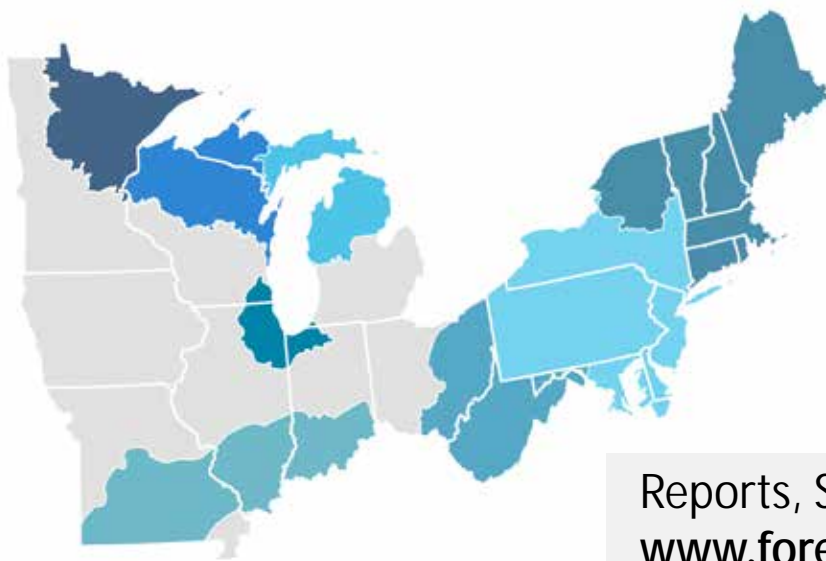
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Vulnerability Assessment

- 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

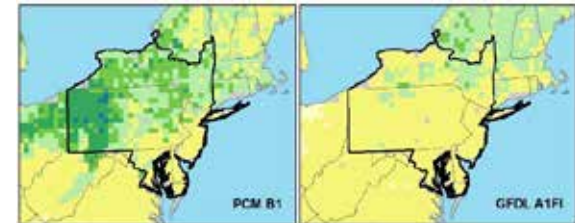


Reports, Summaries and StoryMaps:
www.forestadaptation.org/vulnerability-assessment

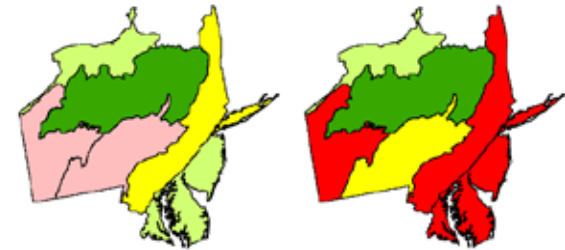
Vulnerability Assessment

- Current Forest Condition
- Observed Climate Change
- Future Climate Change
- Climate Change Impacts on Forests
- Forest Ecosystem Vulnerability
- Implications for Forest Management

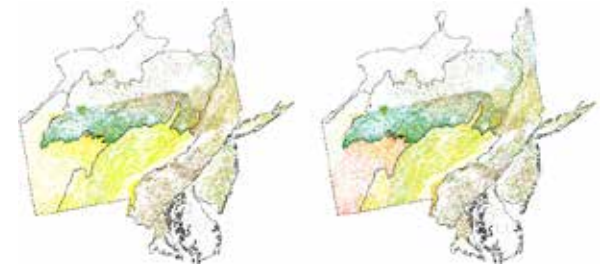
Climate Change Tree Atlas: suitable habitat



LINKAGES: species establishment



LANDIS: productivity and composition



Future Modeling Introduction

We used climate data that was downscaled by ATMOS/K. Hayhoe

Three time periods

2010 to 2039

2040 to 2069

2070 to 2099

7.5-mile grid

Annual and Seasonal changes

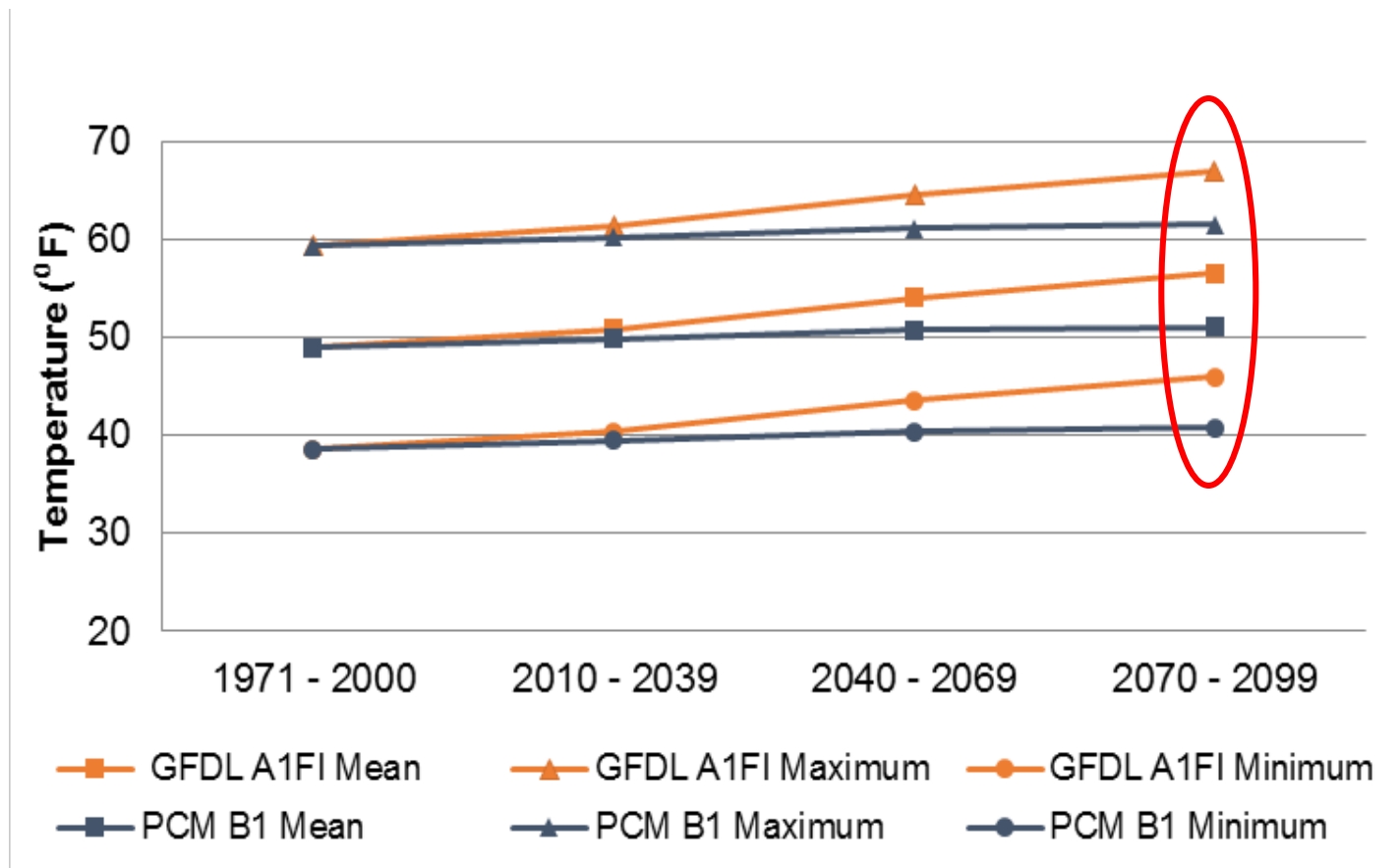
Temperature: Mean, Minimum, Maximum

Precipitation

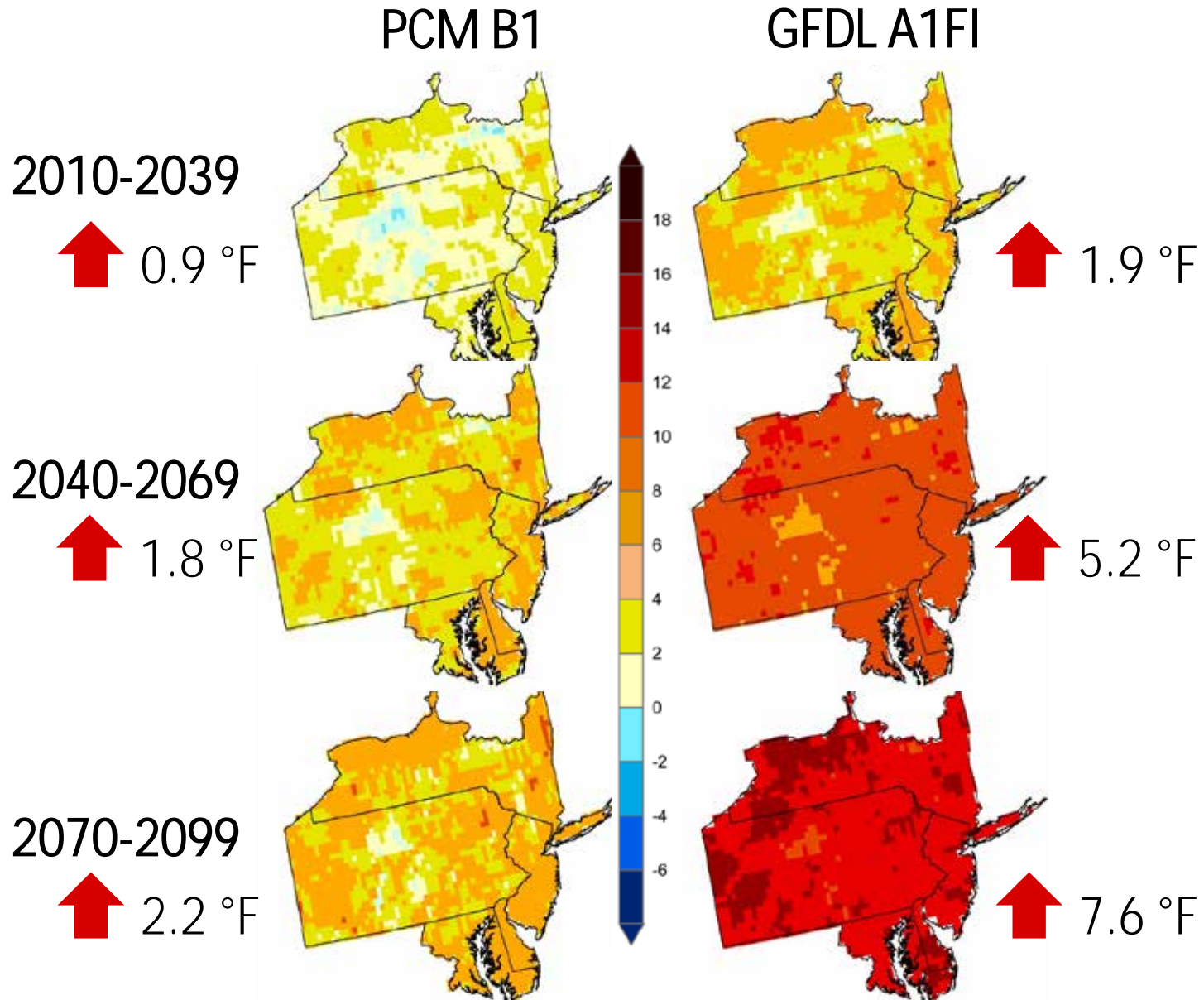
Projected Annual Temperature

PCM B1 and GFDL A1FI diverge more as time progresses

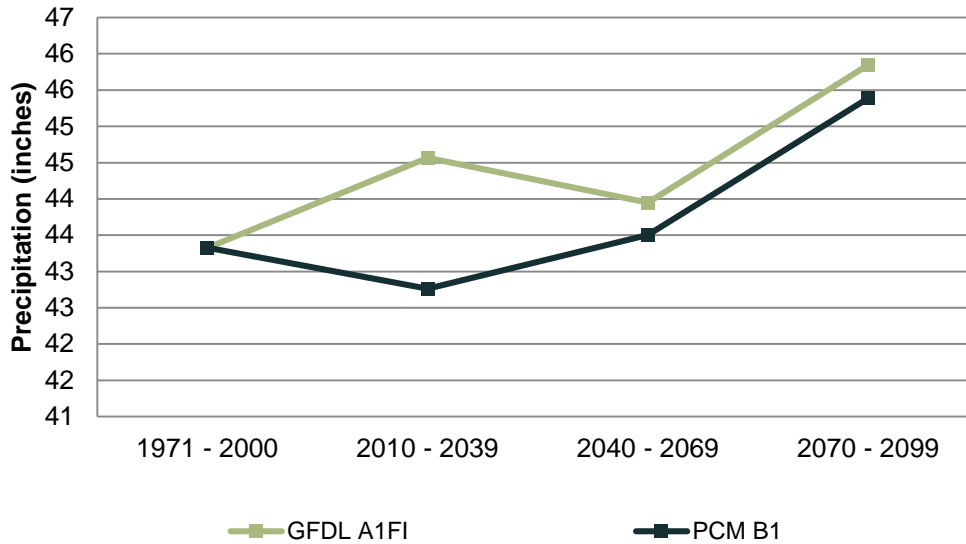
Similar patterns across seasons



Projected Changes in Annual Temperature

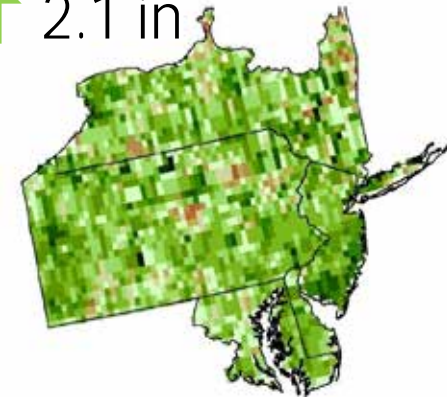


Projected Annual Precipitation



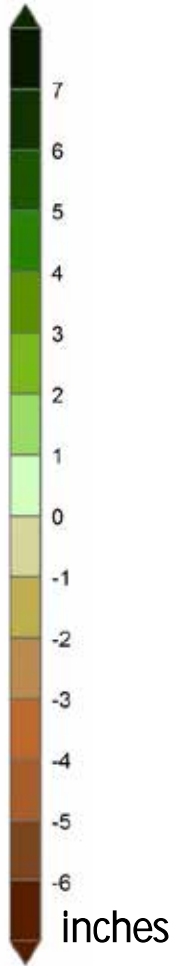
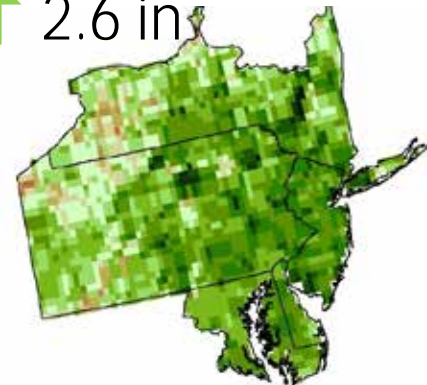
PCM B1: 2070-2099

↑ 2.1 in



GFDL A1FI: 2070-2099

↑ 2.6 in



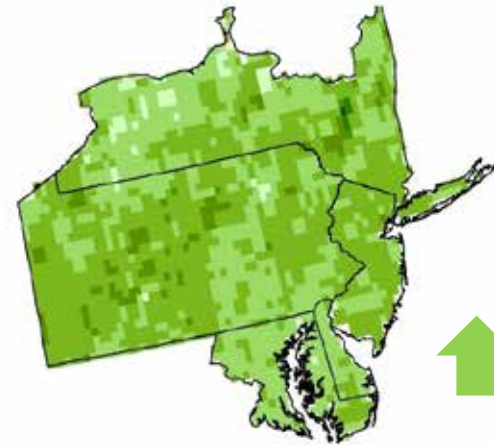
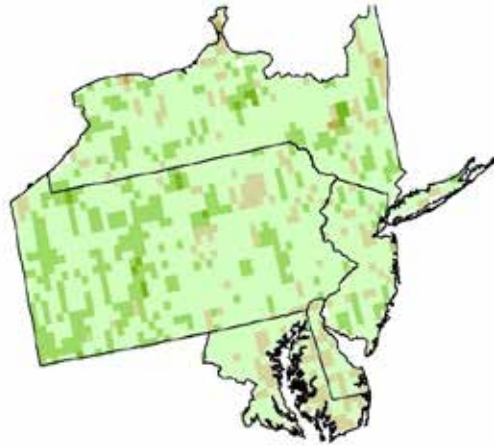
Seasonal Precipitation 2070-2099

PCM B1

GFDL A1FI

Winter

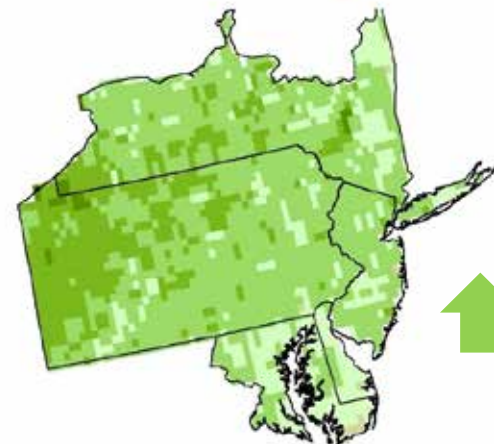
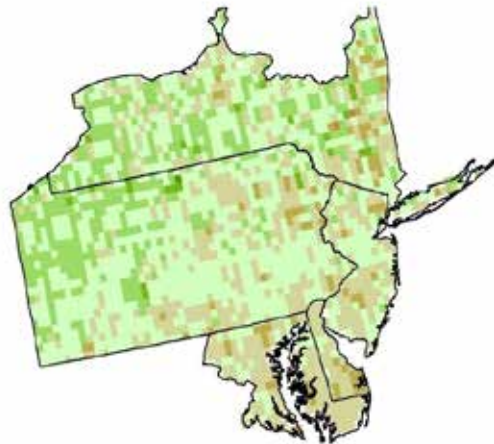
↑ 0.6 in



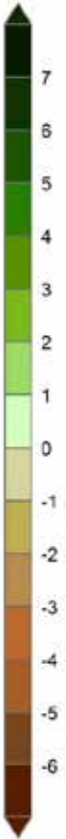
↑ 2.1 in

Spring

↑ 0.3 in



↑ 1.5 in



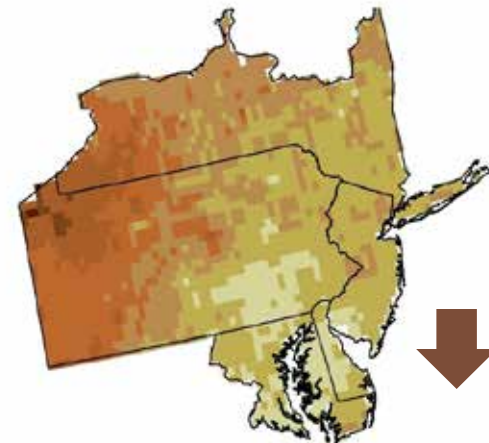
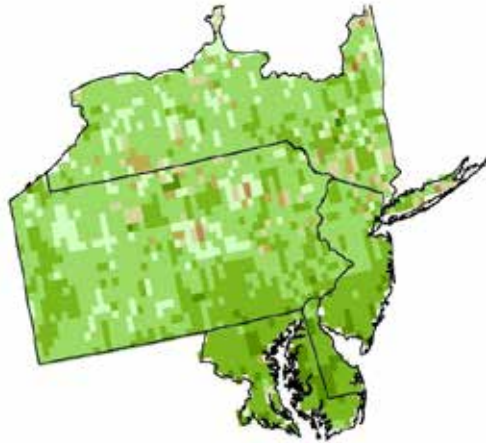
Seasonal Precipitation 2070-2099

PCM B1

GFDL A1FI

Summer

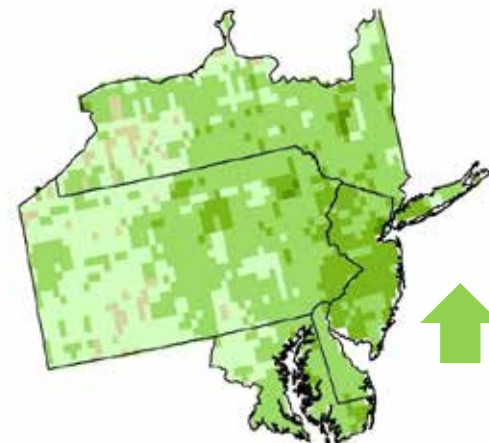
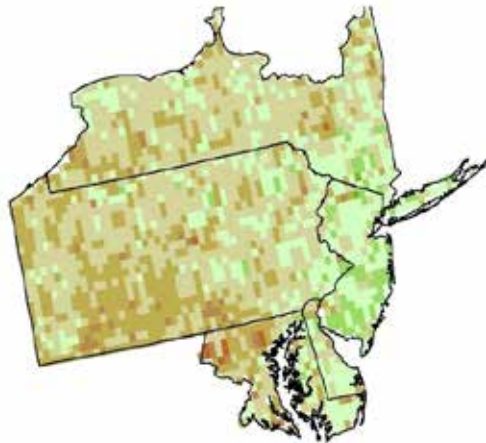
↑ 1.6 in



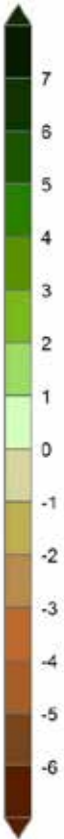
↓ 2.3 in

Fall

↓ 0.5 in



↑ 1.3 in

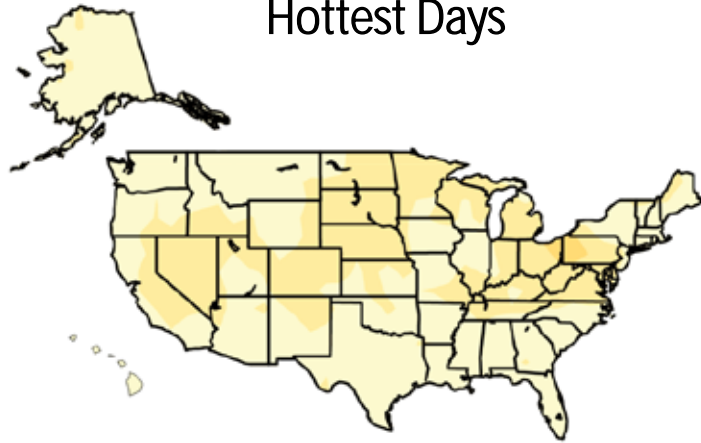
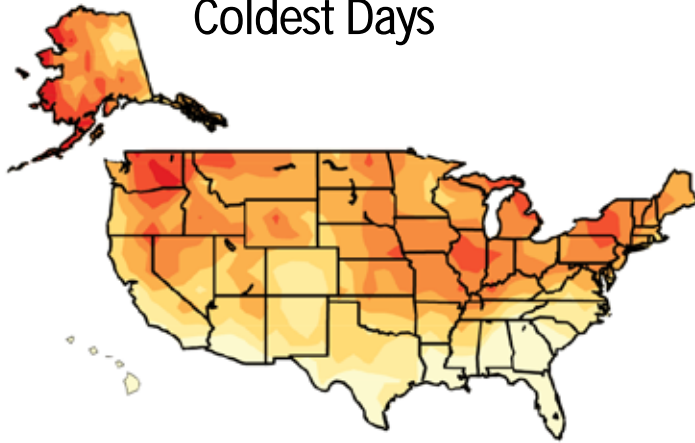


Extreme Temperatures

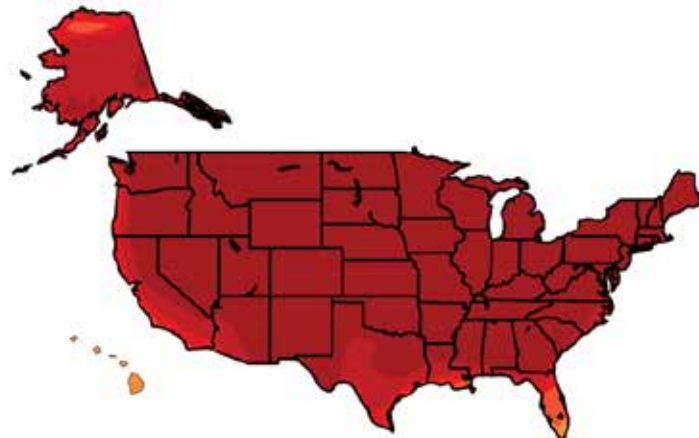
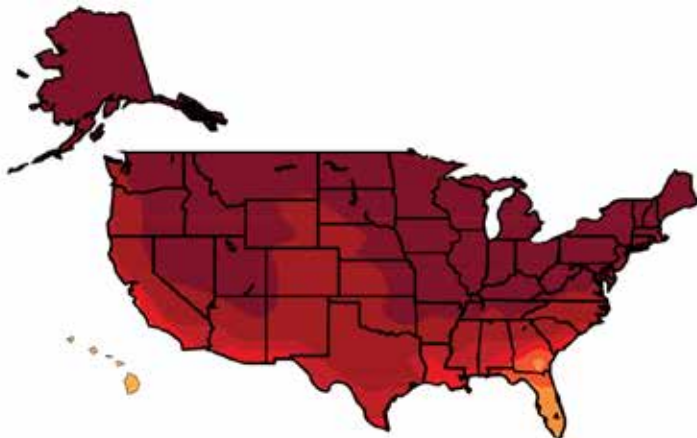
Coldest Days

Hottest Days

RCP 2.6



RCP 8.5



Temperature Change (°F)



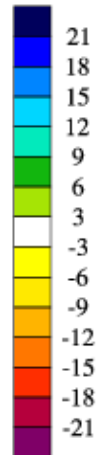
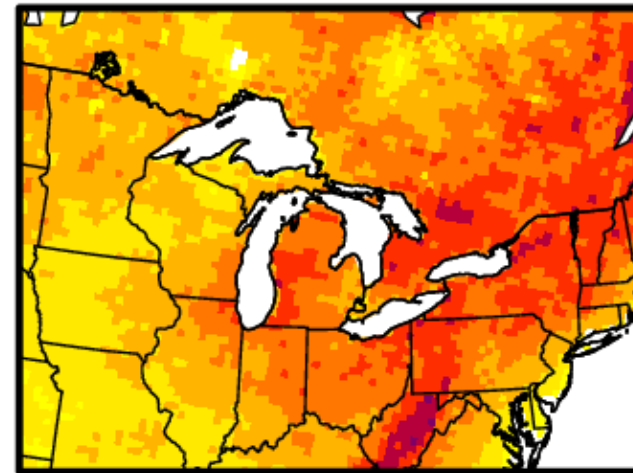
What does this mean for forests?

Shorter Winter (Less Snow)

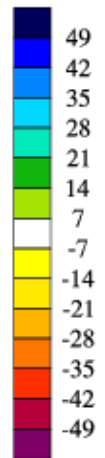
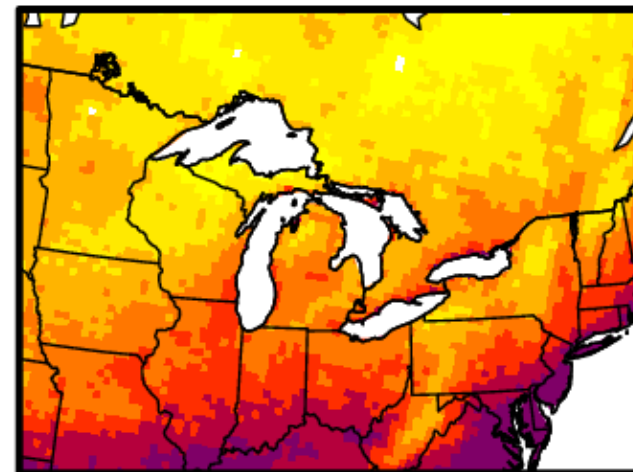
Projected decreases in snow fall, cover, and depth

- § 20-50% decrease in Days with Snowfall
- § 20-50% decrease in amount
- § Greatest loss in December/January

Change Freq Snow 1cm+ RCP8.5 Late21-Late20



% Change Freq Snow 1cm+ RCP8.5 Late21-Late20



Shorter Winter (Less Snow)

Projected decreases in snow fall, cover, and depth

- § 20-50% 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

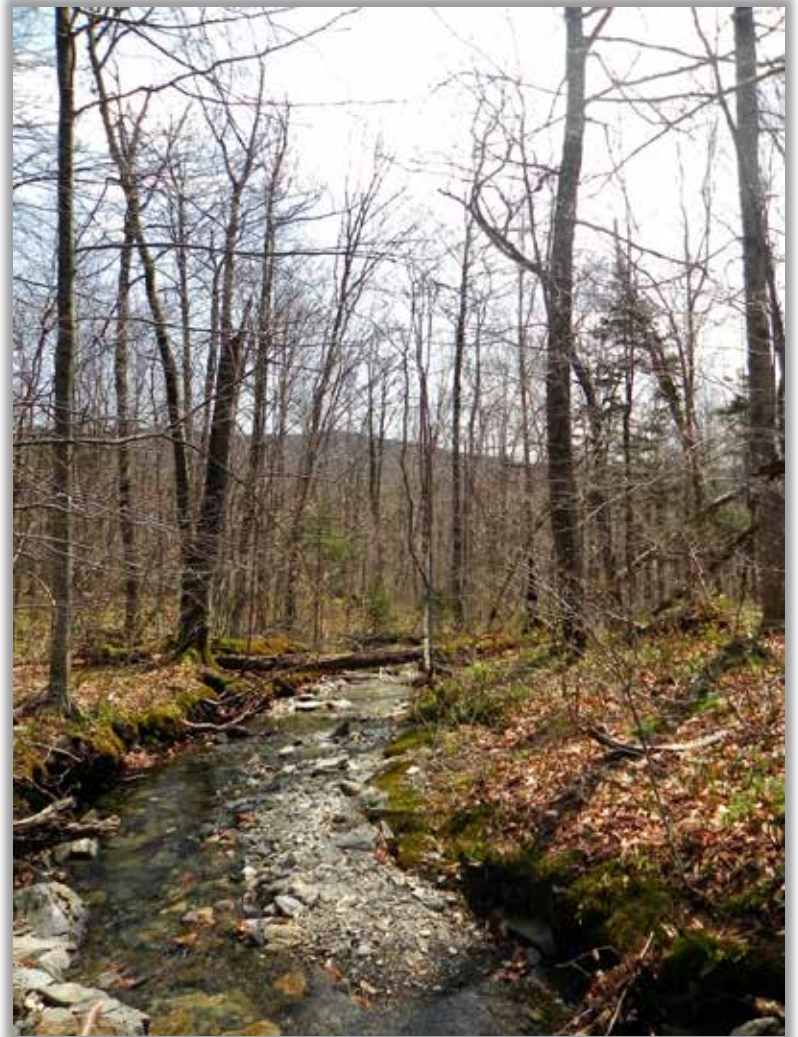
Shorter Winter (More Rain)

More rain

- § Warmer temperatures
- § Increased precipitation
- § Extreme rain events

Earlier peak stream flows

- § Flashiness and episodic high flows may increase



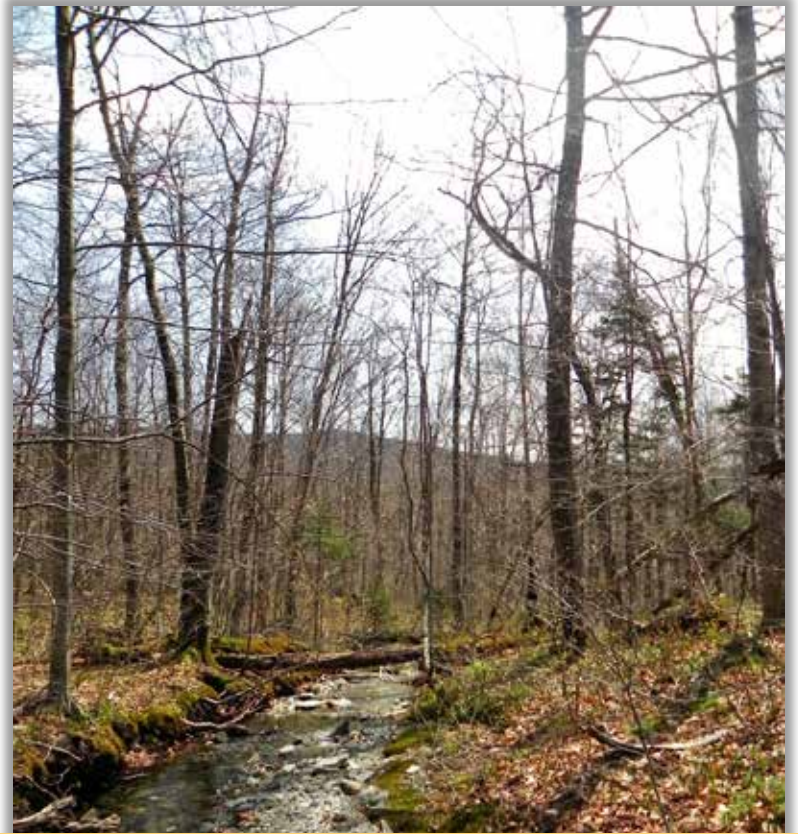
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What may be at risk: Increased erosion/sedimentation on susceptible sites; culvert washouts and road damage from extreme events; aquatic habitats and species

Longer Growing Season

Warmer temps result in longer growing seasons

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

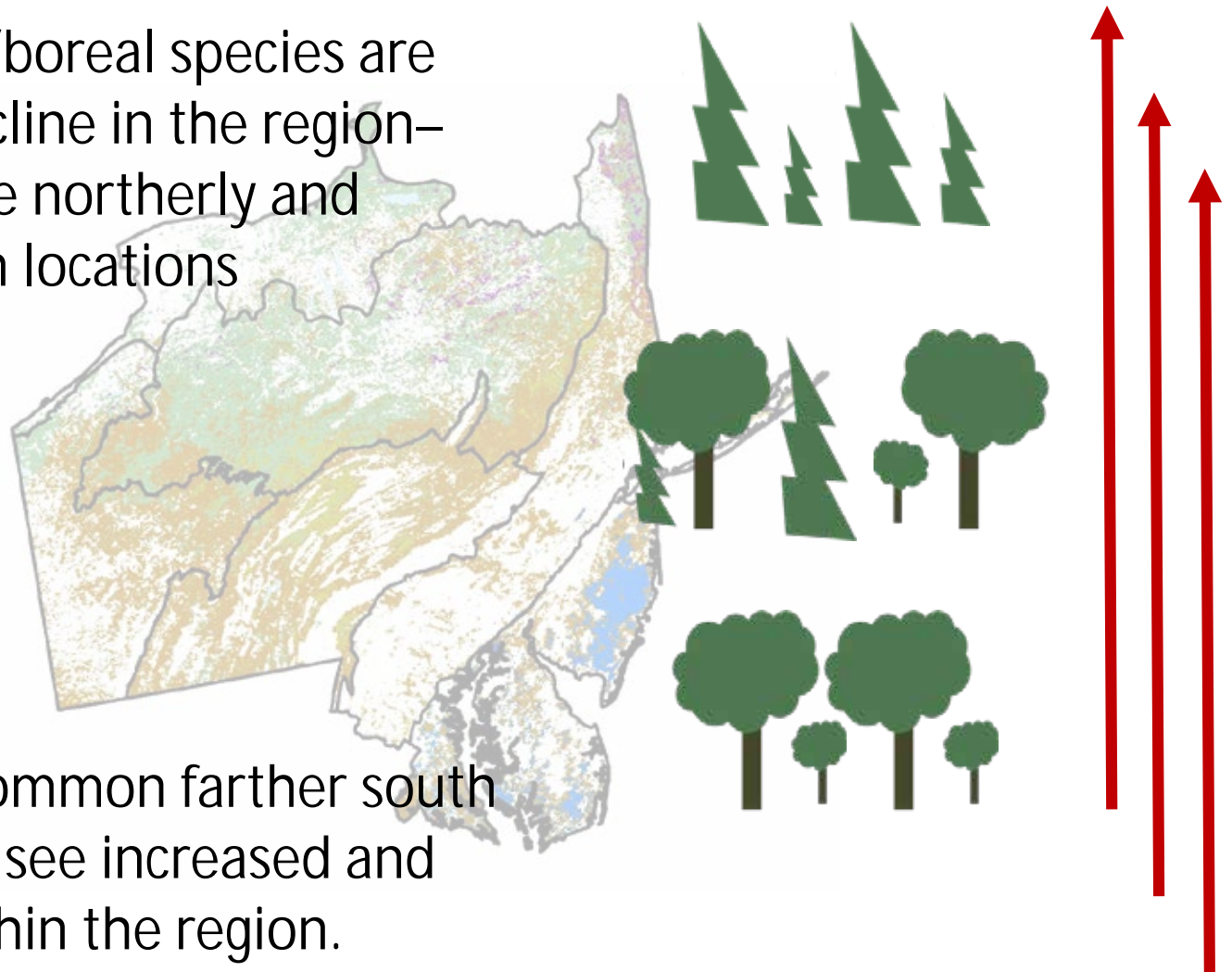
Longer period for plant growth



What may be at risk: Early bud break and frost damage from increased freeze-thaw cycles

Changes in Forest Composition

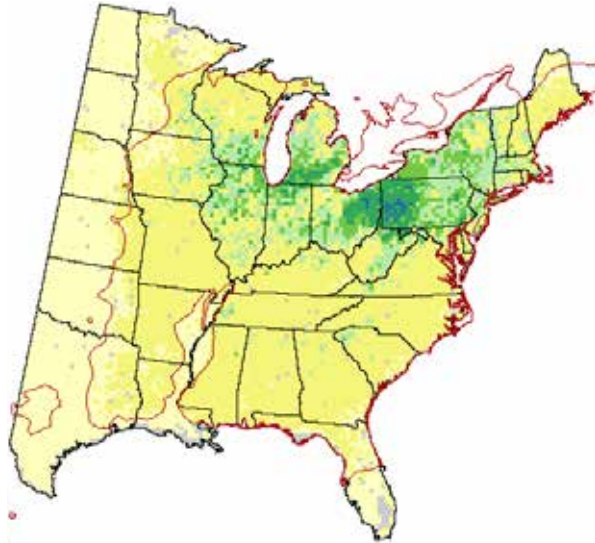
Many northern/boreal species are projected to decline in the region—contract to more northerly and higher-elevation locations



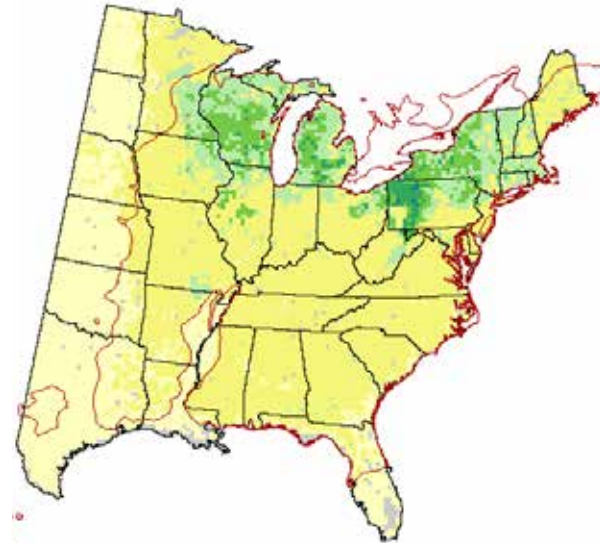
Many species common farther south are expected to see increased and new habitat within the region.

Changes in Forest Composition

Current Habitat



Low Emissions



High Emissions



 Little's Range

Importance Value

0

1 - 3

4 - 6

7 - 10

11 - 20

21 - 30

31 - 50

> 50

No Data

Black Cherry: Decline

2070-2099

fs.fed.us/nrs/atlas

Changes in Forest Composition

Current Habitat



Low Emissions

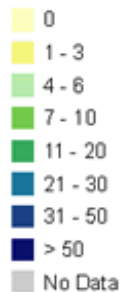


High Emissions



 Little's Range

Importance Value



Southern Red Oak: Increase


2070-2099

fs.fed.us/nrs/atlas

Changes in Forest Composition

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES

MID-ATLANTIC REGION



The region's forests will be affected by a changing climate during this century. A team of forest managers and researchers created an assessment that describes the vulnerability of forests in the Mid-Atlantic region (Duster-Leopold et al. in review). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to assess and summarize key vulnerabilities for major forest types. This handbook is summarized from the full assessment.

TREE SPECIES INFORMATION
This assessment uses two climate scenarios to "bracket" a range of possible futures. These future climate projections were used with two forest impact models (the Atlas and LANDIS) to provide information about how individual tree species may respond to a changing climate. More information on the climate and forest impact models can be found in the assessment. Results for "low" and "high" climate scenarios can be compared on page 2 of this handbook.

SPECIES	ADAPTION STRATEGIES	ADAPTION STRATEGIES	ADAPTION STRATEGIES
MAY DECREASE			
American loblolly pine	Tolerates shade; susceptible to fire		
American beech	Susceptible to frost & bark disease; very shade-tolerant		
Blue-leaf aspen	Early successional colonizer; susceptible to drought		
Black cherry	Susceptible to insects and fire; mildly drought-tolerant		
Eastern hemlock	Hemlock woolly adelgid causes mortality		
Eastern white pine	Good disperser, but susceptible to drought and insects		
Quaking aspen	Early successional colonizer; susceptible to frost & drought		
Scrub oaks	Competitive colonizer; susceptible to drought		
Shortleaf pine	Shade-tolerant; rarely established; susceptible to drought		
Sugar maple	Grows across a variety of sites; tolerates shade		
White oak	Susceptible to drought, fire, tick, and insects		
Yellow birch	Good disperser; susceptible to fire, insects, and disease		
MAY CHANGE			
American hardwood	Tolerates shade; susceptible to fire and drought		
Eastern loblolly pine	Grows across a variety of sites; tolerates shade		
Pin loblolly pine	Early successional colonizer; susceptible to insect pests		

ADAPTION STRATEGIES

- High: Species may perform better than modeled
- Medium
- Low: Species may perform worse than modeled

REMEMBER that models are just tools, and they're not perfect. Model projections don't account for some factors that could be modified by climate change, like drought, wildfire activity, and invasive species. If a species is rare or confined to a small area, tree Atlas 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. The model results presented here were combined with information from published reports and local management expertise to draw conclusions about potential risk and change in the region's forests.

FUTURE PROJECTIONS

Data for the end of the century are summarized for two forest impact models under two climate change scenarios. The Climate Change Tree Atlas (www.forestadaptation.org) and LANDIS (www.fs.fed.us/forest/landis/) models future suitable habitat, while LANDIS models changes in forest growth over time. Future biodiversity presented in this table, additional data are available in the assessment.

SPECIES	LOW CLIMATE CHANGE (PNNM)			HIGH CLIMATE CHANGE (FORBES-DIAZ V1.0)		
	ATLAS	LANDIS	ADAPT	ATLAS	LANDIS	ADAPT
American loblolly pine	+	+	+	+	+	+
American beech	-	-	-	-	-	-
American hemlock	-	-	-	-	-	-
American oak	+	+	+	+	+	+
American sycamore	+	+	+	+	+	+
American white oak	+	+	+	+	+	+
American yellow pine	+	+	+	+	+	+
Balsam poplar	+	+	+	+	+	+
Black cherry	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black walnut	+	+	+	+	+	+
Black yew	+	+	+	+	+	+
Blue oak	+	+	+	+	+	+
Blue spruce	-	-	-	-	-	-
Black gum	+	+	+	+	+	+
Black locust	+	+	+	+	+	+
Black maple	+	+	+	+	+	+
Black pine	+	+	+	+	+	+
Black redstart	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black walnut	+	+	+	+	+	+
Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
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Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
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Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
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Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
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Black spruce	-	-	-	-	-	-
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Black spruce	-	-	-	-	-	-
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Black spruce	-	-	-	-	-	-
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Black spruce	-	-	-	-	-	-
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Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+	+	+	+	+	+
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Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
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Black spruce	-	-	-	-	-	-
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Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
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Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+	+	+	+	+	+
Black oak	+	+	+	+	+	+
Black spruce	-	-	-	-	-	-
Black yew	+					

More Tree Atlas Results

Potential "losers"

- § American beech
- § Balsam fir
- § Black maple
- § Eastern hemlock
- § Eastern white pine
- § Northern white-cedar
- § Paper birch
- § Quaking aspen
- § Red pine
- § Red Spruce
- § Tamarack
- § Yellow birch

Mixed model results

- § Cucumber tree
- § Silver maple
- § Sourwood
- § Table Mountain pine
- § Tulip tree



Potential "winners"


- § Black walnut
- § Chinkapin oak
- § Eastern redcedar
- § Flowering dogwood
- § Pin oak
- § Post oak
- § Scarlet oak
- § Shagbark hickory
- § Southern red oak
- § Sycamore

New habitat under GFDL

- § Black hickory
- § Cedar elm
- § Laurel oak
- § Longleaf pine
- § Ohio buckeye
- § Overcup oak
- § Shumard oak
- § Slash pine
- § Sugarberry
- § Turkey oak




Changes in Forest Composition




CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES

CENTRAL APPALACHIANS



The region's forests will be affected by a changing climate during this century. A team of forest managers and researchers created an assessment that describes the vulnerability of forests in the Central Appalachians (Butler et al. 2015). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full assessment.

TREE SPECIES INFORMATION:
This assessment uses two climate scenarios to "bracket" a range of possible futures. These future climate projections were used with two forest impact models (Tree Atlas and LANDIS) to provide information about how individual tree species may respond to a changing climate. More information on the climate and forest impact models can be found in the assessment. Results for "low" and "high" climate scenarios can be compared on page 2 of this handout.




Remember that models are just tools, and they're not perfect. Model projections don't account for some factors that could be modified by climate change, like droughts, wildfire activity, and invasive species. If a species is rare or confined to a small area, Tree Atlas results may be less reliable. These factors, and others (see table below), 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. The model results presented here were combined with information from published reports and local management expertise to draw conclusions about potential risk and change in the region's forests.


SPECIES	ADDITIONAL CONSIDERATIONS - 30 MOST COMMON SPECIES
MAY DECREASE	
American basswood	Tolerates shade, susceptible to fire
American beech	Susceptible to beech bark disease, extremely shade tolerant
American elm	Grows on a variety of sites, susceptible to Dutch elm disease
Black cherry	Susceptible to insects and fire, somewhat drought-tolerant
Black locust	Early-successional colonizer, susceptible to insect pests
Chestnut oak	Establishes from seed or sprout, adapted to fire
Eastern white pine	Good disperser, but susceptible to drought and insects
Flowering dogwood	Shade tolerant
Red maple	Competitive colonizer in diverse sites, tolerant of disturbance
Sassafras	Early-successional colonizer, susceptible to fire topkill
Scarlet oak	Establishes from seed or sprout, susceptible to fire and disease
Slippery elm	Shade-tolerant, susceptible to disease and fire topkill
Sugar maple	Grows across a variety of sites, tolerates shade
Sweet birch	Susceptible to drought, fire topkill, and insects
Tulip tree	Competitive colonizer tolerant of diverse sites
White ash	Emerald ash borer causes mortality

SPECIES	ADDITIONAL CONSIDERATIONS - 30 MOST COMMON SPECIES
NO CHANGE	
American hornbeam	Tolerates shade, susceptible to fire and drought
Blackgum	Shade tolerant, fire adapted
Cucumber tree	Susceptible to fire topkill
Pignut hickory	Susceptible to insect pests and drought
MIXED MODEL RESULTS	
Northern red oak	Susceptible to insect pests
Sourwood	Competitive in a range of site conditions
MAY INCREASE	
Black oak	Drought tolerant, susceptible to insect pests and diseases
Black walnut	Good disperser, but intolerant of shade and drought
Boxelder	Drought and shade tolerant, competitive in a range of site conditions
Eastern hophornbeam	Grows across a variety of sites, tolerates shade
Mockernut hickory	Susceptible to fire topkill
Serviceberry	Competitive colonizer, susceptible to drought
Virginia pine	Intolerant of shade and pollution
White oak	Fire-adapted, grows on a variety of sites



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Changes in Forest Composition

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES COASTAL PLAIN (SUBREGION 6)

The region's forests will be affected by a changing climate during this century. A team of forest managers and researchers created an assessment that describes the vulnerability of forests in the Mid-Atlantic region (Butler-Leopold et al. in review). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full assessment.



Remember that models are just tools, and they're not perfect. Model projections don't account for some factors that could be modified by climate change, like droughts, wildfire activity, and invasive species. If a species is rare or confined to a small area, Tree Atlas 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.

TREE SPECIES INFORMATION:

This assessment uses two climate scenarios to "bracket" a range of possible

Despite these limits, models provide useful information about future expectations,

as indicators of possibility and here were combined with management expertise to draw in the region's forests.

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES PIEDMONT (SUBREGION 5)

The region's forests will be affected by a changing climate during this century. A team of forest managers and researchers created an assessment that describes the vulnerability of forests in the Mid-Atlantic region (Butler-Leopold et al. in review). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full assessment.



Remember that models are just tools, and they're not perfect. Model projections don't account for some factors that could be modified by climate change, like droughts, wildfire activity, and invasive species. If a species is rare or confined to a small area, Tree Atlas 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.

TREE SPECIES INFORMATION:

This assessment uses two climate scenarios to "bracket" a range of possible

Despite these limits, models provide useful information about future expectations,

ADDITIONAL CONSIDERATIONS - 20 MOST COMMON SPECIES

able to insect pests & diseases
well adapted to fire

and drought
tolerant of disturbance

able to fire and disease

mortality

variety of sites

competitive in a range of sites

able to fire and insects

invasive plants, and drought

temperature gradients

susceptible to insect pests

able to fire and drought

of temperature gradients

topkill

topkill

topkill

topkill

topkill

topkill

topkill

topkill

topkill

topkill

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topkill

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES RIDGE AND VALLEY (SUBREGION 4)

The region's forests will be affected by a changing climate during this century. A team of forest managers and researchers created an assessment that describes the vulnerability of forests in the Mid-Atlantic region (Butler-Leopold et al. in review). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full assessment.



Remember that models are just tools, and they're not perfect. Model projections don't account for some factors that could be modified by climate change, like droughts, wildfire activity, and invasive species. If a species is rare or confined to a small area, Tree Atlas 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.

TREE SPECIES INFORMATION:

This assessment uses two climate scenarios to "bracket" a range of possible futures. These future climate projections were used with two forest impact models (Tree Atlas and LANDIS) to provide information about how individual tree species may respond to a changing climate. More information on the climate and forest impact models can be found in the assessment. Results for "low" and "high" climate scenarios can be compared on page 2 of this handout.

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. The model results presented here were combined with information from published reports and local management expertise to draw conclusions about potential risk and change in the region's forests.

SPECIES LIKELY TO DECREASE

SPECIES LIKELY TO DECREASE	ADDITIONAL CONSIDERATIONS - 20 MOST COMMON SPECIES
American basswood	Tolerates shade, susceptible to fire
Bigtooth aspen	Early-successional colonizer, susceptible to drought
Blackgum	Shade tolerant, fire adapted
MAY DECREASE	
American beech	Susceptible to beech bark disease, very shade-tolerant
Eastern white pine	Good disperser, but susceptible to drought and insects
Serviceberry	Competitive colonizer, susceptible to drought
Striped maple	Shade tolerant and rarely established, susceptible to drought
Sugar maple	Grows across a variety of sites, tolerates shade
Sweet birch	Susceptible to drought, fire topkill, and insects
White ash	Emerald ash borer causes mortality
NO CHANGE	

SPECIES MIXED MODEL RESULTS CONTINUED

SPECIES MIXED MODEL RESULTS CONTINUED	ADDITIONAL CONSIDERATIONS - 20 MOST COMMON SPECIES
Eastern hemlock	Hemlock woolly adelgid causes mortality
Northern red oak	Susceptible to insect pests
Red maple	Competitive colonizer, tolerant of disturbance
Tulip tree	Competitive colonizer tolerant of diverse sites
MAY INCREASE	
Black oak	Drought tolerant, susceptible to insect pests and diseases
Eastern lophophorbeam	Grows across a variety of sites, tolerates shade
Northern hickory	Susceptible to fire topkill
Pignut hickory	Susceptible to insect pests and drought
Sassafras	Early-successional colonizer, susceptible to fire topkill
Scarlet oak	Establishes from seed & sprout, susceptible to fire & disease
Virginia pine	Intolerant of shade and pollution

Changes in Forest Composition

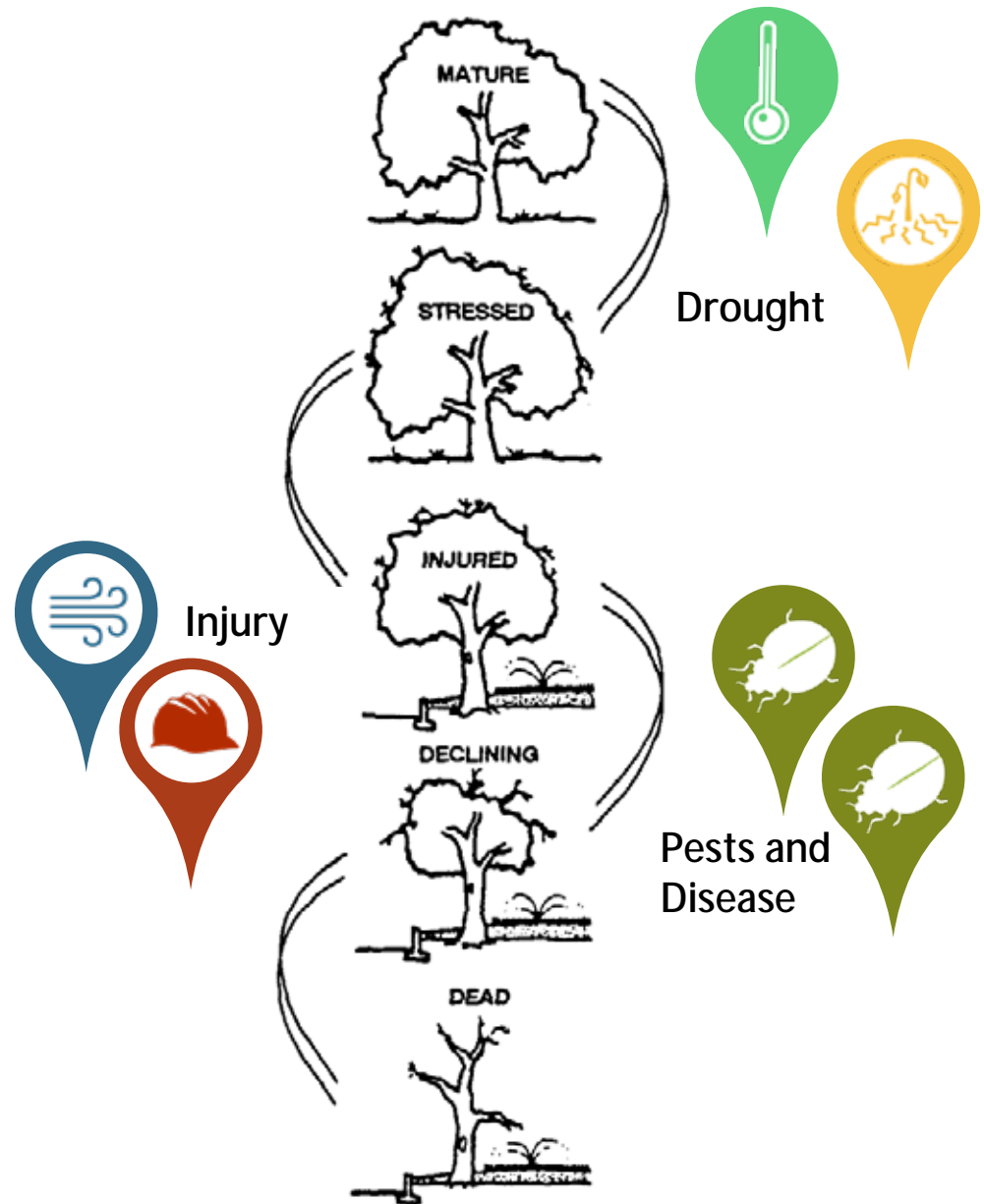
- § Many common tree species are projected to have reduced suitability in the future
- § Changes will occur slowly—not instant dieback
- § Mature and established trees should fare better
- § Immense lags to occupy habitats
- § Critical factors: competition, management, & disturbance

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
- Something is “missing” from the ecosystem
- Other factors cause additional stress

Interactions make all the difference.

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



Extreme Weather Events

Extreme events may become more frequent or severe

Heavy precipitation

Flooding

Ice storms

Heat waves/droughts

Wind storms

Hurricanes

“Events” are not well modeled



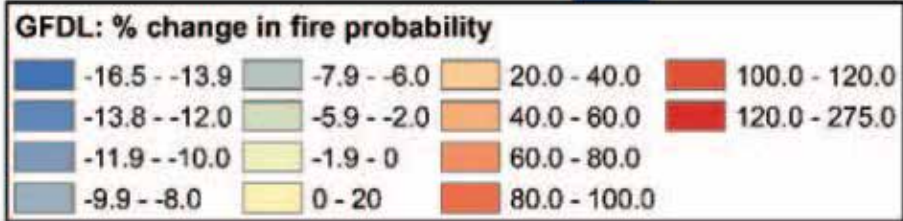
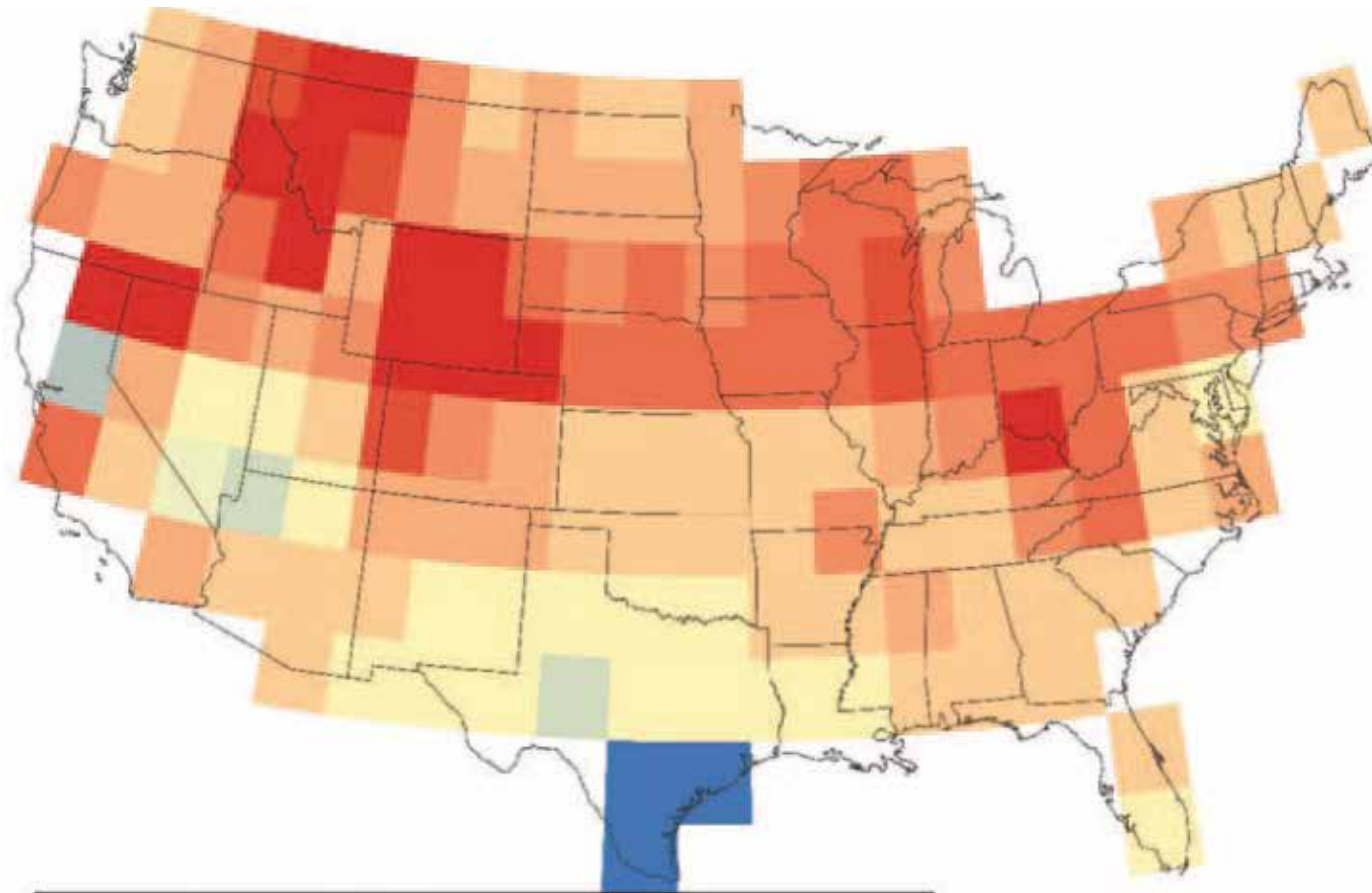
Loyalsock
State Forest;
PA DCNR



Sean Simmers,
PennLive

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

Wildfire Probability



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.

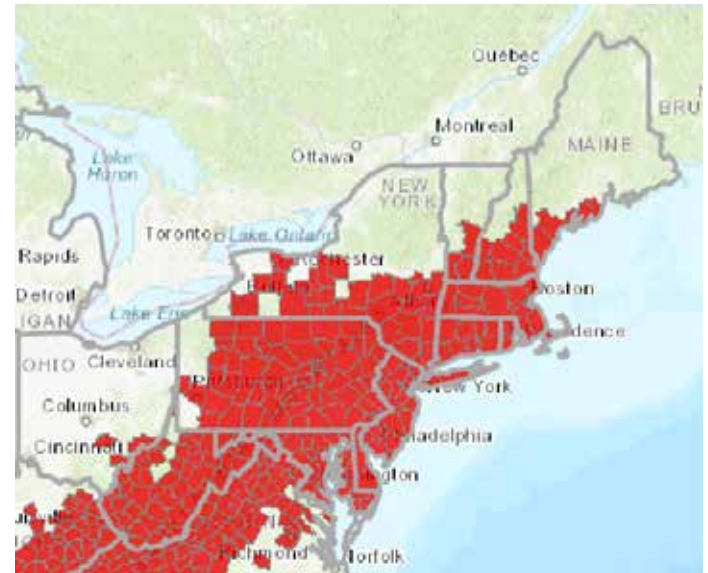
Interactions: Forest Health

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)

Ecosystem Vulnerability

Vulnerability Process



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

Mid-Atlantic Vulnerability Ratings

Forest community	Potential impacts	Adaptive capacity	Vulnerability
Montane Spruce-Fir	Negative	Low	High
Northern Hardwood	Moderate-Negative	Moderate	Moderate-High
Central Oak-Pine	Moderate-Positive	Moderate-High	Moderate-Low
Woodland, Glades, and Barrens	Positive	Moderate-High	Low
Lowland and Riparian Hardwood	Moderate	Moderate	Moderate
Lowland Conifer	Negative	Moderate-Low	High
Forest community	Potential impacts	Adaptive capacity	Vulnerability
Coastal Plain Swamp	Moderate	Moderate-High	Moderate-Low
Coastal Plain Tidal Swamp	Moderate-Negative	Moderate-Low	Moderate-High
Coastal Plain Oak-Pine-Hardwood	Moderate-Positive	High	Moderate-Low
Coastal Plain Pine-Oak Barrens	Moderate	Moderate	Moderate-Low
Coastal Plain Maritime Forest	Negative	Moderate-Low	High

High Vulnerability: Lowland Conifer



- Changes in hydrologic regime: floods *and* droughts
- Tree susceptibility to insect infestations may increase as trees become moisture-stressed
- Most species projected to decline, including balsam fir, black ash, black spruce, eastern hemlock, eastern white pine, red spruce, tamarack, and northern white-cedar
- As the keystone conifers decline, the identity of this forest community may be severely compromised

Low Vulnerability: Woodland, glades, barrens



- Exist in the hottest, driest, and most exposed sites
- Warmer, drier summers are likely to increase the risk of drought and fire in these locations, which could help maintain open conditions
- Most dominant species are projected to increase or remain stable, including eastern redcedar, eastern redbud, hackberry, northern red oak, pignut hickory, pitch pine, scrub oak, Virginia pine, and white oak.

Story Map: Mid-Atlantic Forests & CC

The image is a screenshot of a web-based story map. At the top, the title "Climate Change and Adaptation: Mid-Atlantic Forests" is displayed in white text on a dark background. To the right of the title are social media icons for Facebook, Twitter, and LinkedIn, along with the USDA and UAS logos. Below the title is a navigation bar with six tabs: "Home", "Changing Climate", "Effects on Forests", "Forest Vulnerability", "Adaptation Stories", and "Credits". The "Home" tab is currently selected. The main content area is split into two columns. The left column contains two paragraphs of text. The first paragraph states that forests are a prominent feature of the Mid-Atlantic region, covering approximately half of a 60-million-acre assessment area, and provides benefits such as clean air, water, fish, and wildlife. The second paragraph discusses the efforts of foresters, biologists, and land managers to preserve forests for future generations, mentioning the Mid-Atlantic Climate Change Response Framework and a report on forest ecosystem vulnerability. The right column features a large, scenic photograph of a body of water, likely a bay or estuary, with tall grasses in the foreground and a dramatic, cloudy sky at sunset or sunrise. At the bottom left of the text area, there is a small instruction: "Click on each tab to learn more."

Online Now! <https://tinyurl.com/MAstorymap>

Questions???