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

Pennsylvania's forests will be affected by a changing climate and other stressors during this century. Researchers and managers created an assessment that describes the vulnerability of forests in the Mid-Atlantic region (Butler-Leopold et al. 2018: *doi.org/10.2737/NRS-GTR-181*). 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 ecosystems. This handout summarizes data from the U.S. Forest Service's Climate Change Tree Atlas (*fs.usda.gov/nrs/atlas/tree/)*. 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 Tree Atlas provides information 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

Bigtooth aspen	Pitch pine
Black cherry	Quaking aspen
Black walnut	Red mulberry
Black willow	Swamp white oak
Eastern hemlock	Sweet birch
Eastern white pine	White ash
Jack pine	White spruce
Osage-orange	Yellow birch
Pin oak	

GOOD CAPABILITY

American basswood	Loblolly pine
American beech	Mockernut hickory
American elm	Northern red oak
Bitternut hickory	Pignut hickory
Black locust	Red maple
Black oak	Sassafras
Blackgum	Scarlet oak
Boxelder	Silver maple
Common persimmon	Sugar maple
Eastern redcedar	Sweetgum
Flowering dogwood	Virginia pine
Green ash	White oak

MIXED CAPABILITY

American hornbeam	Shagbark hickory
Chestnut oak	Yellow-poplar
Hackberry	

NEW HABITAT WITH MIGRATION POTENTIAL

American holly	Sourwood
Bald cypress	Southern red oak
Blackjack oak	Swamp tupelo
Cherrybark oak	Sweetbay
Chinkapin oak	Water oak
Laurel oak	Water tupelo
Post oak	Winged elm
Shortleaf pine	

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*
- **▼ DECREASE** *Projected decrease of >20% by 2100*
- **● NO CHANGE** *Projected change 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	ADAPT	ABUN	LOW CLIMATE CHANGE (RCP 4.5) HABITAT CHANGE	LOW CLIMATE CHANGE (RCP 4.5) CAPABILITY	HIGH CLIMATE CHANGE (RCP 8.5) HABITAT CHANGE	HIGH CLIMATE CHANGE (RCP 8.5) CAPABILITY
American basswood	·	−	▲	△	▲	△
American beech	·	−	▲	△	▲	△
American elm	·	−	▲	○	▲	△
American holly	·	−	★		★	
American hornbeam*	·	−	●	▽	▲	○
Bald cypress	·	−	★		★	
Bigtooth aspen	·	−	▼	▽	▼	▽
Bitternut hickory*	+	−	▲	△	▲	△
Black cherry	−	·	●	▽	▼	▽
Black locust*	·	·	●	○	▲	△
Black oak	·	·	▲	△	▲	△
Black walnut*	·	·	▼	▽	▼	▽
Black willow*	−	−	▼	▽	●	▽
Blackgum	+	·	▲	△	▲	△
Blackjack oak	+	−	★		★	
Boxelder*	+	·	●	△	▲	△
Cherrybark oak	·	−	★		★	
Chestnut oak	+	·	●	△	▼	○
Chinkapin oak	·	−	★		★	
Common persimmon*	+	−	●	○	▲	△
Eastern hemlock	−	−	▼	▽	▼	▽
Eastern redcedar	·	·	▲	△	▲	△
Eastern white pine	−	·	▼	▽	▼	▽
Flowering dogwood	·	−	▲	△	▲	△
Green ash*	·	·	●	○	▲	△
Hackberry	+	−	▼	▽	●	○
Jack pine	+	−	▼	▽	▼	▽
Laurel oak	·	−	★		★	
Loblolly pine	·	−	▲	△	▲	△
Mockernut hickory	+	·	▲	△	▲	△
Northern red oak	+	·	▲	△	●	△

SPECIES	ADAPT	ABUN	LOW CLIMATE CHANGE (RCP 4.5) HABITAT CHANGE	LOW CLIMATE CHANGE (RCP 4.5) CAPABILITY	HIGH CLIMATE CHANGE (RCP 8.5) HABITAT CHANGE	HIGH CLIMATE CHANGE (RCP 8.5) CAPABILITY
Osage-orange	+	−	▼	▽	▼	▽
Pignut hickory	·	·	▲	△	▲	△
Pin oak*	−	−	▲	▽	▲	▽
Pitch pine	·	−	▼	▽	▼	▽
Post oak	+	−	★		★	
Quaking aspen	·	−	▼	▽	▼	▽
Red maple	+	+	●	△	▼	△
Red mulberry*	·	−	▼	▽	▼	▽
Sassafras*	·	·	▲	△	▲	△
Scarlet oak	·	·	▲	△	▲	△
Shagbark hickory	·	·	▲	△	●	○
Shortleaf pine	·	−	★		★	
Silver maple*	+	−	●	○	▲	△
Sourwood	+	−	★		★	
Southern red oak	+	−	★		★	
Sugar maple	+	·	▲	△	▲	△
Swamp tupelo	−	−	★		★	
Swamp white oak*	·	−	▼	▽	▼	▽
Sweet birch	·	−	▼	▽	▼	▽
Sweetbay	·	−	★		★	
Sweetgum	·	·	▲	△	▲	△
Virginia pine	·	·	▲	△	▲	△
Water oak	·	−	★		★	
Water tupelo	−	−	★		★	
White ash	−	·	▼	▽	▼	▽
White oak	+	·	▲	△	▲	△
White spruce	·	−	▼	▽	▼	▽
Winged elm	·	−	★		★	
Yellow birch	·	−	●	▽	●	▽
Yellow-poplar	+	·	●	△	▼	○

Species with low model reliability based on five statistical metrics of the habitat models that affect change class. See tables for more information (fs.usda.gov/nrs/atlas/combined/resources/summaries).

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