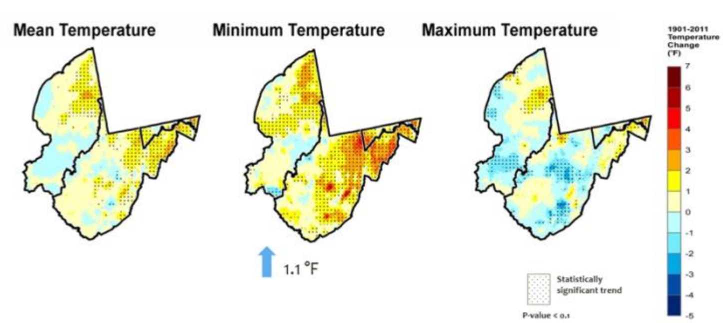
Ohio Hills Adaptive Silviculture for Climate Change (ASCC) Project: Climate Change Considerations

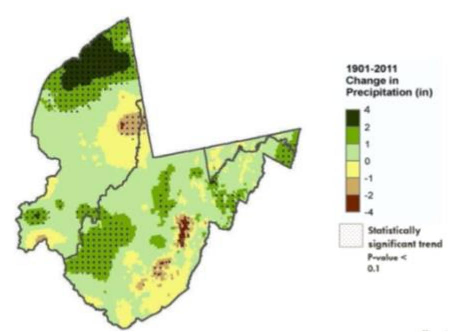
Regional Climate Impacts

- Average annual temperature has increased 0.5 degrees °F across the Central Appalachians region since 1901, and average minimum temperatures have increased by 1.1 degrees °F [1]. Temperatures are projected to increase another 1.9 to 7.8 degrees by the end of the century (2070 to 2100)[2].
- Precipitation in the Central Appalachians region has remained relatively constant since 1901, with an 8% increase in the fall season[1]. Most models project annual precipitation to continue to increase slightly during the next century, with much of the increase shifting to winter and spring. There is greater variability among projections of precipitation during summer and fall, however, models suggest that reduced precipitation sometime late in the growing season can be expected.
- Heavy precipitation events are happening much more frequently in recent decades and periods of intense rainfall will continue to become more frequent. As more rain falls during any one event, there may also be longer dry periods between events, increasing the risk of moisture stress for vegetation.[1]
- The growing season has already shifted earlier by 10-20 days over the past 50 years, primarily due to later onset of fall[1]. By the end of this century, growing degree days are expected to increase substantially in all areas of the region, marking continued increases in the growing season and potential for improved plant growth when adequate water is available. However, higher temperatures or water deficits could limit plant growth.
- A handful of trends may increase the risk of drought stress in the future:
    - Warmer temperatures will increase evaporative demand on trees and soil (vapor pressure deficit).
    - More water will be lost with longer growing seasons.
    - More water will be lost to runoff during intense rain events rather than recharging soil moisture, and there may be longer dry periods between rains.
    - Warmer winters reduce snowpack and accelerate snowmelt, so water "release" in the spring will be less gradual.
- Invasive plants, pests, and pathogens will increase or become more damaging as a warming climate allows some species and pathogens to survive further north than they had previously. Threats such as the southern pine beetle, oak decline, and many invasive species including kudzu, bush honeysuckles, and cogon grass may increase. Moisture stress during the growing season may also increase susceptibility to red oak borer, ambrosia beetle, gypsy moth, armillaria root disease, and other insect pests and diseases.
- Climate conditions will increase favorable wildfire conditions by the end of the century, particularly due to an increasing number of very hot days, as well as drier conditions late in the growing season[1]. How a change in fire risk across the region translates to effects at local scales in forests in the region also depends on land use and management decisions. Fire suppression has already been linked with mesophication in eastern forests, and fire management is expected to continue to drive vegetation and succession in the future.

Observed Change in Annual Temperature[1]



Observed Change in Annual Precipitation[1]



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[1]Butler, P. R., et al. (2015). Central Appalachians forest ecosystem vulnerability assessment and synthesis: a report from the central Appalachians climate change response framework project. Newtown Square, PA, U.S. Department of Agriculture, Forest Service, Northern Research Station: 322.
[2]https://storymaps.arcgis.com/stories/7d3ce3089c1943689984f4fac8506fd9
[3]Climate change tree atlas, Version 4. U.S. Forest Service, Northern Research Station and Northern Institute of Applied Climate Science, Delaware, OH. https://www.nrs.fs.fed.us/atlas.

Projected Changes in Temperature and Precipitation[3]

Temperature (°F)

	Scenario	2009	2039	2069	2099
Annual Average	CCSM45	48.6	50.1	52.2	52.4
	HAD85	48.6	51.3	55.1	58.9
Growing Season (May—Sep)	CCSM45	62.0	63.5	65.5	65.9
	HAD85	62.0	65.0	69.9	74.0
Coldest Month Average	CCSM45	27.7	29.0	30.4	30.8
	HAD85	27.7	29.3	31.0	32.9
Warmest Month Average	CCSM45	66.6	68.1	69.2	69.6
	HAD85	66.6	70.9	74.4	77.0

Precipitation (in)

	Scenario	2009	2039	2069	2099
Annual Total	CCSM45	33.6	35.7	36.3	37.2
	HAD85	33.6	34.9	32.5	35.3
Growing Season (May—Sep)	CCSM45	15.8	16.7	16.6	17.1
	HAD85	15.8	15.9	13.2	13.9

NOTE: For the six climate variables, four 30-year periods are used to indicate six potential future trajectories. The period ending in 2009 is based on modeled observations from the PRISM Climate Group and the three future periods were obtained from the NASA NEX-DCP30 dataset. Future climate projections from two models under two emission scenarios show estimates of each climate variable within the region. The two models are CCSM4 and HadGEM2-ES and the emission scenarios are the 4.5 and 8.5 RCP. These two model-senario combinations represent bookends on a range of possible future climate conditions. The average value for the region is reported, even though locations within the region may vary substantially based on latitude, elevation, land-use, or other factors.

Climate Change Considerations for Dry/Mesic Oak Forest

This forest type was defined in the Central Appalachians Forest Ecosystem Vulnerability Assessment using two classification systems: (1) USFS Forest Inventory and Analysis (FIA) program and (2) forest ecosystems, based on NatureServe ecological systems. Common species include white oak, northern red oak, black oak, and scarlet oak. Associated canopy trees also include red maple, pignut hickory, mockernut hickory, shagbark hickory, sugar maple, chestnut oak, yellow poplar/tulip tree, sweet birch, white ash, American beech, and blackgum. American chestnut and eastern white pine were historically dominant or codominant species in some areas. Fire is an important driver in this forest ecosystem, but contemporary fire suppression has favored maple species over oaks. Wind and ice storms continue to be important disturbances. This system is often stunted and wind-flagged on exposed southwest slopes and ridge crests.

Forest ecosystem used in this assessment	NatureServe ecological systems represented by the forest ecosystems used in this assessment	FIA forest-type groups	Common tree species in forest ecosystem
Dry/mesic oak forest	Northeastern interior dry/mesic oak forest Central and southern Appalachian montane oak forest Southern Appalachian oak forest	oak/hickory, oak/pine, white/ red/jack pine, aspen/birch	white oak, black oak, northern red oak, scarlet oak, red maple, pignut hickory, mockernut hickory, shagbark hickory, sugar maple, chestnut oak, sweet birch, American beech, blackgum, tulip tree, white ash

- Climate Change Vulnerability: Low-Moderate (medium evidence, medium-high agreement)[1]
- Climate Change Impacts: Positive-Neutral[1]
    - Of the many species in southeast Ohio modeled by the Climate Change Tree Atlas[3], climate change capability was good to very good for most, including white oak, northern red oak, black oak, red maple, pignut hickory, mockernut hickory, sugar maple, blackgum, and yellow poplar/tulip tree. Other common species are projected to persist over a smaller extent with fair to poor climate capability, including chestnut oak, scarlet oak, sweet birch, and American beech.
    - Drier soil conditions in summer and fall, especially on south-facing slopes, may increase the risk of wildfire.
    - Increased frequency of extreme weather events (e.g., windstorms and ice storms) may lead to more frequent large-gap disturbances.
- Adaptive Capacity:
    - Low-severity late-season drought generally favors oak species, although severe drought may hinder regeneration, or combine with other stressors to increase mortality or reduce productivity.
    - A history of fire suppression and timber harvesting has facilitated a shift to more mesic soils and associated hardwood species (e.g., sugar maple, American beech, yellow poplar/tulip tree). Increased fire frequency could help regenerate oak species and restore the understory composition. However, very frequent fires have the potential to kill young seedlings of any species, even those species that have relatively fire-resistant, thick bark as adults.
    - This ecosystem is widely distributed, representative of a range of habitat conditions, and likely to expand on the landscape.