Forest Vulnerability

Project Brief

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship & Science
Climate Change Response Program

Climate, Trees, Pests, and Weeds: Change, Uncertainty, and Biotic Stressors at Cumberland Gap National Historical Park

Background

Climate change and nonnative tree pests and plants affect forest composition, structure, and function, and the coming decades will likely bring accelerating changes due to these multiple global change factors. We investigated potential forest change in response to climate, differences in projections of change among climate scenarios (uncertainty), and levels of nonnative biotic stressor (tree pests and invasive plants) at 121 national park units in the eastern U.S. (see Fisichelli et al. 2014 for the full article and the project brief for a synthesis). For Cumberland Gap National Historical Park, we provide here park-specific climate (Table 1) and tree habitat suitability projections (Table 2) for 2100 under two climate scenarios ("least change" and "major change"). These scenarios bracket a range of plausible future conditions based on greenhouse gas emissions and global climate model projections and facilitate assessment of uncertainty in future projections. We also report nonnative tree insects and diseases ("pests") with infestation areas that include the park (Table 3). Park-level nonnative vascular plant ("weeds") information is available from NPSpecies.

Adaptation to ongoing climate change requires revising existing strategies to meet traditional goals and will increasingly require revising goals and developing new strategies. Data presented here is intended to inform managers of potential future change (climate and forests) and exacerbating factors (nonnative species).

More Information

This project is part of ongoing work of the NPS Climate Change Response Program to support park adaptation to changing conditions (websites: for managers, for the public).

Source Publication

Fisichelli, N. A., S. R. Abella, M. P. Peters, and F. J. Krist Jr. 2014. Climate, trees, pests, and weeds: change, uncertainty, and biotic stressors in eastern U.S. national park forests. Forest Ecology and Management 327:31-39.

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Table 1. Baseline (1961-1990) and future (2070-2099) climates used in tree habitat suitability models for Cumberland Gap National Historical Park. Future projections for the two climate scenarios ("Least Change" and "Major Change") illustrate a plausible range of future conditions and are shown as departures from baseline values. The Least Change scenario includes a major decrease in future greenhouse gas emissions while the Major Change scenario is a continuation of historical increases in emissions. Climate data are averaged across a roughly 6200 mi^2 (16000 km^2) area centered on the park.

Climate Variable	Baseline (1961-1990)	Least Change (2070-2099)	Major Change (2070-2099)
mean annual temperature	12.2 °C (53.9 °F)	+1.9 °C (+3.4 °F)	+6.6 °C (+11.9 °F)
mean January temperature	0.2 °C (32.4 °F)	+1.9 °C (+3.4 °F)	+5 °C (+8.9 °F)
mean July temperature	22.9 °C (73.3 °F)	+2.1 °C (+3.8 °F)	+8.2 °C (+14.8 °F)
seasonality (July-January temp.)	22.7 °C (40.8 °F)	+0.2 °C (+0.4 °F)	+3.3 °C (+5.9 °F)
mean May-September temp.	20.5 °C (69 °F)	+1.8 °C (+3.3 °F)	+7.5 °C (+13.6 °F)
annual precipitation	1279 mm (50.3 in)	+5.4 %	+16 %
May-September precipitation	544 mm (21.4 in)	+5.7 %	+10.7 %

Table 2. Potential changes in habitat suitability (2100 compared with 1990) for tree species in Cumberland Gap National Historical Park. Species are grouped into decreasing, no change, increasing, mixed results, and new habitat groups based on change class designations for two future climate scenarios (the "least change" scenario represents strong cuts in greenhouse gas emissions and modest climatic changes and the "major change" scenario represents continued increasing greenhouse gas emissions and rapid warming). Change class designations are based on the ratio of future (2100) to baseline (1990) habitat suitability and baseline habitat values, e.g., for common species, large decrease is ≤ 0.5, small decrease is > 0.5 and ≤ 0.8, no change is > 0.8 and ≤ 1.2, small increase is > 1.2 and ≤ 2.0, and large increase is > 2.0. Note: table below uses finer change classes (n=8) than was used in the original article (n=3) to designate uncertainty in habitat projections. Habitat suitability models from the US Forest Service Climate Change Tree Atlas. Contact author for further details on change class definitions.

Decreases in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Acer rubrum	red maple	small decrease	large decrease
Acer saccharum	sugar maple	small decrease	large decrease
Aesculus octandra	yellow buckeye	small decrease	small decrease
Betula lenta	sweet birch	large decrease	large decrease
Carya glabra	pignut hickory	small decrease	small decrease
Fagus grandifolia	American beech	small decrease	large decrease
Fraxinus americana	white ash	small decrease	small decrease
Liriodendron tulipifera	yellow-poplar	small decrease	large decrease
Magnolia acuminata	cucumbertree	small decrease	small decrease
Pinus rigida	pitch pine	large decrease	large decrease
Pinus strobus	eastern white pine	small decrease	large decrease
Prunus pensylvanica	pin cherry	extirpated	extirpated
Quercus prinus	chestnut oak	small decrease	small decrease
Robinia pseudoacacia	black locust	small decrease	large decrease
Sassafras albidum	sassafras	small decrease	small decrease
Tilia americana	American basswood	large decrease	small decrease

No Change in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Amelanchier spp.	serviceberry	no change	no change
Betula nigra	river birch	no change	no change
Castanea dentata	American chestnut	no change	no change
Cercis canadensis	eastern redbud	no change	no change

Increases in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Acer negundo	boxelder	small increase	large increase
Carya cordiformis	bitternut hickory	small increase	large increase
Carya ovata	shagbark hickory	small increase	small increase
Celtis laevigata	sugarberry	large increase	large increase
Celtis occidentalis	hackberry	small increase	large increase
Diospyros virginiana	common persimmon	large increase	large increase
Juniperus virginiana	eastern redcedar	small increase	small increase
Liquidambar styraciflua	sweetgum	large increase	large increase
Pinus echinata	shortleaf pine	large increase	large increase
Pinus taeda	loblolly pine	large increase	large increase
Quercus falcata var.falcata	southern red oak	small increase	large increase

Increases in Potential Habitat (continued)

Scientific Name	Common Name	Least Change	Major Change
Quercus marilandica	blackjack oak	large increase	large increase
Quercus stellata	post oak	large increase	large increase
Ulmus alata	winged elm	large increase	large increase
Ulmus americana	American elm	small increase	large increase

Mixed Results

Scientific Name	Common Name	Least Change	Major Change
Acer saccharinum	silver maple	extirpated	large increase
Carpinus caroliniana	American hornbeam	small decrease	small increase
Carya illinoinensis	pecan	small decrease	large increase
Carya tomentosa	mockernut hickory	no change	small increase
Cornus florida	flowering dogwood	no change	small decrease
Fraxinus pennsylvanica	green ash	no change	small increase
Gleditsia triacanthos	honeylocust	large decrease	large increase
Juglans nigra	black walnut	no change	small decrease
Morus rubra	red mulberry	no change	large increase
Nyssa sylvatica	blackgum	no change	small increase
Ostrya virginiana	eastern hophornbeam	no change	small increase
Oxydendrum arboreum	sourwood	no change	small decrease
Pinus virginiana	Virginia pine	no change	small decrease
Platanus occidentalis	sycamore	no change	small increase
Populus deltoides	eastern cottonwood	small decrease	large increase
Prunus serotina	black cherry	no change	small increase
Quercus alba	white oak	small increase	no change
Quercus coccinea	scarlet oak	no change	large decrease
Quercus muehlenbergii	chinkapin oak	no change	small increase
Quercus phellos	willow oak	large decrease	large increase
Quercus rubra	northern red oak	no change	small decrease
Quercus shumardii	Shumard oak	no change	large increase
Quercus velutina	black oak	no change	small increase
Salix nigra	black willow	large decrease	large increase
Tsuga canadensis	eastern hemlock	small decrease	no change
Ulmus rubra	slippery elm	no change	small increase

New Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Carya texana	black hickory	new entry	new entry
Maclura pomifera	osage-orange	--	new entry
Pinus elliottii	slash pine	--	new entry
Pinus palustris	longleaf pine	--	new entry
Quercus laurifolia	laurel oak	--	new entry
Quercus macrocarpa	bur oak	--	new entry
Quercus nigra	water oak	new entry	new entry
Quercus nuttallii	Nuttall oak	--	new entry
Ulmus crassifolia	cedar elm	new entry	new entry

Table 3. Nonnative tree insects and diseases ("tree pests") with infestation areas that include Cumberland Gap National Historical Park. Detection scale is the finest spatial scale at which infestation data were available for the park area. Data derived from the US Forest Service Alien Forest Pest Explorer (AFPE) Database.

Scientific Name	Common Name	Detection Scale
Adelges abietis	eastern spruce gall adelgid	state
Adelges piceae	balsam woolly adelgid	state
Adelges tsugae	hemlock woolly adelgid	county
Agrilus planipennis	emerald ash borer	county
Anarsia lineatella	peach twig borer	state
Asterolecanium minus	oak pit scale	state
Asterolecanium variolosum	golden oak scale	state
Caliroa cerasi	pear sawfly	state
Carulaspis juniperi	juniper scale	state
Caulocampus acericaulis	maple petiole borer	state
Ceratocystis fagacearum	oak wilt	county
Cryphonectria parasitica	chestnut blight	county
Cryptorhynchus lapathi	poplar-and-willow borer	state
Cyrtepistomus castaneus	Asiatic oak weevil	state
Diaspidiotus perniciosus	San Jose scale	state
Diprion similis	introduced pine sawfly	state
Discula destructiva	dogwood anthracnose	county
Dryocosmus kuriphilus	chestnut gall wasp	state
Eulecanium cerasorum	calico scale	state
Fiorinia externa	elongate hemlock scale	state
Homadaula anisocentra	mimosa webworm	state
Kaliofenusa ulmi	elm leafminer	state
Lepidosaphes ulmi	oystershell scale	state
Neodiprion sertifer	European pine sawfly	state
Ophiostoma novo-ulmi	Dutch elm disease	state
Orchestes alni	European elm flea weevil	state
Otiorhynchus ovatus	strawberry root weevil	state
Otiorhynchus sulcatus	black vine weevil	state
Periphyllus lyropictus	Norway maple aphid	state
Phyllaphis fagi	woolly beech aphid	state
Phytophthora cinnamomi	littleleaf disease / phytophthora root rot	state
Plagiodera versicolora	imported willow leaf beetle	state
Popillia japonica	Japanese beetle	county
Pristiphora erichsonii	larch sawfly	state
Pseudaonidia duplex	camphor scale	state
Rhyacionia buoliana	European pine shoot moth	state
Scolytus multistriatus	smaller European elm bark beetle	state
Sirococcus clavigignenti juglandacearum	butternut canker	county
Taeniothrips inconsequens	pear thrips	state
Tomicus piniperda	pine shoot beetle	state

Table 3 (continued). Nonnative tree insects and diseases ("tree pests") with infestation areas that include Cumberland Gap National Historical Park.

Scientific Name	Common Name	Detection Scale
Trichiocampus viminalis	poplar sawfly	state
Xanthogaleruca luteola	elm leafbeetle	state