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 Mammoth Cave National 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 Mammoth Cave National 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 Mammoth Cave National 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	13 °C (55.5 °F)	+2 °C (+3.7 °F)	+6.9 °C (+12.5 °F)
mean January temperature	0.1 °C (32.1 °F)	+2 °C (+3.7 °F)	+6 °C (+10.8 °F)
mean July temperature	24.3 °C (75.8 °F)	+2.3 °C (+4.2 °F)	+8.7 °C (+15.7 °F)
seasonality (July-January temp.)	24.3 °C (43.7 °F)	+0.3 °C (+0.5 °F)	+2.7 °C (+4.9 °F)
mean May-September temp.	21.8 °C (71.2 °F)	+2 °C (+3.7 °F)	+7.9 °C (+14.3 °F)
annual precipitation	1296 mm (51 in)	+3 %	+14 %
May-September precipitation	548 mm (21.6 in)	+4.5 %	+1.2 %

Table 2. Potential changes in habitat suitability (2100 compared with 1990) for tree species in Mammoth Cave National 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	small decrease
Acer saccharum	sugar maple	large decrease	extirpated
Asimina triloba	pawpaw	extirpated	extirpated
Carya glabra	pignut hickory	large decrease	small decrease
Cercis canadensis	eastern redbud	large decrease	small decrease
Fagus grandifolia	American beech	large decrease	large decrease
Fraxinus americana	white ash	large decrease	large decrease
Juglans nigra	black walnut	large decrease	extirpated
Liriodendron tulipifera	yellow-poplar	large decrease	large decrease
Platanus occidentalis	sycamore	small decrease	small decrease
Prunus virginiana	chokecherry	extirpated	extirpated
Quercus coccinea	scarlet oak	large decrease	extirpated
Quercus muehlenbergii	chinkapin oak	small decrease	small decrease
Robinia pseudoacacia	black locust	small decrease	large decrease
Sassafras albidum	sassafras	large decrease	large decrease
Ulmus thomasii	rock elm	large decrease	large decrease

No Change in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Acer negundo	boxelder	no change	no change
Carya tomentosa	mockernut hickory	no change	no change
Nyssa sylvatica	blackgum	no change	no change
Prunus serotina	black cherry	no change	no change

Increases in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Celtis laevigata	sugarberry	large increase	large increase
Liquidambar styraciflua	sweetgum	large increase	large increase
Maclura pomifera	osage-orange	small increase	large increase
Ostrya virginiana	eastern hophornbeam	small increase	small 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
Quercus marilandica	blackjack oak	large increase	large increase
Quercus palustris	pin oak	small increase	large increase
Quercus phellos	willow oak	large increase	large increase
Quercus stellata	post oak	large increase	large increase
Ulmus alata	winged elm	large increase	large increase

Mixed Results

Scientific Name	Common Name	Least Change	Major Change
Acer saccharinum	silver maple	small decrease	large increase
Aesculus octandra	yellow buckeye	no change	small increase
Betula nigra	river birch	small decrease	large increase
Carpinus caroliniana	American hornbeam	no change	small increase
Carya cordiformis	bitternut hickory	no change	large increase
Carya illinoinensis	pecan	no change	large increase
Carya ovata	shagbark hickory	small decrease	no change
Celtis occidentalis	hackberry	small decrease	small increase
Cornus florida	flowering dogwood	small decrease	no change
Diospyros virginiana	common persimmon	no change	small increase
Fraxinus pennsylvanica	green ash	no change	small increase
Gleditsia triacanthos	honeylocust	no change	large increase
Juniperus virginiana	eastern redcedar	no change	small decrease
Morus rubra	red mulberry	no change	large increase
Oxydendrum arboreum	sourwood	small decrease	small increase
Pinus virginiana	Virginia pine	small decrease	no change
Quercus alba	white oak	no change	small decrease
Quercus falcata var.pagodifolia	cherrybark oak	no change	small increase
Quercus imbricaria	shingle oak	large decrease	small increase
Quercus prinus	chestnut oak	small decrease	no change
Quercus rubra	northern red oak	no change	large decrease
Quercus shumardii	Shumard oak	extirpated	large increase
Quercus velutina	black oak	no change	small decrease
Salix nigra	black willow	no change	large increase
Ulmus americana	American elm	no change	small increase
Ulmus rubra	slippery elm	no change	small decrease

New Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Carya texana	black hickory	new entry	new entry
Pinus elliottii	slash pine	--	new entry
Pinus palustris	longleaf pine	--	new entry
Populus deltoides	eastern cottonwood	--	new entry
Quercus macrocarpa	bur oak	--	new entry
Quercus nigra	water oak	new entry	new entry
Ulmus crassifolia	cedar elm	new entry	new entry

Table 3. Nonnative tree insects and diseases ("tree pests") with infestation areas that include Mammoth Cave National 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
Caliroa cerasi	pear sawfly	state
Carulaspis juniperi	juniper scale	state

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

Scientific Name	Common Name	Detection Scale
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
Dryocosmus kuriphilus	chestnut gall wasp	state
Eulecanium cerasorum	calico scale	state
Homadaula anisocentra	mimosa webworm	state
Kaliofenusa ulmi	elm leafminer	state
Lepidosaphes ulmi	oystershell scale	state
Ophiostoma novo-ulmi	Dutch elm disease	state
Orchestes alni	European elm flea weevil	state
Otiorhynchus sulcatus	black vine weevil	state
Periphyllus lyropictus	Norway maple aphid	state
Phytophthora cinnamomi	littleleaf disease / phytophthora root rot	county
Popillia japonica	Japanese beetle	county
Rhyacionia buoliana	European pine shoot moth	state
Scolytus multistriatus	smaller European elm bark beetle	state
Sirococcus clavigignenti juglandacearum	butternut canker	county
Trichiocampus viminalis	poplar sawfly	state
Xanthogaleruca luteola	elm leafbeetle	state