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 Richmond National Battlefield 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 Richmond National Battlefield 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 Richmond National Battlefield 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	13.6 °C (56.4 °F)	+2.1 °C (+3.7 °F)	+6.4 °C (+11.5 °F)
mean January temperature	1.6 °C (34.8 °F)	+2.5 °C (+4.4 °F)	+5.1 °C (+9.1 °F)
mean July temperature	24.7 °C (76.4 °F)	+2 °C (+3.7 °F)	+7.5 °C (+13.6 °F)
seasonality (July-January temp.)	23.1 °C (41.6 °F)	-0.4 °C (-0.8 °F)	+2.5 °C (+4.5 °F)
mean May-September temp.	21.8 °C (71.2 °F)	+2.1 °C (+3.8 °F)	+7.2 °C (+12.9 °F)
annual precipitation	1105 mm (43.5 in)	+7 %	+12.9 %
May-September precipitation	505 mm (19.9 in)	+7.9 %	+13.4 %

Table 2. Potential changes in habitat suitability (2100 compared with 1990) for tree species in Richmond National Battlefield 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
Betula lenta	sweet birch	large decrease	large decrease
Carya glabra	pignut hickory	small decrease	small decrease
Cercis canadensis	eastern redbud	large decrease	extirpated
Fagus grandifolia	American beech	large decrease	large decrease
Ilex opaca	American holly	small decrease	large decrease
Juglans nigra	black walnut	extirpated	extirpated
Liriodendron tulipifera	yellow-poplar	large decrease	large decrease
Oxydendrum arboreum	sourwood	small decrease	extirpated
Pinus virginiana	Virginia pine	large decrease	large decrease
Quercus alba	white oak	small decrease	large decrease
Quercus coccinea	scarlet oak	large decrease	extirpated
Quercus prinus	chestnut oak	extirpated	extirpated
Quercus rubra	northern red oak	small decrease	large decrease
Quercus velutina	black oak	small decrease	small decrease

No Change in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Carpinus caroliniana	American hornbeam	no change	no change
Carya tomentosa	mockernut hickory	no change	no change
Fraxinus americana	white ash	no change	no change
Liquidambar styraciflua	sweetgum	no change	no change
Quercus falcata var.falcata	southern red oak	no change	no change

Increases in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Magnolia virginiana	sweetbay	small increase	large increase
Nyssa aquatica	water tupelo	small increase	small increase
Nyssa sylvatica var. biflora	swamp tupelo	small increase	large increase
Pinus echinata	shortleaf pine	small increase	small increase
Pinus serotina	pond pine	large increase	large increase
Pinus taeda	loblolly pine	small increase	small increase
Quercus falcata var.pagodifolia	cherrybark oak	small increase	small increase
Quercus laurifolia	laurel oak	small increase	large increase
Quercus lyrata	overcup oak	small increase	small increase
Quercus nigra	water oak	large increase	large increase
Quercus stellata	post oak	small increase	large increase

Increases in Potential Habitat (continued)

Scientific Name	Common Name	Least Change	Major Change
Taxodium distichum	baldcypress	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
Cornus florida	flowering dogwood	no change	small decrease
Diospyros virginiana	common persimmon	no change	large increase
Fraxinus pennsylvanica	green ash	no change	small increase
Juniperus virginiana	eastern redcedar	no change	small decrease
Morus rubra	red mulberry	small decrease	large increase
Nyssa sylvatica	blackgum	small decrease	no change
Ostrya virginiana	eastern hophornbeam	no change	large increase
Persea borbonia	redbay	no change	large increase
Platanus occidentalis	sycamore	no change	small increase
Populus deltoides	eastern cottonwood	small decrease	large increase
Prunus serotina	black cherry	no change	small increase
Quercus marilandica	blackjack oak	no change	large increase
Quercus michauxii	swamp chestnut oak	no change	small decrease
Quercus palustris	pin oak	extirpated	large increase
Quercus phellos	willow oak	no change	small increase
Quercus shumardii	Shumard oak	large decrease	large increase
Sassafras albidum	sassafras	small decrease	no change
Taxodium distichum var. nutans	pondcypress	large decrease	no change

New Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Carya cordiformis	bitternut hickory	--	new entry
Carya illinoinensis	pecan	--	new entry
Carya texana	black hickory	new entry	new entry
Celtis laevigata	sugarberry	new entry	new entry
Celtis occidentalis	hackberry	--	new entry
Maclura pomifera	osage-orange	--	new entry
Pinus elliottii	slash pine	new entry	new entry
Pinus palustris	longleaf pine	new entry	new entry
Salix nigra	black willow	--	new entry
Ulmus americana	American elm	--	new entry
Ulmus crassifolia	cedar elm	--	new entry
Ulmus rubra	slippery elm	--	new entry

Table 3. Nonnative tree insects and diseases ("tree pests") with infestation areas that include Richmond National Battlefield 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
Anarsia lineatella	peach twig borer	state
Asterolecanium variolosum	golden oak scale	state
Caliroa cerasi	pear sawfly	county
Carulaspis juniperi	juniper scale	state
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
Fiorinia externa	elongate hemlock scale	state
Homadaula anisocentra	mimosa webworm	state
Kaliofenusa ulmi	elm leafminer	state
Lepidosaphes ulmi	oystershell scale	state
Lymantria dispar	gypsy moth	county
Neodiprion sertifer	European pine sawfly	state
Ophiostoma novo-ulmi	Dutch elm disease	county
Orchestes alni	European elm flea weevil	state
Otiorhynchus ovatus	strawberry root weevil	county
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	county
Scolytus multistriatus	smaller European elm bark beetle	county
Taeniothrips inconsequens	pear thrips	state
Tomicus piniperda	pine shoot beetle	state
Trichiocampus viminalis	poplar sawfly	state
Xanthogaleruca luteola	elm leafbeetle	state