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 Upper Delaware National Scenic and Recreation River

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 Upper Delaware National Scenic and Recreation River, 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 Upper Delaware National Scenic and Recreation River. 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	7.3 °C (45.1 °F)	+2.2 °C (+3.9 °F)	+7.1 °C (+12.8 °F)
mean January temperature	-5.4 °C (22.4 °F)	+1.8 °C (+3.3 °F)	+5.7 °C (+10.3 °F)
mean July temperature	19.8 °C (67.7 °F)	+1.8 °C (+3.2 °F)	+8.1 °C (+14.5 °F)
seasonality (July-January temp.)	25.2 °C (45.4 °F)	-0.1 °C (-0.1 °F)	+2.3 °C (+4.2 °F)
mean May-September temp.	16.6 °C (61.9 °F)	+2.1 °C (+3.8 °F)	+7.6 °C (+13.8 °F)
annual precipitation	1113 mm (43.8 in)	+11.8 %	+15.9 %
May-September precipitation	511 mm (20.1 in)	+10.1 %	+9.7 %

Table 2. Potential changes in habitat suitability (2100 compared with 1990) for tree species in Upper Delaware National Scenic and Recreation River. 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 pensylvanicum	striped maple	small decrease	large decrease
Acer saccharum	sugar maple	small decrease	large decrease
Betula alleghaniensis	yellow birch	small decrease	large decrease
Betula papyrifera	paper birch	extirpated	extirpated
Castanea dentata	American chestnut	large decrease	extirpated
Fagus grandifolia	American beech	small decrease	large decrease
Picea glauca	white spruce	extirpated	extirpated
Pinus resinosa	red pine	extirpated	extirpated
Pinus strobus	eastern white pine	small decrease	large decrease
Populus tremuloides	quaking aspen	large decrease	extirpated
Prunus pensylvanica	pin cherry	extirpated	extirpated
Prunus virginiana	chokecherry	large decrease	extirpated
Tsuga canadensis	eastern hemlock	small decrease	large decrease

No Change in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Carpinus caroliniana	American hornbeam	no change	no change
Picea rubens	red spruce	no change	no change
Quercus rubra	northern red oak	no change	no change
Tilia americana	American basswood	no change	no change

Increases in Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Acer saccharinum	silver maple	small increase	large increase
Carya cordiformis	bitternut hickory	small increase	large increase
Carya glabra	pignut hickory	large increase	large increase
Carya ovata	shagbark hickory	small increase	large increase
Carya tomentosa	mockernut hickory	large increase	large increase
Celtis occidentalis	hackberry	large increase	large increase
Cornus florida	flowering dogwood	large increase	large increase
Juglans nigra	black walnut	large increase	large increase
Juniperus virginiana	eastern redcedar	large increase	large increase
Liquidambar styraciflua	sweetgum	large increase	large increase
Liriodendron tulipifera	yellow-poplar	large increase	large increase
Nyssa sylvatica	blackgum	large increase	large increase
Pinus virginiana	Virginia pine	large increase	large increase

Increases in Potential Habitat (continued)

Scientific Name	Common Name	Least Change	Major Change
Platanus occidentalis	sycamore	large increase	large increase
Quercus alba	white oak	large increase	large increase
Quercus coccinea	scarlet oak	large increase	large increase
Quercus ilicifolia	bear oak	large increase	large increase
Quercus muehlenbergii	chinkapin oak	small increase	large increase
Quercus palustris	pin oak	small increase	small increase
Quercus velutina	black oak	large increase	large increase
Robinia pseudoacacia	black locust	large increase	large increase
Salix nigra	black willow	small increase	large increase
Sassafras albidum	sassafras	large increase	large increase
Ulmus rubra	slippery elm	large increase	large increase

Mixed Results

Scientific Name	Common Name	Least Change	Major Change
Acer negundo	boxelder	no change	large increase
Acer rubrum	red maple	no change	large decrease
Amelanchier spp.	serviceberry	no change	small decrease
Betula lenta	sweet birch	small increase	small decrease
Betula populifolia	gray birch	small increase	small decrease
Fraxinus americana	white ash	no change	large decrease
Fraxinus pennsylvanica	green ash	small decrease	large increase
Maclura pomifera	osage-orange	no change	large increase
Ostrya virginiana	eastern hophornbeam	no change	small increase
Pinus rigida	pitch pine	no change	large decrease
Populus deltoides	eastern cottonwood	no change	large increase
Populus grandidentata	bigtooth aspen	no change	extirpated
Prunus serotina	black cherry	no change	large decrease
Quercus prinus	chestnut oak	small increase	no change
Ulmus americana	American elm	no change	large increase

New Potential Habitat

Scientific Name	Common Name	Least Change	Major Change
Carya illinoinensis	pecan	--	new entry
Carya texana	black hickory	--	new entry
Catalpa speciosa	northern catalpa	--	new entry
Celtis laevigata	sugarberry	--	new entry
Cercis canadensis	eastern redbud	new entry	new entry
Diospyros virginiana	common persimmon	new entry	new entry
Gleditsia triacanthos	honeylocust	new entry	new entry
Morus rubra	red mulberry	new entry	new entry
Oxydendrum arboreum	sourwood	--	new entry
Pinus echinata	shortleaf pine	--	new entry
Pinus taeda	loblolly pine	new entry	new entry
Quercus falcata var.falcata	southern red oak	--	new entry

New Potential Habitat (continued)

Scientific Name	Common Name	Least Change	Major Change
Quercus macrocarpa	bur oak	--	new entry
Quercus marilandica	blackjack oak	--	new entry
Quercus nigra	water oak	--	new entry
Quercus phellos	willow oak	--	new entry
Quercus shumardii	Shumard oak	--	new entry
Quercus stellata	post oak	new entry	new entry
Ulmus alata	winged elm	--	new entry
Ulmus crassifolia	cedar elm	--	new entry

Table 3. Nonnative tree insects and diseases ("tree pests") with infestation areas that include Upper Delaware National Scenic and Recreation River. 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
Acantholyda erythrocephala	pine false webworm	state
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	county
Asterolecanium variolosum	golden oak scale	state
Caliroa cerasi	pear sawfly	state
Callidellum rufipenne	Japanese cedar longhorn beetle	state
Carulaspis juniperi	juniper scale	state
Caulocampus acericaulis	maple petiole borer	state
Cephalcia lariciphila	European web-spinning larch sawfly	state
Coleophora laricella	larch casebearer	state
Coleophora serratella	birch casebearer	state
Contarinia baeri	European pine needle midge	state
Cronartium ribicola	white pine blister rust	county
Cryphonectria parasitica	chestnut blight	county
Cryptodiaporthe populea	Dothichiza canker of poplar	state
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
Epinotia nanana	European spruce needleminer	state
Eucallipterus tiliae	linden aphid	state
Eulecanium cerasorum	calico scale	state
Fenusa pusilla	birch leafminer	state
Fiorinia externa	elongate hemlock scale	county

Table 3 (continued). Nonnative tree insects and diseases ("tree pests") with infestation areas that include Upper Delaware National Scenic and Recreation River.

Scientific Name	Common Name	Detection Scale
Gilpinia hercyniae	European spruce sawfly	county
Gremmeniella abietina	scleroderris canker	state
Homadaula anisocentra	mimosa webworm	state
Hylastes opacus	European bark beetle	county
Hylurgus ligniperda	redhaired pine bark beetle	state
Kaliofenusa ulmi	elm leafminer	state
Lepidosaphes ulmi	oystershell scale	county
Leucoma salicis	satin moth	state
Lymantria dispar	gypsy moth	county
Matsucoccus resinosae	red pine scale	county
Nectria coccinea	beech bark disease	county
Neodiprion sertifer	European pine sawfly	state
Nuculaspis tsugae	circular hemlock scale	state
Ophiostoma novo-ulmi	Dutch elm disease	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
Physokermes piceae	spruce bud scale	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	county
Pristiphora geniculata	mountain-ash sawfly	county
Rhyacionia buoliana	European pine shoot moth	county
Scolytus multistriatus	smaller European elm bark beetle	state
Scolytus schevyrewi	banded elm bark beetle	state
Sirococcus clavigignenti juglandacearum	butternut canker	county
Taeniothrips inconsequens	pear thrips	county
Thrips calcaratus	introduced basswood thrips	state
Tomicus piniperda	pine shoot beetle	county
Trichiocampus viminalis	poplar sawfly	county
Venturia saliciperda	willow scab	state
Xanthogaleruca luteola	elm leafbeetle	state