# 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 Prince William Forest 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 Prince William Forest 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 Prince William Forest 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 | 12.5 °C (54.5 °F) | +2 °C (+3.7 °F) | +6.7 °C (+12.1 °F) |
| mean January temperature | 0.2 °C (32.4 °F) | +2.2 °C (+3.9 °F) | +5.3 °C (+9.5 °F) |
| mean July temperature | 23.9 °C (75.1 °F) | +2.1 °C (+3.7 °F) | +8 °C (+14.5 °F) |
| seasonality (July-January temp.) | 23.7 °C (42.7 °F) | -0.1 °C (-0.2 °F) | +2.7 °C (+4.9 °F) |
| mean May-September temp. | 21.1 °C (69.9 °F) | +2.1 °C (+3.8 °F) | +7.5 °C (+13.6 °F) |
| annual precipitation | 1054 mm (41.5 in) | +10.2 % | +15.9 % |
| May-September precipitation | 485 mm (19.1 in) | +9.2 % | +12.8 % |

**Table 2.** Potential changes in habitat suitability (2100 compared with 1990) for tree species in Prince William Forest 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 | large decrease | extirpated |
| *Betula lenta* | sweet birch | large decrease | large decrease |
| *Carya glabra* | pignut hickory | small decrease | small decrease |
| *Cercis canadensis* | eastern redbud | small decrease | large decrease |
| *Fagus grandifolia* | American beech | large decrease | large decrease |
| *Juglans nigra* | black walnut | large decrease | extirpated |
| *Liriodendron tulipifera* | yellow-poplar | large decrease | large decrease |
| *Nyssa sylvatica* | blackgum | small decrease | small decrease |
| *Pinus rigida* | pitch pine | extirpated | extirpated |
| *Pinus strobus* | eastern white pine | extirpated | extirpated |
| *Pinus virginiana* | Virginia pine | large decrease | large decrease |
| *Prunus pensylvanica* | pin cherry | extirpated | extirpated |
| *Quercus coccinea* | scarlet oak | small decrease | large decrease |
| *Quercus prinus* | chestnut oak | large decrease | large decrease |
| *Quercus rubra* | northern red oak | small decrease | large decrease |
| *Robinia pseudoacacia* | black locust | large decrease | large decrease |
| *Sassafras albidum* | sassafras | small decrease | small decrease |

**No Change in Potential Habitat**

| Scientific Name | Common Name | Least Change | Major Change |
|---|---|---|---|
| *Betula nigra* | river birch | no change | no 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 |
| *Juniperus virginiana* | eastern redcedar | no change | no change |
| *Nyssa aquatica* | water tupelo | no change | no change |
| *Platanus occidentalis* | sycamore | no change | no change |
| *Ulmus rubra* | slippery elm | no change | no change |

**Increases in Potential Habitat**

| Scientific Name | Common Name | Least Change | Major Change |
|---|---|---|---|
| *Carya ovata* | shagbark hickory | large increase | large increase |
| *Liquidambar styraciflua* | sweetgum | small increase | small increase |
| *Magnolia virginiana* | sweetbay | small increase | large increase |
| *Ostrya virginiana* | eastern hophornbeam | large increase | large increase |
| *Pinus echinata* | shortleaf pine | large increase | large increase |

### Increases in Potential Habitat (continued)

| Scientific Name | Common Name | Least Change | Major Change |
|---|---|---|---|
| *Pinus taeda* | loblolly pine | large increase | large increase |
| *Quercus falcata var.falcata* | southern red oak | small increase | small increase |
| *Quercus marilandica* | blackjack oak | large increase | large increase |
| *Quercus phellos* | willow oak | small 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 negundo* | boxelder | no change | small decrease |
| *Acer saccharinum* | silver maple | small decrease | large increase |
| *Carya cordiformis* | bitternut hickory | small decrease | large increase |
| *Celtis occidentalis* | hackberry | 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 |
| *Ilex opaca* | American holly | no change | small decrease |
| *Morus rubra* | red mulberry | large decrease | large increase |
| *Nyssa sylvatica var. biflora* | swamp tupelo | no change | small increase |
| *Oxydendrum arboreum* | sourwood | large increase | extirpated |
| *Populus deltoides* | eastern cottonwood | small decrease | large increase |
| *Prunus serotina* | black cherry | small decrease | no change |
| *Quercus alba* | white oak | no change | small decrease |
| *Quercus falcata var.pagodifolia* | cherrybark oak | no change | large increase |
| *Quercus imbricaria* | shingle oak | small decrease | large increase |
| *Quercus palustris* | pin oak | extirpated | large increase |
| *Quercus velutina* | black oak | no change | small decrease |
| *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 | new entry |
| *Celtis laevigata* | sugarberry | new entry | new entry |
| *Gleditsia triacanthos* | honeylocust | -- | 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 nigra* | water oak | new entry | new entry |
| *Quercus shumardii* | Shumard oak | -- | new entry |
| *Salix nigra* | black willow | -- | new entry |
| *Taxodium distichum* | baldcypress | new entry | new entry |
| *Ulmus crassifolia* | cedar elm | -- | new entry |

**Table 3.** Nonnative tree insects and diseases ("tree pests") with infestation areas that include Prince William Forest 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 variolosum* | golden oak scale | state |
| *Caliroa cerasi* | pear sawfly | state |
| *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 |
| *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 |
| *Lymantria dispar* | gypsy moth | county |
| *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 | county |
| *Popillia japonica* | Japanese beetle | county |
| *Pristiphora erichsonii* | larch sawfly | state |
| *Pseudaonidia duplex* | camphor scale | 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 |
| *Trichiocampus viminalis* | poplar sawfly | state |
| *Xanthogaleruca luteola* | elm leafbeetle | state |