



## Climate, Trees, Pests, and Weeds: Change, Uncertainty, and Biotic Stressors at Hopewell Culture 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 Hopewell Culture 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.](#)

### Contact

Nicholas Fisichelli, Ph.D.  
Ecologist, Climate Change Response Program  
National Park Service  
970-225-3578  
[Nicholas.Fisichelli@nps.gov](mailto:Nicholas.Fisichelli@nps.gov)

**Table 1.** Baseline (1961-1990) and future (2070-2099) climates used in tree habitat suitability models for Hopewell Culture 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<sup>2</sup> (16000 km<sup>2</sup>) area centered on the park.

| Climate Variable                 | Baseline (1961-1990) | Least Change (2070-2099) | Major Change (2070-2099) |
|----------------------------------|----------------------|--------------------------|--------------------------|
| mean annual temperature          | 10.7 °C (51.2 °F)    | +2.1 °C (+3.8 °F)        | +7.1 °C (+12.7 °F)       |
| mean January temperature         | -2.1 °C (28.1 °F)    | +1.6 °C (+2.9 °F)        | +5.5 °C (+10 °F)         |
| mean July temperature            | 22.6 °C (72.6 °F)    | +2.1 °C (+3.7 °F)        | +8.5 °C (+15.3 °F)       |
| seasonality (July-January temp.) | 24.7 °C (44.5 °F)    | +0.5 °C (+0.8 °F)        | +3 °C (+5.3 °F)          |
| mean May-September temp.         | 19.7 °C (67.5 °F)    | +2.2 °C (+3.9 °F)        | +8 °C (+14.5 °F)         |
| annual precipitation             | 1025 mm (40.4 in)    | +9.7 %                   | +12.5 %                  |
| May-September precipitation      | 486 mm (19.1 in)     | +9.9 %                   | -1.5 %                   |

**Table 2.** Potential changes in habitat suitability (2100 compared with 1990) for tree species in Hopewell Culture 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  $\leq 0.5$ , small decrease is  $> 0.5$  and  $\leq 0.8$ , no change is  $> 0.8$  and  $\leq 1.2$ , small increase is  $> 1.2$  and  $\leq 2.0$ , 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   |
|------------------------------|--------------------|----------------|----------------|
| <i>Acer rubrum</i>           | red maple          | small decrease | large decrease |
| <i>Acer saccharum</i>        | sugar maple        | small decrease | extirpated     |
| <i>Aesculus glabra</i>       | Ohio buckeye       | large decrease | extirpated     |
| <i>Aesculus octandra</i>     | yellow buckeye     | small decrease | small decrease |
| <i>Betula lenta</i>          | sweet birch        | extirpated     | extirpated     |
| <i>Fagus grandifolia</i>     | American beech     | small decrease | large decrease |
| <i>Fraxinus americana</i>    | white ash          | small decrease | large decrease |
| <i>Pinus rigida</i>          | pitch pine         | small decrease | small decrease |
| <i>Pinus strobus</i>         | eastern white pine | extirpated     | extirpated     |
| <i>Pinus virginiana</i>      | Virginia pine      | small decrease | small decrease |
| <i>Populus grandidentata</i> | bigtooth aspen     | extirpated     | extirpated     |
| <i>Prunus pensylvanica</i>   | pin cherry         | extirpated     | extirpated     |
| <i>Prunus serotina</i>       | black cherry       | large decrease | large decrease |
| <i>Quercus prinus</i>        | chestnut oak       | small decrease | large decrease |
| <i>Robinia pseudoacacia</i>  | black locust       | small decrease | large decrease |
| <i>Tilia americana</i>       | American basswood  | extirpated     | extirpated     |

### No Change in Potential Habitat

| Scientific Name             | Common Name       | Least Change | Major Change |
|-----------------------------|-------------------|--------------|--------------|
| <i>Carpinus caroliniana</i> | American hornbeam | no change    | no change    |
| <i>Carya tomentosa</i>      | mockernut hickory | no change    | no change    |
| <i>Oxydendrum arboreum</i>  | sourwood          | no change    | no change    |

### Increases in Potential Habitat

| Scientific Name                | Common Name        | Least Change   | Major Change   |
|--------------------------------|--------------------|----------------|----------------|
| <i>Acer saccharinum</i>        | silver maple       | small increase | large increase |
| <i>Carya cordiformis</i>       | bitternut hickory  | large increase | large increase |
| <i>Diospyros virginiana</i>    | common persimmon   | large increase | large increase |
| <i>Fraxinus pennsylvanica</i>  | green ash          | small increase | large increase |
| <i>Gleditsia triacanthos</i>   | honeylocust        | small increase | small increase |
| <i>Juniperus virginiana</i>    | eastern redcedar   | large increase | large increase |
| <i>Liquidambar styraciflua</i> | sweetgum           | large increase | large increase |
| <i>Morus rubra</i>             | red mulberry       | large increase | large increase |
| <i>Pinus echinata</i>          | shortleaf pine     | large increase | large increase |
| <i>Populus deltoides</i>       | eastern cottonwood | small increase | large increase |
| <i>Quercus imbricaria</i>      | shingle oak        | large increase | large increase |
| <i>Quercus muehlenbergii</i>   | chinkapin oak      | large increase | small increase |

### Increases in Potential Habitat (continued)

| Scientific Name         | Common Name  | Least Change   | Major Change   |
|-------------------------|--------------|----------------|----------------|
| <i>Quercus stellata</i> | post oak     | large increase | large increase |
| <i>Quercus velutina</i> | black oak    | small increase | small increase |
| <i>Salix nigra</i>      | black willow | large increase | small increase |

### Mixed Results

| Scientific Name                | Common Name         | Least Change   | Major Change   |
|--------------------------------|---------------------|----------------|----------------|
| <i>Acer negundo</i>            | boxelder            | no change      | small decrease |
| <i>Amelanchier spp.</i>        | serviceberry        | no change      | large decrease |
| <i>Asimina triloba</i>         | pawpaw              | small increase | extirpated     |
| <i>Betula nigra</i>            | river birch         | no change      | large increase |
| <i>Carya glabra</i>            | pignut hickory      | no change      | small decrease |
| <i>Carya ovata</i>             | shagbark hickory    | small increase | no change      |
| <i>Celtis occidentalis</i>     | hackberry           | small increase | small decrease |
| <i>Cercis canadensis</i>       | eastern redbud      | no change      | small decrease |
| <i>Cornus florida</i>          | flowering dogwood   | no change      | small decrease |
| <i>Juglans nigra</i>           | black walnut        | small increase | large decrease |
| <i>Liriodendron tulipifera</i> | yellow-poplar       | no change      | large decrease |
| <i>Maclura pomifera</i>        | osage-orange        | no change      | small increase |
| <i>Nyssa sylvatica</i>         | blackgum            | small increase | no change      |
| <i>Ostrya virginiana</i>       | eastern hophornbeam | small decrease | no change      |
| <i>Platanus occidentalis</i>   | sycamore            | no change      | small decrease |
| <i>Quercus alba</i>            | white oak           | no change      | small decrease |
| <i>Quercus bicolor</i>         | swamp white oak     | small increase | large decrease |
| <i>Quercus coccinea</i>        | scarlet oak         | small increase | small decrease |
| <i>Quercus macrocarpa</i>      | bur oak             | no change      | large increase |
| <i>Quercus palustris</i>       | pin oak             | small increase | small decrease |
| <i>Quercus rubra</i>           | northern red oak    | no change      | large decrease |
| <i>Sassafras albidum</i>       | sassafras           | no change      | large decrease |
| <i>Ulmus americana</i>         | American elm        | no change      | large decrease |
| <i>Ulmus rubra</i>             | slippery elm        | no change      | large decrease |

### New Potential Habitat

| Scientific Name                     | Common Name      | Least Change | Major Change |
|-------------------------------------|------------------|--------------|--------------|
| <i>Carya illinoensis</i>            | pecan            | --           | new entry    |
| <i>Carya texana</i>                 | black hickory    | new entry    | new entry    |
| <i>Celtis laevigata</i>             | sugarberry       | new entry    | new entry    |
| <i>Pinus taeda</i>                  | loblolly pine    | --           | new entry    |
| <i>Quercus falcata var. falcata</i> | southern red oak | new entry    | new entry    |
| <i>Quercus marilandica</i>          | blackjack oak    | new entry    | new entry    |
| <i>Quercus nigra</i>                | water oak        | --           | new entry    |
| <i>Quercus phellos</i>              | willow oak       | --           | new entry    |
| <i>Quercus shumardii</i>            | Shumard oak      | --           | new entry    |
| <i>Ulmus alata</i>                  | winged elm       | new entry    | new entry    |
| <i>Ulmus crassifolia</i>            | cedar elm        | --           | new entry    |

**Table 3.** Nonnative tree insects and diseases (“tree pests”) with infestation areas that include Hopewell Culture 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.

| <b>Scientific Name</b>                         | <b>Common Name</b>                         | <b>Detection Scale</b> |
|------------------------------------------------|--------------------------------------------|------------------------|
| <i>Adelges abietis</i>                         | eastern spruce gall adelgid                | state                  |
| <i>Anarsia lineatella</i>                      | peach twig borer                           | state                  |
| <i>Asterolecanium variolosum</i>               | golden oak scale                           | state                  |
| <i>Caliroa cerasi</i>                          | pear sawfly                                | state                  |
| <i>Carulaspis juniperi</i>                     | juniper scale                              | state                  |
| <i>Caulocampus acericaulis</i>                 | maple petiole borer                        | state                  |
| <i>Ceratocystis fagacearum</i>                 | oak wilt                                   | county                 |
| <i>Coleophora laricella</i>                    | larch casebearer                           | state                  |
| <i>Cronartium ribicola</i>                     | white pine blister rust                    | county                 |
| <i>Cryphonectria parasitica</i>                | chestnut blight                            | county                 |
| <i>Cryptodiaporthe populea</i>                 | Dothichiza canker of poplar                | state                  |
| <i>Cryptorhynchus lapathi</i>                  | poplar-and-willow borer                    | state                  |
| <i>Cyrtepidomus castaneus</i>                  | Asiatic oak weevil                         | state                  |
| <i>Diaspidiotus perniciosus</i>                | San Jose scale                             | state                  |
| <i>Diprion similis</i>                         | introduced pine sawfly                     | state                  |
| <i>Dryocosmus kuriphilus</i>                   | chestnut gall wasp                         | state                  |
| <i>Eulecanium cerasorum</i>                    | calico scale                               | state                  |
| <i>Fenusa pusilla</i>                          | birch leafminer                            | state                  |
| <i>Fiorinia externa</i>                        | elongate hemlock scale                     | state                  |
| <i>Homadula anisocentra</i>                    | mimosa webworm                             | state                  |
| <i>Hylastes opacus</i>                         | European bark beetle                       | state                  |
| <i>Kaliofenusa ulmi</i>                        | elm leafminer                              | state                  |
| <i>Lepidosaphes ulmi</i>                       | oystershell scale                          | state                  |
| <i>Lymantria dispar</i>                        | gypsy moth                                 | county                 |
| <i>Neodiprion sertifer</i>                     | European pine sawfly                       | state                  |
| <i>Ophiostoma novo-ulmi</i>                    | Dutch elm disease                          | state                  |
| <i>Orchestes alni</i>                          | European elm flea weevil                   | state                  |
| <i>Otiorhynchus ovatus</i>                     | strawberry root weevil                     | county                 |
| <i>Otiorhynchus sulcatus</i>                   | black vine weevil                          | county                 |
| <i>Periphyllus lyropictus</i>                  | Norway maple aphid                         | state                  |
| <i>Phyllaphis fagi</i>                         | woolly beech aphid                         | state                  |
| <i>Phytophthora cinnamomi</i>                  | littleleaf disease / phytophthora root rot | county                 |
| <i>Plagioderia versicolora</i>                 | imported willow leaf beetle                | county                 |
| <i>Popillia japonica</i>                       | Japanese beetle                            | county                 |
| <i>Pristiphora erichsonii</i>                  | larch sawfly                               | state                  |
| <i>Pristiphora geniculata</i>                  | mountain-ash sawfly                        | state                  |
| <i>Rhyacionia buoliana</i>                     | European pine shoot moth                   | state                  |
| <i>Scolytus multistriatus</i>                  | smaller European elm bark beetle           | state                  |
| <i>Sirococcus clavigignenti juglandacearum</i> | butternut canker                           | county                 |
| <i>Taeniothrips inconsequens</i>               | pear thrips                                | state                  |

**Table 3 (continued).** Nonnative tree insects and diseases (“tree pests”) with infestation areas that include Hopewell Culture National Historical Park.

| <b>Scientific Name</b>         | <b>Common Name</b> | <b>Detection Scale</b> |
|--------------------------------|--------------------|------------------------|
| <i>Tomicus piniperda</i>       | pine shoot beetle  | county                 |
| <i>Trichiocampus viminalis</i> | poplar sawfly      | state                  |
| <i>Xanthogaleruca luteola</i>  | elm leafbeetle     | state                  |