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 in Eastern National Park Forests

Background

Eastern forests experienced tremendous changes in recent decades and centuries due to direct and indirect human influences. The coming decades will likely bring continued changes due to multiple global change factors including climate change and nonnative biota. We investigated potential forest change in response to climate, differences in projections of change among climate scenarios (uncertainty), and levels of nonnative biotic stressors (tree pests and invasive plants) at 121 national parks (Fisichelli et al. 2014).

Methods

This research included future climate projections and tree habitat suitability models for 134 tree species (from the USFS Climate Change Atlas), ranges of 81 nonnative tree pests (from the USFS Alien Forest Pest Explorer Database), and nonnative vascular plant presence data (from NPSpecies) for each park. We examined potential changes in climate and tree habitat suitability (2100 compared with 1990) using two climate scenarios that bracket a plausible range of conditions and facilitate quantification of uncertainty in potential forest change. We further used nonnative tree pest and plant data to examine strengths and spatial patterns of these stressors and their correlations with projected changes in tree habitat. See Fisichelli et al. (2014) for a detailed explanation of methods. We report regional trends; **individual park data are available here**.

Results

Climate change across parks by 2100:

- annual temperature increase of 3-6 °C (5.4-10.8 °F)
- annual precipitation change of -27% to +75%

Forest change across parks by 2100 (Fig. 1a):

- 22-77% of tree species in large change class (>50% decrease or >100% increase)

Uncertainty in forest change projections (Fig. 1b):

- 18-84% (the percentage of tree species at each park in differing change classes by climate scenario)

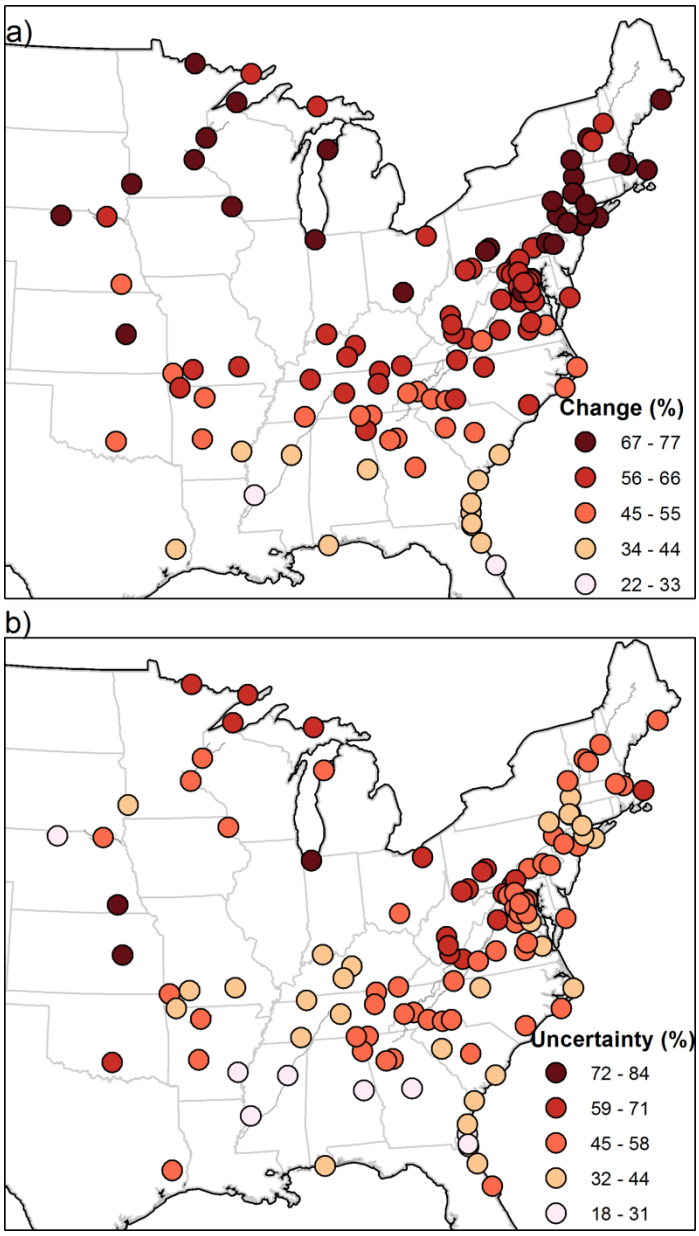

Figure 1. a) forest change: average percentage of modeled tree species with projected large change in potential habitat suitability by 2100 (i.e., >50% decrease or >100% increase). **b)** uncertainty: percentage of tree species in differing change classes by climate scenario.

Park-level patterns of change and uncertainty for individual species vary from large reductions in potential habitat under both climate scenarios to major uncertainty dependent on emissions and climate to large increases in habitat in both scenarios (Fig. 2).

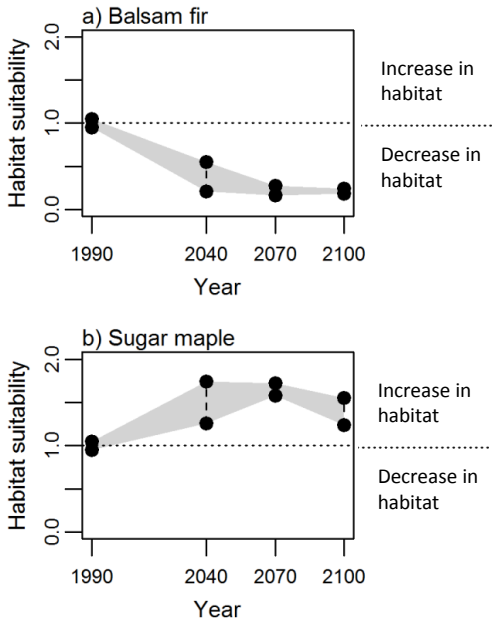

Figure 2. Projected change (black circles) and uncertainty (gray shading) in potential habitat suitability ratios across two climate scenarios and three future periods for two species at Acadia National Park.

Biotic stressors (tree pests and nonnative flora):

- 15-70 tree pests per park (Fig. 3)
- <10% - 50% nonnative species on park plant lists

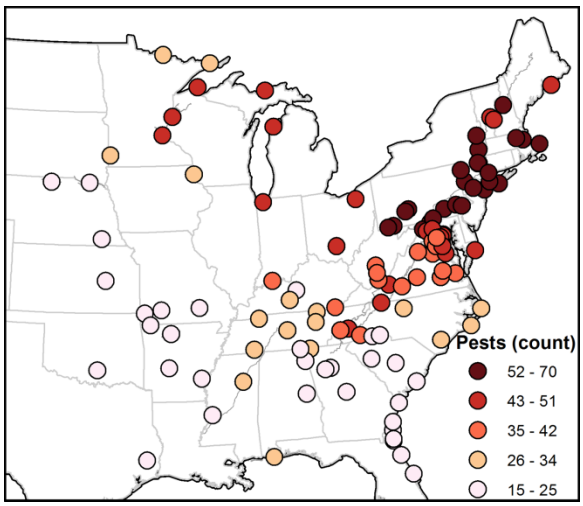

Figure 3. Total number of nonnative tree pest species with infestation zones intersecting park boundaries.

Potential future habitat suitability for some tree species differed between parks within and outside of current tree pest infestation zones. For example, future ash tree habitat is significantly higher at parks currently outside areas infested with emerald ash borer (Fig. 4).

Finally, potential forest change, uncertainty, and nonnative pests and plants have significant positive correlations. For example parks with greater potential forest change (Fig. 1a) also tend to have higher numbers of nonnative tree pests (Fig. 3) (correlation = 0.72). See Fisichelli et al. (2014) for further details.

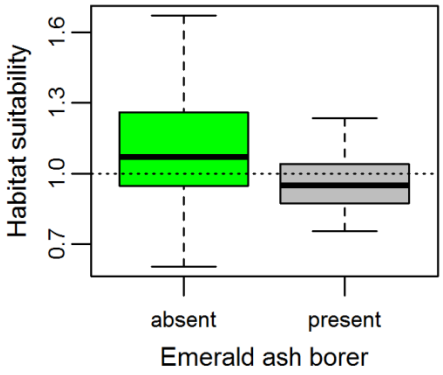

Figure 4. Distributions of ash (all species) habitat suitability (for 2100) at parks outside of (green) and within (gray) current emerald ash borer infested areas.

Implications – Adapting to Change

Adaptation to ongoing climate change requires revising existing strategies to meet traditional goals and will increasingly require revising goals and developing novel strategies as conditions shift beyond the range of variability experienced in the past. Areas with greater potential change, uncertainty, and stressors may require significant revisions and added flexibility to management goals and strategies. Parks with moderate potential change, uncertainty, and current stressors may be well positioned to maintain intact, healthy forests through practical adjustments to existing strategies. Managers can incorporate adaptation strategies in routine management actions such as fire and nonnative plant management.

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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