Acadia National Park Forest Regeneration Brief

Introduction

Forests cover tens of thousands of acres in eastern national parks, providing habitat for countless plants, animals, fungi, and insects. Park forests protect water quality and soil stability, as well as influence our local weather and reduce some gases that contribute to climate change. However, these critical park resources face a range of threats.

Forest health monitoring data indicate significant threats to future sustainability of park forests. Many parks lack the minimum level of seedling and sapling density needed to replace canopy trees as they die, or face threats to tree health. When forests lack sufficient regeneration, or the species composition in the regeneration layer does not match the canopy, we call this a regeneration debt. The most severe form of regeneration debt is a complete lack of regeneration, which, if allowed to persist, can ultimately lead to loss in forest habitat.

Methods

Field Methods & Study Sites - This study analyzed data from 1515 plots in 39 national parks that have similar methods for long-term forest monitoring (Figure 1). In each park, monitoring plot locations were determined using Generalized Random-Tessellation Stratification (GRTS) to generate a spatially balanced and randomized sample of plot locations across the park's forested area (Stevens and Olsen, 2004). Plots were sampled on a 4-year rotating panel, such that one quarter (i.e., one panel) of the plots is sampled every year, and each plot is sampled every 4 years (i.e., one cycle).

Statistical Analysis - We calculated plot-level metrics of forest structure and diversity to assess status and trends in forest health. To estimate trends over time, we used cycle as a numeric independent variable in our models, with cycle 1 covering survey years 2008 - 2011, cycle 2 covering survey years 2012 - 2015, and cycle 3 covering survey years 2016 - 2019. We fit linear mixed effects models, with plot as a random intercept, to estimate trends in forest metrics using the lme4 package (Bates et al., 2015). We used case bootstrapping to generate empirical 95% confidence intervals of model coefficients based on 1000 samples for each model.

Results

Acadia National Park (ACAD) is located in the Northeast Temperate (NETN) Inventory and Monitoring Network (Figure 1). This park's regeneration status is categorized as Secure. Figures 2 & 3 present trends of five different measurements of forests. Figure 4 shows the stocking index for Acadia National Park, and Figure 5 represents trends in tree basal area and density. To see the distribution of diameter at breast height size classes see Figure 6. Finally, a full summary table presenting regeneration status, native canopy trends, native subcanopy trends, and exotic trends for 13 metrics can be seen in Table 1.

Source Publication

XXX

Literature Cited

Bates, D., M. Maechler, and B. Bolker. 2015. Fitting linear mixed-effects models using lme4. Journal of Statistical Software 67:1–48.

Stevens, D.L., and A.R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262–278.

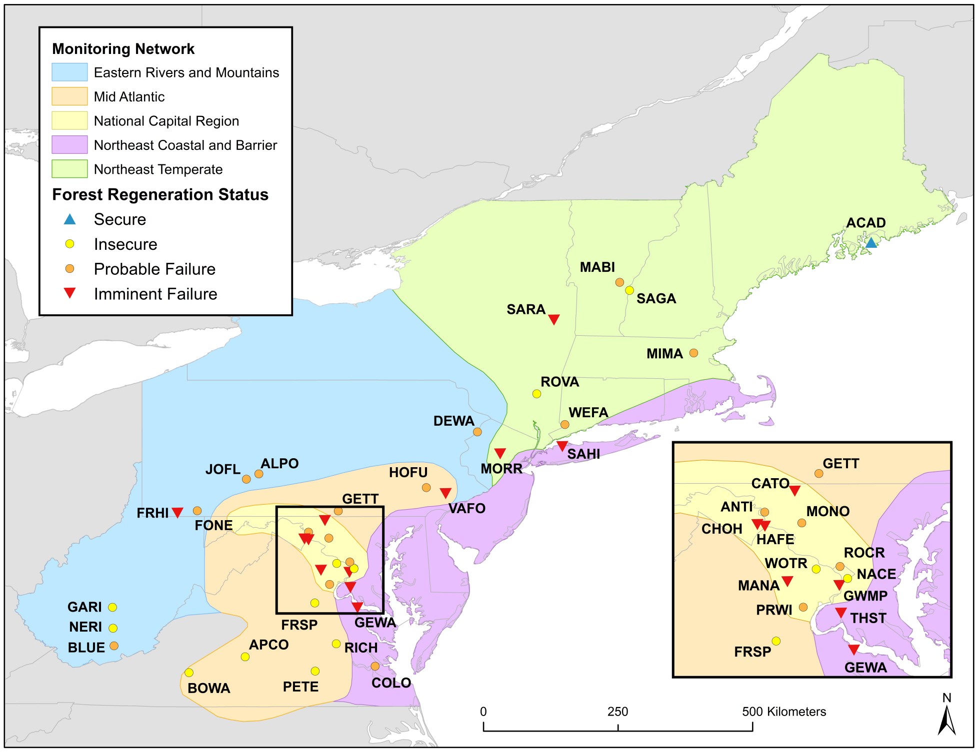

Figure 1. Map of parks included in regional regeneration project.

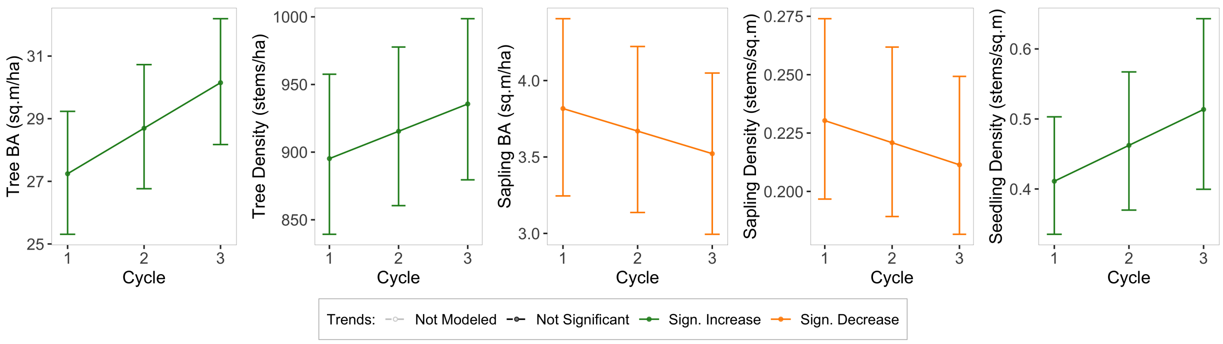

Figure 2. Trends in live tree, sapling and seedling abundance of all species and all size classes. Trends are based on change over time across three complete survey cycles: Cycle 1 spanning 2008 – 2011, Cycle 2 spanning 2012 – 2015, and Cycle 3 spanning 2016 – 2019.

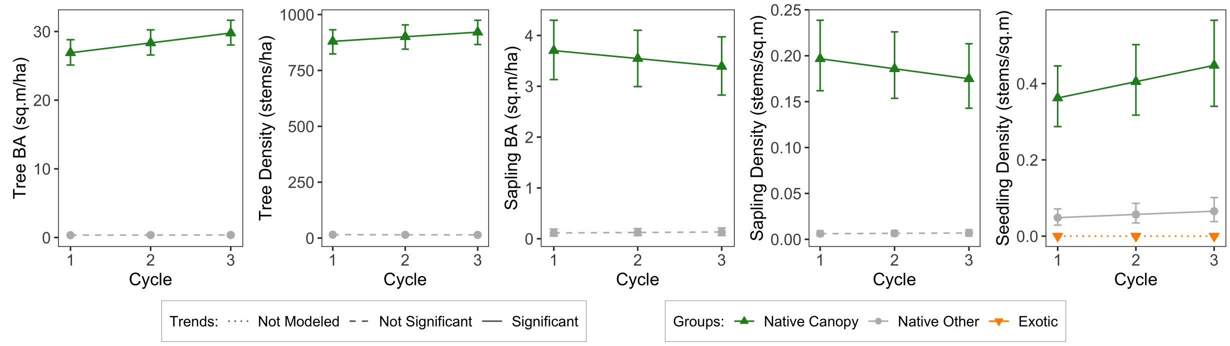

Figure 3. Trends in tree, sapling and seedling abundance by species group. Trends are based on change over time across three complete survey cycles: Cycle 1 spanning 2008 – 2011, Cycle 2 spanning 2012 – 2015, and Cycle 3 spanning 2016 – 2019.

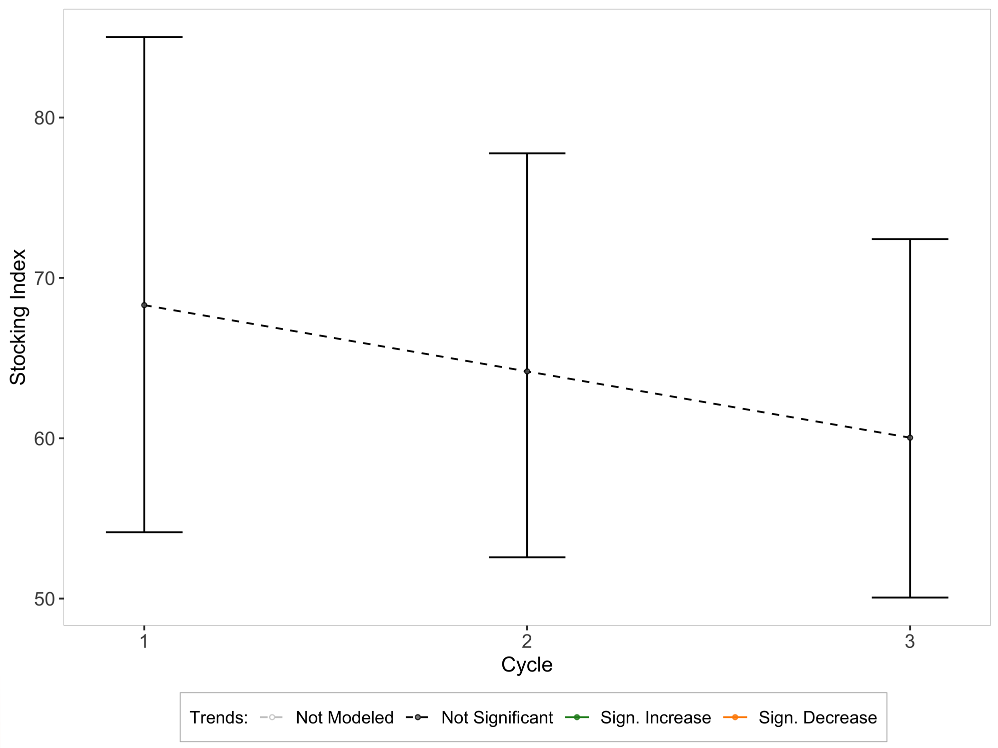

Figure 4. Trends in regeneration stocking index by cycle. The stocking index only includes native canopy-forming species and is an index of whether the regeneration layer is sufficient to stock the future canopy. Note that ash species (Fraxinus spp.) are not included in the stocking index. Trends are based on change over time across three complete survey cycles: Cycle 1 spanning 2008 – 2011, Cycle 2 spanning 2012 – 2015, and Cycle 3 spanning 2016 – 2019.

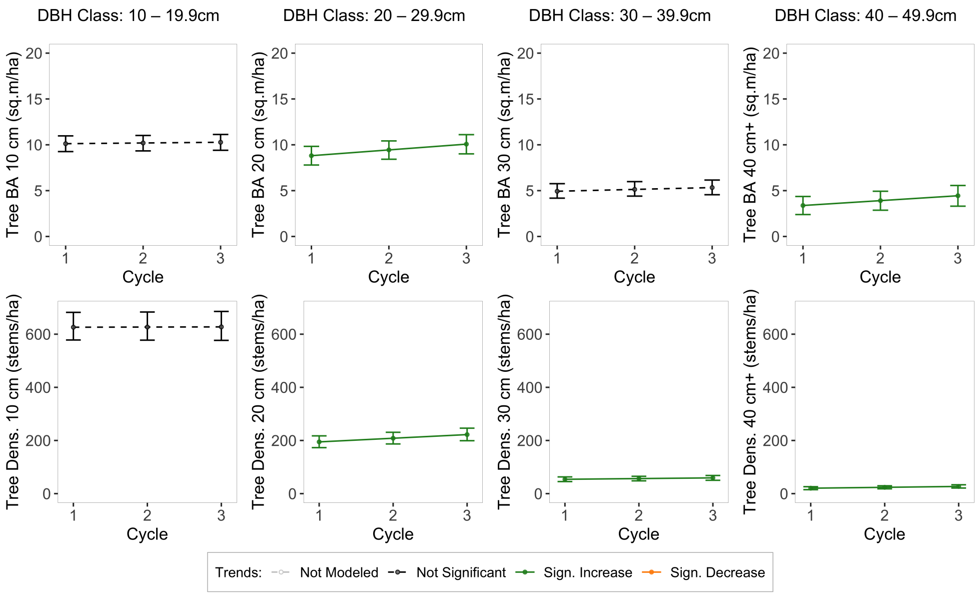

Figure 5. Trends in tree basal area (BA) and density by 10 cm size classes. Trends are based on change over time across three complete survey cycles: Cycle 1 spanning 2008 – 2011, Cycle 2 spanning 2012 – 2015, and Cycle 3 spanning 2016 – 2019.

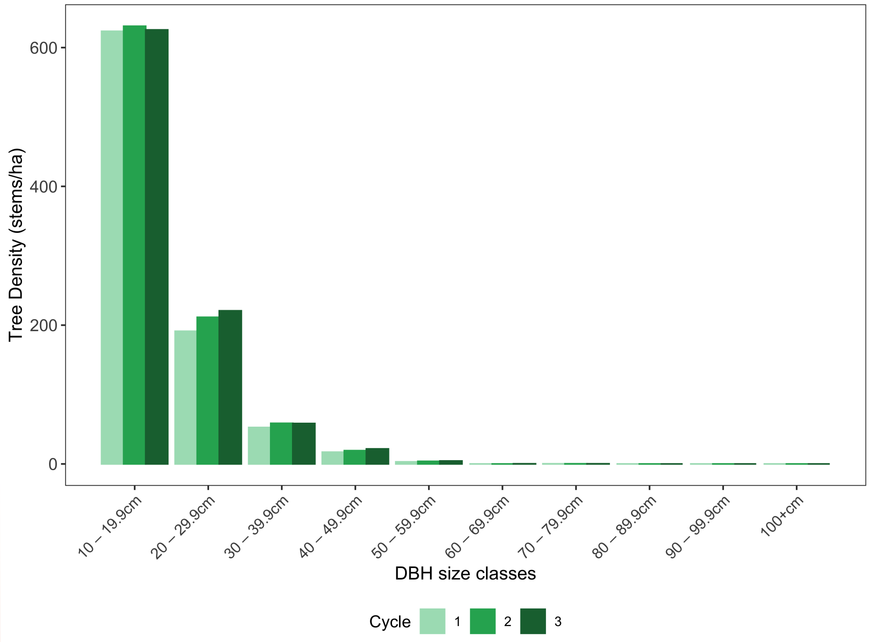

Figure 6. Tree DBH distribution in 10 cm increments by park and cycle. Trends are based on change over time across three complete survey cycles: Cycle 1 spanning 2008 – 2011, Cycle 2 spanning 2012 – 2015, and Cycle 3 spanning 2016 – 2019.

Table 1. Summary of status and trends for each metric. Status metrics are based on the most recent 4 years of data (2016:2019). For more information on how the status thresholds are defined, see the source publication.

Variable	Regeneration Status	Native Canopy Trends	Native Subcan. Trends	Exotic Trends
Tree BA	NA	increase - good	no supported trend	not modeled
Tree Density	NA	increase - good	no supported trend	not modeled
Sapling BA	NA	decrease - bad	no supported trend	not modeled
Sapling Density	acceptable	decrease - bad	no supported trend	not modeled
Seedling Density	caution	increase - good	increase - good	not modeled
Stocking Index	caution	no supported trend	NA	NA
% Stocked Plots	caution	NA	NA	NA
Deer Browse Impacts	acceptable	NA	NA	NA
Flat Tree Diam. Dist.	acceptable	NA	NA	NA
Sapling Composition	acceptable	NA	NA	NA
Seedling Composition	acceptable	NA	NA	NA
Sorensen Sapling	acceptable	NA	NA	NA
Sorensen Seedling	acceptable	NA	NA	NA