# Marsh-Billings-Rockefeller National Historical Park

## Background

The Eastern Forest Working Group of the National Park Service Inventory and Monitoring Program (I&M) has been monitoring forest health in permanent plots across 39 eastern national parks for 12+ years (Fig. 1). Plots are sampled on a 4-year rotation using similar methods across parks. Currently nearly all plots have been sampled three times (i.e., cycles). This brief summarizes results of a trend analysis of invasive plants, a widespread concern in eastern parks, and compares park-level results for Marsh-Billings-Rockefeller National Historical Park (MABI) in the Northeast Temperate Network (NETN) with broader regional patterns across the parks in our study.

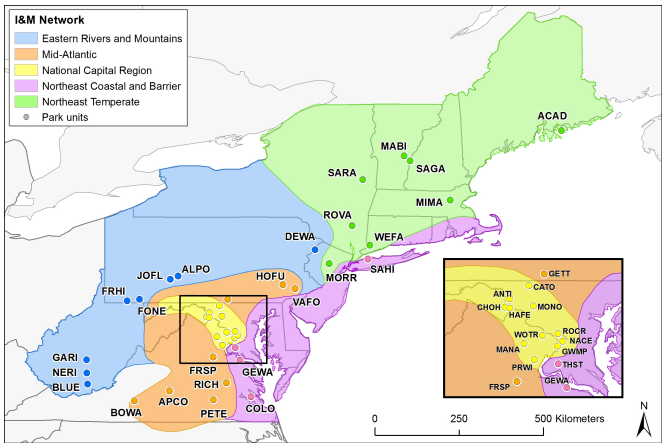


Figure 1. Map of parks included in the analysis.

## Methods

We used linear mixed effects models to assess trends in the following metrics: Average % cover, Quadrat % frequency, and Quadrat richness. Average % cover is the average cover of invasive species within 1 $m^2$ quadrats per plot. Quadrat % frequency is the percent of 1 $m^2$ quadrats per plot with an invasive species. Quadrat richness is the average number of invasive species detected per quadrat. We assessed trends for total invasives and for the following guilds: Trees, Shrubs/Vines, Graminoids (i.e., grasses, sedges and rushes), and Forbs. We only included exotic species considered invasive, and we only modeled guilds that were present in >10% of the plots in a given park. Note that quadrat % cover is not collected for tree species by NCRN. In addition quadrat % cover and frequency data are only collected for indicator invasive species in NCRN and MIDN. While the indicator list includes the most common invasive species in network parks, invasive abundance and richness may be higher than the results presented in this analysis. We modeled each park individually and used random intercepts to account for repeated measures. Trends cover up to three cycles, and for most parks, cycle 1= 2007-2010, cycle 2= 2011-2014, and cycle 3= 2014-2018. To determine whether trends were significant, we used parametric bootstrapping to generate empirical 95% confidence intervals around model coefficients (e.g. slope).

## Results: Overall

Averaging over 50% cover in cycle 3, MONO had the highest invasive % cover of parks in the study (Fig 2). ANTI, CHOH, FRHI, HOFU, and MORR averaged over 30% cover in cycle 3. Average % cover increased significantly in 14 out of 39 parks (Fig. 2). Quadrat % frequency was highest in ANTI, GETT, MONO and SAHI with a roughly 90% of quadrats containing an invasive species in cycle 3. Invasive quadrat % frequency increased significantly in 15 out of 39 parks, and decreased significantly in PRWI. Invasive quadrat richness in cycle 3 was greatest in CHOH, GETT, MONO, MORR, and FRHI, averaging over 2 invasive species per quadrat. Invasive quadrat richness increased significantly in 23 out of 39 parks and decreased significantly in PRWI. Plot % frequency of invasives increased significantly in 6 out of 39. Invasive shrubs/vines were most abundant and often increased over time in northern parks, and both graminoids and shrubs/vines followed similar patterns in southern parks.

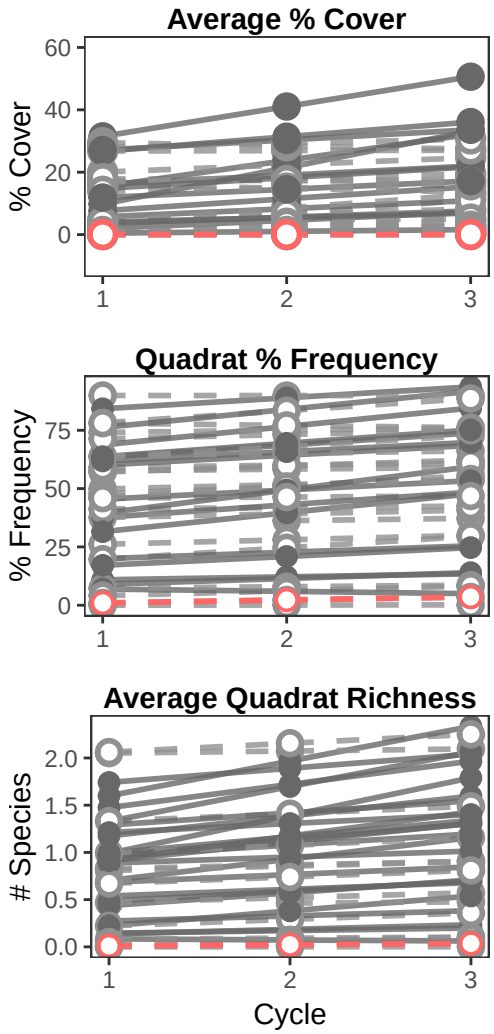


Figure 2. Modeled trends in total invasive plants. Each line represents a park. Solid lines indicate significant trends at alpha <0.05. MABI is highlighted in red.

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## Results: Park-Level

Trends in total invasives varied across metrics in MABI. In cycle 3, average % invasive cover was 0.03%, which was the 38th lowest out of 39 parks in this study. There was no significant trend in invasive % cover. Quadrat % frequency in cycle 3 was 3.52%, which was 38th lowest out of 39 parks in this study. There was no significant trend in invasive quadrat % frequency. Quadrat richness averaged 0.04 invasive species/quadrat in cycle 3, which was 38th lowest out of 39 parks. There was no significant trend in invasive quadrat richness.

Invasive guild trends varied by metric in MABI (Figs 3-5). Invasive shrubs had the highest guild % cover in MABI in cycle 3, averaging 0.03 % and ranking 36th lowest out of 39 parks for this metric. Averaging 3.13%, shrubs had the highest quadrat % frequency in MABI, and ranked 37th lowest out of 39 parks for shrubs quadrat % frequency. Shrubs had the highest quadrat richness in MABI, averaging 0.03 invasive species/quadrat, and ranking 37th lowest out of 39 parks for this metric. Shrubs had the highest plot % frequency in MABI, with 58.33% of plots invaded by shrubs in cycle 3, and ranking 18th highest out of 39 parks.

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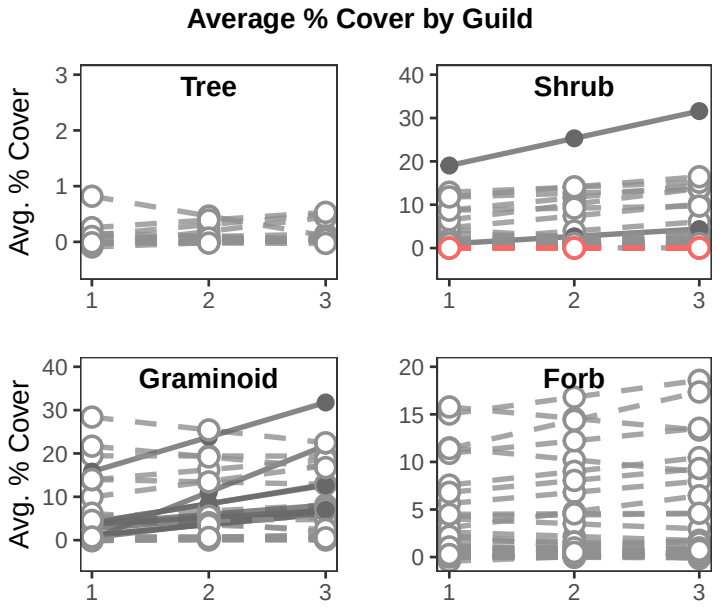


Figure 3. Modeled invasive plant cover trends by guild. Each line represents a park. Solid lines are significant trends. MABI is highlighted in red. Guilds found in <10% of a park's plots and NCRN Trees (% cover only) were not modeled or displayed.

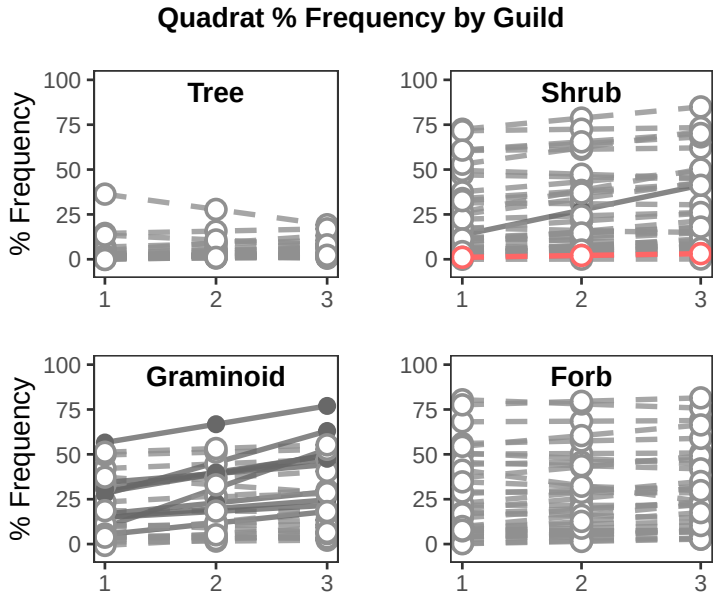


Figure 4. Trends in modeled invasive quadrat frequency by guild. See Figure 3 caption for more information.

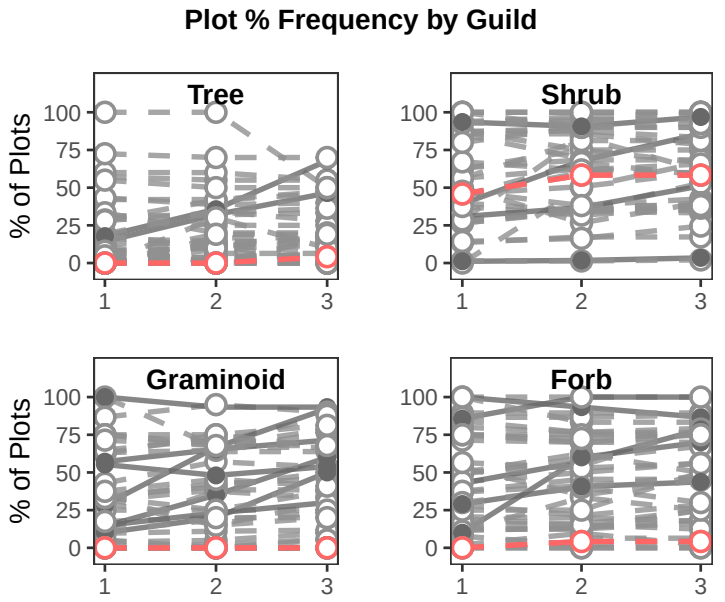


Figure 5. Trends in actual plot % frequency by guild. Significance was determined with logistic regression. See Figure 3 caption for more information.

## More Information

More information about this study can be found on the NETN website (*https://www.nps.gov/im/netn*), or by contacting:

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