Analysis and Quantification of Forest Health using Understory Composition and Establishment of Deer Exclosures

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Abstract

From 2005 to 2006, 93 permanent plots were established across the Central Long Island Pine Barrens to monitor forest health in the unique pine barrens ecosystem, and it was hypothesized then that changes could be detected within 10 years. In the summer of 2011, the plots on the Brookhaven National Laboratory (BNL) property were reanalyzed to determine if changes could be seen earlier, over a 5 to 6 year period. Also, new plots were established where deer exclosures will be erected in order to quantify the effects of deer browsing. For the pre-existing plots, 16- by 25-meter tapes were laid out with 10 twenty-five meter transects within each. For the new plots, the plot corners were randomly chosen and a 16- by 25-meter plot was permanently established along with the 10 transects. For new and pre-existing plots, a 2-meter pole was placed at 20 randomly generated points along each transect and the understory species touching it were recorded. The plots were then categorized as pine- or oak-dominated, based on their overstory composition. The Shannon-Weiner biodiversity index for the pine-dominated plots was 1.439 in 2005/6 and 1.428 in 2011, and for the oak-dominated plots was 1.569 in 2005/6 and 1.497 in 2011. This shows that the understory composition has remained similar for pine-dominated areas, but a slight decline in biodiversity was seen in oak-dominated areas. Also, the pine-dominated areas had significantly more understory species than the oak, with 27.6 vs. 22.0 hits per transect on average (t-test, p=.0067, α=.05). This shows that the oak-dominated areas are experiencing a decline in understory species which could potentially be due to deer browsing. The deer exclosure plots had similar understory species as the control plots, but the percent composition of some species varied and this will be taken into account when future studies are carried out to control for variables other than deer browsing. Future studies will allow management plans to be tailored to the needs of the forest to ensure the survival of this rare ecosystem and the species interactions that exist within it.

Introduction

The Long Island Central Pine Barrens (CPB) is dominated by pitch pine (*Pinus rigida*) and oaks (*Quercus spp.*), with acidic, nutrient poor soil, and an understory of scrub oak, black huckleberry and blueberry (1). A feedback loop exists in the CPB where fire-tolerant understory species have flammable leaves which promote periodic fire that burns the litter allowing pine seedlings to grow thus promoting early successional stage survival (2). The suppression of fire in recent years is leading to a more oak-dominated, uniform ecosystem, since pine communities need periodic burning (1).

Deer are also a threat to the CBP because they have no natural predators on Long Island and hunting has done very little to curb the population growth of this species. Deer browse on common CBP understory shrubs, oak tree seedlings and saplings and also trample new shoots of understory plants (3). Increased deer browsing and trampling alters the forest floor leaving it bare or comprised of huckleberry, ferns and sedges which deer do not commonly eat (3).

The Foundation for Ecological Research in the Northeast (FERN) made studying the health of this region one of its goals and from 2005 to 2006 established 93 forest health monitoring (FHM) plots across Long Island (4). In 2011, seven of the FHM plots located on the BNL property were analyzed to see if changes occurred in less than 10 years. Three experimental plots were established as deer exclosures to help quantify the effects of deer browsing and trampling in the area. Various factors such as height, density, percent make-up and biodiversity were used to analyze changes in understory make-up.

Figure 3: Photographic comparison of Plot 93 M4, 2006 on left, 2011 on right.

Table 1: Biodiversity indices by year and overstory category.

	Shannon Weiner Biodiversity index
Pine-dominated 05/06	1.439
Pine-dominated 11	1.428
Oak-dominated 05/06	1.569
Oak-dominated 11	1.497

Table 2: Average hits per transect by year and overstory category

	Pine average hits/transect	Variance	Oak average hits/transect	Variance	p-value
Pine vs. Oak 05/06	26.85	34.24	20.06	8.01	0.0002
Pine vs. Oak 11	27.6	66.78	22.02	7.81	0.0067

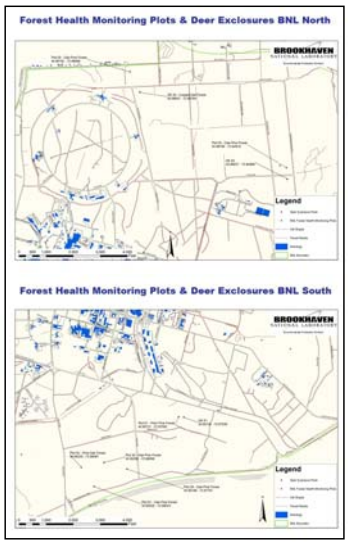

Figure 2: Coordinates and Overstory Classifications of FHM and Deer Exclosure plots

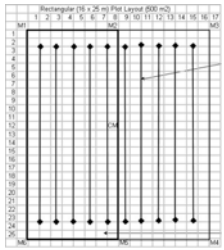

Figure 1: A schematic representation of the plot with side lengths, corner names and example line transect locations (4).

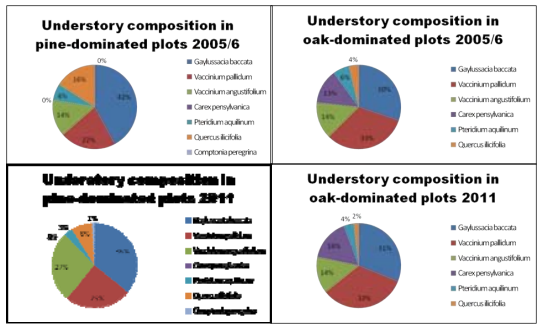

Figure 4: Understory species composition for pine- and oak- dominated plots in 2005/6 and 2011

Materials and Methods

Coordinates of the FHM plots were entered into a handheld Global Positioning System (GPS) to locate them. For each plot, four 50-meter tapes were used to set up the plot with two 16- and two 25-meter sides, seen in Figure 1. A tripod was put in the center and pictures taken facing each corner. Ten, 25-meter randomized line transects were established across the plot, also shown in Figure 1. At 20 points along each transect, a narrow 2 meter collapsible pole was placed in the ground, and each species that touched the pole was recorded (4).

For 3 of the FHM plots, a comparable plot was set up nearby to establish a deer exclosure. The new plots were chosen based on proximity and forest composition so that the FHM plots could act as control areas (4). Locations of all plots used in this study can be seen in Figure 2. The same data were collected in these deer exclosure plots as in the FHM ones, and fencing will be put up in the future to prevent deer browsing.

For each plot, the 2005/6 and 2011 pictures were compared to study understory height and density changes. The plots were split into two categories based on the overstory composition of the forest, either oak- or pine-dominated, shown in Figure 2. For each category, the Shannon-Weiner biodiversity index, and average number of species hits per transect was calculated (5,6).

Results

Photographic comparison showed few changes in the pine-dominated plots, 52 and 91, and also the oak-dominated plots, 81, 29 and 30. Plots 93 and 5 appeared taller and denser compared to 2005/6, and an example is seen in Figure 3. Deer exclosures 5 and 91 appeared less dense while deer exclosure 93 looked more dense than the control.

The Shannon-Weiner biodiversity index for the two overstory categories can be seen in Table 1. The number of hits per transect for each category can be seen in Table 2. Understory composition was analyzed for the two categories, and pie charts of species distributions can be seen in Figure 4.

In pine-dominated areas, statistically less *Gaylussacia baccata* (t-test, p=0.0006, α=.05), *Pteridium aquilinum* (t-test, p=0.0266, α=.05) and *Quercus ilicifolia* (t-test, p=.0020, α=.05) were hit in 2011. For the oak- dominated areas, statistically less *P. aquilinum* (t-test, p=0.0118, α=.05) and *Q. ilicifolia* (t-test, p=0.0239, α=.05) were also hit.

Discussion

A decrease in *Q. ilicifolia* further demonstrates that deer prefer *Quercus spp* and have continued to browse heavily on these species over time. A decrease in *P. aquilinum* was seen, which is a fern deer do not normally eat (3). This decrease was probably due to trampling since these ferns are fragile and top-heavy. A decrease in *G. baccata* in pine-dominated plots may signify less deer browsing over time, showing that other plants have been able to thrive thus decreasing nutrients available for this species.

The pine-dominated plots have higher understory densities than the oak-dominated ones which could be attributed to the fact that deer enjoy browsing on oak seedlings while they will only turn to pine seedlings in times of food shortage (3). No significant increase in any species since 2005/6 was seen, showing that deer browsing is suppressing population growth of understory species, but increases in understory height and density were seen in few oak-dominated plots.

Deer exclosures 5 and 91 have more deer browsing and 93 has less than their controls. These differences from the controls will be taken into account when future studies are carried out. For deer exclosures 5 and 91, it will be important to note the rate at which certain species increase in an area after herbivore removal. Future studies will allow for the continued monitoring of forest health, quantification of deer browsing effects and provide more insight into the species interactions that exist within the Long Island CPB region.

References

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Taken by Alex Mancuso

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