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**Morristown National Historical Park
Barberry/Wiregrass Deer Exclosure
Summary**

Introduction

In conjunction with Linda Rohleder, PhD candidate at Rutgers University, the New Jersey Department of Environmental Protection, Division of Fish and Wildlife began efforts to collect information at deer exclosures located throughout New Jersey in 2008. Exclosures that did not have ornamental or native vegetation planted, and did not have invasive exotic vegetation removed were chosen. Twenty-seven deer exclosures were utilized. Information on the number of species present inside and outside deer exclosures and plant height was obtained. The Floristic Quality Assessment Index and the Plant Stewardship Index were calculated from the plant species present. The Shannon Index of Diversity was obtained using the percent cover by species. The height and density of vegetation inside and outside of the deer exclosure was compared.

Study Area

The Morristown National Historical Park is comprised of 1,697.55 acres located in Morris County. The Park contains four separate units, each of which is associated with the Revolutionary War winter encampments of the Continental Army. The vegetation inside and outside eight exclosures located in the Jockey Hollow Encampment Area in Harding Township were sampled in May and June 2008. Three exclosures were established in 1995 to compare over time the rate of range expansion of two invasive non-native species, Japanese barberry and Japanese wiregrass, with and without exposure to deer browse. One of the three 10-meter by 10-meter exclosures that were erected in 1995 was utilized. This report summarizes the difference in vegetation inside and outside of this one exclosure, located off of the Grand Loop Trail. The exclosure is located at 40.77510 -074.53056.

Methods

Seven randomly located, one-meter² study plots were established outside the exclosure, and seven study plots were established inside the exclosure in May 2008. Percent cover, by species was recorded for each one-meter² study plot. From the center point of each exclosure, and in the corresponding area outside the exclosure, the height of vegetation within a 2-meter radius was recorded. The density of vegetation was recorded inside and outside the exclosure using a density board. The density board was used to determine the percent cover at 20-centimeter heights from a distance of two meters, in eight directions.

All New Jersey and Pennsylvania plants have been catalogued and assigned a number, the Coefficient of Conservatism (CC), from zero to ten by local experts and botanists. Zero represents the most generalist species, tolerant of disturbance and includes invasive or introduced nonnative species. Ten represents the most conservative species and includes many rare and endangered state-listed native plants that require special habitats.

The Floristic Quality Assessment Index (FQAI) is calculated using the CC for only those plants native to New Jersey, while the Plant Stewardship Index (PSI) is calculated using the CCs of both native and non-native plants. The naturalness of the total plant community is calculated by adding in all non-native species and giving them a C value of 0. Thus Total Mean C can be computed, and the PSI value is calculated by multiplying the Total Mean C by the square-root of N, where N is native species richness. The FQAI of an area is computed by multiplying the Native Mean C by the square-root of N, where N is the native species richness. The PSI, FQAI, and Native Mean C were calculated using the PSI calculator found at the Bowman's Hill Wildlife Preserve web site at www.bhwp.org/db/index.php. The mean Coefficient (mean C) for native plants is used as a non-weighted indication of floristic quality. It is not dependent on the size of the area inventoried and can be used for comparing sites of different sizes.

Results

Rosa multiflora was found in six of the seven study plots located inside the exclosure. It covered 100% of two of the study plots. *Ligustrum* sp. covered 90% of one of the study plots located inside the exclosure. Interestingly, *Rosa multiflora* was not found in any of the seven study plots located outside the exclosure.

The study plots located inside the exclosures had a Plant Stewardship Index (PSI) of 5.02 and a Floristic Quality Assessment Index (FQAI) of 8.54. The PSI and FQAI differed because invasive exotic species were found in the study plots. Study plots located outside this exclosure had a PSI of 5.65 and a FQAI of 10.67. Eighteen species of plants were found in the seven study plots inside the exclosure and seventeen species were found in the one-meter² study plots outside the exclosure. This is one of the few deer exclosures studied in New Jersey where the FQAI and the PSI were higher for study plots located outside the exclosure.

The native mean C for the one-meter² plots located inside the exclosure was 2.70. The native mean C for the one-meter² plots located outside the exclosure was 3.56.

The percent cover of plots located outside the exclosure averaged 41%, while the percent cover of plots located inside the exclosure averaged 86%. *Berberis thunbergii* was not found in study plots located inside or outside the exclosure. *Microstegium vimineum* covered an average of 12.8% of the study plots outside the exclosure, but was not found in the study plots located inside the exclosure.

From the center point of the exclosures and in the corresponding study areas outside the exclosures, the height of vegetation within a 2-meter radius was recorded. The heights of *Rosa multiflora*, *Lonicera japonica*, *Ligustrum* sp., *Parthenocissus quinquefolia*, *Fraxinus americana*, inside the exclosure exceeded the heights of the same species outside the exclosure. The height of *Berberis thunbergii* and *Poa* sp. outside the exclosure exceeded the average height of *Berberis thunbergii* and *Poa* sp. inside the exclosure.

Within the 2-meter radius circles, located inside the exclosures, *Lindera benzoin*, *Cardamine impatiens*, *Crataegus* sp., *Oxalis stricta*, and *Carex* sp. were found, but were not found in the 2-meter radius circle located outside the exclosure.

The density of vegetation was recorded from the center point of each exclosure and corresponding areas outside the exclosures. A density board was used to record the percent cover at 20-centimeter(cm) heights from a distance of two meters, in eight directions. The density of vegetation was greater inside the exclosure at all height classes.

Shannon's diversity index (H) was used to examine abundance and evenness of species in the interior plots versus the exterior plots (calculator can be found at <http://math.hws.edu/javamath/ryan/DiversityTest.html>). The diversity index takes into account both the number of species and their proportions. A higher value indicates higher diversity. The diversity index of plots located inside the exclosure is 2.48, while the diversity index of plots located outside the exclosure is 2.66. Evenness (H/H_{max}) indicates the extent to which species are represented in approximately equal proportions. A value closer to 1 would indicate more equitable distribution. The evenness of vegetation species located in plots outside the exclosure is 0.65 and the evenness of vegetation species located in plots inside the exclosure is 0.59.

The soil moisture did not differ. The soil moisture averaged 24 % outside the exclosures and the soil moisture averaged 25% inside the exclosures.

Summary

Unexpectedly, the diversity of vegetation was found to be greater outside the deer exclosure than inside, despite the fact that the plots outside the exclosure had eighteen plant species and the inside plots contained seventeen species. The higher index of diversity was due to the greater evenness of the abundance of species. No one plant species dominated the outside plots. The PSI and FQAI were higher outside the deer exclosure (5.65 and 10.67, respectively) than inside (5.02 and 8.54). The percent cover was much higher inside the deer exclosure (86%) than outside (41%), and the density of plants at all height classes was much greater inside the exclosure than outside. *Berberis thunbergii* was found to grow taller inside the exclosure than outside. *Microstegium vimineum* was found inside the exclosure, but not outside.

A list of plant species identified inside and outside the exclosure is found in Appendix A.

A complete summary of results from the 27 deer exclosures, in New Jersey where species abundance, diversity, and density by height was obtained will be completed in 2009. These results will be correlated with deer population estimates. A copy of this PhD thesis written by Linda Rohleder will be provided to the National Park Service.



Appendix A.

Vegetation Species Found Outside Deer Exclosure in one-meter² plots and in 2-meter radius circle

Ageratina altissima	White snakeroot
Allium vineale	Field garlic
Arisaema triphyllum	Small Jack-in-the-pulpit
Berberis thunbergii	Japanese barberry
Cardamine impatiens	Narrowleaf bittercress
Carex sp.	Sedge sp.
Carex laxiflora	Broad looseflower sedge
Celastrus orbiculatus	Oriental bittersweet
Fraxinus americana	White ash
Galium circaezans	Wild licorice
Geum sp.	Avens
Ligustrum sp.	Privet
Lonicera japonica	Japanese honeysuckle
Microstegium vimineum	Japanese stilt grass
Parthenocissus quinquefolia	Virginia creeper
Poa sp.	Bluegrass
Prunus serotina	Wild black cherry
Quercus velutina	Black oak
Rosa multiflora	Multiflora rose
Rubus phoenicolasius	Wineberry
Sassafras albidum	Sassafras
Toxicodendron radicans	Poison-ivy

Vegetation Species Found Inside Deer Exclosure in one-meter² plots and in 2-meter radius circle

Ageratina altissima	White snakerood
Alliaria petiolata	Garlic mustard
Arisaema triphyllum	Small Jack-in-the-pulpit
Berberis thunbergii	Japanese barberry
Cardamine impatiens	Narrowleaf bittercress
Carex sp.	Sedge sp.
Celastrus orbiculatus	Asiatic bittersweet
Cinna arundinaceae	Sweet woodreed
Crataegus sp.	Hawthorn
Fraxinus americana	White ash
Galium circaezans	Wild licorice
Geum sp.	Avens
Ligustrum sp.	Privet
Lindera benzoin	Spicebush
Lonicera japonica	Japanese honeysuckle
Oxalis stricta	Yellow wood sorrel

Parthenocissus quinquefolia
Prunus serotina
Rosa multiflora
Rubus phoenicolasius
Toxicodendron radicans
Viburnum prunifolium

Virginia creeper
Wild black cherry
Multiflora rose
Wineberry
Poison-ivy
Blackhaw viburnum