Effects of White-tailed Deer on Forests in Watchung Borough in October 2018

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Summary

Studies of forest conditions were conducted at 11 sites in Watchung Borough to determine the effects of local deer populations on forest health. The forest areas with no hunting had extremely low levels of tree regeneration compared to those with deer hunting or deer exclosures. The sapling category, which is the most indicative of deer damage, was 95% lower than the regional average on unhunted properties, and 99.4% lower than the historical average for the region. Properties that were hunted had 25x more saplings than unhunted properties, and exclosures had 136x more. The small tree category, which is the best indicator of longer-term deer damage, was also substantially reduced, with unhunted properties having 40% less than hunted areas or exclosure areas and 90% less than the historical average. Native shrub and woody vine cover was also substantially reduced compared to historical and regional averages, and invasive species were more abundant than natives in all areas, with the only major exception being the herb cover in deer exclosures. Native herbs were 85% higher in exclosures than unhunted areas, and invasive herb cover were 12x higher in unhunted areas and 6x higher in hunted areas compared to exclosures.

In the past two years, Watchung Borough deer surveys were found to be between 22-40/mi^2 in late winter-early spring after the hunting season (Kelly 2018), suggesting an average growing season deer density of approximately 44-80/mi^2 (i.e., after fawning). Higher numbers of deer are therefore present in all seasons than the recommended targets of 10 deer/mi^2 to sustain the health of forests and other ecosystems. Although hunting in Watchung is clearly enhancing forest regeneration compared to unhunted areas, the resulting sapling numbers are 82% lower than areas with exclosures and 60-83% lower than other nearby towns and park systems where more intensive management hunting occurs (Hopewell Open Space, Duke Farms, Princeton Township). Given the elevated numbers of deer present and the impacts observed to forest understories in this study, it is advisable not only that hunting continue in Watchung Borough in 2018-2019 and future years, but that efforts are made to increase its effectiveness in reducing deer numbers. This may be accomplished by increasing the number of properties hunted, implementing policies that would incentivize increased take (e.g., management targets, quotas, subsidizing costs, and/or hunter training), and eliminating restrictions on bow hunting, which would not only diversify the methods available to hunters but would dramatically increase the length of the hunting season in town.

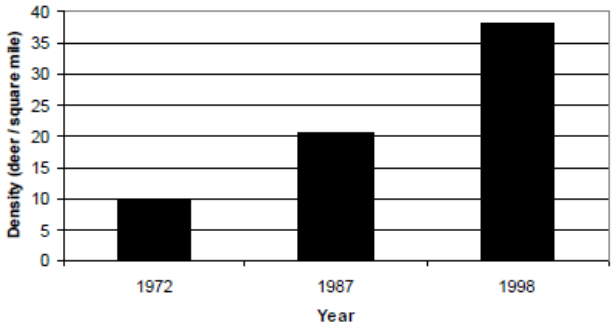
Introduction

Studies suggest that precolonial deer densities were likely to be approximately 5-11 deer/mi^2 (McCabe and McCabe 1997, Alverson et al. 1988). However, due to the extermination of major predators and the banning of commercial hunting in the 19th century, along with warming winters, increased forest fragmentation and suburban development in the 20th century, deer numbers have increased dramatically throughout their range (Cote et al. 2004). Based on hunting statistics, the New Jersey Department of Environmental Protection estimates statewide deer densities to be approximately 38/mi^2 with the highest regional densities of 78/mi^2 occurring in central New Jersey (NJ Division of Fish and Wildlife 1999). In the past two years, Watchung Borough deer surveys were found to be between 22-40/mi^2 in late winter-early spring after the hunting season and prior to fawning (Kelly 2018), suggesting a growing season deer density of approximately 44-80/mi^2. This is problematic, given that preferred browse species begin to decline when deer densities rise above 10/mi^2 (Alverson et al. 1988), and impacts to forest regeneration and the overall structure of the forest understory occur when densities exceed 20/mi^2 (Drake et al. 2002). Given the high numbers of deer observed, studies are needed to determine the extent of their impacts on forests in the Borough.

For research of this kind, we are fortunate to have a large number of prior ecological studies that were conducted in our region by researchers at Rutgers University in the 1940's through early 1970's (e.g., Cantlon 1953, Buell and Wistendahl 1955, Monk 1961). These studies used standard scientific techniques to measure different size classes of trees, along with shrub and herbaceous cover, and included a representative variety of forests and soil types for the region. By using the same methods to study forests today, we

may thus determine precisely how our forests have changed in the 40-50 years since. Because deer densities were far lower at that time in New Jersey (Figure 1), moreover, we may also be able to infer the effects of deer in causing these observed forest changes. In order to gain more precise evidence for causation, however, it is also necessary to include areas where deer exclosures and/or intensive deer hunting have been in place for at least 10 years, allowing for forest understory conditions to respond to these controls. By comparing the results from these areas, where deer numbers are few to none, to other areas where deer are not hunted, I hope to be able to more clearly ascertain the effects of deer on forests in Watchung Borough.

Figure 1. Estimated deer population density trends in New Jersey from NJDEP data (from Van Clef 2004)



Methods

A total of eleven forest sites were selected for study in Watchung Borough in 2018, based on a list of sites provided by Borough officials that were either public property or private properties where permission was granted. Sites included six unhunted properties (Nottingham, Tall Timbers, Wildwood Terrace, Municipal Building, Brookdale Park, Johnston), three hunted properties (High Tor, Elsinore, Camp Endeavor), and two deer exclosures (Sherwood)(Figure 2). The sites were visited on 10/12/18 and 10/15/18 and data was collected by Dr. Jay F. Kelly and two field technicians with Bachelor's Degrees in Ecology and five years of experience working in forest ecology. Study plots were 400 to 600 m^2 in area, depending upon property size, consisting of 100 m^2 quadrats arranged along two parallel transects spaced 20 m apart, with individual quadrats spaced 10 m apart. Trees were identified, measured and categorized by height and diameter at breast height (dbh), including: seedlings (<1' tall, <1" dbh), saplings (>1' tall, <1" dbh), small trees (1-3.9" dbh), medium trees (4-9.9" dbh) and large trees (>10" dbh). Saplings, small, medium and large trees were counted in the 100 m^2 quadrats, and seedlings were counted in two 0.5x2 m (1 m^2) quadrats located at the beginning and end of each 100 m^2 quadrat. Percent cover or herbaceous plants were also recorded in the 1 m^2 quadrats, and shrub and woody vine cover were recorded using the line intercept method, recording the amount of overlap of each species with the transect line running through each 100m^2 quadrat. These categories were consistent with both the regional and historic data sets used for comparison, including 135 sites in the current and 40 sites in the historic data sets (Kelly unpublished data). Shrub, liana and herbaceous data were analyzed in terms of cumulative % cover of individual native and invasive species, respectively. Photos were also taken to document and illustrate site conditions.

Results

Forest understories showed clear signs of major deer impacts. Areas with no hunting had extremely low levels of tree regeneration compared to those with deer hunting or deer exclosures (Plate 1). The sapling category is the most indicative of deer damage, as it represents trees that are generally 2-10 years in age and 1-15' in height, which are highly vulnerable to deer browse. Because it takes years for individual trees to transition out of this stage, the numbers of saplings remain highly vulnerable to continual browsing over time. Sapling numbers observed in unhunted properties in Watchung were 95% lower than the regional average, and 99.4% lower than the historical average for the region, representing some of the lowest numbers recorded in my research (Table 1, Figure 2; Kelly unpublished data). In contrast, properties that were hunted had 25x more saplings, and exclosures had 136x more (Plate 3). Hunted properties in Watchung had 26% more saplings than the regional average, where only recreational or no hunting occurs.

The small tree category, which is the best indicator of longer-term deer damage, also exhibited major declines, with 40% less than hunted areas or exclosure areas in Watchung and 90% less than the historical average. While the trees in this category are not directly vulnerable deer browse due to their larger size (typically >15' tall), if saplings are continually browsed over time, it leads to reductions in the numbers of small trees as insufficient numbers of saplings are produced to replace small trees as they either die off or develop into the next size class (medium size trees).

Seedling numbers were comparable between Watchung and both historical and regional averages, however, this category of trees is not a useful indicator of deer browse. Trees of this size are less than a year old, replenished annually from seed fall, and not typically browed until after the growing season, when less herbaceous vegetation is available. Given that the amount of seed produced may also vary depending upon annual weather conditions, masting events, and cyclical predator populations, we would not necessarily expect to see any signs of impacts to this layer of the forest. Similarly, we would not expect to major impacts to medium and large trees. However, the consistently high number of medium and large trees compared to unhunted areas suggests that the long-term deer exclosures (15-20 years) may indeed have protected trees long enough to begin to see the numbers bolstered from saplings and small trees developing into these larger classes as well.

Figure 2. Locations of Forest Study Sites in Watchung Borough in October 2018. Exclosure locations are shown in red. Basemap from Conservation Blueprint (www.njmap2.com)

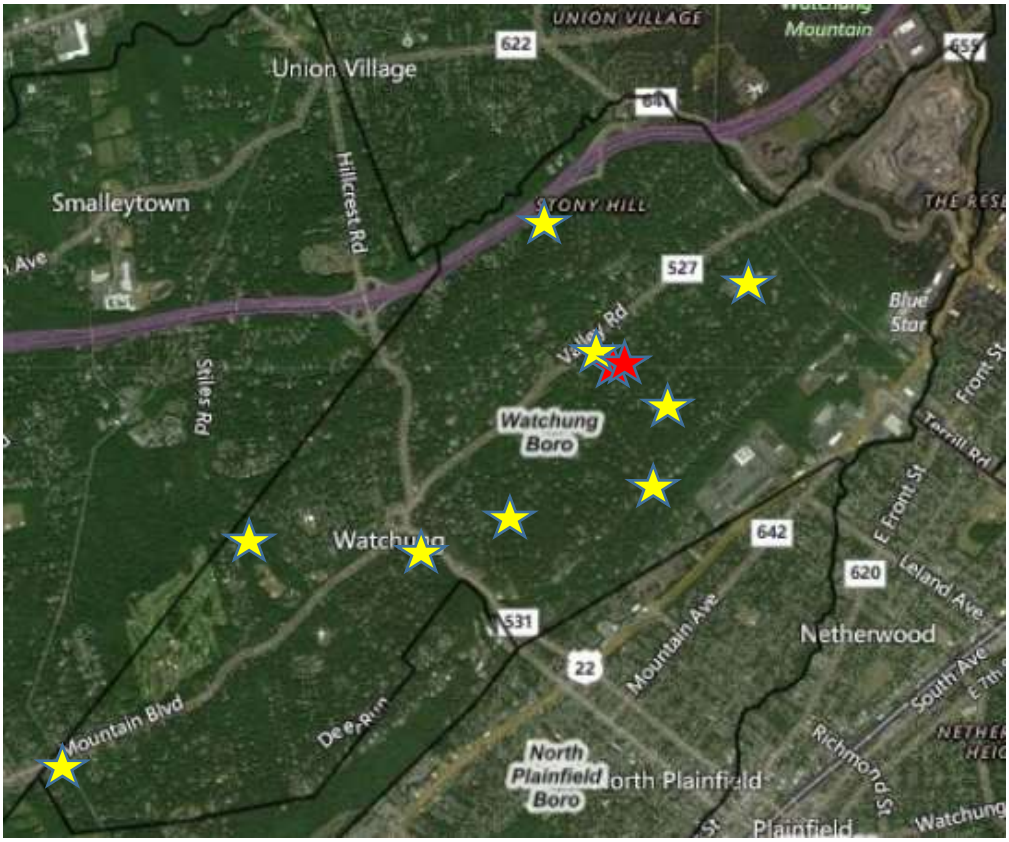
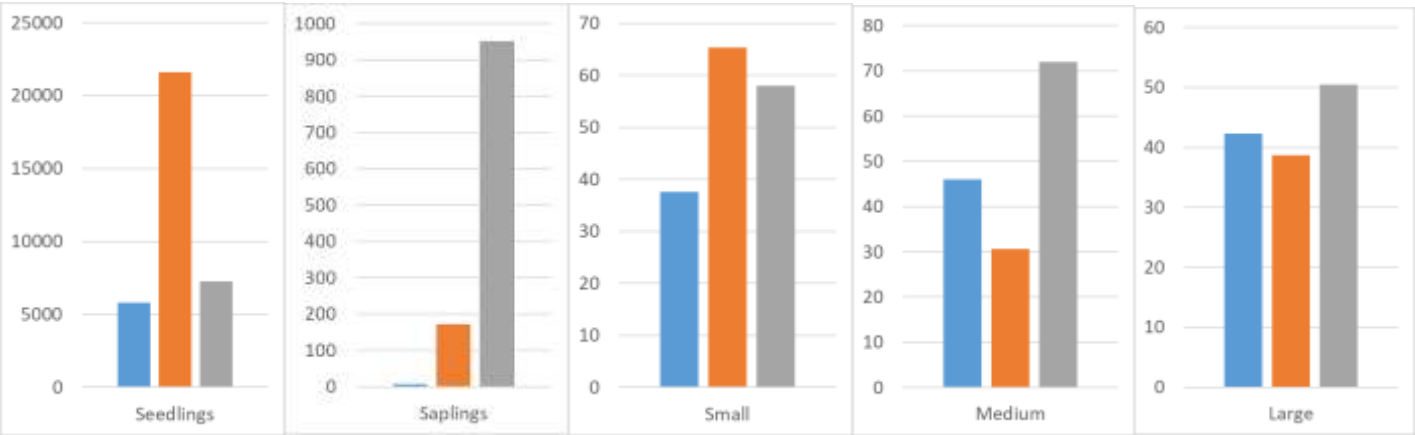


Figure 3. Density of Trees in Different Size Class Categories in Relation to Management Type.
Note: Figure units are standardized to number of individuals per 2000 m^2



Other understory conditions also showed signs of significant deer browse by both the reduction in overall shrub and liana (woody vine) cover and the overwhelming predominance of invasive plant species, which deer avoid eating when possible. Forest understories in Watchung Borough were in fact more invasive than native on average, with the only major exception being the herb

cover in the deer exclosures (Figure 5, Table 2). Native shrub and woody vine cover were substantially reduced compared to historical averages, but comparable to regional averages in areas with no hunting or recreational hunting only (which also suffer from exceedingly high deer densities of >70/mi^2). Native shrubs represented only 0-9% cover compared to 41% historically and 13% regionally. Woody vines were 1-5% compared to 7-8% historically/regionally. In both these categories, the amount of invasive species was substantially higher than historic levels, but lower than the regional averages.

Herbaceous ground cover was much higher than historical or regional averages, likely in response to the absence of shrubs and vines. Native herbs were 85% higher in exclosures than unhunted areas, and invasive herb cover were 12x higher in unhunted areas and 6x higher in hunted areas compared to exclosures. The worst incidences of invasive species overall was on the south-facing slope of Watchung Mountain, where the shallow soil and high degree of exposure has increased the number of tree blowdowns. In these areas, the light gaps are filling with invasive shrubs (*Aralia elata*, *Rhodotypos scandens, Rosa multiflora, Lonicera maackii*) and trees (*Ailanthus altissima*)(Plate 2). Significant effort is needed to restore the native species composition to these areas.

Figure 4. Comparison of un-hunted Watchung forests to historical, regional, and intensive deer management averages
Note: Figure units are standardized to number of individuals per 2000 m^2

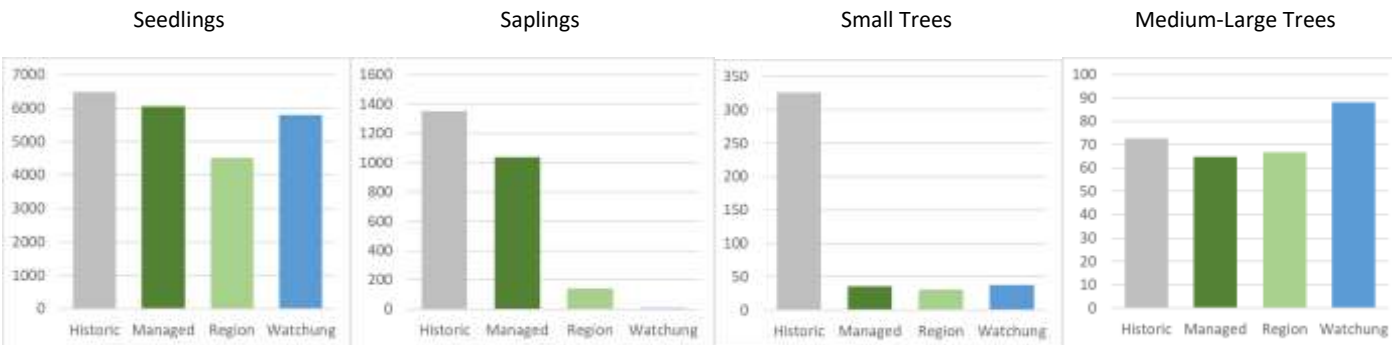
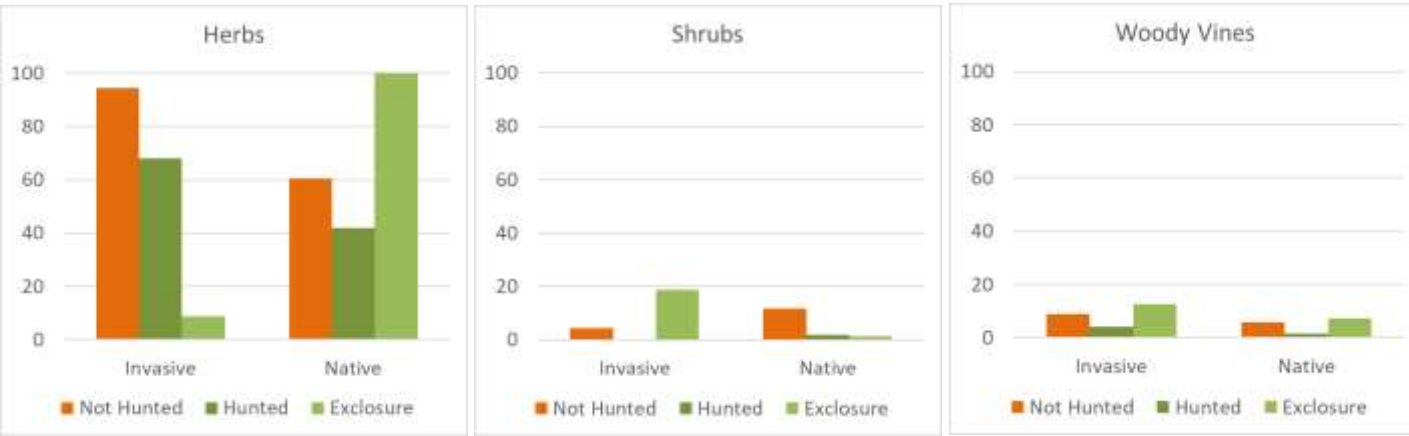


Table 1. Comparison of Watchung Borough tree data to regional, historic, intensive deer management, and exclosure averages from Central New Jersey. Note: Densities are standardized to number of individuals per 2000 m^2

Location	Seedlings	Saplings	Small Trees	Medium Trees	Large Trees
Watchung Borough – Non Hunted	5800	7	38	46	42
Watchung Borough – Hunted	21600	172	65	31	39
Watchung Borough – Exclosures	7250	952	58	72	51
Central NJ Region	5208	137	30	34	34
Intensive Deer Hunting	4633	809	10	29	35
Deer Exclosures	4800	1953	29	40	40
Central NJ Historic (1948-1972)	6481	1353	326	74	

Figure 5. Cumulative Percent Cover of Native and Invasive Herbs, Shrubs and Woody Vines in Relation to Deer Management Type in Watchung Borough



Although hunting in Watchung is significantly enhancing forest regeneration compared to unhunted areas, the resulting sapling numbers are 82% lower than areas with exclosures in Watchung Borough and 60-83% lower than other nearby towns and park systems where more intensive management hunting occurs (Hopewell Open Space, Duke Farms, Princeton Township; Figure 6), showing that there is significant room for improving the effectiveness of the hunting program. The higher numbers of small trees in these areas, which are comparable to exclosure numbers, are likely the residual effect of more intensive hunting practices that took place earlier, in the 2000's, as these tree sizes are typically reached after 10 years of growth. The lower numbers of saplings in Watchung exclosures compared to others in the region are likely due to their being 5-10 years older than the others, which is sufficient time for the major flush of sapling growth to dissipate as many either grow into the small tree category or die from competition. This younger age of the regional exclosures is also the reason that small tree numbers have not yet recovered to historical levels (Figure 4).

In the past two years, Watchung Borough deer surveys were found to be between 22-40/mi^2 in late winter-early spring after the hunting season (Kelly 2018), suggesting an average growing season deer density of approximately 44-80/mi^2 (i.e., after fawning). Given the elevated numbers of deer and the impacts observed to forest understories in this study, it is advisable not only that hunting continue in Watchung Borough in 2018-2019 and future years, but that efforts are made to enhance its effectiveness in reducing deer numbers. This may be accomplished by increasing the number of properties hunted, implementing policies that would incentivize increased take (e.g., setting management targets, quotas, subsidizing costs for butchering or bait, and/or hunter training), and eliminating restrictions on bow hunting, which would not only diversify the methods available to hunters but would dramatically increase the length of the effective hunting season in Watchung Borough.

Table 2. Cumulative Percent Cover of Herbs, Shrubs and Woody Vines in Watchung Compared to Historic and Regional Averages

	Herbs		Shrubs		Lianas	
	Invasive	Native	Invasive	Native	Invasive	Native
Watchung (Not Hunted)	95	60	3	9	7	5
Watchung (Hunted)	51	32	0	0	4	0.7
Watchung (Exclosures)	8	111	14	1	10	1
Central NJ Region (Historic)	1	29	0.1	41	0.8	8
Central NJ Region (Present)	22	17	28	13	25	7

Figure 6. Comparison of Saplings and Small Trees in Watchung (Hunted and Exclosure Areas) to Historic Averages and Other Area With Intensive Deer Management (Hunting or Exclosures)

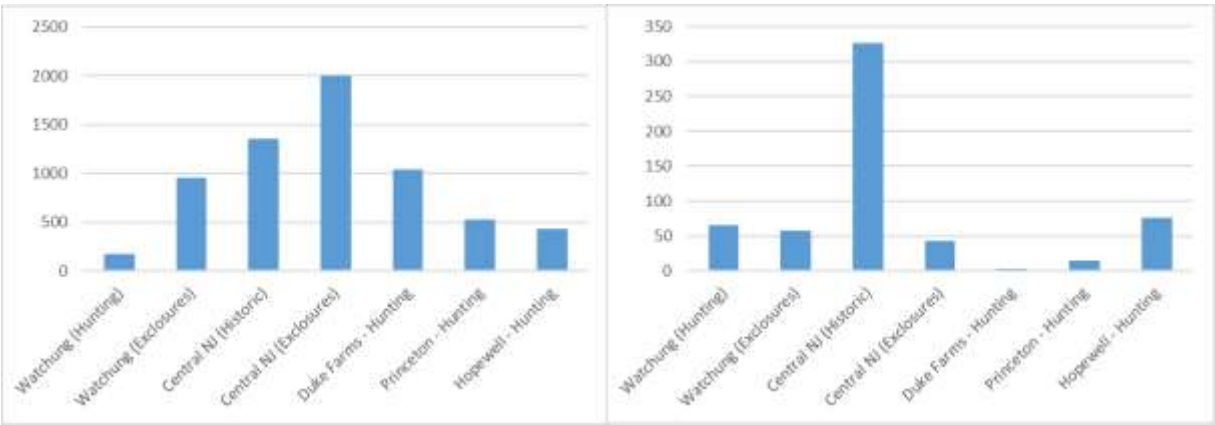


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Plate 1 – Photos of Forest Understories in Unhunted Properties, including (left to right, top to bottom) Municipal Building, Brookdale, Wildwood Terrace, and Tall Timbers, showing a severe lack of tree regeneration and native shrub cover.

Plate 2 - Photos of south-facing slope of Watchung Mountain below Johnston Drive, with major forest disturbance and exotic tree and shrub species invasion. Canopy trees in background are invasive *Ailanthus altissima*, and understory shrubs are *Aralia elata.*

Plate 3 - Photos of Deer Exclosure at Sherwood Lane, showing dense understory of native tree saplings and herb cover.