Brightwood Park Stewardship Plan

Prepared for the Town of Westfield and the Rahway River Association

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Introductory Information

Property Name:	Brightwood Park
Property Owner:	Town of Westfield
Total Acreage:	43
Municipalities/County:	Town of Westfield, Union County
Wildlife Action Plan Conservation Zone:	Northern Piedmont Plains (12)
NJDEP Watershed Management Areas:	Arthur Kill (WMA 7)
Numbers of Species Conservation Targets[1]:	Total Number of Animal Species: 3 Total Number of Plant Species: 0 Total Number of Ecological Communities: 0 *Note: Categories below are not mutually exclusive.* Globally Rare Species: 0 Federally Endangered Species: 0 Federally Threatened Species: 0 State Endangered Species: 0 State Threatened Species: 0 State Special Concern Species: 3 State Game Species of Concern: 0 Wildlife Action Plan Priority Animal Species: 3 Globally Rare Ecological Communities: 0 State Rare Ecological Communities: 0
Habitat Conservation Targets:	1) upland & wetland forest, 2) wildflower meadow, and 3) lake & lakeshore shrubland. These habitat conservation targets form the basis of plant and animal diversity at Brightwood Park.
Landscape-Scale Conservation Areas:	*ENSP Landscape Project Importance Summary* - Upland Forest - 61 contiguous acres, Wetland Forest - < 6 contiguous acres [Note: Contiguous habitat includes patches of habitat extending beyond Brightwood Park boundaries.] *New Jersey Natural Heritage Program Priority Sites* - None

[1] Species include those confirmed or suspected to be present on the Property (including species of adjacent properties or historical occurrence) based upon publicly available information from the NJ Department of Environmental Protection (Endangered and Nongame Species Program and Natural Heritage Program).

Cover photo credit: Great blue lobelia (Lobelia siphilitica) taken by M. Van Clef

Species Conservation Target List[1]:	**Animals (3)** *State Special Concern* - Baltimore oriole, gray catbird, Northern spring salamander
Non-Native Plant Species List:	Each non-native plant species was assigned an 'Action Code' based upon observations of current extent of infestations on the Property and within New Jersey. Codes include: "1" = species requires immediate implementation of an eradication program, "2" = species requires a long-term control program, "3" = species should be watched for spread and controlled if necessary in the future and "4" = no action required, species is not considered invasive or potentially invasive. See Appendix A for species lists and distribution / infestation severity and Appendix B for invasive species that threaten particular habitat types. ***Total Number of Mapped Non-Native Species: 28*** **Action Code = 1 (8 species)** common burdock, common reed, curly dock, English ivy, Japanese barberry, Japanese wisteria, narrowleaf bittercress, winged burning bush **Action Code = 2 (13 species)** Asiatic bittersweet, black locust, bush honeysuckle species, common mugwort, garlic mustard, Japanese honeysuckle, Japanese knotweed, Japanese stiltgrass, multifloral rose, Norway maple, privet species, tree-of-Heaven, wineberry **Action Code = 3 (5 species)** lesser periwinkle, Northern catalpa, pachysandra, trumpet creeper, white mulberry **Action Code = 4 (2 species)** forsythia, horse chestnut

Invasive Pest and Pathogen List:

This plan provides only brief recommendations for pests and pathogens. This list is provided for informational purposes. At a minimum, stewards of Brightwood Park should report any findings of emerging pests and pathogens to the NJ Department of Agriculture.

Current New Jersey Pests and Pathogens (9)

Ash Yellows	(unknown phytoplasm)
Asian long horn beetle	(*Anoplophora glabripennis*)
Bacterial leaf scorch	(*Xylella fastidiosa*)
Beech Bark Disease	(*Nectria coccinea* var. *faginata* (pathogen) vectored by *Cryptococcus fagisuga* (insect))
Butternut Canker	(*Sirococcus clavigignentii-juglandacearum*)
Chestnut Blight	(*Cryphonectria parasitica* - bark disease, *Phytophthora cinnamomi* - root rot)
Dogwood Anthracnose	(*Discula destructive*)
Dutch Elm Disease	(*Ophiostoma ulmi* and *Ophiostoma novo-ulmi* (pathogens) vectored by native elm bark beetle (*Hylurgopinus rufipes*) and the European bark beetle (*Scolytus multistriatus*))
Gypsy moth (European)	(*Lymantria dispar* - European variety)
Hemlock wooly adelgid	(*Adelges tsugae*)

Potential Pests and Pathogens (34)

Emerald ash borer	(*Agrilus planipennis*)
Sudden Oak Death	(*Phytophthora ramorum*)

The two species above represent the most serious potential threats to natural systems, but there are many additional species of potential concern (see Appendix C).

Overabundant Native Animal Species:

This plan will address the need to manage overabundant native animals that can have profound impacts on species and habitat conservation targets.

White-tailed deer
Canada goose (non-migratory populations only)

Executive Summary

Brightwood Park is a natural oasis in a highly developed portion of New Jersey. The primary habitat conservation target is mature forest (upland and wetland), which supports multiple common species of our flora and fauna. Two additional habitat conservation targets are wildflower meadow and lakes & lakeshore shrubland communities. Three state special concern species may also inhabit the Park (Baltimore oriole, gray catbird and Northern spring salamander). All of these conservation targets are under immediate threat from overabundant white-tailed deer and invasive species.

White-tailed deer are a very significant problem at Brightwood Park and their removal of much of the native forest understory facilitates invasive species infestations. Numerous native trees, shrubs and herbs show severe deer browse damage (deer preferentially eat native species relative to invasive species). Sun gaps in the tree canopy typically support the growth of young trees that regenerate the forest. However, deer browsing is eliminating growth of new trees -- if left unchecked, forest cover will ultimately be eliminated at the Park.

The extent of invasive species infestation at Brightwood Park is significant. A total of 28 non-native species were mapped with a combined infestation area of 23 acres (55% of the Park). Eight species require eradication before their spread further threatens conservation targets at Brightwood Park and surrounding lands. There are thirteen invasive species with widespread and/or severe infestations requiring a longer term approach to control. An additional five species should be monitored for future spread and controlled if necessary. Two non-native species are not currently considered to pose serious threats to conservation targets.

The control of invasive species at Brightwood Park is a challenging task that is warranted by its conservation targets. The size of this infestation requires a strategic vision coupled with a continuing allocation of resources. It is estimated that a “brute force” approach that seeks direct control of all invasive species is still possible at Brightwood Park. A coarse estimate for complete control of invasive species is 3,400 hours or the equivalent of 1.6 full-time individuals for one year (estimate based upon individuals utilizing hand clearing and herbicide treatment techniques).

However, this plan recommends a strategic approach with the ultimate goal of significantly reducing invasive species through direct control measures and broad habitat management techniques that reduce invasive species cover and/or increase native species cover and resistance to future infestation. This plan provides twelve strategic goals to improve the ecological health of Brightwood Park and create a refuge for our flora, our fauna and ourselves.

The two lakes at Brightwood Park require restoration to become more suitable for aquatic plants and wildlife. The smaller pond is heavily silted and filling in with vegetation. This pond will cease to exist without restoration efforts. The main Lake has heavy algal blooms that foul the water and make it an unpleasant site for park visitors and uninhabitable for many plants and animals.

Finally, it should be noted that the properties landscape context creates factors either partially or completely beyond the control of stewards of Brightwood Park. These include refugia for both white-tailed deer and invasive species located beyond property boundaries within a highly fragmented landscape. Therefore, stewards of Brightwood Park should strive to provide outreach and build partnerships with neighboring land owners and the general public to reduce the impacts of both white-tailed deer and invasive species.

The following provides a brief summary of recommended goals and strategies for Brightwood Park arranged by habitat conservation targets (See Section III for details):

All Habitat Conservation Targets

Goal 1A: Eliminate deer browse impacts on habitat conservation targets

- Create deer exclosure around entire Park by enhancing existing perimeter fence, installing passively-closing pedestrian gates at the two primary park entrances and installing a cattle grate at the driveway entrance to prevent entry of deer while allowing easy vehicular access to the parking lot. This is the primary strategy to combat invasive species by allowing the native flora to compete without being severely browsed by deer. This concept is referred to as "Ecological Control" of invasive species.

Goal 1B: Eradicate emerging populations of invasive species

- Efforts will prevent future site infestations and demonstrate regional responsibility to limit spread to neighboring lands.

Goal 1C: Reduce private landowner use of invasive species

- Provide outreach brochure and web content for Westfield residents aimed at reducing the use of invasive species in landscape plantings, especially those neighboring the Park. Efforts will prevent future site infestation. Encouraging the use of native plants will increase wildlife habitat (especially butterflies).

Goal 1D: Encourage volunteer stewardship and study of Brightwood Park by local students (K-12)

- Utilize Brightwood Park as a "living laboratory" to enhance classroom learning of natural history, stewardship of natural resources and scientific methods of monitoring the health of natural systems. This can be facilitated by the Rahway River Association.

Forest Habitat (Upland and Wetland)

Goal 2A: Maintain invasive-free areas

- Conduct annual surveys and control newly emerging species within the 11 acres that do not currently have any invasive species.

Goal 2B: Initiate a consistent annual effort toward reduction of invasive species throughout the Park

- Volunteer stewards should be recruited to provide monthly workdays during the growing season to strategically reduce invasive species cover throughout the Park. As available, utilize Town of Westfield public works and other capable staff to strategically support and supplement invasive species control efforts of volunteer stewards.

Goal 2C: Foster native forest regeneration through removal of invasive canopy trees

- Step-wise removal of mature Norway maple trees preceded by construction of deer exclosure and localized clearing of forest understory of invasive species to facilitate native species regeneration.

Wildflower Meadow Habitat

Goal 3A: Create wildflower meadow in the 1-acre area near the parking lot and lake

- Through grant funding being sought by the Rahway River Association, hire contractor to remove all invasive species and install appropriate native species. Maintain native wildflower meadow via annual mowing and selective treatment of invasive species. Wildflower meadow will provide habitat for elements of our flora and fauna not currently found at the Park and demonstrates use of native species that can be emulated by local residents.

Lakes & Lakeshore Shrubland Habitat

Goal 4A: Restore lakeshore shrubland community between the lake and wildflower meadow

- This area of the lake has been severely degraded by invasive species that provide limited wildlife value and eliminate many species of native plants. Clearing and planting efforts would occur in concert with the wildflower meadow restoration project.

Goal 4B: Restore health of lakes by developing and implementing engineering plans to eliminate lake eutrophication

- Both lakes require a detailed hydrological examination and alterations to reduce algal blooms and resultant low water oxygen levels that are detrimental to aquatic wildlife. These efforts will also significantly improve the aesthetic quality of both water bodies. Funding will be sought by the Rahway River Association.

Goal 4C: Restore health of lakes by controlling the resident Canada goose population

- Control Canada goose population through a partnership of the Rahway River Association, Town of Westfield and U.S. Department of Agriculture - Animal and Plant Health Inspection Service - Wildlife Services.

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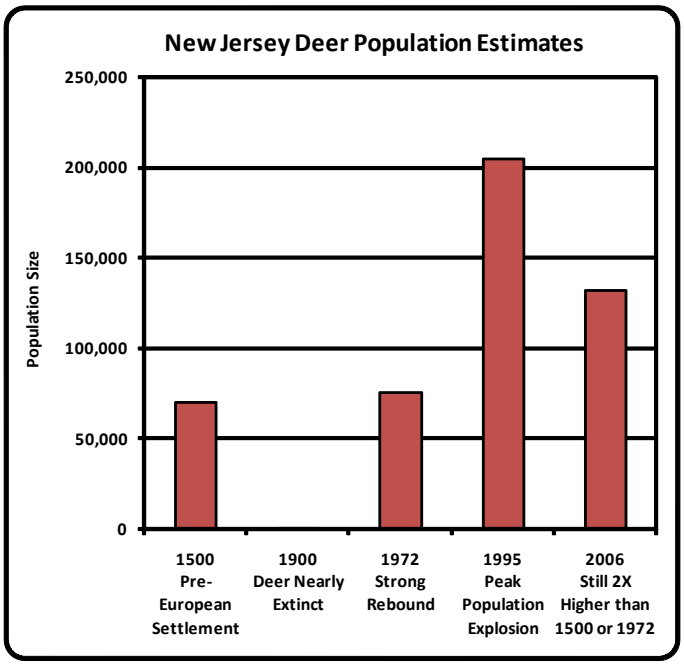
Section I. Introduction

Overview of the Deer Overabundance and Invasive Species Problems

Deer Overabundance - Statewide deer population size has varied significantly over the last one hundred years (see chart below). Historical analyses estimate the pre-European colonization deer herd to be about 70,000 in New Jersey (McCabe and McCabe 1984). Unregulated hunting throughout the 1800's nearly drove deer to extinction and conservation efforts supported by new regulations allowed a rebound to historic population sizes by 1972. However, the deer population grew to 3X its historic level by 1995 and serious declines in the health of forests were observed during that same time period. More recent measures have reduced the deer population, but current levels are still 2X greater than pre-European estimates.

The current statewide deer population cannot support healthy forests. A healthy forest consists of a canopy of tall, mature trees, a sub-canopy of smaller tree species and an understory of tree saplings & seedlings, shrubs and herbs. Deer prefer to eat native plants over non-native invasive plants leading to further degradation of our forests by allowing invasive species to proliferate. The combination of elevated deer numbers and their preference for native plants has led to degradation of New Jersey's forests by eliminating native understory growth and reducing the abundance of animals that require those plants for their survival. Although the 'correct' number of deer may vary depending upon site and regional conditions, the goal of healthy forest communities that support a diversity of plants and animals is a universal.



Invasive Species - Humans have introduced plant species, both intentionally and unintentionally, to parts of the world outside of their natural range. Only a small percentage of these introduced species become invasive, which is formally defined by the National Invasive Species Council as "a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health" (NISC 2001). The financial impacts of invasive species are enormous. Pimentel et al. (2005) estimate an annual cost of $120 billion dollars to agriculture, forestry and recreation. In addition, invasive species are considered the greatest threat to global biodiversity after outright habitat destruction (Wilcove et al. 1998).

Unfortunately, the rate of new plant introduction continues to rise. Snyder and Kaufman (2004) estimate fifty new plant introductions to New Jersey over the last twenty-five years (these are species with individuals growing in natural or semi-natural areas outside of human cultivation). Overall, there are nearly 1,000 non-native plants in New Jersey. Currently, there are approximately thirty widespread invasive plant species in New Jersey, but there are up to 70 species considered invasive or potentially invasive (D. Snyder, personal communication). There are no estimates of the area infested by invasive species in New Jersey, but it is likely that hundreds of thousands of acres are impacted.

Overview of Invasive Species Management

The underlying philosophical context for invasive species management is the obligation to counteract negative human impacts on natural systems, which is often referred to as "stewardship". The guiding principal of stewardship is fostering health of native plant communities that support our flora and fauna, which is indirectly accomplished through the management of invasive species. Management of invasive species is generally achieved through targeted control measures that minimize, but does not eradicate, particular invasive species. Eradication within pre-defined boundaries should only be considered a valid goal when populations are relatively small and the threat of continued spread is significant. In all cases, invasive species management should aim to stimulate native plant communities to resist infestation and minimize the use of pesticides and any other intervention. However, human impacts on natural systems are diverse and perpetual, which will necessitate continuing stewardship of natural resources within the context of a human-dominated environment in order to support healthy native plant communities.

There are two general approaches related to invasive species management. These involve a species-led approach or a habitat-led approach. A species-led approach should be employed when an invasive or potentially invasive species can either be eradicated or contained to reduce impacts across the entire Park or to minimize spread onto surrounding properties. This approach is warranted for invasive species that are emerging locally or regionally and for widespread invasive species with limited distribution at the Park.

A habitat-led approach should be employed when conservation targets within a defined area are threatened by invasive species that are widespread throughout the region and the Park. This approach involves holistic strategies to promote native plant species assemblages that reduce overall invasive species cover through direct competition for light and soil nutrients. The ultimate goal is to foster native plant communities that resist future infestations.

Control Methods - The management of invasive species can be classified into five broad methods referred to as mechanical, chemical, biological, cultural and ecological control (Table 1). Each control method utilizes multiple techniques and control methods may be used alone or in combination depending upon the resource to be protected and practical constraints (Table 2 and Appendix D – Overview of Control Methods).

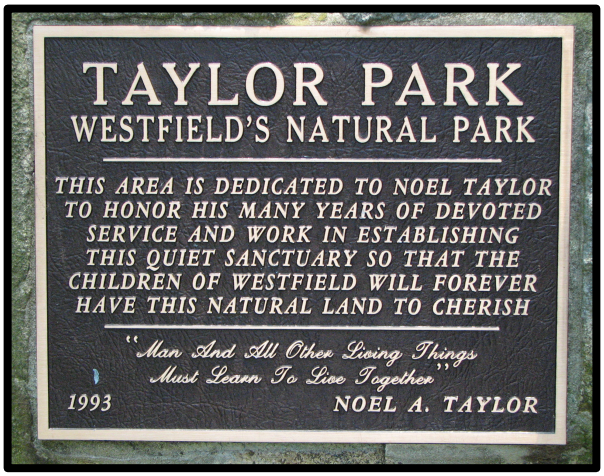
Mechanical control involves physical removal or cutting of invasive species. In the past, many groups performing invasive species control relied entirely on mechanical methods. Although mechanical methods can be the most appropriate choice in limited situations, many groups have abandoned this option because progress is exceedingly slow and methods are often ineffective.

Chemical control is the most commonly used method. It can be used in concert with mechanical control (e.g., cutting plants and applying herbicide to the stump) or alone (e.g., basal bark applications). However, herbicide use to control invasive species should be judicious to avoid impacts to non-target plants and animals. In all cases, herbicide use should involve the most benign formulations and application methods that effectively control the invasive species being treated. Appendix E - Summary of Herbicide Characteristics provides a summary of eleven herbicides that includes target species classes, persistence in the environment, toxicity to humans and wildlife and estimated material cost. Each herbicide was placed into a recommended use grouping that considers all of the above mentioned factors.

The application of pesticides is regulated by the NJ Department of Environmental Protection's Pesticide Control Program (PCP). Lead staff members or volunteers involved with the application of herbicides at Brightwood Park must become 'commercial pesticide applicators', which requires attendance in a one day course on pesticide safety, passing PCP's core exam and at least one PCP category exam and completing 40 hours of on-the-job training for each category of pesticide application. There are two pesticide application categories that cover any potential applications in natural areas and stewards of Brightwood Park would be required to pass both category exams along with the core exam. These categories include Category 2: Forest Pest Control and Category 5: Aquatic Pest Control. The PCP may waive on-the-job training requirements if it can be shown that Westfield currently does not have anyone certified in these two categories to provide training.

Staff or lead volunteers may opt to become 'certified pesticide operators', which are required to attend the one day training course on pesticide safety and receive 40 hours of on-the-job training for each category of pesticide application. Operators are not required to pass any examinations and must be directly supervised by a certified pesticide applicator. According to regulations, direct supervision beyond the 40 hour on-the-job training consists of operators being within "very timely voice contact" and within "three travel hours by land". Staff members or volunteers that are not certified applicators or operators may still apply herbicides if a certified applicator is always physically present and in the line-of-sight of the non-certified staff member.

The PCP also requires a permit for any wetland applications of pesticides. Currently, this involves a simple reporting form and an associated $75 fee. In some cases, the PCP may require an additional permit from the NJ Department of Environmental Protection - Division of Land Use when control work is deemed to significantly alter the vegetative structure of a wetland (e.g., removal of significant invasive shrub cover to promote emergent wetland).



Sign at Park entrance dedicated to the work of Noel A. Taylor.

Table 1. Description of Invasive Plant Control Methods

Control Method	Description	Pros	Cons	Notes
Biological	Introduction of a biocontrol agent (e.g., insect, pathogen) from the invasive species' native range	Dramatic reduction in abundance with minimal costs; minimal accessibility issues	Limited number of invasive species have agents; potential for unintended consequences if the biocontrol agent 'switches' to non-target species	Requires extensive time and effort to provide effective host-specific agents; Numerous federal regulations provide significantly reduced risk of impacts to non-targets species
Mechanical	Physical removal of all or portions of an invasive species	No requirement for specialized training; can be performed by volunteers	Very labor intensive; may require specialized equipment; site accessibility issues, impractical for large infestations; re-sprouting or further invasive species dissemination may occur	Common techniques include mowing, cutting, pulling and girdling
Chemical	Application of herbicide to all or portions of a plant	Most effective and efficient method in most cases; staff can be assisted by volunteers	Labor intensive; site accessibility issues; requires specialized training/license and equipment; may require repeated applications for more difficult species	Common applications include foliar, cut stump, basal bark and injection; Mechanical and chemical controls may be combined for cut stump and hack-and-squirt methods
Cultural	Removal of invasive species through broad land use activities	Very cost effective	Does not apply well to forest habitats	Primarily applies to agricultural or horticultural systems, but may apply to the maintenance of early successional natural systems including grasslands; Techniques include prescribed fire and prescribed grazing
Ecological	Allowing natural ecological processes (e.g., competition for light and soil resources, predator-prey relationships, etc.) to reduce invasive species over time	Very cost effective; utilizes natural processes	May not occur in many systems due to persistent or continuing human impacts (e.g., overabundant deer, continual physical disturbance, habitat fragmentation, etc.)	Primarily applies to forest systems; As an example, very strong anecdotal evidence suggests that overabundant deer facilitate infestations by Japanese stiltgrass and other invasive species in forests

Table 2. Specific Control Techniques by Invasive Plant Class

Invasive Species Class	Suggested Treatment Techniques [1]	Notes
Large tree	Girdling or Harvesting	May be combined with herbicide application to girdled area
Large shrub / small tree	Basal bark, Hack-and-Squirt, Cut Stump, Girdling	Mowing may be used as a pre-treatment to reduce plant size prior to chemical treatments
Small shrub / tree sapling	Basal Bark, Foliar Spray, Cut Stump, Pulling	Mowing may be used as a pre-treatment to reduce plant size prior to chemical treatments; Prescribed Fire or Prescribed Grazing may be used in grassland habitat
Large vines	Basal Bark, Cut Stump, Hack-and-Squirt	Many vine species have extensive root systems that require herbicide treatment
Forest herbs, woody seedlings and small vines	Foliar Spray, Pulling	Mulching may be utilized in garden beds or other human-modified areas

[1]For details on control methodologies see Appendix D – Overview of Control Methods and Appendix F – Invasive Species Phenology and Treatment Recommendations. Cultural and ecological control may apply to all invasive species classes.

Biological control involves the purposeful introduction of an insect or pathogen (biocontrol agent) that attacks an invasive species. The biocontrol agent is usually native to the same point of origin as the invasive species. Biological control is the most effective treatment technology for the limited number of invasive species where biocontrol agents have been developed. Biological control has had notable success stories and notorious failures. For example, the non-native Indian mongoose was released to control non-native rats (European and Asian) in sugarcane plantations in the West Indies. The mongoose was only partially effective (only controlled the Asiatic rat), but proceeded to consume native birds, amphibians and reptiles and ten species were driven to extinction. They also preyed upon domesticated poultry. Finally, the mongoose became a vector of infectious diseases such as rabies. The total economic cost of the biocontrol agent approaches $50 million dollars per year (Pimentel et al. 2005). Notable success stories include the control of alligator weed (New Zealand, Australia, US), mist flower (Hawaii), nodding thistle (New Zealand), prickly pear (Australia), ragwort (New Zealand) and St. John's wort (New Zealand, Canada). In New Jersey, biological control of purple loosestrife has considerable promise. Modern biological control involves thorough testing for 'host specificity' (making sure that the newly released biocontrol agent doesn't harm anything but the invasive species being targeted). This does not guarantee unintended consequences, but provides a reasonable reduction of risk that is assumed to be lower than the risk of damage known to occur through the unchecked spread of the targeted invasive species.

Unfortunately, there are no widespread invasive species at Brightwood Park that have an available biocontrol agent. However, researchers are developing a biocontrol agent for garlic mustard, which is one of New Jersey's worst invasive species (Van Driesche et al. 2002). Research to determine natural enemies of garlic mustard began in 1998. Five weevil species and one flea beetle species were selected as potential biocontrol agents based upon field observations of host specificity and extent of damage created on garlic mustard in its native range. Researchers are currently in the process of performing laboratory tests of host specificity that includes related native species and agricultural crops in the mustard family (Brassicaceae). In addition, studies will be conducted to determine which biocontrol agents or combination of agents may lead to the greatest impacts on garlic mustard. Some of this research will be conducted during field trials in garlic mustard's native range, while others will occur under laboratory conditions. All testing will be done using widely standardized techniques and following guidelines established in the literature and by the U.S. Department of Agriculture.

Cultural control is similar to the concept of agricultural best management practices but can be applied to early successional natural systems (e.g., grasslands, meadows). There are numerous practices that could have the effect of reducing invasive species as well as native woody species. These practices could involve planting native warm season grasses, prescribed fire, prescribed grazing and elimination of hedgerows to promote grassland or meadow plant communities that sustain themselves with minimal use of mowing and herbicide application. Prescribed fire can be an effective technique to maintain grasslands and the use of fire for ecological purposes has received attention across the world (Myers 2006 and references therein). The primary benefit of prescribed fire is its combination of cost efficiency and efficacy, especially where native warm season grasses have been established.

Prescribed grazing is defined as the application of a specific kind of livestock at a determined season, duration and intensity to accomplish defined vegetation or landscape goals (Launchbaugh 2006). The benefits of using livestock to control invasive species have been demonstrated for New Jersey's bog turtles (Tesauro 2001). This work primarily involved the use of cows to consume and destroy root mats of invasive species such as Phragmites and purple loosestrife. Another potential application may be the use of goats or other livestock to consume dense thickets of multifloral rose or autumn olive. There are a number of practical considerations to consider (e.g., cost associated with fencing materials), but targeted grazing may be the best option for land managers under certain conditions.

Ecological control of invasive species refers to the reduction of invasive species through competitive interactions with native species. Strong anecdotal evidence of other sites in New Jersey (e.g., portions of Cushetunk Mountain, Stephens State Park, Wawayanda State Park and Ted Stiles Preserve at Baldpate Mountain) indicate that a healthy native forest can resist infestation from invasive species even when invasive species are located nearby or within the forest (invasive species may be restricted to highly disturbed trail edges without proliferating in the forest interior).

Although the removal of invasive species by any method has the implicit goal of fostering native species that will resist future infestations, there are a variety of factors that limit native species ability to exert ecological control. The single largest factor that can be remedied is overabundance of white-tailed deer.

Canada geese (non-migratory populations) also represent a significant obstacle toward effective ecological control of invasive species by limiting natural native species regeneration and the success of restoration plantings along lakeshores. Historically, Canada geese had resident populations along each of their four major migratory flyways (one of which passes through New Jersey) (Coluccy 2007). Similar to white-tailed deer, the species was nearly extirpated by the early 20th Century due to unregulated hunting and egg collecting. The efforts of wildlife managers and scientists to increase the dwindling population have been very successful. However, current resident Canada geese originated from privately maintained captive flocks originally used as live decoys and food (Coluccy 2007). Natural or agricultural resource problems are associated with resident populations that do not migrate to Arctic breeding grounds. The North American population of resident geese has increased by a factor of eight over the last 20 years (Clark 2003). Resident geese have become problematic by fouling parks and lakes. Although definitive data are lacking, Canada geese have also been implicated in the spread of diseases such as avian pox, Campylobacter, E. coli, exotic Newcastle disease, foot and mouth disease and particular strains of avian influenza. Populations are partially sustained through the creation of detention basins lined with mowed grass and other human-related landscape features (Coluccy 2007). Efforts to remove geese from selected areas have been highly effective in New Jersey (e.g., Morris County Park Commission lands, Duke Farms).

Context for Stewardship at Brightwood Park

Brightwood Park Land Cover **-** The 2002 land cover categories are presented in Table 3 and Figure 3. The Park consists primarily of upland land cover classes (ca. 80% of total) dominated by upland forest cover (ca. 65%). Wetland forest covers approximately 12% of the Park. Open water represents about 12% of the land cover and urban cover (e.g., parking area) is about 8%. Cover of early successional habitat including scrub/shrub and old fields are very small (<1% combined total).

Table 3. Land Cover Categories of Brightwood Park (2002)

Category	**Acres**	**% of Property**
Deciduous Forest (> 50% canopy) – Upland	27.8	65.3
Deciduous Forest (> 50% canopy) – Wetland	5.0	11.7
Deciduous Woodland (10-50% canopy) – Upland	0.8	1.9
Scrub/Shrub (< 10% canopy, > 25% shrub cover)	0	0.0
Old Field (< 25% shrub cover)	0.2	0.5
Open Water	5.3	12.4
Agricultural	0	0.0
Barren Land	0	0.0
Urban	3.5	8.2
Totals	**42.6**	**100**

Historical land use was examined through visual assessment of aerial photographs taken in 1930 (Figure 1). Forest cover and urban cover (non-agricultural human land uses) each represented approximately 50% of the land cover. The current lakes were not present in 1930. Although there was a significant amount of urban development surrounding the current park boundaries, larger forest patches existed immediately to the north and west and agricultural fields existed less than one mile away. By 2002, these forest and agricultural areas had been converted to urban cover.

Surrounding Land Cover – Brightwood Park represents a small oasis of natural land cover in the area (Figure 2 and Table 4). Land cover classes within five miles of the center of the Park indicate very high amounts of urban cover (77%). The remaining natural areas (21% cover) are concentrated in other protected lands (e.g., Watchung Reservation, Lenape Park, Nomahegan Park, Passaic River Park, Echo Lake Park, Ash Brook Golf Course and Reservation) and other small forest fragments scattered throughout the area. Agricultural cover and open water represent < 2% of the total land cover within 5 miles of the Park (Table 4). This poor landscape context will exacerbate management of invasive species at Brightwood Park because of high intensity surrounding human uses and existence of fragmented natural areas that facilitate both invasive species and deer population growth.

Table 4. Broad Land Cover Categories within 5 miles of Brightwood Park (2002)

Land Cover Class	**Acres**	**% of Total**
Urban	38,481	76.6
Barren	427	0.8
Agricultural	203	0.4
Open Water	489	1.0

Natural Cover	10,665	21.2
Total	50,265	100.0

Conservation Targets – The primary habitat conservation targets at Brightwood Park include: 1) upland and wetland forest communities, 2) wildflower meadow community and 3) lakes & lakeshore shrub community. Forest communities serve as the basis for a broad range of common plant and animal species typical of the Eastern United States. Forest habitat also provides stopover feeding opportunities for Neotropical migrant birds and nesting habitat for many species. In general, meadows and other early successional habitat (especially areas lacking infestations of invasive species) have become less common throughout New Jersey. The creation and maintenance of meadow habitat is required by many native species of plants and insects (e.g., numerous wildflowers, butterflies and native solitary bees). The two lakes and the lakeshore are also conservation targets at the Park. These open water areas provide habitat to a variety of animals (e.g., fish, dragonflies, etc.) while providing aesthetic beauty that attracts visitors to the Park. Lakeshore shrub communities provide habitat for a suite of particular plants and animals while enhancing water quality by stabilizing lake banks.

There are three species conservation targets at Brightwood Park as identified by the Endangered and Nongame Species Program (see Introductory Information). These species include gray catbird, Northern oriole and Northern spring salamander. Although these "Species of Concern" are not considered threatened or endangered in New Jersey, they are all suffering from statewide and/or regional population declines. Fostering these species will be part of stewardship activities related to the habitat conservation targets listed above and additional specific management actions will not be required.

Baltimore oriole (Photo courtesy of Wikipedia – The Free Encyclopedia).

Section II. Scope of Deer Browse Damage and Invasive Plants at Brightwood Park

Ecological Solutions evaluated impacts of white-tailed deer and mapped the extent and severity of invasive plant species infestations at Brightwood Park in July 2008 (Figure 4). The scope of the invasive species problem is significant with over 23 acres infested (ca. 55% of the total Park area) with one or more species (See Figures 5 & 6). A total of 28 non-native plant species were mapped.

Evaluation of Deer Browse Damage

White-tailed deer are having a significant negative impact on forest health at Brightwood Park. Native tree regeneration in natural forest canopy gaps is not occurring. Instead, less palatable invasive shrubs, vines and herbs such as multifloral rose, Japanese wisteria and common mugwort are filling forest gaps. If this problem is not addressed, continued elimination of forest cover at the Park is expected over the coming decades as mature native trees naturally fall due to various factors such as storms and disease. In addition to natural factors, mature trees are being pulled down by excessive invasive vine growth (primarily Japanese wisteria).

Also important is the severe browsing of native shrubs and herbs in the forest understory. Large areas of the Park contain little or no understory vegetation that would provide vital habitat for a variety of animals. It is interesting to note that some native shrubs occur at the Park (although they are badly browsed by deer). The presence of small to moderately-sized specimens of maple-leaved viburnum, highbush blueberry and spicebush may indicate that deer browse has not been intense until the recent past. This hypothesis is also supported by the presence of a small area of the Park containing larger specimens of the native sweet pepperbush (although this species is less preferred by deer, it can be severely browsed when the deer population is high over a long period of time).

However, the current presence of native trees and shrubs would assure relatively rapid recovery of forest health if deer are excluded from the Park (see Section III).

Canopy gap invaded by invasive shrubs and herbs instead of being filled by the next generation of native trees.

Mature trees being killed by Japanese wisteria. Yellow arrow showing twining vines, blue arrow shows where top of tree has been killed.

Severe deer browse damage on native trees (upper left, oak seedling), native shade tolerant shrubs (upper right, maple-leaved viburnum) and native shade tolerant herbs (bottom, white wood aster).

A healthy forest at Brightwood Park would resemble the photo on the bottom left, which is filled with a dense native understory providing ecological control of invasive species. The photo on the bottom right from Brightwood Park shows an understory almost completely devoid of plants due to severe deer browse. Where light reaches the ground, less palatable invasive plants flourish (see photos on preceding page).

Results of Non-Native Plant Mapping

Non-Native Plant Mapping Protocols - The methods used to map non-native plant species at the Park involved the delineation of mapping areas. The mapping area technique is a coarse method to broadly define the extent and intensity of non-native plant species infestations. The ultimate goal was to obtain results that identify and prioritize control activities over the next 10 years.

Mapping areas were delineated as locations containing relatively uniform ground cover for each non-native plant species present within the defined area. Within each mapping area, all non-native plants were assigned a cover class rank. Cover classes included: 0: absent, 1: 1-10% ground cover, 2: 11-25% ground cover, 3: 26-50% ground cover, 4: 51-75%, 5: 76-99% ground cover and 6: 100% ground cover (i.e., near monoculture).

Overall Scope - A total of 49 unique mapping areas were recorded (Figure 4). There were five mapping areas representing approximately 11 acres that did not have any invasive species. Areas of open water (ca. 5 acres) and paved or mowed areas (ca. 4 acres) were not included in the mapping process.

Each non-native plant species was assigned an 'Action Code' based upon its level of threat posed to conservation targets, current extent of infestation at the Park and known invasive status in New Jersey (Tables 5 & 6). Overall, 21 species are considered invasive or potentially invasive (Action Codes 1 & 2), five species should be watched for invasive potential (Action Code 3) and two species are not considered to pose significant risk to conservation targets at the Park or to lead to significant additional degradation of surrounding natural areas (Action Code 4). Specific management recommendations for species and areas at Brightwood Park are presented in Section III.

Figures 5 and 6 depict the number of species and relative infestation severity by mapping areas. Excluding areas that are uninfested (shown in green), the majority of the Park has High or Very High infestation levels. Several areas near the lake have relatively moderate or low infestation levels. Areas in the vicinity of the parking lot tended to have the most severe infestations and areas adjacent the southern half of the unimproved access road consisted of low level infestations of many invasive species.

White-tailed deer observed foraging at Brightwood Park.

Table 5. Action Code Summary for Non-Native Plant Species

Action Code	Action Code Explanation	Treatment Recommendations	Number of Species
1	Species has limited distribution at the Park and/or within New Jersey. Risk of becoming an invasive species at the Park and/or spreading throughout New Jersey is high.	Eradicate	8
2	Species has widespread distribution at the Park and is widely recognized as an invasive species within New Jersey.	Control	13
3	Species has limited distribution and/or is not considered to threaten conservation targets at the Park or cause significant harm to surrounding natural areas. Risk of becoming an invasive species in the future is considered moderate.	Watch for Spread, Treat if necessary in the future	5
4	Species has limited distribution and/or is not considered to threaten conservation targets at the Park or cause significant additional harm to surrounding natural areas. Risk of becoming an invasive species in the future is low.	No additional observation or treatment required	2
TOTAL			28

Species Patterns - Table 6 contains a listing of each non-native plant species mapped at the Park (See Appendix A and Species Distribution Maps for more detailed information regarding distribution and intensity of infestations for each species). Table 6 also contains the "Relative Infestation Index Category." This index provides a coarse characterization of both distribution and intensity of infested acreage at Brightwood Park. It is intended to provide a rapid assessment of species that currently have the greatest impacts across all habitat conservation targets and provides a guideline for determining the intensity of control efforts required for each species. Values include 'High', 'Medium', and 'Low', which correspond to ranges of relative infestation scores derived by multiplying the number of acres where a species was present by its cover category within mapped areas. Species labeled as 'High' are those with widespread distributions and/or consist of dense stands. Conversely, 'Low' species have limited distribution across the Park and/or exist at low cover classes. Maps depicting the intensity and distribution of each non-native plant species have been printed as an attachment to this report and are located after the appendices.

Brightwood Park contains large infestations of common invasive species such as garlic mustard (*Alliaria petiolata*), multifloral rose (*Rosa multiflora*) and Japanese knotweed (*Polygonum cuspidatum*). Moderately-sized infestations of other common invasive species include Asiatic bittersweet (*Celastrus orbiculatus*), Japanese honeysuckle (*Lonicera japonica*), bush honeysuckle species (*Lonicera* spp.), Norway maple (*Acer platanoides*) and tree-of-Heaven (*Ailanthus altissima*). Other common invasive species with moderate to small infestations at Brightwood Park include wineberry (*Rubus phoenicolasius*), Japanese stiltgrass (*Microstegium vimineum*), Japanese barberry (*Berberis thunbergii*), winged burning bush (*Euonymus alata*), common reed (*Phragmites australis*) and privet species (*Ligustrum* spp.).

Unfortunately, Brightwood Park contains a serious infestation of an emerging invasive species – Japanese wisteria (*Wisteria floribunda*). There are also small populations of another emerging invasive species (narrowleaf bittercress - *Cardamine impatiens*) and a potentially invasive species (English ivy - *Hedera helix*).

In addition, there are small but intense infestations of both common burdock (*Arctium minus*) and curly dock (*Rumex crispus*). In general, these two species are not serious pests in natural areas, but the primary infestations of these species coincide with the proposed meadow restoration area. Both of these invasive species could significantly degrade restoration efforts if not controlled prior to initiating the project. Small areas of common mugwort (*Artemisia vulgaris*) along the parking lot should be similarly pre-treated. See Section III for additional details.

Table 6. List of Non-Native Plant Species and Their Relative Infestation Levels

Note: Species are sorted alphabetically by scientific name within each Relative Infestation Index Category.

Scientific Name	Common Name	Action Code	Infestation Index Score[1]	Relative Infestation Index Category[2]	Total Acres Present
Alliaria petiolata	garlic mustard	2	35	High	16.9
Polygonum cuspidatum	Japanese knotweed	2	22	High	13.8
Rosa multiflora	multifloral rose	2	33	High	19.8
Wisteria floribunda	Japanese wisteria	1	19	High	8.7
Acer platanoides	Norway maple	2	10	Medium	8.4
Ailanthus altissima	tree-of-heaven	2	9	Medium	5.1
Berberis thunbergii	Japanese barberry	1	6	Medium	5.7
Celastrus orbiculatus	Asiatic bittersweet	2	13	Medium	12.3
Lonicera japonica	Japanese honeysuckle	2	12	Medium	9.2
Lonicera sp. (BUSH)	bush honeysuckle species	2	11	Medium	9.5
Microstegium vimineum	Japanese stiltgrass	2	6	Medium	5.0
Rubus phoenicolasius	wineberry	2	6	Medium	6.3
Aesculus hippocastanum	horse chestnut	4	1	Low	0.9
Arctium minus	common burdock	1	1	Low	0.2
Artemisia vulgaris	common mugwort	2	5	Low	3.6
Campsis radicans	trumpet creeper	3	3	Low	2.6
Cardamine impatiens	narrowleaf bittercress	1	1	Low	0.7
Catalpa speciosa	Northern catalpa	3	3	Low	3.4
Euonymus alata	winged burning bush	1	5	Low	5.0
Forsythia viridissima	forsythia	4	2	Low	2.1
Hedera helix	English ivy	1	5	Low	4.9
Ligustrum sp.	privet species	2	5	Low	4.6
Morus alba	white mulberry	3	2	Low	2.3
Pachysandra terminalis	pachysandra	3	3	Low	3.3
Phragmites australis	common reed	1	1	Low	0.2
Robinia pseudoacacia	black locust	2	2	Low	1.3
Rumex crispus	curly dock	1	1	Low	0.2
Vinca minor	lesser periwinkle	3	4	Low	4.4

[1] The Infestation Index Score combines the extent of acreage infested and the intensity of the infestation. It was derived by multiplying the cover class number by the number of acres within each cover class.

[2]The Relative Infestation Index Category Categories include low, medium and high to represent total scores between 1-5, 6-15 and > 15, respectively.

Habitat Patterns - The habitat conservation targets include: 1) upland and wetland forest communities, 2) wildflower meadow community and 3) lakes & lakeshore shrub community. Table 7 summarizes the number of species by Action Code for each habitat conservation target and Appendix B lists non-native species by impacted habitat. Recommended management goals for each habitat conservation target can be found in Section III.

Table 7. Number of Non-Native Plant Species by Action Code for Habitat Conservation Targets

Habitat Conservation Target	Action Code 1	Action Code 2	Action Code 3	Action Code 4	Total Number of Species[1]
Upland and Wetland Forest Communities	5	12	3	2	22
Wildflower Meadow Community	3	9	3	0	15
Lakes & Lakeshore Shrub Community	1	4	0	0	5

[1]Multiple species threaten more than one habitat conservation target.

Invasive species that are currently producing serious impacts on the health of habitat conservation targets are listed in Table 8. In addition to listed species with high infestation levels, there is likely a serious cumulative impact to habitat conservation targets from a large number of invasive and potentially invasive plant species with relatively low infestation levels.

Table 8. Invasive Species Currently Producing Serious Impacts on Habitat Conservation Targets

Habitat Conservation Target	Invasive Species (listed alphabetically)
Upland and Wetland Forest Communities	Asiatic bittersweet, bush honeysuckle species, garlic mustard, Japanese knotweed, Japanese honeysuckle, Japanese wisteria, multifloral rose, Norway maple, tree-of-Heaven
Meadow Community	Asiatic bittersweet, black locust, common burdock, common mugwort, curly dock, Japanese knotweed, multifloral rose, tree-of-Heaven, wineberry *(Note: These are speculated near-term impacts for the proposed creation and maintenance of meadow habitat).*
Lakes & Lakeshore Shrub Community	Asiatic bittersweet, common reed, Japanese knotweed, multifloral rose, privet species *(Note: These are speculated impacts for the proposed creation and maintenance of lakeshore shrub community habitat).*

<u>Pests and Pathogens</u>

Invasive pest and pathogen species were not detected at Brightwood Park. It is likely that the gypsy moth, which is ubiquitous throughout the state and periodically produces significant defoliations on oak species, is present at Brightwood Park. The gypsy moth is the subject of an intensive treatment program that utilizes a bacterium called *Bacillus thuringiensis* to mitigate their impacts and they are also partially controlled by a naturally occurring fungus. The Gypsy Moth Suppression Program consists of a voluntary cooperative between the NJ Department of Agriculture, US Department of Agriculture, NJ Department of Environmental Protection, county agencies and municipalities. Treatments are performed via aerial spraying, which is not an appropriate methodology for Brightwood Park. It is recommended that alternative application methods be sought if serious defoliations occur in more than one consecutive year.

Bacterial leaf scorch (BLS) may infest species within the red oak group (e.g., red oak, scarlet oak, black oak, pin oak). Currently, BLS is associated with street trees and other ornamental plantings (40% of tested trees were infested across the state), but spread into more natural settings appears to be occurring (J. Arsenault, personal communication). Stewards of Brightwood Park should consider a survey for BLS and determine an action plan if it is detected.

Sudden oak death (SOD) may also become a future threat. The NJ Department of Agriculture was quick to respond to the unintentional introduction of sudden oak death in Cape May in 2004 (introduced via contaminated nursery stock from California). Surveys were conducted for SOD and no infections have been found in wild plants, but there is continued threat of additional introductions to New Jersey.

There are a number of potential pests and pathogens that may impact Brightwood Park in the future (see Appendix C). Imminent threats include Asian long horned beetle, which is the subject of an eradication program in New Jersey and emerald ash borer which has been spreading east and south from the Midwest (recently discovered in Maryland, Pennsylvania, Virginia and Missouri). Stewards of the Park should remain aware of these potential threats during the course of their field work and immediately report any potential occurrences to the NJ Department of Agriculture.

Asian longhorn beetle

Emerald ash borer

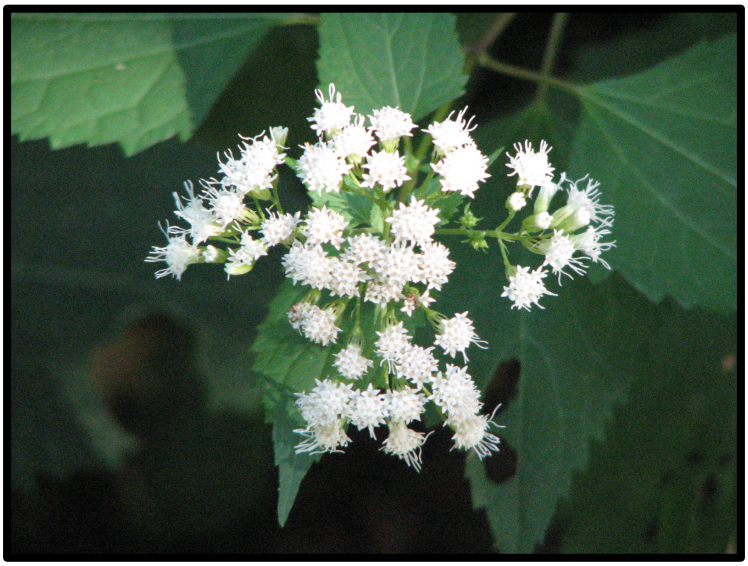
Section III. Management Recommendations and Provisional Cost Estimates

A significant and persistent effort will be required to reduce the impacts of white-tailed deer and invasive species at Brightwood Park. In the short-term (≤ 5 years), discrete strategies include converting existing perimeter fencing to create a deer-proof exclosure that allows native plants to exert ecological control over invasive species, eradicating emerging invasive species (Action Code 1 species) and seeking grant funding to restore wildflower meadow and lakeshore shrubland communities near the parking lot. It is also recommended that grant funding be sought to restore healthy lake ecosystems.

Intermediate-term strategies (5 - 10 years) involve strategic removal of invasive plants throughout the Park, implementing step-wise removal of mature Norway maples, maintaining wildflower meadow community and maintaining the deer exclosure. Long-term strategies (≥ 10 years) will largely involve continuing removals of invasive plants via improved reliance on ecological control and low-intensity mechanical and chemical control efforts throughout the Park. In general, ecological control is the desired ultimate condition (as opposed to perpetual mechanical and/or chemical control methods), but this should not be expected without construction and maintenance of a deer exclosure.

An overview of control methods, detailed information on herbicides, invasive species phenology and species-specific treatment recommendations and photographs of all non-native species documented during mapping activities are provided in Appendices D, E, F and G. These appendices are intended to provide practical guidelines toward plan implementation by stewards of Brightwood Park.

This section will detail strategies by habitat conservation target. A summary of recommended management goals, an activity timeline and provisional cost estimates are included with Table 9.



White snakeroot is a native forest understory herb that is unusually unpalatable to deer.

Table 9. Summary of Goals for 10-Year Implementation Period

Goal Number	Conservation Target	Management Goal	Strategies	Notes	Provisional Cost Estimate (see Section III for detals)	Activity Timeline
1A	All	Eliminate deer browse impacts on habitat conservation targets	Create deer exclosure around entire Park	A deer exclsoure can be created by enhancing existing perimeter fence, installing pedestrian gates at the two primary park entrances and installing a cattle grate at the driveway entrance to prevent entry by deer while allowing easy vehicular access to the parking lot. Deer browse is significantly reducing the quantity of native species and threatening the long-term existence of forest cover at the Park. Excessive deer browse is facilitating the spread of less palatable invasive species. An exclosure is the primary strategy to combat invasive species through ecological control exerted by a healthy forest filled with native plants that resist infestations. Exclusion of deer will also facilitate the creation of wildflower meadow and lakeshore shrub communities.	$14,500	2009
1B	All	Eradicate emerging invasive species (a.k.a. "Early Detection & Rapid Response")	Systematic removal of all Action Code 1 species via mechanical and chemical methods	See Appendix I for species-specific recommendations and timelines. Efforts will prevent future site infestation and demonstrate regional responsibility to limit spread to neighboring lands. Continuing efforts to search for emerging invasive species should be conducted at susceptible locations including riparian corridors, canopy gaps and Park boundaries.	$10,000	2009 - 2013
1C	All	Reduce private landowner use of invasive species	Provide outreach brochure to all residents of Westfield	Outreach is critical to minimize future planting of invasive species and provide support for invasive species control efforts. Brochure should also be posted on Town website.	$3,000	2009
1D	All	Encourage volunteer stewardship and study of Brightwood Park by local students	Utilize Brightwood Park as a "living laboratory" to encourage understanding and stewardship of natural systems	Provide outreach through speakers from the Rahway River Association to local schools and encourage participation of students in stewardship and scientific monitoring activities	$0	2009-2018
2A	Forest	Maintain invasive-free areas	Conduct annual surveys and control emerging invasive species in 11 acres of invasive-free forest (see Figure 5)	This is a cost-effective strategy to keep 'clean' areas perpetually free of invasive species. Volunteer land stewards should be recruited to perform this activity.	$0	2009-2018

Table 9. Summary of Goals for 10-Year Implementation Period (continued)

Goal Number	Conservation Target	Management Goal	Strategies	Notes	Provisional Cost Estimate (see Section III for detals)	Activity Timeline
2B	Forest	Initiate a consistent annual effort to remove invasive species throughout the Park	Spearhead a volunteer stewardship program and utilize existing Town of Westfield staff	There are 23 infested acres at the Park that will require long-term efforts to control. A prioritized timeline for invasive species control efforts are included in Section III. o Volunteer stewards should be recruited to provide monthly workdays during the growing season to strategically reduce invasive species cover throughout the Park. As available, utilize Town of Westfield public works and other capable staff to strategically support and supplement invasive species control efforts of volunteer stewards.	$5,000	2009-2018
2C	Forest	Foster native forest regeneration through removal of invasive canopy trees	Step-wise removal of canopy-level Norway maple trees	Norway maple and other invasive species should be selectively removed within localized areas after installation of the deer exclosure and removal of understory invasive species to promote regeneration of native species.	$3,000	2014-2018
3A	Wildflower Meadow	Create wildflower meadow habitat	Contracted removal of dense infestation of invasive species and planting of native wildflowers and grasses	The proposed project area along the parking lot (see Figure 7) is heavily infested with a variety of invasive species (see Figures 5 & 6). Contracted removals using land clearing machinery are required to prepare the site for installation of native wildflowers and grasses. The Rahway River Association will lead efforts to secure funding for the project. Wildflower meadow will provide habitat for elements of our flora and fauna not currently found at the Park and demonstrates use of native species that can be emulated by local residents.	$7,000	2009
4A	Lake & Lakeshore Shrub Community	Restore lakeshore shrub community habitat	Contracted removal of dense infestation of invasive species and planting of native shrubs	Clearing and planting efforts would be performed in concert with Goal 3A detailed above. Shrub planting would occur along portions of the lakeshore located between the wildflower meadow and the lake.	$4,500	2009
4B	Lake & Lakeshore Shrub Community	Restore health of lakes	Develop engineering plan to eliminate lake euthrophication	Both lakes require a detailed hydrological examination and alterations to reduce algal blooms and resultant low water oxygen levels that are detrimental to aquatic wildlife. These efforts will also significantly improve the aesthetic quality of both water bodies. Funding will be sought by the Rahway River Association to perform this project.	$195,400	2009 - 2010
4C	Lake & Lakeshore Shrub Community	Restore health of lakes	Control resident Canada goose population	The Rahway River Association, Town of Westfield and U.S. Department of Agriculture - Animal and Plant Health Inspection Service - Wildlife Services will devise strategies to reduce negative impacts of Canada geese on lake health.	$0	2009 - 2018
				Total 10-Year Estimated Costs	**$242,400**	

Goal #1: Implement Broad Strategies for All Habitat Conservation Targets

Goal 1A: Eliminate deer browse impacts on habitat conservation targets by enhancing the existing perimeter fence, installing passively-closing pedestrian gates at the two primary entrances and installing a cattle grate at the driveway entrance to prevent entry of deer while allowing easy vehicular access to the parking lot.

It is recommended that the existing fence be heightened so that the total height is 8 feet above ground at all points. This can be accomplished by extending existing metal posts and attaching heavy gauge galvanized wire every one foot above the existing fence. A contractor would have to determine the most cost effective mechanism to seal the bottom of the fence (deer are known to crawl under fences with less than one foot of clearance).

Provisional cost estimates for this work are speculative without direct quotes from qualified contractors following a thorough site visit. However, it is estimated that material and installation costs for a heavy duty deer exclosure would cost $15 - $20 per linear foot. The perimeter of the park is approximately 7,500 feet, which would translate into a cost range of $112,500 to $150,000. However, the existing fence should significantly reduce costs. It is possible that contractor estimates would be 5-10% of this cost range or approximately $6,000 to $15,000 (includes adding height to existing fence and installing pedestrian gates). The cattle grate material costs are approximately $2,500 (2 grates – each 12' x 7'). Shipping costs can be significant (Barn World Products based in Texas would charge $1,500 for shipping to Westfield). Assuming that a closer supplier cannot be located, total material and shipping costs for cattle grates would be approximately $4,000 (installation would be provided by deer exclosure contractor).

Therefore, the total estimated cost to complete Goal 1A is between $10,000 and $19,000 (average of estimate range is $14,500).

Goal 1B: Eradicate emerging populations of invasive species to prevent further spread across the Park and neighboring lands.

There are eight species categorized as Action Code 1(common burdock, common reed, curly dock, English ivy, Japanese barberry, Japanese wisteria, narrowleaf bittercress and winged burning bush). Treatment timelines for each species are provided in Appendix F and species distribution maps are included after the appendices. These species include emerging invasive species and small populations of well-known and widespread invasive species. Some of these species have already begun to produce large populations with wide distribution and significant effort will be required to eradicate them (e.g., Japanese wisteria). However, most species on this list consist of small populations with limited distribution and will require significantly less effort to eradicate (e.g., narrowleaf bittercress). This strategy of early detection & rapid response to emerging problems is ultimately very cost effective and preempts further damage to habitat conservation targets.

Costs for this goal are estimated based upon time required to clear invasive species at a given infestation severity and aerial extent, which was translated into a single value denoted as the 'Cumulative Infestation Score' ('CIS'). The CIS was determined by multiplying the cover class category by acreage covered for each Action Code 1species. The score was summed across all species and then multiplied by a factor of 15. The 15X factor was loosely estimated from previous experiences of the author while tracking control efforts. This newly derived number is equivalent to the number of hours required to perform the control work. It is important to note that the 15X factor considers primary reliance on chemical control methods with some use of mechanical methods (e.g., cut stump method). Based upon past experiences, purely mechanical control methods such as pulling could increase the 15X factor to over 50X. Species such as Japanese stiltgrass provide an illustrative example. This invasive species is extremely easy to pull from the ground by hand. However, dense colonies usually consist of hundreds of thousands of stems over relatively small areas making hand removal an extremely labor intensive exercise. In addition,

mechanical methods can be ineffective against invasive species with deep or easily fractured root systems or species with thorns that make mechanical treatments ineffective or very difficult.

It is estimated that 570 total hours are required to eradicate all Action Code 1 species at Brightwood Park. If seasonal interns are utilized to perform the control work, the total required number of hours may be multiplied by $13.20/hour, which represents the equivalent of $12.00 of hourly wages and a 10% benefit rate. The use of interns to complete this goal would be approximately $7,500. In addition to labor costs, it is estimated that equipment and material costs to start an invasive species control program and herbicide supplies to complete this goal are approximately $2,500.

Therefore, the total cost estimate to complete Goal 1A is $10,000.

Additional organizational costs associated with invasive species control will also depend upon resources used to perform the activities. Alternatives may include combinations of existing staff that could be re-assigned to this activity (i.e., no additional organizational costs) or hired contractors. A large network of existing volunteers can also be leveraged to reduce control costs. It is recommended that the Morris Land Conservancy's Partners for Parks Program be contacted to assist with recruitment of volunteer support for invasive species control work at Brightwood Park.

Goal 1C: Reduce private landowner use of invasive species by producing an informational brochure

The brochure will encourage residents to avoid all invasive and potentially invasive species in all new landscape plantings (removal of existing invasive species will also be encouraged). The use of native species and a call for volunteers to help steward Brightwood Park will also be included in the messaging. The New Jersey Department of Environmental Protection (NJDEP) Policy Directive 2004-02 lists species that will not be purposely planted on NJDEP-managed lands and Township residents will also be encouraged to follow this guidance. The policy directive is attached as Appendix H. Brochure content should also be posted on the Town's official website so that residents have a permanently available source of information.

The design of a full-color, tri-fold brochure is estimated at $500. Printing and mailing to all Westfield households (ca. 11,000) is estimated at $2,500 (assuming bulk mailing rates).

Therefore, the total cost estimate to complete Goal 1C is $3,000.

Goal 1D: Encourage volunteer stewardship and study of Brightwood Park by local students (K-12)

This goal is intended to increase awareness and appreciation of Brightwood Park, while providing a learning experience to local students. The natural oasis provided by Brightwood Park presents an educational opportunity and may also provide an outlet for community service. The Rahway River Association can assist local schools by providing expertise in natural history and scientific study through its membership and contacts with professionals.

There is no cost associated with completion of Goal 1D.

Goal #2: Enhance Forest Habitat

Goal 2A: Maintain Invasive-free areas through efforts of volunteer stewards

Prevention is the best strategy to keep pristine areas of Brightwood Park continually free of invasive species. It is recommended that volunteer site stewards annually search for incursions of invasive species on the 11 acres that have remarkably remained free of infestation. Any new occurrences of invasive species in these areas should be hand-pulled upon detection by site stewards.

There is no cost associated with completion of Goal 2A.

Goal 2B: Initiate a consistent annual effort toward reduction of invasive species throughout the Park

Upon completion of Goal 1B, stewards of Brightwood Park should begin a consistent annual effort to reduce invasive species cover. It is recommended that a minimum of six volunteer work days be organized monthly during the growing season. Each workday should target participation of 10 volunteers. In general, four-hour workdays are appropriate for most volunteers. The targeted total hours, based upon the information above, would be 240 hours per year. It is recommended that stewardship organizers (volunteers or Town staff) prepare annual work plans to guide volunteer control efforts. Expenses for this effort will be minimal (assuming that appropriate equipment was purchased to complete Goal 1B) and would include purchase of herbicides or replacement equipment. It is estimated that this would cost $1,000 per year. This goal is scheduled to be conducted for five of the ten years covered by this plan.

Although removal of all invasive species (including species of all Action Codes) from Brightwood Park is not recommended, the estimated number of required hours is 3,374. If interns were utilized, then the estimated total labor cost would be approximately $45,000.

Therefore, the total cost estimate to complete Goal 2B is $5,000.

Goal 2C: Foster native forest regeneration through removal of invasive canopy trees

In addition to Goal 2B, it is recommended that canopy-level Norway maple trees be removed to encourage native understory growth. Two important caveats are that this goal not be initiated until Goal 1A is completed and any understory invasive species be eliminated in the immediate vicinity of Norway maple before tree removals (The consequence of tree removals without first excluding deer and removing understory invasive species would be an explosion of invasive species growth upon allowing sunlight to reach the forest floor).

Norway maple occurs in nine of the mapping units but is most concentrated in areas 9 & 10, which are also infested with Japanese knotweed (see Species Distribution Maps – *Acer platanoides and Polygonum cuspidatum*) and a variety of other invasive species. The Cumulative Infestation Score for areas 9 & 10 is 9.3 with an estimated effort of 140 hours to complete total invasive species removal (see Goal 1B for explanation of time estimates). The recommended method to control large Norway maple trees is girdling or girdling with addition of herbicide – trees that may ultimately fall into the trail should not be girdled. Please see Appendix F and Table 2 for additional control options and guidance. Removal of large specimens via harvesting would incur significant additional expenses, but may be considered if the presence of fallen trees on the ground is not acceptable to Park users.

Similar to Goal 1B, it is recommended that seasonal interns perform this activity. It is estimated that labor expenses would be approximately $2,000. Expenses for this effort will be minimal (assuming that appropriate equipment was purchased to complete Goal 1B) and would include purchase of herbicides or replacement equipment. It is estimated that this would cost $1,000. This goal is in addition to Goals 1B and 2B.

Therefore, the total cost estimate to complete Goal 2C is $3,000.

Goal #3: Create and Maintain Wildflower Meadow Habitat

Goal 3A: Create wildflower meadow habitat in the 1-acre area near the parking lot and lake

The conversion of an existing 1-acre patch of severely infested habitat near the parking lot (see Figure 7) into a native wildflower meadow will produce important habitat for a variety of plants and animals and provide aesthetic beauty for visitors to the Park. It is recommended that a contractor with specialized

equipment clear all existing invasive species and apply herbicides to prepare the site for planting with native wildflowers and grasses. Planting may involve a combination of plant species that can tolerate dry, sunny conditions. Species selection and landscape stock sizes will depend upon funding obtained for the project. A combination of seeding and installation of plant 'plugs' would provide a relatively low cost option and satisfactory results. The installation of larger (and more expensive) plants would produce quicker results. Project success will depend upon careful planning and production of a planting plan that assures proper selection and placement of species at the restoration site. It is estimated that plan production and supervision by a qualified ecologist would cost approximately $1,500.

Provisional cost estimates for contracted clearing/treatment of invasive species on one acre is approximately $2,500 or approximately 1.5 days of machined clearing and herbicide treatment. It is recommended that at least three months during the growing season pass before installation of native plants. This will allow time for additional re-treatments of invasive species, as necessary.

Planting costs may vary widely as mentioned above. However, it is expected that minimum costs for installations utilizing seed and plant plugs over one acre will cost $3,000 for planting materials ($1,000 for seed and $2,000 for plugs – estimated at $1 per plug). To minimize costs, it is recommended that volunteers be utilized to install plants (e.g., local garden clubs, students, etc.).

Therefore, the total cost estimate to complete Goal 3A is $7,000.

For maintenance of the wildflower meadow, it is recommended that annual mowing be employed in mid-late winter to reduce invasion by woody plants. This task may require the use of weed whackers where the slope is too steep for traditional mowing equipment.

Goal #4: Restore Lakes & Lakeshore Shrubland Habitat

Goal 4A: Restore lakeshore shrubland community between the lake and wildflower meadow

The proposed restoration area is along the lake shore and immediately adjacent to the proposed wildflower meadow (See Figure 7). The restoration involves removal of all invasive species, which dominate the area and planting of native shrubs along a 400 foot x 15 foot strip (6,000 square feet) along the lake edge. The cost of invasive species removal is covered under Goal 3A. As in Goal 3A, the cost of planting material is dependent upon the species and plant sizes selected for restoration. It is recommended that specimen sizes range from 1 gallon (ca. $10/plant) to 3 gallon pot sizes (ca. $35/plant). A planting density of 1 plant per 20 square feet would require 300 plants. It is recommended that 250 gallon-sized plants and 50 3-gallon plants be purchased for the restoration. The total cost estimate for plant materials is approximately $4,500. This price can be adjusted higher or lower by increasing planting density, reducing the number of 3-gallon plants, etc. dependent upon grant funding. To minimize costs, it is recommended that volunteers be utilized to install plants (e.g., local garden clubs, students, etc.).

Project success will depend upon careful planning and production of a planting plan that assures proper selection and placement of species at the restoration site. The cost of this planning work is included under Goal 3C.

Therefore, the total cost estimate to complete Goal 4A is $4,500.

Goal 4B: Restore health of lakes by developing and implementing engineering plans to eliminate eutrophication.

The following information was provided by Arthur F. Senor, Consulting Engineer on behalf of the Rahway River Association and includes the Brightwood Park Pond Engineering Review, Brightwood Park Work Plan Provisional Cost Estimate and associated AutoCAD diagram.

Brightwood Park Pond Engineering Review

Township of Westfield

Tax Map No. 2 as Block 201 Lot No. 9 and Block 206 Lot No. 1.

Dated September 17, 2008

Arthur F. Senor, P.E., P.P., CME
N. J. Professional Engineering
Lic. No. 24GE03961800

Brightwood Park consists of approximately 39 acres in the Township of Westfield. The Park is surrounded by urban residential development. The Park also borders on the municipality of Scotch Plains. The parcel is identified on Tax Map No. 2 as Block 201 Lot No. 9 and Block 206 Lot No. 1.

The Brightwood Park Lake is in the Arthur Kill Watershed Management Area. It is part of the Rahway River basin in the Raritan Water Region. Its HUC identification is 02030104050080. The Pond is not identified in the NJDEP Surface Water classification system. These surface waters are therefore identified as FW-2 waters.

The Main Pond has an approximate area of 4.83 acres minus an upland island feature that is 0.21 acres in area. The resulting water surface area of the Main Pond is approximately 4.62 acres. Westfield DPW personnel have stated that the Main Pond is estimated to be between 6'-12' deep at its deepest points.

The small Pond is approximately 0.41 acres in area and may be only 2' deep at its deepest location.

Stormwater Catchment Area
The upgradient land area that drains toward the Brightwood Park Ponds is less than 6 acres. This upgradient area is predominantly urban residential development. The USGS Quad map indicates that the upgradient elevation contour is 260', while the Ponds at the Park are at elevation contour 220'. The upgradient catchment area is approximately 6 acres. Using a residential development stormwater runoff coefficient and the current annual rainfall, the maximum volume of runoff that could be directed to the Ponds is 5.3 Mgal./year. The Ponds would gain approximately 6 Mgals. of water per year from direct rainfall.

Based on the above areas and depths of the Ponds, it is estimated that they contain 9.8 Mgal. of water. The annual turnover of fresh water to the Ponds is approximately 1.2 times the Ponds water volume per year. A healthy water body would do well with 5-6 water turnovers per year. At a little more than 1 turnover per year, the water body will struggle to remain fresh. As witnessed by the need to aerate the Main Pond, to reduce the amount of algae blooms.

The Westfield DPW initially installed spray aerators; however, they clogged a lot and were recently replaced with 4 aeration bubblers in the Main Pond. This still does not address the anaerobic condition of the water as it still has a large amount of algae blooms. This may be the most important current lake deficiency that needs to be addressed.

Water Quality
The Ponds are not identified in the NJDEP Surface Water Quality Standards; therefore they have a FW-2 designation. The 7:9B-1.14(d) General Surface Water Quality Criteria (WQC) for FW-2 waters would apply. Several initial water indicator tests were performed. The water temperature was 22 degrees Celsius; the WQC is 30 degrees Celsius. The pH was 7.4; the WQC is 6.5 – 8.5. The TDS was 200 ppm;

the WQC is 500 ppm. The dissolved oxygen (DO) was not tested, but the abundance of algae would indicate a DO deficiency. The complete 7:9B-1.14(d) WQC for FW-2 waters should be tested by a state-certified laboratory.

Malodors
While conducting the field investigation, it was noted that there was a strong methane and/or hydrogen sulfide malodor that coincided with the areas of the algae blooms. Methane and hydrogen sulfide are an anaerobic decomposition by-product. Typically, the organic decomposition at the lake bottom off-gasses these malodors to create this condition.

Surrounding Soils
The SCD soil series in the area indicates an Udorthent soils series (the refuse area), and predominantly Boonton and Parsippany soil series. These soils are underlain by glacial soils on the receding side of a terminal moraine, as per NJGS mapping. The bedrock is a sandy mudstone from the Lower Jurassic and Upper Triassic Passaic Formation that has a surface elevation of 100'. The over burden is therefore estimated to be 120' thick in this area. The outfall surface waters of the Ponds seep into the glacial overburden sands and to the groundwater table.

Site's History
The site's history is not fully developed, but there is surface debris in the northwest corner of the property just north of the small pond. This area may have been a municipal dump in earlier times. A Phase I Environmental report would uncover the site's past history.

Offsite Impacts
Contributing to the eutrophication of the ponds are the off-site impacts. The ongoing residential construction surrounding the Ponds has lead to an increase in sedimentation and deposition at the headwaters of the small pond. The upgradient urban residential development includes a detention basin outfall, a stormwater runoff collection system of catch basins, and stormwater swales. The sediment buildup is evident in the small pond. In addition to the sediment; road salts, petroleum hydrocarbons, and residential landscape care herbicides, pesticides, fertilizers, and soil amendment products also wash into the ponds.

Recommendations
There are several upgrades that can be made to the onsite Ponds and there are several programs that can be developed off site to improve the capture of sediment prior to reaching the Ponds.

The onsite upgrades are as follows:

- Increase the number of bubblers to the Main Pond to increase the dissolved oxygen in the Pond. The laboratory results from the WQC testing would identify the current DO levels to size the bubblers. Should Do levels be appropriate, bacterial treatment of the algae may be required.
- Connect the two Ponds by a full depth channel with a wooden pedestrian bridge overpass.
- Create a wetland habitat in the small pond to help remove the buildup of nutrients in the inflow and to buffer the Main Pond from sedimentation.
- Cleanup the surficial refuse on site.

The off-site programs would include the following:

- A residential education program or flyer to the adjacent neighbors on how to be a good environmental land steward to the Brightwoood Park.
- Determine if any sediment filters could be added to the existing catch basin system.

Implementation
The above improvements would require the following work:

- Work Plan approval
    - Township of Westfield
    - Funding source agency

- Background data
    - Phase I Report
    - WQC Laboratory testing
    - Property and topographic survey
- Planning
    - Conceptual design
    - Identify required regulatory approvals
    - Pre-application meetings with NJDEP
- Design
    - All regulatory approved designs
- Permitting
- Construction
- Monitoring
    - Construction specific
    - DPW ongoing maintenance

Brightwood Park Work Plan Provisional Cost Estimate

On-site Improvements	Specific Tasks	Costs
Background Data	Phase I Report	$4,000
	WQC Lab testing	$800
	Survey 38.9 acres	$30,000
Planning	Conceptual Plan	$2,400
	Pre-app mtg w/NJDEP	$1,800
Design	Bubblers, new channel, new wetland	
	habitat, & refuse area to clean	$14,000
Permitting	NJDEP - Wetlands General Permit	$2,800
	NJDEP - Land Use	$1,800
	U.C. SCD	$1,200
	Westfield Planning Board	$1,800
	Scotch Plains Planning Board	$1,800
Construction	Wetland habitat	$84,000
	Channel and Pedestrian Bridge	$14,000
	Aeration Bubblers	$5,000
	Refuse cleanup (extent dependent)	$5,000
Monitoring	Wetlands 5 yrs.at $2,000/yr.	$10,000
	Wetlands repair 5 yrs. at $3,000/yr.	$15,000
Westfield DPW Maintenance for algae	Bacterial Treatments $1,000/yr.	TBD
Project Management, Construction Phase QA & QC	Project Management, Construction Phase QA & QC	TBD
Off-site Programs	**Specific Tasks**	**Costs**
	Residential Educational Program or flyer	TBD
	Catch Basin sediment filters	TBD
TOTAL COST ESTIMATE		**$195,400**

Goal 4C: Restore health of lakes by controlling the resident Canada goose population.

The control of resident Canada geese must be coordinated with the United States Department of Agriculture Animal and Plant Health Inspection Service Wildlife Services. The Town of Westfield and the Rahway River Association, in concert with Wildlife Services, may attempt one or more techniques to reduce the population of Canada geese at Brightwood Park. Appendix K is a USDA APHIS Wildlife Services document entitled "Fact Sheet: A Community Based Approach to Dealing with Canada Goose Damage". This document provides holistic strategies that could improve the health of lakes at Brightwood Park.

A cost estimate cannot be determined until after consultations with USDA APHIS Wildlife Services and formulation of an action plan. In general, costs can be minimized or eliminated with the use of volunteers to implement the action plan.



Resident Canada geese are contributing to the eutrophication of the main lake. Goose excrement can be found wherever vegetation does not block their access to the lake. Algal blooms are evident along the edges of the lake and may be fostered by nutrient additions from geese.

Section IV. Monitoring Protocols

Measuring effectiveness of invasive species control efforts and the response of conservation targets allows for adaptive management. Monitoring also provides continuing moral support to land stewards through a long-term project, demonstrates continuing success to outside funding agencies and provides guidance to other land managers. In addition, monitoring is critical to our long-term understanding of the complexities of ecology and our efforts to mitigate negative human influences on natural systems.

Monitoring protocols should be simple but scientifically rigorous, inexpensive, rapid and produce output that is easily interpreted by non-scientists. Direct measurement of changes in invasive species and/or conservation targets (baseline and post-treatment) should rely heavily on simple techniques such as 'presence/absence' data, which allows for rapid data collection across large areas. The key component of practical monitoring protocols is that they measure relatively coarse but ecologically significant responses.

The measurement of conservation targets is of equal or greater importance to measuring changes in invasive species cover. For example, dense cover of native shrubs and/or herbs is essential to the health of forest systems. These elements of our native flora should respond to removal of invasive species (when deer densities are relatively low) and can be easily measured. There will be a continuing presence of certain invasive species for many decades, but small lingering populations are less important if the native plant community is robust and resistant to large infestations.

The setting of thresholds to determine ultimate success will be exceedingly difficult and largely subjective. [Ecology is an extremely complex science with incalculable interactions among species and strong dependence on initial conditions (i.e., "Chaos Theory").] For instance, a reasonable threshold for forest habitat is to maintain the frequency of plots containing invasive species below 1%. This subjective threshold should not be considered a 'magic number', but illustrates the concept that the goal is to maintain a very low cover of invasive species in forest habitat. A large benefit of monitoring is that it can detect trends over time. If the invasive species frequency starts at 20% and drops by 5% each year for three years, then the treatment is obviously having a positive impact even if the final percentage has not reached the threshold of 1%.

The monitoring protocols suggested in this section are conducive to participation by advanced high school students. The protocols can be used 'as is' or modified to fit particular science projects as long as the essential elements are retained. The Rahway River Association can provide assistance in modifying the protocols for instructors / land stewards if particular aspects (e.g., GIS technology) are not conducive to high school science projects / volunteer monitoring efforts.

<u>Method Descriptions</u>

The following describes methods recommended for monitoring invasive species and conservation targets. The exact use of these protocols will be dependent upon plan implementation strategies that may necessitate small alterations as they are applied to actual circumstances in the field. Therefore, these protocols should be considered guidelines that may require future adaptation.

Sample Plots - This is a simple protocol utilizing random placement of sample plots within various habitats and recording the presence/absence of key community components (a.k.a. response factors). This method requires minimal plant identification skills.

The plot selection protocol is most easily implemented by using GIS (see Table 11 for details). The spatial location of plots can then be transferred to a GPS unit and located in the field. Data can be directly entered into a customized GPS-based collection system and transferred to a database for summarization and analysis. This method requires GPS/GIS abilities that can be learned relatively quickly and are ultimately more efficient to alternative protocol implementation methods involving printed maps, tape

measures, and collecting data on blank printed data sheets followed by hand-entering data to a computer. However, this technology-heavy data collection method is usually beyond the reach of most organizations. Therefore, simplified rules for plot placement (e.g., regular distances along a compass bearing and recording of data on printed data sheets) is an acceptable alternative.

A sample size of one plot per every two acres is recommended for forest habitat. This figure is arbitrary, but is expected to produce robust data sets (i.e., large sample size) in a reasonable amount of time. Sampling time may vary by habitat but it is expected that each plot will require approximately 10 minutes per 3 person team (30 staff minutes total). Therefore, 50 acres will require 50 plots and approximately 8 hours each for 3 staff members. Costs can be substantially minimized by utilizing a single trained staff member accompanied by minimally trained interns or volunteers. The Rahway River Association can provide training if requested by stewards of Brightwood Park.

Table 12 provides a sample summary data table that would be generated in forest habitat. Expanded explanations and a listing of all measured parameters for all habitat conservation targets are included as Appendices J-1 and J-2, respectively. Table 13 provides a summary of measured parameters and their thresholds for each habitat conservation target (see above for discussion of management implications of thresholds).

Sentinel Seedlings and Forest Secchi - These methodologies were developed by the author to monitor the impacts of deer on forest health and have been applied by various organizations in New Jersey. Rationale and implementation details for this protocol are located in Appendix I.

Statistics

The primary goal of monitoring is to determine effectiveness of management strategies and statistical analyses are not required. As a general rule, management actions should produce results that are indisputable (i.e., changes in response factors are substantial and obvious). In other words, biological significance, rather than statistical significance, should validate management actions. However, it is important to note that careful inspection of changes in multiple response factors will be required to fully interpret results.

If statistical analyses are desired, then it is recommended that simple non-parametric analyses (e.g., Chi-square and related methods) be utilized to compare changes in response factors over time. These analyses are generally robust and avoid assumptions regarding the distribution of collected data sets.

Table 10. Monitoring Plot Selection Protocol

Step	Goal	Notes
1	Create 30 meter x 30 meter GIS monitoring grid across entire property	This is a relatively straight-forward task for a GIS technician.
2	Create GIS polygons bounding the area of interest	Forest habitat is the most relevant area of interest at Brightwood Park
3	Randomly select the appropriate number of grid points within the area of interest.	Sample density target is 1 point per 2 acres of habitat. Sample points should not be considered if they are within 25 meters of non-target habitat (e.g., if a forest point is within 25 meters of wildflower meadow habitat) or within 10 meters of a trail.
4	Utilize GPS and data recording system to locate and record data	Customized systems can be generated quickly by GIS technicians. It should be noted that GPS units with appropriate software for this task currently cost approximately $1,000.

Table 11. Example Monitoring Data Summary Table

Habitat Type:	*Forest (upland and wetland)*
Project Area Size:	*34 acres (forest areas only)*
Plot Density (plots/acre):	*0.5*
Number of Sample Points Utilized:	*17*
Current Data Collection Date:	*Year – Month – Day*
Last Data Collection Date:	*N/A (Baseline in 2009)*
Number of Previous Data Collection Dates:	*0 (Baseline in 2009)*
Total Woody Cover within Browse Zone	% via Forest Secchi
Native Woody Cover within Browse Zone	% via Forest Secchi
Non-Native Woody Cover within Browse Zone	% via Forest Secchi
Total Canopy Cover	% via Densiometer
Native Canopy Tree Individuals	Number per 10m^2 circle via Census
Non-Native Tree Individuals	Number per 10m^2 circle via Census
Native Trees & Shrub Seedlings	% present via Presence/Absence in 0.5m^2 plot
Non-Native Tree & Shrubs Seedlings	Percent present via Presence/Absence in 0.5m^2 plot
Native Herbs & Grasses	Percent present via Presence/Absence in 0.5m^2 plot
Non-Native Herbs & Grasses	Percent present via Presence/Absence in 0.5m^2 plot

Table 12. Monitoring Protocols and Thresholds

Conservation Target	Method Name	Response Factor Number	Response Factor Measured	Threshold Guidance	Note
Forests	Sentinel seedlings	N/A	Planted red oak or green ash seedlings in uplands or wetlands respectively	≤ 10% of seedlings browsed over 6 months	See Appendix I for additional details. This technique measures potential to produce advance regeneration (i.e., native tree seedlings are not browsed by deer). It is an experimental approach that allows a preview of observable recovery toward a healthy forest. *This protocol is unnecessary if a deer exclosure is erected.*
Forests	Forest Secchi	1	Total woody cover within the deer browse zone		See Appendix I for additional details. This technique can be used along with the Sentinel Seedlings and/or added to the Sample Plots protocols in forest habitat.
Forests	Forest Secchi	2	Native woody cover within the deer browse zone	≥ 70% cover	See Appendix I for additional details. This technique can be used along with the Sentinel Seedlings and/or added to the Sample Plots protocols in forest habitat.
Forests	Forest Secchi	3	Non-Native woody cover within the deer browse zone	≤ 1% cover	See Appendix I for additional details. This technique can be used along with the Sentinel Seedlings or added to the Transects and Plots protocols in forest habitat.
Forests	Sample Plots	4	Total canopy cover	≥ 60%?	Young and medium aged forests tend to have canopy cover exceeding 90%, whereas old growth forests are typified by canopy gaps and cover may range from 60-80%. This lower density canopy cover tends to increase shrub and herb cover.
Forests	Sample Plots	5	Number of native tree individuals within 10 square meters of sample plot	≥ 99% of total number of canopy trees	
Forests	Sample Plots	6	Number of non-native tree individuals within 10 square meters of sample plot	≤ 1% of total number of canopy trees	
Forests	Sample Plots	7	Frequency of native grass species	≥ 10% of plots	Native grass species are relatively uncommon in forest habitat (especially upland forests)
Forests	Sample Plots	8	Frequency of non-native grass species	≤ 1% of plots	
Forests	Sample Plots	9	Frequency of native herb species	≥ 30% of plots	In general, native herb abundance will be inversely related to mature shrub abundance.
Forests	Sample Plots	10	Frequency of non-native herb species	≤ 1% of plots	
Forests	Sample Plots	11	Frequency of native woody seedling species	≥ 30% of plots	Woody seedlings should be relatively common, but also inversely related to mature shrub abundance.

Forests	Sample Plots	12	Frequency of non-native woody seedling species	≤ 1% of plots	
Conservation Target	**Method Name**	**Response Factor Number**	**Response Factor Measured**	**Threshold Guidance**	**Note**
Wildflower Meadows	Sample Plots	13	Frequency of native grass species	≥ 25% of plots	
Wildflower Meadows	Sample Plots	14	Frequency of non-native grass species	≤ 1% of plots	
Wildflower Meadows	Sample Plots	15	Frequency of native herb species	≥ 95% of plots	
Wildflower Meadows	Sample Plots	16	Frequency of non-native herb species	≤ 1% of plots	
Wildflower Meadows	Sample Plots	17	Frequency of native woody seedling species	≤ 1% of plots	
Wildflower Meadows	Sample Plots	18	Frequency of non-native woody seedling species	≤ 1% of plots	

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