Preserve Stewardship Plan

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Prepared for

New Jersey Conservation Foundation

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Purple False Foxglove is a beautiful
and common species of meadows at the Preserve

Introductory Information

Preserve Co-owners:	New Jersey Conservation Foundation, Somerset County Park Commission
Preserve Acreage:	1,145 acres
Municipality, County:	East Amwell Township, Hunterdon County Hillsborough Township, Somerset County
Wildlife Action Plan Conservation Zone:	Central Piedmont Plains (14)
NJDEP Watershed Management Area:	North and South Branch Raritan (WMA 08) - > 95% of Preserve Millstone River (WMA 10) - < 5% of Preserve (southeastern portion)
Waterbodies:	Neshanic River tributaries (Total = 5.2 miles) First Order = 3.4 miles, Second Order = 1.8 miles Pond (7.5 acres)
Numbers of Rare Species Conservation Targets[1]:	Total Number of Animal Species: 20 Total Number of Plant Species: 4 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: 2 State Threatened Species: 6 State Special Concern Species: 16 State Game Species of Concern: 0 Globally Rare Ecological Communities: 0 State Rare Ecological Communities: 0
Habitat Conservation Targets:	1) Forest, 2) Shrubland, 3) Meadow
Landscape-Scale Conservation Areas:	*ENSP Landscape Project Importance Summary* - Largest Habitat Patch - Forest - 13,578 contiguous acres This is the largest forest patch in the New Jersey Piedmont (contains 6,316 core forest acres, 21 rare animals and 8 rare plants) Largest Habitat Patch – Grassland – 43 contiguous acres *New Jersey Natural Heritage Program Priority Sites* - There are no sites that overlap the Preserve. *New Jersey Audubon Society Important Bird and Birding Areas* – Amwell Valley Grasslands

Species Conservation Target List[1]:

Reported from the Preserve or within its contiguous habitat patches (25)

Birds (18)
American Kestrel - nest (State Threatened), Barred Owl – breeding and non-breeding sightings (State Threatened), Bobolink – breeding sighting (State Threatened), Brown Thrasher – breeding sighting (Special Concern), Canada Warbler – breeding sighting (Special Concern), Cooper's Hawk – nest, breeding sighting (Special Concern), Eastern Meadowlark – breeding sighting (Special Concern), Grasshopper Sparrow – breeding sighting (State Threatened), Great Blue Heron – foraging (Special Concern), Hooded Warbler – breeding sighting (Special Concern), Kentucky Warbler – non-breeding sighting (Special Concern), Red-headed Woodpecker – non-breeding sighting (State Threatened), Savannah Sparrow – breeding sighting (State Threatened), Upland Sandpiper – breeding sighting (State Endangered), Veery – breeding sighting (Special Concern), Vesper Sparrow - breeding sighting (State Endangered), Wood Thrush – breeding sighting (Special Concern), Worm-eating Warbler – breeding sighting (Special Concern)

Retiles (2)
Eastern Box Turtle – occupied habitat (Special Concern), Northern Copperhead – occupied habitat (Special Concern)

Plants (4)*
Virginia Snakeroot – *Aristolochia serpentaria* (S3), Slender Toothwort – *Cardamine angustata* (S3), Purple Blazing Star - *Liatris spicata* var. *spicata* – (S3), Long-spur Violet – *Viola rostrata* (S3)

E=State Endangered; S1=Critically Imperiled (< 5 known populations); S2=Imperiled (6-20 known populations), S3=Rare (21-100 populations).

*Species observed during field surveys by G. Milly. There were no NJ Natural Heritage Program records for rare plant species within the Preserve.

Additional Species Documented within the Vicinity of the Preserve

Birds (2)
Bald Eagle – foraging (State Endangered), Horned Lark – breeding sighting (State Threatened)

Habitats (1)
Vernal Pool

Plants (5)
Virginia Snakeroot – *Aristolochia serpentaria* (S3), Slender Toothwort – *Cardamine angustata* (S3), Northern Adder's-tongue – *Ophioglossum pusillum* (S3), American Yew – *Taxus canadensis* (S2), Long-spur Violet – *Viola rostrata* (S3)

[1] Species include those confirmed to be present within the Preserve or its contiguous habitat patch based upon requested database search requested on September 20, 2018 (Natural Heritage Database and Landscape Project Version 3.3). Additional plant species detected on the Preserve during 2018 field surveys are included.

Invasive Plant Species List:

Each invasive plant species was assigned an 'Action Code' based upon observations of current extent of infestations on the Preserve and within New Jersey. Codes include: "1" = immediate implementation of an eradication program across the entire Preserve, "2" = selective control measures to minimize negative impacts, especially in particular habitats and "3" = no direct control measures due to low probability of causing significant harm or species is very abundant and control measures are impractical. Particular species may be controlled through specific habitat restoration projects. See report for additional information on distribution, infestation severity and control recommendations.

Total Number of Mapped Invasive Species: 33

Action Code = 1 (10 species)
Beefsteak Plant, Callery Pear, Chinese Silvergrass, Japanese Spirea, Japanese Wisteria, Jetbead, Linden Viburnum, Mimosa, Oriental Photinia, Wintercreeper

Action Code = 2 (7 species)
Asiatic Bittersweet, Autumn Olive, Chinese Bushclover, Common Reed, Stinging Nettle, Tree-of-Heaven, Winged Burning Bush

Action Code = 3 (16 species)
Canada Thistle, Carpgrass, Cool Season Grasses, Garlic Mustard, Japanese Barberry, Japanese Honeysuckle, Japanese Stiltgrass, Mile-a-Minute, Morrow's Bush Honeysuckle, Mugwort, Multiflora Rose, Privet, Reed Canary Grass, Spotted Knapweed, Wineberry

Overabundant Native Animal Species:

This plan will address management of invasive species in the context of an overabundant deer population, which has a profound negative impact on conservation values. The Preserve is located within the NJ Division of Fish & Wildlife's Deer Management Zone #7 and Deer Management Units 220 (northern 2/3 of Preserve) and 237 (southern 1/3 of Preserve). Hunting dates and harvest regulations are currently under Regulation Set #7.

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Executive Summary

The Preserve represents an important example of protection of critical natural and recreational resources. This plan includes results of literature review, stakeholder interviews, a public survey, and field investigations conducted at the 1,145-acre Preserve. The Preserve includes lands owned by Somerset County Park Commission (SCPC) and New Jersey Conservation (NJCF). NJCF manages the portion owned by SCPC under a management agreement signed in 2013.

There are three main purposes of this stewardship plan. The first is to clearly state the vision and goals for the Preserve including protection of biodiversity and provision of recreational opportunities. The second is to carefully define conservation values, threats to their health, and strategies/actions to mitigate identified threats. The third purpose is to provide ample sources of reference material for stakeholders and the public to effectively navigate the many aspects of the Preserve and guide its adaptive stewardship over time.

The vision for the Preserve is to provide model stewardship of biodiversity along with excellent public recreation and educational opportunities. Although the primary objective is the enhancement and recovery of natural resources, providing recreational and educational opportunities are considered high priorities that can be balanced with the requirements of biodiversity.

The primary habitat conservation targets are forest and meadow, which form a mosaic at the Preserve. These habitats support multiple common and rare species of our flora and fauna. The Preserve represents an 'ecotone' between contrasting portions of the Sourlands known for their importance in providing interior forest and grassland communities. A total of 24 rare species have been documented to be utilizing the Preserve forests (e.g., Barred Owl, Kentucky Warbler, Virginia Snakeroot) and grasslands (e.g., Bobolink, Upland Sandpiper), although it is speculated that most grassland-dependent species are currently unlikely to be prevalent or have long-term sustainability on the Preserve. All habitats and species are under immediate threat from overabundant deer and invasive species.

Deer are having a dramatic negative impact at the Preserve. Forest habitats fall into two categories – "Empty Forest Syndrome" or "Infested Forest Syndrome". Fallen trees, especially through the ongoing and future loss of ash trees, are not being replaced due to excessive deer browse. Native shrubs and wildflowers are nearly absent throughout the forest. A local reduction of the deer density to 20 per square mile is absolutely critical to allow native species, freed from excessive browse, to exert ecological control of invasive species and produce healthy native plant communities. This will require intensive and strategic deer management. Stewardship goals also include management of meadows, which are disappearing quickly due to infestation by Autumn Olive – this is intended to provide habitat for pollinators and maintain populations of less area-demanding grassland bird species (e.g., Bobolink, Eastern Meadowlark).

The extent of invasive species infestation is significant. A total of 33 invasive species were detected. Approximately 80% of the mapped area was considered to be heavily infested with one or more species. The predominant invaders are Japanese Stiltgrass, Multiflora Rose and Autumn Olive. Importantly, 10 emerging invasive species were detected and should be immediately eradicated (e.g., Oriental Photinia) to prevent future damage. A "brute force" approach that seeks direct control of all invasive species is not practical. This plan recommends a strategic approach with the ultimate goal of significantly reducing invasive species through directed active control and ultimate reliance on ecological control to both reverse current infestations and resist future infestations.

Recreational opportunities will be provided for equestrians and hikers at the Preserve. Trails will be maintained through cooperation with local user groups. This will include extensive trails for long-standing equestrian uses including hunter pace. All equestrian trails will be evaluated for suitability to handle regular use by horses prior to receiving official designation. All equestrian trails will be dual use with opportunities for hikers. There will be a robust network of trails dedicated solely for hiking. Outreach efforts will include ample signage 'learning posts' and regular expert-led guided hikes.

This ambitious plan provides five primary stewardship, recreation, outreach and agricultural recommendations with thirteen associated goals (see next page). Full implementation of these goals is estimated to require over 4,380 hours of co-owner staff and nearly 4,350 hours of volunteer time. The total plan implementation cost is estimated at approximately $335,150 over the next 10 years.

Primary Plan Recommendations

This 10-year plan has five primary recommendations and thirteen associated goals. Goals are further divided into specific tasks with associated level-of-effort and cost estimates (Table 35). A summary of annualized and total plan period goals, priorities and costs are provided in Tables 35 and 36, respectively.

Recommendation #1: Foster Recreational, Outreach and Agricultural Activities

Goal #1-1: Create an Integrated Trail System with Public Parking Access
Provide parking access and enhance/modify existing trail network to facilitate horseback riding and hiking

Goal #1-2: Create a Cultural, Historical and Natural Heritage Outreach Program
Annually provide three guided hikes and utilize 'learning posts' within trail system

Goal #1-3: Perform Preserve Maintenance
Perform initial site cleanup and perform routine tasks to assure public safety and enjoyment of the Preserve

Goal #1-4: Develop an Agricultural Use Agreement
Develop long-term agricultural lease on 130 acres of existing farmland

Recommendation #2: Perform Forest and Meadow Habitat Maintenance and Restoration

Goal #2-1: Restore 25 acres of old forest understory

Goal #2-2: Foster forest establishment on 32 acres through guided old field succession

Goal #2-3: Restore or maintain 105 acres of native wildflower meadow

Recommendation #3: Perform Strategic Invasive Species Control

Goal #3-1: Eradicate 10 emerging invasive species

Goal #3-2: Perform selective control of 7 widespread invasive species

Goal #3-3: Protect high quality "Clean" areas on 120 acres

Recommendation #4: Provide Stewardship of Rare Species and Perform Ecological Monitoring

Goal #4-1: Perform selective rare species monitoring and stewardship

Goal #4-2: Perform ecological health monitoring program

Recommendation #5: Implement an Effective White-tailed Deer Management Program

Goal #5-1: Reduce deer density to meet forest health goals including a dense, native understory

Table of Contents

List of Tables, Figures, Maps and Appendices

List of Tables

List of Figures

List of Maps

List of Appendices

Individual Invasive Species Maps (arranged alphabetically by common name)

Section I. Overview

Introduction

The Preserve consists of twenty-three parcels totaling 1,145 acres in East Amwell Township, Hunterdon County and Hillsborough Township, Hunterdon County (See Table 1, Map 1). The Preserve co-owners include the New Jersey Conservation Foundation (NJCF) and Somerset County Park Commission (lands owned by the Commission are managed by NJCF under a management agreement – See Appendix A).

A 30-acre portion of Block 169, Lot 5.02 (Hillsborough Township) carries a Grant of Life Estate with Lise Thompson and Robert Brander (Map 1, Appendix B). Grantee rights include agricultural and woodland management activities. The Grantor is permitted to maintain a trail along the northern edges of the subject area to access the remainder of the Preserve.

Multiple stakeholders contributing to the preparation of this plan are provided on Page iii. This Stewardship Plan was created to collect and consolidate relevant information to jointly develop strategies to improve the ecological health and recreational and outreach opportunities within the Preserve.

This section provides a brief overview of vision and goals for the Preserve as well as a summary of conservation values, threats to conservation values, and the context for stewardship actions.

Collage of moss and lichens growing on a horse jump

Table 1. Preserve Parcel Ownership

Municipality	Block	Lot	Former Owner	Current Owner	Acreage	Plan Inclusion
Hillsborough	169	5.02	Lanwin Develoment	Somerset County Park Commission	257.7	Yes
Hillsborough	169	5.04	Lanwin Develoment	Somerset County Park Commission	4.3	Yes
Hillsborough	169	6.02	Thompson Realty Co., of	Somerset County Park Commission	9.0	Yes
Hillsborough	169	6.03	W. Bryce Thompson, IV	Somerset County Park Commission	10.0	Yes
Hillsborough	169	7.07	?	Somerset County Park Commission	2.2	Yes
Hillsborough	169	13.01	Thompson Realty Co., of Princeton, Inc.	Somerset County Park Commission	0.2	Yes
Hillsborough	169	14	W. Bryce Thompson, IV	Somerset County Park Commission	26.1	Yes
Hillsborough	169	15	W. Bryce Thompson, IV	Somerset County Park Commission	9.8	Yes
Hillsborough	169	18	W. Bryce Thompson, IV	Somerset County Park Commission	4.9	Yes
Hillsborough	169	19	W. Bryce Thompson, IV	Somerset County Park Commission	3.6	Yes
Hillsborough	169	21	Lanwin Develoment	Somerset County Park Commission	10.3	Yes
Hillsborough	169	23	Lanwin Develoment	Somerset County Park Commission	7.2	Yes
Hillsborough	169	4.02	Higgins	Somerset County Park Commission	4.5	Yes
Hillsborough	169	4.03	Higgins	Somerset County Park Commission	73.6	Yes
Hillsborough	169	25	Higgins	Somerset County Park Commission	160.0	Yes
Hillsborough	169	24.01	Higgins	Somerset County Park Commission	28.0	Yes
East Amwell	35	2	Higgins	New Jersey Conservation Foundation	263.9	Yes - Under Contract
East Amwell	35	3	Wertsville Industries	New Jersey Conservation Foundation	96.8	Yes - Under Contract
East Amwell	35	10	Higgins	New Jersey Conservation Foundation	126.6	Yes
East Amwell	35	12	Higgins	New Jersey Conservation Foundation	18.6	Yes
East Amwell	35	57	Higgins	New Jersey Conservation Foundation	8.8	Yes - Under Contract
East Amwell	35	60	Higgins	New Jersey Conservation Foundation	4.7	Yes
East Amwell	35	65	Wertsville Industries	Higgins	14.4	Yes - Under Contract
Totals					**1145**	

Conservation Values

The Preserve represents excellent examples of the natural heritage contained within the piedmont physiographic region. There were nearly 31 unique ecological communities identified during field surveys, including various forest communities dominated by Red Maple, Red Cedar, American Beech, Red Oak, Sugar Maple and Tulip Poplar. Shrubland and meadow communities, along with forest communities, create a mosaic of different habitats harboring diverse elements of our flora and fauna. The Preserve contains portions of Neshanic River tributaries. A total of 24 rare species have been documented to be utilizing the Preserve forests (e.g., Barred Owl, Kentucky Warbler, Virginia Snakeroot) and grasslands (e.g., Bobolink, Upland Sandpiper), although it is speculated that most grassland-dependent species are currently unlikely to be prevalent or have long-term sustainability on the Preserve.

Vision and Goals

The vision for the Preserve is to provide a collaborative model of stewardship for biodiversity along with provision of excellent recreational and educational opportunities. The five primary recommendations include: 1) Foster recreational, outreach and agricultural activities, 2) Perform Forest and Meadow Habitat Maintenance and Restoration, 3) Perform strategic invasive species control, 4) Provide stewardship of rare species and perform ecological monitoring and 5) Implement an effective white-tailed deer management program. Each of these recommendations includes action-oriented goals (See Section V). Public access will be provided for passive recreational opportunities such horseback riding, hiking, nature observation & photography, and cross-country skiing.

Complete realization of the vision and goals for the Preserve can only be met through cooperative efforts of the co-owners and stakeholders, which must also strive to foster participation of private landowners to implement wise stewardship fueled by deep appreciation of the natural world. Because of the complexity of the task at hand, this plan is considered a living document subject to change over time as additional information becomes available and results from ongoing efforts are evaluated. At a minimum, this stewardship plan should be revised every ten years. The careful stewardship of the Preserve will provide concrete examples of exemplary stewardship and community support that can be broadly applied throughout New Jersey.

Threats to Conservation Values

This section provides a brief overview of three significant factors that impact ecological health. These factors are interrelated and impact ecological health synergistically. In isolation, deer overabundance is the most severe threat, followed by invasive species and continuing impacts of altered soils from past agricultural use.

Degraded forests in New Jersey generally fall under two ‘syndromes’. The first is the “Empty Forest Syndrome” where all native species have been removed from the forest understory by overabundant deer. These forests also have very low invasive species cover, except where canopy gaps provide additional light resources. This syndrome is usually associated with areas that have never received agricultural soil tillage and associated soil alterations (1930 aerial photography showing mature forest cover can act as a guide to determine the lack of past agricultural land use). The second syndrome is the “Infested Forest Syndrome”, which includes dense invasive species cover and small amounts of native cover that is severely browsed by deer. This syndrome is associated with: 1) upland forests with past agricultural tillage that has dramatically altered soil characteristics, 2) many wetland forests regardless of past land use, and 3) riparian forests, especially where unnaturally high water flows create severe and repeated physical disturbances.

White-tailed Deer

Statewide deer population size has varied significantly over the last one hundred years (Figure 1). The historical analysis of the white-tailed deer population density in North America (pre-European colonization) is approximately 10 per square mile (McCabe and McCabe 1984). Figure 1 shows the estimated statewide population size based upon the historical estimate for North America and deer population estimates reported by the New Jersey Division of Fish & Wildlife. By 1900, deer were nearly extinct in New Jersey because of unregulated market hunting for the sale of venison. The recovery of deer population, through the implementation of various game regulations, is a significant conservation success story. However, the deer population mushroomed during the 1900's and peaked in 1995 with 3X more individuals than pre-European estimates. In 2011, there was 1.5X more individuals than pre-European estimates (See notes under Figure 2 for details). In the late 1990's, the NJ Division of Fish & Wildlife implemented changes to reduce the deer herd (e.g., "Earn-A-Buck" program that encouraged harvest of antlerless deer). It is important to note that deer population reduction has occurred when 40-50% of the population is harvested annually (green line in Figure 2) and 60-70% of the harvest is comprised of antlerless deer (orange line in Figure 2). Although there have been recent important changes to facilitate hunting success (e.g., Sunday bow hunting, use of crossbows, reduction in the bow hunting safety zone), population levels continue to exceed pre-European densities with noticeable ecological, economic and human health impacts.

Figure 1. Historic and Current New Jersey Deer Population Estimates

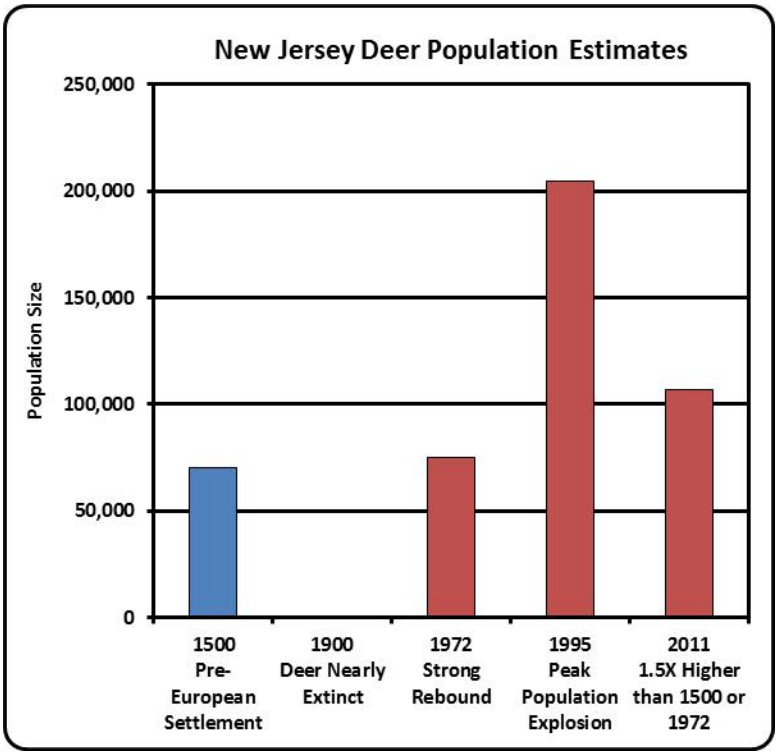
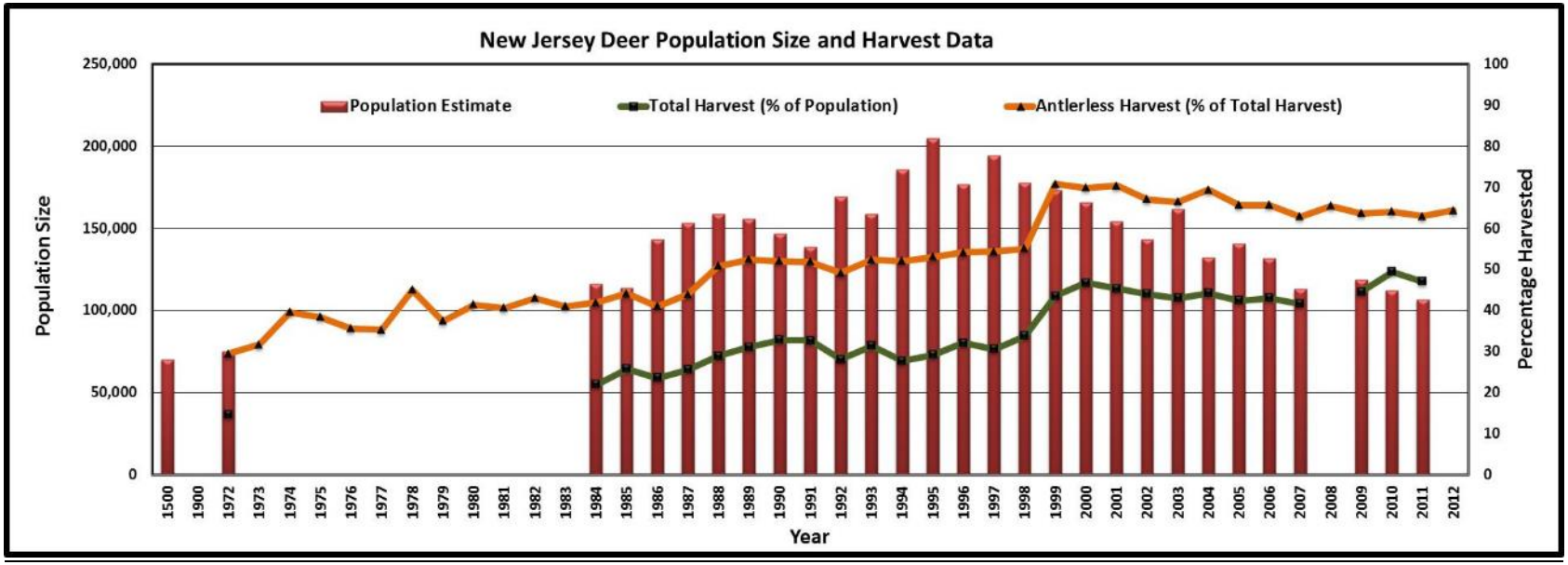


Figure 2. New Jersey Deer Population Size and Harvest Data



Graph prepared using NJ Division of Fish & Wildlife data sources. The estimated number of deer in 1500 is based upon the average deer density across North America (9.5/square mile) reported by McCabe and McCabe (1984) and the NJ land area reported by the US Census Bureau (7,417 square miles). Using this method, overall deer densities in particular years are: 1972 – 10.1; 1995 – 27.6 and 2011 – 14.4

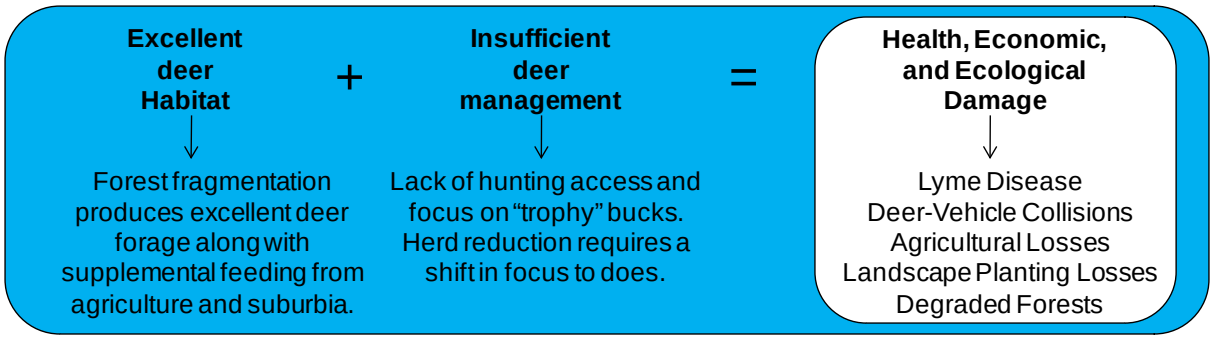
Special Note #1: Deer densities calculated by the Division of Fish & Wildlife are derived from harvest data and do not account for land inaccessible to hunting; therefore, they represent an under-estimate of actual deer population size. Species Note #2: Total population estimates are not available for 2008 or 2012.

The current effective deer densities on forested habitats are significantly greater than pre-Columbian densities because a considerable amount of land in New Jersey is developed / agricultural (ca. 50% of the total land area). In absolute numbers, the New Jersey deer population peaked in 1995 with 2.9X more individuals than pre-Columbian estimates. There is currently 1.5X more individuals than pre-Columbian estimates [but see special note #1 above].

It should be noted that the deer population size or density is less significant than their overall impacts on ecosystem health, which should be measured to inform deer management goals.

A simplified explanation of deer management issues and consequences are depicted in Figure 3. All deer management efforts must consider the current habitat conditions that serve deer population growth. Deer prefer forest edges and fields for feeding and utilize forests for cover and supplemental feeding. Deer also utilize agricultural crops as food sources and residential areas for both food and cover from hunters (state regulations prohibit firearm hunting within 450 feet of an occupied or potentially occupied structure unless written permission is provided by the owner, bow hunting is prohibited within 150 feet). Both restrictions on hunting access and insufficient hunting efficacy, plus the ability of the landscape to serve as an excellent incubator for deer population growth, combine to cause severe deer impacts.

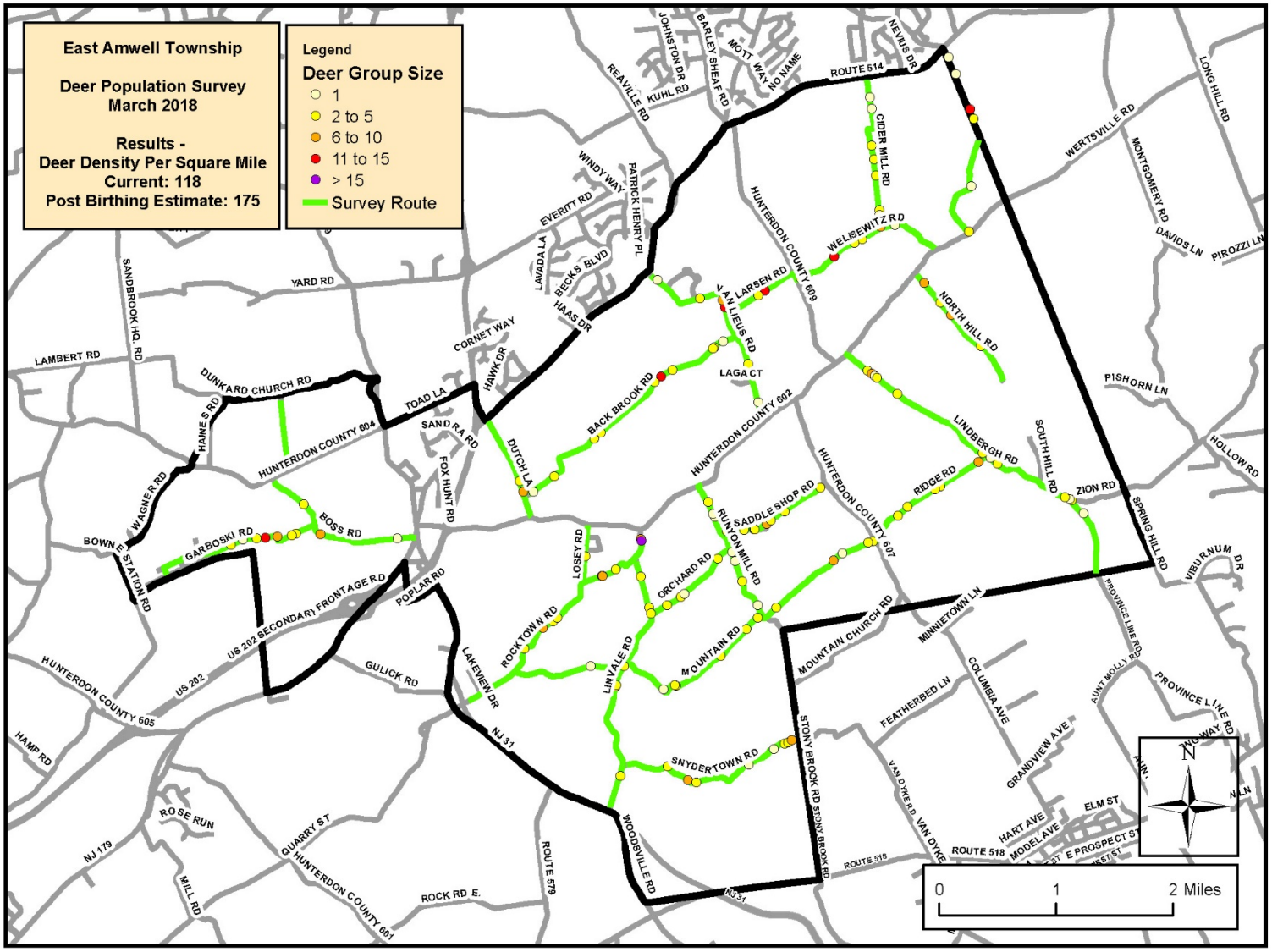
Figure 3. Deer Population Growth Factors and Impacts



The current statewide deer population cannot support healthy forests (and creates significant human health and economic impacts). 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 universal.

In East Amwell Township, deer population estimates are quite grim (Figure 4). In 2018, the deer population was estimated via nighttime distance sampling at 118 per square mile. This number was expected to grow to 175 deer per square mile after birthing occurred in summer 2018. The implications of this extremely excessive deer population are severe. While local and partial successes are possible under effective deer management programs (e.g., Ted Stiles Preserve at Baldpate Mountain), most forests in the East Amwell will continue to degrade. Deer management at the Preserve will have to be robust to assure local herd reduction compatible with reasonably healthy ecological communities.

Figure 4. East Amwell Deer Population Estimates (2018)



Invasive Species

Humans have introduced non-native 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).

From nature's perspective, this problem is relatively new with the first problems becoming apparent in the 1950's (Elton 1958). Accelerating infestations have only been occurring over the last 30 - 60 years in New Jersey with our most serious invasive species originating from areas with similar temperate climates (i.e., Europe and Asia).

Plants - In addition to being less palatable to deer, invasive plant species appear to have left behind many of their native pests and pathogens, which provide them additional benefits. In general, invasive plants are 'weedy' - maturing quickly, producing large seed crops, and having tolerance to a variety of disturbed or human-altered growing conditions. Overall, there are nearly 1,000 non-native plants in New Jersey. There are currently 34 widespread invasive plants and 137 emerging or potentially invasive plants in New Jersey (see New Jersey Invasive Species Strike Team). 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). There are no estimates of the area infested by invasive plants in New Jersey, but it is likely that hundreds of thousands of acres are impacted.

Some of our most notorious invasive plants include Japanese Barberry, Japanese Stiltgrass and Garlic Mustard. Although these widespread species cause severe harm, they are likely to be significantly reduced through ecological control exerted by taller, shade tolerant native species if deer populations are reduced. Among the emerging invasive species, a new class of invasive species is more threatening to forests than our existing invasives. These new species would be resistant to ecological control by native species because they are very tall (12- 20 feet), shade tolerant (can establish under closed forest canopy), and produce large amounts of bird dispersed seed capable of quickly reaching new locations. The five most troubling species are Oriental Photinia, Common Buckthorn, Siebold's Viburnum, Linden Viburnum (now considered widespread) and Japanese Aralia.

Animals - Invasive animals also cause significant harm to native ecosystems. There are currently 21 widespread invasive animals and 23 emerging or potentially invasive animals in New Jersey (see New Jersey Invasive Species Strike Team). Our most widespread invaders (with impacts in parentheses) include: several earthworm species (all earthworms in New Jersey are non-native and severely alter native soils), Brown-headed Cowbird (nest parasite of many birds including forest interior birds - impacts are highest in fragmented forests), Feral Cats (kill large numbers of birds), European Starling (nest competition, primarily in human-dominated areas), Asian Tiger Mosquito (human pest and unknown ecological damage), Rusty Crayfish (alter aquatic communities), Asiatic Clam (impact aquatic systems), and Red-eared Slider (competes with native turtles, especially painted turtles).

The most troubling emerging or potentially invasive species include Feral Hog, Zebra and Quagga Mussels, Mute Swan, and Nutria, which all cause significant damage in the region. Feral Hogs have been noted in several locations across New Jersey with a significant population in Gloucester County that is being targeted for eradication by the Division of Fish & Wildlife. This species causes severe harm to

forest communities in other parts of eastern North America and is a considerable new threat to New Jersey. Zebra and Quagga Mussels cause significant harm to freshwater systems (zebra mussel has been documented in eastern Pennsylvania). Large populations of Mute Swan impact native waterfowl populations and Nutria compete with native wildlife and alter wetland communities.

Pests and Pathogens - Invasive pest and pathogens have the potential to radically alter plant and animal communities. There are currently 12 widespread invasive pests & pathogens and 20 emerging or potentially invasive pests & pathogens in New Jersey (see New Jersey Invasive Species Strike Team). Some of the most notorious invaders include Chestnut Blight, Hemlock Wooly Adelgid and Gypsy Moth. Chestnut Blight has reduced the once dominant American Chestnut to a transient understory tree that rarely produces fruit, Hemlock Wooly Adelgid has killed over half of the state's Eastern hemlocks (ca. 13,000 acres destroyed) with many remaining trees in poor health, and Gypsy Moth periodically ravages oaks leading to localized death of mature trees (including many 300+ year old trees at Hutchinson Memorial Forest). 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. While control of pests and pathogens are uncommon, the intensive work on Asian Long Horned Beetle has led to its eradication in New Jersey.

Other important widespread invasive pathogens include Dutch Elm Disease (continuing to cause damage, but mature American Elm and Slippery Elm are still common), Beech Bark Disease (caused tree death throughout the state, remaining trees appear to be mostly immune) and Dogwood Anthracnose (many plants are not severely impacted and ultimate impacts are unknown).

There are a number of emerging and potential pests and pathogens that may impact the Preserve. Emerging species already present in New Jersey include Viburnum Leaf Beetle (discovered in 2009, has potential to severely impact species such as maple-leaved viburnum, arrowwood, and other viburnums as evidenced in New York state over the past 10 years) and Bacterial Leaf Scorch (BLS). 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 recently tested trees were infested across the state), but spread into more natural settings appears to be occurring (J. Arsenault, personal communication). Ultimate impacts of BLS in natural areas are unknown, but the risk should be considered moderate at this time. Sudden Oak Death (SOD) is also a significant potential threat. The NJ Department of Agriculture was quick to respond to the unintentional introduction of SOD 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. Other potential threats include Pine Flat Bug, Asian Gypsy Moth, Eurasian Nun Moth, Dutch Elm Disease 2, Phytophthera Root Rot, European Oak Bark Beetle, and two species of Ambrosia Beetle.

Unfortunately, Emerald Ash Borer has become established in New Jersey and is likely to occur on the Preserve. While a biological control agent (parasitic wasp) is being released currently, it is likely that New Jersey will lose over 90% of its ash trees even if the control agent eventually becomes effective.

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 principle 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 do 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. Eradication should also be considered at 'showcase' lands. 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 lands within the context of a human-dominated environment in order to support healthy native plant and animal 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 Preserve or to minimize spread onto surrounding areas. This approach is warranted for invasive species that are emerging locally or regionally and for widespread invasive species with limited distribution at a particular property.

A habitat-led approach should be employed when conservation values within a defined area are threatened by invasive species that are widespread throughout the region and the Preserve. 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.

The management of invasive species can be classified into five broad methods referred to as mechanical, chemical, biological, cultural and ecological control (Table 2). 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 3).

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.

The application of pesticides is regulated by the NJ Department of Environmental Protection - Pesticide Control Program (PCP). Lead staff members within the co-owners involved with the application of herbicides within the Preserve 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 categories that cover any potential applications in natural areas and stewards of the Preserve 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 (required for wetland applications).

Additional staff or seasonal interns may opt to become ‘certified pesticide operators’, which requires attendance in a one-day training course on pesticide safety and receipt of 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 current 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, interns 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. While volunteers can legally apply herbicide, this should be avoided on the Preserve.

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 an herbaceous wetland).

Very interesting (and unknown) species of caterpillar at the Preserve

Table 2. 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	Requires extensive resources 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; trained 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 by removing the native shrub layer

Table 3. Specific Control Techniques by Invasive Plant Class

Invasive Species Class	Suggested Treatment Techniques [1]	Notes
Large tree	Basal Bark, 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

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 been very effective toward eliminating persistent infestations, making loosestrife a small component of plant communities with only transient outbreaks that are quickly tamped down. 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.

Biological control agents for mile-a-minute have naturally dispersed within the Preserve and are having impacts on both of these invasive species. 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 multiflora 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 and reverse*** infestations 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 locally remedied is overabundance of white-tailed deer.

The native *Clematis virginiana* (Devil's Darning Needle)
grows throughout hedgerows at the Preserve

Altered Soils from Past Agricultural Use

Natural plant communities growing on former agricultural areas are often beset with infestations of invasive species due to degradation of soils. It is not uncommon to find clear demarcations of infestations in forest habitat (e.g., one side of stone wall or stream is severely infested while the other side is minimally infested). Anecdotally, these demarcations are correlated with former agricultural areas as shown in 1930 historical aerial photography. Presumably, areas showing forest cover in 1930 had never been plowed. It appears reasonable to assume that formerly tilled areas are much more susceptible to invasion than untilled areas.

Native forest soils consist of a series of layers. The "O Horizon" is the top layer and consists of fresh and incompletely decomposed organic matter (i.e., leaves and humus). The next layer is the "A Horizon", which consists of mineral soil mixed with organic material leached down from the O Horizon. The remaining horizons (E, B and C) are defined by chemical leaching and accumulation of minerals over time and contain little or no organic material. Bedrock is located under the C Horizon.

Formerly tilled agricultural soils are quite different than native soils. In general, all soil horizons within one foot of the surface have been mixed into a uniform and unnatural soil horizon. In addition, traditional agricultural activities (e.g., repeated tilling, application of lime and phosphorous, utilization of heavy machinery) create long-term soil changes including loss of organic matter, elevated pH, increased amounts of calcium and phosphorous, and compaction from machinery causing poor water infiltration. These changes also induce fundamental changes in nitrogen cycles and composition of soil microorganism species composition. All of these changes have implications for seed germination and root growth. Although many common native species can grow on these altered soils, it appears that weedy invasive species are most aggressive under these conditions.

The impact of earthworms is also associated with former agricultural activity, but adjacent unplowed forest soils can also be infested. Over time, earthworms mix and eliminate the top soil horizons and virtually eliminate the O Horizon and change soil microorganism species composition. In addition to changing physical properties of the soil (i.e., removing the O Horizon), earthworms change the natural nitrogen cycle. The result is the conversion of nitrogen into a form more readily used by plants, but this increased availability also increases leaching of nitrogen out of the soils. In addition, this change in nitrogen availability causes a shift in soil microorganisms from being dominated by fungi to being dominated by bacteria. This change may impact roots of many native plants that can be physically connected to particular soil fungi (called mycorrhizal fungi) in a symbiotic relationship that allows plants to absorb particular nutrients from the soil.

Suspected relationships and impacts are presented in Figure 5. Actual data showing changes in forest and untilled soil measured in Hopewell Township, Mercer County, New Jersey are presented in Figure 6.

The combined impacts of past agricultural tilling, alone or in concert with changes induced by invasive earthworms, are profound. However, it is important to note that even though impacted forests may not achieve perfect health, substantial improvements in most New Jersey forests can be obtained (primarily by reducing deer browse pressure from native plants that have the ability to survive these altered soil conditions).

Figure 5. Suspected Impacts of Past Agricultural Tilling

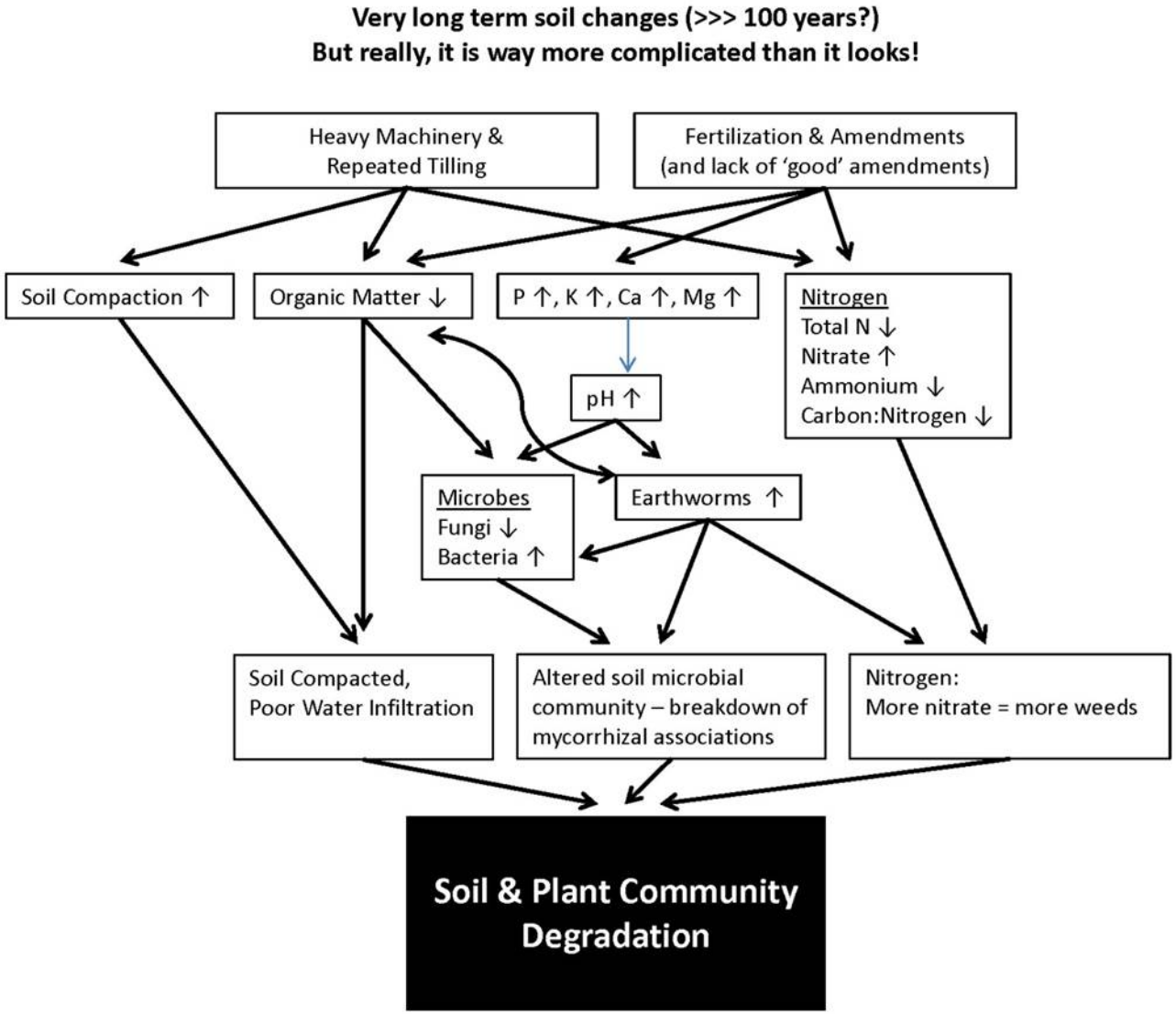
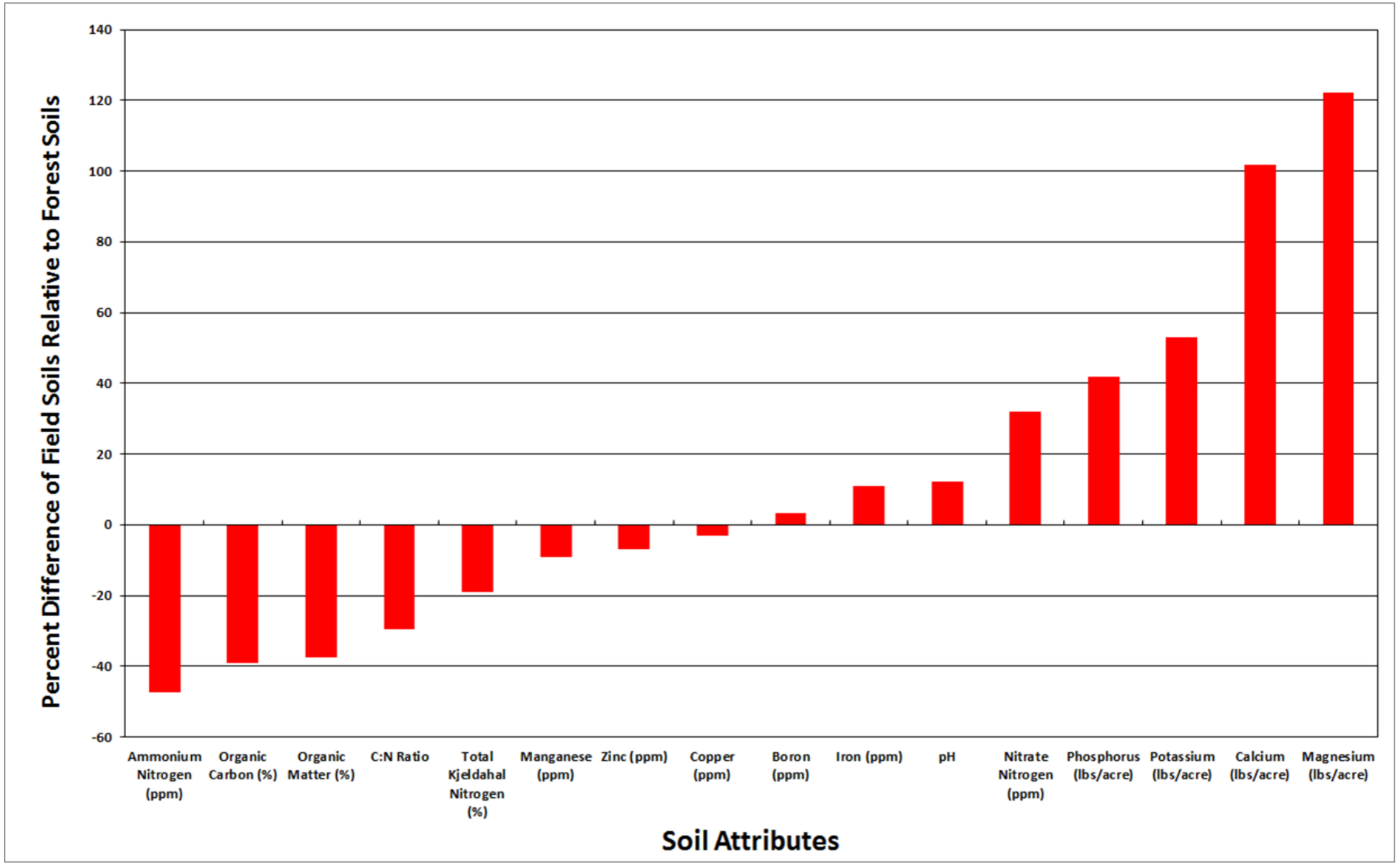


Figure 6. Measured Chemical Changes in Soils from Tilled and Untilled Soils



Stewardship Context

Stewardship activities must consider the context of the project area to maximize effectiveness. This plan section considers physical features, land cover (both historic and current), public sentiment (public survey results related to stewardship are reported here) and co-owners and stakeholders.

Physical Features

Geology – The presence of Jurassic Diabase bedrock geology, which underlies the northeastern portion of the Preserve, creates unique plant communities. These areas are associated with the highest elevations, moderate cliffs and boulder fields at the ground surface. The Passaic Formation and its subset, Passaic Formation Gray Bed, accounts for the remainder of bedrock within the Preserve. Table 4 provides a summary of the bedrock geology and Map 2 depicts bedrock distribution.

The topography within the Preserve is flat to gently rolling (80% has < 5% slopes). Elevations range from 180 to 300 feet above sea level. Steep slopes occur in particular locations (< 3% of preserve has slopes of 20% or greater), especially along the northeastern edge of the Preserve at the boundary of the Jurassic Diabase. There is a somewhat steep ravine formed by a tributary of Honey Brook in the southwestern portion of the Preserve. Topography is depicted in Map 3.

Table 4. Bedrock Geology Summary

Bedrock Type	Bedrock Description	Acres	Percent of Preserve
Jurassic Diabase	diabase, medium- to coarse-grained	6	1
Passaic Formation	siltstone and shale	941	81
Passaic Formation Gray bed	sandstone, siltstone and shale	211	18
Totals		**1158**	**100**

Soils – There are 31 unique soil series within the Preserve. The three most predominant soils are Lehigh silt loams (18%), Chalfond silt loams (15%) and Chalfond-Lehigh silt loam (7%). The majority of soil types (16) are minor (2% or less of the Preserve). A summary of soil types is provided in Table 5 and their distribution is depicted in Map 4.

Table 5. Soil Type Summary

Soil Symbol	Soil Type Description	Acres	Percent of Preserve
LemB	Lehigh silt loam, 2 to 6 percent slopes	122.0	10.5
ChcBa	Chalfont silt loam, 2 to 6 percent slopes, stony	95.7	8.3
LemC2	Lehigh silt loam, 6 to 12 percent slopes, eroded	89.9	7.8
CheCb	Chalfont-Lehigh silt loams, 6 to 12 percent slopes, very stony	77.9	6.7
ChcC2	Chalfont silt loam, 6 to 12 percent slopes, eroded	74.7	6.5
RehB	Reaville silt loam, 2 to 6 percent slopes	72.3	6.2
LdmB	Lansdale loam, 2 to 6 percent slopes	68.4	5.9
PeoC	Penn channery silt loam, 6 to 12 percent slopes	64.4	5.6
PeoB	Penn channery silt loam, 2 to 6 percent slopes	64.2	5.5
RorAt	Rowland silt loam, 0 to 2 percent slopes, frequently flooded	45.5	3.9
LdmC	Lansdale channery loam, 8 to 15 percent slopes	40.7	3.5
PepB	Penn-Bucks complex, 3 to 8 percent slopes	39.7	3.4
LemDb	Lehigh silt loam, 8 to 15 percent slopes, very stony	38.6	3.3
CoxB	Croton silt loam, 3 to 8 percent slopes	33.7	2.9
AbrA	Abbottstown silt loam, 0 to 3 percent slopes	30.1	2.6
ChcB	Chalfont silt loam, 2 to 6 percent slopes	29.8	2.6
PeoD	Penn channery silt loam, 12 to 18 percent slopes	25.1	2.2
CanBb	Califon gravelly loam, 0 to 8 percent slopes, very stony	22.8	2.0
PeoC2	Penn channery silt loam, 8 to 15 percent slope	21.4	1.9
LemD2	Lehigh silt loam, 12 to 18 percent slopes, eroded	20.0	1.7
RedB	Readington silt loam, 3 to 8 percent slopes	19.9	1.7
BucB	Bucks silt loam, 2 to 6 percent slopes	14.6	1.3
PepC2	Penn-Bucks complex, 8 to 15 percent slopes	12.3	1.1
Water	water	7.8	0.7
KkoC	Klinesville channery loam, 6 to 12 percent slopes	7.0	0.6
AbrB	Abbottstown silt loam, 2 to 6 percent slopes	6.1	0.5
RehC2	Reaville silt loam, 6 to 12 percent slopes, eroded	5.4	0.5
CoxA	Croton silt loam, 0 to 3 percent slopes	3.4	0.3
PenC	Penn silt loam, 8 to 15 percent slopes	2.6	0.2
LdmC2	Lansdale channery loam, 6 to 12 percent slopes, eroded	1.8	0.2
RepwB	Reaville wet variant silt loam, 3 to 8 percent slopes	0.2	0.0
Totals		**1158.1**	**100.0**

Water – There first and second order tributaries (totaling 5.2 miles) of the Neshanic River located in the Preserve. These streams all drain northward to the main stem of the Neshanic River and ultimately toward the Raritan River. A very small area of the southern portion of the Preserve drains toward Cattail Brook and ultimately to the Millstone River. There is a single, large pond (7.5 acres). There are no documented vernal pool habitats on the Preserve, but potential habitat was noted during field surveys (see Section III). Waterbodies are depicted in Map 5.

Land Cover – Historic and Current

There have been large changes in land cover at the Preserve since 1930. The 1930 aerial photography (Map 6) shows that the southern portion of the Preserve had mature forest cover (270 acres or 24% of the Preserve) with cultivated fields covering almost ¾ of the area. Older forests are depicted over the modern aerial photography, showing that large amounts of forest regenerated on the site after 1930 (Map 7). This pattern of land use requires careful consideration toward the development of stewardship recommendations. For example, former agricultural lands are now heavily infested with invasive species, while the original forest area seen in 1930 presents the best opportunity to maintain and improve forest health. Current shrublands and meadows are unlikely to develop into healthy forest habitat, possibly for many hundreds of years or longer as the soils slowly recover.

The land use within five miles of the Preserve is summarized below (Table 6 and depicted in Map 8). Approximately 25% of the area is developed and 30% is agricultural lands. The high percentage of developed and agricultural lands will create ongoing challenges toward the stewardship of the Preserve (e.g., deer refugia, sources of invasive species). The majority of natural cover is represented by forest and woodland habitat, followed by lower amounts of shrubland and meadow habitat. The Preserve is uniquely located on the boundary between large agricultural fields that may provide grassland bird habitat and large forest blocks. The Preserve is distinguished from its surrounding landscape in having significantly more forest and woodland habitats (64% inside vs. 35% outside – See Map 9).

Table 6. Preserve and Surrounding Area (5 Mile Radius) Land Use / Land Cover Types (2012)

Category	Acres	Percent of 5 Mile Area		Acres	Percent of Preserve Area
Forest - Coniferous - Upland	394	1		17.7	1.5
Forest - Coniferous - Wetland	8	0		0.0	0.0
Forest - Deciduous - Upland	10,306	21		340.0	29.4
Forest - Deciduous - Wetland	4,986	10		268.0	23.1
All Forest Cover	**15,694**	**31**		**625.7**	**54.0**
Woodland - Coniferous - Upland	242	0		33.5	2.9
Woodland - Deciduous - Upland	1,632	3		78.5	6.8
All Woodland Cover	**1,874**	**4**		**112.0**	**9.7**
Shrubland - Coniferous - Upland	1,518	3		31.2	2.7
Shrubland - Coniferous - Wetland	93	0		0.0	0.0
Shrubland - Deciduous - Upland	584	1		56.6	4.9
Shrubland - Deciduous - Wetland	390	1		3.0	0.3
All Shrubland Cover	**2,585**	**5**		**90.8**	**7.8**
Meadow - Upland	1,084	2		84.1	7.3
Meadow - Wetland	296	1		10.2	0.9
All Meadow Cover	**1,380**	**3**		**94.3**	**8.1**
Water	**415**	**1**		**8.5**	**0.7**
ALL Natural Cover	**21,948**	**44**		**931.3**	**80.4**
Agriculture	**15,103**	**30**		**220.1**	**19.0**
Barren	**357**	**1**		**0.0**	**0.0**
Urban	**12,856**	**26**		**7.0**	**0.6**
Totals	**50,264**	**100**		**1,158.4**	**100.0**

Protected Lands – There is a significant amount of protected open space and preserved farmland near the Preserve (Map 10). These lands include Sourland Mountain Preserve (Somerset County Parks and Hunterdon County Parks) and a complex of lands owned by D&R Greenway Land Trust known as the Sourland Ecosystem Preserve). There are also lands owned by the State of New Jersey (e.g., South Branch Wildlife Management Area), East Amwell Township, Hillsborough Township (e.g., Otto Farm Park) and other private and municipal lands within 2 miles of the Preserve (Cider Mill Grassland Preserve, Highfields Preserve).

Public Survey Results

The public survey was developed to determine interest in both stewardship and recreation/outreach at the Preserve (stewardship-related results are reported in this section, while recreation/outreach results are reported in Section II). Complete survey questions and results are reported in Appendix C. The survey contained eight questions and was made available on Survey Monkey for just over one month (early March through early April 2019). A press release was utilized to create public awareness of the survey and a link to the survey was provided by members of the co-owners and stakeholders.

Question #1: Provide zip code. There was a total of 160 respondents representing 48 unique zip codes. Sixty-percent of respondents were from Ringoes, Flemington, Hopewell, Hillsborough and Lambertville (all had double-digit respondents). There were 30 zip codes with only a single respondent from towns across New Jersey and four out-of-state respondents.

Question #2: Describe your relationship to the Preserve. The greatest interest was in recreational activities (84%), but interest in the ecology of the preserve (69%) and management decisions (58%) were also significant.

Question #3: How often do you participate in recreational activities? Respondents were very active outdoor recreationists (79% recreate more than 20 days per year). Approximately 21% of respondents recreate 1-20 times per year.

Question #4: Please indicate places where you currently enjoy outdoor recreational opportunities near the Preserve? Many of the surrounding lands are actively used by respondents and only 9% of respondents said that they do not recreate near the Preserve. The top three locations were Hunterdon County Sourlands (65%), Duke Farms (47%) and Somerset County Sourlands (39%). The remaining eight listed locations were visited by 10-30% of respondents.

Question #5: Please check the management concerns that you share with us. Generally, listed concerns were shared with respondents with combined "High or Moderate Concern" ranging from 79-93% and "No Concern" ranging from 1-8% for all listed items. Listed items included ecological topics (Deer Management, Invasive Species Management, Restoring Wildlife Habitat and Managing Rare Species) and recreational / human impacts (maintenance of trails/access, vandalism/littering and off-road vehicles).

Question #6: Please check the activities / amenities that you would like to see on the Preserve (provide nine choices). The most popular activity was hiking (90%). Activities ranging from 70-75% included deer management, nature photography, wildlife observation; interest from 45-60% included horseback riding, guided hikes, dog walking and picnicking; and interest < 20% included mountain biking.

Question #7: Please use this space to make any additional comments about past, present or future management of the Preserve. Fifty-three percent of respondents (85 people) provided comments. See Appendix C for verbatim comments.

Question #8: Are you interested in volunteering to help us on the Preserve? Twenty-eight percent of respondents (44 people) offered to volunteer on the Preserve.

Section II. Recreation and Outreach Plan

Introduction

The Preserve has great potential to foster recreational and outreach opportunities. Portions of the Preserve have been managed by the Amwell Valley Trail Association (AVTA), Amwell Valley Hounds (AVH) and a hunting club for over 20 years. These groups have created a dense network of trails totaling 23 miles on the Preserve, with additional trails linking the Preserve with neighboring private lands (Map 11). Trail use is carefully controlled by AVTA to avoid damage from horses in wet conditions. However, there are numerous stream crossings where streambank erosion is of concern or trails are blocked or narrow (See Map 11 and Table 7). There are 8 horse jumps located throughout the trail network (Table 8). Numerous vehicle access points exist, but none of these are currently suitable for public access (e.g., too small or only 4WD accessible - See Map 11 and Table 7). Structures and other human uses / issues were also documented at the Preserve (See Table 9).

There is a need to coordinate both recreational and outreach opportunities through a cohesive plan to maximize opportunities. Public survey results related to recreation and outreach are provided on Page 21. Four goals to improve both recreational and outreach opportunities, along with agricultural activities are provided below.

The total cost to implement all recommendations in this section is $29,250.

Table 7. Trail and Access Notes

Id	Longitude	Latitude	Note
1	-74.77778324	40.46492519	Public Access Parking - Primary
2	-74.77511499	40.45033226	Public Access Parking - Auxiliary
3	-74.77403531	40.44885361	Non-public - Access to gasline ROW
4	-74.78532446	40.46145933	Non-public - Access to existing homes
5	-74.78329635	40.46278859	Non-public - Stewardship Access
6	-74.76165641	40.47362973	Non-public - Stewardship Access
7	-74.76808778	40.47039243	Non-public - Stewardship Access
8	-74.77751757	40.46509846	Non-public - Access to be Closed
9	-74.77989763	40.45586731	Foot access leading to private residence
10	-74.78547505	40.45880576	Off Preserve - Cemetary parking lot
11	-74.78059717	40.46037817	Trail x Stream Crossing
12	-74.77984823	40.46094179	Trail x Stream Crossing
13	-74.76902748	40.45853066	Trail x Stream Crossing
14	-74.77406942	40.45719595	Trail x Stream Crossing
15	-74.77617876	40.46470403	Trail x Stream Crossing
16	-74.76408868	40.46678517	Trail x Stream Crossing
17	-74.76092466	40.47299544	Trail x Stream Crossing
18	-74.7725637	40.45090348	Trail x Stream Crossing
19	-74.7703876	40.45282122	Trail x Stream Crossing
20	-74.77983628	40.46099261	Trail x Stream Crossing
21	-74.77901518	40.46131356	Trail x Stream Crossing
22	-74.77576303	40.45787185	Trail x Stream Crossing - Footpath only to east
23	-74.77708542	40.45870005	Trail x Stream Crossing
24	-74.77359054	40.46275851	Trail x Stream Crossing
25	-74.75837196	40.46424754	Trail x Stream Crossing
26	-74.75307755	40.46641542	Trail x Stream Crossing
27	-74.75384374	40.46703352	Trail x Stream Crossing
28	-74.75485789	40.46914266	Trail x Stream Crossing
29	-74.75542583	40.46925074	Trail x Stream Crossing
30	-74.75597065	40.46892754	Trail x Stream Crossing - very narrow to north
31	-74.76933046	40.45336173	Trail Erosion on hill
32	-74.76686861	40.45272465	Large logs on trail
33	-74.76669977	40.45459152	Large tree on trail
34	-74.7716767	40.45006636	Large pond in trail
35	-74.777709	40.45815367	Downed tree blocked / closed trail
36	-74.77163987	40.45781478	Trail very narrow

Table 8. Horse Jump Locations

Point ID	Latitude	Longitude
1	-74.76496157	40.46871384
2	-74.76405801	40.46781605
3	-74.76375843	40.46566641
4	-74.76390963	40.46262776
5	-74.76414861	40.4624726
6	-74.76103879	40.46533878
7	-74.77945371	40.46343622
8	-74.77971396	40.46130656

Table 9. Structure and Issue Notes

Point ID	Category	Description	Latitude	Longitude
1	Trash	Abandoned Cars (2)	-74.76402707	40.45439346
2	Trash	Abandoned Truck	-74.76657661	40.45572306
3	Trash	Abandoned Car	-74.76911448	40.45473777
4	Trash	Rusty Drum	-74.77240973	40.4551938
5	Trash	Old Fire Pit w/trash	-74.77412903	40.44945877
6	Trash	Abandoned Car	-74.76813438	40.45388549
7	Trash	Old Panel Truck - sugar mapling	-74.75299156	40.45516524
8	Trash	Old metal fence rolls	-74.75300495	40.45497676
9	Trash	Tires, Metal Fencing	-74.76853346	40.45989375
10	Trash	Abandoned Cars	-74.76735299	40.46884694
11	Trash	Abandoned Tires	-74.780534	40.46050431
12	Trash	Large Trash Pile / Target Practice Area	-74.78074	40.45929188
13	Trash	Old Refrigerator	-74.7659488	40.45608508
14	Trash	Abandoned Tires	-74.78054075	40.46049938
15	Abandoned Structure	Abandoned - Cinder Block	-74.77085179	40.46147229
16	Abandoned Structure	Abandoned - Cinder Block	-74.7707268	40.46135772
17	Abandoned Structure	Abandoned - Barn	-74.7696945	40.46082217
18	Active Human Use	Active - Blue Trailer	-74.76937304	40.4605912
19	Active Human Use	Firepit and chairs	-74.76872354	40.45470311
20	Active Human Use	Pond Dam	-74.76963022	40.45612698
21	Active Human Use	Piped water (1' diameter) over trail to stream	-74.75851313	40.46452893
22	Active Human Use	Fire Pit with Bench	-74.75451094	40.4688124
23	Active Human Use	Residential Home and Associated Structures	-74.783374	40.459911
24	Active Human Use	Residential Home and Associated Structures	-74.782441	40.460811

Recommendation #1: Foster Recreational, Outreach and Agricultural Activities

This recommendation has four distinct goals; all directly or indirectly support public use and enjoyment of the Preserve. A variety of topics are covered below, including the incorporation of public survey results along with Preserve rules and policies.

The estimated cost to complete all goals under this recommendation is $x,xxx over the 10-year implementation period (See Tables 34 - 36). An additional $x,xxx of volunteer value is also required for this recommendation.

Goal #1-1: Create an Integrated Trail System with Public Parking Access

There are currently 23 miles of trails on the Preserve. The existing trails were created and maintained to support use by the Amwell Valley Trail Association, Amwell Valley Hounds and a hunting club. These lands were utilized by permission of the landowners, with coordination between the three user groups. Preserve access to these trails occurs from multiple locations in East Amwell Township and neighboring properties.

Existing trails are very intertwined and looping making them nearly impossible to navigate by hikers unfamiliar with the Preserve. To facilitate broader public use, trails will need to be simplified and/or clearly demarcated for their use (hiking or hiking / equestrian). Mountain biking will not be allowed on the Preserve as nearby facilities are better suited for this activity. An additional trail linkage, connecting through the forest from the East Amwell to Hillsborough parcels, will allow visitors to experience mature Sourland forests, creating a single, large loop trail (See Map 11 for conceptual forest loop trail path – final trail placement will be determined by the co-owners). For the entire Preserve, the goal will be to maintain 12 miles of trails, significantly simplifying the existing network.

The estimated cost to complete this goal is $9,900 over the 10-year implementation period (See Table 34). An additional $21,000 of volunteer value is also required for this goal.

Additional information regarding trails and other important aspects of the Preserve are provided below.

Deer Management Program and Trail Use

The goal of the Deer Management Program (DMP) is to foster the ecological health of the Preserve by reducing the local deer population. This will be accomplished while encouraging recreational use of the Preserve. Signage regarding the timing and location of hunting activities will be located along trails. The importance of deer management will be included on interpretive signage. The following provides an outline of the DMP showing accommodations for recreational uses.

1) Bow and gun hunting will occur every day of the hunting season throughout the Preserve, except for Sunday. Typically, bow seasons occur from early September through mid-February (excluding Sundays). Gun hunting seasons typically occur from late November through mid-February (excluding Sundays). The following limitations will apply:

a) Bow hunting will not occur within 150’ safety zones around trails and public parking lots
b) Firearm hunting will not occur within 450’ safety zones around trails and public parking lots

2) Signage will be maintained in the following areas:
   a) Entrance signs will be installed at the public parking lots. Signs will inform trail users of the timing and sporting arms (bow or firearms) being utilized for deer management activities.
   b) Signs along the length of the public hiking trail will remind trail users to stay on trails throughout the hunting season.
   c) Signs will delineate safety zones described above to inform hunters to keep away from trails.

3) Agricultural Depredation Permits and Deer Drives
   a) In coordination with farmers, NJCF will seek depredation permits through the NJ Division of Fish & Wildlife
   b) Coordinated deer drives will be allowed on the Preserve with prior approval from NJCF

Parking Areas

There will be a two public access parking lots located on the Preserve (Map 11, Table 7). The primary pubic access point will be located along Wertsville Road, while the secondary public access lot will be located along North Hill Road. There will be six additional non-public access points utilized for stewardship activities by the co-owners.

Preserve Signage

A relatively large Preserve entrance sign at the Wertsville Road entrance will be installed (allowing visibility of travelers from the east and west). Preserve boundary signs will be designed and installed around the perimeter of the Preserve. A single unified sign will be utilized for the entire Preserve (including all parcels owned by NJCF and Somerset County).

Preserve Uses and Rules

The Preserve is primarily considered a passive recreation area without facilities other than trails and parking access. The following prohibitions will apply to the Preserve:

- Preserve will be open from dawn to dusk
- Horseback riding will be allowed
  - Occurring on dual use trails shared by hikers
  - Hunter pace events will be allowed on a case-by-case base with permission from NJCF
- *Dogs are allowed on leash only*
- Motorized vehicles are prohibited (except for management purposes by co-owners)
- Bicycles are prohibited
- Removal of plants or animals is prohibited
- Camping and fires are prohibited
- Fishing is allowed, catch and release only
- Hunting of white-tailed deer will only be allowed as part of the NJCF Deer Management Program (see below). No other animals will be hunted on the Preserve.

Trail Creation and Maintenance

NJCF staff and volunteers will design, construct, mark, and maintain an approximately 12-mile long trail network in conjunction with local user groups. A significant amount of existing trails will no longer be maintained on the Preserve in order to simplify the network and reduce required maintenance.

The allowance of horseback riding will require significant maintenance, especially at stream crossings, and it is expected that local user groups utilizing the Preserve will contribute to regular trail maintenance. The goal is to have an overarching trail maintenance program that is robust enough to handle typical maintenance and respond to damage created by large storms.

Goal #1-2: Create Cultural, Historical and Natural Heritage Outreach Program

Knowledge of the importance and beauty of the Preserve and the surrounding Sourland Ecosystem should be made easily available to the public. The co-owners have expertise to create content for trail signage, kiosks and web content. These skills include a variety of ecological topics that would build a sense of place for the public. In addition, the co-owners will highlight Sourland cultural and site history elements by reaching out to local historians.

Full-color interpretive trail signage would be placed along the public hiking trails throughout the Preserve (approximately 20 signs total). A trailhead kiosk will be located at main parking access along Wertsville Road. Signage and kiosk content will be tied to website content so that the public has access to ample information to inform and entice them to visit. The website content will be maintained by NJCF, with links to partner groups.

The estimated cost to complete this goal is $5,050 over the 10-year implementation period (See Table 34). An additional $480 of volunteer value is also required for this goal.

The public survey showed a significant interest in expert guided hikes at the Preserve and NJCF and partner groups have skills and experience leading guided hikes and educational programs. To encourage an interest in the ecology, culture and history of the area, a variety of hikes should be provided throughout the year. A consistent program (e.g., every first Saturday of the month during the spring, summer and fall) with a minimum of five hikes per year would provide a service to the community and foster their desire to protect the area's resources.

The estimated cost to complete this goal is $2,000 over the 10-year implementation period (See Table 34). An additional $3,600 of volunteer value is also required for this goal.

Equestrian use is leading to streambank erosion in some locations

Goal #1-3: Perform Preserve Maintenance

There are several key aspects of preserve maintenance related to public uses. These include boundary posting and removal of debris piles identified during the ecological mapping (See Map 13). NJCF will lead volunteer events to remove all debris by October 2019.

The estimated cost to complete this goal is $9,000 over the 10-year implementation period (See Table 25). An additional $2,400 of volunteer value is also required for this goal.

Goal #1-4: Develop an Agricultural Use Agreement

There are currently 133 acres with agricultural activity (Map 14). In 2018, cover included corn (55 acres), food plot (2 acres) and fallow / unplanted (76 acres). Only Patch ID 6 (food plot) will be restored to wildflower meadow. For Patch ID 62 and 68, agriculture will continue indefinitely unless it is restricted under a Deed of Conservation Restriction (DCR). If the DCR, restricts indefinite agricultural use, then farming activity will continue for as long as allowable. Lease agreements will be developed with farmers on all lands remaining in long-term agricultural use.

The estimated cost to complete this goal is $3,300 over the 10-year implementation period (See Table 25).

Table 10. Agricultural Fields

Patch ID	Acres	Current Use	Future Use
1	4.9	Agriculture - Fallow	Agricultural
3	6.0	Agriculture - Fallow	Agricultural
4	3.1	Agriculture - Fallow	Agricultural
6	2.1	Agriculture - Food Plot	Restored Meadow
9	0.9	Agriculture - Fallow	Agricultural
11	0.5	Agriculture - Fallow	Agricultural
13	2.7	Agriculture - Corn	Agricultural
17	10.2	Agriculture - Corn	Agricultural
19	0.5	Agriculture - Fallow	Agricultural
20	1.3	Agriculture - Fallow	Agricultural
23	10.7	Agriculture - Corn	Agricultural
24	0.3	Agriculture - Fallow	Agricultural
27	5.8	Agriculture - Fallow	Agricultural
32	21.1	Agriculture - Fallow	Agricultural
34	26.1	Agriculture - Fallow	Agricultural
62	14.6	Agriculture - Corn	Agricultural
68	8.8	Agriculture - Corn	Agricultural
71	7.7	Agriculture - Corn	Agricultural
111	5.2	Agriculture - Fallow	Agricultural
Total	**132.5**		

Section III. Conservation Values

Introduction

This section provides conservation values within and adjacent to the Preserve. It includes landscape-scale values provided through review of information available from the Endangered and Nongame Species Program and Natural Heritage Program of the NJ Department of Environmental Protection. This section provides results of ecological community mapping and botanical survey performed throughout the Preserve by M. Van Clef and G. Milly.

The primary habitat conservation values include forest and meadow habitats. Forest communities serve as the basis for a broad range of common plant and animal species typical of the Eastern United States, providing stopover feeding opportunities for Neotropical migrant birds and nesting habitat for many species. If managed property, there is also great potential for quality meadow habitat that would support a large variety of birds and pollinators at the Preserve.

Landscape-scale Values

The Landscape Project (Version 3.3) is a product of the New Jersey Department of Environmental Protection, Division of Fish & Wildlife, Endangered and Nongame Species Program (ENSP). The Landscape Project prioritizes sites based upon the biodiversity significance of animal species utilizing patches of habitat. Habitat patches are ranked from 5 (highest) to 1 (lowest). Patch ranks are based upon the level of rarity of the rarest species known to occur within the patch (Note: A single habitat patch may contain multiple species with various ranks, but the overall patch ranking is derived from the occurrence of the species with the highest rank.). A rank of '5' signifies patches containing federally endangered and threatened species, Rank 4 patches contain state endangered species, Rank 3 patches contain state threatened species, Rank 2 patches contain state species of concern, and Rank 1 patches have suitable habitat for rare animals, but do not contain confirmed occurrences.

Patch ranks at the Preserve are depicted in Map 15 and summarized in Table 11. Habitat patches that intersect with the Preserve are primarily Rank 3 because they contain state threatened species including multiple forest and grassland birds (See below for additional rare species). However, it should be noted that the presence of breeding populations of grassland species on the Preserve is likely to be low due to small patch sizes and recent transformation of multiple meadow areas into infested shrublands dominated by Autumn Olive.

The Landscape Project also characterizes habitat patch sizes, which are shown in Map 16 and summarized in Table 12. The most significant habitat patch is contiguous forest of greater than 13,000 acres, which represents the largest forest area in the Sourland region. Although the Preserve's forest represents the northern edge of this patch, it is likely that the Preserve can harbor area-demanding species such as Barred Owl or Kentucky Warbler as well as serving significant stop-over habitat for migrating birds and other species of reptiles and amphibians.

Patches of grassland species have been documented on the Preserve, but these patches are small and multiple fields are being transformed into infested shrublands, which significantly reduces their ability to harbor grassland bird species. This is despite the designation of Preserve lands being included as part of the Amwell Valley Grassland Important Bird Area (Map 17).

Table 11. Landscape Project Patch Rank Summary

Rank	Acres	Percent of Preserve
5	0	0
4	14.4	1
3	868.5	75
2	112.9	10
1	120.1	10
Non-Habitat	42.1	4
Totals	**1158**	**100**

Table 12. Landscape Project Patch Size Summary

Landscape Project Category	Landscape Patch ID	Landscape Patch Acres	Landscape Patch Rank
Forest / Woodland	See Text	13578	3
Cropland / Pastureland	323011	50	1
Cropland / Pastureland	323029	43	1
Old Field	352943	26	3

The New Jersey Natural Heritage Program (NJNHP) is part of the New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management. The Preserve is not associated with priority sites that harbor imperiled plants and ecological communities throughout the state. According to a state database search (Appendix D), there were no known records of rare plants on the Preserve, but adjacent lands were known to harbor rare plant species. Rare plants were documented during field surveys, these are reported later in this plan section.

Ecological Communities

Ecological communities were mapped at the Preserve from June through September 2018. Communities were mapped through a process of crosschecking between three sources of information, which included field survey, 2015 aerial orthophotography, GIS-based 2012 land cover classifications and NJDEP GIS wetland status. Field observations of species present within the canopy, sub-canopy, shrub, and herbaceous layers were recorded and correlated with a 'signature' on aerial photography. Ecological community patches occurring within the Preserve were assigned one of 10 broad types (Table 13) and 24 specific types of xx types (Table 14) assigned by M. Van Clef. This includes eight forest types, six woodland types, uncategorized shrublands, meadows and mosaics.

There was a total of 166 mapped ecological community patches (See Appendix E) across 1,158 mapped acres. In some cases, adjacent patches with the same ecological community designation were provided separate patch designations because of differences in the mapped invasive species cover, which is often a proxy for differences in past land use and canopy density (former agricultural lands and forests with more open canopies have higher amounts of invasive species). Maps depicting various attributes reported in Appendix E are depicted in the following maps and summarized in associated tables below:

- Map 18 and Table 13 – Broad ecological communities

  Forest and woodland habitats (ca. 77% of Preserve cover) are the dominant ecological communities with shrubland (5%) and meadow (10%) communities accounting for lessor, but still significant coverage at the Preserve.

Table 13. Broad Ecological Community Type Summary

Broad Habitat Type	Acres	Percent of Preserve
Forest	603	52
Woodland	170	15
Hedgerow - Woodland	31	2.7
Shrubland	56	4.8
Mosaic: Meadow / Shrubland	20	1.7
Mosaic: Meadow / Woodland	14	1.2
Meadow	119	10
Pond	8	0.6
Agriculture	133	11
Urban	5	0.4
Totals	**1158**	**100**

Large portions of the Preserve were dominated by Red Maple forest and woodlands that were of young to moderate age and typically had infested understories (forests with Japanese Stiltgrass and woodlands with Multiflora Rose).

- Map 19 and Table 14 – Specific ecological communities

  Relatively young forest and woodland habitats were most often dominated by Red Maple (35% of Preserve) and Ash (9%). The highest quality forest areas were associated with Sugar Maple, American Beech and Shagbark Hickory dominance (combined areas approximately 13% of Preserve).

Table 14. Specific Ecological Community Type Summary

Community Name	Acres	Percent of Preserve
Forest - American Beech	39.7	3.4
Forest - Red Cedar	11.0	0.9
Forest - Red Maple	377.2	32.6
Forest - Red Oak	40.6	3.5
Forest - Shagbark Hickory	13.6	1.2
Forest - Sugar Maple	99.7	8.6
Forest - Tulip Poplar	6.0	0.5
Forest - White Ash	15.2	1.3
Woodland - Black Walnut	8.1	0.7
Woodland - Red Cedar	23.7	2.0
Woodland - Red Maple	21.5	1.9
Woodland - Sassafras	21.6	1.9
Woodland - White Ash	95.1	8.2
Hedgerow - Woodland	30.8	2.7
Shrubland	55.7	4.8
Mosaic: Meadow - Shrubland	20.1	1.7
Mosaic: Meadow - Woodland	13.7	1.2
Meadow	102.2	8.8
Meadow - Natural Gas ROW	17.3	1.5
Pond	7.5	0.6
Agriculture - Corn	54.8	4.7
Agriculture - Fallow	75.7	6.5
Agriculture - Food Plot	2.1	0.2
Urban	5.2	0.4
Totals	**1158.1**	**100**

- Map 20 and Table 15 – Ash Decline

It is important to note that canopy-level ash trees were mapped across over 400 acres on the Preserve. Over 200 acres with current ash decline (unrelated to Emerald Ash Borer) was documented, with over 100 acres of land where ash was accounted for greater than 25% of th tree canopy. The majority of future ash decline (both related and unrelated to EAB) will occur in forest areas with less than 25% ash canopy. It is expected that all mature ash trees will be eliminated from the Preserve within the next 5 to 10 years, exasperating current trends that already show significantly increased cover of invasive species following ash loss. This ongoing and worsening problem necessitates intensive deer management to allow native species to compete more effectively with invasive species to avoid significant additional degradation of ecological health.

Table 15. Ash Decline Summary

Ash Cover Category	Current Ash Decline (Acres)	Future Ash Decline (Acres)	Total Ash Decline (Acres)
1-10%	38	134	171
11-25%	60	75	136
26-50%	100	0	100
51-75%	15	0	15
76-100%	0	0	0
Totals	**213**	**209**	**422**

Ash decline will lead to significant increases of invasive species unless deer reduction is also significant.

- Maps 21 - 23; Tables 16 - 18 – Cover of Native Shrubs, Herbs and Regenerating Trees

  Native shrubs and herbaceous species (both vulnerable to deer browse) was relatively low throughout the Preserve. Ideally, native shrub cover in forests would be above 70%, which did not occur anywhere on the Preserve. Several areas had 26-50% native shrub cover in forests (Patches 52, 127, 129, 131). Native shrub cover was low in shrublands, which were dominated by Autumn Olive.

  Native herbaceous species (wildflowers and grasses) were also sparse throughout the Preserve (especially in forest habitats, the most notable exception was Patch Number 52). Four meadow patches were notable for native herbaceous cover (Patches 120, 121, 122 and 132).

  Regenerating trees were very uncommon on the Preserve. They were virtually absent from meadows (excluding Red Cedar), shrublands and most forest/woodland habitats. The exceptions were exclusive to old forest areas in the southern portion of the Preserve (See Map 23) and primarily included American Beech and Shagbark Hickory.

Shagbark Hickory seedlings of varying heights were found in small patches of old forest areas, but no tree seedlings were found elsewhere on the Preserve.

Table 16. Native Shrub Cover by Community Type

Community Type	Native Shrub Cover Category	Acres	Percent of Total Community Type Area
Forest	Absent	0	0.0
Forest	< 1%	393	65.2
Forest	1-10%	116	19.3
Forest	11-25%	43	7.1
Forest	26-50%	51	8.4
Forest	51-75%	0	0.0
Forest	76-100%	0	0.0
Forest - Total		**603**	**100**
Woodland	Absent	0	0.0
Woodland	< 1%	0	0.0
Woodland	1-10%	168	98.5
Woodland	11-25%	0	0.0
Woodland	26-50%	3	1.5
Woodland	51-75%	0	0.0
Woodland	76-100%	0	0.0
Woodland - Total		**170**	**100**
Shrubland	Absent	10	18.1
Shrubland	< 1%	6	9.9
Shrubland	1-10%	22	39.3
Shrubland	11-25%	9	16.7
Shrubland	26-50%	9	16.0
Shrubland	51-75%	0	0.0
Shrubland	76-100%	0	0.0
Shrubland - Total		**56**	**100**
Meadow Mosaics	Absent	0	0.0
Meadow Mosaics	< 1%	0	0.0
Meadow Mosaics	1-10%	34	100.0
Meadow Mosaics	11-25%	0	0.0
Meadow Mosaics	26-50%	0	0.0
Meadow Mosaics	51-75%	0	0.0
Meadow Mosaics	76-100%	0	0.0
Meadow Mosaics - Total		**34**	**100**
Meadow	Absent	33	28.0
Meadow	< 1%	45	37.8
Meadow	1-10%	41	34.3
Meadow	11-25%	0	0.0
Meadow	26-50%	0	0.0
Meadow	51-75%	0	0.0
Meadow	76-100%	0	0.0
Meadow - Total		**119**	**100**

Table 17. Native Herbaceous Cover by Community Type

Community Type	Native Herb Cover Category	Acres	Percent of Total Community Type Area
Forest	Absent	34	5.7
Forest	< 1%	482	80.0
Forest	1-10%	53	8.9
Forest	11-25%	8	1.3
Forest	26-50%	25	4.2
Forest	51-75%	0	0.0
Forest	76-100%	0	0.0
Forest - Total		**603**	**100**
Woodland	Absent	0	0.0
Woodland	< 1%	0	0.0
Woodland	1-10%	162	95.2
Woodland	11-25%	8	4.8
Woodland	26-50%	0	0.0
Woodland	51-75%	0	0.0
Woodland	76-100%	0	0.0
Woodland - Total		**170**	**100**
Shrubland	Absent	10	18.1
Shrubland	< 1%	0	0.0
Shrubland	1-10%	5	8.1
Shrubland	11-25%	11	20.1
Shrubland	26-50%	11	20.4
Shrubland	51-75%	19	33.3
Shrubland	76-100%	0	0.0
Shrubland - Total		**56**	**100**
Meadow Mosaics	Absent	0	0.0
Meadow Mosaics	< 1%	0	0.0
Meadow Mosaics	1-10%	0	0.0
Meadow Mosaics	11-25%	20	59.5
Meadow Mosaics	26-50%	7	21.0
Meadow Mosaics	51-75%	7	19.5
Meadow Mosaics	76-100%	0	0.0
Meadow Mosaics - Total		**34**	**100**
Meadow	Absent	0	0.0
Meadow	< 1%	0	0.0
Meadow	1-10%	0	0.0
Meadow	11-25%	2	1.7
Meadow	26-50%	19	15.6
Meadow	51-75%	54	45.0
Meadow	76-100%	45	37.8
Meadow - Total		**119**	**100**

Table 18. Tree Regeneration Cover for Forest and Woodland Community Types

Patch ID	Patch Acres	Community Name	Species	Height	Cover Class
28	3.6	Forest - Red Maple	White Ash	1-2'	1 -10%
47	7.3	Forest - Sugar Maple	Shagbark Hickory	1-2'	51-75%
51	7.6	Forest - American Beech	American Beech	2-4'	11-25%
52	25.3	Forest - American Beech	American Beech	2-4'	26-50%
56	4.1	Forest - American Beech	American Beech	2-4'	11-25%
98	5.1	Forest - Sugar Maple	Shagbark Hickory	1-3'	11-25%
99	4.1	Forest - Sugar Maple	Shagbark Hickory	< 1'	Trace
100	10.3	Forest - Sugar Maple	Shagbark Hickory	< 1'	26-50%
101	3.1	Forest - Red Oak	Sassafras	2-4'	1 -10%
109	10.7	Forest - Sugar Maple	Shagbark Hickory	< 1'	Trace
110	5.6	Forest - Sugar Maple	Shagbark Hickory	< 1'	Trace
127	13.6	Forest - Shagbark Hickory	Shagbark Hickory	1-2'	26-50%
129	9.0	Forest - Red Maple	Shagbark Hickory	2-6'	26-50%
131	2.9	Forest - Red Maple	Shagbark Hickory	2-6'	26-50%
Total	**112**				

- Map 24 and Table 19 – Relative patch quality

  This is a subjective characterization based upon the following attributes: land use history, amount of invasive species cover, and amount of native shrub and herbaceous cover and presence of regenerating native trees. The relative quality ranks were 'Very High' or 'High' for about 10% of Preserve and 'Low' for nearly 60%. Community quality rankings and additional information on rare species were used to determine strategies in Section IV.

Table 19. Relative Patch Quality Summary

Relative Quality Rank	Acres	Percent of Preserve
Very High	34.1	2.9
High	85.4	7.4
Moderate	204.9	17.7
Low	688.4	59.4
N/A	145.2	12.5
Totals	**1158.0**	**100**

A fantastic spider waiting in an old forest at the Preserve.

Flora

This section, prepared by Gemma Milly, includes information from the field botanical survey.

Botanical Survey Methods

Botanical surveys were performed at the Preserve by Gemma Milly between May 1 and September 22, 2018. Surveys followed a meandering protocol with the aim of maximizing coverage of area and all plant community types and thirty plots (100 square-meters each) were evaluated for plant species composition (Map 25). Fifteen plots were in areas with forest cover pre-dating 1930 per historic aerial imagery, and fifteen plots were in areas cleared since 1931 or before (including areas currently in forest and open cover). Plots were placed during meandering surveys at locations with representative, unique, or otherwise important plant communities. The dataset for each plot includes geographic coordinates and a list of every vascular plant species with cover (not necessarily rooted) in the plot. Surveys also recorded a list of plant species encountered outside of the plots during surveys. Specimens were taken for plants not identifiable in the field and were determined subsequently. Each botanical survey plot is identified by number, FQA-01 to FQA-30, and was evaluated once, sequentially, beginning with FQA-01. There are no plot markers in the field.

Species lists from the thirty survey plots were uploaded to the Universal Floristic Quality Assessment (FQA) Calculator project. The Universal FQA Calculator is a web-based analysis program that performs FQA calculations and allows sharing of survey data and calculation results. Instructions on using the online tool are provided in Appendix F. Floristic Quality Assessment hinges on regionally determined Coefficients of Conservatism (C values), which rank each non-native plant species in the flora as C = 0, and ranks native plant species on a scale, C = 1 to 10, from disturbance-tolerant and promiscuous to disturbance-intolerant and niche faithful. The FQA analyses include variables calculated using the C values of the plant species in each plot. These include mean C (the average C value for all species in the plot) and the Floristic Quality Index (FQI, which equals the mean C multiplied by the square root of the number of species in the plot). Average C calculations can quickly estimate the natural "quality" of a plot, as summarized by the distinctness of the site's plant community—per each species' niche fidelity—and average vulnerability to disturbance. The FQI is similar but additionally favors plots with more species. These calculations can be used to compare quality of sites on the Preserve and to compare sites on the Preserve to sites in the broader region. The Preserve's FQA uses the newly published FQA database for New Jersey, released in October 2018 by the New Jersey Department of Environmental Protection.

Botanical Survey Results – Landscape and Plant Communities

The Preserve contains forest, woodland, shrubland, and meadows. These broad landscape types vary in land use history, soil type, and hydrology, creating a wide diversity of plant communities.

Areas that have remained in forest cover since before 1931 (per historic aerial imagery) are located in the upslope portion of the preserve that straddles the gas line right-of-way and along the ditched stream centrally bisecting the preserve, located in the southern portion of the Preserve. The old-forest areas tend to have closed canopies dominated by oaks, hickories, red

maple, tulip poplar, and ashes, and they contain a wide variety of shrub and herbaceous layer associations (See photos below).

Old-forest plots: Baneberry in FQA-07 (top Left), hickory saplings in FQA-16 (top Right), an open understory in FQA-17 (bottom Left), and a rich, hummocky wetland forest in FQA-21 (bottom Right).

Plant communities in the old forest vary from well-drained forests with rich herbaceous communities (FQA-07, with Baneberry, Broad Beech Fern, and Solomon's Seal) to poor mesic edges (FQA-16, with Chestnut Oak, Sassafras, and Wild Sarsaparilla), glade-like areas (FQA-17, with Cinquefoil, Poverty Oat Grass, and Hairy Skullcap), and dark, seepy forested wetlands (FQA-21, with Swamp White Oak, Skunk Cabbage, and Cardinal Flower).

Areas that have succeeded into forest cover since 1931 are widespread on the preserve north of the gas right-of-way. Tree canopies in these areas have heavier components of Red Maple, Black Cherry, and Green Ash, while retaining some oak components, especially red, black, and pin oaks. Other areas (FQA-01) are dominated by Eastern Red-cedar (See photos below).

Additional notable communities and native plants included two sycamore groves and a persimmon grove. All rare and notable species locations are provided on Map 26.

Young-forest plots: early-successional Juniper-Red Maple woodland in FQA-01 (Left) and a Red Maple stand flooded with Japanese Stiltgrass in FQA-27 (Right).

Shrub and herbaceous layer compositions vary less in the younger forest than in older forest and are largely composed of generalists including Blackhaw Viburnum, Frost Grape, Poison Ivy, Jack-in-the-Pulpit, White Snakeroot, and White Avens. Understory communities in the Preserve's younger forest areas often have significant components of common invasive species, especially Multiflora Rose, Japanese Honeysuckle, and Japanese Stiltgrass (FQA-27).

Several scattered areas in the Preserve have become shrublands overrun by Autumn Olive succeeding through expansive colonies of rhizomatous goldenrod species (See photos below). Some of these areas are additionally blanketed with high-climbing Mile-a-Minute.

Shrublands dominated by autumn olive, with colonial goldenrod species (Left) and Mile-a-Minute (Right).

Meadow communities, or areas otherwise with very minimal woody cover, are scattered and diverse. They include pond-side wet meadows (FQA-02, with Bur-reed, Grass-leaved Goldenrod, and many native graminoids), dry, poor meadows (FQA-09, with Little Bluestem, Stiff Yellow Flax, Narrow-leaf Mountain-mint, Whorled Milkwort, and Lopsided Rush), Black Willow-bordering wet graminoid meadows (FQA-11, with Rice Cut-grass, Soft-stemmed

Bulrush, and Woolgrass), and moist, rich, old field edges with more woody plant elements (FQA-24, with Pin Oak, Dense Blazing-star, Panicgrass, and asters) (See Photos Below).

Meadow plots: a pond-edge wet meadow in FQA-02 (top Left) and dry-scrape meadow located near FQA-09 (top Right). An old-field edge hosting an occurrence of dense blazing-star in FQA-24 (bottom Left) and Black Willow wetland near FQA-11 (bottom Right).

Botanical Survey Results – Species Diversity Inventory

Appendix G presents the complete list of vascular plant species identified at the Preserve. Surveys identified a total of 390 distinct vascular plant taxa. Native species accounted for 73% of these species; 27% are introduced to New Jersey. For native species, C values in the observed flora varied normally between 1 and 9 (Figure 7). Species with high C values were mostly forest-dwelling, perennial herbaceous plants (Table 20).

Figure 7. Distribution of C-values in Observed Vascular Plants (data bars are labeled with absolute count of species in each category).

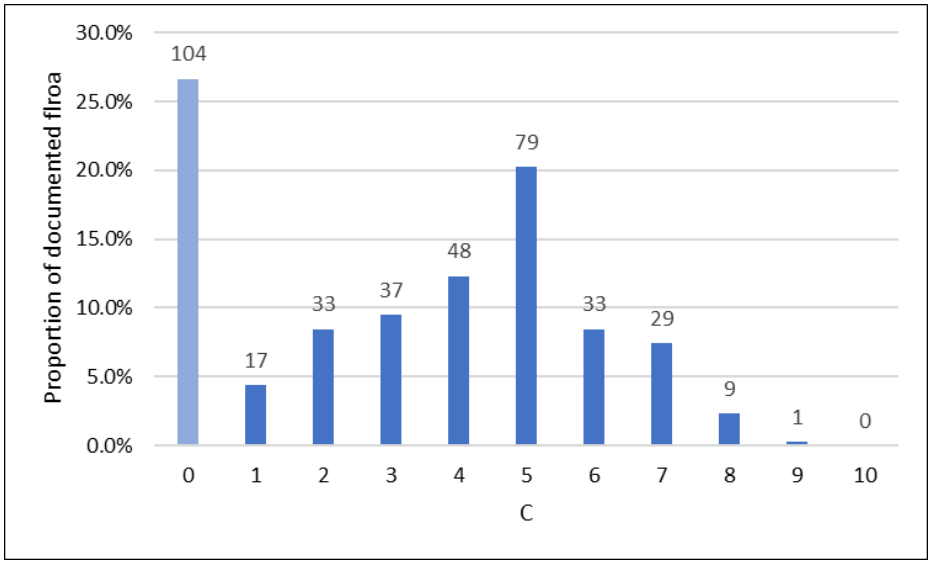


Table 20. Floristic Quality Assessment - Selection of Species with High C-values

C	Scientific Name	Common Name	Growth Habit	Family
9	*Cardamine angustata*	slender toothwort	Forb	Brassicaceae
8	*Actaea racemosa* subsp. *racemosa*	black cohosh	Forb	Ranunculaceae
	Aristolochia serpentaria	virginia snakeroot	Forb	Aristolochiaceae
	Collinsonia canadensis	horse balm	Forb	Lamiaceae
	Pyrola americana	american wintergreen	Forb	Pyrolaceae
	Salix humilis	prairie willow	Shrub	Salicaceae
	Viola rostrata	long-spurred violet	Forb	Violaceae
7	*Agalinis purpurea*	false foxglove	Forb	Scrophulariaceae
	Goodyera pubescens	downy rattlesnake-plantain	Forb	Orchidaceae
	Hepatica nobilis var. *obtusa*	roundlobe hepatica	Forb	Ranunculaceae
	Heteranthera reniformis	mud-plantain	Forb	Pontederiaceae
	Oclemena acuminata	whorled wood aster	Forb	Asteraceae
	Platanthera lacera	ragged fringed-orchid	Forb	Orchidaceae
	Polygonum tenue	slender knotweed	Forb	Polygonaceae
6	*Amelanchier arborea*	common service-berry	Tree	Rosaceae
	Chelone glabra	turtlehead	Forb	Scrophulariaceae
	Juncus marginatus	grass-leaved rush	Graminoid	Juncaceae
	Liatris spicata var. *spicata*	blazing-star	Forb	Asteraceae
	Medeola virginiana	indian cucumber-root	Forb	Liliaceae
	Tipularia discolor	cranefly orchid	Forb	Orchidaceae
	Viola cucullata	blue marsh violet	Forb	Violaceae

Surveys discovered four rare plant species: Virginia Snakeroot, Slender Toothwort, Dense Blazing-star, and Long-spurred Violet (Table 21, See Photos Below). Observations of these rare plant occurrences are further detailed in the appended NJDEP Natural Heritage and ENSP Rare Species Reporting Forms (Appendix X1 – For NJCF only) and Section IV below.

Table 21. Floristic Quality Assessment - Rare Species Documented on the Preserve

Scientific Name	Common Name	NJ S-Rank (2016)	Count or Estimate of Individuals	Observed Distribution
Aristolochia serpentaria	Virginia snakeroot	S3	8	Two locations in old forest
Cardamine angustata	slender toothwort	S3	50-100	Widespread in center of old forest north of the ROW
Liatris spicata var. *spicata*	dense blazing-star	S3	82	One location at edge of old field
Viola rostrata	long-spurred violet	S3	10-50	One location in old forest south of ROW

Rare plant species observed during botanical surveys: Virginia Snakeroot (top Left), Slender Toothwort (top Right), Dense Blazing-star (bottom Left), and Long-spurred Violet (bottom Right).

One invasive species may be a new addition to the New Jersey flora. Hairy Cup Grass (*Eriochloa villosa*), occurs in plot FQA-30 and elsewhere in the surrounding meadow, especially within mowed paths (See Photos Below). There appear to be no previous records of this species occurring in our state. The species' introduction to the U.S. was initially documented in Illinois, Iowa, Nebraska, and Kansas, and records are still most abundant in the Midwest. USDA reports only two records in all the northeastern United States.

Hairy cup-grass, *Eriochloa villosa*, has few occurrence records in the eastern U.S. The USDA Plants Database shows only single records from Pennsylvania and Virginia (Left; map used with permission). The species was observed at the Preserve in a moist meadow and is recognizable by its silky-hairy inflorescences and firm, ridged spikelets (Right).

Lastly, whorled aster (*Oclemena acuminata*), was observed near plot FQA-21 (See Photo Below). This species is native to New Jersey and not rare, but it is unusual in this part of the state (piedmont), being much more common in the northwestern ridge and valley region. NJDEP Botanist David Snyder does not recall having seen it as far south as the Sourlands, citing the Watchung Mountains as the farthest occurrence he knows from its core range (David Snyder, personal communication, 13 September 2018).

Whorled aster, *Oclemena acuminata*, finds an interesting station here, far south of its usual range in New Jersey.

Botanical Survey Results – Floristic Quality Assessment Using Survey Plots

Appendix H presents the complete datasets from the FQA field plots and analysis including geographic coordinates and species lists by plot. A summary of the statistical results follows.

Plot species richness ranged from 18 species (in FQA-27, a denuded successional red maple-Japanese Stiltgrass stand) to 55 species (in FQA-24, a moist old-field edge, and FQA-26, an isolated old-forest stream bank (Table 22). The meadow plots generally were the most speciose (averaging 41 species), followed by old forest (37 species), and young forest (34 species) (Table 23). As a proportion of total species per plot, relative native species composition ranged from 65% to 93%. Old forest plots consistently had higher relative native richness than young forest plots while meadow plots had widely variable relative native richness.

There was relatively little variation in total mean C (ranging 2.1-4.4) and native mean C (3.2-4.8) values. Total FQI scores varied normally between 11 and 27.9 with no outliers. Based on these values, the old forest yielded high and moderate floristic quality* plots (Figure 8). No other land type yielded high quality plots. Young forest and meadow land type categories each contained low and moderate quality plots, with the meadows averaging a slightly higher component of moderate quality plots. Old forest plots scored highest on all mean C and FQI values. Generally, meadow and young forest plots scored similarly in these metrics except for native mean C, which tended to be higher in young forest than in meadow. This shows that the young forest plots were characterized by more native conservatism (higher native mean C values) than the meadow plots, but the young forest's relative native richness was poor enough that the effect of the high conservatism disappears in the rest of the metrics.

The FQA data analysis reveals that old forest, young forest, and meadow areas at the Preserve can all hold promise, but old-forest areas currently have the highest plant community integrity. Plant communities, especially in the old forest, can vary greatly in a small geographic area.

*Total FQI scores were assigned to floristic quality categories as follows: total FQI > 22 (High Quality), FQI scores of 19.1-22 (Moderate Quality), and FQI Scores ≤ 19 (Low Quality). This system follows natural breaks in the distribution of total FQI scores and subjective breaks in perceived quality per field visits. This ranking scheme is relative / tailored specifically to the Preserve.

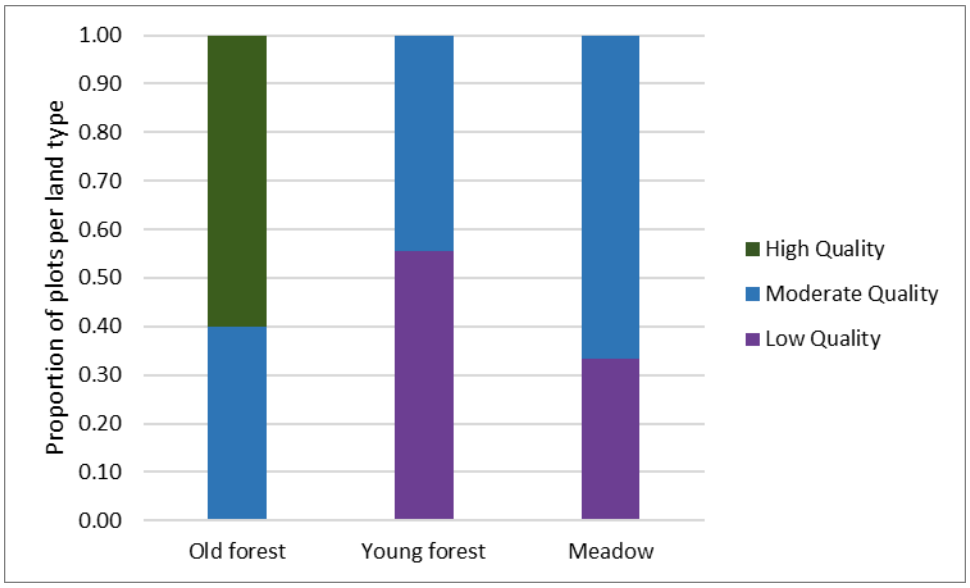
Table 22. Floristic Quality Assessment by Sample Plot

Plot ID	Land Type	Species Richness	Native Species Richness	Relative Native Richness	Non-Native Species Richness	Total Mean C	Native Mean C	Total FQI	Native FQI	Adjusted FQI	Floristic Quality Category
FQA-01	Y	39	28	0.72	11	2.9	4.1	18.1	21.7	34.7	Low
FQA-02	M	37	33	0.89	4	3.5	3.9	21.3	22.4	36.8	Moderate
FQA-03	Y	39	29	0.74	10	3.2	4.3	20.0	23.2	37.1	Moderate
FQA-04	O	37	30	0.81	7	3.6	4.4	21.9	24.1	39.6	Moderate
FQA-05	O	29	26	0.90	3	4.1	4.5	22.1	22.9	42.6	High
FQA-06	O	30	25	0.83	5	3.6	4.3	19.7	21.5	39.3	Moderate
FQA-07	O	40	37	0.93	3	4.4	4.7	27.8	28.6	45.2	High
FQA-08	Y	43	34	0.79	9	3.3	4.2	21.6	24.5	37.3	Moderate
FQA-09	M	42	33	0.79	9	3.0	3.8	19.4	21.8	33.7	Moderate
FQA-10	Y	42	30	0.71	12	2.9	4.1	18.8	22.5	34.7	Low
FQA-11	M	23	20	0.87	3	2.9	3.4	13.9	15.2	31.7	Low
FQA-12	O	43	38	0.88	5	4.0	4.5	26.2	27.7	42.3	High
FQA-13	O	32	28	0.88	4	4.0	4.6	22.6	24.3	43.0	High
FQA-14	Y	24	19	0.79	5	3.4	4.3	16.7	18.7	38.3	Low
FQA-15	O	44	38	0.86	6	3.9	4.5	25.9	27.7	41.8	High
FQA-16	O	29	26	0.90	3	3.9	4.3	21.0	21.9	40.7	Moderate
FQA-17	O	48	39	0.81	9	3.4	4.2	23.6	26.2	37.9	High
FQA-18	Y	24	18	0.75	6	3.2	4.2	15.7	17.8	36.4	Low
FQA-19	O	29	25	0.86	4	3.9	4.5	21.0	22.5	41.8	Moderate
FQA-20	O	38	30	0.79	8	3.4	4.4	21.0	24.1	39.1	Moderate
FQA-21	O	44	40	0.91	4	4.2	4.7	27.9	29.7	44.8	High
FQA-22	M	41	36	0.88	5	3.4	3.9	21.8	23.4	36.5	Moderate
FQA-23	Y	37	30	0.81	7	3.3	4.1	20.1	22.5	36.9	Moderate
FQA-24	M	55	38	0.69	17	2.6	3.8	19.3	23.4	31.6	Moderate
FQA-25	Y	40	32	0.80	8	3.4	4.3	21.5	24.3	38.5	Moderate
FQA-26	O	55	44	0.80	11	3.5	4.4	26.0	29.2	39.4	High
FQA-27	Y	18	12	0.67	6	2.6	3.8	11.0	13.2	31.0	Low
FQA-28	O	25	21	0.84	4	4.0	4.7	20.0	21.5	43.1	Moderate
FQA-29	O	35	30	0.86	5	4.1	4.8	24.3	26.3	44.4	High
FQA-30	M	46	30	0.65	16	2.1	3.2	14.2	17.5	25.8	Low
Minimum		18	12	0.65	3	2.1	3.2	11	13.2	25.8	n/a
Maximum		55	44	0.93	17	4.4	4.8	27.9	29.7	45.2	n/a
Average		37	30	0.81	7	3.5	4.2	20.8	23.0	38.2	n/a
Standard Deviation		9	7	0.07	4	0.5	0.4	4.0	3.9	4.5	n/a

Table 23. Floristic Quality Assessment by Community Type

Land type	Plot Count	Species Richness	Native Species Richness	Relative Native Richness	Non-Native Species Richness	Total Mean C	Native Mean C	Total FQI	Native FQI	Adjusted FQI
Old forest	15	37	32	0.86	5	3.9	4.5	23.4	25.2	41.7
Young forest	9	34	26	0.75	8	3.1	4.2	18.2	20.9	36.1
Meadow	6	41	32	0.79	9	2.9	3.7	18.3	20.6	32.7

Figure 8. Floristic Quality Assessment - Relative Quality Ranks by Habitat Type



Fauna

There are twenty rare animal species that have been documented on the Preserve (Table 24). Field surveys performed for this plan did not involve rare animal surveys, although four Box Turtle observations were made during the course of botanical surveys by G. Milly.

Stewardship recommendations for these species primarily involve improving the ecological health of habitats required by each species – See Section IV. Further future investigation may result in species-specific stewardship recommendations.

There are seven rare grassland birds on the list including American Kestrel, Bobolink, Eastern Meadowlark, Grasshopper Sparrow, Savannah Sparrow, Upland Sandpiper and Vesper Sparrow. Additional surveys should be conducted to determine their current status on the Preserve. It seems unlikely that the Preserve currently provides adequate habitat for the majority of these species due to the size of open grassland/meadow habitat, which does not appear to ever have been very large and is becoming diminished by rapidly developing infestations of Autumn Olive. There does appear to be suitable habitat remaining for American Kestrels and less area-demanding species such as Bobolink.

There are seven rare forest birds on the list including Barred Owl, Canada Warbler, Hooded Warbler, Kentucky Warbler, Veery, Wood Thrush and Worm-eating Warbler. Several of these species require relatively large contiguous forests provided at the Preserve. All require healthy forest habitats, which are currently limited at the Preserve.

There are six species that require successional or a mixture of habitat types including Brown Thrasher, Cooper's Hawk, Great Blue Heron, Red-headed Woodpecker, Box Turtle and Northern Copperhead. Red-headed Woodpeckers and Northern Copperheads do not appear to have a significant amount of appropriate habitat on the Preserve. All other species are likely to occur on the Preserve due to its mixture of habitat types.

Box Turtle observed at the Preserve (Photo by Gemma Milly).

Table 24. Rare Animals of the Preserve

Taxa	Common	Scientific Name	State Rank	Primary Habitat Requirement	Stewardship Notes
Bird	American Kestrel	Falco sparverius	Threatened	Meadow / Grassland	Install nest boxes on posts in fields
Bird	Barred Owl	Strix varia	Threatened	Forest	Encourage forest health
Bird	Bobolink	Dolichonyx oryzivorus	Threatened	Meadow / Grassland	Encourage contiguous grassland habitat -- Limited potential on Preserve
Bird	Brown Thrasher	Toxostoma rufum	Special Concern	Shrubland	Encourage shrubland health
Bird	Canada Warbler	Wilsonia canadensis	Special Concern	Forest	Encourage forest health
Bird	Cooper's Hawk	Accipiter cooperii	Special Concern	Mixed - Woodland, Meadow / Grassland	Encourage mixture of required habitat types
Bird	Eastern Meadowlark	Sturnella magna	Special Concern	Meadow / Grassland	Encourage contiguous grassland habitat -- Limited potential on Preserve
Bird	Grasshopper Sparrow	Ammodramus savannarum	Threatened	Meadow / Grassland	Encourage contiguous grassland habitat -- Limited potential on Preserve
Bird	Great Blue Heron	Ardea herodias	Special Concern	Mixed - Open Water, Meadow / Grassland	Encourage mixture of required habitat types
Bird	Hooded Warbler	Wilsonia citrina	Special Concern	Forest	Encourage forest health
Bird	Kentucky Warbler	Oporornis formosus	Special Concern	Forest	Encourage forest health
Bird	Red-headed Woodpecker	Melanerpes ertythrocephalus	Threatened	Woodland	Encourage forest health (requires open forest) -- Limited potential on Preserve
Bird	Savannah Sparrow	Passerculus sandwichensis	Threatened	Meadow / Grassland	Encourage contiguous grassland habitat -- Limited potential on Preserve
Bird	Upland Sandpiper	Bartramia longicauda	Endangered	Meadow / Grassland	Encourage contiguous grassland habitat -- Limited potential on Preserve
Bird	Veery	Catharus fuscescens	Special Concern	Forest	Encourage forest health
Bird	Vesper Sparrow	Pooecetes gramineus	Endangered	Meadow / Grassland	Encourage contiguous grassland habitat -- Limited potential on Preserve
Bird	Wood Thrush	Hylocichla mustelina	Special Concern	Forest	Encourage forest health
Bird	Worm-eating Warbler	Helmitheros vermivorum	Special Concern	Forest	Encourage forest health
Reptile	Box Turtle	Terrepene carolina	Special Concern	Mixed - Woodland, Meadow / Grassland	Encourage mixture of required habitat types
Reptile	Northern Copperhead	Agkistrodon contortrix mokasen	Special Concern	Mixed - Woodland, Meadow / Grassland	Encourage mixture of required habitat types -- Limited potential on Preserve

Vernal Habitat – The Sourland region is notable for the presence of vernal habitat due to its underlying geology. There are no confirmed vernal pools/habitat or Landscape Project ranked stream segments (Map 26), but five potential areas were observed during field surveys (Map 27, Table 25). The importance of vernal habitat to many amphibians, especially given the large, roadless expanses of habitat within and contiguous to the Preserve, warrants additional surveys to determine vernal habitat presence.

Table 25. Field Observed Possible Vernal Habitat

Point ID	Description	Latitude	Longitude
1	Possible Vernal Habitat	-74.75973513	40.45157271
2	Possible Vernal Habitat / Seep at head of stream	-74.77300904	40.44795857
3	Possible Vernal Habitat	-74.76669962	40.45455383
4	Possible Vernal Habitat / Sink Hole	-74.7538976	40.45439741
5	Possible Vernal Habitat / Excavated Pit	-74.76906194	40.45178189

Possible vernal habitat observed on the Preserve

Section IV. Conservation Challenges

Introduction

This section describes an evaluation of the two primary threats to ecological health at the Preserve – overabundance of white-tailed deer and invasive species. The impacts of white-tailed deer and the extent and severity of invasive plant species infestations were mapped from June to October 2018. Deer management has occurred on portions of the Preserve, but there was significant ecological damage due to deer overabundance. Quantification of impacts through the "Forest Secchi" protocols, along with additional ground plot measurements, was conducted in July 2018. The scope of the invasive species problem is significant with approximately 80% of the Preserve having severe infestations of one or more species. Less than 8% of the area was virtually free of invasive species, while approximately 4% is lightly to moderately infested (ca. 11% of Preserve has built or agricultural cover).

A brief discussion is provided for two additional factors that impact ecological health – relatively small habitat patch size and past agricultural land uses. These factors cannot be remedied, but inform stewardship strategies (See Section IV).

Evaluation of White-tailed Deer Impacts

Currently, ecological impacts of white-tailed deer are severe throughout the Preserve's forests. Young saplings of canopy tree species are virtually absent. Forest shrubs are similarly uncommon with greater than 85% of the Preserve woodlands and forests containing less than 10% shrub cover and there were no mapped areas with greater than 50% shrub cover (Note: Healthy forests should have greater than 70% native shrub cover). In particular areas of old forest, native canopy tree seedlings were present and largely accounted for the measured 'shrub layer' (Table 18), but these areas were the exception Forest herbs are extremely rare and it is likely that multiple species were locally extirpated. This reduction in native plant cover fostered the proliferation of less palatable invasive species in many areas (primarily those that had received past agricultural tilling - See Section I). Despite ongoing deer management on portions of the Preserve, the majority of forests at the Preserve show either the "Empty Forest Syndrome" or the "Infested Forest Syndrome" (See Section I). Importantly, native tree regeneration in natural forest canopy gaps is virtually absent, which threatens the long-term existence of forest cover at the Preserve.

However, there are some opportunities for ecological recovery, especially in forest areas that had never been under agricultural uses (approximately 270 acres). There areas have relatively low levels of invasive species (except for canopy gaps) and directed stewardship activities can begin the restoration process (See Section IV).

Plot-based Forest Health Data - In addition to the community mapping data provided above, specific measurements were taken at twenty randomly selected locations on the Preserve (Map 28). Measurements included canopy density via a concave densiometer, counting the number of trees and saplings within a 10-meter radius circle, utilizing the forest secchi protocol to determine woody understory cover, and determining the presence/absence of native and non-native woody seedlings (< 1 foot tall), herbs and graminoids within 0.5-m^2 plots. Thresholds denoting 'healthy forest conditions' for measurements are provided Table 26. While these thresholds are subjective, they represent reasonable expectations/goals that may be changed upon review/performance of scientific research or other insights provided through observation of similar habitats in our region. Thresholds for tree and saplings were not set – a professional forester should be consulted to set these thresholds. Rapid interpretation of measured values is facilitated by a simple 'green light' (when thresholds are met) / 'red light' (when they are not met) system.

Total woody cover within the browse zone was relatively high at the Preserve, but native cover (25%) was much lower than its threshold goal of 70% and non-native cover (48%) was much higher than its threshold of 10%. Interestingly, native cover was similar in old vs. young forest, but non-native cover was more than 1.5X greater in young forests. The forest canopy cover and proportion of native trees was very high across the Preserve and similar across forest age types. Tree density was much higher (ca. 1.5X) in young vs. old, and tree sapling density was similar across forest age types.

Native grasses were uncommon throughout the Preserve, but were approximately twice as prevlent in old forest. Native wildflowers were uniform between the forest types and found in about 50% of all plots. However, this is misleading as most plots had extremely low cover of wildflowers (e.g., single, non-flowering stems). Native woody seedlings were common, but also very sparse in overall cover / number of stems per plot.

Non-native grasses were common throughout the Preserve, with little distinction between old and young forests, but cover was noticeably higher in young forest plots, especially beneath Red Maple canopy where shrubs were absent. Non-native herbs were relatively uncommon in old forests and common in young forests, although cover in both types was modest (primarily consisted of Japanese Honeysuckle creeping along the ground). Non-native woody seedlings were relatively uncommon at the Preserve, but were twice as prevalent in young forests.

Overall, thresholds were not met for 7 of 12 metrics. It is recommended that these baseline measurements be repeated every 3-5 years following implementation of Preserve-wide deer management activities.

Beautiful fungus!

Table 26. Forest Health Measurement Summary

Response Factor Number	Response Factor Name	All Plots - Measured Values (Mean %)	Target Threshold Values (Mean %)[1]	Mean Statewide Values[2]	Range of Statewide Values[3]	Old Foret Plots - Measured Values (Mean %)	Young Forest Plots - Measured Values (Mean %)
1	Total Woody Cover Within Browse Zone	61	> 70%	40	2 to 86	57	65
2	Native Woody Cover Within Browse Zone	25	> 70%	17	0 to 55	26	23
3	Non-Native Woody Cover Within Browse Zone	48	< 10%	27	0 to 74	37	61
4	Total Canopy Cover	94	> 60%?	92	72 to 99	95	94
5a	Relative Proportion of All Trees - Native Species	99	> 99%	N/A	N/A	100	98
5b	Relative Proportion of All Trees - Non-Native Species	1	< 1%	N/A	N/A	0	2
5c	Stem Density of All Trees (per acre) - Native Species	467	TBD	N/A	N/A	398	550
5d	Stem Density of All Trees (per acre) - Non-Native Species	5	TBD	N/A	N/A	0	11
6a	Relative Proportion of All Saplings - Native Species	99	> 99%	N/A	N/A	100	98
6b	Relative Proportion of All Saplings - Non-Native Species	1	< 1%	N/A	N/A	0	2
6c	Stem Density of All Saplings (per acre) - Native Species	361	TBD	N/A	N/A	366	355
6d	Stem Density of All Saplings (per acre) - Non-Native Species	5	TBD	N/A	N/A	0	11
7	Frequency of Native Grass Species	5	> 10%	N/A	N/A	7	3
8	Frequency of Non-Native Grass Species	58	< 10%	N/A	N/A	52	64
9	Frequency of Native Herb Species	50	> 30%	N/A	N/A	52	47
10	Frequency of Non-Native Herb Species	35	< 10%	N/A	N/A	18	56
11	Frequency of Native Woody Seedlings	65	> 30%	N/A	N/A	68	61
12	Frequency of Non-Native Woody Seedlings	20	< 10%	N/A	N/A	14	28

[1] Color coding for rapid visualization (red means below target threshold value, green meets or exceeds target threshold).

[2] Represents average values across 46 measurements in Central and Northern New Jersey.

[3] Minimum and maximum values across 46 measurements in Central and Northern New Jersey.

A series of photographs with captions are provided below to highlight the severity of deer impacts at the Preserve.

An example of a very healthy forest (above – photo not taken on Preserve), which is filled with a dense native understory providing ecological control of invasive species. Bottom left photo from Preserve shows an understory almost completely devoid of plants due to severe deer browse ('Empty Forest Syndrome'). Bottom right photo shows a dense infestation of unpalatable invasive plants ('Infested Forest Syndrome').

Native tree seedlings are uncommon at the Preserve, except for particular sections of old forest. This does provide some hope for the future, but is too limited at the Preserve.

Large canopy gaps, even within old forest areas, are becoming infested by unpalatable invasive species and lack the next generation of native trees required to regenerate the forest.


Maple-leaved Viburnum – A typical badly browsed plant (Left) and relatively uncommon taller plant (Right).
Over many years, deer have virtually removed most native shrubs from the Preserve.
These two photos show the typical pattern and also an exception showing the potential for future improvements.


Left: White Wood Aster. Right: Sessile Bellwort.
Native forest wildflowers were very uncommon at the Preserve. Both of these plants should be exceptionally common.

Evaluation of Invasive Species Impacts

Mapping Protocols

The method used to map invasive plant species involved the delineation of mapping areas. The mapping area technique is a coarse method to broadly define the extent and intensity of invasive species infestations. Mapping areas were delineated as locations containing relatively uniform ground cover for each invasive species present within the defined area or 'patch'. Within each patch, each invasive plant species was assigned a cover class score. Cover class scores included: "0": absent, "Trace" or < 1% cover, "1": 1-10% ground cover, "2": 11-25% ground cover, "3": 26-50% ground cover, "4": 51-75%, and "5": 76-100% ground cover.

Overall Scope

A total of 166 unique mapped patches totaling 1,158 acres were recorded (Table 27). There were 90 acres (approximately 8%) where invasive species were absent or only present at trace levels. Approximately 80% of the mapped area is considered severely infested (invasive cover > 50%). Map 29 depicts the cumulative infestation scores by mapped patches.

Table 27. Invasive Species - Summary of Infestations by Mapped Patch

Mapped Patch Infestation Summary

Combined Infestation Score per Patch	Combined Infestation Score Category	Total Acreage	Percentage of Reserve
N/A	N/A	132.5	11.4
0*	"Clean"	89.9	7.8
1	Low	24.9	2.2
2	Moderate	12.7	1.1
3	Moderate	6.3	0.5
4	High	31.7	2.7
5	High	86.8	7.5
6	Very High	81.3	7.0
7	Very High	67.6	5.8
8	Extremely High	200.6	17.3
9	Extremely High	190.3	16.4
10	Extremely High	95.0	8.2
11	Extremely High	37.4	3.2
12	Extremely High	22.0	1.9
13	Extremely High	21.6	1.9
14	Extremely High	49.9	4.3
15	Extremely High	7.4	0.6
Totals		**1158**	**100**

*May contain one or more species at "Trace" amounts

Mapped Patch Infestation Summary

Combined Infestation Score per Patch	Combined Infestation Score Category	Total Acreage	Percentage of Preserve
N/A	N/A	132.5	11.4
0*	"Clean"	89.9	7.8
1	Low	24.9	2.2
2-3	Moderate	19.0	1.6
4-5	High	118.5	10.2
6-7	Very High	148.9	12.9
> 7	Extremely High	624.2	53.9
Totals		**1158**	**46**

*May contain one or more species at "Trace" amounts

Each invasive species was assigned an 'Action Code' based upon its threat level to conservation values, current extent of infestation within the Preserve and known invasive status in New Jersey (Table 28). Overall, 33 species are considered invasive – ten should be subject to an eradication program, seven should be subject to a selective control program. Specific management recommendations for particular species and areas within the Preserve are presented in Section IV.

Table 28. Invasive Species - Action Code Summary

Action Code	Action Code Explanation	Treatment Recommendations	Number of Species	Listed Species
1	Species has limited distribution (but is highly threatening) within the Preserve	Eradicate	10	Beefsteak Plant, Callery Pear, Chinese Silvergrass, Japanese Spirea, Japanese Wisteria, Jetbead, Linden Viburnum, Mimosa, Oriental Photinia, Wintercreeper
2	Species has widespread distribution within the Preserve and is considered highly threatening	Selective Control	7	Asiatic Bittersweet, Autumn Olive, Chinese Bushclover, Common Reed, Stinging Nettle, Tree-of-Heaven, Winged Burning Bush
3	Species has limited distribution and/or is not considered to be highly threatening to conservation values and/or control is not feasible within the Preserve	No Treatment	16	Canada Thistle, Carpgrass, Cool Season Grasses, Garlic Mustard, Japanese Barberry, Japanese Honeysuckle, Japanese Stiltgrass, Mile-a-Minute, Morrow's Bush Honeysuckle, Mugwort, Multiflora Rose, Privet, Reed Canary Grass, Spotted Knapweed, Wineberry
TOTAL			**33**	

Species Patterns

There were ten different emerging invasive plant species detected within the Preserve that should be considered for eradication (Table 29, Map 30). All of these species are considered highly threatening to ecological health. In addition, there were several notable widespread species that should be considered for prioritized treatment to reduce continued spreading across the Preserve (Table 30, Map 31).

Oriental Photinia is one of the most threatening emerging invasive species. It is becoming very abundant in portions of New Jersey, but only one location was detected at the Preserve. It is the highest eradication priority to avoid ever increasing ecological damage across the Preserve.

Table 29. Invasive Species – Emerging Species Points

Point ID	Species	Pop_Size	Latitude	Longitude
1	Japanese Wisteria	> 1,000	-74.74993053	40.45812671
2	Linden Viburnum	1	-74.75457457	40.45671253
3	Linden Viburnum	2-10	-74.76652078	40.45571544
4	Linden Viburnum	2-10	-74.75368005	40.45789783
5	Japanese Spirea	2-10	-74.74982209	40.45789121
6	Jetbead	11-100	-74.77578001	40.46440987
7	Mimosa	1	-74.7510244	40.4556133
8	Japanese Wisteria	2-10	-74.74950376	40.45720803
9	Japanese Wisteria	> 1,000	-74.74930848	40.45779157
10	Callery Pear	2-10	-74.77148069	40.45945799
11	Wintercreeper	2-10	-74.77514952	40.46002839
12	Chinese Silvergrass	2-10	-74.77702877	40.45532284
13	Oriental Photinia	2-10	-74.75270431	40.46127236
14	Linden Viburnum	11-100	-74.75860331	40.45150336
15	Linden Viburnum	2-10	-74.76347	40.46102364
16	Beefsteak Plant	2-10	-74.766346	40.46048936
17	Linden Viburnum	2-10	-74.75770332	40.45187165
18	Linden Viburnum	2-10	-74.76344431	40.45381836
19	Mimosa	2-10	-74.75966763	40.47085836

Table 30. Invasive Species - Widespread Species Points

Point ID	Species	Note	Latitude	Longitude
1	Common Reed	1/2 acre patch	-74.77126887	40.45004689
2	Common Reed	1/4 acre patch	-74.7506152	40.45582129
3	Tree-of-Heaven	1/4 acre patch	-74.78207926	40.46161513
4	Tree-of-Heaven	1/8 acre patch	-74.75420516	40.46502774
5	Winged Burning Bush	1 large individual	-74.76496	40.45528564

Table 31 contains data for each invasive species mapped within the Preserve (See individual species maps depicting distribution and intensity of infestations for each species). Table 31 also contains the "Relative Infestation Index Category." This index provides a coarse characterization of both distribution and intensity of infested acreage within the Preserve. It is intended to provide a rapid assessment of species that currently have the greatest impacts. Values include 'High', 'Medium', and 'Low', which correspond to ranges of Infestation Index Scores derived by multiplying the number of acres where a species was present by its cover class score within mapped patches. Species labeled as 'High' are those with widespread distributions and/or consist of dense stands. Conversely, 'Low' species have limited distribution and/or primarily occur at low cover classes.

The three most abundant/widespread invasive species are Japanese Stiltgrass, Multiflora Rose and Autumn Olive. Japanese Stiltgrass and Multiflora Rose were similarly abundant on the Preserve, with Autumn Olive primarily infesting meadows and isolated young forest patches. Additional species with relatively high infestation levels were (in order of index scores): Japanese Honeysuckle, Japanese Barberry, and Mile-a-Minute.

Spatial Patterns

The most severe combined infestations and number of invasive species per patch, and single species infestations (See Map 29, 32 and 33, respectively) tended to occur in former agricultural areas. Further amplifying this phenomenon is the prominence of ash decline within some of these same areas, which decreases shade provided by canopy trees and therefore increases the growth of invasive species such as Multiflora Rose.

Importantly, Multiflora Rose appears to be virtually restricted to shaded or partially shaded forest habitats. It was nearly absent from meadow habitats with isolated individuals infected by Rose Rosette Disease. While ash decline may initially promote rose growth, increased light may ultimately reduce its cover over time in woodland habitats.

Multiflora Rose succumbing to Rose Rosette Disease
in a woodland created through ash decline.

Areas without a history of agricultural tilling were the only areas considered to be “Clean” or have “Low” or “Moderate” infestation levels. However, some areas without agricultural tilling still had significant infestations of species, especially Japanese Stiltgrass.

Regardless of past agricultural land use, canopy gaps were highly infested by a variety of invasive species. Deer frequent canopy gaps (probably instinctively to seek plants with robust growth due to increased sunlight) and remove palatable native species while leaving behind unpalatable invasive species.

Surprising or not?!
This infestation of Mile-a-Minute has completely swarmed over and has nearly killed a 10-15 foot former 10-acre monoculture of Autumn Olive.

Table 31. Invasive Species – Individual Species and Their Relative Infestation Levels (Emerging invasive species are highlighted in yellow)

						Acreage by Percent Ground Cover Categories						
Scientific Name	Common Name	Action Code	Infestation Index Score[1]	Relative Infestation Index Category[2]	Total Acres Present	Category 0: 0%	Category Trace: < 1%	Category 1: 1-10%	Category 2: 10-25%	Category 3: 25-50%	Category 4: 50-75%	Category 5: 75-100%
Ailanthus altissima	Tree-of-Heaven	2	12.1	Medium	59.2	1098.8	52.3	6.9	0.0	0.0	0.0	0.0
Albizia julibrissin	Mimosa	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alliaria petiolata	Garlic Mustard	3	24.3	Medium	48.3	1109.7	26.7	21.6	0.0	0.0	0.0	0.0
Artemisia vulgaris	Mugwort	3	19.6	Medium	39.8	1118.2	22.5	17.3	0.0	0.0	0.0	0.0
Arthraxon hispidus	Carpgrass	3	316.2	High	140.6	1017.4	0.0	43.5	31.1	53.5	12.5	0.0
Berberis thunbergii	Japanese Barberry	3	490.5	High	487.3	670.7	188.7	187.4	65.6	29.4	16.2	0.0
Catalpa bignoniodes	Catalpa	3	2.9	Low	29.1	1128.9	29.1	0.0	0.0	0.0	0.0	0.0
Celastrus orbiculata	Asiatic Bittersweet	2	211.0	High	181.9	976.1	0.0	152.8	29.1	0.0	0.0	0.0
Centaurea maculosa	Spotted Knapweed	3	0.3	Low	2.8	1155.2	2.8	0.0	0.0	0.0	0.0	0.0
Cirsium arvense	Canada Thistle	3	9.7	Low	6.9	1151.1	0.0	5.5	0.0	1.4	0.0	0.0
Elaeagnus umbellata	Autumn Olive	2	1062.6	High	455.2	702.8	18.6	123.1	137.3	80.8	56.4	39.0
Euonymus alata	Winged Burning Bush	2	5.7	Low	56.9	1101.1	56.9	0.0	0.0	0.0	0.0	0.0
Euonymus fortunei	Wintercreeper	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lespedeza cuneata	Chinese Bushclover	2	159.7	High	127.8	1030.2	11.4	74.2	42.2	0.0	0.0	0.0
Ligustrum obtusifolium	Privet	3	86.3	Medium	115.0	1043.0	31.9	83.1	0.0	0.0	0.0	0.0
Lonicera japonica	Japanese Honeysuckle	3	583.1	High	384.7	773.3	57.5	104.0	196.3	26.9	0.0	0.0
Lonicera morrowii	Morrow's Bush Honeysuckle	3	33.7	Medium	33.5	1124.5	2.2	29.1	2.2	0.0	0.0	0.0
Microstegium vimineum	Japanese Stiltgrass	3	2084.5	High	894.7	263.3	88.3	119.2	328.8	196.3	100.5	61.6
Miscanthus sinensis	Chinese Silvergrass	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	Cool season hay grass	3	52.8	Medium	18.3	1139.7	0.0	0.0	9.1	2.2	7.0	0.0
Perilla frutescens	Beefsteak Plant	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phalaris arundinacea	Reed Canary Grass	3	3.1	Low	9.3	1148.7	6.9	2.4	0.0	0.0	0.0	0.0
Photinia villosa	Oriental Photinia	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phragmites australis	Common Reed	2	17.3	Medium	17.3	1140.7	0.0	17.3	0.0	0.0	0.0	0.0
Polygonum perfoliatum	Mile-a-Minute	3	335.0	High	256.5	901.5	55.8	143.2	22.0	13.1	9.1	13.3
Pyrus calleryana	Callery Pear	1	4.5	Low	23.1	1134.9	20.7	2.4	0.0	0.0	0.0	0.0
Rhodotypos scandens	Jetbead	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Rosa multiflora	Multiflora Rose	3	2014.6	High	823.2	334.8	182.7	56.1	162.6	214.4	65.2	142.2
Rubus phoenicolasius	Wineberry	3	188.2	High	262.4	895.6	92.4	165.5	0.0	4.5	0.0	0.0
Spiraea japonica	Japanese Spirea	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Urtica dioica	Stinging Nettle	2	1.5	Low	14.7	1143.3	14.7	0.0	0.0	0.0	0.0	0.0
Viburnum dilitatum	Linden Viburnum	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wisteria floribunda	Japanese Wisteria	1	POINT ONLY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[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 Categories include Low, Medium and High to represent Infestation Index Scores of < 10, 10-100 and > 100, respectively.

Section V. Strategies and Actions

Figure 9. Stewardship Philosophy

'Nature manages itself' is commonly heard from those that feel stewardship of natural lands is inappropriate. In some cases, this is based upon a simplistic understanding of natural systems and the forces that create or maintain them. Some proponents of this view fail to acknowledge that there are many indirect impacts of human activities on natural systems (e.g., introductions of non-native species, irreversible fragmentation of natural areas that support deer population growth, profound alteration of soils from past agricultural use, etc.). Other proponents of this view suggest that nature will have to balance itself within the framework established by human activities and that we should not intervene further. Finally, there are well-qualified experts including some experienced natural historians and research professors that understand that our knowledge of natural systems is incomplete and suggest that stewardship should not be practiced until we learn more about natural systems and how they will react to particular management regimes.

In contrast, proponents of stewardship proceed from the viewpoint that human activities directly and indirectly shape the remainder of our natural world and that there is an obligation to intervene to promote ecological health and avoid further loses to biodiversity. In short, stewardship may be defined as 'the mitigation of human impacts on natural systems'. Stewards feel that action is required when human impacts severely threaten ecological health, thereby consciously reducing human impacts through management strategies and actions.

In most cases, stewards strive for short-term interventions that correct natural systems with declining trajectories. Examples of short-term interventions include significant reductions of the white-tailed deer population (i.e., culling) and control of nascent populations of invasive species. In other cases, the continuing needs of the human population require that active management be perpetual (e.g., creation and maintenance of early successional habitats because catastrophic wildfires must be suppressed or a continuing Deer Management Programs to maintain a smaller deer herd).

In general, there are relatively few compromises available to proponents of the extremes of these two opposing viewpoints. However, most individuals realize that a balance is possible, especially when stewardship is coupled with careful monitoring or designed research experiments that provide greater insights to practice adaptive management. Overall, stewardship strategies should seek to utilize minimal human intervention to foster ecological health and stimulate research to provide a better understanding of the natural world.

Introduction

A significant and persistent effort will be required to improve ecological health at the Preserve. This plan has five primary plan recommendations. The first involves recreational, outreach and agricultural activities. The second through fifth recommendations involve stewardship of the Preserve and include: 2) Perform Forest and Meadow Habitat Maintenance and Restoration, 3) Perform Strategic Invasive Species Control, 4) Provide Stewardship of Rare Species and Perform Ecological Monitoring, and 5) Implement an Effective White-tailed Deer Management Program. Each of these recommendations is accompanied by specific goals that are numbered sequentially across all primary recommendations. There is a total of nine specific stewardship goals.

It is essential that a very effective Deer Management Program continue in perpetuity across the entire Preserve, while continually attempting to influence efforts on nearby private lands whenever possible. Significant reduction of the deer herd is absolutely critical to improve ecological health through increased native plant growth, which in turn will exert ecological control over invasive species (thereby lessening the need for ongoing chemical control). Invasive species are likely to be present in perpetuity, but they are much less likely to form dense infestations with lower deer densities.

Recommendations for control of particular invasive species were prioritized based upon their level of threat to further degrade ecological health (e.g., potential to significantly increase their abundance at the

Preserve and infestations located within or adjacent to areas with high conservation value). Species-specific recommendations are provided below, treatment prescriptions and phenology are provided through the New Jersey Invasive Species Strike Team, which updates its recommendations annually.

A summary of specific goals with suggested completion timeframes and estimated costs is summarized in Tables 34-36. Full plan implementation is estimated to require 3,625 hours of co-owner staff (estimated cost of $108,750) and require 3,205 volunteer hours (estimated value of $76,920) and require approximately $197,150 for contractors and materials over the next 10 years. Total cost for co-owner staff, contractors and materials is estimated at $305,900 over the 10-year plan implementation period.

It is realized that full plan implementation costs may be prohibitive. Recommendations #3 and #5 are considered minimal requirements to steward the Preserve. The combined estimated costs for these recommendations is $72,600. Implementing Recommendations #2 and #4 will require fundraising through private donations and private and public grant sources. The combined estimated costs to implement these recommendations is $233,300.

Recommendation #2: Perform Forest and Meadow Habitat Maintenance and Restoration

There are 37 meadow and shrubland patches on the Preserve (Table 32). Based upon relative quality, size and position on the landscape, recommendations on their stewardship are provided as Goal #2-2 or Goal #2-3. Remaining patches are provided with the recommendation of 'let go' as they are either in poor condition, small or isolated from similar habitats. While grassland bird habitat is marginal on the Preserve, Goal# 2-3 attempts to create the largest possible contiguous open habitat with potential to support less area demanding species, while still serving as pollinator habitat and viewshed. Meadow habitat at the Preserve is relatively diverse compared to other locations in New Jersey and maintaining appropriate mowing regimes and performing hand control of invasive shrubs is likely to produce good meadow habitat. Therefore, wholesale meadow restoration (i.e., eliminating all existing vegetation and seeding with native grasses and wildflowers) is not recommended at the Preserve.

Proposed restoration activities will require substantial funding from private donations and grants. It is also important to note that the scale of each proposed restoration project can be reduced based upon available funds (e.g., restore 10 acres of old forest understory instead of 25 acres).

The estimated cost to complete all goals under this recommendation is $222,000 over the 10-year implementation period (See Table 34). An additional $36,600 of volunteer value is also required for this recommendation.

Goal #2-1: Restore 25 Acres of Old Forest Understory

The restoration should begin with selection of three areas within the highest quality forest patches - Patch #52: 10-acre exclosure, Patches 94, 95, 98 and 99: 10-acre exclosure, Patch #27: 5-acre exclosure. Selected areas should include canopy gaps and relatively dense/diverse patches of native wildflowers. These areas will be protected by deer fencing to allow the natural establishment of native trees and shrubs required to maintain forest cover and planted with additional wildflower species that are suspected to have been lost from the Preserve.

This is the 'Noah's Ark' concept whereby restoring small areas could ultimately restore the entire Preserve (following deer herd reduction). Ideally, seeds should be collected from local sources within the Sourlands for germination by native plant nurseries familiar with propagating each species. A total of 5,000 plants will be installed within the exclosures. Preparation (as removal of any invasive and/or woody plants) and installation would be conducted by NJCF staff and volunteers. Costs for this goal are relatively high, but it is an investment that can provide returns by spreading from initial planting areas.

The estimated cost to complete this goal is $93,000 over the 10-year implementation period (See Table 34). An additional $10,800 of volunteer value is also required for this goal.

Goal #2-2: Foster Forest Establishment on 32 Acres Through Guided Old Field Succession

The primary purpose of this goal is to increase core forest habitat by restoring early successional habitat on the edges of existing forest habitat. This goal will restore low quality meadow and shrubland habitat in the central and western portions of the Preserve to foster forest establishment through invasive species control and planting of native shrubs in mini-exclosures that will ultimately allow native tree establishment. This restoration activity, along with anticipated deer herd reduction, will allow succession through native shrubland to forest over the next several decades. In the interim, higher quality shrubland within a forest matrix provides excellent habitat a number of forest bird species (e.g., productive foraging habitat).

There are seven patches that have already or are in the process of being completely infested with Autumn Olive. These include Patches 104, 105, 125, 134, 138, 144, and 147 (See Map 34). The restoration will begin with repeated mowing to weaken invasive species infestations. Heavy contracted forestry mowing will be required on 24 acres. Forestry mowing will be followed by regular mowing of the entire 32 acres for 2-3 years before hand treatments of remaining resprouts becomes feasible. Dense planting of native shrubs within 100 mini-exclosures (5-foot-tall fencing containing 100 square foot areas) will follow initial hand control efforts. Annual hand control efforts will continue throughout the 10-year plan term.

The estimated cost to complete this goal is $50,000 over the 10-year implementation period (See Table 34). An additional $9,000 of volunteer value is also required for this goal.

Goal #2-3: Restore or Maintain 105 Acres of Native Wildflower Meadow

The restoration of high-quality meadows will provide critical pollinator habitat and an aesthetically pleasing landscape that can be enjoyed by the public. Larger meadow patches have the potential to host less area-demanding grassland bird species. If stewardship is not employed, these areas will very, very quickly develop into Autumn Olive shrublands (see above). Cost estimates included in Table 34 (including estimates taken from Table 32) include an initial heavy mowing, annual mowing costs, and selective hand treatment of invasive shrubs. Chinese Bushclover occurs in relatively low numbers in multiple meadows (some patches are dense), this species will require selective treatment to avoid future widespread infestation within priority meadow areas.

Table 32 shows patches selected for this goal. It includes 105 acres and 17 mapped patches (this includes 17 acres within the gas right-of-way (See below). Some patches require only regular annual mowing, while others require spot treatments of Autumn Olive (herbicide application and removal to allow regular mowing), and Patch #157 requires forestry mowing and hand control of resprouts.

Patch #158 (1.3 acres) is a thin hedgerow that separates two larger meadow patches. It should be removed over time, starting with forestry mowing of shrubs to clear its ‘understory’ and hand control of resprouts. The death of ash trees within the hedgerow will occur shortly, dead ash and other tree species should be cut and removed to create contiguous open habitat that may support grassland bird species.

Patch #76 (5.5 acres) is an exception to other recommendations on the Preserve. This unusually diverse area has low invasive species cover and may have had topsoil ‘scraped off’ in the past, creating a relatively low nutrient, diverse native meadow-shrubland mosaic. It is recommended that this area be maintained through selective removal of invasive shrubs and native Eastern Red Cedar to maintain the current habitat mosaic.

The estimated cost to complete this goal is $79,000 over the 10-year implementation period (See Table 34). An additional $16,800 of volunteer value is also required for this goal.

Additional Note: NJCF should consider discussing the timing of mowing on the 17-acre natural gas right-of-way managed by Texas East. In 2018, mowing occurred in September and led to the observed killing of multiple Box Turtles (NJ State Special Concern Species) as well as eliminating all flowering of species providing food for pollinators (including migrating Monarch Butterflies). If possible, the ROW should be mowed only during the dormant season to protect native species.

Many meadows on the Preserve are relatively diverse and healthy, but are under imminent threat of Autumn Olive infestation. This meadow requires hand removal of large olives to allow regular mowing without obtructions.

Table 32. Status and Recommendations for Early Successional Habitat

Patch ID	Current Mowing Requirement	Community Name	Patch Acres	Relative Quality Rank	Recommendation	Estimated Initial Cost (Forestry Mow)	Estimated Initial Cost (Hand Treatment)	Estimated Annual Regular Mowing Cost
104	Regular	Meadow	0.9	Low	Goal #2-2: Guided to Forest	$0	$0	$43
105	Regular	Meadow	0.8	Low	Goal #2-2: Guided to Forest	$0	$0	$38
125	Forestry Mow	Mosaic: Meadow - Shrubland	7.1	Low	Goal #2-2: Guided to Forest	$8,534	$4,267	$356
134	Regular + Forestry	Mosaic: Meadow - Shrubland	4.6	Low	Goal #2-2: Guided to Forest	$2,787	$1,045	$232
138	Forestry Mow	Shrubland	10.1	Low	Goal #2-2: Guided to Forest	$12,150	$6,075	$506
144	Regular + Forestry	Mosaic: Meadow - Shrubland	1.9	Low	Goal #2-2: Guided to Forest	$1,150	$431	$96
147	Regular + Forestry	Mosaic: Meadow - Shrubland	6.4	Low	Goal #2-2: Guided to Forest	$3,844	$1,441	$320
30	Regular	Meadow	2.0	Moderate	Goal #2-3: Wildflower Meadow	$0	$0	$98
38	Regular	Meadow - Natural Gas ROW	13.8	Moderate	Goal #2-3: Wildflower Meadow	$0	$0	$0
57	Regular	Meadow - Natural Gas ROW	3.5	Moderate	Goal #2-3: Wildflower Meadow	$0	$0	$0
58	Regular + Hand Removal	Meadow	4.9	Moderate	Goal #2-3: Wildflower Meadow	$0	$1,100	$244
59	Regular	Meadow	2.4	High	Goal #2-3: Wildflower Meadow	$0	$0	$118
61	Regular	Meadow	2.8	High	Goal #2-3: Wildflower Meadow	$0	$0	$138
63	Regular + Hand Removal	Meadow	5.5	Moderate	Goal #2-3: Wildflower Meadow	$0	$1,237	$275
76	Hand Removal	Mosaic: Meadow - Shrubland	5.5	Very High	Goal #2-3: Mosaic: Meadow - Shrubland	$0	$1,238	$0
120	Regular + Hand Removal	Meadow	3.1	Very High	Goal #2-3: Wildflower Meadow	$0	$694	$154
121	Regular + Hand Removal	Meadow	1.7	Moderate	Goal #2-3: Wildflower Meadow	$0	$390	$87

Table 32. Status and Recommendations for Early Successional Habitat (continued)

Patch ID	Current Mowing Requirement	Community Name	Patch Acres	Relative Quality Rank	Recommendation	Estimated Initial Cost (Forestry Mow)	Estimated Initial Cost (Hand Treatment)	Estimated Annual Regular Mowing Cost
122	Regular + Hand Removal	Meadow	7.7	High	Goal #2-3: Wildflower Meadow	$0	$1,735	$385
132	Regular + Hand Removal	Meadow	27.8	Moderate	Goal #2-3: Wildflower Meadow	$0	$6,264	$1,392
152	Regular	Meadow	4.7	Moderate	Goal #2-3: Wildflower Meadow	$0	$0	$236
153	Regular	Meadow	4.3	Moderate	Goal #2-3: Wildflower Meadow	$0	$0	$213
155	Regular	Meadow	12.7	Moderate	Goal #2-3: Wildflower Meadow	$0	$0	$634
156	Regular	Meadow	3.3	Moderate	Goal #2-3: Wildflower Meadow	$0	$0	$164
157	Forestry Mow	Shrubland	3.6	Low	Goal #2-3: Wildflower Meadow	$4,348	$2,174	$181
158	Forestry Mow	Hedgerow	1.3	Low	Goal #2-3: Wildflower Meadow	$1,560	$780	$65
15	Regular	Meadow	1.4	Moderate	Let go	$0	$0	$0
22	Regular	Meadow	1.5	Moderate	Let go	$0	$0	$0
67	Regular	Meadow	0.9	Moderate	Let go	$0	$0	$0
74	Forestry Mow	Shrubland	8.4	Low	Let go	$0	$0	$0
75	Forestry Mow	Shrubland	2.9	Low	Let go	$0	$0	$0
81	Forestry Mow	Shrubland	9.3	Low	Let go	$0	$0	$0
114	Forestry Mow	Shrubland	6.9	Low	Let go	$0	$0	$0
115	Forestry Mow	Shrubland	3.2	Low	Let go	$0	$0	$0
119	Forestry Mow	Shrubland	2.2	Low	Let go	$0	$0	$0
137	Regular	Meadow	0.4	Low	Let go	$0	$0	$0
150	Forestry Mow	Meadow	10.7	Low	Let go	$0	$0	$0
151	Forestry Mow	Meadow	3.0	Low	Let go	$0	$0	$0
160	Forestry Mow	Shrubland	1.1	Low	Let go	$0	$0	$0
162	Forestry Mow	Shrubland	2.2	Low	Let go (maintain trail)	$0	$0	$0
Totals						**$34,372**	**$28,871**	**$5,976**

Recommendation #3: Perform Strategic Invasive Species Control

A complete list of invasive species along with control goals (i.e., Action Code) and strategies is provided in Table 33. Treatment prescriptions are available through the New Jersey Invasive Species Strike Team, which updates them annually based upon newly available information. The following annotated recommendations are provided as specific tasks within Table 34 along with cost estimates and timeframes. NJCF staff has substantial knowledge and professional license requirements to effectively guide invasive species control efforts that would primarily be performed by seasonal interns.

Ecological control exerted by native species is the ultimate goal to curb invasive plant species. This should not be expected without further reduction of the deer herd (See Goal #5), however, the majority of recommended control work is focused on species where ecological control is expected to have the lowest rates of success (e.g., tall, shade tolerant species such as Oriental Photinia and Linden Viburnum). Specific control measures for species that would be most susceptible to ecological control (e.g., Japanese Stiltgrass and Multiflora Rose) are not recommended.

The estimated cost to complete all goals under this recommendation is $63,600 over the 10-year implementation period (See Table 34). An additional $36,240 of volunteer value is also required for this recommendation.

Goal #3-1: Eradicate 10 Emerging Invasive Species

Emerging invasive species should be the highest priority for control efforts because they threaten the Preserve and the region with future ecological degradation. This strategy, known as Early Detection & Rapid Response, represents an efficient and effective strategy to prevent damage (and minimize future stewardship costs). There are currently ten emerging species designated as 'Action Code 1' (i.e., eradication is the ultimate goal, See Table 29 and Map 30). Table 34 provides specific time and cost estimates for each species.

The estimated cost to complete this goal is $16,850 over the 10-year implementation period (See Table 34). An additional $6,120 of volunteer value is also required for this goal.

Goal #3-2: Perform Selective Control of 7 Widespread Invasive Species

This goal includes seven species of 'Action Code 2' species - each species has specific strategic recommendations to reverse current impacts and limit future impacts (Table 33 and Table 34). This goal includes treatment of five discrete patches of selected widespread invasive species (See Table 30 and Map 31) to limit spread across the Preserve. Control efforts for other invasive species are incorporated within other goals (See below and above; e.g., Autumn Olive under meadow goals).

The estimated cost to complete this goal is $26,250 over the 10-year implementation period (See Table 34). An additional $6,120 of volunteer value is also required for this goal.

Goal #3-3: Protect High Quality "Clean" Areas on 120 Acres

There are approximately 120 acres that are less impacted by invasive species infestations. This includes approximately 110 acres of forest habitat (Patches # 8, 41, 43, 45, 47, 51, 52, 53, 56, 86, 94, 95, 97, 99, 110, 127, and 165), 5 acres of shrubland (Patch #76 – see Goal #2-3) and 5 acres of meadow (Patches #59 and #61 – See Goal #2-3).

The goal for "clean" areas is to maintain cover at less than 10% cover for all invasive species. All selected areas should be monitored annually and invasive species should be treated to maintain invasive

species at goals listed above over the next 10 years. Ultimately, ecological control of invasive species should maintain these areas with reduced risk of new infestations.

The estimated cost to complete this goal is $20,500 over the 10-year implementation period (See Table 34). An additional $24,000 of volunteer value is also required for this goal.

Species such as this Rattlesnake Plantain grow in “clean” forests
at the Preserve and they cannot tolerate invasive species infestations.

Table 33. Invasive Species - Control Strategy Summary

Scientific Name	Common Name	Action Code	Growth Form	Control Strategy
Ailanthus altissima	Tree-of-Heaven	2	Tree	Selective Control - Focus on elimination of identified clusters and female trees throughout Preserve
Albizia julibrissin	Mimosa	1	Tree	Eradicate all known occurrences; Maintain continual searching and eradication
Alliaria petiolata	Garlic Mustard	3	Herb	No Direct Action - Ecological control through deer herd reduction
Artemisia vulgaris	Mugwort	3	Herb	No Direct Action - Ecological control through deer herd reduction and effective meadow stewardship
Arthraxon hispidus	Carpgrass	3	Herb	No Direct Action - Ecological control through deer herd reduction and effective meadow stewardship
Berberis thunbergii	Japanese Barberry	3	Shrub	No Direct Action - Ecological control through deer herd reduction
Catalpa bignoniodes	Catalpa	3	Tree	No Direct Action - Ecological control through deer herd reduction
Celastrus orbiculata	Asiatic Bittersweet	2	Vine	Selective Control - Prioritize all vines in highest quality areas, followed by female plants in more degraded areas
Centaurea maculosa	Spotted Knapweed	3	Herb	No Direct Action - Ecological control through deer herd reduction and effective meadow stewardship
Cirsium arvense	Canada Thistle	3	Herb	No Direct Action - Ecological control through deer herd reduction and effective meadow stewardship
Elaeagnus umbellata	Autumn Olive	2	Shrub	Selective Control - Forest - Eradicate Fruiting Individuals (esp. high quality areas); Meadow - Eradicate all individuals in high quality habitats and Control via hand treatments or forestry mowing as feasible
Euonymus alata	Winged Burning Bush	2	Shrub	Selective Control - Treat all encountered individuals while performing eradication surveys for species such as Oriental Photinia and Linden Viburnum
Euonymus fortunei	Wintercreeper	1	Vine	Eradicate all known occurrences; Maintain continual searching and eradication
Lespedeza cuneata	Chinese Bushclover	2	Herb	Selective Control - Treat all encountered individuals in high quality meadow habitats
Ligustrum obtusifolium	Privet	3	Shrub	No Direct Action - Ecological control through deer herd reduction
Lonicera japonica	Japanese Honeysuckle	3	Vine	No Direct Action - Ecological control through deer herd reduction
Lonicera morrowii	Morrow's Bush Honeysuckle	3	Shrub	No Direct Action - Ecological control through deer herd reduction
Microstegium vimineum	Japanese Stiltgrass	3	Herb	No Direct Action - Ecological control through deer herd reduction
Miscanthus sinensis	Chinese Silvergrass	1	Herb	Eradicate all known occurrences; Maintain continual searching and eradication
N/A	Cool season hay grass	3	Herb	No Direct Action - Ecological control through deer herd reduction and effective meadow stewardship
Perilla frutescens	Beefsteak Plant	1	Herb	Eradicate all known occurrences; Maintain continual searching and eradication
Phalaris arundinacea	Reed Canary Grass	3	Herb	No Direct Action - Ecological control through deer herd reduction and effective meadow stewardship
Photinia villosa	Oriental Photinia	1	Shrub	Eradicate all known occurrences; Maintain continual searching and eradication
Phragmites australis	Common Reed	2	Herb	Selective Control - Treat selected patches in high quality meadow habitats (e.g., Gas Line ROW)
Polygonum perfoliatum	Mile-a-Minute	3	Herb	No Direct Action - Ecological control through deer herd reduction and effective meadow stewardship
Pyrus calleryana	Callery Pear	1	Tree	Eradicate all known occurrences; Maintain continual searching and eradication
Rhodotypos scandens	Jetbead	1	Shrub	Eradicate all known occurrences; Maintain continual searching and eradication
Rosa multiflora	Multiflora Rose	3	Shrub	No Direct Action - Ecological control through deer herd reduction
Rubus phoenicolasius	Wineberry	3	Shrub	No Direct Action - Ecological control through deer herd reduction
Spiraea japonica	Japanese Spirea	1	Shrub	Eradicate all known occurrences; Maintain continual searching and eradication
Urtica dioica	Stinging Nettle	2	Herb	Selective Control - Treat all encountered individuals in high quality meadow habitats
Viburnum dilitatum	Linden Viburnum	1	Shrub	Eradicate all known occurrences; Maintain continual searching and eradication
Wisteria floribunda	Japanese Wisteria	1	Vine	Eradicate all known occurrences; Maintain continual searching and eradication

Recommendation #4: Provide Stewardship of Rare Species and Perform Ecological Monitoring

This recommendation includes higher levels of stewardship activity including ecological monitoring of forest habitat and monitoring and stewardship of rare species. Ecological monitoring provides accountability and forms the basis for the adaptive management process.

The estimated cost to complete all goals under this recommendation is $11,300 over the 10-year implementation period (See Table 34). An additional $4,080 of volunteer value is also required for this recommendation.

Goal #4-1: Perform Selective Rare Species Monitoring and Stewardship

There are a total of twenty rare animals and plants known to occur within the Preserve (Table 24) and four rare plants were discovered during field mapping (Table 21). The full extent of these species should be determined through the completion of Goal #4-1 above (which might lead to additional discoveries). While the full scope of stewarding these rare plants cannot be determined until a more thorough search is conducted, known populations should be maintained through invasive species control in the immediate vicinity of plants.

Rare animal species will require additional investigation to determine their use of the Preserve. Because the majority of species are birds, it would be ideal that the Preserve becomes an e-Bird Hotspot with regular visits by qualified volunteer birders to determine avian use by habitat, focusing on species listed in Table 24. While targeting overall habitat health is the primary goal of this plan, additional specific rare species stewardship strategies may be necessary based upon results of new surveys. See Goal #2-3 for efforts to support less area-demanding rare grassland bird species.

More thorough surveys need to be completed to document current rare plant occurrence conditions in terms of the number of vegetative and reproductive individuals, the area they occupy in the Preserve, and threats to their persistence. A monitoring protocol should be designed and executed at least every 3-5 years to observe changes in condition over time and to identify needs for adaptive management.

Currently, the Virginia Snakeroot population appears very lacking in abundance of individuals. One individual was observed south of the right-of-way and seven individuals were found north of the right-of-way. The group of seven individuals is persisting under the cover of thick woody vegetation, protecting it from deer browse, which has damaged the individual at the second location. Regionally, deer browse is a significant threat to this species' population health. Small exclosures of these locations and any additional locations found for the population in the future would protect enclosed individuals from deer browse. Monitoring and stewardship should proceed for this species with the objective of increasing population numbers. Surveys, fencing, and other stewardship activities as needed should have the goal of increasing the known population size to at least 50 plants in the next 2-3 years. Eventually, a sustainable occurrence on the property might be considered a minimum of 200 individuals. If permission would be granted, surveys on neighboring properties could also be performed to evaluate the capacity of Preserve's individuals to have effective genetic interaction with nearby vicinities.

The Purple Blazing-star takes full advantage of its limited edge habitat at the observed site. However, its success is limited to this single, very small site, and is therefore at high risk of extirpation from the Preserve. To maintain this occurrence, its habitat must be suitably maintained as an early-successional edge. The site is at the intersection of an old road emerging from the woods with a semi-maintained trail skirting a succeeding old field. Controlling woody growth in this old field and within the occurrence area will be necessary to maintain the blazing-star occurrence here. As an attempt to increase the occurrence's resiliency, considering controlled propagation of the known individuals and introduction to other suitable

sites on the property is also an option. Five additional locations for the species would be a significant asset to the occurrence's health. The overall goal should be 300 stems (minimum of 50 stems at each of six meadow locations previously identified as having long-term management goal of meadow habitat – See Goal #2-3).

Further surveys for the Slender Toothwort and Long-spurred Violet are necessary to evaluate stewardship needs for their occurrences on the Preserve. For all rare species, management of invasive species and vigilance about direct or indirect deer browse impacts in the immediate vicinities of all occurrence areas should be a priority.

The estimated cost to complete this goal is $2,800 over the 10-year implementation period (See Table 34). An additional $400 of volunteer value is also required for this goal.

Goal #4-2: Perform Ecological Health Monitoring

Ecological health should be monitored regularly in forests at the Preserve to evaluate stewardship activities and guide adaptive management over time. Forest health should be monitored every three years (baseline monitoring performed in 2018). This should be completed using established protocols and evaluated using thresholds provided in this plan.

Provide potential ideas for successional monitoring

The estimated cost to complete this goal is $8,500 over the 10-year implementation period (See Table 34). An additional $3,600 of volunteer value is also required for this goal.

Recommendation #5: Implement an Effective White-tailed Deer Management Program

Goal #5-1: Reduce deer density to meet forest health goals including a dense, native understory

The Preserve has a long history of hunting in coordination with equestrian uses. However, the Preserve is heavily impacted by deer browse and deer observations were frequent during the field mapping activities despite an abundance of deer stands and baiting stations (Map 12). It will be necessary for NJCF to implement a deer management program that harvests significantly more deer than in the past. In order to improve ecological health, there will have to be significant and strategic approach to locally reduce the deer herd to approximately 10 deer per square mile. This goal is supported by the literature.

- The historical analysis of the white-tailed deer population density in North America (pre-European colonization) is approximately 10 per square mile (McCabe and McCabe 1984).
- In general, native species diversity / abundance and overall forest health drop significantly with increasing deer herd size. An often-cited research project that provides quantitative guidance on deer population levels associated with ecological damage was performed by David deCalesta, based at the US Forest Service in Pennsylvania (deCalesta 1994, deCalesta 1997). Over the course of a 10-year study using forest enclosures with known densities of deer, deCalesta determined that native forest herbs and tree seedlings became less abundant with deer densities between 10 and 20 per square mile. At densities exceeding 20 per square mile, palatable native plant species disappear and forest shrub-nesting song birds drop in abundance with the loss of the shrub layer.
- Human health impacts may also be associated with deer densities exceeding 10 deer per square mile. According to a study reported from Connecticut (Stafford 2007), deer population size is linked to incidences of Lyme disease. This relationship is dependent upon a threshold deer

population size, requiring a population size of 10-12 deer per square mile to show substantial reduction in human cases of Lyme disease.

It is likely that initial herd reduction efforts will require the harvesting of >100 deer per year from the Preserve. Harvests of this size will require a mixture of recurring agricultural depredation permits, annual strategic and well-coordinated deer drives and skilled and motivated individual hunter activities (e.g., strategically placed and timed baiting and harvesting to avoid creating 'nocturnal deer'). This may require specific recruitment of skilled management hunters. All hunters should be provided a minimum antlerless deer harvest quota in order to remain as a Preserve hunter.

The estimated cost to complete this goal is $9,000 over the 10-year implementation period (See Table 34).

Deer observations were frequent at the Preserve (Photo by Gemma Milly)

Table 34. Detailed Goals for 10-Year Implementation Period

Category	Goal	Activity	Total Estimated Level of Effort (All Hours)	Total Estimated Level of Effort (Staff Hours)	Total Estimated Level of Effort (Volunteer Hours)	Estimated Staff Costs @ $30/hour (Permanent and Seasonal)	Estimated Contractor / Material Cost	Total Cost	Volunteer Value @ $24/hour	Volunteer Support Note	Contractor / Material Notes
Recreation / Outreach	1-1	Trail Creation and Maintenance	1150	275	875	$8,250	$1,650	$9,900	$21,000	Trail Creation and Maintenance	Tools, Lumber
Recreation / Outreach	1-2	Signage, Kiosks, Displays	140	120	20	$3,600	$1,450	$5,050	$480	Signage Installation	Tools, Lumber, Printing
Recreation / Outreach	1-2	Guided Hikes (5 per year)	200	50	150	$1,500	$500	$2,000	$3,600	Hike Leaders	Miscellaneous supplies, Handouts
Recreation / Outreach	1-3	Preserve Management & Maintenance	300	200	100	$6,000	$3,000	$9,000	$2,400	Clean Up Days	Various supplies
Agriculture	1-4	Develop an Agricultural Use Agreement	110	110	0	$3,300	$0	$3,300	$0	None	None
Forest Stewardship	2-1	Forest Restoration - Deer Exclosures and Planting	1050	600	450	$18,000	$75,000	$93,000	$10,800	Fence Installation and Maintenance	Native Wildflowers, Fencing
Forest Stewardship	2-2	Forest Restoration - Guided Succession	875	500	375	$15,000	$35,000	$50,000	$9,000	None	Herbicide, Tools, Contractor with heavy mower for intial clearing. Initial clearing and ongoing annual mowing taken from Table 31. Assumes interns will perform most hand clearing tasks.
Meadow Stewardship	2-3	Meadow Maintenance and Restoration	1000	300	700	$9,000	$70,000	$79,000	$16,800	Planting; Mowing	Herbicide, Tools, Contractor with heavy mower for intial clearing. Initial clearing and ongoing annual mowing taken from Table 31. Assumes interns will perform most hand clearing tasks.
Invasive Species Eradication	3-1	Searching / Eradication - Japanese Wisteria	115	60	55	$1,800	$50	$1,850	$1,320	Searching	Herbicide, Tools
Invasive Species Eradication	3-1	Searching / Eradication - Linden Viburnum	140	60	80	$1,800	$50	$1,850	$1,920	Searching	Herbicide, Tools
Invasive Species Eradication	3-1	Searching / Eradication - Japanese Spirea	70	60	10	$1,800	$50	$1,850	$240	Searching	Herbicide, Tools
Invasive Species Eradication	3-1	Searching / Eradication - Mimosa	35	20	15	$600	$1,000	$1,600	$360	Searching	Herbicide, Tools
Invasive Species Eradication	3-1	Searching / Eradication - Jetbead	35	20	15	$600	$1,500	$2,100	$360	Searching	Herbicide, Tools
Invasive Species Eradication	3-1	Searching / Eradication - Callery Pear	70	60	10	$1,800	$1,000	$2,800	$240	Searching	Herbicide, Tools
Invasive Species Eradication	3-1	Searching / Eradication - Wintercreeper	30	20	10	$600	$1,000	$1,600	$240	Searching	Herbicide, Tools

Table 34 (continued). Detailed Goals for 10-Year Implementation Period

Category	Goal	Activity	Total Estimated Level of Effort (All Hours)	Total Estimated Level of Effort (Staff Hours)	Total Estimated Level of Effort (Volunteer Hours)	Estimated Staff Costs @ $30/hour (Permanent and Seasonal)	Estimated Contractor / Material Cost	Total Cost	Volunteer Value @ $24/hour	Volunteer Support Note	Contractor / Material Notes
Invasive Species Eradication	3-1	Searching / Eradication - Chinese Silvergrass	70	20	50	$600	$1,000	$1,600	$1,200	Searching	Herbicide, Tools
Invasive Species Eradication	3-1	Searching / Eradication - Beefsteak Plant	30	20	10	$600	$1,000	$1,600	$240	Searching	Herbicide, Tools
Widespread Species Control	3-2	Selective Control - Tree-of-Heaven	240	200	40	$6,000	$1,000	$7,000	$960	Searching	Herbicide, Tools
Widespread Species Control	3-2	Selective Control - Asiatic Bittersweet	340	275	65	$8,250	$1,000	$9,250	$1,560	Searching	Herbicide, Tools
Widespread Species Control	3-2	Selective Control - Winged Burning Bush	70	60	10	$1,800	$1,000	$2,800	$240	Searching	Herbicide, Tools
Widespread Species Control	3-2	Selective Control - Chinese Bushclover	160	60	100	$1,800	$1,000	$2,800	$2,400	Searching	Herbicide, Tools
Widespread Species Control	3-2	Selective Control - Common Reed	70	60	10	$1,800	$1,000	$2,800	$240	Searching	Herbicide, Tools
Widespread Species Control	3-2	Selective Control - Stinging Nettle	50	20	30	$600	$1,000	$1,600	$720	Searching	Herbicide, Tools
Forest Stewardship	3-3	Maintenance of Clean Areas	1600	600	1000	$18,000	$2,500	$20,500	$24,000	Searching	Herbicide, Tools
Ecological Monitoring	4-1	Ecological Health Monitoring	80	60	20	$1,800	$1,000	$2,800	$480	Sampling	Miscellaneous Supplies
Rare Species Stewardship	4-2	Monitoring and Stewardship of Rare Plants and Animals	400	250	150	$7,500	$1,000	$8,500	$3,600	Monitoring and Stewardship	Various supplies
Deer Management	5-1	Administer DMP	300	300	0	$9,000	$0	$9,000	$0	N/A	None
Totals			**8,730**	**4,380**	**4,350**	**$131,400**	**$203,750**	**$335,150**	**$104,400**		

Table 35. Goals - Priority and Costs by Plan Year

				Cost by Year									
Goal	**Activity**	**Priority***	**Total Cost**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
1-1	Trail Creation and Maintenance	1	$9,900	$2,500	$1,000	$800	$800	$800	$800	$800	$800	$800	$800
1-2	Signage, Kiosks, Displays	1	$5,050	$1,900	$350	$350	$350	$350	$350	$350	$350	$350	$350
1-2	Guided Hikes (5 per year)	3	$2,000	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200
1-3	Preserve Management & Maintenance	1	$9,000	$3,900	$2,700	$300	$300	$300	$300	$300	$300	$300	$300
1-4	Develop an Agricultural Use Agreement	1	$3,300	$600	$300	$300	$300	$300	$300	$300	$300	$300	$300
2-1	Forest Restoration - Deer Exclosures and Planting	3	$93,000	$0	$37,500	$32,100	$11,200	$3,700	$2,200	$2,200	$1,450	$1,450	$1,200
2-2	Forest Restoration - Guided Succession	3	$50,000	$1,500	$6,500	$6,500	$6,500	$6,500	$6,500	$6,500	$6,500	$1,500	$1,500
2-3	Meadow Maintenance and Restoration	2	$79,000	$0	$51,500	$11,500	$11,500	$900	$900	$900	$600	$600	$600
3-1	Searching / Eradication - Multiple Emerging Species	1	$16,850	$2,115	$3,415	$1,415	$1,415	$1,415	$1,415	$1,415	$1,415	$1,415	$1,415
3-2	Selective Control - Multiple Widespread Species	1	$26,250	$2,460	$3,060	$2,610	$2,610	$2,610	$2,610	$2,610	$2,610	$2,610	$2,460
3-3	Maintenance of Clean Areas	1	$20,500	$1,750	$1,750	$1,750	$2,500	$2,500	$2,500	$2,500	$1,750	$1,750	$1,750
4-1	Ecological Health Monitoring	3	$2,800	$100	$100	$1,000	$100	$100	$100	$1,000	$100	$100	$100
4-2	Monitoring and Stewardship of Rare Plants and Animals	3	$8,500	$850	$850	$850	$850	$850	$850	$850	$850	$850	$850
5-1	Administer DMP	1	$9,000	$900	$900	$900	$900	$900	$900	$900	$900	$900	$900
Totals			**$335,150**	**$18,775**	**$110,125**	**$60,575**	**$39,525**	**$21,425**	**$19,925**	**$20,825**	**$18,125**	**$13,125**	**$12,725**

*1 = Minimum requirement to effectively steward the Preserve
2 = Goals to reach higher stewardship standards
3 = Goals to reach highest stewardship standards

Table 36. Goals - Priority and Total Plan Period Cost

Goal	Activity	Priority*	Total Cost
1-1	Trail Creation and Maintenance	1	$9,900
1-2	Signage, Kiosks, Displays	1	$5,050
1-2	Guided Hikes (5 per year)	3	$2,000
1-3	Preserve Management & Maintenance	1	$9,000
1-4	Develop an Agricultural Use Agreement	1	$3,300
2-1	Forest Restoration - Deer Exclosures and Planting	3	$93,000
2-2	Forest Restoration - Guided Succession	3	$50,000
2-3	Meadow Maintenance and Restoration	2	$79,000
3-1	Searching / Eradication - Multiple Emerging Species	1	$16,850
3-2	Selective Control - Multiple Widespread Species	1	$26,250
3-3	Maintenance of Clean Areas	1	$20,500
4-1	Ecological Health Monitoring	3	$2,800
4-2	Monitoring and Stewardship of Rare Plants and Animals	3	$8,500
5-1	Administer DMP	1	$9,000
Totals			**$335,150**

*1 = Minimum requirement to effectively steward the Preserve
2 = Goals to reach higher stewardship standards
3 = Goals to reach highest stewardship standards

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Newly emerged Monarch on Goldenrod at the Preserve (Photo by Gemma Milly).