Wickecheoke Creek Preserve Management Plan

May 2011

Prepared for the
New Jersey Conservation Foundation

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Introductory Information

Project Area:	Wickecheoke Creek Watershed consisting of 14 miles of waterways within three sub-watersheds (HUC 14's) totaling 26.6 square miles or 17,024 acres
Preserve Name:	Wickecheoke Creek Preserve
Total Acreage:	Fee / Preserve Properties = 890, Easement Properties (includes conservation and farmland easements) = 643, Assisted / Transferred Properties = 1,430; Total Project Properties = 2,963 (ca. 18% of the Project Area)
Preserve Owners:	Fee / Preserve properties solely owned by New Jersey Conservation Foundation (ca.723 acres); Thompson II parcels (ca. 175 acres) are co-owned with Hunterdon County and New Jersey Water Supply Authority
Municipalities/County:	Delaware Township, Franklin Township, Kingwood Township, Raritan Township, Stockton Borough / Hunterdon County
Wildlife Action Plan Conservation Zone:	Skylands Region - Southern Highlands Zone (26)
NJDEP Watershed Management Area:	Central Delaware (WMA 11)
Numbers of Special Conservation Targets[1]:	*Total Number of Special Conservation Target Animal Species:* ***16*** *Total Number of Special Conservation Target Plant Species:* ***15*** *Total Number of Special Conservation Target Ecological Communities:* ***0***

Note: Categories below are not mutually exclusive.
Globally Rare Species: None
Federally Endangered Species: None
Federally Threatened Species: None
Federally Listed Candidate Species: None
State Endangered Species: 2 animals + 3 plants = 5
State Threatened Species: 6 animals + 5 plants = 11
State Special Concern: 8 animals + 7 plants = 15
Wildlife Action Plan Priority Animal Species (Southern Highlands Zone): 16

Globally Rare Ecological Communities: None
State Rare Ecological Communities: None

[1] Species include those confirmed or suspected to be present within the Wickecheoke Creek Project Area.

Cover Photo: Wickecheoke Creek at Lower Creek Road - Photo taken by M. Van Clef

Special Conservation Target List:	**Animals (16)** Amphibians (4) Fowler's Toad, Jefferson Salamander, Longtail Salamander, Marbled Salamander Birds (10) Barred owl, Bobolink, Cooper's hawk, Eastern Meadowlark, Great Blue Heron, Northern Parula, Red-shouldered hawk, Savannah Sparrow, Vesper Sparrow, Wood Thrush Reptiles (2) Eastern Box Turtle, Wood Turtle **Plants (15)** Bush's Sedge, Cattail Sedge, Cranefly Orchid, Gypsywort, Halberd-leaved Greenbrier, Leatherwood, Meadow Parsnip, Pear Hawthorn, Slender Toothwort, Southern Wood Violet, Spotted Phlox, Table Mountain Pine, Virginia Pennywort, Water Horehound, Winged Monkeyflower
Landscape-Scale Conservation Areas:	ENSP Landscape Project Importance Summary: See Text New Jersey Natural Heritage Program Priority Sites: None Audubon Important Bird and Birding Areas (IBBA): None
Recreational Resources:	Approximately 10 miles of hiking trails 13Trail Head Parking Areas; 13 Unmarked Access Areas
Structures:	Abandoned hunting shack at Macak Section; Old Homestead foundation remains at Hilton Section.
Contributors:	The following individuals provided invaluable information and insights to make this management plan possible. Staff of New Jersey Conservation Foundation Alix Bacon, Louis Cantafio, Emile DeVito, Timothy Morris, Sieglinde Mueller, Marie Newell, Raymond Steingall Conservation Partners and Preserve Neighbors Judy Allen, Delaware Township Dennis Bertland, Private Resident Craig Bitler, US Fish & Wildlife Service Troy Ettel, New Jersey Audubon Society Amy Greene, Raritan Township Open Space and Environmental Commissions MacKenzie Hall, Conserve Wildlife Foundation Ty Hodonish, Private Resident Lora Jones, Private Resident/Franklin Township Kenneth Klipstein, New Jersey Water Supply Authority Todd Kratzer, New Jersey Water Supply Authority Kim Leister, Private Landowner Tama Matsuoka, Private Resident James McCue, Private Resident Tom Michalenko, Local Farmer

Leslie Jones Sauer, Private Resident
Carina Sayles, Delaware Township Open Space Committee
and Covered Bridge Trail Association
Kris Schantz, NJDEP – Endangered and Nongame Species Program
Jackie Strigl, Private Resident
Pamela Thier, NJDEP – Green Acres Program
Skip Updike, Local Farmer
Margaret Waldock, Hunterdon Land Trust Alliance
Richard Wolven, United Bowhunters of New Jersey

Mushrooms growing at the Macak Section.

Executive Summary

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

The vision for the Wickecheoke Creek 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 Preserve consists of approximately 500 acres of mature forest, 50 acres of shrubland, 150 acres of meadows, 6 acres of ponds and 150 acres of hay fields utilized by two local farmers. The Wickecheoke Creek is strewn with large boulders and waterfalls. Forest habitats include dramatic rock outcrops, hemlock ravines that hug the Wickecheoke Creek and abundant Sugar Maple trees that put on an incredible fall display. Early successional habitats such as shrublands and meadows provide critical habitat to a variety of plants and animals. Rare species in the Project Area include sixteen animals and fifteen plants.

The primary threats to maintenance of biodiversity include: 1) overabundant white-tailed deer, 2) invasive species, and 3) altered stream flows. The six primary management recommendations include: 1) Create and Implement Community Deer Management Program, 2) Selective Control of Invasive Species, 3) Foster Forest Health, 4) Foster Early Successional Communities, 5) Foster Health of the Wickecheoke Creek, and 6) Enhance Recreational Opportunities and Outreach. See 'Primary Management Recommendations' on the next page for a summary of each recommendation.

Recreational and educational recommendations are intended to build community support and provide opportunities for the general public to learn and appreciate the Preserve's resources. Public access will be provided for passive and active recreational opportunities such as hiking, nature observation & photography, cross-country skiing, horseback riding, hunting, and fishing. Recreational and educational opportunities will be provided through 19 miles of trails accessed from 13 parking areas. Self-guided nature trails, special events and expert guided tours will be provided to supplement opportunities provided to daily visitors of the Preserve.

NJCF has already made significant strides toward effective management of the Preserve, but should consider increasing its stewardship and outreach capacity by assigning a full-time land steward dedicated to the Preserve along with annual support from two seasonal interns. In addition, complete realization of the vision and goals for the Preserve can only be met through cooperation of partners and consideration of multiple stakeholders. 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 the implementation of recommendations are evaluated. At a minimum, this management plan will be revised every ten years. The careful management of the Wickecheoke Creek Preserve will provide concrete examples of exemplary stewardship and community support that can be broadly applied throughout New Jersey.

Primary Management Recommendations

Fulfillment of these recommendations will require increased staff capacity dedicated to the Wickecheoke Creek Project Area (i.e., assignment of a full-time land steward and two seasonal interns). In addition, cost efficiencies would be accrued if lead staff members become 'Certified Pesticide Applicators' and interns become 'Certified Pesticide Operators'.

1. Create and Implement Community Deer Management Program

NJCF should enhance its current Preserve Deer Management Program to encourage increased harvesting of antlerless deer. Ultimately, success at improving ecological health across all lands within the Wickecheoke Creek Project Area will require significant deer herd reduction through cooperative efforts among a variety of stakeholders. NJCF should organize an effort among all four watershed municipalities, hunters, farmers and other stakeholders to achieve success. Specific recommendations should employ simple quantitative measures of deer impacts to document success and guide ongoing management decisions (e.g., forest health, deer-vehicle collisions, Lyme disease, agricultural losses, landscape planting loses). ***This effort should be considered the highest stewardship priority.***

2. Selective Invasive Species Control

NJCF should institutionalize an Early Detection / Rapid Response Program to detect and eradicate new invasive species and nascent populations of otherwise widespread species across the Preserve and recruit private and public landowners within the project area. NJCF can capitalize on its existing partnership with the New Jersey Invasive Species Strike Team to help achieve the goal of eradicating newly emerging invasive species before they cause new problems.

3. Foster Forest Health

The primary strategy to foster forest health is through implementation of a Community Deer Management Program (see above), which would allow native species to exert ecological control over invasive species, allow forest understory structure to return, and allow forest canopy trees to produce seedlings and saplings to perpetuate forest cover. Reforestation of early successional habitats should focus on areas that increase core forest acreage and stream buffers. This can involve active restoration through fencing and/or planting to speed recovery ahead of the necessary deer herd reduction required for ultimate success.

4. Foster Early Successional Communities

Areas of the Preserve away from large contiguous forest habitat should emphasize high-quality early successional habitats dominated by native shrubs or herbs that provide valuable habitat to fauna that require non-forest habitats. Maintenance of early successional habitat will require dedicated stewardship efforts in perpetuity (e.g., regular mowing and/or prescribed burning, selective removal of aggressive invasive species such as Autumn Olive, etc.).

5. Foster Health of Wickecheoke Creek

The New Jersey Water Supply Authority and local municipalities (especially Delaware Township) have produced reports and strategies to mitigate problems associated with uncontrolled high water flows followed by periods of extremely low flows. NJCF can play a critical role as partner toward implementation of these strategies on the Preserve and throughout the Project Area.

6. Enhance Recreational Opportunities and Outreach

NJCF has provided significant recreational opportunities through trails and parking areas throughout the Preserve. Enhancements to existing efforts should include improved communications and updates at the Preserve and via the internet. Formation of a volunteer core organized around pre-determined weekly work days to maintain trails, allowance of horseback riding in selected areas, establishment of self-guided nature trails and educational programs and incorporation of cultural/historic resources.

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*Maps of the entire Wickecheoke Creek Project Area are provided as hard copy. Close-up maps by portions of the Project Area (nine separate areas) showing greater detail are provided electronically only. Individual invasive plant species distribution maps (30 separate species) are also provided electronically.

**Please see interactive maps at www.njisst.org to review current status and print maps.

List of Appendices

Section I. Overview

Introduction

Vision and Goals

The vision for the Wickecheoke Creek Preserve is to provide model stewardship of biodiversity along with excellent public recreation and educational opportunities. Although the primary objective is the enhancement of biodiversity, providing recreational and educational opportunities are considered high priorities that will be balanced with the requirements of biodiversity. The six primary management recommendations include: 1) Create and Implement Community Deer Management Program, 2) Selective Control of Invasive Species, 3) Foster Forest Health, 4) Foster Early Successional Communities, 5) Forester health of the Wickecheoke Creek, and 6) Enhance Recreational Opportunities. The recreational and educational recommendation is intended to build community support and provide opportunities for the general public to learn and appreciate the Preserve's resources. Public access will be provided for passive and active recreational opportunities such as hiking, nature observation & photography, cross-country skiing, horseback riding, hunting, and fishing.

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Preserve Values

The Wickecheoke Creek Preserve represents excellent examples of the natural and agricultural heritage contained within the Wickecheoke Creek Project Area, which harbors a unique, rural portion of the Northern Piedmont. The Northern Piedmont physiographic province runs from southern New England, through the north-central portions of New Jersey and terminating in southeastern Pennsylvania. It is largely developed and remnants of its past natural, agricultural and cultural heritage are few, which highlights the significance of the Preserve. New Jersey Conservation Foundation has been a leader in preserving the Wickecheoke Creek watershed for over 20 years by acquiring, or assisting in the acquisition, of nearly 18% of the Project Area.

The Preserve and surrounding watershed have significant implications for maintaining large amounts of clean drinking water supplied through the New Jersey Water Supply Authority, which pumps water from the Delaware-Raritan Canal at the base of the Wickecheoke Creek watershed. The maintenance and restoration of natural habitats assures groundwater recharge with water filtered through healthy native plant communities. The D&R Canal supplies over 70 million gallons of potable water per day to residents of Central New Jersey.

The Preserve consists of over 500 acres of forest, 200 acres of shrubland and meadow habitat and 150 acres of active farmland. Forest types include Sugar Maple that brings vivid colors to the fall landscape, Oak-Hickory that provides excellent wildlife habitat, and Eastern Hemlock that hugs the Wickecheoke

Creek. Shrubland and meadows containing a diversity of native plants provide high-value fruits for migrating forest birds and foster butterfly and grassland bird populations. Collectively, these habitats harbor a variety of unique and beautiful elements of our flora and fauna including rare species of statewide conservation importance. A short list of rare species includes Barred Owl, Red-shouldered Hawk, Longtail Salamander, Bobolinks and Eastern Meadowlarks.

Threats

This section provides a review of three significant factors that impact forest health. These factors are interrelated and collectively reduce forest health greater than any single factor. In isolation, deer overabundance is the most severe threat, followed by invasive species and continuing impacts of altered soils from past agricultural use including invasive earthworm species whose impact extends into forest areas never cleared for agriculture. Factors related to stream system health are interrelated with forest health, but are discussed separately under 'Physical Features – Water' below and within plan Section III.

Degraded forests in New Jersey fall generally 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 (1890 forest cover GIS layers and 1930 aerial photography showing mature forest cover can act as a guide to determine 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. Historical analyses estimate the pre-European colonization deer herd to be about 70,000 (ca. 10 deer per square mile) in New Jersey (McCabe and McCabe 1984). Unregulated commodity hunting throughout the 1800's nearly drove deer to extinction and conservation efforts supported by new regulations allowed a rebound to pre-European colonization population sizes during the 1960's. However, the deer population has grown significantly since the 1960's with severe consequences to forest health.

Male white-tailed deer in 'velvet' at the Preserve. Visual observations of deer were extremely common in the Project Area, which along with obvious vegetation damage, suggests a deer population that is much higher than other parts of New Jersey.

The root causes of deer overabundance include forest fragmentation, creation of supplemental feeding opportunities and insufficient deer management (Figure 1). In addition, it is believed that the sex ratio of New Jersey's deer herd is significantly higher than 1:1 and may reach as high as 15:1 in particular locations (personal communications with hunters and wildlife professionals). The skewed sex ratio allows deer populations to grow rapidly following seasonal reductions (i.e., the overall population drops significantly - by over 30% following hunting season - but rebounds dramatically after birthing occurs in spring). The reduction of population size from 1995 to 2006 appears to be the result of greater overall harvest size along with harvesting a greater proportion of antlerless deer (Figure 2). This figure suggests that deer herd reduction requires harvesting greater than 40% of the overall population with greater than 60% of the total harvest being antlerless deer.

Figure 1. Deer Population Growth Factors and Impacts

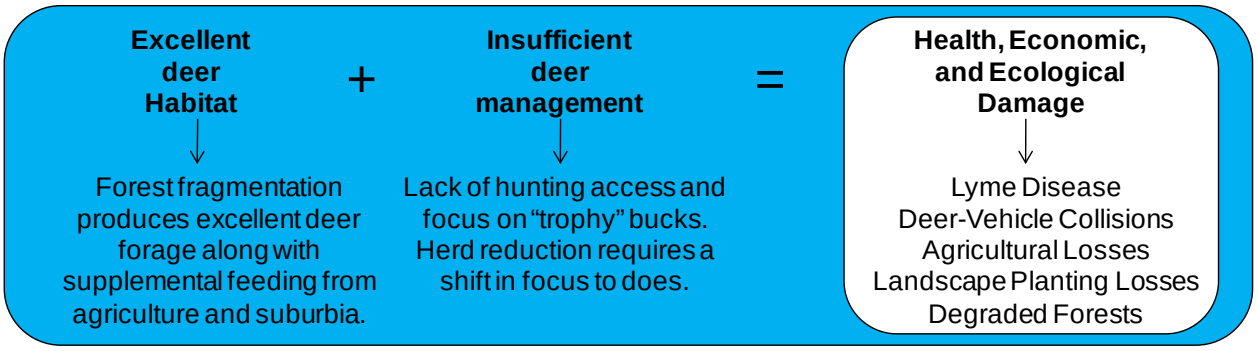
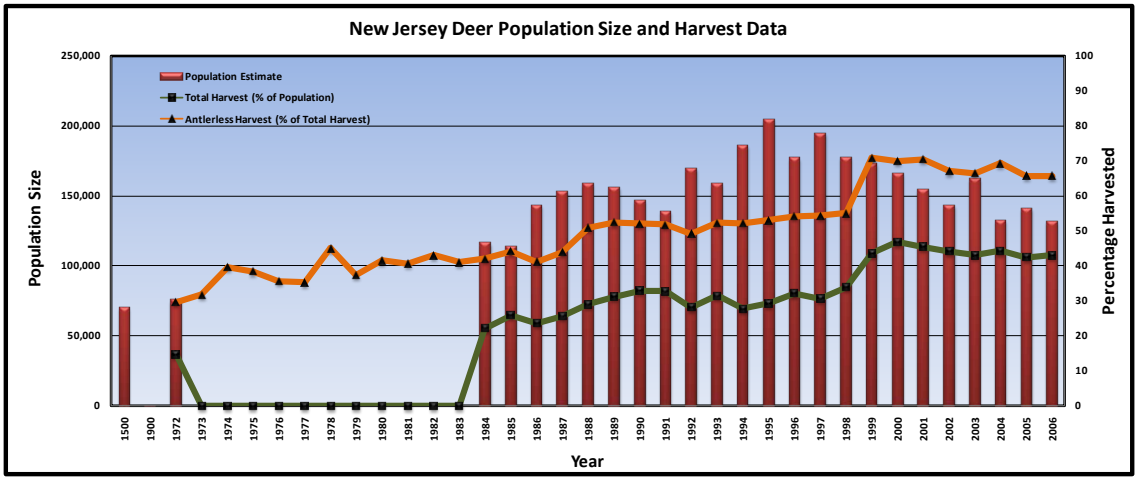


Figure 2. New Jersey Deer Population Size and Harvest Data
Source: NJDEP – Division of Fish & Wildlife



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. Healthy forest communities that support a diversity of plants and animals should be a universal goal.

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 - 50 years in New Jersey with our most serious invasive species originating from areas with similar temperate climates (i.e., Europe and Asia). The non-native flora and fauna is evaluated annually by the New Jersey Invasive Species Strike Team – the numbers of species reported below are from their 2010 evaluation (See www.njisst.org for updated evaluations).

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 additional competitive 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 30 widespread invasive plants and 76 emerging or potentially invasive plants in New Jersey (see Appendix A). 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 (and the other 27 widespread invasives) 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 76 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 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 and Japanese Aralia.

Animals - Invasive animals also cause significant harm to native ecosystems. There are currently 14 widespread invasive animals and 5 emerging or potentially invasive animals in New Jersey (see Appendix B). 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), House Sparrow (nest competition, primarily in human-dominated areas), Asian Tiger Mosquito (human pest and unknown ecological damage), Rusty Crayfish (alter aquatic communities), House Finch (nest site competition, primarily in human-dominated areas), 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 NJ 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 7 widespread invasive pests & pathogens and 17 emerging or potentially invasive pests & pathogens in New Jersey (see Appendix C). 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 states 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 US Department of Agriculture has been working on creating hybrids between the Eastern Hemlock and Tsuga chinensis to test for resistance (analogous to the American Chestnut program). Field trials began in 2006 and hybrids with T. chinensis appear to be most tolerant of HWA (See http://www.ars.usda.gov/is/pr/2010/101110.htm?pf=1). 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.

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 (causing tree death throughout the state, but the ultimate impacts are unknown) and Dogwood Anthracnose (many plants are not severely impacted and ultimate impacts are unknown). Butternut Canker is also widespread, but the native Butternut has never been common in New Jersey and impacts on forest communities are not expected to be severe.

There are a number of emerging and potential pests and pathogens that may impact New Jersey in the future. Emerging species already present in New Jersey include Asian Long Horned Beetle (subject of an intensive eradication program), 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.

Imminent threats include Emerald Ash Borer which has been spreading east and south from the Midwest (recently discovered in Maryland, Pennsylvania, Virginia and Missouri and subject of ongoing searches in New Jersey) and Sudden Oak Death (SOD). 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.

Threats with relatively low risk to the Preserve, but may be important to Christmas tree production include White Pine Blister Rust, Common Pine Shoot Beetle, Sirex Wood Wasp, Red-haired Pine Bark Beetle, European Spruce Beetle, Mediterranean Pine Engraver Beetle, and Brown Longhorned Spruce Beetle.

Asian longhorn beetle

Emerald ash borer

Photo Source: Forestry Images / The Bugwood Network, http://www.forestryimages.org/

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.

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 on native plants that have the ability to survive these altered soil conditions).

Overview of Invasive Species Management

The underlying philosophical context for invasive species management is the obligation to counteract negative human impacts on natural systems, which is often referred to as "stewardship". The guiding principal of stewardship is fostering health of native plant communities that support our flora and fauna, which is indirectly accomplished through the management of invasive species. Management of invasive species is generally achieved through targeted control measures that minimize, but does not eradicate, particular invasive species. Eradication within pre-defined boundaries should only be considered a valid goal when populations are relatively small and the threat of continued spread is significant. Eradication should also be considered at 'showcase' or 'flagship' lands such as the Wickecheoke Creek Preserve. In all cases, invasive species management should aim to stimulate native plant communities to resist infestation and minimize the use of herbicides 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 properties. This approach is warranted for invasive species that are emerging locally or regionally and for widespread invasive species with limited distribution at the Preserve.

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

Control Methods - The management of invasive species can be classified into five broad methods referred to as mechanical, chemical, biological, cultural and ecological control (Table 1). Each control method

utilizes multiple techniques and control methods may be used alone or in combination depending upon the resource to be protected and practical constraints (Table 2 and Appendix D - Overview of Control Methods).

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

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

The application of pesticides is regulated by the NJ Department of Environmental Protection - Pesticide Control Program (PCP). Lead staff members involved with the application of herbicides should become 'commercial pesticide applicators', which requires attendance in a one day course on pesticide safety, passing PCP's core exam and at least one PCP category exam and completing 40 hours of on-the-job training for each category of pesticide application. There are two pesticide application categories that cover any potential applications in natural areas and stewards 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). The PCP may waive on-the-job training requirements if it can be shown that New Jersey Conservation Foundation currently does not have anyone certified in these two categories to provide training.

Staff 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 that are not certified applicators or operators may still apply herbicides if a certified applicator is always physically present and in the line-of-sight of the non-certified staff member.

The PCP also requires a permit for any wetland applications of pesticides. Currently, this involves a simple reporting form and an associated $75 fee. In some cases, the PCP may require an additional permit from the NJ Department of Environmental Protection - Division of Land Use when control work is deemed to significantly alter the vegetative structure of a wetland (e.g., removal of significant invasive shrub cover to promote emergent wetland). In 2011, it is expected that the Environmental Protection Agency will require an additional permit and associated fees for wetland applications.

New England Aster at the Thompson Section. Notice the small insect larvae on the flower. Invasive species become dominant because they lack similar natural predators. While largely unmeasured, this lack of support for insect populations likely has profound impacts on insect diversity & abundance and species higher in the food chain that depend upon them.

Table 1. Description of Invasive Plant Control Methods

Control Method	Description	Pros	Cons	Notes
Biological	Introduction of a biocontrol agent (e.g., insect, pathogen) from the invasive species' native range	Dramatic reduction in abundance with minimal costs; minimal accessibility issues	Limited number of invasive species have agents	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 2. 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

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

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

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

Cultural control is similar to the concept of agricultural best management practices but can be applied to early successional natural systems (e.g., grasslands, meadows). There are numerous practices that could

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

Prescribed grazing is defined as the application of a specific kind of livestock at a determined season, duration and intensity to accomplish defined vegetation or landscape goals (Launchbaugh 2006). The benefits of using livestock to control invasive species have been demonstrated for New Jersey's bog turtles (Tesauro 2001). This work primarily involved the use of cows to consume and destroy root mats of invasive species such as Phragmites and Purple Loosestrife. Another potential application may be the use of goats or other livestock to consume dense thickets of 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 or 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 remedied is overabundance of white-tailed deer.

Land Use History

Wickecheoke Creek Project Area

Rutgers University has an ongoing project to digitize forest cover circa 1890 using historic topographic maps. Currently, GIS mapping data exists for only the northern 1/3 of the watershed (primarily north of State Highway 12). In the 1890's, forest cover represented approximately 34% of the landscape, which was likely dominated by agricultural fields and pastures along with relatively small towns and scattered homesteads (See Map 1). There were 41 unique forest patches with an average size of 18 acres.

Aerial photography from 1930 is available through the NJ Department of Environmental Protection (See Map 2). Analysis of forest patches within the entire watershed shows that approximately 17% of the Project Area had forest cover in 1930 (See Map 1). There were a total of 118 unique forest patches totaling 2,842 acres with an average forest patch size of 24 acres.

Wickecheoke Creek Preserve

The 1890's forest coverage data includes the Huey, Turnquist, Levine and Fishkin (northern 2/3 only) Sections. Forest cover was variable: Huey (ca. ½ of property), Turnquist (< 1 acre), Levine (none), Fishkin (ca. ¾ of property).

In the 1930's, approximately 250 acres of the Preserve had forest cover (ca. 28%). The Fishkin, VanHouten, Lang, Macek, and Soine Sections were almost completely forested. The existing forest areas in the northern

portion of Jungblut and southern portion of Mitchell had nearly complete forest cover in 1930. Areas immediately along the Wickecheoke Creek of Jungblut, Robertson, Hodanish, Stone, Bruce, Johnson, Milano, Hilton, Hackl and Thorpe also had forest cover. Forest cover was minimal or non-existent in other sections of the Preserve. See Appendix I for historic forest cover estimates for each forest patch mapped and described for this management plan.

Based upon the available 1890 and 1930 forest cover data for the northern portion of the watershed, only the Fishkin Section had forest cover in both time periods. This suggests that this area contains the oldest forest in the northern portion of the watershed and its likely age exceeds 120 years.

Physical Features

Climate

The climate of the Wickecheoke Project Area is continental (i.e. typified by large seasonal and daily temperature fluctuations) and the growing season is approximately 240 days, lasting from late March to mid-November (Collins and Anderson 1989). Temperature and precipitation patterns at the Flemington, New Jersey weather station for the period of 1971 - 2000 are summarized below and depicted in Figures 3 - 5 (Office of the State Climatologist 2010). Annual average daily temperature is 51 degrees Fahrenheit and approximately 49 inches of precipitation fall annually. Annual snowfall averages were 27 inches per year (maximum was 72 inches).

Figure 3. Average Minimum and Maximum Temperatures by Month (1971-2000)

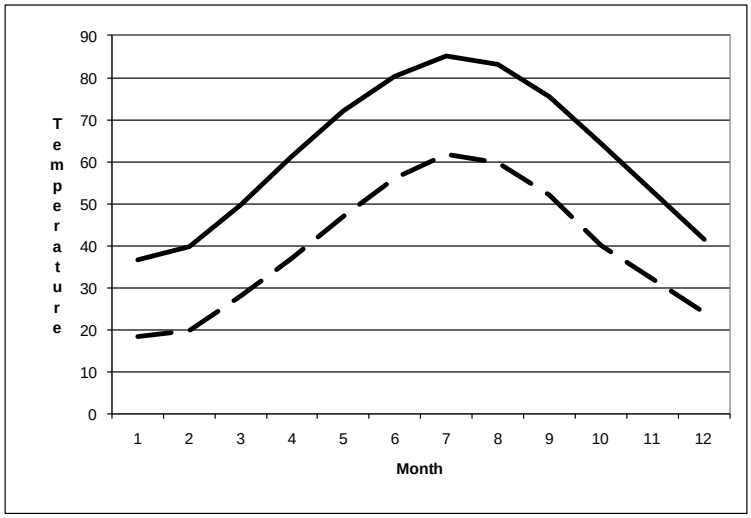


Figure 4. Average Precipitation by Month (1971-2000)

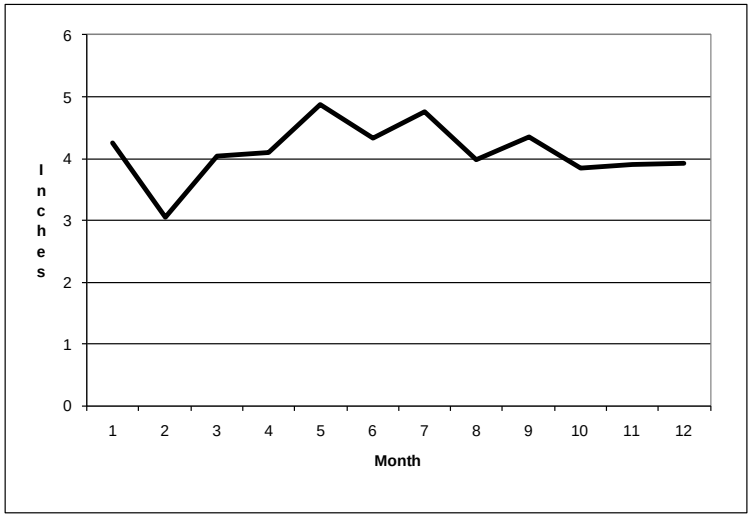
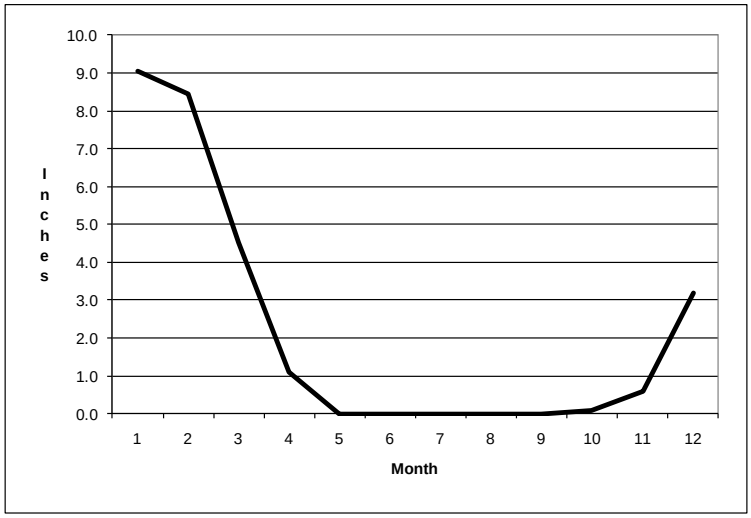


Figure 5. Average Snowfall by Month (1971-2000)



Geology

The Wickecheoke Creek Project Area is underlain by the Lockatong Formation (65%), Red Bed of Lockatong Formation (13%) and the Stockton Formation (22%) (See Map 3). The Stockton Formation consists of sandstones, mudstones, siltstone and shale. The two Lockatong formations contain a very hard, sedimentary rock called argillite that significantly impacts the character of the Wickecheoke Project Area. This bedrock is highly resistant to erosion, which allows formation of cliffs, outcrops, rocky slopes and waterfalls. Argillite is also non-porous to water, which leads to flooding, stream bank erosion from increased runoff during storm events and loss of stream flow in dry periods through reduced groundwater recharge that would serve as base flow. In some portions of the stream, bank erosion is significant despite the relative lack of human-related impervious surfaces throughout the watershed (ca. 2%).

The elevation in the watershed ranges from 20 feet above mean sea level at the confluence with the Delaware River to 700 feet (See Map 4). Steep slopes GIS data was provided by the New Jersey Water Supply

Authority. There are approximately 1,200 acres (ca. 7%) of the project area with slopes ≥ 15% (See Map 5). Excessively steep slopes (≥ 30%) account for approximately 200 acres (or 1%) of the project area and occur along the main branch of the Wickecheoke Creek in the southern 1/3 of the watershed (primarily within the Stockton Formation). The Preserve includes many of these very steep areas (Mitchell, Macak, Soine, Johnson, Ling, Hilton and Hackl Sections). The steepest portion of the entire watershed is contained within the Johnson Section just west of Pine Hill Road.

Dramatic rock outcrops mark the steepest slopes in the watershed at the Johnson Section of the Wickecheoke Creek Preserve.

Soils

The Wickecheoke Creek Project Area has 17 different soil series representing 37 unique soil map units with varying qualities that impact vegetation (Table 3). The Project Area contains significant amounts of important farmland soils and erodible lands (See Maps 6 & 7). Soils classified as "Prime Farmland" (ca. 12%) or "Farmland of Statewide Importance" (ca. 76%) account for nearly 88% of the Project Area. "Highly Erodible Lands" (ca. 8%) and "Potentially Highly Erodible Lands" (ca. 87%) accounted for over 95% of the Project Area. Many areas listed as Farmland of Statewide Importance were also classified as Potentially Highly Erodible Lands. The majority of agricultural activity in the watershed involves hay production, which likely minimizes erosion risks relative to typical row crops such as corn, but there is a clear need to address erosion concerns to maintain stream health. The majority of the Project Area contains poorly drained soils with hydrologic soil groupings of C, C/D or D (ca. 86%, See Map 8).

Table 3. Soils of the Wickecheoke Creek Project Area and Preserve

Soil Series	Soil Symbol	Soil Map Unit	% Slope	Percent of Watershed Area	Percent of Preserve Area	Depth to Bedrock (inches)	Depth to Water Table (feet)	Hydric Soil Category	Hydrologic Soil Grouping	Annual Flooding	Prime Ag	State Ag	HEL	PHEL
ABBOTTSTOWN	AbrA	Abbottstown silt loam	0 - 3	1.0	0.0	40 - 60	0.5 - 1.5	No	C	NONE	No	Yes	No	Yes
ABBOTTSTOWN	AbrB	Abbottstown silt loam	3 - 8	2.6	0.9	40 - 60	0.5 - 1.5	No	C	NONE	No	Yes	No	Yes
BOWMANSVILLE	Boy	Bowmansville silt loam	0 - 2	0.1	0.0	40 - 60	0 - 1	Yes	B/D	FREQ	No	Yes	No	No
BUCKS	BucB	Bucks silt loam	3 - 8	0.4	0.0	40 - 60	6 - 6	No	B	NONE	No	No	No	Yes
BUCKS	BucC2	Bucks silt loam	8 - 15	0.4	0.3	40 - 60	6 - 6	No	B	NONE	No	Yes	No	Yes
CHALFONT	ChcA	Chalfont silt loam	0 - 3	17.2	12.2	40 - 60	0.5 - 1.5	No	C	NONE	No	Yes	No	Yes
CHALFONT	ChcB	Chalfont silt loam	3 - 8	29.2	21.8	40 - 60	0.5 - 1.5	No	C	NONE	No	Yes	No	Yes
CHALFONT	ChcC2	Chalfont silt loam	8 - 15	3.2	5.1	40 - 60	0.5 - 1.5	No	C	NONE	No	Yes	Yes	No
CHALFONT	ChcCb	Chalfont silt loam	0 - 15	0.4	0.0	40 - 60	0.5 - 1.5	No	C	NONE	No	No	No	Yes
CHALFONT	ChfB	Chalfont-Quakertown silt loams	0 - 8	0.3	0.0	40 - 60	0.5 - 1.5	No	C	NONE	No	No	No	Yes
CROTON	CoxA	Croton silt loam	0 - 3	11.0	10.1	40 - 60	0 - 1	Yes	D	NONE	No	Yes	No	Yes
CROTON	CoxB	Croton silt loam	3 - 8	2.7	3.1	40 - 60	0 - 1	Yes	D	NONE	No	Yes	No	Yes
CROTON	CoxBb	Croton silt loam	0 - 8	2.6	2.6	40 - 60	0 - 1	Yes	D	NONE	No	No	No	Yes
HAZLETON	HdyB	Hazleton channery loam	3 - 8	0.5	0.6	48 - 60	6 - 6	No	B	NONE	No	Yes	No	Yes
HAZLETON	HdyB2	Hazleton channery loam	8 - 15	1.5	4.2	48 - 60	6 - 6	No	B	NONE	No	Yes	No	Yes
HAZLETON	HdyD	Hazleton channery loam	15 - 25	1.5	4.7	48 - 60	6 - 6	No	B	NONE	No	No	Yes	No
HAZLETON	HdyDb	Hazleton channery loam	5 - 20	0.4	2.5	48 - 60	6 - 6	No	B	NONE	No	No	No	Yes
HAZLETON	HdyEb	Hazleton channery loam	25 - 45	1.2	11.0	48 - 60	6 - 6	No	D	NONE	No	No	Yes	No
LANSDALE	LbmB	Lansdale loam	3 - 8	3.4	0.2	40 - 60	6 - 6	No	B	NONE	Yes	No	No	Yes
LANSDALE	LbmC2	Lansdale loam	8 - 15	3.6	1.2	40 - 60	6 - 6	No	B	NONE	No	Yes	No	Yes
LANSDALE	LbmD	Lansdale loam	15 - 25	0.9	1.6	40 - 60	6 - 6	No	B	NONE	No	No	Yes	No
PENN	PeoB	Penn channery silt loam	3 - 8	0.3	0.0	20 - 40	6 - 6	No	C	NONE	Yes	No	No	Yes
PENN	PeoC2	Penn channery silt loam	8 - 15	0.4	0.0	20 - 40	6 - 6	No	C	NONE	No	Yes	No	Yes
PENN	PeoD	Penn channery silt loam	15 - 25	0.1	0.0	20 - 40	6 - 6	No	C	NONE	No	No	Yes	No
BUCKS	PepB	Penn-Bucks complex	3 - 8	0.3	0.2	40 - 60	6 - 6	No	B	NONE	Yes	No	No	Yes
BUCKS	PepC2	Penn-Bucks complex	8 - 15	0.2	0.0	40 - 60	6 - 6	No	B	NONE	No	Yes	No	Yes
POPE	PomA	Pope fine sandy loam	0 - 3	0.2	0.5	60 - 60	6 - 6	No	B	OCCAS	Yes	No	No	No
QUAKERTOWN	QukA	Quakertown silt loam	0 - 3	0.3	0.0	40 - 60	6 - 6	No	C	NONE	Yes	No	No	No
QUAKERTOWN	QukB	Quakertown silt loam	3 - 8	7.0	0.4	40 - 60	6 - 6	No	C	NONE	Yes	No	No	Yes
QUAKERTOWN	QukC2	Quakertown silt loam	8 - 15	1.9	2.9	40 - 60	6 - 6	No	C	NONE	No	Yes	Yes	No
RARITAN	RarB	Raritan silt loam	3 - 8	0.0	0.0	60 - 60	0.5 - 2.5	No	C	RARE	Yes	No	No	Yes
READINGTON	RedB	Readington silt loam	3 - 8	0.2	0.0	40 - 60	1.5 - 3	No	C	NONE	Yes	No	No	Yes
REAVILLE	RehA	Reaville silt loam	0 - 3	0.2	0.0	20 - 40	1 - 2	No	C	NONE	No	Yes	No	Yes
REAVILLE	RehC2	Reaville silt loam	8 - 15	0.1	0.6	20 - 40	1 - 2	No	C	NONE	No	No	No	No
REAVILLE VARIANT	RepwB	Reaville wet variant silt loam	3 - 8	0.1	0.0	20 - 40	0 - 1	Yes	D	NONE	No	No	No	Yes
RIVERHEAD	RksB	Riverhead gravelly sandy loam	3 - 8	0.1	1.7	60 - 60	6 - 6	No	B	NONE	Yes	No	No	Yes
ROWLAND	RorAt	Rowland silt loam	0 - 3	3.4	11.7	60 - 60	1 - 2.5	No	C	FREQ	No	No	No	No
WATER	WATER	WATER	0 - 0	0.03	0.03	0 - 0	0 - 0	Yes	N/A	N/A	No	No	No	No

Soil Table Code Explanations:

Prime Ag: Soil designated as Prime Farmland. State Ag: Soil designated as Farmland of Statewide Importance

HEL: Soil designated as Highly Erodible Land. PHEL: Soil designated as Potentially Highly Erodible Land

Annual Flooding: FREQ = Frequent; OCCAS = Occassional

Hydrologic Soil Grouping: A=High Infiltration rates. Soils are deep, well drainted to excessively drained sands and gravels.; B=Moderate infiltration rates. Deep and moderately deep, moderately well drained, soil that have moderfately course textures; B/D=Drained/undrained hydroogy class of soils that can be drained and are classified. Moderate to very slow infiltration rates; C= Slow infiltration rates. Soils with layers impeding downward movement of water, or soils that have moderately fine of fine textures; C/D= Drained/undrained hydrology class of soils that can be drained and classified. Slow to very slow infiltration rates; D= Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.

The Preserve has 11 different soil series representing 23 unique soil map units with varying qualities that impact vegetation (Table 3). Soils classified as "Prime Farmland" (ca. 3%) or "Farmland of Statewide Importance" (ca. 62%) account for a significant area of the Preserve. "Highly Erodible Lands" (ca. 25%) and "Potentially Highly Erodible Lands" (ca. 62%) also account for a significant area of the Preserve. Other important soil characteristics are summarized in Table 4. The majority of soils on the Preserve is poorly drained and/or has shallow depths to the water table

Table 4. Summary of Important Soil Characteristics within the Wickecheoke Creek Preserve

Characteristic	Approximate Percent of Preserve
Hydric Soil	16
Prone to Frequent Annual Flooding	11
Depth to Water Table < 1.5 feet	56
Hydrologic Soil Grouping = A	0
Hydrologic Soil Grouping = B	18
Hydrologic Soil Grouping = C, C/D, D	82

Water

The following information is summarized from the New Jersey Water Supply Authority (NJWSA 2009c). Wickecheoke Creek is a third order stream consisting of 14 miles of waterways within a 26.6 square mile or 17,000-acre watershed (See Map 9). The watershed consists of three sub-watersheds (a.k.a. HUC14's). Two sub-watersheds encompass Wickecheoke Creek (one encompasses areas north of Locktown and the second lies south of Locktown), while a third includes lands surrounding Plum Brook to the east. Wickecheoke Creek originates from wetlands in Franklin and Raritan Townships, flows through Kingwood and Delaware Townships and empties into the D&R Canal at Prallsville Mills in Stockton. The watershed is characterized by its position on the Hunterdon (Croton) Plateau, which features hard, argillite bedrock and thin soils. The bedrock prevents water infiltration / groundwater recharge and human water uses result in regular loss of flow in Wickecheoke Creek during dry periods.

The entirety of the Wickecheoke Creek and its tributaries is considered "C1". The northern 2/3 of the stream is categorized as FW2-Non Trout Status and the lower third is categorized as FW2-Trout Maintenance (NJWSA 2009c). The NJ Division of Fish & Wildlife stocks approximately 800 trout annually at the Covered Bridge, but it is unlikely that these fish have the potential to 'holdover' to subsequent years due to lack of stream flow in summer (T. Morris, personal communication). The Wickecheoke and Lockatong watersheds account for 60% of the D&R Canal inflow (downstream of the Delaware River intake) and are important to the water supply. The D&R Canal provides over 70 million gallons of potable water per day to New Jersey residents through the New Jersey Water Supply Authority. Water purveyors have observed increased sediment loads since 1997, which has served as an impetus for comprehensive studies and subsequent management recommendations.

The Wickecheoke Creek Project Area has been subject to a number of planning and monitoring activities, which were summarized by the New Jersey Water Supply Authority (Table 5, NJWSA 2009c). These include a wide variety of individuals and organizations interested protecting the watershed that may partner with NJCF toward the implementation of this management plan. All reports available in electronic format have been provided as addendum to this management plan.

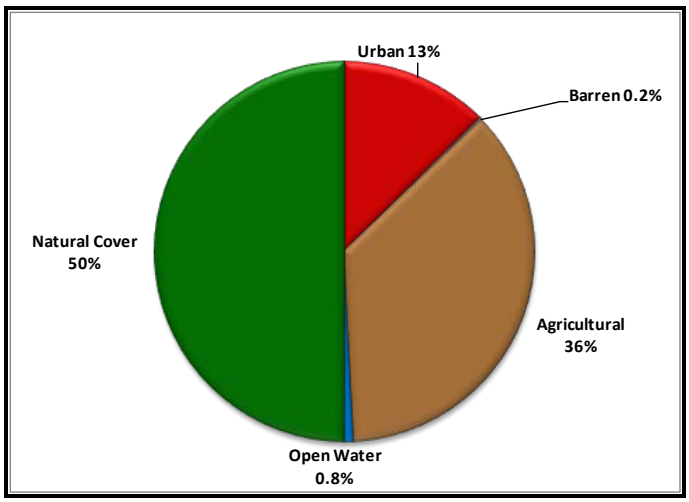
Table 5. Completed Reports for the Wickecheoke Creek Project Area

Project	Time Conducted	Participants	Funders
Limnological Study of the Wickecheoke Creek Ecosystem	1979-1981	Rutgers University	Magnesium Elektron Incorporated
Lower Delaware River Management Plan	1992-2000	National Park Service, Delaware River Greenway Partnership	National Park Service
State of the Watershed Project	1994-1996	Environmental Commissions of Kingwood, West Amwell and Delaware Townships	NJDEP
Biological Monitoring Project	1996-1999	Environmental Commissions of Kingwood and Delaware Townships	Environmental Endowment for New Jersey
Lockatong and Wickecheoke Watersheds Planning Project	1997	Association of New Jersey Environmental Commissions	William Penn Foundation, Wild and Scenic River Program (through Heritage Conservancy), NJDEP
Lockatong and Wickecheoke Watersheds Management Plan	1998 - 2002	Environmental Commissions of Kingwood, Delaware, Raritan, Franklin and West Amwell Townships, D&R Greenway Land Trust, ANJEC, NJDEP, Hunterdon Land Trust Alliance, Castle Valley Consultants	Heritage Conservancy, NJDEP, William Penn Foundation
Central Delaware Tributaries Watershed Management Area Planning Project	2000-2003	Regional Planning Partnership including Isles, Inc., ANJEC, Mercer County Soil Conservation District, Hunterdon County Soil Conservation District	NJDEP
Regulations for the Review Zone of the D&R Canal State Park	2004	Delaware and Raritan Canal Commission	Delaware and Raritan Canal Commission
Lockatong and Wickecheoke Creek Watershed Sediment and Phosphorus Source Report	2007	USDA-NRCS	USDA-NRCS
Lower Delaware River Action Plan: 2007-2011	2007	National Park Service, Delaware River Greenway Partnership	National Park Service
Work/Quality Assurance Project Plan – Lockatong and Wickecheoke Creek Watersheds Restoration and Protection Project	2007	New Jersey Water Supply Authority	NJDEP, USEPA (Section 319 Grant), USDA-NRCS
Wickecheoke Creek Stream Visual Assessment Results and Restoration Plan	2005-2008	New Jersey Water Supply Authority	NJDEP, USEPA (Section 319 Grant), USDA-NRCS
Lockatong Creek Stream Visual Assessment Results and Restoration Plan	2005-2008	New Jersey Water Supply Authority	NJDEP, USEPA (Section 319 Grant), USDA-NRCS
An Assessment of Municipal Plans, Policies and Regulations Effecting Water Quality in the Lockatong and Wickecheoke Creek Watersheds	2005-2008	New Jersey Water Supply Authority	NJDEP, USEPA (Section 319 Grant), USDA-NRCS
Non-Point Source Pollutant Loading Build-Out Analysis for the Lockatong and Wickecheoke Creek Watersheds	2005-2009	New Jersey Water Supply Authority	NJDEP, USEPA (Section 319 Grant), USDA-NRCS
Lockatong and Wickecheoke Creek Watersheds Restoration and Protection Plan	2005-2009	New Jersey Water Supply Authority	NJDEP, USEPA (Section 319 Grant), USDA-NRCS
Characterization and Assessment of the Lockatong and Wickecheoke Creek Watersheds	2005-2009	New Jersey Water Supply Authority	NJDEP, USEPA (Section 319 Grant), USDA-NRCS

Landscape Context

Project Area Land Use - The land cover and uses of surrounding lands constitute the landscape context of the Preserve. Overall, the 2007 Land Cover data for the Project Area suggests a mosaic of natural lands (ca. 50%), agricultural lands (ca. 36%) and urban development (ca. 13%) (See Figure 6, Map 10). Most forest areas are relatively small / fragmented, but there are several areas with relatively large / contiguous forest areas that intersect with the Preserve. Agricultural lands occur throughout the Project Area, but there is a large concentration in the southern area (about 1/3 of the watershed) and the northern tip. Urban development follows somewhat similar patterns, but also exists as narrow bands along roadways throughout the watershed.

Figure 6. 2007 Broad Land Cover Classifications in the Wickecheoke Creek Project Area



Notes: Urban lands include right-of-ways (both upland and wetland), retention basins, and "disturbed wetlands". Agricultural lands include hay fields and pastures that provide habitat for a variety of species.

Preserved Lands - Preserved open space and farmland account for approximately 30% of the Project Area (ca. 5,000 acres). Preserved farmland accounts for approximately 2,800 acres and the remainder of protected lands is primarily attributable to NJCF, which owns about 750 acres in fee and facilitated the preservation of 1,400 additional acres (Preservation of areas in the adjacent Lockatong Watershed are not included in these figures.). Additional parcels owned by Hunterdon County and D&R Greenway Land Trust were not available as GIS shapefiles and therefore are not included in the totals above. There are no state lands within the Project Area, but the Lockatong Wildlife Management Area is located near the Thompson II Section located adjacent to the Project Area boundary.

The largest amount of protected lands occurs in Delaware Township in the southern and central portion of the Project Area (Map 11). A smaller concentration of protected land is forming in the northern tip of the Project Area (near Huey and Turnquist Sections).

Landscape-Scale Conservation Areas - The Landscape Project 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 in the vicinity of the Preserve are depicted in Map 12. It is important to note that although many rare species occurrences are documented, there are likely many more that are undocumented. The Landscape Project also characterizes habitat patch sizes, which are shown in Map 13.

Habitat patch ranks are summarized in Table 6. The majority of the natural areas within the Project Area contain one or more rare animal species (ca. 83%). These habitat patches broadly overlap with the Preserve. A total of sixteen rare animal species associated with these ranks are reported in Table 17.

Habitat patch sizes are summarized in Table 7. It is important to note that the Landscape Project Version 3.0 applies to Project Area located north of State Highway 12, while Version 2.1 applies to the south of State Highway 12. It appears that significant changes were made in the categorization of fragmentation features between the two versions, which Version 3.0 being much more stringent (i.e., more fragmentation features identified resulting in much smaller habitat patch sizes). If these more stringent rules were applied to southern portions of the Project Area, then patch size estimates would be dramatically reduced (and probably provide more accurate assessment of actual habitat fragmentation). For the purposes of this management plan, Table 6 combines data from both versions.

There are five habitat patches greater than 1,000 acres (accounting for ca. 50% of the Project Area). However, given the above discussion it is unlikely that these are actually unfragmented. There are significant numbers of small patches throughout the Project Area and the majority of larger patches are likely to be 250 acres or less. Many of the largest forest patches intersect with the Preserve and are reported in Appendix I with descriptions of each mapped ecological community (See Section II). Given the landscape context of the Project Area, these larger contiguous forest blocks are critical for the maintenance of area-demanding species such as Red-shouldered Hawk, Barred Owl, and Bobcat.

Table 6. Landscape Project Patch Rank Summary for Wickecheoke Creek Project Area

	Landscape Project Rank - Total Acres per Rank					
Habitat Type	**5**	**4**	**3**	**2**	**1**	**Totals**
Forest	0	209	7836	1013	1025	10083
Forested Wetland	0	174	111	2120	7	2412
Grassland	0	759	2238	1778	2459	7234
Emergent Wetland	0	229	126	680	5	1040
Totals	0	1371	10311	5591	3496	20769

	Landscape Project Rank - Number of Patches per Rank					
Habitat Type	**5**	**4**	**3**	**2**	**1**	**Totals**
Forest	0	96	29	71	368	564
Forested Wetland	0	15	34	227	3	279
Grassland	0	65	74	3	46	188
Emergent Wetland	0	22	19	184	2	227
Totals	0	198	156	485	419	1258

Table 7. Landscape Project Patch Size Summary for Wickecheoke Creek Project Area

	Patch Size Class - Total Acres per Size Class						
Habitat Type	**> 1000**	**250 - 1000**	**100 - 250**	**25 - 100**	**10 -25**	**< 10**	**Totals**
Forest	7639	0	457	685	391	910	10082
Forested Wetland	0	0	451	908	408	645	2412
Grassland	2535	1502	1460	1393	108	238	7236
Emergent Wetland	0	0	0	347	254	438	1039
Totals	10174	1502	2368	3333	1161	2231	20769

	Patch Size Class - Number of Patches per Size Class						
Habitat Type	**> 1000**	**250 - 1000**	**100 - 250**	**25 - 100**	**10 -25**	**< 10**	**Totals**
Forest	3	0	3	12	28	518	564
Forested Wetland	0	0	4	18	27	230	279
Grassland	2	4	8	26	8	139	187
Emergent Wetland	0	0	0	7	17	203	227
Totals	5	4	15	63	80	1090	1257

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 NJNHP produces two GIS products that allow rapid assessment of any area. The first product provides locations of priority sites that harbor imperiled plants and ecological communities throughout the state. The second product provides generalized locations of imperiled plants and ecological communities that fall within a predefined grid system that covers the entire state. There are no priority sites associated with the Project Area. A total of eight grid cells overlap with the Project Area (Map 14). Preserve sections that overlap with these grids include VanHouten, Lang, Mornan, Hilton, Jarboe, Cook, Hackl and Prall House (Note: Grid overlap does not necessarily indicate that rare plants are located within Preserve boundaries). In addition, Plant Stewardship Index surveys performed at the Preserve also contained listings for rare plants not found in the Natural Heritage database. See Table 16 for a listing of rare plants located within the Project Area.

The New Jersey Audubon Society (NJAS) has a program called the Important Bird and Birding Areas (IBBA) that identifies important sites for avian biodiversity. Sites are nominated by individuals or organizations and are vetted by NJAS in consultation with avian biologists/naturalists. There are no IBBA sites located within the Project Area.

Social Context

The Wickecheoke Creek Project Area is located in Hunterdon County and includes portions of Delaware Township, Franklin Township, Kingwood Township, Raritan Township and a very small portion of Stockton Borough. Information from the 2000 U.S. Census (Table 8) was used to compare the four predominant municipalities within the context of Hunterdon County and the State of New Jersey (2010 census data has not yet been completely compiled).

The most significant difference is that Project Area municipalities have a much lower population density than the rest of New Jersey. The low population density is due to the large amount of preserved open space and active agricultural lands as well as development restrictions (All municipalities have downzoned, e.g., increased average lot size in areas where bedrock is of Lockatong and Stockton argillite - NJWSA 2009c). The Project Area also shows a demographic difference, with a significantly larger percentage of white residents relative to the State. Median household income is significantly higher than the statewide average.

Table 8. U.S. Census Information (Source: 2000 U.S. Census)

Category	Delaware Township	Raritan Township	Franklin Township	Kingwood Township	Hunterdon County	State of New Jersey
Land Area (square miles)	36.7	37.8	22.3	35.8	437.7	7417.3
Population	4478	19809	2990	3782	121989	8414350
Population Density (per square mile)	121	524	130	105	278	1134
# of Households	1701	7094	1125	1442	45032	3310275
Median Age	42.4	37.4	41.6	38.8	38.8	36.7
Median Household Income	$80756	$85996	$91364	$71551	$79888	$55146
Per Capita Income	$38285	$38819	$39668	$30219	$36370	$27006
Below Poverty Line - % of Population	3.4	2.0	1.6	2.9	2.6	8.5
Demographics						
% White	97.7	93.2	97.5	97.6	93.9	72.6
% African American	0.4	1.2	0.4	0.6	2.2	13.6
% Native American	0.0	0.1	0.2	0.1	0.1	0.2
% Asian	1.0	3.5	0.8	0.8	1.9	5.7
% Hawaiian or Pacific Islander	1.0	0.0	0.0	0.0	0.0	0.0
% Other	1.1	0.7	0.3	0.2	0.8	5.4
% Two or more races	2.5	1.3	0.7	0.7	1.0	2.5
% Hispanic/Latino of any race from the above categories	1.1	2.8	2.2	1.9	2.8	13.3

Public Survey

NJCF staff member Sieglinde Mueller conducted a survey of local public opinion and prepared a report dated June 30, 2010 (Appendix G). The goal of the survey "was to determine how the local community perceived the Preserve, and to determine their use patterns, stewardship concerns and suggestions and familiarity with NJCF." The survey results suggested strong community acknowledgement of NJCF's efforts, but respondents are less likely to volunteer or provide financial contributions to NJCF. Detailed methods and results are provided in the report and a brief summary is provided in Table 9. The primary recommendation resulting from the report is to initiate an outreach campaign and educational programming to increase public participation. Specific recommendations and discussion based upon survey results have been incorporated into Sections IV and V.

In addition to the public survey, phone interviews were conducted with seventeen individuals representing local residents, partners and other professionals with varied expertise (See Introductory Information). Several additional individuals provided other helpful information, but were not formally interviewed. Recommendations from plan contributors have been incorporated into this management plan and notes from each interview are provided as a separate document. These individuals, and the organizations they represent, are natural partners moving forward with plan implementation.

Table 9. Brief Summary of Public Survey Results

Survey Question Topic	Response
Preserve Value to Community	Yes: 92%
NJCF Membership	No: 67% Current Member: 23% Former Member: 9%
Frequency of Preserve Use	Weekly: 39%, Quarterly: 34%
Modes of Preserve Access	Foot from Residence: 62% Vehicle Road Pull Off: 34%
Preserve Visit Purpose	Hiking/Walking: 85%
Requested Improvements	Increased Trail Maintenance: 42% Additional Trails: 37% Additional Parking: 13%
Concerns	Littering: 71% Increased Vehicle Traffic: 22%
Interest in Future Programs	Guided Hikes / Talks: 42% Ecological Studies: 37% Photography/Art: 27% No interest in any programs: 40%
Deer Population Forest Impacts	Very Concerned: 35% Slightly Concerned: 27% Undecided: 12% Slightly Indifferent: 8% Very Indifferent: 20%
Volunteerism Interest	Not Interested: 50% Trails: 25% Invasive Species Control: 25% Other: 15%
Financial Contribution Interest	None: 45% Provide < $100: 46% Provide > $100: 8%

Note: Results based upon total survey response of 59.

Partnerships

Implementation of this management plan will require strong partnerships with a variety of public and private partners. In addition to considerable technical staff expertise, direct funding through the Natural Resources Conservation Service (NRCS) and United States Fish & Wildlife Service (USFWS) are particularly relevant. NRCS Farm Bill programs include the Wildlife Habitat Incentive Program (WHIP) and EQIP (Environmental Quality Incentive Program). The EQIP program now includes forest habitat and NJCF eligibility for specific projects can be obtained after completing a Forest Stewardship Plan (which can also be funded through EQIP). The USFWS provides technical and financial support through their 'Partners for Fish & Wildlife' program. The New Jersey Water Supply Authority is also a natural partner for a variety of projects due to staff expertise and access to grant programs that cannot be directly accessed by NJCF.

The State also offers expertise in various disciplines to provide guidance on management decisions (i.e., Endangered and Nongame Species Program, Natural Heritage Program). Small grants are offered annually through the Conserve Wildlife Foundation & NJDEP - Division of Fish & Wildlife. Hunterdon County Parks might also be approached to assist with stewardship issues such as deer management due to their extensive experience and program recognition by the Division of Fish & Wildlife. NJCF has already established partnerships with Project Area municipalities, but furthering these partnerships for particular elements of this plan will be critical for success (e.g., Community Deer Management Program described in Section IV).

There are only two other private land trusts working in the Project Area or nearby (Hunterdon Land Trust Alliance and D&R Greenway Land Trust). D&R Greenway has established land protection and stewardship programs in the Plum Brook area and the organization has considerable experience with deer management and native plant propagation. NJCF has initiated conversations regarding a stewardship partnership with the Hunterdon Land Trust Alliance (HLTA). HLTA has received and continues to actively pursue grant funding for planning and stewardship efforts in the Delaware River area, which included the Wickecheoke Creek Project Area. Dependent upon future funding, possible partnerships could include sharing grant funding for a team of shared stewardship interns supervised by NJCF staff.

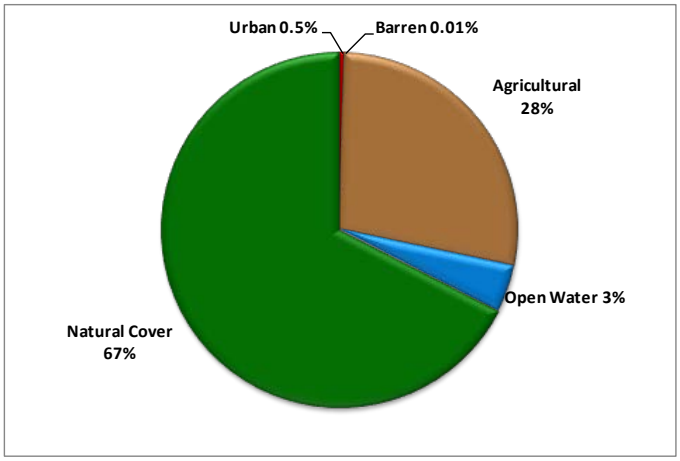
Deep red fall color of Arrowwood at the Fishkin Section.

Section II. Conservation Targets

Introduction

The overarching conservation targets are ecological communities that provide habitat for the full complement of flora and fauna of the region. For convenience, these communities have been placed into two broad categories – Forest Habitat and Early Successional Habitat (includes meadows and shrublands). These communities were field mapped and evaluated as part of this management plan and results are reported in this section with accompanying appendices that describe discrete patches (Appendices I and J). To provide context for ecological community mapping, the Preserve consists of roughly 2/3 natural cover and 1/3 agricultural lands according to 2007 Land Use / Land Cover data (Figure 7). Many of these agricultural lands are abandoned or delayed mowed and now serves as natural habitat.

Figure 7. 2007 Broad Land Cover Classes within the Wickecheoke Creek Preserve

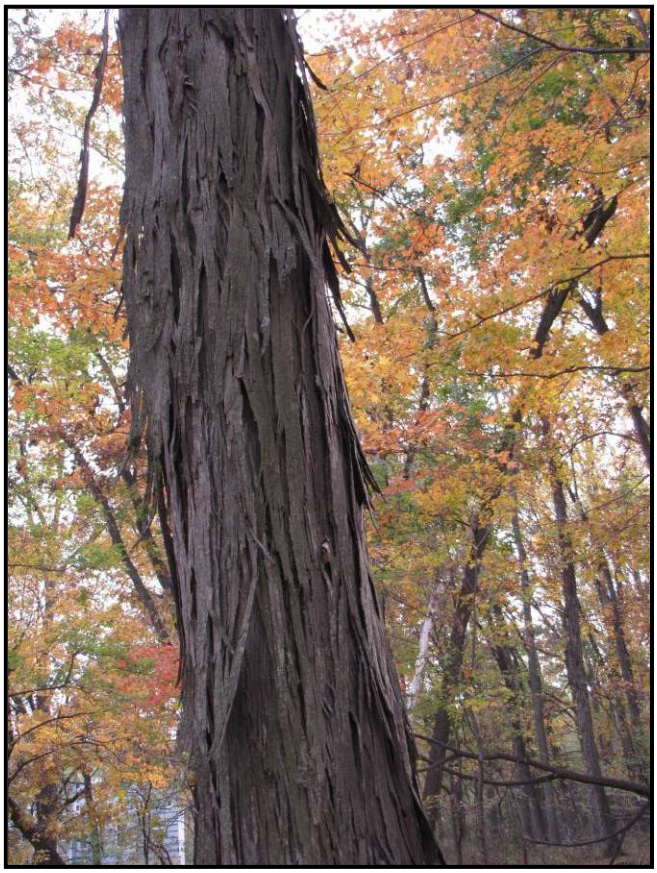


Species lists for various taxa are provided as appendices (Appendices L - T) to supplement brief descriptions in this section. Table 10 provides the number of species documented or likely to occur in the Project Area. There are a total of fifteen rare plant species (Table 16) and sixteen rare animal species (Table 17) that are documented within the Project Area. Strategies to foster these rare species primarily involve promotion of overall habitat health, but specific recommendations for rare animals are listed in Table 17 and incorporated into recommendations in Section IV.

Table 10. Number of Species by Taxa for the Wickecheoke Creek Project Area

Taxa	Number of Species*	Appendix
Plants	572	L
Mammals	35	M
Birds	116	N
Reptiles	24	O
Amphibians	24	P
Freshwater Fish	85	Q
Butterflies & Moths	139	R
Dragonflies & Damselflies	168	S
Freshwater Mussels	6	T

*Species are documented at the Preserve or considered likely to occur at the Preserve based upon presence in the region.



Shagbark Hickory is common in many parts of the Preserve, this provides opportunities for bat conservation.

Ecological Communities

Ecological communities were mapped at the Preserve from June through October 2010. Communities were mapped through a process of crosschecking between three sources of information, which included field survey, 2007 aerial orthophotography, GIS-based 2007 land cover classifications and NJDEP GIS wetland status. Field observations of species present within the canopy, sub-canopy, shrub, and herbaceous layers were recorded throughout the Preserve. Field observations were correlated with a 'signature' on aerial photography and compared to the 2007 land cover classifications. The assignment of named ecological communities from Breden et al. (2001) was provided for 186 unique forest habitat patches (See Appendix I, Map 15 – Close up views by portion of the Project Area are also provided electronically as addenda to this Plan). 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).

The Breden classification system utilizes increasingly narrow groupings starting with Formation (broad climate, soil moisture and plant growth form), Alliance (predominant species present that provide overall plant community structure) and Association (dominant and co-dominant species including representatives of all major plant growth forms). A complete list of ecological community types found within the Gettysburg Piedmont physiographic province is provided as Appendix H. From this list, a total of nine forest community types were considered probable to occur within the Preserve (Table 11).

Ecological communities found on the Preserve are reported at the Association level. However, it was determined that observed plant community composition always consisted of variants or combinations of more than one pre-defined ecological community type. To facilitate interpretation, Table 12 provides a coarse summary of acreage by predominant pre-defined ecological community type. There was a total of 516 acres of forest habitat mapped at the Preserve (ca. 60% of the Preserve's land cover). The two most common forest types included upland Sugar Maple forest (ca. 23% of the Preserve's forest cover) and Red Maple forests with a significant/dominant Pin Oak component (ca. 23%), various oak-hickory types (19%) and floodplain Sugar Maple forest (14%). Other types included Eastern Hemlock forest (ca. 6%) and American Beech forest (ca. 2%). Map 15 depicts the distribution of these simplified forest types.

Table 13 provides a summary of observed variants and combinations of pre-defined types. Appendix I provides detailed observations of each mapped forest patch along with additional information regarding presumed forest age (based upon 1890 and/or 1930 GIS data), entire forest block size (includes areas that extend outside the Preserve), and a summary of invasive species cover. These attributes were used to assign relative quality ranks. 'High' rank forest areas had relatively high amounts of old forest, were part of larger forest blocks and had relatively low amounts of invasive species. 'Moderate' ranked forests had at least two of these positive attributes and 'Low' ranked forests had one or none of the attributes. The relative quality ranks were 'High' for approximately 29% of the forest areas, 'Moderate' for 76% of the areas and 'Low' for 57% of the areas (See Appendix I, Map 16 - Close up views by portion of the Project Area are also provided electronically as addenda to this Plan). Quality rankings and other listed attributes were used to prioritize stewardship strategies (See Section IV).

Swamp Milkweed at the Levine Section.

Table 11. Ecological Community Descriptions for the Wickecheoke Creek Preserve

Community Number	Association Name - Scientific	Association Name - Common	Dominant Trees	Sub-Dominant Trees	Other Trees	Shrubs and Vines	Herbs
1	Acer saccharum-Fraxinus americana-Tilia americana-Magnolia acuminata / Actaea racemosa	Sugar Maple-White Ash-American Basswood-Cucumber Magnolia / Black Cohosh Forest	Sugar Maple	White Ash, American Basswood	Red Oak, Hop Hornbeam, Red Elm, Red Maple, Yellow Birch, Sweet Birch, American Beech, Black Walnut, Tulip Poplar, Cucumber Magnolia, Bitternut Hickory, Black Cherry	Variable Composition: Alternate-leaved Dogwood, Witch-hazel, Spicebush, Persimmon, Fly Honeysuckle, Pinxster Azalea, Maple-leaved Viburnum.	Maidenhair Fern, Wild Ginger, Black Cohosh, Cut-leaf Toothwort, Hepatica, Eastern Waterleaf, Bottlebrush Grass, Sweet Cicely, White Trillium, Violets, Marginal Wood Fern, Grape Fern, Wood Anemone, Wild Geranium, Blue Cohosh, Bloodroot, Spring Beauty, Wild Leek, Jack-in-the-Pulpit, Canadian Woodnettle.
2	Quercus rubra-Carya (glabra, ovata) / Ostrya virginiana / Carex pensylvanica Forest	Red Oak-Hickory (Pignut, Shagbark) / Hop Hornbeam / Pennsylvania Sedge Forest	Red Oak	Pignut Hickory, Shagbark Hickory, Hop Hornbeam	White Oak, Black Oak, Red Hickory, White Ash, Red Maple, Flowering Dogwood, Downy Serviceberry, Chokecherry, Sugar Maple, White Pine, Northern White Cedar.	Witch-hazel, Maple-leaved Viburnum, Lowbush Blueberry, Flowering Raspberry, Beaked Hazelnut.	False Sarsaparilla, Canada Mayflower, Pointedleaf Ticktrefoil, Panicledleaf Ticktrefoil, White Lettuce, Silverrod, Hepatica.
3	Quercus (alba, rubra, velutina) / Cornus florida / Viburnum acerifolium Forest	Oak (White, Red, Black) / Flowering Dogwood / Maple-leaved Viburnum Forest	Red Oak, White Oak, Black Oak	Pignut Hickory, Shagbark Hickory, Red Hickory	Red Maple, Sassafras, Downy Serviceberry, Hop Hornbeam, White Ash, White Pine, Sweet Birch, Flowering Dogwood.	Maple-leaved Viburnum, Witch-hazel, Highbush Blueberry, Beaked Hazelnut, American Hazelnut, Lowbush Blueberry, Black Huckleberry.	Pennyslvania Sedge, Canada Mayflower, False Sarsaparilla, Rattlesnake Hawkweed, Silverrod, Pointedleaf Ticktrefoil, Panicledleaf Ticktrefoil, Cow-wheat, Striped Wintergreen, White Wood Aster, False Foxglove, Frostweed.
4	Fagus grandifolia-Quercus alba-Quercus rubra-Liriodendron tulipifera Forest	American Beech-White Oak-Red Oak-Tulip Poplar Forest	American Beech, White Oak, Red Oak, Tulip Poplar, Scarlet Oak		Sugar Maple, Paper Birch, Flowering Dogwood, American Holly.	Maple-leaved Viburnum	Canada Mayflower, False Solomon's Seal, Jack-in-the-Pulpit, Wild Geranium, Swan's Sedge.
5	Quercus rubra-Acer saccharum-Liriodendron tulipifera Forest	Red Oak-Sugar Maple-Tulip Poplar Forest	Red Oak, White Oak, Sugar Maple, Tulip Poplar	Red Maple, Shagbark Hickory, Mockernut Hickory, Black Tupelo, Scarlet Oak, Chestnut Oak, Black Oak.	Americn Beech, White Ash, Smooth Serviceberry, Downy Serviceberry,	Dogwoods, Witch-hazel, Spicebush, Maple-leaved Viburnum, Arrowwood, Riverbank Grape.	Blue Cohosh, Hay-scented Fern, Mayapple, Canada Mayflower, New York Fern, Indian Cucumber, Sessile Bellwort, White Snakeroot, Black Cohosh, Wild Licorice, Fragrant Bedstraw, Christmas Fern.
6	Quercus rubra-Acer saccharum-Fagus grandifolia / Viburnum acerifolium Forest	Red Oak-Sugar Maple-American Beech / Maple-leaved Viburnum Forest	Not Described	Not Described	Not Described	Not Described	Not Described

Table 11. Ecological Community Descriptions for the Wickecheoke Creek Preserve (continued)

Community Number	Association Name - Scientific	Association Name - Common	Dominant Trees	Sub-Dominant Trees	Other Trees	Shrubs and Vines	Herbs
7	Acer saccahrum-Fraxinus spp.-Tilia americana / Matteuccia struthiopteris-Ageratina altissima Forest	Sugar Maple-Ash species-American Basswood / Ostrich Fern-White Snakeroot Forest	Sugar Maple, White Ash, American Basswood		Butternut, Black Ash, Ironwood, Black Cherry	Virginia Creeper	White Snakeroot, Virginia Wild Rye, Riverbank Wild Rye, Interrupted Fern, Graceful Sedge, Bladder Sedge, Zig-Zag Goldenrod, Rough Goldenrod, Giant Goldenrod.
8	Acer rubrum-Fraxinus (pennsylvanica, americana) / Lindera benzoin / Symplocarpus foetidus Forest	Red Maple-Ash (Green, White) / Spicebush / Skunk Cabbage Forest	Red Maple	Green Ash, White Ash	Black Ash.	Highbush Blueberry, Swamp Azalea, Sweet Pepperbush, Spicebush, Winterberry.	Skunk Cabbage, Cinnamon Fern, Jewelweed, Tussock Sedge, False Hellebore, Royal Fern, Sensitive Fern, Sphagnum mosses.
9	Tsuga canadensis-Betula alleghaniensis Lower New England / Northern Piedmont Forest	Eastern Hemlock-Yellow Birch Lower New England / Northern Piedmont Forest	Eastern Hemlock.	Sugar Maple, Yellow Birch, American Beech	Red Maple, Sweet Birch, Hickory species, White Pine, Black Cherry, White Oak, Red Oak, American Elm, Hop Hornbeam.	American Hazelnut, Witch-hazel, Wayfaring Viburnum, Mountain Laurel, Rosebay Rhododendron, Northern Lowbush Honeysuckle, Lowbush Blueberry.	Wood Anemone, Bunchberry, Spinulose Woodfern, Canada Mayflower, Cucumber Root, Partridgeberry, Starflower, White Trillium, Wake-robin, Woodsorrel.

Table 12. Summary of Forest Communities at the Wickecheoke Creek Preserve (Lead Types)

Type	Dominant Canopy	Acreage	Percent of Total Forest
0	N/A - Edge or Hedgerows	67	13.1
1	Sugar Maple (upland)	118	22.9
2	Oak-Hickory Type	41	7.9
3	Oak-Hickory Type	N/A	N/A
4	American Beech	12	2.2
5	Oak-Hickory Type	58	11.2
6	Oak-Hickory Type	N/A	N/A
7	Sugar Maple (floodplain)	74	14.3
8	Red Maple / Pin Oak Variant	117	22.7
9	Eastern Hemlock	30	5.8

Note: Type 6 is not fully described in Breden et al. (2001) and was not utilized in these designations. Type 3 was not considered the "lead" type in any community variants observed at the Preserve.

Table 13. Summary of Forest Communities at the Wickecheoke Creek Preserve (Variants/Mixtures)

Forest Type Approximation	Acreage	Percent of Total Forest
1: Variant	24	4.7
1: Variant (Shagbark)	15	3.0
1-4: Variant	5	0.9
1-5: Variant	48	9.3
1-9: Variant	26	5.0
2: Variant	18	3.6
2-4: Variant	21	4.1
2-5: Variant	1	0.2
4: Variant	11	2.2
5: Variant	7	1.3
5-1: Variant	8	1.6
5-2: Variant	8	1.5
5-3: Variant	19	3.7
5-7: Variant	10	1.9
5-8: Variant	5	0.9
5-9: Variant	1	0.2
7: Variant	43	8.3
7-2: Variant	13	2.6
7-5: Variant	16	3.1
7-8: Variant	2	0.3
8: Variant	7	1.3
8: Variant (Pin Oak)	109	21.2
8-7: Variant	1	0.2
9: Variant	9	1.8
9-1: Variant	13	2.6
9-2: Variant	7	1.4
Edge/Hedgerow	67	13.1

It is important to note that Breden does not describe successional ecological communities. Field observations of areas at the Preserve with successional communities are detailed in Appendix J, which provides species lists and predominant growth forms (herbs, shrubs), along with invasive species observations. Table 14 summarizes the acreage of early successional patches as either 'meadow' or 'shrubland' along with acreages for other types of land cover at the Preserve (e.g., lawn, pond).

There was a total of 343 acres characterized as early successional. The majority of this acreage was abandoned farmland that was either meadow or shrubland depending upon the time since abandonment. Each of these areas was provided a relative quality rank based upon the quantity and diversity of native plant cover and abundance of invasive species. Approximately 6% was considered 'High' quality, 20% was considered 'Moderate' quality and 74% was considered 'Low' quality (See Map 16). Quality rankings and other listed attributes were used to prioritize stewardship strategies (See Section IV).

Table 14. Summary of Field Mapped Land Cover at the Wickecheoke Creek Preserve

Current Habitat Type	Current Acreage	Percent of Total Preserve
Forest	516	60.0
Hay	148	17.3
Lawn	4	0.5
Meadow	134	15.6
Plantation	3	0.3
Pond	9	1.0
Shrubland	45	5.3

Flora

A complete list of the flora within the Project Area is not available, but previously performed Plant Stewardship Index surveys (Bowman's Hill Wildflower Preserve) and a list of woody plants of Hunterdon County (Brooklyn Botanic Garden, Metropolitan Flora Project, www.bbg.org) were compiled to create a species list for the Project Area, which includes 572 species (Appendix L).

A summary of Plant Stewardship Index (PSI) surveys performed within the Preserve and Project Area is provided in Table 15 and complete PSI reports are provided in Appendix M. An explanation of PSI is provided at the Bowman's Hill website: "The index is calculated based on averaging numbers assigned to each plant by a group of leading botanists and ecologists in the state. These numbers are referred to as "CC" or coefficients of conservatism. They range from 0 to 10 with zero being those "generalist" plants that can be found in any area (including parking lots, plowed fields and other highly disturbed land sites) to ten being "specialist" plants that the botanists have agreed can be found naturally in very specific habitats. Many (although not all) of our threatened and endangered plants have been assigned a 10 because they are so specialized and their required habitats are disappearing. The average of all these numbers is called the Mean C." The combined sum of all CC's is used to calculate the overall PSI Score for a site. In general, PSI scores and native mean C values for the Preserve are moderate to low relative to other sites in the PSI database.

The flora listed in Appendix L includes 447 native (ca. 88% of total) and 125 non-native species (ca. 22% of total). CC ranks for the entire species list include: 0 (22%), 1-3 (19%), 4-6 (28%), 7-9 (21%) and 10 (6%). A total of 30 species (5%) on the list are currently not assigned a CC rank. A sample of species

with CC ranks of 10 that were documented on the Preserve includes Alum Root, American Germander, Spotted Phlox, Broad-leaf Sedge, and Blue Marsh Violet.

According to Natural Heritage data and PSI surveys, there are 26 populations of fifteen rare plant species at the Preserve or within the Project Area (Table 16). Population surveys are required to determine exact locations and population size & condition for these species. Specific management recommendations are restricted due to this lack of information, but broad approaches to habitat management should improve the health of many of these rare species (see Section IV).

Table 15. Summary of Plant Stewardship Index Surveys in the Wickecheoke Creek Project Area

PSI Site Name and ID	Preserve Section(s)	Plant Species Total	% Native Species	PSI Score	Native Mean C	Total Mean C
Floodplain 06; BHWP List #2331	Unknown	244	80	50.12	4.50	3.60
Mitchell 06; BHWP List #746	Mitchell	124	87	45.42	5.02	4.37
Mitchell Field Edge; BHWP List#756	Mitchell	23	57	4.55	2.23	1.26
Mitchell Historic; BHWP List# 981	Mitchell	73	100	39.3	4.60	4.60
Fishkin; BHWP List# 631	Fishkin	148	89	49.88	4.92	4.36
Wickecheoke Corridor Area #1, BHWP List #5516	N/A	86	79	27.42	4.21	3.33
Wickecheoke Corridor Area #2, BHWP List #5521	N/A	84	77	28.60	4.58	3.55
Wickecheoke Corridor Area #3, BHWP List #5531	VanHouten, Lang	92	86	40.09	5.25	4.51
Wickecheoke Corridor Area #4, BHWP List #5526	Hodanish, Robertson	74	80	29.89	4.88	3.89

Virginia Waterleaf at the Milano Section.

Table 16. Rare Plants of the Wickecheoke Creek Project Area

Scientific Name	Common Name	Grid Location	Global Rank	State Rank	State Status	Regulatory Status*	Habitat	Occurrence Precision**	Notes
Cardamine angustata	Slender Toothwort	4094	G5	S3	None	HL	Terrestrial	S	
Carex bushii	Bush's Sedge	4462	G4	S1	E	HL, LP	Palustrine, Terrestrial	S	
Carex typhina	Cattail Sedge	N/A	G5	S3	None	HL	Paustrine	N/A	PSI Survey "Floodplain 06"
Crataegus calpodendron	Pear Hawthorn	3746	G5	S1	E	HL, LP	Terrestrial	M	Grid overlaps with Thompson II Section.
Data Sensitive Species or Community	Data Sensitive Species or Community	4817	G4	S1.1	E	?	Terrestrial	S	Likely to be Table Mountain Pine (*Pinus pungens*) found only at the Abraitys Pine Stand Site (located adjacent to Wickecheoke Creek Project Area).
Dirca palustris	Leatherwood	3745	G4	S2	None	HL	Palustrine, Terrestrial	S	Grid overlaps with Thompson II Section.
Lycopus americanus var. longii	Water Horehound	N/A	G5	S2S3	None	HL	Paustrine	N/A	PSI Survey "Floodplain 06"
Lycopus americanus var. longii	Water Horehound	N/A	G5	S2S3	None	HL	Paustrine	N/A	PSI Survey "Mitchell Historic"
Lycopus rubellus	Gypsywort	N/A	G5	S2	None	HL	Palustrine	N/A	PSI Survey - Fishkin Section
Mimulus alatus	Winged Monkeyflower	N/A	G5	S3	None	HL	Palustrine	N/A	PSI Survey - Fishkin Section
Mimulus alatus	Winged Monkeyflower	N/A	G5	S3	None	HL	Palustrine	N/A	PSI Survey "Mitchell Historic"
Mimulus alatus	Winged Monkeyflower	N/A	G5	S3	None	HL	Palustrine	N/A	PSI Survey "Floodplain 06"
Obolaria virginica	Virginia Pennywort	4636	G5	S2	None	HL	Terrestrial	M	
Obolaria virginica	Virginia Pennywort	4637	G5	S2	None	HL	Terrestrial	M	
Obolaria virginica	Virginia Pennywort	4817	G5	S2	None	HL	Terrestrial	M	
Phlox maculata var. maculata	Spotted Phlox	3913	G5T4T5	S2	None	HL	Palustrine	M	
Phlox maculata var. maculata	Spotted Phlox	3914	G5T4T5	S2	None	HL	Palustrine	M	
Phlox maculata var. maculata	Spotted Phlox	4093	G5T4T5	S2	None	HL	Palustrine	M	Grid overlaps with Prall House Section.
Phlox maculata var. maculata	Spotted Phlox	4094	G5T4T5	S2	None	HL	Palustrine	M	Grid overlaps with Hackl, Jarboe, Cook, Hilton and Thorpe Sections.
Phlox maculata var. maculata	Spotted Phlox	4099	G5T4T5	S2	None	HL	Palustrine	S	Grid overlaps with VanHouten, Land and Mornan Sections.
Phlox maculata var. maculata	Spotted Phlox	4274	G5T4T5	S2	None	HL	Palustrine	M	Grid overlaps with Cooper Section.
Phlox maculata var. maculata	Spotted Phlox	N/A	G5T4T5	S2	None	HL	Palustrine	M	PSI Survey "Floodplain 06"
Smilax pseudochina	Halbard-leaved Greenbrier	N/A	G4G5	S3	None	HL	Paustrine	N/A	PSI Survey "Mitchell Historic"
Thaspium trifoliatum var. trifoliatum	Meadow Parsnip	N/A	G5T5	S3	None	HL	Paustrine	N/A	PSI Survey "Mitchell Historic"
Tipularia discolor	Cranefly Orchid	N/A	G4G5	S3	None	HL	Paustrine	N/A	PSI Survey "Mitchell Historic"
Viola hirsutula	Southern Wood Violet	N/A	G4	S2	None	HL	Terrestrial	N/A	PSI Survey "Mitchell Historic"

*Regulatory Status: HL = Listed species in the Highlands, LP = Listed species in the Pine Barrens

**Occurrence Precision: S = Location known precisely, M = Location known within 1.5 miles

Fauna

There are sixteen rare animal species at the Preserve or within the Project Area (Table 17). Specific recommendations from ENSP are provided under the column "Special Management Considerations". Also refer to Appendix K for ENSP fact sheets (available for eight of the sixteen species).

Table 17. Rare Animals of the Wickecheoke Creek Project Area

								Habitats				
Scientific Name	Common Name	Taxa	Global Rank	Federal Status	State Rank	State Status	WAP Priority	Forest	Shrubland	Meadow	Special Management Considerations	Notes
Accipiter cooperii	Cooper's Hawk	bird	G5	None	S2B/S4N	T/None	Yes	X	y	y	None	Consider minimum area requirements; > 250 acres required
Ambystoma opacum	Marbled Salamander	amphibian	G5	None	S3	SC	Yes	X		X	Perform surveys, Indentify and survey vernal pools	High risk when roads are located between ponds and forest wintering areas.
Amystoma jeffersonianum	Jefferson Salamander	amphibian	G4	None	S3	SC	Yes	X			Perform surveys, Indentify and survey vernal pools	High risk when roads are located between ponds and forest wintering areas.
Ardea herodias	Great Blue Heron	bird	G5	None	S3B/S4N	SC/None	Yes	y		X	None	Aquatic habitat required
Bufo woodhousii fowleri	Fowler's Toad	amphibian	G5	None	S3	SC	Yes	X			None	
Buteo lineatus	Red-Shouldered Hawk	bird	G5	None	S1B/S2N	E/T	Yes	X	y		Perform survyes	Consider minimum area requirements; > 250 acres required
Dolichonyx oryzivorus	Bobolink	bird	G5	None	S2B/S3N	T/SC	Yes			X	Perfrom surveys, maintain grasslands, removal of hedgerows	Consider minimum area requirements; 25 - 75 acres required
Eurycea longicauda	Longtail Salamander	amphibian	G5	None	S2	T	Yes	X			Perform survyes	
Glptemys insculpta	Wood Turtle	reptile	G4	None	S2	T	Yes	X	y	y	Perform surveys, Identify areas for artificial nest construction in open riparian areas	Riparain health critical
Hylocichla mustelina	Wood Thrush	bird	G5	None	S3	SC/RP	Yes	X			Maintain large forest blocks interspersed with shrub-scrub canopy gaps (< 1 hectare).	Consider minimum area requirements; > 200 acres
Parula americana	Northern Parula	bird	G5	None	S3/None	SC	Yes	X			Maintain large forest blocks interspersed with shrub-scrub canopy gaps (< 1 hectare).	Requires riparian habitat with tall conifers such as Eastern Hemlock.
Passerculus sandwichensis	Savannah Sparrow	bird	G5	None	S2B/S4N	T/T	Yes			X	Perfrom surveys, maintain grasslands, removal of hedgerows	Consider minimum area requirements; > 25 acres required
Pooecetes gramineus	Vesper Sparrow	bird	G5	None	S2	E/E	Yes			X	Perfrom surveys, maintain grasslands, removal of hedgerows	Requires very low vegetation and bare ground; Consider minimum area requirements; > 40 acres required
Strix varia	Barred Owl	bird	G5	None	S2B/S2N	T/T	Yes	X			Artificial nest construction, Perform surveys	Consider minimum area requirements; 200 - 900 acres required
Sturnella magna	Eastern Meadowlark	bird	G5	None	S3B/S3N	SC/SC	Yes			X	Perfrom surveys, maintain grasslands, removal of hedgerows	Consider minimum area requirements; > 10 acres required
Terrapene carolina	Eastern Box Turtle	reptile	G5	None	S3	SC	Yes	y	y	X	None	

Global and State Ranks: 5 = demonstrably secure, 4 = apparently secure, 3 = rare or local, 2 = imperiled, 1 = critically imperiled
Habitats: X denotes primary habitat requirement; y denotes secondary habitat requirements
State Rank: B = Breeding Populations, N = Non-breeding Populations
State Status: E = Endangered, T = Threatened, SC = Special Concern, RP = Regional Priority (designated by Partners In Flight)

Amphibians - There are a total of 24 species of amphibians that may be found at the Preserve or within the Project Area (See Appendix N for a list of amphibians known to occur in Hunterdon County). Rare species are listed in Table 17. Five species are listed as Wildlife Action Plan (WAP) priority conservation species for the Southern Highlands region.

Reptiles - There are a total of 24 species of reptiles that may be found at the Preserve or within the Project Area (See Appendix O for a list of reptiles known to occur in Hunterdon County). Rare species are listed in Table 17. Five species are listed as Wildlife Action Plan (WAP) priority conservation species for the Southern Highlands region.

Birds - There are a total of 116 species of birds that may breed at the Preserve or within the Project Area (See Appendix P for a list of birds that have confirmed, probable or possible breeding observations in the Project Area). Rare species are listed in Table 17. Forty-nine species are listed as Wildlife Action Plan (WAP) priority conservation species for the Southern Highlands region.

Mammals - There are a total of 35 species of mammals that may be found at the Preserve or within the Project Area (See Appendix Q for a list of mammals known to occur in the Hunterdon County area). There are no documented occurrences of rare mammals in the Project Area. Four species are listed as Wildlife Action Plan (WAP) priority conservation species for the Southern Highlands region.

Freshwater Fish - There are a total of 85 species of freshwater fish that may be found at the Preserve or within the Project Area (See Appendix R for a list of fish known to occur in New Jersey). There are no documented occurrences of rare fish in the Project Area. Seven species are listed as Wildlife Action Plan (WAP) priority conservation species for the Southern Highlands region.

Invertebrates - There are a total of 139 species of lepidopterans, 168 species of odonates and 6 species of mussels that may be found at the Preserve or within the Project Area (See Appendices S – Hunterdon County species list, T – Hunterdon County species list and U – statewide and middle Delaware drainage species list, respectively). There are no documented occurrences of rare invertebrates in the Project Area. One invertebrate species is listed as Wildlife Action Plan (WAP) priority conservation species for the Southern Highlands region (Yellow Lampmussel).

Wickecheoke Creek

The Wickecheoke Creek and its tributaries, both within the Preserve and throughout the Project Area, is a distinct conservation target. Specific attributes of concern include hydrology, water quality and stream flora & fauna (including aquatic invasive species). However, it is important to note that the health of the stream system is heavily dependent upon the health of ecological communities, including forest buffers, discussed earlier in this section. A brief description of the Project Area waterways is provided in Section I, challenges are provided in Section III, and strategies that could include NJCF are provided in Section IV.

III. Challenges

Introduction

This section describes challenges that must be addressed to successfully accomplish conservation recommendations. Broad conservation recommendations include: 1) Create and Implement Community Deer Management Program, 2) Selective Control of Invasive Species, 3) Foster Forest Health, 4) Foster Early Successional Communities, and 5) Forester health of the Wickecheoke Creek (See Section IV). The two most severe threats are an overabundant population of white-tailed deer and infestations of invasive species. In addition, the overall condition of the watershed presents challenges for the health of the Wickecheoke Creek.

Evaluation of White-tailed Deer Impacts

White-tailed deer have had a significant negative impact on forest health at Wickecheoke Creek Preserve. Native tree regeneration in natural forest canopy gaps is not occurring. Instead, less palatable invasive shrubs (e.g., Multiflora Rose) and grasses (e.g., Japanese Stiltgrass) are filling forest gaps. The current trajectory would lead to continued elimination of forest cover at the Preserve over the coming decades as mature native trees naturally fall due to various factors such as storms and disease.

Also important is the severe browsing of native tree seedlings, shrubs and herbs in the forest understory. Large areas of the Preserve contain little or no understory vegetation that would provide vital habitat for a variety of animals. However, mature trees (with continuing seed production) and remaining shrubs and herbs can assure long-term recovery of forest health if deer populations are dramatically reduced in the near future.

The forests of Wickecheoke Creek Preserve present both the “Empty Forest Syndrome” and the “Infested Forest Syndrome” (see Section I – Threats). Forest areas dominated by Sugar Maple, Eastern Hemlock, American Beech, and young (‘pole stage’) forests with Red Maple / Pin Oak have very sparse understory vegetation. This is likely due to excessive deer browse on native species and dense shading that significantly reduces growth rates for both native and invasive species. In each of these forest types, canopy gaps are generally infested with invasive species that are resistant to deer herbivory.

Other forest types dominated by oak or hickory tend to have canopies that cast less dense shade than the forests described above. In these forests, understory vegetation consists of significant amounts of invasive species, but may also contain varying amounts of badly browsed individuals of native species such as Spicebush, Blackhaw or Arrowwood. Tree seedlings and saplings were virtually absent in forests throughout the Preserve.

Despite the severe impacts to forests at the Preserve, there were several locations with healthy, diverse native shrubland habitat forming on abandoned agricultural lands (e.g., Huey and Turnquist Sections). It appears that these species produce enough individuals (and/or have relatively low palatability, and/or grow quickly in open sunlight) to saturate deer appetites and have grown to maturity. The potential for this to occur in other areas seems likely. This habitat type is particularly uncommon in most areas of New Jersey and appears to be influenced by relatively high soil moisture levels that encourage a particular suite of species with the characters listed above. Common species observed include Gray Dogwood, Silky Dogwood, Red-Osier Dogwood, Arrowwood, and Hardhack. However, the invasive Autumn Olive is a severe threat to this community type.

A description of native and non-native plants found within each mapped forest and early successional habitat patch throughout the Preserve is provided in Appendix I and Appendix J, respectively. A series of photographs that depict these observations are provided below to highlight deer impacts to forest health at the Preserve.




Severe deer browse damage on native shrubs and herbs. Upper left, Spicebush showing "crew cut" effect of re-sprouting stems that cannot replace the large dead stem. Upper right, Spicebush showing distinct browse line that maintains an open understory not suitable for shrub nesting birds. Lower left, Zig-Zag Aster badly browsed and only minimally producing flowers – the dense patch of short stems is atypical of this species. Lower right, Blue Wood Aster in a similarly browsed condition.


The 'Infested Forest Syndrome' - Japanese Stiltgrass (left) and combination of Japanese Barberry, Multiflora Rose and other invasive species (right). Regenerating native trees and shrubs are nearly absent in these areas due to excessive deer browse.

An exception to the general rule (above) – This open canopied forest has a shrub mixture of Spicebush and Multiflora Rose. Apparently, the additional light resources allow Spicebush to grow above the browse line and compete with the invasive species.

The 'Empty Forest Syndrome'. Dense canopy dominated by Sugar Maple and Shagbark Hickory. Shrub and herb layers are badly browsed and virtually absent.

The two photos on this page represent two potential long-range outcomes for all forests at the Preserve.

Top Photo: Forest canopy collapse precipitated by dense growth of invasive vines (Japanese Honeysuckle) – notice tree in center with broken crown covered by vines. The understory is infested with invasive species responding to the open canopy. Native tree seedlings/saplings that could re-fill the canopy are browsed by deer – ultimately, this area will be converted from a forest to a shrub-thicket dominated by invasive species.

Bottom Photo: A healthy forest filled with native understory species providing ecological control of invasive species. Native shrubs provide habitat for forest nesting birds. The understory growth includes tree seedlings/saplings that would replace lost canopy trees. Herbs would be abundant and diverse, especially in canopy gaps.

In contrast to forest health, selected areas of the Preserve are producing healthy and diverse native shrublands. These areas tend to be damp (but not designated wetlands) and contain dense growth of native shrubs such as Gray Dogwood, Silky Dogwood, Red-Osier Dogwood, Hardhack, Red Chokeberry and Arrowwood. Numerous native wildflowers co-occur in more open portions of the habitat and include Goldenrods, Asters, Virginia Mountain Mint, Monkeyflower, Small-flowered Agrimony, New York Ironweed, Swamp Milkweed and various species of rushes & sedges. Invasive species, such as Autumn Olive and Callery Pear, threaten the health of these areas (especially prior to the establishment of a tall, dense native shrub layer).

Evaluation of Invasive Species Impacts

Mapping Protocols - The methods used to map invasive plant species at the Preserve 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. The ultimate goal was to obtain results that identify and prioritize control activities over the next 10 years.

Mapping areas were delineated as locations containing relatively uniform ground cover for each invasive species present within the defined area or 'patch'. Within each patch, all invasive plants were assigned cover class scores. Cover class scores included: "0": absent, "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 529 unique mapped patches totaling 858 acres were recorded. There were 145 acres, or 17% of the Preserve, that did not have any invasive species present (primarily associated with forest types that cast dense shade such as Sugar Maple). The total number of species per patch is summarized in Table 18. Subjective categories were created to facilitate interpretation of data – patches with 'Low' numbers of species accounted for about 8% of the Preserve. 'Moderate' (ca. 41% of Preserve), 'High' (ca. 26%), and 'Very High' (ca. 9%) numbers of species per patch were recorded.

Severity of infestation per patch is summarized in Table 19. Combined infestation scores were calculated as the sum of cover classes (See above) for each detected invasive species. Scores ranged from 0 to 15 and were subjectively categorized as above for the number of species per patch. 'Low' infestation levels were recorded at approximately 4% of the Preserve. 'Moderate' (ca. 9% of the Preserve), 'High' (ca. 26%) and 'Very High' (ca. 45%) infestation levels were recorded.

Maps 17 and 18 depict the total number of invasive species and cumulative infestation scores by mapped patches, respectively (Close up views by portion of the Project Area are also provided electronically as addenda to this Plan).

Table 18. Number of Invasive Plant Species Per Mapped Patch

Number of Species per Patch	Total Acreage	Percentage of Preserve	Species Count Category
0	145.1	16.9	CLEAN
1	64.6	7.5	Low
2	184.4	21.5	Moderate
3	167.9	19.6	Moderate
4	166.7	19.4	High
5	55.9	6.5	High
6	36.9	4.3	Very High
7	28.7	3.3	Very High
8	8.1	0.9	Very High

Table 19. Combined Infestation Scores for Invasive Plants Per Mapped Patch

Combined Infestation Scores per Patch	Total Acreage	Percentage of Preserve	Infestation Category
0	145.1	16.9	CLEAN
1	33.7	3.9	Low
2	78.1	9.1	Moderate
3	61.9	7.2	High
4	49.5	5.8	High
5	108.5	12.6	High
6	45.7	5.3	Very High
7	123.7	14.4	Very High
8	63.7	7.4	Very High
9	30.5	3.6	Very High
10	36.2	4.2	Very High
11	20.8	2.4	Very High
12	30.5	3.6	Very High
13	1.2	0.1	Very High
14	14.5	1.7	Very High
15	14.9	1.7	Very High

Each invasive species was assigned an 'Action Code' based upon its threat level to conservation targets, current extent of infestation at the Preserve and known invasive status in New Jersey (Table 20; Action Codes for particular species are reported in Table 24 in Section IV). Specific management recommendations for each species are presented in Section IV.

Table 20. Action Code Summary for Invasive Plant Species

Action Code	Action Code Description	Broad Treatment Recommendation	Number of Species
1	Species has limited distribution (but is highly threatening) at the Preserve. This includes all regionally emerging invasive plant species and nascent populations of species with widespread distributions outside of the Preserve.	Eradicate	12
2	Species has widespread distribution at the Preserve, but specific control measures are warranted to protect conservation targets.	Long-term Control Program	3
3	Species has limited distribution and/or is not considered to be highly threatening to conservation targets at the Preserve.	Watch for Spread, Treat as necessary in the future	2
4	Species may be widespread & abundant, but control is not considered practical. This category also includes species that are not considered invasive and control is not required to protect conservation targets.	No Control Effort Recommended	13
TOTAL			30

Species Patterns - Table 21 contains data for each invasive species mapped at the Preserve (See individual species distribution maps provided electronically as addenda to this Plan). Table 21 also contains the "Relative Infestation Index Category." This index provides a coarse characterization of both distribution and intensity of infested acreage at 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 across the Preserve and/or primarily occur at low cover classes.

The five most widespread and abundant invasive species included Multiflora Rose (*Rosa multiflora*), Japanese Stiltgrass (*Microstegium vimineum*), Japanese Honeysuckle (*Lonicera japonica*), Autumn Olive (*Elaeagnus umbellata*) and Small Carpgrass (*Arthraxon hispidus*). Multiflora Rose continues to be a serious problem in field edges, riparian areas of small streams, and forest interiors with relatively open canopies despite being heavily impacted by Rose Rosette Disease (RRD) in open fields. Japanese Stiltgrass and Japanese Honeysuckle are serious problems in riparian areas, moist/wet forests, canopy gaps in resistant forest types (e.g., Sugar Maple), and oak-hickory forests. Autumn Olive is most prevalent in meadows and forest edges. Small Carpgrass, while very abundant in meadows, is not considered a serious threat because native species appear to be able to outcompete this species (it forms a uniform low ground cover beneath other meadow species, primarily on moist ground).

Species with relatively moderate infestation levels include Garlic Mustard (*Alliaria petiolata*), Japanese Barberry (*Berberis thunbergii*), Wineberry (*Rubus phoenicolasius*) and Bush Honeysuckle species (*Lonicera* spp.). An additional 14 plant species were recorded at the Preserve. Several are highly threatening and may grow densely in limited areas – many should be considered for eradication. This list includes Winged Burning Bush (*Euonymus alata*) which, counter to the general rule for invasive species, can be heavily browsed by deer and might be expected to rapidly increase in abundance following successful deer herd reduction.

Importantly, Wickecheoke Creek Preserve contains ten emerging invasive species including seven plants, one fish, one mussel and one insect (See Table 22 and Map 19 - Close up views by portion of the Project Area are also provided electronically as addenda to this Plan). Nine of these species are recommended for eradication efforts and NJCF has already taken on this challenge for Big Head Carp and Chinese Pond Mussel located at the Huey Section. The Chinese Pond Mussel has never been documented in North America until its discovery at the Preserve. It is commonly associated with carp species and its introduction to Europe was associated with fish farms. Since 1984, Chinese Pond Mussel has spread across thirteen other countries and is now the most widely introduced mussel in Europe (See http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=2824). Viburnum Leaf Beetle is expected to have significant deleterious impacts in the Project Area (and throughout New Jersey), but there are no practical stewardship remedies. It was first documented in New Jersey in 2009, but observations in many northern counties in 2010 suggest that the species had gone undetected for many years.

Spatial Patterns - Severe infestations (See Map 18 - Close up views by portion of the Project Area are also provided electronically as addenda to this Plan) were recorded on 45% of the Preserve area and 17% of the Preserve was free of any invasive species. Infestations were associated with recently abandoned agricultural lands, oak-hickory forest types, and canopy gaps within more resistant forest types. Areas that were completely invasive-free were forests with intact canopies dominated by Sugar Maple, Eastern Hemlock, American Beech and young/dense stands consisting of Red Maple or Pin Oak. Feeder streams of the Wickecheoke Creek were particularly infested with Multiflora Rose and other species, while the banks of the Wickecheoke were variable (Common Mugwort, Japanese Stiltgrass and Autumn Olive were

common where invasive species were abundant). Summary infestation levels are recorded for each habitat patch within the Preserve – including forest and early successional plant communities (See Appendices I and J).

Table 21. Summary of Invasive Plant Distribution and Severity

					Acreage by Percent Ground Cover Categories					
Scientific Name	Common Name	Infestation Index Score[1]	Relative Infestation Index Category[2]	Total Acres Present	Category 0: 0%	Category 1: 1-10%	Category 2: 10-25%	Category 3: 25-50%	Category 4: 50-75%	Category 5: 75-100%
Acer platanoides	Norway Maple	6.2	Low	5.5	852.9	4.8	0.7	0.0	0.0	0.0
Ailanthus altissima	Tree-of-Heaven	0.5	Low	0.1	858.3	0.0	0.0	0.0	0.0	0.1
Alliaria petiolata	Garlic Mustard	207.0	Moderate	155.2	703.2	112.7	34.8	6.1	1.6	0.0
Artemisia vulgaris	Common Mugwort	40.2	Low	23.9	834.5	12.9	8.7	0.8	0.0	1.5
Arthraxon hispidus	Asian Carpgrass	381.2	High	120.6	737.8	39.5	10.6	4.5	23.0	43.0
Berberis thunbergii	Japanese Barberry	205.2	Moderate	162.5	695.9	123.6	36.9	0.2	1.8	0.0
Celastrus orbiculata	Asiatic Bittersweet	2.4	Low	2.4	856.0	2.4	0.0	0.0	0.0	0.0
Cirsium arvense	Canada Thistle	60.5	Low	57.6	800.8	54.7	2.9	0.0	0.0	0.0
Coronilla varia	Crown Vetch	0.3	Low	0.3	858.1	0.3	0.0	0.0	0.0	0.0
Elaeagnus umbellata	Autumn Olive	428.4	High	283.4	575.0	200.2	45.4	15.5	20.6	1.7
Euonymus alata	Winged Burning Bush	18.4	Low	18.1	840.3	17.8	0.3	0.0	0.0	0.0
Ligustrum sp.	Privet species	15.6	Low	15.4	843.0	15.4	0.0	0.0	0.0	0.04
Lonicera BUSH	Bush Honeysuckle	115.3	Moderate	94.8	763.6	78.3	12.5	4.0	0.0	0.0
Lonicera japonica	Japanese Honeysuckle	462.2	High	264.4	594.0	140.8	67.7	37.9	17.7	0.3
Lythrum salicaria	Purple Loosestrife	15.2	Low	15.2	843.2	15.2	0.0	0.0	0.0	0.0
Microstegium vimineum	Japanese Stiltgrass	957.1	High	376.8	481.6	70.3	135.6	85.1	68.7	17.1
Pachysandra terminalis	Japanse Pachysandra	0.2	Low	0.1	858.3	0.0	0.1	0.0	0.0	0.0
Phalaris arundinacea	Reed Canary Grass	76.9	Low	41.7	816.7	22.6	9.4	6.1	0.8	2.8
Phragmites australis	Common Reed	9.7	Low	8.1	850.3	7.7	0.0	0.0	0.0	0.4
Robinia pseudoacacia	Black Locust	1.2	Low	0.9	857.5	0.8	0.0	0.0	0.1	0.0
Rosa multiflora	Multiflora Rose	1293.7	High	588.7	269.7	288.1	100.9	65.3	64.1	70.3
Rubus phoenicolasius	Wineberry	135.6	Moderate	132.8	725.6	130.1	2.7	0.03	0.0	0.0
Vinca minor	Lesser Periwinkle	3.6	Low	1.9	856.5	0.7	0.9	0.2	0.0	0.1

[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 < 100, 100-250 and > 250, respectively.

Table 22. Emerging Invasive Species at the Wickecheoke Creek Preserve

Scientific Name	Common Name	Number of Detected Populations
Albizia julibrissin	Mimosa	1
Dioscorea oppositifoloia	Chinese Yam	1
Euonymus fortunei	Wintercreeper	10
Hedera helix	English Ivy	13
Hypophthalmichys nobilis	Big Head Carp	1
Miscanthus sinensis	Chinese Silvergrass	3
Pyrrhalta viburni	Viburnum Leaf Beetle	2
Pyrus calleryana	Callery Pear	2
Sinandonta woodiana	Chinese Pond Mussel	1
Wisteria floribunda	Japanese Wisteria	3

Pests and pathogens of forest trees most relevant to the Wickecheoke Cree Preserve include Beech Bark Disease and Hemlock Wooly Adelgid (See photos below). Other common invasive species (i.e., gypsy moth) likely produce intermittent problems within oak-dominated forest types. Emerging species (e.g., Bacterial Leaf Scorch and Sudden Oak Death) may cause future problems. A complete list of widespread and emerging pest & pathogen species is presented in Appendix C.

Chinese Silver Grass (left) is an emerging invasive species that threatens meadow habitats. Three very small populations were found at the Preserve and can be eradicated easily before becoming large infestations. Wintercreeper (right) is forming large infestations in the vicinity of the Covered Bridge. Treatments have begun, but additional control efforts are required to completely eradicate the species from the Preserve.

Native Arrowwood is abundant in select locations at the Preserve and produces large amounts of high-quality fruit in summer (photo at left). Unfortunately, the emerging invasive species - Viburnum Leaf Beetle – has established at the Turnquist Section (see leaf damage at right) and the ultimate fate of this valuable native shrub is questionable.
Control efforts for this new invasive insect are not practical.

Beech Bark Disease is prevalent at the Fishkin Section. The disease starts as an infection that causes a discoloration of the bark (left) and ultimately leads to the death of the tree (right). Many trees (ca. 25%) are mildly to moderately infected in this section of the Preserve and dramatic changes to forest composition are possible in coming years.
Control efforts for this invasive pathogen are not practical.

The current condition of hemlock trees at the Preserve is mixed. Individual trees have varying amounts of infestation (top left, heavily infested leaves); top right – complete death of tree, which is now being covered with Wintercreeper, an emerging invasive species). However, the majority of the canopy in hemlock-dominated forests is intact and relatively healthy (but infected) tree saplings can be observed in select locations (bottom). More than half of New Jersey's hemlocks have been eliminated over the past 20-30 years – it is currently unclear whether existing trees will remain over the coming decades. The NJ Department of Agriculture had released a biocontrol agent (a small beetle that eats the adelgids), but its impacts are not considered to be significant. The USDA is currently working on production of resistant hybrids of Chinese hemlock.

Evaluation of Stream System Impacts

There have been numerous assessments of the Wickecheoke Creek watershed (See Section I). Overall, the creek is considered 'flashy', with heavy springtime and storm-related flows followed by long periods with little or no flow during the summertime. In part, this is related to the natural underlying geology that increases overland flows and limits groundwater recharge that would act as base flow for the stream (See Section I). However, human-related impacts significantly exacerbate the natural condition. Primarily,

insufficient forest stream buffers, agricultural-related soil compaction and roadway-altered overland flow patterns increase the frequency and intensity of water flow (which increase stream bank erosion) and reduce groundwater recharge that might improve summertime flow rates. Heavy stream bank erosion during high flow periods may account for up to 90% of the sediment yield that has become problematic in the D&R Canal.

The NJWSA prepared a comprehensive report in 2008 (Wickecheoke Creek Visual Assessment - NJWSA 2008a). NJWSA utilized the United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS) Stream Visual Assessment Protocol (SVAP). SVAP scores stream segments using 15 indicators of stream health. Although SVAP relies on subjective observations rather than quantitative measurements, it allows relative comparisons between sites and provides useful information on visually observable physical and chemical stream parameters. Indicators include: Channel Condition, Hydrologic Alteration, Riparian Zone, Bank Stability, Water Appearance, Nutrient Enrichment, Barriers to Fish Movement, Instream Fish Cover, Pools, Invertebrate Habitat, Canopy Cover, Manure Presence, Salinity, Riffle Embeddedness, and Macroinvertebrates Observed. The maximum score for each indicator ranges from 1 to 10 (with two exceptions) and the overall score for a particular stream segment is presented as the sum of scores for each indicator divided by the number of indicators measured. As performed on Wickecheoke Creek, the potential scores could range from 1 to 10.4. Overall score ranges were categorized as Poor ($\leq$ 6.0), Fair (6.1-7.4), Good (7.5-8.9) or Excellent ($\geq$9.0).

Twenty-five locations were measured by NJWSA and overall scores ranged from 6.1 to 9.0 (Average = 7.6, Median = 7.7). The number of stream segments in each ranking category is summarized below:

	Excellent	Good	Fair	Poor
Number of Segments	1	14	10	0

Based upon these findings, NJWSA recommended site-specific restoration activities including riparian buffer restoration (48 sites), River-Friendly Farm projects (7), roadside ditch mitigation (1), and floodplain reconnection (1). Cost estimates and maps are provided in their report and direct implications for the Wickecheoke Creek Preserve are provided in Section IV.

The New Jersey Water Supply Authority prepared a comprehensive assessment of the Wickecheoke watershed (NJWSA 2009c – "Summary of the Characterization and Assessment of the Lockatong and Wickecheoke Creek Watersheds"). A number of entities have monitored surface water flow and quality in past years. NJWSA and the United States Geological Survey (USGS) have monitored surface water flow at the mouth of Wickecheoke Creek since 2006. A water quality monitoring station was located near the mouth until 1991. The Hunterdon County Department of Health has monitored the location for fecal coliform levels and NJDEP had been performing limited biological assessments. Overall water quality was good, but degraded to fair in summer months with elevated temperatures and excessive levels of total nitrogen. From 1999 to 2004, the Delaware River Basin Commission (DRBC) maintained a water quality and flow monitoring station at the mouth of the Creek. NJDEP lists the Wickecheoke Creek on "Sublist 4" and "Sublist 5" of its integrated list of water bodies meaning that it has known water quality impairments including water temperature, fecal coliform and total phosphorus. Sedimentation of the D&R Canal from upstream bank erosion has been a noticeable problem since the late 1990's.

Common Mugwort dominating a streamside meadow. This species, along with Japanese Stiltgrass, frequently form monocultures along the Wickecheoke Creek. Their presence may be related to the seasonal high flows followed by lack of flow in summertime.

Other Threats

The Wickecheoke Creek Preserve fortunately does not have significant issues with 'undesirable activities' such as Off-Road Vehicles (ORV's) or vandalism. ORV's do not appear to be causing any significant damage at the Preserve. Incidents that involved overnight camping and graffiti on rocks along Upper Creek Road appear to have subsided since being addressed by the Delaware Township Police Department and NJCF in 2008.

Beaver activity on the Huey Section has caused damage to the trail system in the recent past. Engineering-type solutions may be considered if the problem persists (e.g., "Beaver-Deceivers", raised foot bridges, etc.). Persistent flooding may ultimately kill mature trees in the vicinity and their likely replacements will be invasive species that are unpalatable to deer. If the deer problem could be mitigated, then beaver activity would not be associated with degradation of natural areas at the Preserve.

Interactions between beavers, deer and native plants – This Hop Hornbeam was cut by beaver and re-sprouts are being chewed by deer, which will eventually kill the tree.

IV. Strategies and Actions

Introduction

This plan section provides strategies and actions to mitigate threats to conservation targets. The topic of strategies and actions was discussed with NJCF staff and plan contributors representing a diverse array of expertise and experiences. Additional input was provided through interviews with private residents and results of the public survey. Collectively, this input strongly influenced the recommendations contained in this section.

The primary threats to conservation targets include: 1) overabundant white-tailed deer, 2) invasive species infestations, and 3) altered stream flows. The five primary conservation recommendations include: 1) Create and Implement Community Deer Management Program, 2) Selective Control of Invasive Species, 3) Foster Forest Health, 4) Foster Early Successional Communities and 5) Foster health of Wickecheoke Creek. Each of these recommendations has associated strategies detailed in this plan section.

Stewardship activities focus on broad improvements to the health of habitats required to support the fullest array of regional flora and fauna within the Project Area (e.g., Community Deer Management Program to improve forest health throughout the Project Area, realistic invasive species control efforts that focus on emerging populations before they cause regional damage). The conservation of rare species is primarily considered through improvements to habitat health, but particular species-specific recommendations are provided where appropriate (e.g., targeted forest restoration to maximize the size of contiguous forest habitat for many species, but also including installation of Barred Owl nest boxes to facilitate breeding success). The Preserve contains a variety of habitat types, including many areas of recently abandoned farmland. The recommended habitat types for current early successional habitat can range from maintenance of meadows or shrublands to forest restoration. Table 23 summarizes the acreage of current and recommended habitat types across the Preserve. Specific recommendations for mapped patches of early successional and forest habitats are provided in Appendices I and J, respectively.

It is important to recognize that it is impossible to fully remedy past and continuing human impacts, but efficient and effective strategies must be employed to preserve and improve ecological health. These strategies 'ignore' some serious impacts in an effort to focus activities that amplify nature's inherent ability to repair herself once human impacts have been lessened. Despite this philosophy to land stewardship, a significant and persistent effort involving NJCF staff and many conservation partners will be required to improve the health of conservation targets by reducing human impacts at the Wickecheoke Creek Preserve. Implementation is considered to be a 10-year process and a calendar of activities by plan year is provided in Table 26, which also provides level-of-effort estimates and specific locations for stewardship activities.

Based upon estimated level-of-effort required for all recommendations, NJCF should dedicate a full-time land steward specifically for the Wickecheoke Creek Preserve. This land steward should become a certified pesticide applicator to implement invasive species recommendations in the most cost effective manner (See page 8). In addition, two seasonal interns should be hired each summer (estimated cost of $10,000 annually – see 'Partnerships' under Section I for potential collaboration with the Hunterdon Land Trust Alliance). Other capacity improvements could include the implementation of a 'Volunteer Preserve Monitoring Program (See Section V) and mandatory stewardship requirements for Deer Management Participants (See Recommendation #1).

Monitoring and Evaluation Protocols - As is typical in any highly complex undertaking, careful planning and adaptive management will be required to effectively manage the Preserve. For each recommendation,

monitoring techniques, measurement units and desired outcomes have been defined (Table 27). Most recommendations can be monitored using extremely simple methods (e.g., completion of community deer management plan, visual assessment of invasive species cover). For forest health monitoring, protocols established by Ecological Solutions are recommended to guide the effectiveness of the Preserve Deer Management Plan (Appendix V).

Table 23. Summary of Habitat Type Recommendations for the Wickecheoke Creek Preserve

Current Habitat Type	Current Acreage	Percent of Total Preserve	Recommended Habitat Type	Recommended Acreage	Acreage Change from Current	Percent of Total Preserve
Forest	516	60.0	Forest	623	109	72.6
Hay/Pasture	148	17.3	Hay/Pasture	43	-105	5.0
Lawn	4	0.5	Lawn	2	-2	0.2
Meadow	134	15.6	Meadow	160	26	18.6
Plantation	3	0.3	Savanna	3	3	0.3
Pond	6	0.7	Pond	6	0	0.7
Shrubland	45	5.3	Shrubland	20	-26	2.3

Recommendation #1: Create and Implement Community Deer Management Program

A majority of survey respondents expressed concern over deer impacts to forest health (See Table 9) and observations of severe impacts were common throughout the Preserve and Project Area (See Section III). Interviews with two local farmers (Skip Updike, Tom Michalenko) highlighted significant economic impacts based upon the need to switch to less palatable crops (e.g., corn or alfalfa to hay). Other impacts such as Lyme disease, deer-vehicle collisions and landscape planting losses have not been quantified within the Project Area, but it is likely that significant impacts mimic those of other parts of New Jersey.

NJCF has an active deer hunting program on 90% of the Preserve (approximately 100 acres are not hunted for logistical reasons – i.e., narrow Preserve sections located along roadways – See Map 20). NJCF staff directly manages approximately 400 acres (includes Huey, Turnquist, Jungblut, Thompson and Thompson II).

The United Bowhunters of New Jersey (UBNJ) manages approximately 380 acres (under the supervision of NJCF staff). UBNJ selects hunters from its membership on a first come, first serve basis (requires members to register via UBNJ website). The total number of hunters selected is based upon available acreage to meet a pre-determined hunter density (1 hunter per 15 acres – excluding large open fields). Although UBNJ members participate in gun hunting, only bow hunting has been allowed by NJCF. Enhanced deer harvesting techniques such as baiting, food plots and driving have not been utilized at the Preserve. Harvest records have not been requested or maintained in past years. However, UBNJ has suggested that the program typically involves fourteen hunters that harvest a total of fourteen deer per year (approximately 1 deer per 27 acres per year; harvest ratios by sex have not been recorded).

Recommendations to increase program effectiveness at the Preserve are provided as Recommendation #1A. Although this recommendation should be considered an important strategy toward obtaining positive conservation outcomes at the Preserve-level, its greatest value will be providing a local example of an effective Deer Management Program that translates to a community level deer management program that could improve ecological health across the entire Project Area (Recommendation #1B). NJCF has been the leader in spotlighting the problem of statewide deer overabundance and applying policy pressure to force improvements to the game code. These efforts must continue, but Preserve and Project Area efforts will be required regardless of desired changes to the game code.

The New Jersey Farm Bureau should be considered a strong ally in efforts to formulate a community deer management program. The Bureau's 2010 Policies suggest a number of policy and implementation options to reduce deer impacts on agricultural productivity (NJ Farm Bureau 2009, pages 42-43). Particular suggestions include: reinstatement of the Earn-a-Buck Program, bow hunting in summer, and improvements to the Depredation Permit process including the allowance of hunters to sell venison. These and other suggestions could result in a meaningful reduction of the deer population.

It is important to recognize that recreational hunters are the only source of deer herd management and their participation in deer herd reduction is ultimately voluntary. If deer herd reduction to decrease impacts (including ecological, economic and public health impacts) will occur, then hunters will have to be willing participants in initial herd reduction efforts and necessary ongoing maintenance of a much smaller deer population. The Quality Deer Management Association (www.qdma.com) is a hunting organization that encourages a holistic approach that balances the deer herd with their habitat and generally leads to smaller, healthier herds living within healthy forests. The traditional element of Deer Management Programs (i.e., focus on antlerless deer harvest) is coupled with restrictions on harvesting young bucks to allow the growth of larger bucks. The restoration of balance between males to females in the population, along with healthy habitats filled with high-value forage (a.k.a. ecologically healthy forests) is required for successful QDM. Overall, QDM provides motivation for hunters because it leads to large trophy bucks by instilling the discipline and ethic required to maintain a smaller herd.

Recommendation #1A: Enhance existing Preserve Deer Management Program

- Set harvest goals based upon site acreage. For example, the Friends of Hopewell Valley Open Space (FoHVOS) requires the harvest of one antlerless deer per five acres. Verification is performed through the requirement of hunters to provide deer harvest tag numbers, which are cross-checked through the NJ Division of Fish & Wildlife database. Failure to meet harvest goals results in replacement of existing hunters. The harvest goals utilized by FoHVOS are likely to be appropriate at the Preserve based upon observed browse conditions and numerous sightings of deer during field work performed for this plan.
- Allow gun hunting at all Preserve sections to increase the harvest, where appropriate.
- Allow a greater number of hunters into the DMP to increase the total number of hours spent hunting, which would increase the total harvest.
- Improve signage at Preserve entrances to allow the public to be aware of ongoing hunting activities.
- Institute fees and mandatory workday requirements from DMP participants to increase stewardship capacity. Note: Some programs utilize fee structures to encourage the harvesting of antlerless deer.
- The annual success of DMP should be based upon meeting harvest goals, but the long-term success should be based upon direct measurements of forest health (See Table 27 & Appendices U - X).
- NJCF should initiate discussions with similar organizations to gather elements of their efforts that may be incorporated into an improved DMP at the Preserve. Examples of Preserve-level deer management programs can be found at www.deerinbalance.org. Local examples of effective DMP's include the Schiff Natural Lands Trust and D&R Greenway Land Trust.

Recommendation #1B: Coordinate Community Deer Management Program

- The ultimate health of forests throughout the Project Area will depend upon community-level efforts to reduce the deer population. NJCF should review recent efforts in Hopewell Township, Mercer County (See http://www.hopewelltwp.org/Final_Deer_Task_Force_Report_092710.pdf). In Connecticut, the Fairfield County Deer Alliance is an excellent model for combining the

efforts of multiple municipalities (http://www.deeralliance.com/). Key elements of a community-level effort are listed below.

- Create 'demand' for deer herd reduction through outreach that includes impacts to all residents of the Project Area such as agricultural losses, deer-vehicle collisions, Lyme disease and landscape planting losses.
    - Begin discussions with Project Area municipalities
    - Begin discussions with local agricultural leaders and organizations
- Encourage farmers to seek depredation permits.
- Seek changes to game codes within Project Area deer management zones to require Quality Deer Management
    - Changes would involve restrictions on harvesting small bucks and emphasizes doe harvests
    - Provide outreach on benefits of QDM to recreational hunters (i.e., more quality and less quantity)
- Formalize municipal Deer Management Task Forces with associated Plans
    - Begin with Delaware Township and establish others based upon interest and proportion of the Project Area encompassed by their municipal boundaries by seeking 1-2 local residents within each municipality to 'champion' the outreach effort.
    - NJCF serves as plan creation and implementation leaders
    - NJCF assists public and private landowners with creation of site-specific DMP's that cross property lines
    - NJCF conducts annual stakeholder meetings at the Prall House to provide outreach and formulate ongoing strategies

Recommendation #2: Selective Control of Invasive Species

This recommendation only includes species-specific treatments of newly emerging invasive species within New Jersey and nascent populations of widespread invaders with small populations at the Preserve. Recommendation #2A should be completed by 2012. Other invasive species related strategies are included with Recommendations 3 & 4, which involve maintenance of uninfested portions of the Preserve, hand clearing of less dense infestations and contracted clearing of dense infestations. Future management efforts beyond 10 years will largely involve continual low-intensity removals of invasive plants. Ultimately, ecological control via dense native plant growth is likely to significantly reduce the need for ongoing chemical control of invasive species. Invasive species are likely to be present in perpetuity, but they are much less likely to form dense infestations following deer herd reduction.

Table 24 provides goals and prescriptions for all invasive species found at the Preserve. It employs the 'Action Code' prioritization system explained in Section III (Note: Table 24 shows all species with Action Code = 4 in gray to symbolize that no control efforts are recommended). The table includes threat levels to major habitat types, a generalized prescription and specific treatment recommendations. An overview of control methods (including explanation of codes used in Table 24), detailed information on herbicides, and invasive species phenology are provided in Appendices D, E, and F. These appendices are intended to provide practical guidelines toward plan implementation by stewards of the Wickecheoke Creek Preserve.

Recommendation #2A: Eradicate Newly Emerging Invasive Species

- Staff members should become certified pesticide applicators to facilitate this work (See page 8 for details).
- The highest priority for invasive species control is the eradication of newly emerging invasive species. These species threaten the Preserve and the region with future degradation. This

strategy, known as Early Detection & Rapid Response, represents an efficient and effective strategy to prevent damage and minimize future stewardship costs. Currently, there are ten species of newly emerging invasive species at the Preserve.

- NJCF has provided leadership in ED/RR through the eradication of Big Head Carp at the Huey Section. Additional ongoing efforts will assure the eradication of Chinese Pond Mussel and Wintercreeper near the Covered Bridge.
- For seven emerging invasive plants found at the Preserve (See Table 22 and Map 19). Species-specific treatment recommendations are provided in Table 24. Ongoing vigilance is required throughout the 10-year plan implementation to assure that additional populations do not establish.

Recommendation #2B: Control Nascent Populations of Widespread Invasive Species

- A high priority should be given to eradication or containment of widespread invasive species that currently have a limited distribution at the Preserve. Species include Norway Maple, Tree-of-Heaven, Asiatic Bittersweet, Purple Loosestrife, Phragmites, Black Locust and Winged Burning Bush.
- Refer to Table 24 and individual species distribution maps for currently known populations, but continual vigilance through informal/coincidental field observations is required.

American Sycamore bark at the Thompson II Section.

Table 24. Invasive Species Control Goals and Prescriptions

			Generalized Threat				
Scientific Name	**Common Name**	**Action Code[1]**	**Meadow**	**Shrubland**	**Forest**	**Generalized Prescription**	**Treatment Options[2]**
Acer platanoides	Norway Maple	1	Low	Moderate	High	Girdling of larger saplings and trees. Use foliar spray for small saplings and seedlings. Annual survey of known populations should be conducted for a minimum of five years following treatment of all larger individuals / seed sources.	Options: BB, CS, FS, GI; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications.
Ailanthus altissima	Tree-of-Heaven	1	High	High	Low	Use basal bark treatments to eliminate seed production from larger individuals. Use foliar spray treatments on smaller indivduals.	Options: BB,FS,HS; Species has great potential to re-sprout; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications. Species has male and female individuals - target females first to eliminate seed sources.
Albizia julibrissin	Mimosa	1	Low	Low	Low	Use cut stump treatment - Only 1 plant observed. Species currently only considered "Watch" by the NJ Invasive Species Strike Team.	Options: BB, CS, FS; Glyphosate recommended for foliar and cut stump treatments; Triclopyr recommended for non-foliar applications.
Alliaria petiolata	Garlic Mustard	4	Low	Low	High	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS,MU,PU; FS applications in late-winter/early spring reduce harm to most native herbs; Long-lived seed bank requires 3-5 years of treatments; Glyphosate recommended.
Artemisia vulgaris	Common Mugwort	4	High	Low	Low	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS, MO; Very difficult to control - may require multiple cutting and herbicide treatments; Garlon 3A or Picloram minimize damage to grasses and can be used in early successional habitats
Arthraxon hispidus	Asian Carpgrass	4	Moderate	Low	Low	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS; Long-lived seed bank requires 3-5 years of treatments; Species has extremely dense growth of individuals - pulling is impractical; Glyphosate recommended
Berberis thunbergii	Japanese Barberry	4	Moderate	Moderate	High	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: BB, FS,CS,MO,PU; Glyphosate recommended for all methods except BB, where triclopyr is recommended
Celastrus orbiculata	Asiatic Bittersweet	2	Low	High	High	Prevent seed establishmnent by treating fruiting individuals, Utilize foliar spray treatments on plants less than 5 feet tall after cutting taller stems from trees. Cut stump or basal bark treatments may be optimal on some individuals depending upon growth habit in relation to surrounding vegetation.	Options: BB,FS,CS; Species has an extensive root system and pulling is ineffective; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications

Table 24. Invasive Species Control Goals and Prescriptions (Continued)

			Generalized Threat				
Scientific Name	**Common Name**	**Action Code[1]**	**Meadow**	**Shrubland**	**Forest**	**Generalized Prescription**	**Treatment Options[2]**
Cirsium arvense	Canada Thistle	3	High	Low	Low	Watch - If necessary, implement an annual program using foliar spray spot treatments to minimize cover until native woody plants establish shade that will provide Ecological Control.	Options: FS; Long-lived seed bank requires multiple years of treatments; Garlon 3A or Picloram minimize damage to grasses and can be used in early successional habitats
Coronilla varia	Crown Vetch	3	Moderate	Low	Low	Watch - If necessary, implement an annual program using foliar spray spot treatments to minimize cover. Healthy native meadows will provide Ecological Control.	Options: FS; Long-lived seed bank requires multiple years of treatments; Garlon 3A or Picloram minimize damage to grasses and can be used in early successional habitats
Dioscorea oppositifoloia	Chinese Yam	1	Low	High	Low	Hand pull stems and check for re-growth. Use foliar spray if pulling is ineffective. Perform outreach with neighboring land owner regarding removal from any landscape plantings.	Options: FS for larger populations; PU for limited situations with small populations.
Elaeagnus umbellata	Autumn Olive	2	High	High	Low	Focus on larger individuals located in meadow habitat and utilize mowing/burning regime to eliminate future infestations. Use basal bark treatments to eliminate larger individuals; Use foliar spray treatments on smaller indivduals. Treat nearby sources (e.g., adjacent meadow edges as resources allow -- grant-related contracted clearing with larger machinery is recommended).	Options: BB, FS,CS; Glyphosate recommended for foliar applications; Triclopyr recommended for non-foliar applications
Euonymus alata	Winged Burning Bush	2	Low	High	High	Eradicate from Preserve using basal bark treatments (larger plants) or foliar spray treatments (smaller plants). Annually visit known locations to eliminate previousl undetected smaller individuals. This invasive species is atypical and is often browsed heavily by deer. Species will increase with more effective deer management.	Options: BB,FS,CS; Glyphosate recommended for all methods except BB, where triclopyr is recommended
Euonymus fortunei	Wintercreeper	1	Low	Low	High	Eradicate from Preserve using foliar spray and cut stump treatments.	Options: BB,FS,CS; Species has an extensive root system and pulling is ineffective; Triclopyr recommended for all treatment methods. Spraying may be done in dormant season to minimize risk to deciduous native species.

Table 24. Invasive Species Control Goals and Prescriptions (Continued)

			Generalized Threat				
Scientific Name	**Common Name**	**Action Code[1]**	**Meadow**	**Shrubland**	**Forest**	**Generalized Prescription**	**Treatment Options[2]**
Hedera helix	English Ivy	1	Low	Low	High	Eradicate from Preserve using foliar spray and cut stump treatments.	Options: BB,FS,CS; Species has an extensive root system and pulling is ineffective; Triclopyr recommended for all treatment methods. Spraying may be done in dormant season to minimize risk to deciduous native species.
Ligustrum sp.	Privet species	4	Low	High	High	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: BB, FS,CS; Glyphosate recommended for all methods except BB, where triclopyr is recommended
Lonicera BUSH	Bush Honeysuckle	4	Moderate	High	Moderate	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: BB, FS,CS; Glyphosate recommended for all methods except BB, where triclopyr is recommended
Lonicera japonica	Japanese Honeysuckle	4	Moderate	High	High	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS; Foliar application is the only practical solution - hand-pulling very difficult as species roots at multiple leaf nodes; Mowing may be performed in July and September to weaken plants prior to spraying; Spraying may occur in non-growing season because species is semi-evergreen; Glyphosate recommended
Lythrum salicaria	Purple Loosestrife	1	High	Low	Low	Eradicate from Preserve using foliar spray treatment in late summer / fall and watch for necessity of follow up treatment in spring.	Options: FS; Hand-pulling is ineffective because of large root system; Glyphosate recommended
Microstegium vimineum	Japanese Stiltgrass	4	Moderate	Low	High	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS; Long-lived seed bank requires 3-5 years of treatments; Species has extremely dense growth of individuals - pulling is impractical; Glyphosate recommended
Miscanthus sinensis	Chinese Silvergrass	1	High	Low	Low	Eradicate from Preserve using foliar spray treatment in late summer / fall and watch for necessity of follow up treatment in spring.	Options: FS; Species has extensive root system - pulling is ineffective; Glyphosate recommended in fall and spring re-treatment may be required

Table 24. Invasive Species Control Goals and Prescriptions (Continued)

Scientific Name	Common Name	Action Code[1]	Generalized Threat			Generalized Prescription	Treatment Options[2]
			Meadow	Shrubland	Forest		
Pachysandra terminalis	Japanse Pachysandra	4	Low	Low	Low	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS; Species has numerous sprouting points from extensive root system and pulling is ineffective; Triclopyr recommended. Spraying may be done in dormant season to minimize risk to deciduous native species.
Phalaris arundinacea	Reed Canary Grass	4	High	Low	Low	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS,MO; Very difficult to control - may require multiple cutting and herbicide treatments; Glyphosate recommended
Phragmites australis	Common Reed	1	High	Low	Low	Eradicate from Preserve using foliar spray treatment in late summer / fall and watch for necessity of follow up treatment in spring.	Options: FS, MO; Very difficult to control - may require multiple cutting and herbicide treatments; PF,PG and MO are helpful to remove old stems or reduce height of living stems prior to FS; Glyphosate recommended in fall and spring re-treatment may be required
Pyrrhalta viburni	Viburnum Leaf Beetle	4	Low	High	High	Unfortunately, this species is now widely distributed across Northern New Jersey. Treatments are not feasible and damage may be intense within the Preserve (Arrowwood, Blackhaw and Maple-leaved Viburnum are all in serious jeopardy).	Hand removal of egg cases located on branch tips in fall/winter before larvae emerge in spring. Systemic pesticide treatments applied to plants.
Pyrus calleryana	Callery Pear	1	High	High	Low	Eradicate from Preserve using basal bark treatments (larger plants) or foliar spray treatments (smaller plants). Annually visit known locations to eliminate previousl undetected smaller individuals.	Options: BB,FS,CS; Glyphosate recommended for FS; Triclopyr is recommended for BB and CS.
Robinia pseudoacacia	Black Locust	1	High	High	Low	Eradicate from Preserve using basal bark treatments (larger plants) or foliar spray treatments (smaller plants). Annually visit known locations to eliminate previousl undetected smaller individuals.	Options: BB,FS,CS; Glyphosate recommended for FS; Triclopyr is recommended for BB and CS.
Rosa multiflora	Multiflora Rose	4	High	High	High	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population. Rose Rosette Disease is dramatically impacting individuals growing in full sunlight, but is having only minimal impacts on plants growing in full to partial shade.	Options: BB, FS, CS; Glyphosate recommended for all methods except BB, where triclopyr is recommended

Table 24. Invasive Species Control Goals and Prescriptions (Continued)

			Generalized Threat				
Scientific Name	**Common Name**	**Action Code[1]**	**Meadow**	**Shrubland**	**Forest**	**Generalized Prescription**	**Treatment Options[2]**
Rubus phoenicolasius	Wineberry	4	Low	Moderate	Moderate	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS; BB and CS are impractical due to thinness of stems; Glyphosate recommended
Vinca minor	Lesser Periwinkle	4	Low	Low	Low	Direct treatment not recommended at the Preserve. Allow Ecological Control to minimize population.	Options: FS; Species has numerous sprouting points from extensive root system and pulling is ineffective; Triclopyr recommended. Spraying may be done in dormant season to minimize risk to deciduous native species.
Wisteria floribunda	Japanese Wisteria	1	Low	High	High	Eradicate from Preserve using BB, CS or FS dependent upon field situation.	Options: BB,FS,CS; Glyphosate recommended for FS; Triclopyr is recommended for BB and CS.

[1]Action Codes: 1=eradicate, 2=long-term control program, 3=Watch for spread and treated as necessary, 4=Rely on Ecological Control

[2]Treatment recommendations from Zerbe et al. (2003), multiple websites, personal experiences of author and fellow colleagues. Optimal treatment methods vary by size of individual plants and extent of infestation in selected treatment areas. For bark applicactions, triclopyr should be used in its ester form (e.g., Pathfinder II). See Appendix D - Overview of Invasive Species Control Methods for treatment codes and additional

See below for a sample of invasive species control and species information websites:

Plants for a Future	http://www.pfaf.org/index.html
Flora of North America	http://www.efloras.org/flora_page.aspx?flora_id=1
USDA PLANTS	http://plants.usda.gov/index.html
Invasive Plant Atlas of New England	http://www.lib.uconn.edu/webapps/ipane/search.cfm
Plant Conservation Alliance - Alien Plant Working Group	http://www.nps.gov/plants/alien/fact.htm
Plant Invaders of Mid-Atlantic Natural Areas	http://www.invasive.org/weeds.cfm
National Invasive Species Information Center	http://www.invasivespeciesinfo.gov/plants/control.shtml

Recommendation #3: Foster Forest Health

There are many impacts on forest health at the Preserve including alteration of soils through past agricultural activities, earthworm infestations, severe deer browse of native understory species, near elimination of canopy tree regeneration, and severe infestations of invasive species. Although these impacts will remain for many decades or even centuries, their alleviation through commitment to deer herd reduction will allow natural processes to repair human-generated damages and largely restore forest health. For example, the re-establishment of native understory shrubs can significantly reduce Japanese Stiltgrass, Garlic Mustard, Wineberry and Japanese Barberry infestations through ecological control.

However, NJCF should also consider active, targeted stewardship efforts to 'jump start' natural processes and speed recovery. The two recommendations provided below include increasing existing forest habitat through direct planting of native trees and shrubs and fencing of former agricultural areas, improving existing forest habitat through deer exclusion fencing and maintaining 'invasive-free' areas throughout the Preserve.

There are also specific recommendations to monitor and manage forest-related rare animal species (See Table 17) that are presented as Recommendation #3C. In addition, the Preserve also has the potential to provide a significant benefit to bat populations by providing summer roosting habitat due to relatively large numbers of naturally occurring Shagbark Hickory trees (bats crawl under the loose bark). Conserve Wildlife Foundation and USFWS have established a program to increase bat habitat in response to the impacts of White Nose Syndrome. Sites with greater than 16 shagbark hickories per acre (with > 20" dbh) can provide excellent bat habitat (See Appendix I for potential patch locations).

Recommendation #3A: Increase and Improve Forest Habitat

- Forest restoration including planting and construction of deer exclusion fencing has already occurred in three areas totaling 9.3 acres (Bruce, Area #1; Bruce, Area #2; Mitchel, Area #63).
- A new forest restoration project involving planting and fencing is recommended for Cook (Area #13 – 10.9 acres).
- A new forest restoration project involving planting and fencing is recommended at Thompson II is recommended (41.7 acres). This could be done in partnership with NJWSA (See Recommendation #5 below).
- Construct a deer exclosure around Jungblut forest area #153 (20.6 acres). This area has numerous browsed native shrubs and relatively small amounts of woody invasive species. This project should be considered a stop-gap measure to rapidly improve forest health prior to deer herd reduction.

Recommendation #3B: Maintain Invasive-Free Areas

- Approximately 40 acres of forest habitat are currently free of any invasive species – Sections include Fishkin, Macak, Johnson and Mitchell (See Appendix I for site-specific details). These areas should be monitored annually and newly detected occurrences of any invasive species should be eradicated immediately. This should be performed annually for the next 10 years. Search and control efforts should focus on newly formed canopy gaps, which are highly susceptible to invasive species. As resources allow, deer exclosure fencing should be considered to increase native species abundance and reduce future risk of infestation by invasive species.

Recommendation #3C: Monitor and Manage Rare Forest Animals

- Recommendations in Table 17 suggest active monitoring and management for a variety of forest species. This includes monitoring vernal pools for salamanders, monitoring area-demanding birds such as Red-shouldered Hawk and Barred Owl and creation of canopy gaps for forest breeding passerines, wood turtles and bats (ENSP recommends gap sizes of less than 1 acre. Note: Gaps should not be purposefully created until deer populations are dramatically reduced or gaps are fenced to allow native species to effectively compete with invasive species).

Recommendation #4: Foster Early Successional Communities

Early successional communities and hay fields form a large part of the Project Area and provide valuable habitat for a suite of plants and animals. Shrublands provide habitat for a variety of birds including Prairie Warbler, Blue-Winged Warbler, Brown Thrasher, Eastern Towhee, Catbird, Common Yellowthroat, Eastern Bluebird, Yellow Warbler and Woodcock. Stands of Red Cedar or other conifers near shrubland or meadows could provide habitat for Long-eared Owls in winter and also provide winter cover for many other winter birds. Early successional areas are also utilized by many forest passerines that move their young into openings to feed after fledging.

Most shrubland birds are not area sensitive and relatively small patches are valuable habitat. ENSP recommends that early successional areas that are not near large patches of grasslands/meadows be managed for shrubland (i.e., isolated early successional areas less than 25 acres). Shrubland management can be performed every several years through the use of large clearing equipment (e.g., GyroTrac, Hydro-Axe) when grant funding is available. Alternatively, selective hand treatment of invasive shrubs and trees can be performed by staff and volunteers.

The valley south of the Covered Bridge along County Route 604 is predominantly hay fields with many private landowners enrolled in the LIP program. These areas are under delayed mowing and provide valuable grassland bird habitat (effort coordinated by Leslie Sauer).

Meadow/grassland habitats provide habitat for species such as Bobolinks, Eastern Meadowlarks, and American Kestrels. Typical maintenance involves mowing or burning every other year. Enhancement of habitat for these birds could include removal of hedgerows to create larger, contiguous habitat patches. However, individual trees with cavities and other large trees within/between the grasslands should remain to support nesting opportunities for American Kestrels.

Recommendation #4A: Shrubland Community Regular Maintenance

- Approximately 20 acres have been recommended for permanent shrubland habitat – See Appendix J. Each distinct area will require bi-annual treatment of Autumn Olive and any tree species to maintain native shrubland habitat. If grant funding is available, mowing of established shrubland should be performed every 3-4 years to eliminate trees. Potential funding sources could include NRCS-WHIP, USFWS Partners for Fish & Wildlife or Conservation Resources, Inc. – Franklin Parker Small Grants Program. In general, contracted clearing costs for dense shrub growth range from $1,500 - $2,000 per acre.

Recommendation #4B: Meadow Community Regular Maintenance

- Approximately 160 acres have been recommended for permanent meadow habitat – See Appendix J. Each distinct area will require bi-annual mowing or prescribed fire to eliminate establishment of woody plants. NJCF may consider seeking grant funding to purchase a mower

to manage this significant amount of meadow habitat. Alternatively, 'barter' arrangement may be made with hunters or farmers to perform mowing.

Recommendation #4C: Minimize Woody Invasive Species in Meadow Communities

- There are many fields with growing populations of larger individuals of Autumn Olive that preclude bi-annual mowing (See Appendix J). Large individuals will require herbicide treatments and complete removal to allow mowing. The treatment of Multiflora Rose in open fields appears unnecessary due to severe infestation by Rose Rosette Disease (RRD), but larger dead individuals need to be removed prior to establishing a regular mowing regime.

Upper Left: Multiflora Rose succumbing to RRD. Upper Right: Autumn Olive overgrowing/replacing infected Multiflora Rose. Bottom: Resprouting Autumn Olive producing dense growth that precludes mowing and requires herbicide treatment to eliminate from meadow habitats.

Recommendation #4D: Monitor Invasive Herbs in Meadow Communities

- There are two herbaceous species generally found in disturbed or early successional habitats that may become future infestations (i.e., Canada Thistle, Crown Vetch). These species are not considered a very high risk based upon the fact that they would be most likely to form infestations in the first several years following agricultural abandonment. However, it is recommended that these species be watched and treated as necessary because there is the potential for growth that is dense enough to significantly impair native species.

Recommendation #4E: Contracted Clearing of Very Dense Infestations Along Field Edges

- As funding allows, initiation of contracted clearings of heavily infested meadow edges (i.e., where cumulative cover class scores are ≥ 3) should be conducted. This would significantly reduce the need to clear woody invasives within meadows because the majority of seeds of any

plant species do not travel greater than 20 meters from parent plants. Hand treatment using NJCF staff and volunteers is not considered practical to accomplish this recommendation. Potential funding sources could include NRCS-WHIP, USFWS Partners for Fish & Wildlife or Conservation Resources, Inc. – Franklin Parker Small Grants Program. In general, contracted clearing costs for dense shrub growth range from $1,500 - $2,000 per acre.

Recommendation #4F: Removal of Hedgerows to Increase Contiguous Meadow Habitat

- The removal of hedgerows is very labor intensive and is not practical utilizing staff and volunteers. Removal would require contracted clearing following receipt of grant funding. Potential funding sources could include NRCS-WHIP, USFWS Partners for Fish & Wildlife or Conservation Resources, Inc. – Franklin Parker Small Grants Program. In general, contracted clearing costs for dense shrub growth range from $1,500 - $2,000 per acre.
- Hedgerows located at Thompson II should be removed to enlarge early successional habitat (Forest Habitat Areas # 70, 71 & 83). Fields located between these hedgerows (Early Successional Areas # 72, 73 & 74 are currently hay fields cut under a delayed mowing regime by Tom Michalenko). Removal of hedgerows would create nearly 40 acres of contiguous grassland bird habitat.

<u>Recommendation #5: Foster health of Wickecheoke Creek</u>

Recommendation #5A: Implement Projects to Improve the Wickecheoke Creek with the New Jersey Water Supply Authority

Threats to the Wickecheoke Creek can be mitigated by reducing or eliminating stormwater runoff from private and public lands, and roadways. There are numerous policy and mitigation projects required to improve the health of Wickecheoke Creek, some of which directly involve the Preserve. The NJWSA and Delaware Township have extensive resources and expertise and NJCF can serve as a critical partner to both entities. Leslie Sauer, private resident of Delaware Township, is interested in working with NJCF to assist with project development and implementation.

- NJWSA has plans and access to funding sources for a variety of projects that intersect with the Preserve. Six of the SVAP locations are within or immediately adjacent to the Wickecheoke Creek Preserve (Table 25). In its capacity as a lead actor in conservation with the Project Area, NJCF should work with NJWSA anywhere within the Project Area.
- The reforestation of portions of the Thompson II Section provides important conservation opportunities.
- For existing fields across the Wickecheoke Creek Preserve (See goals above): Abandoned fields that will remain as meadows – uncompact downslope areas via chisel plow. Abandoned fields that will be converted to shrubland or forest – uncompact entire field via chisel plow prior to establishment of woody vegetation.
- Investigate potential restoration/stabilization opportunities where erosional ditches are forming – usually occur within agricultural drainage ditches were created in the past (e.g., Barbiche and Ling Sections).

Table 25. NJWSA Monitoring and Mitigation Projects near the Wickecheoke Creek Preserve

NJWSA Site ID	Type	Nearby Roadway	Preserve Section
W8	SVAP Monitoring	Lower Creek	Adjacent to Milano Section
W11	SVAP Monitoring	Pine Hill	Adjacent to Bruce Section
W12	SVAP Monitoring	Featherbed	Adjacent to Jungblut Section
W13	SVAP Monitoring	Old Mill	Adjacent to Jungblut Section
W17	SVAP Monitoring	Rake	Adjacent to Levine Section
W24	SVAP Monitoring	Allen	Within Turnquist Section
471	Stream Buffer Project	Lower Creek	Adjacent to Thorpe Section
472	Stream Buffer Project	Lower Creek	Adjacent to Ling Section
N/A	Forest Restoration	N/A	Within Thompson II Section

Other Management Concerns

There are no additional severe threats to the Preserve, but perennial problems such as ORV's and other undesirable activities require continual vigilance. NJCF staff has actively worked with the Delaware Township Police Department regarding the camping/vandalism issue at the VanHouten and Ling Sections along Upper Creek Road. NJCF staff has blocked several old roads that would have facilitated ORV usage at the Preserve. NJCF has established a presence within the community through regular contact with Project Area residents and conservation partners over many years. This is likely to have contributed to the limited number of past problems and is critical to minimizing future problems. An additional strategy to further community contact and support involves a 'Volunteer Preserve Monitoring Program' (See Section V).

Beavers have caused damage to recreational resources at the Huey Section, which may require mitigation strategies to maintain the integrity of the trail system (See Section V). In addition, removal of native vegetation during dam creation causes harm to native plant communities when considering the impacts of an overabundant white-tailed deer population (See Section III). Proactive management of beavers may be considered in the future. This would require hiring a contractor to perform live trapping if the risk to conservation targets becomes unacceptable. Live traps should be used to eliminate potential harm to river otters that may become trapped. Advice from the Division of Fish & Wildlife should be sought to implement effective threat mitigation.

Table 26. Stewardship Recommendations Summary and Calendar

Goal ID	Goal	Preserve Section	Area ID(s)[1]	Task Notes	Annual Average Staff LOE Estimate[2]	Annual Average Volunteer LOE Estimate[2]	Year[3]									
							2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1A	Enhance existing Preserve Deer Management Program	All	All	See Plan text for details.	200	0	X	X	X	X	X	X	X	X	X	X
1B	Coordinate Community Deer Management Program	All	All	See Plan text for details.	500	0	X	X	X	X	X	X	X	X	X	X
2A	Eradicate Newly Emerging Invasive Species	Multiple	Multiple	There are 33 known populations. See Table 22 and Map 19 (also www.njisst.org for maps and data downloads)	20	40	X	X	X	X	X	y	y	y	y	y
2B	Control Nascent Populations of Widespread Invasive Species	Multiple	Multiple	See Individual Species Distribution Maps provided electronically as an Addendum to this plan.	40	80	X	X	X	y	y	y	y	y	y	y
3A	Increase and Improve Forest Habitat	Bruce; Mitchell	ES1 & ES2; ES63	Maintain existing deer exclosure fencing surrounding 9.3 total acres.	20	40	y	y	y	y	y	y	y	y	y	y
3A	Increase and Improve Forest Habitat	See Appendix J	See Appendix J	Involves conversion from early successional habitats to forest habitat on approximately 100 acres across 35 distinct areas. Primary activity is treatment of Autumn Olive to allow natural regeneration following deer herd reduction.	TBD	TBD	X	X	X	X	X	X	X	X	X	X
3A	Increase and Improve Forest Habitat	Jungblut	F153	Installation will require grant funding to purchase fencing material.	20	40						X	y	y	y	y
3B	Maintain Invasive-Free Areas	Multiple	Multiple	There are approximately 36 acres of forest that do not contain any invasive species. Sites include Fishkin, Macak, Johnson and Mitchell. See Map 17 and its nine associated close up maps provided electronically.	20	40	y		y		y		y		y	
3C	Monitor and Manage Rare Forest Animals	Multiple	Multiple	Monitoring should be performed in partnership with ENSP. Management activities focus on artificial nest creation (Barred Owl, Wood Turtle) and creation of canopy gaps for a number of species.	100	200				X	X	X	X	X	X	X

Table 26. Stewardship Recommendations Summary and Calendar (continued)

							Year[3]									
Goal ID	**Goal**	**Preserve Section**	**Area ID(s)**	**Task Notes**	**Annual Average Staff LOE Estimate[1]**	**Annual Average Volunteer LOE Estimate[1]**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
4A	Shrubland Community Regular Maintenance	See Appendix J	See Appendix J	Approximately 20 acres will be maintained as shrubland. Clearing of invasive shrubs and trees to maintain native shrubland habitat. Grant funding may be sought to hire contractors with heavy machinery	80	80	X	X	X	X	X	X	X	X	X	X
4B	Meadow Community Regular Maintenance	See Appendix J	See Appendix J	Approximately 160 acres will be maintained as meadows. Goal achieved via mowing or prescribed burning. Contracted clearing, purchase of NJCF equipment or barter payments from farmers or hunters should be explored.	60	0	X	X	X	X	X	X	X	X	X	X
4C	Minimize Woody Invasive Species in Meadow Communities	See Appendix J	See Appendix J	Approximately 160 acres will be maintained as meadows. Goal completion dependent upon hiring of seasonal interns.	20	40	X	X	X							
4D	Monitor Invasive Herbs in Meadow Communities	See Appendix J	See Appendix J	Approximately 160 acres will be maintained as meadows. Goal completion dependent upon hiring of seasonal interns.	10	20	y		y		y		y		y	
4E	Contracted Clearing of Very Dense Infestations Along Field Edges	Multiple	Multiple	See Plan text for details. Requires grant funding to hire contractors. Priority should be given to fields with highest quality ranks.	TBD	TBD	y	y	y	y	y	y	y	y	y	y
4F	Removal of Hedgerows to Increase Contiguous Meadow Habitat	Thompson II	F170, F171, F183	See Plan text for details. Requires grant funding to hire contractors.	10	0						y	y	y	y	y

Table 26. Stewardship Recommendations Summary and Calendar (continued)

							Year[3]									
Goal ID	Goal	Preserve Section	Area ID(s)	Task Notes	Annual Average Staff LOE Estimate[1]	Annual Average Volunteer LOE Estimate[1]	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
5A	Implement Projects to Improve the Wickecheoke Creek with the New Jersey Water Supply Authority	Multiple	Multiple	See Plan text for details.	40	0	X	X	X	X	X	X	X	X	X	X
6A	Maintain and Improve Trail System	Multiple	Multiple	Regular mowing and pruning overhanging branches performed in June, August and November	100	200	X	X	X	X	X	X	X	X	X	X
6B	Establish Picnic Area and Fishing Access at Huey Section	Huey	2	Mowing as necessary to maintain typical lawn characteristics. Volunteer performance of this task is desirable to allow NJCF staff to focus on stewardship activities.	20	0	X	X	X	X	X	X	X	X	X	X
6C	Provide Outreach to Increase Membership and Volunteerism	All	All	See Plan text for details.	500	0	X	X	X	X	X	X	X	X	X	X
Average Annual LOE Sum					**1760**	**780**										
Total 10-Year LOE Sum					**12600**	**7800**										

[1] Prefix = F for mapped forest patches and Prefix = ES for mapped early successional patches

[2] Estimated across all 10-years of plan implementation

[3] "X" symbolizes significant effort, while "y" symbolizes minor/follow-up efforts

Table 27. Quantifiable Monitoring Criteria to Guide Adaptive Management

Goal ID	Goal	Monitoring Technique	Measurement Units	Desired Outcome
1A	Enhance existing Preserve Deer Management Program	Standarized Record Keeping	Doe harvest	1 per every 5 acres
1B	Coordinate Community Deer Management Program	N/A	Plans finalized	Plans created for each municipality
1B	Coordinate Community Deer Management Program	N/A	Plan Implementation	Quantified plan goals met or exceeded
2A	Eradicate Newly Emerging Invasive Species	Visual Inspection	All populations eradicated	All populations eradicated
2B	Control Nascent Populations of Widespread Invasive Species	Visual Inspection	All populations eradicated	All populations eradicated
3A	Increase and Improve Forest Habitat	Visual Inspection	Restorations completed and maintained	Restorations completed and maintained
3A	Increase and Improve Forest Habitat	Sentinel Seedlings; Select 10 locations and perform annually at two locations (5 year rotation). See Appendix V.	Deer browse on planted seedlings	Less than 10% browsed over six month monitoring period
3A	Increase and Improve Forest Habitat	Forest Secchi; Select 10 locations and perform annually at two locations (5 year rotation). See Appendix V.	Native and Non-Native woody understory cover	Greater than 70% native cover and Less than 5% non-native cover
3B	Maintain Invasive-Free Areas	Visual Inspection	All populations eradicated	All populations eradicated
3C	Monitor and Manage Rare Forest Animals	Various - Consult with ENSP	Various - Consult with ENSP	Various - Consult with ENSP
4A	Shrubland Community Regular Maintenance	Visual Inspection	Tree and non-native shrub cover	Tree cover < 5%; Non-native shrub cover < 5%
4B	Meadow Community Regular Maintenance	Visual Inspection	Woody cover	Woody cover less than 1%
4C	Minimize Woody Invasive Species in Meadow Communities	Visual Inspection	Woody cover	Woody cover less than 1%
4D	Monitor Invasive Herbs in Meadow Communities	Visual Inspection	Invasive herb cover	Invasive herb cover less than 5%
4E	Contracted Clearing of Very Dense Infestations Along Field Edges	Visual Inspection	Invasive shrub cover	Invasive shrub cover less than 1%
4F	Removal of Hedgerows to Increase Contiguous Meadow Habitat	Visual Inspection	Woody cover	Woody cover less than 1%
5A	Implement Projects to Improve the Wickecheoke Creek with the New Jersey Water Supply Authority	Visual Inspection	Various depending upon project	Various depending upon project

V. Recreation and Outreach Plan

Introduction

The Wickecheoke Creek Preserve can serve many purposes in addition to public services provided through preservation of natural resources and biodiversity. The Preserve will serve as a resource for recreation, outreach, and environmental education that will directly benefit the public and indirectly benefit all management goals on the Preserve by creating broad community support. Ideally, the Preserve should supplement and complement existing opportunities while preserving the integrity of natural resources and biodiversity. This section was informed by results of the public survey conducted by NJCF staff and other stakeholder interviews.

Partnerships - NJCF will continue to seek input on Preserve management from local political representatives and residents, members of business, recreation and conservation communities, and private Preserve users. For particular projects, partnerships will be sought with groups such as the Hunterdon County Parks Department, Hunterdon Land Trust Alliance, Project Area municipalities, user groups, Bowman's Hill Wildflower Preserve, Torrey Botanical Society, and cultural and historic groups.

Preserve, Project Area and Regional Resources

Preserve Resources - The Preserve has nineteen parking areas (11 formal, 8 informal) to access over 10 miles of trails that can accommodate a variety of recreational opportunities (See Map 21 and Table 28 - Recommendations provided in Table 28 are summarized under Recommendation #6 below). The natural beauty of the Preserve provides ample interest to nature enthusiasts, those seeking a connection with the natural world, solace from a busy life, or exercise.

In the lower portion of the Project Area, the trails form a loose regional network by utilization of roads to connect non-contiguous portions of the Preserve. These trails provide excellent access to the Wickecheoke Creek and well-placed benches at the Johnson and Milano Sections allow visitors to relax and enjoy it. Bike racks are provided at the Cook and Richards Sections to encourage the numerous passing cyclists to stop for a hike. Kiosks with information on the Preserve and natural history facts are provided at Hackl and Huey Sections. Independent loop trail systems exist at the Huey, Turnquist, Fishkin, Mitchell/Bruce/Stone, and Jarboe/Cook Sections to provide greater exploration of various habitats including meadows, shrublands and a variety of forest types.

Permitted Preserve uses include hiking, cross-country skiing, and horseback riding (limited to designated trails at the Thompson II Section), observation of wildlife and flora, nature photography, fishing (Huey Section ponds only), and canoeing (access from VanHouten Section only). Hunting is restricted to white-tailed deer as part of an organized Deer Management Program (See Section IV). Prohibited activities include use of motorized vehicles (except for management, maintenance, and operation of the Preserve or provision of emergency services), hunting or trapping of wildlife (except as part of a written wildlife management program), camping and camp fires, and collection or disturbance of flora and fauna.

Table 28. Recreational and Cultural Resources by Preserve Section

Note: Sections arranged from North to South within Project Area

Section	Resources and Recommendations
Huey	Formal Parking Access along Joe Ent Road, Kiosk, Picnic Area, Fishing, Loop Trail System. Recommendation: Simplify / shorten trail system, improve trail markings. Regular mowing required through fields and field edges.
Turnquist	Formal Parking Access along Allen Road, Loop Trail System. Recommendation: Increase trail markings. Regular mowing required through fields and field edges.
Levine	Informal Parking Access along Rake Road and Sam Levine Road, No Trails. Recommendation: No change, loop trail system would require significant stream crossing.
Fishkin	Informal Parking Access, Loop Trail System. Recommendation: Abandon trail until parking access is attained in the future.
VanHouten	No parking access or trail. Recommendation: Eventually incorporate regional trail system from Lang (south) that leads to Locktown Stone Church (north - requires use of roadway) – dependent upon future acquisition of 'gap' parcels.
Lang	Formal Parking Access along Upper Creek Road, Point of Interest Trail – 0.05 miles (Road to Waterfall). Recommendation: Incorporate regional trail system that connects to VanHouten (north) to Mornan (south - requires use of roadway). Canoe/kayak access may be provided.
Mornan	No parking access or trail. Recommendation: Incorporate into regional trail system by using roadway to connect to Lang (north) and Robertson (south).
Robertson	No parking access, Regional Trail System – 0.2 miles. Recommendation: Incorporate into regional trail system that connects Mornan (north – requires use of roadway) and Hodanish (south).
Hodanish	Informal Parking Access along Upper Creek Road, Regional Trail System – 0.1 miles. Recommendation: Eventually incorporate into regional trail system that connects Robertson (north) and Stone – dependent upon future acquisition of 'gap' parcels. Formalize parking access for regional trail system and access to new Jungblut loop trail.
Jungblut	No parking access or trail. Recommendation: Develop loop trail system and utilize newly created formal parking area across road at Hodanish.
Stone	No parking access, Loop Trail (portion connected to Bruce & Mitchell) – 0.2 miles includes portion of private land along Creek. Recommendation: Incorporate into regional trail system using roadways (Old Mill Road and Upper Creek Road) to connect to Hodanish.
Bruce	Informal Parking Access along Pine Hill Road, Loop Trail (portion connected to Stone & Mitchell) – 0.8 miles. Recommendation: Formalize parking access to avoid need to gain access via stream crossing at Mitchell/Bruce, Incorporate into regional trail system. Regular mowing required through fields and field edges.
Mitchell	Formal Parking Access along Upper Creek Road, Loop Trail (portion connected to Stone & Bruce) – 1.0 miles. Stream crossing required between Mitchell and Bruce. Recommendation: Incorporate into regional trail system (Stone to north and Macak to south, which would require private land cooperator (future acquisition of Jacobs easement) and stream crossing. Regular mowing required through fields and field edges.
Macak	No Parking Access, Regional Trail System – 0.4 miles. Private land disrupts connection between Mitchell and Macak (See above). Recommendation: Incorporate into regional trail system by connecting to Mitchell (north) and Soine (south).
Soine	Formal Parking Access, Regional Trail System – 0.1 miles. Connects to Macak via stream crossing. Recommendation: Incorporate into regional trail system.
Johnson, L	Point of Interest trail to Creek with bench – 0.1 miles. Recommendation: No change, incorporation into regional trail system impractical due to strong slopes along Creek.
Johnson, A	Recommendation: Create formal parking access along Pine Hill Road to allow access to Johnson, L. and Covered Bridge.
Cosman	Informal Parking Access along County Route 604, no trail. Recommendation: Formalize parking access and incorporate as trail head for regional trail system by using Upper Creek Road to connect to Soine. Cultural feature is adjacent Green Sergeants Bridge. However, NJCF has an informal/verbal agreement with the current neighbor across the street that it will not create a formal parking area until the property is sold to another owner – See Johnson, A. above for an alternate parking arrangement recommendation.
Johnson, R	No parking access or trail within Preserve. Regional Trail System – 0.2 miles along Lower Creek Road adjacent to Preserve). Recommendation: No change.
Snevily	Informal Parking Access along Lower Creek Road, Regional Trail System – 0.01 miles. Connects to Ling via stream crossing. Recommendation: Formalize parking area to access future loop trail at Ling and serve as entrance to the regional trail system.
Ling	No parking access (but access via Snevily). One-way trail – 0.5 miles. Recommendation: Develop loop trail system, existing trail requires significant clearing and increased trail marking.

Table 28. Recreational and Cultural Resources by Preserve Section (continued)

Section	Resources and Recommendations
Milano	No parking access, Regional Trail System – 0.3 miles (connected to Richards), creek-side bench. Recommendation: Incorporate into regional trail system by connection to Snevily via Lower Creek Road and existing connection to Richards.
Richards	Formal Parking Access, Regional Trail System – 0.3 miles, bike rack. Recommendation: Incorporate into regional trail system by connection to Milano via Lower Creek Road.
Hilton	No parking access, Regional Trail System – 0.1 miles (along Lower Creek Road), Cultural/Historic resource with former homestead with stone fireplace remaining (public access would be impractical). Recommendation: Incorporate into regional trail system by using Lower Creek Road and crossing Creek at green metal bridge toward Hackl.
Hackl	Formal Parking Access at two points, Regional Trail System – 0.2 miles (connected to Hilton by walking along roadway and crossing green metal bridge), Kiosk. Recommendation: Maintain one access point (at green metal bridge) that serves as the primary southern parking access for the regional trail system and access to Cook/Jarboe loop trail via road crossing). Convert existing trail that loops back to road to a Point of Interest trail ending at a bench along Creek. Eliminate second parking access point along Lower Creek Road. Move bike rack from Cook to Hackl.
Jarboe	Formal Parking Access on County Route 519, Loop Trail and connection to Regional Trail – 1.2 miles. Recommendation: No change, Regular mowing required through fields and field edges.
Cook	Formal Parking Access on Lower Creek Road, Regional Trail and connection to Jarboe Loop Trail – 0.3 miles, Bike Rack. Recommendation: Eliminate formal parking access because of duplication with Hackl access at green metal bridge, also move bike rack to Hackl. Create loop trail within field that maintains connection to Jarboe. Regular mowing required in field and field edges.
Thorpe	Informal Parking Access along Lower Creek Road, Regional Trail System – 0.1 miles. Recommendation: Convert trail that continues onto Division of Fish & Wildlife land to a Point of Interest Trail with bench along Creek. Seek long-term permission from Division of Fish & Wildlife to maintain trail on their lands.
Prall House	Formal Parking Access along State Highway 29, Loop Trail. Recommendation: Complete loop trail to Worman Road and back to Prall House (through newly acquired Barbiche Section). Maintain Point of Interest Trail to pond.
Thompson & Thompson II	Informal Parking Access along County Route 519, Loop Trail System. Recommendation: Formalize parking access, install trail markers. Horseback riding could be accommodated along field edges if access becomes suitable. All trails should be located west of Route 519. Regular mowing required through fields and field edges.
Cline	No parking access or trails. Recommendation: No changes.
Finkle	No parking access or trails. Recommendation: No changes.
Cooper	No parking access or trails. Recommendation: No changes.

Project Area and Regional Resources - The public survey results suggested other frequently visited areas within the region but outside of the Project Area. These included:

- Round Valley State Recreation Area
  - Location: Lebanon Township; Acres: 3,700; Uses: Boating, hiking, camping, hunting, fishing, picnicking, swimming, scuba diving
- D&R Canal State Park
  - Location: Central New Jersey; Acres: 5,400; Uses: Boating, hiking, picnicking, fishing, swimming, interpretive programs
- Deer Path Park (Hunterdon County Parks)
  - Location: Readington Township; Acres: Not reported; Uses: Softball fields, horseback riding, cross country skiing, fishing, fitness trail, gardens, hiking, horseshoe court, hunting, nature study, picnic pavilions, playground area, restrooms
- Spruce Run State Park
  - Location: Clinton Township; Acres: 2,000; Uses: Boating, hiking, camping, hunting, fishing, picnicking, swimming
- Howell Living History Farm (Mercer County Parks)
  - Location: Hopewell Township; Acres: Not reported; Uses: Replica of 1890's farmstead, historic programs, seasonal programs, agricultural production

- Westcott Nature Preserve (Hunterdon County Parks)
    - Location: Delaware Township; Acres: 180; Uses: Mountain biking, horseback riding, cross country skiing, fishing, hiking, hunting, nature study

Natural and recreational opportunities within the Project Area are limited outside of the Preserve and primarily involve use of roadways by cyclists. Historic and cultural resources within the Project Area include the Locktown Stone Church and Green Sergeants Bridge. Detailed resources within the Project Area can be found in a report prepared by Dennis Bertland (copy filed at NJCF main office).

Recommendation #6: Enhance Recreational Access and Outreach

Recommendations for the Preserve and connections to other features within the Project Area are provided below. Table 28 and Map 21 provide recommendations for each Preserve section and a depiction of existing resources and proposed improvements, respectively.

Recommendation #6A: Maintain and Improve Trail System

Public survey results and interviews suggest that the trail system is highly regarded by Project Area residents. Numerous access points, trails and other amenities unobtrusively fit into the surrounding landscape. The goal of implementing a regional trail system creates logistical issues including the requirement to use paved roadways to connect non-contiguous preserve sections and necessary stream crossings in several locations. However, the use of roadways through the Project Area should not be considered a significant impediment due to winding, narrow roads that limit traffic volume and speed and overhanging trees make the walk comfortable (Project Area residents frequently walk along roads for exercise, dog walking, etc.). Stream crossings are usable only during dry periods, but the rocky Wickecheoke Creek allows relatively easy passage during those times. The construction of bridges would be impractical due to permitting requirements related to the Creek's C1 status and should not be considered. Related trail maintenance strategies are included under Recommendation #6C.

- Formalize regional trail system that travels from the Hackl Section to the Locktown Stone Church.
    - Provide maps and improve on-the-ground trail marking through cooperation with municipalities. Markings on the road surface and sign posts with maps at Preserve Sections along the way would improve public use by creating enhanced certainty along the trail corridor. This recommendation requires acquisition (fee or easement) of 'gap' parcels that are currently in private ownership.
- Create new loop trails at Thompson II and Jungblut Sections.
    - Thompson II should provide equestrian access
- Create formal parking areas with kiosks in key locations that currently contain informal parking areas
    - Hodanish, Mitchell, Johnson, A., Snevily, Thompson II
- Eliminate duplicative parking areas at Cook and Hackl
- Increase mowing of trails that utilize fields and field edges to maintain vegetation below six inches tall
- Increase trail markings at various Preserve sections (see Table 28)

Recommendation #6B: Establish picnic area and fishing access at Huey Section

The northern portion of the Project Area has relatively less preserved lands and recreational opportunities than lower portions. The establishment of multiple uses at the Huey Preserve would provide additional recreational opportunities and provide greater geographical balance to NJCF's efforts.

- Regularly mow field area adjacent to kiosk and around ponds to maintain lawn
- Maintain picnic area
- Upon completion of eradication activities for Chinese Pond Mussel, stock appropriate species to provide fishing opportunities (Consult with Pat Hamilton, NJ Division of Fish & Wildlife).

Recommendation #6C: Provide Outreach to Increase Membership and Volunteerism

NJCF holds two significant events annually at the Preserve - the Donald B. Jones Memorial Hike and Barn Dance. The Public Survey Report summarized public use and attitudes and highlighted a number of additional events/strategies to increase membership and volunteerism, which are provided below. Current staff capacity will not allow full implementation of these strategies and increased staffing should be considered. The positive contributions of increased staffing can be amplified through the harnessing of volunteers to significantly increase recreational and educational opportunities that would further increase membership and volunteerism.

- Improve outreach through advertising, educational programming, and volunteer opportunities.
- Develop a volunteer Adopt-A-Preserve or Adopt-A-Trail network through a Volunteer Preserve Monitoring Program. This will enhance recreational and stewardship efforts and increase visibility by gaining local residents that communicate NJCF's mission to their neighbors and friends. In general, this type of program is most successful when monitoring is part of the recreational pursuits of the individuals performing the monitoring. The program will strive to allow all sections of the preserve to be monitored quarterly – see Appendix W for a sample monitoring form.
- Organize weekly trail and stewardship workdays to maintain the trail system and support land stewardship. Volunteer Preserve Monitors could serve to lead these efforts across all sections of the Preserve.
- Provide guided hikes with focus on specific topics such as native plants, bird watching, child friendly, etc.
- Provide Wickecheoke Creek-specific updates in NJCF newsletters and website
- Provide public outreach through regularly occurring articles in local newspapers, enlist naturalists and historians to provide expert guided natural and cultural history walks on the Preserve for local school children and the general public, and regularly schedule staff-run special events.

Recommendation #6D: Encourage Connections between the Preserve and Project Area Resources

The Preserve is one element of the Project Area that creates a 'sense of place'. Additional natural features along with a number of cultural and historic resources throughout the Project Area should be tied together to emphasize all resources and their connection to the Preserve. Specific partners for this goal could include Delaware Township Historic Society, Prallsville Mill Society, Friends of Locktown Stone Church, Franklin Township historic society and Preservation New Jersey.

- Incorporate signage highlighting historic districts, historic sites, archaeological resources and cultural geography along the regional trail system and throughout the Project Area.
- Sponsor Periodic Bike and Motor tours of the Project Area
    - This could be considered as a special event or in partnership with local cultural/historic or recreational groups.

Old Homestead located just west of the Wickecheoke Creek on the Hilton section.

The Green Sergeants Bridge is New Jersey's only remaining covered bridge,
which is located between the Cosman and Johnson Sections along County Route 604.

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Witch-hazel flowers in late October at the Wickecheoke Cree Preserve.