# Helping Our Land Heal

**Ellanor C. Lawrence Park**

**2012 – 2015**

**Final Progress Report**

***Prepared for:***

**Fairfax County Park Authority**

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# Contents

# Executive Summary

From 2012-2015, ecological restoration and natural resource management work was carried out at Ellanor C. Lawrence Park utilizing taxpayer bond funding and other funding sources for natural capital improvements. The project goals were: 1) to promote the natural regeneration of native species, 2) to limit the negative impacts of humans, white-tailed deer and non-native invasive species in the park, and 3) to develop practices and processes that can be replicated by other land managers. Overall, the project goals were achieved and each of the stated objectives were met. The project was carried out by FCPA staff in partnership with nine discrete agencies and contractors. A variety of field investigations informed the development and implementation of two written resource management plans. Nine strategies of public engagement and education were utilized and included newly-developed concepts of natural capital and resource stewardship. Over twenty hands-on restoration practices were implemented to meet project goals. Among the methods used were: nine types of forestry treatments; three strategies of non-native invasive plant control; two methods of deer management; four soil treatments; and two methods of natural disturbance regime re-introduction. In addition, administrative processes were developed to address project scoping, planning, management and implementation, and closure that will aid in completing future natural capital projects.

Recommendations for restoration, in most cases, are not fully defined because the natural capital improvement process occurs over a timeframe that is beyond the scope of this project. Because of the relatively slow rate of forest vegetative growth and the number of growing seasons required to demonstrate results, recommendations are solely based on results observed during the time frame of this project.

# Introduction

This final progress report summarizes the outcomes of the Helping Our Land Heal (HOLH) project at Ellanor C. Lawrence Park (ECL) during its 3.5 year implementation. The majority of the report is dedicated to describing the methods applied and recording the outcomes.

In December 2011, the Fairfax County Park Authority (FCPA) Board approved the scope of work for a “Pilot Forest Management Project” at Ellanor C. Lawrence Park (ECL). This project would be the first of its kind to utilize taxpayer bond funding to conduct natural resource management on county park land. The approval of the project’s scope of work followed the

efforts of the FCPA Natural Capital Project in 2009. Natural capital is the concept that natural resources are capital assets which can be treated like other forms of capital such as infrastructure and building facilities. They require investments and maintenance to function correctly and in return they provide ecosystem and social services which have a measurable value to people.

The stated components of the scope of work for the pilot forest management project were:

1. Information gathering and field investigations;
2. Natural resource management planning,
3. Natural resource management implementation
4. Education, interpretation and outreach.

This translates to assessing the condition of the natural resources at ECL, developing and implementing resource management plans and educating the public and stakeholders.

A project manager was hired in early 2012 to begin work under the Natural Resource Management and Protection Branch (NRMPB). The first employee left in fall 2012 and a new project manager was hired in late 2012 and has continued until the present, with an anticipated project completion date of September 30, 2015. The project manager has worked closely with the ECL on-site natural resource manager and conferred frequently with ECL on-site park manager, naturalists and NRMPB staff.

During the course of the study, the project was named and branded “Helping Our Land Heal” (HOLH). A logo was created with the assistance of the FCPA graphic designer to promote awareness and education of the project and create brand recognition. This brand is intended for use in future restoration projects involving natural capital investments countywide.

The practices and processes developed during this pilot project are intended to be shared and replicated in other parks and forests throughout the county and the region. A major component of the project was to incorporate forest management into the interpretive programming of the park, to allow the public and stakeholders to observe best management practices, educate them about the ecological principals being applied and communicate the necessity for taking action.

The forest pilot project was in part motivated to change land management models on park land to better manage natural capital, especially forest systems. Previous land management models in FCPA and nationwide have centered on “benign neglect” which suggests that leaving land alone is the best form of care. In terms of capital, this would be analogous to neglecting to paint, roof or clean a building. Contemporary pressures to natural systems in Northern Virginia, such as non-native invasive species, also greatly undermine the benign neglect model making it nearly impossible for natural systems to take care of themselves. Local forests require more dynamic and intensive management, with an integrative and adaptive approach. The many pressures include human impacts, the rise of non-native invasive plant and animal species,

over-browsing by white-tailed deer, fire suppression and strong natural disturbances such as storms.

# Goals

The stated goals of the project according to the Park Authority Board approved scope of work were to:

1. Apply methods to promote natural regeneration, manage for native species and communities, and limit impacts from human activities, deer and invasive species.
2. Develop practices and processes that can be replicated in other parks and forest stands throughout the county and the region

Stated objectives were to:

1. Work with partners to achieve goals
2. Assess conditions of natural resources at ECL
3. Develop and implement natural resource management plans
4. Educate the public and stakeholders

### *1. Work with partners to achieve goals*

HOLH staff engaged with 7 external organizations and several internal divisions of the Park Authority.

1. Virginia Department of Forestry (VDOF) provided a forest stewardship management plan as well as technical guidance and feedback on reforestation techniques, restoration methods, traditional forestry methods, permitting processes and prescribed burning.
2. Virginia Department of Game and Inland Fisheries (VDGIF) provided guidance and facilitated permitting issues pertaining to white tailed deer management using a sharpshooting contactor.
3. White Buffalo, Inc. provided a management plan for white-tailed deer population control and implemented this plan in coordination with FCPA and Fairfax County Police Department staff.
4. Patriot Land and Wildlife Management/ESA provided guidance on monitoring vegetation changes and/or recovery following white-tailed deer management.
5. The Fairfax County Wildlife Biologist provided guidance and assistance in deer population surveys and permitting.
6. Invasive Plant Control, Inc. provided the vast majority of invasive plant species removal.

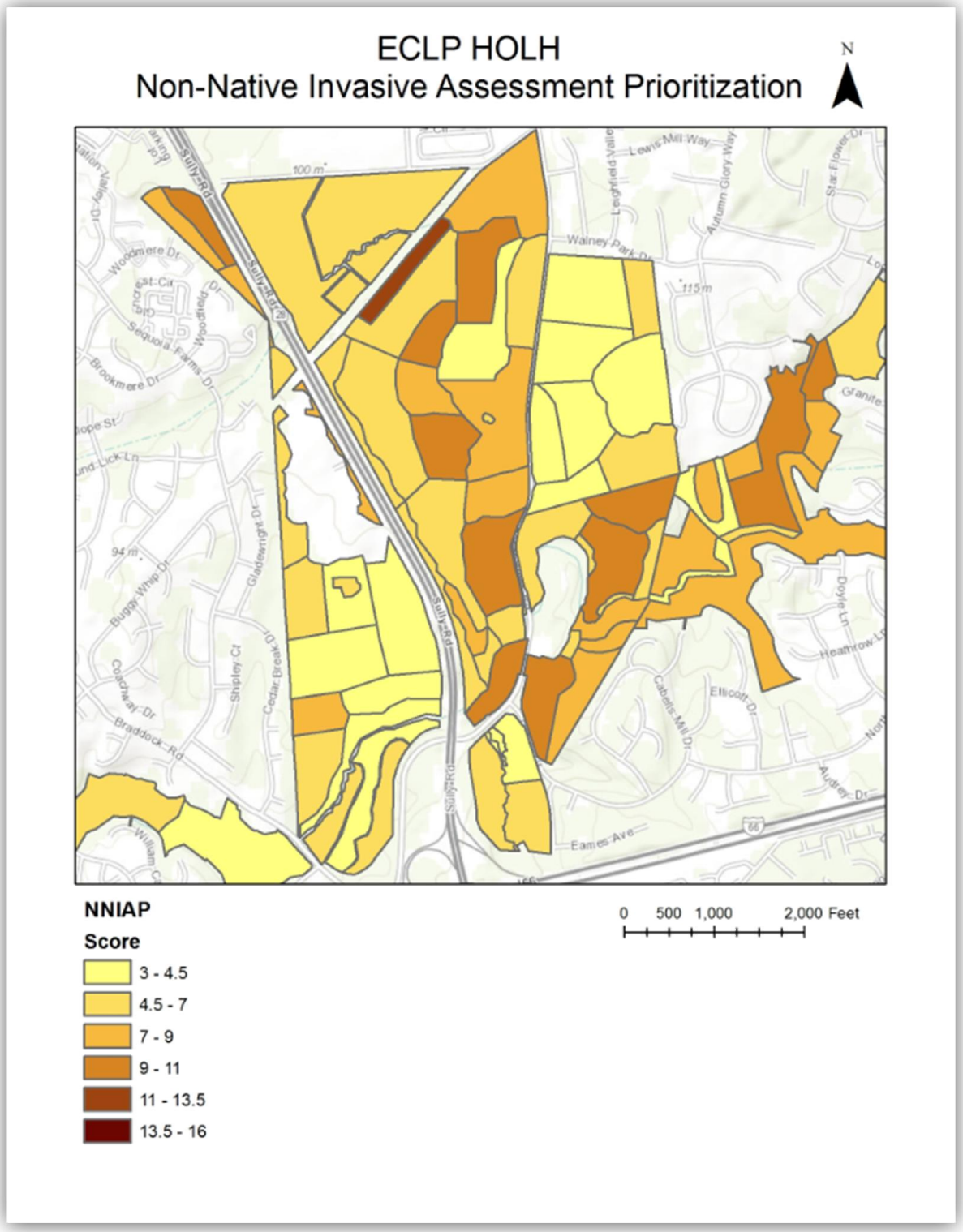
7. The Northern Virginia Soil and Water Conservation District hydrologist and soil scientist provided technical support for stream rehabilitation and soil surveying.
8. FCPA Cultural Resources Management and Protection Branch (CRMP) provided archaeological surveys and input.
9. FCPA Operations Division (POD) provided logistical support in terms of equipment, mechanical treatments, crew, materials and other support through the Area 5 crew, Mobile crew and Forestry crew.

## *2. Assess conditions of natural resources at ECL*

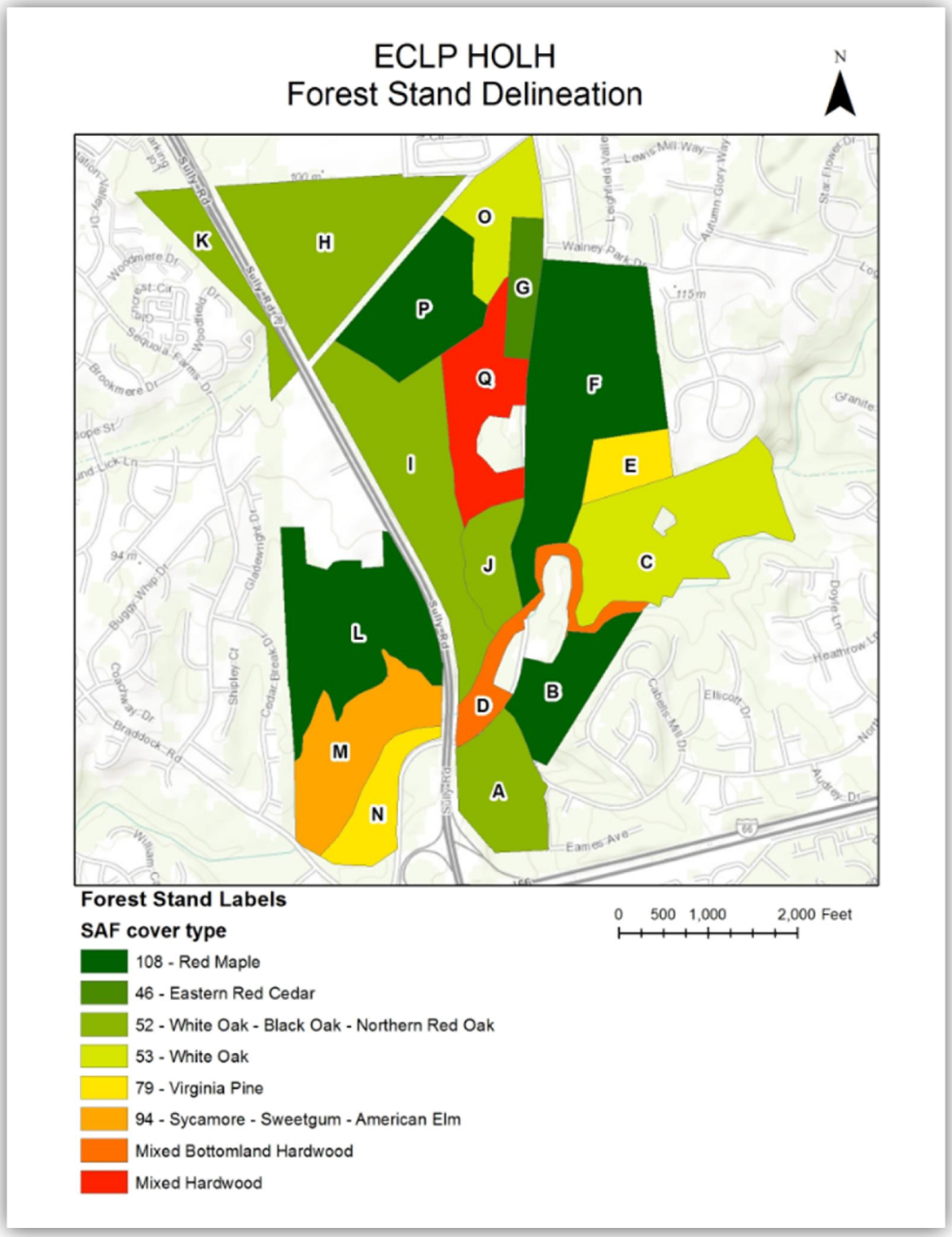
A variety of efforts were undertaken to assess the condition of ECL's natural resources to inform management planning and implementation.

**Vegetation:**

1. Non-native Invasive Assessment Prioritization (NNIAP) – The purpose of the NNIAP is to provide a work prioritization model in assessing the relative level of risk of biological invasion on parklands and in determining the proper allocation of limited resources for control. It was conducted at ECL in 2012 by FCPA staff and ranked areas of the park according to the ecological quality, NNI threat level and relative ease of successful treatment. The results inform decision making about NNI plant treatments.


ECLP HOLH
Non-Native Invasive Assessment Prioritization
N
NNIAP
Score
3 - 4.5
4.5 - 7
7 - 9
9 - 11
11 - 13.5
13.5 - 16
0 500 1,000 2,000 Feet

2. Forest stand delineation – conducted by VDOF in 2012 to delineate the park's forest into discrete forest stand units for the purposes of management, and to collect information about each stand that will inform management choices. A map was produced of the stands, detailed information about each forest stand with recommendations and a ten year timeline of recommended actions was created. Reference for stand categories is: Eyre, F.H., 1980, Forest Cover Types of the United States and Canada: Society of American Foresters, 148p. The ten year timeline of actions can be found in Appendix A.


ECLP HOLH
Forest Stand Delineation
N
K
H
O
P
G
Q
F
I
E
J
C
L
B
D
M
A
N
Forest Stand Labels
SAF cover type
0 500 1,000 2,000 Feet
108 - Red Maple
46 - Eastern Red Cedar
52 - White Oak - Black Oak - Northern Red Oak
53 - White Oak
79 - Virginia Pine
94 - Sycamore - Sweetgum - American Elm
Mixed Bottomland Hardwood
Mixed Hardwood

3. Deer browse impact survey – conducted by FCPA staff annually to record vegetation responses to deer browse. Monitoring is on-going.

**Example of deer browse impact survey transects at ECL**

4. Gorsira method vegetation survey – conducted by a contractor, Environmental Systems Analysis (ESA), to monitor differences in vegetation within and adjacent to deer exclosures during deer management efforts. Four survey locations were established in the park in 2013 and monitoring is on-going.

5. Purple milkweed survey – conducted by FCPA staff to determine the presence and location of the state rare plant purple milkweed (*Asclepias purpurea*), within the park. The survey found the rare plant at several locations in the mowed area in the gas easement in the northern section of the park.


**Soils:**

1. The Fairfax County soil survey was completed by the NVWSCD in 2011 and used to examine soil differences in the forest stands delineated by VDOF's stewardship report.

2. Soil samples were taken from 16 points in the park. Samples were analyzed at a commercial laboratory and results were interpreted with assistance from the NVWSCD soil scientist. The purpose of this survey was to determine if there were any obvious differences in soil characteristics between different areas of the park that were of different quality, displayed differing NNIAP scores, land use history, or restoration

treatment types. Overall, there were no obvious differences in the soil in any single location outside of reasonable expectations of differences between sampling locations.

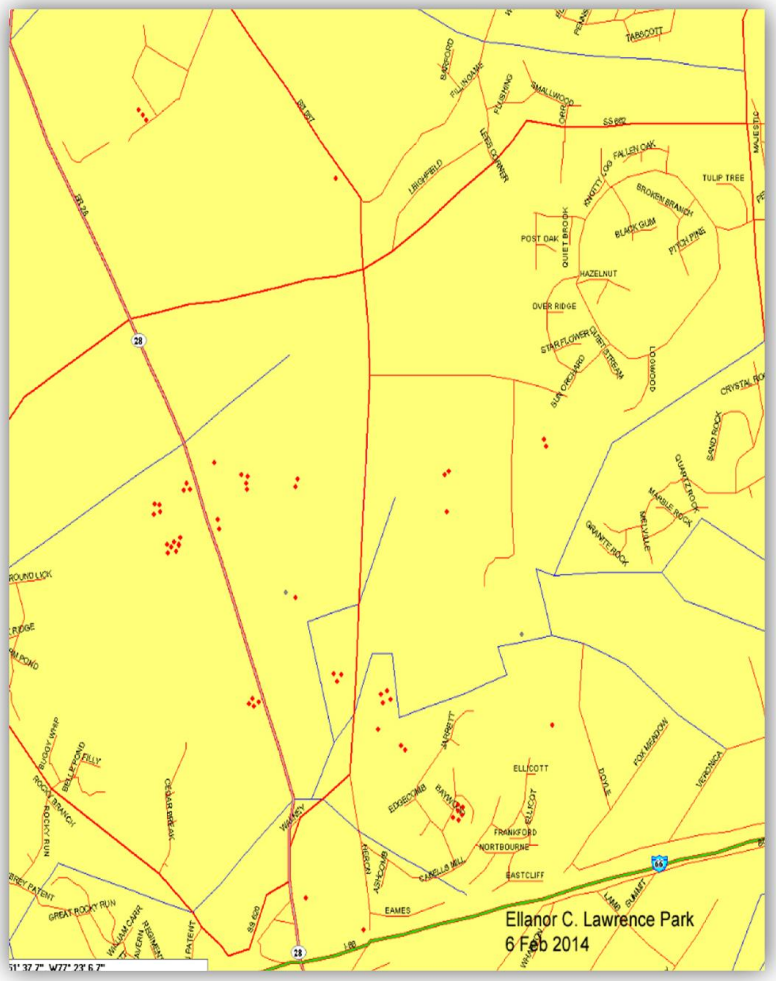
**Wildlife:**

1. Breeding bird survey: conducted annually by FCPA staff to record trend changes over the course of the project and in different treatment areas of the park. ECL site staff conducting the surveys reported that bird observations have included more frequent sightings of birds that were less common before the project began, such as woodcocks in the new meadow installation treatment area.

2. Herpetological survey: conducted by FCPA staff on an on-going basis. Records were kept of herpetological sightings, and a box turtle survey has been conducted to estimate their population.

3. White-tailed deer camera survey – conducted by FCPA staff in 2014 and 2015 to estimate the white-tailed deer population using a standard published method (Jacobson, Harry, et al. "Infrared-triggered cameras for censusing white-tailed deer." Wildlife Society Bulletin 1997, 25(2): 547-556.) Surveys were compared to the results of white-tailed deer sharpshooting efforts to estimate populations and changes over time. The population estimate in 2014 was 35 deer in the park. The results of the 2015 camera survey are forthcoming.

4. Forward Looking Infrared (FLIR) survey – Conducted by a contractor, Davis Aviation, in the winter of 2013-2014 to estimate the white-tailed deer population as part of the white-tailed deer management plan. The population estimate based on this survey was 26 deer following contracted sharpshooting during the winter of 2013-2014.




**Geospatial interpretation of FLIR data provided by contractor**

## *3. Develop and implement resource management plans*

Two primary resource management plans were completed for the project.

### 1. White-tailed deer management plan

The white-tailed deer management plan was written by a contractor, White Buffalo, Inc. (WBI), with the goal of controlling the deer population in the park. In the context of Fairfax County's deer management programs, this plan was unique in that it, 1.) Engaged a professional sharpshooting contractor, 2.) Took place both during daylight

hours and after dark, 3.) Utilized a baiting protocol that conditioned deer to arrive at a consistent time each day, 4.) Minimized deer "education" through the use of specialized shot choice. This plan was implemented for two years (winter of 2013-2014 and winter of 2014-2015) with a perfect safety record and with the cooperation of several of our partners and assistance from the Fairfax County Police Department Animal Control units. The plan can be found in Appendix B.

**2. Forest management plan**

The VDOF contracted to write a Forest Stewardship Management Plan for ECL completed on May 2, 2013. VDOF staff conducted field investigations and delineated forest stands within the park, providing a GIS map and dataset. The report characterized each stand by its composition and condition (Society of American Foresters SAF classification see reference above), and provided management considerations and recommendations. A ten-year timeline of management actions was provided and was organized by forest stand.

The report's author offered the caveat that traditional forest management plans have not settled on an accepted methods of forest management that can account for the threats posed by non-native invasive (NNI) plants and the impacts of deer browse. With this in mind, the plan's recommendations emphasize NNI plant management and deer management as requirements that transcend forest management objectives and must be implemented in all cases. As these expenses would extend beyond the time frame of the HOLH project at ECL, they could only be implemented partially with current funding.

The plan's recommendations were implemented in many cases and forest treatments undertaken are described in the outcomes and discussion section.

## *4. Educate the public and stakeholders*

There have been several focused efforts to meet this objective. Efforts were primarily driven by staff located on-site at ECL and were intended to introduce and educate park visitors, neighbors, volunteers, school groups and the wider county community about the concepts behind HOLH and natural capital as well as the specific efforts implemented at ECL. The project was kicked-off with a Forest Festival special event that included partnering county agencies and nongovernmental groups, and a public announcement and ceremony. Outreach efforts were conducted to push these ideas into the community even further at schools and public events such as Celebrate Fairfax.

**Public education and engagement:**

1. HOLH illustration: A large (24'' x 36'') teachable, original color illustration was produced by FCPA staff and drawn by a local artist to demonstrate issues of forest health and human participation in stewardship of natural areas. The illustration is packed with specific and general concepts in a "compare and contrast" style as well as a "find and seek" style. The illustration has been used as a tool to assist in programming, web site, school curriculum, and special events at the park, and in outreach efforts.

2. Teacher's hand outs: Single page hand outs were developed for use by school teachers as a guide for teaching the elements contained in the HOLH illustration.
   a. A Copy of the illustration and hand out was distributed to every 1st grade teacher in the Fairfax County School system in the spring of 2015. These were used in a unit titled "Parks are Important" that fit in with school curriculum.
   b. Handouts and posters were also used and distributed to school programs held at ECL.

3. HOLH brochure: A brochure was developed to educate the public about HOLH at ECL. The brochure is 11''x17'' (ANSI size B) in full color, double sided and folded to 3.5'' x 8.5'' units. The brochure addresses the need for public stewardship of parks

and natural areas, reasons for and explanations of natural resource management and restoration actions taken by FCPA, and how members of the public may contribute and participate in good stewardship. The fold out section of the brochure contains the HOLH illustration with specific issues hi-lighted and explained in more detail. A copy of the brochure is available in Appendix C.

4. Project naming, logo and branding:
   a. Naming: A group of ECL site staff and NRMPB staff met quarterly over the course of the first year of the project and chose a name for the pilot forest management project: Helping Our Land Heal (HOLH). The name was felt to reflect the need for public ownership of the project and participation in stewardship actions, as well as the idea that healing was needed to improve the quality of natural areas.
   b. Logo: A focus group of ECL and NRMPB staff worked with the FCPA graphic designer to create a logo for HOLH that could be used to brand the project, education efforts and future ecological restoration and natural resource management projects. The logo chosen included symbols for nature (oak leaves and stream), healing (the hospital style cross) and the colors of foliage and water. The logo has been used on printed materials, signs, stickers, pencils, and other materials.
   c. Branding: The project name and logo can be used for future natural capital investments at other parks to demonstrate the network of projects taking place around the county.

5. Web presence: A webpage for HOLH will be created by county staff to provide an overview and an interactive version of the educational illustration for the project and the brand as a whole. As of this progress report, the webpage is still in progress but expected completion is within the Calendar Year 2015.

6. Traveling exhibit: ECL staff are in process of designing and fabricating a physical exhibit to teach stewardship programs. As of this writing, the form of this exhibit has not been finalized but it will be designed to be mobile so it may travel to classrooms, libraries, farmer's markets, events, or reside temporarily at different parks and nature centers.

7. Boot brush station: Three boot brush stations were installed in the park that serve to provide a cleaning station to reduce the spread of NNI plant seeds and to educate park visitors about NNI plants and the harm they can cause.

8. Interpretive programs: ECL staff has developed a variety of interpretive programs that have incorporated concepts and materials derived from HOLH for visiting program groups. The HOLH message was also incorporated into all natural history

programs. Approximately 439 field trips, reaching over 10,000 park patrons were conducted from the Spring of 2012 until the Spring of 2015 and a component of HOLH was included in each program. Programs that specifically targeted HOLH were offered 22 times from 2013 to 2015.

9. Outreach: A staff member at ECL conducted outreach to Fairfax County schools to generate interest in programs focused on natural capital stewardship.

# Methods applied

Methods were chosen and developed based on assessments completed, contracted resource management plans, FCPA staff knowledge and consultations with partners. Many methods were implemented and with varying degrees of success. Criteria for success included having a positive ecological impact on natural resources, but also success in the employment of actual implementation techniques, considerations for staff time, financial resources and reproducibility.

## *Traditional Forestry Treatment Models:*

These treatment methods were applied based on traditional forestry management methods. They were adapted only minimally to ECL site conditions and were done in consultation with VDOF.

**Understory competition release cut: Stand J**

The VDOF delineated Stand "J" as part of the Forest Stewardship Plan and it is composed of a mature oak and hickory canopy, with plentiful young oak whips and seedlings that appear to be regenerating spontaneously. The understory, however, was composed of shade tolerant, fire-intolerant species such as Liriodendron tulipifera, Acer rubrum, Fagus grandifolia and Ulmus Americana. These trees will eventually replace the oak and hickory canopy and will heavily shade the oak and hickory seedlings, preventing their re-colonization of the canopy and favoring shade tolerant seedlings instead. This succession pathway would lead to a complete conversion of the community from one type to another, in this case from the Society of American Forester's (SAF) cover type 52 to cover type 108.

To prevent this change, FCPA staff delineated a project site within stand J, and used chainsaws to fell or girdle >85% of all shade tolerant, fire-intolerant tree species present. Shrub species such as witch hazel and service berry were untreated; however, tree species in the shrub layer were treated. The site was then fenced to prevent deer browse.

FCPA staff reviewed the following peer-reviewed article for reference: Lorimer, Craig et al. "Tall understory vegetation as a factor in the poor development of oak seedlings beneath mature stands." Ecology 1994.

**Selective thinning: Stand E**

The area between forest stands C, E and F marks a transition from a relatively high quality oak community (SAF cover type 53) to a relatively low quality red maple community (SAF cover type 108). To observe the results of a selective thinning treatment in this transition zone, FCPA staff used chain saws and selectively felled Liriodendron tulipifera, Acer rubrum, Fagus grandifolia and Ulmus Americana to release oak species. Healthy oak trees are present in this transition zone and offer the opportunity to occupy canopy space; however, they were being outgrown by the species moving in from the maple community.

Anticipated results of this method were accelerated growth of potential oak canopy trees and expansion of the oak community type in the stand transition zone through seeding and canopy tree manipulation. Observations were made to determine the change in invasive plant cover. The site chosen contained a variety of invasive plants and their response to selective thinning treatments will be used to inform decisions about similar treatments in forest stands with fewer NNI plants and correspondingly higher quality.

**Shelterwood cut: Stand G**

Forest stand G is characterized by eastern red cedar (SAF cover type 46). Crowding of maturing trees and NNI plant invasions are the two challenges to integrity of this forest stand. The understory of the stand was composed almost exclusively of NNI plants such as autumn olive, oriental bittersweet, wineberry and Japanese stiltgrass. In combination, these plants had eliminated the possibility of native plant succession. FCPA staff consulted with VDOF regional foresters on-site at ECL and settled on a shelterwood cut to restore age diversity and vertical structure to the stand, and to shift its successional pathway towards native tree dominance.

To achieve this, FCPA staff selected a treatment location and used chain saws to fell red cedar trees favoring those that were healthiest, had the best crown and that could provide seed. The treatment sought to reduce the canopy cover to approximately 30%,

allowing enough sun to support native warm season grasses and forbs that would be planted during the fall. Herbicide would be used to limit NNI plants including a pre-emergent herbicide in the spring that would not affect established native plantings.

It was recognized that there was a high risk of NNI plant dominance following this treatment. Stand G, therefore, presented an opportunity to determine the system's successional response to a tradition forestry practice without the risk of compromising a high quality area. This treatment was adapted during its implementation and became a part of the alternative treatment method titled "Shelterwood cut and NNI stabilization."

**Prescribed forest understory burn: Stand J**

Consultations with VDOF lead to the decision to conduct a prescribed forest burn as a way to return natural disturbance regimes to the forest and to promote the growth of fire-tolerant species such as oak and blueberry. A site was selected that offered excellent fire breaks with minimal preparation work required. A burn was conducted on April 23, 2013 and the area was subsequently fenced to prevent deer browse.

**Clear cut and planting: Stand L**

VDOF and FCPA staff recognized the relatively low quality and poor condition of forest stand L (SAF cover type 108) on the west side of the park near the sports field complex. The stand was composed of failing hardwoods, especially red maple, and high density of NNI plants, especially Japanese stiltgrass. Very little regeneration of woody species is taking place and the canopy is patchy and relatively open in many places. The VDOF plan indicates the stand is "understocked" and a large number of fallen pine logs across the site prevent tractor drawn mowing.

A clear cut and replant action was deemed most appropriate if a restoration activity was to take place. FCPA staff investigated the possibility of hiring a contractor to clear cut the site, dispose of woody biomass on site or remove it, and replant. Cost estimates and procedural guidelines were obtained for logging, clearing, removal of biomass, access construction, soil treatments, planting and permitting.

## *Alternative forestry treatment models:*

These treatment methods were adapted from traditional forestry practices for use at ECL to account for the pervasiveness and aggressiveness of NNI plants and heavy browsing of white-tailed deer.

**Shelterwood cut and NNI stabilization: Stand G**

Similar to the shelterwood cut described above in stand G, this treatment emphasized shifting the forest stand's successional track towards a native tree dominated system. This treatment is adapted from the traditional forest practice in that native grasses will be established to stabilize the site against recolonization of NNI plants. The grasses will provide management options of mowing and herbicide that will be easier, less expensive and can be carried out by FCPA staff institutional knowledge. The treatment area will be maintained in this "savannah" type system for several years before being allowed to return to forest. The primary maintenance method would be to use broad leaf selective herbicide (such as Triclopyr) and to mow the grasses once a year with a tractor drawn bush hog. With that in mind, it was necessary to remove logs, stumps and other large obstacles that would prevent a tractor from easily moving through the site. Otherwise, the canopy was opened to approximately 30% cover and the best trees were selected to remain. The part of the stand selected contained more Virginia pine and assorted hardwoods than the part of Stand G described in the previous treatment.

Notable in this section of Stand G is the significant fall out of pine and cedar trees that were not replaced by tree species because Oriental bittersweet and autumn olive plants had come to dominate the understory prior to conifer transition. The canopy contained large empty spaces that revealed the future of the forest stand.

To treat this stand, a forestry cutting attachment was fitted on a T-770 Bobcat track machine. The forestry cutter was used to remove and mulch standing and fallen trees and especially to remove mature autumn olive shrubs and oriental bittersweet. Fallen wood debris was further mulched to smaller pieces to the extent possible. The largest logs were moved with a root grapple attachment and piled for burning. Smaller logs were moved by hand and with tractors.

A pre-emergent herbicide treatment was applied following mulching treatment to reduce NNI germination, especially oriental bittersweet, autumn olive, Japanese stiltgrass and mile-a-minute weed. Another round of herbicide was applied to all NNI plants that emerged from seed or from stump sprouted woody roots. A native grass seed mix was then applied across the treatment site. Another herbicide treatment will take place before the end of the growing season using a broad leaf specific herbicide (Triclopyr/Garlon). Ideally, a fourth round of treatment will take place next spring as well.

**Meadow installation for forest restoration: "Special Meadow Area Salvage Habitat" (SMASH)**

This treatment type adapts the traditional forestry practice of clear cutting to account for NNI plants. The planned treatment was to remove failing trees, logs and NNI plants, establish a native herbaceous plant dominated system, to manage it temporarily as a meadow to control NNI and to experiment with soil improvement before selectively returning the site to a forest system.

The treatment site was a location split by the boundary between Stand O and Stand P that had been a project site for the Invasive Management Area (IMA) program, in which numerous attempts were made over the course of six years to remove NNI plants by manual methods, using a plastic sheet to smother plants and seeds, and through a planting of pine trees with tree protector tubes. None of these methods were successful and after 6 years the site saw no change.

The method to build this new system was to use tractor drawn implements to prepare the soil, amend the soil of part of the site with leaf compost and seed with a native plant seed mix.

**Understory planting project: Stand F**

A major problem underlying the current forest structure in many parks is the lack of an understory layer, that is, young trees and shrubs that provide habitat beneath the primary canopy trees and that will eventually replace canopy trees when older trees die. The two primary causes of this condition in Fairfax County Parks are intensive deer browse on woody sprouts and shoots, and smothering of native plants by NNI plants through competition for light, soil and water. A healthy understory layer provides future cycles of dominant canopy trees and thus the continued presence of forest stands. Current vegetative conditions in the park indicate that many forest stands will be replaced by NNI species such as Autumn Olive and Oriental bittersweet.

This treatment attempts to install an understory layer beneath existing mature canopy trees by planting age-diversified woody species that correspond to a desired natural community composition. In this case, the model natural community was an Acidic Oak-Hickory community that is present in the adjacent stand and elsewhere in the park and which is generally in decline. A species list was developed based on the Virginia Department of Conservation and Recreation (DCR) classification system and this list was submitted to a county contractor for bid.

Site preparation for the plantings included an herbicide treatment of the herbaceous layer of NNI plants which was 100% dominated by Microstigium in the summer of 2014. The site was then exclosed to prevent deer browse on plantings in the spring of 2015,

prior to commencement of planting. Planting began in late April, 2015 and an herbicide treatment for major woody NNI species followed to reduce competition.

**Species list and quantity:**

| | species | size | quantity |
|---|---|---|---|
| **Trees** | Quercus alba | 2.5'' caliper | 5 |
| | Quercus bicolor | 2.5'' caliper | 5 |
| | Quercus palustris | 2.5'' caliper | 5 |
| | Quercus phellos | 2.5'' caliper | 5 |
| | Quercus rubra | 2.5'' caliper | 5 |
| | Quercus velutina | 2.5'' caliper | 5 |
| **Trees** | Cercis canadensis | 3 gallon | 5 |
| | Cornus florida | 3 gallon | 5 |
| | Carya glabra | 3 gallon | 5 |
| | Carya tomentosa | 3 gallon | 5 |
| | Diospyros virginiana | 3 gallon | 5 |
| | Prunus serotina | 3 gallon | 5 |
| | Quercus falcata | 3 gallon | 5 |
| | Sassafras albidum | 3 gallon | 5 |
| **Trees** | Quercus alba | tubeling | 45 |
| | Quercus bicolor | tubeling | 45 |
| | Quercus palustris | tubeling | 45 |
| | Quercus phellos | tubeling | 45 |
| | Quercus rubra | tubeling | 45 |
| | Quercus velutina | tubeling | 45 |
| | Cercis canadensis | tubeling | 15 |
| | Cornus florida | tubeling | 15 |
| | Carya glabra | tubeling | 15 |
| | Carya tomentosa | tubeling | 15 |
| | Diospyros virginiana | tubeling | 15 |
| | Prunus serotina | tubeling | 15 |
| | Quercus falcata | tubeling | 15 |
| | Sassafras albidum | tubeling | 15 |
| **TOTAL** | | | **460** |

| | | | |
|---|---|---|---|
| **TREES** | | | |
| **Shrubs** | Amelanchier arborea | 1-2 gallon | 50 |
| | Gaylusaccia baccata | 1-2 gallon | 20 |
| | Hammemalis virginiana | 1-2 gallon | 40 |
| | Lindera benzoin | 1-2 gallon | 30 |
| | Vaccinium corymbosum | 1-2 gallon | 80 |
| | Vaccinium pallidum | 1-2 gallon | 20 |
| | Vaccinium stamineum | 1-2 gallon | 20 |
| | Viburnum acerifolium | 1-2 gallon | 30 |
| | Viburnum dentatum | 1-2 gallon | 80 |
| | Viburnum prunifolium | 1-2 gallon | 40 |
| **TOTAL SHRUBS** | | | **410** |
| | | | |
| **TOTAL PLANTS** | | | **870** |

**Light gap forest incubator project: Stand H**

This treatment raised deer exclosure fencing around naturally occurring light gaps in the forest canopy. New light gaps are frequently overrun by NNI plants and any woody native plants attempting to take advantage of the sunlight are at risk of browse by white-tailed deer. The concept behind this project was to protect the regenerative dynamics of the forest stand from the pressures of deer browse and NNI plant presence so that native forest plants regain canopy dominance and appropriate vertical forest structure through natural disturbance patterns.

A pair of large Quercus rubra trees fell in forest stand H in June of 2014 creating a large light gap. The area was treated for all NNI plants identified in August 2014 and a deer exclosure fence was raised in December 2014. NNI treatment took place August of 2015 as well.

## *Non-native invasive treatments:*

NNI treatments focused on relieving the park of NNI plant stresses that were likely to spread through high quality areas of the park;, target NNI plants that could expand rapidly and eliminate native forest structure; and used to support restoration project methods. A county contractor was utilized to conduct the spraying, supplemented by efforts of qualified FCPA staff when necessary.

**High quality maintenance treatments:**

Areas of high ecological quality were identified by the NNIAP, ECL and NRMP staff, and by the VADOF Forest Stewardship plan. Invasions were found in some of these areas and treatments were applied when the quality of the ecosystem was threatened:

1. Stand H - A 66 acre oak-hickory forest stand with a heavy invasion of Microstigium vimineum dominating the herbaceous layer.
2. Stand J – An area of this oak-hickory stand was invaded by Wisteria sinensis and this plant threatened to smother herbaceous and subcanopy layers of the forest.
3. Cabell's Mill Meadow – The meadow contained many Eleagnus umbellata shrubs that prevented management by mowing or burning and served as a large seed source for the rest of the park.
4. Big Rocky Run stream corridor – Areas along the stream were treated for Wisteria sinensis Pueraria montana and English ivy in the floodplain and bordering forest. In addition, Ranunculus ficaria was treated in the stream and floodplain.

**"Worst offenders" – aggressive NNI targets:**

Especially aggressive NNI plants that threaten forest structure were treated at a maintenance scale with herbicide application as a preventative measure. These treatments targeted Wisteria sinensis, Ailanthus altissima, Ranunculus ficaria, Oplismenus hirtellus, Pueraria montana. These were targeted park wide as they represented a threat to all forest stands.

**Project support treatments:**

Most forest treatments utilized herbicide application component. In some cases, these targeted a specific plant and in others, it was an attempt to rid the site of all NNI species present. Details of the application can be found in the Results and discussions sections for each treatment. The following treatments contained an herbicide component:

1. Selective thinning
2. Shelterwood cut
3. Clear cut and planting
4. Shelterwood cut and NNI stabilization
5. Meadow installation
6. Understory planting
7. Light gap regeneration incubator
8. Reverse fertilization experiment

## *Deer Management treatments:*

Active and passive deer management was employed to address regeneration of forest plants. Active management (sharpshooting) sought to provide park-wide benefits while passive management (exclosures) could only provide benefits to discrete areas in support of other treatments. Archery hunting occurred in the park prior to HOLH as a part of the county deer management program with limited success but failed to sufficiently reduce the deer population to a level that allowed vegetative regeneration.

**Sharpshooting contract:**

During the winters of 2013-2014, and 2014-2015, a contracted organization, White Buffalo, Inc. (WBI) conducted sharpshooting operations in the park to reduce the deer population. Methods followed the White-tailed deer management plan produced by the contractor available in Appendix B.

**Deer exclosure fencing:**

In the presence of white-tailed deer overabundance, any forest restoration treatment method must account for deer impacts or risk failure. The exclosures were a low maintenance way to ensure this. Exclosures were designed to be easy to maintain, inexpensive and to have a lifespan of a minimum of 5 to 10 years to allow young plants to grow above the browse line.

Exclosure fencing was erected to support the following forestry treatment methods:

1. The forest understory burn
2. Understory competition release cutting
3. Understory planting project
4. Light gap incubator project

## *Soil treatments:*

Soils are often overlooked when considering the health of natural areas. Likewise, they need to be considered during resource management operations. HOLH soil treatments assumed a connection between soil characteristics and NNI plant dynamics. A Literature review was conducted to learn about the types of soil treatments that might be effective and actionable for

the purposes of HOLH. Soil samples were taken from multiple forest stands and analyzed. NVSWCD staff assisted in the interpretation of results.

**Meadow installation:**

This treatment was described above in section 3.3.2. With regard to soil treatments, the variables tested were the use of native warm season grasses (NWSG), compost, and the use of a tractor drawn disc. These methods were intended to relieve post-agricultural soil compaction, improve soil structure and composition, and impart organic matter and nutrients to the soil with the objective to enhance tree seedling survival and ultimately forest regeneration potential.

**Soil Compaction relief:**

FCPA staff worked with NVSWCD and DPWES staff to observe the potential benefits of using annual Daikon radishes to relieve soil compaction and contribute organic matter to the soil. Several proposed applications were identified from a natural resource perspective:

1. Relief of compacted trail surfaces following closure of trails.
2. Relief of compaction of post-agricultural soils preceding restoration plantings.
3. Relief of soil compaction on closed, informal trails, or waste areas to facilitate plant recolonization.
4. Improved infiltration capacity to reduce stormwater runoff in small watersheds.

Radishes were donated by DPWES and planted in 4 locations at ECL: In the untreated portion of the SMASH meadow site, on a closed trail, at the visitor center in a vegetative rehabilitation area, at a section of the maintenance yard that experiences heavy use.

**Reverse fertilization experiment:**

A literature review was conducted about soil chemistry and its relationship to NNI plant invasions. Relatively high amounts of nitrogen and other nutrients occur in post-agricultural soils and in soils affected by acid rain. This favors the growth of NNI plants, especially annuals that can use nitrogen more quickly than native perennials. Experiments undertaken to reduce the fertility of the soil found that a competitive advantage was provided to native perennials. Soil fertility was reduced by adding carbon in the form of hardwood sawdust in a prairie setting. (Averett, Jack, et al. Effects of Soil Carbon Amendment on Nitrogen Availability and Plant Growth in an Experimental Tallgrass Prairie Restoration. *Restoration Ecology*, Vol. 12, 4, pp. 568-574.)

Four locations at ECL received a sawdust amendment; 1.) A forested area in Stand H where invasive and native woodies and herbaceous plants grew together, 2.) a tall

fescue dominated site in full sun on the gasline easement in the north section of the park, and 3.) a thicket of wisteria and sumac near the Middlegate building complex, and 4.) in the southern section of Cabell's Mill meadow.

**Biochar experimental process:**

A literature review was conducted on the benefits of biochar and its potential application to favor native plants. Little research had been conducted about this aspect of the soil amendment. Research was conducted on costs and production methods. Costs were up to $225 per cubic yard, beyond the threshold of financial resources intended for this experiment in the context of ECL and HOLH. Thus, in-house production was attempted to produce some material to apply.

In concept, woody NNI plants could be harvested by volunteers, chipped with FCPA equipment and converted into biochar with fuel wood from hazard trees or logs. This biochar could then be incorporated into the soil to provide nutrient, water retention and microbial benefits to plant communities. FCPA and ECL staff conducted operations to produce biochar.

## *Re-introducing natural disturbance regimes:*

These efforts sought to restore natural patterns of disturbance to stimulate native plant growth. Human based suppression of natural disturbance has been cited as a contributing factor to forest change.

**Prescribed Fire:**

Fire is was a commonly occurring natural disturbance that has been excluded by human activity despite its ecological impact during evolution and development of eastern forests. Prescribed burning activity was conducted at ECL as part of HOLH in two locations: Forest Stand J and the Cabell's Mill meadow. Prescribed fire was planned for application in Stand F and in the SMASH meadow but due to staff resources and weather constrictions, these burns have not yet been conducted.

**Selective forest thinning:**

This treatment simulates natural tree falls to provide sunlight to the understory and stimulate new growth. Given the challenges of deer herbivory and NNI plant invasions, thinning was undertaken very cautiously in Stand F on a small scale. Dominant shade tolerant trees were cut to favor maturing oak species along the border between the shrinking, high quality oak-hickory community and the relatively lower quality tulip tree-red maple community to the east. The goal was to expand the oak-hickory community by releasing the maturing oak trees and provide better habitat for acorn germination.

The herbaceous layer of the stand is dominated by Microstigium vimineum and an herbicide application was applied to improve the chances of acorn germination. Elymus hystrix was seeded into the area treated with herbicide to provide a more conducive landing pad for acorns and to compete with Microstigium vimineum.

### *Stream rehabilitation:*

Stormwater flows generated significant channel erosion within ECL. FCPA staff worked with NVSWCD to employ small scale experimental methods for streams that were too small to qualify for large scale stream restorations, where such restorations were not appropriate and in streams where the problem was in relatively early stages.

**Roundlick Run:**

A stream rehabilitation was planned for Roundlick Run, a small creek that runs across the gasline easement in the northern section of the park. It originates in a stormwater detention feature in the neighborhood across Walney Road to the East. Due to staff time limitations and permitting procedures, this project has not been undertaken as of this writing.

# Outcomes and results

In this section, results will be presented in the form of processes and practices developed. Processes were developed from project management work and practices were developed from methods applied on the ground in the park.

## Processes developed

**Project initiation:**

Project initiation in the context of HOLH at ECL was an evolving process. A scope of work (SOW) planning tool was adopted to assist the initiation phases of restoration work. The SOW provided a platform for creating goals, objectives, tasks and specifications for the overall restoration project and for the individual treatment level. It captures the technical, administrative and personnel requirements for a given project. A SOW was

created for three individual treatments and contributed to their planning and success. An example of a SOW appears in appendix E.

The SOW tool was adopted late in the project's implementation phase and would have been useful earlier. SOWs were created for the understory planting treatment, the shelterwood cut and NNI stabilization treatment, and the light gap exclosure project.

**Project management:**

Through the scope of work process, more organized project planning took place. Especially important was estimating costs for treatments and examining the budget for the project as a whole for context. Consultations with contractors, reviews of existing vendor contracts and consultations with partners were very helpful. The SOW tool was valuable because it allowed adaptive planning in the context of a limited budget and timeframe.

For treatments that involved ground disturbing activities, consultation with the Cultural Resources Management and Protection Branch was necessary and should be built into project planning. Consultation with the FCPA planning and development division provided perspective on permitting requirements as well. These processes could significantly affect project timing and cost.

Expenditures and encumbrances were tracked carefully and projected expenditures were tracked simultaneously. The project budget was reviewed with the Department of Finance each year. Identifying and separating the funding source(s) dedicated to the project ensures the funding available is clear and completely spent. Shared funding sources can become confusing when financial accounting systems don't identify which costs are associated with which projects. It is recommended that project managers work with their finance department to isolate funding sources to avoid over or underspending and cross contamination of funds.

**Project Planning:**

In almost all cases, deer population management and NNI plant control are critical components of treatments implemented. The process of addressing these two aspects should be built into every HOLH project through the SOW tool on the project and treatment levels.

Partnerships established prior to the planning phase allow input from partners to be incorporated during the planning phase and enhance investment in the project.

Regular monitoring of work should take place during implementation including monitoring of contractor activity. Photo documentation is useful and any baseline data collection should take place prior to treatment actions.

**Project closure:**

This report serves as the final progress report and project close-out report. Review of the initial goals and anticipated tasks was conducted to ensure all aspects of the funding approval had been met at the midpoint of the project in 2014 and as the project approached its completion. Goals and tasks were recorded in Park Authority Board item records. In the future, it is recommended that these items are incorporated into an overall project SOW that can be a reference point for treatment SOWs.

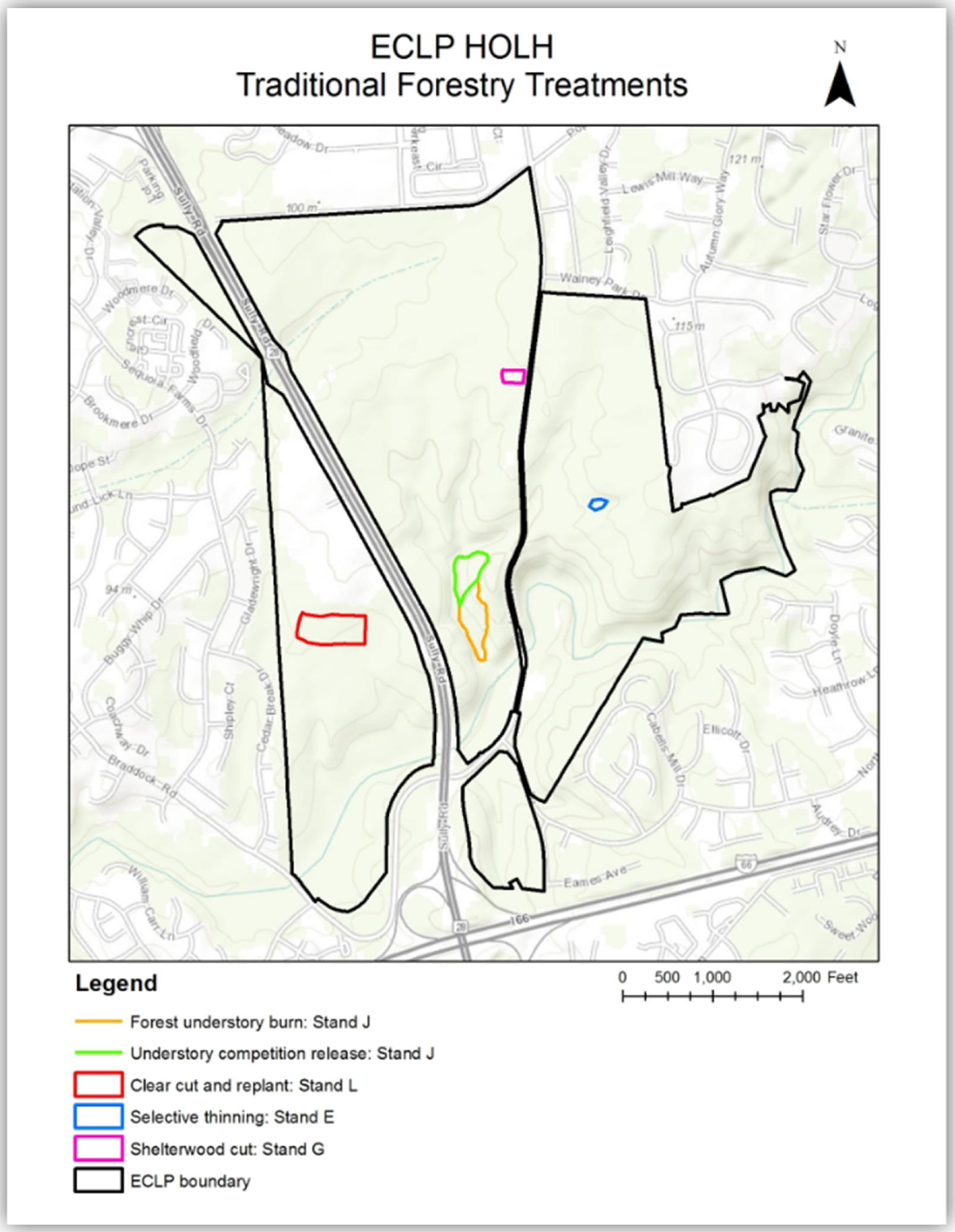
In the project's final year, funding source expenditure tracking sheets were reconciled with records of the Department of Finance. It is recommended to reconcile project budgets every quarter to ensure any mistakes can be corrected within the same fiscal year. The process of reconciliation also contributes to planning efforts and adaptive management.

**Expenditures:**

Total expenditures for the project sum to $310,000 with an anticipated amount of $30,000 to be spent on education and outreach upon completion of a website for HOLH and a physical educational exhibit.

1. Field investigations: Expenditures on field investigations and management plans totaled approximately $31,000. This included a Forest Stewardship Plan from the VDOF, soil data collection and analysis, contractor installation and report on vegetation data collection procedures, white-tailed deer population surveys.
2. Management plan and treatment implementation: Treatment implementation incurred approximately $269,000 of expenditures including all materials, contractors, and staff time.
3. Education and outreach: Expenditures on outreach and education totaled $10,000 at the time of this writing with and anticipated $30,000 spent to create an interactive HOLH website and a physical educational exhibit.

## Practices developed



## *Traditional forestry treatment models:*

**Understory competition release cut: Stand J**

Work began on 3/13/13 and was conducted over two days in the spring, totaling approximately 40 person hours of labor. Trees were cut down with chain saws or girdled if felling was considered difficult and stumps were cut flush with the ground. The area treated was approximately 2.1 acres. Shade tolerant tree species were treated: Acer rubrum, Liriodendron tulipifera, Ulmus Americana, Fagus grandifolia, Ilex americana. Approximately 75 trees with diameters greater than 1'' were cut. Trees smaller than 1'' in diameter were cut but data was not collected. The largest diameter tree cut was 12'', the average basal area of trees cut was 5'' and the average diameter at breast height (DBH) was 5''. Most trees were in the understory but several large Liriodendron were tall enough to be in the canopy.

The treated area was exclosed from deer browse with a fence. The fence measured 8' tall, was 1364' long and exclosed an area of 2.05 acres. The fence was constructed with nylon plastic fencing material that was affixed with zip ties to 1.25'' diameter metal electrical conduit poles. An access to the inside of the exclosure was created by tying the end of a section of fencing to a pole that was not installed in the ground and which was tied to the next pole with string. Pole locations were pre-marked with spray paint every 10' before scout troop installation. Where necessary, trees were used as poles because of difficulty installing poles into rocky soil. The poles were installed using a post driver or pole pounder from a 6' step ladder. The labor was provided by a volunteer Eagle Scout troop with approximately 20 members participating and supervised by ECL staff for 8 hours.

Cost of the fence materials was approximately $1.84 per linear foot and $0.03 per square foot or $1221.95 per acre. This may vary depending on perimeter length and shape.

**Costs table:**

| Fencing | Source | Quantity | cost/unit | cost |
|---|---|---|---|---|
| Fence rolls | Trident Enterprises | 5 | $200 | $1000 |
| Poles | Home Depot | 140 | $10.5 | $1470 |
| Paracord | www.amazon.com | 1 | $25 | $25 |
| Zip ties | Home Depot | 1 | $10 | $10 |
| Labor | Eagle Scouts | 1 | 0 | $0 |
| **TOTAL** | | | | **$2505** |

**Immediately following understory release cut treatment, April 2013**

**Two and a half growing seasons after treatment and deer exclosure installation, July 2015**

**Selective thinning: Stand E**

Work began on 3/31/14 over the course of 3 days in March and April and one seeding day in October, totaling 19 person hours of labor. The site treated was approximately 0.4 acres and 500' in diameter. Canopy coverage of undesirable trees was reduced approximately 65%.

Trees were marked for removal based on species, position relative to desirable species and health. Chainsaws were used to cut trees or girdle them and ropes and winches were used to direct the fall of large diameter trees. Oak species were released from shade and crown impingement. Species removed were any NNI species, Liriodendron tulipifera, Acer rubrum, Fagus grandifolia, Ulmus Americana. The largest trees cut were Liriodendron tulipifera including two at 30'' and 28'' and a Fagus grandifolia at 18''. On average the trees in this treatment was much larger than the understory release cut because these trees were canopy trees that had grown up faster than maturing oaks in the site. In addition, greater care was required in felling trees because of the risk of damage to trees targeted for release.

Over the summer, the area received much more sunlight than the previous growing season and Microstigium grew to 5' tall. An herbicide treatment of 0.5% glyphosate was applied to destroy the Microstigium. In October, FCPA staff raked away the thatch of dead Microstigium to create a landing pad for acorns. Elymus hystrix was seeded into the site to compete with Microstigium and other NNI. It was chosen because it is a native perennial plant known to compete well in the park, it tolerates shade and grows tall enough to shade Microstigium beneath it. The grass seed was seeded at an approximate rate of 20 lbs. per acre.

**Costs table:**

| Item | Source | Quantity | cost/unit | cost |
|---|---|---|---|---|
| Staff time | FCPA | 19 hours | $25 | $475 |
| Native plant seed | County contractor | 9 lbs. | $50 | $450 |
| Herbicide application | County contractor | 1 | $300 | $300 |
| **TOTAL** | | | | **$1225** |

**An example of the forest stand before thinning treatment, July 2013**

**Three months after the thinning treatment and herbicide to control Microstigium vimineum, July 2014**

**Shelterwood cut: Stand G**

Two representatives of the VA DOF visited ECL in April 2013 and discussed the principles of forest treatments and thinning forest stands with ECL and NRMPB staff. Stand G was chosen as a site that would benefit from this treatment and trees were marked for removal. Trees were chosen for removal based on shape, crown and foliage health, size, density and position relative to other desirable trees, presence of vines. Trees that were targeted for release were those deemed the healthiest, with the best crown and the most foliage, straight and capable of providing seed for future generations of trees.

The initial plan was to remove NNI plants mechanically, thin the stand, plant native plants and use pre-emergent herbicide to keep the site NNI free to determine the ability of the plantings to colonize and stabilize the vegetation on site.

Site preparation required removal of a heavy presence of NNI plants to be able to engage tree work. Persecaria perfoliata, Rubus phoenicolasius, Celastrus orbiculatus and Microstigium vimineum were the primary targets of removal. A string trimmer was used as machine or tractor access was not possible. About 8 hours of string trimming was required to lower the stature of the NNI layer for tree work to begin.

The completed site was 0.76 acres with a rectangular perimeter of 745 feet. 61 person hours were spent over the course of two months on tree work.

Regarding tree work, limitations on machine and staff time caused ECL and NRMPB staff to engage in small team operations working by hand with chainsaws. It was unclear how quickly this work could be accomplished and a small initial area was chosen with good vehicle access at the south end of Stand G. Canopy opening of 50-70% was desired to create a kind of savannah system with enough sun for native perennial grasses that can be easily managed with mowing and which would prevent further domination by NNI plants.

Marked trees were removed with chainsaws and ropes. Species included Fraxinus pennsylvannica, Acer rubrum, Virburnum prunifolium, Juniperus virginiana, Pinus virginiana. Brush and logs were dragged into piles for habitat creation or pulled out of the work site for removal later and large logs were removed with a tractor. Stumps were cut flush with the ground to allow bushhogging.

An Eagle Scout group was engaged to plant 500 native plants in 1 gallon containers in December 2013. 8 hours of planting was done by 6 scouts supervised by ECL staff. The quantity of plants was calculated based on planting one every two feet, minus an estimate of space occupied by shrubs, tree trunks and the large brush piles at the recommendation of the native plant nursery.

A pre-emergent herbicide treatment was desired for the site in February 2014 but the herbicide contractor was unable to provide the service prior to seed germination by Microstigium vimineum, Allaria petiolata and others. Plantings survived the winter and were marked by NRMPB staff with orange ground flags.

The herbicide contractor's experience did not include the use of a pre-emergent herbicide that only affected germinating seeds. So, their recommendation was to spray carefully with Plateau, an Imazipic chemical product, around the native plantings because the chemical would act as a foliar spray and also reside in the soil for some months after application, thereby acting as a pre-emergent as well. Then glyphosate would be used to foliar spray NNI that came up in close proximity to the plantings. This was implemented in late May 2014 and during the following months, the sprayed areas remained generally free of NNI but the areas immediately surrounding the plantings were overrun with NNI, notably Microstigium vimineum and Persecaria perfoliata.

At this point, the plan was reviewed and altered. The herbicide Plateau was not an effective tool in this context and the native plantings were not growing densely enough to stabilize the site. The new plan was to completely eradicate NNI plants growing on site to provide a completely neutral seed bed, return in the summer to seed in NWSG and follow up with Garlon, a Triclopyr chemical product, treatments on any broadleaf NNIs that germinate, thereby reducing the risk that any desirable plants would be harmed by herbicide treatment. The herbicide contractor was re-engaged in August 2014 to aggressively herbicide all NNI plants on the site and then applied a pre-emergent chemical, Proclipse a Prodiamine chemical product, in mid-March 2015 at our special request. The Proclipse was applied at 0.75 lbs. per acre to last until late June and was mixed with 1 oz. per acre of Plateau to control any NNI that had already germinated. This mix was discussed with Art Gover, a researcher at Penn State's Plants Science Department who had used it in treatments with success against our target plants. Then the site was treated for all NNIs with foliar spray in early June of 2015. A mix of NWSG was hand broadcast over the site in mid-July 2015 at a rate of 25 lbs. per acre. As of this writing, native grasses have germinated and coverage is up to 25% and NNI coverage is relatively low, up to 10% cover.

**Herbicide table:**

| Date | Chemical | Application | purpose | effective | cost |
|---|---|---|---|---|---|
| 5/29/2014 | Imazipic | 6 oz. per acre | prevent seed germination | partial | $2000 |
| | Glyphosate | 1.5% solution | release plantings from NNI | no | |
| 8/19/2014 | Glyphosate | 3% solution | eliminate all NNI | yes | $1300 |
| 3/12/2015 | Prodiamine and Imazipic mix | 12 oz. per acre Proclipse mixed with 1 oz. per acre Plateau | pre-emergent and post emergent coverage | partial | $650 |
| 6/9/15 and 7/7/15 | Triclopyr | 3% solution | eliminate all NNI | yes | $1230 |
| | Glyphosate | 1.5% solution | Microstigium vimineum | yes | |
| **Total** | | | | | **$5180** |

**Species list and quantity:**

| Species | % of mix | lbs. | cost/lb. | cost |
|---|---|---|---|---|
| Elymus hystrix | 5 | 0.95 | $200 | $190 |
| Elymus virginicus | 15 | 2.85 | $8 | $22.8 |
| Sorghastrum nutans | 18 | 3.42 | $20 | $68.4 |
| Andropogon virginicus | 12 | 2.28 | $64 | $145.92 |
| Dichanthelium clandestinum | 20 | 3.8 | $18 | $68.4 |
| Tridens flavus | 10 | 1.9 | $36 | $68.4 |
| Tripsacum dactyloides | 10 | 1.9 | $22 | $41.8 |
| Coleataenia anceps | 10 | 1.9 | $20 | $38 |
| **Total** | **100** | **19** | | **$643.72** |

**Forest stand G was overstocked, failing and overrun with NNI plants before treatment, August 2013**

**An example of the desired open spacing and healthier tree selection using the shelterwood cut, October 2013**

**Prescribed forest understory burn: Stand J**

A forest understory burn was conducted in Stand J on April 23, 2013. The burn was completed successfully with no issues by 6 staff from ECL and NRMPB over the course of 3 hours. Firing operations took place along the perimeter of the burn unit which was approximately 2025 feet long and contained an area of 3.62 acres. However, because of atmospheric humidity and plant embodied moisture levels, ignition was not complete. As a result, approximately 1.07 acres burned completely within a perimeter of 968 feet. The burn consumed leaf litter and top killed many young trees which began to stump sprout over the summer. The area that did not burn contained many more NNI plants such as Lonicera japonica and Microstigium vimineum. Vegetation data was collected on July 19, 2013 and again on July 22, 2014. Data analysis did not reveal any obvious difference but regrowth of native plants was plentiful with little new invasion of NNI plants. The intent intention was to have a dormant season burn but it was effectively a growing season burn because the plants had sprouted leaves and were actively growing.

**Commencing firing operations and fire line holding activity during the prescribed understory burn in Stand J, April 2013**

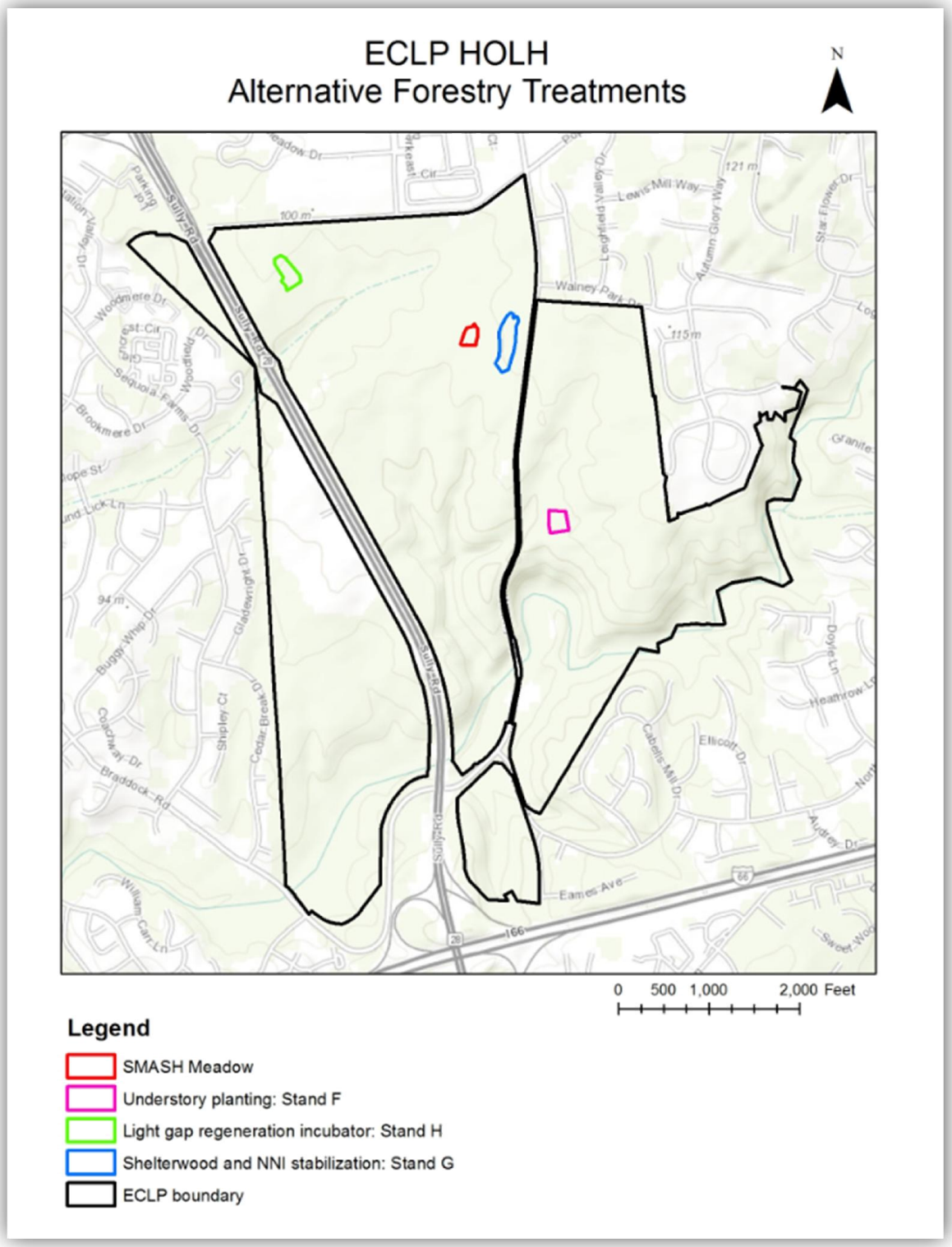
**Regrowth of woody understory vegetation after two and a half growing seasons and installation of a deer exclosure, August 2015**

**Clear cut and re-planting: Stand L**

Stand L was identified in the DOF forest stewardship plan as an area that could benefit from a complete clear cut and replanting. NRMPB staff investigated the costs that would be involved in such a project to determine if it would be feasible in the current HOLH budget for ECL. A technical plan was outlined and costs estimated through contractors for each step. The total cost for 6 acres with 3 treatment types was estimated at least $195,000 or approximately $32,500 per acre and becoming slightly less expensive per acre as total acres increased. The three treatment types were largely centered on planting hardwood trees, pines or a grass dominated system. The entire treatment would be on 6 contiguous acres and protected from deer browse by an 8' permanent chain link fence. Other costs included in the estimate were archaeological investigations, equipment access road construction, root ball extraction, planting labor and plant stock. Biomass removal or disposal of slash, heavy materials or wood chips was not estimated but the costs associated were likely to be significant.

Given the current budget, this project was deemed infeasible.

*Alternative forestry treatments:*



**Shelterwood cut and NNI stabilization: Stand G**

This treatment was developed out of the shelterwood cut in Stand G described above in section. The approximate cost for this treatment was $4200 per acre including staff time, seed materials and herbicide treatments. This does not include incidental costs for operation of the forestry cutter and bobcat.

The goal was the same, to remove failing trees and NNI plants and to replace them with a savannah system that could be managed with mechanical treatments until native tree species could regenerate the forest's understory. A major capacity change resulted from the purchasing of a piece of heavy equipment that could much more quickly remove trees and NNI vegetation. The machine was purchased by the Resource Management Division and intended for use on natural resource management projects. The machine is a T-770 tracked bobcat with a forestry cutter attachment that was capable of removing trees where they stood, and reducing them to mulched woody biomass. The site was treated this way and mulching was completed and logs removed so that a tractor drawn bush hog would be capable of mowing the site for maintenance management. Some logs were mulching by the machine and others were piled for burning next winter.

Machine work began in early February 2015 and work continued through mid-June 2015. Delays occurred because of weather, machine repair work and conflicting scheduling needs for the machine. Approximately 2.2 acres were treated. Total labor time was 67 person hours which includes time spent operating the forestry cutter attachment, moving heavy biomass with the grapple bucket attachment, machine maintenance and refueling, troubleshooting, treatment area scouting and flagging, and removing logs for bush hog access.

An herbicide treatment of *Proclipse* was applied to 1.5 acres of the site by an herbicide contractor on March 12, 2015. This was to prevent sprouting of NNI seeds exposed by the mulching work. It was applied at 0.75 lbs. per acre to remain active until the end of June and mixed with 1 oz. per acre of *Plateau* to provide coverage of anything that had already germinated. On June 9, 2015, the contractor returned to apply Triclopyr to all NNI across the entire site (2.2 acres), especially Celastrus orbiculatus and Eleagnus umbellata, the two primary NNIs on site. This work was partially successful and the contractor was asked to return and treat again on July 7, 2015. The site will be treated again with herbicide before the end of the growing season with Triclopyr to avoid damage to the grass seedlings. An additional treatment may take place the following growing season as well on an as-needed basis. Mowing will be used every year or second year to maintain the system in savannah to control NNI until selected native tree species can come to dominate the site.

On June 30, 2015, FCPA staff hand broadcast NWSG seed across the treatment site at a rate of 25 lbs. per acre. A total of 7 person hours was needed to seed the site. The seeds chosen were small, hard and round and would hopefully pass through the

mulched woody debris to find soil in which to germinate. This “trickle down” seed mix was as follows:

**Species list and quantity:**

| Species | % of mix | lbs. | cost/lb. | cost |
|---|---|---|---|---|
| Elymus hystrix | 5 | 2.75 | $200 | $550 |
| Elymus virginicus | 15 | 8.25 | $8 | $66 |
| Sorghastrum nutans | 18 | 9.9 | $20 | $198 |
| Andropogon virginicus | 12 | 6.6 | $64 | $422.40 |
| Dichanthelium clandestinum | 20 | 11 | $18 | $198 |
| Tridens flavus | 10 | 5.5 | $36 | $198 |
| Tripsacum dactyloides | 10 | 5.5 | $22 | $121 |
| Coleataenia anceps | 10 | 5.5 | $20 | $110 |
| **Total** | **100** | **55** | | **$1863.40** |

**Herbicide costs**:

| Date | Chemical | rate | purpose | effective | cost |
|---|---|---|---|---|---|
| 3/12/2015 | Proclipse and Plateau mix | 0.75 lbs. Per acre Proclipse mixed with 1 oz. per acre Plateau | pre-emergent and post emergent coverage | partial | $1860 |
| 6/9/15 and 7/7/15 | Garlon | 3% solution | eliminate all NNI | yes | $3350 |
| | Rodeo | 1.5% solution | Microstigium vimineum | yes | |
| **Total** | | | | | **$5210** |

**Stand G had been overtaken by NNI plants such as Celastrus orbiculatus, and was prevented from replacing its own canopy, April 2014**

**Stand G project area six months after it was treated with the forestry mulching machine, free of the NNI understory and displaying germination of NWSG, August 2015**

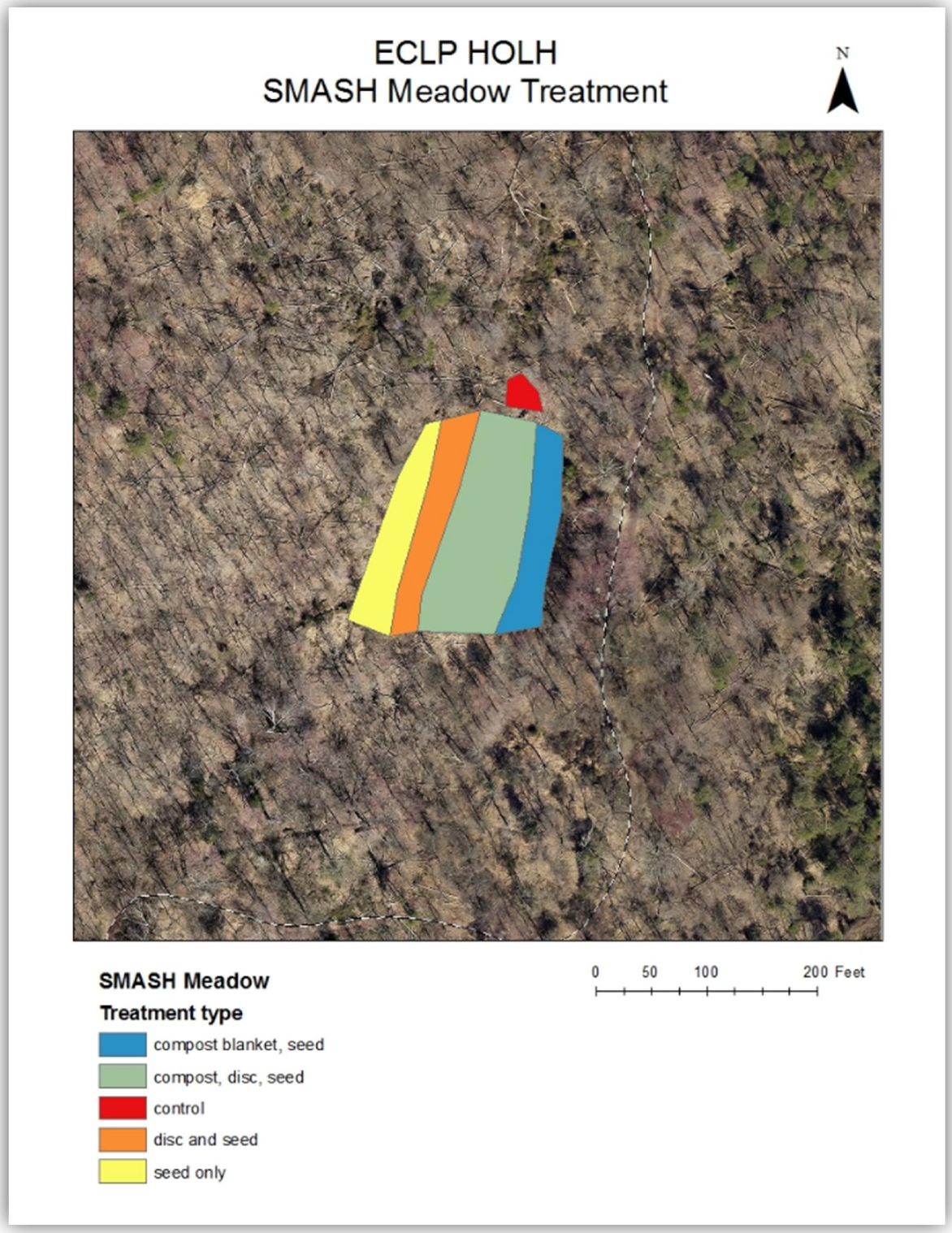
**SMASH Meadow installation:**

Work began in February 2013 to delineate the site. It is approximately 0.75 acres with a perimeter of 700 feet. Chainsaws were used to cut undesirable trees and shrubs in the work area. In April, POD Mobile Crew was engaged to clear brush to the outside perimeter of the work site to form brush piles that could serve as habitat. This work cleared the site and the POD forestry crew was engaged to grind down any tree stumps low enough that a tractor and bush hog could be used to mow the site in the future. Their equipment however, malfunctioned and stump grinding was not completed. By June, vegetation had grown up and the site was mowed with a tractor. A handful of Eleagnus umbellata stumps and a Paulownia tomentosa tree were treated with Triclopyr. It was then disked once across the site with a heavy disc pulled by a tractor. For five days, staff and volunteers transported leaf compost from the parking lot where it had been delivered, down the trail in utility vehicles to the site. It was spread across half of the treatment area to a 2'' depth evenly distributed by hand raking and tractor raking where needed.

In late winter 2013, FCPA staff began to cut the remaining unhealthy trees to clear an area for treatment. In April, POD's mobile crew used a bobcat with a root grapple attachment to clear all debris from the site and push it into piles around the perimeter. A work site of approximately ¾ acre was created. The POD Forestry crew was engaged to grind remaining stumps to facilitate tractor drawn implements. A heavy disc was used to begin to loosen the soil in early May. The site was allowed to grow and observations were noted about what was expressed in the plant community. The site was then bushhogged low in the second half of June and disked again. Leaf compost was added to half the project site. Half of the compost was incorporated into the soil about 4'' deep using the disc and the other half of the compost was left as a 2'' blanket on the surface. A third strip of the site was then disked again before seeding without compost and the final fourth of the site was neither disked nor composted prior to seeding. Thus, 4 treatments were created and one control location. No herbicides were used to prepare the site.

**Treatment types:**

| | Treatment | area $ft^2$ | seeded |
|---|---|---|---|
| 1 | Compost blanket | 5302 | yes |
| 2 | Incorporated compost to 4'' | 13558 | yes |
| 3 | disking without compost | 5492 | yes |
| 4 | untreated | 5820 | yes |
| 5 | control | 813 | no |


ECLP HOLH
SMASH Meadow Treatment
N
SMASH Meadow
Treatment type
compost blanket, seed
compost, disc, seed
control
disc and seed
seed only
0 50 100 200 Feet

Approximately half of the compost was disked to incorporate it into the soil. The disc penetrated about 4'' deep on average. In addition, one un-composted portion of the site was also disked for comparison. This left 4 treatment types: compost blanket (undisked), incorporated compost, disked soil, undisked soil. A small area was left as a control plot that was not treated. The site was then seeded with a custom native plant seed mix by hand broadcasting at a rate of 20 lbs. per acre. The control area was not seeded. The seeded areas were then lightly covered with straw mulch.

**ECL Natural Resource Manager, Jim Dewing, discs the project areas in the SMASH meadow site, June 2013**

Seeds germinated in all areas and observations throughout 2014 showed high rates of success in growing native species. In August 2013, a volunteer group of 15 students removed Persecaria perfoliata by hand from across the site. This was repeated in July of 2014 by a corporate volunteer group. Remains and seeds were bagged and removed from the site. This seems to be the most effective way of removing the plant without risking collateral damage to native plants with herbicide spraying. In July of 2014, an experimental mow took place in an area of about 0.03 acre to determine the effect it could have on controlling Persecaria perfoliata. The treatment area was mowed to a height of 6'' to avoid destroying young perennials. This is not an effective strategy to combat Persecaria perfoliata here and it increased the presence of the plant in this area.

Germination was successful and growth of native vegetation outpaced that of NNI plants. Overall, the site was dominated by native vegetation at the beginning of the second growing season. After the second growing season, in February of 2015, the

meadow was bushogged for the first time. Growth into the third growing season has been excellent again. However, Persecaria perfoliata was not removed in 2015 and has shown that it will continue to be a major problem.

Approximate cost is $7960 per acre for this treatment including staff time, seed and compost materials.

**Costs table:**

| Date | Activity | Person hours | Staff time cost | Materials costs |
|---|---|---|---|---|
| 2/12/2013 | tree and brush cutting | 20 | $640 | |
| 4/19 & 4/22/13 | brush clearing and brush pile building | 8 | $200 | |
| 5/2/2013 | stump grinding | 8 | $120 | |
| 6/19/2013 | mowing | 1 | $32 | |
| 6/20/2013 | disking | 1 | $32 | |
| 6/20 - 6/27/13 | spread compost | 131 | $1120 | $2196 |
| 6/28/2013 | disc portions of compost and soil | 1 | $32 | |
| 6/28/2013 | seed and straw mulch | 6 | $128 | $1416 |
| August 2013 | Persecaria perfoliata removal | 30 | 0 | $20 |
| July 2014 | Persecaria perfoliata removal | 20 | 0 | $20 |
| July 2014 | Growing season mow experiment | 1 | $32 | |
| February 2015 | Mechanical mowing | 1 | $32 | |
| **Totals** | | 228 | $2368 | $3652 |
| **Total cost** | | | | **$6020** |

**Species list and quantity:**

| Species | lbs. | cost/lb. | cost |
|---|---|---|---|
| Shizachryium scoparium | 2 | $50 | 100 |
| Sorghastrum nutans | 4.6 | $32 | 147.2 |
| Andropogon virginicus | 3 | $64 | 192 |
| Dichanthelium clandestinum | 2.6 | $16 | 41.6 |
| Tridens flavus | 2.6 | $12 | 31.2 |
| Elymus virginicus | 2 | $15 | 30 |
| Cinna arundinaceae | 1 | $200 | 200 |
| Elymus hystrix | 1 | $200 | 200 |
| Carex squarrosa | 0.6 | $80 | 48 |
| Desmodium paniculata | 0.4 | $160 | 64 |
| Juncus effusus | 0.4 | $66 | 26.4 |
| Asclepias syriaca | 0.2 | $180 | 36 |
| Solidago juncea | 0.2 | $220 | 44 |
| Juncus tenuis | 0.2 | $96 | 19.2 |
| Carex crinita | 0.2 | $120 | 24 |
| Symphyotrichum prenanthoides | 0.2 | $180 | 36 |
| Euthamia graminifolia | 0.2 | $400 | 80 |
| Polygonum Pennsylvanicum | 0.2 | $12 | 2.4 |
| Symphyotrichum Laeve | 0.2 | $220 | 44 |
| **TOTAL** | | | **1366** |

**From 2006 to 2012, the SMASH project area was dominated by NNI plants such as Persecaria perfoliata and Rosa multiflora, Summer 2006**

**Poor quality trees and shrubs were cut down and later brush was cleared, February 2013**

**Two and a half growing seasons after installation of the SMASH meadow -**
**The composted section on the right has been matted down by NNI annuals, September 2015**

**Understory planting: Stand F**

An area of 1.1 acre was treated with Plateau herbicide in the summer of 2014. In spring of 2015, prior to planting, an archaeological investigation took place to find any cultural resources that might conflict with the planting project. In the spring of 2015, the area was exclosed from deer with an 8' fence and planted with native tree and shrub species. Species planted were those typical of an acidic oak-hickory community as described by Virginia's DCR community classification system. A contractor planted these in late April 2015 and the plants were watered periodically. Through consultation with the VADOF regional forester, a density of 460 Trees per acre was chosen. These were planted and 418 shrubs were interplanted with the trees. The number of shrubs was modified from 460 stems per acre. An herbicide treatment was applied in August of 2015 to control all NNI plants.

**Cost table:**

| Item | cost |
|---|---|
| fencing materials | $2350 |
| plants and labor | $30585 |
| staff time fencing and watering | $640 |
| herbicide treatments | $3000 |
| **Total** | **36575** |

**Light gap regeneration incubator: Stand H**

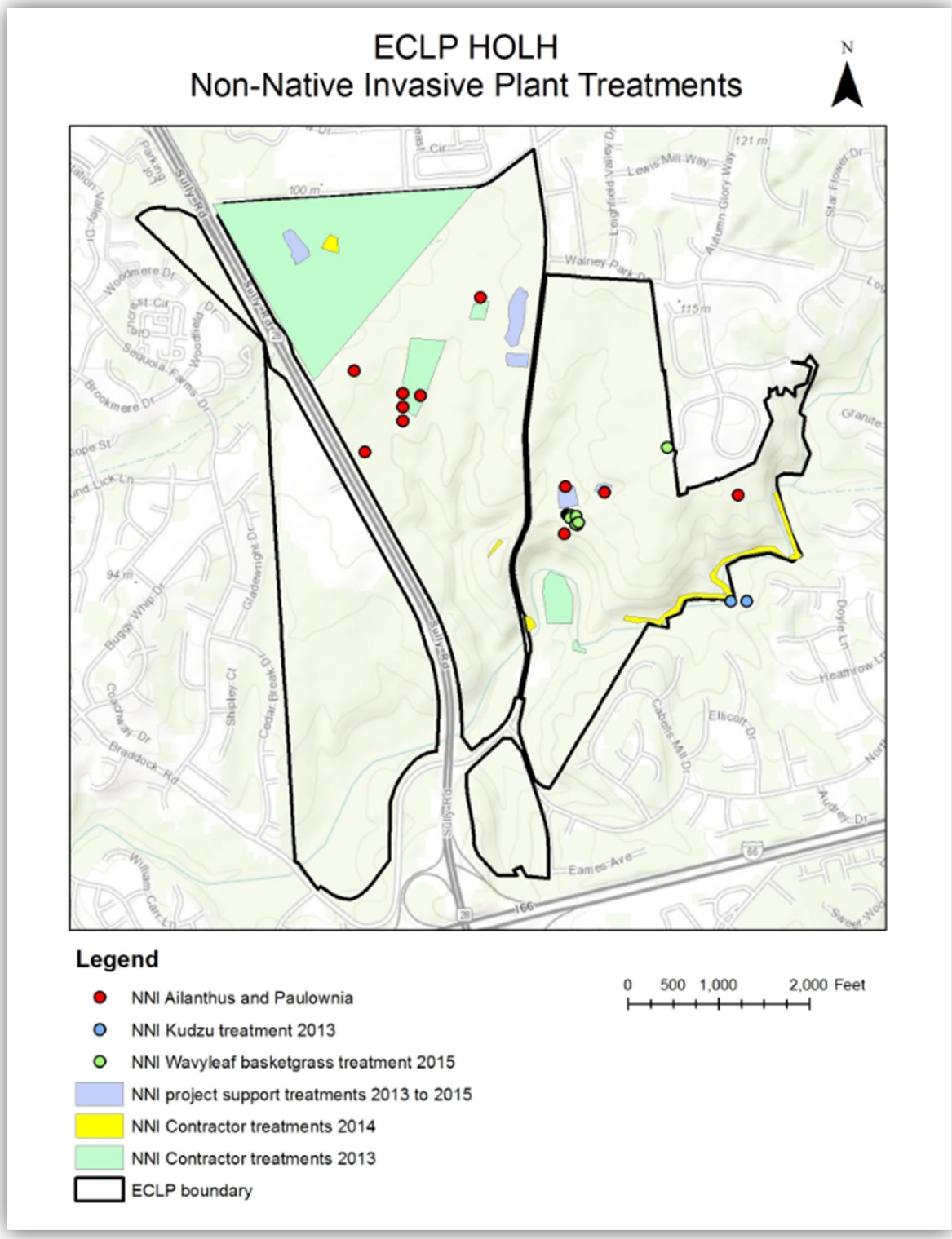
The light gap identified in June 2014 was treated for all NNI plants present in August 2014. A deer exclosure was built around the area in mid-December 2014. The total size of the area protected light gap is 1.3 acres with a perimeter of 1057'.

**Cost table:**

| Light Gap project | Source | Quantity | cost/unit | cost |
|---|---|---|---|---|
| herbicide application | contractor | 1 | $1000 | $1000 |
| Fence rolls | Trident Enterprises | 3 | $319 | $957 |
| Poles | Home Depot | 60 | $10.5 | $630 |
| Paracord | www.amazon.com | 1 | $55 | $55 |
| Zip ties | Home Depot | 1 | $20 | $20 |
| Labor | 20 Scouts | 1 | 0 | 0 |
| **TOTAL** | | | | **$2662** |

**Large tree fall and light gap in Stand H, October 2014**

*NNI treatments:*



**High quality maintenance treatments completed:**

1. Stand H - 66 acres were treated at a cost of $23,000 in the summer of 2013.
2. Stand J – Wisteria here was treated with a legume specific herbicide, Transline, a Clopyralid chemical product, at a cost of $1000 in July 2014. The application appeared to be effective into 2015.
3. Cabell's Mill Meadow – Eleagnus umbellata was treated here by cutting the shrubs and applying herbicide to the stump at a cost of $2000 in the summer of 2013. By the growing season of 2014, the area needed a touch up treatment but appears largely to have been effective. A prescribed burn conducted in April 2015 was improved because of the absence of the shrubs.
4. Big Rocky Run stream corridor – Ranunculus ficaria treatments will likely be an on-going maintenance need. Treatments are relatively inexpensive, approximately $500 per year for three years. Treatment of wisteria in the summer of 2013 and 2014 appears to be successful, however, there is some invasion of Persecaria perfoliata in its place.

**Stand H before treatment of Microstigium vimineum, June 2013**

**Stand J after treatment of Wisteria sinensis, August 2014**

**"Worst offenders" – aggressive NNI targets:**

Treatments of these offenders will need to be on-going maintenance work as they are a constant threat and seed sources are plentiful outside of the park. Treatments are relatively inexpensive because of low intensity invasions, but monitoring must be constant.

**Project support treatments:**

These treatments were provided over the course of 2013-2015 and are incorporated into the project costs charts listed above.

**Cost table:**

| Project | Cost | Acres treated |
|---|---|---|
| Selective thinning | $650 | 0.4 |
| Shelterwood cut | $5810 | 0.76 |
| Clear cut and planting | estimated $24,000 over 5 years | 6 |
| Shelterwood cut and NNI stabilization | $5210 | 2.2 |
| Meadow installation | $500 | 0.1 |
| Understory planting | $1500 | 1.1 |
| Light gap regeneration incubator | $1000 | 1.3 |
| Reverse fertilization experiment | $150 | 0.05 |
| **Total** | **$14820** | **11.91** |

## *Deer Treatments*

**Sharpshooting contracting:**

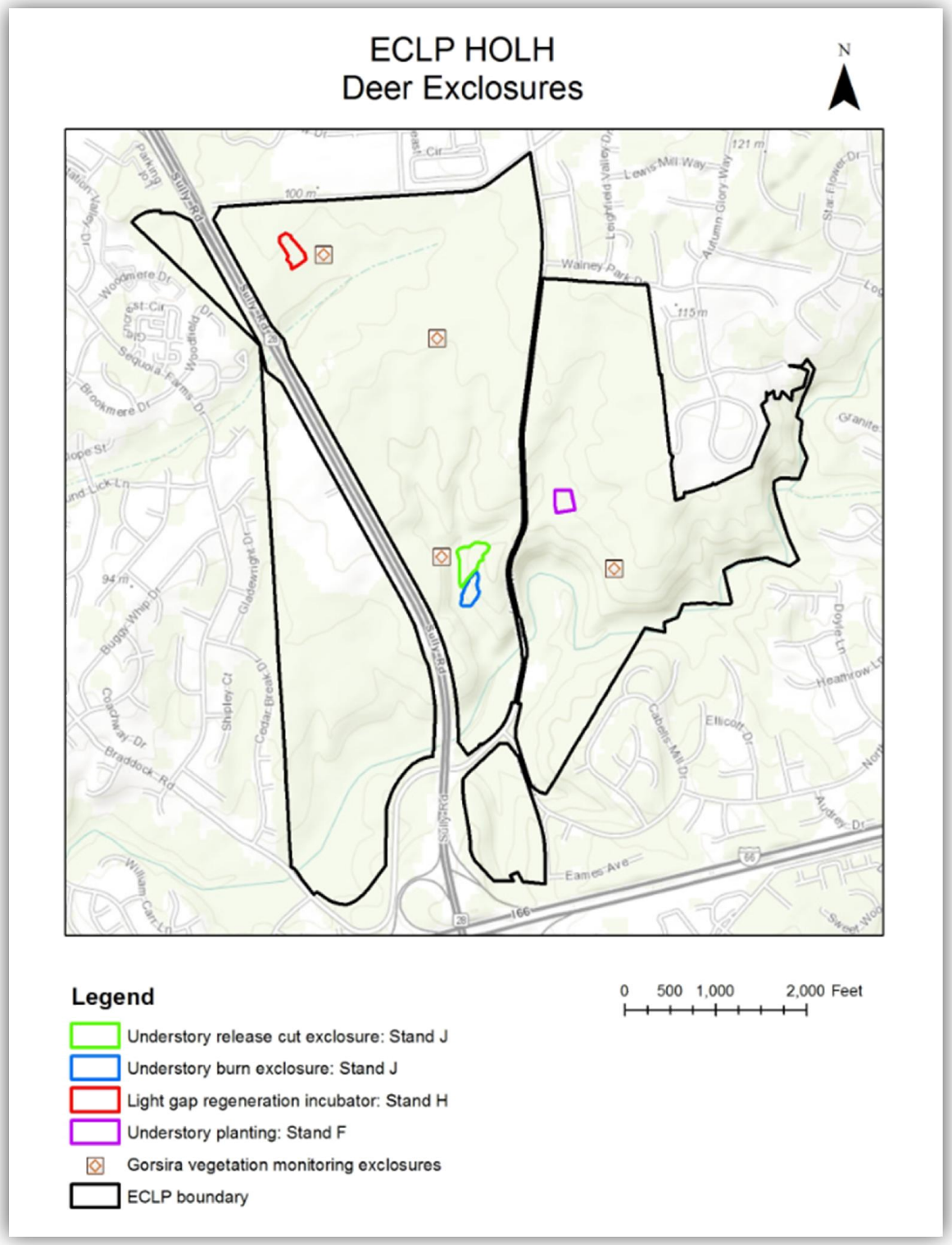
Deer sharpshooting contracting was implemented over the winters of 2013-2014 and 2014 – 2015. In the winter of 2013-2014, eighteen days were used to harvest 92 deer. In the winter of 2014-2015, nine days were used for a harvest of 40 deer. Details on the results of these treatments are available in Appendix D.

**Deer exclosure fencing:**

A total of four deer exclosures were installed not including the 4 small data collection exclosures installed by a contractor for vegetation monitoring related to deer management activities. The four deer exclosures were installed to protect the resources treated in other projects and to isolate the effects of the treatment from browse impacts.

**Exclosures cost table:**

| Project | Acres exclosed | Perimeter in feet | Cost | Cost per linear foot | Cost per acre | Date installed |
|---|---|---|---|---|---|---|
| Forest understory prescribed burn | 1.07 | 968 | $2085 | $2.15 | $1948.60 | 6/8/2013 |
| Understory competition release cut | 2.05 | 1364 | $2505 | $1.84 | $1221.95 | 11/9/2013 |
| Light gap incubator | 1.3 | 1057 | $1662 | $1.57 | $1278.46 | 12/1/2014 |
| Understory planting | 1.1 | 854 | $2086 | $2.44 | $1896.36 | 4/25/2015 |
| **Total** | **4.45** | **3275** | **$6253** | **$1.91** | **$1405.17** | |


ECLP HOLH
Deer Exclosures
N
Legend
Understory release cut exclosure: Stand J
Understory burn exclosure: Stand J
Light gap regeneration incubator: Stand H
Understory planting: Stand F
Gorsira vegetation monitoring exclosures
ECLP boundary
0 500 1,000 2,000 Feet
Sully Rd
Walney Park Dr
Lewis Mill Way
Eames Ave
Braddock Rd
Granite
Doyle Ln
Heathrow Ln
Ellicott Dr
Cabells Mill Dr
Shirley Ct
Cedar Brook Ln
Gladewright Dr
Buggy Whip Dr
Coachway Dr
Brookmere Dr
Sequoia Farms Dr
Woodmere Dr
Woodfield Dr
Leighfield Valley Dr
Autumn Glory Way
Star Flower Dr
Audrey Dr
William Carr Ln
Parking lot
100 m
121 m
115 m
94 m
166
66
28

**Exclosure around the prescribed burn unit in Stand J, May 2014**

## *Soil Treatments:*

**New Meadow installation:**

During the construction of the new meadow, one half of the site (about 0.4 acres) was amended with 60 cubic yards of leaf compost, or about a 2'' thick layer, at a cost of $2,196. An area about the same size was disked, though only 0.3 acres of this had received the compost amendment. The entire site was seeded.

As of this report, the meadow is in its third growing season, and its second full season. After the compost and disking treatments, compaction had indeed been reduced and organic matter added to the soil. However, the true test of this soil treatment will not be measurable within the timeframe of this project, that is, whether NWSG species will improve the soil significantly for forest regeneration.

**Soil Compaction relief:**

Daikon radishes or "tillage radishes" were planted in four locations in the park. After the growing season was completed, none of these locations had witnessed significant root growth of the radishes. Samples were less than 5" long and thinner than a pencil. Initially, radishes had grown vigorously, but were highly dependent on sunlight and where competing vegetation was taller, radishes did not exhibit much growth. In addition, radish vegetation had been browsed by deer and eaten by insects or other animals. The literature about radish "drilling" supports their ability to reduce compaction under certain conditions but none had tried it in a park or forest setting with limitations on light, space, nutrients and with competition.

**Reverse fertilization experiment:**

A total of 105 cubic yards was delivered at a cost of $1800. Sawdust was spread in the three project areas by volunteer labor in the forested areas and by tractor in the meadow and waste environments. Native plant seeds were spread in the gasline easement site and the waste site near the Middlegate complex. The sawdust was from hardwood species, and contained a few small cuttings of unmilled wood.

The sawdust appeared to function as a kind of mulch and delayed the return of vegetation slightly. However, the success of this treatment may not be possible to observe before the HOLH project at ECL has ended.

**Biochar experimental process:**

NRMPB and ECL staff worked together to produce biochar on series of days in January and February of 2014. Using the ECL equipment, herbicide killed Eleagnus umbellata stems were chipped in a wood chipper and captured in the back of a pickup truck. Capturing the chips in the truck was surprisingly difficult and required the use of tarps, hay bales and other baffling features. A fire pit was dug in the soil and wood from past tree falls was used to create a fire on which to "cook" a 55 gallon drum filled with the Eleagnus wood chips.

This drum, or kiln, was sealed and three ½'' holes were drilled into one side of the drum near the top, middle and bottom. The kiln was laid the fire on its side with the three holes pointed down into the fire. Gases escaping the barrel were burned as well in the low oxygen environment within the drum and could be seen jetting from these holes.

After several failed attempts, it was found that a very hot fire with a large quantity of fuel was needed to heat the barrel for at least 4 hours. A barrel packed full of wood chips, cooked down to about one-half a barrel of bio-char material. About 20 hours of staff time

was required to produce 25 gallons of bio-char, including time spent tending the fire, chipping the Eleagnus stems and splitting wood fuel for the fire. The market value for 25 gallons of bio-char could be on the order of $200-$250.

Staff time would be used much more efficiently once a procedure was chosen. However, given the current limitations on staff time resources, it was decided that production of bio-char on site is time/cost prohibitive. Volunteer time or improvements in the bio-char kiln system could reduce the time required as well. Other than staff time, costs were minimal. A 55 gallon metal drum cost $35, fuel wood was harvested from the park's fallen trees and char material consisted of NNI plants.

The biochar was not used as a soil amendment in any of the experimental treatments as its effects are documented and the quantity produced was not enough to scale up. Due to limitations in FCPA equipment and especially staff time, in-house production is currently cost prohibitive. Innovations in resource use to produce biochar could be a valuable undertaking if biochar could be added to root balls of native plantings.

## *Disturbance regime reintroductions:*

### Prescribed understory fire: Stand J

Prescribed fire was reintroduced in the forest understory burn conducted on April 23, 2013. This was the first forest burn conducted at the park and upon review, the conditions on the day of the burn qualified it as a growing season burn instead of a dormant season burn, which was the original intent. The long term results of this burn can't be observed within the timeframe of this HOLH project but data collection began in the first two years following this burn.

In addition, a meadow burn was conducted on March 19, 2015. The burn consumed the fuels on site relatively efficiently. ECL staff felt that part of this was attributable to control of NNI plants, notably Eleagnus umbellata, which can reduce fuel loading under its canopy and limit fuel continuity.

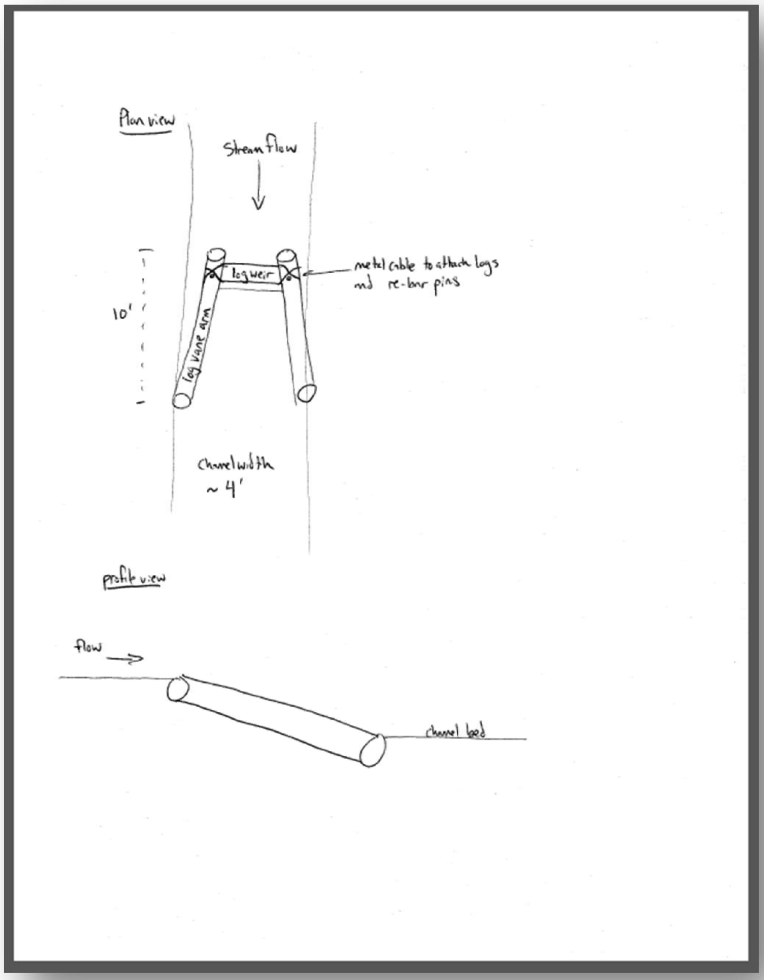
### Selective thinning: Stand E

The greatest challenge in implementing thinning activities is the risk of NNI plant invasions. This was apparent in both the treatment in Stand G as well as the area on the border of Stand C and Stand F. Microstigium and Wineberry in the treated areas grew three times higher than the same plants growing in the shade nearby. The understory release cut treatment did not have as pronounced an impact on NNI plant invasions. Nearby NNI species did advance in to the site but it is unclear whether the rate of spread was changed by the treatment.

## *Stream rehabilitation:*

Changes in the portion of impervious surface of Roundlick Run's watershed have increased flow volumes pasting through the park, creating erosion, channel incision and severe headcutting. A location was identified where steep grade was contributing to headcutting. NVSWCD designed a small structure that could be installed by hand and NRMPB staff applied for a voluntary stream improvement permit from the Army Corps of Engineers.

As a result of scheduling conflicts with partnering agencies, this treatment was not implemented within the time frame of the project. A permit was received from the US Army Corps of Engineers to implement the project. The permit was granted on 9/29/14.




**Schematic of in-stream log structure**

# Discussion

It is difficult to draw clear conclusions about certain types of treatments and whether they are successful or need alteration. In general, the scope of time required to gain perspective on ecological restoration of a forest ecosystem is much longer than the parameters set for HOLH at ECL. Additional observations need to be made and data collected in future growing seasons. Foresters typically measure silvicultural work over the course of decades because tree growth rates are a major limiting factor. The same is true in a forest restoration where time must pass to observe the success of native plant regeneration and to apply adaptive management.

The work done at ECL was the "construction," or implementation phase of a forest restoration project and is analogous to the building construction of a traditional capital construction project, for example, an office building. HOLH represents investment in natural capital and just as an office building requires maintenance to protect the investment, so do natural capital investments. It will likely be several years before definite conclusions can be drawn about some of the methods applied in the pilot project, and without maintenance of the project sites for the pressures of white-tailed deer, NNI plants and human impacts, these pilot project sites may returned to a lower quality state, and indications of success may be masked or erased.

A major difference in capital analogies is that ecological restoration in the wildland urban interface is still a very young field. Development and mastery of successful techniques continues to be forthcoming and practitioners invent new techniques frequently. The pilot aspect of HOLH at ECL, therefore, is important to keep in mind when reviewing outcomes.

## *Traditional Forestry treatments:*

**Understory release cut: Stand J**

Overall, there has been an increase in the growth of woody plants in the shrub layer. These are composed of both tree and shrub species, notably a variety of oak species, hickories and witch hazel. Cut stumps have re-sprouted in many cases and seedlings of these species are also present. It seems likely that the exclosure has allowed the woody species to grow without browse pressure. There is a small increase in the presence of NNI plants, notably Microstigium vimineum in areas that received increased direct sunlight.

Oak and hickory whips seem in a good condition to develop into the understory and possibly eventually the canopy provided that NNI presence remains relatively low and

that they are not outpaced by seedlings of Liriodendron tulipifera, Fagus grandifolia and Acer rubrum.

This treatment would be recommended in forest stands where there is a low presence of NNI plants, where there is a reasonable tolerance for increases in NNI and where delaying changes in stand composition are desired. The Success of the exclosure seems clear and can be recommended in locations requiring protection of woody growth in the understory.

**Selective thinning: Stand E**

Determination of this treatment's success is outside of the timeframe of the project with regard to the growth of oak species and increased presence of oak in the understory. However, in the short term, the release of crop trees has corresponded with a release of NNI plants, mostly Microstigium vimineum which was present prior to treatment. Even with reasonable control efforts applied to the site, NNI invasion became a problem. Installing competing native plants as nurse plants for acorns is a challenge in the forest environment where agricultural methods and tractors can't operate. The best management plan for this treatment on a larger scale would have to include NNI management for many years.

It is difficult to imagine a scenario in which this treatment would be recommended without heavy investments into NNI control for many years following the initial treatment, given the ubiquity on parkland of species that would threaten the treatment with failure.

**Shelterwood cut: Stand G**

This treatment was adapted several times to account for new challenges that arose during implementation. The shelterwood cut was successful in reaching goals for canopy coverage and tree choices but the mode of implementation required a great deal of staff time and treated only a small area. Ultimately, the greatest demonstrable success in this method was the repeated and aggressive use of herbicide against NNI plants. As of the summer of 2015, the site is nearly clear of invasive plants after four treatments over two growing seasons. It has been seeded with NWSG which has germinated, albeit somewhat inconsistently because soil was not prepped prior to hand broadcasting and a thin layer of dead vegetation remained on the ground. A soil preparation would have been preferred but a method could not be devised as a result of the many stumps and trunks. An additional lesson learned is that plantings do not provide enough coverage to out-compete NNI plants for domination of the system unless they are planted in very high densities. High density plantings could become very expensive and seed is preferred.

This treatment is not generally recommended unless staff resources and herbicide funding is available in sufficient amounts.

**Prescribed forest burn: Stand J**

Many young trees were topkilled and have since stump sprouted. Where ground level herbaceous plants were growing vigorously, ignition was not successful. These areas were usually populated with NNI plants and so the fire's impacts on NNI plants were limited.

Mortality of woody stems was not our goal but the resulting density of stems is beneficial. Woody stem density increased because multiple stems re-sprouted from the stumps of topkilled young trees. The exclosure has been successful as well because there is energetic growth on many of the young oaks and leggy shoots on Ericaceous species and Rhododendron species. Changes in NNI plant presence are little and any changes could be independent of the prescribed fire.

This practice would be recommended if conducted during the dormant season to increase the herbaceous vegetation and stimulate woody species. However, a growing season forest burn is not recommended where woody understory regeneration is desired.

**Clear cut and planting: Stand L**

This method was determined to be too expensive to be implemented by the time it was estimated. However, it provides a financial reference point for this type of treatment in the future.

## *Alternative Forestry treatments:*

**Shelterwood and NNI stabilization: Stand G**

This treatment clearly showed how much more efficient the forestry cutting machine can operate than hand crews with power saws. The machine treatment proceeded at nearly three times the rate of the hand crews; about 30 hours per acre versus hand crews at 80 hours per acre. In addition, the machine cleared much more dense vegetation in an area of the same forest stand that would have been impossible to walk through and would have slowed the hand crews further.

One of the challenges of this treatment is successfully growing native species to follow the mechanical treatment. The custom, “trickle down” seed mix created for this treatment emphasized seed characteristics that would allow seeds to fall through the woody debris and reach the soil because bare soil would not be available everywhere. Favorable characteristics included small size, hard and smooth seed coating, round shapes and heavy weight.

As of the time of this writing, grasses had germinated and begun to grow, despite the very dry conditions in August. However, the growth is very patchy and inconsistent. Germination is better in areas that received some shade, contained more soil moisture and that had relatively less woody debris on the ground. Some of the grasses appear to have germinated through woody debris up to 4’’ thick but at much lower rates than areas that had visible soil mixed with the debris.

Methods to improve soil mixture with the woody debris would improve growth rate of the native grass seed. One idea is to use the Bobcat’s grapple bucket attachment as a root rake and stir the soil in with the woody debris. Skipping this step would be advantageous because it would mean there was only one machine treatment required. The treatment at ECL did not implement this step because observations of similar treatments were not available before implementation and could not be undertaken after seeding without destroying seed and seedlings and possibly exposing more NNI seed.

Regarding herbicide, it is unclear what impact the use of pre-emergent had on the treatment’s long-term success. In September 2015, observations suggest the pre-emergent produced a modest decrease in the presence of annual NNIs, specifically Microstigium vimineum and Persecaria perfoliata. If this allowed NWSG seedlings to compete better, then the use of a pre-emergent could be an effective measure. Germination of Celastrus orbiculatus and Eleagnus umbellata from seed was not observed. During the effective period of the pre-emergent, annual ryegrass (Lolium multiflorum) was broadcast in treated and untreated areas. The seed germinated in both locations but germination occurred at a slightly lower rate and growth was somewhat less vigorous and slower in the pre-emerged area. By July however, there did not seem to be any difference in germination rates of NWSG.

**SMASH meadow:**

This treatment has shown good potential and significant success. Overall, the site is now in a vastly improved condition and dominated by native vegetation with some native woody plants already beginning to volunteer such as Carya glabra. The disking treatment for soil preparation was a success for germination and establishment of NWSG. It does not appear that additional herbicide treatments were necessary to improve establishment of native grasses.

The utility of the compost amendment to soil is undecided. Over the first two growing seasons, the compost made a very obvious contribution to the vigor, height and density of the perennial native plants. Initially, it appeared that the NWSG grew so large that it limited the sunlight available to NNI plants, notably Persecaria perfoliata and Microstigium vimineum, and controlled their growth. However, the third growing season was the first in which Persecaria perfoliata was not removed from the site and it overwhelmed the native plants in some areas where compost was present. With this in mind, the nutrient benefit to the NNI may have been greater over the course of 3 growing seasons than the benefit to the native plants in the first two seasons. As such, the third growing season has showed that the disking for soil preparation without compost is the best treatment for encouraging native perennial growth with fewer NNI plants.

NNI annuals like Persecaria perfoliata and Microstigium vimineum are difficult to control because they are persistent in the seed bank, require treatment every year, and immigration of new seed can come from numerous nearby locations. Here, I would recommend a hand pulling team to remove it at least once every growing season and ideally twice. Additionally, I would advise caution when using this type of treatment in an area that has or may experience a significant infestation of aggressive NNI annuals species.

**Understory planting project: Stand F**

Results of this treatment are forthcoming and likely will be difficult to characterize for 5-10 years. Initially, many of the small plantings have survived although rodents dug up many of the oak plantings immediately after installation. Most of these were salvaged. Some of the larger plantings appear to be experiencing transplant shock and may recover. NNI maintenance treatments may be needed in the future.

**Light gap regeneration incubator: Stand H**

The results from this project will likely require several years to become apparent. Regeneration of woody and herbaceous species is likely to occur within 2 years, however, clues to the composition of the community that can be expected to grow in an exclosed light gap will take longer to observe. The balance between native and invasive plants needs to be observed. NNI annuals are present and may pose a significant problem for light competition with native perennials.

## *NNI treatments:*

**High quality maintenance treatments:**

1. Stand H - FCPA staff observed approximately 85% less Microstigium during the growing season of 2014. Microstigium returned in 2015 and was nearly as dense as pre-treatment in 2013. Overall, this maintenance activity is not recommended for the future because of the characteristics of Microstigium vimineum and the size of the area.
2. Stand J – This treatment was a success and would be recommended in other areas. Wisteria threat to the stand has been vastly reduced and possibly eliminated.
3. Cabell's Mill Meadow – Success controlling Eleagnus umbellata in this context would need a maintenance re-treatment approximately every 3 years. Ecological function response from prescribed fire was excellent and re-treatment would be recommended.
4. Big Rocky Run stream corridor – Currently, maintenance treatments are successfully controlling Ranunculus ficaria in ECL. Continued re-treatment is recommended. Wisteria sinensis treatments were largely successful as well. Kudzu treatment was successful but its presence was very small to begin with.

**"Worst offenders" – aggressive NNI targets:**

Treatments of these offenders will need to be on-going maintenance work as they are a constant threat and seed sources are plentiful outside of the park. Treatments are relatively inexpensive because of low intensity invasions, but monitoring must be constant.

**Project support treatments:**

Control of invasive plants as part of combined treatments was often successful and comprised a necessary component for native plant growth in all treatments. Without this component, most if not all of these restorations would fail. Maintenance treatments may be required in most cases.

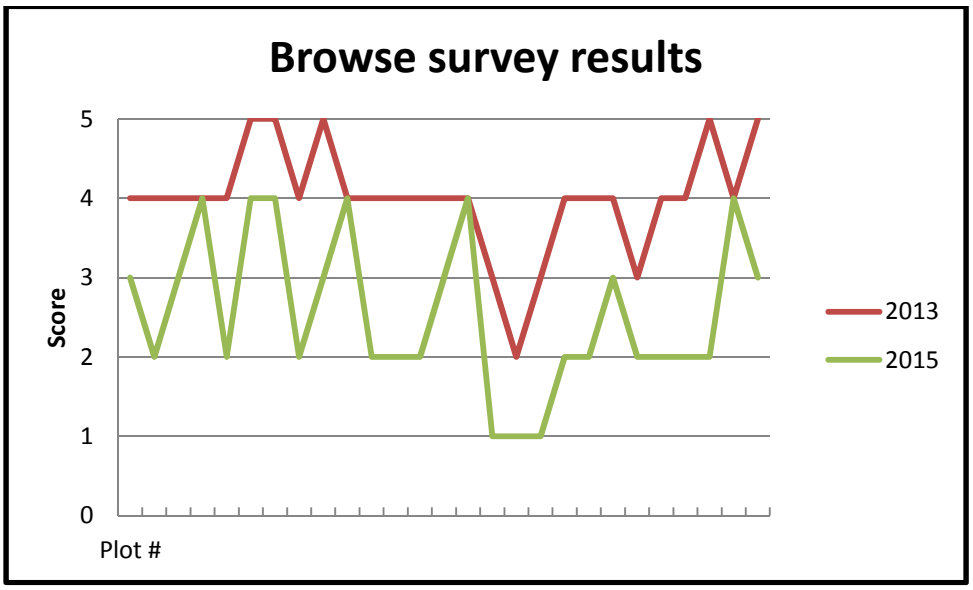
## *Deer Treatments:*

**Sharpshooting contracting:**

Sharpshooting was successful in removing a high number of deer in a short period of time. Initial data collection by NRMPB staff on vegetation recovery shows significant improvements in the park after two years of contracting sharpshooting. However, contracting with a private organization for this work may not be financially sustainable in most cases.

Population analysis is on-going, especially regarding migration, to determine the duration of impact on the deer population and what level of maintenance effort will be required to limit the deer population to levels that support vegetation recovery. Maintenance treatments could be in the form of the county's volunteer archery program or in future sharpshooting by the Animal Control unit of the Fairfax County Police Department, or in future private contracting should the need arise and funding be available.

The following table shows the results of the Deer browse survey from 2013 and 2015. A lower score indicates less deer browse observed in the plot. Many plots showed reductions by 1 or 2 points.



**Deer exclosure fencing:**

The exclosure system itself was largely a success. The light construction is not as durable but is much simpler and easier to repair, making the overall lifespan of the fence longer and more financially sustainable. Each exclosure was repaired approximately twice a year depending on weather conditions that caused branches or trees to fall on fences. Chain link, welded wire or other materials would have required resources set aside for these repairs. No problems with deliberate human vandalism or damage were discovered.

Observations in exclosures installed in 2013 showed obvious woody plant growth that outpaced that of plants outside the exclosure. This can be regarded as a success in the short term against browse pressure from deer and as a success for protecting combination treatments that involved mechanical work, prescribed fire, etc. In the long term, it is unclear what community composition changes may take place. In addition, differences in the spread of NNI plants due to deer movement are anticipated but currently not observable.

## *Soil treatments:*

Other than the intensive growth observed in the second growing season in the SMASH meadow treatment, soil treatments did not produce observable benefits to ECL HOLH goals. As soil chemistry changes in response to the addition of the amendments, there may be community changes in the future, but those changes are likely beyond the timeframe of the current project.

## *Disturbance regime reintroductions:*

These practices were successfully carried out, although the benefits to the plant community cannot be observed within the timeframe of the project.

## *Stream rehabilitation:*

This treatment and similar practices were not implemented during the course of the project but observations of similar treatments at Huntley Meadows Park show some success in restoring limited function to badly incised streams. Sedimentation increased and channel depth was reduced in places. The success leads to a follow up question about how far apart structures need to be installed in a stream to have a system wide effect. If successful, this and similar small scale stream structures would be highly valuable to ECL's forest streams for aquatic and amphibian wildlife as well as soil health

and plant community habitat. With volunteer labor in the form of scout troop projects, FCPA staff could install a variety of these structures at a very low cost over a period of several years.

**Sedimentation downstream of log structure installed in November of 2012 at Huntley Meadows Park. Photo taken June 2013.**

# Conclusions

Overall project goals were achieved. Methods to promote natural regeneration were applied, the park's natural communities were managed for native species and communities, and impacts from human activities, white-tailed deer and NNI species were limited. Twenty practices and four processes were developed that can be replicated in other parks and projects throughout the county and region.

Recommendations in most cases are not well defined because the natural capital improvement process occurs over a timeframe that is beyond the scope of this project. This is primarily because of the relatively slow rate of forest vegetative growth and the number of growing seasons needed to demonstrate results.

However, observations of the results of many treatment types show positive changes in vegetation regeneration after just a few growing seasons. For example, the SMASH meadow, the understory release cut, the deer exclosures and the shelterwood cut and NNI stabilization treatments, all demonstrate improvements from their previous states. In addition, the parkwide reduction of the deer population showed widespread improvements in woody plant regeneration. If the positive trend in these treatments continues, they offer potentially valuable lessons for other restoration efforts.

**Final Cost comparison table**:

| Forestry treatments | cost | size in acres | cost / acre |
|---|---|---|---|
| Understory competition release cut | $3905 | 2.05 | $1905 |
| Selective thinning | $1225 | 0.4 | $3063 |
| Shelterwood cut | $7653.72 | 0.76 | $10071 |
| Prescribed forest burn | $300 | 3.62 | $83 |
| Clear cut and replant (not implemented) | $195000 | 6 | $32500 |
| Shelterwood cut and NNI stabilization | $8393.4 | 2.2 | $3815 |
| SMASH meadow | $6020 | 0.75 | $8027 |
| Understory planting | $36575 | 1.1 | $33250 |
| Light gap incubator | $2662 | 1.3 | $2048 |
| | | | |
| **Deer treatments** | | | |
| Sharpshooting contracts (2 seasons) | $93019.5 | 650 | $143 |
| Deer exclosures | $6253 | 4.45 | $1405 |

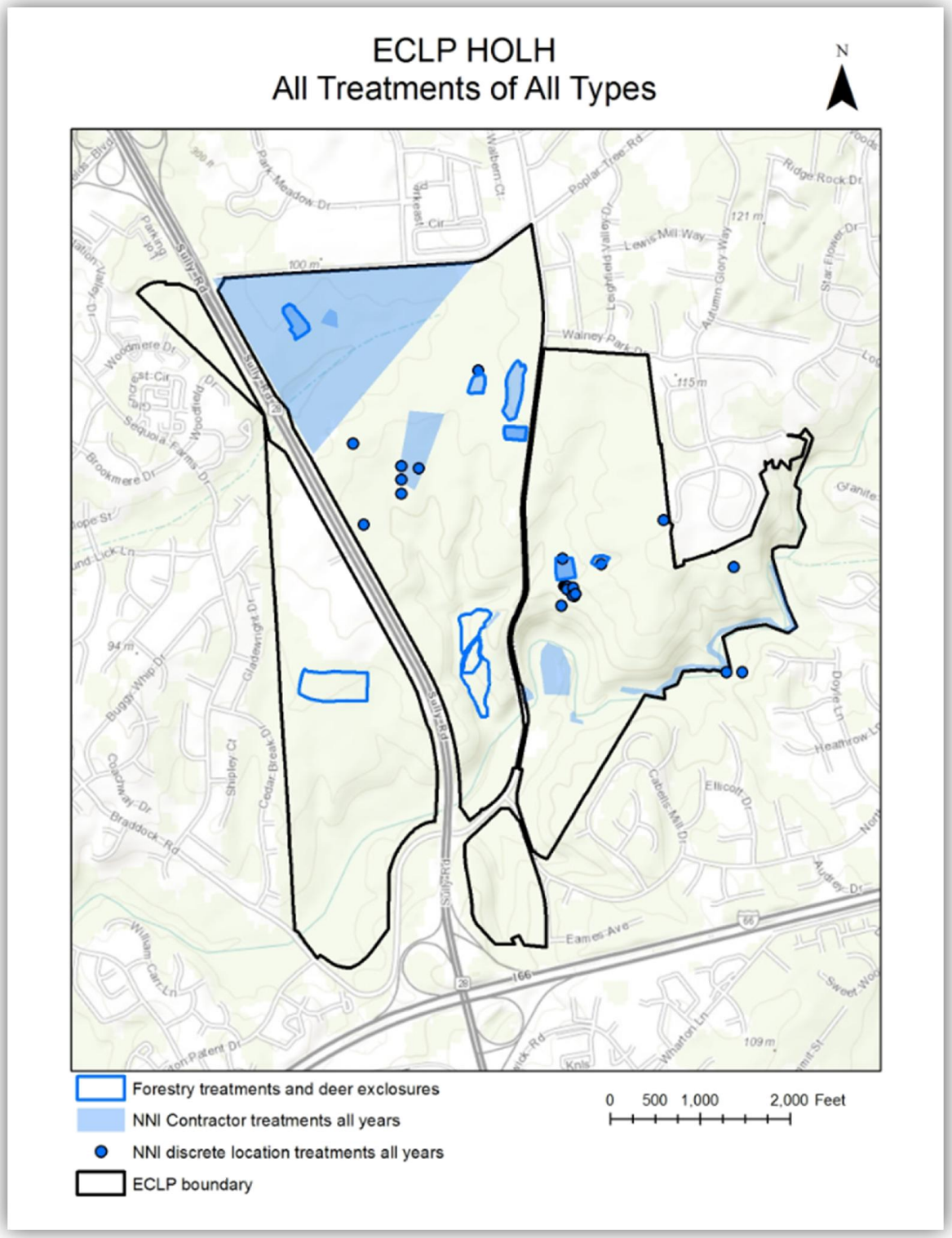
**Recommendations:**

Natural resource management activities should continue under the supervision of the ECL on-site natural resource manager.

1. Provide maintenance level management services to restoration treatment areas:
    a. Parkwide:
        i. Continue to participate in the county's deer management program.
        ii. To the extent possible, continue to control NNI plant species of the "worst offender" category such as Ailanthus altissima, Ranunculus ficaria and Oplismenus hirtellus.

   b. Treatment project areas:
      i. Implement maintenance level NNI control, especially in areas that have received intensive treatments such as the Shelterwood cut and NNI stabilization, the SMASH meadow installation and the understory planting project.

2. To whatever extent possible, expand restoration treatments piecemeal.
   a. If access to required resources becomes available, consider implementing the most effective and lowest cost restoration treatments where appropriate. For example, with funding for herbicide, seed and staff time, the shelterwood cut and NNI stabilization treatment could be continued in Stand G at a rate of about $4000 per acre. In addition, prescribed forest burns are a very low cost method of resource management.


ECLP HOLH
All Treatments of All Types
N
Forestry treatments and deer exclosures
NNI Contractor treatments all years
NNI discrete location treatments all years
ECLP boundary
0 500 1,000 2,000 Feet

# Appendices

## Appendix A

From the VADOF Virginia Forest Stewardship Plan:

### Ten Year Time Line of Actions

This timeline distills the specific management recommendations from the stand descriptions into a list of proposed actions. To an extent this time line reflects the urgency of actions and their expense. Because of their issues, stands F and L have been considered separately.

| | |
|---|---|
| 2013 | Prepare deer management plan to reduce and control deer herd. |
| | Begin implementing deer management plan. |
| | Implement early detection rapid response to prevent invasion of stands not already heavily invaded by non-native invasive plants. |
| | Conduct an understory burn in stand J. |
| | Begin invasives control in Stand G using triclopyr based herbicide and late July cutting of stiltgrass. |
| | Perform a crop tree release on part of the eastern section of Stand A. |
| | Address erosion of old road bed in Stand B. |
| | Begin stilt grass eradication in Stand H. |
| | Girdle 5 large hickories in Stand K. |
| 2014 | Continue deer management and EDRR. |
| | Monitor results from release performed on stand A. |
| | Continue invasive management in Stands G and H |
| | Determine direction of Stand P and begin implementing management recommendations to achieve desired outcome. |
| | Install erosion control in Round Lick Run in conjunction with Northern Virginia Soil and Water conservation District. |
| | Burn Stand C. |
| 2015 | Continue deer management and EDRR. |
| | Monitor results from release performed on stand A. |
| | Mark stands A, B, C, D, H, J, N, O, P, and the riparian part of stand Q for thinning. Delineate boundaries of Stand E for clear cutting. |
| | Develop invasive management plan for thinned and cut over stands based on experience |

| | |
|---|---|
| | with Stand A. |
| | Continue invasive management in Stands G and H. |
| 2016 | Continue deer management and EDRR. |
| | Continue invasive management in Stands G and H. |
| | Monitor results from release performed on stand A. |
| | Sell marked timber in stands A, B, C, D, E, H, J, N, O, P, and Q. |
| | Conduct crop tree release and /or timber stand improvement in Stand G and begin introduction of native warm season grasses. |
| 2017 | Continue deer management and EDRR. |
| | Continue invasive management in Stands G and H. |
| | Implement invasive management plan for stands A, B, C, D, E, H, J, N, O, P, and Q. |
| | Plant Stand E with Short Leaf Pine |
| 2018 | Continue deer management. |
| | Continue invasive management. |
| 2019 | Continue deer management. |
| | Continue invasive management. |
| 2020 | Continue deer management. |
| | Continue invasive management. |
| | Conduct chemical release of shortleaf pine in Stand E at end of growing season. |
| 2021 | Continue deer management. |
| | Continue invasive management. |
| 2022 | Continue deer management. |
| | Continue invasive management. |

## Appendix B

See attached deer management plan produced by White Buffalo, Inc.

## Appendix C

See attached HOLH brochure produced by FCPA staff.

## Appendix D

See attached reports from White Buffalo, Inc. regarding the results of sharpshooting programs during the winter of 2013-2014 and 2014-2015.

## Appendix E

See attached the Scope of Work example for the Understory Planting project.

# Fairfax County Park Authority, Virginia

**REQUEST FOR PROPOSAL**

**FOR**

**DEER MANAGEMENT SERVICES - TECHNICAL PROPOSAL**

**14 June 2013**

**Proposal By:**

**Dr. Anthony J. DeNicola**
**White Buffalo, Inc.**
**A Connecticut 501(c)(3) Non-profit Corporation since 1995**
**EIN: 06-1431342**
**SCC ID Number: F191944-0**

## Introductory Statement

Communities and parks often employ two different types of lethal management programs when they decide to reduce local deer populations; hunting or professional sharpshooting. Hunting has the advantage of using volunteer participants to harvest deer, reducing program costs. However, it has been shown that there are limits to the level of deer reduction that is attainable when using recreational hunters and regulated hunting methods. It is of particular concern when deer densities are desired that relate to biodiversity priorities. Sharpshooting, as defined by the use of trained professionals using culling techniques outside of permitted recreational hunting methods, can reduce local deer populations lower than what has been achieved historically using recreational hunting. The limiting factor with expanded use of this approach is the labor cost associated with such programs. Therefore, I propose a hybrid strategy were volunteers are trained in sharpshooting methods and are supported and managed by local professional staff, which also receives additional project-specific training. This approach utilizes the oversight capacity and existing institutional infrastructure of the governing entity, combined with trained volunteers, resulting in a program that can be scaled with controlled cost, and that has the potential to meet all deer management objectives.

It will be imperative to develop a system that is resilient to changing administrations, personnel, and politics. The program will need to become institutionalized so that if the personnel/administrators that are trained initially leave the Park, it remains viable. If proven to be a successful mechanism to manage local deer populations in the Park, then this program needs to become as ingrained in the Park system as grounds maintenance operations; implemented year after year.

## Consulting

As noted in the RFP, the objective is to develop a management model that can be objectively evaluated then expanded based on identified successes and failures. The first component of the process is to review all past management program initiatives and assess the relative merits of each. After choosing the best components of these existing programs, and simultaneously identifying the necessary in-house staffing, we will build the best model to test. This alternative approach may be used in conjunction with, or supplant, past initiatives based on the site-specific factors.

## Population Inventory

We recommend using fixed-wing FLIR counts to estimate the population annually. Larry Davis, with Davis Aviation, is the most experienced and most reliable contractor in this very specialized discipline. Once deer densities are reduced, the accuracy of Distance sampling methods or camera trap evaluations becomes limited with small sample sizes. Bait station-based camera monitoring is further compromised and biased by using bait for culling operations. Park staff should continue to assess long-term ecological benefits, through vegetation monitoring, of

reduced deer densities. Davis Aviation charges $2.50/acre plus $2.00/mile ferry fee. He is based in Kent, OH.

## Planning

Once a general strategy is agreed upon, the broader Park system will be assessed through aerial imagery to determine what the optimal deer management approach will be for each location. Variables such as development density, human activity, points of ingress, past deer manage methods and their respective effectiveness, road and trail access, vegetation composition, and political considerations will be integrated into the decision-making process. All elements of the selected deer reduction program will be transitioned to fully trained Park staff and volunteers for long-term continuance of field operations.

## Population Control

White Buffalo Inc.'s (WBI) strategic approach to suburban deer management is specifically designed to address and avoid the most common cause of failure; creating an "educated" population that is skilled in avoiding deer management activities. Well before the first deer is dispatched, we focus on how to remove the last. The defining strategic characteristic of every population control effort is the management team's singular focus on preventing the remaining deer from being educated to avoid humans even as the population is rapidly reduced. A suburban deer management team must remove a high percentage of a population and repeat this process for years into the future, so maintaining the naïveté of the select population is strategically paramount, and is the most important means of reducing risk of failure and minimizing long-term costs. For this standard to be met, the team must possess superior technical ability (e.g., to shoot with precision in suboptimal conditions), field intuition (e.g., to determine whether animals encountered should be engaged), and discipline (e.g., to refrain from engaging if conditions are not conducive). In summary, the behavioral characteristics of the deer at low density, and the ability to subsequently harvest them, will be shaped by events unfolding from the first day of the management activities.

WBI's methods are humane and address concerns for animal welfare by following the American Veterinary Medical Association's stringent guidelines for humane euthanasia of animals (AVMA 2001). We have spent the last 18 years committed to improving both technology and techniques to maximize safety and efficiency for the management of white-tailed deer (i.e., ballistics testing, bullet development, baiting techniques, adaptation of other technologies for use in deer management, including night vision scopes and suppressors). We have the best available equipment with numerous hours of hands-on use to ensure precise shot placement. This results in safe use of equipment and humane treatment of target animals. We have thoroughly tested and selected bullets, in addition to having developed specialized bullets. As a result of our extensive testing, we have found that no bullet fragments with significant size or inertia exit the target animal, therefore ensuring public safety. We have extensive experience in both lethally removing (>10,000 deer) and capturing deer (>2,000 deer) in a variety of human occupied environments without incident. We have used our discretion in the selection of shooting sites with complete satisfaction of both local/state officials and property owners. In

conclusion, although safety is the primary issue to be considered when implementing a program to reduce deer numbers, with the above precautionary measures and the expertise of White Buffalo, Inc., it need not be a concern. These skill sets and discipline, developed through years of repeated field evaluations, will be imparted to the volunteer sharpshooters.

The Park may decide to continue existing hunting programs in some circumstances while integrating professional sharpshooting techniques to manage the local deer populations. It is critical that the hunting programs and the sharpshooting efforts are tightly integrated for the entire program to be successful. The two methods are not always compatible when used in the same location because deer become adversely conditioned to humans during recreational hunting activities. Initially, it would be preferable to use the two different approaches in non-overlapping areas. The only time hunting (particularly over bait) does not significantly impact the efficiency of sharpshooting is when deer can be shot from a vehicle (versus a tree stand). However, because hunters cannot use bait on municipal lands this will not be a serious problem as long as timing of the two approaches does not overlap.

The precision and lethality of archery technology has progressed significantly in recent years, however in most cases only **one** deer from a group can be killed at each encounter. In comparison, in most cases **all** the deer are euthanized when using sharpshooting methods. Sharpshooting leaves very few remaining deer leery to management activities. Whereas archery hunting results in high diminishing return over the years as the remaining population becomes adept at avoiding management activities. This is typical of all suburban hunting programs where deer have numerous refugia on unhunted adjoining properties and learn to avoid bait when hunters (or sharpshooters) are present (i.e., bait is consumed after dark, or deer inspect the area for human scent/presence before approaching).

If Fairfax County Parks wishes to use professional sharpshooting techniques to manage the local deer population, then the management of deer via this method will require comprehensive oversight and training by a very skilled and experienced group of wildlife control professionals to be successful long-term. A strategic use of methods will be necessary to ensure that the deer are removed in a timely, safe, and humane manner. This initiative also will require full support from the Park Administration, including very close coordination with local law enforcement, through the authorization of diverse field methods and flexible timing of deer removal activities. Moreover, the plan will have to be adaptive to allow for methodological adjustments as deemed necessary during the project tenure.

## Specific Field Methods

### Pre-baiting, Site Selection, and Site Preparations

Because of high human activity throughout much of the Park system, deer should be drawn to select areas using bait for sharpshooting for both discretionary and safety purposes. Bait should be placed out 3 weeks in advance of anticipated removal efforts. All baiting should be done daily from the same vehicle at a consistent time in the late afternoon/evening. This acts as positive conditioning for the deer; they recognize the vehicle and person baiting and associate it with the appearance of food. Some vegetation that may obstruct shooting opportunities, if present, it will be thinned or pruned to ensure optimal removal conditions.

Sharpshooting

We recommend using suppressed .223 caliber rifles for sharpshooting applications. All rifles should be match-grade and specially designed for sharpshooting deer (specific tactical lighting, optics, ammunition selection, etc). When shooting from a vehicle topographic relief should be used to ensure an earthen backdrop. All deer should be shot in the center of the brain (~95%) or the cervical spine (~5%). Cervical spine shots are taken only when there is an obstruction between the shooter and the deer's brain.

*Sharpshooting protocol*

White Buffalo, Inc. recommends that the following procedures are used:

1) Prior to initiating any field activities the target area/s and surrounding properties should be thoroughly surveyed using topographic maps and aerial photographs followed by field confirmation. By knowing the location of every occupied structure and areas of human use you are better able to work safely, discretely, and efficiently;

2) Bait sites should be selected based on safety concerns, discretion, and deer activity;

3) Field operations should be conducted during hours of lower human activity. In addition, during the removal operation people and non-target animals should be searched for intensively to avoid mishaps;

4) Deer of all ages and sexes should be harvested, however, adult does should be prioritized. Deer may be shot from a vehicle with a rifle during the night with the aid of spotlights. It may be necessary to shoot some deer over bait from a tree stand with a rifle during the day or at night. Night-vision equipment, tactical lights, and suppressed firearms may be used to expedite field procedures and to ensure discrete operations, The fundamental rule is: when in doubt, do not shoot;

5) During deer reductions there will be continuous open communication between community members, municipality officials, law enforcement, participating volunteers, and White Buffalo, Inc. to keep people well informed regarding field activities to avoid conflicts;

6) All deer carcasses should be transported with the highest degree of discretion.

Non-lethal Methods

Even the most modern non-lethal methods are still very inefficient at reducing deer populations. There may be some value in more urban Park settings to surgically sterilize female

deer if firearm discharge is deemed to be unsafe. This will need to be determined once the entire Park system is reviewed during the Consulting and Planning phases.

# Training

Once Park staff are selected they will be trained how to plan, design, implement, and oversee a professional sharpshooting operation from a holistic perspective. They also will be provided comprehensive documents that can be used to train volunteers for their respective responsibilities. We will identify volunteers to assist with site preparations, baiting, camera monitoring, sharpshooting, and carcass handling for donation. When volunteers are not available some tasks may need to be supplemented by Park personnel. This will be a highly structured process where there will be either staff or volunteers that are responsible for each component of the deer management program.

One of our core responsibilities is to train Park personnel and volunteer sharpshooters in field methods related to shot selection and proper shooting techniques. We have designed five very successful deer population reduction programs using sharpshooting techniques that involved training law enforcement agencies. This approach (i.e., training local people to serve as sharpshooters) has merit as a means of reducing long-term costs and meeting management goals.

**Identifying, screening, and training volunteer sharpshooters**

Correspondence should be sent to all participants in the General Managed hunts, asking for volunteers who have experience hunting with rifles. Individuals will be initially screened via an interview process and a background check. Major considerations will be: 1) number of years of hunting experience, 2) number of deer harvested in the past while hunting, 3) number of days per year that they can allocate to this program, and 4) their perceptions of their role in the deer management program.

We will initially take select staff and volunteers to the range for assessment of firearm handling, safety, and proficiency. Selected volunteer or staff sharpshooters then will be required to go through a 2-day specialized training with an additional apprenticeship phase. During the training we also will demonstrate practice drills specifically designed for sharpshooting deer. A comprehensive four-hour PowerPoint presentation is integrated into the training process. After passing the training course they will work directly with professional sharpshooters to learn first-hand how to conduct operations in the field. We will then transition the shooting responsibilities to the volunteers when they are deemed ready to conduct full aspects of the operation. Finally, trainees will observe all phases of the project (site selection, baiting strategies, etc.) to ensure a holistic understanding of the program.

**Developing a Database**

We will assist in the establishment of a database for each park that will have numbered shooting locations and prerequisite wind directions, combined with the associated camera data. Volunteer sharpshooters will be able to log on and see what the wind direction is that day and what shooting locations are adequately active based on the recent camera data. The key to this system is that volunteer sharpshooters will rarely sit at a shooting location without actually

engaging animals. This is in contrast to recreational hunters that often sit many hours and see few deer, and then they lose interest in participating even at high deer densities.

**Volunteer Incentives**

One consideration will be to "compensate" the volunteer sharpshooters with exclusive hunting access to some parks so that they can run a quality deer management program of their interest. We will assist with the design of the hunts in these select parks so doe harvests are adequate in conjunction with the male harvest objectives. This model, once thoroughly evaluated, can be expanded throughout the Park system based on deer management plan priorities. The Park also should consider providing select equipment and supplies to volunteers.

# Permitting

We will facilitate communications with Virginia Department of Game and Inland Fisheries during the process of obtaining a research permit to harvest deer outside of the regulated hunting season. No Federal permits will be required for the scope of this project.

# Treatment of Issues

We do not have any recommended changes to the RFP.

# Preliminary Work Plan

The initial consultation will be used to identify who will be assigned to the research project and to refine how subsequent actions are sequenced. This meeting can take place any time after the contract signing. We envision the process to follow with a thorough research site evaluation, taking involved staff through the planning and design process so that they understand how a strategic deer management project is devised and implemented. We will review training materials and discuss the best process to identify potential volunteers. Identification of volunteer sharpshooters and initial screening and training should take place during Summer 2013. Other volunteers can be identified during Fall 2013. Shooting locations also can be determined and prepared during Fall 2013, preferably after leaf fall. Baiting will start around mid-December and and sharpshooting activities will begin ~3 weeks thereafter. Volunteers involved with baiting and camera management will be trained during the pre-baiting period. Volunteer sharpshooters will be involved each day culling activities are conducted to begin the instruction process. Sharpshooting will take place until early March 2014 depending on the data collected by the remote IR cameras. A population estimate should be conducted shortly after the culling efforts are completed. Upon completion of all data collection for the first year a full review and debriefing meeting, involving all involved parties, should be organized. Discussions and

conclusions derived during this gathering will be incorporated into a summary report that will provide direction for the second year of the program.

## Statement of Qualifications

Please see included CVs and an abbreviated Business Portfolio that details our experience. The following White Buffalo, Inc. employees will be allocated to the project. These include:

**Dr. Anthony DeNicola** – Senior Scientist, President, White Buffalo, Inc.

**Ryan Rodts** – Wildlife Biologist, White Buffalo, Inc.

## Conclusion

Of primary importance and recognition is that field methods are only as good as the personnel implementing them. This is not an expression of arrogance, but a point of clarity and great significance. It is critical for success to have extensive experience to make day to day decisions and adjustments beyond the established general guidelines and protocols. White Buffalo, Inc. has been actively involved in wildlife population control programs for 18 years. With our experience, we are confident that our proposed methods/strategy and training will provide the greatest likelihood of a successful management program. Also realize that the relative success of this program hinges on the availability and quality of Park staff and local volunteers. Finally, our approach will be the safest, most efficient, and humane solution to your management challenge.

# Fairfax County Park Authority, Virginia

**REQUEST FOR PROPOSAL**

**FOR**

**DEER MANAGEMENT SERVICES - COST PROPOSAL**

**14 June 2013**

**Proposal By:**

**Dr. Anthony J. DeNicola**
**White Buffalo, Inc.**
**A Connecticut 501(c)(3) Non-profit Corporation since 1995**
**EIN: 06-1431342**
**SCC ID Number: F191944-0**

# Budget for Year 1: Fall/Winter 2013-14

**PERSONNEL**

**Senior Scientist**

**Consulting**
1 person X 3 days X $150/hr X 10 hr/day $4,500

**Population Inventory**
Separate contractor (recommendation in proposal) $0

**Planning**
1 person X 2 days X $150/hr X 8 hr/day $2,400

**Population Control** (Park staff assistance for site preparation and baiting)
1 person X 14 days X $150/hr X 10 hr/day $21,000

**Training**
1 person X 6 days X $150/hr X 10 hr/day $9,000

**Permitting**
1 person X 1 day X $150/hr X 8 hr/day $1,200

**Wildlife Biologist**

**Training**
1 person X 4 days (includes travel) X $95/hr X 10 hr/day $3,800

**Population Control**
1 person X 5 days (includes travel) X $95/hr X 10 hr/day $5,700

**DIRECT COSTS**

Supplies (ammunition, bait, miscellaneous) $1,500

Travel
Mileage (1,500 miles @ $0.60/mile) $900

Per diem (9 person-days @ $50/day) $450

FLIR deer count $3,000

**TOTAL** **$52,500**

# Budget for Year 2: Fall/Winter 2014-15

**WHITE BUFFALO, INC. EXPENSES**

**PERSONNEL**

**Senior Scientist**

**Consulting**
1 person X 1 day X $150/hr X 10 hr/day $1,500

**Population Inventory**
Separate contractor $0

**Planning**
1 person X 1 days X $150/hr X 8 hr/day $1,200

**Population Control** (Park staff assistance for site preparation and baiting)
1 person X 12 days X $150/hr X 10 hr/day $18,000

**Training**
1 person X 2 days X $150/hr X 10 hr/day $3,000

**Permitting**
N/A

**DIRECT COSTS**

| | |
|---|---|
| Supplies (ammunition, bait, miscellaneous) | $700 |
| Travel | |
| Mileage (800 miles @ $0.65/mile) | $520 |
| FLIR deer count | $3,000 |
| **TOTAL** | **$27,920** |

# Budget for Year 3: Fall/Winter 2015-16

**WHITE BUFFALO, INC. EXPENSES**

**PERSONNEL**

**Senior Scientist**

**Consulting**

1 person X 1 day X $150/hr X 10 hr/day $1,500

**Population Inventory**

Separate contractor $0

**Planning**

N/A

**Population Control** (Park staff assistance for site preparation and baiting)

1 person X 4 days X $150/hr X 10 hr/day $6,000

**Training**

1 person X 2 days X $150/hr X 10 hr/day $3,000

**Permitting**

N/A

**DIRECT COSTS**

| | |
|---|---|
| Supplies (ammunition, bait, miscellaneous) | $200 |
| Travel | |
| Mileage (600 miles @ $0.70/mile) | $420 |
| FLIR deer count | $3,000 |
| **TOTAL** | **$14,120** |

# Budget for Year 4: Fall/Winter 2016-17

**WHITE BUFFALO, INC. EXPENSES**

**PERSONNEL**

**Senior Scientist**

**Consulting**

1 person X 1 day X $150/hr X 10 hr/day $1,500

**Population Inventory**

Separate contractor $0

**Planning**

N/A

**Population Control** (Park staff assistance for site preparation and baiting)

1 person X 2 days X $150/hr X 10 hr/day $3,000

**Training**

1 person X 2 days X $150/hr X 10 hr/day $3,000

**Permitting**

N/A

**DIRECT COSTS**

Supplies (ammunition, bait, miscellaneous) $200

Travel

Mileage (600 miles @ $0.70/mile) $420

FLIR deer count $3,000

**TOTAL** **$11,120**

**4-YEAR TOTAL** **$105,710**

## What are we doing?



The Helping Our Land Heal study is being piloted at Ellanor C. Lawrence Park (ECLP) in Chantilly. ECLP staff and the county's Resource Management Division are busy with restoration activities. As you visit the park, notice signs that indicate hard work in many parts of the park. Here are some of the projects:

### Why are staff pulling green plants out of the woods?

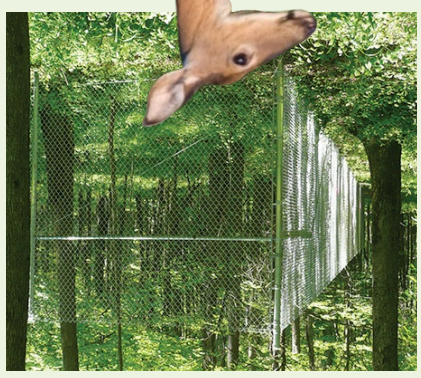
Staff and volunteers are pulling non-native invasive plants. Invasive plants are usually non-native species that cause ecological or economical harm. They share certain characteristics, such as being able to grow quickly, generate many offspring and tolerate a wide range of habitats. For instance, Japanese stilt grass will produce seed in as little as 1% sunlight!

*An IMA volunteer works on a field of invasive Garlic Mustard.*

**Helping Our Land Heal: A Natural Capital Stewardship Model** is a cooperative pilot study sponsored by the Fairfax County Park Authority to transform an unhealthy forest, impacted by many stresses, into a healthy self-sustaining ecosystem.

### What are those fenced-in areas deep in the forests?

These areas are called deer *exclosures*. This tool helps measure forest growth when not impacted by deer foraging. Over time, comparisons between this area and the surrounding forest will give important information about the effectiveness of deer and forest management tools.



### Why are there controlled hunts in the park?

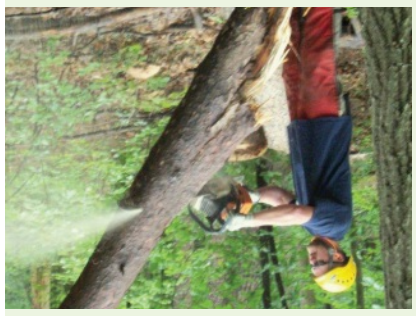
When there are too many deer, the environmental impact on a forest can be devastating. A single adult deer consumes 5 to 7 lbs. of plant matter in one day. Over 1 ton of vegetation is consumed by one deer in one year. A healthy forest has 15 to 20 deer per square mile, but some areas of Fairfax County have as many as 100 deer per square mile!

### Why does the forest smell burnt?

Part of managing a forest is using a tool called a prescribed burn. In meadow and forest ecosystems, fire is a highly effective method for promoting good quality native habitat, limiting or eliminating invasive plant species and reducing the risk of unplanned fires.

### Why are those boot brush stations and how do they help?

These stations help stop the spread of non-native invasive plant species such as Japanese stilt grass, wayleaf basketgrass, and garlic mustard by removing unwanted seeds from the soles of hikers' shoes and boots. Please use these stations before you head into the forest and when you leave.



### Why did I hear a chainsaw while walking in the park, and why are there so many cut trees?

Trees need space to grow and thrive. Thinning trees that are growing too close together is an effective tool in forest management. Sections of the park have been cleared or thinned to help preserve special meadow and cedar forest habitats.

Overpopulation causes damage to native plants and trees as stems, buds, lower leaves and seeds are all eaten by hungry deer. This reduces food and shelter for other animals, resulting in fewer species and an overall loss of biodiversity. Deer also suffer. Herd health declines as the amount and quality of plant foods declines. Crowding also spreads infectious diseases.

Human health is also affected when there are too many deer. Virginia ranked 5th in the nation for deer-vehicle collisions in 2009. Nearly one in every 136 Virginia drivers will have a vehicle accident involving deer in the next 12 months.

## What Can You Do?

**How we treat the land has lasting impacts.** There are many things you can do to help with the Helping Our Land Heal Forestry Pilot program. Here are some of them.

❖ **Sign up for one of our programs.** We have many programs listed in our Calendar of Events that talk about HOLH. Ask the person at the desk about these programs. Once you have attended one of these programs, you will be able to help us protect the forest.

❖ **Keep your dogs on leash and out of the streams.** Dogs are natural hunters and when off leash can be harmful to the forest. And please scoop! Scooper laws protect streams from being polluted by pet waste.

❖ **Stay on the trail.** When a person goes off trail they harm plants and compress soil. Shoes and boots can also spread harmful plant seeds.

❖ **Observe wildlife from afar.** All of the animals in the park are protected. Watching them from afar insures your and their safety.

**Please Follow Park Rules.** These rules are in place to protect the forest. When you are familiar with the rules and follow them you are helping protect the park.

1. **Protect the Animals.** Persons or pets should not harass, capture, remove, injure or kill any animal, its young or its eggs, or disturb the nest, den, burrow, lodge, roost, dam or other structure found in a park.
2. **Protect Plants and Fungi.** Plants and fungus (e.g., mushrooms), including cuttings, flowers, seeds, berries or nuts, should be left as they are found.
3. **Protect Natural Materials.** All naturally occuring materials, including wood, wood chips, sod, earth, humus, rocks, minerals, fossils, sand, water, should not be tampered with or removed.

Visit the Helping Our Land Heal Website.
**www.fairfaxcounty.gov/parks/resource-management/holh.htm**

**Ellanor C. Lawrence Park**
703-631-0013
www.fairfaxcounty.gov/parks/ecl

Visitor Center Hours: Mon., Wed.-Fri. 9 a.m.-5 p.m.
Sat. and Sun. 12 p.m.-5 p.m. Closed Tues.

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Stewardship Series #15 • 10/14

# Helping Our Land Heal

## A Natural Capital Stewardship Model

HELPING OUR LAND HEAL
A NATURAL CAPITAL STEWARDSHIP MODEL

# The Way We Treat the Land has Lasting Impacts

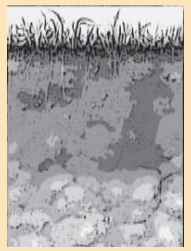
Illustration by Phyllis Saroff

## Harmful Things

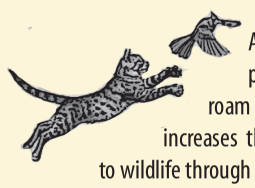
Planting grass, mowing or dumping yard waste in parkland damages the ecosystem. Pesticides kill beneficial insects, and fertilzers may pollute streams if applied incorrectly.

All-terrain vehicles are prohibited on all park trails in Fairfax County. They scare wildlife and wear away trails. Bikes can cause trail damage and erosion, so riding is limited to certain trails and parks.

Carving into or peeling bark off trees opens the door to insects and disease. Trees weaken and die due to air pollution and strangulation from invasive vines.



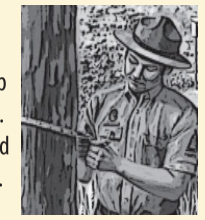
Mowing, high foot traffic and lack of foliage lead to compacted soils where roots become starved for oxygen and few animals live. Hard soils contribute to excessive water runoff, flooding and erosion.



Allowing pets to roam wild increases the threat to wildlife through hunting, or destruction of nests and habitats. There are dangers to your pet as well.

## Helpful Things

Choose climate-hardy native plants when landscaping your yard. Reduce the need for pesticides by installing bird boxes to attact nature's pest controllers.



Be a good steward of your parks. Park staff need your help caring for parkland. Follow the rules and protect wild places. Stay on trails, and don't remove, collect or tamper with plants or animals.

Healthy trees are key players in air quality. Foliage cleans the air by absorbing carbon dioxide and releasing oxygen. Trees also provide natural habitat for native birds and wildlife.

Leaf litter and old wood retains moisture and reduces erosion. Softened ground is ideal habitat for insects and animals that break down the surface debris and create nutrient-rich soil. Healthy soil then invites plant and tree growth.

Pets should be kept on a leash for their safety as well as the safety of native wildlife and other trail users. Keeping pets close and on the trail reduces their exposure to ticks, rabies and risk of injury.

Overabundant deer deplete native vegetation through overbrowsing. Many forests lack native vegetation near the ground, and there are fewer young trees to replace the old when they die.

Invasive species such as honeysuckle, English ivy and pachysandra are not eaten by native animals. They crowd out native species and reduce the diversity of life in the forest.

Steep stream banks are a sign of soil erosion. As higher volumes of rainwater flow into streams due to hard packed soils and lack of anchoring roots, soil is washed into the stream, starving fish and insects of oxygen.

Litter is not just unsightly, it attracts unwanted pests and pollutes streams. Some materials release toxins into the water. Releasing non-native pets into our waterways disrupts local ecology.

Healthy streams teem with life. Fish, insects, amphibians and crustacians thrive in waters rich in oxygen and other nutrients. They also play an important role in the food chain for non-aquatic wildlife.

Stream banks that are full of native vegetation reduce soil erosion. Gently sloping banks form catch pools and eddys which provide fertile spawning and nesting habitat for native wildlife.

Native plants and animals are part of a balanced ecosystem. Native and migratory species often depend on the availability of certain plants in specific seasons in order to maintain their populations.

Managed deer populations allow native plants and other wildlife to thrive. Fewer deer also means healthier deer because food sources are more plentiful.

**FINAL REPORT**

**2015 Deer Management Program**

**Fairfax County Park Authority, Virginia**

**by**

**White Buffalo, Inc.**

**19 February 2015**

## INTRODUCTION

The Fairfax County Park Authority manages numerous suburban parks that compose approximately 23,000 acres and contain a matrix of woodlands and open fields. There have been limited deer management actions in most of the Park system which has resulted in the local deer population increasing to levels incompatible with forest regeneration/health priorities. Sharpshooting operations were conducted in E.C. Lawrence Park (ECL) by Fairfax County Police Department on and off over the past 12 years and archery hunting was permitted for three of the four previous years (Fall 2011, 2012, 2014). The objective was to evaluate the feasibility of reducing the local deer populations in the two aforementioned parks below ecological carrying capacity (<20 deer/mile$^2$) using sharpshooting methods. This is the second year in which an alternative deer sharpshooting program was implemented.

## METHODS

Pre-baiting was conducted from 15 January – 6 February 2015. Sharpshooting efforts were conducted from 7 – 18 February 2015 at four shooting locations. Nine days of fieldwork were required to achieve the harvest of 40 deer.

## RESULTS

The entire data set generated from harvested deer is represented in the spreadsheet entitled "Fairfax County Park Authority Deer Harvest: 7 – 18 February 2015" (Appendix A). The overall harvest demographics are summarized in Table 1.

The following summarizes the harvest record from each shooting location:

8 - Ball Field -
10 - Henry Pond -
6 - Meadow -
16 - Gas Line -

**Table 1.** Sex and age class of deer harvested in Fairfax County Parks, Virginia from 7 – 18 February 2014 - ECL.

| AGE | # MALE (%) | # FEMALE (%) | # COMBINED |
|---|---|---|---|
| Yearling/Adult | 24 (60%) | 8 (20%) | 32 (80%) |
| Fawns | 3 (8%) | 5 (12%) | 8 (20%) |
| Total | 27 (68%) | 13 (33%) | 40 (100%) |

**Population estimates**

Camera surveys were used to estimate the population in late-summer and early-fall 2014. Approximately 40 deer were projected to be in the park. Sixteen deer were harvested during the archery season (8 females, 4 adult males, and 4 male fawns). Upon completion of the sharpshooting activities the park was walked with fresh snow. We could only account for tracks of ~12 deer remaining; <15 deer/mile$^2$.

**DISCUSSION**

We were able to reduce the local populations to low densities using only fixed shooting positions, even after a long history of sharpshooting over bait, and some archery hunting. This was feasible because we had good access and there were no locally available competing artificial food resources. This project required substantial effort because it was apparent the deer in ECL were "educated" to risks associated with bait and approached shooting locations with caution. This often resulted in deer exiting the shooting zone after the initial shot was fired versus the typical response of confusion when deer have not been exposed to firearm culling.

The harvest data were consistent with the projected remaining population last year when accounting for fawning, with the exception of yearling/adult males. There was clearly a substantial immigration of males once last winter with at least 20 males immigrating (mostly yearlings).

We would like to thank the following individuals and organizations for assistance provided prior to and during the culling period; Katie Auer, Jim Dewing, Justin Roberson, John Shafer, Kristen Sinclair, Erin Stockschlaeder, Owen Williams, Fairfax County Animal Control, and Jason McIntosh from Custom Deer Processing (venison processing for charitable donation).

# Appendix A

**Fairfax County Park Authority Deer Harvest: 7 – 18 February 2015**

| DATE | TAG # | PARK | SITE | SEX | AGE |
|---|---|---|---|---|---|
| 2/7/15 | 001 | ECLP | Gas Line | F | A |
| 2/7/15 | 002 | ECLP | Gas Line | F | A |
| 2/7/15 | 003 | ECLP | Gas Line | F | A |
| 2/7/15 | 004 | ECLP | Gas Line | M | Y |
| 2/7/15 | 005 | ECLP | Gas Line | M | Y |
| 2/7/15 | 006 | ECLP | Gas Line | M | Y |
| 2/7/15 | 007 | ECLP | Gas Line | M | Y |
| 2/7/15 | 008 | ECLP | Gas Line | M | A |
| 2/7/15 | 009 | ECLP | Gas Line | M | A |
| 2/7/15 | 010 | ECLP | Gas Line | M | Y |
| 2/7/15 | 011 | ECLP | Gas Line | M | F |
| 2/7/15 | 012 | ECLP | Meadow | M | Y |
| 2/7/15 | 013 | ECLP | Meadow | M | Y |
| 2/7/15 | 014 | ECLP | Meadow | M | A |
| 2/8/15 | 015 | ECLP | Henry Pond | M | Y |
| 2/8/15 | 016 | ECLP | Henry Pond | F | A |
| 2/8/15 | 017 | ECLP | Henry Pond | F | F |
| 2/8/15 | 018 | ECLP | Henry Pond | F | F |

| | | | | | |
|---|---|---|---|---|---|
| 2/8/15 | 019 | ECLP | Henry Pond | F | F |
| 2/8/15 | 020 | ECLP | Meadow | M | A |
| 2/8/15 | 021 | ECLP | Meadow | M | Y |
| 2/8/15 | 022 | ECLP | Meadow | M | Y |
| 2/9/15 | 023 | ECLP | Ball Field | M | A |
| 2/9/15 | 024 | ECLP | Ball Field | M | Y |
| 2/9/15 | 025 | ECLP | Ball Field | M | Y |
| 2/9/15 | 026 | ECLP | Ball Field | M | Y |
| 2/9/15 | 027 | ECLP | Ball Field | M | Y |
| 2/10/15 | 028 | ECLP | Henry Pond | M | Y |
| 2/11/15 | 029 | ECLP | Gas Line | M | Y |
| 2/11/15 | 030 | ECLP | Gas Line | M | Y |
| 2/11/15 | 031 | ECLP | Gas Line | M | F |
| 2/11/15 | 032 | ECLP | Gas Line | M | A |
| 2/11/15 | 033 | ECLP | Ball Field | F | A |
| 2/11/15 | 034 | ECLP | Ball Field | F | A |
| 2/11/15 | 035 | ECLP | Ball Field | F | F |
| 2/16/15 | 036 | ECLP | Gas Line | F | A |
| 2/17/15 | 037 | ECLP | Henry Pond | M | F |
| 2/17/15 | 038 | ECLP | Henry Pond | M | A |
| 2/17/15 | 039 | ECLP | Henry Pond | F | F |
| 2/17/15 | 040 | ECLP | Henry Pond | F | A |

**FINAL REPORT**

**2014 Deer Management Program**

**Fairfax County Park Authority, Virginia**

**by**

**White Buffalo, Inc.**

**7 March 2014**

## INTRODUCTION

The Fairfax County Park Authority manages numerous suburban parks that compose approximately 23,000 acres and contain a matrix of woodlands and open fields. There have been limited deer management actions in most of the Park system which has resulted in the local deer population increasing to levels incompatible with forest regeneration/health priorities. Sharpshooting operations were conducted in E.C. Lawrence Park (ECL) by Fairfax County Police Department on and off over the past 12 years and archery hunting was permitted for two previous years (Fall 2011 and 2012). Old Colchester Park Preserve (OCPP) was archery hunted during Fall 2012 only. The objective was to evaluate the feasibility of reducing the local deer populations in the two aforementioned parks below ecological carrying capacity (<20 deer/mile$^2$) using sharpshooting methods. This is the first year in which an alternative deer sharpshooting program was implemented.

## METHODS

Prebaiting was conducted from 10 December 2013 – 1 January 2014. We used manual baiting techniques in ECL and automatic feeders in OCPP. Sharpshooting efforts were conducted from 2 January – 14 January 2014 (Phase 1) and again from 10-20 February 2014 (Phase 2). Eighteen days of fieldwork were required to achieve the harvest of 92 deer in ECL. Six days of fieldwork were required to achieve the harvest of 6 deer in OCPP.

Five shooting sites were available in ECL and 2 sites were established in OCPP. One of the sites in ECL was shut down after the first phase to concentrate the remaining deer at the other proximate bait locations.

**RESULTS**

The entire data set generated from harvested deer is represented in the spreadsheet entitled "Fairfax County Park Authority Deer Harvest: 2 January – 20 February 2014" (Appendix A). The overall harvest demographics are summarized in Tables 1 and 2. We expended 193 person-hours for the sharpshooting activities in ECL (92 deer harvested) and 56 person-hours for the sharpshooting activities in OCPP (6 deer harvested) resulting in 2.1 and 9.3 person-hours per deer harvested, respectively.

The following summarizes the harvest record from each shooting location for ECL:

37 - Ball Field -
17 - Henry Pond -
14 - Meadow -
14 - Gas Line -
10 - Park House -

The following summarizes the harvest record from each shooting location for OCPP:

5 - House -
1 - Pond -

**Table 1.** Sex and age class of deer harvested in Fairfax County Parks, Virginia from 2 January – 20 February 2014 - ECL.

| AGE | # MALE (%) | # FEMALE (%) | # COMBINED |
|---|---|---|---|
| Yearling/Adult | 27 (29%) | 41 (45%) | 68 (74%) |
| Fawns | 11 (12%) | 13 (14%) | 24 (26%) |
| Total | 38 (41%) | 54 (59%) | 92 (100%) |

**Table 2.** Sex and age class of deer harvested in Fairfax County Parks, Virginia from 2 January – 20 February 2014 - OCPP.

| AGE | # MALE (%) | # FEMALE (%) | # COMBINED |
|---|---|---|---|
| Yearling/Adult | 2 (33%) | 2 (33%) | 4 (66%) |
| Fawns | 0 (0%) | 2 (33%) | 2 (33%) |
| Total | 2 (33%) | 4 (66%) | 6 (100%) |

**Population estimates**

FLIR report provided previously. There were 46 deer observed in ECL after the first shooting phase and 31 deer were culled in Phase 2 resulting ~15 deer remaining; ~15 deer/mile$^2$. There were 4 deer observed in OCPP after the first shooting phase and one deer was culled in Phase 2 resulting ~3 deer remaining; ~15 deer/mile$^2$.

## DISCUSSION

We were able to reduce the local populations to low densities using only fixed shooting positions, even after a long history of sharpshooting over bait, and some archery hunting. This was feasible because we had good access and there were no locally available competing artificial food resources. This project required substantial effort because it was apparent the deer in ECL were "educated" to risks associated with bait and approached shooting locations with caution. This often resulted in deer exiting the shooting zone after the initial shot was fired versus the typical response of confusion when deer have not been exposed to firearm culling. In contrast, we experienced low efficiency at OCPP because of operational inconsistencies of the automatic feeders (which made it difficult to pattern deer arrival times) and low initial densities.

When evaluating the FLIR data from ECL and OCPP, as compared to other parks that are being hunted, deer that were observed outside the park are not likely using the park. The difference between parks being hunted versus those being culled using sharpshooting is that sharpshooting uses bait to attract deer and it will pull deer in from the periphery of the park and remove them. In comparison, hunting will result in pushing deer to the fringe of their home-range towards to the outside edges of the park. So deer that are detected with FLIR outside the sharpshooting parks that are not using bait sites (based on camera data and snow tracking) are not likely using the park habitat to any degree. Deer that are detected near the park edges of parks that are using sharpshooting are on the outside fringe of their range that is proximate to the park, and most of their home range is further away from the park. In contrast, deer that are detected near the park edges of hunted parks are likely "park deer" that are using the periphery of their home ranges on the edges of the parks to escape the hunting pressure. So these FLIR-counted deer proximate to hunted parks are most likely "park deer".

We expended >4 times the person-hours for removal efforts in OCPP as compared to ECL. Much of this difference is due to the substantial differences in initial densities. ECL started with >100 deer/mile$^2$, whereas OCPP had closer to 50 deer/mile$^2$. The increased harvest efficiency was amplified by the manual baiting protocol that was deployed in ECL.

We would like to thank the following individuals and organizations for assistance provided prior to and during the culling period; Jim Dewing, Justin Roberson, John Shafer, Kristen Sinclair, Charles Smith, Erin Stockschlaeder, Owen Williams, Fairfax County Animal Control, and Jason McIntosh from Custom Deer Processing (venison processing for charitable donation).

# Appendix A

**Fairfax County Park Authority Deer Harvest: 2 January – 20 February 2014**

| DATE | TAG # | PARK | SITE | SEX | AGE |
|---|---|---|---|---|---|
| 1/2/14 | 001 | ECLP | Meadow | M | Y |
| 1/2/14 | 002 | ECLP | Meadow | F | A |
| 1/2/14 | 003 | ECLP | Meadow | M | F |
| 1/2/14 | 004 | ECLP | Meadow | M | A |
| 1/2/14 | 005 | ECLP | Park House | M | A |
| 1/2/14 | 006 | ECLP | Park House | M | Y |
| 1/2/14 | 007 | ECLP | Park House | M | Y |
| 1/2/14 | 008 | ECLP | Park House | M | A |
| 1/2/14 | 009 | ECLP | Park House | M | A |
| 1/2/14 | 010 | ECLP | Gas Line | M | Y |
| 1/2/14 | 011 | ECLP | Gas Line | M | A |
| 1/2/14 | 012 | ECLP | Gas Line | M | A |
| 1/2/14 | 013 | ECLP | Gas Line | M | Y |
| 1/2/14 | 014 | ECLP | Gas Line | M | A |
| 1/2/14 | 015 | ECLP | Gas Line | M | A |
| 1/3/14 | 016 | OCPP | House | F | A |
| 1/3/14 | 017 | OCPP | House | F | Y |
| 1/3/14 | 018 | OCPP | House | F | F |

| | | | | | |
|---|---|---|---|---|---|
| 1/3/14 | 019 | OCPP | House | F | F |
| 1/3/14 | 020 | OCPP | Water Retention | M | Y |
| 1/4/14 | 021 | ECLP | Ball Field | M | A |
| 1/4/14 | 022 | ECLP | Ball Field | M | A |
| 1/4/14 | 023 | ECLP | Ball Field | M | Y |
| 1/4/14 | 024 | ECLP | Ball Field | M | Y |
| 1/4/14 | 025 | ECLP | Ball Field | M | A |
| 1/5/14 | 026 | ECLP | Ball Field | F | A |
| 1/5/14 | 027 | ECLP | Ball Field | F | Y |
| 1/5/14 | 028 | ECLP | Ball Field | F | A |
| 1/5/14 | 029 | ECLP | Ball Field | F | F |
| 1/5/14 | 030 | ECLP | Ball Field | M | A |
| 1/5/14 | 031 | ECLP | Gas Line | F | A |
| 1/5/14 | 032 | ECLP | Gas Line | F | A |
| 1/5/14 | 033 | ECLP | Gas Line | F | Y |
| 1/5/14 | 034 | ECLP | Gas Line | M | F |
| 1/6/14 | 035 | ECLP | Park House | F | A |
| 1/6/14 | 036 | ECLP | Park House | M | F |
| 1/6/14 | 037 | ECLP | Henry Pond | F | A |
| 1/6/14 | 038 | ECLP | Henry Pond | F | A |
| 1/6/14 | 039 | ECLP | Henry Pond | F | A |
| 1/6/14 | 040 | ECLP | Henry Pond | F | A |

| | | | | | |
|---|---|---|---|---|---|
| 1/6/14 | 041 | ECLP | Henry Pond | M | F |
| 1/7/14 | 042 | ECLP | Park House | M | F |
| 1/7/14 | 043 | ECLP | Park House | F | A |
| 1/7/14 | 044 | ECLP | Henry Pond | F | A |
| 1/7/14 | 045 | ECLP | Henry Pond | F | F |
| 1/8/14 | 046 | ECLP | Meadow | F | A |
| 1/8/14 | 047 | ECLP | Meadow | F | F |
| 1/8/14 | 048 | ECLP | Meadow | F | A |
| 1/8/14 | 049 | ECLP | Gas Line | F | A |
| 1/9/14 | 050 | ECLP | Gas Line | F | A |
| 1/9/14 | 051 | ECLP | Gas Line | M | F |
| 1/10/14 | 052 | ECLP | Park House | M | F |
| 1/10/14 | 053 | ECLP | Ball Field | F | A |
| 1/10/14 | 054 | ECLP | Ball Field | F | Y |
| 1/10/14 | 055 | ECLP | Ball Field | F | A |
| 1/10/14 | 056 | ECLP | Ball Field | F | A |
| 1/11/14 | 057 | ECLP | Ball Field | M | Y |
| 1/11/14 | 058 | ECLP | Ball Field | M | A |
| 1/12/14 | 059 | ECLP | Henry Pond | F | A |
| 1/12/14 | 060 | ECLP | Henry Pond | F | F |
| 1/13/14 | 061 | ECLP | Ball Field | F | A |
| 1/13/14 | 062 | ECLP | Ball Field | F | A |

| | | | | | |
|---|---|---|---|---|---|
| 1/13/14 | 063 | ECLP | Ball Field | F | F |
| 1/13/14 | 064 | ECLP | Ball Field | F | Y |
| 1/13/14 | 065 | ECLP | Ball Field | F | Y |
| 1/13/14 | 066 | ECLP | Ball Field | F | A |
| 2/10/14 | 067 | ECLP | Henry Pond | F | A |
| 2/10/14 | 068 | ECLP | Henry Pond | F | F |
| 2/10/14 | 069 | ECLP | Meadow | F | F |
| 2/10/14 | 070 | ECLP | Meadow | F | A |
| 2/10/14 | 071 | ECLP | Meadow | F | A |
| 2/11/14 | 072 | OCPP | House | M | Y |
| 2/12/14 | 073 | ECLP | Gas line | F | A |
| 2/12/14 | 074 | ECLP | Meadow | M | A |
| 2/12/14 | 075 | ECLP | Meadow | M | A |
| 2/12/14 | 076 | ECLP | Meadow | M | Y |
| 2/12/14 | 077 | ECLP | Meadow | M | Y |
| 2/14/14 | 078 | ECLP | Henry Pond | M | F |
| 2/14/14 | 079 | ECLP | Henry Pond | F | A |
| 2/14/14 | 080 | ECLP | Henry Pond | M | A |
| 2/14/14 | 081 | ECLP | Henry Pond | M | Y |
| 2/14/14 | 082 | ECLP | Ball Field | F | A |
| 2/14/14 | 083 | ECLP | Ball Field | F | F |
| 2/14/14 | 084 | ECLP | Ball Field | F | F |

| | | | | | |
|---|---|---|---|---|---|
| 2/14/14 | 085 | ECLP | Ball Field | F | F |
| 2/14/14 | 086 | ECLP | Ball Field | M | F |
| 2/16/14 | 087 | ECLP | Ball Field | F | A |
| 2/16/14 | 088 | ECLP | Ball Field | F | A |
| 2/16/14 | 089 | ECLP | Ball Field | F | F |
| 2/19/14 | 090 | ECLP | Henry Pond | F | A |
| 2/19/14 | 091 | ECLP | Henry Pond | F | F |
| 2/20/14 | 092 | ECLP | Ball Field | F | F |
| 2/20/14 | 093 | ECLP | Ball Field | M | F |
| 2/20/14 | 094 | ECLP | Ball Field | M | F |
| 2/20/14 | 095 | ECLP | Ball Field | F | Y |
| 2/20/14 | 096 | ECLP | Ball Field | F | A |
| 2/20/14 | 097 | ECLP | Ball Field | F | A |
| 2/20/14 | 098 | ECLP | Ball Field | F | A |

# FAIRFAX COUNTY PARK AUTHORITY

**S c o p e  o f  W o r k**

## Understory Planting

As part of Helping Our Land Heal (HOLH), Ellanor C. Lawrence Park (ECLP) will plant tree and shrub species to accelerate the restoration of vertical forest structure in the park. The site will be approximately 1-5 acres in size depending on cost determinations conducted as part of the project. The project location will be in "Stand F" as identified in the Virginia Dept. of Forestry's Forest Stewardship Plan written in 2013.

### *Work Plan*

Goals -
The goal of the project is to restore forest structure and preserve forest canopy. -

Objectives
The objective of the project is to increase the number of woody stems in the forest with shrub species that will restore the shrub sub-canopy layer and tree species (especially Quercus) that will further restore the shrub layer and will have the potential to replace currently declining canopy trees.

Tasks -
HOLH staff will create plans, cost estimates and plant shrubs and trees using contractors. -

1. - Technical guidance for planting will be prepared that include details about site preparation, species selection, planting density, invasive plant control and deer protection.
2. - A per acre cost estimate will be developed based on the technical plan specifications and the size of the Understory Planting project will be determined based on resources remaining in the HOLH budget.
3. - Contractors will be identified and engaged for planting labor and suppliers identified for native plants of appropriate sizes.
4. - NNI plants will be controlled with contractors and herbicide applications.
5. - Deer protection measures will be implemented and maintained.
6. - Planting will take place when deer protection measures are installed or otherwise capable of effective protection.
7. - If possible, water new plantings to improve survival rates.
8. - Monitor planting survival rates and enforce warranty on planting contract.
    a. - Conduct a pre-installation monitoring of plant stock to ensure correct species and good health.
    b. - Conduct inspections during installation to ensure plans and specifications have been followed.

c. - Conduct post-installation inspection at one and three months to monitor survival of plantings.
d. - Conduct a final vegetation data collection plot within the treatment area consistent with prior data collection procedures to create a reference point on this treatment type and for comparison to other areas of the park. If possible, 90% survival will be required in the planting contract.

Specifications

1. - Control of NNI will be conducted by a county contractor using foliar post-emergent herbicides and/or hand pulling by park volunteers. Herbicide will be applied in the growing season of 2014 and 2015 and will be monitored for continued maintenance in on-going years.
2. - A deer exclosure fence will be erected around the light gap using polyvinyl fencing material at a minimum height of 8'. It will be secured to 10' long metal fence poles of 1.25'' diameter that are placed 2' into the ground and installed with eagle scout labor. The fence will be monitored for damage monthly and repaired as necessary to ensure exclusion of deer is consistently enforced. The fence is expected to last for about 5 years. A gate will be included in the design to allow access for NNI control contractors and staff or volunteers for on-going maintenance.
3. - After the installation of the deer exclosure, the treatment area will be planted with native shrub and tree species. Special emphasis will be given to Quercus species.
4. - For all activity related to planting, please refer to and follow the specifications laid out in Attachment F, the planting specifications created by Fairfax County Department of Public Works on landscaping specifications: http://www.srs.fs.usda.gov/pubs/63915
5. - A combination of large and small containers will be planted to promote a mixed age forest and vertical forest structure. Please refer to Attachment A: "Planting list," for details.
6. - Planting will be done at a density of 460 stems per acre for trees and interplanted with an additional 410 stems per acre of shrub species.
    a. - The group of shrubs and the group of trees will be planted each in their own grid pattern set on 10' centers. The two grids will then be offset by 5' so that they will not over-crowd each other. Please refer to Attachment D: "Tree and shrub grid specifications." All trees of all sizes should conform approximately to appropriate positions in the tree grid and all shrubs of all sizes should conform approximately to appropriate positions in the shrub grid. The outside borders of the tree grid should completely contain the outside borders of the shrub grid. This is shown in Attachment D as well.
    b. - The largest trees at 2.5'' caliper should be distributed according to the map below of approximate locations - see Attachment B: "2.5'' Tree planting map." They should be planted approximately 40' away from each other and at least 15' feet away from any pre-existing trees, shrubs, brambles or vines growing naturally on site. Ideally, they will also be

planted in a location that allows partial direct sunlight to reach the planting through the forest canopy.

c. - The trees in the 5 gallon containers should be planted on 10' centers and evenly distributed across the site. The different species must be planted in a randomized order in rows. They should be planted at least 5' feet from any pre-existing trees, shrubs, brambles or vines that are growing naturally onsite. They will be interplanted with the other size trees at a rate of approximately (1) 3 gallon tree for every 10 trees of any other size.

d. - The tubelings should be planted on 10' centers and evenly distributed across the site. The different species must be planted in a randomized planting order in rows. They should be planted at least 5' feet from any pre-existing trees, shrubs, brambles or vines that are growing naturally onsite.

e. - Shrubs should be planted on 10' centers and evenly distributed across the site. They will be planted in a grid that is offset from the grid of tree species – please refer to Attachment D: "Tree and shrub grid specifications." The different species must be planted in a randomized planting order in rows. They should be planted at least 5' away from any pre-existing trees, shrubs, brambles or vines that are growing naturally onsite.

f. - There is a small drainage area in the northern half of the site. Because of the increased water in this area, only certain species may be planted here. Please refer to Attachment C: "Drainage map."

i. All species may be planted here as usual except:

1. - Do not plant tree tubelings: Quercus rubra, Quercus alba, Quercus velutina, Quercus falcata, Carya glabra, Carya tomentosa

2. - Do not plant shrubs: Viburnum acerifolium, Hammemalis virginiana, Vaccinium stamineum, Vaccinium pallidum, Gaylussacia baccata.

ii. - Otherwise, distribute these species evenly across the site in a randomized planting order.

iii. - Please refer to Attachment C: "Drainage map."

g. - Overall planting example shown in Attachment E

7. - If possible, planting contract will include a 1 year warranty required survival rate of 100% for the 2.5'' trees, 90% for 3 gallon trees and all shrubs and tubelings.

8. - Water plantings once each week in the first 4 weeks after planting, and once a month until October 2015.

9. - Plant community data collection will focus on woody and herbaceous plant coverage, vertical stratification and species compositions. Data analysis can be compared to other vegetation data plots taken in the park as a part of HOLH and Virginia DCR Natural Heritage Program plot data.

Project Deliverables

1. - The primary project deliverable will be a minimum of 1 acre planted with trees and shrubs that will provide the opportunity to make observations and collect vegetation data.
2. - A project cost estimate per acre will be developed that can be shared with other land managers.

## *Budget Narrative*

The table below details the expenditures for the project on a per acre basis. The project will be paid for by the Monopole funds that have been approved for the HOLH project.

| **Personnel** | | | |
|---|---|---|---|
| **Position** | **Rate** | **Hours** | **Cost** |
| | | | $ |
| **Sub-total Personnel** | | | **$** |
| **Fringe Benefits** | | | |
| **Description** | **Rate** | | **Cost** |
| Total Personnel | % | | $ |
| **Sub-total Fringe** | | | **$** |
| **Travel** | | | |
| **Description** | **Rate** | **Number** | **Cost** |
| | | | $ |
| **Sub-total Travel** | | | **$** |
| **Equipment** | | | |
| **Description** | **Rate** | **Number** | **Cost** |
| | | | $ |
| **Sub-total Equipment** | | | **$** |
| **Supplies** | | | |
| **Description** | **Rate** | **Number** | **Cost** |
| Fencing material | 319 | 4 | $1276 |
| Fence poles | 10.50 | 100 | $1050 |
| Paracord | 55 | 1 | $55 |
| Zip ties | 20 | 1 | $20 |
| 1.5-2.5'' caliper trees | 325 | 30 | $9750 |
| 5 gallon container trees | 80 | 40 | $3200 |
| Tubeling trees | 5 | 390 | $1950 |
| 1 gallon container shrubs | 5-20 | 400 | $3308 |
| | | | |
| **Total Supplies** | | | **$20609** |
| **Contractual** | | | |
| **Description** | **Rate** | **Number** | **Cost** |
| Herbicide applications | 800 | 2 | $1600 |
| Planting labor | 72 | 120 | $8640 |

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| **Sub-total Contractual** | | | **$10240** |
| **Construction** | | | |
| **Description** | **Rate** | **Number** | **Cost** |
| | | | $ |
| **Sub-total Construction** | | | **$** |
| **Other Costs** | | | |
| **Description** | **Rate** | **Number** | **Cost** |
| | | | $ |
| **Sub-total Other** | | | **$** |
| **GRAND TOTAL** | | | **$30849** |

## *Completion Schedule*

Identification of the light gap and completion of the deer exclusion fence drive the timeframe of the project. This began in the summer of 2014 with the identification of a suitable light gap and the beginning of control of NNI a few months later in July and August 2014. Control of NNI and data collection will be on-going as appropriate until the end of HOLH (expected completion in Fall 2015). Deer exclusion should be completed before spring 2015 to prevent browsing on freshly budding woody stems. Ideally, the exclosure fencing will remain permanently or until deer population control measures have removed the pressure of deer on regenerating woody plants.

| **Tasks** | **1st Qtr 2015** | **2nd Qtr 2015** | **3rd Qtr 2015** | **4th Qtr 2015** | **1st Qtr 2016** | **2nd and 3rd Qtr 2016** | **4th Qtr 2016** |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **1. Technical guidance prepared** | | On-going | Complete | | | | |
| **2. Per acre cost estimate** | | On-going | Complete | | | | |
| **3. Identify and engage contractors** | | | Complete | | | | |
| **4. NNI control** | On-going | On-going | On-going | Complete | | | |
| **5. Deer protection install** | | | Complete | | | | |
| **6. Planting** | | | On-going | Complete | | | |
| **7. Watering** | | | On-going | On-going | On-going | Complete | |
| **7. Monitoring and data collection** | | | On-going | On-going | On-going | On-going | Complete |

## *Project Site Map*

The project site is in “Stand F” as identified in the Virginia Dept. of Forestry Forest Stewardship Plan on the Northeast side of the park near the driveway to the Frye house driveway. It is approximately 1 acre in size with a perimeter of about 850’ as confined by the deer exclusion fence.

## *Attachments*

Attachment A: Planting List

| | species | size | quantity |
|---|---|---|---|
| **Trees** | Quercus alba | 2.5'' caliper | 5 |
| | Quercus bicolor | 2.5'' caliper | 5 |
| | Quercus palustris | 2.5'' caliper | 5 |
| | Quercus phellos | 2.5'' caliper | 5 |
| | Quercus rubra | 2.5'' caliper | 5 |
| | Quercus velutina | 2.5'' caliper | 5 |
| **TOTAL** | | | **30** |
| **Trees** | Cercis canadensis | 3 gallon | 5 |
| | Cornus florida | 3 gallon | 5 |
| | Carya glabra | 3 gallon | 5 |
| | Carya tomentosa | 3 gallon | 5 |
| | Diospyros virginiana | 3 gallon | 5 |
| | Prunus serotina | 3 gallon | 5 |
| | Quercus falcata | 3 gallon | 5 |
| | Sassafras albidum | 3 gallon | 5 |
| **TOTAL** | | | **40** |
| **Trees** | Quercus alba | tubeling | 45 |
| | Quercus bicolor | tubeling | 45 |
| | Quercus palustris | tubeling | 45 |
| | Quercus phellos | tubeling | 45 |
| | Quercus rubra | tubeling | 45 |
| | Quercus velutina | tubeling | 45 |
| | Cercis canadensis | tubeling | 15 |
| | Cornus florida | tubeling | 15 |
| | Carya glabra | tubeling | 15 |
| | Carya tomentosa | tubeling | 15 |
| | Diospyros virginiana | tubeling | 15 |
| | Prunus serotina | tubeling | 15 |
| | Quercus falcata | tubeling | 15 |
| | Sassafras albidum | tubeling | 15 |
| **TOTAL** | | | **390** |
| **Shrubs** | Amelanchier arborea | 1-2 gallon | 50 |

| | | | |
|---|---|---|---|
| | Gaylusaccia baccata | 1-2 gallon | 20 |
| | Hammemalis virginiana | 1-2 gallon | 40 |
| | Lindera benzoin | 1-2 gallon | 30 |
| | Vaccinium corymbosum | 1-2 gallon | 80 |
| | Vaccinium pallidum | 1-2 gallon | 20 |
| | Vaccinium stamineum | 1-2 gallon | 20 |
| | Viburnum acerifolium | 1-2 gallon | 30 |
| | Viburnum dentatum | 1-2 gallon | 80 |
| | Viburnum prunifolium | 1-2 gallon | 40 |
| **TOTAL** | | | **410** |
| | | | |
| **TOTAL** | | | **870** |

Attachment B: 2.5’’ Tree planting map

Attachment C: Drainage map


DO NOT PLANT THESE SPECIES IN THE DRAINAGE:

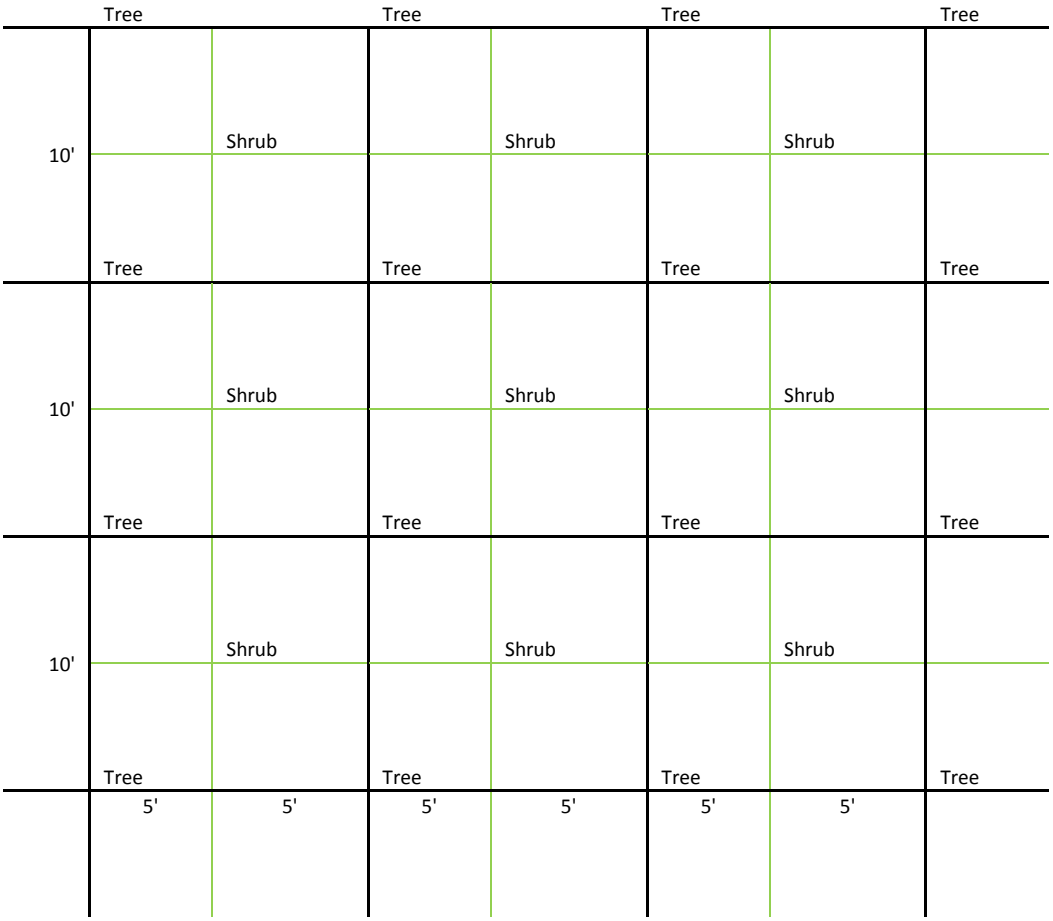
Tree tubelings: Quercus alba, Quercus rubra, Quercus velutina

Shrubs: Viburnum acerifolium, Gaylussacia, baccata, Hammemalis virginiana, Vaccinium pallidum, Vaccinium stamineum

Attachment D, Part 1: Tree and shrub grid specifications

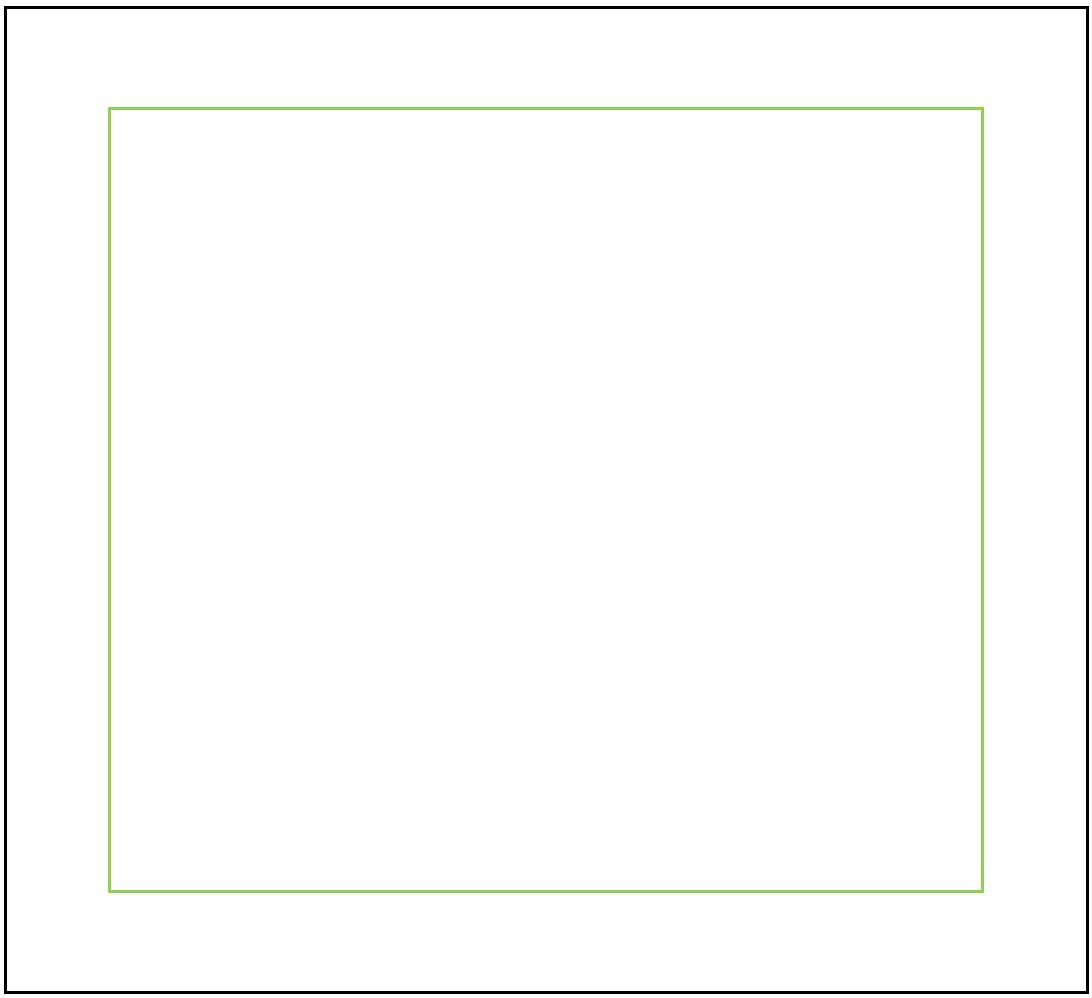
Part 1:

Trees planted on 10 foot centers in a grid.
Shrubs planted on 10 foot centers in a grid that is offset from the Tree grid by 5 feet.



Attachment D, Part 2: Tree and shrub grid specifications

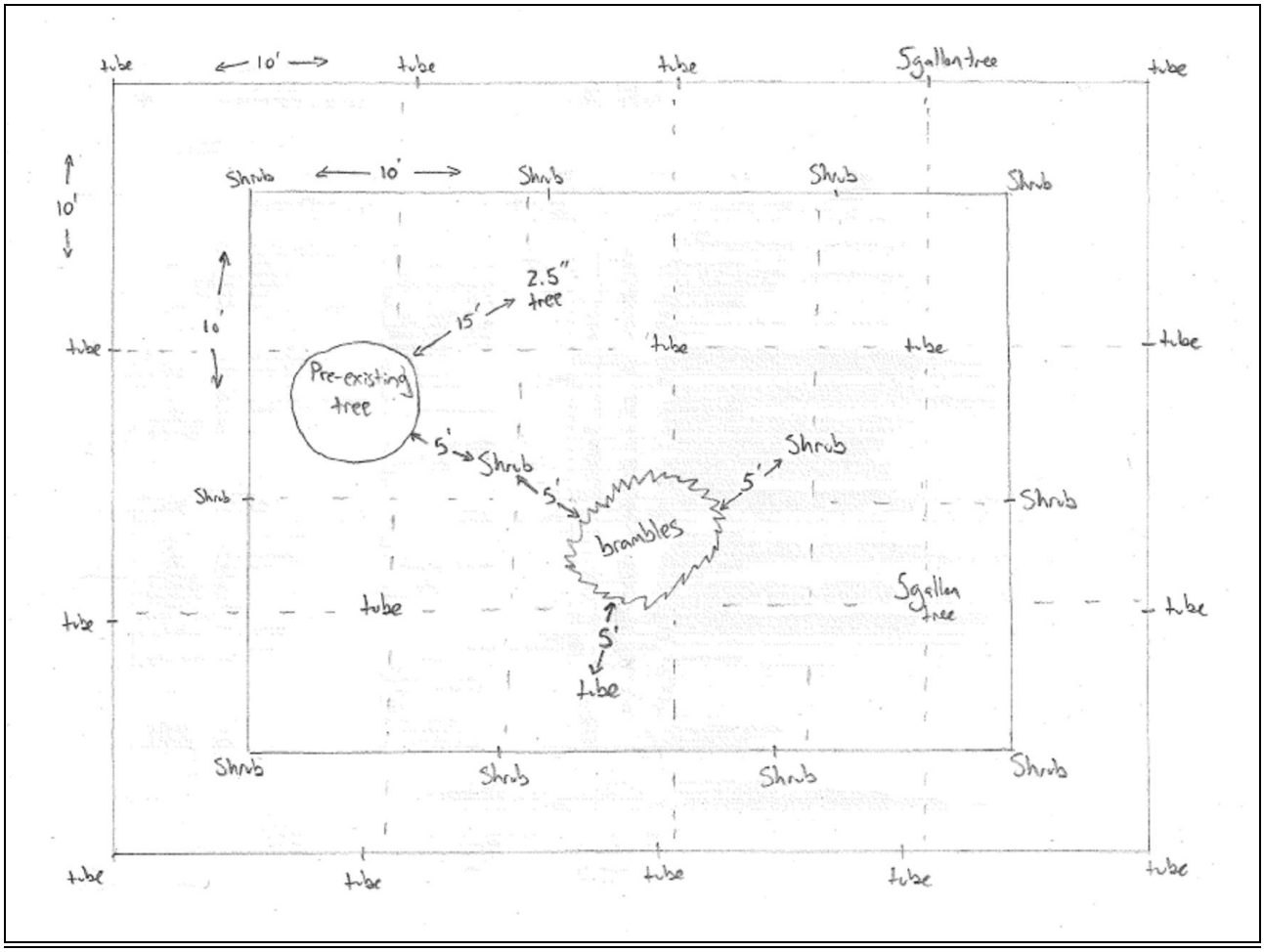
Part 2:



Outside border of treegrid

Outside border of shrub grid

Attachment E: Overall planting plan example




Attachment F: Planting specifications