



ADKINS ARBORETUM

Natural Areas Management Plan

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INTRODUCTION

1. Introduction to Adkins Arboretum

Description and Purpose of Adkins Arboretum

Adkins Arboretum's mission is to promote the appreciation and conservation of the native plants of the Delmarva Peninsula. The Arboretum's diverse setting of woodlands, meadows, wetlands, streams, and gardens serves as a model for land management and ecological restoration. Through its educational, research, cultural, and recreational programs, the Arboretum strives to inspire its community to adopt land stewardship practices for a healthier and more beautiful world.

The Arboretum strives to maintain a diverse and dynamic living collection that is authentic, engaging and a model for land management. The Arboretum reaches beyond its borders to address conservation needs of the region. As a significant cultural, educational and recreational resource, the Arboretum fosters civic pride, influences public policy and contributes to the economic vitality of the region.

Overview of the Arboretum's Location and Plant Communities

Adkins Arboretum is a 400 acre garden and preserve centrally located on the Delmarva Peninsula. It borders the Tuckahoe Creek to the west and Eveland Road to the east. It is surrounded on three sides by Tuckahoe State Park. Several streams including Blockston Branch and Piney Branch cross the Arboretum and flow into the Tuckahoe. The Tuckahoe becomes tidal near Hillsboro, about 1.5 miles south of the southern border of the Arboretum.

The major plant community types found at Adkins Arboretum are floodplain forest, mature upland forest, slope forest, young upland forest, pine plantation, thickets, meadows, and freshwater marsh. The developed area around the visitor's center includes cultivated gardens, a parking area, and lawn.

Within these major plant community types are more specific associations of plants governed by hydrology, geology and land use history. Several communities harbor species considered threatened or endangered in Maryland, but no federally listed plant species have been identified.

Restoration Projects

Wetland: The one acre marsh in front of the Arboretum visitor's center was created in 2000. Originally a stream, in 1980 a pond was dug at the site. The Arboretum received funding from a highway mitigation project to restore the pond to a more natural eastern shore feature, a braided wetland. The marsh was modeled on the wetland area in Tuckahoe State Park that formed around Crouse Pond. Though the Arboretum's marsh was planted with native plants, a number of species have volunteered. The wetland is managed to display a diversity of native plant species found in Delmarva wetlands. In 2006-2007 a bog area was created at the edge of the wetland.

Meadows: The South Meadow, west of the visitor's center, had been a cultivated farm field at least since the 1920s and probably since the early 1800s. In 2000 it was planted with native warm season grasses and has been managed as a meadow since then. The North Meadow, north of the visitor's center, had also been a farm field and was let go to form a meadow. Due to trumpet creeper aggressiveness, sections of the meadow were planted with short warm season grasses in 2007 to increase the effectiveness of burning as a means of controlling woody plants in that meadow. Both meadows are managed by burning on a three year rotation. The open area to the north of the entrance road was also planted as a meadow in 1988 with a mix of native and non-native plants (Appendix C). Some remain such as *Asclepias tuberosa*.

Data available

Plant communities were mapped in 1992 on aerial photos and a complete survey of vascular plants was conducted in 1998 and 1999 by Janet Ebert and Jack Holt. Plant communities were re-mapped using GPS in 2005.

1. Native Plant Database – Currently data on accession records and plant communities is stored in the Native Plant Database. This database uses Green Venues software, customized for the Arboretum by Advanced Data Solutions (adv-data-solutions@sbcglobal.net). The database combines a high resolution aerial photo of the Arboretum and other GIS layers containing data on plant species and communities and other information. Much of the horticultural data came from an Access database the Arboretum purchased from Bowman's Hill in 2004.

Management can be tracked by specimen or community. Long term research plots were also established in 2005 in which all trees over 10 cm DBH were tagged and all plants have been identified. These plots can be used to monitor long-term changes in the plant communities over time. Additional plots can be added as needed.

2. 1998-99 Vascular Plant Survey – The survey done by Janet Ebert and Jack Holt provided a relatively complete inventory of plant species occurring at the Arboretum. Locations of rare plants are noted in the text. The survey was done using releves set up in the major habitat types occurring at the Arboretum. Data from releves has been entered into the plant community field of the Native Plant Database.
3. 2001 Non-native species management plan – this plan outlines what invasive species were found at Adkins Arboretum and what management techniques can be used to control them. Most of the information from that plan is included in this plan.
4. 2000 DNR Forest Management Inventory – The Department of Natural Resources conducted a forest management inventory of the Arboretum forests to help plan management decisions in these areas. Stand types were delineated and recommendations for management outlined.
5. 1995 Environmental Assessment Report – Earth Data Incorporated performed an environmental assessment of the Arboretum prior to the Friends of the Arboretum leasing the land from the State. This assessment report identifies possible areas of environmental concern. It includes information on the site history and geology of the site.
6. 1992 Plant Community map – The Department of Natural Resources mapped plant communities onto an aerial photo of the Arboretum. The community survey was done by Yvette Ogle, a botanist in Washington, DC.
7. 1964 Caroline County Soil Survey – Records soil types present at the Arboretum. The soil survey map is being updated but has not been published yet.
8. Land use historical data – there are several sets of aerial photographs taken prior to the existence of the Arboretum. Aerials are available from 1937, 1958, 1999 and an orthophoto from 1992 (1:40,000 scale CIR photography). An environmental assessment report done in 1995 by Earth Data Incorporated also has information on previous landowners and land uses.

2. Overview of Management Goals

Purpose of the Natural Areas Management Plan

This plan provides guidance for protecting and maintaining the Arboretum's plant communities based on four goals – conservation, restoration, education and aesthetics. It overlaps with the Plant Collection Policy in guiding collections care.

The Natural Areas Management Plan addresses mapping and monitoring of specimens and plant communities, management of major restoration projects, protection of plant communities in natural areas and maintenance of accession records. It also tracks historical records of land management at the Arboretum. The Plan is a living document that will be revised as management issues change over time. It is updated regularly by the Curator with the input of the Director and grounds staff.

Conservation

For most of the natural areas, conservation of plant species and their habitats is a primary goal. The Arboretum's natural areas host 19 Maryland state rarities; 14 in wetland communities, 3 in woodland habitats and 2 in meadow or thicket habitat. An additional 22 species are considered rare in Delaware. Currently the only species that is monitored is *Cypripedium acaule*, the pink lady's slipper orchid which is not considered a rare orchid. One of the most unique habitats is the rich woods pocket which includes several species more commonly found in the Piedmont. In order to preserve species diversity, some areas should be maintained at early and mid-successional stages. State listed rare and threatened species will be re-located and monitored.

Restoration

Restoration projects are used to improve plant and wildlife habitat. The two major restoration projects at Adkins Arboretum have been the wetland and the south meadow. The north meadow has also undergone some restoration. The meadows were farm fields and are maintained as meadows now through burning, some mowing, and removal of woody plants. The marsh in front of the visitor's center was created from a farm pond and does not necessarily reflect the original stream that was present before the farm pond was built, but is a more natural feature for the eastern shore than a farm pond.

Invasive plant control takes place at many sites on the Arboretum grounds to improve or restore habitat. Some sites are likely to have been old house sites and others were former farm fields and field edges.

Education

The Arboretum uses its grounds to educate the public on native plants and land management. Trees and shrubs are labeled along the most heavily used paths and signs are placed at restoration sites and among the plant communities to explain ecological principles, conservation and land management. The north meadow has demonstration plots to show how different restoration techniques look. An audio tour guides visitors throughout the northern half of the Arboretum. Guided walks are offered regularly covering different themes. As land management is undertaken, public education through signs, brochures, and classes is considered.

Aesthetics

Because the Arboretum is a public garden and one of its activities is to promote appreciation of native plants through gardening, the Arboretum also does some land management for aesthetic purposes. For example, along many paths greenbriar, *Smilax rotundifolia*, is cut back periodically, and along Blockston Branch some plantings have been done including planting *Packera aurea* and *Mertensia virginica*. Along more heavily used paths, sticks and fallen logs are kept back from the path edges to maintain a neater appearance and poison ivy is herbicided.

3. Management Activity Assessment and Prioritization

Because of the many ongoing projects at Adkins Arboretum, assessment and prioritization of management activities is undertaken. When deciding which projects deserve priority, first consideration goes to the management goals stated above. However, sometimes opportunities present themselves to achieve a goal of lesser priority in the form of grant funding or availability of volunteer help.

Assessment involves monitoring plant communities for new management issues and assessing the effectiveness of ongoing management projects. More detail is given on assessment and prioritization below for several projects.

Invasive Species

The management goals are considered when deciding on invasive species control project priorities as are aggressiveness of the invader, size of the invasion, funding, staff resources, and site accessibility. When new invasive species are discovered, such as *Alliaria petiolata*, garlic mustard, or mile-a-minute vine, *Polygonum perfoliatum*, high emphasis has been placed on removing these species to prevent further spread. Removing all *Ailanthus altissima*, tree of heaven, is a high priority because of its ability to spread rapidly and cause significant changes to the plant communities.

Path edges are often targeted for invasive species control because invasive plants often establish along path edges where there is more light and soil disturbance and because these sites are also accessible. Japanese honeysuckle, *Lonicera japonica*, and Oriental bittersweet, *Celastrus orbiculatus*, are frequently targeted along path edges when groups of volunteers are available.

Restoration projects (meadows and marsh) also receive more attention because they are often used in public programs and/or are close to the visitor's center.

Some species such as *Lespedeza cuneata*, Chinese lespedeza, and larger areas of Oriental bittersweet and Japanese honeysuckle are best controlled using herbicides. Lespedeza control often requires large scale spray equipment.

Megan Pulver, a summer intern, mapped occurrences and severity of plant invasions from the Nursery north to Piney Branch in 2006 providing some

baseline data for monitoring and managing invasive plants. The data was entered in to the Native Plant Database. This data can be used in combination with maps of community and species occurrences to prioritize invasive species management. This data can be revised and expanded upon as needed.

Invasive species management has been recorded in an Excel file and on the Native Plant Database. Monitoring is done by walking through the plant communities on a semi-annual basis to look for new occurrences of invasive species. This must be done during different seasons (spring, summer, fall, winter) as some species are more visible in one season than another.

Early Successional Plant Communities

Early successional communities will become mature forests without intervention. The Arboretum maintains a diversity of habitats for conservation and educational purposes and has therefore chosen to maintain some areas as meadows, thickets, and young forests.

Meadows are maintained by burning or mowing on a three year cycle, but thickets and forests are allowed to mature. Because of the size of the Arboretum it is likely that there will always be some areas of thickets and young forests due to natural disturbances. Alternatively, a rotation system may need to be developed where sections of the Arboretum are cut every 15 – 20 years on a rotational basis in order to maintain these younger habitats.

Land Management Demonstration Projects

The meadows, marsh and pine plantation areas can be used as demonstration projects for active land management. Currently the pine plantation is not used for education programs and is not as accessible as the meadow and marsh projects because of its physical distance from the visitor's center.

MONITORING AND MAPPING

1. Plant Communities

Existing Surveys and Maps

Mapping of the plant communities and accession records was most recently done in 2005 and overlaid on a high resolution aerial photo as part of the development of the Native Plant Database. Some additional species locations have been added since then including an invasive plant survey in 2006. Plant community boundaries are unlikely to change unless a new community is identified or plant community types are refined. Species composition within communities could change however due to major disturbances such as hurricanes or fire. New aerial

photos will need to be taken as buildings and landscaping change. Species composition of plant communities was recorded in the 1998-1999 survey by the Jack and Janet Ebert, but not all communities were surveyed by them. An earlier more general survey was done in 1992 by Yvette Ogle.

Long-term Monitoring Plots

Long-term monitoring plots established in 2005 are located in two of most major community types - meadow, thicket, young forest, mature upland and mature lowland forest. All the woody plants in these plots were identified in summer 2005 and herbaceous plants were identified in spring 2006. Trees over 10 cm DBH were tagged and DBH and canopy placement was recorded for each tree. These plots should be re-surveyed every 5 years or more frequently if a major disturbance occurs.

To re-survey the plots, establish the plot boundaries. One southern corner of each plot is marked with a 3 ft. rebar stake. Plots are 25 x 25 meters square oriented to the cardinal directions (The slope plot on the western edge of the South Meadow is 20 x 30 m with the stake in the SE corner). All trees over 10 cm DBH should be re-measured and tags checked and replaced or repositioned if needed. Tags are round or oval numbered aluminum tags. Data sheets are in the Natural Areas Management Plan binder and collected data is stored in the Native Plant Database folder on the server. At some point it would be useful to map the trees in each plot because tags will be lost. Surveys of non-woody plants will need to be done during spring, summer and fall to capture the full diversity of each plot. Non-woody plant species are currently just listed with no measure of abundance. Adding abundance data would be another useful project.

Community Surveys

In summer 2007 interns surveyed all the plant communities at the Arboretum for which we had no species data. They focused on woody plants in their surveys and the surveys were done as random walk throughs of the communities. More thorough surveys should be done for herbaceous plants and identification of oak and hickory species in particular should be confirmed. Locations of Maryland rare and threatened plant species from the Ebert survey should be re-mapped for the Native Plant Database and these species should be monitored. Data for plant communities can continue to be updated and improved (a copy of the Ebert survey is in the Management Plan binder).

Cypripedium acaule Monitoring

The Arboretum has at least 3 populations of *Cypripedium acaule*, pink lady's slipper orchids. The largest population grows on the Tuckahoe Valley Trail near the southern intersection of the Tuckahoe Creekside path. This population has been overlaid by a 1m² grid and monitored since 2003. In 2003 all plants found were tagged with a numbered aluminum tag, but in 2005 the census was switched to a more general population census rather than tracking individual plants. Every 1-2 years the population is measured for the number and size class of orchids in

each 1m² section. Data can be found in the file folder *Cypripedium acaule*-Data. The data have not been entered into a computer file. Data sheets are found online in the Orchid folder.

In 2005, several beech saplings were removed to increase light reaching the orchids. Light has been found to increase flowering in pink lady's slippers and consequently seed set. The canopy above this population is to be kept open to encourage flowering and seed production. Flowers could be cross-pollinated artificially as well to encourage seed production.

2. Accession Records

Policies for accessioning and de-accessioning plants are recorded in the Adkins Arboretum Plant Collections Policy. Accession records of plants in the natural areas were added in 2005 using GPS to map them. Accessions of trees and shrubs were chosen to represent one or two specimens of each woody tree or shrub species. Specimens were chosen based on their health, accessibility and as representatives of the typical form of that species. Each accessioned plant is marked with an aluminum tag nailed to the side of the tree facing away from the nearest path or with a tag attached to a branch using plastic coated wire. The tags are numbered and the accession number is entered into the database with the plants location, size, and measure of health.

New accession records can usually be added to the database without using GPS if the specimen can be located on the high resolution aerial. A voucher specimen should be collected from each new accession to be pressed and sent to the Claude Philips Herbarium at Delaware State University (<http://herbarium.desu.edu/>, contact Dr. Art Tucker, atucker@desu.edu or Arboretum Volunteer Beverly Gemmill). An extra specimen is kept in the Arboretum herbarium's teaching collection.

Tags are purchased from Forestry Suppliers (www.forestrysuppliers.com) as pre-numbered tags or numbers can be engraved on blank tags using an electric engraving tool. Coated wire can be purchased at local hardware stores.

Accessions should be monitored every 3-5 years to make sure that tags are in place and to assess the size and health of the specimen.

3. Management Activities

Management activities are recorded in the Native Plant Database and in files for each project (south meadow, north meadow, little meadow, marsh, bog garden, invasive plant removal). The Curator is responsible for these records. Currently, weed warrior volunteer Michelle Lawrence records activities in a log kept in the Volunteer log book with past logs stored by the Curator. No regular log is kept

by staff other than the Curator. Maintenance on accessioned plants is recorded by the Curator, but little maintenance is done on accessions within the natural areas.

Any management done by staff or volunteers in the natural areas and for restoration projects should be recorded. The Curator recommends establishing a recording system for use by all staff and volunteers who work on management activities. These records would be compiled by the Curator each quarter. For example, volunteers who regularly work on maintenance activities should have a log sheet on which to record their activities for the day (Appendix B). Currently no records are kept of trail maintenance.

Maintenance records include the area where work was done, number of person hours, tools used and herbicides used (active ingredients and concentration).

Herbicide use should be recorded at the nursery in a log maintained by the Maintenance Supervisor. Herbicide use at the nursery is reported every year to the Maryland Department of Agriculture.

4. Wildlife Surveys

Volunteers have conducted surveys of wildlife at the Arboretum. Dr. Wayne Bell assembled a bird checklist and has proposed ordering it by what habitat types birds are found in. The Arboretum is under consideration with Tuckahoe State Park as an Important Bird Area because of the extensive mature woodlands providing habitat for forest interior birds species.

A bluebird trail was installed in 1996 and records of bluebird nesting success have been kept since 2003. Records are kept by volunteers or staff and are stored by staff. Currently Buck Schuyler has the records. Wood duck boxes are also in place but are not currently monitored or maintained.

Ted Suman (tsuman@express.com) started an insect survey in 2006 collecting data on insects found within the long-term monitoring plots. The Arboretum does not yet have a copy of that data. He will also be doing a pollinator survey at the Arboretum.

INVASIVE AND AGGRESSIVE SPECIES MANAGEMENT

The Arboretum defines an invasive species as one that was introduced either deliberately or accidentally by humans which spreads rapidly in natural areas. These are generally species introduced after European settlement which cause changes to native plant populations, communities or ecosystems. Some native species that spread rapidly are

considered aggressive and are managed within certain community types to maintain the diversity of those communities.

Control methods are selected to have as little impact on the surrounding plant community as possible. Techniques include manual removal of plants, brush hogging, and chemical control. For control techniques of individual species, see Appendix A.

1. Manual and Mechanical

Manual and mechanical control have the advantages of causing little harm to surrounding plants and being less expensive, but they do cause soil disturbance sometimes and take a great deal of labor. The Arboretum often uses hand pulling for plants like honeysuckle and spotted knapweed that are relatively easily pulled by volunteers. Since volunteers prefer to work in poison ivy free areas, remove poison ivy prior to controlling other species. Volunteers are provided with sturdy gloves and are warned about poison ivy and any other hazards. For mechanical control the Arboretum has chainsaws for larger trees, weed wrenches for saplings, and assorted loppers and pruning shears for smaller plants.

2. Chemical

For chemical control the Arboretum has mainly relied on herbicides containing glyphosate or triclopyr. Glyphosate is a broad-spectrum herbicide, whereas triclopyr acts mainly on broadleaf plants. Glyphosate can be found in formulations for use near water such as Rodeo.

There are many tools available to apply herbicides. For foliar spraying, a hand pump sprayer works well for small areas. A gas powered backpack sprayer can be used for larger areas. The Arboretum may also plans to acquire a sprayer that can be mounted on the back of the Kubota for spraying plants like Lespedeza and honeysuckle that cover large open areas which can be driven over. While foliar spraying can be done quickly, it has the disadvantage of potentially affecting surrounding plants. Most foliar spraying is done with a 1-3% solution of glyphosate.

In sensitive areas, such as the marsh, herbicides are often applied to cut stems or are wiped onto invasive plants to avoid affecting neighboring plants. Trees and shrubs too tall to be sprayed can be cut and the stumps painted with herbicide or the “hack and squirt” method can be used. Hack and squirt involves cutting a notch in the trunk with an axe and dripping or spraying herbicide into the notch. The rule of thumb is to cut one notch for every inch of trunk diameter. For cut stem or hack and squirt the herbicide should be applied at 50 – 100% strength. Triclopyr herbicides are generally used for woody plants unless they are in wet areas.

Herbicides can also be wiped onto plants using a paintbrush, roller or “the glove of death”. Placing a cotton glove over an herbicide proof rubber glove, wet the palm and fingers of the cotton glove with herbicide solution and run your gloved

hand over the target plant. This technique works well with slender plants like Lespedeza or Phragmites.

In the sections below, the invasive species present are listed. Appendix A has a schedule for control of all invasive and aggressive species at the Arboretum. The most widespread invasives at the Arboretum are Japanese honeysuckle and Oriental bittersweet. New species of concern are mile-a-minute vine and garlic mustard.

MARSH

1. Background

The marsh in front of the visitor's center was created in 2000. Originally a stream, in 1980 a pond was dug out at the site. The Arboretum received funding from a highway mitigation project to restore the pond to a more natural Eastern Shore feature, a braided wetland. The wetland was modeled on the wetland area in Tuckahoe State Park that formed around Crouse Pond. The Arboretum's marsh was planted with native plants and a number of species have volunteered. The wetland is managed to display a diversity of native plant species found in Delmarva wetlands. In 2006-2007 a bog area was created at the edge of the wetland.

Some trees planted during the original restoration are being left to grow (see map in Appendix E). Tree growth is being limited so that the marsh continues to receive high sunlight in most locations and to maintain it as a marsh rather than allowing it to become a forested swamp.

2. Monitoring

The marsh is monitored for how new plantings are performing, invasive and aggressive plant growth, woody plant growth, and for water quality. New plantings should be monitored on a weekly basis to ensure that they are receiving enough water. Flooding can also wash out new plantings.

Because the marsh is an open area with flooding and a ready input of new propagules, invasive and aggressive species monitoring should be done several times a year.

Water quality has occasionally been monitored in the past, but on an irregular basis. A program should be set up for regular water quality monitoring particularly with new construction beginning around the wetland. Several monitoring points need to be established including at inflow points (the stream and parking lot swale/drainage), the outflow and at a point within the wetland. Water samples can be tested using the Arboretum's water testing kit. Michelle Lawrence and Gayle Jayne have volunteered to do water monitoring. Michelle assisted with the first water test done on 12/19/07.

3. Management

The islands in the marsh are expected to contain more shrubs over time edged with herbaceous plants. Most of the islands have a few trees which are being let grow. These trees are marked on the map in Appendix D. Tree growth is managed to maintain the area as a marsh rather than allowing it to become a swamp.

Invasive Plants

The banks of the wetland contain the non-natives *Lonicera japonica*, *Lespedeza cuneata*, *Vinca minor*, *Morus alba*, *Celastrus orbiculatus*, *Rosa multiflora*, *Cirsium* spp., *Lolium* sp. and *Rubus* spp. as well as aggressive natives such as *Campsis radicans* and *Toxicodendron radicans*. Within the wetland are *Phragmites australis*, *Lespedeza cuneata* (on the islands), *Salix nigra*, *Typha latifolia* and *Hydrocotyle umbellata*.

Rodeo, an herbicide containing glyphosate but formulated for use around water is generally used for most chemical treatment of invasive and aggressive species. Marsh pennywort, cattails and Japanese honeysuckle are removed by hand pulling. Treatments for invasive and aggressive plants in the marsh are as follows:

- Woody plants - control in late summer to early fall using cut stump herbicide treatments.
- Marsh pennywort and cattails - pull out in summer by wading into the wetland. Marsh pennywort can be composted, but the seeds of cattails may survive in the compost pile.
- Phragmites - cut and treat with Rodeo in late summer or for larger patches, Chesapeake Wildlife Heritage (410-822-5100) can be contracted to treat it.
- Vinca - remains from the original visitor's center plantings and does not spread very aggressively nor to inhibit the growth of shrubs or perennials.
- Honeysuckle - often easier to remove manually or herbicide in late fall to early spring after other vegetation has died back.
- Lespedeza - spray large areas of lespedeza in summer or cut and dab cut stem with herbicide for scattered plants.

Beaver

In late winter or early spring beaver sometimes take up temporary residence (2 -4 weeks) in the wetland. They do damage some trees and cause the overflow grate to clog up with cut branches and grasses. Because they seldom stay for long, trapping has not been necessary.

Bog Garden

The bog garden was established in 2007. A mixture of peat moss and sand (3:1) was added to a low area at the edge of the marsh. This area was planted with cranberries, pitcher plants, sphagnum moss, blueberries, swamp azalea and sweetspire (for plant list see Appendix F). A barrier of metal mesh was put in place to stabilize the bog until the plant roots were well established. If it proves stable, the bog garden plantings should be augmented with additional species appropriate to coastal plain bogs.

MEADOWS

1. North Meadow

Background

The North Meadow was farmed from at least 1937 until Tuckahoe State Park was established. It was then left to grow into a meadow without any planting. The North Meadow began renovation in 2006-2007 due to excessive growth of *Campsis radicans*. Chesapeake Wildlife Heritage (410-822-5100) herbicided *Campsis radicans* and woody saplings. They planted 2 sections with short warm season grass and forb seeds in Spring, 2007 (see species list for planting in Appendix C), but due to an extremely dry summer and regrowth of *Campsis*, they will be retreating in Fall, 2008. There was also heavy growth of *Croton glandulosus* in planted areas in summer 2007.

The southwest corner of the meadow has very sandy, low nutrient soils. A healthy stand of *Andropogon ternarius* and *A. virginicus* thrives in this area along with *Gnaphalium obtusifolium* and *Heterotheca subaxillaris*. There is a fox den in this corner of the meadow and ground nesting bees at some of the burrow entrances. This corner also contains an area with several types of lichens growing on the ground. A former staff person (Nancy Adamson) attempted to establish a colony of *Lupinus perennis* in this area in 2001, but it was not successful.

Some woody plants are left to grow. There is a small stand of loblolly pines on the northwest side as well as a small stand of mixed hardwoods. Several stands of shining sumac are also growing along the edges of the meadow.

Along the eastern edge of the meadow bordering Eveland Road, the MD State Highway Administration is planting trees in 2008 as part of a highway mitigation project. They herbicided the site in summer 2007 and mowed in December 2007.

Monitoring

Monitoring in the North meadow principally consists of monitoring for incursions of woody and invasive plants. As the newly planted areas are establishing they will be monitored for species composition and success at establishing a healthy stand of short, warm-season grasses.

Maintenance

Generally the meadow is maintained by burning. The first burn occurred in 2002. Woody plants are cut and removed by staff and a strip 6 feet wide is disked around the area to be burned. The burning is conducted by staff from Chesapeake Wildlife Heritage (CWH, 410-822-5100). Requests for burning are submitted to CWH in September-October to enable them to file a burn plan with the fire department. CWH will need a map with the areas to be burned marked on them (see map Appendix C). Notices to neighbors are sent out in January before burning. Addresses are found in Raiser's Edge and a sample letter

is contained in the Meadow Restoration folder on the Arboretum's server within the Curator's files.

The meadow had been divided into three sections with one section burned each year, but because the size of the meadow has been reduced with the highway mitigation project, the meadow will instead be divided into 2 burn units with no burning done in the third year. Burning will be postponed until the newly planted grasses are established. Usually woody plant removal is done prior to burning, as the grasses are establishing woody plants should be removed once a year.

Invasive plants in the north meadow include *Centaurea biebersteinii*, spotted knapweed and along the edges oriental bittersweet and Japanese honeysuckle. The knapweed is controlled by hand pulling plants in summer as the plants are beginning to flower. Bittersweet and honeysuckle along the edges should be controlled by spraying in early fall for bittersweet and in late fall – early spring for honeysuckle.

2. South Meadow

Background

The south meadow had been a farm field for at least 60 years (based on 1937 aerial). Farming ceased in 1980 (?). In May 1999 15 acres were placed into the WHIP program for 10 years (agreement ends May 26, 2009). In Fall 1999 the field was herbicided and in Spring 2000 planted with warm season grasses using a drill seeder (species list in Appendix B). This work was done by Chesapeake Wildlife Heritage. The first summer after planting the meadow was dominated by *Croton glandulosus*. CWH herbicided again and replanted in spring 2001.

Monitoring

The meadow is monitored for re-occurrence of invasive woody plants, particularly where *Ailanthus* and black locust have grown. Spread of blackberries and trumpet creeper should also be monitored to determine when it is necessary to herbicide these species. It is easiest to monitor the meadow in spring after a burn when it is easy to walk through the newly growing grasses.

Maintenance

Prior to 2004, the meadow was maintained by mowing. By 2004 the grasses were well established and CWH burned the western half of the meadow in February 2004. The eastern half closest to the visitor's center was burned in 2005. No burn was done in spring 2006 because the meadow is on a three year burn rotation. A large section of the meadow was mowed in summer 2006 for a capital campaign event near the visitor's center, and because of that and the drought in summer 2007, the meadow will not be burned in spring 2008. In spring 2009 the western half of the meadow will be burned to return to the regular burn schedule (see map Appendix C).

Prior to burning woody plants are cut and stump treated with herbicide or can be sprayed with herbicide in summer. A fire break must be disced around the edge of the

area to be burned as well. CWH has generally loaned the Arboretum the equipment to do the discing.

The south meadow's invasive plants include a stand of *Ailanthus altissima*, *Robinia pseudoacacia* near the edges of the meadow and occasional patches of oriental bittersweet. The trees can be removed any time of year and the bittersweet sprayed in late summer. Trumpet creeper and blackberries should also be monitored for occasional removal if enough control is not achieved through burning.

3. Little Meadow

Background

The little meadow area between the Visitor's Center and the entrance to the woods paths along the Blockston Branch forest edge was seeded at the same time as the South Meadow. In 2004 the Arboretum received a grant from the Chesapeake Bay Trust to make the meadow into a demonstration small-scale meadow that a homeowner could create on their property. Herbaceous flowering perennials were added to the meadow as plugs, but a very dry summer led to very low success rates in establishment. Further planting has been postponed until after construction of the new visitor's center as this activity will be using part of the meadow area as a construction staging area.

Maintenance

The Lespedeza in this area needs further control before more planting occurs. The area is also monitored for *Centaurea biebersteinii*. This area is maintained as a meadow by mowing every two years. It will be mowed in winter, 2009.

4. Berms

Background

The berms along Eveland Road were first established in 1980 when the farm pond was dug out in front of the visitor's center. The soil for the berms was what was dug out of the pond. Some of the soil was returned in 2000 when the marsh was established. The berms were re-graded and seeded with warm season grasses in 2001. A hedgerow was designed for the meadow but never planted (see plant list Appendix D). In 2003 groups of shrubs were planted on the berms including wax myrtle, shining sumac and sassafras but few of the shrubs survived. The soil on the berm is extremely compacted and retains water in some places.

The goal for the berms is to maintain it as an open meadow area with occasional groupings of small trees like sassafras, red cedar and sumac. There is a stand of *Rhus typhina* south of the Service entrance that is maintained because it is the only staghorn sumac at the Arboretum. There is no record of whether it was planted or a natural occurrence.

Maintenance

Populations of *Polygonum cuspidatum*, Japanese knotweed, occur where creeks cross Eveland Road between sections of the berm. Japanese knotweed is pulled or cut in July before flowering and resprouts are sprayed in the fall. Lespedeza should be sprayed in late summer before seed set. Near the service entrance black locust, mile-a-minute vine and tree of heaven have been treated and this area should be monitored carefully for recurrences of these species. Multiflora rose should be treated along the berm as well.

FORESTS

1. Pine Plantation

Background

The pine plantation at the Arboretum's southern boundary was planted soon after Tuckahoe State Park was established. A section of it was thinned in 1999 and is succeeding to a mixed pine hardwood forest. A forester needs to assess the pine plantation to determine whether it needs thinning or other maintenance and consulted on the long-term goals for the pine plantation area.

Monitoring

Succession in the plantation area should be monitored depending on the goals chosen for the site. The area is also be monitored for insects and diseases affecting pine trees.

Maintenance

The border of the pines along the road should be brushhogged once a year to keep the oriental bittersweet in check and vines should be cut off of trees along the edge. No maintenance has been done in this area previously.

2. Thickets

Background

The thickets surrounding the south meadow have grown up since the mid 1980s on what had been farm land. A mix of typical hardwood species is establishing. There are also scattered larger trees along the roads that were planted when the Arboretum was established as part of the Western Maryland Loop including chestnut oak, sugar maples, hemlock and white pine. These have been left out of historical interest as representative of the Arboretum's early goals. There are natural stands of hemlock on the Eastern shore as well. The pine and hemlock are also used to provide greens during the holiday season.

Monitoring

The thickets are monitored for invasive plants including mile-a-minute vine and oriental bittersweet. New populations of mile-a-minute are of particular concern because of the aggressiveness of this annual vine. One thicket area has a long-term monitoring plot.

Maintenance

The thickets are succeeding to a mixed hardwood forest. Should the Arboretum decide to maintain these as thickets or young forests, a rotation for cutting should be established. The thicket areas are divided by paths and roads and such a rotation would be relatively easy to set up although it would require significant labor to cut the trees in each section.

One section between the service entrance and the nursery may be planted as part of a State Highways mitigation project. This area contains a large number of invasive plants including *Lonicera tatarica*, *Ailanthus altissima*, *Polygonum perfoliatum* and *Morus alba*. These would be removed as part of the mitigation.

The section along the northern edge of the south meadow bordering mature forest is allowed to succeed to forest as it is difficult to maintain a meadow along a forest edge. In this area, vines are kept clipped off of trees and herbicided around the base of the trees. This area has heavy infestations of Oriental bittersweet, Japanese honeysuckle and some areas of Lespedeza.

3. Young forests

Background

One young forest stand occurs between the Upland path and eastern edge of the North meadow bordered to the south by Birch Alee and to the north by Tuckahoe Valley. A second grows along the north edge of the North meadow. It is probably part of an old house site as it contains osage orange, hazlenuts and fruit trees. Both of these forests contain one of the long-term research plots to monitor succession. An area of young forest also grows to the west of the South meadow bordered by the Blockston Branch Overlook Path on one side and bisected by the Ridge walk.

Monitoring

These areas are monitored for insects and diseases and for invasive plants on a yearly basis.

Maintenance

Invasive plants are removed when necessary to assure continued growth of these forests.

4. Mature Forests

Background

Most of the Arboretum's mature forests have trees 100 years old or older. The upland forests were probably all cleared at one point and the bottomland forests probably had some selective logging. There is also evidence in some places of gravel borrow pits and possibly portable saw mills. The edges of the mature forests are often visible because of the presence of very large trees with spreading branches that would have grown at the edge of a field.

Monitoring

The mature forests are monitored for insects, diseases and invasive plants. Priorities for monitoring are invasive plants occurring along edges of the forests, in gaps, and along paths. Walking these paths during all seasons, any occurrences should be noted in the Plant Database or removed immediately. Some areas where more intensive invasive plant removal have occurred are at the entrance and exit to the woods paths, at the Blockston Branch/Ridge walk intersection and removing *Glechoma hederaceae* from the floodplain of the bridge on the Upland Path.

Maintenance

Invasive plants are removed when necessary to assure continued growth of these forests. Dead wood is left for wildlife use except along trail edges where it is moved further back into the woods for aesthetic reasons.

PATHS

Background

The Arboretum's path system contains about 4 miles of paths. The main paths are roads established around 1980 with a substantial base of crush and run. Blockston Branch was mulched in 2007 for aesthetics and drainage concerns. Other secondary paths are dirt or grass and are maintained with mowing and herbiciding.

Maintenance

Paths in the woods close to the Visitor's Center (Upland, Blockston Branch, Creekside, Ridge Walk, Blockston Overlook, Birch allee) are blown once a week to keep leaves from accumulating on them.

Vegetation is kept trimmed back from the path edges such as green briar and paw paw. Dense stands of poison ivy on the ground are also sprayed or pruned if they are encroaching on the path. Poison ivy and greenbriar are also sometimes removed for aesthetic reasons so that visitors can see into the woods from a path and for safety reasons because of thorns and allergic reactions.

Erosion can be a problem on sloped paths. Water bars were installed in 2006 to control erosion. If the center of the water bar fills with fine particles they will need to be cleared out. Paths often need to have additional fill placed in sloped areas after heavy rainfall and mulched paths require raking mulch back into place.

APPENDIX A. INVASIVE PLANTS

Ailanthus altissima

common name: tree-of-heaven

- A. Current distribution on site – *Ailanthus altissima* is found between the service entrance and the nursery and in scattered locations in thicket areas between the service entrance and visitor’s center.
- B. Damage and threats - Tree-of-heaven is a prolific seed producer with one plant producing up to 350,000 seeds in a year. Seedlings establish a taproot three months from germination. Thus they quickly outrace many native plant species in competition for sunlight and space. Tree-of-heaven also produces a toxin in its bark and leaves. As these accumulate in the soil, the toxin inhibits the growth of other plants. This toxin is so effective it is being studied as a possible source for a natural herbicide. These factors combine to make tree-of-heaven a very aggressive invasive plant able to displace native tree and herb species. Furthermore, the root system is capable of doing damage to sewers and foundations. It is adapted to a wide variety of soil conditions and is tolerant of drought. The tree is common in urban areas and disturbed sites and is a pioneer in succession with limited ability to compete in a closed-canopy forest. It can, however, take advantage of forests defoliated by insects (e.g. gypsy moth) or impacted by slides, windstorms or other natural disasters. *Ailanthus* forms dense, clonal thickets that displace native species.
- C. Methods of reproduction and dispersal - Tree-of-heaven reproduces both sexually (seeds) and asexually (vegetative sprouts). Flowering occurs in June. The species is dioecious, with male and female flowering on separate trees. Fruits are papery, somewhat twisted, winged structures called samaras that are tan to pink-colored. Samaras occur in large clusters from September to October of the same year and may persist on the tree through the following winter. Established trees also produce numerous suckers from the roots and resprout vigorously from cut stumps and root fragments. A few trees along a fencerow or forest edge can rapidly invade adjacent meadows. In addition to its prolific vegetative reproduction, *Ailanthus* has allelopathic effects on many other tree species and consequently inhibit succession.
- D. Goals – To eradicate existing trees and monitor for new populations
- E. Management options

Cutting trees at ground level with power or manual saws is most effective when trees have begun to flower to prevent seed production. Because *ailanthus* spreads by suckering, resprouts are common after treatment. Cutting is an initial control measure, and success will require either an herbicidal control or repeated cutting for resprouts.

Girdling can be used on large trees where the use of herbicides is not practical. Using a hand axe, make a cut through the bark encircling the base of the tree, approximately 6 inches above the ground. Be sure that the cut goes well into the cambium layer. This method will kill the top of the tree but resprouts are common, and may require follow-up treatments for several years until roots are exhausted.

Hand pulling is an effective control for the removal of young seedlings. Plants should be pulled as soon as they are large enough to grasp, but before they produce seeds. Seedlings are best pulled after a rain when the soil is loose. The entire root must be removed since broken fragments may resprout.

Foliar spray method should be considered for large thickets of Ailanthus seedlings where risk to non-target species is minimal. Air temperature should be above 65 degrees F to ensure absorption of herbicides. The herbicide mixture should be applied leaves and green stems, including sprouts and suckers, until thoroughly wet but not to the point of runoff. **Glyphosate:** Apply a 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Glyphosate is a non-selective systemic herbicide that may kill non-target partially-sprayed plants. **Triclopyr:** Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic thoroughly wetting all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to no-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around Ailanthus, triclopyr can be used without non-target damage.

Cut stump method should be considered when treating large individual trees or where the presence of desirable species preclude foliar application. Stump treatments can be used as long as the ground is not frozen. Application of the herbicide to the cut stumps must be conducted immediately after cutting, within 5-15 minutes of the cut with water soluble formulations, longer with oil mixtures, to ensure uptake of the chemical before the plant seals the cut area off. This method is likely to be most successful during the growing season, with diminishing success through the early fall. Dormant season applications may prevent resprouting from the stump itself, but will do little to inhibit root suckering. However, at any time of year, if the tree must be cut it is better to treat the stump than not. **Glyphosate:** Horizontally cut stems at or near ground level. Immediately apply a 50% solution of glyphosate and water to the cut stump making sure to cover the outer 20% of the stump. **Triclopyr:** Horizontally cut stems at or near ground level. Immediately apply a 50% solution of triclopyr and water to the cut stump making sure to cover the outer 20% of the stump.

Basal bark method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the tree to a height of 12-15 in. from the ground. Thorough wetting is necessary for good control; spray until run-off is just noticeable at the ground line.

Hack and squirt method or injection method is also very effective and usually inhibits or prevents sprouting and suckering at certain times of year. Best results are obtained

during the summer, with gradually decreasing control of root suckering through the fall, and poor control root suckers in winter and spring. A straight (100%) concentration of water-soluble triclopyr product (e.g. Garlon 3A) is applied into downward-angled cuts made into the sapwood around the tree trunk at a comfortable height, using a hand ax. Within a minute or two apply 1-2 milliliters into each cut (typically 1-2 squirts of trigger squirt bottle) so that the bottom of the cut is covered, but not running out of the cut. Generally, make 1 hack cut for each inch of diameter, plus one (e.g. for a 10" diameter tree, about 11 cuts). Space the cuts so that about 1-2 inches of uncut living tissue remains between them. This method can be used with trees of any size, though it is most productive with stems over 2 inches in diameter. This method requires follow-up the next season with a foliar application to control any basal sprouts or root suckers which emerge.

F. Actions Planned – Hack and squirt and treatment of resprouts with foliar spray or herbicide applied to broken tips has been underway since 2005. Monitoring and continued treatment should be done each year. Basal bark treatment could also be very effective and could be done in winter.

G. Monitoring methods - Monitoring for resprouts in treated locations and monitor for new plants.

H. References

Southeast Exotic Pest Plant Council, *Ailanthus altissima* (Updated October 24, 2000)

Plant Conservation Alliance, Alien Plant Work Group, Jil M. Swearingen, National Park Service, Washington, DC and Phil Pannill, Maryland Department of Natural Resources, Forest Service, Hagerstown, MD (last updated 4/6/99)

Invasive Alien Plant Species of Virginia, Fact Sheet,(undated)

The Nature Conservancy, Element Stewardship Abstract for *Ailanthus altissima*, Marc C. Hoshovsky, (11-30-88)

Berberis thunbergii

common name: Japanese barberry

- A. Current distribution on site – A few barberry plants were found in the bottomland hardwood forest northwest of the nursery. These were hand pulled by staff in 2007.
- B. Damage and threats - Japanese barberry poses a significant threat to natural areas due to its popularity as a landscape shrub, ability to tolerate full shade, and the dispersal of its prolific seeds by birds.
- C. Methods of reproduction and dispersal - Japanese barberry reproduces from prolific seeds, rhizomes or layering. Seeds have a germination rate as high as 90% and are disturbed by birds including ruffed grouse, bobwhite, pheasant and wild turkey. Because barberry is shade tolerant, an extensive population can become established in a short time under a closed forest canopy. Severe drought or extreme winters have little effect on overall mortality or seed production. Deer avoid barberry while often browsing surrounding vegetation, which may effectively increase barberry's competitive advantage.
- D. Goals – To prevent recurrence of barberry
- E. Management options

Hand pulling is an effective control method for small populations of barberry, since plants pull up easily in most forested habitats. Hand-pulling is an extremely effective method of reducing population and seed productivity; this can be done during most of the year. Barberry is especially easy to see in the winter and early spring before deciduous plants leaf out. If plants have fruit present, they should be bagged and disposed of to prevent seed dispersal. Care should be taken to minimize soil disturbance.

Mowing/cutting is appropriate for initial small populations or environmentally sensitive areas where herbicides cannot be used. Repeated mowing or cutting will control the spread of Japanese barberry but will not eradicate it. Stems should be cut at least once per growing season as close to ground level as possible. Hand-cutting of established clumps is difficult and time consuming due to the long arching stems and prolific thorns.

Foliar spray method should be considered for large thickets of barberry where risk to non-target species is minimal. Air temperature should be above 65 degrees F to ensure absorption of herbicides. **Glyphosate:** Apply a 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. Glyphosate is a non-selective systemic herbicide that may kill non-target partially-sprayed plants. **Triclopyr:** Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray

drift damage to non-target species. Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around Japanese barberry, triclopyr can be used without non-target damage.

Cut stump method should be considered when treating individual bushes or where the presence of desirable species precludes foliar application. Stump treatments can be used as long as the ground is not frozen. **Glyphosate:** Horizontally cut barberry stems at or near ground level. Immediately apply a 25% solution of glyphosate and water to the cut stump, covering the outer 20% of the stump. **Triclopyr:** Horizontally cut barberry stems at or near ground level. Immediately apply a 25% solution of triclopyr and water to the cut stump, covering the outer 20% of the stump.

- F. Actions planned – Monitor for new plants
- G. Monitoring methods – Monitor for resprouts in 2008
- H. References

Southeast Exotic Pest Plant Council, Japanese barberry (Updated October 24, 2000)

Broussonettia papyrifera

common name: paper mulberry

- A. Current distribution on site – Paper mulberry grows along both sides of the road around the bend from the Nursery. This area had been brushhogged at one point but the trees resprouted and are now over ten feet tall.
- B. Damage and threats – Paper mulberry can form dense stands and it is very difficult to eradicate once established.
- C. Methods of reproduction and dispersal – Fruits are bird-dispersed.
- D. Goals - To eliminate paper mulberry from the Arboretum.
- E. Management options

Manual removal/hand pulling of young seedlings can be an effective control. Seedlings quickly develop a long tap root and are difficult to remove unless in sandy soils. Seedlings are best pulled after a rain when the soil is loose. Larger stems can be removed using a weed wrench. The entire root must be removed since broken fragments may resprout.

Foliar spray method can be effective for isolated small trees where non-target effects would be minimal. Air temperatures should be above 17 degrees C to ensure that herbicides are absorbed. Trees can be sprayed in summer to early fall, but mulberries do not hold their leaves late in fall. **Glyphosate** (brand name Roundup): A 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. (Roundup is a non-selective herbicide. **Triclopyr** (brand name Garlon, Pathfinder II and others): A 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant, sprayed to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. (Triclopyr is a selective herbicide for broadleaf species only.)

Cut stump method should be considered when treating individual trees or where the presence of desirable species precludes foliar application. This treatment can be applied as long as the ground is not frozen. Immediately after cutting stems at or near ground level, apply a 25% solution of glyphosate and water or triclopyr and water to the cut stump, being careful to cover the entire surface. Effectiveness of the herbicide is increased if holes are cut in the top of the freshly felled stump, to hold the herbicide in for better absorption by the plant.

Basal bark method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the shrub

to a height of 12-15 inches from the ground. Thorough wetting is necessary for good control; spray until run-off is just noticeable at the ground line.

- F. Actions planned – Cut and stump treat trees. This area is also covered in vines and will require a significant amount of effort. May be a good group project site.
- G. Monitoring methods – Monitor for resprouts after treatment.
- H. References

Celastrus orbiculatus

common name: Oriental bittersweet

- A. Current distribution on site - This species is located along most of the meadow edges at the Arboretum and in thickets. Seedlings are often found along path edges.
- B. Damage and threats - Oriental bittersweet is an aggressive invader that threatens all vegetation levels of forested and open areas. It grows over other vegetation, completely covering it, and kills other plants by preventing photosynthesis, girdling and uprooting by force of its massive weight. In the northeastern United States, exotic Oriental bittersweet appears to be displacing the native climbing bittersweet, *Celastrus scandens*, which occurs in similar habitats, through competition and hybridization.
- C. Methods of reproduction and dispersal - Oriental bittersweet reproduces prolifically by seed, which is readily dispersed to new areas by many species of birds. Its seeds germinate in late spring in partial to dense shade. It also expands vegetatively by stolons (above-ground stems) and rhizomes (underground stems) and through root suckering, the ability to send shoots up from the roots.
- D. Goals - To continue the control measures started in January 2001 to remove Oriental bittersweet from woodland edges and path edges.
- E. Management options - Since Oriental bittersweet produces numerous seeds, extensive seed reserves can become established in the soil within a year or two. Seeds of Oriental bittersweet remain viable for several years and control actions must continue until seed sources are eliminated.

Cut climbing or trailing vines as close to the root collar as possible. This technique is feasible on small populations; as a pretreatment on large impenetrable sites; in areas where herbicide cannot be used; or if labor resources are not sufficient to adequately implement herbicidal control. This treatment will prevent seed production and strangulation of surrounding woody vegetation. Oriental bittersweet will resprout unless cut so frequently that its root stores are exhausted. Treatment should begin early in the growing season and be repeated at two-week intervals until autumn.

Grubbing is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski or similar digging tool, remove the entire plant, including all roots and runners. Juvenile plants can be hand pulled depending on soil conditions and root development. Any portions of the root system not removed will potentially resprout. All plant parts, including mature fruit, should be bagged and disposed of in a trash dumpster to prevent reestablishment.

Stump treatment should be used in areas where vines are established within or around non-target plants or where vines have grown into the canopy. **Glyphosate**: cut the stem 2

inches above ground level. Immediately apply a 25% solution of glyphosate and water to the cross-section of the stem. This procedure is effective at temperatures (as low as 40 degrees F) and may require a subsequent foliar application of glyphosate. **Triclopyr:** cut the stem 2 inches above ground level. Immediately apply a 25% solution of triclopyr and water to the cross-section of the stem. This procedure remains effective at low temperatures (<60 degrees F) as long as the ground is not frozen. A subsequent foliar application may be necessary to control new seedlings.

Foliar spray method can be used to control large populations. It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. **Glyphosate:** Apply a 2% solution of glyphosate and water plus 0.5% non-ionic surfactant to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. Glyphosate is a non-selective systemic herbicide that may kill non-target partially sprayed plants. Ambient air temperature should be above 65 degrees F. **Triclopyr:** Apply a 2% solution of triclopyr and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. The ideal time to spray is after surrounding native vegetation has become dormant (October - November) to avoid affecting non-target species. A 0.5% concentration of a non-ionic surfactant is recommended in order to penetrate leaf cuticle. Ambient air temperature should be above 65 degrees F.

- F. Actions planned – Spray dense stands of *Celastrus* along meadow edges. Cut vines from around trees. Monitor for new plants along woods paths.
- G. Monitoring methods – Revisit treated sites in summer of following year. Scout for seedlings along woods paths and hand pull or dig out.
- H. References

Plant Conservation Alliance, Alien Plant Work Group, Carol Bergmann, Montgomery County Department of Parks, Silver Spring, MD and Jil M. Swearingen, U.S. National Park Service (last updated 3/2/99)

Southeast Exotic Pest Plant Council, *Celastrus orbiculatus* (Updated October 24, 2000)

The Nature Conservancy, Element Stewardship Abstract for *Celastrus orbiculatus*, Glenn D. Dreyer, (5-3-94)

Centaurea biebersteinii

common name: spotted knapweed

- A. Current distribution on site - This species is located in various locations in the North Meadow, particularly at the southwestern edge of the meadow and in the very sandy section on the southern edge. It is also near the beginning of the path from the parking lot to the North Meadow and at the edge of the Little Meadow by the visitor's center.
- B. Damage and threats - Spotted knapweed colonizes disturbed areas. Once established it may infest neighboring habitats that are relatively undisturbed or in good condition. Infestation generally leads to a decline in biodiversity, because the invasive plant chokes out native vegetation. The root system of this plant does not hold soil as well as native vegetation. Studies have monitored a significant loss of soil on sites infested with this species compared to sites with native vegetation.
- C. Methods of reproduction and dispersal - Spotted knapweed grows in dry sterile, gravelly, or sandy openings such as pastures, old fields and roadsides. It is a biennial or short-lived perennial in the aster family. Spread primarily through passive seed dispersal generally occurring in late summer (but may continue through the fall, winter and spring). Dispersal distances are relatively short, with seeds falling close to the parent plant. Seeds germinate in the fall and early spring. Research has shown that 30% of seeds may be viable after eight years of burial. Seedlings form rosettes which may produce 1-7 flowering stems the following spring. Plants may flower only once, or up to three years in succession. Flowers open from late June through early August. Lateral root-sprouting may result in rosettes that may remain attached to the parent for an indefinite length of time, but expansion of a colony is primarily dependent upon seed production.
- D. Goals - To continue to control and reduce the population of spotted knapweed and to identify any new locations not controlled. Control began in 2000.
- E. Management options

Manual removal by hand-pulling, grubbing and clipping early in the flower stage may control spotted knapweed. This process must be repeated over several years. Plants are less likely to sprout or regrow if allowed to bolt before cutting. Although labor intensive, hand-cutting will ensure that all flower buds are destroyed.

Mowing is a method of control that can be used in areas with little or no other vegetation. If mowed in the early flowering state, the plants will usually regrow and produce abundant late season seeds. Those mowed even the same day as florets appear out of the bud have enough energy to produce seed. The optimal time for mowing is just after most flowering has ended but before seeds have matured. This would make regrowth unlikely since moisture levels late in the season are probably too low for continued growth, but would offer a possible advantage of reducing reserves for flowering the following year.

Research has shown that mowing does reduce the amount of seed produced but a well established seed bank, most likely compensates for this loss. Mowing would probably be a way to control populations, but not eradicate them.

Prescribed burns may reduce established stands of knapweed. A follow-up of selective pulling and digging will further reduce populations. Annual burns have reduced populations by 5-90% and may be correlated with burn intensity. Single, low intensity burns may actually worsen the problem since it is not hot enough to prevent resprouting and seed germination. Additionally, fires may disturb the area promoting colonization.

Herbicides can be useful in the control of *Centaurea maculosa* but there are problems associated with these chemicals. Picloram and 2,4-D have been used. Control by 2,4-D is temporary, since it does not prevent germination from seeds in the soil. Picloram persists in soils but in 4 years, enough is lost to allow germination and reinfestation. When using chemical applications, the area around the *Centaurea maculosa* colonies must be treated also. Follow-up treatments are extremely important for the continual control of spotted knapweed.

- F. Actions planned - As plant colonies in the North and South Meadow are identified in June through August, **manual removal** as started in 2000 will be continued while plants are flowering. Surveillance of the North and South meadows will continue through this time period, identifying plants to be removed. **Manual removal** will continue until it is apparent that the flowering is nearing completion. All handling of knapweed will be done with gloves due to possible skin irritation.
- G. Monitoring methods - Populations of *Centaurea maculosa* will be identified in the North and South Meadows and noted for removal June through August.
- H. References

The Nature Conservancy, Element Stewardship Abstract for *Centaurea maculosa*, Teresa Mauer, Mary J. Russo (revision), Margaret Evans (revision) (undated)

Invasive Alien Plant Species of Virginia, Fact Sheet, 5/99

Weed Notes: *Centaurea maculosa*, The Nature Conservancy, TunyaLee Morisawa, 6/28/99

Cirsium arvense

common name: Canada thistle

- A. Current distribution on site - This species was identified in the Vascular Plant Survey of Adkins Arboretum, Caroline County, Maryland, 1998,1999, Prepared by Janet Ebert and Jack Holt. Thistles appear along the bank of the wetland exhibit and along Eveland Road. These areas will be monitored.
- B. Damage and threats - Natural communities that are threatened by Canada thistle include non-forested plant communities such as prairies, barrens, savannas, glades, sand dunes, fields and meadows that have been impacted by disturbance. As it establishes itself in an area, Canada thistle crowds out and replaces native plants, changes the structure and species composition of natural plant communities and reduces plant and animal diversity. This highly invasive thistle prevents the coexistence of other plant species through shading, competition for soil resources and possibly through the release of chemical toxins poisonous to other plants. Canada thistle is declared a Noxious weed throughout the U.S. and has long been recognized as a major agricultural pest, costing tens of millions of dollars in direct crop losses annually and additional millions in costs for control. Only recently have the harmful impacts of Canada thistle to native species and natural ecosystems received notable attention.
- C. Methods of reproduction and dispersal - Canada thistle produces an abundance of bristly-plumed seeds which are easily dispersed by the wind. Most of the seeds germinate within a year, but some may remain viable in the soil for up to 20 years or more. Vegetative reproduction in Canada thistle is aided by a fibrous taproot capable of sending out lateral roots as deep as 3 feet below ground, and from which shoots sprout up at frequent intervals. It also readily regenerates from root fragments less than an inch in length.
- D. Goals - To identify any locations of *Cirsium arvense* on the Arboretum grounds and to remove the verified plants.
- E. Management options

Management of Canada thistle can be achieved through **hand-cutting**, **mowing**, **controlled burning**, and **chemical treatment**, depending on the level of infestation and the type of area being managed. Due to its perennial nature, entire plants must be killed in order to prevent regrowth from rootstock. **Hand-cutting** of individual plants or **mowing** of larger infestations should be conducted prior to seed set and must be repeated until the starch reserves in the roots are exhausted. Because early season burning of Canada thistle can stimulate its growth and flowering, controlled burns should be carried out late in the growing season for best effect.

In natural areas where Canada thistle is interspersed with desirable native plants, targeted application of a systemic herbicide such as glyphosate (e.g. Roundup or Rodeo), which

carries plant toxins to the roots, may be effective. For extensive infestations in disturbed areas with little desirable vegetation, broad application of this type herbicide may be the most effective method. Repeated applications are usually necessary due to the long life of seeds stored in the soil.

F. Actions planned

A few small colonies of thistles occasionally appear. These can be dug out or treated with Roundup or Rodeo depending upon their location.

G. Monitoring methods

Thistles are particularly visible when flowering in mid-summer. Open areas of the Arboretum should be monitored for new populations.

H. References

Plant Conservation Alliance, Alien Plant Work Group, by Gwendolyn Thunhorst, The Nature Conservancy and Jil M. Swearingen, National Park Service, Washington, DC, (last updated 1997)

The Nature Conservancy, Element Stewardship Abstract for *Cirsium arvense*, Victoria Nuzzo, (6-23-97)

Hedera sp.

common name: Ivy

- A. Current distribution on site - This species is located adjacent to the intersection of the Tuckahoe Valley and the Upland Walk. It is primarily on the ground.
- B. Damage and threats - English ivy is very drought tolerant once it is established. It out competes both grasses, herbs and trees.
- C. Methods of reproduction and dispersal - English ivy can grow throughout the year if temperatures stay relatively warm. Seeds are often spread by birds and yard waste that is dumped at woodlands edges can quickly root and become established.
- D. Goals - To eradicate the existing population.
- E. Management options

Cutting is successful with persistence but does not always kill the plant. Used in combination with application of herbicide generally provide better control. Immediately control English ivy that is growing up trees by cutting the vine at waist height, loosening the vine around the limbs and removing the roots. If the root can not be removed by hand, strip the bark and notch the exposed section of the vine. Paint on an undiluted herbicide such as glyphosate

Digging and/or pulling plants by hand or with pliers provides immediate control with little regrowth.

Foliar spray method is generally not effective due to the wax layer on the leaves which often prevents herbicides from permeating the leaves.

- F. Actions planned – Remaining plants will be pulled or dug out, bagged and placed in the trash.
- G. Monitoring methods – The area will be monitored once a year for any resprouts.
- H. References

The Nature Conservancy, Weed Notes, TunyaLee Morisawa, 6/30/99

Lespedeza sericea

common name: sericea lespedeza

- A. Current distribution on site - This species is located along the edges of the South Meadow, in the wetland exhibit, along the berms by the main entrance and in scattered other open areas around the Arboretum.
- B. Damage and threats - Lespedeza is primarily a threat to open areas such as meadows, prairies, open woodlands, wetland borders and fields. Once it gains a foothold, it can crowd out native plants and develop an extensive seed bank in the soil, ensuring its long residence at a site. Established dense stands of lespedeza suppress native flora and its high tannin content make it unpalatable to native wildlife.
- C. Methods of reproduction and dispersal - Chinese lespedeza begins growth from root crown buds at the base of last year's stem. The flowers begin to develop in late July and continue through October. There are no specialized structures for seed dispersal. Dispersal is aided by animals consuming the fruits and passing the seeds. A study on natural populations found that several species of Lespedeza comprise 1.5% to 86.8% of the annual diet of bobwhite quail in the Southeastern U.S. Autumn dispersal is aided by the haying of infested fields. Scarification is necessary for the germination of lespedeza seeds. Mature seeds of this genus remain viable for up to twenty years; one study found a germination rate of 60% after cold storage for 55 years. Seedlings may represent only 1% of the seeds actually available in the soil.
- D. Goals - To continue attempts to control and minimize the amount of Lespedeza on the Arboretum grounds. Attempts were initiated in 1999 and 2000 with various rates of success. Control measures used included cutting stems and applying concentrated Round Up and applying a foliar application of the herbicide - Ally. The county has sprayed areas of Lespedeza with Ally which has killed plants but not eliminated regrowth from the seed bank. Plants in the wetland are controlled by spraying with Rodeo or treating cut stems with Rodeo.
- E. Management options

Mechanical and chemical methods are the most effective options currently available for Lespedeza. **Hand pulling** is impractical due to lespedeza's extensive perennial root system. **Mowing** plants in the flower bud stage for two or three consecutive years may reduce the vigor of lespedeza stands and control further spread. Plants should be cut as low to the ground as possible and impact to adjacent native plants should be minimized as much as possible.

Herbicide treatments should be completed in early to mid summer, since root reserves increase up to the flower bud stage. The addition of a non-ionic surfactant at a concentration of 0.5% improves the effectiveness of foliar treatments. Triclopyr (Garlon 4, Turflon ester, Access, Remedy) and clopyralid have been shown to be effective in

controlling Lespedeza. A 2% solution Triclopyr or 0.5% solution of clopyralid throughly mixed with water is effective during the vegetative stage prior to branching and during flowering. Treatments should cover the leaves and stems of plants to the point of runoff. These herbicides are not labeled for use in wet areas or adjacent to streams. On wet sites, a 2% solution of glyphosate is effective from last of June until seed set. In early September 2000, the Caroline County Weed Control Program tested Ally on an area of Lespedeza. While dieback of the plants was not evident at that time, the following growing season we have seen some plants that have not comeback and many that have been delayed in resprouting.

F. Actions planned

Lespedeza is located throughout various and diverse Arboretum open areas. Dense patches will be sprayed with Ally or Roundup in July –August. Small areas can be hand treated by coating the stalks with herbicide or cutting stems and applying herbicide.

G. Monitoring methods

Monitor treated areas for regrowth and monitor open areas for new populations.

H. References

Plant Conservation Alliance, Alien Plant Work Group, Tom Remaley, Great Smoky Mountains National Park, Gatlinburg, TN and edited by Jil M. Swearingen, National Park Service, Washington, DC, (last updated 6/25/98)

Lolium arundinaceum

Common name: tall fescue

- A. Current distribution on site – Tall fescue or ryegrass is found on the banks of the marsh and in the Little Meadow.
- B. Damage and threats – Tall fescue is an aggressive grass that spread from lawn areas. It is a cool season grass staying green through the winter and going dormant in summer heat and drought. Where it grows densely it inhibits the growth of other early successional species.
- C. Methods of reproduction and dispersal – Tall fescue spreads by underground rhizomes and by seed. At the Arboretum it mainly occurs in areas that had been planted with fescue originally.
- D. Goals – To reduce the presence of tall fescue around the marsh edges and in the Little Meadow.
- E. Management options
 - Manual removal/Hand pulling** – Small clumps can be pulled up by hand and larger clumps can be dug out.
 - Foliar spray** – Because this grass grows actively when most native plants are dormant, it can be sprayed using 2 % solution of glyphosate in late fall – early spring.
- F. Actions planned – Spray clumps of tall fescue in the meadow and around the wetland edge. Remove by hand clumps from the edge of the garden to avoid spraying garden plants.
- G. Monitoring methods – Look for new occurrences in fall – early spring.
- H. References

Kaufman and Kaufman. 2007. Invasive Plants. Stackpole Books, Mechanicsburg.

Ligustrum vulgare

common name: common privet

- A. Current distribution on site - This species was identified in the Vascular Plant Survey of Adkins Arboretum, Caroline County, Maryland, 1998,1999, Prepared by Janet Ebert and Jack Holt. A few plants were found in 2007 in the young forest south of Piney Branch near Eveland Road.
- B. Damage and threats - *Ligustrum vulgare* can form dense thickets that out compete native vegetation. It has the potential to invade natural areas such as floodplain forests, woodlands, and disturbed agricultural fields. They generally expand along fence-rows, windbreaks and roadsides. Forest gaps can also become invaded since birds often disperse *Ligustrum* seeds.
- C. Methods of reproduction and dispersal - *Ligustrum vulgare* is a perennial shrub that grows readily from seed or from root and stump sprouts. It can escape from cultivation when the fruits are consumed by wildlife, particularly birds, which often excrete the seeds unharmed at distant locations where they may germinate and become established. Reported seed germination rates vary greatly - from 5-27% to as high as 77%. The leaves are high in phenolic compounds that defend against herbivores, especially insects. These work by inhibiting digestive enzymes and proteins. *Ligustrum vulgare* grows well in high light, low nutrient soils, but will tolerate lower light levels if nutrients are increased.
- D. Goals - To identify the location of *Ligustrum vulgare* and initiate control measures.
- E. Management options

Mowing and cutting are appropriate for small populations or environmentally sensitive areas where herbicides cannot be used. Stems should be cut at least once per growing season as close to ground level as possible. Repeated mowing or cutting will control the spread of *Ligustrum*, but may not eradicate it.

Manual removal/hand pulling of young seedlings can be an effective control. Plants should be pulled as soon as they are large enough to grasp but before they produce seeds. Seedlings are best pulled after a rain when the soil is loose. Larger stems can be removed using a weed wrench. The entire root must be removed since broken fragments may resprout.

Foliar spray method can be effective for large thickets of *Ligustrum* where risk to non-target species is minimal. Air temperatures should be above 17 degrees C to ensure that herbicides are absorbed. The ideal time to treat is while plants are in leaf in late autumn or early spring but when many native species are dormant. **Glyphosate** (brand name

Roundup): A 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. (Roundup is a non-selective herbicide. **Triclopyr** (brand name Garlon, Pathfinder II and others): A 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant, sprayed to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. (Triclopyr is a selective herbicide for broadleaf species only.)

Cut stump method should be considered when treating individual shrubs or where the presence of desirable species precludes foliar application. This treatment can be applied as long as the ground is not frozen. Immediately after cutting stems at or near ground level, apply a 25% solution of glyphosate and water or triclopyr and water to the cut stump, being careful to cover the entire surface. Effectiveness of the herbicide is increased if holes are cut in the top of the freshly felled stump, to hold the herbicide in for better absorption by the plant.

- F. Actions planned – Remove existing plants by cutting and treating cut stumps with herbicide.
- G. Monitoring methods – Monitor for resprouts.
- H. References

Southeast Exotic Pest Plant Council, *Ligustrum* spp. (Updated October 24, 2000)

The Nature Conservancy, Element Stewardship Abstract for *Ligustrum* spp, Michael S. Batcher, (August 2000)

Lonicera japonica

common name: Japanese honeysuckle

- A. Current distribution on site - This species is located throughout the Arboretum property but is primarily concentrated along the interface between the woodland edge and the open meadows.
- B. Damage and threats - Where light levels are optimal, such as in forest edges, canopy gaps or under sparse, open forest, newly established Japanese honeysuckle vines grow and spread rapidly. Suppressed vines growing in dense shade, however, are capable of rapid growth and spread when light levels in a habitat are increased by disturbance. In forests, Japanese honeysuckle vines spread both vertically and horizontally by climbing up tree trunks and/or trailing or clambering over the forest floor and associated vegetation. Trailing vines produce stolons which root when they contact soil, aiding the vegetative spread and persistence of the species. Dense, strangling growths of Japanese honeysuckle can impact desirable vegetation by decreasing light availability within the habitat, depleting soil moisture and nutrients, or by toppling upright stems through the sheer weight of accumulated vines. Negative effects of Japanese honeysuckle invasion include development of malformed trunks in trees, suppression of plant growth, inhibition of regeneration in woody and herbaceous plants, and alteration of habitats used by native wildlife. The semi-evergreen condition of this honeysuckle allows for growth both prior to and after dormancy of other deciduous plants. Although this prolonged growth period is beneficial to the plant, it is also beneficial in controlling the plant.
- C. Methods of reproduction and dispersal - *Lonicera japonica* is spread primarily by birds, which consume the fruits and pass the seeds, carrying and disseminating them over great distances. It readily roots from cuttings and where the stem touches the soil.
- D. Goals - To significantly reduce the amount of *Lonicera japonica* along the woodland edges. To remove *Lonicera* from woodland path edges.
- E. Management options

Manual removal, by hand pulling, grubbing with a hoe or shovel, can be used to control small populations if done carefully and the entire vine and root are removed.

Mowing twice a year can slow vegetative growth, however due to vigorous resprouting, stem density is likely to increase.

Foliar spraying using **glyphosate** is the recommended treatment. A 2% solution (2.6 oz of Roundup/gallon water) applied as a spray to the foliage will effectively eradicate Japanese honeysuckle. The herbicide should be applied after surrounding vegetation has become dormant in autumn but before a hard freeze (25 degrees F). Timing of the application is critical to effectiveness, in general, applying herbicide shortly after the first

killing frost (most effective within 2 days), and before the first hard freeze. Glyphosate should be applied carefully by hand sprayer and spray coverage should be uniform and complete. Do not spray so heavily that the herbicide drips off the target species. Retreatment may be necessary for plants that are missed because of dense growth. Although glyphosate is effective when used during the growing season, use at this time is not recommended in natural areas because of the potential harm to non-target plants. Foliar application of herbicides will be less effective prior to early summer (July 4) because early season shoot elongation will limit the transfer of chemical to the root system. Glyphosate is non-selective, so care should be taken to avoid contacting non-target species. Non-target plants will be important in recolonizing the site after Japanese honeysuckle is controlled. **Crossbow**, a formulation of triclopyr and 2,4-D is also a very effective herbicide that controls Japanese honeysuckle. Crossbow should be mixed according to label instructions for foliar application and applied as a foliar spray. It may be applied at dormant periods, like glyphosate, and precautions given above for glyphosate should be followed when using Crossbow. Either herbicide should be applied while backing away from the treated areas to avoid walking through the wet herbicide. Garlon 3A and Garlon 4 (triclopyr) are also effective in foliar applications. Combining **burning** and **herbicides** may prove to be more effective than either method by itself if late autumn or winter burns are used to reduce Japanese honeysuckle biomass and all resprouts are then treated with a foliar application of glyphosate about a month after they emerge. **Prescribed burns** may also be used to help prevent spread of Japanese honeysuckle because seedlings and young plants are most susceptible to fires.

Mechanical cutting of aerial vines, followed by cut-surface herbicide treatment can be effective and minimizes the risk of spray drift. Undiluted Garlon 4 or a 20% solution of Roundup should be applied to cut stems immediately following cutting.

- F. Actions planned - In 2001, Japanese honeysuckle along the woodland edge of the South Meadow will be targeted for removal using a combination of **foliar spraying of Roundup** and **mowing**, while other areas will be treated with **foliar spraying of Roundup** only. This will allow us to determine if mowing prior to spraying causes any effect. **Mowing** will be done in early October in the designated areas and **foliar spraying of a 2% solution (2.6 oz of Roundup/gallon water)** will be applied in all areas to be treated within one week of the first killing frost.
- G. Monitoring methods - Populations of *Lonicera japonica* to be treated will be identified along the woodland edge of the South Meadow and marked for treatment. Photographs will be taken prior to treatment. Visual observations and approximate size of the population will be recorded and added to this document prior to removal.
- H. Populations of *Lonicera japonica* to be treated in 2001 will be located on the Arboretum Site Map, along with GPS locations. Additional populations of *Lonicera japonica* will be noted for subsequent treatment. Photographs will be added to this document as specified above.
- I. References

The Nature Conservancy, Element Stewardship Abstract for *Lonicera japonica*, Victoria Nuzzo, edited by John M. Randall (last updated April 15, 1997)

Invasive Alien Plant Species of Virginia, Fact Sheet, undated

Lonicera tatarica

common name: Amur honeysuckle

- A. Current distribution on site – A large stand of this shrub occurs between the nursery and the nursery road. Scattered shrubs also grow between the nursery road and the service entrance.
- B. Damage and threats – Amur honeysuckle forms dense stands excluding other vegetation and spreading rapidly.
- C. Methods of reproduction and dispersal – Fruits are bird-dispersed. They ripen in mid-summer – early fall.
- D. Goals - To eliminate Amur honeysuckle from the Arboretum.
- E. Management options

Manual removal/hand pulling of young seedlings can be an effective control. Seedlings are best pulled after a rain when the soil is loose. Larger stems can be removed using a weed wrench. The entire root must be removed since broken fragments may resprout.

Foliar spray method can be effective for small shrubs where non-target effects would be minimal. Air temperatures should be above 17 degrees C to ensure that herbicides are absorbed. Shrubs can be sprayed late fall when most other plants are dormant. **Glyphosate** (brand name Roundup): A 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. (Roundup is a non-selective herbicide. **Triclopyr** (brand name Garlon, Pathfinder II and others): A 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant, sprayed to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. (Triclopyr is a selective herbicide for broadleaf species only.)

Cut stump method should be considered when treating individual plants or where the presence of desirable species precludes foliar application. This treatment can be applied as long as the ground is not frozen. Immediately after cutting stems at or near ground level, apply a 25% solution of glyphosate and water or triclopyr and water to the cut stump, being careful to cover the entire surface. Effectiveness of the herbicide is increased if holes are cut in the top of the freshly felled stump, to hold the herbicide in for better absorption by the plant.

Basal bark method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the shrub

to a height of 12-15 inches from the ground. Thorough wetting is necessary for good control; spray until run-off is just noticeable at the ground line.

F. Actions planned – Cut and stump treat shrubs or use basal bark application.

G. Monitoring methods – Monitor for resprouts after treatment.

H. References

Morus alba

common name: white mulberry

- A. Current distribution on site – Mulberries occur in the open areas and woodland edges at the Arboretum.
- B. Damage and threats – Mulberry trees grow rapidly in open areas. They need to be removed to maintain meadow vegetation and should be removed from thickets to allow other native species to grow.
- C. Methods of reproduction and dispersal – Bird dispersed fruits mature in mid-summer.
- D. Goals - To significantly reduce the existing number of trees and prevent them from reaching maturity.
- E. Management options

Manual removal/hand pulling of young seedlings can be an effective control. Seedlings quickly develop a long tap root and are difficult to remove unless in sandy soils. Seedlings are best pulled after a rain when the soil is loose. Larger stems can be removed using a weed wrench. The entire root must be removed since broken fragments may resprout.

Foliar spray method can be effective for isolated small trees where non-target effects would be minimal. Air temperatures should be above 17 degrees C to ensure that herbicides are absorbed. Trees can be sprayed in summer to early fall, but mulberries do not hold their leaves late in fall. **Glyphosate** (brand name Roundup): A 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. (Roundup is a non-selective herbicide. **Triclopyr** (brand name Garlon, Pathfinder II and others): A 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant, sprayed to thoroughly wet all leaves. Use a low pressure and coarse spray pattern to reduce spray drift damage to non-target species. (Triclopyr is a selective herbicide for broadleaf species only.)

Cut stump method should be considered when treating individual trees or where the presence of desirable species precludes foliar application. This treatment can be applied as long as the ground is not frozen. Immediately after cutting stems at or near ground level, apply a 25% solution of glyphosate and water or triclopyr and water to the cut stump, being careful to cover the entire surface. Effectiveness of the herbicide is increased if holes are cut in the top of the freshly felled stump, to hold the herbicide in for better absorption by the plant.

- F. Actions planned – Remove mulberries along berm, in meadows and along woodland edges on a yearly basis.

G. Monitoring methods – Sites will be monitored for regrowth yearly.

B. References

Phragmites australis

common name: common reed

- A. Current distribution on site - This species is located along the banks of the wetland exhibit. It has been in this location for several years and has been controlled by annual Fall spraying of Rodeo by Chesapeake Wildlife Heritage up to 2005. Populations are now small enough that they are treated by hand. Due to its location adjacent to the new wetland exhibit, it will be monitored closely to ensure that it does not spread further into the wetland.
- B. Damage and threats - Disturbances and stresses which favor invasion include: pollution, alteration of hydrologic regime, dredging, increased levels of nutrients and increased sedimentation. Dense, single-species stands of Phragmites up to 15 feet tall disrupt important habitat for native animal species and decrease overall biological diversity.
- C. Methods of reproduction and dispersal - Phragmites spreads rapidly mainly by rhizomes. Caution should be taken when grading is being done in and around Phragmites due to the easily relocated rhizomes which can become lodged in the tracks of construction equipment and disbursed throughout the construction area.
- D. Goals - To continue to manage the small patches of Phragmites around the new wetland exhibit and to keep any new populations from becoming established in the new wetland exhibit.
- E. Management options

Cutting or mowing is generally not successful in eradicating Phragmites, but can be useful to eliminate any fire hazard potential and to control the spread of Phragmites. Cutting Phragmites at the wrong time may actually stimulate growth and increase the density of the plant. Cutting at the end of the growing season or in winter can increase density. Cutting after tasseling (flowering - before the end of July) may produce the most stress on the plants. This regime may eliminate a colony if carried out annually for several years. Care must be taken to remove cut shoots to prevent their sprouting and forming stolons. Hand cut material should be bagged and removed from the site.

Prescribed burning does not reduce the growing ability of Phragmites unless **Root Burn** occurs. Root burn seldom occurs, however, because the rhizomes are usually covered by a layer of soil, mud and/or water. Burning does remove accumulated Phragmites leaf litter, giving the seeds of another species area to germinate. Prescribed burning has been used with success after chemical treatment for this purpose. Winter and spring burning may actually stimulate growth, whereas mid- to late summer burns may be effective. It may be that late summer burns are more likely to penetrate roots and affect the plant at the most vulnerable time (when it is moving nutrients from above ground to roots).

Flooding can control Phragmites if the rhizome is covered with water for four months during the growing season.

Herbicide application of Rodeo, a nonselective herbicide, kills all grasses and broad-leaved emergents. It degrades quickly into natural products, so in testing it has been found to be virtually non-toxic to aquatic animals. Rodeo should be applied after the Phragmites has tasseled (late July to late August) when the plant is supplying nutrients to the rhizome. At this time, when Rodeo is sprayed onto the foliage of aquatic weeds, it translocates into the roots. Rodeo interferes with essential plant growth processes, causing gradual wilting, yellowing, browning and deterioration of the plant. Rodeo must be mixed with water and a surfactant which allows it to stick to and subsequently be absorbed by the plant. Instructions for application, amounts needed per acre, the approved surfactants and ratios for mixing, are on the Rodeo label. Glyphosate must be mixed with clean or, if possible, distilled water because it binds tightly to sediments and is thus rendered non-toxic to plants. Rodeo should not be applied in windy conditions, as the spray will drift. It also should not be applied if rain is forecast within 12 hours because it will wash away before it has a chance to act. Rodeo can be applied by backpack sprayers and wick applicators.

- F. Actions planned - The existing colonies around the perimeter of the new wetland exhibit have been **herbicided** by Chesapeake Wildlife Heritage for the past several years and will be continued in 2001. Spraying will be applied from mid-August to early September. Additionally, tassels will be **cut** and removed from these plants in late July. The wetland exhibit area will be monitored monthly (from May to October) for any signs of the Phragmites australis becoming established.
- G. Monitoring methods – Monitor in early summer for resprouts of Phragmites.
- H. References

The Nature Conservancy, Element Stewardship Abstract for Phragmites australis, Marianne Marks, Beth Lapin and John Randall (undated)

Massachusetts Audubon Society, Phragmites: Controlling the All-Too-Common Common Reed, Massachusetts Wetlands Restoration Technical Notes, Technical Note Number 1, April 1995, Prepared by: Ralph Tiner

Polygonum cuspidatum

common name: Japanese knotweed

- A. Current distribution on site - This species is located along the Arboretum perimeter at Eveland Road at the Blockston Branch, Piney Branch, and a culvert by the pine plantation. This location is upstream from the newly restored wetland exhibit at the Visitor Center. The wetland exhibit will be monitored for closely for signs of this species.
- B. Damage and threats - Japanese knotweed spreads quickly to form dense thickets that exclude native vegetation and greatly alter natural ecosystems. It rapidly colonizes in riparian areas. Once established, populations are extremely persistent.
- C. Methods of reproduction and dispersal - Japanese knotweed spreads primarily by vegetative means with the help of its long, stout rhizomes. It is sometimes distributed by water and to a lesser extent by the wind.
- D. Goals - To significantly reduce the existing populations and to keep any new populations from becoming established in the new wetland exhibit area.
- E. Management options

Grubbing is effective for small initial populations or environmentally sensitive areas where herbicides cannot be used. Using a pulaski or similar digging tool, remove the entire plant including all roots and runners. Juvenile plants can be hand pulled depending on soil conditions and root development. Any portion of the root system not removed will potentially resprout. All plant parts (including mature fruit) should be bagged and disposed of in a trash dumpster to prevent reestablishment.

Cut stem treatment should be used in areas where plants are established within or around non-target plants. This treatment remains effective at low temperatures as long as the ground is not frozen. Cut the stem about 2 inches about ground level and immediately apply a 25% solution of glyphosate (e.g. Rodeo at the location at Blockston Branch). A subsequent foliar application of glyphosate may be required to control new seedlings and resprouts. Also, cutting the stalks as often as three times during the growing season will offset growth of the rhizomes. Cutting followed immediately by an application of glyphosate herbicide has been found to be most effective. This should be done in late August through September when plants are translocating material to their root system for the winter. Several years of treatment may be needed to ensure that the rhizomes have been exterminated.

Foliar spray method is used to control large populations. It may be necessary to precede foliar applications with stump treatments to reduce the risk of damaging non-target species. Apply a 2% solution of glyphosate and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. The ideal time to

spray is after surrounding vegetation has become dormant (October to November) to avoid affecting non-target species. A 0.5% non-ionic surfactant is recommended in order to penetrate the leaf cuticle and ambient air temperature should be above 65E F.

- F. Actions planned - The existing populations are cut in July before flowering and resprouts are sprayed with a 2% solution of glyphosate in early fall.
- G. Monitoring methods – Sites will be monitored for regrowth yearly.
- H. Locations are documented on the Native Plant Database.
- I. References

Plant Conservation Alliance, Alien Plant Work Group, Tom Remaley, Great Smoky Mountains National Park Gatlinburg, TN (last updated 9/9/99)

Invasive Alien Plant Species of Virginia, Fact Sheet, 12/97

Polygonum perfoliatum

common name: mile-a-minute vine

- A. Current distribution on site – Mile-a-minute-vine principally grows near the service entrance. There was a heavy infestation along the service entrance road going towards the nursery behind the large beech trees. A few plants also grew on the berm to the north of the service entrance. Another infestation grows along Quail run near the Nursery Road. Single plants have been found fruiting by the east bridge and on one of the nursery burn piles. It was first noticed in 2005.
- B. Damage and threats – This vine grows extremely quickly and produces abundant fruits. It can grow densely enough to overtop and outshade small trees and shrubs.
- C. Methods of reproduction and dispersal – This annual vine produces bird-dispersed fruits.
- D. Goals – To eradicate mile-a-minute vine from the Arboretum\.
- E. Management options

Hand pulling is effective for small initial populations or environmentally sensitive areas where herbicides cannot be used. Vines are easy to uproot in mid-summer before fruit set. Blankets of vines can be rolled up and disposed of in the dumpster.

Foliar spray method is used to control large stands. Apply a 1% solution of glyphosate and water to thoroughly wet all foliage. Do not apply so heavily that herbicide will drip off leaves. The ideal time to spray is just before fruit set when the vines are at their largest. Because vines can only be treated in summer there is a high risk of killing surrounding vegetation.

- F. Actions planned – Hand pulling is done every summer and new occurrences are watched for.
- G. Monitoring methods – Sites will be monitored for regrowth yearly.
- H. References

Rosa multiflora

common name: multiflora rose

- B. Current distribution on site - This species is located along the edge of the Upland Walk, opposite the Indian Village and various locations along the edge of the North Meadow and the South Meadow. *Rosa multiflora* seedlings regularly sprout up in the cultivated planting beds around the Visitor Center and adjacent to the parking area.
- C. Damage and threats - *Rosa multiflora* is extremely prolific and can form impenetrable thickets that exclude native plant species. It readily invades open woodlands, forest edges, successional fields and meadows - especially those areas that have been subjected to land disturbance. Results from studies done on multiflora rose suggest it is highly competitive for soil nutrients. It grows well in full sun or shade, loamy soils to eroded clay pans and on moist to dry sites.
- D. Methods of reproduction and dispersal - Multiflora rose reproduces by seed, root sprouts and by forming new plants that root from the tips of arching canes that contact the ground. Flowers emerge from May to July and the fruits develop in September through October. Fruits are readily sought after by birds which are the primary dispersers of its seed. It has been estimated that an average multiflora rose plant may produce a million seeds per year, which may remain viable in the soil for up to twenty years. Germination of multiflora rose seeds is enhanced by passing through the digestive tract of birds. Seedlings develop within 60 days at soil temperatures above freezing. Plants grow slowly for the first one or two years followed by rapid expansion through layering and root sprouts.
- E. Goals - To control known populations of *Rosa multiflora* and locating any unidentified populations.
- F. Management options

Mowing and cutting is appropriate for small initial populations or environmentally sensitive areas where herbicides cannot be used. Repeated mowing or cutting will control the spread of multiflora rose, but will not eradicate it. Stems should be cut at least once per growing season as close to ground level as possible. Hand cutting of established clumps is best done by 2 people, one holding the long canes back with a pitchfork and the other cutting the stems with loppers. Severe infestations of multiflora rose are effectively controlled if the treatment is repeated 3-6 times a year for 2-4 years.

Foliar spray method should be considered for large thickets of multiflora rose where risk to non-target species is minimal. Air temperature should be above 65 degrees F to ensure absorption of herbicides. This treatment has been successful but due to the long-lived stores of seed in the soil, follow up treatments are likely to be necessary.

Glyphosate: Apply a 2% solution of glyphosate and water plus a 0.5% non-ionic surfactant thoroughly wetting all leaves. Use a low pressure and coarse spray pattern to

reduce spray drift damage to non-target species. **Triclopyr:** Apply a 2% solution of triclopyr and water plus a 0.5% non-ionic surfactant to thoroughly wet all leaves. In areas where desirable grasses are growing under or around multiflora rose, triclopyr can be used without non-target damage.

Cut stump method should be considered when treating individual bushes or where the presence of desirable species preclude foliar application. This treatment remains effective at low temperatures as long as the ground is not frozen. This method is most effective if done late in the growing season. **Glyphosate:** Horizontally cut multiflora rose stems at or near ground level. Immediately apply a 25% solution of glyphosate and water to the cut stump making sure to cover the entire surface. **Triclopyr:** Horizontally cut multiflora rose stems at or near ground level. Immediately apply a 25% solution of triclopyr and water to the cut stump making sure the entire surface is covered.

Basal bark method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the shrub to a height of 12-15 inches from the ground. Thorough wetting is necessary for good control; spray until run-off is just noticeable at the ground line.

- G. Actions planned – Plants can be cut or bushhogged and resprouts sprayed with glyphosate or triclopyr. Cut stem treatments can be effective as well.
- H. Monitoring methods - The *Rosa multiflora* population adjacent to the Indian Village will be photographed prior to each treatment and approximately two weeks following each treatment. As stated above, the woodland edges and meadows will be monitored during the month of June to locate any additional populations. Visual observations and approximate size of the populations will be recorded and added to this document.
- I. Populations will be located on the Arboretum Site Map, along with their respective GPS locations. Photographs will be added to this document as specified above.
- J. References

Plant Conservation Alliance, Alien Plant Work Group, Carol Bergmann, Montgomery County Department of Parks, Silver Spring, MD and Jil M. Swearingen, U.S. National Park Service, Washington, DC (last updated 7/7/99)

The Nature Conservancy, Element Stewardship Abstract for *Rosa multiflora*, Nancy Eckardt, (7/24/87)

Appendix C: Meadow Plantings

South Meadow Planting 2000-2001

Sorghastrum nutans
Andropogon gerardii
Panicum virgatum
Andropogon virginicus
Schizachyrium scoparium
Bouteloua curtipendula
Monarda fistulosa
Aster spp.
Solidago spp.
Echinacea purpurea
Phlox paniculata
Coreopsis lanceolata
Coreopsis tinctoria
Chamaecrista fasciculata
Rudbeckia hirta

North Meadow Planting 2007

Andropogon virginicus
Chamaecrista fasciculata
Gaillardia aristata
Schizachyrium scoparium

Little Meadow Planting 2004

Scutellaria incana
Helenium autumnale
Baptisia australis
Anaphalis margaritaceae
Chrysopsis mariana
Heliopsis helianthoides
Asclepias tuberosa
Rudbeckia fulgida var. *fulgida*
Aquilegia canadensis
Liatriis spicata
Heterotheca subaxillaris
Aster ericoides
Symphiotrichum patens
Eupatorium rotundifolium
Solidago sempervirens
Solidago caesia

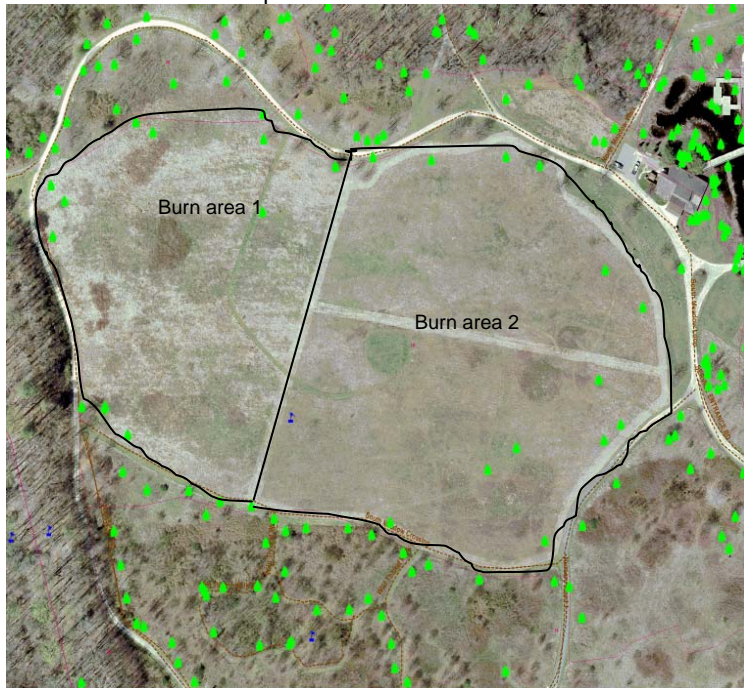
Entrance Road Planting 1988

Achillea millefolium
Centaurea cyanus
Rudbeckia hirta
Chrysanthemum leucanthemum
Cichorium intybus
Helianthus annuus
Aster novae-angliae
Verbascum thapsus
Daucus carota
Asclepias tuberosa
Chrysopsis mariana

North Meadow Burn Map



South Meadow Burn Map



Appendix D.

Hedgerow Planting Recommendations

Cornus amomum

Cornus florida

Diospyros virginiana

Hamamelis virginiana

Ilex opaca

Juniperus virginiana

Liquidambar styraciflua

Morella cerifera

Nyssa sylvatica

Pinus virginiana

Platanus occidentalis

Prunus serotina

Rhus copallinum

Sassafrass albidum

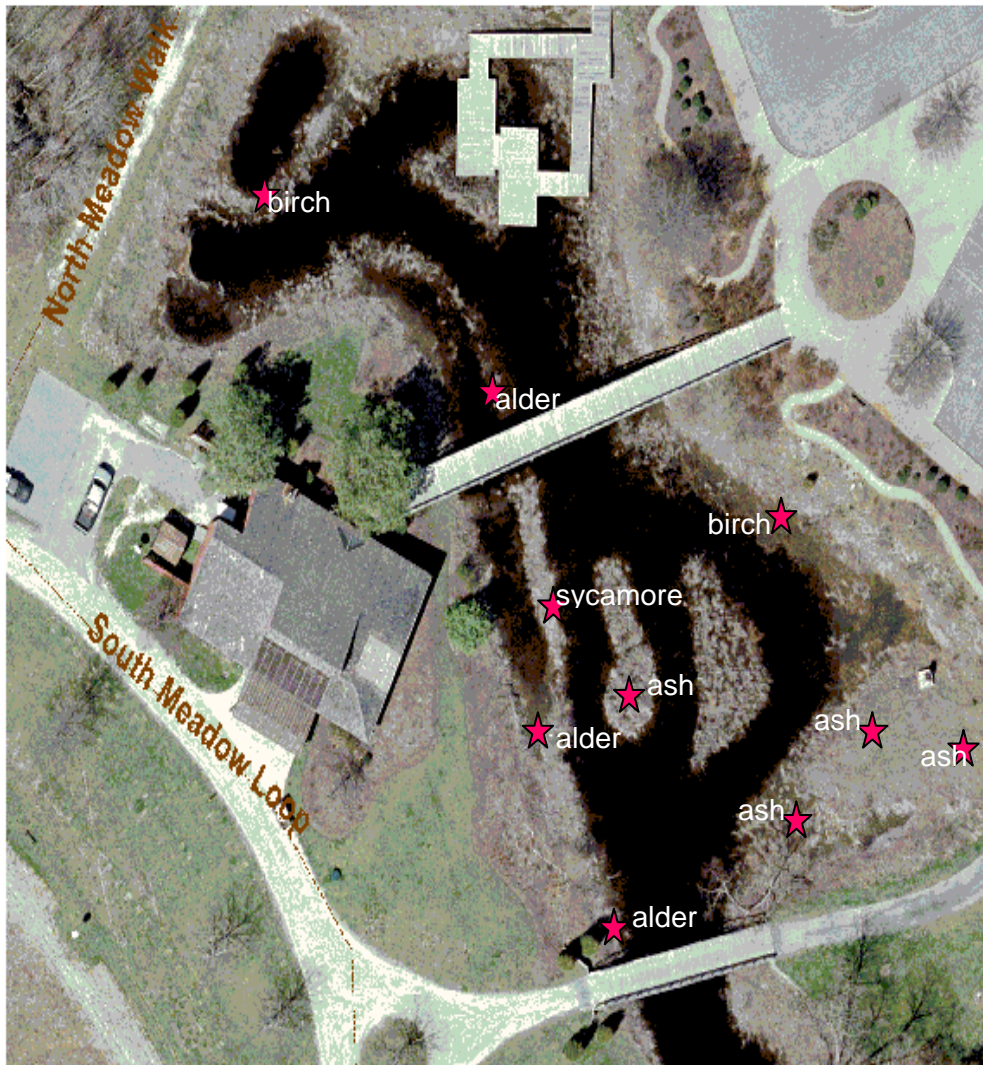
Viburnum dentatum

Appendix E. Map of marsh with locations of trees to be preserved.

Print of current map screen

11/30/2007

10:45:23AM



LEGEND

Thumpet Vine Area
Roads
Aerial Photo



Appedix F. Bog Planting list

2006

Sphagnum moss – Carnivorous Plant Nursery

Viola lanceolata – Carnivorous Plant Nursery

Polygala lutea – Carnivorous Plant Nursery

2007

Sphagnum moss - Adkins Arboretum (wild collected)

20 Sarracenia purpurea – Carnivorous Plant Nursery

5 Uvularia gibba – Carnivorous Plant Nursery

5 Lycopodium inundatum – Carnivorous Plant Nursery

5 Viola lanceolata – Carnivorous Plant Nursery

10 Vaccinium macrocarpus – Carnivorous Plant Nursery

5 Polygala lutea – Carnivorous Plant Nursery

3 Drosera intermedia – Carnivorous Plant Nursery

10 Drosera rotundifolia – Carnivorous Plant Nursery

Sphagnum moss – Carnivorous Plant Nursery

10 Vaccinium macrocarpus ‘Stevens’ – Virginia Berry Farm

4 Vaccinium corymbosum – nursery propagated

1 Rhododendron viscosum – Bobtown Nursery

8 Osmunda cinnamomea – nursery propagated

5 Itea virginica – nursery propagated

4 Vaccinium sp. – wild collected, Midshore II Landfill, Caroline Co.

An additional list of native bog plants can be found in the Bog Garden folder.